Appendix A

Approved Minutes of GSA BBASC Meetings

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Organizational Meeting
Tuesday, December 15, 2009 at 1:00 p.m.
GBRA – River Annex
Seguin, Texas

MINUTES

Welcome and Introductions
Bill West, General Manager for the Guadalupe-Blanco River Authority, welcomed the group to the meeting and thanked and encouraged the committee members' participation in this important process.

Members of the committee introduced themselves to the group, identifying their background and interest group they represent.

Discussion and agreement on agenda
Cory Horan, TCEQ, explained that the purpose of these meetings, in keeping with the intent of the legislation, was to allow the decision making process to be put in the hands of the Basin and Bay Stakeholders. He noted that while the TCEQ drafted the initial agenda with input from various members and other agency staff, it was the group's decision to approve the agenda and address items of concern to the group. It was requested that some additional background on the evolution of the environmental flows process in Texas be provided. Mr. West and committee member Robert Puente commented on some of the steps and background work that led to the passage of Article 1, SB3.

Overview of SB3 and role of the Basin and Bay Area Stakeholders
Cory Horan, TCEQ, gave an overview of the environmental flows timeline and process for this particular basin and bay system, referring to a flowchart that outlined the steps mandated by the legislation. He noted that the schedule for implementation of the SB3 process did not match the dates to which the group was appointed, but that the Environmental Flows Advisory Group can revise the schedule upon request. He then explained the various duties of the committee as outlined by the statute. These include:

- Formation of a Basin and Bay Expert Science Team (BBEST)
- Review and comments on the BBEST environmental flow recommendations
- Development of environmental flow recommendations and strategies to meet the environmental flow standards for submission to the TCEQ and the Environmental Flows Advisory Group
- The Stakeholder Committee was not subject to Government Code but meeting should be open to the public
- The Committee must operate on a consensus basis to the maximum extent possible

Report on funds available for Expert Science Team (BBEST) expenses
Nolan Raphelt, TWDB, explained the funding available for the members of the BBEST to perform their work, noting that a total of $228,000 was available to the BBEST for this Basin and Bay system. He distributed a handout which included scenarios of various BBEST expenditures based on the number and size of the BBEST selected.

Overview of the State Wide Science Advisory Committee (SAC) for Environmental Flows
Bob Huston, Chair of the SAC, gave a brief history on the Science Advisory Committee for environmental flows. He noted that the current group was the 3rd Advisory Committee, which was established under SB3. He encouraged the committee to review documents developed by the previous Science Advisory Committees from 2004 and 2006. Both documents are available on the TCEQ's environmental flows resources website located here: http://www.tceq.state.tx.us/permitting/water_supply/water_rights/eflows/resources.html
Mr. Huston explained the roles of the BBASC and BBEST, noting that the BBEST was only to consider available science while the BBASC would incorporate other factors into their recommendations. He stated that the primary responsibility of the SAC was to provide guidance, coordination and consistency among the various basin and bay groups, but the decision making process would be left to the individual basin and bay groups. He also noted that the SAC had developed several guidance documents for use by the BBESTs and stakeholders in the development of their environmental flow analysis and regimes. Those guidance documents can be found on the SAC website located here:
http://www.tceq.state.tx.us/permitting/water_supply/water_rights/eflows/txenvironmentalflowssac.html. Mr. Huston also discussed the makeup of the BBEST. He noted the challenges the group will face regarding time to complete their charge and funding availability. He suggested the committee consider a smaller sized group which would allow for easier scheduling of meetings, less use of budget, etc. He then noted that the SAC was to provide an overview of the BBEST recommendation reports to the Advisory Group, who would then provide comments to TCEQ.

Cory Horan then gave an overview of the websites developed to support the environmental flows process. He noted that there were websites set up for each basin and bay group, as well as one for the Advisory Group, the SAC, and a website containing resources to support the development of environmental flows. He also noted that e-mail groups were available that allow subscribers to be notified of upcoming meetings and any changes made to one of the environmental flows websites.

Overview of environmental flows
John Botros and Norman Boyd, both with TPWD, gave general presentations on the ecological function and importance of environmental flows, both instream flows and freshwater inflows respectively. Their presentations will be made available on the group's website located here: http://www.tceq.state.tx.us/permitting/water_supply/water_rights/eflows/guadalupe-sanantonio-bbsc

Elect Committee chair
The Committee elected both a chair and vice-chair. Suzanne Scott was nominated, seconded, and unanimously approved as committee chair. Diane Wassenich was nominated, seconded, and unanimously approved as committee vice-chair. Both Suzanne and Diane accepted the positions.

Set ground rules/operating procedures
The committee discussed various potential ground rules including the following:

- Organizational structure / group coordination
- The election of additional officers
- Quorum/Consensus
- The committee decision making process
- When will public input be taken at meetings

- How will the committee communicate with the members between meetings
- Do alternates need to be appointed

The group agreed to allow the committee chairs to draft an initial set of meeting rules, similar to rules set by other committees and various aspects of the group discussion, for discussion and consideration at the January meeting. The group will refine and finalize the meeting rules at that time.

Discuss nominations process for basin expert science team (BBEST)
The committee discussed the process for nominating and selecting members for the BBEST. The committee agreed to form a work group to discuss relevant disciplines that should be represented on the BBEST, schedule for accepting nominations, and to develop a nomination form and process for accepting nominations. The work group will hold a conference call to discuss various aspects of the BBEST nomination and selection process prior to the January meeting. The results of the conference call discussions will be presented to the committee as a whole for discussion at the January meeting. The committee will then finalize the process, seek nominations, and make selections at the February meeting.

Committee Vacancies
The committee discussed how to fill vacancies on the committee due to resignations of appointed members from the Commercial Fisheries and Recreational Water User categories. The group agreed to look at the candidates submitted for those two categories in the initial BBASC selection process. The TCEQ will forward the information on the various nominees who were not selected to serve on the BBASC the day following the meeting. Members agreed to review and comment on the number of available nominees for each category by December 22, 2009. If sufficient candidates are available the group agreed to fill the vacancies from that pool of nominees. The committee agreed that if there are not sufficient candidates to fill either category then the committee members can submit their own nominees to fill the vacancies. The candidates for both categories will be discussed at the January meeting.

Set next meeting
The next meeting was scheduled for Monday, January 11, 2009, to be held at the Invista facilities in Victoria, TX. The meeting will begin at 10:00 am and go through 3:00 pm. There will be a working lunch.

Items to be discussed include:

- Committee Vacancies
- Ground Rules
- BBEST Selection

Meeting Adjourned

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Monday, January 11, 2010 at 10:00 a.m.
INVISTA - Victoria, Texas

MINUTES

Call to Order
Committee Chair Suzanne Scott called the meeting to order and asked for introductions from the members and other participants.

Public Comments
Dale Duhon welcomed the group to the Invista facilities and invited them to view the wetlands center adjacent to the meeting room after the meeting. There were no other comments at this time.

Discussion and agreement on agenda
The Committee reviewed the agenda, agreed to move the discussion of committee vacancies to after the meeting rules discussion, and approved it unanimously with this change.

Approval of meeting minutes from December 15, 2009
The minutes from the previous BBASC meeting were approved unanimously.

Review of Draft Meeting Rules document
Members discussed the draft meeting rules as prepared by the committee chair with input from various members. The committee reached consensus on item one, concluding that meetings are open to the public and the agenda will be posted on the group's website 72 hours in advance of the meeting. Meeting materials will also be posted to the website after each meeting. Members also discussed administrative support, agendas, and record keeping, the scheduling of future meetings, public participation at meetings, the formation of workgroups/subcommittees and their responsibilities, and the election and terms of committee chairs and vice chairs. Also discussed was how the group would define quorum, the designation of alternates, member/alternate attendance and participation in meetings, removal and replacement of committee members, voting procedures, conduct of meetings, and amendments to the meeting rules. The group discussed each area, commenting and making changes as each section was reviewed, and agreed to distribute the revised meeting rules with all comments incorporated as discussed, for adoption at the next meeting.

Discussion and adoption of Meeting Rules
While the meeting rules were not officially adopted, the committee agreed to operate on the 75% threshold basis, as proposed in the draft meeting rules, for the remainder of the meeting.

Discussion/Filling of Committee Vacancies
The Committee took up the vacancies for the Recreational Water Users and Commercial Fishermen categories. The group agreed to move forward with the candidates for Commercial Fishermen and discussed the two candidates. The group ultimately chose Kenneth Finster and approved his appointment to the Commercial Fishermen category unanimously. The committee discussed the various candidates for the Recreational Water users. Various members discussed the candidates for this category, explaining their background, qualifications, and areas of expertise. The group ultimately agreed to appoint West Warren to fill the Recreational Water User Category with a 75% approval vote of the membership.

Update on BBEST Work Group activities and Discussion of BBEST Criteria/Nomination Process

Cory Horan, TCEQ, gave an overview of the BBEST work group conference call that was held on December 28, 2009. The work group altered the BBEST nomination form to include a request for resume or CV. The cover letter was discussed and noted that each member could alter it to meet their needs if they chose to use it. The BBASC agreed that the work group would not develop a slate of recommended nominees, but rather categorize each nominee by background and areas of expertise. The primary areas of expertise were identified as hydrology (both instream and freshwater inflows), geomorphology/sediment transport, water quality, biology (both riverine and estuarine), general riverine ecology, riparian/botany knowledge, geography and land use patterns, and estuarine circulation. Knowledge of endangered species was also mentioned as an important consideration. It was clarified that agency staff could participate in the BBEST process but as non-voting members. Cory will distribute the revised nomination form, cover letter, and a document that discusses the duties and charge of the BBEST to the committee. All nominations are to be sent to Cory at the TCEQ for compilation. The deadline for submittals was set as February 1, 2010. The BBEST work group will meet after that date and categorize the nominees for review and consideration by the full BBASC at the next meeting.

Extension Request to Environmental Flows Advisory Group

Cory Horan noted that staff for the Advisory Group had been notified that the BBASCs would be considering submittal of an extension request. Committee Chair Suzanne Scott agreed to draft a letter, in conjunction with the Colorado/Lavaca BBASC, requesting an extension of the environmental flows schedule. The request would allow the BBEST to have a full year beginning March 1, 2010 to complete their work. This would allow the BBASC six months after the BBEST recommendations are due to develop their comments and recommendations.

Public Comments

James Dodson announced the upcoming "Future of San Antonio Bay" conference to be held the following day. Jennifer Ellis, NWF, asked if BBEST nominations could be submitted from outside the BBASC membership. The group agreed that this was appropriate and the BBEST nomination form and cover letter will be posted to the website and notice of the nomination period and deadline will be sent out via e-mail. Vice-Chair Diane Wassenich requested that members send in a short bio of themselves that she will compile so that the committee members can get to know one another. She also asked that members send her dates of regularly scheduled meetings that she will compile so the group can attempt to set standing meeting dates for future meetings.

Set next meeting

The next meeting will be held on Monday, March 1, 2010 at the San Antonio Water System facilities in San Antonio. The meeting will begin at 10:00 AM.

The committee requested that at the beginning of each meeting the host make a short presentation.

Suggested topics of discussion for next meeting and possible future meetings included:

- Finalize meeting rules
- Approval of Alternates
- BBEST selection
- Discussion of how industry uses water
- Regional water issues/general presentation

Meeting Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)
Monday, March 1, 2010 at 10:00 a.m.
San Antonio Water System, Customer Service Building/Tower II, Rm. C-145
2800 U.S. Highway 281 North, San Antonio, Texas 78212

MINUTES

Call to Order
Committee Chair Suzanne Scott called the meeting to order and roll call was taken.

Members Present: Suzanne Scott, Dianne Wassenich, Bill Braden, Tyson Broad, Thurman Clements, David Crow, Velma Danielson, Paula DiFonzo, Dale Duhon, Ken Dunton, Garrett Engelking, Jay Gray, Chris Hale, Jerry James, Everett Johnson, Mike Mecke, Con Mims, James Murphy, Mike Peters, Robert Puente, West Warren, Walter Womack, Jack Campbell – Alternate for Kenny Finster, Jennifer Youngblood – Alternate for Brad Groves, Sam Helmle – Alternate for Scott Smith.

Public Comments
Myron Hess, National Wildlife Federation (NWF), gave a background of the BBEST categorization matrix and how it was used in the decision making process for the Colorado/Lavaca BBASC. Cory Horan, TCEQ, explained how the Guadalupe/San Antonio BBEST Subcommittee utilized the same matrix with several modifications to categories. He noted that unlike the Colorado/Lavaca BBASC, the BBEST subcommittee did not develop a recommended slate of BBEST candidates, only ranking each candidate according to the areas of expertise outlined in the categorization matrix.

Discussion and agreement on agenda
The BBASC reached consensus on agenda as presented with no changes.

Approval of meeting minutes from January 11, 2010
The minutes from the January 11, 2010 were approved unanimously.

Overview of Water in the San Antonio Area presented by San Antonio Water System
Steve Clouse, San Antonio Water System (SAWS), gave a presentation regarding water in the San Antonio area. He began by presenting background information on San Antonio water, noting that San Antonio is America's 7th largest city and that SAWS provides water and wastewater services to over 1.3 million people. He outlined the per capita water use over the last three decades, specifically mentioning an increase of 67% more customers, but a decrease in average water used. He discussed water demand in relation to conservation and identified several conservation programs currently in place. He gave an overview of SAWS aquifer storage and recovery project, wastewater discharge and the increase in effluent volumes by year, while noting that water reuse in the San Antonio area is the largest in the United States. He specifically discussed data on river flows at Falls City and gave an overview of flows from 1930 to present. He discussed the poor water quality conditions that occurred in the 1980s and the improvement to water quality since then, citing Index of Biological Integrity (IBI) scores that are all currently over 50, indicating increased biodiversity and improvements in water quality and habitat.

Discussion and adoption of Meeting Rules
The group began a discussion of draft meeting rules. Once small change was made to item 13 to clarify that the meeting rules may be amended by an affirmative vote of 75% of the full voting membership,

rather than the full voting membership present. The meeting rules were adopted as amended unanimously.

BBEST Appointments (to include a discussion of agency staff support)
The committee began the process of selecting members to be appointed to the Basin and Bay Expert Science Team (BBEST). Cory Horan gave an overview of the previous meetings of the BBEST subcommittee, noting how the matrix had been populated and utilized. There was a total pool of 39 nominees that were evaluated and input to the BBEST categorization matrix. The BBASC appointed four nominees to the BBEST unanimously. After these four appointments the group discussed the remaining nominees and their areas of expertise but could not reach consensus on the remaining pool. Therefore, per the adopted meeting rules, the process went to a vote of the committee members. The members were polled by ballot and an additional five nominees were identified as potential BBEST members, however the group still could not reach consensus. A request was made to include nominees from GBRA, SAWS, and SARA as potential candidates. The committee continued to review the five candidates plus the three from the previously mentioned agencies. A motion was put forth to accept the five candidates identified by ballot, as well as one additional candidate from SARA as full voting members of the BBEST, with the two remaining candidates from GBRA and SAWS to be included as non-voting members of the BBEST. The motion was seconded and the committee voted to pass this motion. The motion passed by a greater than 75% vote of the members, and per meeting rules, was adopted by the committee. The group appointed the following nominees to the BBEST as follows:

Voting Members
- Tim Bonner
- Ed Buskey
- Mike Gonzales
- Thom Hardy
- Scott Holt
- Paul Hudson
- Norman Johns
- Warren Pulich
- Elizabeth Smith
- Sam Vaugh

Non-Voting Members
- Gregg Eckhardt
- Debbie Magin

It was noted that agency staff from TCEQ, TWDB, and TPWD can serve on the BBEST as non-voting members and could provide technical support to both the BBEST and the BBASC. It was encouraged that both groups utilize this resource. A motion was made and the group unanimously agreed to allow staff from these three agencies as non-voting members of the BBEST.

Report on the modified schedule for the completion of environmental flows recommendations
It was noted that the letter requesting an extension of the environmental flows schedule was submitted to the Environmental Flows Advisory Group (EFAG). The extension request was for one full year, March 2010 to March 2011, to allow the BBEST to complete their tasks. A letter was also sent to the EFAG by the Science Advisory Committee in support of this request. No response or action has been taken as of yet.

Presentation of biographical information on BBASC members
Vice Chair Dianne Wassenich distributed the biographical information she had received from many of the BBASC members. She noted that not every member had submitted information and the package was not complete, but that information on, as well as a picture, several of the members were included in the packet.

Public Comments
No public comments were received at this time.

Set Schedule for Future Meetings
The group agreed to attempt to have future meetings held on the first Wednesday of the month. It was agreed to hold future meetings in either the San Antonio area or the Victoria area, with the meetings alternating between these two general locations. The next meeting was scheduled for April 7, 2010 to begin at 10:00 in the Victoria area.

Future Agenda Items
Suggested items for future agendas included:

- Discussion of alternates
- Review of maps of basin to familiarize members with the basin/bay system –
    - Where are water right impoundments/diversions, wastewater/stormwater dischargers, other informational detail, etc
- Overview of the Environmental Flows development process

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC) and Basin and Bay Expert Science Team (BBEST)

Wednesday, April 7, 2010 at 10:00 a.m.
Community Center Annex, Victoria, TX
(http://www.victoriatx.org/communitycenter/directions.asp)

MINUTES

Welcome, call to order, and introductions
Roll call was taken, and Jerry James welcomed the attendees and called the meeting to order.

Public comments
None.

Discussion and agreement on agenda
Consensus approval of the agenda

Approval of BBASC meeting minutes from March 1, 2010
Discussion regarding meeting locations. No changes made to minutes, but locations will remain open to discussion. Correct spelling of Warren Pulich's name. Revise language under "Overview of Water in the San Antonio Area" to state that SAWS aquifer storage and recovery project stores Edwards Aquifer water in the Carrizo Aquifer. Clarify that agency staff refers to the three agencies – TCEQ, TWDB, and TPWD. Minutes with changes approved unanimously.

Update on the Texas Instream Flow Program: Dakus Geeslin - TCEQ, Gordon Linam - TPWD, Mark Wentzel - TWDB
Mark Wentzel presented the background on the Texas Instream Flow Program/SB2. Local river authorities work as partners with the three agencies. Expect to be done with the lower San Antonio River (LSAR) Basin (downstream of USGS gage at Elmendorf and Cibolo Creek) by 2013. Agencies and river authorities design a study, followed by data collection and evaluation and producing a final report with flow regime recommendations. Numerous opportunities exist for stakeholder involvement. Study design and study report are peer reviewed. Preliminary information from the lower San Antonio River study should be available for the BBEST to use.

Gordon Linam discussed aquatic and riparian habitat assessment. Field work being done to identify specific habitats that various species prefer at different times/flows. Five indicator species selected – burrhead chub, pugnose minnow, freshwater eel, darter species, and the golden orb mussel.

Dakus Geeslin discussed the water quality aspect of the instream flow studies. Existing data will be evaluated. Additional data (temperature, dissolved oxygen-DO, pH, and conductivity) will be collected via long-term sonde deployment. A water quality modeling approach will be developed to allow prediction of water quality under various flow conditions. Presented temperature and DO data from the Goliad site. SARA is collecting nutrient data.

Additional discussion about specifics of LSAR study – extent of study area, how river and bay needs will be jointly taken care of (SB3 not SB2), consideration of Guadalupe River Basin (instream flow work to start in 2011-2012), availability of data for the BBEST (some preliminary data should be available), reconciling flow regimes from BBEST and TIFP (adaptive management).

BBEST budget overview – Ruben Solis

Ruben Solis explained that the TWDB provides budgeting and funding support for the BBESTs. Overall goal is to provide same amount of funding for each BBEST – this amount is $228,000. Money available to the BBEST for travel, per diem, work tasks, and contracts. Previous BBESTs have set up a budget, submitted it to the TWDB, who then submits it to the Environmental Flows Advisory Group for approval. Funds are then available for use. Ruben offered to attend next full BBEST meeting to provide information and assistance to members on reimbursement. Money can be moved around within the budget. Members should submit reimbursement requests promptly so that the budget can be tracked. The budget is tight.

SAC/BBEST relationship – Bob Huston, SAC Chair

Bob Huston pleased with the joint BBASC/BBEST meeting. He reviewed the SB3 process. Six groups are involved in the process: EFAG, BBASC, BBEST, SAC, TCEQ (regulatory/rulemaking agency), resource agencies (TPWD, TWDB, TCEQ). Encourages the BBEST and BBASC to make use of the resource agencies. Review of SB3 charge (handout). Clear delineation of duties: BBEST responsible for determining a science-based flow regime, BBASC responsible for considering other factors in addition to the science. The SAC is supposed to be the body that maintains continuity in the scientific process across the state as the various basins work through the SB3 process. The SAC appoints liaisons to each BBEST. For Guadalupe-San Antonio, the primary liaison is George Ward, and the secondary is Jim Wiersema.

The current SAC has developed a series of six technical guidance documents. These are all working documents. The SAC also has developed and adopted the document "Discussion Paper: Moving from Instream Flow Regime Matrix Development to Environmental Flow Standard Recommendations," which was transmitted to the BBASCs and BBESTs on February 17, 2010. In a perfect world, SB2 studies would have been started ten years ago and completed before the SB3 process started. The BBEST should not wait for SB2 results; the timing is not right. The SB2 results will be very important for the adaptive management component of SB3. The BBASC will develop a workplan for revisiting the flow standard at least every ten years. SAC will coordinate with the resource agencies to modify existing data collection programs to feed better into the SB3 adaptive management/workplan needs. Otherwise, there will not be enough money to fund much additional data collection.

The SAC liaison is a resource for the BBEST and also a conduit for information back to the SAC. It's mainly about communication, not shifting work responsibilities. No official liaison from TCEQ, but a healthy dialogue has been maintained throughout the SB3 process. The BBEST needs to get to interim decisions by consensus and limit revisiting interim decisions. Be willing to make hard decisions and expect imperfections.

Overview of BBEST charge as stated in SB3 – Cory Horan

Cory presented a short handout on duties of the BBEST under SB3. He stated that the BBASC has submitted a request to the EFAG to extend the originally imposed schedule for the work of the BBEST and the EFAG will be considering an extension. Encouraged the BBEST members to make use of environmental flows resources posted on the Web: SAC guidance documents, HEFR documentation, etc. Cory will e-mail the links to the group.

Previous BBEST experience – Sam Vaugh, HDR Engineering and member of the BBEST for the Sabine and Neches Rivers and Sabine Lake

Presented a summary of and commentary about his experiences on the Sabine-Neches BBEST. He noted that the Guadalupe-San Antonio BBEST has more members from academia, which should be a benefit. He outlined the Sabine-Neches BBEST process, discussed the subcommittees that were formed to address the various disciplines, discussed work that was contracted out and the reasons for taking that approach, and acknowledged the significant support provided by the Sabine River Authority and the resource agencies. Emphasized how valuable their decision tree was in capturing options evaluated and decisions made. Used HEFR as a starting point, then looked at other disciplines relative to flow (biology, water quality, sediment transport). Included qualifying language in each flow matrix table. BBEST developed not only recommendations, but also recognitions, which helped achieve consensus. Also had unresolved issues, and identified future studies and adaptive management as ways of dealing with them. There was minimal formal interaction between the BBEST and the BBASC; there was likely some informal communication. He emphasized that the starting point for the BBEST is defining what constitutes a sound ecological environment. Consideration of how the BBEST's recommended flow regime would impact water rights is outside the scope of its charge under SB3. That task is assigned to the BBASC.

BBASC process and schedule – Suzanne Scott

Suzanne Scott expressed the desire for the BBASC to meet throughout the next year while the BBEST is doing its work and to get status reports from the BBEST. The BBASC would like to have a presentation from the South Texas Watermaster regarding how he handled the last two-year drought, how it affected water rights holders, and how riparian water rights affected conditions in the basin during the drought. Consensus of group is to meet monthly, the first Wednesday of each month.

Tyson Broad presented his memo regarding getting maps from various entities (TPWD, GBRA, SARA, etc.) to help BBASC members become familiar with the entire basin. The letter requests information that is readily available, not anything that has to be created. He requested input from BBASC members regarding which agencies to ask, how to word the request, what type of information to ask for. He wants to keep this simple – maybe about a dozen maps. Try to avoid getting duplicate information from different entities. Suzanne Scott offered to be the point of contact. BBASC consensus is that this information would be useful and should be obtained.

Future meetings and agenda items

BBASC

Next meeting is Wednesday, May 5, 2010. Suggested agenda items:

- Status report from BBEST, either in person or written.
- Water use presentation – who uses water in the basin and how.
- Estuary overview – George Ward or Norman Boyd
- Briefing on SAC discussion paper mentioned by Bob Huston.
- Region L Water Plan – hold for later meeting. Also other two regions (N and J).
- Upper basin hydrology – maybe middle and lower.
- Drought – South Texas Watermaster
- Riparian water rights – does anyone keep track of water used under these rights?

Location of May 5 meeting: 1st choice – GBRA (Seguin), 2nd choice – SAWS (San Antonio)

BBEST

Next meeting is likely on Thursday, April 29, 2010. Cory will notify all members when date is finalized. Meeting location has not been determined and will also be sent out at a later date.

Public comments

James Dodson offered information on the San Antonio Bay Partnership.

Bob Huston added that an additional lesson learned from previous basins is that BBASC and BBEST need to interact even after the BBEST finishes its recommendation report. BBEST should be considered an additional resource after completing its report. Also, note that the charge to the BBASC includes developing both flow standards <u>and strategies</u> to meet those standards.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, May 5, 2010 at 1:00 p.m.
GBRA – River Annex, Seguin, TX

MINUTES

Introductions **Kellye Rila – TCEQ**

Cory will be unavailable for a while and Chris Loft is serving as Cory's replacement today. Minutes from the April 7, 2010 meeting will not be available until the next meeting.

Roll call **Suzanne Scott – SARA**

Discussion and agreement on agenda

Consensus approval of agenda.

Approval of April 7, 2010 minutes

Postponed until the next meeting.

BBEST update **Suzanne Scott – SARA**

Summary provided in handouts. BBEST elected Sam Vaugh as chairman and Norman Johns as vice-chairman. Seven voting members will be considered a quorum. Three subgroups formed: instream, estuarine, and hydrology. Next BBEST meeting will be June 11, 2010. BBASC has provided information about existing studies to BBEST.

Water Usage Presentation– Electrical Generation **Sam Helmle – CPS Energy**

CPS produces energy for the San Antonio area. Produces power through a variety of means: gas/steam electric, coal, nuclear, renewables, and gas turbines. The presentation provided detail on historical water use by CPS Energy and projections for future water use. Reuse of treated wastewater for once-through cooling also conserves water. Water use will continue to increase with population growth and air regulations requiring scrubbing.

Water Usage Presentation– Chemical Manufacturing **Dale Duhon - Invista**

Invista-Victoria plant construction began in the mid to late 1940s. Production began in 1951. Primary water source is the Guadalupe River. Invista withdraws about 20,000 acre-feet of water per year and is permitted for approximately 60,000 acre-feet per year. About 80% is returned to the Guadalupe River. Most water is used for cooling. Groundwater is used for potable water. Evaporation is the largest source of water loss. Treated wastewater goes through a 50-acre constructed wetland before being discharged to the Guadalupe River.

Bay and Estuary Presentation **Norman Boyd - TPWD**

Estuaries are semi-enclosed coastal bodies of water which have a free connection with the open sea and within which sea water is measurably diluted with freshwater. Three important components of estuaries are salinity gradients, nutrient inputs, and wetlands. Sediment loads, which are brought in by freshwater inflows, maintain habitats in estuaries. Changing freshwater inflows also alter salinity gradients within estuaries. Norman Boyd stated that mobile species, like blue crabs, can be used to determine what habitats/conditions they prefer.

Region L and N – Initially Prepared Water Plans **Brian Perkins - HDR**

Region L, the South Central Texas Planning Region, is projected to need an additional 400,000 acre-feet per year by 2060. The San Antonio-Nueces River Basin portion of Region N (Aransas, Bee, and San Patricio counties) is projected to need an additional 13,375 acre-feet per year by 2060. Each plan is evaluated using a cumulative effects assessment that includes hydrologic, environmental, and ecologically based assessments. Results of hydrologic assessments were presented using flow frequency graphs to compare flows projected under the plan against baseline conditions. Baseline conditions include full use of water rights and actual effluent discharge levels (as of 2006). Results of ecologically based assessments were also presented under natural conditions (no human impact), present conditions (actual water diversions and discharges), baseline conditions, and the Regional Water Plan for 2060.

Based on the volume of questions about the presentation, the group agreed to compile a list of questions to be sent to Suzanne Scott and have HDR come back to the next meeting to discuss them.

Discussion of proposed presentation schedule **Steve Raabe – SARA**

Steve discussed potential presentations to the BBASC through October 2010. Remainder of outline covers tasks that BBASC will need to do to prepare for reviewing the BBEST recommendations and developing its recommendations regarding environmental flow standards.

Group Discussion **BBASC**

Members requested that information be provided on water measurement terminology, for example, acre-feet, cubic feet per second, etc. The group also suggested that a basic "Water 101" type presentation be provided. Suzanne Scott committed to coordinating such a presentation. Dianne Wassenich suggested that attending the BBEST meetings would be very beneficial for the BBASC members. Group suggested contacting USFWS regarding potential Recovery Implementation Plan for the Whooping Crane.

A suggestion was made to include a briefing on The Aransas Project v. TCEQ Commissioners, et al be included. Kellye Rila responded that the TCEQ will be reviewing its ability to participate in such a briefing due to the ongoing litigation.

Set next meeting

Where/when:

Next meeting is Wednesday, June 2, 2010 at 10:00 a.m. at Doc's Roadhouse in Gonzales, Texas (tentative location)

Suggested agenda items:

- "Water 101" presentation
- Follow-up to Region L and N Initially Prepared Water Plan presentation
- Current water rights, water availability models (WAM), usage, and facilities
- South Texas Watermaster operations, activities, and procedures; the experiences of the 2008-2009 drought; and how domestic and livestock riparian water use affects the appropriative rights in the basins

How long:

Not discussed

Future meeting logistics:

Members should submit questions on the Region L and N Initially Prepared Water Plan presentation to Suzanne Scott by May 19.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, June 2, 2010 at 10 a.m.
Doc's Roadhouse Restaurant
Gonzales, Texas

Minutes

I. Call to order and roll call — **Suzanne Scott – SARA**

Roll was called and alternates noted. Sign-in sheet was passed around.

II. Public comment

None.

III. Discussion and agreement on agenda

Consensus approval of agenda.

IV. Approval of meeting minutes for April 7, 2010 and May 5, 2010

Consensus approval of April 7, 2010 and May 5, 2010 meeting minutes.

V. BBEST update

BBEST status update provided as a handout. Both the estuary and hydrology subcommittees of the BBEST have met. BBEST members will be attending a HEFR workshop in Austin on June 10. The next BBEST meeting will be held at the TCEQ on June 11. In addition, the Environmental Flows Advisory Group met on May 27 and approved the revised schedule for the Guadalupe-San Antonio basin and the other basins. SARA prepared minutes of the EFAG meeting, which were provided as a handout.

BBASC members were reminded to register on the TCEQ website to receive automatic notices of meetings of the SAC, EFAG and BBEST.

VI. An overview of estuaries — **George Ward – SAC**

Dr. George Ward presented an overview of estuaries. He provided defining characteristics of estuaries and primary forcing factors and discussed specific features of San Antonio Bay.

Presentation is on the BBASC website.

VII. Water 101: review of basic water quantity and quality terminology — **Brian Perkins – HDR**

Brian Perkins discussed basic water terminology, including units of measurement, unit conversions, water rights terms, reuse, instream flows and environmental flows, flow regimes, and return flows. Water terminology glossary handout provided to the BBASC.
Presentation is on the BBASC website.

BBASC members were requested to review the glossary of terms and suggest additions as needed to ensure that the glossary reflects required definitions

VIII. Follow-up on Region L and N initially prepared water plans — Brian Perkins – HDR

Brian Perkins reviewed the modeling assumptions portion of the Region L IPP presentation.

IX. South Texas Watermaster operations — Albert Garces – TCEQ

Albert Garces provided information on the overall watermaster program, including more specific information about the South Texas Watermaster program. He discussed water rights and water use types, duties of watermaster staff, example issues and violations in South Texas, and drought response by the watermaster.

Presentation is on the BBASC website

X. Characteristics and water rights of the Guadalupe-San Antonio River basin — Tommy Hill – GBRA & Steve Raabe – SARA

The group agreed to move this presentation to the July meeting.

XI. Setting Future Meeting:

a. Meeting date: Wednesday, July 7, 2010 at 10:00 a.m.
b. Future agenda items: The BBASC suggested the following items. BBASC chairman and TCEQ staff will finalize scheduling of presentations for upcoming meetings:

    Characteristics and water rights of the Guadalupe-San Antonio River basin
    Update from Guadalupe-San Antonio BBEST
    Coastal activities – fishing, recreation
    UGRA and Region J Water Planning
    Conservation activities in the basin
    SAC lessons learned (August)
    SAC implementation document
    Lessons learned in other basins (August)
    Edwards RIP (September)

c. Location: GBRA River Annex in Seguin

XII. Public comment

None.

XIII. Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, July 7, 2010 at 10:00 am
GBRA – River Annex
Seguin, Texas

MINUTES

Members Present: Suzanne Scott, Dianne Wassenich, Bill Braden, Tyson Broad, Tim Andrews (alternate for) Thurman Clements, Velma Danielson, Paula DiFonzo, Dale Duhon, Ken Dunton, Jack Campbell (alternate for Kenneth Finster), Garrett Engleking, Jay Gray, Jennifer Youngblood (alternate for Brad Groves), Chris Hale, Gary Middleton (alternate for Jerry James), Everett Johnson, Mike Mecke, Con Mims, Tommy Hill (alternate for James Lee Muprhy), Mike Peters, Robert Puente, Scott Smith, West Warren, Walter Womack.

Introductions
Members and audience members introduced themselves. Alternates identified themselves.

Public Comment
There was no public at this time.

Discussion and agreement on agenda and Approval of meeting minutes for June 2, 2010
Members agreed to proceed with the agenda as drafted. The minutes from the June 2, 2010 meeting were approved unanimously.

BBEST Update
Sam Vaugh, BBEST chair, gave an update to the activities of the BBEST, recapping their most recent meeting. He noted that member Dr. Paul Hudson would not be able to continue serving as a member of the BBEST. He detailed the discussion of the BBEST members regarding this vacancy. The BBEST members agreed that sufficient expertise resided among the members and recommended to the BBASC that a replacement was not necessary.

Replacement of Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays BBEST member
Members discussed how to address the vacancy on the BBEST and ultimately agreed by consensus to accept the recommendation of the BBEST that a replacement for Dr. Paul Hudson was not necessary. Member Walter Womack noted that geomorphology is a very important element to the BBEST process. Members agreed to inform the BBEST of this concern regarding geomorphology and BBEST chair Vaugh indicated he would relay this information to the BBEST members.

Water Resources of the Guadalupe-San Antonio River Basin – Steve Raabe, SARA and Tommy Hill, GBRA
Steve Raabe, SARA, and Tommy Hill, GBRA, gave presentations discussing the water resources of the Guadalupe and San Antonio River Basins. They discussed the hydrologic conditions of the basins including major aquifers and reservoirs. They also discussed existing water rights within the basins as well as treated effluent discharge which contributes to stream flow.

Water Resources of the Upper Guadalupe River Basin– Ray Buck, General Manager, Upper Guadalupe River Authority

Ray Buck, UGRA, gave a presentation discussing the water resources of the Upper Guadalupe basin, which noted water characteristics of the upper basin, water supplies of Kerr County, and UGRA programs designed to address water supply issues.

Region J Initially Prepared Plan
Jonathon Letz, Chair of the Region J Water Planning Group, discussed aspects of the regional water plan, noting population distribution and population projections. He also discussed projected water demand, available groundwater sources, and recommendations put forth by the planning group.

Groundwater-Surface water interaction studies in the Guadalupe-San Antonio River Basin
Darwin Ockerman, USGS, gave a presentation outlining streamflow, evapotranspiration, and groundwater recharge in the lower San Antonio River watershed as well as Gain/Loss studies in the Guadalupe river basin. He gave an overview of the gain/loss studies, discussion streamflow gaging stations, gain/loss measurements and results which were input into regional models used by the USGS.

Hydrologic Environmental Flow Regime (HEFR) – Dan Opdyke, TPWD
Dan Opdyke, TPWD, presented an introduction to the HEFR methodology. He explained that the rationale for using the HEFR method was that hydrology is considered the master variable in the available literature and that it has a significant impact on many ecosystem functions. He discussed the SAC guidance document which outlines the HEFR methodology and noted that the consideration of hydrology was only a first step that provides only an initial estimate.

TPWD's discussion of the state methodology for estimating bay and estuary inflow was postponed to the next monthly meeting.

****Note: all PowerPoint presentations can be found on the group's website located at:**
http://www.tceq.state.tx.us/permitting/water_supply/water_rights/eflows/guadalupe-sanantonio-bbsc

Set next meeting
The next BBASC meeting will be held on August 4, 2010 at a New Braunfels Utility facility TBD. Potential agenda items include:

- River Operations 101
- Presentation on the Mission and Aransas basins
- The Aransas Project Lawsuit
- New USFWS Recovery Implementation Program

Public Comment
No additional public comment.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, August 4, 2010 at 10:00 am
New Braunfels Utilities, Service Center Training Room
355 FM 306, New Braunfels, Texas

MINUTES

Members present: Suzanne Scott – Chair, Dianne Wassenich – Vice Chair, Bill Braden, Tyson Broad, Thurman Clements, Velma Danielson, Paul DiFonzo, Dale Duhon, Jennifer Ellis (alternate for Ken Dunton), Garrett Engelking, Jack Campbell (alternate for Kenneth Finster), Jay Gray, Jennifer Youngblood (alternate for Brad Groves), Chris Hale, Jerry James, Con Mims, James Lee Murphy, Mike Peters, Robert Puente, Scott Smith, West Warren, Walter Womack

Introductions and Public Comment
Roll call was taken and a quorum was reached.

There was no public comment at this time.

Discussion and agreement on agenda and Approval of meeting minutes for July 7, 2010
The members approved the proposed agenda by consensus. The minutes from the July 7, 2010 meeting were approved by consensus.

BBEST Update
BBEST Chair Sam Vaugh gave an update on the BBEST activities to date. He noted that the group had established 3 subcommittees focusing on hydrology, instream, and estuary considerations. These groups are identifying issues with the focus of maintaining a sound ecological environment. He noted that the group had chosen to use 16 gage sites throughout the study area, and were performing an initial pilot study on 5 of those sites for preliminary hydrological analysis.

Follow-up Questions Regarding Upper Guadalupe River Presentations – Tara Bushnoe, UGRA
There were no follow up questions at this time. It was noted that relevant reports were located on the UGRA website: www.ugra.org.

Municipal Water Use Presentations

- **San Antonio Water System – Steve Clouse, Chief Operating Officer and Sr. VP**
  Steve Clouse, SAWS, gave an overview of water in the San Antonio area. He discussed the decrease in per capita water use, from 225 to 124 gallons per person per day, with the goal of a decrease to 116 gallons per person per day by 2016 during a normal year. He discussed the various water conservation programs that SAWS offers and gave an overview of their aquifer storage and recovery programs. He noted that SAWS had the largest direct recycle water system in the United States.

- **City of San Marcos – Tom Taggart, Director, Water and Wastewater**
  Tom Taggart, city of San Marcos, discussed the Edwards Aquifer and springflow in relation to the city of San Marcos, its heritage and history, as well as being a major source of water for recreation, research, and drinking water. He discussed the sources of water for the city

explained the city's usage history, as well as discussing a profile of the water system, including the amounts and capacity of plants and wells used by the city. He then discussed water projections citing demand vs. supply over the next 50 years.

- **New Braunfels Utilities – Roger Biggers, Executive Director of Water Services**
  Roger Biggers, New Braunfels Utilities, discussed NBU's water supply and operational strategy noting a very high level of growth over the past decade with the highest annual consumption occurring in 2008. He discussed the Utilities' raw water supply sources and the city's use of those sources, as well as existing drought restrictions and significant events that would affect supply. He concluded by discussing the city's water supply vs. treatment capacity and supply vs. projected growth.

Guadalupe-Blanco River Authority - Jim Murphy, Executive Manager of Water Resources and Utility Operations; Tommy Hill, Chief Engineer

- **Guadalupe River Operations 101**
  Tommy Hill, GBRA, gave a general presentation on the Guadalupe River basin. He noted that the basin begins at a higher elevation in the upper reaches, dropping quickly within the first 200 river miles. As the river gets closer to the coast the elevation flattens which can produce flooding. He discussed the climatological conditions affecting water supply in the basin, including the drought of record, but noted that streamflow averages are higher than they had been in the past. He also discussed the major flood events that have occurred in the basin, noting that the central Texas basin was one of the most flood prone areas in the United States.

- **Upper/Mid Basin Water Use and Needs/ Lower Basin Water Use and Needs**
  James Murphy, GBRA, gave a presentation discussing three major GBRA projects within the basin, beginning with the mid-basin project which will provide water to IH-35 corridor throughout central Texas, includes a water rights application for 75,000 acre-feet/year as well as both the construction of a new pump station near Gonzales, the construction of an off-channel reservoir, which will provide a (preliminary) firm yield of 25,000 acre-feet/year.
  He then discussed the GBRA Simsboro project which will provide water to the SH-130 corridor, provide a (preliminary) firm yield of 50,000 acre-feet/year, develop a well field in Bastrop & Lee Counties, and include construction of a pipeline and pump station.
  He concluded by discussing the New Appropriation (Lower Basin) project. This project utilizes the existing GBRA diversion system and includes the construction of an off-channel reservoir, the construction of a new pump station on the main canal which will provide a (preliminary) firm yield of 9,000 acre-feet/year to 11,500 acre-feet/year.

Set next meeting
The next meeting is scheduled for 10:00 a.m. on Wednesday, September 1, 2010, to be held in Refugio, Texas. The subsequent meeting will be held at 10:00 a.m. on Wednesday, October 6, 2010. The location for this meeting is TBD at this time.

Jack Campbell requested a presentation by the U.S. Army Corps of Engineers on the operation of Canyon Dam.

Suzanne Scott noted that the packets included a copy of the report from the SAC on Lessons Learned from the initial SB3 BBEST activities.

Public Comment
There was no public comment at this time.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, September 1, 2010 at 10:00 am
Refugio City Hall, Club Room
609 Commerce St.
Refugio, TX 78377

MINUTES

Members Present: Suzanne Scott – Chair, Dianne Wassenich – Vice Chair, Bill Braden, Tyson Broad, Thurman Clements, David Crow, Karl Dreher, Paula DiFonzo, Stephen Fotiades (alternate for Dale Duhon), Ken Dunton, Garrett Engelking, Jack Campbell, Jay Gray, Brad Groves, Chris Hale, Jerry James, Everett Johnson, Mike Mecke, Con Mims, James Lee Murphy, Steven Clouse (alternate for Robert Puente), Scott Smith, Walter Womack.

Introductions and Public Comment
Roll call was taken and a quorum was reached. There was no public comment at this time.

Discussion and agreement on agenda
Members agreed to proceed with the agenda as drafted.

Appoval of meeting meeting minutes for August 4, 2010
Suzanne Scott announced that the August meeting minutes were not included in the packet and Cory Horan will email for approval.

BBEST Update
The members were given an update on the activities of the BBEST to date. Steve Raabe reviewed with the committee the written report submitted by BBEST Chair Sam Vaugh included in the packet materials. It was noted that the BBEST subcommittees were making progress in their tasks. The hydrology subcommittee has not yet received results from the pilot study for hydrological analysis on the five selected gage sites chosen by the full BBEST. Those results will be completed at the next BBEST meeting scheduled for September 14, 2010.

Replacement of BBASC Members Kenneth Finster and Velma Danielson
BBASC Members Kenneth Finster and Velma Danielson have submitted their resignation from the BBASC. Mr. Finster recommended Mr. Jack Campbell as his replacement. Ms. Danielson recommended Mr. Karl Dreher as her replacement. The BBASC members approved the two recommended replacements by consensus.

Municipal Water Use
a. **City of Victoria – Jerry James, City of Victoria**

BBASC member Jerry James, City of Victoria, gave a presentation on the city's water systems. He discussed water production and treatment, the city's industrial pretreatment program, their potable drinking water system, and their surface water supply project. He noted that the original source of water came from 15 groundwater wells that produced approximately 1500 gallons per minute. In discussing the city's water supply strategy he noted the primary and backup sources and the amounts produced by each. For the city's new water supply strategy he discussed the available water sources, including surface water from the Guadalupe River, purchased water rights, off channel reservoirs and groundwater wells.

State Methodology for Estimating Bay and Estuary Inflow – Cindy Loeffler, TPWD

Cindy Loeffler, TPWD, discussed the state methodology for estimating freshwater inflows to bays and estuaries. She noted that freshwater inflows create and sustain the estuaries by carrying nutrients, and establishing wetlands. She discussed the negative effects of decreased freshwater inflows. She also discussed the benefits that healthy estuaries provide. She noted the legal background for the freshwater inflow methodology. She explained the process of developing freshwater inflow recommendations, citing the Guadalupe estuary example.

Development of Community-Based Planning around the Whooping Crane – Leigh Bernacchi, Institute for Renewable Natural Resources, Texas A&M University

Leigh Bernacchi and Chara J. Ragland gave a presentation on their project regarding the development of community-based planning around the Whooping Crane. They noted that the specific area for this project were the communities around Aransas National Wildlife Refuge and Whooping Crane migration patterns. She explained the initial project goals as identifying and interview interested parties, using interview responses to identify possible approaches to community-based planning, and to bring together interested parties for an initial meeting in September using a collaborative learning process. They discussed possible outcomes of the project, including crane and coastal conservation.

Mission- Aransas Rivers – Liz Smith, Texas A&M-Corpus Christi

Liz Smith, BBEST member with Texas A&M Corpus Christi, gave an overview of the Mission and Aransas watersheds. She discussed habitat diversity within the watersheds, available riparian data as well as hydrologic data. She also discussed recommendations to assist with the environmental flows process, suggesting periodic riparian inventories using national classification methods be conducted, recommending that base riparian area management decisions on landscape needs as well as site-specific requirements, and the need to emphasize riparian areas in natural resources conservation policies and programs.

Mission-Aransas National Estuarine Research Reserve – Ed Buskey. UT Marine Science Institute

BBEST member Ed Buskey with the University of Texas Marine Science Institute gave a presentation on the characterization of the Mission-Aransas National Estuarine Research Reserve. He discussed the benefits of estuaries, and defined the goals of a national estuarine research reserve, noting one of the goals is to ensure a stable environment for research through long-term protection. He then discussed the overall components of the Mission-

Aransas National Estuarine Research Reserve, nothing the physical attributes of Copano and Aransas Bays and the research components of the program.

San Antonio Bay Partnership – James Dodson, Groundswell Enterprises
BBASC member James Dodson gave a presentation on the development of an estuary management program for the San Antonio Bay and Guadalupe Estuary System, the key task of the San Antonio Bay Partnership. He discussed the steps involved in developing a stakeholder-driven management plan for the bay and estuary system. He also discussed the purpose and goals established by the partnership including to characterize status of resources and availability of information, prepare appropriate management strategies and action plans, and the implementation of projects supporting management strategies.

Coastal Bend Bays and Estuaries Program – Ray Allen, Executive Director
BBASC member Ray Allen gave a presentation on the Coastal Bend Bays and Estuaries Program. He discussed the history and goals of the program, the program's geographic range, its source of funding, and the priority issues of the program. He discussed various projects the program was involved in, including habitat restoration, the Copano Bay oyster reef restoration project, tarpon tagging, and Nueces delta freshwater inflow management. Various other programs and projects were discussed.

Set next meeting
The next meeting of the BBASC is scheduled for Wednesday, October 6, 2010. The meeting will be held at the San Antonio Water System.

Suzanne Scott noted that the November meeting would be in Port O'Connor and Jim Dodson noted that the San Antonio Bay Partnership is planning a seninar around the same dates in Victoria.

Public Comment
There was no public comment at this time.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays
Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, October 6, 2010 at 10:00 am
San Antonio Water System
Customer Service Center Room 145
2800 US Hwy 281 North
San Antonio, TX 78298

MINUTES

Members Present: Suzanne Scott – Chair, Dianne Wassenich – Vice Chair, Bill Braden, Tyson Broad, Jack Campbell, Steve Clause (Alternate),Thurman Clements, David Crow, Paula DiFonzo, James Dodson (Alternate), Karl Dreher, Garrett Engelking, Jay Gray, Sam Helmle (Alternate), Chris Hale, Rick Illgner (Alternate), Jerry James, Mike Mecke, Con Mims, James Lee Murphy, Robert Puente, Mike Smith, Walter Womack.

Introductions and Public Comment

Roll call was taken and a quorum was reached. There was no public comment at this time.

Discussion and agreement on agenda

Members agreed to proceed with the agenda; however the order of items was modified due to schedule conflicts.

Discussion and agreement on meeting minutes from August and September

Members approved August minutes. September minutes approved with one correction.

Edwards Aquifer Recovery Implementation Program – Robert Gulley, Program Manager

Robert Gulley started with an overview on Texas water law, the Sierra Club lawsuit and the establishment of the Edwards Aquifer Authority by the legislature. He discussed how USFWS established a voluntary recovery implementation program in 2006 however, in 2007 SB3 directed the EAA and four state agencies to participate in the EARIP and to prepare a USFWS approved plan to protect the listed species at Comal and San Marcos Springs by 2012. He stated that the EARIP is a collaborative, consensus based stakeholder process. He stated the EARIP is developing a habitat conservation plan and will submit a draft plan to USFWS in the summer of 2011.

Replacement of BBASC Member Dale Duhon

BBASC Member Dale Duhon has submitted his resignation from the BBASC. Mr. Duhon had recommended Mr. Steve Fotiades, Mr. Duhon’s alternate to the committee, as his replacement. The BBASC members approved the replacement as suggested by consensus.

BBEST Update
The members were given an update on the activities of the BBEST by Diane Wassenich and Steve Raabe. The BBASC members commented that they would like to continue receiving updates on progress and key decision points by the BBEST. The BBEST update summary was provided in the handouts.

Bexar-Medina-Atascosa WCID #1 - Will Carter, Board President
Will Carter, gave a presentation on the history of Medina Lake and canal system. Medina Lake was constructed in 1912 as an irrigation reservoir. He discussed the concern over the integrity of the dam due to the 2002 flooding. He stated that modification of the dam is required due to the hydraulic capacity requirements. He stated the failure of Median Dam would result in inundation of numerous downstream communities and substantial loss of municipal water supply for the city of San Antonio. He then discussed the proposed dam modifications and BMA's ongoing canal improvements in order to improve water conveyance efficiencies and reduce water loss.

Guadalupe-Blanco River Trust – Janae Reneaud, Executive Director
Janae' Reneaud, gave a presentation on the Guadalupe-Blanco River Trust. She discussed the mission of the River Trust and the counties of operation. She also discussed the value and benefits of conservation easements. She then gave examples of conservation easements currently secured by the trust and noted the trust has preserved over 9,400 acres and conserved over 16 miles of water frontage.

Bandera County River Authority and Groundwater District – David Mauk
David Mauk gave a presentation on the Bandera County River Authority and Groundwater District. He discussed the enabling legislation that established the river authority and the Springhills Water Management District and the subsequent name change. He discussed the various activities and duties of the river authority and groundwater district including public education, groundwater monitor wells, rainfall data collection, public water analysis, surface water sampling, well plugging program, well registrations/permits, OSSF program and environmental investigations. He noted that the BCRAGD is within the Region J water planning area.

Bexar Metropolitan Water District Municipal Water Use – Humberto Ramos
Humberto Ramos, gave an overview of Bexar Metropolitan's municipal water use. He stated that Bexar Met service area is concentrated on the south side of San Antonio, however it also includes several rapidly growing areas surrounding the city. He noted that Bexar Met services approximately 90,000 customers. He discussed the current surface water sources including Canyon Lake, Lake Dunlap, Medina Lake and the Medina River. He also discussed other water sources that Bexar Met utilizes including the San Antonio River, Edwards, Carrizo and Trinity Aquifers.

Corps of Engineers Operations of Canyon Lake – Paul Rodman, Ft Worth District, USACE
Paul Rodman, USACE gave a presentation on Canyon Lake. He noted the overall mission of the Ft. Worth District include flood control operations, water supply, hydropower and recreation. He stated that Canyon Lake was first authorized in 1945 and was built for flood control in the upper basin and water supply. He noted that at the top of conservation pool

Canyon Lake holds 366,400 acre-feet of water. He then discussed the specific flood control operations of Canyon Lake and the impacts from the floods of 1992, 1998 and 2002.

Texas Instream Flow Program Lower San Antonio River Study – Ed Oborny, Bio-West Consultants

Ed Oborny, Bio-Wet and SAC member gave a presentation on the Lower San Antonio River Instream Flow Study. He discussed SB2 which established the Texas Instream Flow Program (TIFP). He stated the goal of the TIFP is to determine flow conditions necessary for supporting a sound ecological environment. He identified the specific study boundaries. He then discussed the four disciplines of the TIFP including hydrology, biology, physical processes and water quality. He discussed the definition and objectives of the various flow components (subsistence, base flow, high flow pulses and overbank flow). He gave a status on the field efforts including habitat and substrate mapping, hydraulic data collection, habitat measurements, water quality, fish and mussel sampling, riparian sampling and sediment transport. He stated that preliminary results of the study should be available for the BBEST in December 2010.

Set next meeting

The next meeting of the BBASC is scheduled for Wednesday, November 3, 2010. The meeting will be held at the Port O'Connor Community Center.

- Agenda
  Bob Houston (SAC) to discuss Lessons Learned and Moving from Instream Flow Regime Matrix Development to Environmental Flow Standard Recommendations documents

Additional Meetings: Dec 1, 2010 – Dianne Wassenich to reserve location in San Marcos

Public Comment

There was no public comment at this time.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays
Basin and Bay Area Stakeholder Committee (BBASC)
Wednesday, November 3, 2010 at 10:00 am
Port O'Connor Community Center
3674 W Adams St., Port O Connor, TX

MINUTES

Members Present: Suzanne Scott – chair, Dianne Wassenich – vice chair, Bill Braden, Tyson Broad, Jack Campbell, Thurman Clements, David Crow, Karl Dreher, Paula DiFonzo, Ken Dunton, Steven Fotiades, Jay Gray, Chris Hale, Tommy Hill (alternate for James Murphy), Everett Johnson, Mike Mecke, Gary Middleton (alternate for Jerry James), Con Mims, Robert Puente, Scott Smith, West Warren, Walter Womack

Introductions and Public Comment

Roll call was taken and a quorum was reached. There was no public comment at this time.

Discussion and agreement on agenda

The draft meeting agenda was approved by consensus.

Approval of meeting minutes for October 6, 2010

The minutes from the October 2010 meeting were approved by consensus.

BBEST Update

Steve Raabe, SARA, gave an update on the BBEST activities as provided by BBEST chair Sam Vaugh. He noted that the BBEST has developed a draft outline of their recommendations report and that members were working to complete individual tasks corresponding to the draft outline. The BBASC members discussed the BBEST use of derived data, as well as the calculation of freshwater inflow data. Carla Guthrie, TWDB, noted that the BBEST will be allocated $47,000 to support the work of the BBEST and BBASC after the BBEST environmental flow recommendations have been delivered to the BBASC.

Scientific Advisory Committee Guidance – Robert Huston, Chair

Robert Huston, chair of the Texas Environmental Flows Science Advisory Committee, discussed two key guidance documents that have been developed by the SAC for the SB3 BBEST and BBASC groups: the "Lessons Learned from Initial SB3 BBEST Activities" and "Moving from Instream Flow Regime Matrix Development to Environmental Flow Standard Recommendations." He emphasized the importance of communication between the BBASC and BBEST throughout the process, particularly in the interpretation of BBEST recommendations and in workplan development. Members discussed the need to understand how the BBEST decisions are made, as well as how the BBEST defined what constitutes a sound ecological environment. Members identified options as to how they would like to see this communication and interaction with the BBEST and agreed to increase the interaction with the BBEST, primarily through the BBEST subcommittees, as that group finalized their environmental flow regime recommendations. Chairman Huston and the members briefly discussed work plan development and the associated SAC guidance.

Review of SB 3 BBASC Charge – Cory Horan, TCEQ

Cory Horan, TCEQ, discussed the charge of the BBASC as outlined in SB3. He presented a flow chart describing the steps of the environmental flows process from BBASC appointment through work plan development. He noted that the BBASC may not change the environmental flow analyses or environmental flow regime recommendations of the BBEST. He explained that the BBASC is charged with reviewing the environmental flow analyses and environmental flow regime recommendations submitted by the BBEST and shall consider them in conjunction with other factors, including the present and future needs for water for other uses related to water supply planning. In doing so the BBASC shall develop recommendations regarding environmental flow standards and strategies to meet the environmental flow standards, while operating on a consensus basis to the maximum extent possible. These tasks are to be completed by September 1, 2011.

Discussion Regarding Guadalupe-San Antonio-Mission-Aransas-Copano BBASC Charge

The BBASC members discussed and identified issues that will need to be addressed in the development of environmental flow standards and strategies to meet those standards. The members also discussed factors related to these issues that will need to be considered. Issues identified and factors to be considered include:

- Minimum levels of freshwater inflows adequate to support commercial fisheries
- Exempted well and domestic water usage throughout the basin
- Invasive species
- Impact of flow regimes on region L water project plan yields
- How the saltwater barrier affects instream flow and freshwater inflow dynamics
- Sea level rise

SAC chairman Huston suggested that these issues be categorized as many of the issues discussed will fall to the BBEST to address and recommended that the BBASC will want to communicate these issues to the BBEST so that they can be addressed.

The members also discussed what their final report/successful completion of the BBASC charge might look like:

- Flow regime adequate to protect environmental and human needs during drought
- Balancing present and future conditions
- Better management of existing water rights
- Healthy riparian habitat
- Recognition that water is a finite resource
- Handing down something members can be proud of to future generations

Set next meeting
The next meeting will be held on December 1, 2010 in the San Antonio area.

The January 12, 2011 meeting will be held in the upper basin.

The February 2, 2011 meeting will be held in the lower basin.

Public Comment
Members discussed a "Crab workshop" hosted by the BBEST. Members requested additional information regarding details and participation in the workshop.

Jennifer Ellis, National Wildlife Federation (NWF), proposed offering field tours to members in conjunction with future meetings. The members agreed by consensus to proceed with this proposal.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder committee (BBASC)

Wednesday, December 1, 2010 at 10:00 am
San Antonio Water System

MINUTES

Members Present: Suzanne Scott – Chair; Dianne Wassenich – Vice Chair; Bill Braden; Tyson Broad; Jack Campbell; Tim Andruss (alternate for Thurman Clements); David Crow; Roger Biggers (alternate for Paula DiFonzo); Rick Illgner (alternate for Karl Dreher); Jennifer Ellis (alternate for Ken Dunton); Garrett Engelking; Steven Fotiades; Josh Gray; Chris Hale; Jerry James; Everett Johnson; Con Mims; James Lee Murphy; Mike Peters; Robert Puente; Scott Smith; West Warren; Walter Womack

Introductions and Public comment

Roll call was taken and a quorum was reached. There was no public comment at this time.

Committee Vacancy

Chair Suzanne Scott announced that there was a vacancy on the committee due to the passing of member Brad Groves. Vice chair Dianne Wassenich expressed sympathy on behalf of the BBASC. Suzanne Scott will send a letter of condolence on behalf of the committee. Cory Horan, TCEQ, discussed the process for replacement of the vacancy, noting that SB3 allows for a member to be replaced by majority vote. The group agreed to accept nominations to fill the committee vacancy. Nomination forms will be sent out for formal submissions to be sent to Cory Horan. Nominees will be distributed for consideration and a vote to fill the vacancy will occur at the January meeting.

Discussion and Agreement on Agenda

The draft meeting agenda was approved by consensus.

Approval of Meeting Minutes for November 3, 2010

The minutes from the November 3, 2010 meeting were approved by consensus.

BBEST Update

BBEST Chair Sam Vaugh gave an update on recent activities of the BBEST.

He discussed analysis being conducted by the three BBEST subcommittees: Instream, Estuary, and Hydrology. The BBASC members discussed various aspects of their analysis including:

- Salinity Zone approach for freshwater inflows
- Drought criteria
- Groundwater pumping in the upper basin
- And other characteristics of the basin

Chairman Vaugh also discussed the recently proposed rule standards for environmental flows in the Trinity/San Jacinto and Sabine/Neches basin and bay systems. He explained the impact of adoption of these standards and the considerations the BBEST has initiated in light of the proposed rules.

Chairman Vaugh noted that the BBEST focus is to ensure there are sufficient flows to protect a sound ecological environment. He stated that the report and analysis of the BBEST will provide the data which the BBASC will need to consider and balance in light of other factors.
He explained that the BBEST analysis will include evaluation of flow recommendations as would be applied to a generic water supply project. After discussion the BBASC suggested the BBEST look at the impacts of a "hypothetical" water supply project, not a specific region L project. Mr. Vaugh will bring this recommendation back to the BBEST. BBASC member Walter Womack

noted that he does not think the BBEST should be involved in making suggestions about any kind of water supply projects.

The members discussed a list of factors to be presented to the BBEST for analysis to support considerations identified by the BBASC. Those factors include:

- Minimum freshwater inflows needed to protect commercial fish species
- Impact to wildlife, to include terrestrial animals dependant on rivers/bays
- Geomorphology
- Sea level rise
- Retreat of the delta

Discussion - Identified Factors and What Success will Look Like

Members continued discussion from the November meeting on factors identified that the committee will need to address in the development of their recommendations for environmental flows and strategies to meet those flows. Factors identified and considered include:

- Sediment transport and impact of sediment deposition
- Impacts of wells and alluvial deposits
- Agricultural issues
- Correlation of conservation and drought management in the lower basin.
- Terrestrial/riparian biology

Members discussed the importance of the consideration of existing water rights in the development of their recommendations. Members discussed other considerations identified. The Chairman of the committee said these discussions will continue at the January BBASC meeting.

Members then focused on implementation strategies. Discussion included consideration of the following:

- Voluntary management strategies
- Donation/ purchase of unused water rights to meet environmental flow requirements
- dry lease options

Field Tours Organized by National Wildlife Federation

Jennifer Ellis, National Wildlife Federation, stated that the proposed field tours will take place after the January 12and February 2, 2011 meetings. The January and February meetings will be arranged so that the tours are scheduled for the afternoons. The members agreed to proceed in the planning of these field tours

Set Next Meeting

The next meeting of the BBASC is scheduled for Wednesday, January 12, 2011. The meeting location will be determined at a later date. Items to be discussed at the January meeting include:

- Desired outcome of BBASC deliberations
- Discussion of potential assistance by consultant
- Committee vacancy
- Lower basin field tours

Public Comments

Bruce Wasinger, GBRA, provided an update on the Aransas Project lawsuit against the TCEQ. Vice chair Dianne Wassenich noted that the work of the BBASC was important as the BBASC will make recommendations and strategies for conditions on future water rights, whereas the lawsuit is about water rights granted in the past.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and
Mission, Copano, Aransas, and San Antonio Bays
Basin and Bay Area Stakeholder Committee (BBASC)
Wednesday, January 12, 2011 at 10:00 am
Cibolo Nature Center
140 City Park Road
Boerne, TX 78006

MINUTES

Members Present: Suzanne Scott, Chair; Dianne Wassenich, Vice-Chair; Bill Braden; Tyson Broad; Jack Campbell; Thurman Clements; Paula DiFonzo; Rick Illgner (for Karl Dreher); Ken Dunton ; Garrett Engelking; Steven Fotiades; Josh Gray (for Jay Gray); Chris Hale; Jerry James; Everett Johnson; Mike Mecke; Con Mims; James Lee Murphy; Robert Puente; Scott Smith; West Warren; Walter Womack; Brad Bredesen (for Mike Peters)

Introductions and Public Comment
There was no public comment at this time.

Discussion and agreement on agenda
The members agreed to proceed with the agenda as drafted.

Approval of meeting minutes for December 1, 2010
Revisions were requested on the minutes from the December meeting. Walter Womack requested a section to be added to under the BBEST update to reflect the BBASC discussion on the BBEST selection of projects for analysis purposes of the environmental flows recommendation. Other slight editing revisions.

Suzanne Scott stated that approval of both the December and January meetings would be placed on the agenda for approval at the February meeting.

Replacement of BBASC member Brad Groves
Jennifer Youngblood, serving as alternate to Brad Groves, was the sole candidate nominated to fill the vacancy created by the passing of member Brad Groves. d Micah Voulgaris General Manager of the Cow Creek Groundwater District was in attendance and expressed interest in serving as the replacement. . After discussion the members selected Jennifer Youngblood to fill the vacancy with Mr. Voulgaris serving as an alternate to Ms. Youngblood.

Resignation of member Scott Smith
BBASC member Scott Smith has notified the BBASC chairs that he intends to resign from the committee. He has recommended Kimberly Stoker as his replacement. After discussion the members voted and approved Kimberly Stoker to replace member Scott Smith. Ms. Stoker will name her alternate at a later date.

BBEST Update

BBEST Chair Sam Vaugh presented maps to the BBASC that geographically represent existing gauge locations, average streamflow or freshwater flow throughout the basin, major water rights and consumptive uses, and major discharges of treated effluent.

He then gave an update on recent activities of the BBEST. He discussed analysis being conducted by the three BBEST subcommittees: Instream, Estuary, and Hydrology. BBASC member Walter Womack indicated that he is concerned that science based recommendations might be "massaged" when the impact of hypothetical water supply projects is considered. Both Sam Vaugh and BBEST vice-chair Norman Johns stated that the BBEST had discussed the advantages and disadvantages of the BBEST conducting hydrological time series analysis in development of its recommendations and concluded that these analysis are part of an accepted methodology by the Scientific Advisory Committee for the BBEST to conduct.

Discussion on identified factors and what success will look like from Dec. meeting

Chair Suzanne Scott opened the discussion of factors and successes. It was noted that not all concerns would be able to be addressed in the BBASC recommendations but they could be addressed in the work plan for adaptive management. The BBASC will also have an opportunity to revisit their final recommendations through the work plan. The group agreed that a protocol for reviewing the BBASC recommendations will need to be developed. Members discussed options for consideration in the development of the work plan.

Discussion on potential Technical and Facilitation Assistance

Steve Raabe, San Antonio River Authority (SARA), began a discussion of potential technical and facilitation assistance to aid the BBASC in the development of their final recommendations. He presented draft requests for qualification (RFQ) for both assistance tasks. Members discussed the draft technical RFQ and identified factors that need to be included in the draft. The group discussed the need for a subset of members to evaluate respondents to the RFQs.

By consensus the group agreed to move forward with the technical scope of work for the purposes of initiating the solicitation of professional services as discussed with the caveat that required tasks to be negotiated with a selected consultant be further developed with the BBASC upon review of respondents to the technical RFQ.

Members discussed the draft RFQ for facilitation and agreed by consensus to move forward with this process and decide if a facilitator is necessary based on the respondents to the RFQ. The BBASC requested that the scope of work for facilitation services recently released by the Lower Colorado BBASC be reviewed and incorporated, as appropriate.

Members Tyson Broad, James Lee Murphy, Paula DiFonzo, Steve Clouse (alternate to Robert Puente), Jerry James, Suzanne Scott, Kimberly Stoker and Steve Fotiades agreed, and the group approved, to serve as a workgroup to review and evaluate respondents to the RFQs. Comments on both scopes will be accepted prior to the February meeting.

Options to solicit funding from members to support the technical and facilitation assistance will be explored.

Riparian Zone Presentation

Steve Nelle, NRCS, gave a presentation on the ecology, function, and importance of riparian zones. He discussed components of a properly functioning riparian system, the benefits of floodplains, and the role of flooding and sediment transport in riverine ecology.

Field Tour

Jennifer Ellis discussed the afternoon's field tour schedule. Chad Norris, TPWD, discussed research performed on the Cibolo Creek headwaters prior to the tour of Cibolo Creek.

Set next meeting
The next meeting will be held on February 2, 2011 in the Rockport/Fulton area and will include a tour of the surrounding bay and estuary. SAC member George Ward will also present at the February meeting.

Public Comment
There was no public comment at this time.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, February 2, 2011

Paws & Taws Fulton Convention Center
402 N. Fulton Beach Rd.
Fulton, TX 78358

MINUTES

Aransas Bay Tour

The tour of Aransas Bay was canceled due to mechanical problems. Members participated in a short driving tour that included viewings of Whooping Cranes and coastal habitat. Joan Garland of the International Crane Foundation presented a brief history of the of the Whooping Crane and its annual migration from Wood Buffalo National Park in the northwest territories of Canada to the Whooping Crane refuge in San Antonio Bay. She also announced the Annual Whooping Crane Festival scheduled for February 24-27 in Port Aransas.

Members Present: Suzanne Scott, Chair; Dianne Wassenich, vice chair; Tim Andruss (for Thurman Clements); Roger Biggers (for Paula DiFonzo); Bill Braden; Jack Campbell, Steve Clouse (for Robert Puente); Karl Dreher; Ken Dunton; Jennifer Ellis (for Tyson Broad); Garrett Engelking; Steve Fotiades; Jay Gray; Chris Hale; Jerry James; James Lee Murphy; Mike Peters; Steve Raabe (for Con Mims); Kimberly Stoker; West Warren; Walter Womack Jennifer Youngblood;

Introductions and Public Comment:

Roll call was taken and a quorum was reached. There was no public comment at this time.

Discussion and agreement on agenda

The draft meeting agenda was approved by consensus.

Approval of meeting minutes for December 2010 and January 2011

The minutes from the December 1, 2010 were approved by consensus. The minutes from the January 12, 2011 meeting were amended to show the attendance of Brad Bredesen for Mike Peters. Minutes were approved as amended, by consensus.

BBEST Update

BBEST Chair Sam Vaugh gave an update on recent activities of the BBEST. Their next meeting is scheduled for Thursday, February 3, 2011, also in Rockport. A second meeting is scheduled for Thursday, February 17, 2011 to approve and finalize environmental flow recommendations so that any final changes can be completed by the March 1, 2011 deadline.

He noted that at this time, most of the technical work is complete and efforts are focused on refining the recommendations and process documentation. He stated that the BBEST has selected 16 instream sites as well as the estuaries for which environmental flow recommendations are being developed. He presented an overview of how the BBEST recommendations are structured. The statistical hydrology analysis, including HEFR and time series analysis, is complete and members are working on process documentation. He added that members are working on the biology, geomorphology, habitat, riparian and other overlays, and presented a brief description of their efforts. By integrating this information and correlating with the hydrology analyses, it is possible to relate flow with diversity in habitat of the different guilds of indicator species. These findings can then be overlaid with the statistical hydrology for the different tiers of flow to make sure that the recommendations are protective of a sound ecological environment.

Discussion on scopes of work and the selection process for Technical and Facilitation Assistance

Steve Raabe, San Antonio River Authority (SARA), stated that at the last meeting the BBASC had authorized SARA to solicit proposals for technical and facilitation assistance to aid the BBASC in the development of their final recommendations. The technical proposal was sent to the 6 firms the BBEST used for similar services. The facilitation proposal was sent to 25 firms from several sources. Proposals are due Monday, February 7, 2011 and will be distributed to the evaluation team the following day. The team will meet February 17 or 18, 2011. The team will negotiate the final scope based on available funding, and hopes to have a recommendation for BBASC approval at the March 2, 2011 meeting.

Members discussed the factors outlined in the technical scope of work, what considerations the contractor will need to address, and provided comments received on the draft scope. Steve Raabe reviewed with the committee specific modifications to the scope previously submitted to him by Tyson Broad. By consensus the scope was modified to include, subject to budget considerations, a qualitative assessment of effects on streamflows of 1) groundwater use in the headwaters of streams using the GMA 9 model runs, 2) climate change and 3) effects of invasive woody species. Members were asked to review the two scopes and submit any comments by Monday February 7, 2011.

Cedar Bayou Presentation – George Ward, SAC

Dr. George Ward presented results from the Cedar Bayou project, designed to establish a timeline of conditions that define Cedar Bayou, compiling historical data. He discussed the sources of information used in the project, sources of error related to the data, and observations made upon analysis of available data. Dr. Ward answered questions of the members.

Set Next Meeting

The next meeting will be held at 10:00 am on March 2, 2011 to be held at the San Antonio Water Systems. The primary focus of the meeting will be the BBEST report. Copies of the BBEST recommendation will be distributed at the meeting and a presentation on the report will be given by BBEST members. The BBASC will have 6 months from this date to finalize their recommendations. There will also be a recommendation from the selection committee on the technical and facilitation RFPs and process selection.

Public Comment

There was no public comment at this time.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, March 2, 2011

San Antonio Water System (SAWS) Customer Service Building, Room CR-145
2800 US Highway 281 North
San Antonio, TX

MINUTES

Members Present: Suzanne Scott, Chair; Dianne Wassenich, Vice Chair; Jennifer Youngblood; Garrett Engelking; James Lee Murphy; Tyson Broad; Chris Hale; Jerry James; Steve Fotiades; Jay Gray; Mike Mecke; Walter Womack; Thurman Clements; Brad Bredesen (for Mike Peters); West Warren; Roger Biggers (for Paula DiFonzo); James Dodson; Con Mims; Robert Puente; Kim Stoker; Everett Johnson; Jack Campbell; and Karl Dreher.

Introductions and Public Comment:

Roll call was taken and a quorum was reached. There was no public comment at this time. Mike Mecke introduced Jack Clark from the Kerr County Soil & Water Conservation Board who is considering the alternate position for Mr. Mecke.

Discussion and Agreement on Agenda

The draft meeting agenda was approved by consensus.

Approval of meeting minutes for February 2, 2011

The minutes from the February 2, 2011 were approved by consensus.

Presentation of BBEST Environmental Flow Regime Recommendation

BBEST Chair Sam Vaugh gave a presentation discussing the Guadalupe-San Antonio BBEST environmental flow regime recommendations report. The presentation included an overview of the report, the SB3 process, and the charge of the BBEST. He discussed the instream flow and estuary components of the recommendation, the methodology used, and how biology and the hydrologic system were integrated. He presented the general structure of the flow regime recommendation prior to key members of each subcommittee presented the methodology used to derive the recommendations in more detail. Chairman Vaugh presented an example of how the instream flow recommendations would be applied. He suggested that members review at least Chapters 1 and 6 of the report before the next meeting.

Discussion and Agreement on Consultant Services

Committee Chair Suzanne Scott gave a brief summary of the proposal process for Consultant Services. The evaluation committee's recommendation of HDR Engineering for technical assistance was approved by consensus. The recommendation of the Rozelle Group for facilitation assistance was approved with one dissenting vote.

Steve Raabe, SARA, discussed the scope of work for each service, how the scopes were developed, and the cost estimates included in each. The cost of both services is $130,000. Mr. Raabe had commitments of $105,000 with several leads identified for additional funding to procure these services. Members unanimously approved the motion to contract HDR Engineering for the technical services. The motion to contract the Rozelle Group for facilitation services was approved with two dissenting votes.

Brian Perkins, HDR, asked members to identify specific sites for analysis and consider certain technical assumptions which would allow HDR to move forward. Members approved six locations under Task II of the scope of work for evaluation of a new diversion of up to 10,000 acre-feet under various environmental criteria including the base flow and subsistence flow criteria of the BBEST recommendations. The six locations chosen are:

- San Marcos River at Lulling
- Guadalupe River at Gonzales
- Guadalupe River at Victoria
- San Antonio River near Elmendorf
- Cibolo Creek near Falls City
- Mission River near Refugio

Regarding the technical assumptions to use in the modeling, members chose to use the TCEQ water availability model and to include the use of treated effluent in all modeling scenarios. Members did not reach a decision on what spring flow assumption to use. Mr. Perkins will provide members with the issues under consideration via email so that a decision can be made at the next meeting.

Set Next Meeting
The next meeting will be held on March 15, 2011 at GBRA where members of the BBEST will be present to answer questions about the recommendations report. The following meeting is tentatively scheduled for April 6, 2011 in New Braunfels. Additional meetings are planned for April 19, 2o11 and August 23, 2011.

Public Comment
There was no public comment at this time.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and
Mission, Copano, Aransas, and San Antonio Bays
Basin and Bay Area Stakeholder Committee (BBASC)
Tuesday, March 15, 2011
Guadalupe Blanco River Authority, River Annex
905 Nolan, Seguin, Texas 78155

MINUTES

Members Present: Suzanne Scott, Chair; Dianne Wassenich, Vice Chair; Jennifer Ellis (for Chris Hale); Garrett Engelking; James Lee Murphy; Tyson Broad; Jerry James; Steve Fotiades; Jay Gray; Walter Womack; Thurman Clements; Paula DiFonzo; James Dodson (for Ken Dunton); David Crow; Bill Braden; Con Mims; Robert Puente; Kim Stoker; and Karl Dreher.

Introductions and Public Comment:
Roll call was taken. Jerry James discussed a bill introduced by Senator Wentworth that was filed under the Edwards Aquifer Recovery Implementation Program that may provide funding for implementation of the BBASC work plan and state water plans in the future.

Discussion and Agreement on Agenda
The draft meeting agenda was approved by consensus.

Cory Horan, TCEQ, presented an overview of the role and responsibilities of the SAC in the BBEST report review process and reported what steps the SAC has taken to date. The SAC will meet Wednesday, March 16, 2011, to discuss the BBEST reports for the Guadalupe-San Antonio as well as the Colorado-Lavaca Basin and Bays system.

Discussion and Questions Regarding BBEST Environmental Flow Regime Recommendation Report.
BBEST Chair Sam Vaugh and key members of the subcommittee were present to answer questions regarding the BBEST recommendation report. Chairman Vaugh explained that members of the BBEST were available to support the BBASC to the limit of the budget and funding. Members had questions on specific sites, terminology, details of the recommendation, and flow criteria recommendations.

Discussion and Direction Regarding Consultant's Work and Schedule Technical Support Contract
Brian Perkins, HDR Engineering, discussed the remaining options needed of the BBASC regarding the work provided by HDR under the technical support contract. He discussed the two theoretical projects which were evaluated by the BBEST and presented five surface water management strategies evaluated in regional water plans. He briefly summarized the type of project, the project's location within the basin, firm yield of the project, available instream, habitat, and geomorphology data, existing or proposed water rights associated with each, and whether the project is dominated by a senior water right. The first four projects listed are located on the Guadalupe River and the last is located in the San Antonio basins:

- GBRA Mid Basin (surface water only)
- GBRA New Appropriation in the lower basin
- GBRA Lower Basin Storage
- Aquifer Storage and Recovery, Storage above Canyon Reservoir

- Canyon Regional Water Authority Siesta Project.

Of the 5 projects from the regional water plans, he strongly recommended the GBRA Mid-Basin Project because it is a run of the river project with off channel storage and a significant firm yield that meets the needs of a regional water plan. The Mid-Basin Project is a new surface water right, has good available science, and is not dominated by senior water rights. Thus, the effects of different environmental flows on the project would be observable. Of the theoretical projects, he recommended a large run of the river diversion with off-channel storage at either Goliad or Elmendorf on the San Antonio River because sufficient habitat data is available and they are not dominated by senior water rights.

Mr. Perkins explained that each of the two projects will be evaluated using four scenarios; the BBEST recommendations, Lyons method, Region L consensus criteria, and no environmental flow constraints.

Garret Engelking recommended the BBASC select the GBRA Mid Basin Project and the theoretical run of the river with off-channel storage project at Goliad as the two projects for further evaluation under Task 1 of the scope of work. The committee approved the motion with two members abstaining. HDR was directed to proceed with these two projects.

Members Present: As several members were unable to stay for the afternoon session, there was no quorum at this point.

Mr. Perkins summarized the options for Task II of the scope of work discussed at the last meeting. Task II is the evaluation of six locations for a new diversion of up to 10,000 acre-feet under various environmental criteria including the base flow and subsistence flow criteria of the BBEST recommendations. The six locations chosen are:

- San Marcos River at Lulling
- Guadalupe River at Gonzales
- Guadalupe River at Victoria
- San Antonio River near Elmendorf
- Cibolo Creek near Falls City
- Mission River near Refugio

In response to a question during the last meeting, Mr. Perkins presented the TCEQ water availability maps for the Guadalupe and San Antonio River Basins to illustrate the areas where water is still available for appropriation in the basins.

For technical assumptions used in the modeling, members agreed to use the TCEQ water availability model and chose to include effluent in all the scenarios.

Members still needed to decide which springflow assumption to use. Since the Edwards springflows are very important to the Guadalupe River, members needed to choose which Edwards pumping scenario to use. He discussed the 5 options available noting the advantages and disadvantages of each.

Karl Dreher discussed his concern with the conservatism of the model and that the baseline conditions presented by HDR are not reflective of present conditions. Sam Vaugh noted that the present conditions were run for the BBEST as one of the 7 scenarios that range from the natural conditions to full use of water rights with no return flows. The time series of flows for the present condition are available. Mr. Dreher explained that using SB3 modflow as the model is probably the best option considering what options are available today. He estimated that an updated model run of the Edwards that more accurately reflects present conditions is probably 6 years away. Suzanne Scott stated the BBASC could identify the need for an updated run of the Edwards as part of the adaptive management plan since the tools are available as well as including an update of the TCEQ water availability model (WAM) to current time.

Tyson Broad moved to use the SB3 springflow set of the GWSIM4 for the years 1934 – 1946, and the SB3 modflow from 1947 – 1989 as the springflow assumption. Present members unanimously agreed.

Facilitation Contract

Susan Springer, The Rozelle Group, introduced herself to the BBASC members present and informed the group that her first task will be to contact up to 10 members of the BBASC by phone within the next week to get a cross section of stakeholder interests. During the 30 minute call, these members will be asked to comment on issues, expectations, and concerns related to the BBASC which will be compiled and used to determine how to proceed with the facilitation plans for all future meetings beginning at the April 6th meeting. The comments will be confidential in that comments will not be contributed to any individual. The findings will be presented to a core group composed of Suzanne Scott, Dianne Wassenich, Steve Raabe, and Sam Vaugh of the BBEST.

Set Next Meeting Date, Time and Location

The next meeting will be held at 10:00 a.m., Wednesday, April 6th, 2011 in New Braunfels. The following meeting is tentatively scheduled for April 19, 2011 in San Marcos. To limit time and travel expenses of consultants, meetings will be scheduled closer to Austin when consultants are required to attend. Meetings will be held in the lower basin when consultants are not required to attend.

Public Comment

Ron Outen, Rockport Navigation District Commissioner and The Aransas Project Regional Director, discussed the impact of drought conditions and low freshwater inflows on the fishing and recreation industry which the area depends on. He encouraged the BBASC to be clear in their recommendations in order that future predictions don't overshadow what is currently affecting those in the lower basin. Chair Scott reiterated that human impacts are part of the BBASC's charge.

Charles Smith, Aransas County Court Commissioner, noted his concern regarding salinity levels in San Antonio Bay and asked if the BBEST analytical tools were calibrated. Dr. Johns explained that the underlying mathematic procedure used in the evaluation is heavily dependent on the Texas Water Development Board (TWDB) model that relates inflow, salinity and other variables. The model was calibrated through October 2009 and captured the hypersalinity Mr. Smith discussed.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, April 6, 2011

New Braunfels Utility Service Center Training Room
355 FM 306
New Braunfels, Texas 78131

MINUTES

Members Present: Suzanne Scott, Chair; Dianne Wassenich, Vice Chair; Garrett Engelking; Jack Campbell; James Lee Murphy; Tyson Broad; Jerry James; Steve Fotiades; Jay Gray; Jennifer Youngblood; Chris Hale; Jerry James; Everett Johnson; Tim Andruss (for Thurman Clements); Roger Biggers (for Paula DiFonzo); Mike Mecke, Ken Dunton; David Crow; Bill Braden; Con Mims; Mike Peters; Steve Clouse (for Robert Puente); Kim Stoker; and Walter Womack.

Introductions and Public Comment:
Roll call was taken. Chairman Suzanne Scott introduced the facilitators, Marty Rozelle and Susan Springer, of the Rozelle Group. There was no public comment at this time.

Discussion and Agreement on Agenda
The draft meeting agenda was approved by consensus.

Approval of Minutes from the March 2, 2011 and March 15, 2011 meetings
Members discussed revisions to the minutes from the March 2, 2011 and March 15, 2011 meetings. The minutes for the March 2, 2011 and March 15, 2011 meetings, as amended per discussion, were approved by consensus.

BBEST Chair Report – Sam Vaugh
BBEST Chairman Sam Vaugh attended the March 16, 2011 SAC meeting which included a very preliminary review of the Guadalupe/San Antonio BBEST report. SAC members will expand on the comments made at that meeting based on further review, and a draft review document should be available soon. Comments will be discussed with BBEST members at the April 13, 2011 SAC meeting. The SAC hopes to submit final comments to the EFAG and BBEST by the end of April.

BBEST Chairman Vaugh stated that the BBEST was successful at staying within budget and funding allotted to assist the BBASC was still available. He proposed that the BBASC consider having Dr. Norman Johns perform the time series analysis and review as scoped, to determine if present conditions are in compliance with the criteria, and present his findings at the April 19, 2011 meeting. He further proposed that Dr. Johns perform the analysis and review on the findings of the technical consultants as scoped, and present those results at the May 5, 2011 meeting. Included in the scope is written documentation of the analysis and findings that can be included as a section in the BBASC report. Members approved by consensus the motion to direct Dr. Johns to proceed as proposed.

BBEST Chairman Vaugh relayed that TWDB and SAC had leftover funds that were available to the BBEST to assist the BBASC in development of the work plan that could be completed by the end of the fiscal year. Members discussed areas where additional work is needed including the list of adaptive management concepts in chapter seven of the BBEST report. The BBASC suggested development of a comprehensive list of work plan elements that would also include the factors and strategies previously identified by the BBASC. Chairman Vaugh was tasked to draft an initial list of issues for the work plan for presentation at the April 19, 2011 meeting.

In addition, the technical consultants were asked to provide an outline of the draft table of contents for the work plan, for review.

Cory Horan, TCEQ, reminded members to send questions to him for distribution to Chairman Vaugh and Dr. Johns.

Facilitated Discussion of Process to Reach BBASC Recommendations – Rozelle Group

Chairman Scott discussed the facilitation process. She announced the members of the core team which will ensure that the group meets all requirements and deadlines. Marty Rozelle, the Rozelle Group, explained the process and purpose of the facilitators. A summary of interview comments received from selected members of the BBASC were shared. She then led the group in the process to develop a purpose statement for the BBASC and then asked the group to review and comment on a list of parameter issues.

Facilitator Notes

- The facilitators, Dr. Marty Rozelle and Susan Springer, introduced themselves, asked each BBASC member to do the same, and reviewed the meeting objectives: Clarify and agree on BBASC mission and deliverables; discuss 'straw man' parameters; and agree on a method for keeping discussions on topic.
- Marty discussed the role of a facilitator and how it differs from a meeting moderator. Facilitators help design the process the group will use to reach their objectives. They have no opinion on the content or results.
- Susan summarized the results of the stakeholder interviews.
- The group worked individually and then in groups to clarify the mission of the BBASC and the product or outcome needed by September 1st. A draft statement was developed and will be finalized at the May meeting.
- The next task was to read through a list of 11 parameters or known facts created by the core group and based in part on the BBEST report. The group agreed that 6 of the statements were factual. More discussion is need on the remainder.

Set Next Meeting Date, Time and Location

The next meeting will be held at 10:00 a.m. on Tuesday, April 19, 2011 at Dunbar Recreation Center in San Marcos.

Proposed Agenda Items:

- HDR/Technical consultant status report
- Dr. Johns presentation on the Bay and Estuaries
- Update on BBEST presentation at SAC April 13th Meeting - BBEST Chair Sam Vaugh
- Discussion of how BBEST regime recommendations can be implemented

Public Comment

There was no public comment at this time.

Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, April 19, 2011

Dunbar Recreation Center
801 MLK
San Marcos, Texas

MINUTES

Members Present: Suzanne Scott, Chair; Dianne Wassenich, Vice Chair; Bill Braden; Tyson Broad; Thurman Clements; David Crow; Paula DiFonzo; Ken Dunton; Jennifer Ellis (for Everett Johnson); Steve Fotiades; Jay Gray; Chris Hale; Rick Illner (for Karl Dreher); Jerry James; James Lee Murphy; Mike Mecke, Mike Peters; Robert Puente; Steve Rabbe (for Con Mims); Charlie Smith (for Jack Campbell); Kim Stoker; Walter Womack and Jennifer Youngblood.

I. and II. Introductions and Public Comment:

Roll call was taken. BBASC alternate Charlie Smith introduced several members of Aransas County government who were in attendance. Mr. Smith discussed the SB 3 process and also discussed impacts to SA Bay from continued permitting.

III. Discussion and Agreement on Agenda

The draft meeting agenda was approved by consensus.

IV. Approval of Minutes from the April 6, 2011 meeting

Minutes for the April 6, 2011 meeting were approved by consensus.

V. BBEST Chair Report – Sam Vaugh

BBEST Chairman Sam Vaugh reported on the remaining BBEST funds to assist the BBASC and potential funds that SAC may have available for further assistance. He presented a handout of the second round of preliminary comments on the BBEST report by a subcommittee of SAC members, and added that the comments will be finalized by the end of April. He discussed the process used to produce the comments, and highlighted points of special interest from the handout. He noted that the overall opinion on the instream analysis was the BBEST should have used more science available from the SB2 program, however the SAC responded favorably to the estuarine analyses. Steve Rabbe mentioned that the Texas Instream Flow Program will provide an interim report in June that could be used to assist the BBASC in their deliberations. Suzanne Scott will contact SAC member Dr. Ward and request a presentation to the BBASC on the final SAC comments. The next SAC meeting is scheduled for May 11, 2011.

VI. Report on Bay and Estuary Time Series Analysis, Part I – Norman Johns

Dr. Norman Johns gave a presentation on the bay and estuary time series analysis that was completed at the direction of the BBASC. He reviewed the estuary criteria, need for the time series evaluation, and the approach used for the evaluation. He discussed the results of the analysis with respect to attainment of criteria for rangia clams and oysters. Dr. Johns will perform the analysis and review of the findings including evaluating biological consequences of HDR’s work on Tasks I and II, and those preliminary results will be presented at the May 4, 2011 meeting. The final results of all of Dr. Johns' analyses will be presented at the BBASC meeting on June 1, 2011. The final technical memo summarizing the findings of all analyses requested by the BBASC will include a review by the BBEST estuary committee with a tentative deliverable date in June. The resulting technical memorandum will be included as an appendix to the BBASC report.

VII. BBEST Recommendation Implementation Framework – Vaugh
BBEST Chairman Sam Vaugh gave a presentation on the implementation of the BBEST flow regime recommendations, and the specifics and details of how it works. He discussed how the recommendations might be applied using the BBEST flow regime recommendations for the San Antonio River at Goliad. The BBEST Goliad flow regime recommendation included a subsistence flow, three levels of base flow (based on hydrologic conditions) and five levels of pulse flows. BBEST Chairman Vaugh distributed and discussed an example application that included numerous scenarios including different seasons, hydrologic conditions, streamflow levels, the flow regime recommendations and how it may apply for a proposed diversion or impoundment of water.

VIII. HDR Status Report and Draft BBASC Report Table of Contents – Perkins
Brian Perkins, HDR, presented a status report on the work being done by HDR. He said the results of the analysis for Task I (the two large firm yield projects) and Task II (the six locations for a new run-of-the-river diversion of up to 10,000 acre-feet) will be presented in their entirety at the May 4, 2011 meeting. Mr. Perkins distributed a draft table of contents for the BBASC recommendations report. Members discussed the six major sections in the outline and proposed revisions to the table of contents.

IX. Presentation of Draft Work Plan Elements – Vaugh
BBEST Chairman Vaugh distributed handouts and presented the first draft of the table of contents for the work plan for adaptive management. He discussed the statutory directive for adaptive management and other guidance documents available to the BBASC. BBEST Chairman Vaugh will integrate BBASC work plan related topics and provide a budget estimate for the work assigned to the BBEST at the next meeting. BBASC Chairman Scott said any decisions on the subcommittee that will be formed to work on the work plan will be deferred until the May 4, 2011 meeting.

X. Set Next Meeting Date, Time and Location
The next meeting will be held at 10:00 a.m. on Wednesday, May 4, 2011 at GBRA River Annex. Members were asked to reserve Thursday, May 19, 2011 as a tentative meeting date.

Proposed Agenda Items:
- Presentation by Brian Perkins (HDR) on final results of Task I and Task II technical analysis
- Presentation by Dr. Norman Johns on preliminary evaluation of HDR results on Tasks I & II
- Formation of the Work Plan subcommittee
- Presentation on the Work Plan Elements.
- Presentation by SAC members on the final comments on the BBEST report.
- Presentation by Watermaster on how special conditions may be implemented/operated

XI. Public Comment
Richard Bianchi stressed the importance of taking care of the bays and stated he appreciates

the time and effort spent on this issue by the BBASC.

XII. Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, May 4, 2011

Guadalupe-Blanco River Authority, River Annex
905 Nolan, Seguin, Texas 78155

MINUTES

Members Present: Suzanne Scott, Chair; Dianne Wassenich, Vice Chair; Bill Braden; Tyson Broad; Thurman Clements; David Crow; Paula DiFonzo; Ken Dunton; Gary Middleton (for Jerry James); Everett Johnson; Steve Fotiades; Jay Gray; Chris Hale; Karl Dreher; James Lee Murphy; Mike Mecke; Mike Peters; Robert Puente; Con Mims; Jack Campbell; Kim Stoker; Walter Womack; Garrett Engelking; West Warren; and Jennifer Youngblood.

I. and II. Introductions and Public Comment:
Roll call was taken and a quorum was reached. Jennifer Ellis distributed a newspaper article from the Houston Chronicle describing a project by the City of Houston and several conservation organizations as an example of potential strategies that can be used to meet environmental flow standards. She added that a white paper by NWF on proposed strategies will be presented at the next meeting. Liz Smith talked about a project funded by the Coastal Bend Bay and Estuary Program (CBBEP) to identify sites for conservation and restoration in the San Antonio Bay estuary to be completed by August, 2011. Betty Stiles, representing Aransas County, announced that the Navigation District recently approved the University of Texas Marine Science Institute (UTMSI) to study blue crab larva in the bay and estuary system, and would appreciate the BBASC's efforts to preserve the freshwater needs of the area.

III. Discussion and Agreement on Agenda
The draft meeting agenda was approved by consensus.

IV. Approval of Minutes from the April 19, 2011 Meeting
Minutes for the April 19, 2011 meeting were approved by consensus.

V. Facilitators Report including Review and Consensus on BBASC Purpose Statement (Marty Rozelle, Rozelle Group)
Marty Rozelle, Rozelle Group, reviewed the draft purpose statement and role of the facilitator in group discussions. Susan Springer, Rozelle Group, talked about the ground rules for use during the meeting. Members discussed revisions to the draft purpose statement in light of the SB3 charge, and approved the purpose statement as amended.

VI. Technical Evaluations with Facilitated Discussion of Water Supply Project Firm Yields and New Run-of-River Permits (Perkins, Oborny, Johns)

Task I–San Antonio River Project
Brian Perkins, HDR, discussed the San Antonio River (Lower Basin) project near Goliad, a large theoretical project needed to meet one of the two project requirements of Task I of the charge. The project consists of a large run of the river diversion from the San Antonio River near Goliad to an off-channel reservoir for subsequent uniform delivery of the firm yield to the Twin Oaks Water Plant. Mr. Perkins discussed the hydrologic conditions and how the

project was evaluated using the four scenarios; the BBEST recommendations, Lyons method, consensus criteria (CCEFN), and no environmental flow constraints. He explained how the amount of the flows diverted and/or left in the river is determined by needs of senior water rights, environmental flow constraints, pipeline constraints and permit constraints. He walked through an example to explain the process used to determine firm yield and apply the environmental flow criteria, before comparing the project costs based on results from each criteria.

Ed Oborny, Bio-West focused on the instream assessment of the Goliad project including evaluation of the magnitude, frequency and duration of flows, and the quantitative ecological ramifications from the project. He discussed what magnitude, frequency, and duration mean to the project based on the four levels of flows: subsistence flows, base flows, high flow pulses and overbanks. He talked about the existing studies completed in the area on species, riparian communities and their relationship to flow, and sediment transport. He said the evaluation of the project focused on water quality (dissolved oxygen and temperature) at low flows; habitat availability at the subsistence and base flow levels; riparian communities and their link to flow pulses; and changes in total annual volume which are important components in riparian communities and sediment transport. He explained the tools available and how they are used.

Mr. Oborny explained how to use the results and the different displays available to spatially relate flow, habitat, species, and water quality. He said the results of the study are supportive of the project except for the following:

- "Stress" at the subsistence flow level of the BBEST recommendation based on the water temperatures during extremely hot months (July and August);
- A 10% annual reduction in sediment yield may be a concern depending on clarification of the BBEST recommendation.

He mentioned that a presentation on sediment transport was planned for the May 11, 2011 SAC meeting and welcomed members to attend.

BBEST member Dr. Norman Johns reviewed the criteria developed for the BBEST recommendations. He talked about the spring criteria based on rangia and summer criteria based on oysters; and for each criteria, an attainment frequency that needed to be met based on the historic record with some allowable level a departure. He discussed how the Goliad project was evaluated on these criteria using various scenarios; natural, historical, present, Region L baseline (full water rights), and TCEQ (full water rights use and no return flows). He said his review used the monthly net flows into the estuaries adjusted for the addition of the Goliad project. Dr. Johns said his review of the effects of the project with the BBEST recommendation applied indicated that the instream flow criteria are doing a pretty good job. He added that the lack of flow is as a result of existing water rights and the project has minimum effect on those flows. BBEST Chair Sam Vaugh added that the BBASC can address issues with existing water rights as part of the recommended strategies to meet environmental flow standards.

Marty Rozelle introduced members to an exercise to determine whether the BBEST recommendations as applied to the hypothetical projects are balanced or restrictive of environmental and/or other needs. Chairman Vaugh asked members to consider the request as to whether the BBEST recommendation unduly restricts yield or the environment. The ultimate objective of the exercise is to determine what action will be taken under Task III and to provide direction to the technical consultants as to needed modifications to the BBEST recommendations and/or process of evaluation.

Task I–GBRA (Mid Basin) Project

Brian Perkins, HDR, presented the GBRA mid basin project near Gonzales similar to a project in the Region L Water Plan and the second large theoretical project needed to meet the requirements of Task I of the charge. The GBRA project is a large run of the river diversion from the Guadalupe River near Gonzales to an off channel reservoir for subsequent uniform delivery of firm yield to Luling and San Marcos water treatment plants. As was presented for the first project, Mr. Perkins discussed the description of the GBRA project, firm yield calculations, and cost of the project. He discussed changes in the basic assumptions used in the evaluation from those used for the first project. He said that the BBEST recommendation had a greater effect on the yield because it is located in the middle of the basin unlike the San Antonio Project which is located in the lower basin, and the diversions in the Guadalupe Basin outweigh the return flows. Regarding the costs, Mr. Perkins was asked to look into the infrastructure costs to explain why the construction costs were so much higher when compared to the first project.

Mr. Ed Oborny, BioWest, presented the instream assessment of the GBRA project evaluated using the same process as for the San Antonio project. He noted that unlike the San Antonio project, the habitat suitability curves for the GBRA project were developed from generic statewide data, and show a wider range of suitable habitat. Therefore, the results from the various scenarios were the same. He recommended further evaluation of base flows because of the way the curves were generated. He noted the results also indicated that it would be difficult to meet an annual sediment yield of 10% change.

BBEST member Dr. Norman Johns talked about the results from the estuary ecology evaluation of the GBRA project. He said that the results indicated very little water available for diversion.

Discussion and Direction to Technical Consultants on BBASC Recommendations of Environmental Flow Standards (Task 3) (Perkins)

Mr. Perkins stated that the BBEST recommendations along with CCEFN and Lyons had been evaluated using two sample projects, and asked the BBASC for direction on how to proceed. He added that after seeing the effect of the BBEST recommendations on the two sample projects, members needed to decide if there is a need to increase yield by taking water from the streams or a need to leave more water in the streams for the environment. If an adjustment is needed, he asked what changes if any the members would want to make to the BBEST recommendations or what new direction is needed to be evaluated for members to complete the final BBASC recommendation. He provided a handout with possible options. Members discussed the options available. Members recommended the following for further review:

- Left hand column – No. 1 using SB2 numbers in San Antonio & Q95 in Guadalupe
    - full analysis (river ecology, estuary ecology, and cost) Presented June 1st
- Left hand column – No. 2 Eliminate Diversions Below Baseflows Presented June 1st
    - full analysis
- Right hand column – No. 3 Eliminate Some/All Pulses
    - Yield results and flow numbers
- Right hand column – No. 4 Place Hydrologic Conditions on Pulses
    - Yield results and flow numbers
    - Members to decide on how to model May 19th with results on June 1st

New Task II Run of the River Unappropriated Flow Discussion
The discussion for the new run of the river unappropriated flow discussion was postponed until the next meeting. Dr. Perkins stated that the technical support work can be done at a later date, and the question to address is how to define the threshold between a large and a small project which has been tentatively defined as 10,000 acre-feet. Members requested that the presentation for this discussion be distributed prior to the meeting.

X. Set Next Meeting Date, Time and Location
The next meeting will be held at 10:00 a.m. on Thursday, May 19, 2011 at GBRA River Annex.

Proposed Agenda Items:

- Presentation of SAC Review Comments on the BBEST Report
- BBEST members to discuss the Estuary Effects
- Discussion of TPWD letter commenting on the GSA BBEST report
- Presentation by Brian Perkins (HDR) on final results Task II technical analysis
- Presentation by Dr. Norman Johns on preliminary evaluation of HDR results on Tasks II
- Formation of the Work Plan subcommittee
- Presentation on the Work Plan Elements.

XI. Public Comment
Tony Smith suggested additional changes to the draft objective statement.

XII. Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Thursday, May 19, 2011

Guadalupe-Blanco River Authority, River Annex
905 Nolan
Seguin, Texas 78155

MINUTES

Members Present: Suzanne Scott, Chair; Dianne Wassenich, Vice Chair; Tyson Broad; Thurman Clements;; Paula DiFonzo; Karl Dreher; James Dodson (for Ken Dunton);; Everett Johnson; Steve Fotiades; Jay Gray; Chris Hale; Jerry James; James Lee Murphy; Mike Mecke; Mike Peters; Steve Clouse (for Robert Puente); Con Mims; Jack Campbell; Kim Stoker; Walter Womack; Garrett Engelking; Everett Johnson; and Jennifer Youngblood.

I. and II. Introductions and Public Comment:
Roll call was taken and a quorum was reached. Jennifer Ellis distributed and discussed the white paper by NWF on potential strategies for meeting environmental flow standards. Chair Suzanne Scott added that the white paper will be a good resource when members consider potential strategies as they relate to the BBASC recommendations.

III. Discussion and Agreement on Agenda
The draft meeting agenda was approved by consensus.

IV. Approval of Minutes from the April 19, 2011 Meeting
Approval of the minutes for the May 4, 2011 meeting as well as the May 19, 2011 meeting will be considered at the next meeting.

V. Review of TPWD and SAC Comments on BBEST Recommendations (Dr. Dan Opdyke, Dr. George Ward, and Ed Oborny)

TPWD Comments on the BBEST Recommendations (Dr. Dan Opdyke):
Dan Opdyke, TPWD, discussed the TPWD comments regarding the BBEST recommendations. He noted that TPWD commended the BBEST committee for their efforts and supported the BBEST recommendation with one exception; the low flow value applied to support critical water quality and habitat needs during very dry times. BBEST Chairman Sam Vaugh added that it was the intent of the BBEST to apply the instream flow recommendation below the last gage in the river. Chair Scott asked if it was possible for HDR to present a comparison of 7Q2, BBEST recommendation, and Q95 at the next meeting using the available 7Q2 data.

Summary of SAC Comments (Dr. George Ward):
SAC member Dr. George Ward presented a slideshow summarizing the SAC review of the science used to develop the BBEST recommendation. He noted that the SAC felt the BBEST recommendation was the best seen to date He explained how the SAC used standardized questions to review all BBEST reports, and the written responses prepared for each question. He stated that SAC was concerned that the recommendation was based on flow regimes derived from historic flow and not founded on a clear connection between levels of flow and the metrics of ecosystem health. He commended the BBEST on the new analysis developed and its value in future environmental flow studies. However, the SAC felt the report fell short

of its potential due to the complexity of the task, limited resources and time constraints.

VI. BBASC Questions on BBEST Recommendations and SAC - TPWD Comments
Instream BBEST Subcommittee (Dr. Thom Hardy, Ed Oborny):
Dr. Thom Hardy responded on behalf of the Instream BBEST Subcommittee. Dr. Hardy felt the SAC comments were accurate and added that additional analysis was completed that did not make it into the report. He noted that the present review process, as defined in SB3, does not allow for revisions in the BBEST report after submittal. He presented several findings of the BBEST that addressed noted concerns. Dr. Hardy explained that the results of the additional work requested by the BBASC to incorporate the newly available data in the analysis and report the effects on the existing recommendation, should be ready by the first week of July. Chairman Vaugh added the BBEST will attempt to address the issues identified by the BBASC through continued interaction between the BBEST and BBASC.

Estuary BBEST Subcommittee (Dr. Norman Johns and Dr. George Ward):
Dr. Norman Johns responded to the TPWD and SAC review of the report. He introduced the members of the estuary subcommittee who were present at the meeting. In response to SAC comments, he stated that findings of the SAC were misleading in that the attainment frequency for the focal species was not universally based on historical statistics. BBEST member Ed Buskey discussed the species/freshwater inflows relationship and why the number of focal species was limited.

VII. Progress Report on Bay and Estuary Time Series Analysis, Ecological Impacts (Dr. Norman Johns)
Dr. Johns presented a progress report on the time series analysis and resulting ecological impacts. He discussed the purpose of indicator species and the problems seen in the low flow regimes. He outlined the issues of concern and opened the floor for a panel discussion with subcommittee members. Subcommittee members noted the white shrimp was not used as an indicator species because of insufficient data to link inflows to white shrimp abundance. Dr. Johns indicated that the subcommittee is still working on the biological implications of each flow regime and trying to determine if a pattern in the occurrence of non-attainment years is meaningful.

Chair Scott stated that members were concerned with what impact will be seen on the environment when existing water rights utilize their full authorizations especially since the results of the analysis show that impacts will occur when flow recommendations are applied.

Brian Perkins, HDR, suggested providing members with some biological opinion on the impact of existing water rights using the Region L baseline (existing water rights and return flows), and their impact would be with the addition of the test projects. He proposed a two part memo; part one, discussing the impacts of full utilization of existing water rights using the Regions L baseline; and part two addressing whether there are additional concerns for adding projects. Members agreed to direct the technical consultant to perform the additional analysis. BBEST Chair Vaugh stated that a portion of the additional work was within the existing budget. However, additional funds may be needed.

VIII. Technical Evaluations of Application of BBEST Flow Recommendations on New Run-of-the-River Permits (Sam Vaugh, HDR)
Sam Vaugh, HDR, presented the technical evaluations performed for a new run of the river application for a diversion of 10,000 acre-feet as directed by the group. He explained the difference between a run of the river project and a diversion from storage. He described the

parameters used and process followed. He discussed the results of applying the three flow options: no environmental flow, Lyons Method, and the BBEST recommendation. He said after looking at a hypothetical application for a 10,000 acre-foot diversion at numerous locations in the basin, the results indicate that an individual 10,000 acre-foot diversion has minimal impact on the stream flow in the basin. He added that the question the BBASC needed to address is whether a 10,000 acre-foot threshold is an appropriate recommendation for projects not requiring pulse flow requirements.

Members discussed the results represented and considered the need for seasonality or additional evaluation for the impact of multiple, simultaneous applications. Mr. Vaugh suggested that an analysis of the impact of using a 10,000 acre-foot diversion at all six locations to determine the cumulative impact. Members agreed by consensus that the group was not ready to make a recommendation and directed the technical consultant to provide further information on seasonality. Members will continue the discussion at the next meeting.

IX. Follow-Up on BBASC Balancing Analysis Requests Regarding Flow Recommendations Relating to Water Supply Projects (Sam Vaugh, HDR)

Sam Vaugh, HDR, discussed the technical analysis of the BBEST recommendations on the two large firm yield projects; San Antonio River Project and the Mid- Basin Project. He noted that the cost figures were revised to correct the errors discovered at the last meeting. He briefly described each project and discussed the results from each of the analyses; CCEFN (Consensus Criteria), no flow restriction, Lyons method and BBEST recommendations for each project. He outlined the increase in firm yield by removing components of the flow recommendations from maximum to no restrictions. Members discussed the results and considered whether further work was needed.

With regard to the balancing scenarios recommended at the May 4th meeting for analysis, Mr. Vaugh presented the options available for hydrologic conditions on pulses available for technical analyses of GSA BBEST recommendations. Chair Scott stated that although at the May 4th meeting an analysis of the TCEQ approved flow framework for the East Texas basins was not recommended as a balancing option to analyze, upon further consideration it may provide a structure to evaluate the impact of modifications to pulses. She noted that instead of having the consultants create several iterations of pulse scenarios, applying the approved TCEQ structure from the East Texas basins could provide the BBASC with an analysis of the impact modifications to pulses could have on project yields along with an assessment of the impact such changes to yields would have on flows to the bays and estuaries.

Many members of the BBASC expressed concerns with the approved TCEQ structure for the East Texas basins stating that those standards are not be protective of environmental flows. Chair Scott suggested that the analysis would be performed as a balancing evaluation along with the others the BBASC recommended. The data from all the analyses would be used as the basis for the BBASC environmental flow recommendations.

Mr. Vaugh reviewed how the options are weighted in terms of human and environmental needs and the BBEST recommendations.. He discussed the 4 options and some of the ecological and other conditions that would result from the pulses for each. Members discussed the options and agreed by a vote of 15 to 4, the group was comfortable with the use of the "East Texas /TCEQ" structure for evaluation purposes only. Members asked that historical flows be added on future slides of flow frequency curves.

Mr. Vaugh stated that by mid-June the instream subcommittee should be completed with the new task and the estuary subcommittee should have the basic biological opinion on baseline flows.

X. Discussion Regarding Work Plan Development

Chair Scott referenced the draft Work Plan table of contents and work elements distributed at the last meeting as well as the list of potential strategies. She stated the work plan elements were a combination of all the suggested work elements from the BBEST and BBASC. BBEST Chair Vaugh explained the handouts and outlined the steps that can be taken by the BBEST to support the work plan development. He emphasized the importance for the group to determine the directive to the BBEST so time and cost can be allotted appropriately for the June 1st deadline. The following members volunteered to serve on a subcommittee to address the work plan development: Tyson Broad, James Lee Murphy, Mike Peters, and Chair Suzanne Scott.

XI. Discussion Regarding West Warren's Resignation from BBASC

Members considered the resignation of West Warren and discussed whether to replace Mr. Warren or leave the position vacant. Members agreed by a 12 to 4 vote to appoint Jennifer Ellis, representing Recreational Water Users, to the BBASC.

XII. Set Next Meeting Date, Time and Location (June 1, 2011)

The next meeting will be held at 10:00 a.m. on Wednesday, June 1, 2011 at Cuero

XIII. Public Comment

Vice Chair Dianne Wassenich noted an incident regarding D&L usage of water from San Marcos River.

XIV. Adjourn

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Wednesday, June 1, 2011

Chisholm Trail Heritage Museum, Wofford Room
302 N. Esplanade Street
Cuero, Texas

MINUTES

Members Present: Suzanne Scott, Chair; Dianne Wassenich, Vice Chair; Tyson Broad; Thurman Clements; David Crow; Paula DiFonzo; Earl Matthews (for Everett Johnson); Steve Fotiades; Chris Hale; Jerry James; James Lee Murphy; Mike Mecke; Mike Peters; Con Mims; Jack Campbell; Kim Stoker; Walter Womack; Garrett Engelking; Bill Braden; James Dodson (for Ken Dunton); Josh Gray (for Jay Gray); Jennifer Youngblood; Steve Clouse (for Robert Puente); and Jennifer Ellis.

I. Introductions:

Roll call was taken and a quorum was reached. Member Bill Braden welcomed members to the Chisholm Trail Heritage Museum. Robert Oliver, Chairman of the Board for the Chisholm Trail Heritage Museum gave members a brief history of the museum.

II. Public Comment:

Mr. Richard Fritz of Victoria spoke of the May, 2011 BBASC meetings and his concern that the BBASC and BBEST were not considering human needs and the needs of the commercial fisherman to the same degree as those of the environment. He urged members to consider the needs of all the stakeholders.

Mr. Charles Smith of Aransas County representing a large group of noted members in the community stated that the full utilization of water rights would not be beneficial for the county and spoke of the loss of habitat and decline of aquatic species due to the lack of instream flow. He urged members to focus on the work of the BBEST in determining their recommendations.

The Honorable Ron Outen, Aransas County Navigation District Commissioner, spoke about the ecological response to loss of inflows and the process used by the BBEST and BBASC. He stated that the BBEST report was based on scientific methodology and lacked the benefit of personal knowledge from individuals who have direct experience in the bay area having seen what the lack of flow has done through the years. He noted that the salinity approach used is flawed when applied to motile species since these species don't move as was suggested by the BBEST.

Leslie "Bubba" Casterline, Aransas County Commissioner, talked of the effects of high salinity on oysters and his disappointment with the Region L Planning Group's lack of consideration of the need for inflows in the bay areas. He considered the salinity approach flawed when used for motile species since these species don't move as was suggested by the BBEST, and the environmental conditions are critical in the larval stage.

Mr. Steve Barrett, Harbormaster, stated that the health of recreational and commercial fishing affects the economy of the area, and river inflows have a direct impact on the fish and bait population. He talked about the Whooping cranes and how the loss of forage due to low inflows has directly impacted the population.

Mr. Steven Andrews, a recreational fisherman, discussed the effect of droughts on fishing and the commercial fishing industry.

Ms. Jane Wendt discussed the impact of the increasing number and use of water rights on the bays since the 1970s.

III. Discussion and Agreement on Agenda
Chair Suzanne Scott discussed the revisions made to the agenda. The agenda as revised was approved.

IV. Approval of Minutes from the May 4, 2011 and May 19, 2011 Meetings
Approval of the minutes for the May 4, 2011 and the May 19, 2011 meeting will be considered at the next meeting.

V. Preliminary Results of BBASC Balancing Analyses for Exampled Water Supply Projects Near Goliad and Gonzales (Brian Perkins, HDR)
Chair Scott, gave an overview of what has been completed and what results are forthcoming. She asked members for their perception of where the BBASC is in the recommendation process and what additional effort is needed for members to reach their objectives.

Mr. Brian Perkins, HDR, addressed two issues brought up at the last meeting. In response to the instream subcommittee's question concerning seasonality of when water is available with respect to Task II run of the river diversions, Mr. Perkins checked random locations and found no seasonality patterns. In response to the TPWD proposing to raise the subsistence flow level and the request to compare the 7Q2, BBEST recommendation, and Q95 using the 7Q2 data, Mr. Perkins presented a table showing the comparison of the methods on 16 specified sites. Results indicate that the 7Q2 method was higher than the BBEST recommendation and Q95 values.

Mr. Perkins gave a quick recap of what was presented at the last meeting on Task I (6 run of the river projects) and Task II (2 large firm yield projects) comparing the Lyons method, CCEFN (Consensus Criteria), no flow restriction and the BBEST recommendation. With those comparisons completed, he stated Task III is to apply modifications to the BBEST recommendations and review the results to determine the best recommendation.

Mr. Perkins presented the results of increasing the subsistence flow to the SB2 estimates at Goliad and Q95 estimates at Gonzales. Increasing the subsistence to both the SB2 and Q95 estimates reduced the firm yield.

He also presented the results of the additional BBASC charge to look at two iterations of the full comprehensive method (including yield, cost, flows and the ecological effects of those) at two sites. The first scenario eliminated diversions below base level so once base flow was reached, there were no diversions at the subsistence flow level. Mr. Perkins indicated that the reduction in firm yield seen did result in increase flow in the river. However, the increase flow during periods of drought is more a result of flow left in the river to satisfy downstream senior water rights. He added that it should be considered whether increased flow is a result of flow criteria or senior water rights. The second scenario used the TCEQ adopted flow standard structure with the BBEST recommendation numbers which resulted in an increase in firm yield.

SAC member Dr. Ed Oborny discussed the ecological impact of the results. He stated that at low flow conditions there is no difference between TCEQ structure and the BBEST recommendation since the TCEQ recommendation has subsistence and a base dry. Differences are seen at the intermediate flow which can be captured using pulses. The differences become more obvious with the addition of multiple projects.

BBEST member Dr. Norman Johns discussed the bay and estuary impacts. He discussed the historical inflows into the bay and estuaries and compared them to the drought of 2009. He presented tables on different scenarios on the Guadalupe project with different criteria applied to see the impact on flows and species in the bay and estuaries.

VI. Review and Discuss Potential Strategies to Meet Environmental Flow Standards (Johns, Ellis)

BBASC member Jennifer Ellis distributed a revised list of potential strategies developed by National Wildlife Federation. Ms. Ellis gave an overview of the strategies listed in the handout. BBASC member James Murphy noted that the group should realize that these strategies are for future needs and not existing needs especially considering that the BBEST determined that there is an existing sound ecological environment.

Dr. Norman Johns noted that this is a National Wildlife Federation (NWF) project and the foundation intended to contribute funding to the process. He noted that to complete the analysis of specified strategies by June and present the results to the BBASC in July, the consultants would need to begin next week. Dr. Johns explained that to investigate the different strategies, the Water Availability Model (WAM) is used to predict inflows to the estuaries. Strategies he discussed included dedicating wastewater return flows, “dry year option” or unused irrigation water rights for not planting, unused water rights, and the Edwards Recovery Implementation Plan (ERIP) to protect spring flows.

Dr. Johns also mentioned the potential to use some of the monies acquired by the state from the British Petroleum settlement to build up the resiliency of the estuaries to prevent similar impacts from potential oil spills. Member Con Mims noted that the RIP project is at a critical stage and asked that the group avoid considering involvement with the RIP at this time.

Members directed Dr. Johns to investigate the following strategies: voluntary dedication of return flows (or wastewater dedication), “gap” approach, unused water rights by category, and the “dry year” strategies. The motion to direct Dr. John to investigate these options was approved by majority (21 in favor).

VII. Full Group Discussions

Chair Scott opened the floor for discussion. Based on all information received and analyses to date, members were asked to provide feedback on BBEST recommendations and identify additional information/analyses required from BBEST and the technical consultants.

Members noted the following as favorable elements of the BBEST recommendations.

- Pulses: Use of pulses good for the bays and estuaries and narrative support for the use provided in the report. BBASC should emphasize pulses source of nutritional flows;
- Sound Ecological Environment (SEE): First good description of conditions needed in rivers, bays and estuaries of SEE;
- Subsistence flow “rule”: Defining subsistence flow as 50% of baseline a positive approach;
- Instream Flow Recommendations: Use of a range provides easier means for implementation;
- Estuary Inflows: Favored the fresh approach and appreciated effort in moving away from the state methodology though had concerns with some of the elements;
- Estuary Needs: Appreciated recognition by the BBEST of the estuaries’ need for all

types of flows to create a healthy environment.
- Confidence in Recommendations: Members are confident in the recommendations because of the expertise of the BBEST members, and science used to develop them;

Members noted the following as concerns regarding the BBEST recommendations.
- Flow Requirements of the Bay: Understanding of the flows;
- Consideration of Habitat: Use of habitat curves to support Recommendations. Some linkage seen in San Antonio basin however don't appear to be present in Guadalupe basin;
- Lack of Effort in Headwaters: More effort needed to address springs and groundwater interaction and contribution to the flows. Don't appear to be considered as that important;
- Methodology used to derive Subsistence levels: Lack of justification as to why HEFR used over Q95 especially in light of TPWD letter;
- Indicator Species: Oysters and *rangia* are not motile species and thus are not representative. Failed to show importance of timing of inflows. Would like to see white shrimp or blue crab used;
- Length of Period used for Assessment: Evaluating flow on monthly or seasonal basis not adequate. Three years needed to restore bays. Assessment should be based on broader basis;
- Default Analyses: Instream flows defaulted to HEFR and Bay & Estuary flows defaulted to indicator species. Did not utilize wetland habitat evaluation, geomorphology concerns, and nutrient components to evaluate this complex system;
- Adequate Data: Not adequate data in bays and estuaries to come up with predictive tool;
- Estuary Flows Addressed in Permitting Process: Not a clear understanding of how it will occur.
- Limitations of SB3 Charge: Conditions (time, etc.) established for process by legislature limited ability to thoroughly evaluate charge and may result in a recommendation more protective than needed;
- Concept of Existing flow restrictions vs. Rules for Future: BBEST should have focused on assessment of every aspect of basins to present a concept of what a SEE is, how it is defined and what is needed. Role of BBASC is to recommend how to preserve and improve environment in the future. Did not address lowest stretches of the rivers, long pulses. Should have started with the estuaries.
- Address the Entire System: Report should have addressed the system as a whole and assessed all components and their contributions. Lacked "linkage";
- Mission and Aransas Rivers not linked to the overall system
- TPWD Concerns: Need to capture concerns of TPWD.
- Integrated system: Recommendations focused on flows and elements in the river. Estuary has different issues and assessment was insufficient and should have been given equal attention.

Members noted the following as how the BBEST recommendations can be altered to address these concerns.

Understanding the flows to the Bay:
- BBASC directed Dr. Johns to perform analysis to provide a better understanding of the type of flows and provide a linkage between instream and freshwater inflows to the bay;
- Need monitoring of flows below Victoria;
- Need access to monitored flow data over the saltwater barrier
- Flow challenges of bay may not be addressed with BBEST recommendations as applied to future water rights;

Consideration of Habitat Curves:
- Instream flow subsistence flows on the San Antonio River
- Funding SB2 work on Guadalupe River

Lack of Effort on Headwaters
- Groundwater/Spring water Interaction. Better monitoring, more data collected and analyzed for spring flow, groundwater flow and gages on headwaters.
- Better understanding of contribution of headwaters on streamflow. Do these have any relevance other than releases from Canyon Dam and what is groundwater impact on rivers downstream fed by groundwater (Comal and San Marcos)
    - Above Kerrville
    - Comfort and Canyon North
    - Medina River
- Determine the proportional impact of groundwater derived flows in work done by Dr. Johns

Methodology used to derive Subsistence levels
- At last meeting Dr. Dan Opdyke discussed TWDB comments and he will provide a list recommendations to address their concerns at a later date

Indicator Species
- The fact that better species are available should be mentioned and other ways to evaluate this are available should be mentioned in the report. Also recognize existing methodology as well as other methods may have utility.
- UTMSI will study blue crab in Rockport pending available funding

Length of Period used for Assessment
- Increase the period used for assessment

Default Analysis
- Acknowledge the uncertainty of the recommendation and provide TCEQ more regulatory flexibility in applying rules. More stringent rules for instream flow and the use of adaptive management in measuring the effects on bay and estuaries

Estuary Flows Addressed in Permitting Process
- BBEST reports assumes all flows recorded by the most downstream gage flow to the estuary. Possible establishment of "Fail Safe Override" in cases of extremely high salinity

Limitations of SB3 Charge
- Address concerns through policy decisions and the workplan

Address the Entire System
- Consider the entire watershed
- Allow TPWD to make recommendations on how to handle the bay and estuaries through adaptive management

Mission and Aransas Rivers and Copano Bay
- Determine the influence of Mission and Aransas on the system. What if these rivers stop flowing

Integrated System
- BBASC directed time series work by Dr. Johns

VII. Review Dates and Agenda Topics for Remaining July and August Meetings

The next meeting will be held at 10:00 a.m. on Wednesday, July 6, 2011.

Agenda Topics
- Presentation draft report by Brian Perkins (HDR) due July 15
- Presentation of preliminary evaluation of strategies, (NWF) due July.
- Presentation of Instream Flow Recommendations on San Antonio by Dr. Hardy
- Report on Ecological Impacts on "Brown boxes" by Dr. Johns
- Presentation on Task 4 (qualitative analysis of invasive plants, GMA 9, Climate Change

by Brian Perkins, HDR in July or August

- BBASC Water Womack requested a presentation by GBRA similar to the one given by NWF on strategies.

Group facilitator Mary Rozelle stated that the framework of BBASC recommendations would not be discussed today. A subcommittee was formed to look at the format and framework for the report; subcommittee members include: Chair Suzanne Scott, Vice Chair Diane Wassenich, Jennifer Ellis, Paula DiFonzo and Dr. Earl Matthews

IX. Public Comment

X. Adjourn

Appendix B

Science Advisory Committee Review and Comments Regarding the GSA BBEST Environmental Flows Recommendations Report

Memorandum

To: **Environmental Flows Advisory Group (EFAG)**
From: **Texas Environmental Flows Science Advisory Committee (SAC)**
Date: **May 3, 2011**
Re: **Review comments on Guadalupe and San Antonio Rivers, San Antonio Bay and Aransas-Copano Bay Basin and Bay Expert Science Team (BBEST) Environmental Flows Recommendations Report dated March 1, 2011**

Introduction

The Guadalupe and San Antonio Rivers, San Antonio and Aransas-Copano Bays BBEST submitted its environmental flow analyses and environmental flow regime recommendations to its Stakeholder Committee, the EFAG and the Texas Commission on Environmental Quality (TCEQ) on 2 March 2011. Texas Water Code Sec. 11.02362 (q), as added by Senate Bill 3 in the 80th Texas Legislature, 2007 (SB 3), provides that "In accordance with the applicable schedule…the advisory group, with input from the science advisory committee, shall review the environmental flow analyses and environmental flow regime recommendations submitted by each basin and bay expert science team. If appropriate the advisory group shall submit comments on the analyses and recommendations to the commission for use by the commission in adopting rules under Section 11.1471. Comments must be submitted not later than six months after the date of receipt of the analyses and recommendations." This memorandum represents the SAC's input to the EFAG based on our review of the BBEST report.

The timeframe dictated by SB 3 presents a challenge to the BBEST. They have only 12 months from their appointment to organize themselves, develop their agenda for addressing the requirements placed on them under the statute, conduct their analyses and report their results. In many respects, the Guadalupe/San Antonio BBEST was the best-prepared of all to undertake this assignment. A high proportion of its members had previous experience addressing the nuances of environmental flow analyses, including some with prior BBEST experience; the information bases for both the basin and bay are especially rich, members of the BBEST being among the principal contributors; and SB2 studies were underway within the basin to provide a source for detailed field observations. In addition, the BBEST was provided substantial staff support from TWDB, TPWD, TCEQ, SARA, SAWS and GBRA.

SAC Review and Comments

These comments are organized following the *Framework for SAC review of BBEST work products (2nd ed. 12/17/2010)*, and conclude with a summary. The SAC also had the opportunity to visit with BBEST leadership and ask for further explanation of their work at our meeting on April 13 as we prepared these comments.

1. Do the environmental flow analyses conducted by the BBEST appear to be based on a consideration of all reasonably available science, without regard to the need for water for other uses?

1.1 Has the BBEST identified and considered available literature and data? Were relevant scientific data and/or analyses discounted by the BBEST?

The literature reviews are excellent. The organization and presentation of the physical and biological systems encompassed in this basin are very well done. The reviews of the riparian environment and the candidate estuarine organisms are particularly good. It is noteworthy that SB2 results from San Antonio were made available to the BBEST and were considered in its work. Moreover, several state agencies (notably TWDB and TPWD) assisted in performing analyses and modeling runs, and in conducting field surveys of river cross sections to improve the hydraulic data base.

1.2 Are the data sources and methods adequately documented?

Data sources are very well described, and much of the data are provided in various appendices. The extent to which the methods are described is variable. Figure 1 and 2 diagram the apparent logical sequence by which the recommendations are formulated, for Instream Flows and Estuary Inflows, respectively.

The methods for determination of instream flow recommendations are especially disappointing, given the importance of these recommendations and the substantial data resources available to this BBEST. While an impressive body of work is presented in the determination of physical-habitat requirements as a function of flow, as schematized in the right side of Fig. 1, the only justification for adopting (or defaulting to) the historical HEFR base flows is the sentence:

> Results of habitat modeling for both the SB2/LSAR and GSA guild sets at two locations on the San Antonio River (Elmendorf and Goliad) and two locations on the Guadalupe River (Gonzales and Victoria) indicate that the statistically derived base flows will maintain suitable habitat for all of the habitat guilds considered. (p. 6.19)

How exactly the detailed depictions of WUA curves for the various guilds resulted in (or "indicated") the recommendation of maintenance of the historical HEFR flows is the crux, and the above sentence is quite inadequate. Members of the BBEST have informed the SAC that these recommendations were based upon consideration of the WUA results together with professional judgment, but that these were insufficiently documented due to the press of time.

In the case of the estuary, a novel analysis was carried out by the BBEST using an estuary equivalent of weighted usable area, defined in terms of the proportion of salinity coverage of species-dependent fixed-habitat zones, in which the weight is based upon a salinity preference diagram for the species. Documentation of the data sources (salinity model results from the TWDB hydrodynamic/salinity model, literature reviews of salinity dependence of the species, and data-based

INSTREAM FLOW DETERMINATION

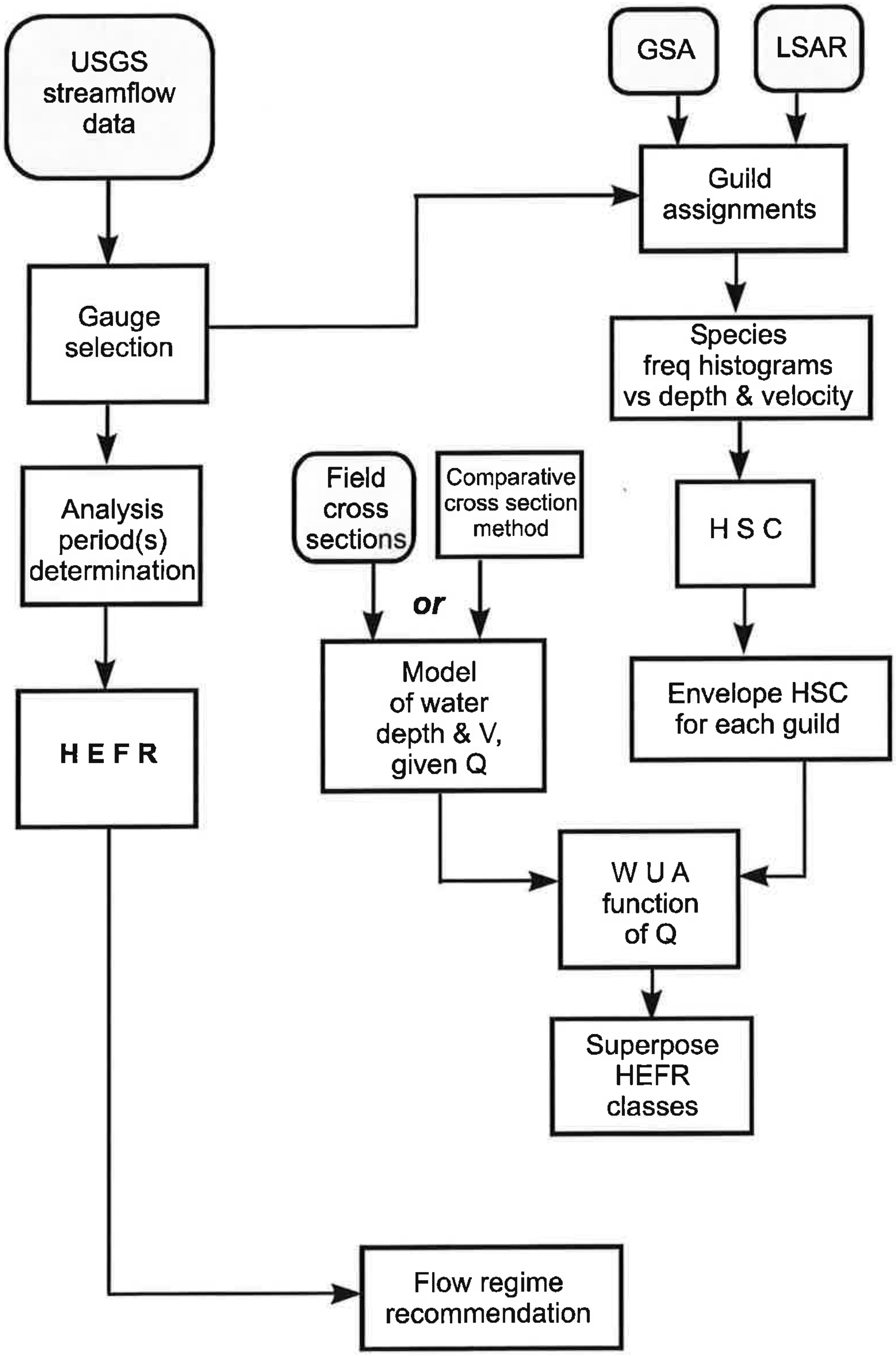

Figure 1 - Decision path for instream flow recommendations

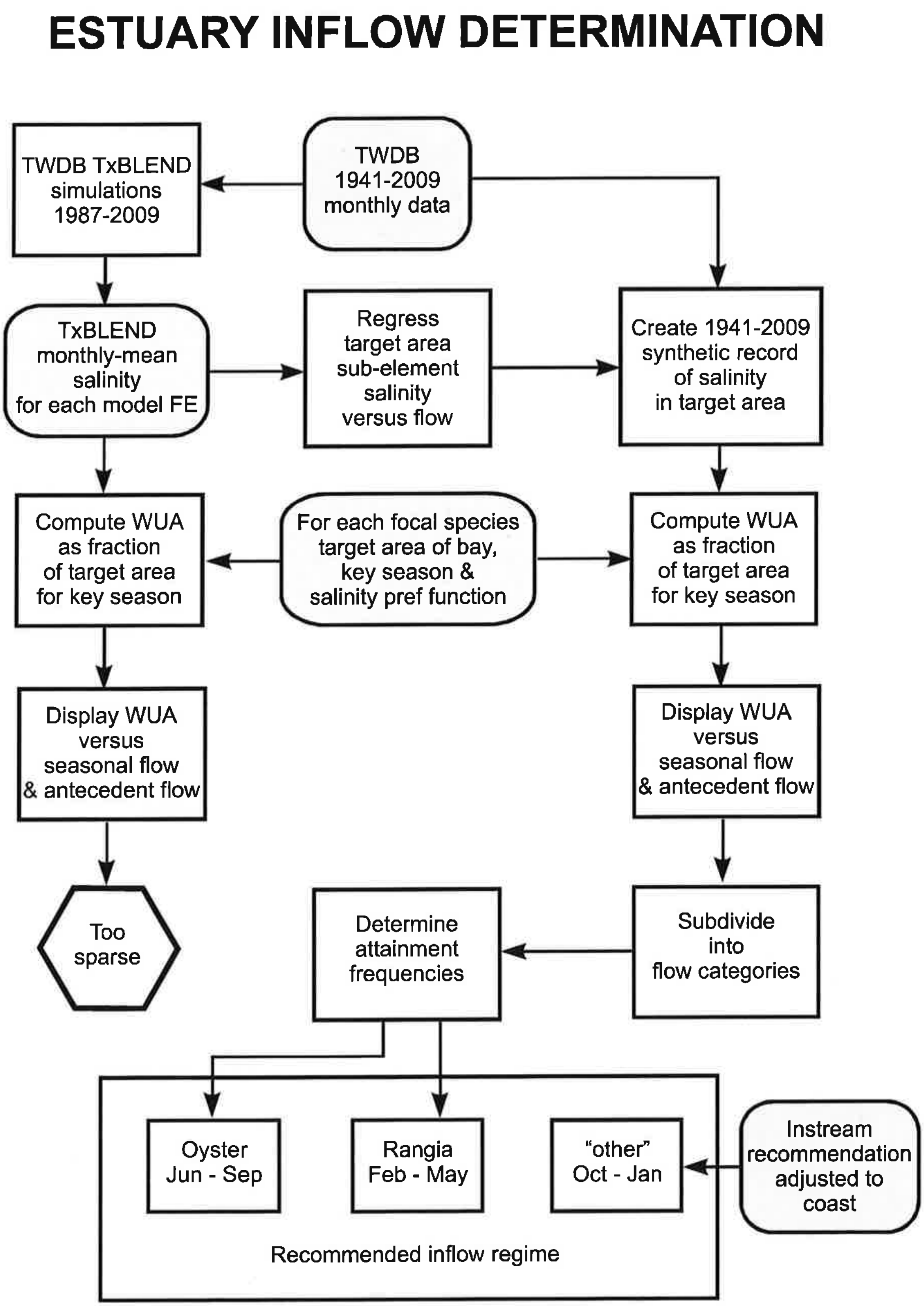

Figure 2 - Decision path for estuary inflow recommendations

identification of the zones of greatest abundance in the estuaries) and the analytical methodology is generally thorough.

1.3 To what extent has the BBEST considered factors extraneous to the ecosystem, especially societal constraints, such as other water needs?

External societal factors did not play any role in the scientific issues addressed or in the methodologies. Several scenarios of alternative recommendations and/or hypothetical projects were evaluated, but only as a detailed demonstration of how the recommendations could be applied.

2. Did the BBEST perform an environmental flow analysis that resulted in a recommended environmental flow regime adequate to support a sound ecological environment and to maintain the productivity, extent and persistence of key aquatic habitats in and along the affected water bodies?

2.1 How is a sound environment defined and assessed for both riverine (lotic) and estuarine systems? What metrics of ecosystem health were used?

The report contains thorough discussions of the definition(s) and metrics for a sound environment. A thoughtful overview of the concept and its definition(s) is presented at the outset of the report (Section 1.3). Instream flows are based on the Physical Habitat Simulation System (PHABSIM) approach, using physical requirements, mainly depth and velocity, of several guilds of fish. Flows to estuaries are based on salinity versus inflow relations, together with literature results for salinity preference mainly for sessile or limited-motility focal organisms, *viz.* oyster (*Crassostrea virginica*) and the clam *Rangia*. Other species are considered in overlay sections.

2.2 How were locations selected for environmental flow analysis? Are these shown to be representative of and adequate to protect the basin? Was the process and rationale for selection adequately described? Were environmental flow regimes recommended for each selected site? Was a procedure presented by which the flow regime at other locations could be estimated?

For instream flows, the assessment of gauge locations was based upon distribution, period of record and the representativeness of the gauge, and the presentation was very well done, including a good survey of available gauge records. HEFR-type regimes are defined and the initial HEFR analyses presented in Appendix 3.2-1. A procedure for flow regime determination at other locations is not stated. However, a brief paragraph (Section 3.1.2.6) recommends that the TCEQ develop "appropriate methods for interpolation of flow conditions …" (p. 3.8).

In the estuary, flow determination was linked to habitat zones in which the focal species are typically present in greatest abundance. There are two estuaries within the geographical responsibility of this BBEST, San Antonio Bay and Aransas-Copano Bay. For the latter, flow determination posed a complex problem due to influence of San Antonio Bay river inflows, which enter Aransas

Bay from San Antonio Bay, as well as the direct inflows into the Aransas-Copano system. This was well-handled by the BBEST.

2.3 How were the historical flow periods defined and evaluated? How was a particular period selected as the basis for determining the flow regime?

A transition date was established demarcating the beginning of substantial anthropogenic effects on the flow, namely (1) date of reservoir construction in the Guadalupe (1965), (2) approximate date of urban expansion in San Antonio (1970). Generally, the full period of record was selected for analysis, except on the San Antonio River where the pre-development period (up to 1970) was used because of lower municipal return flows.

One feature of the hydroclimatology of the two river basins is that there has been an upward trend in inflow over the past seven decades, due to increased rainfall and associated runoff. The mean flow has nearly doubled in the Guadalupe (as measured at Victoria) and has increased about a factor of 2.4 in the San Antonio (as measured at Goliad). In the latter, part of the increase is doubtless driven by the accelerated urbanization in the San Antonio area and the associated increase in return flows, but the majority of the increase is hydroclimatological (see Appendix 5.1-1).

2.4 Was a sound ecological environment determined to exist at each selected site during the selected period? If not, were the underlying causes and/or modifications needed identified?

This conclusion is forwarded at the outset of the report in Section 1.3, in which the scientific basis is presented for both the riverine and estuarine environments. In the body of the report, notably in the "overlay" sections, additional supporting information is presented.

In the case of the riverine environment, the concept of community "intactness" is invoked in the opening chapter and repeatedly in Chapter 3. Nowhere is this concept defined nor a procedure for its determination cited. In Section 3.3.5.1, it is stated that "relative intactness" was assessed (p. 3.49), but no results of this assessment are shown. The "intactness" of the Guadalupe aquatic ecosystem was offered as justification for employing the entire period of record (along with the "best representation of the natural hydrograph"), despite the above-noted increasing trends in inflow.

2.5 Was a functional relationship between flow regimes and ecological health developed? Or, were proxy or intermediate variables used? Are assumptions underlying the methodology clearly stated? To what extent were overlay considerations (sediment transport, water quality, nutrients, etc.) addressed?

For instream flows, a version of PHABSIM was used, in which the measure of ecological health was, in effect, abundance of guilds of fish and associated habitat requirements, namely depth and current speed. The report itself does not contain a discussion of how the WUA curves were evaluated or otherwise considered by the BBEST nor does it explain the logic by which the BBEST defaulted to HEFR-based recommendations.

An example of the WUA results of the analysis is shown in Figure 3. The blue rectangle plots the full range of historical baseflows over all seasons and hydroclimate classes. This would seem to allow the interpretation that baseflows are generally higher than they need to be, considering their relationship with the flows necessary to achieve maximum habitat for most guilds. The BBEST advises that such an interpretation based strictly on maximizing habitat for most guilds would be wrong. Indeed, there is a variety of displacements of WUA's and the corresponding baseflow range shown in the report (pp 3.53-73), none of which, the SAC is advised, was deemed sufficient to modify the hydrology-based results. Rather, it seems that the WUA results were viewed as simply not contradicting the adequacy of the HEFR flows.

For this reason, our schematic of the decision path shown in Fig. 1 indicates no logic path from the WUA analyses to the flow recommendations, which are entirely the default HEFR results. The BBEST has acknowledged that its discussion of the use of the WUA's in the report was incomplete due to press of

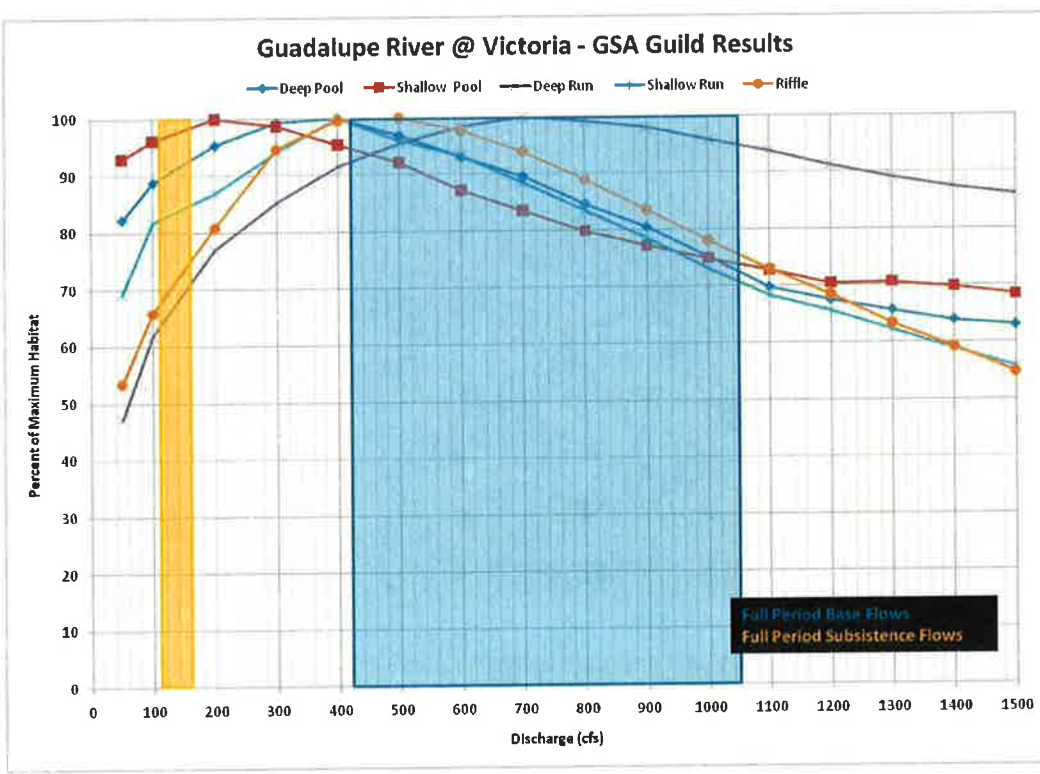

Figure 3 - Weighted Usable Area curves for a station on the Guadalupe (p 3.56 in the BBEST report). Guilds are named for the physiographic area in which the fish are generally found. The two rectangles show the range of subsistence flows (yellow) and base flows (blue) from the HEFR analysis.

time, and that it intends to work with the BBASC as necessary to clarify its recommendations.

The SAC believes that the WUA methodology and its use should be clearly delineated in the Workplan, its deficiencies noted, and any necessary data collection and methodological revisions, as well as further analysis, should be high-lighted as an important part of future adaptive management strategy.

The overlays for instream flows are generally well done. The water quality analysis is thorough, its presentation succinct, and demonstrates the general high quality of river water in the basin, even under low-flow conditions. The riparian overlay (Section 3.6) is a well-written discourse on the vegetation of the riparian community and its dependence upon river flow. Its greatest weakness is the much greater proportion of text of a general and tutorial nature compared to information specific to the basin. The BBEST notes (p 3.123) that field data from the basin are still in the process of analysis. In its present state, this section is inconclusive and did not affect the decision path for flow recommendations. However, information such as Figs. 3.6-14 and 3.6-15, and Table 3.6-6 beg to be populated with real data specific to the basin including topography and associated inundation stages.

The geomorphology overlay (Section 3.5) contains the results of a number of hydrological scenarios, including two HEFR cases with 2 and 5 tiers of flood pulses and several WAM simulations for hypothetical river developments. These results would have general value in other contexts, and it is puzzling why they were not presented in their own section, then referenced as necessary. The geomorphology analysis is a sediment transport modeling exercise, in which the historical sediment-versus-discharge relations are used to compute sediment load under the various hydrological scenarios. As one would expect, sediment transport diminishes with increased impact on flood pulses. The BBEST concludes that the channel will remain stable (i.e., not change) so long as sediment load does not change more than 10%. A single literature source is cited for this judgment (which is based on channel-forming flows, a concept which its authors acknowledge "is not universally accepted").

The report appears ambiguous on whether the geomorphology overlay is incorporated into the environmental flow recommendations. In Section 6.1, only the HEFR-based regime tables are presented, with no additional conditions. Yet in the discussions of Section 6.4 addressing hypothetical projects, suggestions are proffered as to how the hypothetical project might be constrained to reduce its effect on sediment load to within the 10% range. The SAC feels that the BBEST should clarify for the stakeholders and TCEQ whether this and any other additional conditions are to be applied to the flow recommendations.

If, indeed, it is the intention of the BBEST to apply this condition, the SAC observes that the basis for the rather stringent constraint of being within 10% of historical sediment load is limited, being based upon one didactic reference, in which the 10% limit is suggested without observational basis or literature citation, hardly the "preponderance of literature within the published scientific literature *[sic]*" that is claimed in the BBEST report (page 7.5).

For the estuary, an extensive and detailed analysis was carried out for occurrence of salinity preference as a function of (bivariate) inflows. The focal organisms oyster and *Rangia* primarily defined the regime, though other organisms were used as overlays. Oyster and *Rangia* have different seasonal requirements, and together define the recommendations for February – September. The recommendations are presented as seasonal flows with associated attainment-frequency goals. These will not be directly applicable to operational use, but would be employed in long term simulations to determine the effect (e.g. achievement of recommended attainment frequencies) of a proposed diversion or impoundment. There were also detailed analyses of a number of species or parameters which ultimately did not play a role in the inflow recommendations. This is not a criticism of the work as a comprehensive approach is clearly valuable and much good information is presented. In particular, a lot of effort was expended on blue crab because of its important role in San Antonio Bay foodwebs, and while it is clear that salinity plays a role in disease, growth, and reproduction, there was insufficient data available to use blue crab as an indicator species.

2.6 Was a sound ecological environment demonstrated to be achieved at each selected site under conditions of the recommended flow regime?

No. However, to a certain extent, this was moot, since the systems were determined to be presently healthy, and the recommendation was to revert to historical-data-based flows (HEFR statistics for the instream flows and historical frequencies of flows that achieve target salinity zones for the estuary), even though strict adherence to the HEFR-based flows and associated attainment frequencies does not specifically preserve the historical statistics of all flows. On the other hand, it also has not been demonstrated that all of the flow components of the recommended instream flow regimes, including three levels of base flow and up to five levels of high-flow pulses, are necessary to protect a sound ecological environment.

2.7 Is uncertainty in the analyses described or quantified? Where models were employed, was the extent of validation and associated predictive errors described and quantified?

We acknowledge the attempt by the BBEST to address the issue of uncertainty at various places in the report, albeit largely qualitative. Uncertainty in these analyses is important, and we appreciate the suggestions for future studies, etc. which might ameliorate some of the inherent uncertainty. It would have been helpful if known uncertainty had been presented as a quantified qualifier to the recommended regime.

As there is no relation between the WUA results and the instream flow recommendation values, a quantitative expression of uncertainty would be difficult. Members of the BBEST have indicated that the number of cross sections available for the WUA calculations in the instream flow regime substantially affects the uncertainty of the results, and that the one or two cross sections for many of the stations rendered the results imprecise.

The salinity-flow relations in the estuary were based on modeled salinities, not data. (Reliance on data alone would have not have allowed the BBEST the specificity of geographic salinity zones needed for its analysis.) While the accuracy of the model is quantified in an appendix (as variance of the data about the predicted values), and the accuracy of the regressions of modeled salinity on flows was determined (again, as a variance), the two were not combined and translated into the effective confidence of the inflows.

Summary and Conclusions

The general philosophy of the BBEST in its approach to environmental flow determination is characterized by statements throughout the report, e.g.:

- Adoption of the natural flow paradigm, in which the dynamic variation exhibited in the natural hydrograph is used to identify key regime components, also qualitatively consistent with the conceptual treatment of streamflow dynamics in the Texas Instream Flow Program, considered necessary to maintain natural habitats. [pp 3.25-3.28]

- Selection of the entire period of record upon which to base flow recommendations, because "...longer periods of record likely capture the natural variation in precipitation and discharge." [p 3.49]

- For the estuary, "historical flow patterns of magnitude, timing, frequency, and duration should be passed through to the estuary, but they should not be artificially modified or exacerbated by water management operation." [p 4.9]

Given this philosophy, it is perhaps not surprising that the BBEST chose to recommend environmental flows based on historical values.

It is sobering, however, that the best-equipped BBEST thus far could not make a quantifiable recommendation founded upon a clear connection between levels of flow and metrics of ecosystem health that could be defended as adequate, which is the goal of Senate Bill 3 with regard to the BBEST charge, and instead recommended little, if anything, more than default HEFR flow regimes based on historical hydrology.

It is the SAC's opinion that the BBEST has achieved excellence in its report, except for the following items that are of concern to the SAC:

- While an impressive body of technical work on WUA's of important guilds has been developed, there is no logical connection presented between these results and the (default) HEFR flows ultimately recommended.

- The variety of relationships displayed between the WUA's and the range of baseflows raises the question: what kind of relationship would be necessary to yield a flow recommendation different from HEFR?

- In the estuary, a convincing presentation of the dependence of preferable salinities within key habitat zones on the inflows (more precisely, the time history of inflows) was made for each of the focal species oyster and *Rangia*. However, the attainment frequency for each of these was essentially the historical statistics, which is equivalent to specifying the historical occurrence of the corresponding flow classes.

In closing, we observe that much new analysis was developed by this BBEST of potentially great value in future environmental flow studies in this basin, and we particularly appreciate the inclusion of Chapter 7 which introduces potential content of a work plan for the basin as required by SB3. It is also possible, even probable, that the work of the BBEST was more complete than its report would suggest. This should be communicated directly to the BBASC by the BBEST membership, and we encourage a robust interaction with the stakeholders as they undertake development of recommended Standards and Strategies. (We do note the *faux pas* that the BBEST fails to acknowledge in the introduction to Section 6 that the BBASC is a primary recipient of the BBEST recommendations). Finally, that the BBEST report falls short of the potential is an indication of the difficulty of the SB3 task, the complexity of the present state of the science, and the limitations of resources and time within which the BBEST must work.

Appendix C

Texas Parks and Wildlife Department Staff Perspectives on the GSA BBEST Report and Supporting Documentation

April 21, 2011

The Honorable Troy Fraser, Co-Chair
Environmental Flows Advisory Group
Texas Senate
P.O. Box 12068 - Capitol Station
Austin, TX 78711

The Honorable Allan Ritter, Co-Chair
Environmental Flows Advisory Group
Texas House of Representatives
P.O. Box 2910
Austin, TX 78768-2910

Re: Texas Parks and Wildlife Department Staff Perspectives on the Colorado - Lavaca and Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Basin and Bay Expert Science Team Reports

Dear Chairman Fraser and Chairman Ritter:

As you know, the Basin and Bay Area Expert Science Teams (BBESTs) for the Colorado-Lavaca and Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Basin and Bay Systems recently submitted their environmental flow regime recommendations for their respective basins. The Texas Environmental Flows Science Advisory Committee (SAC) has been reviewing the BBEST report with the intent to provide comments to assist the Environmental Flows Advisory Group as it considers the regime recommendations.

As the agency charged with the responsibility to protect the state's fish and wildlife resources, Texas Parks and Wildlife Department (TPWD) is in a unique position to have data and scientific expertise to support the challenges of determining the environmental needs of Texas rivers, streams, estuaries, and bays. TPWD staff has been involved in the development of technical guidance documents and tools for the SAC and has provided assistance to the BBESTs in crafting environmental flow regime recommendations. Based on staff expertise, involvement, and commitment to the success of SB 3 efforts, TPWD staff reviewed and compiled comments on the BBEST reports.

I have met with TPWD staff to discuss the reports and the staff review of the regime recommendations. I have attached the comments and respectfully request that you consider them. These comments are intended to assist the Environmental Flows Advisory Group, the Texas Commission on Environmental Quality, and the Basin and Bay Area Stakeholders Committees for the Colorado-Lavaca and Guadalupe,

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San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Systems in reviewing the BBEST recommendations.

I look forward to continuing to work with you and others as we strive to ensure that the needs of the state's fish and wildlife resources are considered and addressed across the state. Thank you for your consideration of this matter. Should you have any questions, please contact Cindy Loeffler at 512-389-8715.

Sincerely,

Karen J. Hixon
Member

KJH:CL:ch

Attachments

cc: EFAG Members
SAC Members
Colorado-Lavaca BBASC and BBEST Chairs
Guadalupe, San Antonio, Mission, and Aransas BBASC and BBEST Chairs
Mr. Todd Chenoweth, TCEQ
Mr. Cory Horan, TCEQ
Dr. Ruben Solis, TWDB

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Date: April 21, 2011

To: The Honorable Karen J. Hixon
Executive Director Carter Smith
Deputy Executive Director Ross Melinchuk

From: Ms. Cindy Loeffler, Water Resources Branch
Ms. Colette Barron Bradsby, Legal Division
Mr. Norman Boyd, Coastal Fisheries Division
Mr. David Bradsby, Water Resources Branch
Ms. Lynne Hamlin, Water Resources Branch
Mr. Nathan Kuhn, Coastal Fisheries Division
Dr. Wen Lee, Coastal Fisheries Division
Mr. Kevin Mayes, Inland Fisheries Division
Dr. Dan Opdyke, Water Resources Branch
Mr. Clint Robertson, Inland Fisheries Division
Ms. Angela Schrift, Coastal Fisheries Division

Re: Texas Parks and Wildlife Department Staff Perspectives on the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Expert Science Team Report

Senate Bill 3, Article 1 (SB 3), as passed by the 80th Texas Legislature in 2007, created a statewide process for identifying and protecting environmental flow needs. As part of this process, a Basin and Bay Expert Science Team (BBEST) was formed for the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays (GSA BBEST). The GSA BBEST submitted its final report on March 1, 2011 documenting science-based recommendations for an environmental flow regime for the applicable rivers and bay systems. SB 3 directs each BBEST to develop an environmental flow regime recommendation:

> *...through a collaborative process designed to achieve a consensus. In developing the analyses and recommendations, the science team must consider all reasonably available science, without regard to the need for the water for other uses, and the science team's recommendations must be based solely on the best science available.*

The BBEST engaged resource agency staff and others throughout the process. Texas Parks and Wildlife Department (TPWD) staff assisted and supported the BBEST by providing data, maps, and information related to riparian habitats; assisting with cross-sectional work for the Comparative Cross Section Methodology (CCM); developing lists of instream focal species/guild criteria, habitat suitability envelope curves, and analyses; statistically evaluating blue crab abundance data; enhancing and improving the Hydrology-based

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Environmental Flow Regime (HEFR) methodology; and refining and improving the Flow Regime Application Tool (FRAT). The BBEST fostered participation by TPWD and others that resulted in the use of best available science to generate environmental flow regime recommendations that TPWD generally supports.

Having worked on numerous instream flow and freshwater inflow recommendations over many years, TPWD staff is familiar with the uncertainty embedded in such efforts, cognizant of the challenges faced by the BBEST, appreciative of the efforts expended by the members, and grateful for the many opportunities to provide input throughout the process. Each BBEST had approximately twelve months and a limited budget for outside services to meet the SB 3 charge. The difficulty of the challenge cannot be overstated and the progress of the BBEST is commendable. The GSA BBEST clearly learned and benefitted from the experiences of previous BBESTs and extended the state of the science in many respects. Furthermore, the GSA BBEST had the additional advantage of contemporary, if still incomplete, instream flow studies on the lower San Antonio River, as well as relevant information at selected sites on the lower Guadalupe River. That said, it is widely recognized that the science of environmental flows is not an exact one, and the GSA BBEST did not have the time, data, directive, or budget to perform a definitive analysis.

This memorandum contains general comments regarding the GSA BBEST report and the SB 3 charge to develop an environmental flow regime, and it contains specific comments addressing instream flows and freshwater inflows. More detailed technical comments are provided as an appendix. These comments are intended to assist the Environmental Flows Advisory Group, the Texas Commission on Environmental Quality, and the GSA Basin and Bay Area Stakeholder Committee (GSA BBASC) in reviewing the BBEST recommendations.

General Comments

TPWD staff commends the GSA BBEST for its efforts to address the requirements set forth by SB 3. In general, the BBEST followed guidance provided by the Texas Environmental Flows Science Advisory Committee (SAC) and addressed the requirements set forth by SB 3.

Section 1 contains a thorough explanation of the SB 3 process and the BBEST charge. TPWD staff appreciates the efforts of the BBEST in Section 1.3 to define a sound ecological environment and supports the BBEST's definition, with the mutual understanding that the phrase "to a reasonable extent" is both broad and subjective. TPWD staff understands that it is impossible to provide a precise definition of a sound ecological environment given the scope of the SB 3 tasks. Subsequently, the BBEST concludes that the current conditions "are, broadly speaking, 'sound' today with few exceptions." Several such exceptions are listed on page 1.8 and include declines in the numbers of tarpon, blue crab, southern flounder, and episodic declines in whooping cranes. TPWD staff agrees that additional studies would be required to fully ascertain the influence of freshwater inflows on these observed effects.

Section 2 provides a highly useful overview of the basins and ecosystems, including relevant information on hydrology, water quality, biology, and physical processes.

Instream Flow Analyses

TPWD staff supports the GSA BBEST instream flow recommendations with one exception and a few qualifications described below. TPWD staff commends the GSA BBEST members for their use of the best available science (such as preliminary Senate Bill 2 instream flow study data collected on the lower San Antonio and lower Cibolo Creek) to make instream flow regime recommendations. The GSA BBEST recommendations provide an appropriate degree of flow variability required to support a sound ecological environment by incorporating seasonal subsistence, a range of base flow conditions, and a suite of high flow pulses.

Section 3 presents details on the BBEST's instream flow analyses. The BBEST generated flow recommendations at 16 gaged locations. TPWD staff believes that this is a reasonable suite of locations, both in number and spatial distribution. On Page 3.8 the BBEST recommends that TCEQ develop methods to identify environmental flow requirements at intermediate locations on an as-needed basis using drainage area adjustments and/or other reasonable approaches. TPWD staff agrees with this recommendation and encourages the BBEST to give this issue additional attention when assisting the BBASC in developing its work plan if TCEQ does not adopt specific rules in the interim. In particular, the BBEST should make clear if it is their intent for all instream flow recommendations to be extended to the salt water barrier.

The BBEST used the full period of record at all locations except those downstream of the City of San Antonio, where the early period of record was used. TPWD staff agrees with this decision.

For subsistence flow recommendations, the BBEST used the default HEFR flow calculation which results in an extremely low flow at many of the locations. Similar to the approach taken by the Colorado-Lavaca BBEST, TPWD staff recommends the greatest of Q95, TCEQ's critical low flow (generally 7Q2) , or the default HEFR subsistence flow calculation to support critical water quality and habitat needs during very dry times. As one example, at the Mission River at Refugio location, the BBEST recommended subsistence flow values range from 1.0 to 1.3 cfs. Based on Figure 3.3-24, these flows only protect from 1 to 7% of the maximum habitat for each guild. Comparatively, Q95 for this location is 1.5 cfs and the critical low flow is 4.7 cfs which would protect from 15-35% of each guild's maximum habitat. While recognizing that subsistence flows are not intended to provide optimal habitat at all times, TPWD staff believes that the protection of only 1% of the maximum habitat of deep runs is inadequate. Many of the other tributary and upstream locations exhibit similar results. In addition, use of Q95 or the critical low flow value would enhance the ability to meet the standards for important water quality parameters such as dissolved oxygen and temperature. HEFR provides the options to calculate Q95 and manually enter flow values to address water quality protection.

A series of habitat-flow relationships, one at each location, are provided on pages 3.53 – 3.72. Four locations (lower San Antonio River and Cibolo Creek) are based on preliminary TIFP study results and two locations (Guadalupe River at Gonzales and Victoria) are based on PHABSIM outputs using existing cross-section data. The remaining locations are based on the CCM method, which uses limited site-specific data and hydraulic model outputs. A comparison of CCM results to PHABSIM and preliminary TIFP output would have helped to illustrate the utility and uncertainty of the CCM method. TPWD staff recommends that the BBEST perform such a comparison to help guide the BBASC in setting priorities in their work plan. TPWD staff also supports an analysis of habitat time series for sites with PHABSIM or preliminary TIFP habitat output to assist in evaluating how changes in instream flow recommendations could potentially affect instream habitat.

Freshwater Inflow Analyses

TPWD staff appreciates the significant effort expended by the BBEST to extend the state of the science with regard to the salinity zone approach. While recognizing that the BBEST report is a final report, TPWD submits the following comments (and detailed comments in the appendix to this letter) in the interest of further expanding understanding and communication of the overall approach.

The habitat-based salinity zone approach employed by the BBEST to develop quantitative freshwater inflow recommendations relies heavily upon salinity preferences of two species: *Rangia* and oysters. As a result, the recommendation lacks explicit freshwater inflow recommendations for certain months. In addition, the beneficial effects of freshwater inflows other than salinity, e.g., nutrient and sediment delivery, are not considered. Nutrients and sediments are largely delivered during high flow pulses ("Very High Inflows" and "Med-High Sustained Inflows w. Pulse(s)", in the lexicon of Figure 4.1-2). Since nutrients and sediments are not considered in this method, no recommendations are provided for such events. As a result, high flow pulses receive no quantitative discussion or specification. For the "missing months" those months which have no freshwater inflow recommendations, the BBEST has explicitly specified that instream flow requirements are to be extended to the bay. TPWD staff is unclear if this extension of instream flow recommendations to the bay is a recommendation of the BBEST for all months. The section "3.1.2.6 Geographic Interpolation" does not specifically state the intent of the BBEST in this regard. TPWD staff believes that that it is important to extend the instream flow recommendations to the bay in all months, in light of the limitations of the habitat-based salinity zone approach. TPWD staff encourages the BBEST to follow this approach when assessing impacts of future water development scenarios.

The BBEST recommendation allows for a 25% reduction in the frequency of G2-A and G2-B conditions (Table 4.5-2). Support for this decision is provided by a Heinz Center report and an EPA report with sediment contaminant breakpoints, but TPWD staff is uncertain of the EPA report's relevance. TPWD staff notes that the BBEST recommendation allows greater than a 25% reduction in other flows. For example, any flows in the G2-A range could be diverted down to the floor of the G2-A category, with 25% of such events diverted down to the G2-B floor, and still be in compliance with the recommendation. Thus, in this context, the BBEST recommendation of a 25% reduction is effectively a minimum allowed reduction in flows. This does not appear to be consistent with the maximum 25% reduction in key flow characteristics (with unknown reductions in other flows) used by the Heinz Center to classify minimally impacted sites, assuming that the 25% Heinz number is a relevant and appropriate precedent for the BBEST to adopt. Furthermore, in the 69 year historical record, 28 years exceeded the maximum of the G2-A flow range and thus provide sub-optimal (i.e., too fresh) habitat. These years are afforded no protection by the habitat-based methodology and essentially unlimited diversions would be allowed in these years except as potentially limited by instream flow requirements. TPWD staff understands the difficulty in judgment calls related to acceptable reductions in flows. TPWD staff also understands that such calls must be made by the BBEST. However, TPWD staff questions whether a minimum 25% reduction in flows is appropriate or supported by the literature.

TPWD staff agrees that freshwater inflows in the summer months may be most critical for oysters because of the proliferation of parasites during hot months. However, appropriate salinity conditions are beneficial to oysters throughout the year, and TPWD staff believes that an annual schedule of beneficial inflows should have been recommended for oysters, as was done by the Colorado-Lavaca BBEST.

The BBEST makes the case that while salinity may not significantly influence white shrimp, other effects of freshwater inflows may (page 4.115). The BBEST then provides a series of statistical analyses to relate freshwater inflows to white shrimp abundance, most notably Figure 4.5-26, which is a regression between these two variates (using freshwater inflows from June-Sept). This regression has a modest R^2 value, but it does appear to demonstrate increases in abundance as inflow increases. Ultimately, the BBEST concluded that "below 250,000 ac-ft, [total for July-Sept] there would appear to be a significant limiting effect on abundance…" TPWD staff believes freshwater inflow does influence white shrimp abundance and recommends further evaluation of the relationship between white shrimp abundance and freshwater inflows be considered in the work plan.

Integration of Instream Flow and Estuary Inflow Regimes

TPWD staff questions whether it is appropriate to simply add the HEFR tables for Goliad and Victoria (plus downstream ungaged flows) to facilitate a comparison to the recommended freshwater inflow regime. Appendix B of the SAC guidance document (Methodologies for Establishing a Freshwater Inflow Regime for Texas Estuaries Within the Context of the Senate Bill 3 Environmental Flows Process) takes a different approach, wherein daily flow data from various locations (Goliad, Victoria, TxRR) are summed to create a total inflow hydrology which is then entered into HEFR as an input and then a single new flow matrix is generated. Without a more detailed analysis, it is difficult to compare the advantages and disadvantages of the BBEST and SAC approaches. As long as the results are simply used semi-quantitatively to compare to freshwater inflow requirements, perhaps both approaches are acceptable.

Environmental Flow Regime Recommendations

As noted above, TPWD staff does not support the subsistence flow recommendations. This concern is somewhat ameliorated by the 50% diversion rule spelled out in Section 6.1.1. This implementation rule provides significantly increased protection, as compared to the BBEST's initial strawman recommendation of allowing all water to be diverted down to the subsistence flow value (when flows are below base under dry hydrologic conditions). However, if the implementation rule is not carried forward into the GSA

BBASC recommendation or is not adopted in TCEQ rulemaking, TPWD staff believes that the subsistence flow recommendations should be re-evaluated.

Concluding Comments

TPWD plans to remain involved with the important work of SB 3 and the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays by offering technical and professional assistance and guidance to the GSA BBASC as requested. TPWD staff looks forward to assisting the BBASC and BBEST with the development of a focused and prioritized work plan that addresses many of the issues raised in the BBEST report and this letter.

Attachment

Appendix of Detailed Comments (listed by page number)

Page 4.10: Figure 4.1-2 illustrates various "inflow regime levels" with associated seasonality and ecosystem functions. These four flow levels are very similar to the four flow components commonly used in instream flow efforts (overbank events, high flow pulses, base flows, and subsistence flows). It's unclear whether there is a compelling reason to maintain different terminology, for essentially the same ideas, in the estuarine section as compared to the instream section.

Page 4.30: *Rangia* and oysters were chosen as focal species. However, since TPWD does not use sampling gear and methodologies designed to quantitatively sample *Rangia*, there is significant uncertainty related to this species' distribution, abundance, and trends.

Page 4.64 describes the occurrence of a few varieties of "low salinity-sensitive plant species." Given that the freshwater inflow recommendations are based on only two species (*Rangia* and oysters) and cover only 6-8 months (depending on flow level), the use of additional species, particularly ones with different life cycles, would have been beneficial. The limited data regarding these species is essentially the same as the (also limited) data that was available to the Trinity-San Jacinto BBEST in its salinity zone analysis of *Vallisneria*. TPWD staff recommends that additional species, particularly those with different life cycles, be further considered in the work plan.

Page 4.66: The report states that "for oysters the time window was chosen to cover the high temperature time of year July – September when the 'dermo' parasite can be problematic at high salinities". According to page 4.33, dermo "proliferates at temperatures above 68F and at salinities above 20psu suggesting a focus on non-winter months". A review of the TPWD Coastal Fisheries database suggests that the months of April – October have average temperatures above 68 °F. TPWD staff suggests that the BBEST revisit the temperature data and consider expanding the suite of months associated with oyster health in the work plan.

Page 4.84: Table 4.4-2 has a value of 0.73 for 2008. The chart on page 4.84 shows this at approximately 0.65 instead of 0.73. One of these is incorrect.

Page 4.94: TPWD staff recommends that the BBEST evaluate the expected frequency of *Rangia* spawning in their work plan. The inflow recommendations may vary if *Rangia* need to spawn every year to maintain viable populations.

Page 4.66 states "the salinity zone approach needs salinity data thoroughly covering the entire habitat extent, reflecting variations therein." TWPD staff questions the degree to which data "thoroughly covering…" are actually needed. As shown in Figure 4.2-7, isohalines (i.e., lines of equal salinity) are fairly smooth across both the oyster and *Rangia* habitat areas. Given the uncertainty in salinity suitability curves, it appears that the effort associated with the BBEST's approach could be reduced, with limited impact on the results, if simply two locations associated with each habitat area (one on the upstream end and one on the downstream end) were carried forward in the analysis.

Page 4.82: If TPWD staff understands the method correctly, 15 individual linear regressions between TXBLEND modeled salinity and Guadalupe River inflows were developed, one for each of the Thiessen polygons shown on Figure 4.4-9. Two correction factors were then added to each regression, one for low flows and one for high flows. Because the objective here is to fit modeled salinity data with a regression, it appears that a non-linear regression (e.g., quadratic) have been both simpler and more accurate than a linear regression with two correction factors.

Page 4.91: Figure 4.5-1 shows that the suite of freshwater inflow recommendations includes 6 tiers (A, B, C, CC, D, and DD). Some of these categories represent multiple years in the 69 year period of record. However, category CC represents only a single year and D represents only 2. Additionally, category CC is the only category where antecedent flows are part of the recommendation. Finally, category CC is recommended to occur no more than 1/6 of the total of categories C (as stated in Table 4.5-2, or 1/4, as stated in footnote #5 to Table 4.5-2) and CC combined, which have an unspecified combined recommended occurrence but only a 10% combined historical occurrence. TPWD staff wonders if the clearly rare category CC is so necessary that it warrants the inclusion of such complexity. If category CC could be dropped or modified, the complicated analyses and rules associated with the June antecedent flow could be avoided.

Page 4.102: The regression analysis of both Guadalupe and Mission-Aransas inflows concludes that "most of the behavior of salinity in this area, as related to inflow, is dominated by the influence of Guadalupe River inflows." This is based on the very modest improvement in R^2 values when the Mission-Aransas inflows are added to the regression (Figure 4.5-7). However, there could be an alternative explanation. If Mission-Aransas inflows are highly correlated to Guadalupe inflows, then it is possible that Mission-Aransas inflows actually have a substantial impact on salinities but this impact is masked by the statistical approach employed by the BBEST (i.e., running statistics using Guadalupe inflows, then adding Mission-Aransas). TPWD staff understands that the BBEST also performed the statistics with Mission-Aransas inflows first and then adding Guadalupe inflows, with the conclusion remaining that Guadalupe inflows are much more important to salinities than Mission-Aransas inflows. TPWD staff recommends that the BBEST and BBASC explore the dependence of Mission-Aransas salinities on Mission-Aransas inflows further in the work plan.

Page 4.134: To maintain *Rangia* habitat in Copano Bay, page 4.113 notes that the G1-Aprime category includes both a Guadalupe Estuary inflow value as well as a Mission-Aransas inflow value (50-125k ac-ft/yr). This latter Mission-Aransas inflow value does not appear in the synthesis inflow regimes on page 4.134. TPWD staff recommends that the BBEST clarify their intent with regards to the Mission-Aransas inflow requirements under the G1-Aprime criteria level.

Page 4.135: The attainment frequencies specified in the attainment goal tables (e.g., Table 4.6-3) are somewhat ambiguous. For example, G1-Aprime is recommended "at least 12% of years" and G1-A is recommended at least "12% of years." Consider the scenario where a model simulation predicts that G1-Aprime will be met in 14% of years and G1-A in only 10% of years. Seemingly, this would be satisfactory from an ecological perspective, but this is clearly not allowed under the written recommendations. It may be helpful for the BBEST, in its deliberations with the BBASC, to recast these frequencies as "this category or a higher category." For example, G1-A could be recommended to be equaled or exceeded (up to the ceiling of the G1-Aprime category) at least 24% of the time.

Page 6.25: TPWD staff questions the value of Section 6.2 (Comparisons to Water Rights Permits) in the BBEST report. A comparison to special conditions in existing permits may not be useful in that such conditions were developed using a more limited technical analysis than that employed by the BBEST under its charge to use the best science available. It does not appear that these comparisons influenced the BBEST's recommendations.

Page 6.30: Clause 6.4.2(2) suggests that only 50% of the flows above subsistence must be passed, whereas the example clearly shows that this 50% is in addition to the subsistence flow itself. TPWD staff believes that the intent is clear, but the language ("…then 50% of the difference between inflow and the seasonal subsistence value must be passed, and the balance may be impounded…") could be misinterpreted. TPWD staff recommends that the BBEST closely coordinate with the BBASC and TCEQ to ensure that the correct intent is carried forward.

USGS Streamflow Gage Name	TPWD level of concern	TPWD Ecologically Significant Segment	TCEQ Aquatic Life Uses	Notes on subsistance flow
Guadalupe River at Comfort, TX	High	**Yes**	**Exceptional**	Habitat minimal - less than 20% of max
Guadalupe River near Spring Branch, TX	High	**Yes**	**Exceptional**	Habitat minimal for some types - less than 20%; all less than 50%
Blanco River at Wimberley, TX	High	**Yes**	**Exceptional**	Habitat minimal for some types - less than 20%; all less than 50%
San Marcos River at Luling, TX	Moderate	**Yes**	High	No habitat model available; subsistance less than seasonal Q95 and/or TCEQ critical low flow
Plum Creek near Luling, TX	High	No	High	Model uncertainty high; subsistance not modeled; habitat may all be less than 20% if trends continue
Guadalupe River at Gonzales, TX	Low-Moderate	**Yes**	High	All habitat types greater than 80% of max although recommendations less than some seasonal Q95 and TCEQ critical low flow; no water quality model available
Sandies Creek near Westhoff, TX	High	No		Habitat minimal for some types - less than 20%; all less than 50% (or so)
Guadalupe River at Cuero, TX	Moderate	No	High	Model uncertainty high
Guadalupe River at Victoria, TX	Moderate	**Yes**	High	Some habitat less than 80% of max
Medina River at Bandera, TX	High	**Yes**	**Exceptional**	Habitat model did not extend to subsistence flow; dry base results in some habitat types less than 20% of max
Medina River at San Antonio, TX	High	No	High	Habitat minimal for some types - less than 20%; all less than 50%
San Antonio River near Elmendorf, TX	Moderate	No	High	One habitat type less than 80%; LSAR interim recommendation = 80 cfs (based on water quality model)
San Antonio River near Falls City, TX	Moderate	No	High	No habitat model available; recommendations less than some seasonal Q95 and TCEQ critical low flow; LSAR interim recommendation = 80 cfs
Cibolo Creek near Falls City, TX	Moderate	No	High	Some habitat types less than 80% of max; LSAR interim recommendation = 7.5 cfs
San Antonio River at Goliad, TX	Moderate	No	High	One habitat type less than 80%; LSAR interim recommendation = 80 cfs
Mission River at Refugio, TX	High	**Yes**	High	Habitat minimal - less than 20% of max

Period of Record	RunName		
		Winter	Spring
X	GRSpringBranch1923to1946&1957to1964_N5_HEFR_outputs	44	34
E	GRVictoria_LP319351964_N9_HEFR_outputs	231	231
L	GRVictoria_LP319652009_N9_HEFR_outputs	510	368
F	GRVictoria_LP319352009_N9_HEFR_outputs	375	317
E	GRComfort19401964_N5_HEFR_outputs	20	6
L	GRComfort19652009_N5_HEFR_outputs	61	36
F	GRComfort19402009_N5_HEFR_outputs	31	18
E	GRSpringBranch19231964_N5_HEFR_outputs	30	17
L	GRSpringBranch19652009_N5_HEFR_outputs	84	43
F	GRSpringBranch19232009_N5_HEFR_outputs	41	27
E	BRWimberley19291964_N5_HEFR_outputs	7.9	9.8
L	BRWimberley19652009_N5_HEFR_outputs	20	18
F	BRWimberley19292009_N5_HEFR_outputs	10	13
E	SMRLuling19401964_N5_HEFR_outputs	78	80
L	SMRLuling19652009_N5_HEFR_outputs	109	93
F	SMRLuling19402009_N5_HEFR_outputs	89	89
E	PCLuling19311964_N5_HEFR_outputs	1.5	0.8
L	PCLuling19652001_N5_HEFR_outputs	5	2.9
F	PCLuling19312001_N5_HEFR_outputs	2.7	1.5
E	GRGonzales_LP319401964_N7_HEFR_outputs	218	220
L	GRGonzales_LP319652009_N7_HEFR_outputs	518	356
F	GRGonzales_LP319402009_N7_HEFR_outputs	346	313
F	SCWesthoff19652009_N5_HEFR_outputs	3.5	1.4
E	GRCuero_LP319361964_N9_HEFR_outputs	201	206
L	GRCuero_LP319652009_N9_HEFR_outputs	496	341
F	GRCuero_LP319362009_N9_HEFR_outputs	345	283
E	MedRBandera19411969_N5_HEFR_outputs	2.2	3.7
L	MedRBandera19702009_N5_HEFR_outputs	24	13
F	MedRBandera19412009_N5_HEFR_outputs	5.5	6.6
E	MedRSanAntonio19401969_N5_HEFR_outputs	11	7.7
L	MedRSanAntonio19702009_N5_HEFR_outputs	84	61
F	MedRSanAntonio19402009_N5_HEFR_outputs	14	12
E	SARElmendorf19341969_N5_HEFR_outputs	82	62
L	SARElmendorf19702009_N5_HEFR_outputs	181	125
F	SARElmendorf19342009_N5_HEFR_outputs	96	80
E	SARFallsCity19261969_N7_HEFR_outputs	89	67
L	SARFallsCity19702009_N7_HEFR_outputs	186	122
F	SARFallsCity19262009_N7_HEFR_outputs	102	82
E	CCFallsCity19311969_N5_HEFR_outputs	12	6.6
L	CCFallsCity19702009_N5_HEFR_outputs	21	9.3

F	CCFallsCity19312009_N5_HEFR_outputs	13	7.4
E	SARGoliad19401969_N9_HEFR_outputs	105	69
L	SARGoliad19702009_N9_HEFR_outputs	242	162
F	SARGoliad19402009_N9_HEFR_outputs	130	106
E	MRRefugio19401969_N5_HEFR_outputs	2.5	1.6
L	MRRefugio19702009_N5_HEFR_outputs	2.5	1.1
F	MRRefugio19402009_N5_HEFR_outputs	2.5	1.5

Notes:

1. #N/A means that no subsistence flow days ocurred in that season in that period of record. Thi
   because the upper and lower HFP thresholds are set using the early period of record.
2. In StdHEFR outputs, zero means that (a) the 50th percentile of all subsistence flow days that oc
   subsistence flow day was identified in that season in the entire period of record. In this latter
   flow rec to zero. I have not seen this before, but it happened three times herein. The only wa
   "base flows" sheet and the count of subsistence flow days in each season. However, as a rule
   recommendations are large numbers (e.g., >10) and one season is zero, that is probably an err
3. n/a means critical period low flow not available from RG-194

Q95			Std HEFR				TCEQ Crit Period Low Flow	
Summer	Fall	Annual	Winter	Spring	Summer	Fall		Winter
8.7	33	21	12	15.5	12	17	74	74
108	111	154	126	87	108	98	525	525
155	426	359	**0**	275	171	267	525	525
140	257	223	160.5	133	146	112	525	525
0	10	1.33	0	0.05	0	0	55	55
16	55	33	#N/A	18	17	22	55	61
1.1	25	14	10	5.2	2	2.65	55	55
0	15	9	9.8	3.3	0.4	0	74	74
13	61	40	33	26	16	28.5	74	84
2.2	24	18	13	6.6	4.6	6.6	74	74
6.7	7	7.6	6.7	5.1	6.6	6.7	9.4	9.4
10	14	14	13	13	10	13	9.4	20
7.6	9.53	9.4	7.9	6.7	7.6	7.1	9.4	10
71	68	74	74.5	62	72	66	81	81
73	98	93	91	88	76	88	81	109
72	81	81	78	75	73	77	81	89
0	0.2	0.2	0.2	0.1	0	0	2.3	2.3
0.9	2	1.8	#N/A	1	0.88	0.8	2.3	5
0.1	0.6	0.7	0.4	0.2	0.1	0.1	2.3	2.7
156	166	179	176	126	158	134	489	489
230	434	347	#N/A	281	241	287	489	518
193	294	258	205	206	205	181	489	489
0.4	1.7	1.1	#N/A	0.7	0.6	0.9	n/a	3.5
84	84	127	102	73	83	75	525	525
163	424	351	**0**	252	172	262	525	525
127	231	197	134	118	131	86	525	525
1.1	0.8	1.2	0.8	0.8	0.8	0.8	8.2	8.2
2.8	14	9	#N/A	5.5	3.5	5.2	8.2	24
1.4	1.7	2.4	1.1	0.8	1.2	1.0	8.2	8.2
6.3	8.8	7.89	6.2	7.2	6.8	6.9	78	78
56	71	64	**0**	49	49	46	78	84
8.3	13	12	7.9	7.6	7	7.4	78	78
46	65	62	61	50	49	56	136	136
104	166	132	99.5	91	94	94	136	181
61	78	77	67	53	54	62	136	136
50	69	64	60	52	52	57.5	144	144
98	177	135	#N/A	83	86	79	144	186
59	79	76	64	55	55	64	144	144
4	8.1	6.6	5.9	4.8	4.9	6.4	15	15
6.0	14	10	5.5	5.2	5.6	8	15	21

4.6	8.9	7.6	6	4.9	5	6.5	15	15
52	84	76	76	60	54	66	205	205
123	212	167	126	113	113	130	205	242
74	116	105	84	65	62	81	205	205
1.2	1.7	1.6	2	1.6	1.6	1.6	4.7	4.7
0.21	1.8	0.93	0.61	0.31	0.3	0.6	4.7	4.7
0.7	1.8	1.5	0.9	1.3	1	1.3	4.7	4.7

s often happens in the latter period of record

ccurred in that season in that period of record was zero, or (b) only one
case, HEFR has a bug that assigns the subsistence
y to verify when this happens is to look at the
of thumb, if most subsistence flow seasonal
or. I have flagged the three in **bold underline.**

Max		
Spring	Summer	Fall
74	74	74
525	525	525
525	525	525
525	525	525
55	55	55
55	55	55
55	55	55
74	74	74
74	74	74
74	74	74
9.8	9.4	9.4
18	10	14
13	9.4	10
81	81	81
93	81	98
89	81	81
2.3	2.3	2.3
2.9	2.3	2.3
2.3	2.3	2.3
489	489	489
489	489	489
489	489	489
1.4	0.6	1.7
525	525	525
525	525	525
525	525	525
8.2	8.2	8.2
13	8.2	14
8.2	8.2	8.2
78	78	78
78	78	78
78	78	78
136	136	136
136	136	166
136	136	136
144	144	144
144	144	177
144	144	144
15	15	15
15	15	15

15	15	15
205	205	205
205	205	212
205	205	205
4.7	4.7	4.7
4.7	4.7	4.7
4.7	4.7	4.7

Appendix D

Texas Instream Flows Program Interim Recommendations for the Lower San Antonio River

TIFP - Elmendorf Recommendations

ELMENDORF

Overbank Flow (February–October):

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days
Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 8,000 cfs
Frequency = 1 event
Duration = 2 days
Key Indicators:
Riparian: Inundates approx. 75% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses:

May–June:
Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indicators: Cottonwood

July–November:
Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indicators:
Riparian: Green Ash / Box Elder

April–June:
Magnitude = 3,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) Key Indicators: Aquatic Habitat, Water Quality												
Base Wet	319	336	329	338	372	382	384	303	336	357	390	355
Base Average	264	268	256	235	259	216	177	160	195	220	226	225
Base Dry	119	113	114	109	113	98	90	90	107	90	91	101
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat Key Indicators: Water Quality, Aquatic Habitat												
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80

TIFP – Falls City Recommendations

FALLS CITY

Overbank Flow

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 8,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 80% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Magnitude = 6,500 cfs
Frequency = 2 events
Duration = 2-3 days

Key Indicators:
Riparian: Green Ash / Box Elder

Key Indicators: Riparian - Sycamore
Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-5 days

Magnitude = 4,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) **Key Indicators: Aquatic Habitat, Water Quality**

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
Base Wet	429	429	413	427	487	489	489	380	422	459	511	466
Base Average	292	296	288	261	281	249	200	177	218	242	244	251
Base Dry	152	158	147	142	145	125	103	96	141	105	119	127

SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat **Key Indicators: Water Quality, Aquatic Habitat**

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80

TIFP – Goliad Recommendations

GOLIAD

Overbank Flow

Magnitude = 14,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 65% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Key Indicators: Riparian - Sycamore
Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-5 days

Magnitude = 4,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

Magnitude = 8,000 cfs
Frequency = 2 events
Duration = 2-3 days

Key Indicators:
Riparian: Green Ash / Box Elder

BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) **Key Indicators: Aquatic Habitat, Water Quality**

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
Base Wet	475	460	471	470	538	498	503	434	507	531	579	535
Base Average	325	340	323	305	326	308	248	212	252	272	287	282
Base Dry	200	203	197	178	190	154	121	111	186	155	169	176

SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat **Key Indicators: Water Quality, Aquatic Habitat**

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80

TIFP - Cibolo Creek Recommendations

CIBOLO CREEK

Overbank Flow

Magnitude = 8,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 5,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 75% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Magnitude = 2,500 cfs
Frequency = 2 events
Duration = 2-3 days

Key Indicators:
Riparian: Green Ash / Box Elder

Magnitude = 1,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

Magnitude = 1,000 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indictors: Riparian - Buttonbush

BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability)							**Key Indicators: Aquatic Habitat, Water Quality**					
Base Wet	39	41	38	38	48	45	44	31	35	35	43	42
Base Average	29	28	27	26	29	28	21	17	20	23	25	25
Base Dry	19	20	19	18	17	14	11	9	12	13	13	15
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat								**Key Indicators: Water Quality, Aquatic Habitat**				
Subsistence	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
MONTH	January	February	March	April	May	June	July	August	September	October	November	December

CALAVERAS

Overbank Flow

[February – October]

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

[February – October]

Magnitude = 8,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 75% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

[May – June]

Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indicators: Cottonwood

[July – November]

Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-3 days

Key Indicators:
Riparian: Green Ash / Box Elder

[April – June]

Magnitude = 3,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) **Key Indicators: Aquatic Habitat, Water Quality**

MONTH	January – March	April – June	July – September	October – December
Base Wet	328	364	341	367
Base Average	262	237	178	223
Base Dry	115	106	87	92

SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat **Key Indicators: Water Quality, Aquatic Habitat**

MONTH	January – March	April – June	July – September	October – December
Subsistence	60	60	60	60

FALLS CITY

Overbank Flow

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 8,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 80% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Magnitude = 6,500 cfs
Frequency = 2 events
Duration = 2-3 days

Key Indicators:
Riparian: Green Ash / Box Elder

Key Indicators: Riparian - Sycamore
Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-5 days

Magnitude = 4,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability)			**Key Indicators: Aquatic Habitat, Water Quality**	
Base Wet	424	467	430	479
Base Average	292	264	199	246
Base Dry	152	137	113	117
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat			**Key Indicators: Water Quality, Aquatic Habitat**	
Subsistence	60	60	60	60

MONTH	January	February	March	April	May	June	July	August	September	October	November	December

CIBOLO CREEK

Overbank Flow

(February – October)

Magnitude = 8,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

(February – October)

Magnitude = 5,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 75% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

(July – November)

Magnitude = 2,500 cfs
Frequency = 2 events
Duration = 2-3 days

Key Indicators:
Riparian: Green Ash / Box Elder

(April – June)

Magnitude = 1,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

(July – October)

Magnitude = 1,000 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indictors: Riparian - Buttonbush

BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) Key Indicators: Aquatic Habitat, Water Quality

	January – March	April – June	July – September	October – December
Base Wet	39	44	37	40
Base Average	28	28	20	24
Base Dry	20	16	11	13

SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat Key Indicators: Water Quality, Aquatic Habitat

	January – March	April – June	July – September	October – December
Subsistence	7.5	7.5	7.5	7.5

MONTH	January	February	March	April	May	June	July	August	September	October	November	December

GOLIAD

Overbank Flow

Magnitude = 14,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 65% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Magnitude = 8,000 cfs
Frequency = 2 events
Duration = 2-3 days

Key Indicators:
Riparian: Green Ash / Box Elder

Key Indicators: Riparian - Sycamore
Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-5 days

Magnitude = 4,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) **Key Indicators: Aquatic Habitat, Water Quality**

Base Wet	469	502	481	548
Base Average	329	313	237	280
Base Dry	200	174	139	167

SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat **Key Indicators: Water Quality, Aquatic Habitat**

Subsistence	60	60	60	60
MONTH	January February March	April May June	July August September	October November December

Appendix E
Summary Information from Simulations Made by GSA BBASC in Development of Recommendations Report

Appendix E1 – Hydrology and Instream Summary Information

Appendix E2 – Estuary Analyses: Additional Resources and Methodological Details

Appendix E3 – TCEQ Run 3 GSA WAM Files

Appendix E1 – Hydrology and Instream Summary Information

GSA WAM Modeling Background Information

Simulations for the GSA BBASC were performed using TCEQ's Guadalupe – San Antonio Water Availability Model (GSA WAM), as obtained from the TCEQ website on 4/5/2011, with modifications to address GSA BBASC assumptions and to ensure an accurate representation of streamflow and freshwater inflows to the Guadalupe Estuary. The WAM modifications made to the TCEQ's model include:

(1) Return flows consistent with 2006 reported effluent discharges were included in the modeling for the GSA BBASC. These return flows are consistent with the work performed by the GSA BBEST and in the regional planning process.

(2) Simulated springflows (FAD File) were replaced with revised simulated springflow information based on a GWSIM4 model simulation for the period 1934-1946 and a MODFLOW simulation for the period 1947 to 1989; and represents Edwards Aquifer pumpage and critical period management rules consistent with Senate Bill 3 (80th Texas Legislature)

(3) A control point change in the model to ensure proper simulation of Comal Springs was incorporated into the GSA WAM.

(4) Select water rights were modified to ensure proper representation of streamflows. Initial review of baseline results revealed that small amounts of water were always showing up as regulated flow to the Guadalupe Estuary during drought months when senior lower basin water rights were shorted. Since these lower basin rights do not have instream flow requirements, it was that several upstream junior non-consumptive or hydropower rights were altering streamflow in unrealistic ways. As such, the following water rights were either altered or removed from the model:

   a. CA #18-2019 (THE BLUE WING CLUB) was modified to remove the refilling of the reservoir at a junior water right
   b. CA #18-3846 (CITY OF GONZALES) was modified to remove the storage associated with the hydropower authorization
   c. CA #18- 3853 (CUERO HYDROELECTRIC, INC.) was modified to remove the storage associated with the hydropower authorization
   d. CA #18- 3859 (SOUTH TEXAS ELECTRIC COOP INC) was split into a consumptive portion and an instream flow portion
   e. CA #18-5485 (CENTRAL POWER & LIGHT CO) was removed from the model

(5) It was noted that the JO record in the TCEQ's version of RUN3 has PX record 3 flagged as the default for all water rights in the model. This results in two simulation passes for all water rights in the model with each water right being limited to the depletions recorded in the first pass. The two primary purposes of this logic appear to be (1) to

represent the Canyon amendment which is based upon, in part, the subordination of GBRA's senior Hydropower rights to Canyon Reservoir; and (2) to represent the subordination of Canyon Reservoir to numerous upstream water rights. However, by imposing this logic on all water rights in the model by default, water rights junior to the Canyon Reservoir water right amendment are improperly constrained to their depletion during the first pass (without the Canyon amendment in place) which results in improper results. This issue was pointed out to TCEQ staff but no resolution was reached. Accordingly, the new projects placed in the model pursuant to the GSA BBASC analysis (new test projects) are coded with a specific PX 2 record so that these new activities will not be improperly limited to depletions in the first simulation pass.

(6) The control point for the Guadalupe River near Gonzales was placed in the model using location information and watershed parameters from the 2011 SCTRWP. Several other new control points were placed into the model network as entry locations for return flows, again using watershed parameters from the 2011 SCTRWP. In addition, several dummy control points were inserted for the purposes of representing the off-channel reservoirs; or, recording various intermediate WAM simulation results.

Detailed Information Regarding Run-of-River Simulations for the GSA BBASC

Simulations of new run-of-river diversions were made at six locations in stakeholder area (see Figure E1-1). The locations were:

- San Marcos River at Luling
- Guadalupe River at Goliad
- Guadalupe River at Victoria
- San Antonio River at Elmendorf
- Cibolo Creek near Falls City
- Mission River at Refugio

Each new diversion was for 10,000 acft/yr of authorized diversion, with a uniform diversion of streamflow subject to downstream senior water rights and three environmental flow criteria: No Environmental Flow Criteria, Lyons Method, and Full BBEST Recommendation. For the Full BBEST Recommendation, the environmental criteria were limited to the subsistence and baseflow components only.

The maximum, average, and minimum annual diversion for each of the location under each of the environmental criteria are presented in Tables E1-1 through E1-6, respectively, as is the monthly and daily reliabilities. Figures E1-2 through E1-7 present the resulting downstream flow frequency under each of the environmental criteria for the six locations, respectively.

It is noted that the inclusion of the Pulse Exemption Rule (Section 4.3.1) in the GSA BBASC Recommendations has addressed the issue of pulse recommendations for new run-of-river appropriations. As such, the simulations presented in this section were superseded by the GSA BBASC Recommendations.

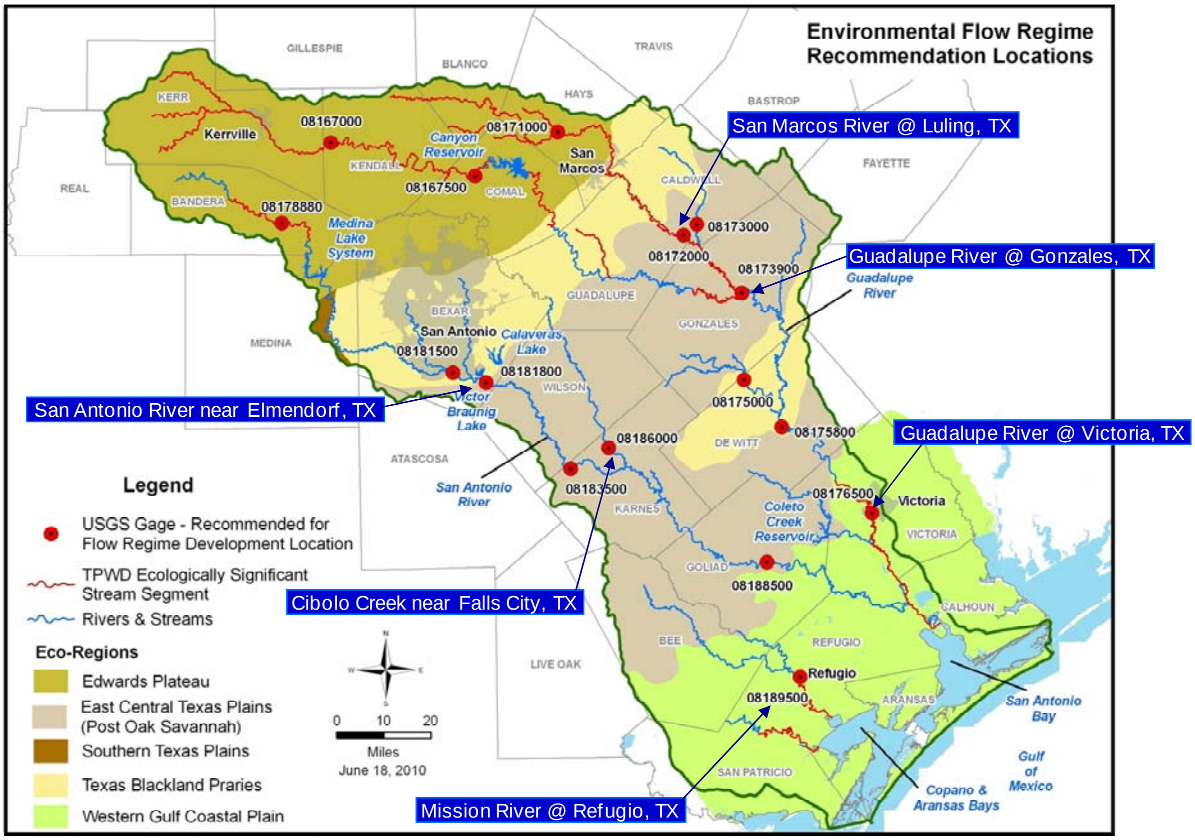

Figure E-1. Locations of the Run-of-River Simulations

Table E1-1. Run-of-River Statistics – San Marcos River at Luling

	No Environmental Flow	Lyons Method	BBEST Recommendation
Maximum Annual Diversion (acft/yr)	10,000	10,000	10,000
Average Annual Diversion (acft/yr)	6,161	5,542	5,015
Minimum Annual Diversion (acft/yr)	0	0	0
Monthly Reliability	56.6%	45.8%	37.0%
Daily Reliability	57.9%	52.8%	46.1%

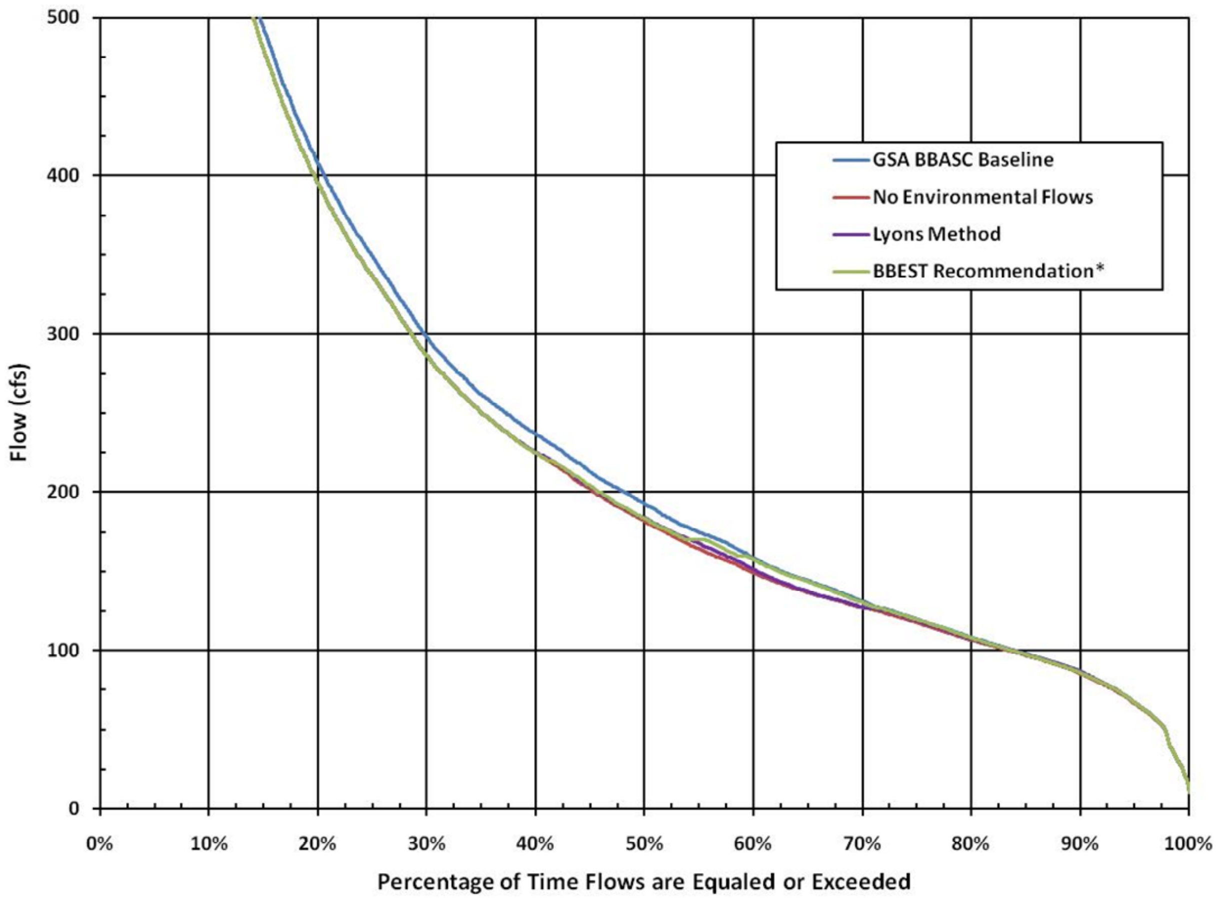

Figure E1-2. Flow Frequency – San Marcos River at Luling

Table E1-2. Run-of-River Statistics – Guadalupe River at Gonzales

	No Environmental Flow	Lyons Method	BBEST Recommendation
Maximum Annual Diversion (acft/yr)	10,000	10,000	10,000
Average Annual Diversion (acft/yr)	8,130	5,997	5,128
Minimum Annual Diversion (acft/yr)	54	10	22
Monthly Reliability	80.1%	49.5%	38.1%
Daily Reliability	80.4%	58.5%	49.8%

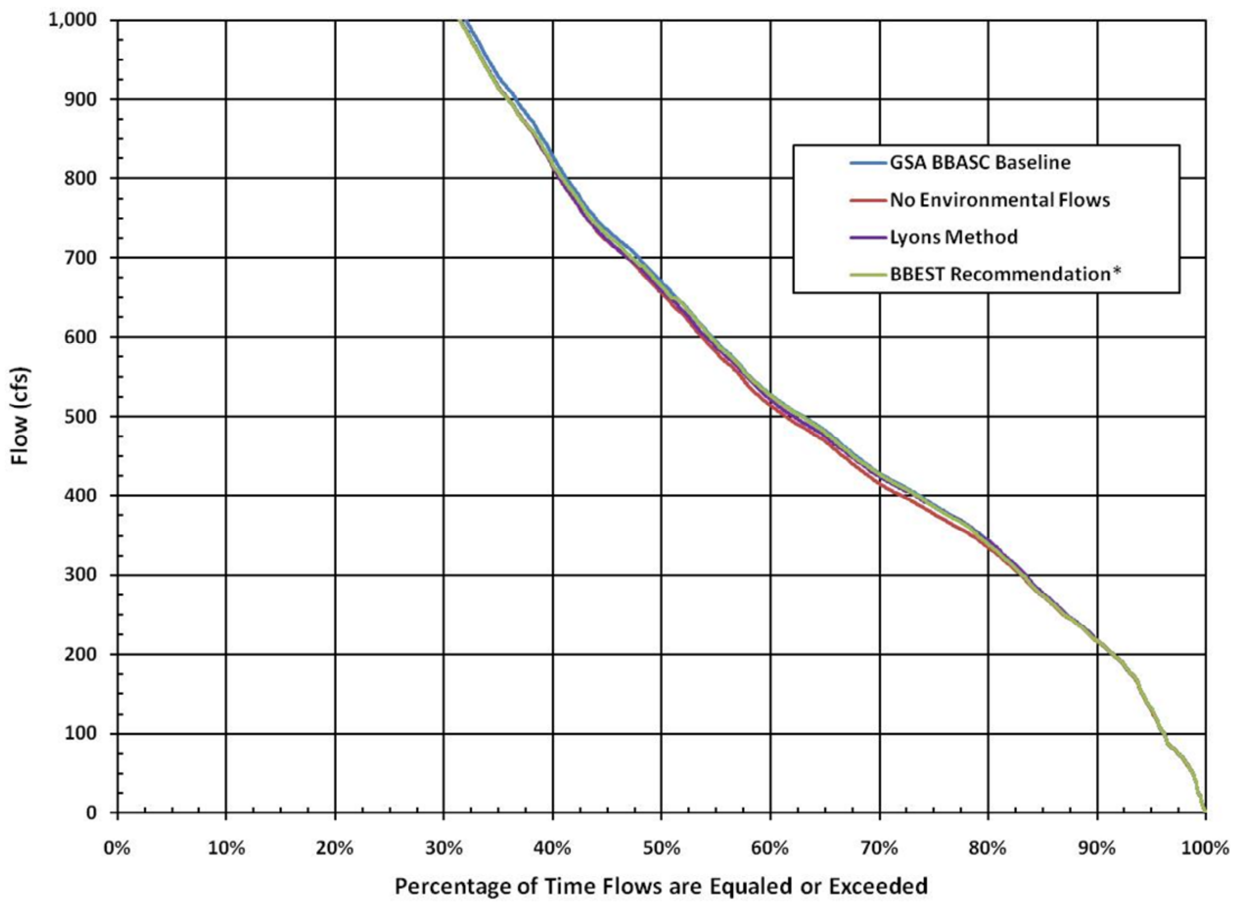

Figure E1-3. Flow Frequency – Guadalupe River at Gonzales

Table E1-3. Run-of-River Statistics – Guadalupe River at Victoria

	No Environmental Flow	Lyons Method	BBEST Recommendation
Maximum Annual Diversion (acft/yr)	10,000	10,000	10,000
Average Annual Diversion (acft/yr)	8,547	6,273	5,831
Minimum Annual Diversion (acft/yr)	584	82	311
Monthly Reliability	85.0%	48.3%	42.0%
Daily Reliability	85.3%	62.2%	57.0%

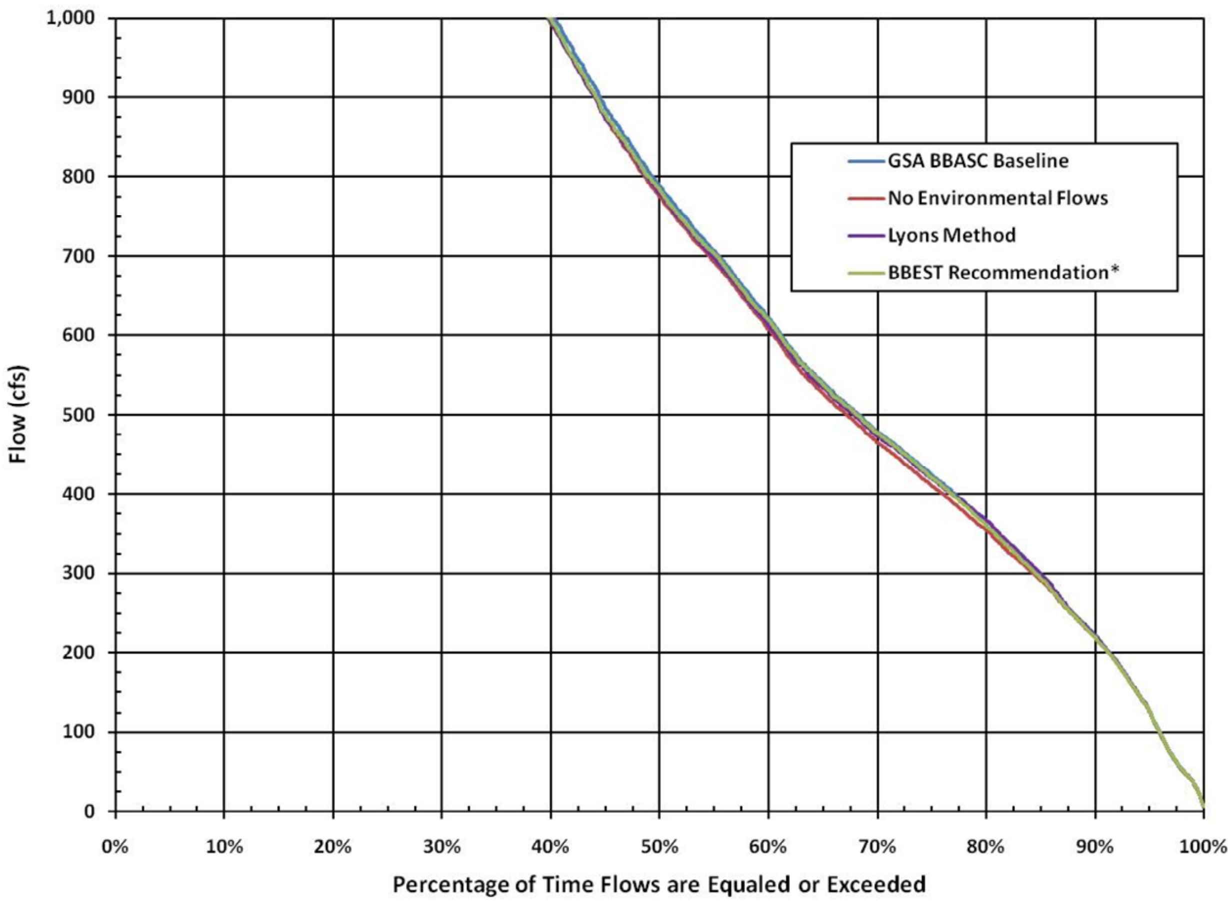

Figure E1-4. Flow Frequency – Guadalupe River at Victoria

Table E1-4. Run-of-River Statistics – San Antonio River at Elmendorf

	No Environmental Flow	Lyons Method	BBEST Recommendation
Maximum Annual Diversion (acft/yr)	10,000	10,000	9,368
Average Annual Diversion (acft/yr)	4,437	3,066	3,797
Minimum Annual Diversion (acft/yr)	0	0	0
Monthly Reliability	41.2%	18.7%	24.7%
Daily Reliability	42.4%	29.2%	35.2%

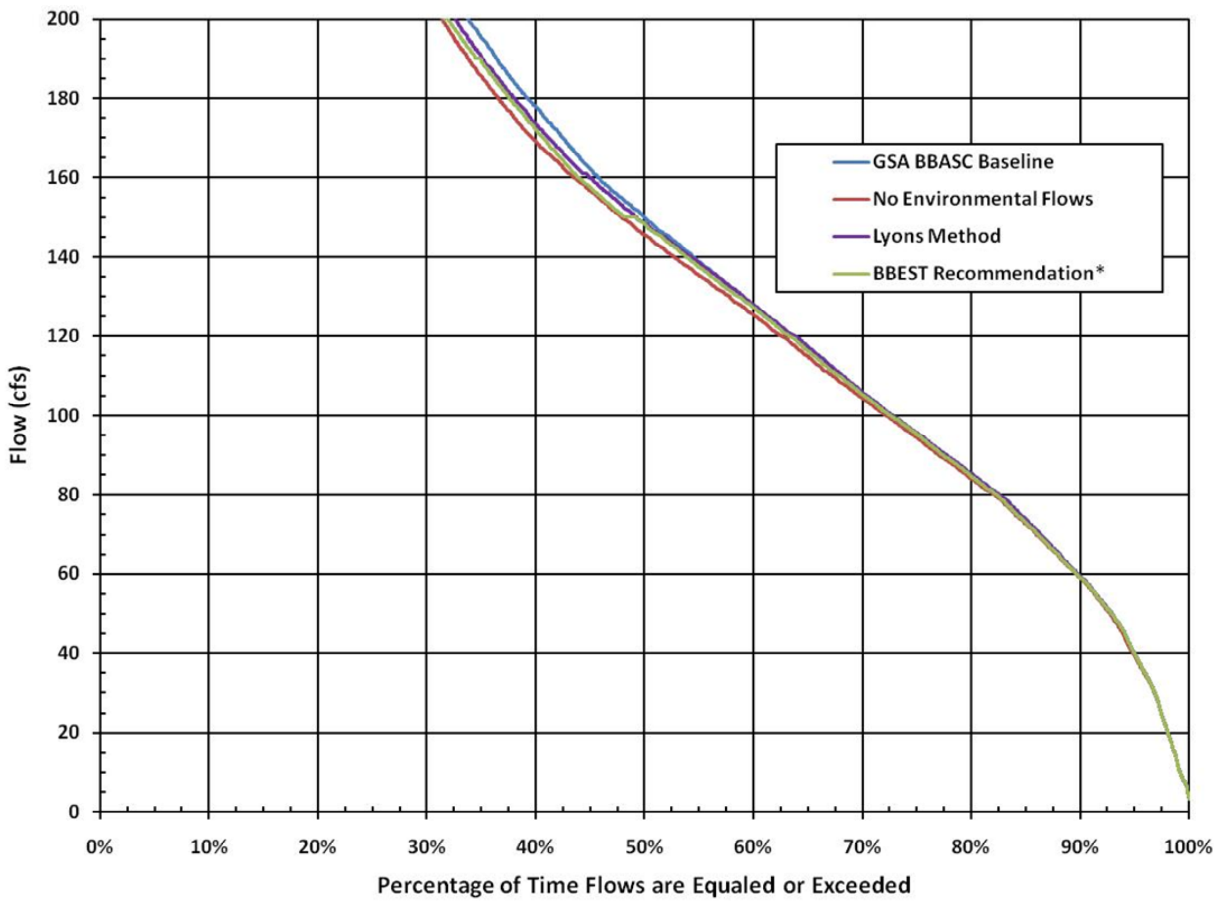

Figure E1-5. Flow Frequency – San Antonio River at Elmendorf

Table E1-5. Run-of-River Statistics – Cibolo Creek near Falls City

	No Environmental Flow	Lyons Method	BBEST Recommendation
Maximum Annual Diversion (acft/yr)	9,598	9,559	9,509
Average Annual Diversion (acft/yr)	5,575	4,440	4,676
Minimum Annual Diversion (acft/yr)	204	82	133
Monthly Reliability	32.7%	16.2%	15.0%
Daily Reliability	42.6%	32.9%	33.2%

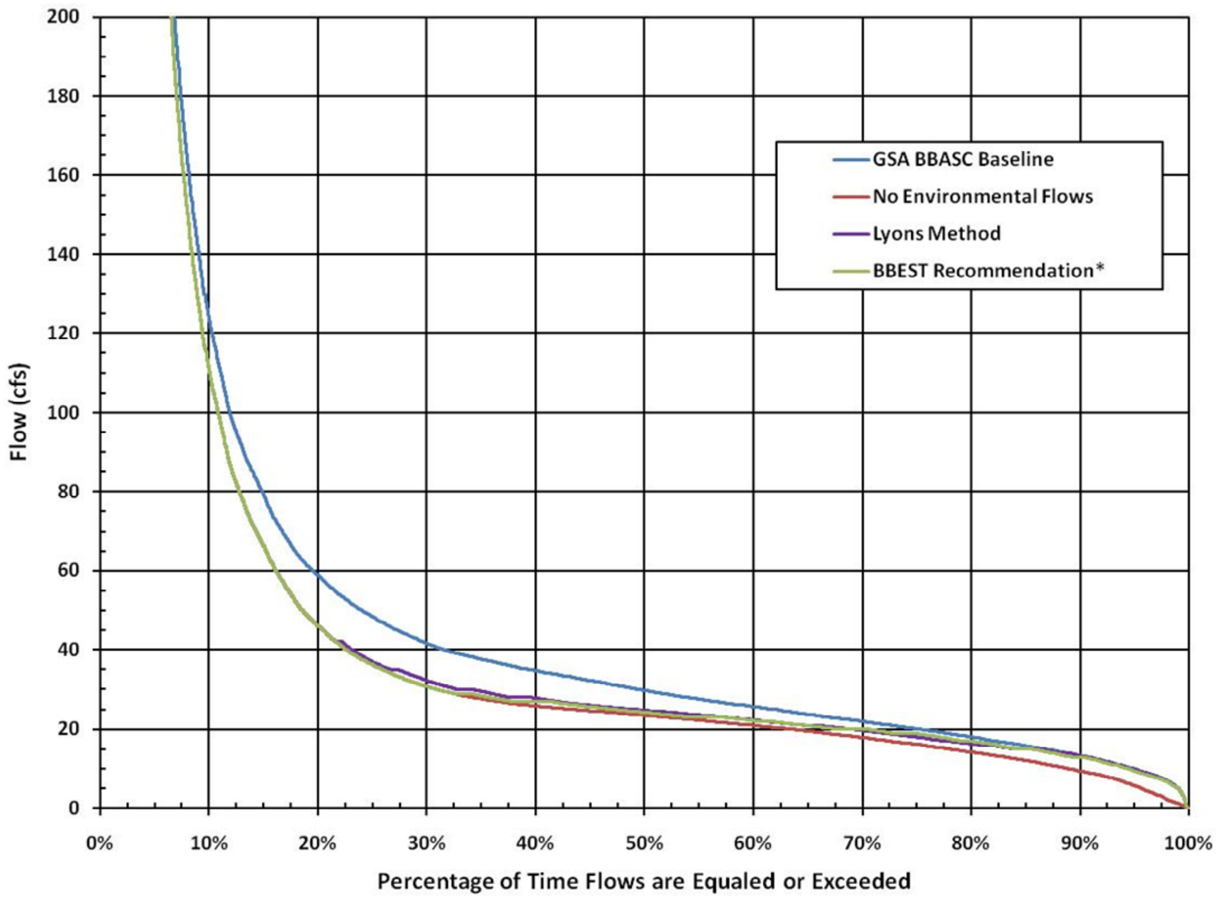

Figure E1-6. Flow Frequency – Cibolo Creek near Falls City

Table E1-6. Run-of-River Statistics – Mission River at Refugio

	No Environmental Flow	Lyons Method	BBEST Recommendation
Maximum Annual Diversion (acft/yr)	10,000	9,699	9,896
Average Annual Diversion (acft/yr)	6,039	3,605	3,852
Minimum Annual Diversion (acft/yr)	0	0	0
Monthly Reliability	25.1%	11.7%	11.3%
Daily Reliability	44.6%	29.6%	30.2%

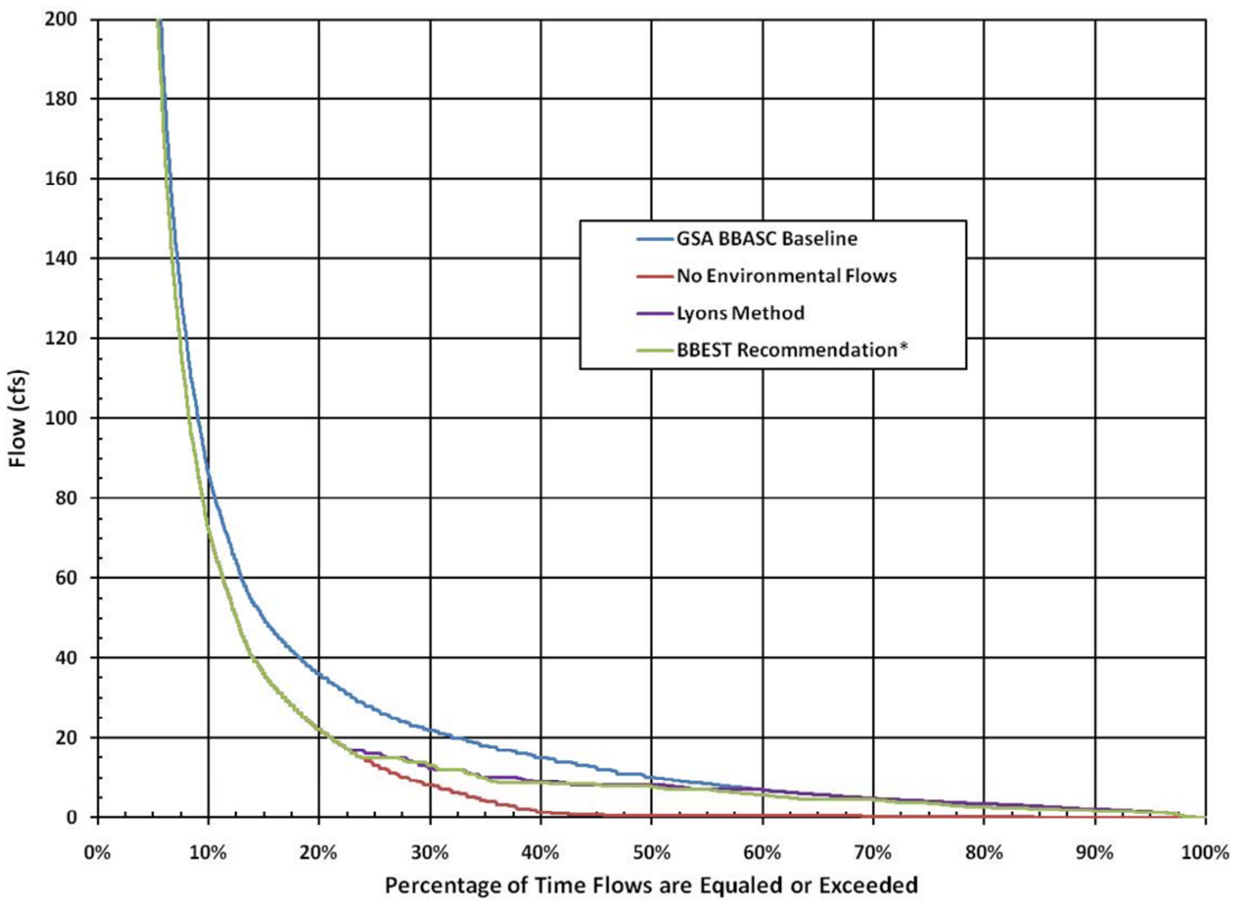

Figure E1-7. Flow Frequency – Mission River at Refugio

Appendix E2 – Estuary Analyses: Additional Resources and Methodological Details

The BBEST Estuary Inflow Recommendations

The Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Expert Science Team (GSA BBEST) developed a set of recommended freshwater inflow criteria for the Guadalupe Estuary and the Mission-Aransas Estuary. The BBEST estuary criteria, structured to cover two principal seasons, consist of a multi-tiered suite of inflow volumes and an associated frequency of attainment for each. Although the BBEST inflow criteria covered both the estuaries, the interconnected nature of the estuaries led to a majority of the recommendations focused on the Guadalupe, with only minimal independent inflow recommendations for the Mission-Aransas Estuary. Since these Guadalupe Estuary recommendations will be referred to repeatedly in this report, for ease of reference these are repeated here in Tables E2-1 through E2-4 (as they appear in Section 6 of the BBEST report).

For the Guadalupe Estuary, the BBEST derived the "G1" recommendations set covering principally the March-May spring period, with a requirement for February in a lower portion of the criteria suite (the G1-C and G1-CC levels). These criteria, summarized in Tables E2-1 and E2-2, are based on the reproductive requirements of the *Rangia* clam which, according to data collected by Texas Parks and Wildlife Department (TPWD), are abundant in the northern portion of the estuary, nearest the freshwater source of the Guadalupe River.

The GSA BBEST also developed a "G2" suite of inflow recommendations covering the summer period, principally July-September, but with a requirement for June in some lower levels of the suite (G2-C and G2-CC). These criteria, summarized in Tables E2-3 and E2-4, are based on the requirements of oysters in the Guadalupe Estuary.

Both the G1 and G2 suite of recommendations cover a broad range of inflows, salinity, and biologic suitability conditions for their respective organisms with the upper levels of G1 and G2 criteria (G1-A, G1-B, or G2-A and G2-B) representing good or very good conditions. The lower levels of both criteria suites (G1-D and G2-D & G2-DD) represent periods of limited reproductive success for *Rangia* and significant disease and parasite problems for oysters, respectively. Another prominent feature about the BBEST recommendations, as shown in both Tables E2-2 and E2-4 is that some inflows tiers are assessed independently or in "single" such as G1-A. Others are to be assessed in combination, or jointly, with other tiers, such as the combined occurrence of G1-A and G1-B. The attainment goals for the various tiers were based partially on historical levels in the 1941-2009 period.

Table E2-1. Summary of Guadalupe Estuary G1 Criteria, Recommended Inflow Volumes for the Spring Period (February – May)

Criteria level	Inflow Volumes (1000 ac-ft)	
	Feb.	Mar.-May
G1-Aprime,	n/a	550-925
G1-A	n/a	375-550
G1-B	n/a	275-375
G1-C	≥75	150-275
G1-CC	0 - 75	150-275
G1-D	n/a	0 - 150

Table E2-2. Summary of Guadalupe Estuary G1 Attainment Goals for the Recommended Inflow Volumes for the Spring Period (February – May)

Criteria level	Specification	Inflow Criteria Attainment[1]
G1-Aprime	Attainment, G1-Aprime	at least 12% of years
G1-A	Attainment, G1-A	at least 12 % of years
G1-A & G1-B	Attainment, G1-A & G1-B combined	G1-A and G1-B combined at least 17% of years
G1-C & G1-CC	Attainment, G1-C & G1-CC combined[1]	G1-C and G1-CC can be equal to or greater than 19% of years. G1-CC no more than 2/3 of total
G1-D	Attainment, G1-D	no more than 9% of years
1) The attainment goals for categories G1-C and G1-CC are contingent upon other criteria level attainment goals being met.		

Table E2-3. Summary of Guadalupe Estuary G2 Recommended Inflow Volumes for the Summer Period (June – September)

Criteria level	Inflow Volumes (1000 ac-ft)	
	June	July-Sept.
G2-Aprime	n/a	450-800
G2-A	n/a	275-450
G2-B	n/a	170-275
G2-C	≥50	75-170
G2-CC	0 - 50	75-170
G2-D	n/a	50-75
G2-DD	n/a	0-50

Table E2-4. Summary of Guadalupe Estuary G2 Attainment Goals for the Recommended Inflow Volumes for the Summer Period (June – September)

Criteria level	Specification	Inflow Criteria Attainment
G2-Aprime	Attainment, G2-Aprime	at least 12% of years
G2-A	Attainment, G2-A	at least 17 % of years
G2-A & G2-B	Attainment, G2-A & G2-B combined	G2-A and G2-B combined at least 30% of years
G2-C & G2-CC	Attainment, G2-C & G2-CC combined[1]	G2-C and G2-CC can be equal to or greater than 10% of years. G2-CC no more than 1/6 of total
G2-DD	Attainment, G2-DD	G2-DD no more than 6% of years
G2-D & G 2-DD	Attainment, G2-D & G2-DD combined	G2-D and G2-DD combined no more than 9% of years
1) The attainment goals for categories G2-C and G2-CC are contingent upon other criteria level attainment goals being met.		

The Method for Evaluating Attainment Performance Inflow Scenarios

The assessment of how each scenario's inflows to the Guadalupe Estuary compare to the BBEST recommendations begins by examining the total inflow for each of the 49 spring and summer periods. One portion of the total 49 year period is illustrated in Figure E2-1, a wet to dry transition in 1983-84. The dotted boxes indicate the spring "G1" and summer "G2" periods. For each "G1" period, the inflow of February and sum of inflows for March-May are calculated in each scenario. Similarly, the June inflow and sum of inflows for July-September are calculated to assess the "G2" summer period. For the 1983-84 example period, the results for each scenario are presented in Table E2-6. For example under the rainfall-runoff conditions that prevailed in 1983, a wet year, the Historical inflows in the March-May period totaled 413.0 thousand ac-ft, garnering a ranking of "G1-A" in the BBEST recommendations for Spring. Slightly higher inflows (~427 thousand ac-ft) would have resulted in spring for 1983 under the Naturalized scenario, but these would also fall within the G1-A tier of the BBEST recommendations. Under both the Present Use and Region L Baseline scenarios, the inflow sum for March-May falls below 375 thousand ac-ft, the breakpoint between G1-A and G1-B levels (see Table E2-1). For the summer of 1983, also wet, all scenarios except the Region L Baseline have a July-September sum of inflow greater that 275 thousand ac-ft, the breakpoint between the G2-A and G2-B tiers (see Table E2-3). Similar comparisons of the inflows for 1984, a much drier year, show the spring G1 season inflows were "G1-CC" under Naturalized and Historical conditions. Under the Present Use and Region L Baseline scenarios, the inflows fall somewhat and the resulting ranking is that of the G1-D level. For the very dry summer of 1984, Table E2-5 shows that all but the Naturalized scenario had inflows in the G2-DD tier.

One important note here about this type of ranking / assessment stems from the results for the summer of 1984. As Table E2-5 shows, all three of the scenarios Historical, Present Use, and Region L Baseline are in the G2-DD tier, even though their respective inflow sums for July-September are quite different, with Historical (43.5 thousand ac-ft) being almost six times that of the Region L Baseline (7.7 thousand ac-ft). This is an inherent characteristic of “categorical” data.

Table E2-5 - Guadalupe Estuary Inflow and Attainment Summary of the Natural, Historic, Present Conditions, and Region L Baseline scenarios for the 1983-84 example period shown in Figure E2-1.

	non-project scenario			
Inflow (1000 ac-ft) and BBEST Tier Assignment	Naturalized	Historical	Present Use	Region L Baseline
1983, wet year				
Spring "G1" inflows				
February	139.3	142.3	114.8	102.6
Mar.-May sum	426.8	413.0	320.6	276.3
BBEST “G1” tier	G1-A	G1-A	G1-B	G1-B
Summer "G2" inflows				
June	118.3	97.6	76.9	59.2
July-Sept. sum	385.8	375.5	288.4	228.0
BBEST “G2” tier	G2-A	G2-A	G2-A	G2-B
1984, dry year				
Spring "G1" inflows				
February	64.0	58.2	40.9	30.2
Mar.-May sum	201.5	166.3	119.4	81.3
BBEST “G1” tier	G1-CC	G1-CC	G1-D	G1-D
Summer "G2" inflows				
June	41.8	19.8	13.5	0.1
July-Sept. sum	97.3	43.5	21.8	7.7
BBEST “G2” tier	G2-CC	G2-DD	G2-DD	G2-DD

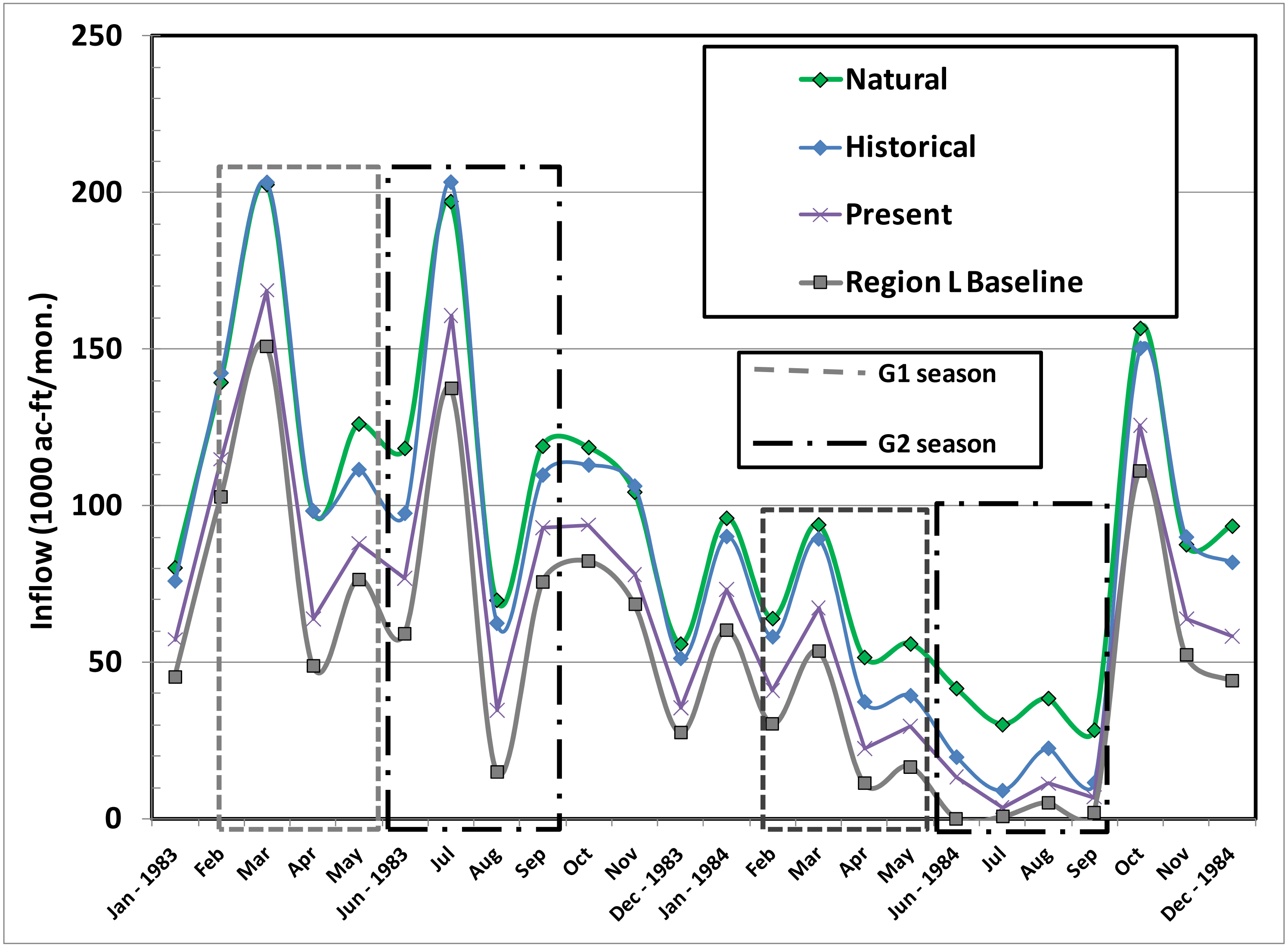

Figure E2-1. Illustration of the inflows to the Guadalupe Estuary under several principal non-project scenarios for the 1983-84 period. Also shown with dotted line boxes are the G1 and G2 seasons in which the inflows are assessed for performance in meeting the BBEST recommendations.

Summary Presentation of Results, all Scenarios

While the two-year period above illustrates in some detail the way in which the assessment of each scenario's attainment performance proceeds, it is much more convenient to examine a summary for all 49 years in the period of record. For each Guadalupe Estuary seasonal criteria (e,g, G1) a three part summary table was designed for this purposes. The tables here also present the results of the estuary assessment for all the scenarios evaluated: non-project and various combinations of project / instream criteria (a.k.a. "with project" scenarios).

Table E2-6, in parts a-c, summarizes the attainment performance of each of the non-project scenarios with regard to the G1 criteria covering the springtime months (Feb. -May). Part a) for each scenario is the count of the number of Spring seasons (=years) that fall in each inflow category. Part b) measures attainment performance for the portions of the criteria that are stand-alone "single" measures (e.g. occurrence of G1-A >12% of years). Part c) measures attainment for criteria that are to be assessed jointly (eg. the total occurrence of G1-C and G1-CC). Attainment performance is highlighted with a color scheme indicated at the bottom[1].

The cells highlighted in red indicate BBEST recommendations that the particular scenario fails to meet at levels that are cause for concern with regard to the ability to sustain a sound ecological environment. For instance, using the G1-D criteria as an example, Table E2-6 shows that the non-attainment of this criteria under the Region L Baseline was due to the 14 years of its occurrence (indicated in Table E2-6 part a). This equates to this level of inflow occurring 28.6% of years (indicated in part b), whereas the BBEST recommendation was for no more that 9% of years.

Table E2-7 similarly illustrates the performance of the various non-project scenarios with regard to meeting the BBEST recommendations for the summer June-Sept. season. For example, under the Region L Baseline G2-D and G2-DD inflows occur in a total of 11 years (indicated in Table E2-7 part a as 3 years and 8 years, respectively). This equates to these levels of inflow occurring 22.4% of years (indicated in part b), whereas the BBEST recommendation was for no more that 9% of years in total.

[1] Color scheme as adopted by the BBEST Estuary Subcommittee in that groups report to the BBASC titled "Biological and Ecological Implications of Non-Attainment of the BBEST Guadalupe Estuary Criteria", July, 2011.

Table E2-6 Summary of the all scenarios, attainment performance for the G1 suite of Guadalupe Estuary inflow criteria for the spring (Feb.-May) period. (see notes at bottom).

Part a) Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Naturalized	9	15	7	6	3	6	3	49
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Baseline	7	10	8	3	3	4	14	49
TCEQ Run 3	7	10	8	1	5	3	15	49
w. Guadalupe Mid-Basin Project, Dv=500cfs								
1: 105k V, No instream flow (IF) criteria	7	9	9	1	5	4	14	49
2: 105k V, Full BBEST IF recomms.	7	10	8	2	4	4	14	49
3: 105k V, Consensus CEFN	7	9	9	1	5	4	14	49
4: 105k V, Lyons Method	7	9	9	2	4	4	14	49
5: 105k V, BBEST IF, no div if Q<Base Dry	7	10	8	2	4	4	14	49
6: 105k V, BBEST IF & Pulse 10% div rule	7	9	9	2	4	4	14	49
7: 105k V, BBEST IF & Pulse 20% div rule	7	9	9	2	4	4	14	49
8: 105k V, BBEST IF & Pulse 30% div rule	7	9	9	2	4	4	14	49
9: 105k V, East Tx. 1 base / 1 Pulse struc.	7	10	8	1	5	4	14	49
10: 105k V, Prelim BBASC Gonzales IF Recomm.	7	9	9	2	4	4	14	49
11: 192k V, BBEST Full Instream (IF) Recomms.	7	10	8	2	4	4	14	49
12: 192k V, Prelim BBASC Gonzales IF Recomm.	7	9	9	1	5	4	14	49
13: 105k V, 1-3-3-1 Base Wet; Subs 50% rule; Pulse 20% div rule	7	10	8	2	4	4	14	49
w. San Antonio River Project (800 cfs max. diversion)								
A: 150k V, No instream flow (IF) criteria	7	9	9	1	5	4	14	49
B: 150k V, Full BBEST IF Recomms.	7	9	9	1	5	4	14	49
C: 150k V, Consensus CEFN	7	9	9	1	5	4	14	49
D: 150k V, Lyons Method	7	9	9	2	4	4	14	49
E: 150k V, BBEST IF, no div if Q<Base Dry	7	9	9	1	5	4	14	49
F: 150k V, TIFP 80cfs subs., no 50% subs/base rule	7	9	9	2	4	4	14	49
G: 150k V, TIFP 60cfs subs., 50% rule, Pulse 10% div. rule	7	9	9	2	4	4	14	49
H: 150k V East Tx. 1 base / 1 Pulse struc	7	9	9	1	5	4	14	49

Part b) Attainment - single criteria measures	Single G1 criteria attainment (% of yrs.)						
Scenario	**>A-pr**	**A-pr**	**A**	**B**	**C**	**CC**	**D**
Goal	n/a	>12%	>12%	n/a	n/a	n/a	≤9%
Naturalized		30.6%	14.3%	12.2%	6.1%	12.2%	6.1%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Baseline		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
TCEQ Run 3		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%
w. Guadalupe Mid-Basin Project, Dv=500cfs							
1: 105k V, No instream flow (IF) criteria		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
2: 105k V, Full BBEST IF recomms.		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
3: 105k V, Consensus CEFN		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
4: 105k V, Lyons Method		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
5: 105k V, BBEST IF, no div if Q<Base Dry		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
6: 105k V, BBEST IF & Pulse 10% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
7: 105k V, BBEST IF & Pulse 20% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
8: 105k V, BBEST IF & Pulse 30% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
9: 105k V, East Tx. 1 base / 1 Pulse struc.		20.4%	16.3%	2.0%	10.2%	8.2%	28.6%
10: 105k V, Prelim BBASC Gonzales IF Recomm.		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
11: 192k V, BBEST Full Instream (IF) Recomms.		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
12: 192k V, Prelim BBASC Gonzales IF Recomm.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
13: 105k V, 1-3-3-1 Base Wet; Subs 50% rule; Pulse 20% div rule		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
w. San Antonio River Project (800 cfs max. diversion)							
A: 150k V, No instream flow (IF) criteria		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
B: 150k V, Full BBEST IF Recomms.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
C: 150k V, Consensus CEFN		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
D: 150k V, Lyons Method		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
E: 150k V, BBEST IF, no div if Q<Base Dry		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
F: 150k V, TIFP 80cfs subs., no 50% subs/base rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
G: 150k V, TIFP 60cfs subs., 50% rule, Pulse 10% div. rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
H: 150k V East Tx. 1 base / 1 Pulse struc		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%

Part c) Attainment - joint measures	Joint G1 criteria attainment (% of years and fractions)						
Scenario	**>A-pr**		**A & B**		**C & CC**	**frac. CC**	
Goal	n/a		>17%		≥19%	≤67%	
Naturalized			26.5%		18.4%	66.7%	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Baseline			22.4%		14.3%	57.1%	
TCEQ Run 3			18.4%		16.3%	37.5%	
w. Guadalupe Mid-Basin Project, Dv=500cfs							
1: 105k V, No instream flow (IF) criteria			20.4%		18.4%	44.4%	
2: 105k V, Full BBEST IF recomms.			20.4%		16.3%	50.0%	
3: 105k V, Consensus CEFN			20.4%		18.4%	44.4%	
4: 105k V, Lyons Method			22.4%		16.3%	50.0%	
5: 105k V, BBEST IF, no div if Q<Base Dry			20.4%		16.3%	50.0%	
6: 105k V, BBEST IF & Pulse 10% div rule			22.4%		16.3%	50.0%	
7: 105k V, BBEST IF & Pulse 20% div rule			22.4%		16.3%	50.0%	
8: 105k V, BBEST IF & Pulse 30% div rule			22.4%		16.3%	50.0%	
9: 105k V, East Tx. 1 base / 1 Pulse struc.			18.4%		18.4%	44.4%	
10: 105k V, Prelim BBASC Gonzales IF Recomm.			22.4%		16.3%	50.0%	
11: 192k V, BBEST Full Instream (IF) Recomms.			20.4%		16.3%	50.0%	
12: 192k V, Prelim BBASC Gonzales IF Recomm.			20.4%		18.4%	44.4%	
13: 105k V, 1-3-3-1 Base Wet; Subs 50% rule; Pulse 20% div rule			20.4%		16.3%	50.0%	
w. San Antonio River Project (800 cfs max. diversion)							
A: 150k V, No instream flow (IF) criteria			20.4%		18.4%	44.4%	
B: 150k V, Full BBEST IF Recomms.			20.4%		18.4%	44.4%	
C: 150k V, Consensus CEFN			20.4%		18.4%	44.4%	
D: 150k V, Lyons Method			22.4%		16.3%	50.0%	
E: 150k V, BBEST IF, no div if Q<Base Dry			20.4%		18.4%	44.4%	
F: 150k V, TIFP 80cfs subs., no 50% subs/base rule			22.4%		16.3%	50.0%	
G: 150k V, TIFP 60cfs subs., 50% rule, Pulse 10% div. rule			22.4%		16.3%	50.0%	
H: 150k V East Tx. 1 base / 1 Pulse struc			20.4%		18.4%	44.4%	

Notes: Part a) is the counts of seasons (=years) that fall in each inflow category. Part b) measures attainment performance for the portions of the criteria that are stand-alone measures (e.g. occurrence of G1-A >12% of years). Part c) measures attainment for criteria that are to be assessed jointly (eg. the total occurrence of G1-C and G1-CC). Attainment performance is highlighted with a color scheme indicated at the bottom[2].

cell color scheme

Color Scheme				
meaning	criteria met	criteria nearly met. rounding & period of record change probable causes.	criteria not met, departure from BBEST recommendations not great	criteria not met, departure of concern from BBEST recommendations

[2] Color scheme as adopted by the BBEST Estuary Subcommittee in that groups report to the BBASC titled "Biological and Ecological Implications of Non-Attainment of the BBEST Guadalupe Estuary Criteria", July, 2011.

Table E2-7 Summary of the all scenarios, attainment performance for the G2 suite of Guadalupe Estuary inflow criteria for the summer (June-Sept.) period. notes and color scheme as in Table E2-6.

Part a) Counts	Criteria G2 Attainment (no. years 1941-89)								
Scenario	**>A-pr**	**A-pr**	**A**	**B**	**C**	**CC**	**D**	**DD**	**sum**
Naturalized	9	11	15	7	3	2	2	0	
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Baseline	4	8	8	8	7	3	3	8	49
TCEQ Run 3	4	6	9	8	6	4	3	9	49
w. Guadalupe Mid-Basin Project, Dv=500cfs									
1: 105k V, No instream flow (IF) criteria	4	8	8	8	6	4	2	9	49
2: 105k V, Full BBEST IF recomms.	4	8	8	8	7	3	3	8	49
3: 105k V, Consensus CEFN	4	8	8	8	7	3	3	8	49
4: 105k V, Lyons Method	4	8	8	8	7	3	3	8	49
5: 105k V, BBEST IF, no div if Q<Base Dry	4	8	8	8	7	3	3	8	49
6: 105k V, BBEST IF & Pulse 10% div rule	4	8	8	8	7	3	3	8	49
7: 105k V, BBEST IF & Pulse 20% div rule	4	8	8	8	7	3	3	8	49
8: 105k V, BBEST IF & Pulse 30% div rule	4	8	8	8	7	3	3	8	49
9: 105k V, East Tx. 1 base / 1 Pulse struc.	4	8	8	8	6	4	2	9	49
10: 105k V, Prelim BBASC Gonzales IF Recomm.	4	8	8	8	7	3	3	8	49
11: 192k V, BBEST Full Instream (IF) Recomms.	4	8	8	8	7	3	3	8	49
12: 192k V, Prelim BBASC Gonzales IF Recomm.	4	8	8	8	7	3	3	8	49
13: 105k V, 1-3-3-1 Base Wet; Subs 50% rule; Pulse 20% div rule	4	8	8	8	7	3	3	8	49
w. San Antonio River Project (800 cfs max. diversion)									
A: 150k V, No instream flow (IF) criteria	4	7	9	7	7	4	2	9	49
B: 150k V, Full BBEST IF Recomms.	4	8	8	8	7	3	3	8	49
C: 150k V, Consensus CEFN	4	8	8	8	6	4	2	9	49
D: 150k V, Lyons Method	4	8	8	8	7	3	3	8	49
E: 150k V, BBEST IF, no div if Q<Base Dry	4	8	8	8	7	3	3	8	49
F: 150k V, TIFP 80cfs subs., no 50% subs/base rule	4	8	8	6	8	4	3	8	49
G: 150k V, TIFP 60cfs subs., 50% rule, Pulse 10% div. rule	4	8	8	6	8	4	3	8	49
H: 150k V East Tx. 1 base / 1 Pulse struc	4	8	8	7	7	4	3	8	49

Part b) Attainment - single criteria measures	Single G2 criteria attainment (% of yrs.)							
Scenario	**>A-pr**	**A-pr**	**A**	**B**	**C**	**CC**	**D**	**DD**
Goal	n/a	>12%	>17%	n/a	n/a	n/a	n/a	≤6%
Naturalized		22.4%	30.6%	14.3%	6.1%	4.1%	4.1%	0.0%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Baseline		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
TCEQ Run 3		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%
w. Guadalupe Mid-Basin Project, Dv=500cfs								
1: 105k V, No instream flow (IF) criteria		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
2: 105k V, Full BBEST IF recomms.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
3: 105k V, Consensus CEFN		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
4: 105k V, Lyons Method		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
5: 105k V, BBEST IF, no div if Q<Base Dry		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
6: 105k V, BBEST IF & Pulse 10% div rule		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
7: 105k V, BBEST IF & Pulse 20% div rule		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
8: 105k V, BBEST IF & Pulse 30% div rule		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
9: 105k V, East Tx. 1 base / 1 Pulse struc.		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
10: 105k V, Prelim BBASC Gonzales IF Recomm.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
11: 192k V, BBEST Full Instream (IF) Recomms.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
12: 192k V, Prelim BBASC Gonzales IF Recomm.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
13: 105k V, 1-3-3-1 Base Wet; Subs 50% rule; Pulse 20% div rule		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Antonio River Project (800 cfs max. diversion)								
A: 150k V, No instream flow (IF) criteria		14.3%	18.4%	14.3%	14.3%	8.2%	4.1%	18.4%
B: 150k V, Full BBEST IF Recomms.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
C: 150k V, Consensus CEFN		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
D: 150k V, Lyons Method		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
E: 150k V, BBEST IF, no div if Q<Base Dry		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
F: 150k V, TIFP 80cfs subs., no 50% subs/base rule		16.3%	16.3%	12.2%	16.3%	8.2%	6.1%	16.3%
G: 150k V, TIFP 60cfs subs., 50% rule, Pulse 10% div. rule		16.3%	16.3%	12.2%	16.3%	8.2%	6.1%	16.3%
H: 150k V East Tx. 1 base / 1 Pulse struc		16.3%	16.3%	14.3%	14.3%	8.2%	6.1%	16.3%

Part c) Attainment - joint measures	Joint G2 criteria attainment (% of years and fractions)				
Scenario	**>A-pr**	**A & B**	**C & CC**	**frac. CC**	**D & DD**
Goal		≥30%	≥10%	≤17%	≤9%
Naturalized		44.9%	10.2%	40.0%*	4.1%
Historical		38.8%	12.2%	16.7%	10.2%
Present		36.7%	18.4%	11.1%	12.2%
Baseline		32.7%	20.4%	30.0%	22.4%
TCEQ Run 3		34.7%	20.4%	40.0%	24.5%
w. Guadalupe Mid-Basin Project, Dv=500cfs					
1: 105k V, No instream flow (IF) criteria		32.7%	20.4%	40.0%	22.4%
2: 105k V, Full BBEST IF recomms.		32.7%	20.4%	30.0%	22.4%
3: 105k V, Consensus CEFN		32.7%	20.4%	30.0%	22.4%
4: 105k V, Lyons Method		32.7%	20.4%	30.0%	22.4%
5: 105k V, BBEST IF, no div if Q<Base Dry		32.7%	20.4%	30.0%	22.4%
6: 105k V, BBEST IF & Pulse 10% div rule		32.7%	20.4%	30.0%	22.4%
7: 105k V, BBEST IF & Pulse 20% div rule		32.7%	20.4%	30.0%	22.4%
8: 105k V, BBEST IF & Pulse 30% div rule		32.7%	20.4%	30.0%	22.4%
9: 105k V, East Tx. 1 base / 1 Pulse struc.		32.7%	20.4%	40.0%	22.4%
10: 105k V, Prelim BBASC Gonzales IF Recomm.		32.7%	20.4%	30.0%	22.4%
11: 192k V, BBEST Full Instream (IF) Recomms.		32.7%	20.4%	30.0%	22.4%
12: 192k V, Prelim BBASC Gonzales IF Recomm.		32.7%	20.4%	30.0%	22.4%
13: 105k V, 1-3-3-1 Base Wet; Subs 50% rule; Pulse 20% div rule		32.7%	20.4%	30.0%	22.4%
w. San Antonio River Project (800 cfs max. diversion)					
A: 150k V, No instream flow (IF) criteria		32.7%	22.4%	36.4%	22.4%
B: 150k V, Full BBEST IF Recomms.		32.7%	20.4%	30.0%	22.4%
C: 150k V, Consensus CEFN		32.7%	20.4%	40.0%	22.4%
D: 150k V, Lyons Method		32.7%	20.4%	30.0%	22.4%
E: 150k V, BBEST IF, no div if Q<Base Dry		32.7%	20.4%	30.0%	22.4%
F: 150k V, TIFP 80cfs subs., no 50% subs/base rule		28.6%	24.5%	33.3%	22.4%
G: 150k V, TIFP 60cfs subs., 50% rule, Pulse 10% div. rule		28.6%	24.5%	33.3%	22.4%
H: 150k V East Tx. 1 base / 1 Pulse struc		30.6%	22.4%	36.4%	22.4%

Note: *the 40% level for this attainment is not problematic since the overall level of G2-C and G2-CC have not increased appreciably above 10% (as per the BBEST recommendations in Table 4.5.2 and discussion in Section 4.5.1.1).

Estuary Inflows With New Water Supply Projects During Low Streamflow Periods

Section 3.3.1-3 describes the BBASC efforts to apply different instream flow criteria or no criteria to the new firm yield water supply projects, namely, the Guadalupe Mid-Basin Project (MBP) and the San Antonio River Project(SARP). In the course of evaluating the resulting estuary inflows of these scenarios, it was observed that there was little difference in inflows during drought times for the case on No Instream Environmental Criteria versus the several other approaches like Lyons, Consensus Criteria for Environmental Flow Needs, or the full BBEST recommendations.

Figure E2-2 illustrates this with a wet to dry transition period of 1983-84 as used earlier. Generally, there are only small differences in inflow among the scenarios. Figure E2-3 uses an amplified vertical scale to examine the same information and highlight differences in inflow at the low range. The fact that there are such small differences in inflow is attributed to a combination of factors. Most important, given that there is not that much difference in the "No Environmental Flow conditions" values versus the "with" instream criteria values at dry times, indicates that there is little water available because of the demands of downstream senior water rights. Of course, this will also lead to a lack of differentiation among the instream criteria with regard to the inflow to the Guadalupe Estuary. In periods when there is water available to the MBP, such as December 1983, there is some evident difference in the resulting inflows due to differences in the withdrawals of the project as influenced by the applicable instream criteria.

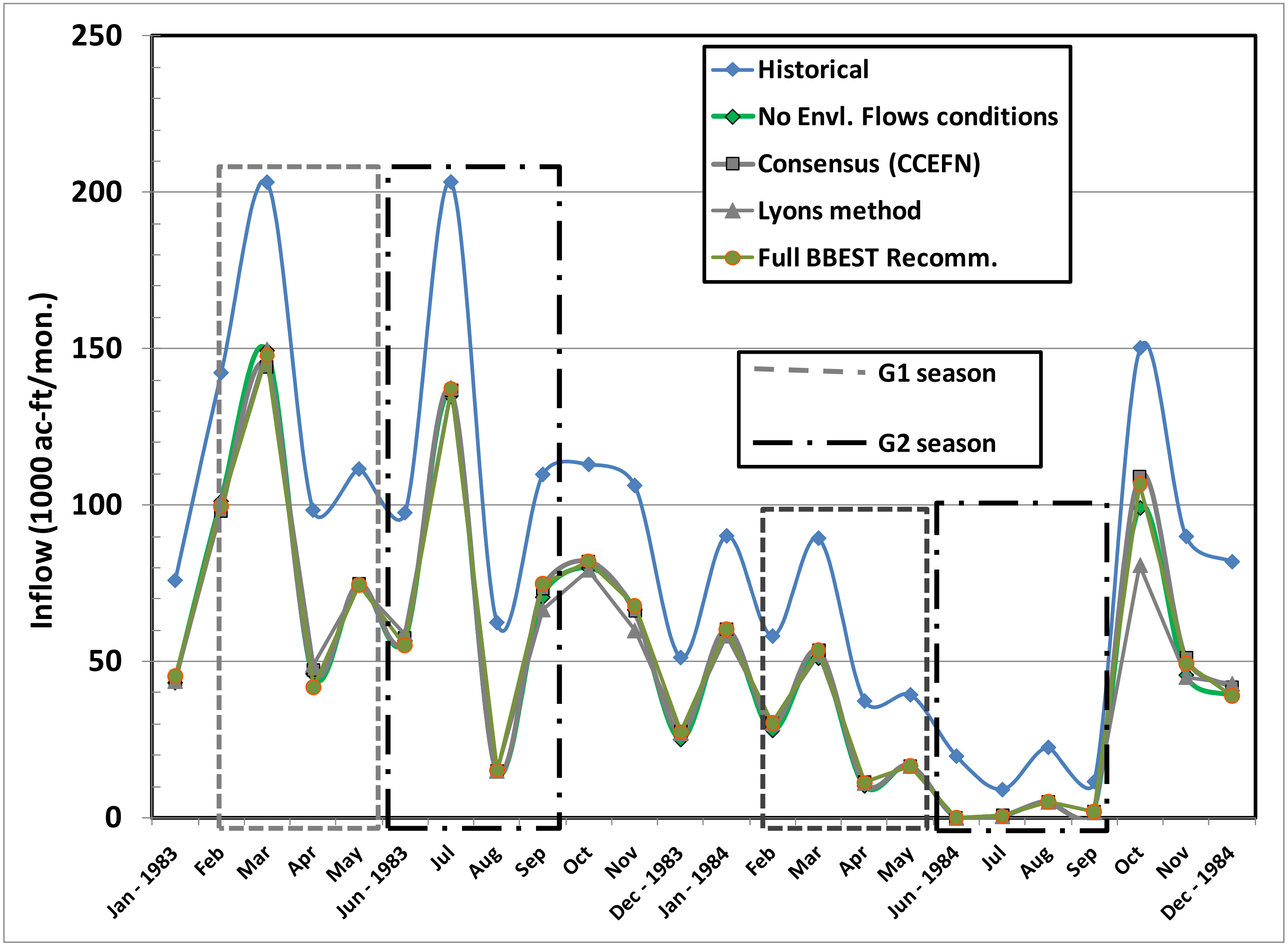

Figure E2-2. Illustration of the inflows to the Guadalupe Estuary for the 1983-84 period with the Mid-basin Project subject to no instream flow criteria and three types of instream flow criteria applied. Also shown with dotted line boxes are the G1 and G2 seasons in which the inflows are assessed for performance in meeting the BBEST recommendations.

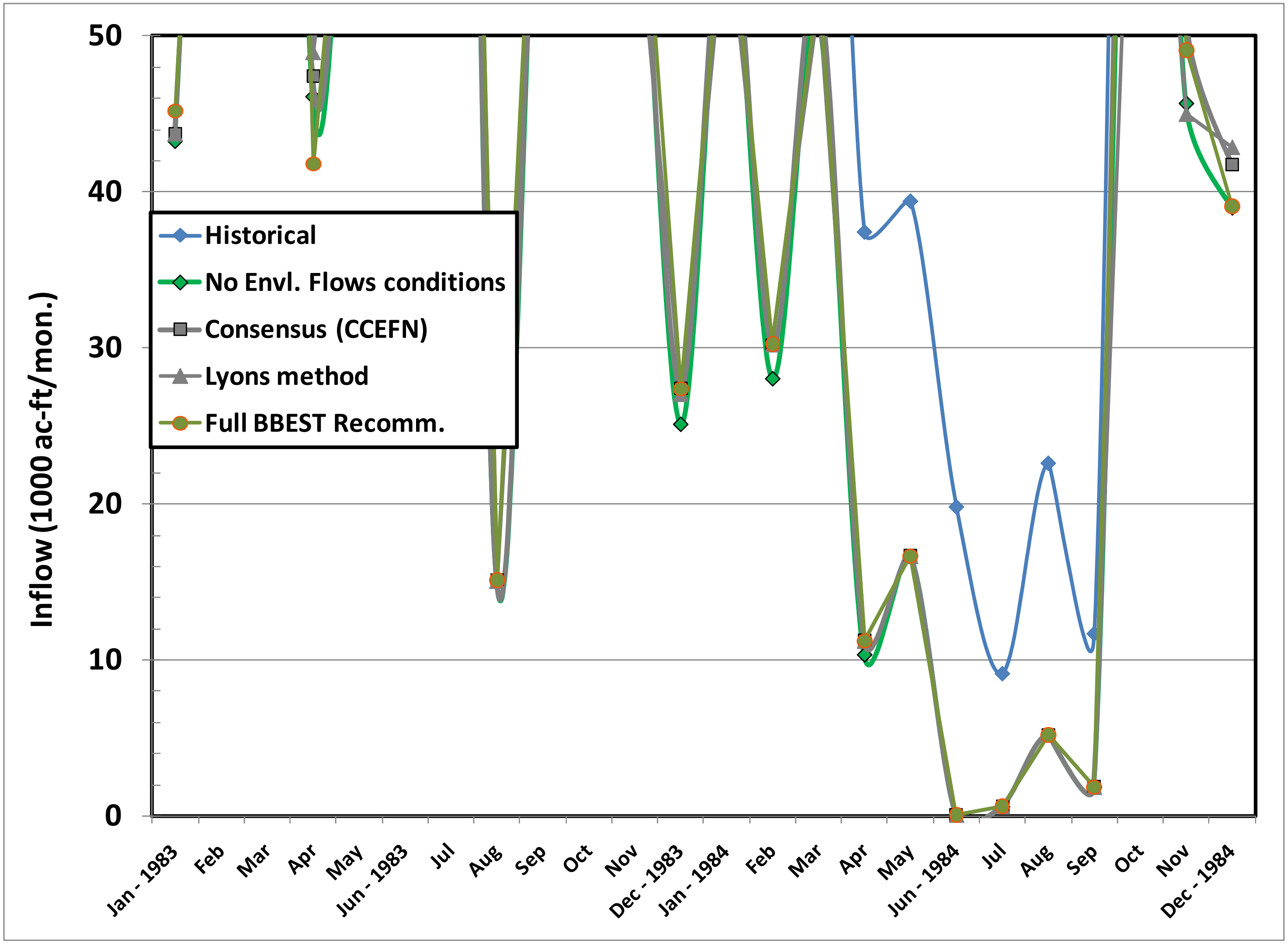

Figure E2-3. Same information as Figure E2-2 with amplified vertical scale to highlight differences in inflows to the Guadalupe Estuary for the 1983-84 period with the Mid-basin Project subject to no instream flow criteria and three types of instream flow criteria applied.

Appendix F

"Evaluation of Aquatic Habitat Relationships in the Guadalupe River at the Gonzales and Victoria Study Sites" Report by Dr. Thom Hardy

Evaluation of Aquatic Habitat Relationships in the Guadalupe River at the Gonzales and Victoria Study Sites

Prepared for:

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee

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July, 2011

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0. Introduction

This report provides a comparison of habitat modeling results based on habitat guilds and their associated habitat suitability criteria derived from the Lower San Antonio/Cibolo Creek SB2 and the Guadalupe-San Antonio BBEST studies. These comparisons are made in light of their use to develop and interpret the habitat versus discharge results for the Guadalupe River at Gonzales and Victoria study sites in light of environmental flow regime assessments being contemplated by the BBASC. The report is broken down into five sections:

1. An overview of the study site data used for calibration and simulation of hydraulic features at Gonzales and Victoria used in the habitat modeling
2. Comparison of LSAR and GSA Habitat Guilds and Suitability Criteria
3. Evaluation of Habitat Quantity and Quality Relationships
4. Discussion of the Habitat Modeling Results in light of Environmental Flow Regime Recommendations

1. Overview of Study Site Data and Hydraulic Model Calibration/Simulations

Study site data previously collected by the Texas Parks and Wildlife Department (TPWD) were provided in electronic form for use in the hydraulic modeling during the development of the BBEST environmental flows report to the BBASC. At each study site, cross section geometries of the river channel, observed water surface elevations and velocity profiles from 14 cross sections at Gonzales and 16 cross sections at Victoria were available from a variety of mesohabitat features. Each site contained at least three calibration water surface elevations at each cross section and a calibration velocity set. These data were used in the Physical Habitat Simulation System (PHABSIM) (Hardy 2003) to calibrate water surface and velocity hydraulic models for simulating water surface elevations and velocities for a range of flows corresponding to the flow ranges derived from the HEFR Base Flow matrix outputs at each site. Table 1 provides a listing of the available habitat types surveyed for hydraulic and habitat modeling at the Gonzales and Victoria study sites on the Guadalupe River.

Hydraulic modeling at each site was undertaken following a two step process (see BBEST report Section 3 for an overview of PHABSIM; Hardy 2003). At each site a step-backwater model was calibrated at an initial calibration flow by adjusting each cross section Manning's N until the predicted versus observed longitudinal profile of the water surface elevation was less than 0.01 feet. For each additional calibration flow, a roughness modifier was selected that minimized the error between the observed and predicted longitudinal water surface profile at the alternate calibration flows. Overall model calibration errors for both study sites and each calibration flow are provided in Table 2.

Table 1. Mesohabitat sampled from the Guadalupe River at the Gonzales and Victoria Study Sites.

Gonzales		Victoria	
Xsec	MesoHabitat	Xsec	MesoHabitat
1	Run	1	Transition from pool to fast run
2	Fast Run	2	Deep Pool
3	Riffle	3	Deep Pool
4	Shallow Run	4	Run
5	Slow Run	5	Run
6	Shallow Run	6	Run
7	Run	7	Pool
8	Pool	8	Run
9	Pool	9	Run
10	Run	10	Shallow Pool / Slow Run
11	Woody Run	11	Riffle
12	Slow Deep Run	12	Riffle
13	Fast Run	13	Run
14	Fast Run	14	Deep Pool
		15	Fast R w/ Side Pool and Channel
		16	Riffle

Table 2. Hydraulic Model Longitudinal Profile of Water Surface Elevation Calibration Errors.

	Gonzales - Calibration Flows (cfs)			Victoria	Victoria - Calibration Flows (cfs)		
	337.59	190.6	936.2		567.8	267.75	1473.4
XSec	WSL-Error (feet)	WSL-Error (feet)	WSL-Error (feet)	XSec	WSL-Error (feet)	WSL-Error (feet)	WSL-Error (feet)
1	0.00	0.00	0.00	1	0.00	0.00	0.00
2	0.00	-0.03	0.04	2	0.00	0.03	-0.16
3	-0.01	-0.07	0.19	3	0.01	0.03	-0.14
4	0.00	-0.02	0.06	4	0.00	0.24	-0.03
5	0.00	0.01	0.05	5	0.01	0.21	-0.02
6	0.00	-0.01	0.11	6	0.02	0.25	0.09
7	0.00	0.04	0.03	7	0.01	0.19	0.08
8	-0.01	0.04	-0.07	8	0.00	0.08	0.42
9	0.00	0.01	0.03	9	0.00	0.15	0.09
10	0.00	0.02	0.02	10	0.00	0.12	-0.06
11	0.01	0.10	-0.09	11	0.00	-0.09	0.09
12	0.00	0.08	-0.06	12	0.00	-0.10	0.03
13	0.00	0.09	-0.06	13	0.00	0.19	0.14
14	0.00	0.10	0.10	14	0.00	0.15	-0.08
				15	0.00	0.02	-0.63
				16	0.00	0.04	-0.10

At the Victoria study site, the roughness modifiers were selected to match the low flow longitudinal profile in deference to slightly higher errors at the high calibration flow profile as this higher discharge was greater than the early, late, or full period of record HEFR Base Flow ranges of discharge and not used for the calculation of available habitat.

The second step in the hydraulic model calibration involved adjusting the Manning's N values on a cell by cell basis where necessary until reasonable agreement between the predicted and observed velocities at each cell on the cross section was obtained. Figure 1.1 provides an example from Guadalupe River and includes the velocity profiles over the full range of simulated discharges. The later results were used at each cross section to evaluate the efficacy of the simulation results (see Hardy 2006). Appendix A provides the predicted versus observed velocities and simulated velocities over the range of simulated discharges for all cross section at the Gonzales and Victoria study sites. Hydraulic model calibration and simulation results are considered to be within the accepted ranges for this class of model at all cross sections at both study sites. The calibrated hydraulic model outputs were then utilized in conjunction with the suitability curves for the LSAR and GSA habitat guilds to generate the quantity and quality of available habitat at each study site as discussed in Section 3 below.

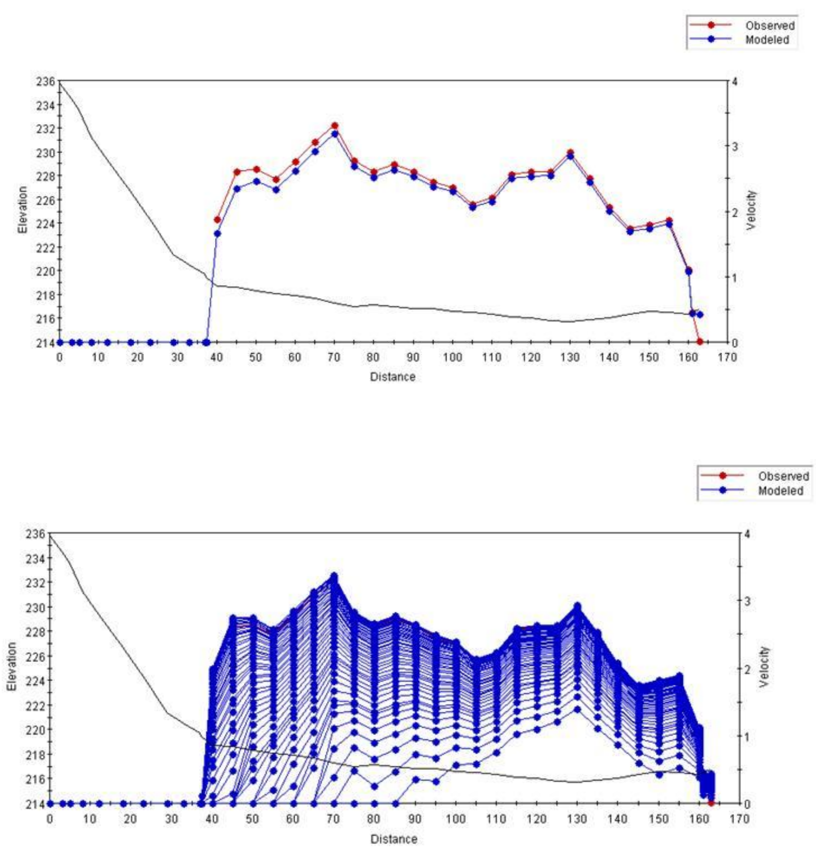


Figure 1-1.1 Observed versus predicted calibration velocities and simulation results at Cross Section 6 at the Gonzales study site.

2. Comparison of LSAR and GSA Habitat Guilds and Suitability Criteria

2.1 Background on Habitat Suitability Curves – Fact and Fiction

It is important to understand that use of habitat suitability curves to represent habitat guilds regardless of whether they are regional or site specific curves requires that they encompass the full range of depth, velocity and substrate needs for numerous individual fish species and their various life stages that may inhabit a particular habitat guild. This is fundamentally different from development of habitat suitability curves for an individual species and single life stage (e.g., blue sucker spawning) which only represents that target organism's suitability for depth, velocity and substrate. In that case, a single species and life stage might be selected as a 'representative species' for a habitat guild. Obviously, such an approach is inherently biased since the habitat use of different species and their life stages are not the same, even for different species inhabiting a common habitat type (e.g., runs).

There is a common misconception that site specific habitat suitability curves are 'superior' to envelope curves whether they are for a single species and life stage or a guild based curve. This may or may not be the case due to a number of factors as explained below.

One of the concepts that have helped ecologists understand the distribution and abundance of species is the ecological niche (Hutchinson 1957; Schoener 1988). The ecological niche is the set of environmental conditions (e.g., depth, velocity and substrate) and resources (things that are consumed by a species) that are required for a species to exist and persist in a given location. There are many environmental conditions and resources that make up a niche. Typically each condition and resource is thought of as a dimension of the niche. Along an individual dimension of a niche there is a range of values of the condition/resource that is suitable for the species (e.g., depth and velocity). The individual dimensions of the niche interact to create a multidimensional "niche volume" of conditions and resources that provide an environment that is suitable for a species (e.g., temperature, velocity, depth, food). This environment of suitable conditions and resources is the fundamental niche of a species. Within the context of the existing SB2/SB3 instream flow assessments of physical habitat the evaluation of environmental conditions is basically confined to the depth, velocity and substrate attributes of the fundamental niche.

The fundamental niche of a species must exist in a location both temporally and spatially for a species to occupy that location. Whether or not a species actually occupies a location, however, also depends on whether or not the species is precluded from occupying the location by other species as a result of competition (inter as well as intra- specific) or predation. The portion of a species fundamental niche that a species actually occupies can be referred to as its realized niche. The realized niche varies depending on the number, types, and effectiveness of competitors and predators and is almost always less than the fundamental niche in real world conditions. Multiple species can coexist in a river by utilizing a combination of niche dimensions differently in space and time. However, if two species utilize the same or nearly the same combination of resources and environmental conditions at the same time and in the same locations (i.e., flow limits the breadth of habitat availability), the potential exists for the more competitive of the two species to exclude the other from much of its fundamental niche. Likewise predators can exclude species from occupying much of their fundamental niche through intimidation or mortality (Powers et a.1985; Schlosser 1987; and others).

Habitat suitability curves as used in instream flow determinations are an attempt to represent the fundamental niche (i.e., depth, velocity and substrate) for a particular species and life stage or guild (Gore and Nestler 1988). The assumption is that there is a positive relationship between the amount of space that exhibits suitable niche conditions and the potential numbers of the species and life stages in the river (Orth and Maughan 1983; Jowett 1992; Nehring and Anderson 1993; others). In principle, increasing the range, availability, and abundance of niche dimensions utilized by riverine fishes can increase the number of potential niches that can coexist and can increase the diversity of fish species and life stages sustainable in the river (assuming other factors such as water quality, temperature, or competitors and predators and not limiting). Several investigators have shown that species and life stage diversity in rivers is directly related to the diversity of important niche dimensions (e.g., Gorman and Karr 1978, Schlosser 1982).

Several investigators have quantified the range of conditions and resources that various riverine fishes inhabit (Lobb and Orth 1991; Aadland 1993; Bain et al. 1988; Bowen et al. 1998), particularly with respect to depth and velocity. They have identified species and life stage guilds that utilize the niche dimensions of depth and velocity in a similar manner. Guilds typically use a set of environmental conditions or resources similarly, but typically differ in the temporal or spatial use of these resources or differ along other niche dimensions (i.e., food utilization) to coexist. Diversity of environmental conditions and resources, begets biotic diversity (Allan 1995), but only if the spatial and temporal diversity is within a range of conditions that the species are pre-adapted to exploit. For example, highly variable environmental conditions result in a diverse environment, but low species diversity (Horwitz 1978; Bain et al. 1988) because many species are not adapted to the rapidly changing conditions.

Because stream flow is one of the key factors that controls the temporal and spatial availability of stream hydraulics (interaction of depth and velocity), substrate, cover, food, and to a lesser extent temperature (e.g., Statzner 1986), stream flow within a given river system controls the abundance and diversity of niche dimensions and the diversity of species that can exist. One method of quantifying the effects of stream flow on riverine biota is to quantify the diversity of habitat types (types inhabited by typical riverine fish guilds) versus flow (e.g., Aadland 1993; Bowen et al. 1998). The diversity of the habitats types, particularly key bottleneck habitats that may affect recruitment of fishes at various times of the year (e.g, nursery habitat) and can potentially be used to identify stream flows that maintain habitats for a diversity of species and life stages (Bain et al. 1988; Scheidegger and Bain 1995; Nehring and Anderson 1993).

Given perfect knowledge of all species and life stage's realized niche (seasonally and with respect to discharge) in a river system, it would be possible to quantify how the amount of their realized niche changes with flow. This could be used to generate a flow regime that minimizes habitat bottlenecks for the various target species/life stage. Perfect knowledge of all (or any) species/life stage niche is unobtainable, however, and as a result approximations of the realized niche must suffice. Suitability criteria generated from fish observations in a river system are typically used to quantify the realized niche in terms of depth, velocity, substrate, and cover. However, generation of suitability criteria is fraught with many difficulties. Some of the most serious of these are logistics constraints that affect the size, timing, and quality of the data sample; habitat availability biases that exist at the time of sampling and predation/competition biases that exist at the time of sampling.

It is generally known that fish habitat use changes with fish size, season, temperature, activity, habitat availability, presence and abundance of competitors and predators, discharge, and changes between years (Orth 1987; Shrivell 1986; Heggenes 1990; Shrivell 1994; Smith and Li 1983; Bozek and Rahel 1992; Everest and Chapman 1972; Moore and Gregory 1988; Modde and Hardy 1992). Practical data collection constraints dictate that suitability criteria are generated from a finite number of fish observations typically over a small range of conditions. For example, data are collected for a discrete range of fish sizes (e.g., fry), during one or two seasons, in a range of different habitat types and flows that may have already been anthropogenic ally modified, fish densities, predator and competitor densities, and temperatures that are available in the river at the time of sampling. These data are then analyzed to create suitability criteria. These data and results are at best only an approximation of the realized niche.

Additional noise or "uncertainty" exists in any suitability criteria developed from sampling bias. For example, fry often utilize different habitats depending on the time of day. At night they typically move to even shallower and slower water along the margins of the channel than they occupy during the day; often they move into extremely shallow water (Bardonnet et al., 2006) perhaps as a predation avoidance behavior. In addition, fish utilize different microhabitats (depth, velocity) in different mesohabitats (pools, riffles, eddies) (Jackson 1992; Moody and Hardy 1992) and use different microhabitats at different flows (e.g., Shrivell 1994). They also utilize different habitats depending on localized predation threats (e.g., Powers 1985; Schlosser 1982) and during different seasons (e.g., Baltz et al. 1991). Fish swimming capabilities change with temperature (Smith and Li 1983) and the velocities that they utilize is dependent on temperature. Temperature in rivers varies dramatically between seasons, within seasons, and daily; therefore, habitat use varies on these same time scales.

Additional uncertainty arises in suitability criteria development due to biases and spurious correlations (e.g., Heggenes 1988). Obvious biases can result because habitat conditions (niche dimensions) do not exist at the time of sampling. For example, depths and velocities available in a river change depending on discharge, channel morphology, slope, and size of the river. The measured realized niche dimensions of a species/life stage are biased wherever depth, velocities, etc. are not available at the time of sampling, but would be utilized if available at different flows or in different channel morphologies. Some of these biases can easily be detected by sampling habitat availability (e.g., depth, velocity). A more insidious problem can occur, however, when one or more dimensions of the niche are correlated. For example, cover is frequently correlated with velocity shelter. It is often difficult to ascertain the range of a niche dimension and its independence or dependence on other niche dimensions. For example, suitable velocities based on sampling may be correlated with vegetation and specific substrates at one flow and correlated with different substrates at a lower flow where vegetation does not occur.

Depending on the specifics of the habitats and flows sampled during the development of suitability criteria the results will be different. It is logistically impossible, even on one section of one river, to empirically develop suitability criteria for each fish size, time of day, behavior, macrohabitat type, discharge, fish density, predator or competitor density, season, temperature, etc. As a practical modeling procedure, however, it does seem possible to envelop a specific range of habitat conditions (realized niche dimensions) that generally encompasses the conditions suitable for occupation by a species/life stage or guild. It also seems important, however, that the enveloped conditions be sufficiently constrained so that extraneous conditions that are not likely to be within the realized niche of a species/life stage or guild are not included.

Some investigators that have dealt with the problems outlined above have suggested that enveloped conditions are a relatively good solution. Bozek and Rahel (1992) found differences in the suitability and preference (corrected for habitat biases) criteria of young cutthroat trout between years and between rivers. They found that composite models (combining data from rivers and years) provided a practical solution for representing the underlying niche dimensions of depth and velocity. Jowett (1992) found that using enveloped suitability criteria from four rivers preformed almost as well as stream specific criteria, and very much better than functions developed at one river and applied to another. Based on Jowett's data he advocated the use of generalized envelope criteria. Several authors, conversely, have advocated the use of only site-specific suitability for criteria describing the realized niche of a particular species/life stages due to the above problems (e.g., Moyle and Baltz 1985; Shirvell 1989; Gore and Nestler 1988). This is a reasonable approach where it can be done properly, but the same problems discussed above plague site-specific data. In particular, when flows change or fish competitors/predators change the realized niche of a species/life stage may change and not be encompassed in the potentially "narrowly" defined site specific data (or time, fish density, habitat availability, flow, etc.). In fact, narrowly defined site-specific curves frequently perform poorly when applied in locals other than where they were developed (e.g., Bozek and Rahel 1992; Jowett 1992). At the present time, properly defined envelop curves appear to be one of the most practical approaches for describing the realized niche dimensions of species/life stages and in particular guilds where multiple species and life stages are to be represented.

2.2 Sources of LSAR and GSA Habitat Guilds and Associated Suitability Curves

2.2.1 Habitat Guilds

The designation of habitat based guilds is fundamentally arbitrary but rational in that the number (or types) of guilds is often contingent on the nomenclature that particular investigators used when publishing their habitat associations from fisheries studies or the nomenclature used during field sampling for a particular study. Some studies may report the simplest commonly recognized habitat types such as run, pool and riffle, while others may report associations using a more finely divided designation such as deep and shallow runs, deep and shallow pools, deep and shallow riffles, backwaters, glides, etc. In large measure, the BBEST adopted their set of habitat guilds based on published habitat associations of Texas fish that are regional in context while habitat guilds selected for the Lower San Antonio were derived in part from site specific habitat availability tied to field sampling at these sites. Table 3 provides a comparison of the LSAR and GSA habitat guilds.

Table 3. LSAR and GSA habitat guild categories.

LSAR	GSA BBEST
Deep Pool	Deep Pool
Mod Pool	Shallow Pool
Back Water	n/a
Deep Run	Deep Run
Shallow Run	Shallow Run
Riffle	Shallow Riffle

These habitat guilds are intended to represent broad mesoscale features within a river and guild types are generally transferable as definable features between different rivers. However, there is a degree of subjectivity in both classification schemes such as 'Deep Pool' or 'Shallow Pool' that may be quantitatively different between small versus large rivers. It is also important to understand that a shallow run may become a deep run at a higher discharge or a riffle at low flow may become a run at high flow.

The primary purpose of these guilds is to allow the organization of the aquatic community into a conceptual framework of the river (i.e., mesoscale habitats) based on both professional experience and in most cases published relationships of habitat associations between the target species and these habitat types. The characterization of each habitat guild for the purpose of developing relationships between the amount and quality of available habitat as a function of discharge can be approached from several valid but fundamentally different perspectives. In some instances, each guild is characterized based on the combined range of hydraulic parameters (e.g., depths, velocities, shear stress, Reynolds numbers, etc). In this instance, the guild definitions are purely physical attributes and the investigator imparts meaning based on known habitat associations of the fish community within each guild.

Alternatively, as in these studies, each guild is assigned a suite of known fish species associations and the species ranges of depth, velocity, and substrate are used to characterize the guild. This can be either based on a single (or few) representative species within each guild or development of envelope guild curves that encompass all the species inhabiting a particular guild. This is discussed further in Section 2.2.2.

As can be seen in Table 3 the difference between the LSAR and GSA habitat guilds is primarily in nomenclature and the designation of a Back Water guild for LSAR not represented in the GSA guilds. Both sets of defined guilds are rational and cover the range of mesohabitat types expected to be present in river systems in Texas and typical of many instream flow studies. As will be demonstrated in Section 2.2.2, the LSAR Backwater guild is encompassed within the suite of GSA guild attributes of depth and velocity.

Overlap between guild characteristics, whether based on physical attributes or species derived ranges of depth and velocity, is to be expected given that these variables represent a continuous gradient without definable break points between guild types. For example, suitable ranges of depth and velocity that define a shallow run guild are also found within the expected ranges of depth and velocity in a deep run guild. Even when utilizing species derived gradients of depth and velocity, the fact that many species inhabit more than one guild type results in overlapping ranges of attributes. What is critical is that the combination of guild types and their underlying ranges of depth, velocity and substrate represent the full range of required and/or usable conditions for all target aquatic resources.

2.2.2 Habitat Suitability Criteria

GSA habitat suitability curves were developed collaboratively by the BBEST Instream Flow Subcommittee and TPWD based on available quantitative data and professional experience from a broad database of fish collections from rivers in Texas. The preliminary focal species assigned to each guild were based on known habitat guild associations and professional judgment. However, quantitative data on depth, velocity and substrate necessary to develop suitability curves was not available for all focal species and species were added to guilds where necessary to ensure sufficient quantitative data existed to define the habitat suitability curves for each guild. Specifically, this occurred where the initial focal species had only one or two species with quantitative data. In all cases, for any guild, only species that were known to utilize that guild were considered in the development of the resulting habitat suitability curves. As would be expected, several species were assigned to more than one guild and reflect the fact that some species are generalists and occupy more than one guild type.

The approach relied on development of 'envelope curves' that encompassed species specific habitat suitability curves within each guild and is documented in Section 3.3.3.5 of the BBEST report. The use of envelope curves to represent each habitat guild was chosen given the intended application of these curves across many river types throughout the entire basin, the fact that each habitat guild is occupied by several species and various life stages concurrently, and acknowledgement of the material presented in Section 2.1. Given the data and method used to develop these envelope curves, they are best characterized as regional curves versus site-specific curves. Conversely, at the time the BBEST conducted its analysis and finalized its report, the Lower San Antonio River (LSAR) instream flow study was not completed and DRAFT LSAR suitability curves for specific habitat guilds were provided to the BBEST. The LSAR curves were developed from data collected from the lower San Antonio River and Cibolo Creek; hence they are best characterized as site-specific habitat guild curves. Since they also represent a number of target species and life stages by habitat guild type, they are also envelope curves. A key point is to note that the LSAR site specific envelope curves are derived from a river system with much smaller HEFR base flow ranges compared to the Guadalupe River at Gonzales and Victoria. The implications of these flow differences on use of LSAR curves at Victoria and Gonzales is discussed below.

The BBEST applied LSAR curves to quantification sites within the San Antonio River and GSA curves were applied to all other quantification sites. Regardless of the source data or analytical techniques used to develop suitability curves, professional experience and judgment are always exercised given the intended application, known issues and inherent uncertainties and biases articulated previously. A potential 'issue' arises then between the utilization of site specific curves versus more regional curves at a particular quantification site. Specifically, is it more 'appropriate' to apply GSA curves to the Guadalupe River at Gonzales and Victoria or the LSAR curves? As discussed in Section 2.1, studies strongly suggest that site specific curves typically perform 'worse' when transferred to other sites when compared to use of generalized curves across different river systems. It is also generally recognized that transferability of suitability curves from a smaller river system to a larger river system rarely works, while transferability of suitability curves from a larger river system to a smaller river system usually works, while the converse is not true. This is easily illustrated by a hypothetical example. A suitability curve is developed from Widget Creek where a species is found in all available depth with equal frequency but the maximum depth in the creek is say 3 feet. The resulting suitability curve would show no suitability for a depth greater than 3 feet. If the curve were then applied to Mondo Creek where depths of 4, 5, and 6 feet were plentiful, these areas would not be recognized as suitable habitat. However, if the suitability curve for depth was developed in Mondo Creek and the fish was found with equal frequency in all available depths, then the resulting suitability curve would recognize the full range of depths in Widget Creek as suitable habitat.

The only way to ensure that a site specific suitability curve from a source site is 'transferable' to a target site is by testing the transferability based on empirical observations of fish use at the target site. However, keep in mind the material in Section 2.1, where actual utilization at both the source and target sites may be altered by anthropogenic changes to the channel, flow regime differences, or the presence of a different fish community structure (e.g., competitors and predators). It is logical however to see that combining the data from both Widget Creek and Mondo Creek would yield a suitability curve logically applicable to both sites since it encompasses the range of depths available at each site. This is in essence the underlying ethos for use of regional envelope curves derived from as many river systems as possible when assessing habitat availability across a wide array of river systems.

2.2.3 Comparison of LSAR and GSA Habitat Suitability Criteria

The differences inherent in site specific versus regional type envelope curves is evident by a comparison of LSAR and GSA habitat guild curves shown in Figures 2.1 through 2.3. These results show that in general the GSA curves have a broader range of depths and velocities over which non-zero suitability is defined in each guild. As noted previously, these differences are to be expected given the regional nature of data used to develop the GSA curves, use of multiple species, and their intended purpose for application across a wide array of river types throughout the basin. In contrast, the LSAR curves have somewhat more narrowly defined ranges of depth and velocity arising from site specific characteristics (i.e., channel shape and much lower base flow discharge ranges) and site specific fisheries collections from the San Antonio River and Cibolo Creek.

The implication of these differences in terms of assessing the available quantity and quality of physical habitat is that a slightly wider range of depth and velocities will have some contribution to available habitat with the GSA curves on a guild by guild basis. The largest differences are associated with the extended depth suitability for pool and run guild curves compared to the equivalent LSAR guild curves. The author has no firsthand knowledge of the rationale for the particular ranges of suitable depth and velocity of the LSAR curves but is intimately familiar with rationale for the form of the GSA curves. First, for these three guilds, the depth was extended at a higher suitability compared to LSAR curves based on known life history of the guild species used to develop these envelope curves. It is not uncommon in many instream flow studies where individual species curves for adults are extended at a suitability of 1.0 for all depths, once that suitability has been reached since there is no physiological reason the fish cannot utilize deeper water. Sensitivity to higher flows is controlled by the velocity suitability which is directly linked to the size and ichthyomechanics of the target species. For example, for most riverine species, the maximum burst speed is on the order of 8 to 10 body lengths/second and is an upper limit of physical propulsion. Another difference arises from the assumption inherent in the LSAR Moderate Pool guild for depth which implies for that guild, no moderate pools are more than about 6 feet deep and show very little suitability for depths greater than about 3 feet. The curve also implies a very narrow range of suitable depths that span only 1 foot between 0.98 and 1.97 feet. This is a farily narrow range for suitable depths for all potential species utilizing 'moderate pools'. On the other hand the GSA depth suitability for Shallow Pools allows for some suitability, albeit lower suitability than the Deep Pool guild, no matter how deep the pool may get.

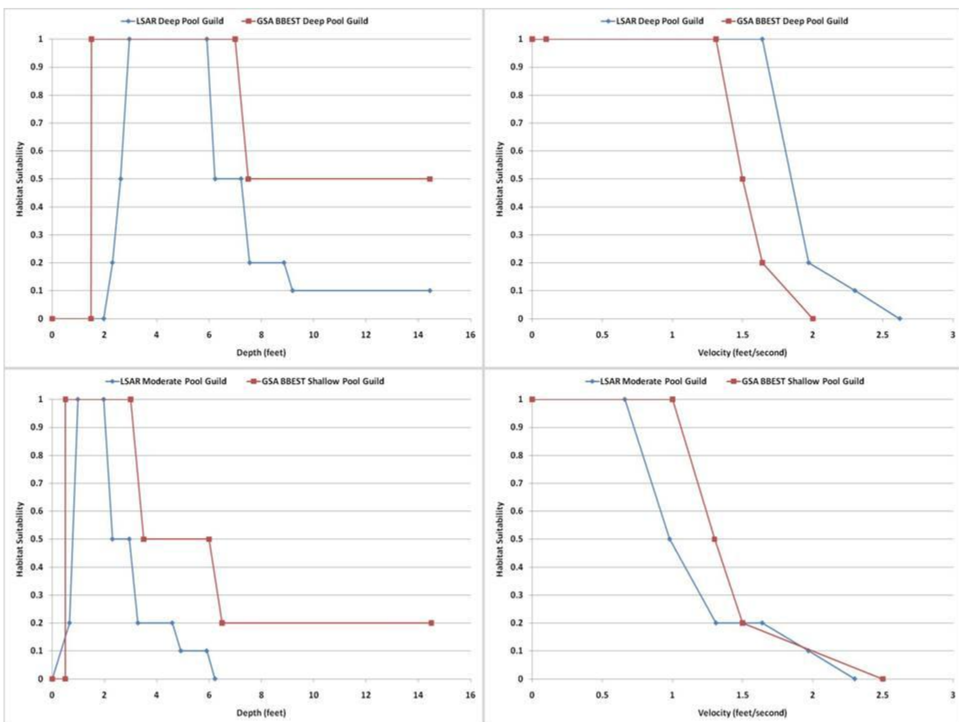


Figure 2-1 Comparison of LSAR and GSA Deep Pool and Moderate/Shallow Pool habitat guild suitability curves.

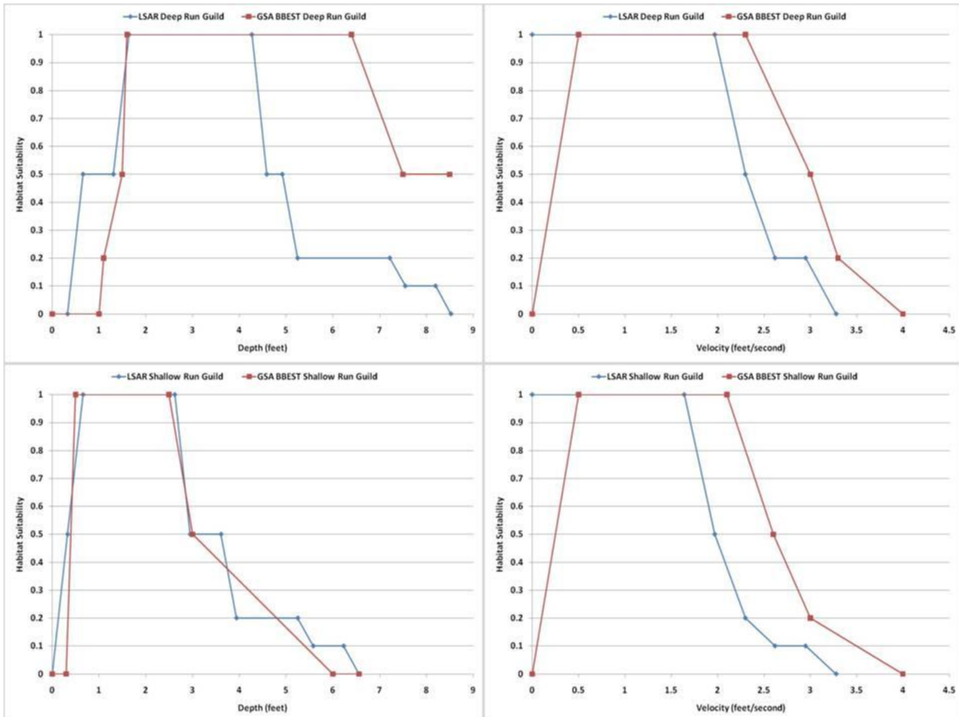


Figure 2-2 Comparison of LSAR and GSA Deep Run and Shallow Run habitat guild suitability curves.

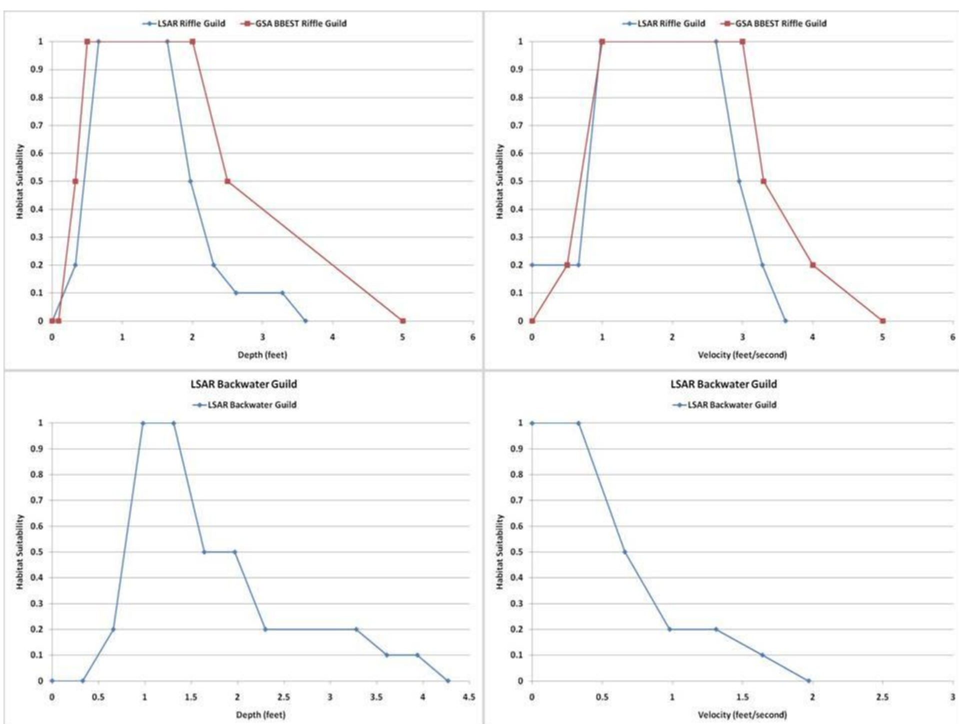


Figure 2-3 Comparison of LSAR and GSA Riffle and Backwater habitat guild suitability curves.

A final observation on the differences between the LSAR and GSA suitability curves is the differences in the Deep Run guild depths. The LSAR Deep Run guild implies low suitability for any run that would exceed about 5 feet and no run habitats are represented by any of the two LSAR run guilds when depths exceed 8.5 feet. Potential suitability for these deeper habitats is restricted to the suitability associated with only Deep Pool guilds which at these depths is restricted to a value of 0.1. Conversely, the GSA Deep Run guild maintains some suitability (0.5) for all depths greater than 7 feet. In essence, the LSAR suite of guilds only provide for suitable habitats at depths greater than 8.5 feet and where velocities are less than 2 feet/second (see LSAR Deep Pool guild). The LSAR curves also have more 'flat areas' where the suitability is constant over ranges of depth and will therefore have the potential to be slightly more insensitive to computed areas over small ranges in discharge on a cell by cell basis. The fundamental differences between the LSAR and GSA guilds have implications on the simulation of available habitat quantity and quality as shown below.

3. Evaluation of Habitat Quantity and Quality Relationships

3.1 Habitat Availability – Quantity versus Quality and Spatial Overlap

One component in the evaluation of any instream flow regime is a consideration of the quantity versus quality aspects of available habitat. It is clear from simple observations across a wide array of aquatic species that individuals will occupy less than ideal habitats due to a variety of factors such as competition, linear dominance, community density, community structure (predator versus prey), etc. It is also known that if a more suitable location is made available, species will move to that 'higher preferred" habitat location. This directly points out the subtle difference between pure quantities versus quality habitat in habitat selection by species. The analysis presented in this report is an estimate of the available habitat at each discharge but does not consider these behavioral factors or species interactions. It is simply an estimated potential of locations having depth, velocity and substrate conditions that the biologist considers useable by the each target species. Given the type of habitat suitability criteria being employed in these studies, the calculation of physical habitat availability based on combinations of depth, velocity and substrate imply that over some combination of their ranges, the combined suitability will range between 0.0 (totally unsuitable) to 1.0 (assumed to be ideal). What is assumed however, is that any potential location having non-zero combined suitability is potentially inhabitable by the target species and that a location having a combined suitability of 0.0 would not be occupied. The calculation of available habitat at any discharge is therefore the sum of all locations (cell areas) weighted by the combined suitability at each location. Clearly, if every location in the stream at given discharge had a combined suitability of 1.0 then the computed available habitat (Weighted Usable Area) would equal the stream surface area. Inherent in these calculations of total available habitat is that two identical values of available habitat at some discharge can be composed of two entirely different conditions of absolute suitability. If the river at some discharge contained 10 cells, each 1 square foot, and the combined suitability of each cell was 0.1 (poor quality) the total WUA would be estimated as 1 square foot. However, given this same discharge and 10 cells in which 9 cells had no suitability (0.0) and 1 cell had perfect suitability (i.e., 1.0) then the computed WUA would still be 1 square foot. At issue for the biologists then is making an informed decision between different flow rate ranges where one might be maximizing the total habitat area which may be composed mostly of poor quality suitability versus an alternative discharge in which more proportional area is composed of higher quality habitat areas.

Another aspect of evaluating habitat quantity and quality is related to the potential for spatial overlap or compression at different discharges. For example, at some higher discharge the total amount of habitat for two species may each be 100 square feet but segregated spatially where species A habitat is along the margins (~ shallow run guild) while species B is located near the deepest part of the channel (~ deep run guild) at the same cross section. At some lower flow, species A and B may still have the same 100 square feet of available habitat by given the reduction in flow; the available habitat areas show considerable spatial overlap. The potential for this is clearly illustrated by a close examination of the habitat guild suitability curves in Section 2 where suitable ranges of depth and velocity are shared by more than one habitat guild. Clearly in the first case, the spatial segregation would imply a minimum of competition for available space while under the second case it is more likely that increased spatial competition may affect community dynamics differentially. This is explored in the remainder of this section of the report at both study sites.

3.2 Habitat Availability as a Function of Discharge

Habitats versus discharge relationships are examined in terms of both total available habitat and the quality of the habitat at each study site. The total quantity of available habitat as a function of discharge was computed for each cross section by cross section. For these analyses, all cell areas are summed as long as the combined suitability is non-zero. The combined suitability was computed utilizing the geometric mean of the component suitability values for depth, velocity and substrate (see BBEST report Section 3; Hardy 2003). Results in the form of Weighted Usable Area (WUA) are reported at the reach level from aggregating the results for all cross sections.

In addition to the quantity of available habitat, the quality of available habitat was also simulated by constraining the combined suitability to be $\geq$ 0.80. This threshold was chosen to be consistent with other instream flow assessments in Texas where habitat quality was considered in the evaluations such as the LSWP studies on the Lower Colorado River and the Lower San Antonio River and Cibolo Creek studies. Selection of this threshold included input from TPWD, TCEQ, TWDB, SARA and other stakeholders. Finally, the potential for spatial guild overlap on a cross section by cross section basis was examined at each study site over ranges of discharge associated with modifications to the BBEST recommended flow regimes within the subsistence, Low, Medium, and High Base Flow HEFR ranges. It is stressed that these analyses do not incorporate water quality, temperature, geomorphic or other factors important to maintaining a sound ecological environment. Consideration of those factors is beyond the scope of this report.

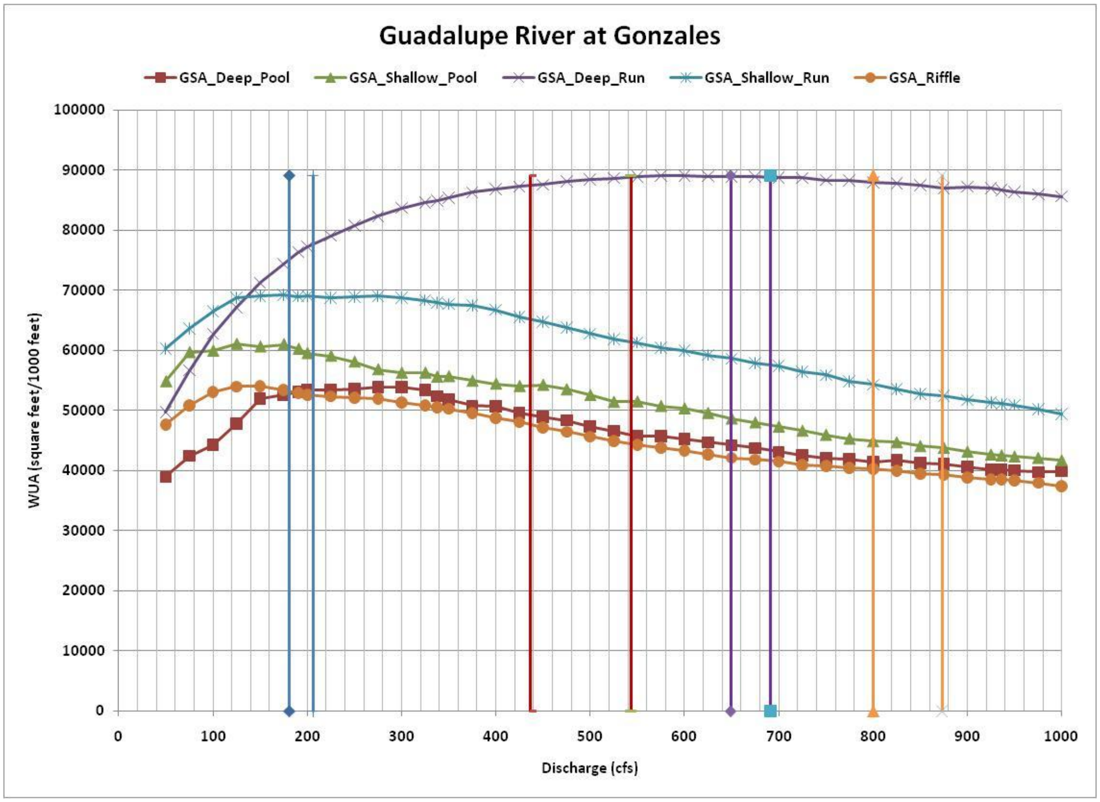
3.2.1 Guadalupe River at Gonzales

Figure 3.1 shows the relationship between total available habitat and discharge at the Gonzales study site using both the LSAR and GSA habitat guilds. The paired vertical colored lines are the seasonal minimum and maximum range of discharges for subsistence, Low, Medium and High HEFR derived discharges for the site based on the full period of record. It is apparent that the LSAR suitability curves which have a narrower range of suitable depths and velocities compared to the GSA suitability curves result in almost one-half the estimated WUA on a guild by guild basis. Although the functional relationships between available habitat and discharge are somewhat similar, there are quantitative differences in the relative sensitivity to estimated available habitat and discharge between the guilds based on suitability curve set.

Overall, the GSA results suggest that the total habitat remains relatively constant between the upper ranges of the HEFR High Base flow range down to subsistence flow ranges. This is also reflected in the LSAR based results with perhaps the exception of the LSAR Deep Pool guild which show a more rapid decline at flows below the HEFR Low Base flow ranges of discharge. Figure 3.2 shows the relationship between available quality habitat and discharge for the GSA and LSAR guilds at Gonzales over the range of discharges from subsistence to the HEFR High Base flow discharges. The GSA habitat guild results show that the total amount of quality habitat is relatively constant over these discharge ranges with the exception of Deep Runs which shows more reductions between the HEFR Low Base and Subsistence flow ranges. The LSAR habitat guilds also show little response to flow between Subsistence and the HEFR High Base flow discharges with the exception of Shallow Runs and Deep Runs. LSAR Shallow Runs decline rapidly in available quality area from the lowest simulated discharges through the HEFR High Base flow range while the LSAR Deep Run habitat areas remains relatively constant over the HEFR Low, Medium and High Base flow ranges but declines more rapidly below the Low Base flow ranges.

Figures 3.3 through Figure 3.7 show an example of the combined suitability for each GSA guild at five cross sections representing different mesohabitat types at 175 and 400 cfs. These flows are approximately the lower bounds on HEFR Subsistence and Low Base ranges of discharge. What these results illustrate is that the suitability curves for the various habitat guild types produce rational results when compared between different mesohabitat types within the river. They also show that to some degree, guild habitat suitability overlaps for different guild types at cross sections in specific mesohabitat types as would be expected from the overlapping suitability of guild depth and velocity ranges as noted previously. The results also show that there are in fact quantitative differences in relative suitability of different habitat guilds between the HEFR Low Base and Subsistence flow ranges depending on the mesohabitat type (i.e., cross section). These results suggest that although the total available habitat remains relatively constant over these flow ranges at the reach level, available habitat for each guild shows overlap on each cross section and to some degree as flows are reduced, habitat availability is shifting between cross sections (i.e., mesohabitat types).

When these are considered in concert it is apparent from a physical habitat perspective that some adjustments to the HEFR base flow regime numbers could be considered. For example, the minimum seasonal discharge for the HEFR Low Base flows might be set at ~400 cfs while the maximum seasonal discharge might be adjusted down to ~500 cfs. Similar shifts in the Medium and High Base flow seasonal minimum and maximum could also be considered. However, it must be stressed that these analyses do not have the benefit of water quality and temperature simulation overlays nor do they consider other ecological processes such as implications of competition, predation, etc that are import to maintaining a sound ecological environment. As such, large reductions in flows at any of the HEFR Low, Medium or High base regimes based solely on these results are discouraged. Furthermore, substantial reductions of the seasonal Low, Medium, and High Base flow regimes must also consider the potential implications on the required Bay and Estuary flow regimes.



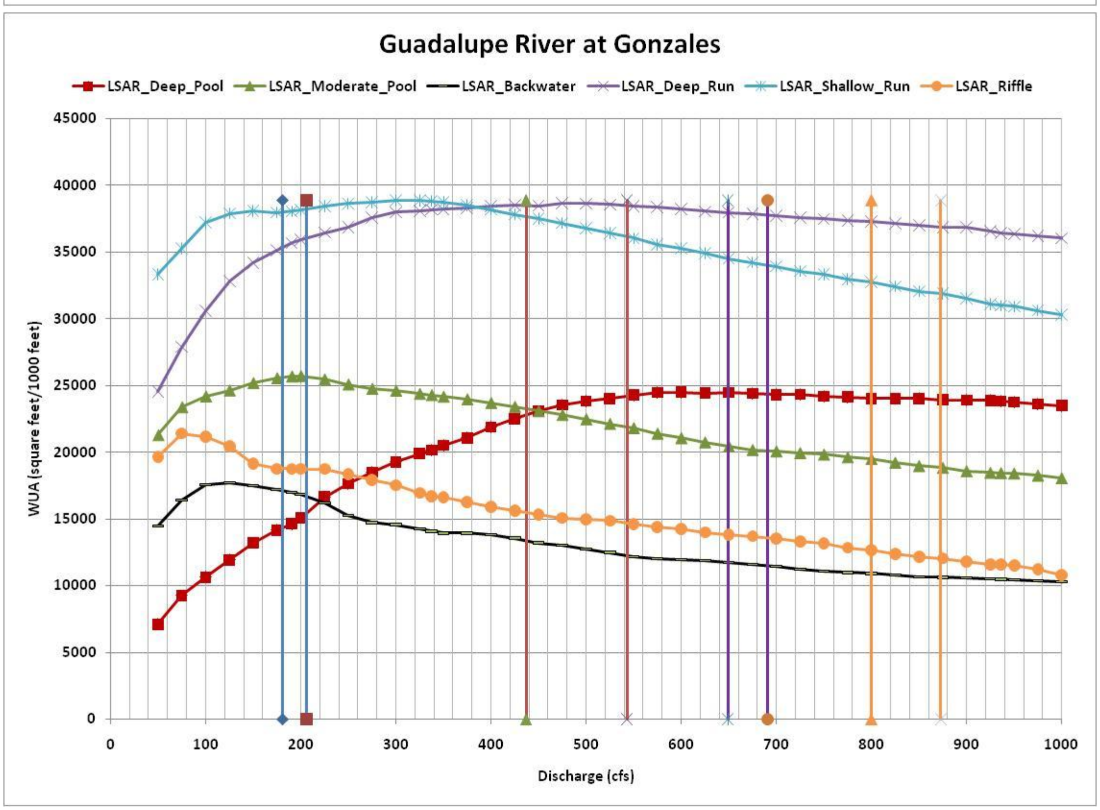


Figure 3-1 Total available habitat (WUA) as a function of discharge at the Gonzales study site based on LSAR and GSA habitat guild suitability curves.

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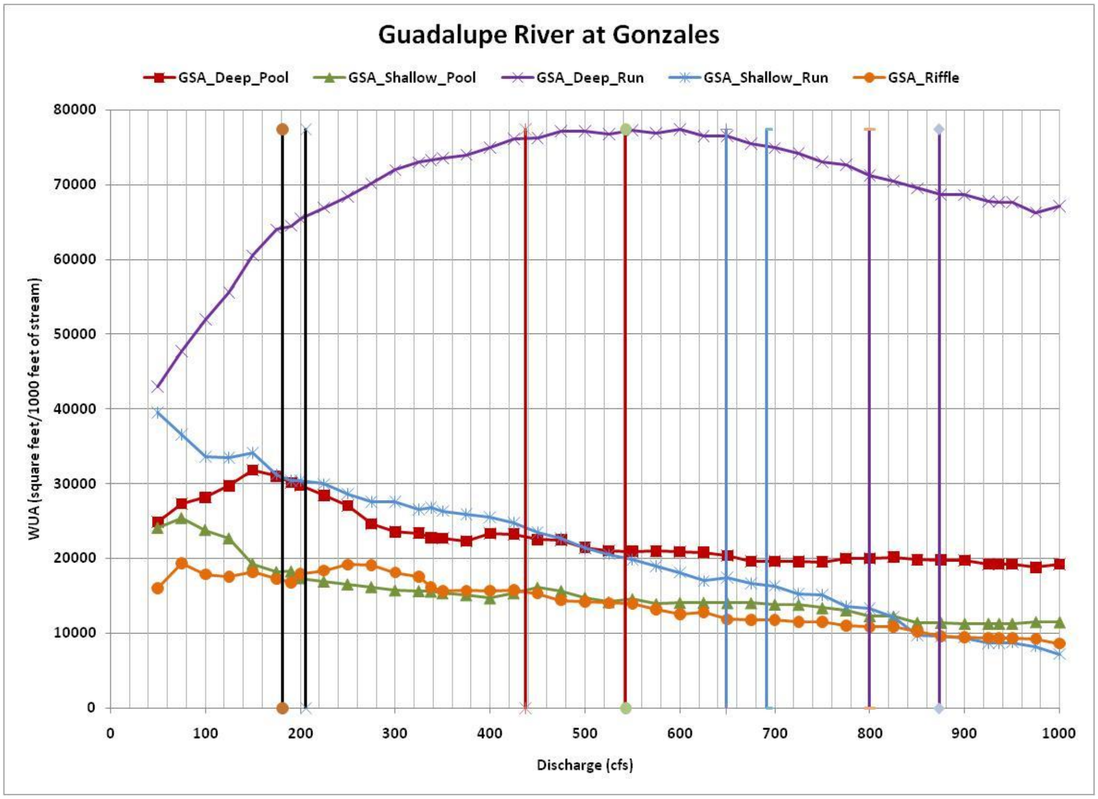

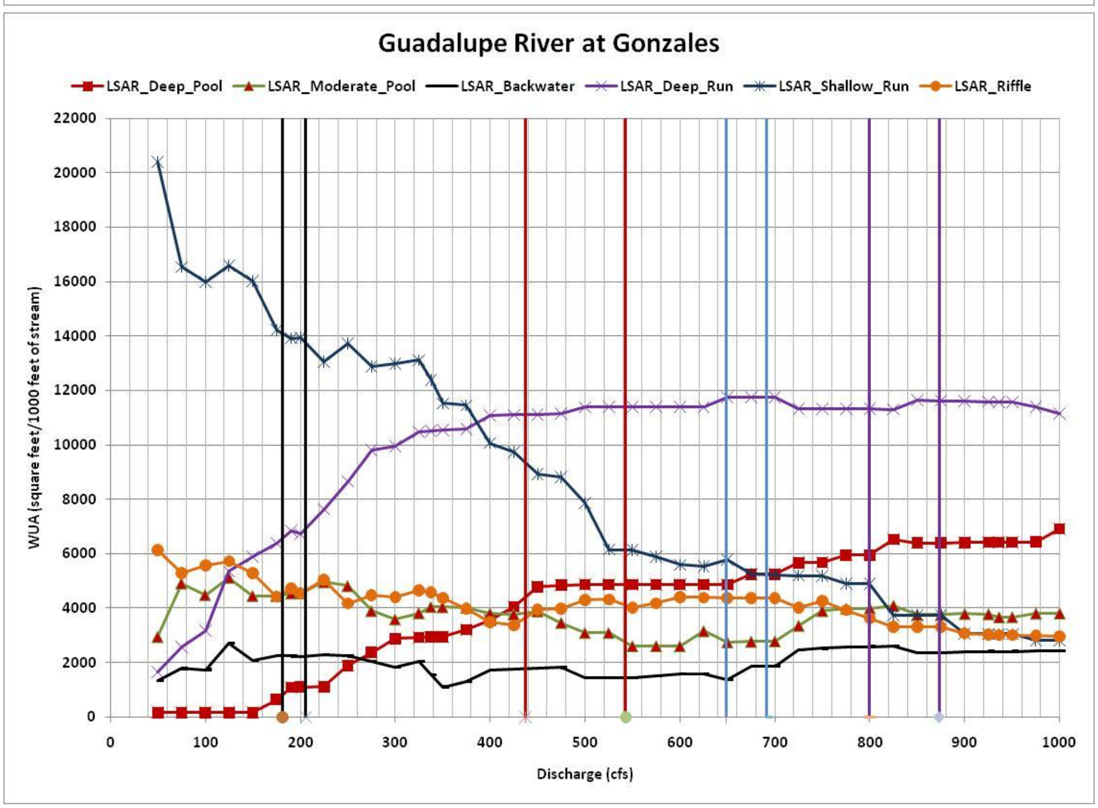

Figure 3-2 Total quality habitat (WUA) as a function of discharge at the Gonzales study site based on LSAR and GSA habitat guild suitability curves.

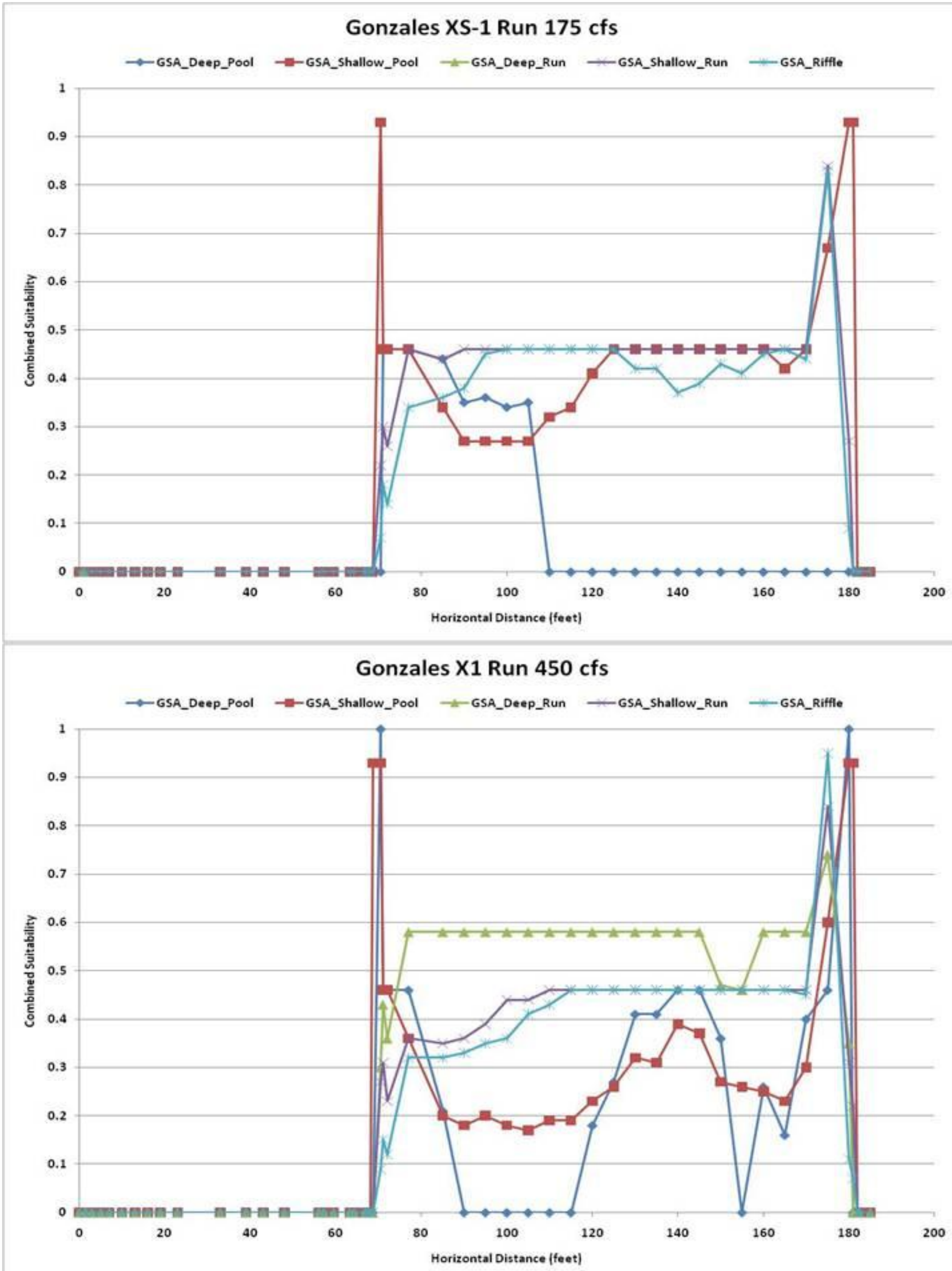

Figure 3-3 Distribution of combined suitability at Gonzales for each GSA guild within a Run cross section at 175 and 400 cfs.

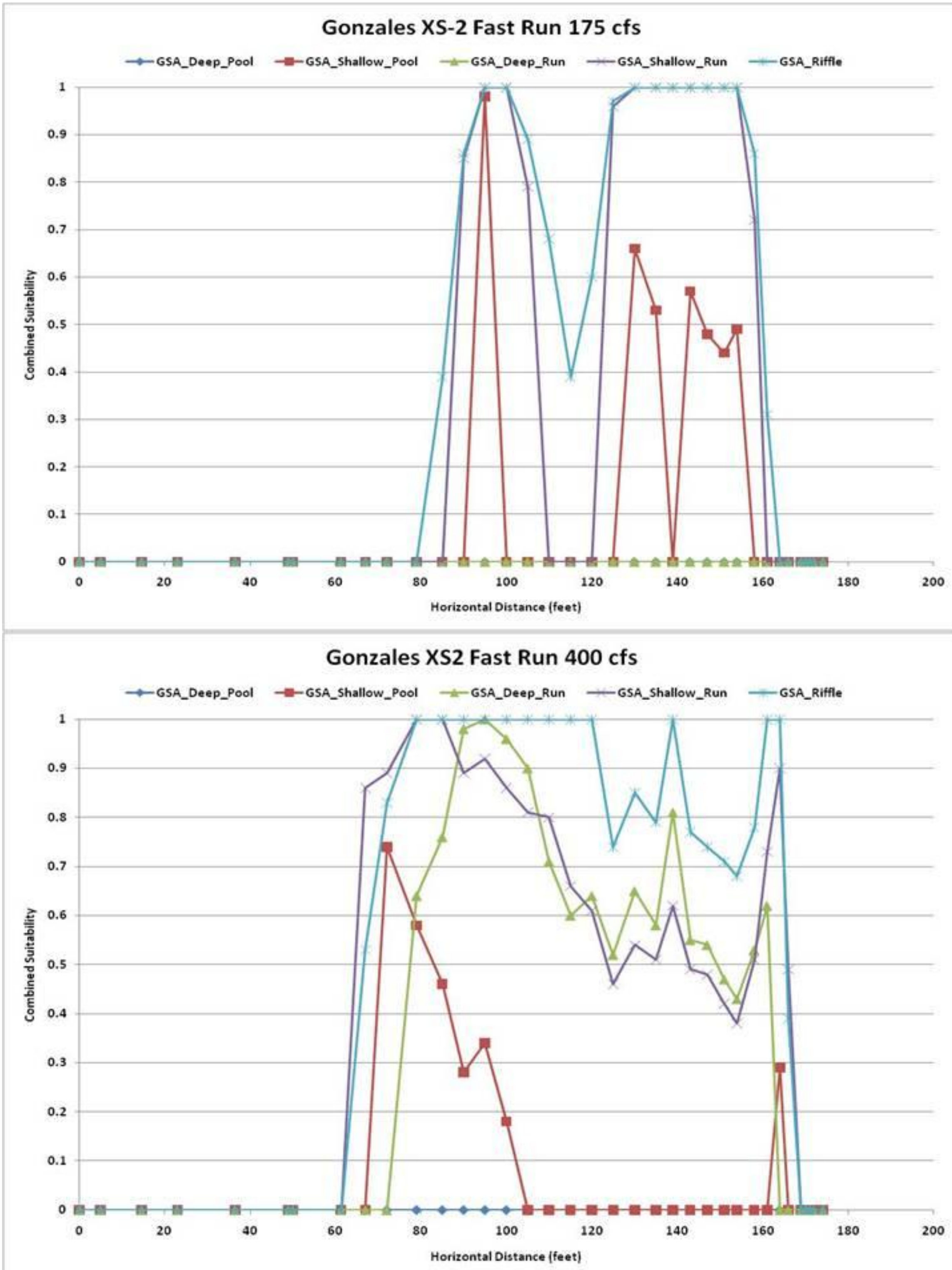

Figure 3-4 Distribution of combined suitability at Gonzales for each GSA guild within a Fast Run cross section at 175 and 400 cfs.

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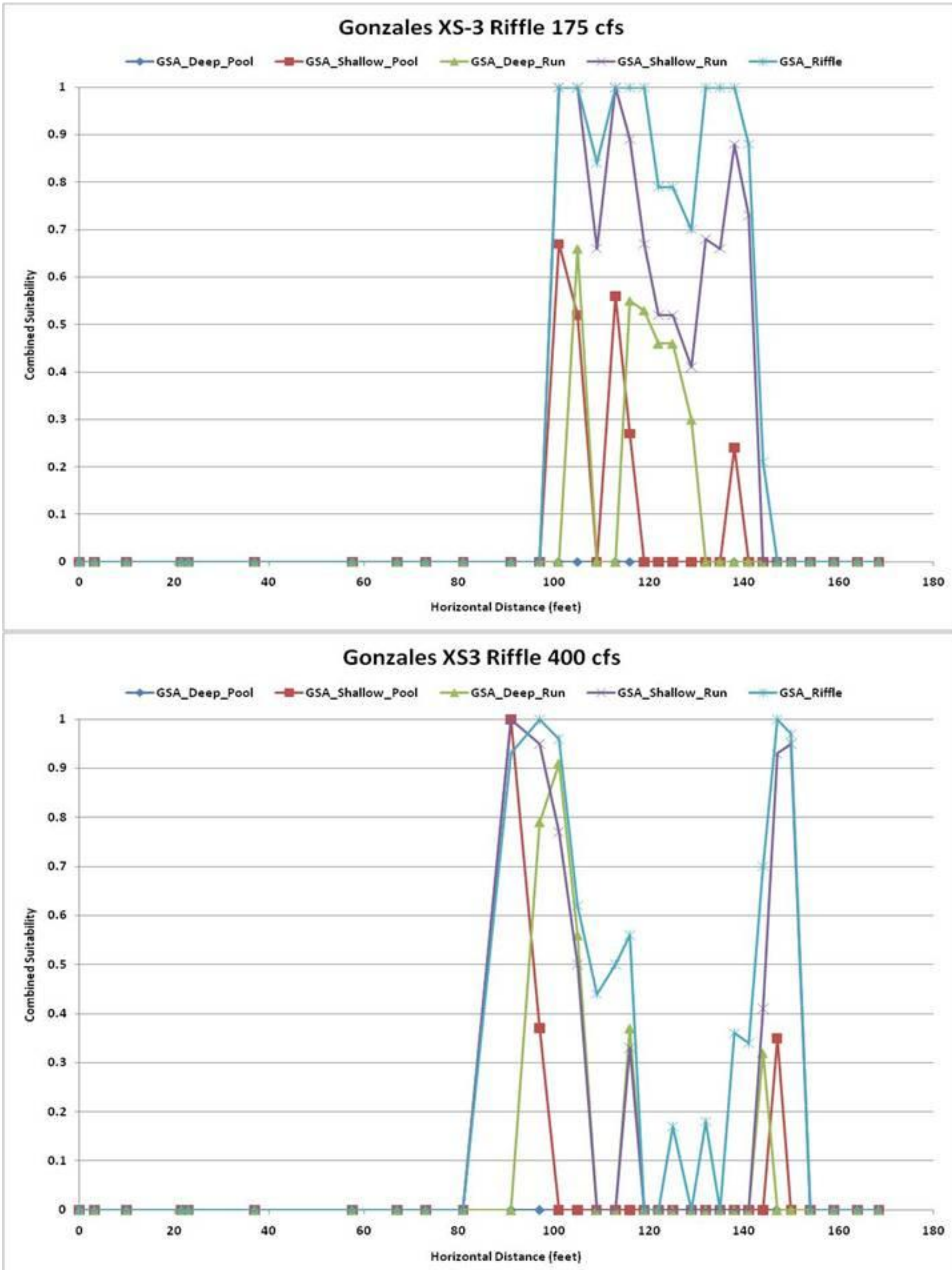

Figure 3-5 Distribution of combined suitability at Gonzales for each GSA guild within a Riffle cross section at 175 and 400 cfs.

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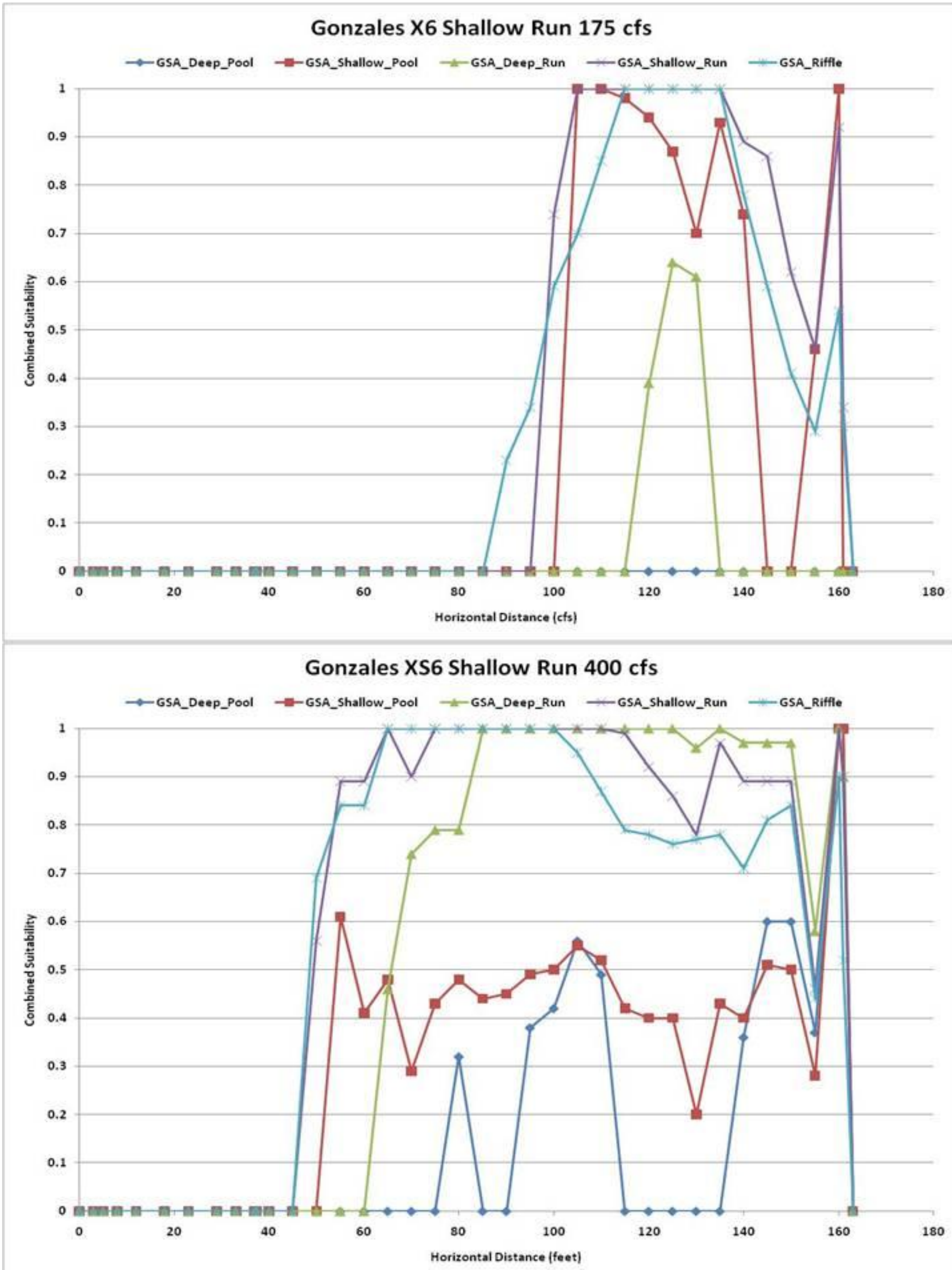

Figure 3-6 Distribution of combined suitability at Gonzales for each GSA guild within a Shallow Run cross section at 175 and 400 cfs.

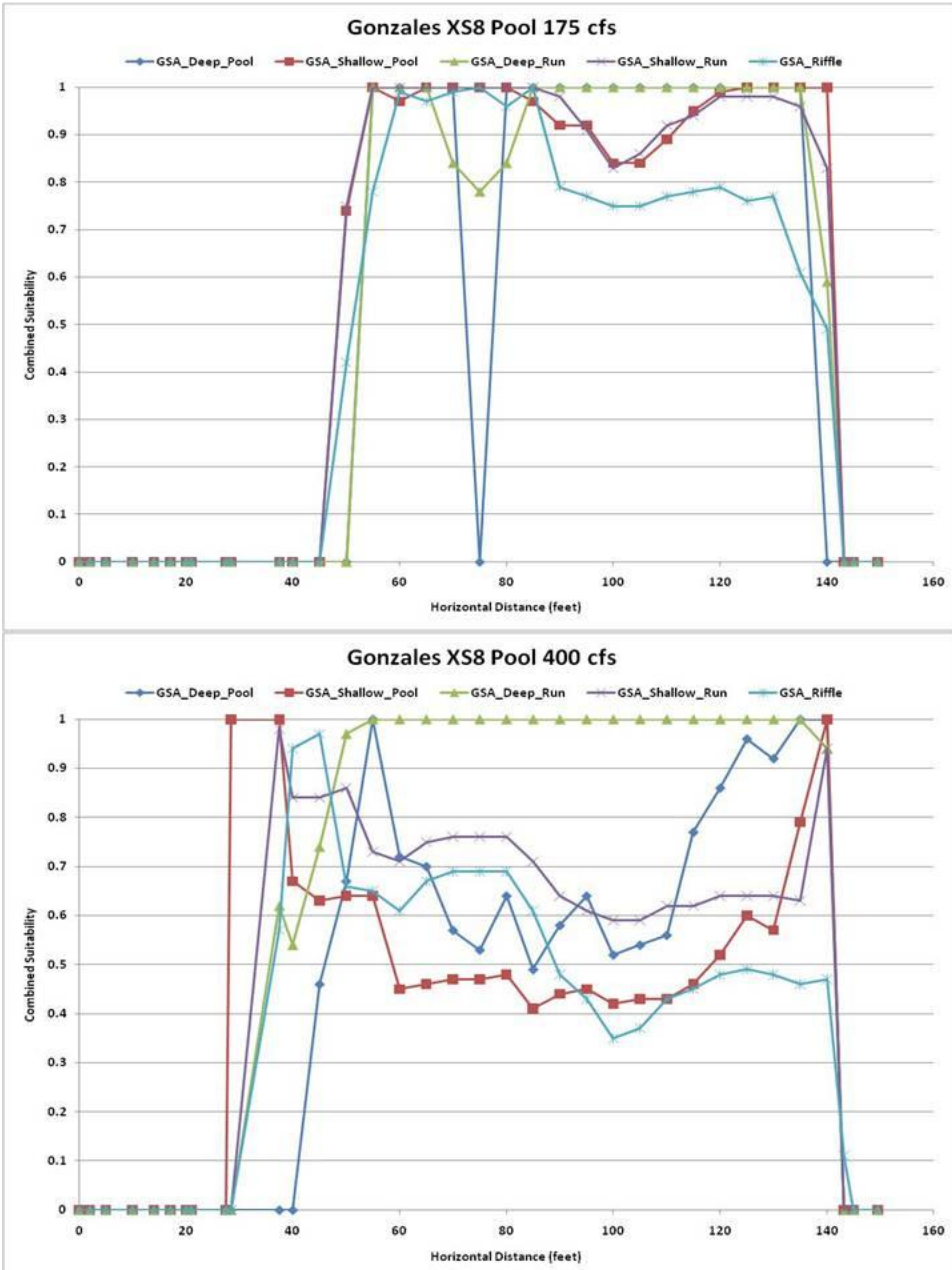

Figure 3-7 Distribution of combined suitability at Gonzales for each GSA guild within a Pool cross section at 175 and 400 cfs.

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3.2.2 Guadalupe River at Victoria

Figure 3.8 shows the relationship between total available habitat and discharge at the Victoria study site using both the LSAR and GSA habitat guilds. The paired vertical colored lines are the seasonal minimum and maximum range of discharges for subsistence, Low, Medium and High HEFR derived discharges for the site based on the full period of record. The primary differences between the two habitat guild suitability curve results is that the LSAR results show a 'shift left' relative to the GSA guild results and show a wider spread in the total magnitude of available habitat between the various LSAR habitat guilds. This is again attributed the narrower range of suitable depth and velocities for the LSAR habitat guilds compared to the equivalent GSA habitat guild.

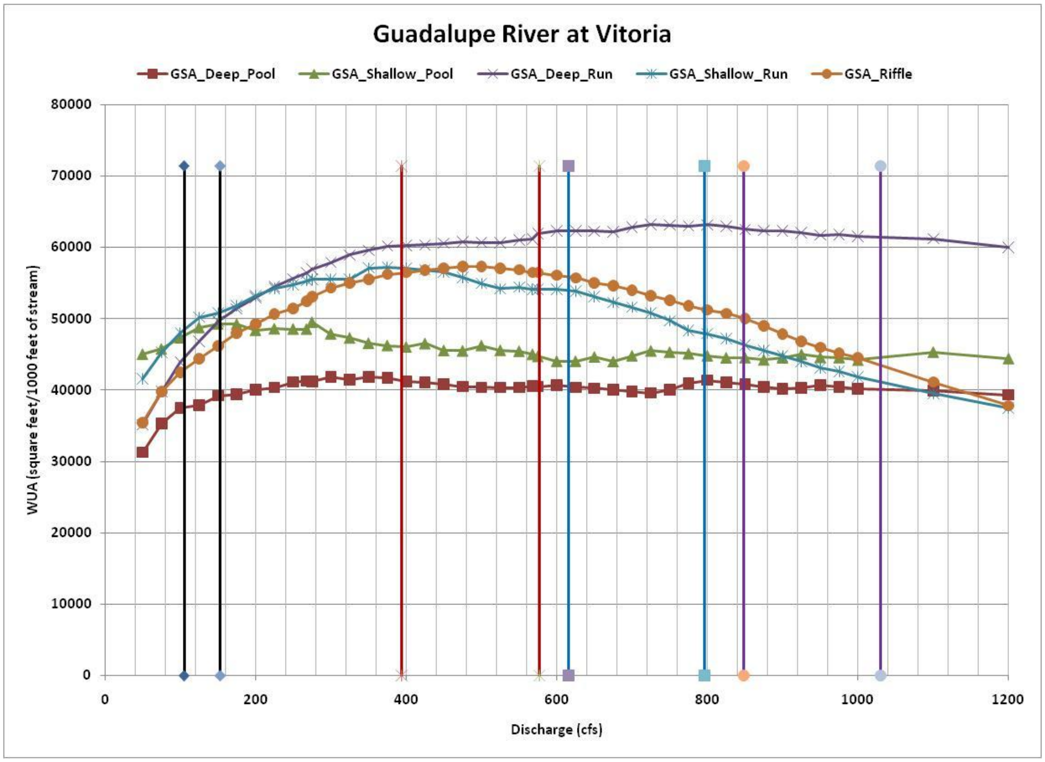
Overall, the GSA results suggest that the total habitat for GSA Deep Pool and Shallow Pool guild habitats remain relatively constant between the upper ranges of the HEFR High Base flow range down to the lower range of the HEFR Subsistence flow discharges. GSA Deep Run guild habitat remains relatively constant from HEFR High Base flow through Low Base flow discharge, while both GSA Riffle and Shallow Run guild habitat increases between the HEFR High Base and Low Base flow ranges where they attain their maximum value. The relative rate of decline in total area for all the GSA habitat guilds increases below subsistence flow ranges. In contract, the LSAR based results generally show increasing habitat availability between the HEFR High Base flow range through discharges intermediate between the HEFR Low Base flow and Subsistence discharge range. The exception is the LSAR Riffle guild which shows a general decline as flow increase above subsistence flow levels.

Figure 3.9 shows the relationship between available quality habitat and discharge for the GSA and LSAR guilds at Victoria over the range of discharges from subsistence to the HEFR High Base flow discharges. The GSA Shallow Run, Deep Run, and Deep Pool habitat guilds remain fairly constant between the HEFR High Base flow and Low Base flow discharge ranges. The Shallow Pool guild generally shows a steady decline from Subsistence flow through the HEFR High Base flow discharge ranges. The Riffle guild shows a maximum near the lower range of HEFR Low Base flow discharges and then steadily declines through the HEFR High Base flow discharge range.

LSAR Deep Pool, Moderate Pool, and Riffle guild habitats remain fairly constant between Subsistence and the HEFR High Base flow discharge range. The LSAR Riffle guild shows a maximum in the HEFR Low Base flow discharge range but has very little total quality habitat. The Shallow Run guild remains relatively high between Subsistence and the lower end of the HEFT Low Base flow discharge range and then declines until remaining fairly constant over the HEFR Medium and High Base Flow ranges of discharge. The LSAR Deep Run guild reaches a maximum between Subsistence and the lower discharge range of the HEFR Low Base flow and then steadily declines through the HEFR High Base flow discharge range.

Figures 3.10 through Figure 3.13 show an example of the combined suitability for each GSA guild at four cross sections representing different mesohabitat types at 125 and 400 cfs. These flows are approximately the lower bounds on HEFR Subsistence and Low Base ranges of discharge. As was shown for the results at Gonzales, the suitability curves for the various habitat guild types produce rational results when compared between different mesohabitat types within the river. The guild habitat suitability overlaps for different guild types at cross sections in specific mesohabitat types as would be expected from the overlapping suitability of guild depth and velocity ranges as noted previously. The results also show that there are quantitative differences in relative suitability of different habitat guilds between the HEFR Low Base and Subsistence flow ranges depending on the mesohabitat type (i.e., cross section). As noted for the results at Gonzales, available habitat for each guild shows overlap on each cross section and to some degree increase as flows are reduced but the degree of overlap is dependent on the particular mesohabitat type.

These results suggest that some alteration to the HEFR Low, Medium and High Base flow regime discharges could be considered. For example, shifts to flows by ~ 50 to 75 cfs within these flow regime seasonal discharges would likely maintain the relative contribution of high quality habitat whether one considers GSA or LSAR habitat guild results. However, as stated previously, it must be stressed that these analyses do not have the benefit of water quality and temperature simulation overlays nor do they consider other ecological processes such as implications of competition, predation, etc that are import to maintaining a sound ecological environment. As such, large reductions in flows at any of the HEFR Low, Medium or High base regimes based solely on these results are discouraged. Furthermore, substantial reductions of the seasonal Low, Medium, and High Base flow regimes must also consider the potential implications on the required Bay and Estuary flow regimes.



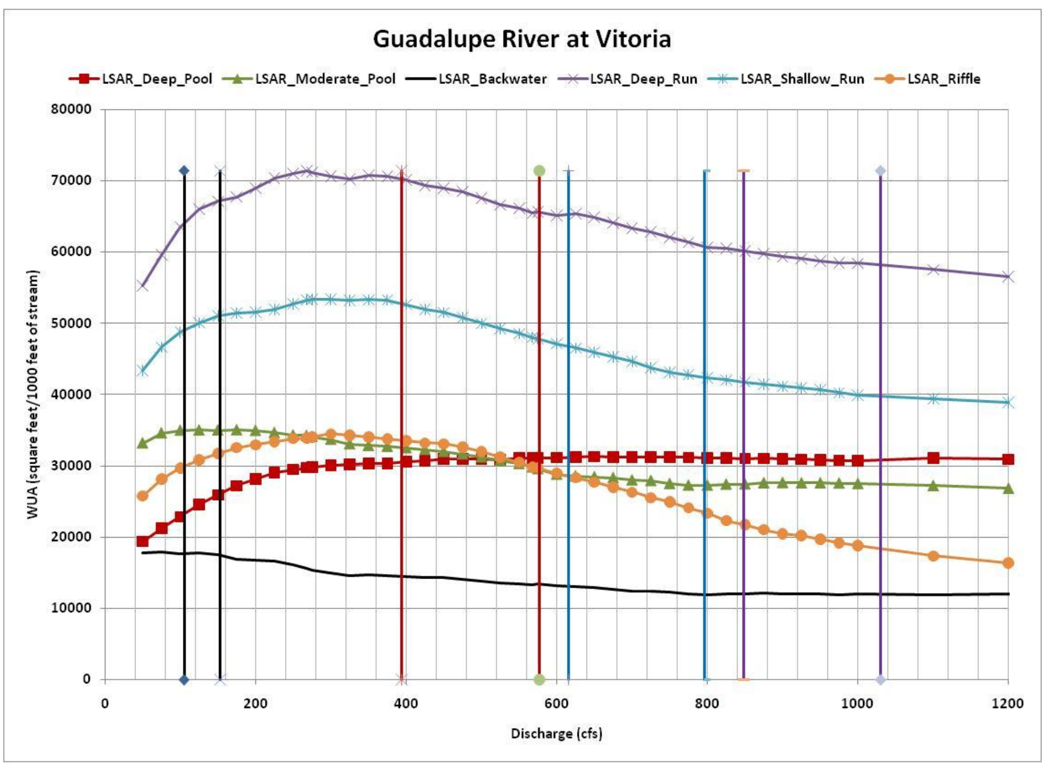
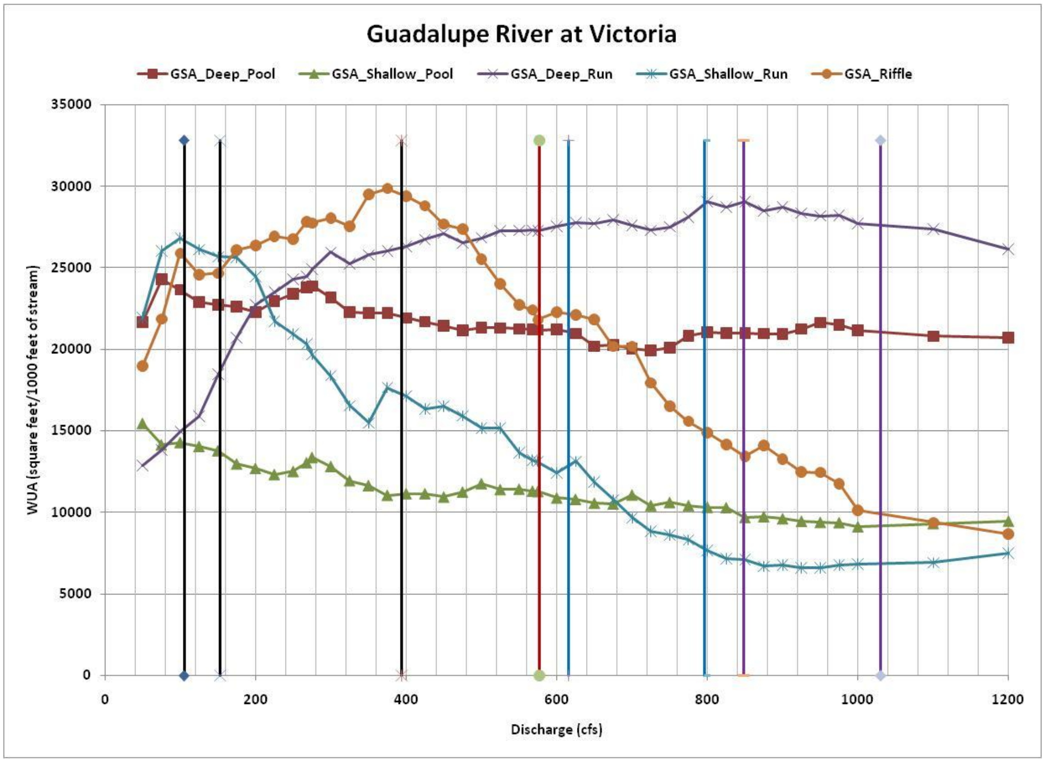


Figure 3-8 Total quantity habitat (WUA) as a function of discharge at the Victoria study site based on LSAR and GSA habitat guild suitability curves.



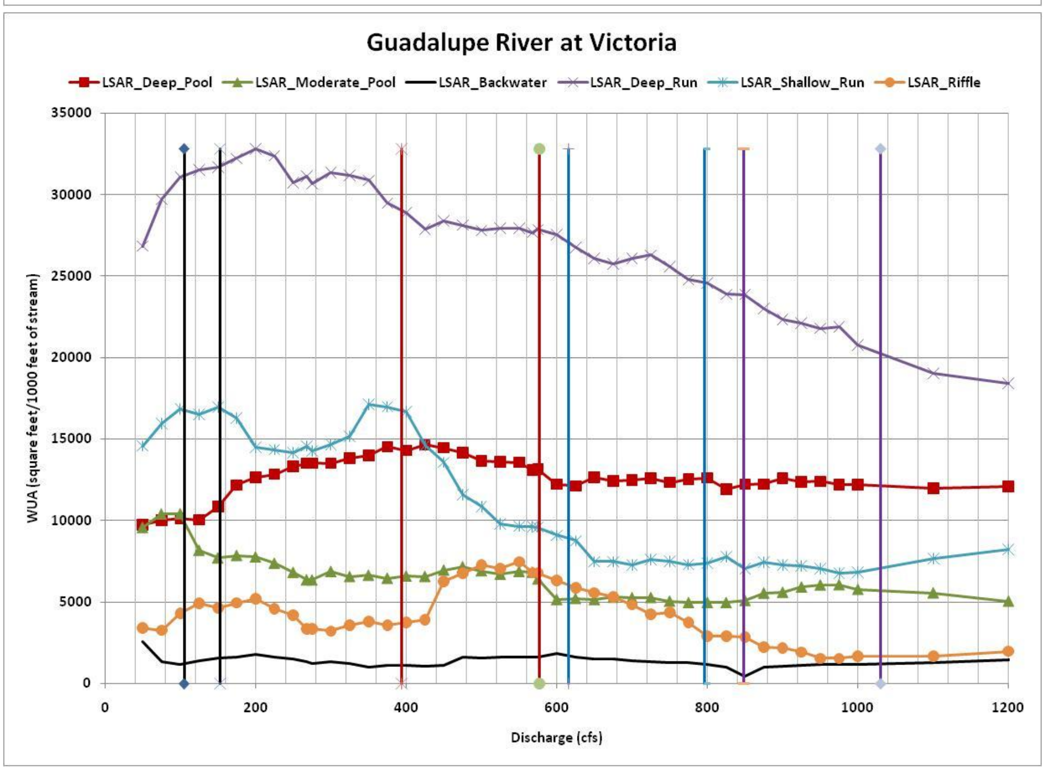


Figure 3-9 Total quality habitat (WUA) as a function of discharge at the Victoria study site based on LSAR and GSA habitat guild suitability curves.

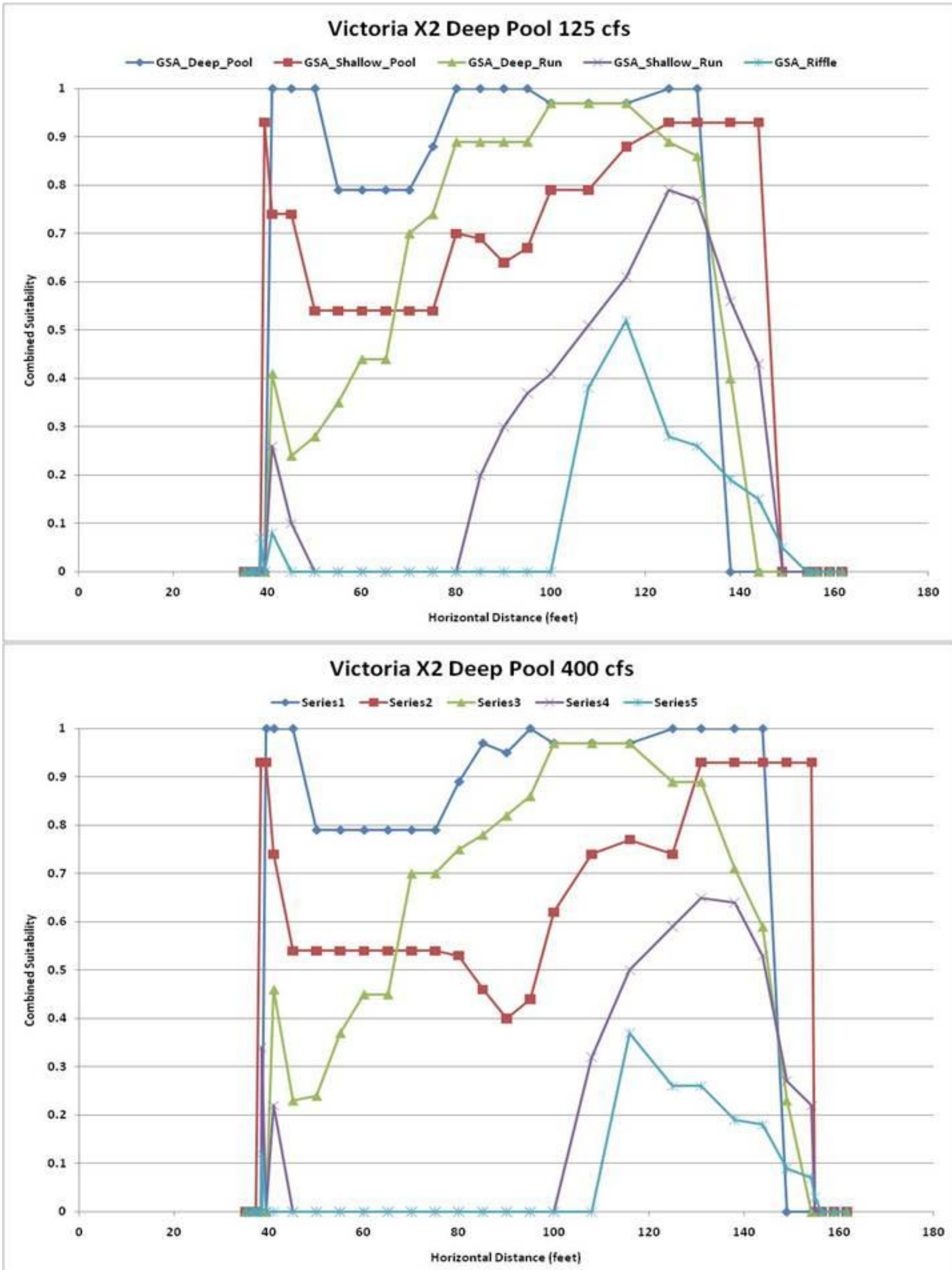
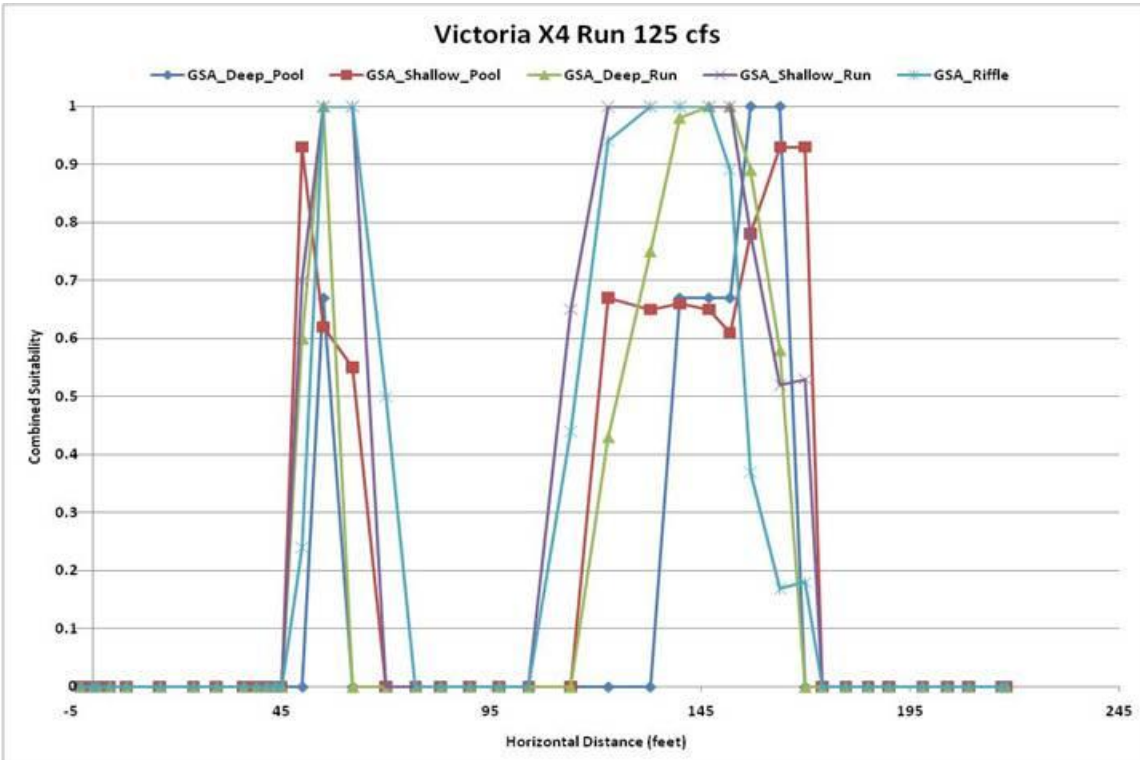


Figure 3-10 Distribution of combined suitability at Victoria for each GSA guild within a Deep Pool cross section at 175 and 400 cfs.



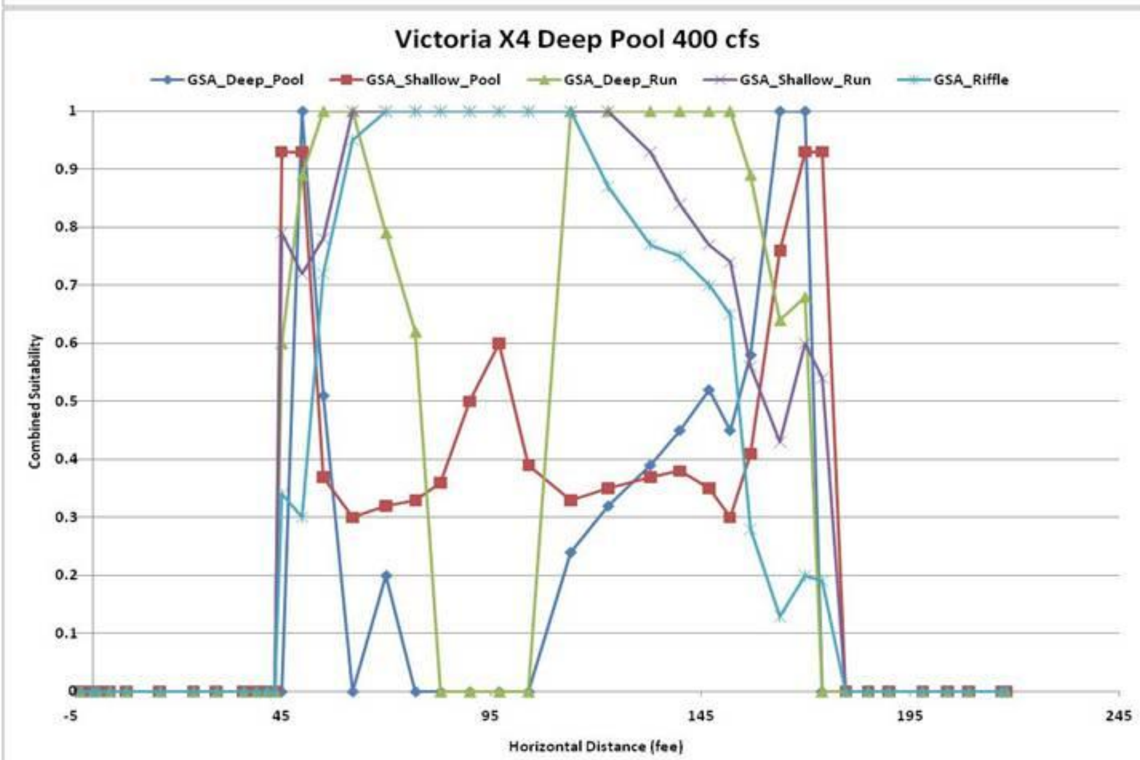
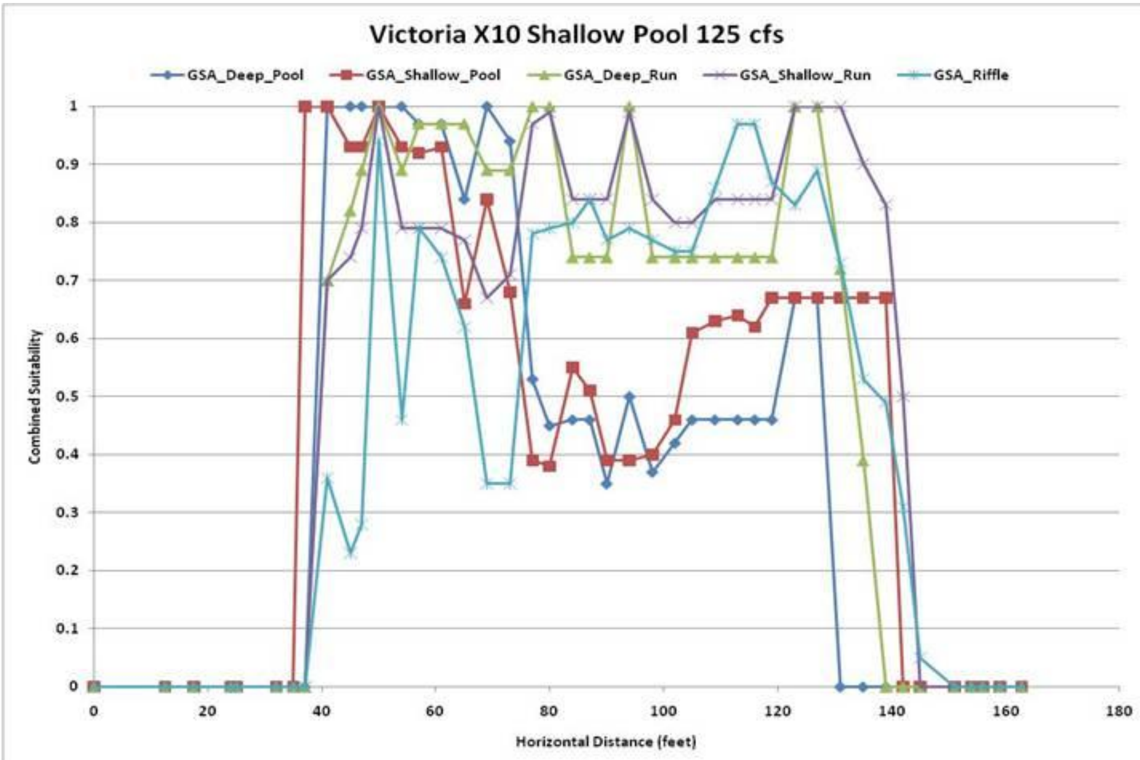


Figure 3-11 Distribution of combined suitability at Victoria for each GSA guild within a Run cross section at 175 and 400 cfs.



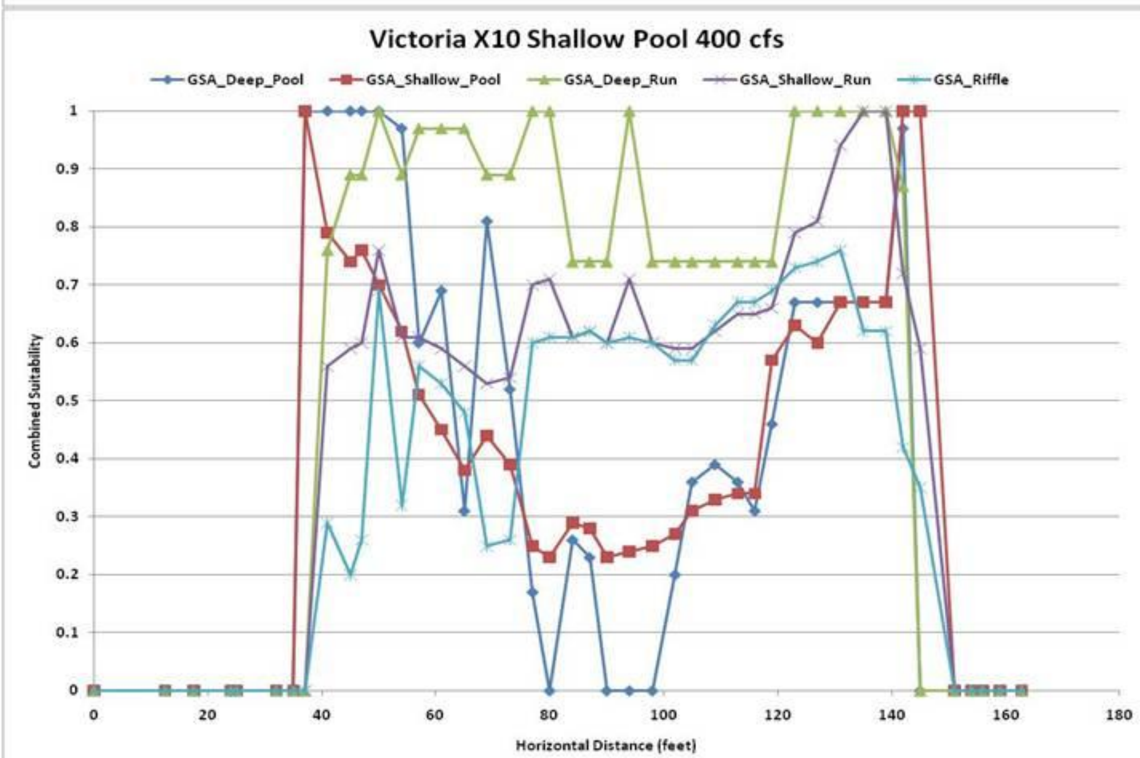


Figure 3-12 Distribution of combined suitability at Victoria for each GSA guild within a Shallow Pool cross section at 175 and 400 cfs.

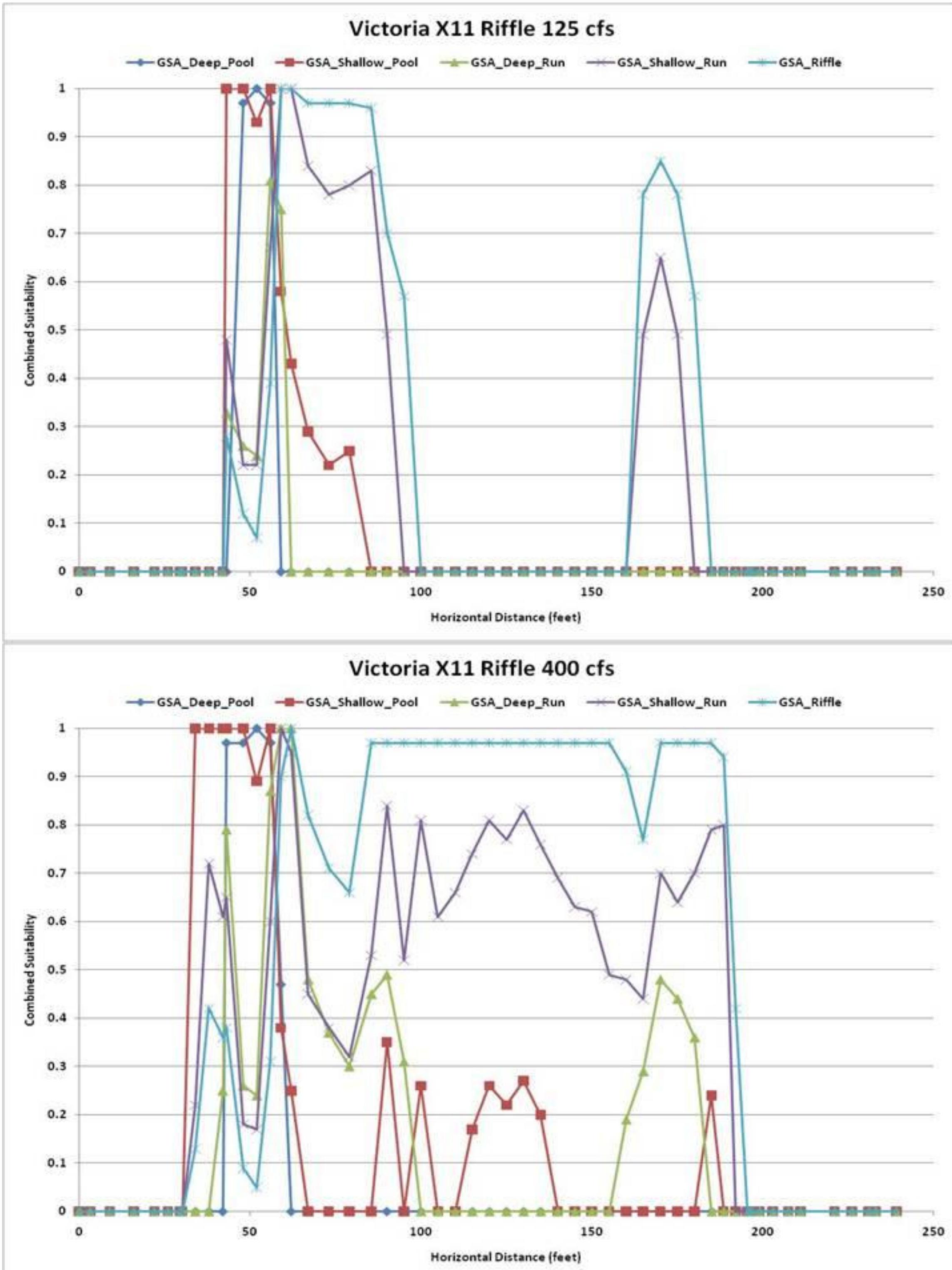


Figure 3-13 Distribution of combined suitability at Victoria for each GSA guild within a Riffle cross section at 175 and 400 cfs.

4. Implications for Evaluation of Environmental Flow Regime Recommendations

The analyses provided above would suggest that some reductions in the seasonal HEFR Low, Medium and High Base flow discharges could be entertained as part of the BBASC deliberations without substantially affecting the likelihood of maintaining a sound ecological environment based on physical habitat. Large scale reductions in the flow regime however would likely raise the ecological risk of maintaining a sound ecological environment to unacceptable levels. The results should also not be interpreted, in this authors opinion to eliminate the three base flow regimes (i.e., collapse them into two or one regime recommendation). Physical habitat is a necessary but not sufficient condition to maintain a sound ecological environment and without quantitative overlays for water quality and temperature the risk to these aquatic systems is unwarranted. Also, as noted above, alteration of the HEFR seasonal base flow regimes should be carefully weighed against potential impacts on Bay and Estuary inflow needs.

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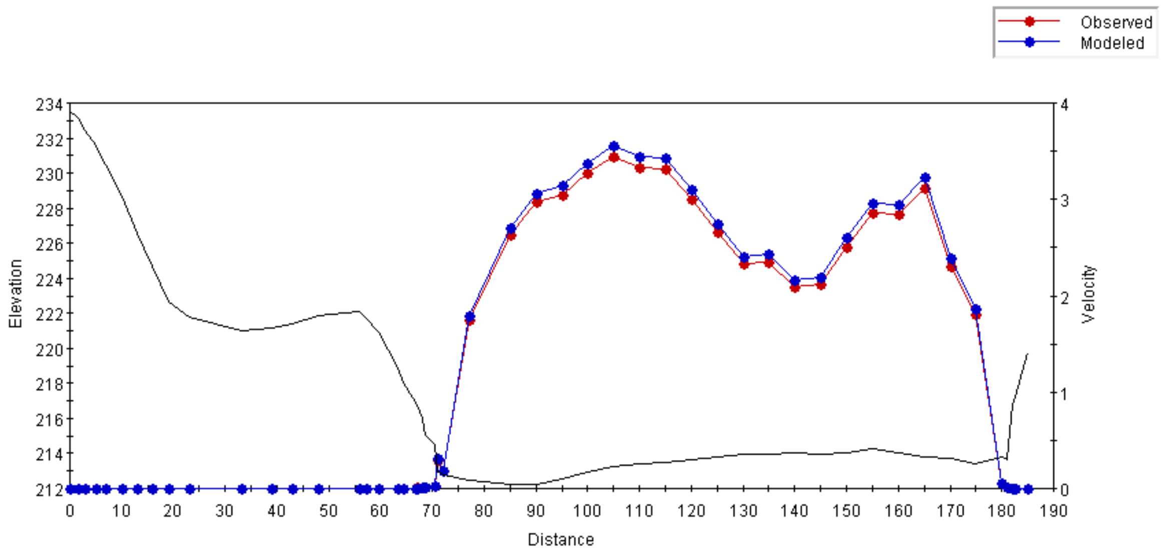
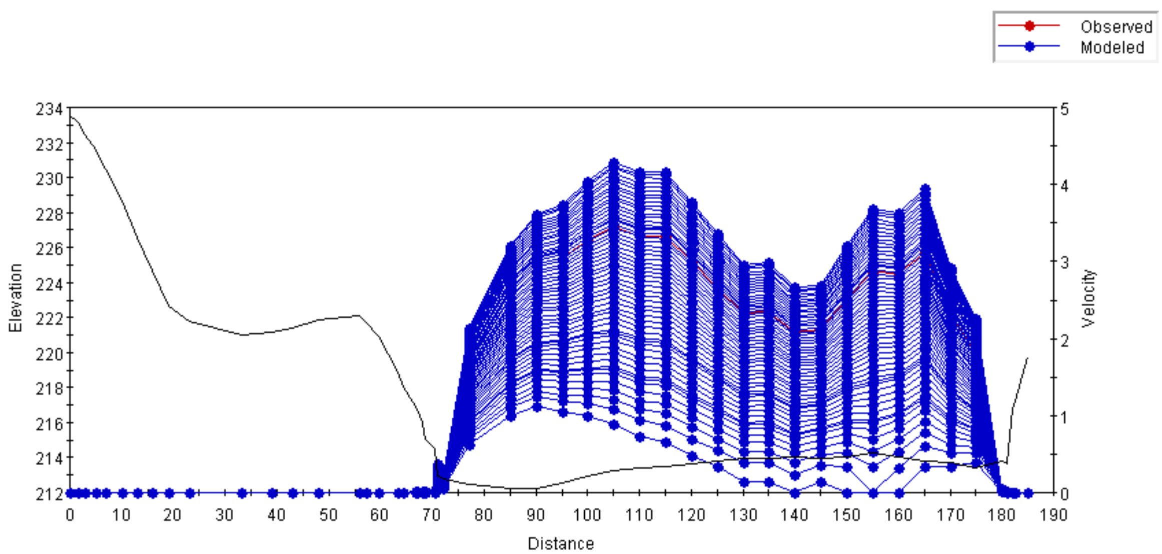
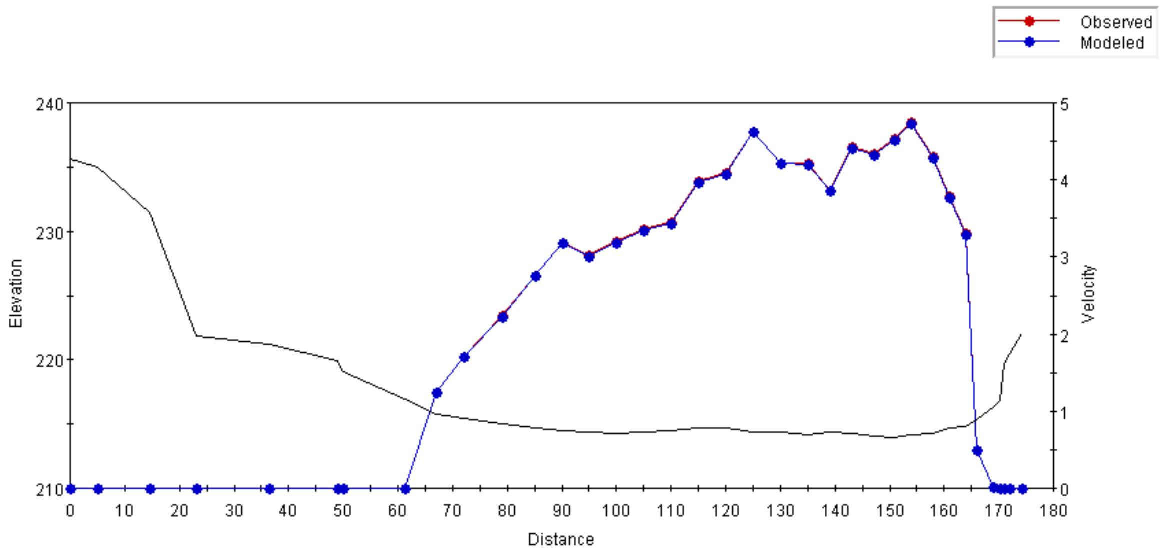
6. Appendix A – Hydraulic Model Velocity Calibration and Simulation Results

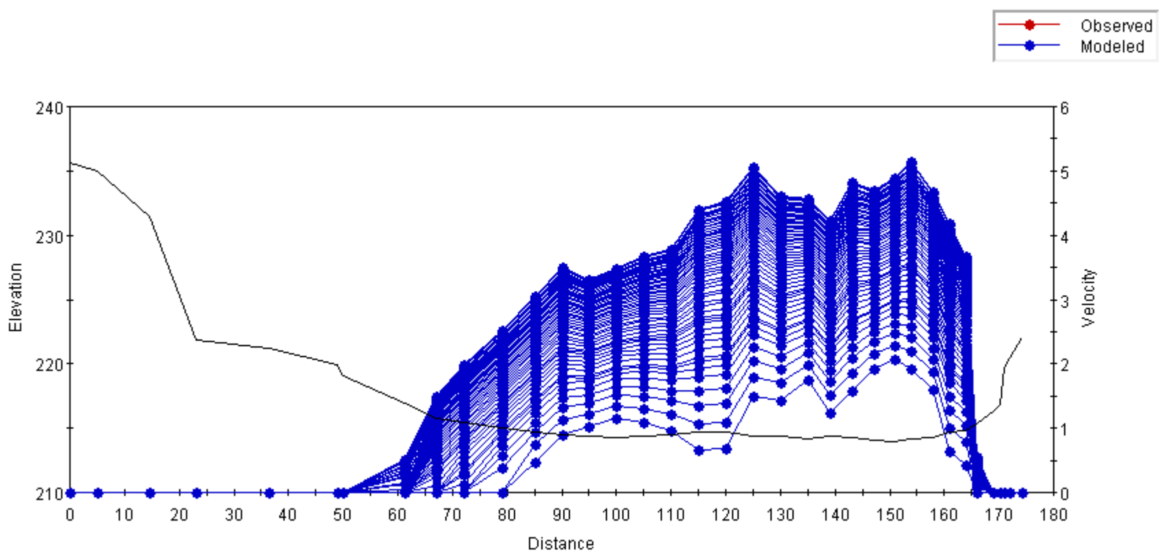
Guadalupe River at Gonzales





Gonzales – Cross Section 1





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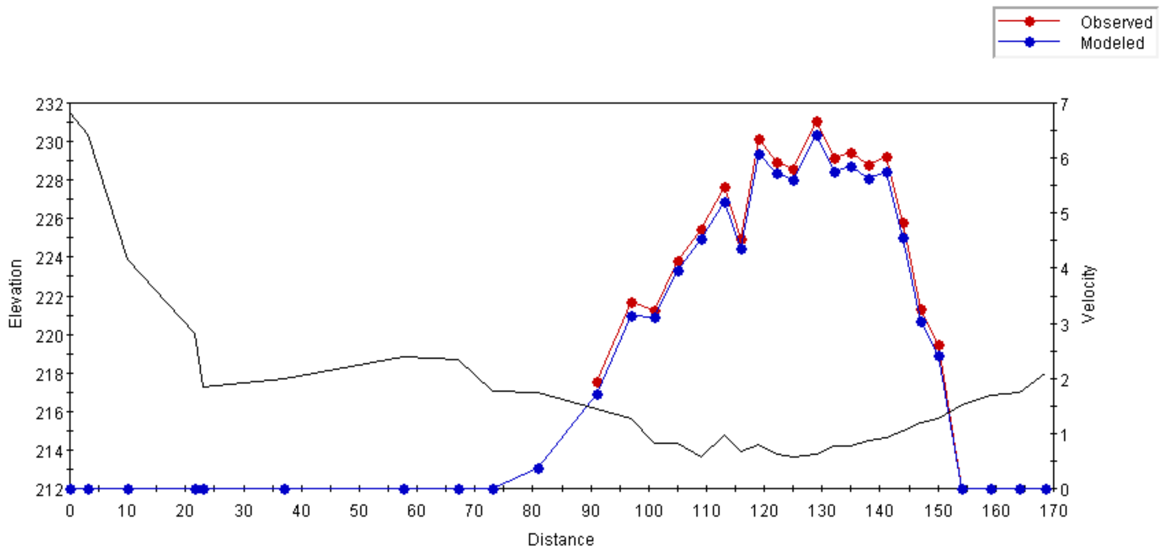

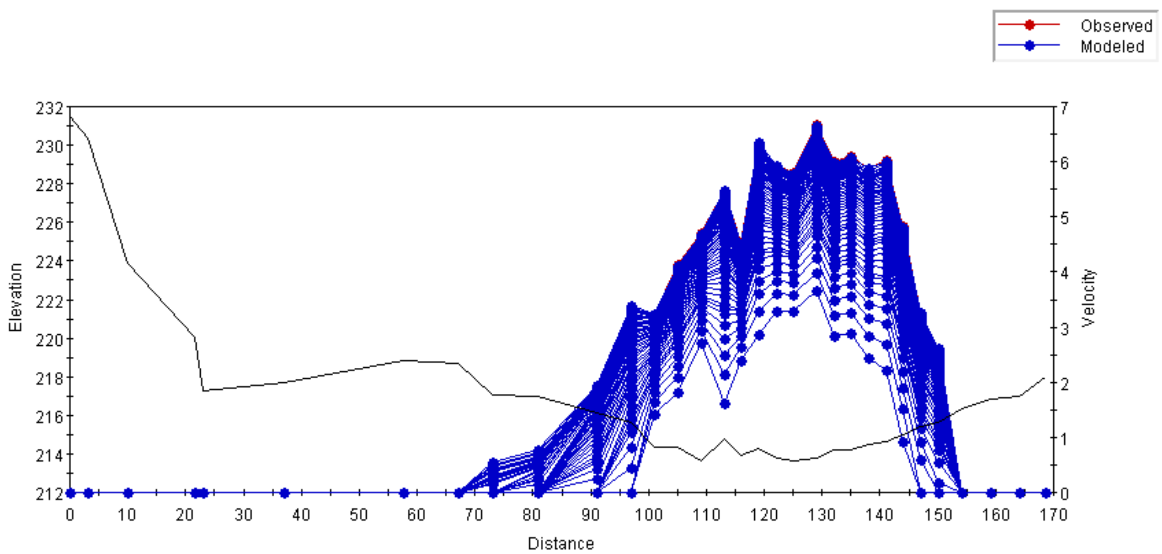

Gonzales – Cross Section 3

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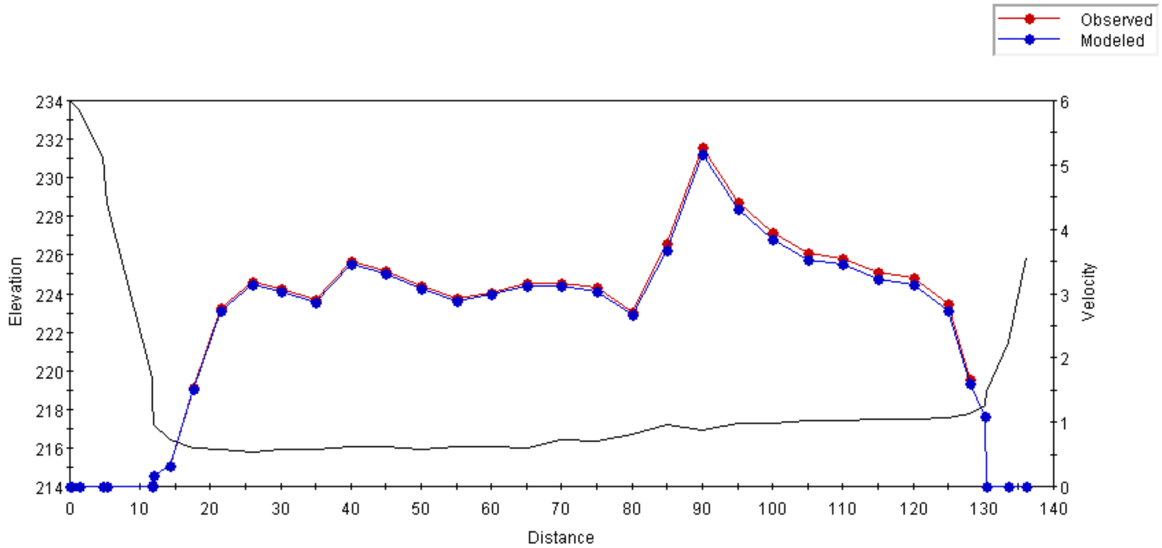

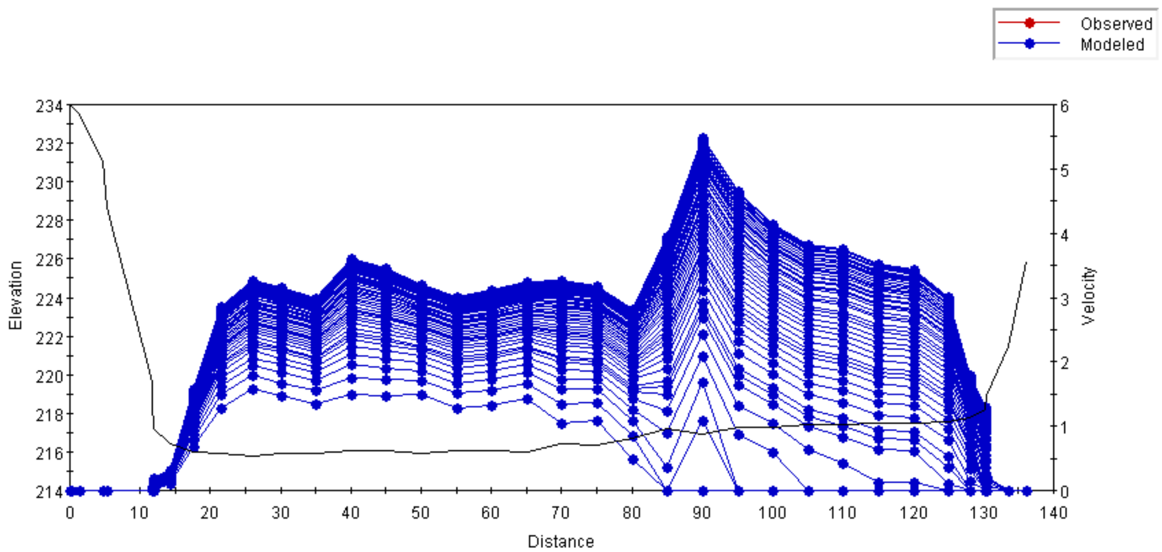

Gonzales – Cross Section 4

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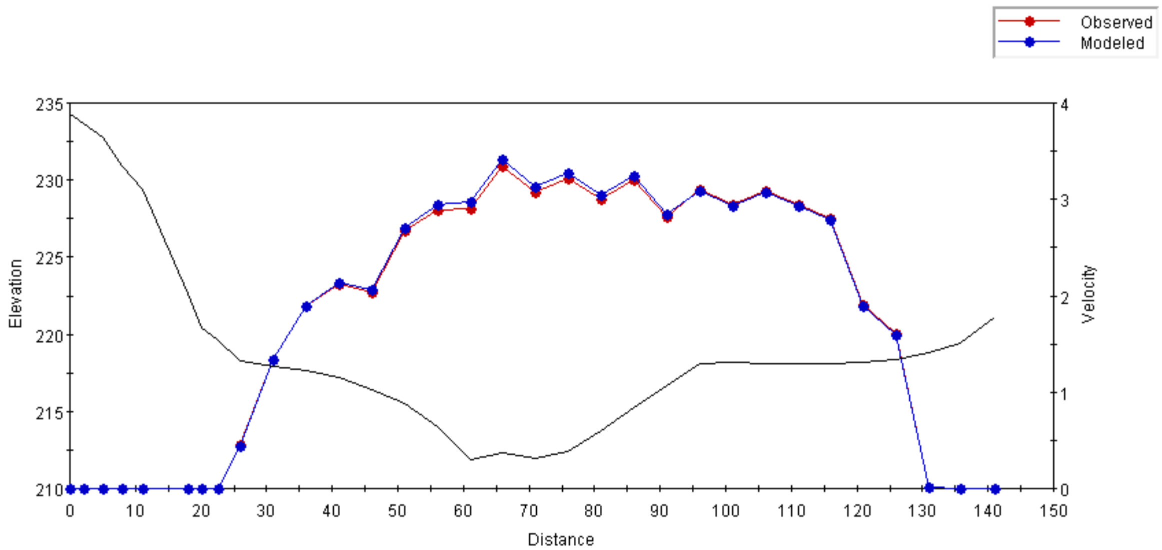

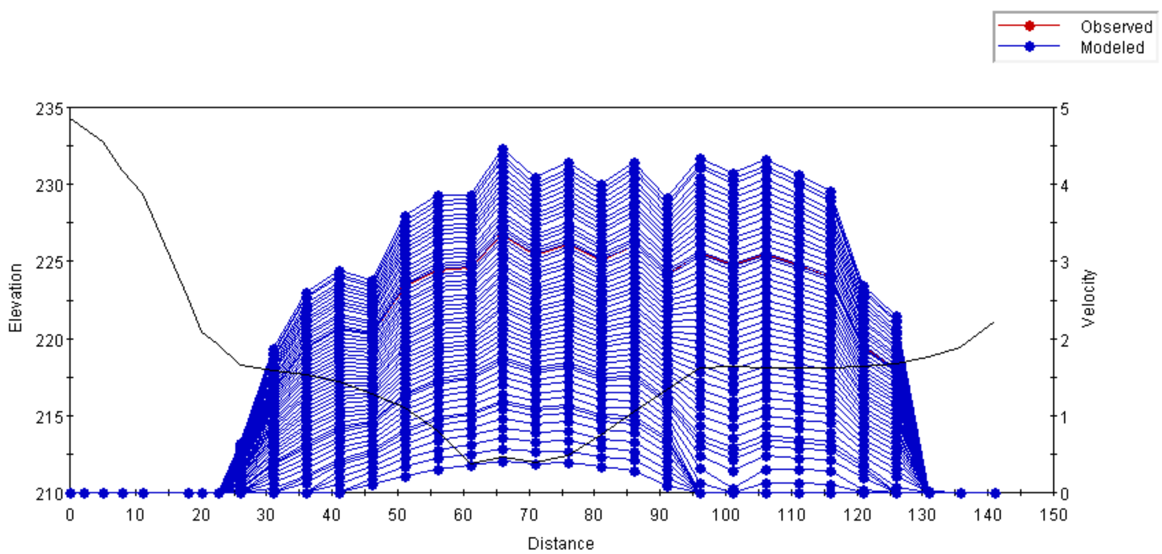

Gonzales – Cross Section 5

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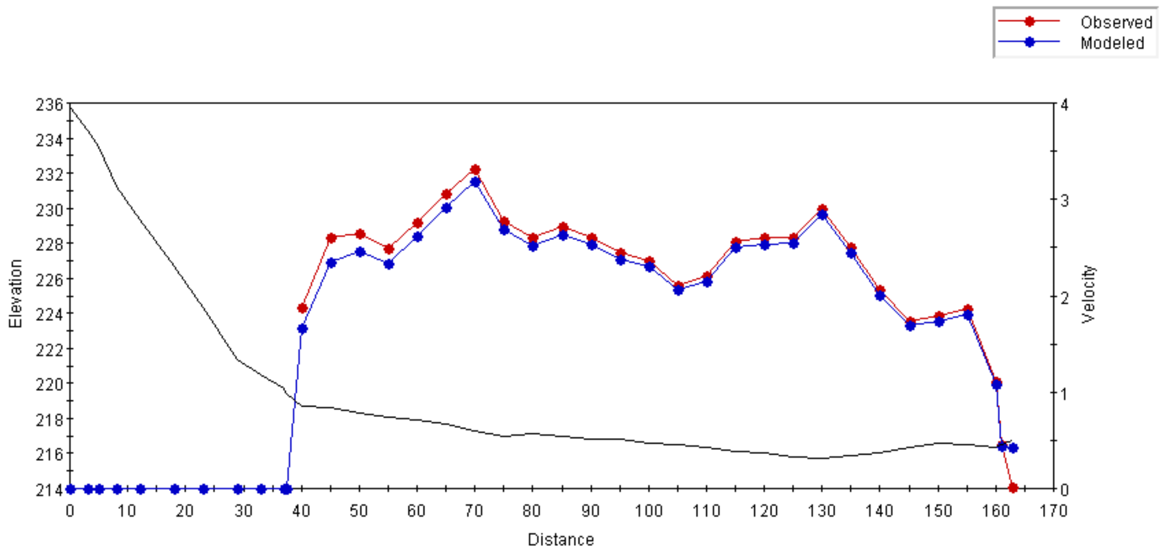

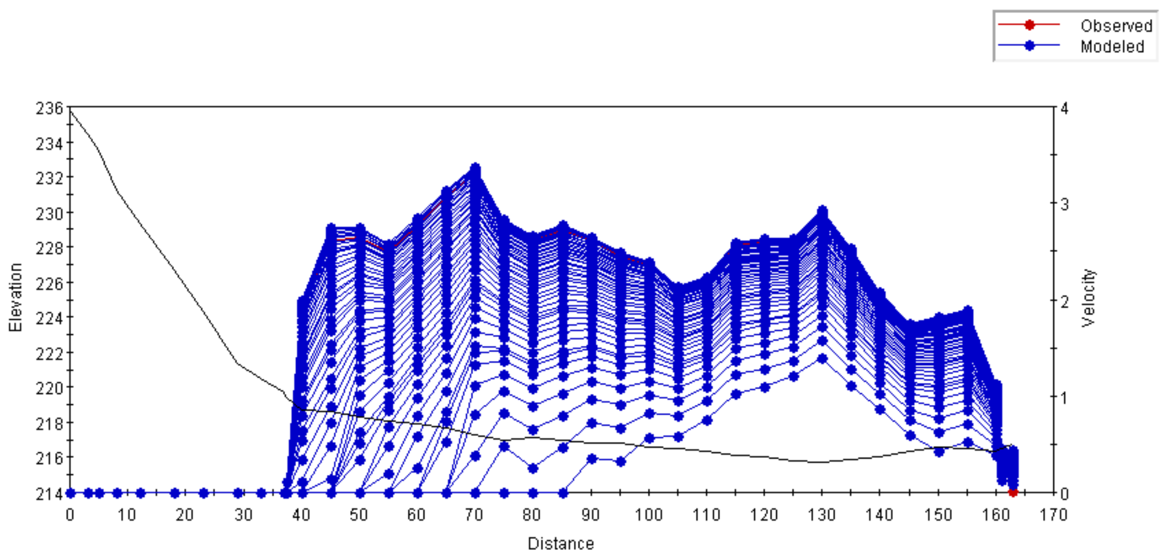

Gonzales – Cross Section 6

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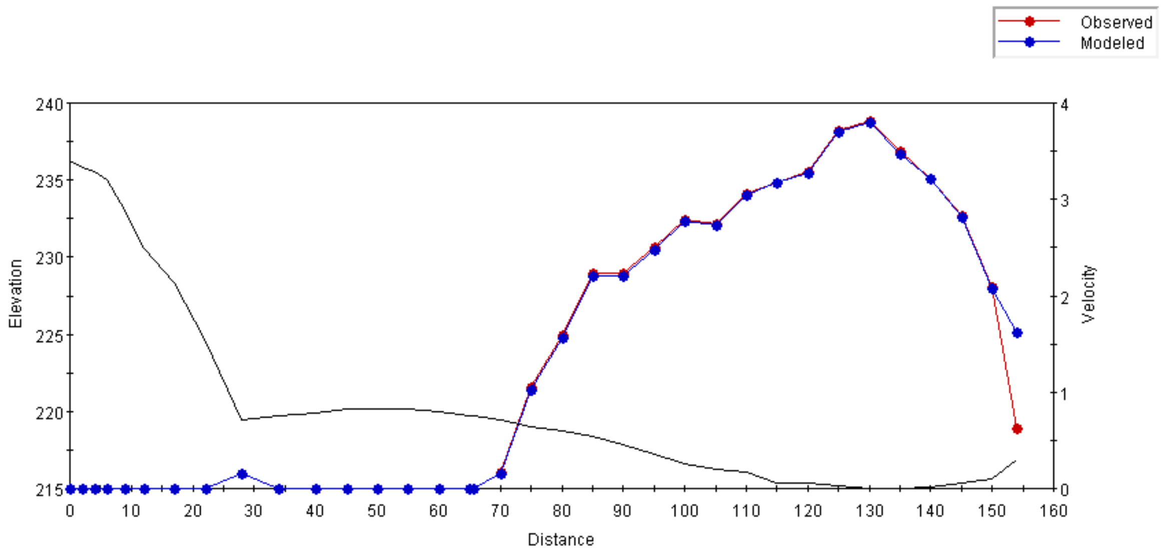
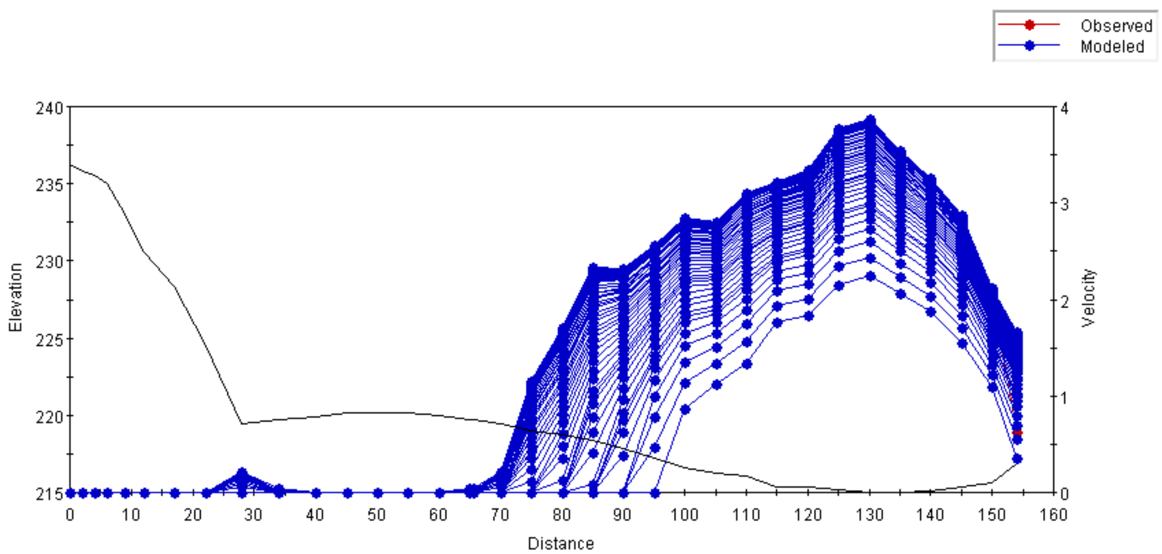
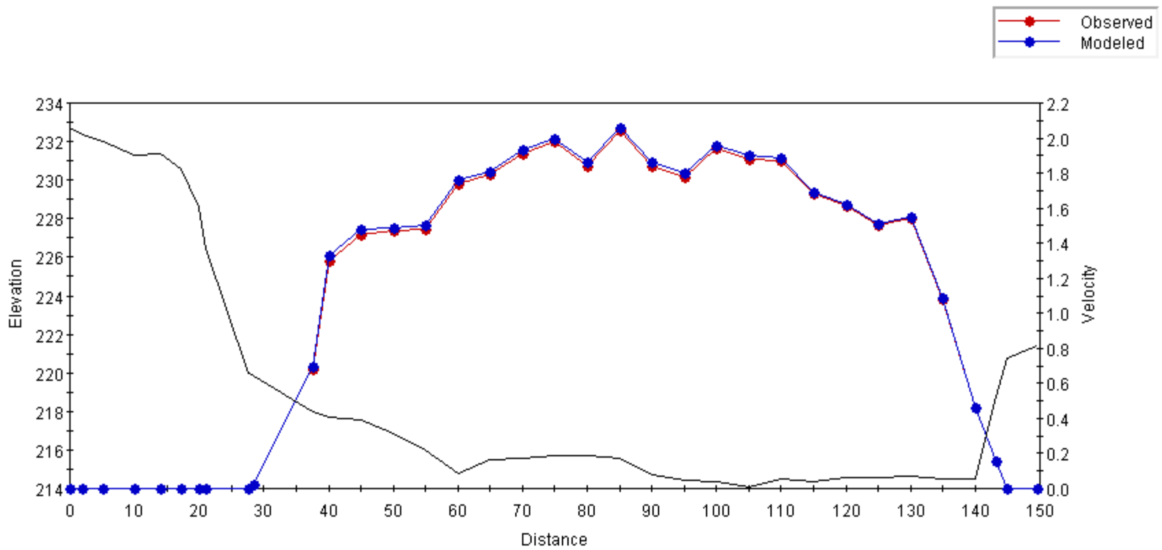
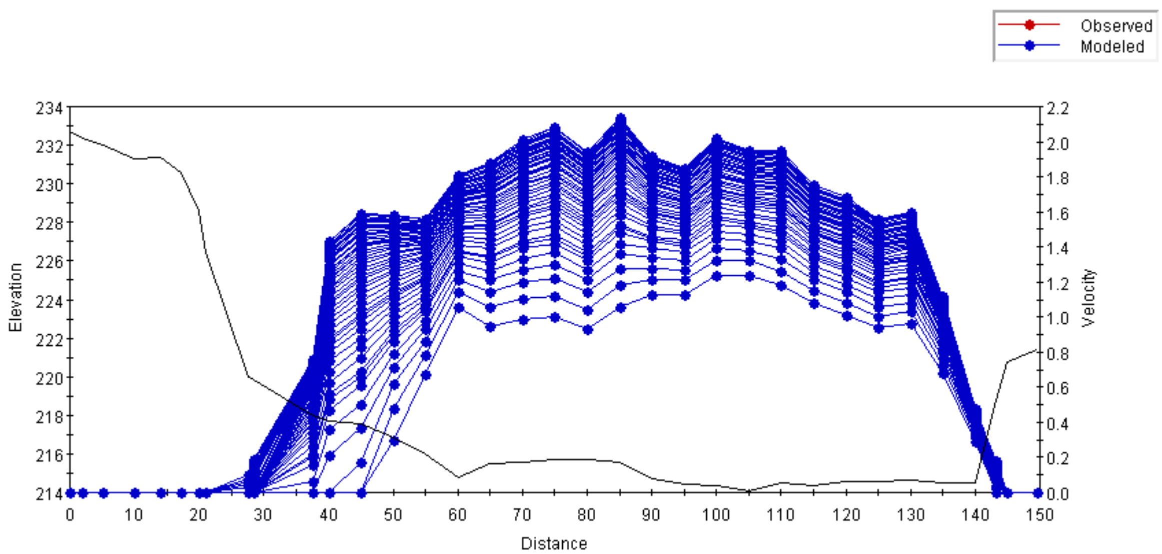




Gonzales – Cross Section 7





Gonzales – Cross Section 8

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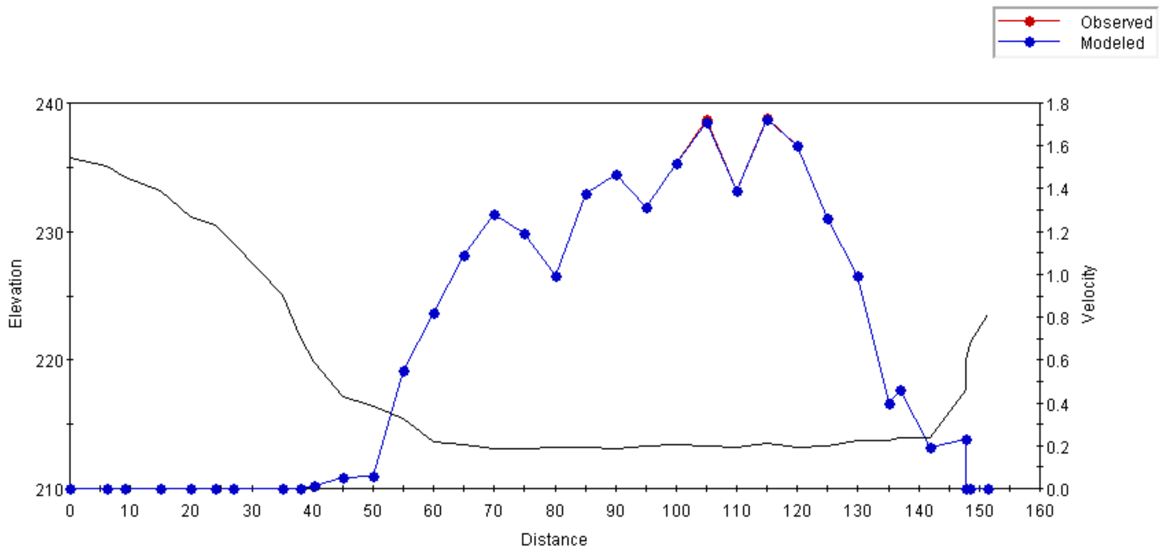

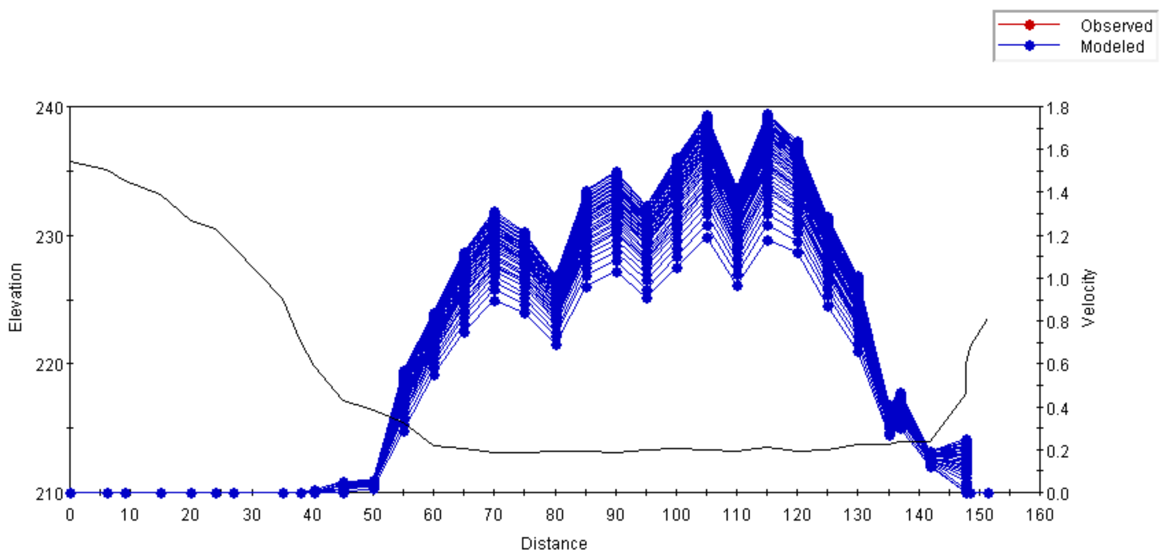

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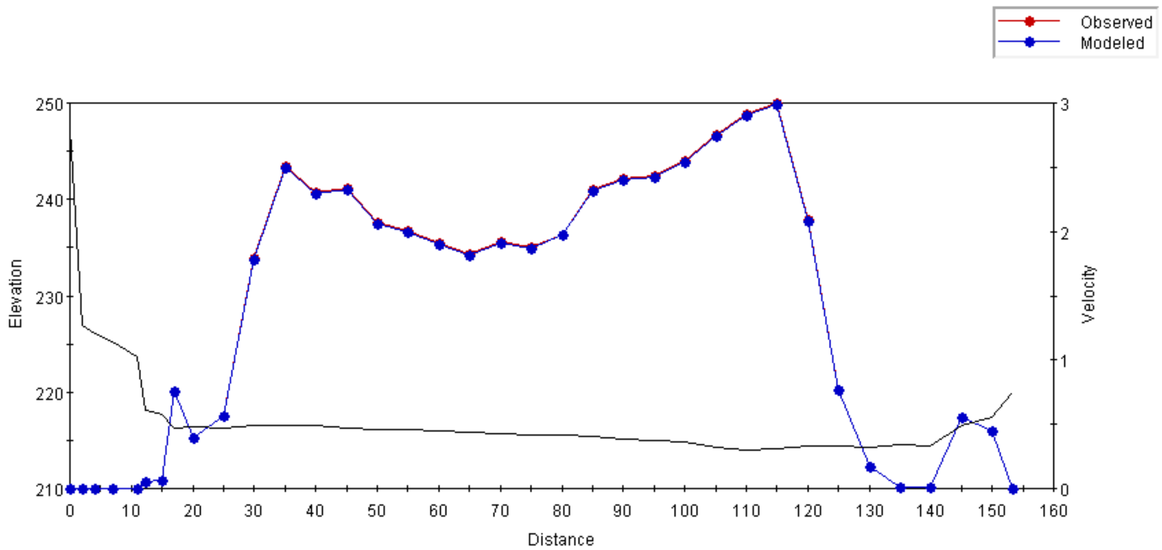

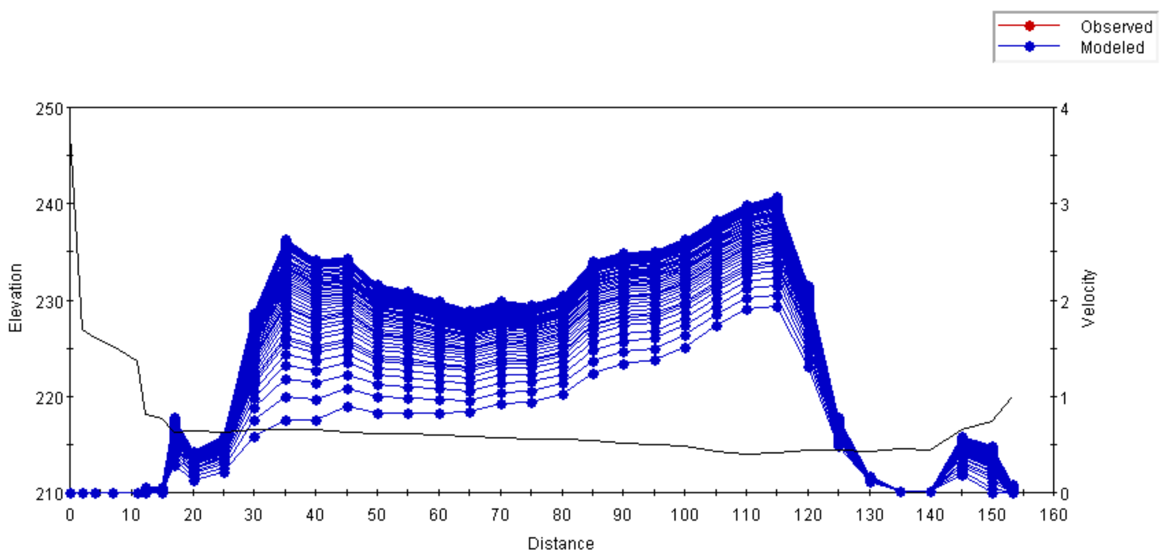

Gonzales – Cross Section 10

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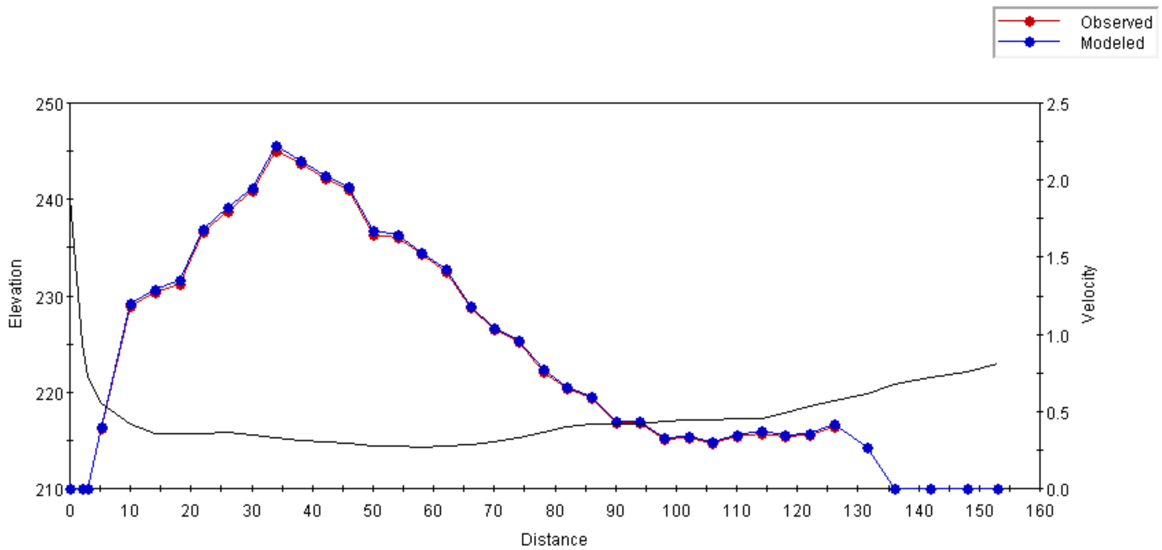

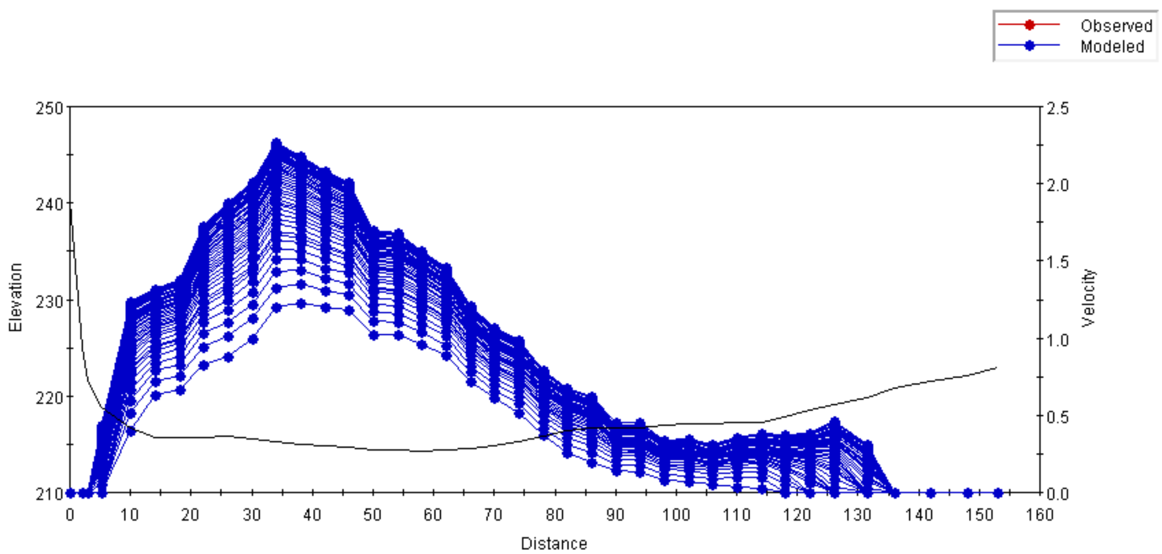

Gonzales – Cross Section 11

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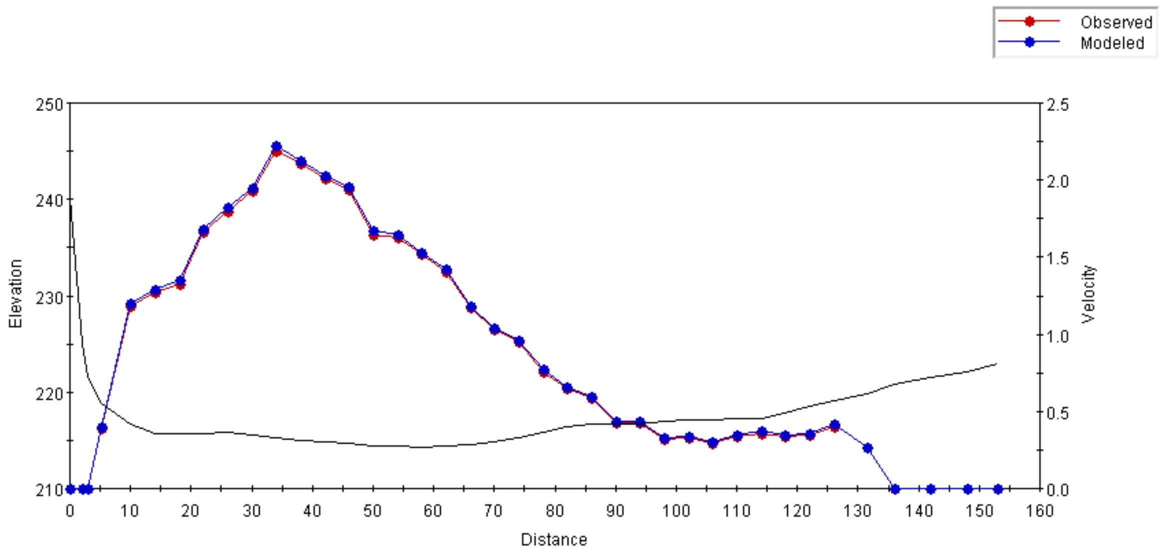

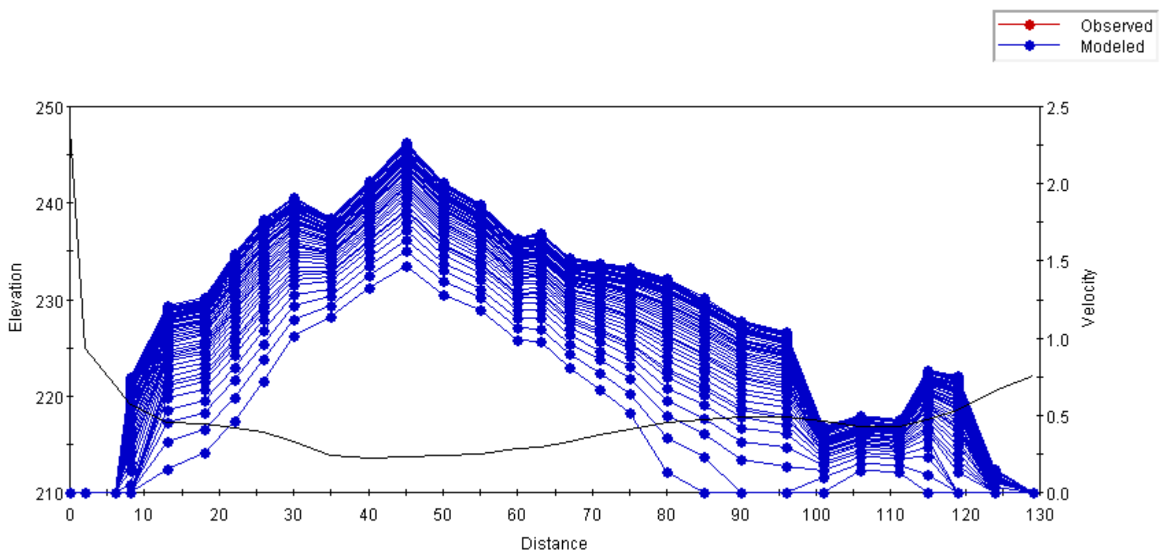

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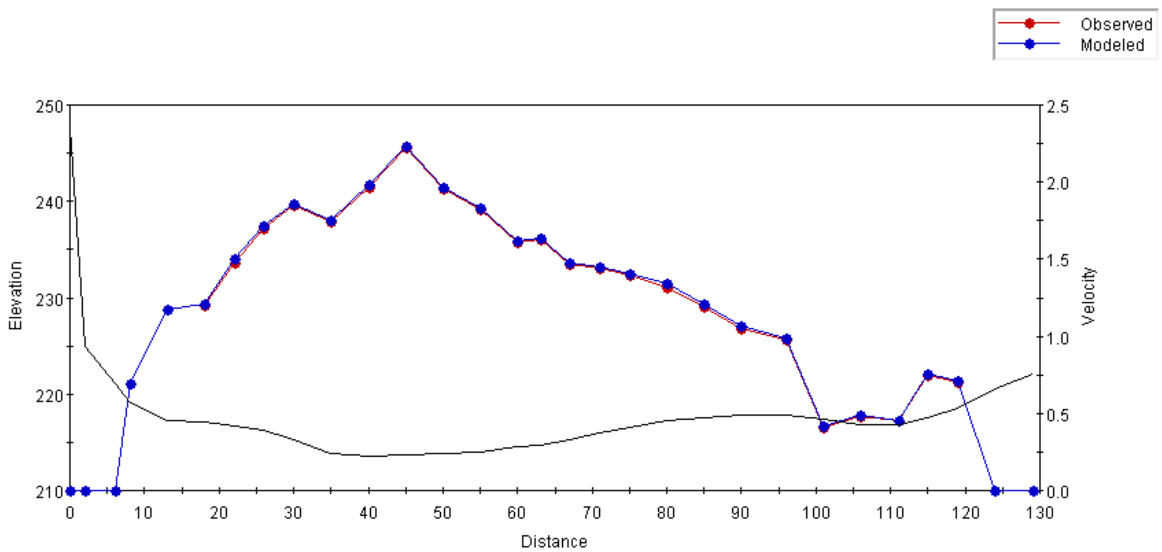

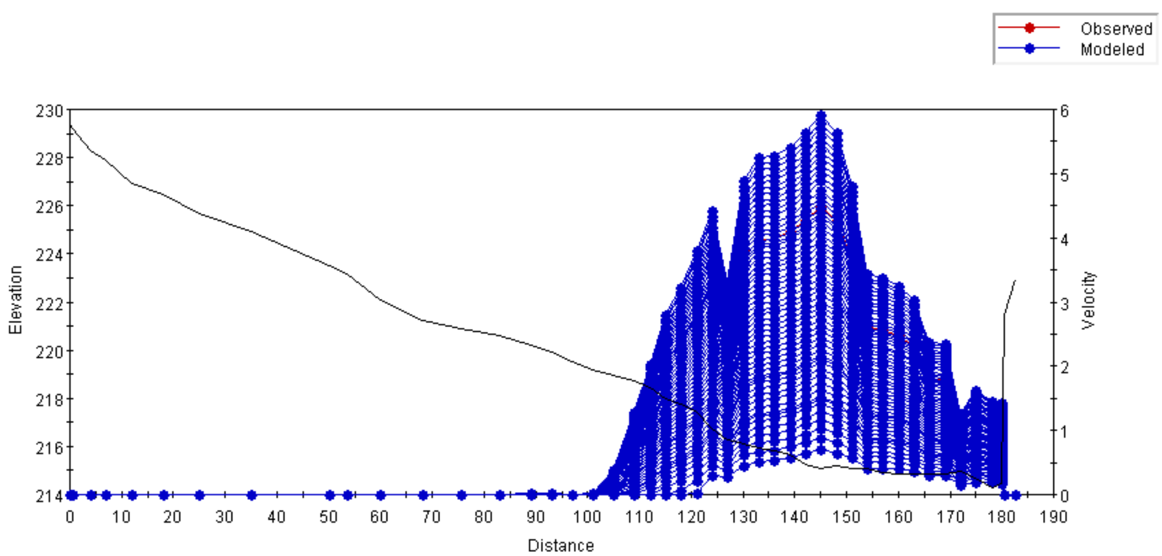

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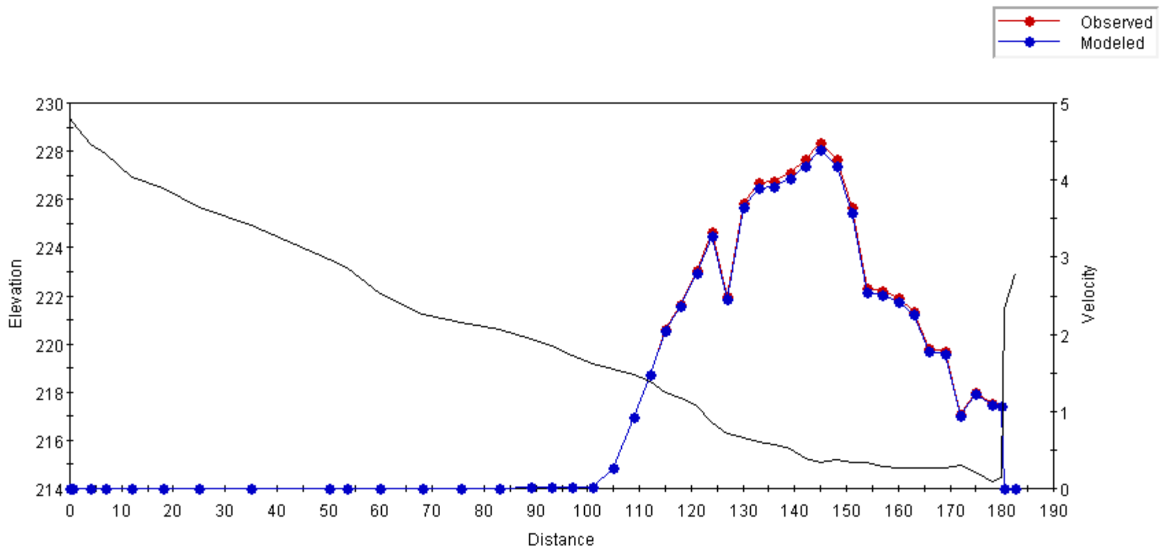

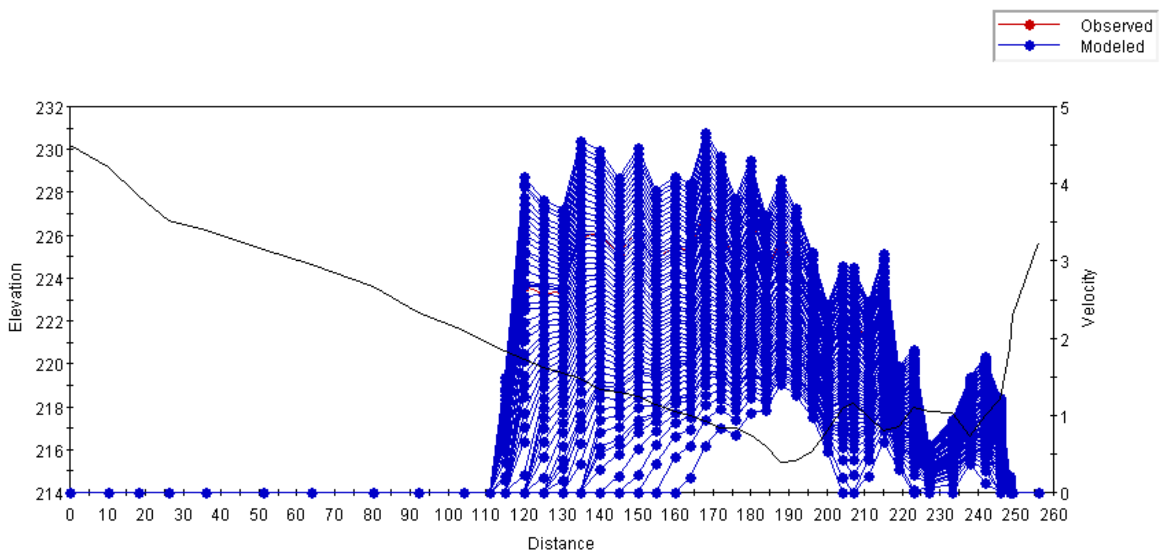

Gonzales – Cross Section 14

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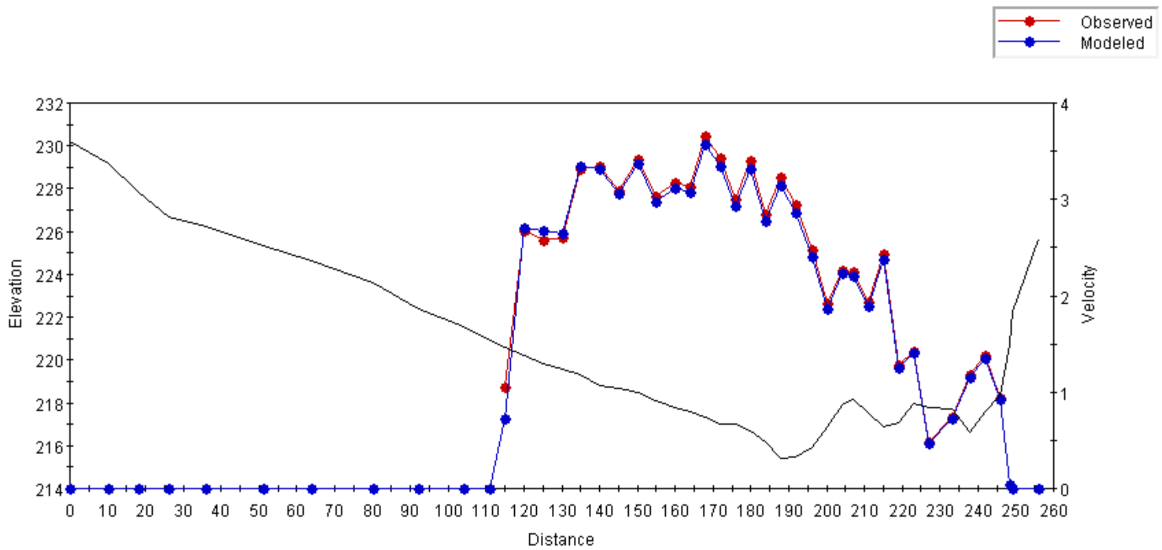
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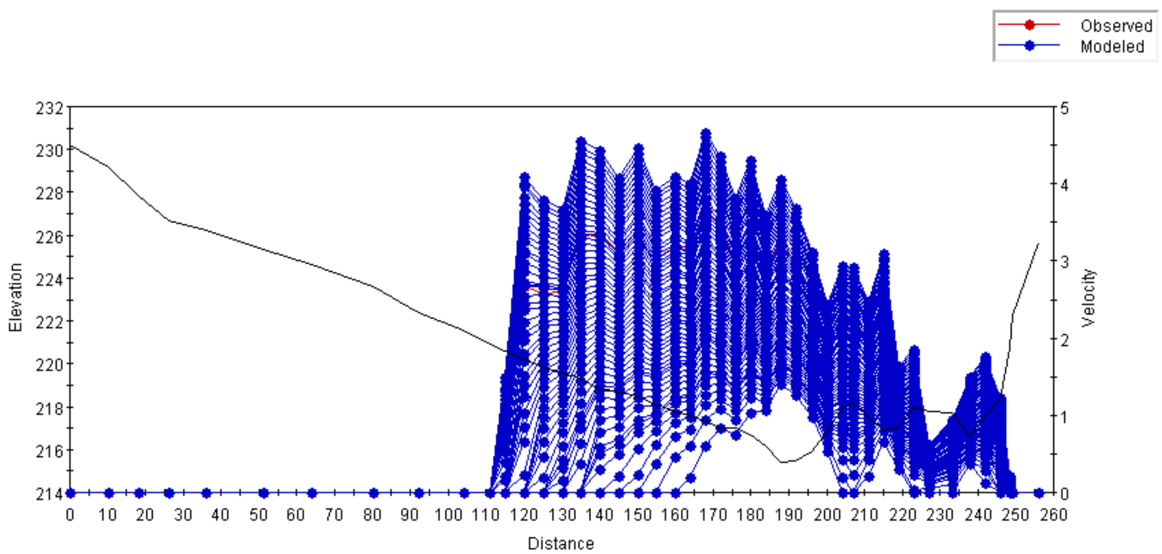
Modeled
Elevation
Velocity
Distance


Observed
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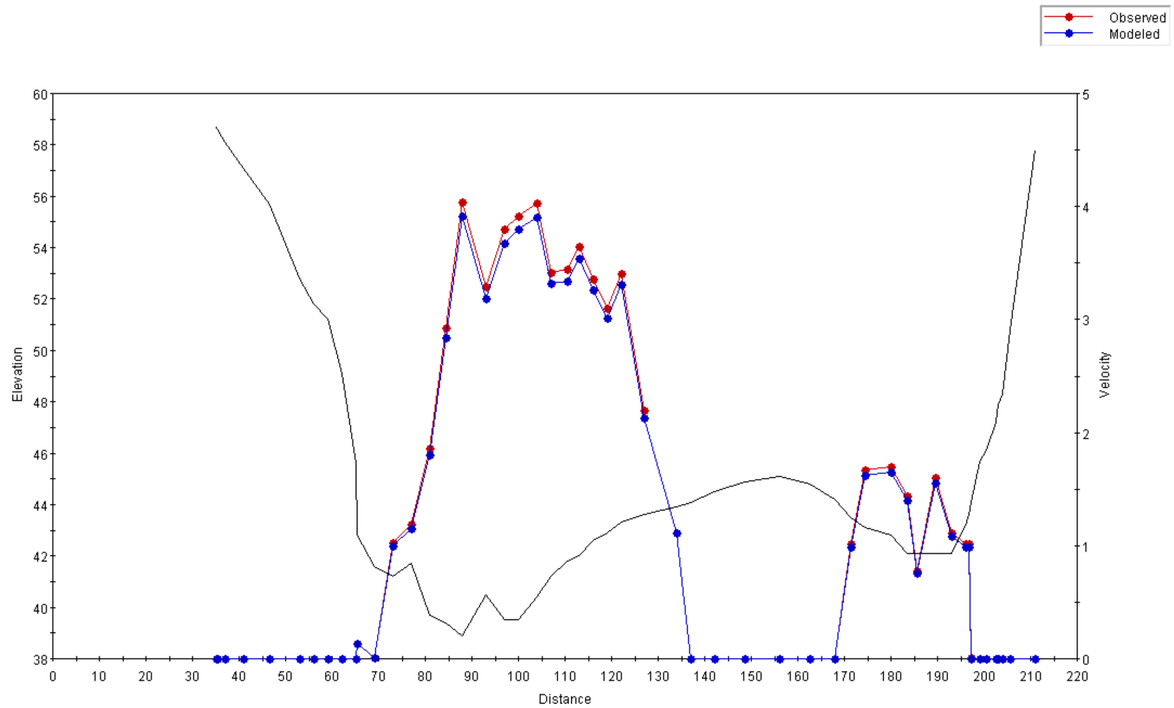
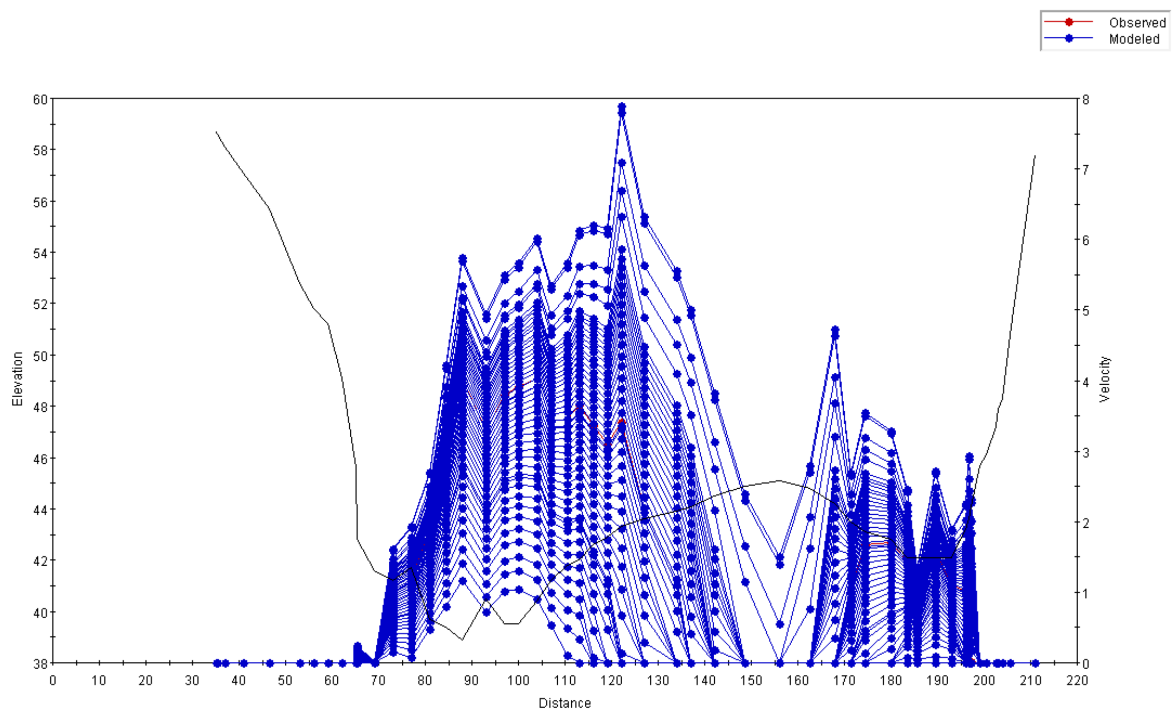
Guadalupe River at Victoria





Victoria – Cross Section 1

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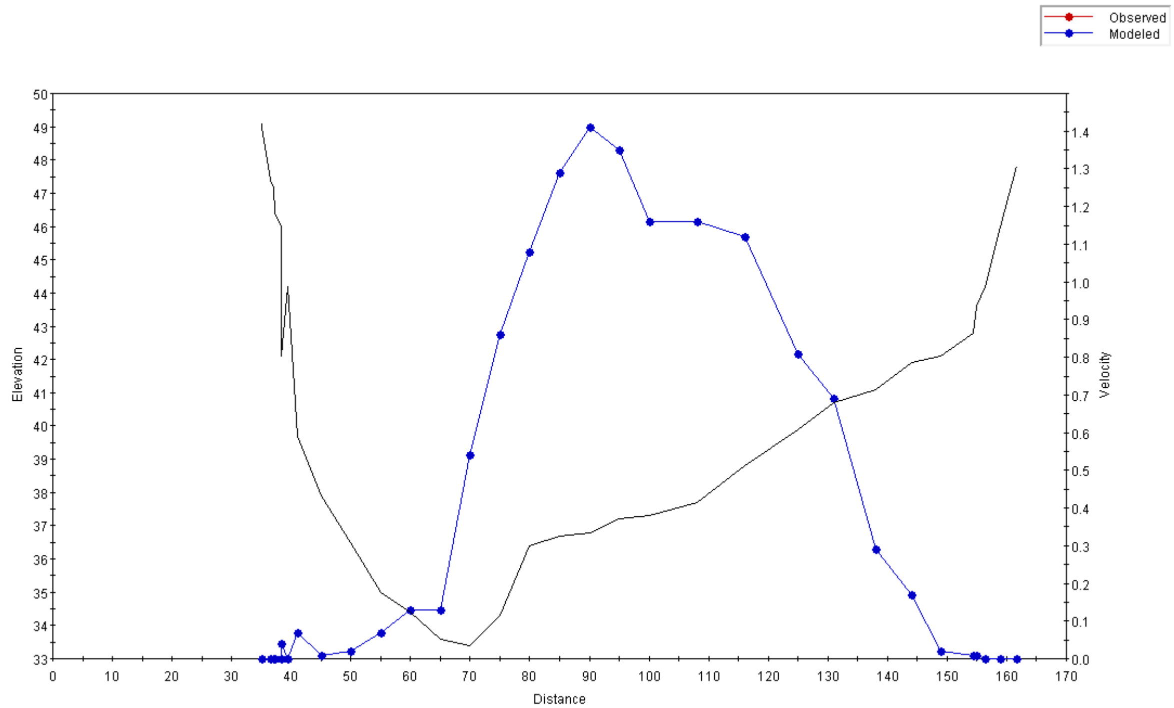

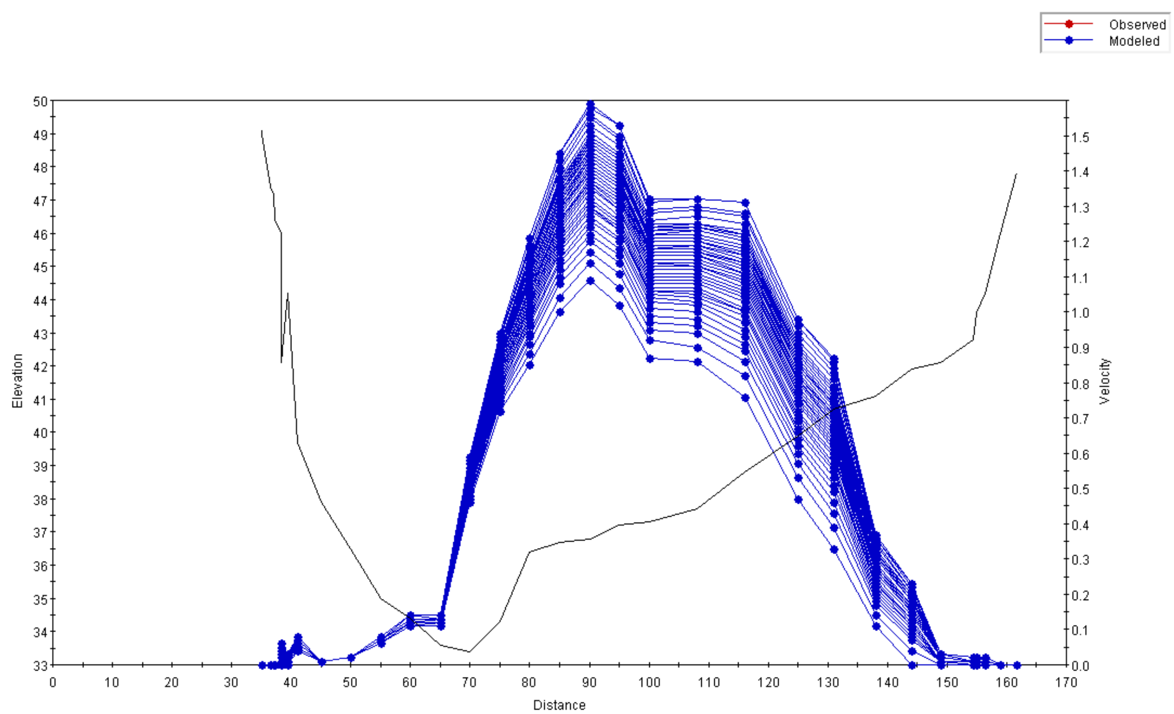

Victoria – Cross Section 2

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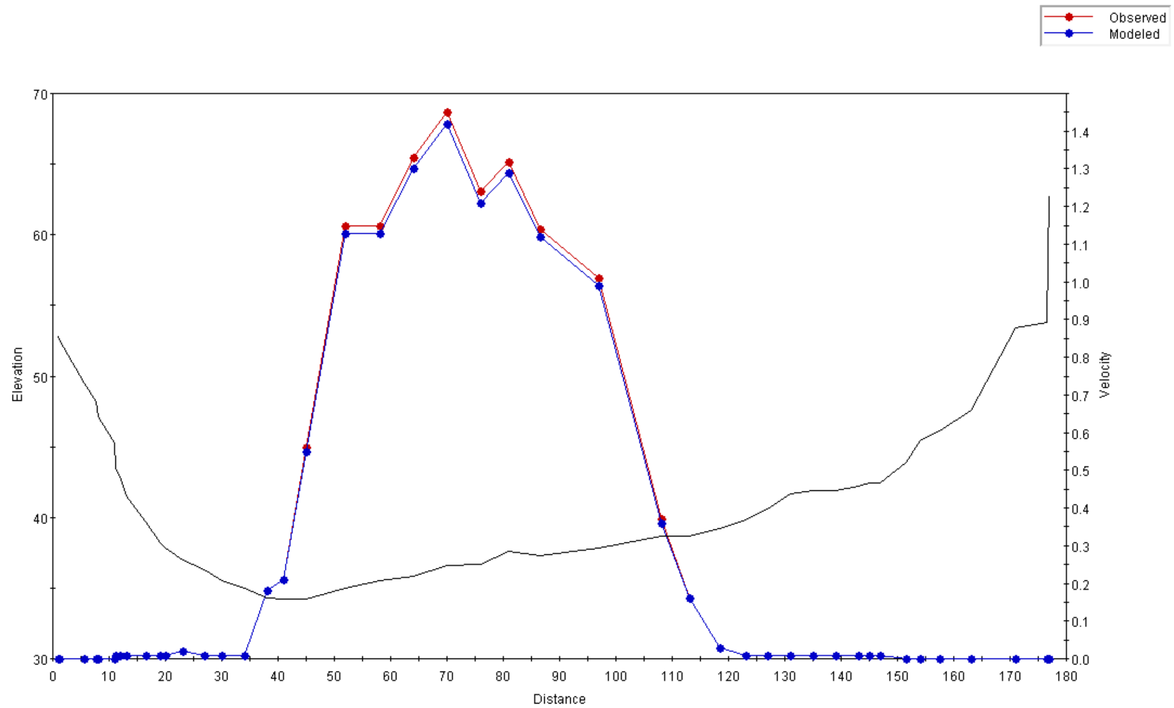

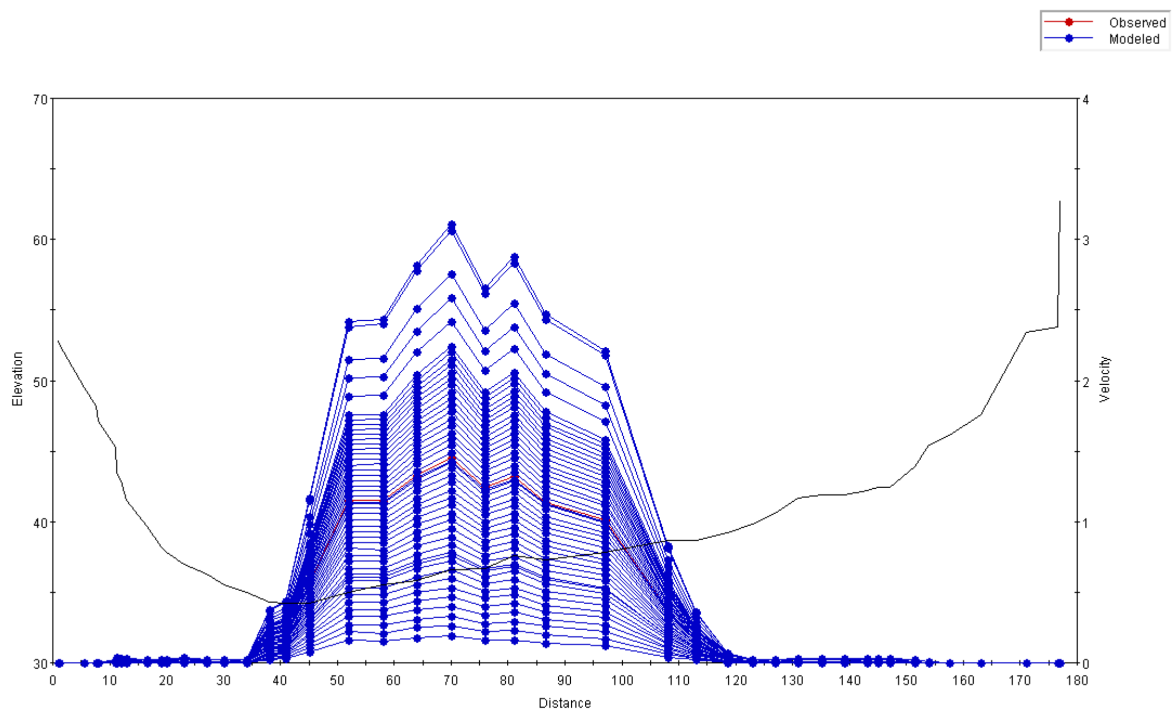

Victoria – Cross Section 3

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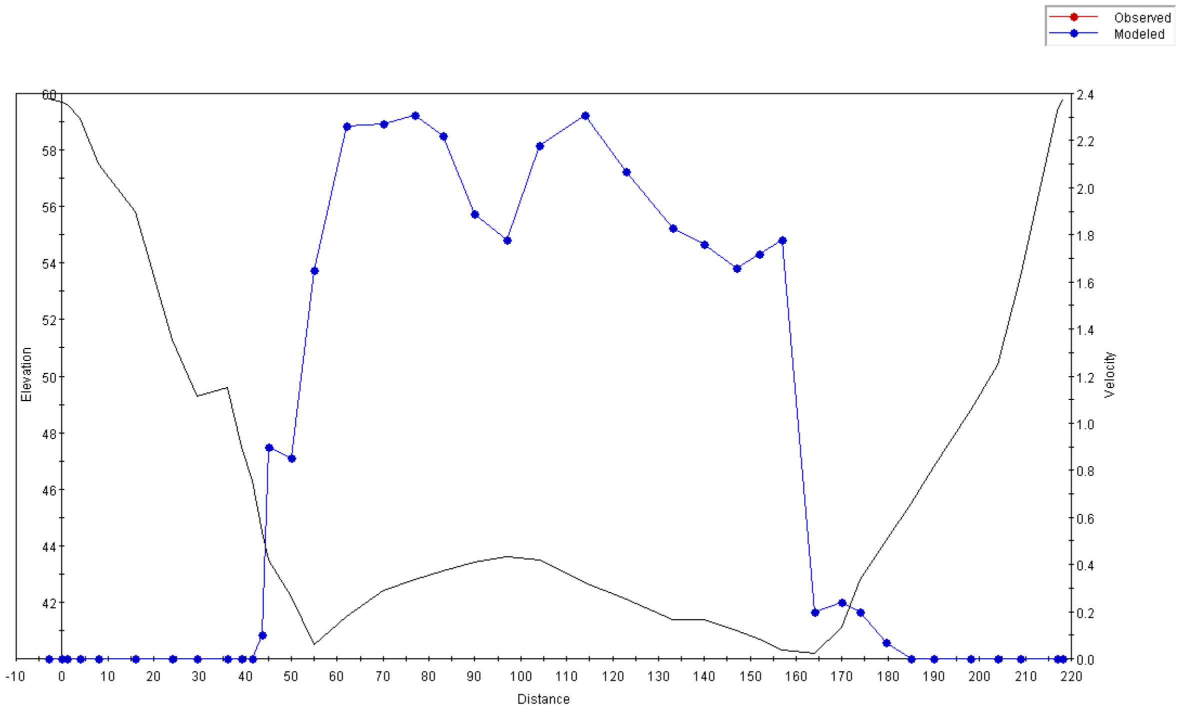

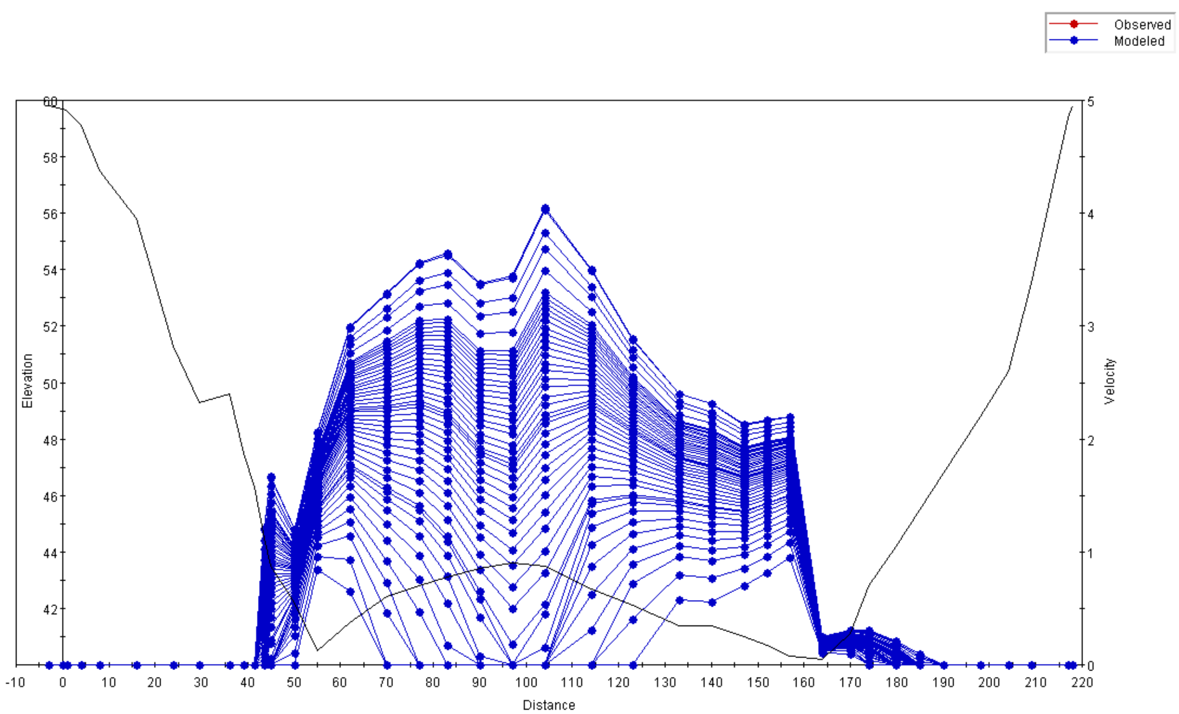

Victoria – Cross Section 4

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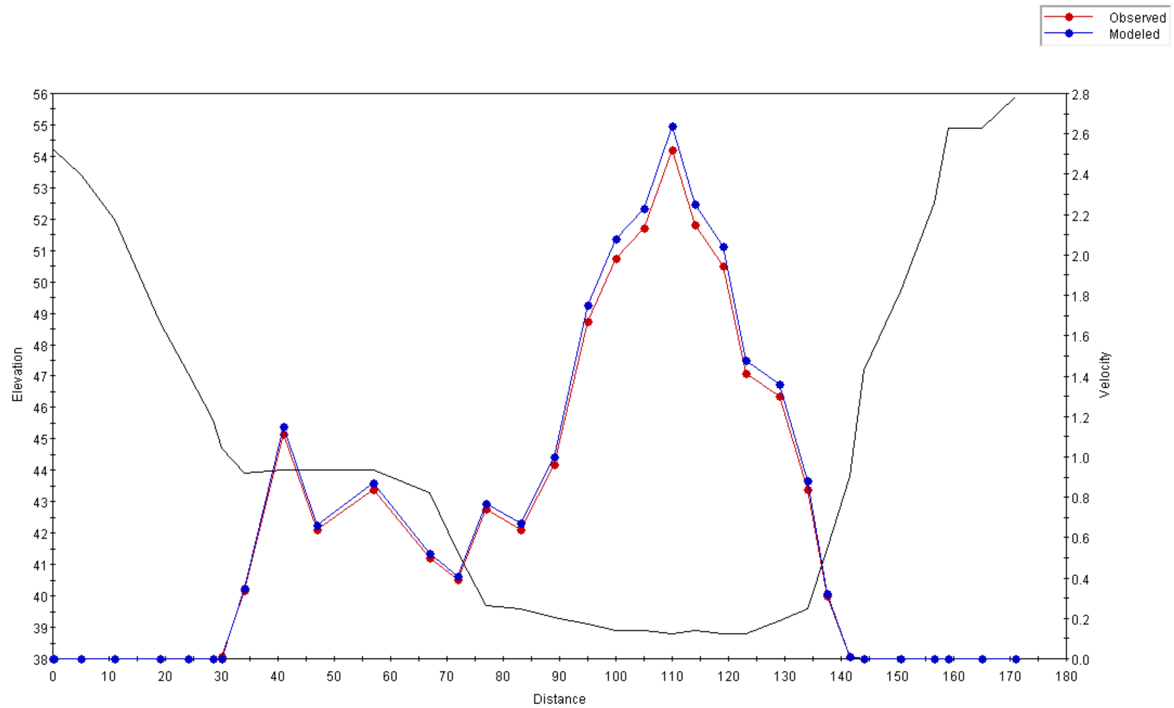

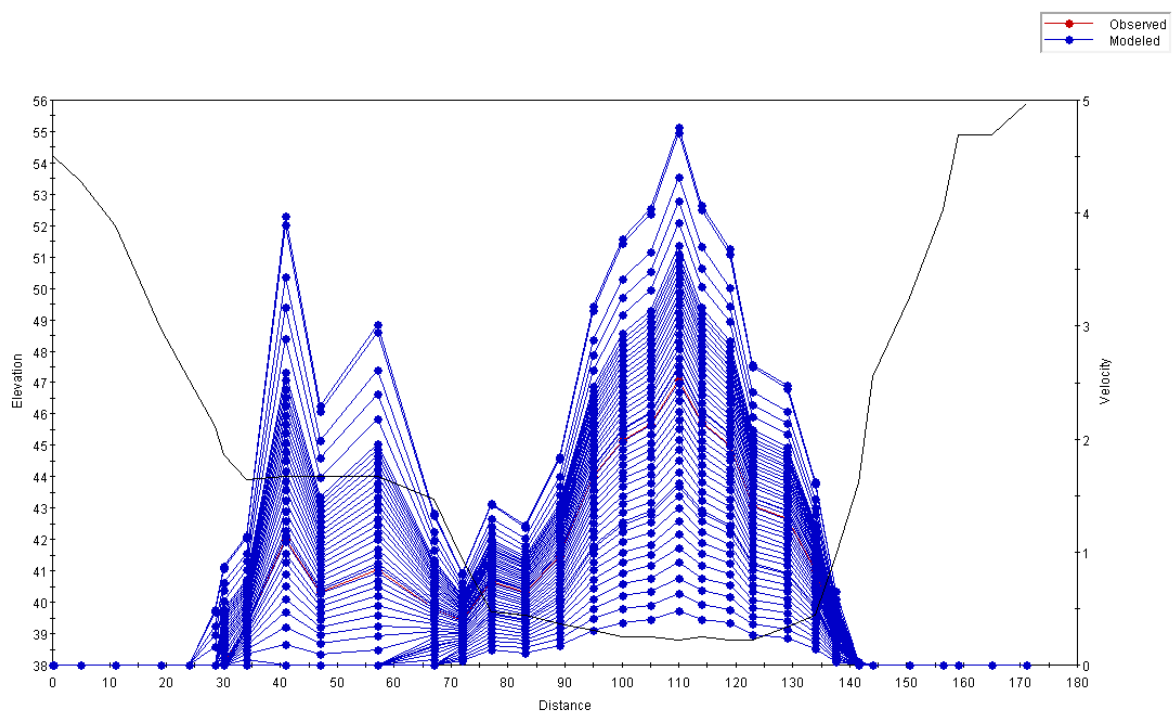

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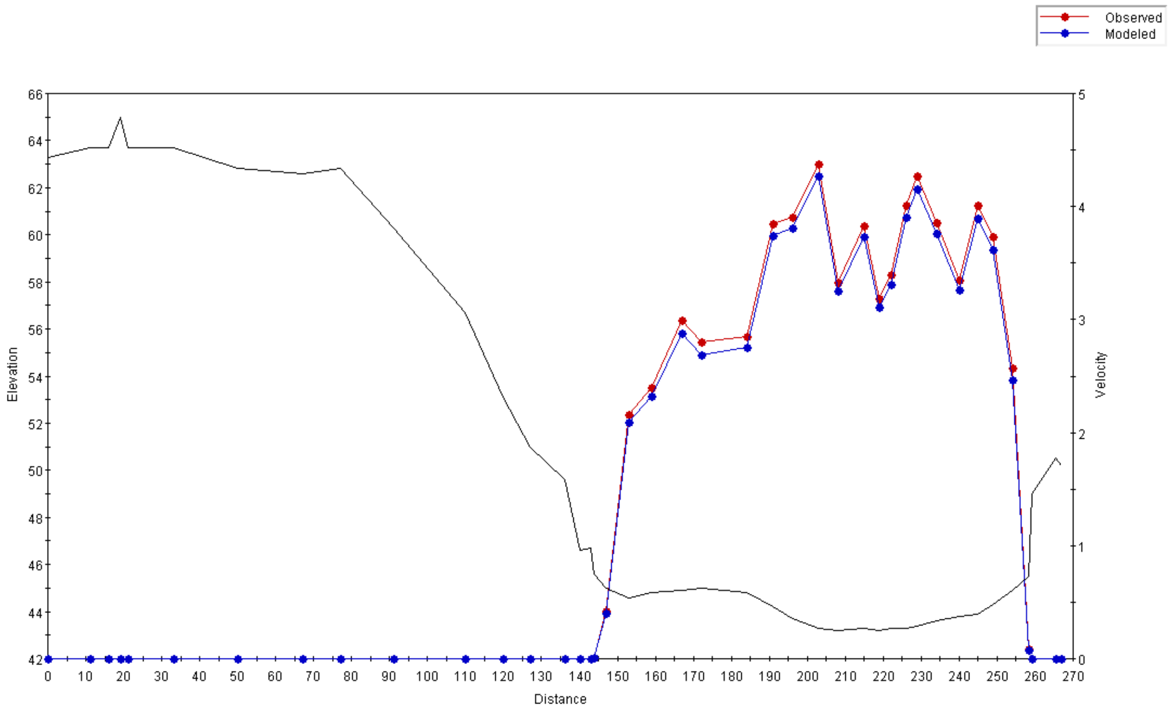

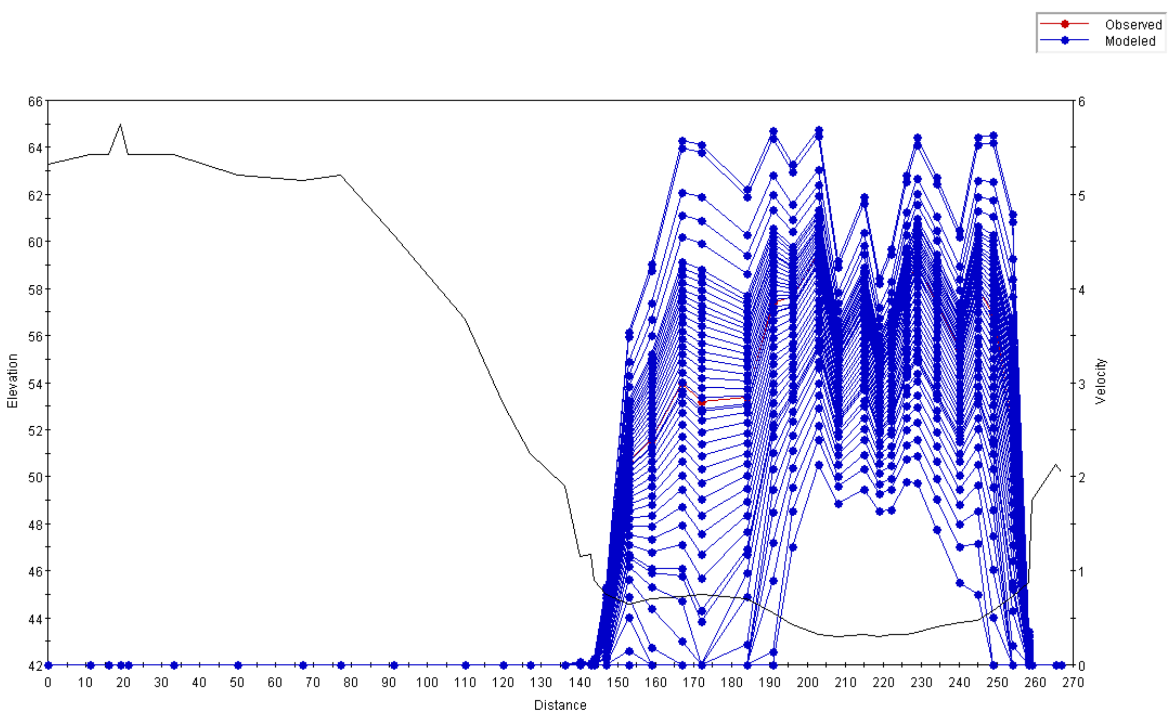

Victoria – Cross Section 6

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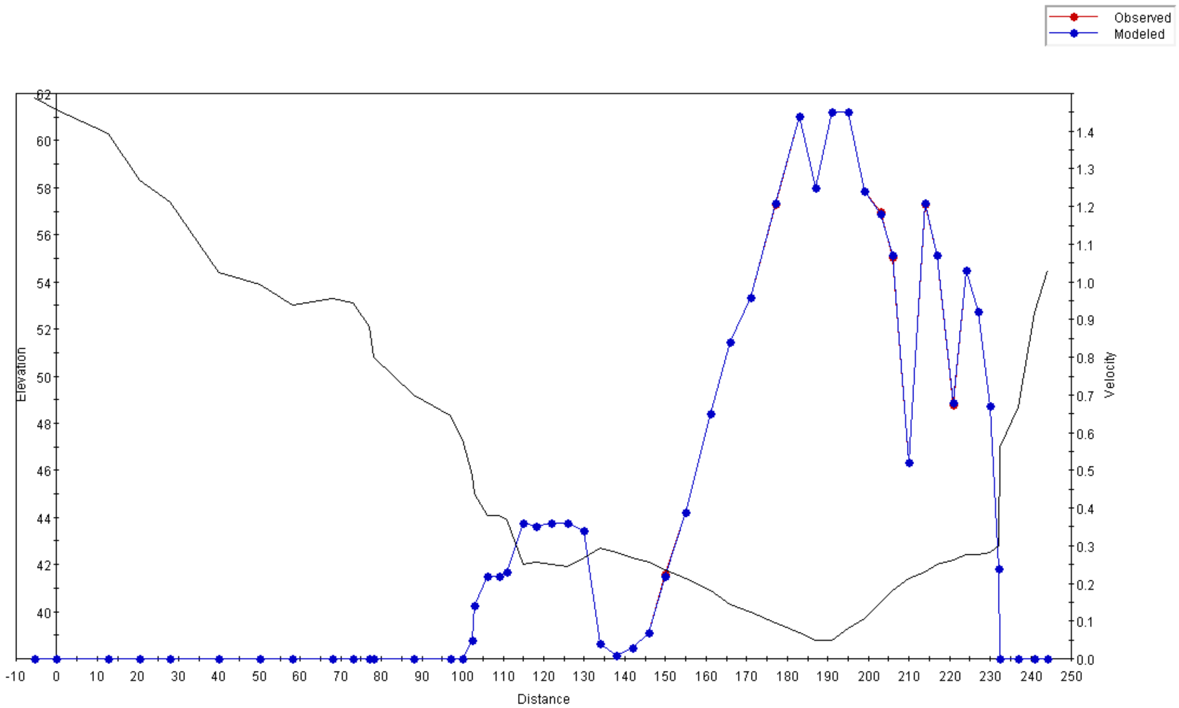

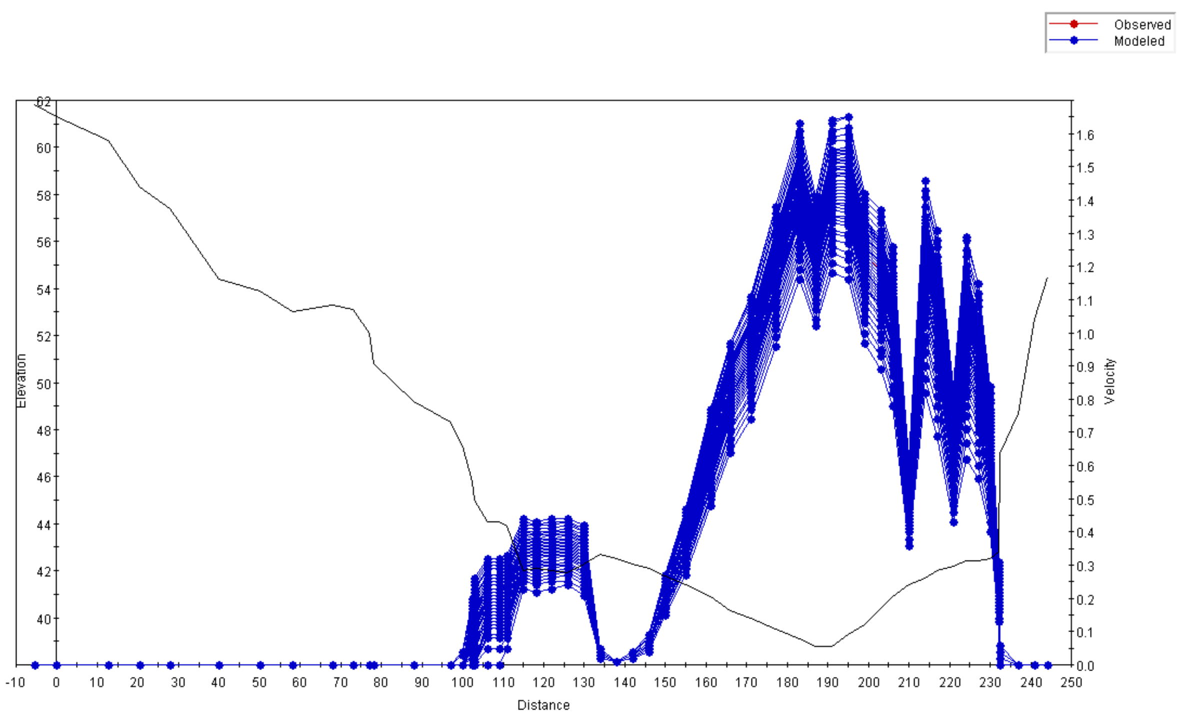

Victoria – Cross Section 7

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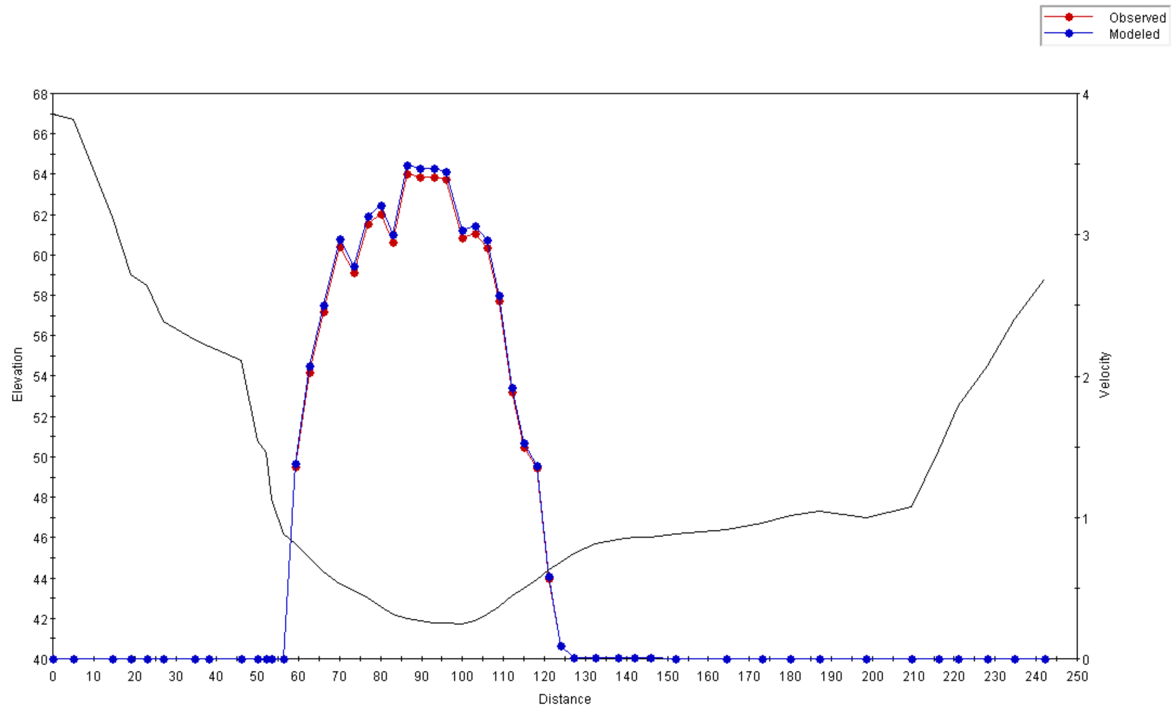

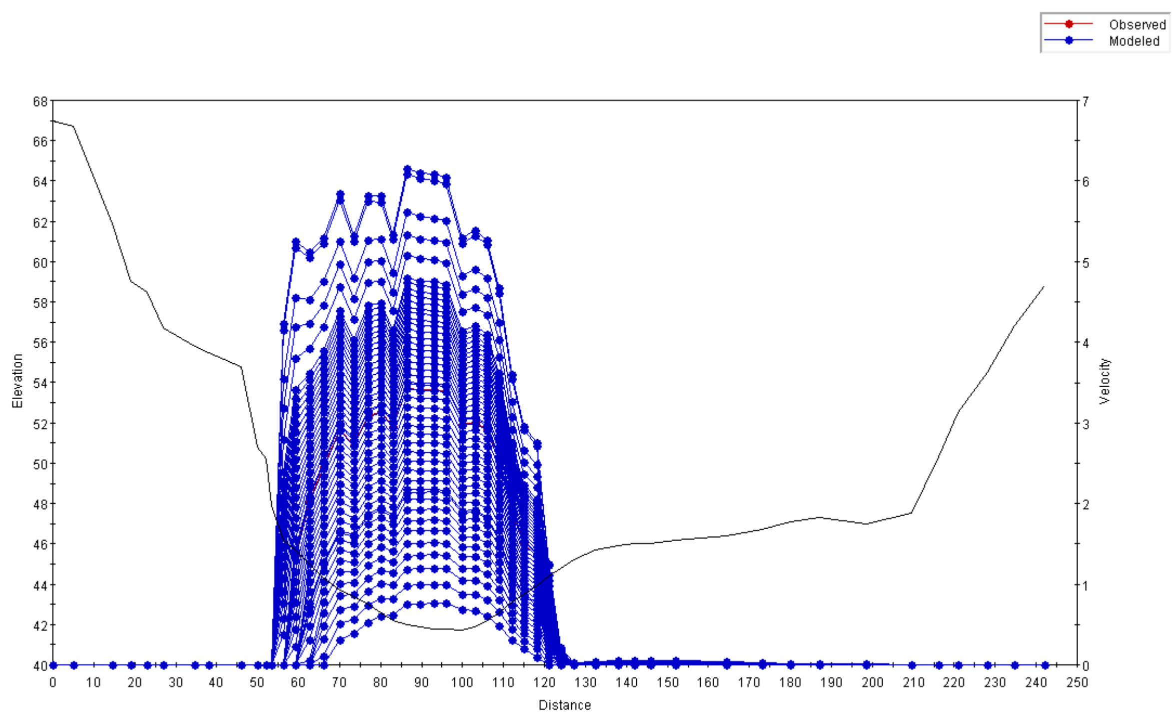

Victoria – Cross Section 8

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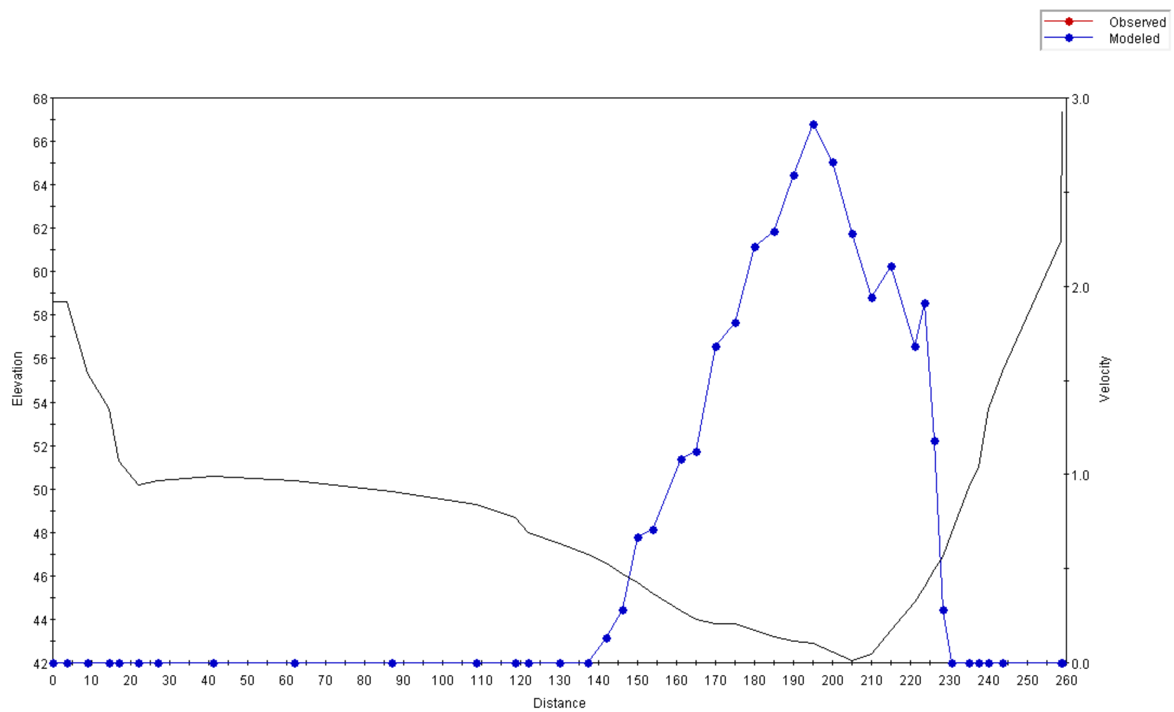

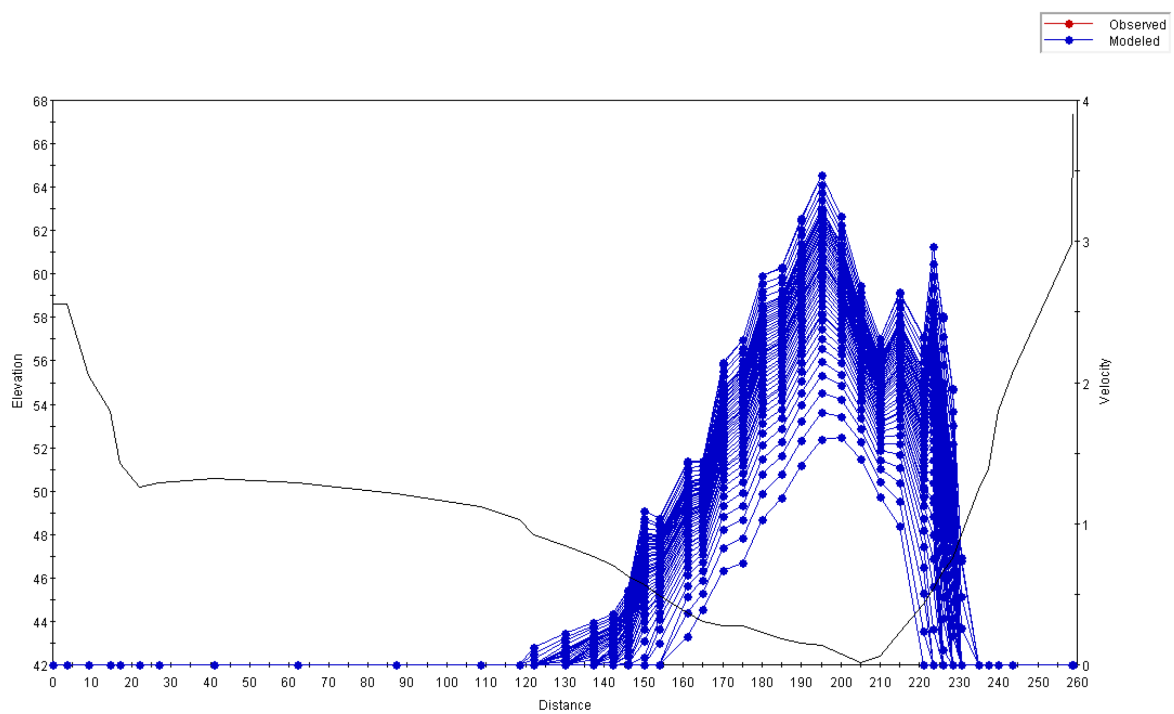

Victoria – Cross Section 9

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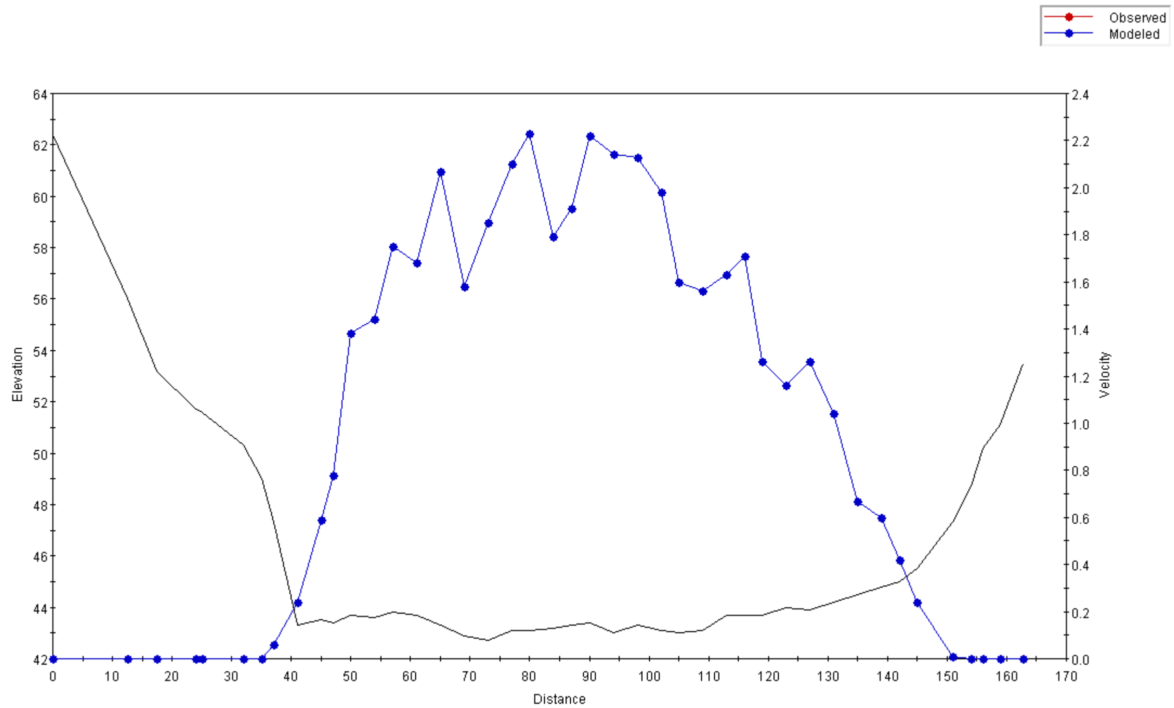

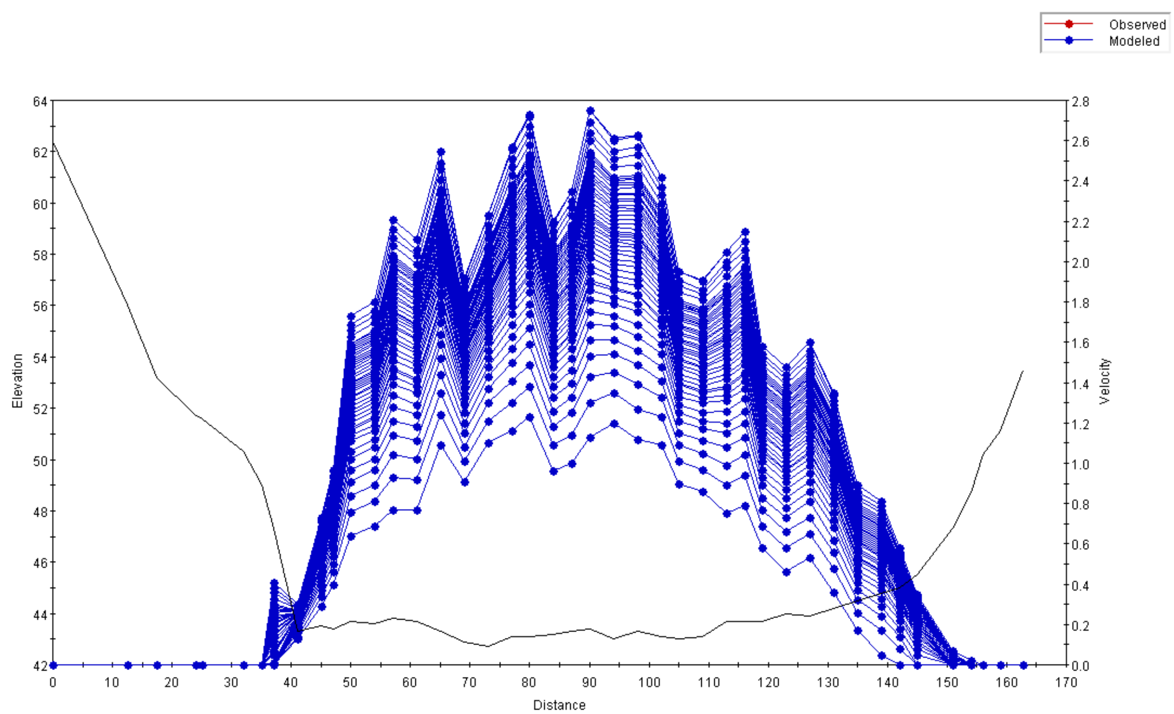

Victoria – Cross Section 10

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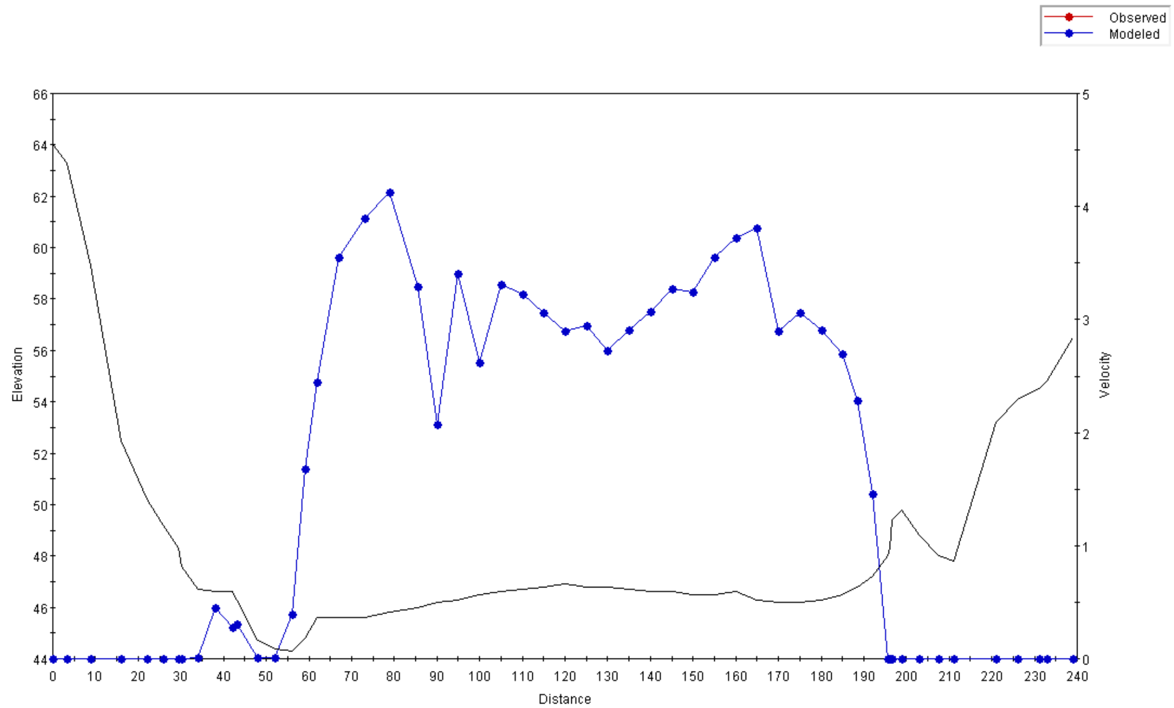

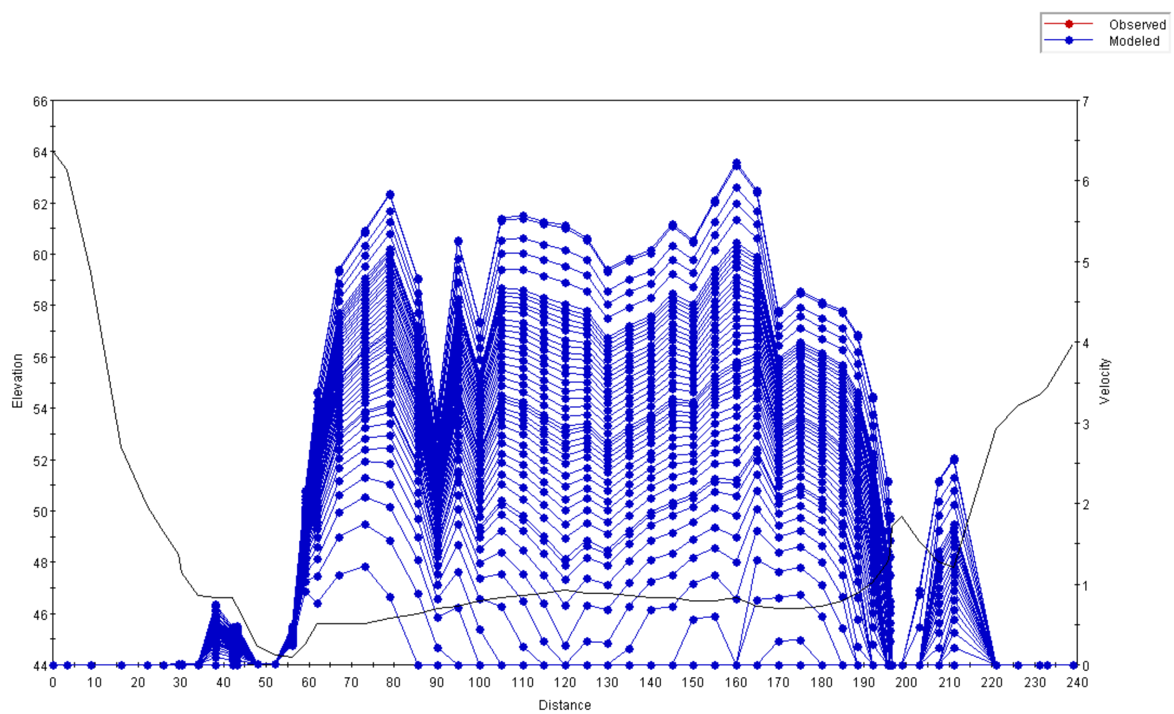

Victoria – Cross Section 11

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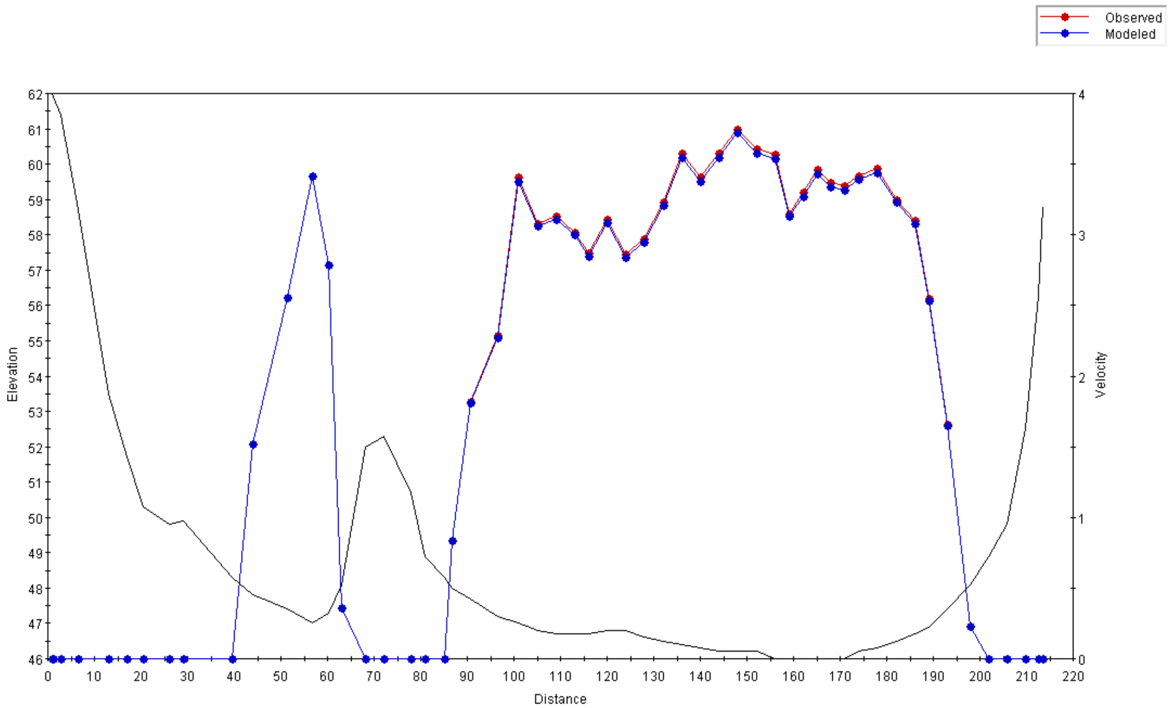

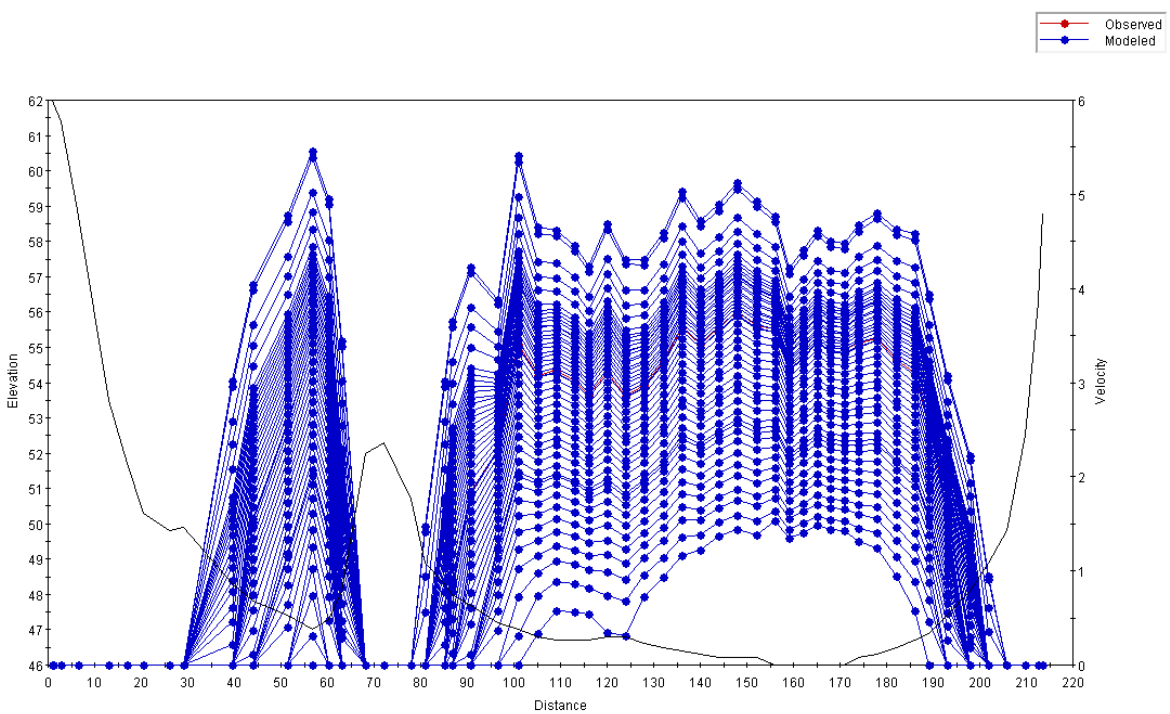

Victoria – Cross Section 12

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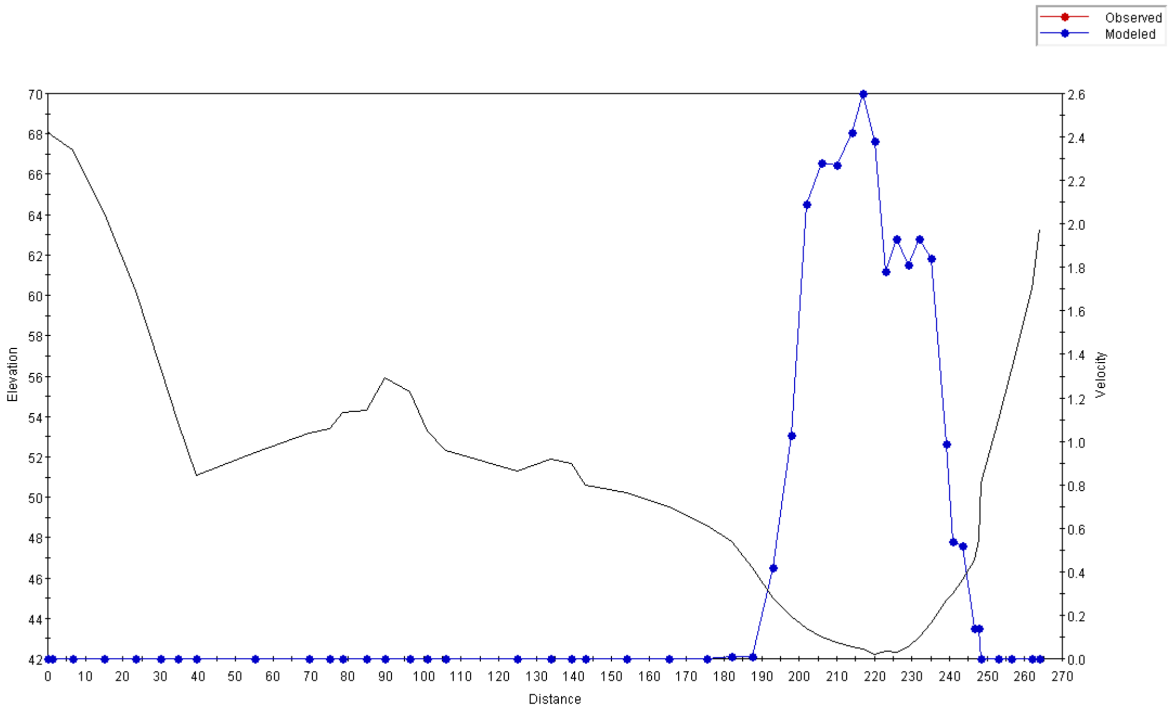

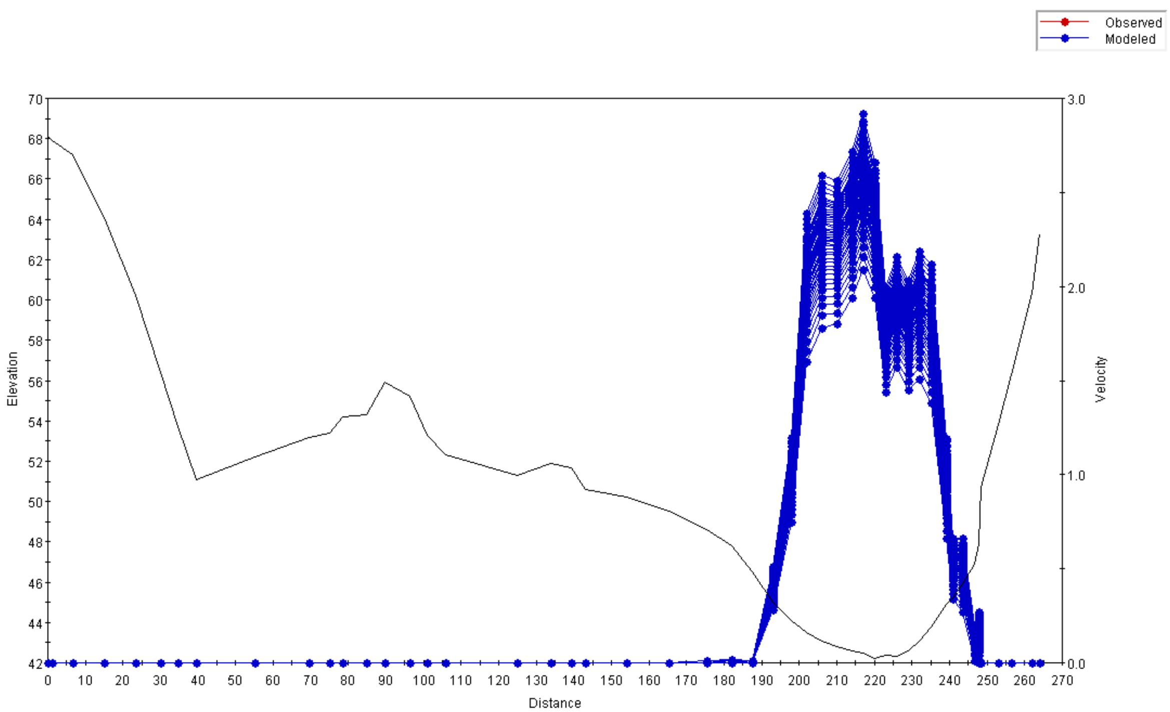

Victoria – Cross Section 13

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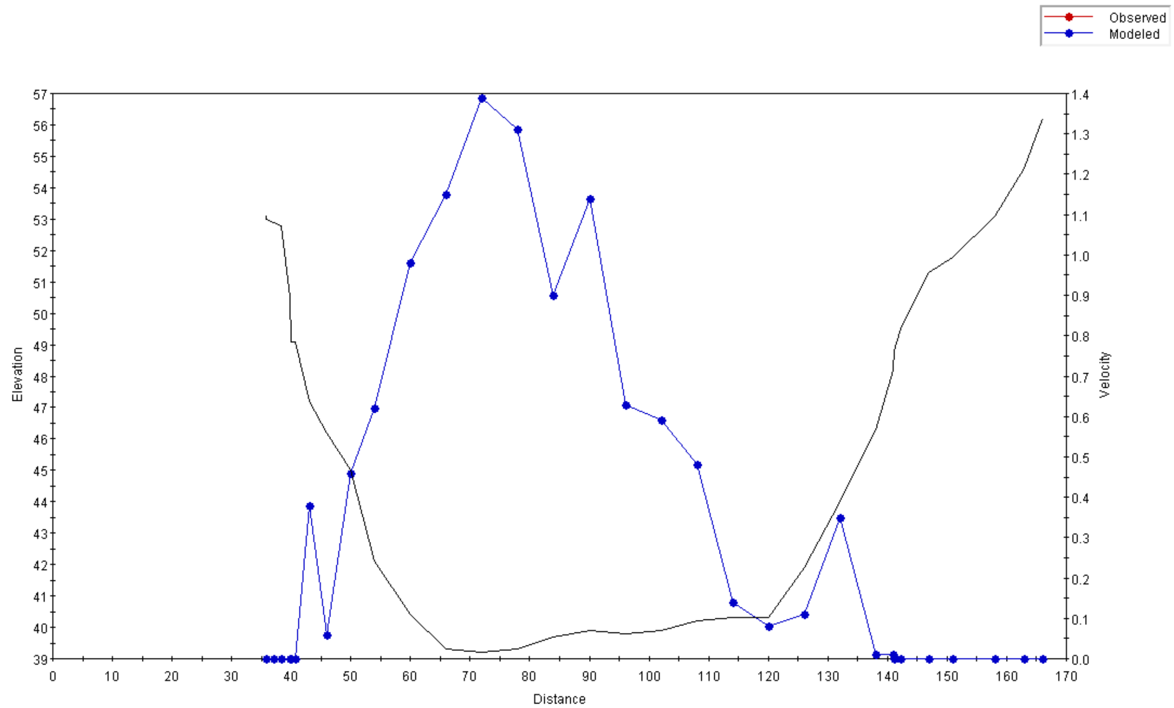

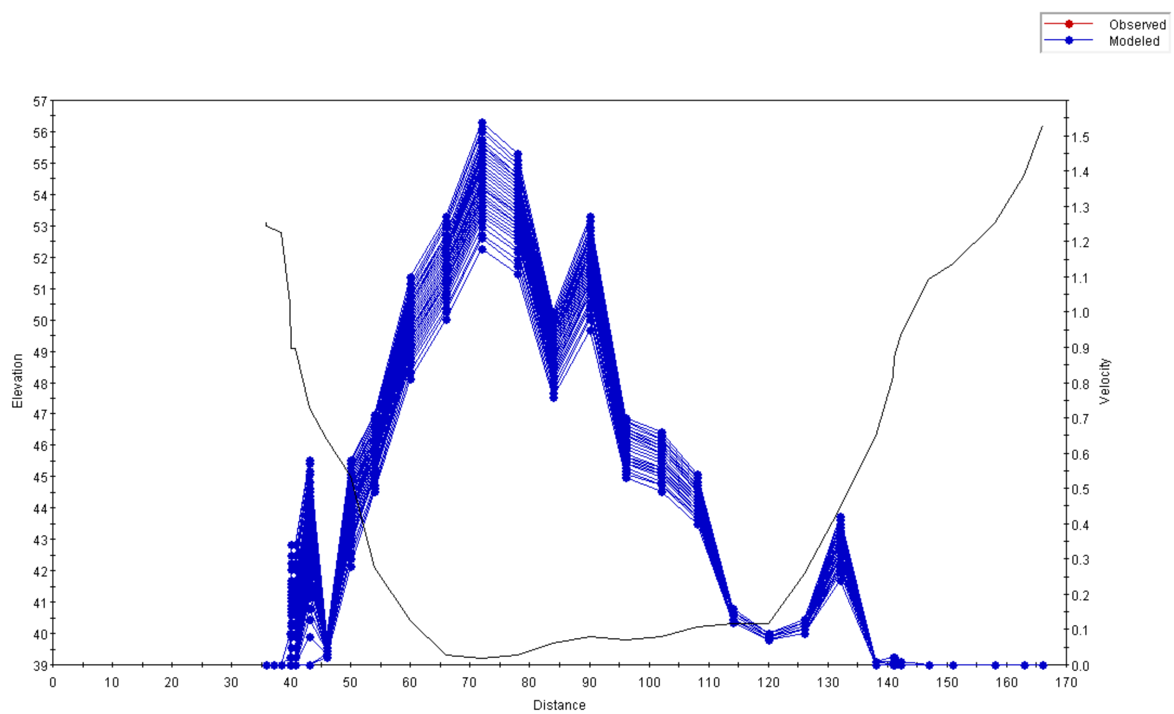

Victoria – Cross Section 14

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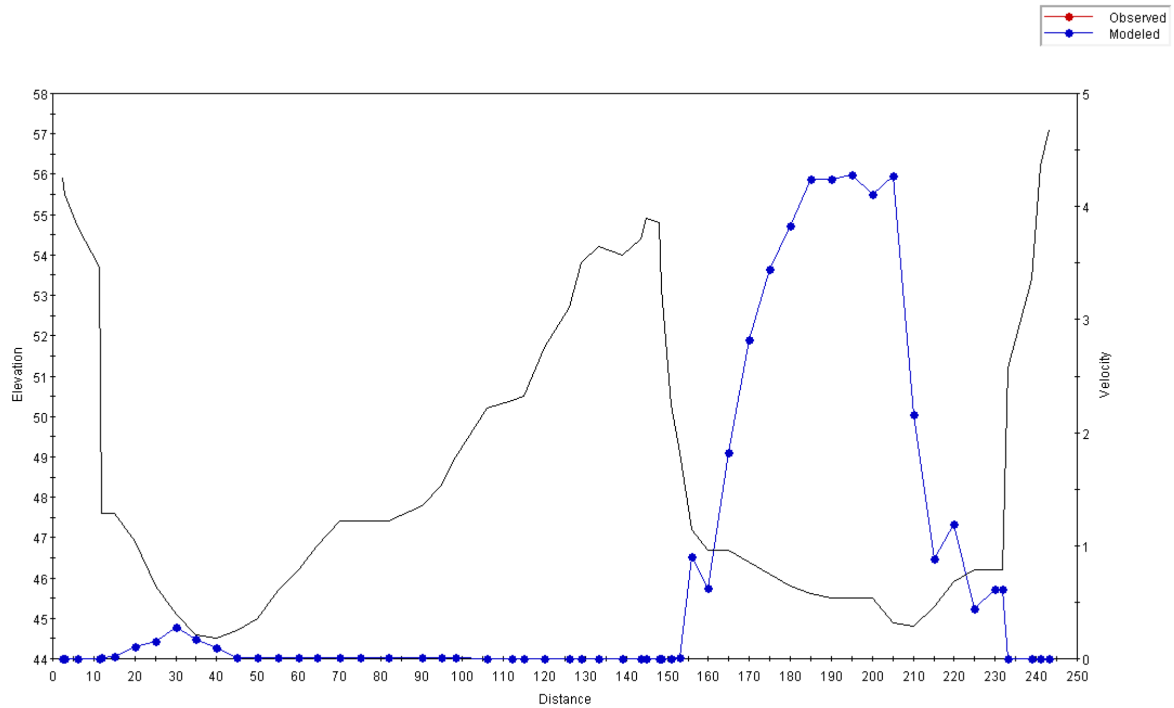

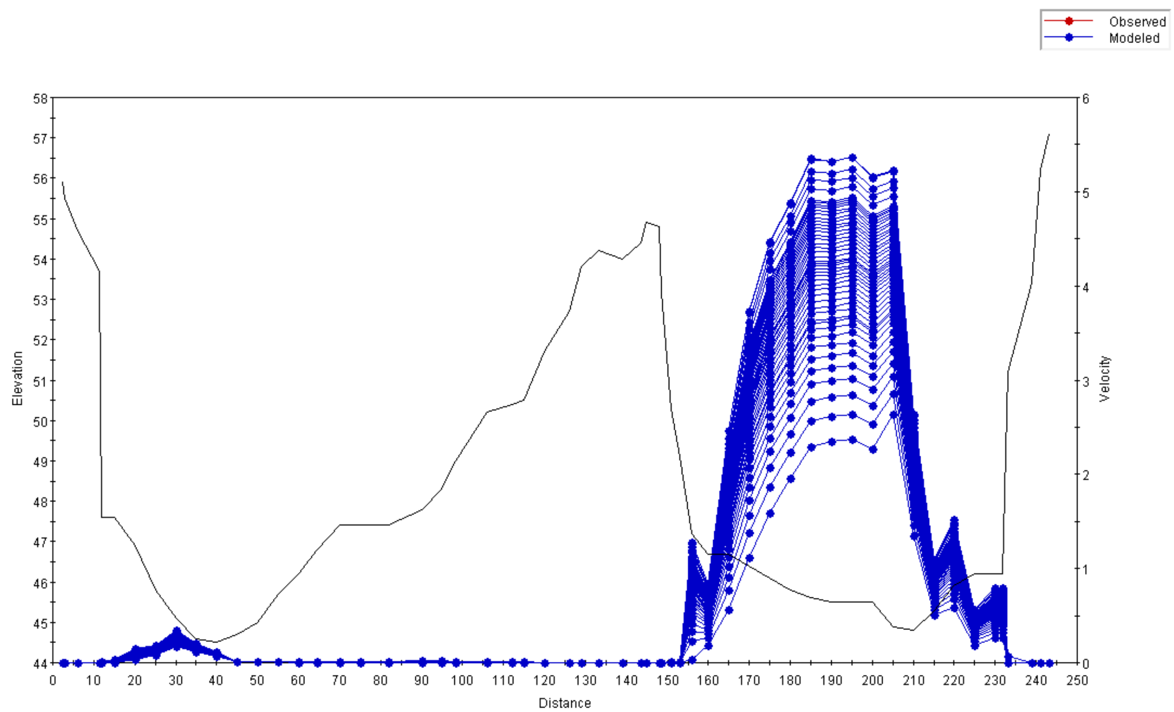

Victoria – Cross Section 15

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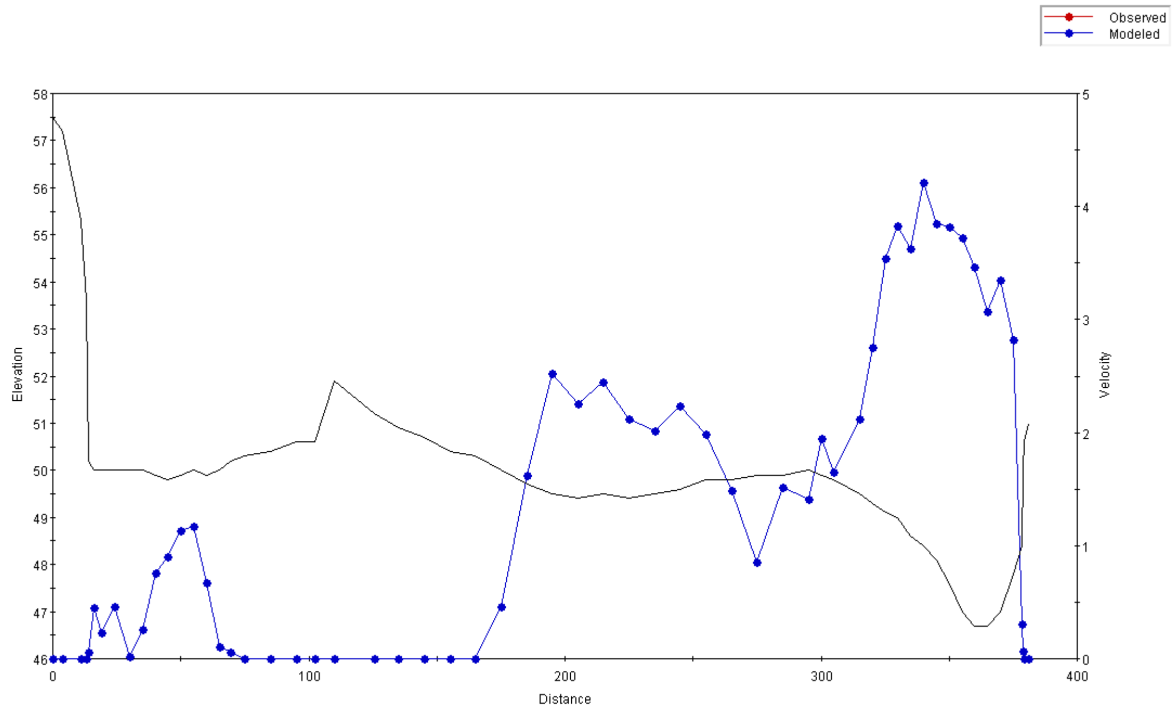

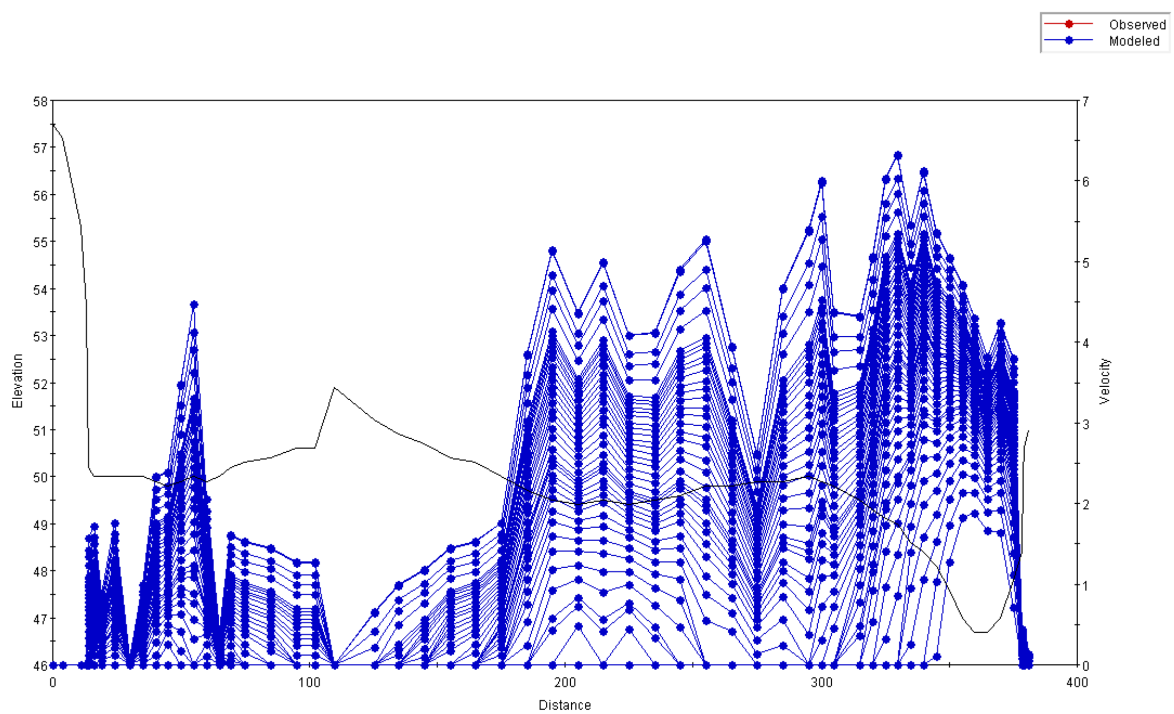

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Appendix G

“Biological and Ecological Implications of Non-Attainment of the BBEST Guadalupe Estuary Criteria,” Report by the GSA BBEST Estuary Sub-Committee

Biological and Ecological Implications of Non-Attainment of the BBEST Guadalupe Estuary Criteria

Report to the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee

by

The Estuary Subcommittee
of the
Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Expert Science Team

July 4, 2011

Members of the Estuary Subcommittee

Warren Pulich – Subcommittee Lead
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Norman Johns
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The Stakeholder Committee Request of the BBEST

On March 1, 2011 the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Expert Science Team (GSA BBEST) published and delivered to their Stakeholder Committee (GSA BBASC) a multi-tiered suite of recommended freshwater inflow criteria for the Guadalupe Estuary and the Mission-Aransas Estuary. In the course of the Stakeholder Committee efforts to find a balance between environmental goals and human water supply needs, they tasked the Estuary Subcommittee of the BBEST with evaluating the biological and ecological implications of some scenarios in which the recommended criteria could not be fully met. This report present the findings of the Subcommittee and represents the consensus opinion of that group.

Background, the Criteria, and Scenarios of Non-Attainment

The estuary criteria consist of a multi-tiered suite of inflow volumes, each with an associated frequency of attainment. There are two principal subsets of criteria, one covering the February-May spring period and another covering the summer June-September months. While the BBEST inflow criteria covered both the Guadalupe and Mission-Aransas Estuaries, the interconnected nature of the two estuaries allowed for a focus on the Guadalupe with only minimal independent inflow recommendations for the Mission-Aransas Estuary. For ease of reference, these criteria, as they appear in Section 6 of the BBEST report, are repeated in the BBEST Criteria Synopsis at the end of this document.

Shortly after publication of the BBEST criteria, the Stakeholder Committee tasked BBEST member Dr. Norman Johns with performing several "time series" analyses with regard to the ability to satisfy these recommendations, under several scenarios of water use. In results presented on April 19, 2011, it became apparent that there are some scenarios which exhibited non-attainment of portions of the criteria (more below). Given the charge of the Stakeholder Committee to strive for a balance between environmental goals and human water supply needs, the Estuary Subcommittee of the BBEST was also tasked with evaluating the biological and ecological implications of the scenarios which exhibited non-attainment of the criteria. The focal points of the evaluations herein have been limited to the Guadalupe Estuary criteria due to time and budget constraints.

Biological and ecological underpinnings of the criteria[1]

While the tables at the back of this document serve to summarize the BBEST criteria, in order to adequately communicate our assessment of the implications of non-attainment, it is necessary to briefly review the biological and ecological underpinnings of the inflow recommendations. As mentioned, there are two principal subsets of criteria, one covering the February-May spring period and another covering the summer June-September months. Both criteria sets were

[1] This report, by convention, will not specifically cite the scientific literature if the point being made is already supported in the BBEST report.

derived based on a single “indicator” specie’s apparent salinity requirements during some portion of their life-cycle, based on thorough review of the scientific literature. The springtime criteria are based on *Rangia* clams and the summer on Eastern oysters, the latter a source of an important commercial fishery.

Although these select “indicator” species formed the basis for the development of inflow recommendations, it is anticipated that through this approach other species and indeed other ecosystem components will also be maintained. This concomitant maintenance may be exhibited through several channels, the most direct of which would be supporting other species that prey upon the indicator, as is the case for *Rangia*, especially. Literature indicates that a variety of waterfowl, fish , and crustaceans utilize *Rangia* as food source. In the case of *Rangia* and oysters both, they also offer broad ecosystem benefits as filter feeders capable of turning detritus and plankton into biomass, as well as offering some reduction in turbidity of the estuary waters. Oysters in particular, because of their reef-forming characteristics, also provide other habitat benefits for other fish and crustaceans.

For the Guadalupe Estuary, the BBEST derived the “G1” criteria set covering principally the March-May spring period, with a requirement for February in a lower portion of the criteria suite (the G1-C and G1-CC levels). These criteria are based on the reproductive requirements of the *Rangia* clam which, according to data collected by Texas Parks and Wildlife Department (TPWD), are abundant in the northern portion of the estuary, nearest the freshwater source of the Guadalupe River. The literature on *Rangia* indicates that in order to successfully reproduce the clams must have salinities in the range of 2-10 part per thousand[2] (ppt) for about 20 days continuously.

The GSA BBEST criteria set G1 provides a range of inflows covering from near optimal reproductive conditions for the entire 3-month season, the G1-A level, to inflows that are only sufficient to support reproduction for 1 month in a very reduced area near the Guadalupe River mouth. This range of inflow criteria and the associated areas and durations supporting *Rangia* reproduction are illustrated in Figure 1 in several panels. These figures illustrate the same information embodied in BBEST report Table 4.5-3, but portrayed in a map format.

The GSA BBEST also developed a “G2” suite of inflow criteria covering the summer period, principally July-September, but with a requirement for June in some lower levels of the suite (G2-C and G2-CC). This set of criteria are based on the BBEST’s analyses of available literature on the requirements of oysters. Unlike *Rangia*, with the sharp edged 2-10 ppt range for reproductive success, the requirements of oysters related to salinity are more of a continuum with an optimal range of 10-20 ppt as shown in Figure 2 (a repeat of 4.4-2 in the BBEST report). As detailed in Section 4.3.1.1 of the BBEST report, oysters themselves are tolerant of a wide range of temperatures and salinities, but predation and disease problems occur at higher salinities. The

[2] Also called practical salinity units (psu). Full strength seawater is generally 35 ppt.

primary predator is the southern oyster drill and the primary disease is Perkinsus marinus, commonly called ―Dermo, with the later described as the primary limiting factor in oyster health. Both of these predators and disease organisms are limited by low salinities (<10 ppt) and increase with high salinities (>20 ppt).

Figure 3 illustrates the salinities that would prevail over the Guadalupe Estuary oyster habitat area across a broad spectrum of inflows within the BBEST recommended levels (G2-A, -B, -D, and -DD). Thus the multi-level BBEST recommendations for summer cover a broad range of salinity suitability for oysters.

Both the G1 and G2 suite of criteria cover a broad range of inflows, salinity, and biologic suitability conditions for their respective organisms. It is also important to bear in mind that the various levels of inflow the BBEST recommended do represent inflows that have occurred in the historic period (1941-2009 in the BBEST analyses). The attainment goals spelled out in Table 6.1-18 (and in the BBEST Synopsis at rear) vary with regard to how much departure was recommended from the historical levels. In the professional judgment of the BBEST, the upper levels of G1 and G2 criteria (G1-A, G1-B, or G2-A and G2-B), representing good conditions for *Rangia* and oysters, respectively, could decline over a long period of time by up to 25% and still likely provide for a sound ecological environment. However, the BBEST also felt that the lowest levels of both criteria suites (G1-D and G2-D & G2-DD, together) which represent periods of limited reproductive success for *Rangia* and significant disease and parasite problems for oysters, respectively, should not be allowed to increase beyond historic levels.

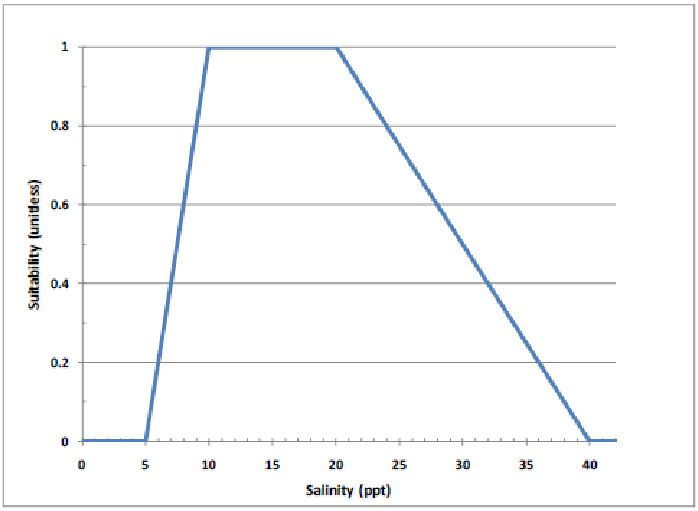


Figure 4.4-2. The salinity suitability curve for Eastern oysters utilized in the salinity zone analyses in the Guadalupe and Mission-Aransas Estuaries. An index of 1.0 indicates optimum salinity conditions and 0 indicates very bad conditions. This curve is from Cake (1985).

Figure 2 - Illustration of the salinity suitability curve for oysters as utilized by the BBEST.

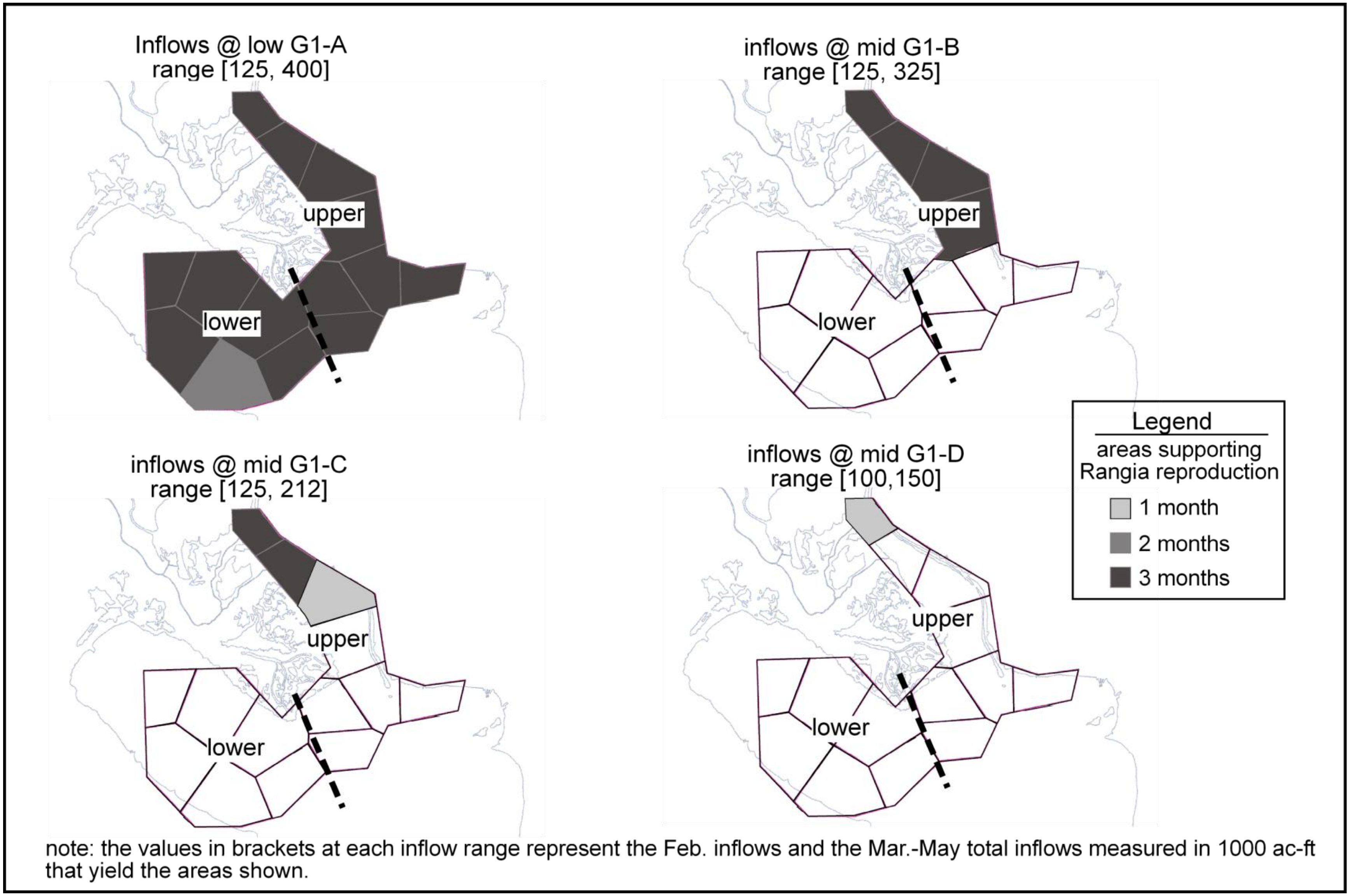


Figure 1- Illustration of the area the of the Guadalupe Estuary supporting *Rangia* reproduction under several levels of inflow as per the BBEST recommended G1 criteria. Salinity in the “upper” area is tracked in later figures.

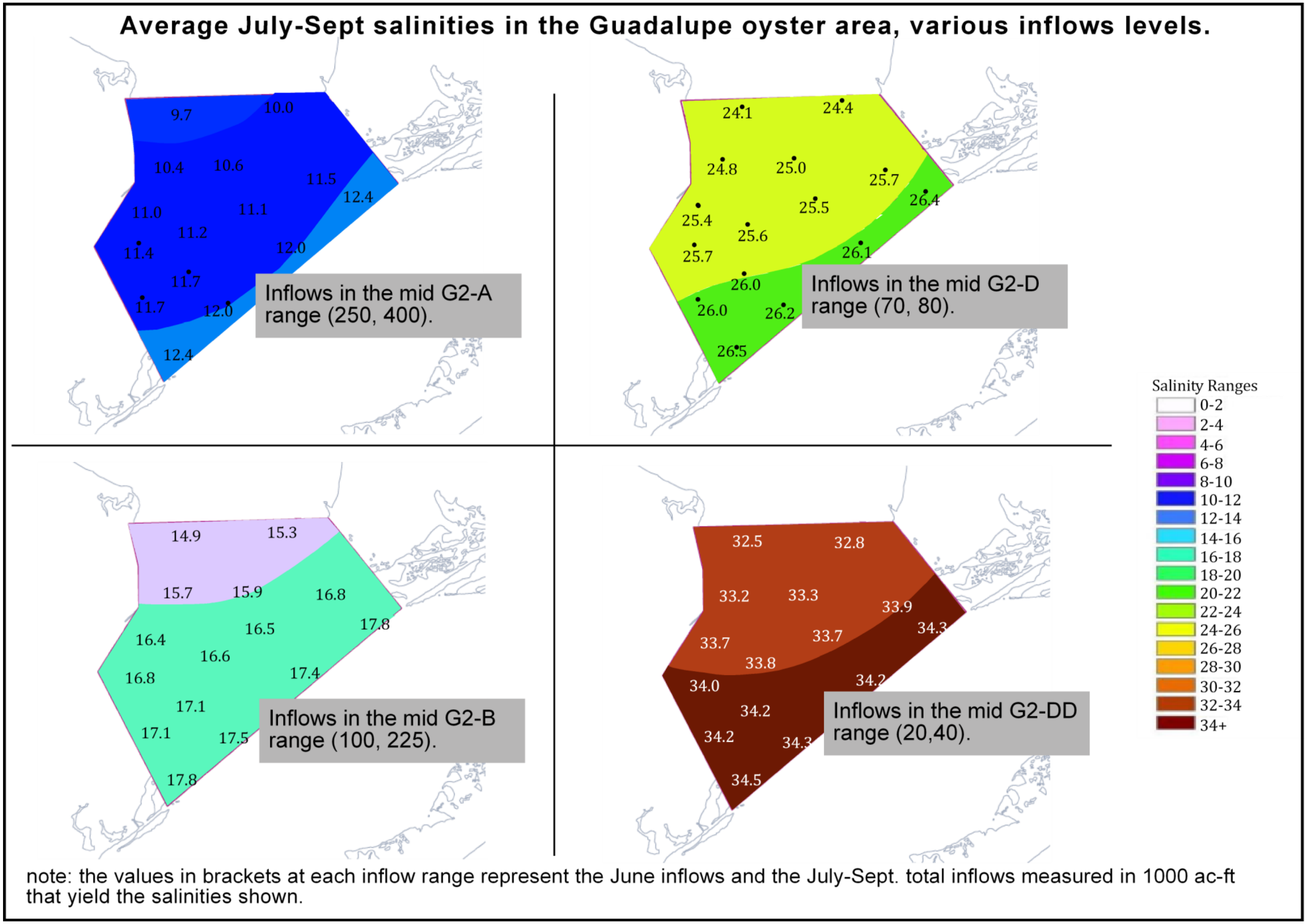


Figure 3 Illustration of the large range in salinities (average for July-Sept.) that would prevail over the oyster-rich area of the Guadalupe Estuary under the G2-B and G2-DD levels of inflow as per the BBEST recommendations.

Scenarios and Non-Attainment Characteristics

The scenarios that the Stakeholder Committee have been evaluating are listed in Table 1 along with some principal characteristics of each. The Estuary Subcommittee's determinations of biological and ecological implications of any incidences of non-attainment are, of course, inextricably linked to the particular time-series sequence of flows of these scenarios.[3] As indicated in Table 1, there are very specific attributes of each scenario such as the assumed future wastewater discharges and utilization of existing water rights and other assumptions of the Region L Baseline WAM utilized at the time of evaluations. Furthermore, the "with project" scenario inflows are also based on conditions that include: modeled new project infrastructure constraints (diversion rate and off-channel reservoir size) and the fact that the project was subject to the full suite of BBEST instream criteria, including three base flow levels and a five-tiered pulse requirement at the diversion site. Since any conclusions that the Estuary Subcommittee may reach are directly conditioned upon these assumptions and the resulting sets of inflow time-series, we felt it necessary to document the exact inflows that we used in our evaluations. These appear in a series of tables in the Appendix.

Table 2 for the G1 criteria covering the springtime months (Feb. -May) and Table 3 for the G2 summer time criteria (June-Sept.) summarize the characteristics of attainment and non-attainment for each scenario. The cells highlighted in red indicate criteria that the particular scenario does not meet at levels that are cause for concern with regard to the ability to sustain a sound ecological environment. It is apparent that most instances of non-attainment are concentrated in the future scenarios (below "Present" in Tables 2 and 3) that entail full use of existing water rights permits and/or loss of wastewater as in TCEQ Run3. Also, the incidences of non-attainment are concentrated in the lower tiers of the criteria (G1-D, G2-CC, G2-D and G2-DD).

[3] As are Stakeholder determinations of available project yields, cost, etc.

Table 1 - Summary of the scenarios evaluated by the Estuary Subcommittee for attainment of the recommended Guadalupe Estuary inflow criteria.

	Scenarios						
						run-of-river diversion	
features	**Natural**	**Historical**	**Present use**	**Region L Baseline**	**TCEQ Run3**	**Goliad [San Antonio River project]**	**Gonzales [Guadalupe River project]**
Surface water use: - existing rights	n/a	historical, transient	max. 10yr, constant	Full use, constant	Full use, constant	Full use, constant	Full use, constant
new potential rights	n/a	n/a	n/a	n/a	n/a	subject to e-flow criteria	subject to e-flow criteria
WW Returns	n/a	historical, transient	min. 5 yr, constant	recent (2006) levels, constant	near 0, few permits with requirmt.	recent (2006) levels, constant	recent (2006) levels, constant
Edwards Aq. use / mgmt.	n/a	historical, transient	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.
Environmental flow requirements	n/a	limited, transient	recent permits mostly post 1985	recent permits mostly post 1985	recent permits mostly post 1985	recent permits & BBEST instream recomm.	recent permits & BBEST instream recomm.
Data source	model	data	model	model	model	model	model
Period of record	1934-1989	1941 - 2009	1934-1989	1934-1989	1934-1989	1934-1989	1934-1989

Table 2 - Summary of various water use scenarios ability to meet the attainment goals of the G1 suite of Guadalupe Estuary inflow criteria for the spring (Feb.-May) period. Part a is the counts of seasons (=years) that fall in each inflow category. Part b measure attainment performance for the portions of the criteria that are stand-alone measures (e.g. occurrence of G1-A >12% of years). Part c measures attainment for criteria that are to be assessed jointly (eg. the total occurrence of G1-C and G1-CC). Attainment performance is highlighted with a color scheme indicated at the bottom.

Part a) Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline	7	10	8	3	3	4	14	49
w. Guadalupe Project	7	10	8	2	4	4	14	49
w. San Antonio Project	7	9	9	1	5	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

Part b) Attainment - single criteria measures	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
goal	n/a	>12%	>12%	n/a	n/a	n/a	≤9%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. Guadalupe Project		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
w. San Antonio Project		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

Part c) Attainment - joint measures	Joint G1 criteria attainment (% of years and fractions)			
Scenario	>A-pr	A & B	C & CC	frac. CC
goal	n/a	>17%	19%	≤67%
Historical		22.4%	20.4%	50.0%
Present		18.4%	20.4%	50.0%
Region L Baseline		22.4%	14.3%	57.1%
w. Guadalupe Project		20.4%	16.3%	50.0%
w. San Antonio Project		20.4%	18.4%	44.4%
TCEQ Baseline; (Run 3)		18.4%	16.3%	37.5%

cell color scheme

color				
meaning	criteria met	criteria nearly met. rounding & period of record change probable causes.	criteria not met, departure from BBEST recommendations not great	criteria not met, departure of concern from BBEST recommendations

Table 3 - Summary of various water use scenarios ability to meet the attainment goals of the G2 suite of Guadalupe Estuary inflow criteria for the summer (June-Sept.) period. Part a is the counts of seasons (=years) that fall in each inflow category. Part b measure attainment performance for the portions of the criteria that are stand-alone measures (e.g. occurrence of G2-A >17% of years). Part c measures attainment for criteria that are to be assessed jointly (eg. the total occurrence of G2-C and G2-CC). Attainment performance is highlighted with a color scheme indicated at the bottom.

Part a) Counts	Criteria G2 Attainment (no. years 1941-89)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline	4	8	8	8	7	3	3	8	49
w. Guadalupe Project	4	8	8	8	7	3	3	8	49
w. San Antonio Project	4	8	8	8	7	3	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

Part b) Attainment - single criteria measures	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
goal	n/a	>12%	>17%	n/a	n/a	n/a	≤6%	n/a
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guadalupe Project		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Antonio Project		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

Part c) Attainment - joint measures	Joint G2 criteria attainment (% of years and fractions)				
Scenario	>A-pr	A & B	C & CC	frac. CC	D & DD
goal		≥30%	≥10%	≤17%	≤9%
Historical		38.8%	12.2%	16.7%	10.2%
Present		36.7%	18.4%	11.1%	12.2%
Region L Baseline; BBASC		32.7%	20.4%	30.0%	22.4%
w. Guadalupe Project		32.7%	20.4%	30.0%	22.4%
w. San Antonio Project		32.7%	20.4%	30.0%	22.4%
TCEQ Baseline; (Run 3)		34.7%	20.4%	40.0%	24.5%

note: cell color scheme is as in Table 2.

Evaluating Biologic and Ecologic Implications

While the Tables 2 and 3 summarize the details of inflow levels and percentage attainment information for several scenarios, the BBASC requested a fuller explanation of the biologic and ecologic implications of these non-attainment occurrences, mostly evident in the future scenarios. Clearly, the data in these tables provide a beginning point for these determinations by the BBEST Estuary Subcommittee. However, the Subcommittee also feels that other types of scenario-specific information is warranted in order to make fully informed evaluations of the biological and ecological ramifications of non-attainment. Such additional information includes more particular characteristics such as the year-upon-year reoccurrence of inflow levels, salinity characteristics, and indications of the severity of non-attainment (e.g. nearly achieving or barely meeting a criteria). This information all emanates directly from the very specific time-series sequence of inflows of the scenarios. While there are no facets of the BBEST criteria that address items such as year-upon-year trends, the Subcommittee does not feel that examination of such information amounts to “new” criteria, but rather provides for a more in-depth evaluation. The Estuary Subcommittee also desires that our evaluations of impacts be done in a manner consistent with other facets of the Stakeholders’ work to “balance” environmental and human water needs. Stakeholder determinations of available project yields, cost, etc. are inextricably linked to the particular time-series sequence of flows of these scenarios; thus the Estuary Subcommittee will be providing “impacts” information on a consistent footing.

The Region L Baseline of Inflows

Implications for *Rangia* of non-attainment of the G1 criteria, Region L Baseline Inflows

Figure 4 and Figure 5 below highlight some of the particular characteristics of springtime inflows under historic and Region L Baseline scenarios. Since the areas of non-attainment evident on Table 2 were concentrated in the lower levels of *Rangia* criteria, we have concentrated on those inflow levels for these figures. Each year with a solid bar means that the inflows of that scenario were within that level of BBEST-recommended criteria. We also track average salinity over the Mar.-May period in the upper portion of the present *Rangia* habitat, read on the right axis, since the focal area for potential reproduction of *Rangia* shifts to just the upper area under lower criteria levels, (see Figure 1). Years without a solid bar in any of those figures are years in which the inflow level was (historically), or would be (Region L), in either a the G1-A or G1-B level, representing good or very good conditions for *Rangia*. For the Region L Baseline, years of G1-A or G1-B inflows are also depicted in Figure 6.

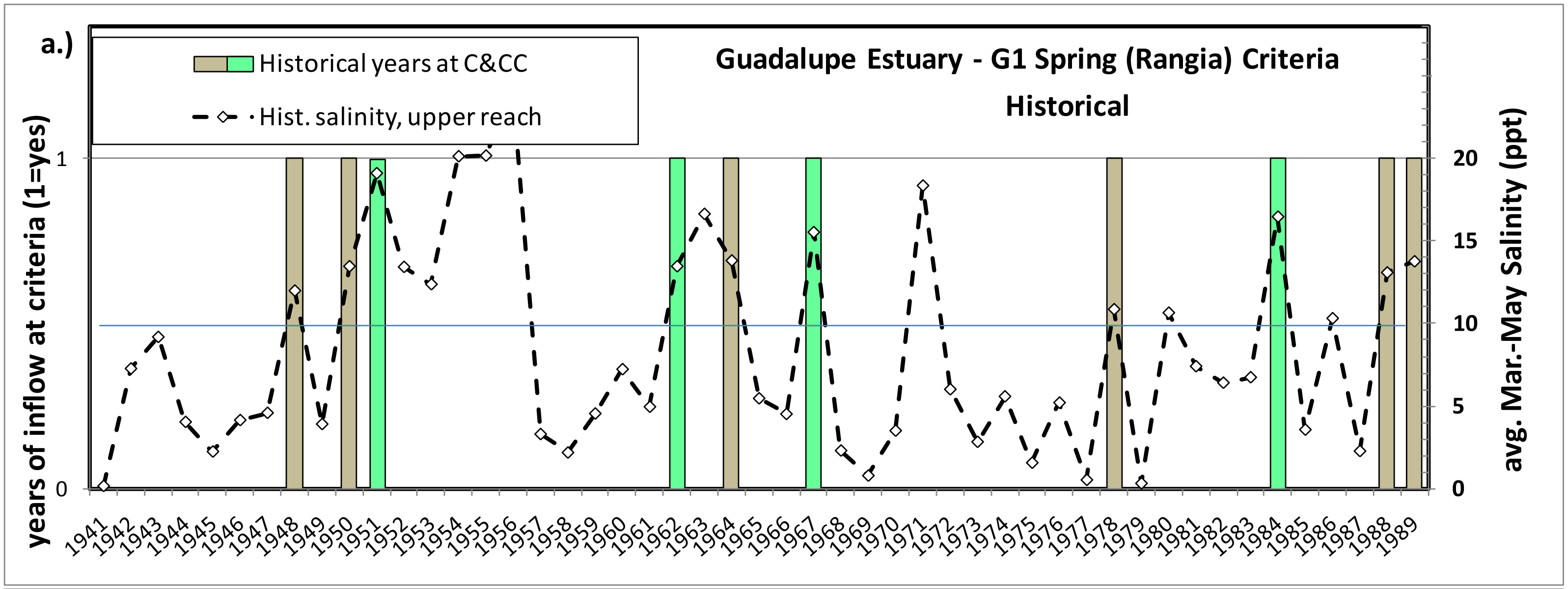
As shown previously on Figure 1, spring inflows in the G1-C and G1-D range (and G1-CC between these) represent suitable reproduction requirements over only a limited area of the current *Rangia* habitat. Furthermore, at the G1-D level, the time window of suitable conditions is reduced to just one month. Under the Region L Baseline level of inflows, there is a large increase in the occurrence of G1-D inflows, many of these being years of already historically low G1-C or G1-CC level inflows moving down into the lower bracket (e.g. 1967, 1978) under the Region L Baseline scenario.

The Estuary Subcommittee, in our best professional judgment, believes that these changes in springtime inflow characteristics of the Region L Baseline indicate the following for *Rangia* clams:

a) there is the potential for long-term alteration in the area or density of clams, especially in the lower part of the current habitat area used as a focal area by the BBEST. This is due to the increasing prevalence of G1-C & CC and D inflows which do not support reproduction of the clams in this portion of the habitat area.

b) since the *Rangia* clams are long-lived, and there are continuing higher levels of inflows in the G1-Band G1-A range at a sufficiently short return interval, the clams would not likely be eliminated from any of the focal area.

c) because of the importance of *Rangia* as a filter feeder and as an apparent food source for other organisms, we would expect some concomitant impacts if their abundance were reduced. Filter feeding is a broad ecosystem service provided by *Rangia*'s removal of suspended particulate matter, which contributes to water clarity. Scientific literature indicates that *Rangia* are a food source for fish, waterfowl, and crustaceans, thus a reduction in the clams abundance could affect other species. Further investigation of the ecological role of *Rangia* in the Guadalupe Estuary is warranted.



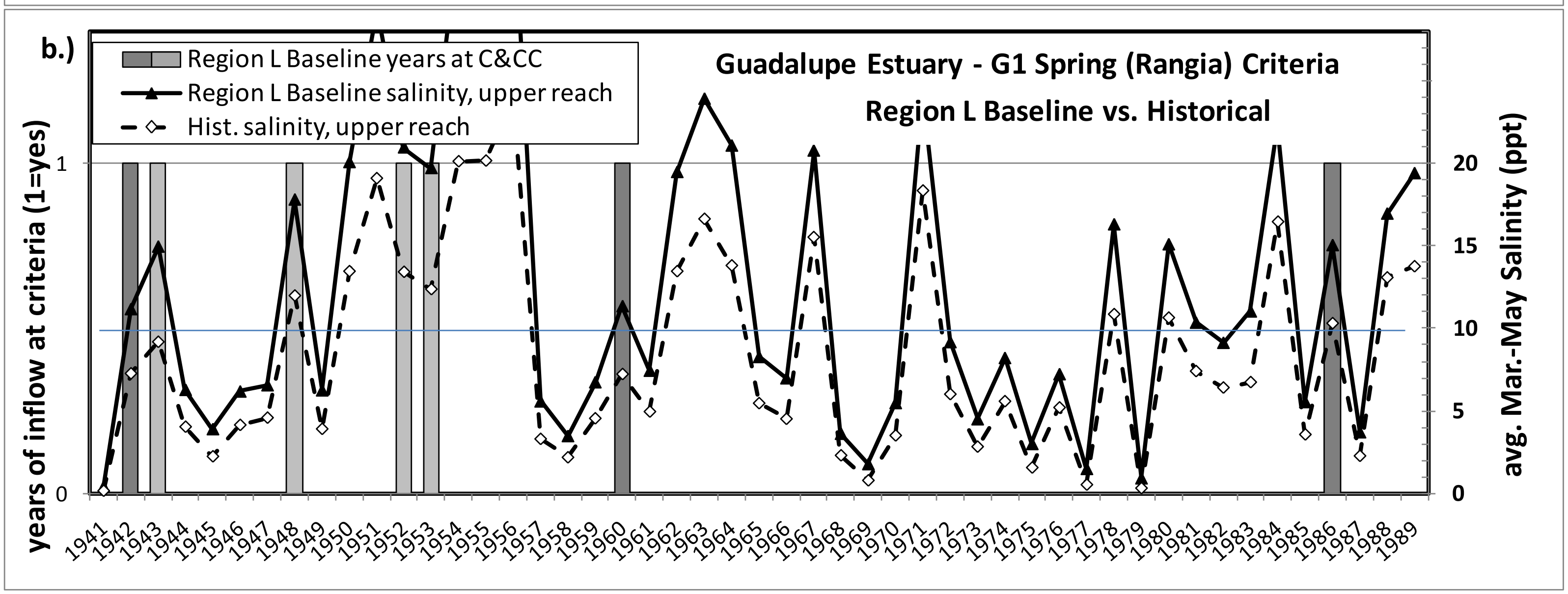


Figure 4- Upper panel illustrates the historical occurrence of spring inflows in the G1-C and G1-CC criteria range[lighter shading for CC]. Lower panel shows the changes predicted with the Region L Baseline inflow scenario. Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe *Rangia* habitat area under that scenario. Lower panel also contrast to historical salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

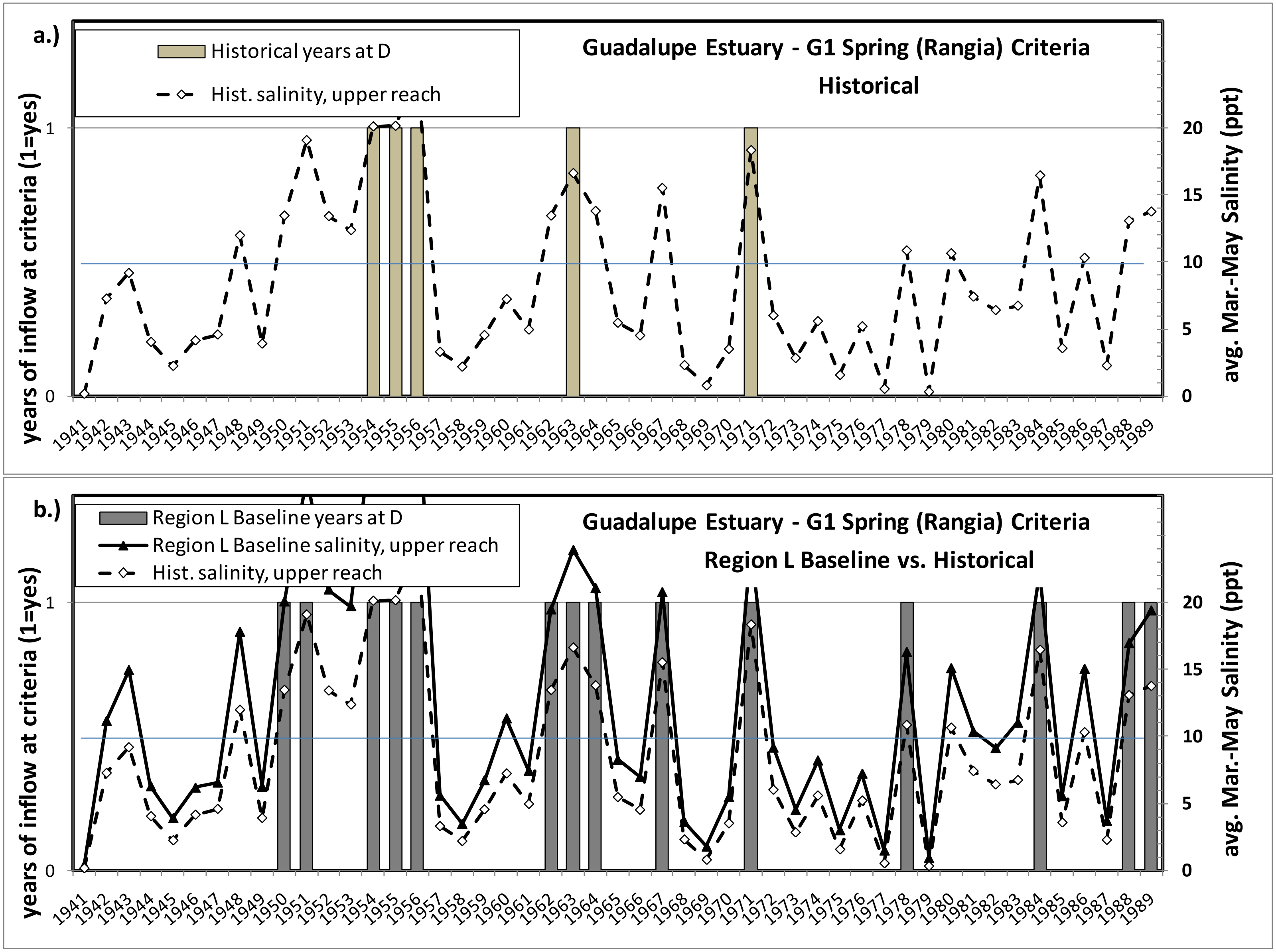


Figure 5- Upper panel illustrates the historical occurrence of spring inflows in the G1-D criteria range. Lower panel shows the changes predicted with the Region L Baseline inflow scenario. Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe *Rangia* habitat area under that scenario. Lower panel also contrast to historical salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

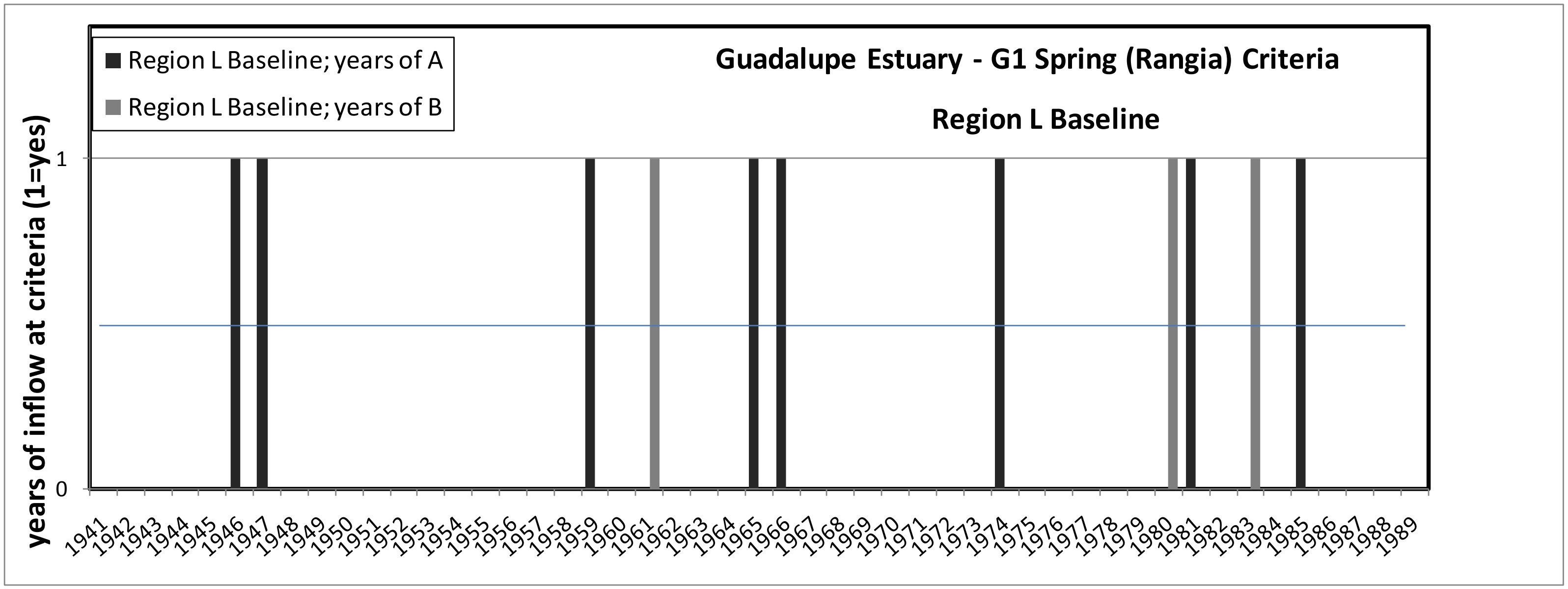


Figure 6- Illustration of the continuing projected occurrence of G1-A or G1-B inflows with the Region L Baseline scenario.

Implications for oysters of non-attainment of the G2 criteria, Region L Baseline Inflows

Figures 7, and 8 highlight some of the particular characteristics of average to low inflow periods under historic and Region L Baseline scenarios for the summer period. As with the G1 portrayals, since the characteristics of non-attainment evident in Table 3 are concentrated in the lower levels of G2 criteria, only those inflow levels are highlighted in these figures. We also present years of G2-A or G2-B inflows in Figure 9 for the Region L Baseline.

The very high salinity response that accompanies the G2-D and G2-DD criteria levels was shown on Figure 3. Such high levels would likely be very problematic for oysters due to the infestation by the Dermo parasite, which grows prolifically in high water temperatures of summer when coupled with salinity above 20 ppt. These high-salinity episodes would likely also be accompanied by high incidence of attack by the oyster drill, a parasitizing snail.

As evident in Table 3 above, there were significant increases in the incidence of both G2-D and G2-DD levels of inflow under the Region L Baseline scenario. Figures here also show that there are significant alterations in other significant features of the inflow record, particularly increases in the duration of low inflows across consecutive years and within short multi-year (e.g. 5 year) intervals. Figure 8 shows that the 1954 - 56 period, historically with two G2-DD years (upper panel of Figure 8) separated by 1955 at the CC level (upper panel of Figure 7), becomes three straight years of G2-D or G2-DD inflows. In the early 1960s what was historically a single occurrence of DD inflows in 1963 (upper panel of Figure 8) becomes a three out of four year sequence in the 1962-65 period of D and DD (lower panel Figure 8). Adding to this, 1964 and 1966 also newly become only G2-CC and G2-C years (lower panel Figure 7) whereas they were historically G2-Band G2-A years, respectively.

Specifically, with regard to G2-C and G2-CC inflows, Table 3 shows that while there is an allowable increase in the total number of years with only average (G2-C) or low average inflows (G2-CC), there was a larger proportion than recommended of the lower G2-CC level (30% rather than a max of 17%). G2-CC inflows, are differentiated from G2-C inflows only by the weaker June antecedent inflows. G2-CC level inflows can lead to moderate to high salinities and fairly bad conditions for oysters. As pointed out in the March 2011 BBEST report, salinities under G2-CC inflows range from a minimum of 20 ppt to a high of about 39 ppt (Table 4.5-2). As also indicated by the BBEST, these are high enough salinities to sustain “dermo” growth in warmer months (page 4.33). Thus our principal concern with an increase in G2-CC years is the potential for these to couple with those years that are more formally in drought, G2- D and G2-DD, and hasten the onset of, or lengthen duration of, the already deleterious effects of those years. There are several examples in the Region L Baseline where new G2-CC summers precede ensuing G2-DD or G2-D years. These are the 1964 - 65 sequence, the 1988 - 89 sequence, and to a lesser extent the 1948 - 50 sequence in which 1949 would be a G2-C year. Similarly, under the Region L Baseline, the added G2-CC summer inflow year of 1964 follows on the heels of a D and DD sequence in 1962 -63, likely extending the period of significant dermo infestation and parasite problems of that drought period which historically was interrupted by a G2-B year in 1964.

Unfortunately, there is a deficiency in actual fishery or other data from the historic drought of the 1950s, although not a total absence of information on its biological and ecological effects. Direct observations of the 1950s drought occurred in Mesquite Bay, between San Antonio Bay and Aransas Bays. Hoese (1960)[4] conducted limited biotic sampling in Mesquite bay in the fall and winter of 1956 and more extensive sampling in Mesquite Bay in the period immediately following the end of the 1950's drought. During the drought he measured salinities in Mesquite Bay to be in the range of 35 to 50 ppt compared to more "normal" levels of 4-28 ppt. His sampling during the drought found that all the eastern oysters were dead (except for a few large, old individuals along Ayres Reef) and the dead shells were colonized by a high-salinity-tolerant community of other species of oysters and mussels. Other much more salinity tolerant species had become widely established as well. Hoese reported that the species composition of mobile fish and invertebrates had not changed substantially as a result of the higher salinities. Hoese's study, over a period of a year or so after the drought ended, found that the mobile species of Mesquite Bay had mostly returned to their normal community structure. The author noted that the study was not long enough to document the return of non-mobile species such as eastern oysters to the area. Somewhat later, Hoese (1967)[5] summarized his observations on the effect of the 1950's drought in Texas on the estuarine biota: There was widespread invasion of organisms normally only found under high-salinity conditions into the estuaries; some estuarine fauna was dispersed or suffered substantial mortality; fisheries organisms most damaged were white shrimp, blue crabs (poor development of young), and oysters (from loss of protection from predators).

Therefore, the Estuary Subcommittee, in our best professional judgment, believes that the predicted changes in summer period inflow characteristics of the Region L Baseline indicate the following for oysters:

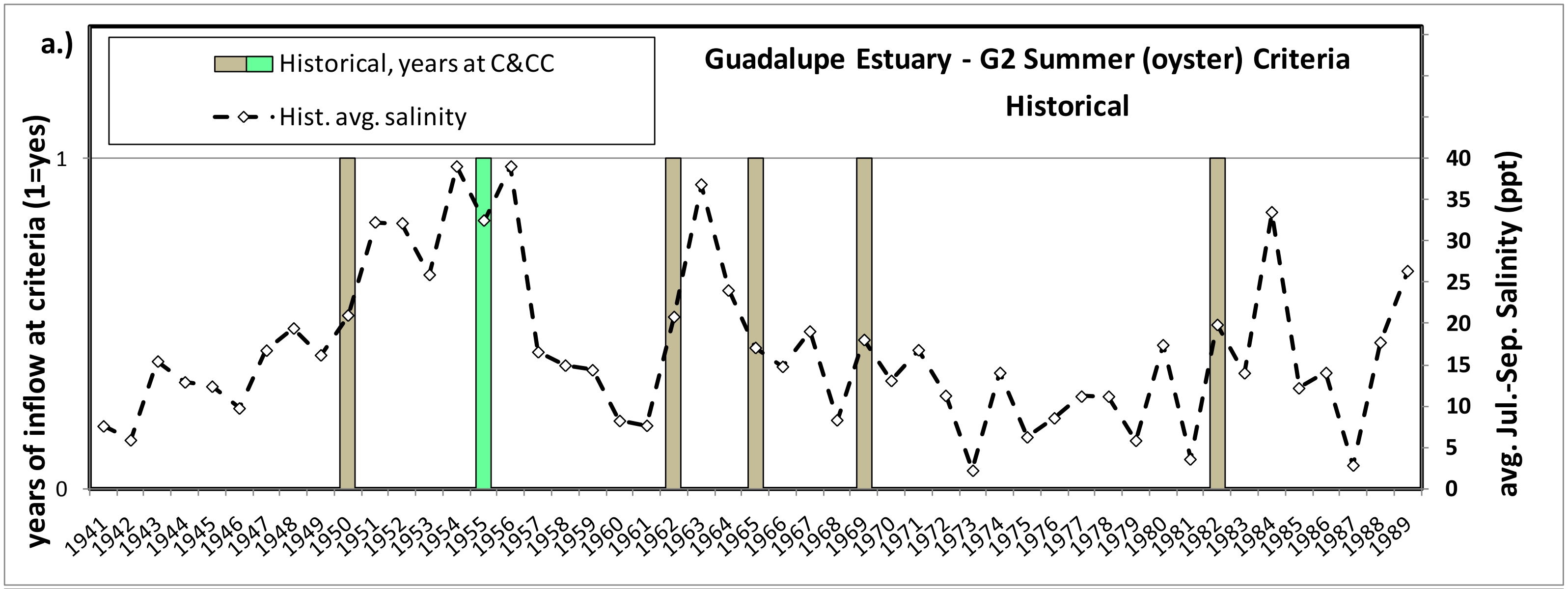
a) the effects of the extension of duration of a drought such as that which would result from the same hydro-climatology of the historic 1950's period, could be detrimental, but likely transitory, for the oyster reefs in the Guadalupe Estuary. There is the potential for significant mortality of oysters over a greater period within the estuary during the drought;

b) given that oyster parasites and the Dermo pathogen are known to be eliminated from oyster reefs during high inflow / low salinity events, and given that high G2-A and G2-B levels of inflow are predicted to continue with some regularity (Figure 9), we believe that the cycle of oyster decline and rejuvenation of the historic period will continue;

[4] Hoese, H.D. 1960. Biotic changes in a bay associated with the end of a drought. Limnology and Oceanography 5(3):326-336.
[5] Hoese, H.D. 1967. Effects of higher than normal salinities on salt marshes. Contributions in Marine Science.

c) the larger proportion than recommended of the lower G2-CC level inflows also represents an increase in the prevalence of stressed, albeit not drought, conditions for oysters. The principal concern with the increase in G2-CC years is the evident sequencing of these with other years that are more formally in drought, G2- D and G2-DD, likely hastening the onset of, or lengthening duration of, the already deleterious effects of those years.

The Estuary Subcommittee believes that much additional research with available data may help quantify impacts of drought and near-drought conditions on oyster reefs in the Guadalupe Estuary . Examination of more recent Dermo infestation data as related to sequential years and salinity patterns would be of exceptional benefit to more fully understand the implications of G2-CC years and their potential cumulative effects with drought year inflows. Additional examination of historic data, such as that by the old Oyster Commission, may also help quantify impacts of drought on oyster reefs in the Guadalupe Estuary. .



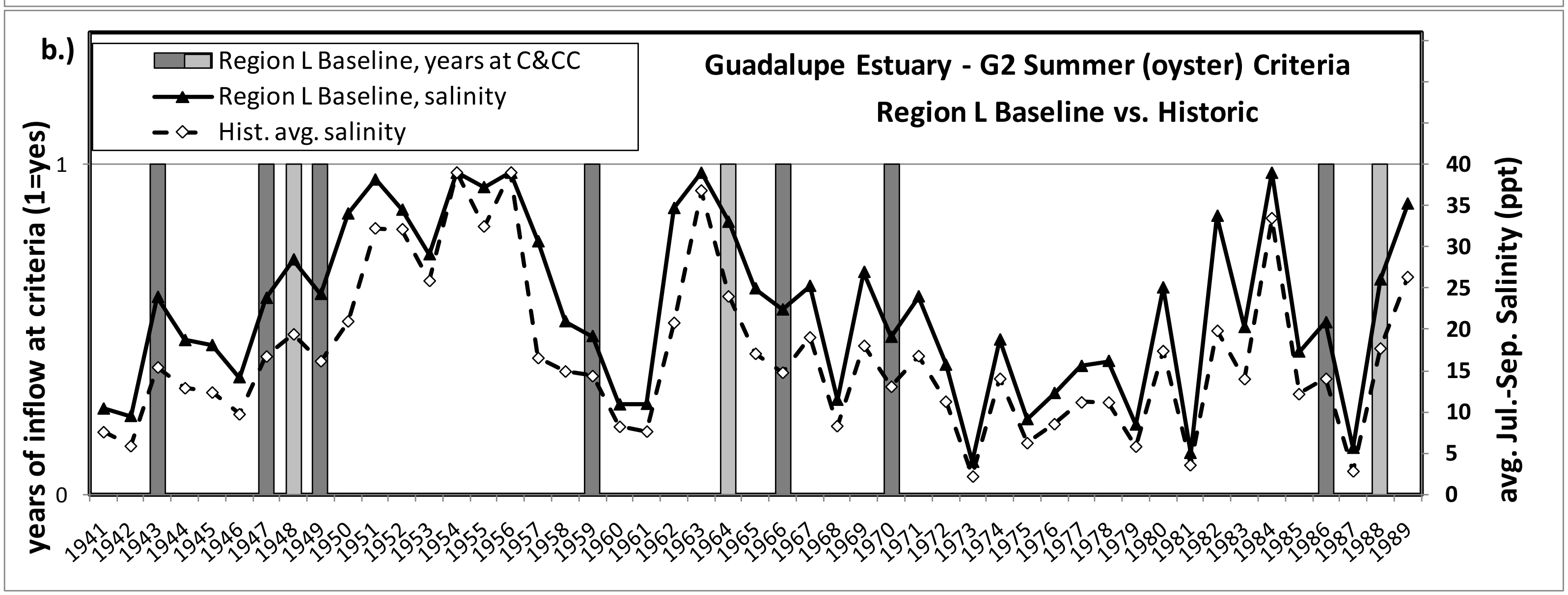


Figure 7- Upper panel: the historical occurrence of Summer inflows (Jul.-Sept.) in the G2-C and G2-CC criteria range [lighter shading for CC]. Lower panel:changes predicted with the Region L Baseline inflow scenario. Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast to historical salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

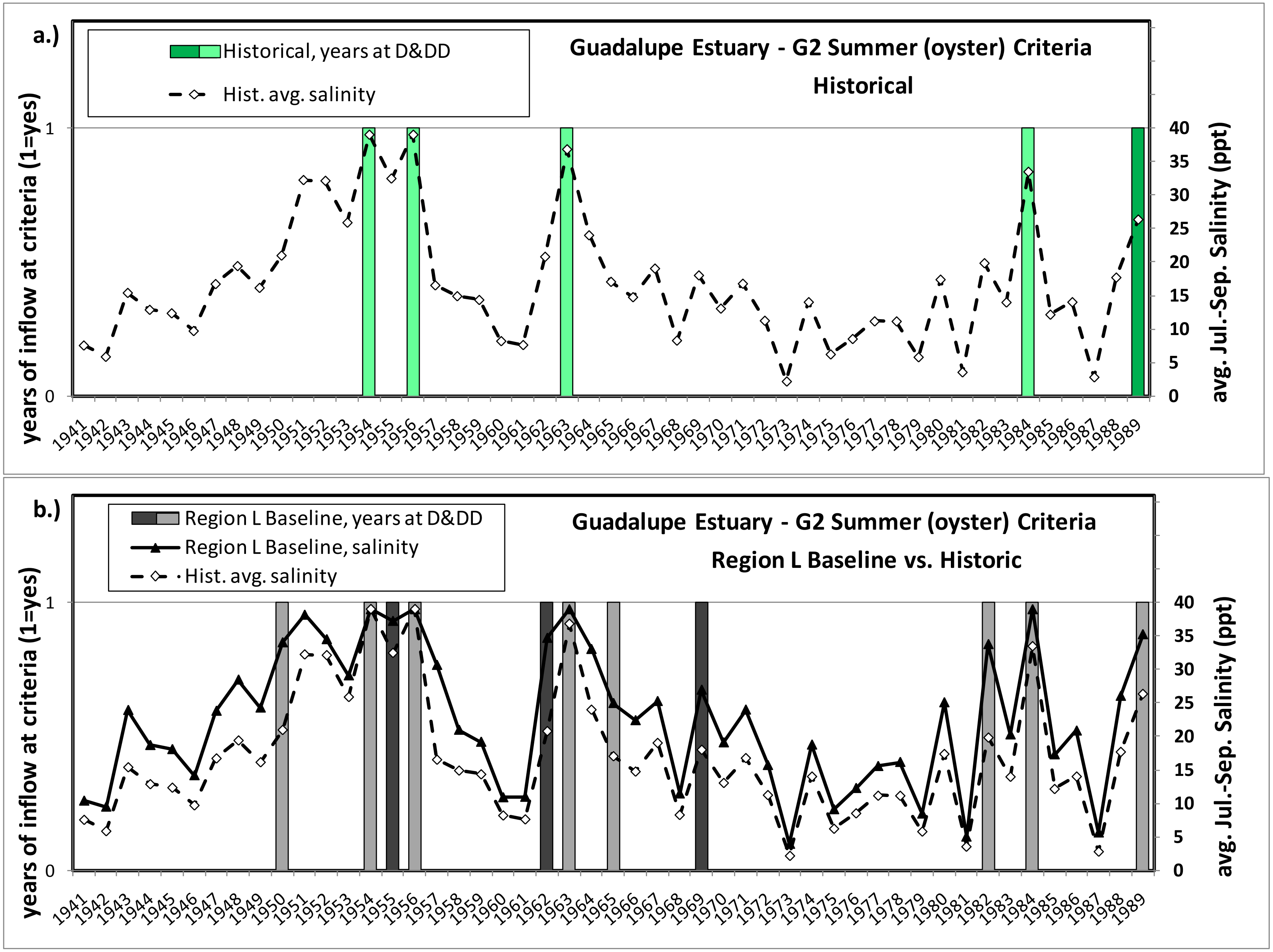


Figure 8- Upper panel illustrates the historical occurrence of Summer inflows (Jul.-Sept.) in the G2-D and G2-DD criteria range (DD in lighter shade). Lower panel shows the changes predicted with the Region L Baseline inflow scenario. Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast to historical salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

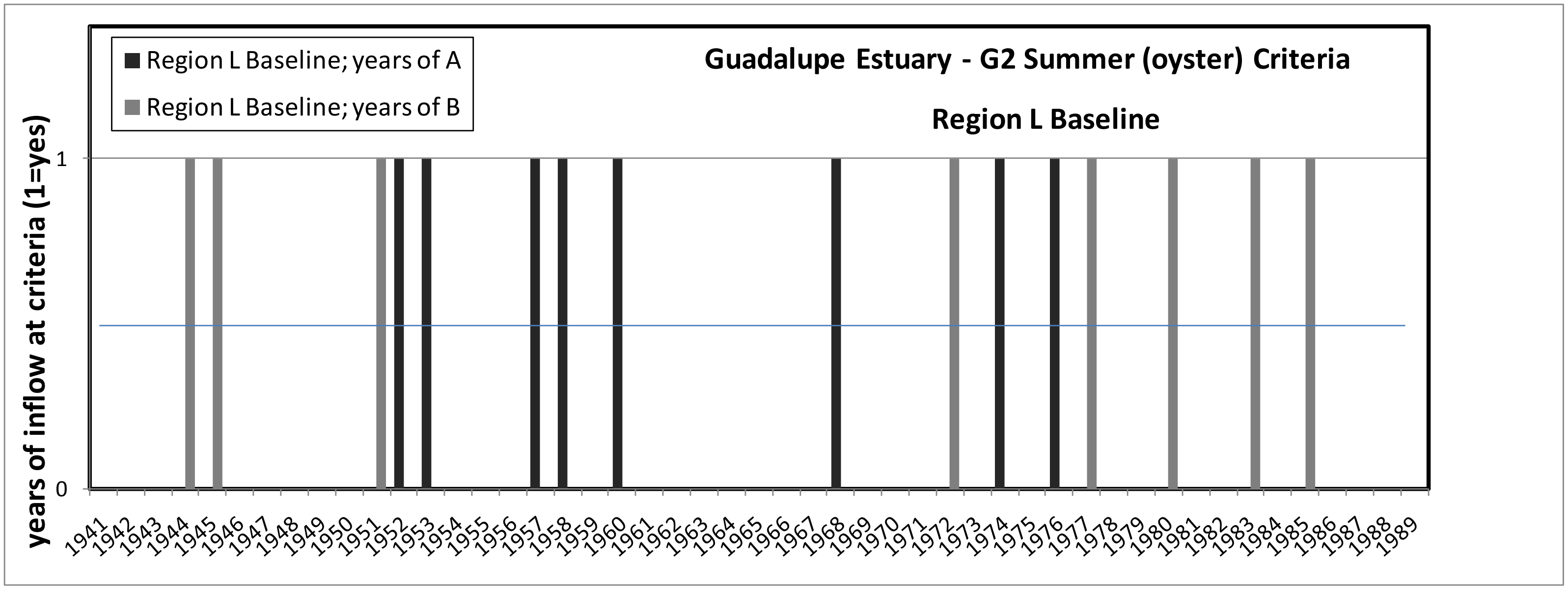


Figure 9- Illustration of the continuing projected occurrence of G2-A or G2-B inflows with the Region L Baseline scenario.

Additional Project Impacts

Other future scenarios that the GSA BBASC have evaluated involve the possible permitting of additional water rights for run-of-river diversion projects, coupled with an off-channel reservoir. The technical consultant to the BBASC developed a set of predicted inflows to the Guadalupe Estuary that would result if these projects were implemented, subject to the BBEST instream criteria at their respective locations. These inflows, as delivered on April 29, 2011, were also evaluated by the Estuary Subcommittee of the BBEST in the same manner as other scenarios and the exact inflow values are in Appendix tables. It is important to note that the inflows of the time-series for each project that is evaluated here, and any conclusions reached, are derived from specific conditions that include: the given infrastructure constraints (diversion rate and off-channel reservoir size); the fact that the project was subject to the full suite of BBEST instream criteria, including three base flow levels and a five-tiered pulse requirement at the diversion site; and the wastewater discharge and existing water rights utilization characteristics of the Region L Baseline WAM utilized at the time of evaluations[6].

The overall attainment results for these projects were presented in Tables 2 and 3 above. Here we look more specifically at the implications of these projects. While the Tables 2 and 3 show little incremental impact as measured by the overall number and characteristics of non-attainment, here we also track salinities of importance. This step was pursued, because we realize that the structure of the BBEST criteria, in finite ranges, could allow for substantial movement within a criteria category to be somewhat masked by the simple "attain / not attain" measures of Tables 2 and 3.

Implications of non-attainment of the G1 and G2 criteria, Additional Guadalupe River Project

Figure 10 illustrates that, for the spring season, there would be minimal additional impact of this project as evaluated, over an above that of the Region L Baseline: one additional spring season (1983) of G1-C occurs. This was a year just barely above the 275,000 ac-ft/3month breakpoint between G1-B and G1-C categories in the Region L Baseline. The average salinity in the upper portion of the *Rangia* area shows only minimal changes. Figure 11 illustrates, as in Table 2, no change in the overall occurrence of the problematic G1-D spring seasons compared to the Baseline, and very minimal or no change in salinity.

Figure 12 and Figure 13 illustrate similar results, but for the summer period. There would be no change in the overall level of non-attainment of the summer G2-C, G2-CC, G2-D, or G2-DD criteria (as shown in Table 3) compared to the non-attainment problems already evident in the Region L Baseline. Also, there would only be very minimal incremental change in the summertime salinity response in the Guadalupe Estuary as compared to the sometimes problematic levels evident in the Region L Baseline.

[6] The new projects utilized the underlying Region L Baseline WAM to determine initial water available subject to senior downstream water rights and then further limited diversions based on the BBEST criteria.

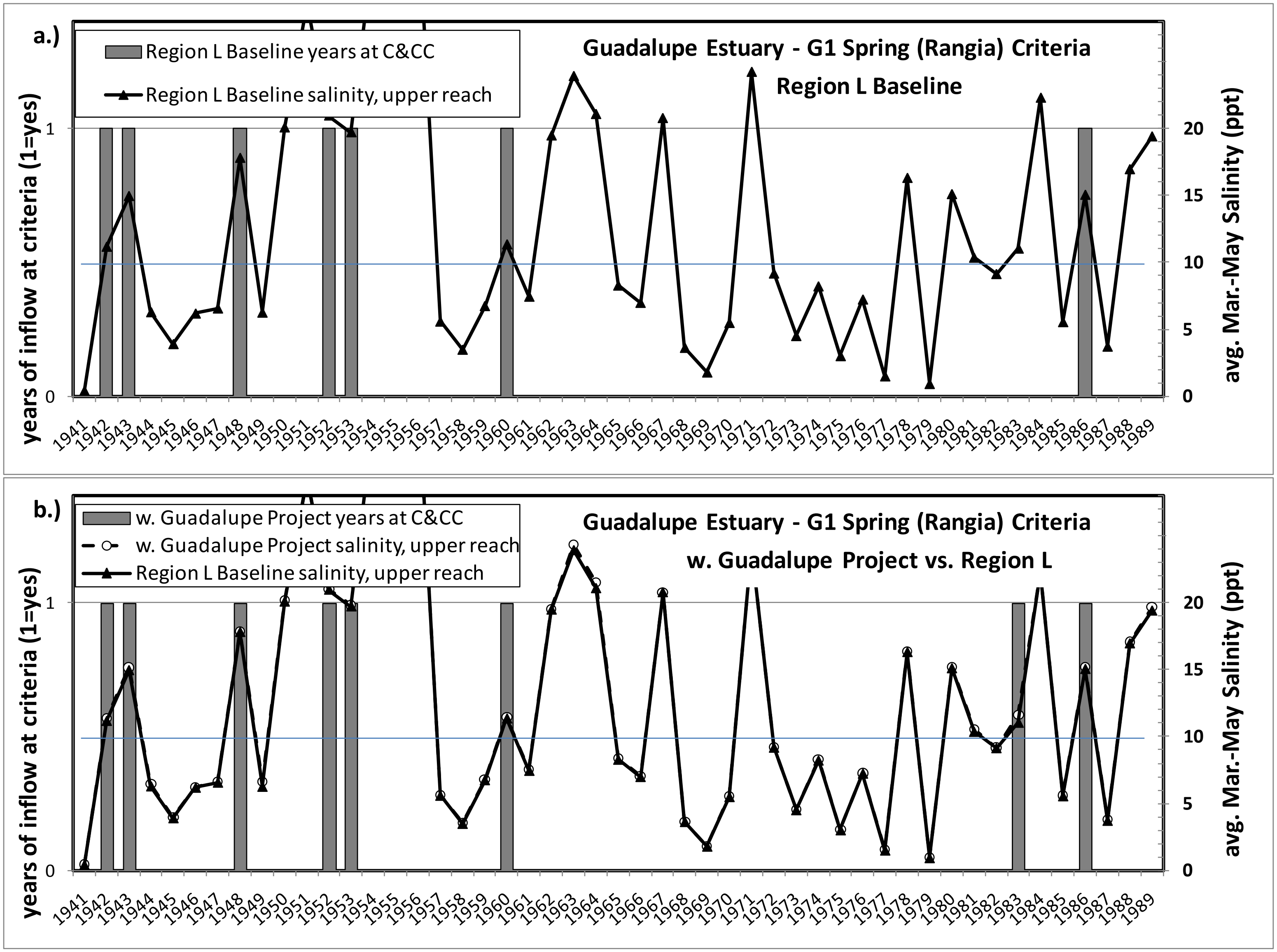


Figure 10- Illustration of the additional springtime impacts of the Guadalupe run-of-river diversion project subject to the BBEST instream criteria. Spring inflows (Mar.-May) in the G1-C and G1-CC criteria range are shown for the Region L Baseline (upper panel) and with the project (lower panel). Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast the with project and Region L salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

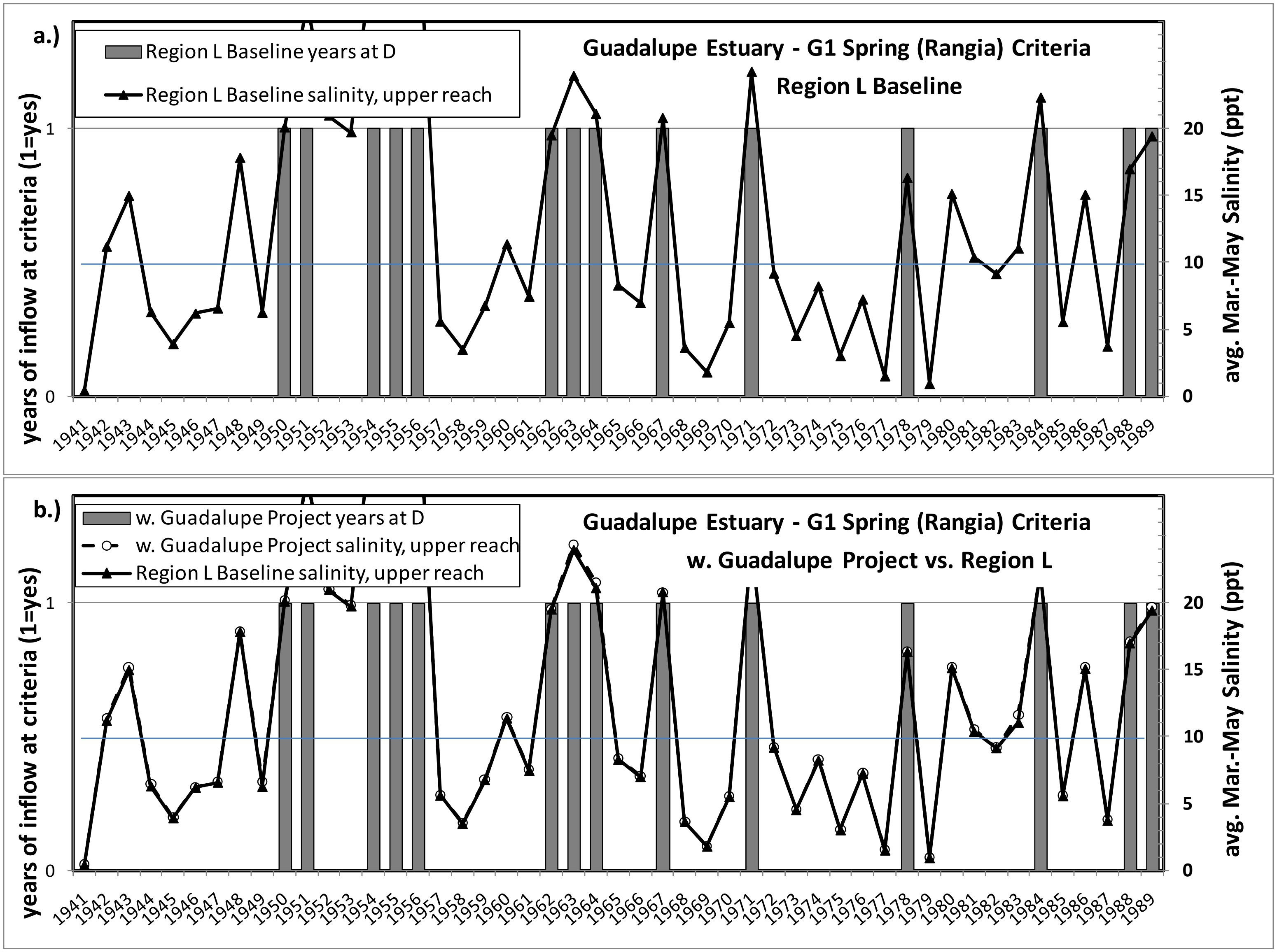
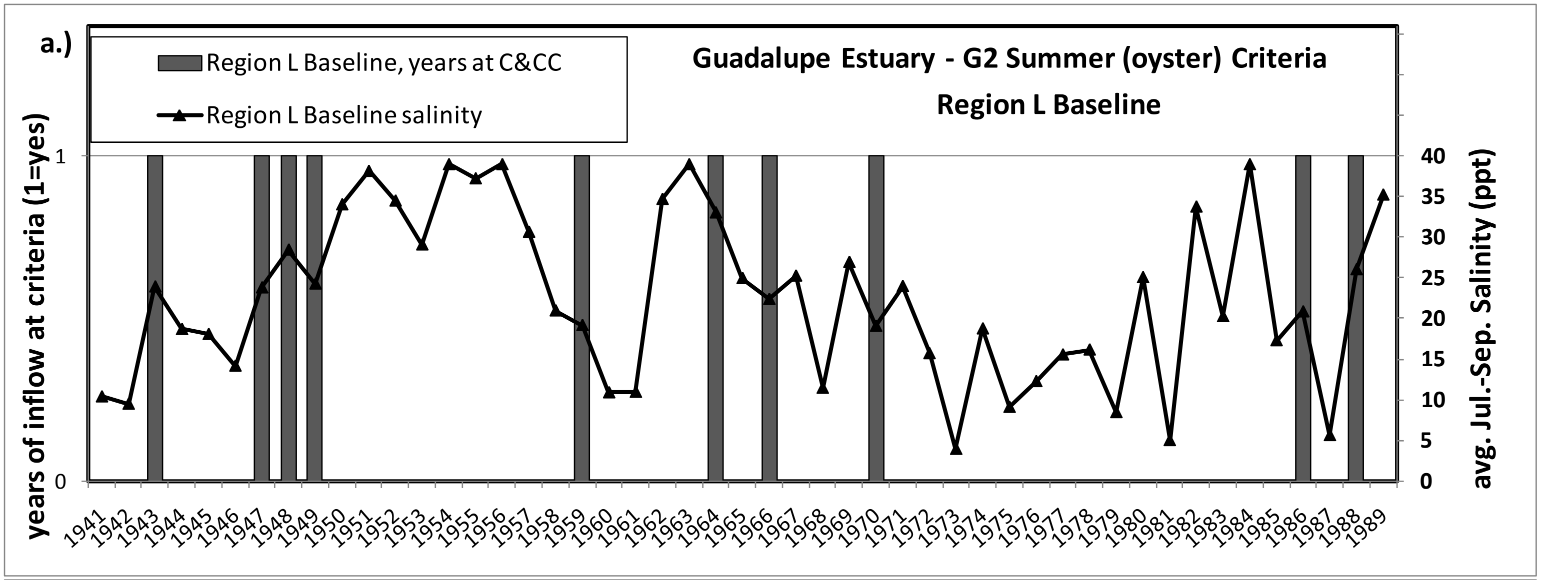


Figure 11- Illustration of the additional springtime impacts of the Guadalupe run-of-river diversion project subject to the BBEST instream criteria. Spring inflows (Mar.-May) in the G1-D criteria range are shown for the Region L Baseline (upper panel) and with the project (lower panel). Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast the with project and Region L salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.



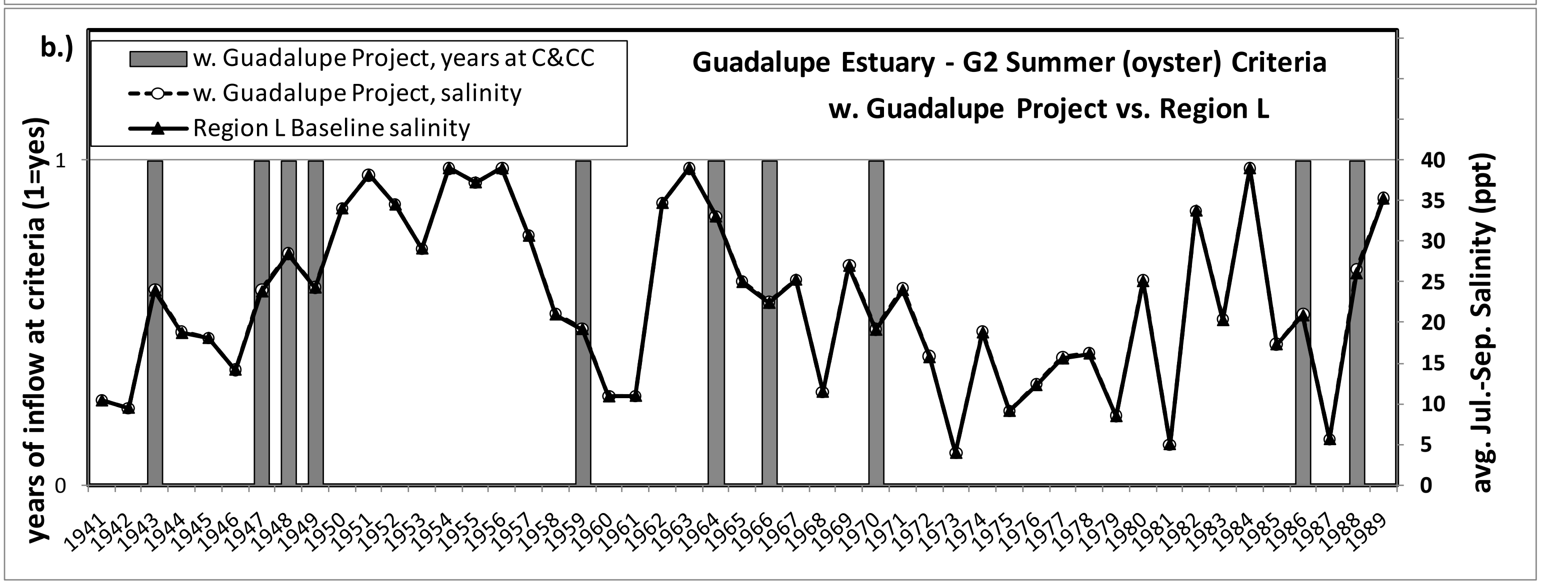


Figure 12- Illustration of the additional summer impacts of the Guadalupe run-of-river diversion project subject to the BBEST instream criteria. Summer inflows (Jul.-Sept.) the G2-C and G2-CC criteria range are shown for the Region L Baseline (upper panel) and with the project (lower panel). Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast the with project and Region L salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

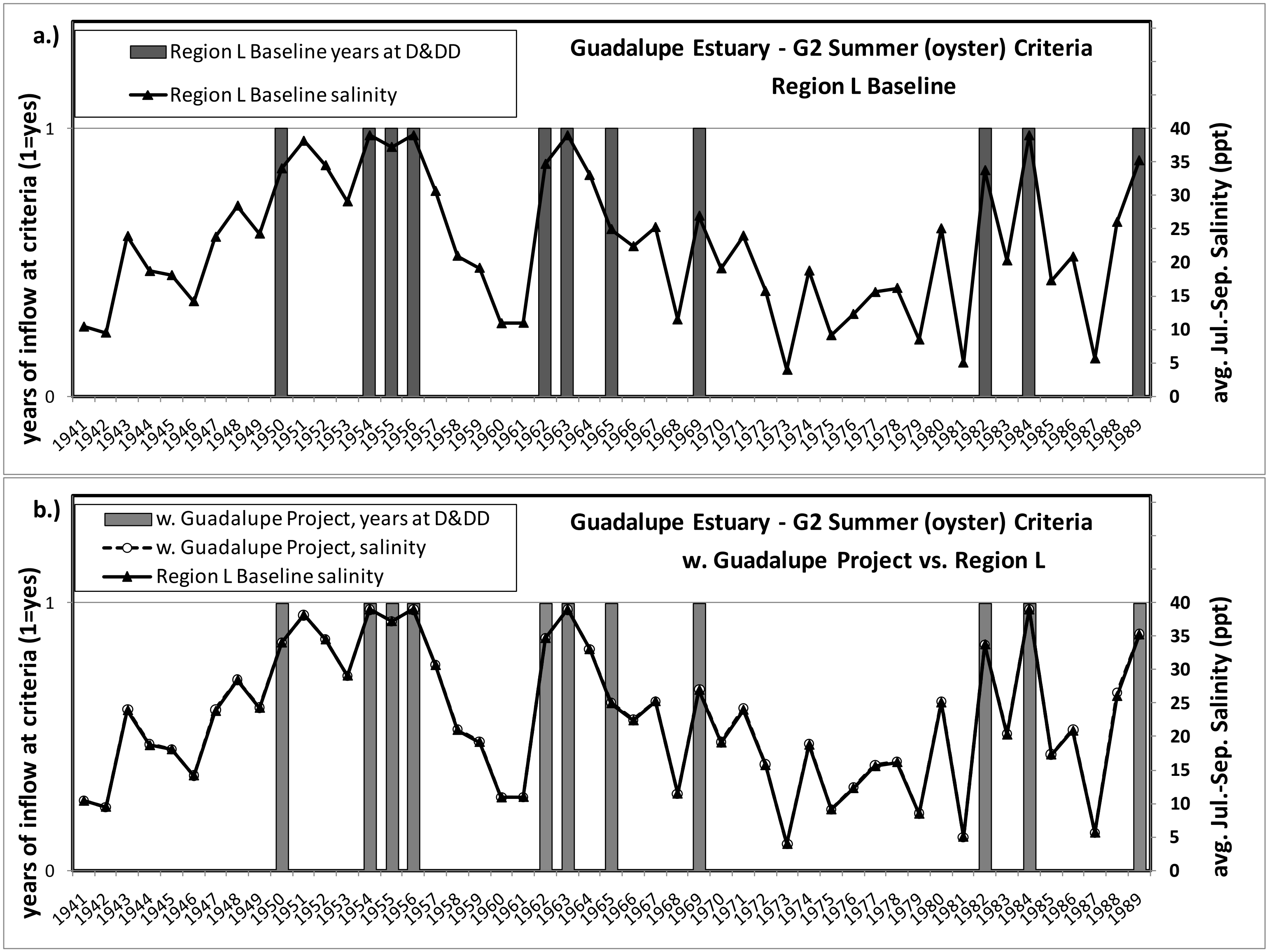


Figure 13- Illustration of the additional summer impacts of the Guadalupe run-of-river diversion project subject to the BBEST instream criteria. Summer inflows (Jul.-Sept.) the G2-D and G2-DD criteria range are shown for the Region L Baseline (upper panel) and with the project (lower panel). Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast the with project and Region L salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

Implications of non-attainment of the G1 and G2 criteria, Additional San Antonio River Project

Figure 14 illustrates that there would be small additional springtime impacts of this project as evaluated, over and above the non-attainment problems already evident in the Region L Baseline. The figure illustrates, as in Table 2, that there are two additional years that fall into the G1-C or G1-CC categories in the spring. Both of these (1961 and 1983) were just above the 275,000 ac-ft/3month breakpoint between G1-B and G1-C categories in the Region L Baseline and the project diversions place the total inflow for the same Mar.-May period just below that threshold. However, the changes in salinity for these years and other G1-C and G1-CC years are minimal compared to the Region L Baseline. Figure 15 shows that there are no additional years of the spring drought level inflow G1-D and that there are only minimal changes in salinity as compared to the non-attainment occurrences already evident in the Region L Baseline. Overall, for the springtime *Rangia* G1 criteria, the non-attainment occurrences evident in the Region L Baseline that are cause for concern (see above) are only slightly increased with the San Antonio river project and not in the lowest G1-D category.

Figures 16 and 17 illustrate results, for the summer period, that would result from the San Antonio run-of-river diversion project. There would be no change in the overall level of non-attainment of any of the criteria levels G2-C down through G2-DD (as previously shown on Table 3), and furthermore, very minimal changes in the salinity response in the Guadalupe Estuary. As before, the conclusion to be drawn is that there would only be very minimal incremental change in the summertime salinity response in the Guadalupe Estuary as compared to the sometimes problematic levels already evident in the Region L Baseline.

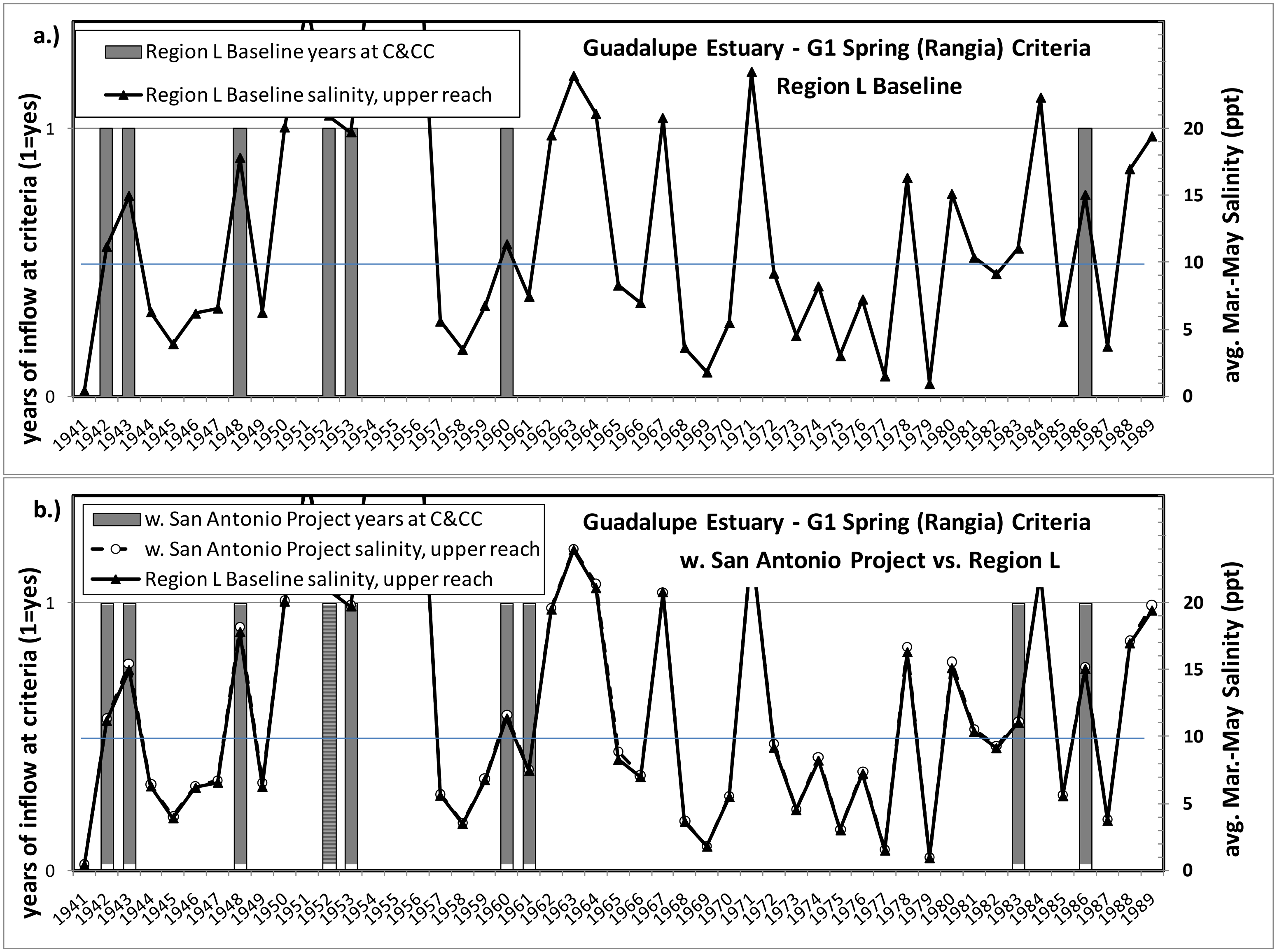
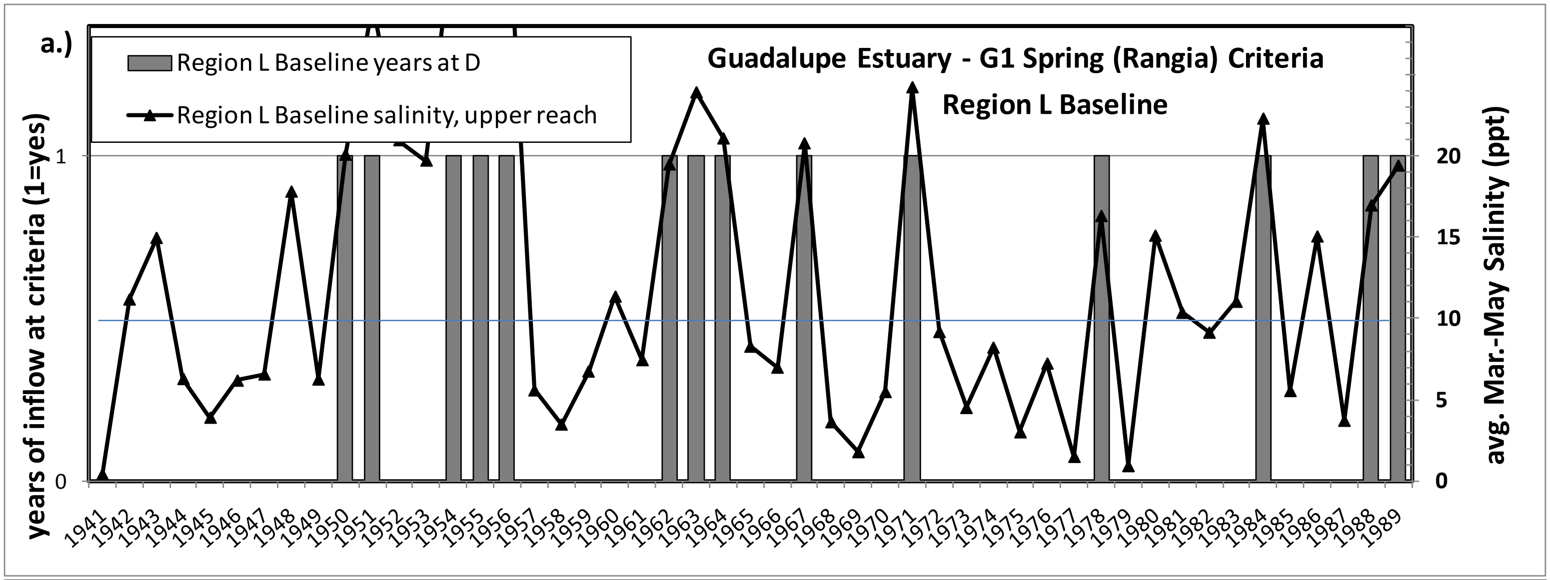


Figure 14- Illustration of the additional springtime impacts of the San Antonio run-of-river diversion project subject to the BBEST instream criteria. Spring inflows (Mar.-May) in the G1-C and G1-CC criteria range are shown for the Region L Baseline (upper panel) and with the project (lower panel). Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast the with project and Region L salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.



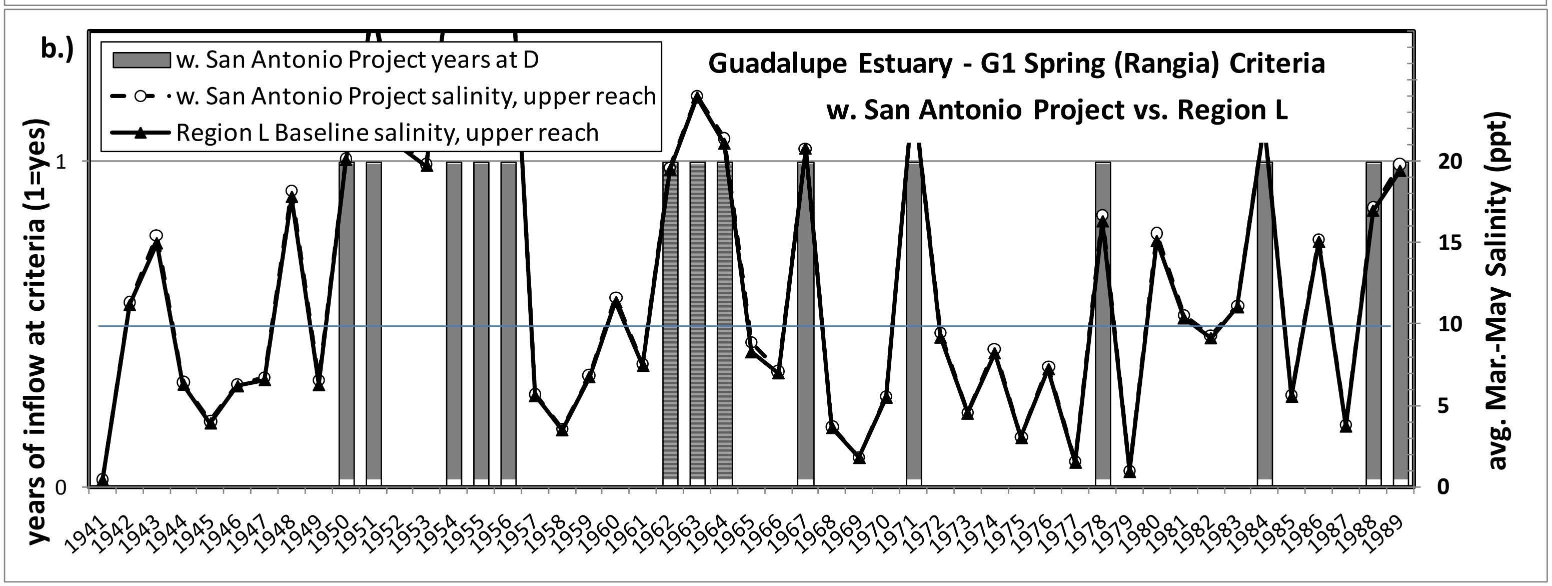


Figure 15- Illustration of the additional springtime impacts of the San Antonio run-of-river diversion project subject to the BBEST instream criteria. Spring inflows (Mar.-May) in the G1-D criteria range are shown for the Region L Baseline (upper panel) and with the project (lower panel). Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast the with project and Region L salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

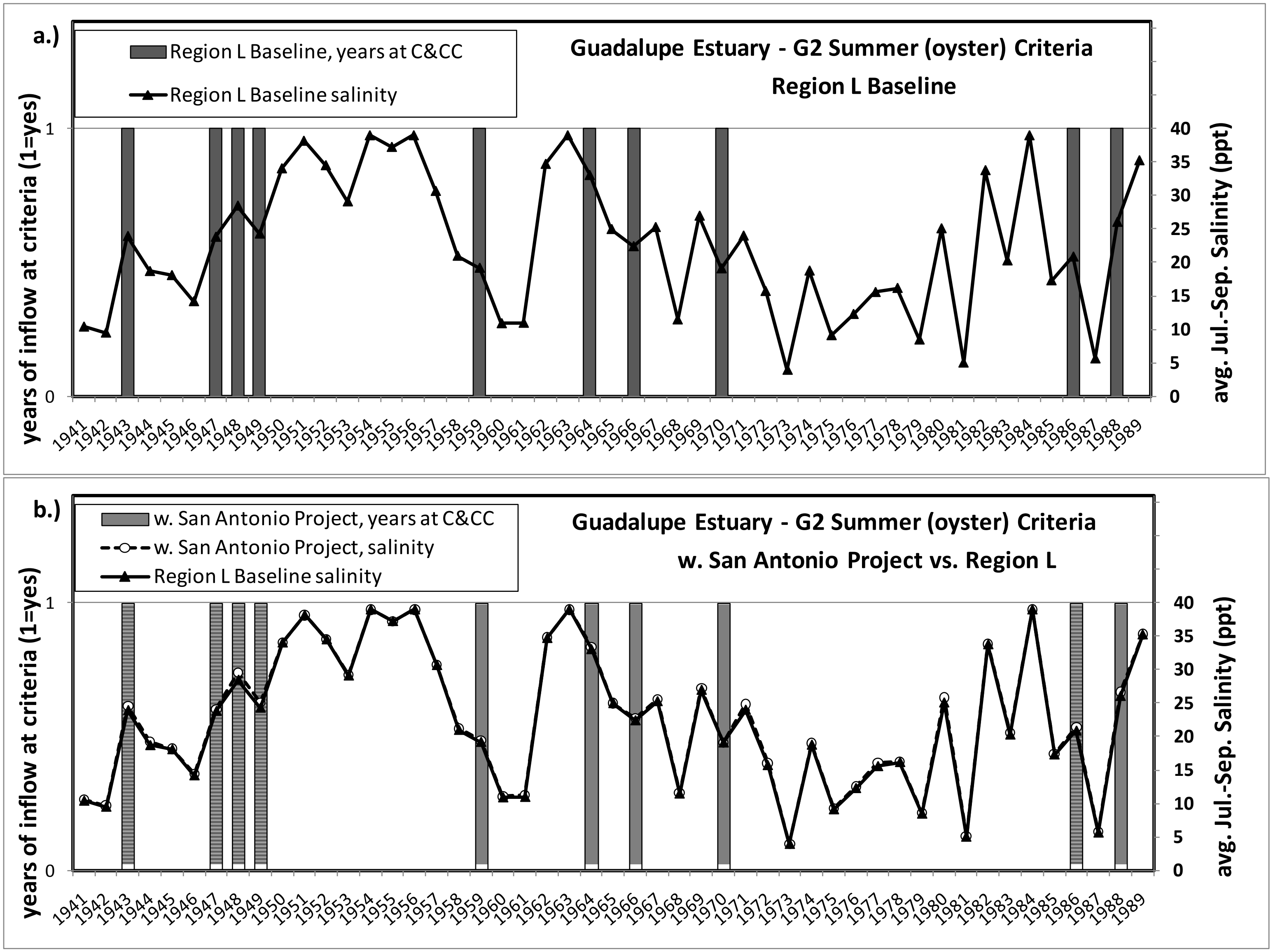


Figure 16- Illustration of the additional summer impacts of the San Antonio run-of-river diversion project subject to the BBEST instream criteria. Summer inflows (Jul.-Sept.) the G2-C and G2-CC criteria range are shown for the Region L Baseline (upper panel) and with the project (lower panel). Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast the with project and Region L salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

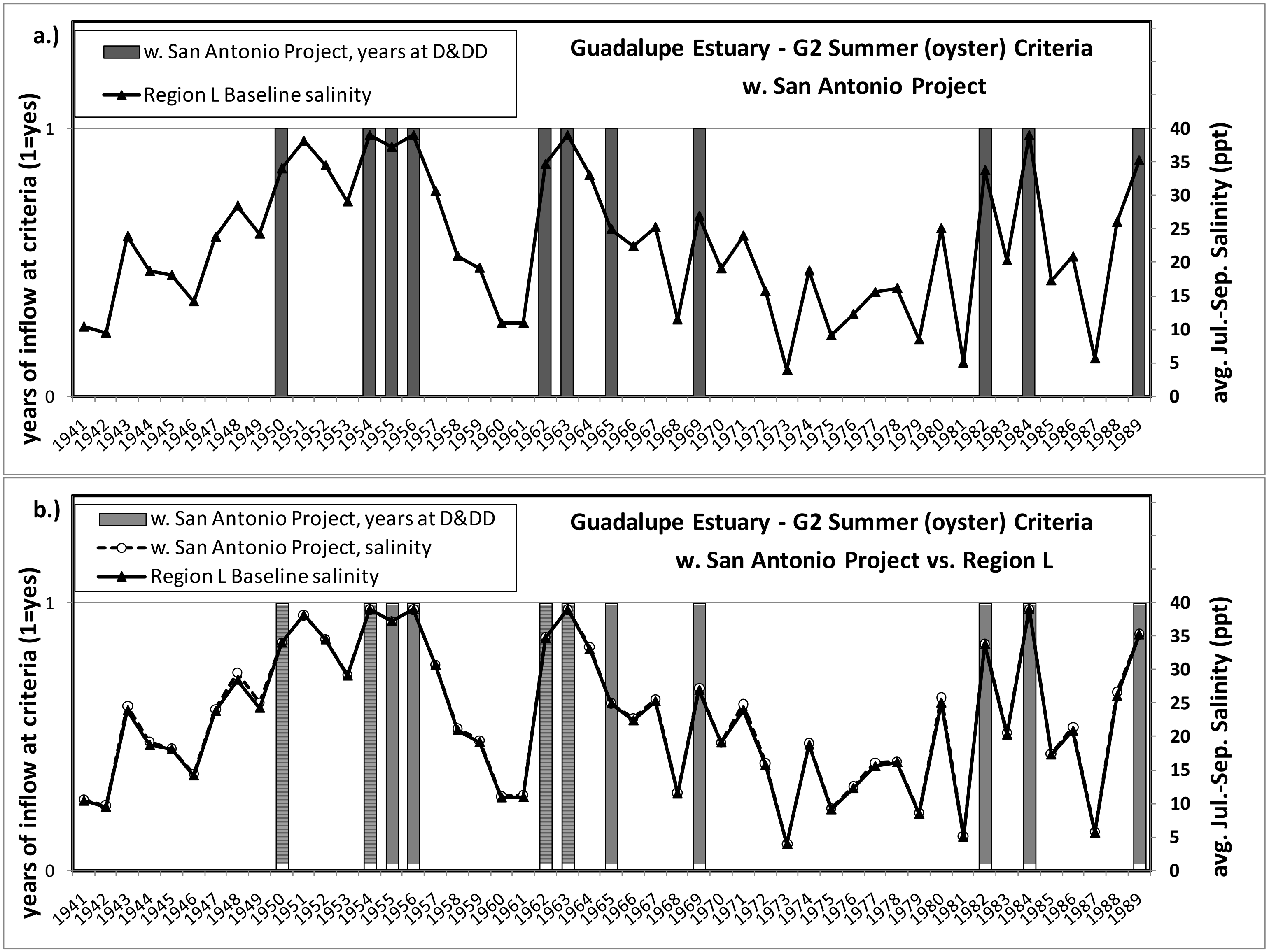


Figure 17- Illustration of the additional summer impacts of the San Antonio run-of-river diversion project subject to the BBEST instream criteria. Summer inflows (Jul.-Sept.) the G2-D and G2-DD criteria range are shown for the Region L Baseline (upper panel) and with the project (lower panel). Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast the with project and Region L salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

Conclusions

The Estuary Subcommittee is of the consensus opinion that the scenarios of future water use that we evaluated would hold some biological and ecological ramifications for the Guadalupe Estuary, some perhaps more significant, and some more detrimental, than others. Among the available information for arriving at our opinion, the most straightforward was simply an evaluation of attainment performance of any scenario as measured against our criteria (as in Tables 2 and 3). Other lines of evidence, consistent with the "balancing" endeavors of the Stakeholder group, involved examining particular sequencing characteristics of the time-series of inflows embodied in each scenario. These include year-upon-year trends such as clusters of average to bad seasons in sequence, as well as the frequency and elapsed time between higher inflow seasons that are often necessary to foster recovery. Additional research, upon assignment of this task to the Estuary Subcommittee, has also yielded insights into the effects of the historic 1950's drought which has informed our opinion.

In our best professional judgment, the Estuary Subcommittee believes that the changes in inflow characteristics of the Region L Baseline indicate the following:

a) there is the potential for long-term alteration in the area or density of *Rangia* clams, especially in the lower part of the current habitat area used as a focal area by the BBEST. This is due to the increasing prevalence of low and average inflows (G1-C & CC and D levels) which do not support reproduction of the clams in this portion of the habitat area.

b) however, since the *Rangia* clams are long-lived, and there are continuing re-occurrence of higher levels of inflows in the G1-Band G1-A range at a sufficiently short return interval, the clams would not likely be eliminated from any of the area used as a focal area by the BBEST.

c) because of the importance of *Rangia* as a filter feeder and as an apparent food source for other organisms, we would expect some concomitant impacts if their abundance were reduced. Filter feeding is a broad ecosystem service provided by *Rangia*'s removal of suspended particulate matter, which contributes to water clarity. Literature indicates that *Rangia* are a food source for fish, waterfowl, and crustaceans, thus a reduction in the clams abundance could affect other species. Further investigation of the ecological role of *Rangia* in the Guadalupe Estuary is warranted.

d) the effects of the extension of duration of a severe drought such as that which would result from the same hydro-climatology of the historic 1950's period, could be detrimental, but likely transitory, for the oyster reefs in the Guadalupe Estuary. Based upon published accounts of effects of the 1950's drought, there is the potential for significant mortality of oysters over a greater period within the estuary during the drought;

e) given that oyster parasites and the Dermo pathogen are known to be eliminated from oyster reefs during high inflow / low salinity events, and given that higher summer levels of inflow in the G2-A and G2-B categories, and even those in the springtime, are predicted to continue with some regularity, we believe that the cycle of oyster decline and rejuvenation of the historic period will continue;

f) the larger proportion than recommended of the lower G2-CC level inflows also represents an increase in the prevalence of stressed, albeit not drought, conditions for oysters. The principal concern with the increase in G2-CC years is the evident sequencing of these with other years that are more formally in drought, G2- D and G2-DD, likely hastening the onset of, or lengthening duration of, the already deleterious effects of those years.

g) the incremental impacts of the Guadalupe River run-of-river diversion project, given the assumed infrastructure limits, and subject to the full BBEST instream criteria, are minimal as compared to the concerns and problems already evident in the Region L Baseline;

h) the incremental impacts of the San Antonio River run-of-river diversion project, given the assumed infrastructure limits, and subject to the full BBEST instream criteria, are minimal as compared to the concerns and problems already evident in the Region L Baseline;

BBEST Criteria Synopsis

Table 6.1-17 Summary of recommended inflow volumes for the Guadalupe and Mission-Aransas Estuaries. Units are thousands of acre-feet in the period indicated, either per 3 month period or per month.

Guadalupe Estuary Criteria - Volumes				
	Inflow Criteria Volumes, suite G1 for *Rangia* clams		Inflow Criteria Volumes, suite G2 for Eastern oysters	
Criteria level	Feb. (1000 ac-ft/mon)	Mar.-May (1000 ac-ft/3mon)	June (1000 ac-ft/mon)	July-Sept. (1000 ac-ft/3mon)
G1-Aprime, G2-Aprime	n/a	550-925	n/a	450-800
G1-A, G2-A	n/a	375-550	n/a	275-450
G1-B, G2-B	n/a	275-375	n/a	170-275
G1-C, G2-C	≥75	150-275	≥40	75-170
G1-CC, G2-CC	0 - 75	150-275	0 - 40	75-170
G1-D, G2-D	n/a	0 - 150	n/a	50-75
G1-DD, G2-DD	n/a	n/a	n/a	0-50
Mission-Aransas Estuary Criteria - Volumes				
	Inflow Criteria Volumes, set MA1 for *Rangia* clams		Inflow Criteria Volumes, set MA2 for Eastern oysters	
Criteria level	Feb.	Mar.-May	June	July-Sept.
MA2 - Aprime	n/a	n/a	n/a	500-1000

Table 6.1-18 Summary of attainment goals for the respective inflow volume recommendations in Table 6.1-17. The percentages of years refer to a long-term period, similar to that used in the criteria derivation, and as further described in Section 6.1.7.

Guadalupe Estuary Criteria -Attainment Recommendations			
Criteria level	Specification	Inflow Criteria Attainment, G1 suite for *Rangia* clams	Inflow Criteria Attainment, G2 suite for Eastern oysters
G1-Aprime, G2-Aprime	Attainment, G - Aprime	G1-Aprime at least 12% of years	G2-Aprime at least 12% of years

G1-A, G2-A	Attainment, G - A	G1-A at least 12 % of years	G2-A at least 17 % of years
G1-A&G1-B, G2-A&G2-B	Attainment, G - A & G - B combined	G1-A and G1-B combined at least 17% of years	G2-A and G2-B combined at least 30% of years
G1-C&G1-CC, G2-C&G2-CC	Attainment, G - C & G - CC combined	G1-C and G1-CC equal to or greater than 19% of years. G1-CC no more than 2/3 of total	G2-C and G2-CC equal to or greater than10% of years. G2-CC no more than 1/6 of total
G1-D	Attainment, G1- D	no more than 9% of years	n/a
G2-DD	Attainment, G2- DD	n/a	G2-D no more than 6% of years
G2-D&G2-DD	Attainment, G2-D & G2-DD combined	n/a	G2-D and G2-DD combined no more than 9% of years
Mission-Aransas Estuary Criteria -Attainment Recommendations			
Criteria level	Specification	Inflow Criteria Attainment, set MA1 for *Rangia* clams	Inflow Criteria Attainment, set MA2 for Eastern oysters
MA-Aprime	Attainment MA-Aprime	n/a	MA2-Aprime at least 2% of years

Note: The attainment goals for categories G1-C, G1-CC, G2-C, and G2-CC, which allow for an increase in the frequency of occurrence of these magnitudes of inflows, are contingent upon other criteria level attainment goals being met.

Appendix - Inflows of Scenarios Evaluated

Table A1 - Inflows to the Guadalupe Estuary, Scenario - Natural

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1941	203.0	344.5	388.0	519.7	1225.4	423.7	359.6	131.7	144.0	185.6	113.8	125.6
1942	75.0	140.3	88.3	197.2	137.4	77.2	916.8	162.6	585.8	314.3	149.7	126.1
1943	151.1	101.9	140.7	88.4	111.9	172.2	110.2	60.3	80.6	59.3	81.5	93.0
1944	252.9	121.2	312.3	112.5	487.5	217.2	94.7	106.9	185.5	103.9	101.0	202.9
1945	243.9	231.7	224.1	455.7	123.9	152.2	101.4	245.6	56.7	122.4	64.8	82.8
1946	103.5	173.9	247.6	140.0	253.8	296.6	81.3	192.1	603.3	796.1	297.4	172.6
1947	278.2	149.7	169.0	185.6	316.4	115.4	93.3	110.1	60.1	57.9	81.9	69.9
1948	81.9	103.6	96.1	55.2	143.9	47.3	73.1	99.9	120.8	50.9	35.8	38.1
1949	43.3	88.4	125.0	561.1	217.9	131.9	135.6	67.5	53.8	403.6	73.1	107.6
1950	66.1	78.0	58.3	102.9	73.4	190.4	53.4	41.5	43.6	32.8	31.1	35.2
1951	33.9	36.6	39.8	41.4	118.9	220.5	31.0	22.1	224.0	36.8	34.5	31.9
1952	31.0	46.3	41.4	97.9	204.8	111.3	50.7	23.2	505.0	55.7	110.0	141.8
1953	117.7	69.0	53.0	65.5	260.1	31.3	31.8	211.3	210.6	139.7	54.2	71.6
1954	48.2	37.9	35.5	43.3	65.9	27.8	20.9	17.5	18.1	60.6	29.9	25.1
1955	29.0	86.2	34.3	28.5	80.9	62.8	26.6	48.8	80.3	26.1	17.7	25.0
1956	22.5	25.4	23.9	28.2	48.2	15.0	15.5	15.0	21.1	44.6	23.9	62.8
1957	19.2	38.6	223.5	644.0	720.6	537.7	58.7	36.5	379.9	572.4	426.4	146.2
1958	470.2	859.8	303.0	152.3	414.3	161.1	113.3	63.1	299.2	293.3	229.2	187.1
1959	111.0	280.7	106.3	267.5	168.8	128.6	104.2	140.1	68.1	352.2	107.2	107.7
1960	114.2	148.1	128.6	102.3	178.1	306.3	214.1	285.4	91.4	1115.7	640.9	399.0
1961	349.7	432.6	195.4	139.7	92.8	586.5	309.2	102.7	241.6	100.3	206.5	85.6
1962	78.9	72.5	66.7	91.7	73.0	153.3	52.7	37.3	92.9	65.7	68.5	112.6
1963	61.3	94.4	58.1	62.3	48.2	46.2	39.4	28.6	29.1	37.8	83.7	51.4
1964	56.8	106.9	125.3	58.2	46.8	77.5	34.4	91.3	164.1	76.0	94.8	64.0
1965	154.3	449.3	109.3	121.1	557.8	385.7	93.1	65.7	58.0	172.6	165.6	296.5
1966	142.4	163.1	121.0	209.2	349.9	134.5	107.9	88.3	110.6	101.1	76.8	68.6
1967	78.3	66.5	64.2	67.2	88.6	53.7	43.1	81.9	2129.9	454.2	248.4	173.6
1968	793.0	317.4	208.7	246.0	559.3	562.6	269.1	113.7	190.7	149.4	110.4	183.7
1969	136.3	268.3	279.7	403.1	354.5	169.3	73.4	74.6	79.2	161.6	113.5	168.0
1970	167.8	138.6	284.6	173.2	316.9	369.9	120.4	79.8	117.5	150.6	65.5	65.2
1971	61.7	52.2	55.6	55.1	67.7	53.2	51.9	293.8	468.5	372.4	205.2	287.7
1972	151.5	155.8	105.4	92.9	1093.2	284.6	131.5	142.2	119.7	167.2	178.2	82.1
1973	101.5	140.0	195.7	451.5	189.6	816.5	530.0	314.5	320.4	1255.5	342.7	215.7
1974	275.8	191.5	162.3	115.1	307.0	149.2	78.1	166.2	364.4	188.2	403.3	336.7
1975	206.7	364.4	236.1	209.5	729.7	582.6	300.4	178.8	177.0	108.9	124.7	122.1
1976	114.2	76.1	83.4	533.3	579.5	305.1	313.0	131.7	154.8	411.6	549.9	717.8
1977	286.0	368.8	197.8	921.0	476.0	404.6	146.0	112.9	135.8	117.3	227.4	99.9
1978	100.3	118.1	96.0	107.4	81.4	180.3	62.7	402.1	511.0	131.2	190.1	114.2
1979	460.7	294.6	327.3	502.7	695.3	552.9	295.0	169.7	410.3	92.9	88.0	92.9
1980	147.5	90.6	78.6	73.6	296.7	86.8	58.5	124.5	180.4	104.9	81.8	85.4
1981	96.5	77.8	126.8	157.9	298.5	1102.2	374.0	195.0	825.7	342.6	413.5	141.4
1982	111.2	233.9	106.8	92.3	500.7	115.9	72.8	59.8	55.6	77.8	183.5	76.2
1983	80.2	139.3	202.4	98.4	126.1	118.3	197.0	69.9	119.0	118.6	104.3	55.9
1984	96.0	64.0	93.9	51.7	56.0	41.8	30.2	38.6	28.5	156.5	87.6	93.5
1985	210.6	124.4	264.0	298.3	145.4	296.6	233.7	83.2	86.7	196.0	280.9	238.2
1986	136.7	129.9	99.4	80.0	166.6	401.8	113.5	74.6	132.5	310.9	223.8	548.5
1987	343.6	302.7	373.9	170.2	277.8	2504.0	447.9	255.3	167.5	135.7	165.7	129.7
1988	106.7	93.3	107.7	84.3	83.3	92.5	130.3	78.5	68.8	58.3	51.5	61.2
1989	89.8	68.7	72.3	77.5	123.2	99.1	51.5	43.5	32.5	50.0	62.9	49.5

Table A2 - Inflows to the Guadalupe Estuary, Scenario - Historical

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1941	205.5	334.9	380.9	508.2	1239.6	430.7	358.0	129.5	142.6	179.0	111.6	121.6
1942	72.3	135.6	84.9	191.8	125.5	71.7	949.1	157.3	615.2	322.0	149.7	125.7
1943	150.3	100.2	139.1	85.8	109.6	170.2	107.2	57.2	77.8	56.8	79.1	90.8
1944	249.8	121.2	311.5	110.4	479.6	214.9	91.8	103.3	185.1	100.3	100.2	202.8
1945	244.0	233.8	219.9	460.1	121.0	149.6	97.4	238.2	51.9	120.2	63.1	80.4
1946	103.4	173.9	252.4	141.9	260.9	299.9	78.2	193.0	635.1	839.4	299.5	175.0
1947	281.4	149.3	169.0	176.9	306.1	90.4	71.4	95.6	47.4	51.7	80.3	69.4
1948	80.8	101.5	92.8	43.0	129.7	24.9	51.4	83.6	104.3	44.7	33.8	36.6
1949	42.1	81.3	122.4	566.3	214.4	124.0	126.2	56.0	44.2	407.2	72.7	108.3
1950	64.9	76.1	55.3	96.6	63.3	182.0	38.5	28.4	33.2	27.1	28.4	33.2
1951	31.3	33.3	34.9	28.1	96.5	205.7	5.1	0.0	208.3	27.6	31.0	28.7
1952	28.3	42.5	35.7	84.1	188.9	88.3	22.8	0.0	512.8	46.9	107.9	142.6
1953	118.0	67.5	47.6	54.2	258.5	3.8	3.5	185.6	193.8	132.2	50.1	68.9
1954	44.6	32.9	29.1	30.0	48.9	2.9	0.0	0.0	0.0	48.9	23.0	18.4
1955	25.6	86.7	29.9	14.9	65.5	42.9	1.2	29.8	68.7	16.8	11.2	20.6
1956	18.6	20.9	16.0	15.8	36.3	0.0	0.0	4.0	11.8	43.4	16.5	58.6
1957	14.0	33.9	259.0	670.7	755.0	558.6	46.1	22.9	392.6	577.9	448.2	142.5
1958	483.4	892.8	290.1	144.5	414.5	128.3	101.5	50.6	314.8	328.3	239.7	191.3
1959	109.9	303.4	105.4	262.7	167.2	118.1	93.6	131.6	61.4	364.8	108.3	111.3
1960	114.5	151.5	128.5	99.2	175.2	308.0	205.2	273.0	80.7	1207.5	666.5	413.8
1961	362.0	453.2	195.3	133.3	84.4	598.0	323.4	91.3	254.9	98.0	213.4	82.9
1962	76.6	69.6	63.5	89.5	65.0	153.0	39.6	22.3	91.6	57.4	66.2	109.9
1963	57.1	92.5	53.0	53.0	28.0	20.6	12.2	0.0	12.3	29.9	82.8	47.9
1964	56.0	108.4	127.9	42.0	25.3	60.0	5.4	81.1	129.4	68.2	93.3	58.1
1965	151.6	442.5	99.6	92.3	493.9	341.5	69.6	39.7	42.8	165.5	166.4	293.8
1966	155.7	177.1	117.8	215.9	384.4	136.9	115.9	70.8	95.3	101.0	74.1	64.8
1967	74.9	62.3	54.5	55.8	75.5	33.6	18.9	67.4	2227.3	481.1	259.3	186.8
1968	725.5	299.6	187.1	237.7	559.3	562.4	273.1	101.3	178.1	155.1	109.8	184.6
1969	143.5	278.2	296.5	396.8	347.1	153.1	49.2	57.2	60.4	110.0	115.4	156.6
1970	184.1	140.3	277.8	182.9	284.2	397.2	112.2	65.7	110.7	144.5	57.1	57.3
1971	54.1	44.7	42.9	36.5	50.2	27.5	32.8	174.2	507.6	387.1	222.5	301.8
1972	151.7	173.7	101.7	83.3	1069.9	289.0	130.5	135.6	103.7	167.6	185.1	74.6
1973	96.4	131.9	189.7	450.8	191.9	797.1	541.1	342.3	339.7	1257.5	385.4	234.5
1974	282.5	204.5	165.9	102.9	284.8	138.0	54.4	117.9	364.2	189.7	406.8	360.1
1975	214.4	372.5	243.5	206.2	701.9	637.8	299.8	180.5	176.2	94.2	120.2	107.8
1976	107.6	68.2	76.6	530.3	580.4	317.1	297.7	132.4	142.8	395.8	584.3	764.4
1977	301.2	381.6	206.0	924.3	498.7	441.1	141.1	94.2	120.2	107.4	226.1	93.2
1978	96.0	113.5	87.8	97.7	63.7	166.1	42.5	329.7	526.4	138.4	189.8	101.9
1979	464.1	310.6	331.6	509.1	723.9	562.5	292.8	168.2	413.1	80.1	80.6	86.4
1980	135.9	84.6	66.4	59.4	275.3	72.0	37.0	109.9	144.4	86.1	74.8	75.5
1981	88.4	74.5	103.2	126.1	303.1	1108.9	389.5	181.1	847.3	316.6	434.1	152.5
1982	110.4	241.5	103.6	83.2	476.9	95.8	55.1	42.9	36.8	71.4	170.9	69.8
1983	76.0	142.3	203.1	98.4	111.5	97.6	203.2	62.5	109.8	113.0	106.2	51.3
1984	90.2	58.2	89.4	37.5	39.4	19.8	9.2	22.6	11.7	150.2	90.0	81.9
1985	184.5	115.4	262.3	307.0	126.5	232.6	225.4	73.6	74.0	169.1	290.8	240.2
1986	139.1	123.1	90.8	66.2	143.2	386.3	97.5	56.0	102.6	283.6	224.6	509.9
1987	386.2	303.9	382.8	168.5	239.2	2478.1	556.6	334.7	189.3	136.1	144.8	113.5
1988	91.4	77.8	93.9	64.9	60.6	72.0	74.3	73.4	49.1	38.9	40.3	51.0
1989	79.0	61.5	63.7	63.8	105.4	82.0	31.8	22.9	9.5	33.6	57.2	46.2

Table A3 - Inflows to the Guadalupe Estuary, Scenario - Present Use Conditions

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1941	176.8	274.7	354.6	477.4	1175.2	387.7	319.4	93.0	108.7	159.1	87.2	100.7
1942	51.0	117.2	62.1	162.3	98.2	40.0	886.4	128.9	552.5	285.3	121.5	99.3
1943	127.5	76.7	112.6	53.8	82.4	132.4	74.6	27.3	54.5	35.2	61.7	73.1
1944	231.4	94.4	280.7	79.5	448.5	175.1	53.8	64.2	151.2	73.3	80.3	179.0
1945	215.0	205.8	190.9	417.4	85.2	113.6	62.3	210.3	21.3	89.6	39.0	56.9
1946	82.8	151.8	220.1	109.8	222.1	263.4	46.6	176.4	567.5	764.3	266.9	145.9
1947	251.4	120.7	139.5	152.4	285.8	71.5	53.9	74.5	32.4	34.6	60.6	49.5
1948	62.8	84.4	72.8	30.0	117.0	15.8	38.4	70.9	100.9	30.0	18.3	20.4
1949	26.8	51.3	95.1	521.6	179.2	98.2	102.7	32.8	26.4	378.1	51.1	88.2
1950	46.3	56.8	33.9	77.2	42.8	158.5	22.3	16.0	23.4	14.5	14.1	18.3
1951	18.3	19.7	18.4	17.6	87.5	185.3	7.0	1.3	203.2	21.1	19.1	15.8
1952	16.6	30.4	23.3	71.6	167.8	79.5	25.0	1.4	368.9	33.0	89.9	118.3
1953	95.0	49.4	30.2	39.6	235.5	9.7	8.9	186.3	170.2	113.7	34.3	51.2
1954	30.2	20.2	16.3	23.0	37.6	7.5	1.3	1.3	1.3	44.7	13.3	10.0
1955	14.9	68.3	16.5	9.5	53.0	38.6	5.3	30.0	65.9	12.1	5.4	11.7
1956	10.2	11.6	8.4	11.8	33.9	1.2	1.3	1.4	3.6	30.6	11.0	45.0
1957	7.9	26.5	197.6	539.9	653.0	472.2	24.6	11.4	339.7	487.8	372.4	102.7
1958	411.0	814.0	261.9	117.6	381.8	157.4	68.9	26.4	253.0	253.6	187.6	157.1
1959	88.5	259.0	75.8	236.4	139.0	90.6	62.4	104.0	38.9	313.5	80.9	83.1
1960	90.6	123.7	100.1	73.2	145.8	273.3	176.4	234.2	58.0	1089.4	612.4	371.4
1961	320.6	401.8	214.1	104.2	58.6	550.4	270.2	63.1	212.3	73.4	184.7	62.6
1962	57.3	50.0	41.5	65.5	44.5	119.7	22.5	10.2	67.6	41.4	47.9	91.8
1963	42.4	74.2	35.6	33.9	23.3	20.6	12.0	4.2	9.7	15.6	62.9	33.3
1964	38.9	84.8	96.2	31.9	23.8	46.1	9.4	64.9	104.1	41.9	64.7	41.8
1965	133.1	410.9	76.5	78.3	460.9	344.8	53.9	31.2	29.7	141.5	141.8	273.6
1966	120.8	141.8	94.9	179.6	319.6	98.7	68.2	46.9	75.5	70.7	51.1	46.9
1967	56.6	45.9	39.3	41.7	65.9	30.5	16.8	55.9	2075.0	422.2	210.5	146.0
1968	752.5	285.2	172.3	210.5	516.2	523.5	224.7	76.7	161.2	123.9	86.7	160.1
1969	115.7	245.8	252.8	365.7	324.3	132.3	38.3	38.8	49.0	111.7	88.0	140.4
1970	143.3	115.7	252.8	139.4	285.5	327.0	78.9	42.9	87.9	123.7	41.9	41.6
1971	39.3	30.1	30.5	28.5	42.7	26.3	22.9	161.5	434.1	338.7	226.6	260.4
1972	125.8	128.8	74.9	60.2	1044.7	242.3	91.0	101.6	86.2	137.5	152.2	56.6
1973	80.0	117.9	166.7	421.3	152.8	780.4	455.4	320.0	288.6	1209.1	304.5	182.4
1974	249.5	161.7	130.4	80.4	269.6	108.2	40.4	117.4	328.4	157.5	375.4	306.7
1975	174.9	328.0	253.2	174.4	692.6	531.3	249.8	134.3	139.6	77.2	95.4	96.7
1976	87.8	49.5	55.5	498.6	539.7	260.5	265.6	85.1	118.5	382.0	515.9	683.7
1977	255.5	333.7	160.0	888.3	480.4	357.3	95.5	69.2	101.0	82.3	194.1	70.9
1978	76.3	93.4	65.5	75.9	49.8	139.7	28.2	295.4	529.5	96.2	166.0	87.2
1979	435.8	264.1	284.2	457.8	652.4	545.8	250.4	122.7	373.9	61.5	60.2	65.8
1980	122.9	65.0	49.4	40.3	266.3	50.6	23.1	91.7	124.6	68.0	54.4	56.5
1981	70.4	52.0	91.4	115.2	258.6	1053.5	378.3	155.0	785.7	300.8	380.8	110.2
1982	84.0	209.4	76.1	60.6	462.5	73.8	32.2	22.4	24.6	51.2	157.5	50.8
1983	57.3	114.8	168.8	63.9	88.0	76.9	160.6	34.7	93.1	93.9	77.9	35.5
1984	73.2	40.9	67.3	22.5	29.5	13.5	3.7	11.3	6.8	125.6	63.8	58.3
1985	138.4	92.9	228.9	264.0	106.8	256.6	191.0	42.1	51.9	163.6	261.5	211.9
1986	110.9	103.7	68.4	46.8	135.9	350.6	62.6	37.3	90.8	265.1	186.9	516.4
1987	360.7	273.5	331.0	127.6	222.1	2462.9	444.6	202.7	130.6	99.5	137.3	102.7
1988	79.2	65.7	75.6	49.5	50.5	51.2	75.4	35.0	32.9	30.1	26.5	37.1
1989	62.2	40.7	41.5	44.5	90.6	64.8	22.4	16.7	10.2	25.7	40.6	28.8

Table A4 - Inflows to the Guadalupe Estuary, Scenario - Region L Baseline

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1941	168.2	276.6	338.3	460.4	1155.4	362.4	299.9	74.3	92.7	146.7	77.6	91.2
1942	39.6	104.9	46.8	145.3	79.4	20.6	862.5	109.2	533.8	275.1	111.7	89.9
1943	114.8	64.1	96.2	39.1	63.2	113.2	54.3	9.9	35.8	23.1	49.4	62.8
1944	216.1	82.7	263.9	64.1	430.1	153.3	34.6	47.3	135.8	62.3	70.1	168.6
1945	201.3	192.4	174.4	401.2	68.0	93.4	43.3	192.8	7.4	79.9	29.3	48.0
1946	69.0	138.7	203.5	93.0	203.8	242.1	24.9	148.4	555.4	752.1	257.1	136.3
1947	239.0	105.8	121.1	135.2	267.9	52.6	33.4	55.2	15.8	24.4	50.7	40.4
1948	50.5	73.5	59.6	15.2	101.4	0.5	19.1	52.6	86.8	19.4	9.6	12.6
1949	16.1	39.5	80.2	501.5	162.5	76.6	80.0	14.2	11.8	364.1	41.3	76.2
1950	34.0	43.9	17.9	59.8	23.9	133.9	5.0	0.1	9.2	3.1	5.0	9.4
1951	6.9	8.9	5.3	5.6	69.0	162.1	0.0	0.0	183.7	9.5	9.3	5.1
1952	4.5	18.6	8.4	54.6	151.2	59.1	4.5	0.0	347.6	20.4	76.1	106.1
1953	81.5	34.5	13.8	23.5	216.6	0.1	0.0	163.5	148.3	99.5	21.6	35.7
1954	14.9	6.5	0.8	7.7	18.5	0.0	0.0	0.0	0.0	30.4	4.5	0.0
1955	2.2	52.1	1.2	0.0	32.0	17.5	0.0	6.9	49.0	2.7	0.0	0.6
1956	0.0	0.0	0.6	3.6	11.2	0.0	0.0	0.1	0.0	13.2	2.6	32.4
1957	0.0	11.1	176.4	509.6	622.5	440.6	6.5	0.0	316.4	484.7	382.4	106.9
1958	413.6	779.8	239.5	98.1	353.5	91.9	52.7	15.0	243.6	256.6	189.7	150.0
1959	74.5	247.1	63.1	221.4	120.8	73.7	45.6	88.8	25.9	301.8	72.9	76.7
1960	79.0	112.0	85.1	56.8	127.0	250.4	151.9	211.4	40.0	1071.2	597.7	357.9
1961	303.9	383.7	146.0	90.1	43.5	529.0	245.4	43.9	196.5	60.4	172.4	53.5
1962	45.1	39.1	28.2	48.9	27.6	98.3	4.3	0.0	48.2	27.0	35.7	78.3
1963	28.5	60.2	18.4	17.8	6.3	0.8	0.0	0.0	0.0	0.0	51.1	21.7
1964	25.8	68.2	75.9	14.6	5.4	22.0	0.0	43.0	83.6	27.2	49.7	29.1
1965	118.2	388.1	56.0	56.2	437.0	305.4	28.1	9.8	12.1	125.5	128.9	256.3
1966	103.0	124.9	74.8	159.8	296.1	74.4	45.3	24.8	55.7	57.1	39.2	36.0
1967	43.2	33.1	24.3	27.0	50.0	13.3	6.3	39.5	2050.7	404.4	197.4	133.1
1968	736.3	260.8	146.1	186.1	488.1	495.0	197.1	54.1	140.9	109.2	74.0	147.0
1969	100.6	230.1	233.5	350.3	296.6	106.7	14.7	18.5	30.0	86.5	75.4	127.6
1970	127.5	99.5	229.9	119.3	256.7	298.5	55.0	21.8	70.7	108.0	29.6	31.5
1971	26.5	17.9	17.3	15.8	28.2	9.5	6.4	139.0	416.2	315.8	164.6	246.6
1972	109.8	114.8	60.0	45.8	1026.4	217.7	65.0	78.0	66.6	125.4	140.1	45.0
1973	64.7	99.5	145.2	395.9	127.9	745.8	433.6	238.8	268.6	1197.9	285.4	165.7
1974	229.1	144.8	112.7	63.4	245.0	84.3	17.9	95.5	304.2	141.0	356.0	290.1
1975	154.4	314.6	180.5	155.0	670.5	507.2	224.6	114.7	124.5	66.8	85.9	88.2
1976	76.6	41.1	44.0	479.8	513.5	234.2	232.7	62.0	98.1	358.5	492.5	659.9
1977	229.8	313.9	136.8	858.9	408.2	332.2	73.7	51.2	84.0	71.7	184.6	61.5
1978	62.7	81.1	52.0	61.2	33.4	119.9	10.7	280.0	458.9	83.2	151.7	74.5
1979	414.2	246.2	272.1	446.2	633.0	481.8	223.4	101.0	356.6	52.5	52.7	57.0
1980	110.4	54.8	38.2	28.3	247.4	32.0	6.7	72.1	109.7	60.8	45.6	48.4
1981	58.3	41.7	75.3	99.8	240.8	1025.3	295.9	135.8	769.2	293.5	372.2	103.2
1982	72.6	197.9	64.6	48.1	440.3	54.3	14.0	6.8	10.7	42.1	150.2	43.0
1983	45.3	102.6	150.8	49.0	76.5	59.2	137.4	15.1	75.5	82.3	68.4	27.4
1984	60.2	30.2	53.4	11.2	16.7	0.1	0.6	5.2	1.9	111.0	52.3	44.0
1985	133.8	81.7	199.6	244.6	88.3	231.2	163.5	21.7	34.0	146.6	242.9	196.5
1986	96.3	90.9	55.2	33.1	115.6	322.8	37.0	16.1	72.6	247.4	173.5	495.2
1987	295.2	263.5	321.7	114.2	230.2	2430.7	376.6	187.8	119.8	94.5	131.1	99.0
1988	71.8	60.0	67.6	40.8	38.3	35.8	53.4	21.2	20.7	21.7	20.3	32.5
1989	52.2	31.7	31.5	31.6	75.7	50.0	11.3	4.5	0.4	18.4	33.9	19.4

Table A5 - Inflows to the Guadalupe Estuary, Scenario - TCEQ Baseline; (Run 3)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1941	154.5	264.8	306.8	449.7	1145.8	353.8	293.0	67.3	84.2	137.3	70.3	84.1
1942	31.9	98.3	40.9	133.2	71.2	14.3	849.7	102.5	522.8	265.1	103.1	83.6
1943	107.5	57.0	89.5	32.9	56.0	106.7	46.2	3.2	27.3	15.0	42.3	54.7
1944	208.8	75.7	256.1	59.0	416.5	147.0	28.5	38.1	129.2	54.0	62.3	159.8
1945	192.0	184.8	165.9	392.7	62.3	86.6	35.6	185.4	3.0	66.6	21.8	40.8
1946	61.6	131.9	195.6	86.2	191.7	232.8	19.3	147.8	544.9	742.2	248.4	128.0
1947	228.4	101.3	114.6	129.0	259.5	45.6	26.8	46.2	8.0	14.8	40.7	29.9
1948	40.4	62.6	50.0	8.3	91.1	0.0	10.5	44.2	78.6	8.8	1.8	3.8
1949	8.4	29.0	73.2	484.1	151.1	78.6	73.9	8.8	6.0	349.8	34.8	69.2
1950	25.9	38.8	11.7	52.3	16.9	128.5	0.0	0.9	2.8	1.1	1.1	1.1
1951	3.5	2.2	0.7	0.8	57.7	154.1	1.3	1.1	177.1	3.6	2.7	1.1
1952	0.8	11.8	3.4	47.2	142.7	55.7	1.4	1.1	341.1	17.7	72.2	101.2
1953	78.4	33.0	10.2	18.3	209.5	1.5	1.0	159.0	141.3	93.8	17.9	32.9
1954	12.7	6.0	1.0	1.8	9.9	0.9	0.9	1.0	1.0	28.9	4.2	1.1
1955	1.7	44.8	1.2	1.0	23.9	14.7	1.4	5.1	47.0	1.2	1.0	1.6
1956	0.5	0.9	1.4	4.5	7.3	0.7	0.9	1.1	1.0	10.2	1.2	29.6
1957	0.8	7.2	176.4	499.6	615.2	436.6	3.6	1.2	301.0	468.3	376.7	101.7
1958	404.5	775.2	235.6	94.2	344.3	81.1	42.4	4.9	226.7	242.9	181.2	141.8
1959	64.5	236.3	54.5	210.3	113.1	63.4	36.9	80.6	17.7	288.5	64.5	65.2
1960	69.4	103.2	76.0	50.8	120.2	247.4	149.3	202.9	38.5	1061.2	592.6	353.6
1961	298.2	379.2	137.6	82.4	37.6	517.9	238.5	38.2	187.8	50.6	166.0	45.6
1962	36.3	31.5	21.3	38.8	21.2	92.2	1.6	1.1	39.5	22.5	29.2	72.1
1963	24.0	52.6	16.3	11.8	1.2	0.9	0.9	1.0	1.0	0.4	40.1	16.0
1964	20.6	62.6	70.6	10.5	1.1	17.4	1.0	38.6	77.7	21.4	43.0	24.0
1965	114.5	383.7	53.9	52.5	463.3	300.5	30.8	9.3	7.0	120.4	124.9	249.8
1966	102.2	120.7	73.2	155.4	292.0	74.1	44.9	17.1	50.8	52.9	34.8	30.1
1967	39.2	30.0	19.0	22.2	44.7	8.2	7.0	29.0	2039.8	402.4	188.1	130.7
1968	725.1	262.1	146.6	184.2	484.9	495.0	197.8	53.8	135.6	104.9	69.0	140.0
1969	95.0	221.3	227.4	346.0	290.8	106.2	16.4	18.9	29.1	75.9	73.2	122.0
1970	121.2	93.5	226.2	116.1	249.9	298.6	58.3	20.6	65.5	104.2	26.8	27.5
1971	21.3	14.2	13.3	9.6	21.3	2.7	2.4	122.5	410.6	304.4	158.5	241.2
1972	106.6	107.4	52.3	37.5	1011.2	211.7	64.4	73.9	60.8	117.7	135.2	39.0
1973	58.2	91.7	142.4	392.4	127.2	745.6	441.3	237.8	268.3	1204.6	291.2	166.1
1974	227.7	142.8	107.9	57.7	238.3	83.7	15.5	86.6	300.3	137.6	355.6	289.6
1975	153.0	317.0	176.2	149.9	671.0	506.9	221.5	107.7	117.5	57.1	78.4	80.1
1976	66.0	32.1	32.2	466.4	511.7	232.8	235.2	59.6	92.1	357.4	497.1	665.9
1977	234.0	316.7	137.1	862.1	408.6	327.1	69.0	44.2	74.1	61.3	176.9	53.7
1978	54.6	71.8	41.7	49.7	23.9	111.2	6.2	267.2	452.4	78.1	145.6	72.2
1979	412.0	246.4	271.6	443.7	628.0	477.1	221.3	96.3	350.5	42.9	42.4	46.7
1980	102.3	45.7	28.9	17.0	234.4	27.2	2.6	66.2	97.7	51.5	36.2	39.5
1981	49.3	33.5	66.0	90.4	230.1	1029.9	292.9	136.8	761.3	281.9	364.6	95.9
1982	63.3	188.1	53.2	37.7	430.6	48.8	8.8	2.0	7.4	28.9	139.3	34.0
1983	38.9	92.5	141.2	45.7	66.6	61.1	133.9	13.5	66.3	72.6	58.4	22.3
1984	52.0	27.4	46.5	6.8	11.7	0.9	1.6	6.2	3.0	94.9	44.6	36.2
1985	122.6	76.5	191.2	238.5	80.9	224.6	161.2	22.0	27.4	137.3	239.0	193.0
1986	90.8	83.4	49.7	24.7	106.2	317.4	36.7	14.0	64.1	239.3	167.0	487.9
1987	287.1	255.3	313.4	104.9	217.8	2434.7	365.3	175.9	107.4	80.6	117.5	84.7
1988	59.6	46.4	52.8	27.7	26.3	26.5	43.3	14.9	11.7	12.9	11.4	21.7
1989	40.9	24.3	21.9	21.4	68.5	38.0	12.7	5.7	1.5	8.7	23.4	11.2

Table A6 - Inflows to the Guadalupe Estuary, Scenario - w. Guadalupe Project

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1941	167.8	275.8	337.6	460.2	1155.1	362.0	298.1	74.3	91.9	143.6	77.6	91.2
1942	39.6	104.9	46.8	138.3	78.0	20.6	861.0	108.9	531.7	274.0	110.5	88.8
1943	113.8	63.5	94.3	37.8	63.1	110.3	53.3	9.9	35.8	23.1	49.4	62.8
1944	212.3	76.7	263.0	62.8	429.6	151.5	33.4	47.0	132.3	62.1	67.5	167.9
1945	200.6	192.0	173.6	400.7	66.2	92.1	43.0	192.8	7.4	76.7	29.3	46.2
1946	63.7	138.2	202.6	92.4	202.4	241.7	24.9	148.4	552.1	751.0	256.4	135.2
1947	238.5	104.5	120.2	134.8	266.3	51.7	33.4	52.9	15.8	24.4	50.7	40.4
1948	50.5	73.5	59.6	15.2	99.2	0.5	19.1	52.6	86.8	19.4	9.6	12.6
1949	16.1	37.2	72.7	493.2	153.9	75.1	80.0	14.2	11.8	359.9	41.3	76.2
1950	34.0	43.4	17.9	58.1	23.5	131.6	5.0	0.1	9.2	3.1	5.0	9.4
1951	6.9	8.9	5.3	5.6	69.0	160.2	0.0	0.0	183.7	9.5	9.3	5.1
1952	4.5	18.6	8.4	54.6	148.2	56.8	4.5	0.0	345.1	20.4	74.2	101.4
1953	78.2	34.5	13.8	22.6	216.6	0.1	0.0	163.5	146.2	95.7	21.6	34.7
1954	14.5	6.5	0.8	7.7	18.3	0.0	0.0	0.0	0.0	30.4	4.5	0.0
1955	2.2	50.1	1.2	0.0	31.6	16.7	0.0	6.9	49.0	2.7	0.0	0.6
1956	0.0	0.0	0.6	3.6	11.2	0.0	0.0	0.1	0.0	13.2	2.6	32.4
1957	0.0	11.1	172.4	505.1	609.6	418.8	6.5	0.0	311.1	467.9	359.7	104.8
1958	413.3	779.8	238.3	96.9	352.7	90.2	51.7	15.0	239.4	255.9	188.6	148.9
1959	73.3	246.8	61.9	220.5	119.6	71.9	44.9	88.5	25.9	299.4	69.9	73.9
1960	78.0	111.1	83.9	55.8	127.0	247.9	150.0	209.8	39.7	1071.0	596.8	357.4
1961	302.9	383.0	144.6	88.7	43.3	527.2	244.0	43.9	194.5	59.3	171.2	53.5
1962	45.1	39.1	28.2	48.1	27.6	97.7	4.3	0.0	47.9	21.4	31.0	73.2
1963	25.4	59.5	16.8	16.4	6.3	0.8	0.0	0.0	0.0	0.0	46.7	20.8
1964	25.8	63.9	71.4	13.2	5.4	22.0	0.0	43.0	83.0	24.6	42.8	28.2
1965	113.1	387.1	54.7	55.0	436.7	304.5	27.3	9.8	12.1	124.9	125.7	252.1
1966	101.9	124.4	73.3	159.0	295.2	73.6	45.3	24.6	54.4	56.3	39.2	36.0
1967	43.2	33.1	24.3	27.0	50.0	13.3	6.3	39.5	2040.0	404.4	185.2	128.3
1968	736.5	260.8	146.1	183.8	487.3	495.3	195.1	54.1	140.7	109.2	72.5	144.0
1969	100.5	227.2	232.7	349.8	295.5	104.7	14.7	18.5	30.0	78.8	74.2	126.6
1970	126.7	98.8	229.0	117.9	256.4	296.2	53.9	21.5	70.7	106.4	29.6	31.5
1971	26.5	17.9	17.3	15.8	28.2	9.5	6.4	127.5	406.2	314.7	163.2	245.8
1972	108.9	113.6	59.8	45.8	1024.8	215.9	63.7	76.0	66.6	124.7	138.4	44.9
1973	60.4	98.9	144.6	395.6	126.5	745.8	431.3	236.7	267.6	1198.4	284.0	164.1
1974	228.5	143.3	111.3	63.4	242.2	83.5	17.9	91.1	303.6	139.7	355.7	288.9
1975	153.1	313.6	179.1	154.6	671.0	505.9	223.1	112.9	123.6	64.2	85.6	87.3
1976	76.6	41.1	44.0	474.9	513.0	232.1	231.4	59.6	96.8	358.7	491.9	659.5
1977	229.2	312.9	135.4	859.2	407.0	330.8	71.5	50.3	84.0	70.6	179.0	61.5
1978	62.7	81.1	52.0	60.8	33.4	119.2	10.7	267.6	458.5	82.4	150.1	73.5
1979	414.1	245.5	271.1	445.8	632.8	480.2	221.9	99.2	355.5	51.8	52.7	56.7
1980	110.3	54.8	38.2	28.2	238.6	31.9	6.7	72.1	105.1	54.7	45.1	48.1
1981	57.0	40.0	74.0	98.8	239.7	1025.5	293.8	136.2	767.2	292.8	370.9	101.9
1982	72.3	196.2	64.6	48.1	437.4	54.3	14.0	6.8	10.7	42.1	150.2	43.0
1983	45.2	99.8	147.9	41.8	74.4	55.1	137.3	15.1	74.8	82.1	67.7	27.4
1984	60.2	30.2	53.4	11.2	16.7	0.1	0.6	5.2	1.9	106.6	49.1	39.1
1985	121.0	80.9	198.8	243.9	86.9	229.7	161.3	21.7	34.0	141.1	242.9	195.3
1986	95.2	89.8	54.1	33.1	112.8	321.5	35.8	16.1	67.4	246.9	172.7	495.3
1987	294.1	263.5	320.3	112.3	230.0	2432.5	374.5	186.0	117.3	92.3	130.2	98.0
1988	70.5	58.8	66.2	40.8	37.7	34.9	47.5	20.9	20.6	21.7	20.3	32.5
1989	52.2	31.7	31.5	29.5	68.9	48.7	11.3	4.5	0.4	18.4	33.9	19.4

Table A7 - Inflows to the Guadalupe Estuary, Scenario - w. San Antonio Project

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1941	167.3	276.4	337.8	460.0	1153.8	360.3	295.7	71.7	88.2	144.6	75.3	89.7
1942	37.4	103.4	46.8	141.7	77.6	18.5	861.5	109.2	529.6	276.3	109.3	87.9
1943	113.0	62.5	93.0	36.6	59.9	110.7	50.3	9.6	31.8	21.6	44.4	59.3
1944	215.8	81.9	263.1	61.3	429.5	153.1	32.1	43.4	125.4	60.8	67.7	168.6
1945	200.7	192.3	172.9	399.3	64.2	90.6	42.6	192.8	7.4	72.6	28.2	45.5
1946	65.1	135.2	199.9	91.8	202.0	239.4	23.6	140.9	558.7	749.9	255.7	135.4
1947	238.2	103.7	118.9	132.8	265.7	51.6	33.4	53.1	15.2	24.3	48.7	36.5
1948	49.7	71.3	59.4	14.2	96.2	0.5	12.2	49.7	86.8	13.6	9.6	12.6
1949	16.1	37.4	77.9	485.9	152.8	76.1	75.6	11.9	11.4	357.3	38.8	74.9
1950	32.8	43.9	17.9	58.0	23.7	131.2	5.0	0.0	9.2	3.1	5.0	9.4
1951	6.9	8.9	5.3	5.6	58.7	146.8	0.0	0.0	171.2	9.5	9.3	5.1
1952	4.5	18.6	8.4	50.8	146.8	59.1	4.5	0.0	327.9	20.4	75.1	105.3
1953	80.4	34.5	13.8	23.5	212.6	0.1	0.0	159.2	129.5	96.7	21.6	35.0
1954	14.9	6.5	0.8	7.7	16.8	0.0	0.0	0.0	0.0	30.4	4.5	0.0
1955	2.2	49.8	1.2	0.0	27.3	17.5	0.0	6.9	48.4	2.7	0.0	0.6
1956	0.0	0.0	0.6	3.6	11.2	0.0	0.0	0.1	0.0	10.5	2.6	22.8
1957	0.0	11.1	172.9	488.4	577.9	412.7	6.5	0.0	302.8	470.2	359.8	102.9
1958	400.3	779.7	237.8	96.7	351.4	89.4	49.7	15.0	238.2	256.4	187.7	148.3
1959	72.8	246.4	62.8	217.3	118.7	71.2	42.9	88.8	25.9	293.5	68.4	75.1
1960	77.4	110.8	84.1	53.6	124.1	246.9	148.0	209.0	39.0	1067.7	596.0	357.4
1961	302.4	382.7	143.6	87.3	43.3	524.8	244.0	39.7	192.4	58.3	170.9	51.8
1962	43.5	38.8	28.2	46.7	27.6	94.7	4.3	0.0	47.7	27.0	35.7	73.3
1963	28.5	56.7	18.4	17.8	6.3	0.8	0.0	0.0	0.0	0.0	47.6	21.0
1964	25.8	60.4	70.2	14.6	5.4	21.4	0.0	38.2	78.4	24.2	44.9	29.1
1965	111.9	355.9	52.9	47.9	437.6	302.0	28.1	9.8	12.1	120.3	128.5	241.9
1966	102.4	123.2	73.8	156.7	294.3	74.1	45.3	23.7	49.4	57.1	39.2	36.0
1967	43.2	33.1	24.3	27.0	50.0	13.3	6.3	35.4	2023.0	388.5	196.1	131.4
1968	737.9	259.7	144.2	184.6	486.4	492.7	193.3	54.0	133.8	109.0	73.7	141.0
1969	99.2	229.3	231.8	349.5	294.2	103.9	14.7	18.5	27.1	79.8	74.6	124.4
1970	122.3	97.9	228.4	117.0	256.4	294.6	55.0	21.8	70.7	107.5	29.6	31.5
1971	26.5	17.9	17.3	15.8	28.2	9.5	6.4	102.6	406.7	314.5	162.8	245.5
1972	108.2	112.6	58.6	41.8	1027.1	214.9	61.5	75.2	63.6	122.5	138.4	43.0
1973	63.8	98.7	143.1	395.7	127.1	744.1	431.7	234.7	270.1	1197.2	282.8	163.0
1974	227.7	142.3	110.3	60.8	243.2	81.6	17.9	89.4	302.0	139.3	355.8	288.6
1975	152.6	313.7	178.0	153.3	670.4	504.8	221.0	110.6	121.0	65.1	85.3	82.6
1976	74.2	39.8	42.6	477.8	512.5	230.4	230.7	58.0	95.4	358.1	491.1	658.7
1977	229.2	312.0	134.2	859.2	406.1	329.0	68.3	47.7	77.9	69.7	183.1	58.9
1978	61.4	79.6	49.9	59.4	30.9	116.0	10.7	271.5	459.0	79.7	151.5	72.9
1979	413.9	245.0	270.8	445.7	630.4	480.0	221.7	97.1	353.1	52.5	51.5	53.1
1980	105.6	53.8	38.1	24.3	244.5	31.1	6.7	64.0	102.4	59.3	43.0	46.4
1981	56.9	40.3	73.5	98.1	239.9	1025.8	291.7	131.8	765.4	293.4	369.9	101.0
1982	71.2	195.9	62.6	46.9	438.8	52.9	14.0	6.8	10.7	34.2	141.8	38.0
1983	42.7	101.2	149.7	48.9	73.8	57.2	137.4	15.0	61.4	80.2	65.7	27.3
1984	58.9	30.2	52.4	11.2	16.7	0.1	0.6	5.2	1.9	90.7	37.0	43.0
1985	132.8	80.5	198.2	243.0	85.5	230.3	160.8	21.7	30.2	139.5	242.0	194.3
1986	94.3	89.9	55.2	33.1	110.8	321.1	31.5	16.1	65.4	246.9	171.9	496.0
1987	293.4	263.5	319.5	111.3	231.5	2430.6	372.8	182.2	116.3	93.4	126.3	97.5
1988	69.8	58.4	66.3	39.3	38.2	35.2	45.6	21.2	20.7	21.7	20.3	32.5
1989	49.8	31.0	31.5	27.3	72.6	48.8	11.3	4.5	0.4	18.4	28.6	18.0

Appendix H

Report on Strategies to Meet Environmental Flow Standards by National Wildlife Federation

Strategies to Achieve Environmental Flow Standards in the Guadalupe Estuary

August 25, 2011

NATIONAL WILDLIFE FEDERATION

Strategies to Achieve Environmental Flow Standards in the Guadalupe Estuary

Submitted to: Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Bay and Basin Stakeholder Committee (GSA BBASC)

August 25, 2011

Submitted by:
National Wildlife Federation, Austin, Texas

Analyses performed by:
Norman D. Johns, Ph.D. of the National Wildlife Federation

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Introduction

On March 1, 2011, the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Expert Science Team (GSA BBEST) published a set of recommended freshwater inflow criteria for the Guadalupe Estuary. The estuary criteria consist of a multi-tiered suite of inflow volumes and an associated frequency of attainment for each (see Appendix A). Deliberations by the Stakeholder Committee for those same basins and estuaries (GSA BBASC) have focused on the ability under several scenarios of future water use, with and without new water supply development projects, to meet the BBEST recommendations at the recommended frequencies.

It has become apparent that any future scenario that includes the full use of existing water rights will have difficulty achieving the inflow criteria at the recommended frequencies, especially in the lower drought or near-drought tiers of the criteria. The starting “baseline” scenario for the GSA BBASC has been that of the Senate Bill 1 Region L Water Planning Group covering most of the Guadalupe River Basin. That scenario, referred to as the Reg. L Baseline, includes the full use of existing water rights and the 2006 levels of wastewater discharge[1]. Table 1 (in parts a-c) illustrates the portions of the BBEST recommendations for the spring Feb.-May season that are not achieved under the Region L Baseline scenario. Table 2 similarly illustrates the portions of the BBEST recommendations for the summer June-Sept. season that are not achieved under the Region L Baseline scenario.

Thus, the National Wildlife Federation, with the June 1, 2011 endorsement of the GSA BBASC, performed an evaluation of the effectiveness of several voluntary, pro-active water management “strategies” to address the shortcomings in meeting the BBEST recommendations. Table 3 outlines the three types of “strategies” endorsed by the BBASC for using existing water rights and wastewater flows in this effort to satisfy the estuary inflow recommendations.

A central and novel focus of these strategy evaluations was the underlying assumption that any water or wastewater made available via a strategy will actually be dedicated to environmental flow purposes. Under the normal “prior-appropriation” system used in Texas, water rights with unmet needs can divert any water in the stream not needed by other more senior water rights downstream, regardless of the source of that water. Thus, the analyses described herein involved special modeling techniques to simulate conditions where the dedicated wastewater or water freed up via specialized management of existing water rights was protected from diversion by other downstream rights. We recognize at the outset that the hydrologic analyses performed herein represent very specialized water management scenarios, which would likely require significant financial, legal, and administrative support to bring to fruition.

[1] The GSA BBASC version of this differs slightly from that of Region L itself, due to the adoption of springflows predicted by a new groundwater model.

Table 1 - Summary of the Historic, Present Conditions, and Region L Baseline scenarios attainment performance for the G1 suite of Guadalupe Estuary inflow criteria for the spring (Feb.-May) period. see notes at bottom..

Part a) Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline	7	10	8	3	3	4	14	49

Part b) Attainment - single criteria measures	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
goal	n/a	>12%	>12%	n/a	n/a	n/a	≤9%
Historical		28.6%	14.3%				10.2%
Present		28.6%	8.2%				16.3%
Region L Baseline		20.4%	16.3%				28.6%

Part c) Attainment - joint measures	Joint G1 criteria attainment (% of years and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	
goal	n/a		>17%		19%	≤67%	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline			22.4%		14.3%	57.1%	

Notes: Part a) is the counts of seasons (=years) that fall in each inflow category. Part b) measures attainment performance for the portions of the criteria that are stand-alone measures (e.g. occurrence of G1-A >12% of years). Part c) measures attainment for criteria that are to be assessed jointly (e.g. the total occurrence of G1-C and G1-CC). Attainment performance is highlighted with a color scheme indicated below[2]

Cell color scheme

color	(green)	(gray)	(orange)	(red)
meaning	criteria met	criteria nearly met. rounding & period of record change probable causes.	criteria not met, departure from BBEST recommendations not great	criteria not met, departure of concern from BBEST recommendations

[2] Color scheme as adopted by the BBEST Estuary Subcommittee in that group's report to the BBASC titled "Biological and Ecological Implications of Non-Attainment of the BBEST Guadalupe Estuary Criteria", July, 2011.

Table 2 - Summary of the Historic, Present Conditions, and Region L Baseline scenarios attainment performance for the G2 suite of Guadalupe Estuary inflow criteria for the summer (June-Sept.) period. Parts a), b) and c) and color scheme as in Table 1.

Part a) Counts	**Criteria G2 Attainment (no. years 1941-89)**								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline	4	8	8	8	7	3	3	8	49

Part b) Attainment - single criteria measures	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
goal	n/a	>12%	>17%	n/a	n/a	n/a	n/a	≤6%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%

Part c) Attainment - joint measures	Joint G2 criteria attainment (% of years and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
goal			≥30%		≥10%	≤17%	≤9%	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	

Table 3 – Brief description of "strategies" used for illustration of the effects of efforts to use existing wastewater and water rights to satisfy inflow recommendations for the Guadalupe Estuary.

Strategy	Description	Special Issues for Analyses
Strategy 1) wastewater dedication	Dedicate a portion of wastewater from most major dischargers to environmental flow purposes.	Assure dedicated wastewater is protected from diversion by other downstream rights and passes along rivers and into Guadalupe Estuary.
Strategy 2) dry year option on firm irrigation right(s)	On a temporary, weather-driven basis, convert all or a portion of one or more sr. irrigation water right to environmental flow purposes.	As above for Strategy 1. Also entails modifying WAM so that environmental dedication of the chosen right(s) is limited only to drought years.
Strategy 3) purchase / conversion of unused right	Convert all or portions of some major currently unused firm senior right(s) to environmental flow purposes.	Assure converted right's or rights' water is protected from diversion by other downstream rights; non-impairment of other senior rights.

Methodology

The principal tool for evaluation of these strategies was the Guadalupe - San Antonio Water Availability Model (WAM). The WAM is essentially a detailed accounting tool that tracks the water available for diversion by water rights, both existing and potential, under the prior-appropriation system and with various scenarios of water management. Among the principal features of the WAM, as relevant here, is the capacity to vary the water use levels and monthly diversion patterns by existing rights and vary the assumed wastewater return flows (Figure 1). Instream environmental flow conditions can also be imposed on new water rights, which govern the amount of diversion that the right may make. The starting "baseline" scenario for the GSA BBASC has been that of the Senate Bill 1 Region L Water Planning Group covering most of the Guadalupe River Basin. That scenario, referred to as the Reg. L Baseline, includes the full use of existing water rights and the 2006 levels of wastewater discharge[3].

As alluded to earlier, evaluation of each of the strategies required special effort to simulate conditions under which the water made available for the purpose of satisfying environmental flow needs was not simply diverted by other water rights downstream under the normal precepts of the prior-appropriation system. To accomplish this, NWF and contractors performed specialized executions of the Guadalupe - San Antonio WAM. For each strategy, a pseudo water right was placed at the mouth of the Guadalupe River below all other actual water rights. This imaginary water right was modeled such that it could divert only the water made available via the particular strategy being simulated, such as through dedication of wastewater. With the correct specification of the priority date of the pseudo right, we were able to utilize the WAM's normal prior-appropriation modeling system to "dedicate" and thus protect the water of the strategy from diversion by others. The water diverted by the imaginary right was then "returned to the river" at the Guadalupe Estuary. Much more detail on these modeling techniques can be found in Appendix B, the report from NWF's primary contractor, Intera Geosciences & Engineering.

As previously outlined in Table 3, the NWF effort involved three type of strategies. More specific information about the strategies is presented here. For each, in order to determine the approximate amount of water or wastewater that might be available to that particular strategy, NWF and the contractors examined the discharges and water rights characteristics that would appear to govern in each case. For example, by examining the WAM's input data, we were able to get a general idea of agricultural irrigation rights that might be used for the dry-year option (Strategy 2) or the volume of underutilized water rights (Strategy 3). However, it should be noted that the overriding focus of these efforts was to illustrate the potential effectiveness of these strategies on a conceptual basis, not to identify specific wastewater discharges or water rights that should be the necessary focus of any future implementation efforts.

[3] The GSA BBASC version of this differs slightly from that of Region L itself, due to the adoption of springflows predicted by a new groundwater model.

Strategy 1 - Wastewater Dedication.

This strategy relied upon wastewaters discharged from key municipal and industrial sources throughout the Guadalupe and San Antonio river basins. The GSA BBASC indicated a preference that in the evaluation of this strategy a portion of wastewater discharges from an array of dischargers covering a broad geographic area be utilized. In the Guadalupe - San Antonio WAM, wastewater discharges are described in a set of "constant inflow" data representing well-defined constant inputs of wastewater. In this strategy, NWF utilized ten of the largest wastewater discharges partially dedicated to the purpose of environmental flows. A map of the selected wastewater discharges and the amounts of each discharge re-purposed to the strategy are found in Figure B-1 and Table B-2 of Appendix B. Each of the wastewater discharges was set so that the same percentage of total discharges was dedicated to the strategy. In summary, the overall wastewater volumes assumed to be dedicated (units of ac-ft/yr) were 60,000 in Strategy1a and 120,000 in Strategy 1b.

Strategy 2 –Dry-Year Option, Irrigation Water Rights

This strategy relied upon water rights in the irrigation category to examine the effects of a temporary weather-driven modification of the right's or rights' use of water. Under this approach, an irrigator would be paid not to irrigate, or to irrigate fewer acres, during selected dry years with the equivalent volume of water left in the river or stream and dedicated to environmental flow purposes. Again, the water not removed from the stream as a result of the dry-year option, which would normally be available for diversion by others, was modeled so that it was protected from diversion by those other water rights.

NWF and contractors identified six irrigation rights to simulate for use in this strategy as detailed in Table B-3 and Figure B-4 in Appendix B. Furthermore, under this strategy, the conversion of the irrigation water right was exercised only during the driest ten years in the WAM's period of record covering 1934-89. In the analyses here, we "exercised" the dry-year option for all five irrigation water rights in 1950, 1954, 1956, 1963, 1965, 1969, 1982, 1984, 1988 and 1989. Under modeling Strategy 2a, a total of 16,599 acre-ft/yr was dedicated from five of the six water rights. With Strategy 2b, a slightly different set of five water rights was used to get a total of 31,836 acre-ft/yr dedicated. It is important to bear in mind that the actual amount of water made available to the estuary in any of the dry years depends heavily on the priority dates of the selected water rights vis-à-vis others in the basin. The water left in the stream and river channel is also subject to the normal channel losses that are approximated in the WAM. More details on the actual deliveries are presented in Appendix B.

Strategy 3 – Underutilized Water Rights, Conversion/Dedication

This strategy used five water rights that appear to have a sizeable unused portion under current conditions and that are predicted to be highly reliable under full water rights conditions. Generally, 'highly reliable' is synonymous with an early priority date. The identification of underutilized water rights followed a two-step process. Initially, NWF's primary contractor, Intera, used the TCEQ's standard WAM data files for Current Conditions (Run 8) and Full Use (Run 3), to begin the process. The difference between WAM Run 3 and Run 8 use levels is indicative of the existence of an underutilized increment on any given water right. These "raw" results are indicated in Figure B-7 of Appendix B. In the second step of this process, NWF modified those initial results based on conversations with the Guadalupe-Blanco River Authority (GBRA), the owner of many of the water rights near the end of the basin that appeared underutilized in step one. Based on those conversations, NWF identified several differences between the TCEQ's WAM Run 8 use levels and the actual utilization levels of water rights. The actual rights and the volumes that were utilized in this strategy are shown in Appendix B Table B-4. As with the others, this strategy was performed in two increments. Strategy 3a involved examining a conceptual conversion of underutilized rights with approximately 49,000 ac-ft/yr of total diversion capacity. Strategy 3b used the same five water rights but with an assumed total conversion of approximately 98,000 ac-ft/yr. As with Strategy 2, it is important to bear in mind that the actual amount of water made available to the estuary in any year will depend heavily on the priority dates of the selected water rights vis-à-vis others in the basin and will reach the full total in only wet years. Channel losses from the normal point of diversion to the estuary also diminish the delivery. More details on the actual predicted deliveries are presented in Appendix B.

Combination Strategy.

NWF and Intera also performed an evaluation of a combination strategy comprised of parts "a" of Strategies 1, 2, and 3. The actual predicted deliveries of water to the estuary can be found in Appendix B.

Evaluation Approach for Strategy Results

As previously described, the beginning point for these analyses was the so-called Region L Baseline of assumed water use, which also served as the baseline for water supply project evaluations for the GSA BBASC. Tables 1 and 2 highlighted the aspects of the BBEST recommendations that are not met under this water use scenario. Thus, the focus of the analyses of strategies here is to examine incremental improvements in the levels of attainment of those aspects of the recommendations that can be achieved through the use of these types of strategies. A primary indication of improved inflow conditions would be if the strategy produced a predicted improvement (i.e., for the "D", "frac. CC", and "D & DD" categories: a lessening of the percentage of years shown in gold or red) in the non-attainment measures highlighted in Tables 1 and 2. For instance, using the G1-D criteria as an example, Table 1 shows this level of inflow occurring 28.6% of years (indicated in part b) under the Region L Baseline scenario, whereas the BBEST recommendation was for no more than 9% of years. If any given strategy can augment the inflows enough to elevate the 3-month Mar-May sum into the next BBEST category (in this case, G1-C), this will reduce the percentage of time occurrence of G1-D. For these analyses, such a reduction is a primary indication of any strategy's effectiveness. As relevant here, the percentages are based on the number of years out of the modeled period of record that inflows fall within these particular categories. For example, the Table 1a) shows attainment counts in number of years and Table 1b) shows attainment by percentage of years.

However, changing the counts or attainment percentages as described above is not the only indication of a strategy's benefits. A strategy may increase low inflows in a beneficial manner but still fall short of augmenting the seasonal inflow sum enough to move it fully into the next higher inflow tier in the BBEST criteria (e.g. not enough increase to move from G1-D to G1-C). Clearly, the ability for any strategy to effect the desired incremental changes described above depends on both the magnitude of inflow change of that strategy as well as how big the inflow gaps to be made up are. Since each tier of the BBEST inflow criteria covers a range, sometimes a broad range, of inflow over a three-month period, this may be a difficult target. Thus, as a secondary indicator of success, we also examined the effectiveness of strategies by assessing for increases in the absolute amount of inflow during those low flow conditions even if that increase was not sufficient to move the total inflows into the next higher tier.

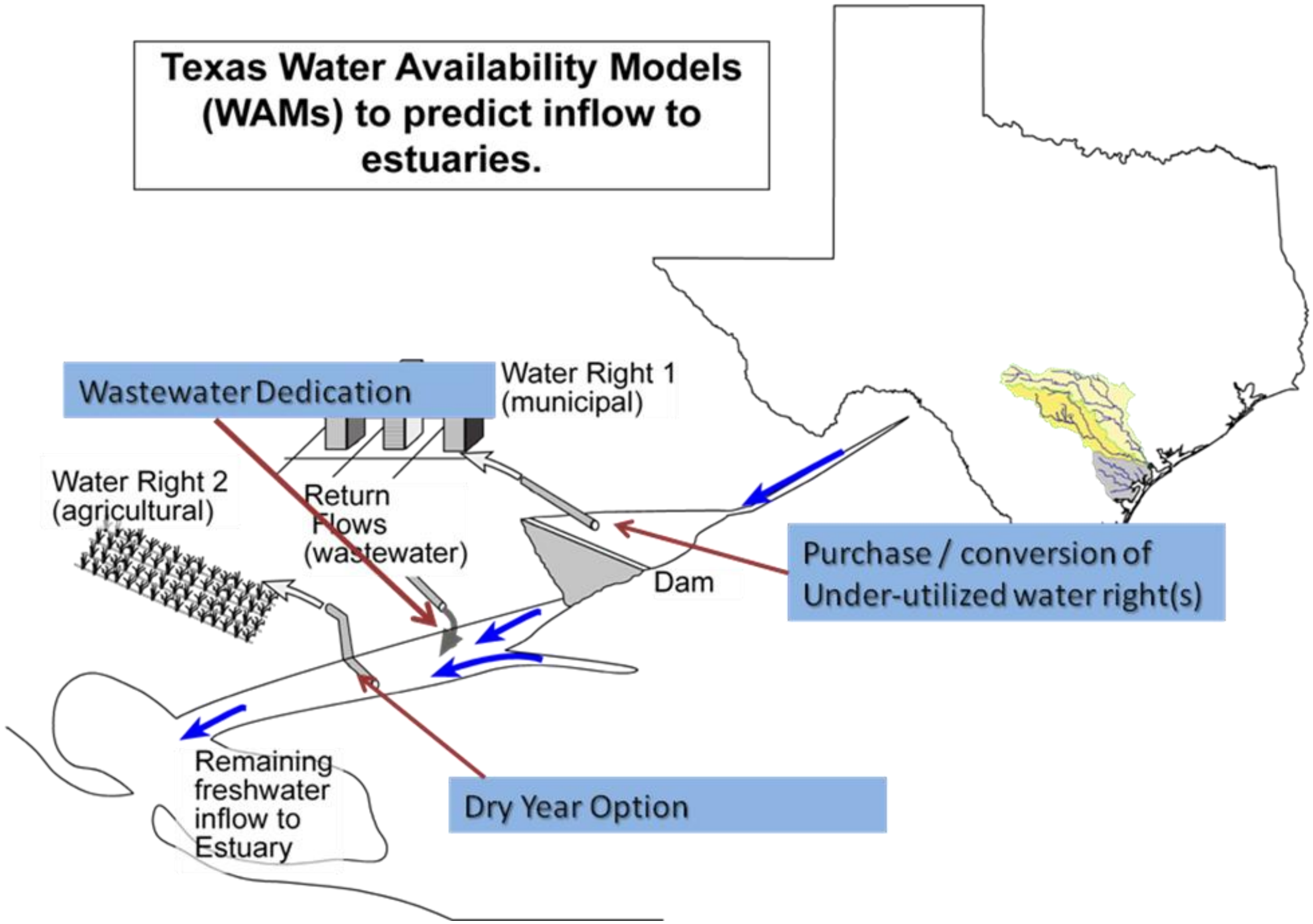

Figure 1. Illustration of the principal components of the Guadalupe - San Antonio WAM and the three strategies evaluated for the potential to meet the BBEST inflow recommendations for the Guadalupe Estuary.

Results

As introduced in the Methodology section we analyzed the effectiveness of the evaluated strategies to improve times of low inflows using two measures:
-1) the capacity of a strategy to bring about an integer change in the non-attainment measures highlighted in Tables 1 and 2 (such as lowering the percentage of years of G1-D occurrence).
-2) the capacity of a strategy to make significant improvements in inflow, even though the augmented inflows were not enough to lead to an actual change in the percentage of years. For ease of discussion we will refer to the changes described in "1" above as "categorical" changes and the changes described in "2" above as "within-category" changes.

Strategy 1 - Wastewater Dedication

Parts 1a and 1b of this strategy assumed dedication of 60,000 ac-ft/yr and 120,000 ac-ft/yr of wastewater to environmental flow purposes, respectively. Due to channel losses as modeled in the Guadalupe - San Antonio WAM, the net inflow to the estuary of these dedications were 42,377 ac-ft/yr and 84,638 ac-ft/yr, respectively, or approximately 70% of the dedicated amount. While there is some minor variation in the overall wastewater discharge on a monthly basis, the contributions are constant for all years in the period of record, even during drought periods.

Table 4 shows that neither level of Strategy 1 resulted in an improvement in the attainment, based on number of years, of the G1-D criteria compared to the Region L Baseline.

Table 4 - Summary of inflow attainment measures due to Strategy 1 for the G1 suite of criteria pertaining to the Guadalupe Estuary in the spring (Feb. - May) period.

Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	>A-pr[1]	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline	7	10	8	3	3	4	**14**	49
Strat1a - Ww Ded. 60k/yr	7	10	8	3	3	4	14	49
Strat1b - Ww Ded. 120k/yr	7	10	8	3	3	4	14	49

Notes: "Ww" means wastewater. 1) These are years with inflows above A-prime (A-Pr). There is no BBEST recommendation for inflows greater than A-prime; they are included here to track all 49 years in the analyses.

Cell color scheme for Tables 4 through 10.

color	meaning
14	Portion of Region L Baseline that is in non-attainment of the BBEST recommendations (see Table 1)
3	No change from the Region L Baseline
4	Categorical changes compared to Region L Baseline; not in areas of non-attainment.
11	Categorical changes compared to Region L Baseline and in areas of non-attainment.

Although Strategy 1 did not result in an improvement in the attainment of the G1-D criteria compared to the Region L Baseline, this lack of improvement via this "categorical" measure masks the fact that there are some very significant changes in inflow. This is especially the case during very dry periods as shown in Figure 2 for 1955-56. We include a more thorough examination of these "within category" improvements in a subsequent section.

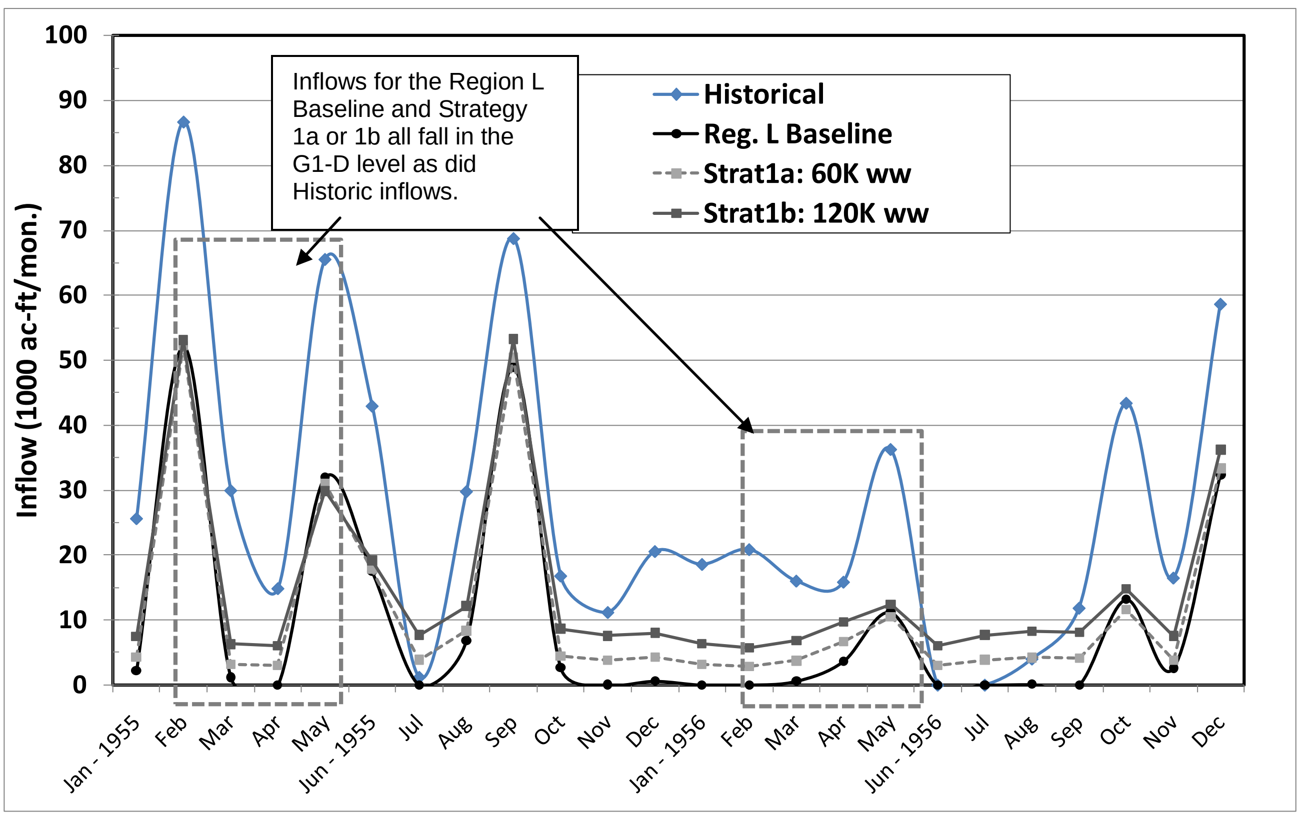

Figure 2 - Illustration of the changes in inflows to the Guadalupe Estuary in the 1955-56 period due to Strategy 1, a dedication of wastewaters to environmental flow purposes. Highlighted are the Feb.-May periods of the G1 criteria. The wastewater volumes dedicated were 60,000 and 120,000 ac-ft/yr in Strategy 1a and 1b, respectively.

Strategy 1 did lead to some categorical improvements in the attainment of the lowest level of the Guadalupe Estuary G2 summer criteria. As shown in Table 5, the Region L Baseline level of 8 years in the G2-DD level was improved to 7 years with Strategy 1a. That is the only improvement for Strategy 1a. For Strategy 1b, with a greater level of wastewater dedication, several categorical changes occurred: one year of G2-DD was improved to the G2-D level; one year of G2-D was improved to the G2-CC level; and one year of G2-CC was improved to the G2-C level.

Table 5 - Summary of inflow attainment measures due to Strategy 1 for the G2 suite of criteria pertaining to the Guadalupe Estuary in the summer (June-Sept.) period.

Counts	Criteria G2 Attainment (no. years 1941-89)								
Scenario	>A-pr[1]	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline	4	8	8	8	7	**3**	**3**	**8**	49
Strat1a - Ww Ded. 60k/yr	4	8	8	8	7	3	4	7	49
Strat1b - Ww Ded. 120k/yr	4	8	8	8	8	3	3	7	49

Notes: “Ww” means wastewater. 1) These are years with inflows above A-prime (A-Pr). There is no BBEST recommendation for inflows greater than A-prime; they are included here to track all 49 years in the analyses.

One of these changes is highlighted in Figure 3, using 1963-65 as an illustrative period. There are significant increases in inflows into the Guadalupe Estuary for the summer G2 periods through this strategy compared to the Region L Baseline. The increase in 1965 was enough to raise inflows into the G2-D range for either Strategy 1a or 1b and thus improve upon the Region L Baseline, which was a G2-DD year (actual historic inflows were at the G2-C level). Obviously, even in dry years without a categorical change, like 1963, there are very significant improvements, when compared to the Region L Baseline scenario. Again, these “within-category” changes are examined below.

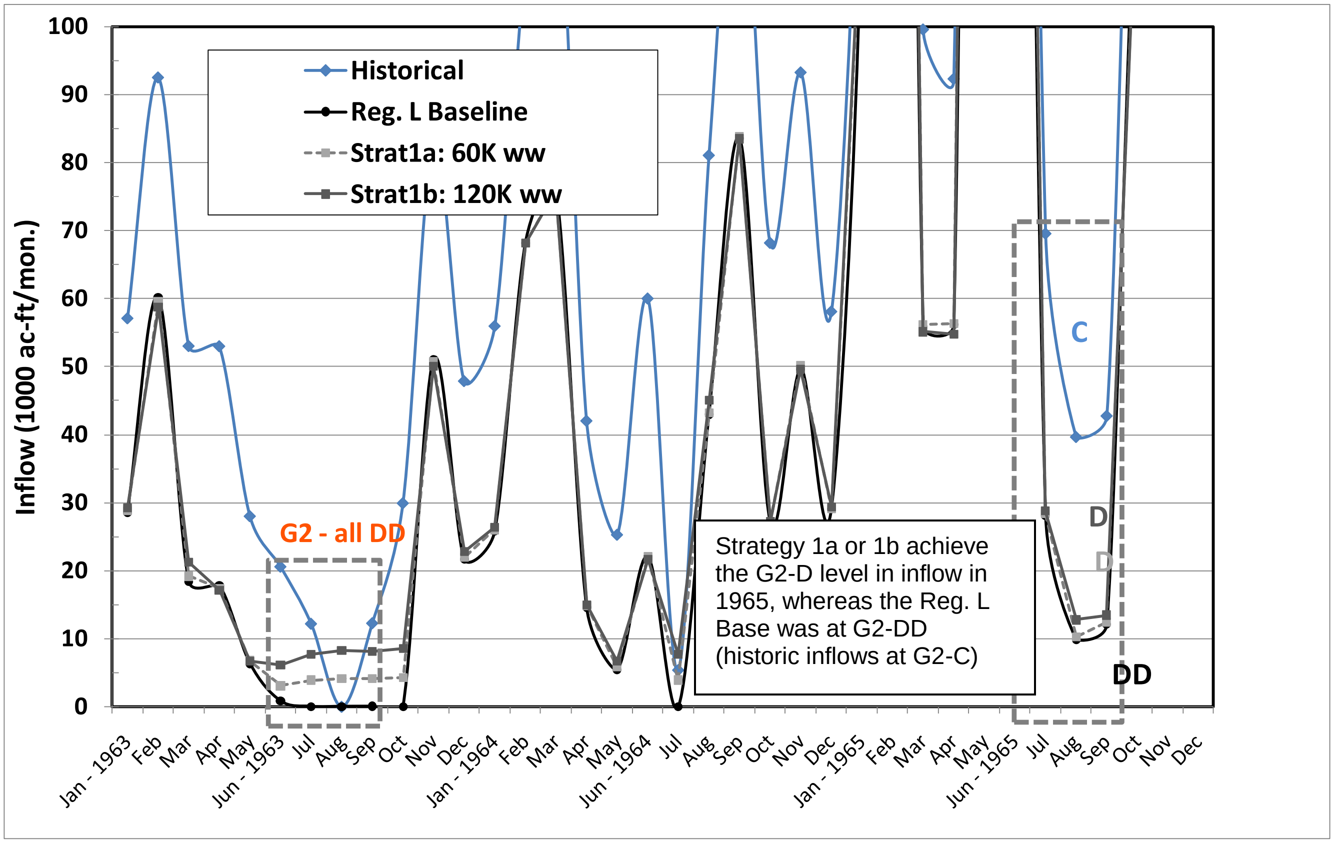

Figure 3 - Illustration of the changes in inflows to the Guadalupe Estuary in the 1963-65 period due to Strategy 1, a dedication of wastewaters to environmental flow purposes. Highlighted are the June-Sept. periods of the G2 criteria.

<u>Strategy 2 - Dry-Year Option, Irrigation Water Rights</u>

For this strategy, portions of irrigation water rights were assumed to be dedicated during only 10 of the driest years of the period of record (1950, 1954, 1956, 1963, 1965, 1969, 1982, 1984, 1988 and 1989) out of a total of 49 years. Under modeling Strategy 2a, a total of 16,599 acre-ft/yr was dedicated from 5 water rights. Under modeling Strategy 2b, a total of 31,836 acre-ft/yr was dedicated from those same rights. More information on the dedicated water rights and locations is provided in Appendix B.

Table 6 shows that the dry-year option strategy increased inflows in the spring period enough to result in a single year of change in the G1-D inflow level compared to the Region L Baseline. As indicated in Figure 4 and Table 6, inflow increases in the spring period of 1988, with either Strategy 2a or 2b, were sufficient to result in G1-CC level inflows compared to the G1-D level of the Region L Baseline (historical inflows were in the G1-C category).

Table 6 - Summary of inflow attainment measures due to Strategy 2 for the G1 suite of criteria pertaining to the Guadalupe Estuary in the spring (Feb. - May) period. Color scheme and notes as indicated above for Tables 4 and 5.

Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	>A-pr[1]	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline	7	10	8	3	3	4	14	49
Strat2a: 16k dry yr. option	7	11	7	3	3	5	13	49
Strat2b: 32k dry yr. option	7	11	7	3	3	5	13	49

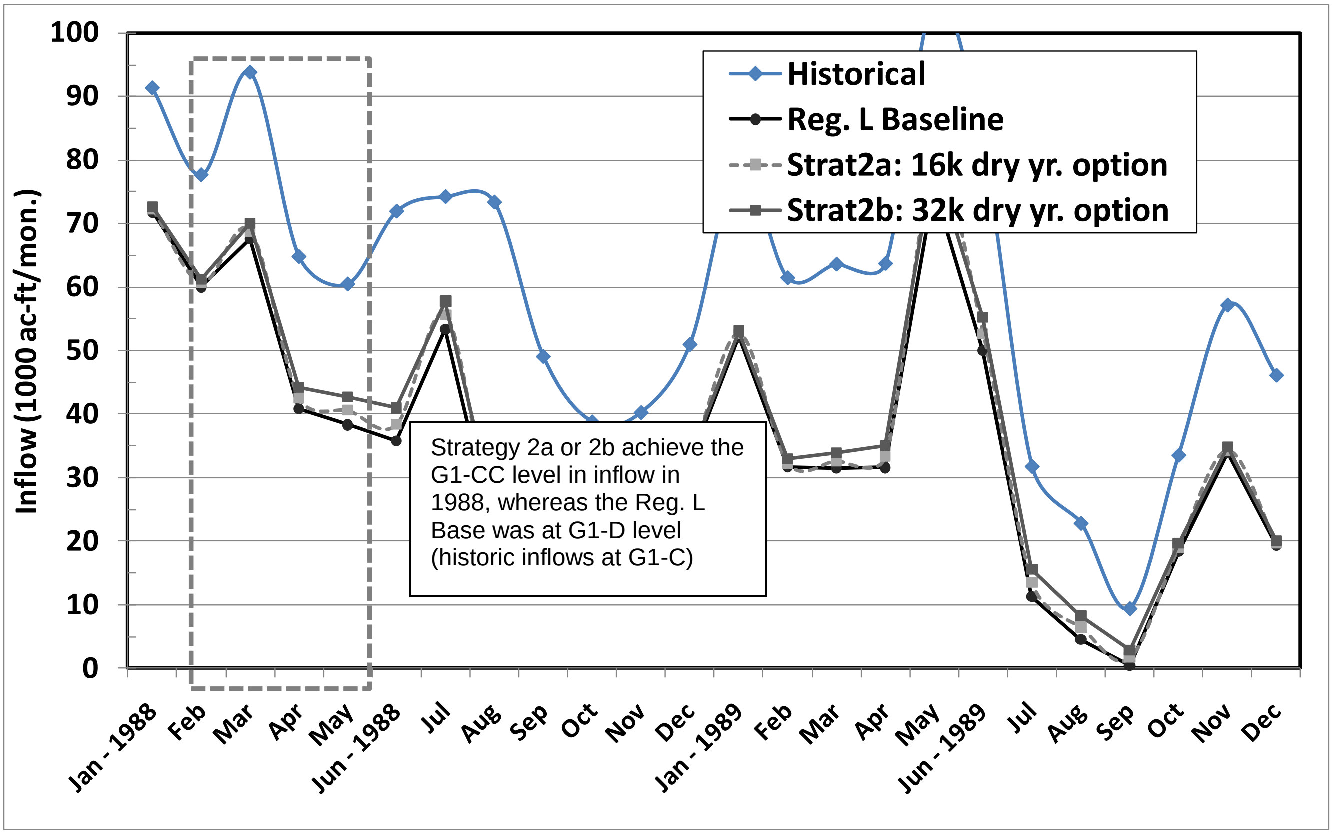

Figure 4 - Illustration of the changes in inflows to the Guadalupe Estuary in the 1988-89 dry period due to Strategy 2, the irrigation rights dry-year option. The Feb.-May period of the G1 criteria is evaluated here.

The dry-year option approach of Strategy 2 resulted in a modest improvement in the summer inflow period. As shown in Table 7, both 2a and 2b portions of this strategy were able to augment inflows in the July-Sept. period enough to elevate one year from the G2-DD level of the Region L Baseline to the G2-D level. The year of change was 1965. As in Strategy 1, this year only has a very small gap to make up under the Region L Baseline to achieve the G2-D level.

Table 7 - Summary of inflow attainment measures due to Strategy 2 for the G2 suite of criteria pertaining to the Guadalupe Estuary in the summer (June-Sept.) period.

Counts	Criteria G2 Attainment (no. years 1941-89)								
Scenario	>A-pr[1]	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline	4	8	8	8	7	**3**	**3**	**8**	49
Strat2a: 16k dry yr. option	4	8	8	8	7	3	4	7	49
Strat2b: 32k dry yr. option	4	8	8	8	7	3	4	7	49

Strategy 3 - Underutilized Water Rights, Conversion/Dedication

Table 8 illustrates the effects of the assumed conversion of underutilized rights in Strategy 3. Under Strategy 3a several categorical improvements occur in the spring season. First, there is a reduction of the occurrence of the G1-D level from 14 years to 12 in strategy 3a (these occurred in 1978 and 1988). Strategy 3b, which involved a greater increment of conversions, results in additional improvements, with an additional year (1989) being elevated (to G1-CC). In addition to these changes in the lowest level of G1 criteria, there were additional changes in higher categories. For instance, with Strategy 3a, the 2 years of G1-D that were elevated (as cited above) went into categories G1-C and G1-CC, respectively. However, as Table 8 shows the overall attainment counts for Strategy 3a in these categories are the same as the baseline. This is because other years of G1-CC and G1-C inflows were also elevated with Strategy 3a. Similar results occurred for Strategy 3b. In both Strategies 3a and 3b, two years of G1-C inflows in the Region L Baseline (1942, 1960) were elevated to the G1-B level. Additionally, several improvements occurred in even higher categories.

Table 8 - Summary of inflow attainment measures due to Strategy 3 for the G1 suite of criteria pertaining to the Guadalupe Estuary in the spring (Feb. - May) period.

Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	>A-pr[1]	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline	7	10	8	3	3	4	**14**	49
Strat3a: 49k conversion	7	11	7	5	3	4	12	49
Strat3b: 98k conversion	7	12	6	5	3	5	11	49

The Strategy 3 approach of conversion and dedication of underutilized rights also brought about categorical changes in the attainment levels of the summer G2 criteria. Most notable, Strategies 3a and 3b dropped the occurrence of the lowest G2-DD level from 8 years under the Region L Baseline to 7 and 6 years, respectively. Strategy 3b also led to other notable changes in somewhat higher inflow categories: one year of G2-D was elevated into G2-C and one year of G2-CC was elevated into the G2-B level, as compared to the Region L Baseline inflows.

Table 9 - Summary of inflow attainment measures due to Strategy 3 for the G2 suite of criteria pertaining to the Guadalupe Estuary in the summer (June-Sept.) period.

Counts	Criteria G2 Attainment (no. years 1941-89)								
Scenario	>A-pr[1]	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline	4	8	8	8	7	3	3	8	49
Strat3a: 49k conversion	4	8	8	9	6	3	4	7	49
Strat3b: 98k conversion	4	8	8	10	7	2	4	6	49

Combination Strategy 1

This evaluation examined an assumed combination strategy consisting of parts "a" of each of the individual strategies: 60,000 ac-ft of wastewater dedication; approximately 16,000 of the dry-year option; and the approximate 49,000 ac-ft/yr conversion / dedication. These results are illustrated in the bottom row of Table 10 with the previous strategy results included for comparison. The combination strategy resulted in an additive effect compared to the previous individual strategies in the spring. For instance, with regard to G1-D level of inflows, the combination strategy was predicted to achieve the total benefits of both the 2a and 3a subcomponents, which had individual reductions of 1 and 2 years, respectively. Given the use of a total of 10 different water rights in this strategy with a wide range of locations and priority dates, this is far from a guaranteed result. Of course, that caveat applies for all of these evaluations. Any individual strategy or set of strategies will have to be evaluated carefully.

Table 10 - Summary of inflow attainment measures due to Strategy 4 for the G1 suite of criteria pertaining to the Guadalupe Estuary in the spring (Feb. - May) period.

Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	>A-pr[1]	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline	7	10	8	3	3	4	14	49
Strat1a - Ww Ded. 60k/yr	7	10	8	3	3	4	14	49
Strat1b - Ww Ded. 120k/yr	7	10	8	3	3	4	14	49
Strat2a: 16k dry yr. option	7	11	7	3	3	5	13	49
Strat2b: 32k dry yr. option	7	11	7	3	3	5	13	49
Strat3a: 49k conversion	7	11	7	5	3	4	12	49
Strat3b: 98k conversion	7	12	6	5	3	5	11	49
Strat4: combination	7	11	7	5	3	5	11	49

Table 11 presents similar results for Strategy 4, the combined strategies approach, but for the G2 season. Here the combination did not result in the same additive effect as in the spring for the lowest level of inflow. The improvement in the G2-DD level was no greater than any of the individual subcomponents (1a, 2a, 3a). In this case, it would appear that some of the water rights devoted to these strategies are in competition and thus not able to make the same total increase in inflows.

Table 11 - Summary of inflow attainment measures due to Strategy 4 for the G2 suite of criteria pertaining to the Guadalupe Estuary in the summer (June-Sept.) period.

Counts	Criteria G2 Attainment (no. years 1941-89)								
Scenario	>A-pr[1]	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline	4	8	8	8	7	**3**	**3**	**8**	49
Strat1a - Ww Ded. 60k/yr	4	8	8	8	7	3	4	7	49
Strat1b - Ww Ded. 120k/yr	4	8	8	8	8	3	3	7	49
Strat2a: 16k dry yr. option	4	8	8	8	7	3	4	7	49
Strat2b: 32k dry yr. option	4	8	8	8	7	3	4	7	49
Strat3a: 49k conversion	4	8	8	9	6	3	4	7	49
Strat3b: 98k conversion	4	8	8	10	7	2	4	6	49
Strat4: combination	4	8	8	9	7	3	3	7	49

Notes: 1) These are years with inflows above A-prime (A-Pr). There is no BBEST recommendation for inflows greater than A-prime; they are included here to track all 49 years in the analyses.

Inflow Changes within BBEST Inflow Categories

In addition to the analyses of incremental "categorical" improvements detailed above, we also analyzed each strategy's capacity to change inflows within an inflow category, especially the lower drought conditions levels (G1-D and G1-DD). The need for this level of analysis can be illustrated with an example. As was shown in Table 4, Strategy 1 did not result in any improvements in the attainment of the G1-D criteria compared to the Region L Baseline. However, as shown in Figure 2, using 1955-56 as an illustrative period, inflows into the Guadalupe Estuary were increased through this strategy in both the spring (G1) and summer (G2) periods. The increases may represent very significant improvements, when compared to the Region L Baseline scenario, during this very low-inflow period, although the effects were not sufficient to attain the historic level or to cause an integer change in the attainment measures of G1-D or G2-DD. Due to these obvious beneficial changes in inflow that are not registered by the categorical measures used in Tables 4 through 10, we also examined the effectiveness of the strategies on a "within-category" basis. Here the focus was on significant improvements in seasonal inflows that were not sufficient to lead to a complete categorical change in the ranking of that season.

Table 12 presents the results for all strategies, detailing the inflow changes for years in which the Region L Baseline inflows are in the G1-D level for the spring season (Mar-May). The Region L columns indicate the inflows of those years that fell in the G1-D range, and the size of the "gap" that a strategy must overcome to reach the G1-C level. Under the columns labeled "Strategy Effects - G1-D", the values indicate the percentage of the gap made up by the strategy's improved inflows. Years with values greater than 100% indicate a categorical improvement as tracked in Tables 6-11 above.

Obviously, although a particular strategy's improved inflows may not lead to a complete change in category of inflow, there are some often sizeable changes within a category. For example, the smaller 16,000 ac-ft/yr version of the dry-year option, led to improved spring inflows in 1989, which made up nearly 47% of the modest gap of 11.2 thousand ac-ft in under the Region L Baseline. The 32,000 ac-ft/yr version made up almost 92% of this gap. It is important to remember that Strategy 2 was not exercised every year, and this leads to some counter-intuitive results in Table 12. For example, the smaller gap of only 3,400 ac-ft for 1978 was not addressed because the dry-year option was not exercised in that year and is indicated by "na" (applied only in 1950, 1954, 1956, 1963, 1965, 1969, 1982, 1984, 1988 and 1989). There are many notable "within category" improvements, too numerous to itemize. These results illustrate that various combinations of these and other strategies might be pursued to achieve incremental progress in attaining compliance with the BBEST flow regime recommendations.

Table 12 - Yearly results for each strategy's capacity to improve upon the Region L Baseline level of inflows in the G1-D range in the spring (Mar-May) period.

	Reg. L Baseline		Strategy Effects - G1-D						
year	Inflow (1000 ac-ft)	Gap (1000 ac-ft)	Strat1a - Ww Ded. 60k/yr	Strat1b - Ww Ded. 120k/yr	Strat2a: 16k dry yr. option	Strat2b: 32k dry yr. option	Strat3a: 49k conversion	Strat3b: 98k conversion	Strat4: combination
1941	-	-	-	-	-	-	-	-	-
1942	-	-	-	-	-	-	-	-	-
1943	-	-	-	-	-	-	-	-	-
1944	-	-	-	-	-	-	-	-	-
1945	-	-	-	-	-	-	-	-	-
1946	-	-	-	-	-	-	-	-	-
1947	-	-	-	-	-	-	-	-	-
1948	-	-	-	-	-	-	-	-	-
1949	-	-	-	-	-	-	-	-	-
1950	101.6	48.4	1%	-1%	10.7%	21.1%	17%	36%	28%
1951	79.9	70.1	1%	-1%	na	Na	12%	25%	11%
1952	-	-	-	-	-	-	-	-	-
1953	-	-	-	-	-	-	-	-	-
1954	27.1	122.9	2%	5%	4.2%	8.3%	8%	16%	12%
1955	33.2	116.8	3%	8%	na	Na	6%	12%	9%
1956	15.4	134.6	4%	10%	3.9%	7.6%	5%	9%	13%
1957	-	-	-	-	-	-	-	-	-
1958	-	-	-	-	-	-	-	-	-
1959	-	-	-	-	-	-	-	-	-
1960	-	-	-	-	-	-	-	-	-
1961	-	-	-	-	-	-	-	-	-
1962	104.7	45.3	1%	-1%	na	Na	20%	39%	19%
1963	42.5	107.5	1%	2%	4.9%	9.6%	8%	16%	13%
1964	95.9	54.1	1%	3%	na	Na	21%	39%	16%
1965	-	-	-	-	-	-	-	-	-
1966	-	-	-	-	-	-	-	-	-
1967	101.3	48.8	0%	3%	na	Na	18%	35%	18%
1968	-	-	-	-	-	-	-	-	-
1969	-	-	-	-	-	-	-	-	-
1970	-	-	-	-	-	-	-	-	-
1971	61.3	88.7	1%	5%	na	Na	10%	19%	10%
1972	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-
1978	146.6	3.4	23%	-1%	na	Na	269%	539%	269%

	Reg. L Baseline		Strategy Effects - G1-D						
year	Inflow (1000 ac-ft)	Gap (1000 ac-ft)	Strat1a - Ww Ded. 60k/yr	Strat1b - Ww Ded. 120k/yr	Strat2a: 16k dry yr. option	Strat2b: 32k dry yr. option	Strat3a: 49k conversion	Strat3b: 98k conversion	Strat4: combination
1979	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-
1984	81.3	68.7	5%	14%	7.8%	15.1%	13%	26%	25%
1985	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-
1988	146.7	3.3	28%	-1%	160.6%	313.2%	275%	548%	435%
1989	138.8	11.2	1%	-16%	46.8%	91.7%	80%	159%	127%

Table 13 portrays similar results for the lowest summer criteria G2-DD comprising total inflows in the July-Sept. period of 0-50,000 ac-ft. There are notable changes in inflows that, while not sufficient to lead to a change in the categorical ranking up to G2-D, still provide benefits. For instance, during the very worst drought years of 1954, 1956, and 1963 when Region L Baseline inflows drop to zero, or very close to zero, the larger of the wastewater dedication strategies (1b) contributes enough inflow to make up nearly 49% of the gap. In other words, in these years, approximately 25,000 ac-ft of inflow makes it to the Guadalupe Estuary compared to essentially zero inflow under the Region L Baseline.

Other notable improvements within the G2-DD category are those of the dry-year option (2a, 2b) in years of modest droughts like 1950 and 1982 (indicated by smaller gaps of 35, 18 thousand ac-ft). The effects of this strategy are minimal during the worst of droughts, apparently due to other more senior water rights diminishing the water available to the suite of irrigation rights. The conversion/dedication strategy (3a and 3b) is similarly most effective during years of lesser drought and appears to have lesser availability during the most severe drought years, apparently again, due to other more senior rights claiming the available water. The combination strategy appears to have a very significant effect on "within-category" inflows, even during the worst of drought years although changes are generally limited to within the G2-DD category.

Table 13 - Yearly results for each strategy's capacity to improve upon the Region L Baseline level of inflows in the G2-DD range in the summer (July-Sept.) period.

	Reg. L Baseline		Strategy Effects - G2-DD						
year	Inflow (1000 ac-ft)	Gap (1000 ac-ft)	Strat1a - Ww Ded. 60k/yr	Strat1b - Ww Ded. 120k/yr	Strat2a: 16k dry yr. option	Strat2b: 32k dry yr. option	Strat3a: 49k conver-sion	Strat3b: 98k conver-sion	Strat4: combina-tion
1941	-	-	-	-	-	-	-	-	-
1942	-	-	-	-	-	-	-	-	-
1943	-	-	-	-	-	-	-	-	-
1944	-	-	-	-	-	-	-	-	-
1945	-	-	-	-	-	-	-	-	-
1946	-	-	-	-	-	-	-	-	-

	Reg. L Baseline		Strategy Effects - G2-DD						
year	Inflow (1000 ac-ft)	Gap (1000 ac-ft)	Strat1a - Ww Ded. 60k/yr	Strat1b - Ww Ded. 120k/yr	Strat2a: 16k dry yr. option	Strat2b: 32k dry yr. option	Strat3a: 49k conver-sion	Strat3b: 98k conver-sion	Strat4: combina-tion
1947	-	-	-	-	-	-	-	-	-
1948	-	-	-	-	-	-	-	-	-
1949	-	-	-	-	-	-	-	-	-
1950	14.3	35.7	9.2%	32.8%	15.0%	29.3%	29.7%	59.8%	50.6%
1951	-	-	-	-	-	-	-	-	-
1952	-	-	-	-	-	-	-	-	-
1953	-	-	-	-	-	-	-	-	-
1954	0.0	50.0	24.1%	48.0%	11.0%	3.8%	3.2%	13.4%	39.7%
1955	-	-	-	-	-	-	-	-	-
1956	0.1	49.9	24.1%	48.1%	10.8%	3.6%	3.0%	8.2%	39.1%
1957	-	-	-	-	-	-	-	-	-
1958	-	-	-	-	-	-	-	-	-
1959	-	-	-	-	-	-	-	-	-
1960	-	-	-	-	-	-	-	-	-
1961	-	-	-	-	-	-	-	-	-
1962	-	-	-	-	-	-	-	-	-
1963	0.0	50.0	24.1%	48.0%	11.0%	10.9%	14.7%	29.4%	49.8%
1964	-	-	-	-	-	-	-	-	-
1965	49.99	0.0	>200%	>200%	>200%	>200%	>200%	>200%	>200%
1966	-	-	-	-	-	-	-	-	-
1967	-	-	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-	-	-
1969	-	-	-	-	-	-	-	-	-
1970	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-
1982	31.4	18.6	14.6%	47.5%	29.4%	56.8%	56.3%	111.8%	92.4%
1983	-	-	-	-	-	-	-	-	-
1984	7.7	42.3	28.5%	56.7%	13.0%	17.9%	21.6%	39.5%	56.5%
1985	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-
1989	16.2	33.8	35.6%	70.9%	16.2%	31.3%	27.7%	55.8%	79.6%

Tables 12 and 13 illustrate the “within-category” benefits of the strategies for the lowest springtime and lowest summer inflow levels. Other similar examinations of the changes in the next higher tiers of the inflow recommendations, such as G1-C in the spring, or G2-D and G2-C would likely show similar improvements within those categories in addition to the few actual shifts in categorical attainment highlighted in Tables 4 through 11.

Conclusions

The strategies considered above were meant to help evaluate the potential for the use of such strategies to close the gap between the BBEST recommendations for the Guadalupe Estuary and the attainment levels predicted for the Region L Baseline. There are several conclusions to be drawn based on the results above:

- a) Strategies with the most benefit of those examined were wastewater dedication and conversion of under-utilized rights [and the combination of the two];

-b) Strategies, if implemented as modeled here, would lead to modest changes in categorical attainment in both the G1 and G2 criteria suites;

- c) For many years, especially the driest, there are notable changes in inflows that, while not sufficient to lead to a change in the categorical ranking, are still capable of providing increased beneficial inflows to the Guadalupe Estuary.

Although it was beyond the scope of this project to evaluate, during the course of the WAM analyses and subsequent evaluations of inflow effects, we identified several potential means to better optimize these strategies. For instance, the conversion of the water rights under Strategy 3 may not need to occur every year, indicating some sort of year-to-year approach could be beneficial. It would also seem that there is the potential for amplifying the beneficial effects of any of these strategies if they could be coupled with storage in order to concentrate the benefits. The combination strategy also seemed to indicate that there could be sub-optimal combinations of differing strategies that may be in competition with one another.

The evaluation of conceptual strategies undertaken here illustrates that they have the potential to bring about significant beneficial changes in the inflows to the Guadalupe Estuary compared to the Region L Baseline. As noted earlier, that was the underlying goal of these efforts. Having found that to be true, a logical next step would be aimed at refining this approach to undertake more extensive efforts to identify and potentially optimize the actual wastewater discharges and / or water rights that could be pursued in any future implementation efforts.

Appendix A - Summary of BBEST Estuary Inflow Recommendations.

All information from Tables 4.5-3 or 4.6-1 or 6.1-17 in BBEST report.

Table A-1. Summary of Guadalupe Estuary G1 recommended inflow volumes for the Feb. - May period.

Criteria level	Inflow Volumes (1000 ac-ft)	
	Feb.	Mar.-May
G1-Aprime,	n/a	550-925
G1-A	n/a	375-550
G1-B	n/a	275-375
G1-C	≥75	150-275
G1-CC	0 - 75	150-275
G1-D	n/a	0 - 150

Table A-2. Summary of Guadalupe Estuary G1 attainment goals for the above recommended inflow volumes for the Feb. - May period.

Criteria level	Specification	Inflow Criteria Attainment[1]
G1-Aprime	Attainment, G1-Aprime	at least 12% of years
G1-A	Attainment, G1-A	at least 12 % of years
G1-A & G1-B	Attainment, G1-A & G1-B combined	G1-A and G1-B combined at least 17% of years
G1-C & G1-CC	Attainment, G1-C & G1-CC combined[1]	G1-C and G1-CC can be equal to or greater than 19% of years. G1-CC no more than 2/3 of total
G1-D	Attainment, G1-D	no more than 9% of years

Notes:

1) The attainment goals for categories G1-C, G1-CC are contingent upon other criteria level attainment goals being met.

Table A-3. Summary of Guadalupe Estuary G2 recommended inflow volumes for the June - Sept. period.

Criteria level	Inflow Volumes (1000 ac-ft)	
	June	July-Sept.
G2-Aprime	n/a	450-800
G2-A	n/a	275-450
G2-B	n/a	170-275
G2-C	≥40	75-170
G2-CC	0 - 40	75-170
G2-D	n/a	50-75
G2-DD	n/a	0-50

Table A-4. Summary of Guadalupe Estuary G2 attainment goals for the above recommended inflow volumes for the June - Sept. period.

Criteria level	Specification	Inflow Criteria Attainment
G2-Aprime	Attainment, G2-Aprime	at least 12% of years
G2-A	Attainment, G2-A	at least 17 % of years
G2-A & G2-B	Attainment, G2-A & G2-B combined	G2-A and G2-B combined at least 30% of years
G2-C & G2-CC	Attainment, G2-C & G2-CC combined[1]	G2-C and G2-CC can be equal to or greater than 10% of years. G2-CC no more than 1/6 of total
G2-DD	Attainment, G2-DD	G2-D**D** no more than 6% of years
G2-D & G 2-DD	Attainment, G2-D & G2-DD combined	G2-D and G2-DD combined no more than 9% of years

Notes:

1) the attainment goals for categories G2-C, and G2-CC are contingent upon other criteria level attainment goals being met.

Table A-5. Summary of Mission-Aransas Estuary recommended inflow volumes for the June - Sept. period.

Criteria level	Inflow Volumes (1000 ac-ft)	
	June	July-Sept.
MA2-Aprime	n/a	500-1000

Table A-6. Summary of Mission-Aransas Estuary attainment goals for the recommended inflow volumes for the June - Sept. period.

Criteria level	Specification	Inflow Criteria Attainment
MA2-Aprime	Attainment MA2-Aprime	at least 2% of years

Appendix B - Report of Intera Geosciences & Engineering on Specialized WAM Execution for the Strategies.

WAM-Based Hydrologic Analyses of Strategies to Meet SB3 Environmental Flow Standards for the Guadalupe Estuary

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July 5, 2011

Executive Summary

INTERA, Inc was retained by the National Wildlife Federation (NWF) to modify the Water Availability Model (WAM) of the Guadalupe-San Antonio Basin to assess the impact of potential water management “strategies” designed to enhance environmental flows into the Guadalupe Estuary. Using an established WAM model for the Region L water plan (as provided by NWF), INTERA devised modified WAM models which increase freshwater inflows to the estuary by: 1) dedicating selected wastewater discharges to meet environmental flow needs, 2) converting selected irrigation water rights into environmental flow rights during dry years, and 3) dedicating historically un-used portions of water rights for environmental flow purposes. For each modeled strategy, modified water rights (or wastewater discharges) were selected by NWF, including the amount of modified diversions and the years in which modified diversions were to occur. The effectiveness of each modeled environmental flow enhancement strategy was determined through a comparison of modeled flows with flows resulting from the un-modified Region L WAM model. Comparisons were made using modeled stream flows in the San Antonio River near Goliad, modeled stream flows in the Guadalupe River near Victoria, and modeled inflows to the Guadalupe Estuary. Further impacts of environmental flow enhancement were assessed through comparisons of water right reliabilities in the Guadalupe-San Antonio Bay system. The model results created by INTERA were then transferred to NWF for further analyses regarding the effectiveness of the strategy.

This report documents for NWF, the modeling effort undertaken by INTERA, and serves as the final project deliverable. INTERA does draw any conclusions from this work, as all such data interpretation and analysis is to be performed by NWF. INTERA does recommend, however, further WAM-based investigations into each strategy in order to maximize environmental flow benefits while minimizing impacts on basin water right holders. All WAM-modeling was performed by INTERA Senior Water Resources Engineer Dr. Jordan Furnans, PE, PG.

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Introduction

On March 1, 2011 the Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Expert Science Team (GSA BBEST) published a set of recommended freshwater inflow criteria for the Guadalupe Estuary. The estuary criteria consist of a multi-tiered suite of inflow volumes and an associated frequency of attainment for each. Ensuing deliberations by the Stakeholder Committee for those same basins (GSA BBASC) have focused on the ability of several scenarios of future water use to meet the BBEST recommendations at the frequencies specified. It has become apparent to the BBASC that any of the examined future scenarios that include the full use of existing water rights and the Region L assumed levels of wastewater discharge, will have difficulty achieving the inflow criteria at the recommended frequencies, especially in the lower drought or near-drought tiers of the criteria.

Thus, the NWF, with the June 1, 2011 endorsement of the GSA BBASC, undertook an examination of the effectiveness of several voluntary, pro-active water management “strategies” to address the shortcomings in meeting the BBEST recommendations. To accomplish this effort, NWF retained INTERA, Inc. to develop versions of the Guadalupe / San Antonio water availability model (WAM) designed to test and enhance the quantity of freshwater entering the Guadalupe Estuary. Table B-1 below outlines the three endorsed types of “strategies” for using existing water rights and wastewater flows in this effort to satisfy environmental flow requirements. Evaluation of each of these strategies required specialized execution of the WAM with a common theme: that the water made available for the purpose of satisfying environmental flow needs must be “dedicated” and thus protected from diversion by other water rights downstream. While these WAM simulations track the effectiveness of very specialized water management scenarios, NWF and INTERA realize these would require significant financial, legal, and administrative support to bring to fruition. Details of each of the three modeled strategies are provided in Section 3.

Table B-1 – Brief description of “strategies” to examine in effort to use existing water rights to satisfy environmental flow needs.

Strategy	Description	Issues for special WAM use
Strategy 1) wastewater dedication	dedicate a portion of wastewater from many major dischargers to environmental flow purposes.	Assure dedicated wastewater is protected from diversion by other downstream rights and passes along rivers and into Guadalupe Estuary.
Strategy 2) dry year option on fairly firm irrigation right(s)	on a temporary, weather-driven basis, convert all or a portion of one or more sr. irrigation water right to environmental flow purposes.	As above for Strategy 1. Also entails modifying WAM so that environmental dedication of the chosen right(s) is limited to only certain years.
Strategy 3) purchase / conversion of unused right	convert all or portions of some major currently unused firm senior right(s) to environmental flow purposes.	Assure converted right’s or rights’ water is protected from diversion by other downstream rights; non-impairment of other senior rights; potential changes in use pattern of converted water.

WAM modifications for Environmental Flows

To dedicate prescribed water quantities for environmental flow purposes, INTERA developed a modeling approach which adjusted the Region L WAM model (provided to NWF by the BBASC Technical Consultant), altering only selected water rights and wastewater discharges while protecting the "dedicated" waters from use by any downstream water rights. In this discussion, "dedicated" waters refer to water reserved for environmental flow that was made available through implementation of any of the strategies in Table B-1. From a modeling standpoint, to protect dedicated waters from use by downstream water rights, INTERA stored the dedicated waters in "dummy" or "artificial" reservoirs located adjacent to the control points at which the dedicated waters were withdrawn from the modeled streamflow. Water in these dummy reservoirs is then released into the stream network in order to satisfy only the demand of a "dummy" diversion INTERA created at the location where the Guadalupe River enters the Guadalupe Estuary. Modifications made specifically for each of the three strategies are described in Section 3.1-3.3. It should be noted that the "dummy" reservoirs and water right(s) developed in these analyses are only needed to enable the protection of the dedicated waters of a strategy within the WAM. This does not indicate that actual reservoirs or additional water rights would be needed.

Deliverables to NWF for this project include all modified WAM files created from the baseline Region L WAM. The enclosed DVD contains all such files in a directory "INTERA_WAM," which has the following subdirectories, one for each modeled strategy:

Case 0 – Original Region L Files
Case 1a – Wastewater Dedication
Case 1b – Wastewater Dedication
Case 2a – Dry Year Irrigation
Case 2b – Dry Year Irrigation
Case 3a – Unused Rights
Case 3b – Unused Rights
Case 4 - Combination Strategy

Each subdirectory contains all WAM files needed to run each modified WAM using the WinWRAP software, as well as the output files generated when running the SIM and TAB functions in WinWRAP. Modifications were only made to the main WAM input file, with the "DAT" file extension. Within each "DAT" file, edits made by INTERA are denoted with the following lines of text:

```
********************************************************************************************
** INTERA EDITS - DATE                                                                    **
** Jordan Furnans - Description                                                           **
********************************************************************************************
**
MODIFIED CODE HERE
**
********************************************************************************************
** END INTERA EDITS - DATE                                                                **
********************************************************************************************
```

In place of the “DATE” text, actual edits are denoted by the calendar date the edits were made. The “Description field contains a brief statement of the purpose of each set of edits. The “MODIFIED CODE HERE” section contains WAM code created by INTERA modified from the original code in the Region L WAM. In all instances, the original Region L WAM code is retained in the “MODIFIED CODE HERE” section, with each line preceded by the WAM indicator “**” which identifies the line as a comment line. As all comment lines are ignored within WinWRAP, adding the “**” text in front of any line removes that line from consideration in the WAM model processing. All original lines of Region L WAM code were retained (as functional code or comment lines) so that edits made by INTERA or others could be easily changed and the code could be easily returned to the original Region L WAM file if desired.

This method of commenting modifications to input files was also implemented in successive versions of the modified WAM files created by INTERA. INTERA first developed the modified WAMs for Case 1a and 1b, then for Case 2a and 2b, and then for Case 3a and 3b. As such, all modifications made in developing the Case1 WAMs were included in the Case 2 WAM “DAT” files, with the lines modified only for Case 1 scenarios preceded by the “**” comment line identifier. Similarly, all modifications made for the Case 1 and Case 2 WAMs are included in the Case 3 WAMs, preceded by the “**” comment line identifier. In this manner, creating a combination or hybrid strategy WAM model using components of each of the Case 1, Case 2, and Case 3 strategies would be relatively straight forward.

To determine the impact of each water dedication strategy, INTERA created three separate TIN files for use in the WinWRAP program “Tables.” The first file, named “CASEXY_TIN.TIN” (where XY could be 1a, 2b, etc) generates the required streamflow output for: 1) the San Antonio River at Goliad (CP 37), 2) the Guadalupe River at Victoria (CP 15), and 3) the streamflow entering the Guadalupe Estuary (CP CPEST). This TIN file also includes any output used to assess the validity of the modeled strategy, including outputting the amount of environmental flow water generated through strategy implementation. The second TIN file, named “selected_rel.TIN,” generates reliability tables for water rights selected by NWF for their review and assessment. This file is identical as included in each of the Case scenario folders provided. The third TIN file, “Streamflows.TIN” is used to create data for inclusion in Appendix B-1 of this report. This file generates the identical streamflow output as the “CASEXY_TIN.TIN” file, yet with the data formatted into an annual-row, columnar month format. This file is identical as included in each of the Case scenario folders provided.

3.1 Strategy 1: Dedication of Selected Wastewater Discharges

For this strategy, portions of wastewater discharges (return flows) from 10 locations were dedicated to satisfy environmental flow needs. The 10 locations (Figure B-1) were selected based on the annual discharge amounts and also with a goal of selecting discharge points that are dispersed throughout the Guadalupe & San Antonio basins. Each discharge was partially dedicated to meet environmental flow needs, with remaining portions of the discharge following the normal simulation method and available to satisfy downstream water right holders. Details pertaining to each wastewater discharge are provided in Table B-2. For modeling Strategy 1a, 46.7% of each discharge was dedicated to meet environmental flow needs, amounting to a total dedication of 60,065 acre-ft/yr. For modeling Strategy 1b, 93.3% of each discharge was dedicated to meet environmental flow needs, amounting to a total dedication of 120,003 acre-ft/yr.

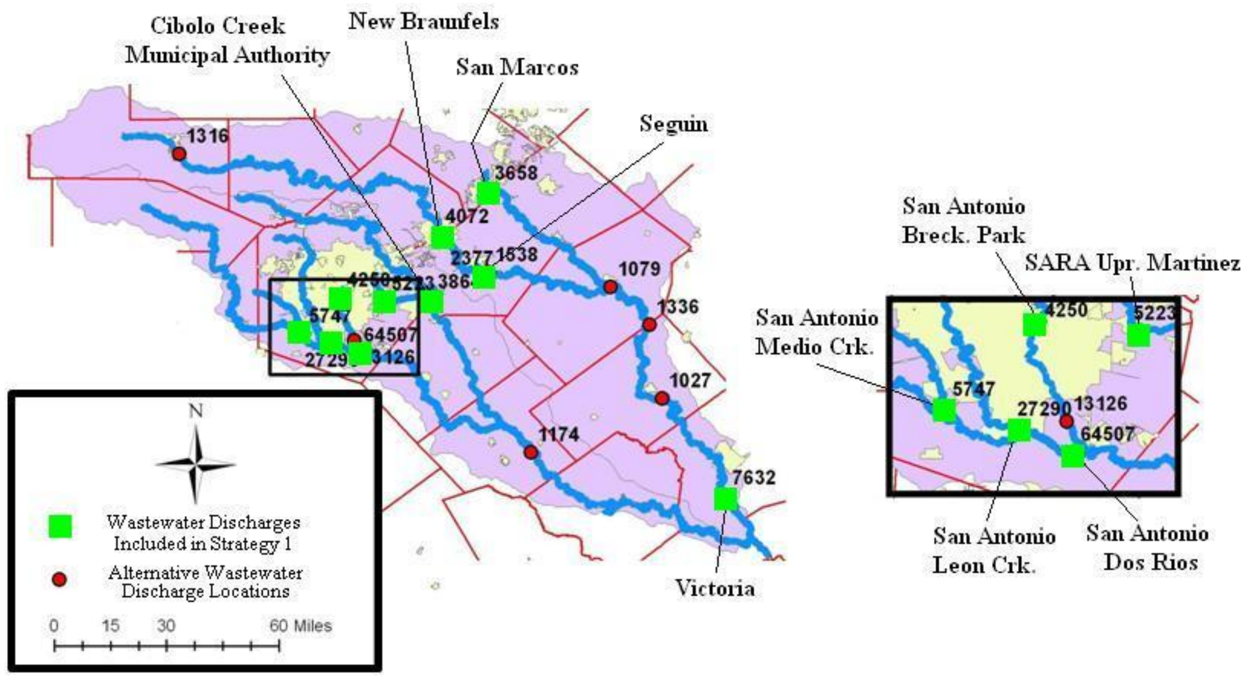

Figure B-1 – Guadalupe-San Antonio basin showing the locations of WAM-modeled wastewater discharges. Green squares indicate the locations of wastewater discharges partially dedicated to meet environmental flow needs. Original Region L WAM-modeled discharge amounts (ac-ft/yr) are displayed adjacent to each discharge location. Basin, County, and City boundaries as provided by the Texas Water Development Board. Rivers derived from the National Hydrography Dataset. Discharge locations provided by the Texas Commission on Environmental Quality.

Table B-2 – WAM modeled Wastewater Discharges Modified for Strategies 1a, 1b.

Waste Water Discharge			Dedicated Environmental Flows	
Control Point	Jurisdiction / Discharger*	Amount acre-ft/yr	Strategy 1a 46.7%	Strategy 1b 93.3%
215611	San Antonio - Dos Rios	64,507	30,125	60,185
215101	San Antonio - Leon Creek	27,290	12,744	25,462
386001	Victoria	7,632	3,564	7,121
476831	San Antonio - Medio Cr.	5,747	2,684	5,362
526521	SARA - Upr. Martinez	5,223	2,439	4,873
215332	San Antonio, Breck. Park	4,250	1,985	3,965
383001	New Braunfels	4,072	1,902	3,799
S905	Cibolo Crk. Mun. Auth. (Selma, Schertz)	3,864	1,804	3,605
G911	San Marcos	3,658	1,708	3,413
548804	Seguin	2,377	1,110	2,218
	TOTAL dedicated	141,746	60,065	120,003
	TOTAL to Guadalupe Estuary		42,377	84,638
	Overall Channel Loss Factor		29.5%	29.5%

Note: * The Region L Baseline WAM data set generally does not identify the wastewater discharger. These apparent dischargers are based on conversations with Brian Perkins of HDR Engineering, the Technical Consultant the GSA BBASC.

Each wastewater discharge is specified in the WAM model as a set of CI records. These records represent “constant inflows” into control points, and are in addition to any naturalized stream flows present at the control point locations. Thus these flows are to be present and reliable during all periods modeled in the WAM, irrespective of drought conditions.

To dedicate flows from each selected wastewater discharger, INTERA created an additional dummy control point located upstream of the normal discharge “target” control point that receives the wastewater to which the CI record pertained. Each dummy control point then receives the dedicated wastewater from the CI record and does not receive streamflow from any other source (no naturalized flows). The dummy additional stream reach connecting the added dummy control point to the original target control point also does not subject the water to channel losses or evaporation. Modified CI data values were then specified for each dummy control point and for each original target control point. For each tandem set of dummy and original target control points, the total quantity of water specified for a given month was set equal to the monthly quantity specified in the original CI value for the target control point. The proportion of water dedicated as new CI values to each dummy control point is provided in Table B-2 (46.7% for Strategy 1a, 93.3% for Strategy 1b). The proportion of water allowed to remain on the target control point is therefore calculated as 1-X, where “X” is the proportion dedicated to environmental flows. As described earlier, in order to actually protect these repurposed discharges, “dummy” reservoirs were created to store the water specified for each added control point, with each reservoir filled monthly by a modeled water right at each added control point. The water in each dummy reservoir was then dedicated for environmental flow needs by defining an artificial water right “WWforBay” at a final added control point located at the upstream end of the Guadalupe Estuary (CP WW2GB). The WWforBay water right was defined so that its demands could only be satisfied by releases from the 10 dummy reservoirs and could not be met by any available streamflow. Water released from each dummy reservoir flowed downstream through the modeled river network, and was subject to the normal WAM channel losses as would any other modeled streamflow. For the 10 wastewater discharges used in this scenario, the combined channel loss rate from the discharge points to the estuary amounted to 29.5%.

3.1a Modeling Results: Strategy 1

The contributions to environmental flow needs for strategies 1a and 1b are 42,377 acre-ft/yr and 84,638 acre-ft/yr, respectively. These contributions are constant for all years in the period of record. Therefore these water quantities would be available to satisfy environmental flow needs even during drought periods, including the drought of record. As shown in the bottom panel of Figure B-2, inflows into Guadalupe Estuary typically increased through this strategy, when compared to the Region L Baseline (or just “baseline”) scenario, especially during low-inflow periods. However there were times when the increase was miniscule, and there were even times where overall inflows decreased. This is evident in the April 1989 flows, highlighted in the upper panel of Figure B-2, where Guadalupe Estuary inflows under Strategy 1a were nearly identical to the baseline inflows, and those under Strategy 1b were less than the baseline inflows, albeit by only about 1,500 ac-ft.

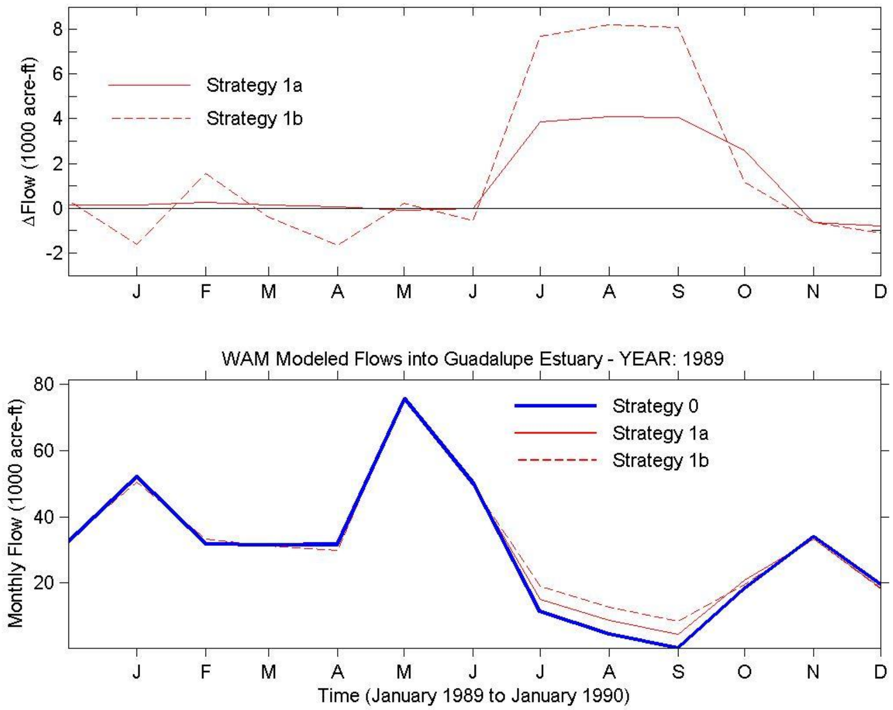

Figure B-2 – Modeled Guadalupe Estuary inflow results for 1989, including the original Region L WAM model results and those from Strategy 1a (dedication of 60,065 acre-ft/yr) and Strategy 1b (dedication of 120,003 acre-ft/yr).

These counter-intuitive results, as shown for April in Figure B-2, stem (at least in part) from the influence of channel losses. The wastewater flows dedicated for environmental flow purposes under these modeled scenarios are subject to relatively large channel losses as they travel downstream nearly the full length of the river system. Had these flows not been dedicated to environmental needs, they would have likely been used to satisfy water rights further upstream in the basin (relative to the estuary), and therefore would not have suffered as extensive channel and evaporative losses. Over the period of record for the model simulations, in 61% of all months inflows to the estuary were greater as a result of Strategy 1a than Strategy 1b, despite the fact that Strategy 1b has twice as much dedicated wastewater discharges. At these times, however, the difference in inflows is a small percentage of the modeled monthly inflow. At times when the inflows from Strategy 1b are greater than those from 1a (the normal expectation), the differences can be up to 33% of the modeled 1a inflow. This is evident in Figure B-2 for the period July-September, where wastewater flow dedication due to 1b yield increased estuary inflows with respect to both the 1a and baseline modeling scenarios.

Results from this modeling strategy are also influenced by the priority assigned to the artificial water right ““WWforBay””which releases wastewater stored in the dummy reservoirs. If the right has a high-priority (senior), then the released wastewater flows dedicated for environmental flow purposes also have the capability to assist in satisfying some applicable instream flow requirements in the modeled stream network. Since these dedicated wastewaters stay in the stream, it is plausible that some junior water rights with such environmental flow requirements may be permitted to divert more water, of non-wastewater origin,than they would have been allowed to divert in the baseline Region L WAM model. As such, the possibility exists that these junior water rights would ultimately divert water (in Strategy 1 WAM runs) which would contribute to estuary inflows in the Region L WAM model. Thus, this exercise reveals that with wastewater discharges dedicated to environmental flow purposes, it is possible that reduced monthly inflows to the estuary may result. To assess this possibility, INTERA re-ran the Strategy 1b model after having modified the priority of the water right calling for releases from the 10 dummy reservoirs. In this scenario, the water right was set such that it was the last water right executed in the priority loop within WinWRAP, and therefore would not be able to contribute to instream flow requirements to the benefit of other water rights. Computed flows into the estuary under this strategy were typically higher than the original Strategy 1b model, yet still indicated that wastewater dedication can lead to decreased environmental flows to the estuary. This is evident in Figure B-3, which compares annual estuary inflows in the baseline, original Strategy 1b model (labeled as "IF Satisfaction") and the modified Strategy 1b model (labeled as "No IF Satisfaction"). Of note in Figure B-3 is that of the total 128,620 acre-ft of annual wastewater discharges contained in the 10 discharges included in this analysis, a large fraction of this water reaches the estuary under all modeling scenarios. In many years, dedications of wastewater flows did not significantly increase estuary inflows, and in some years (1958, 1965, and 1968) decreases in inflows were calculated. Figure B-3 also clearly indicates that wastewater dedication, as a strategy, has the potential for enhancing environmental flows in periods of drought, as evidenced from the periods 1950-1956,1962-1964, and 1982-1984.

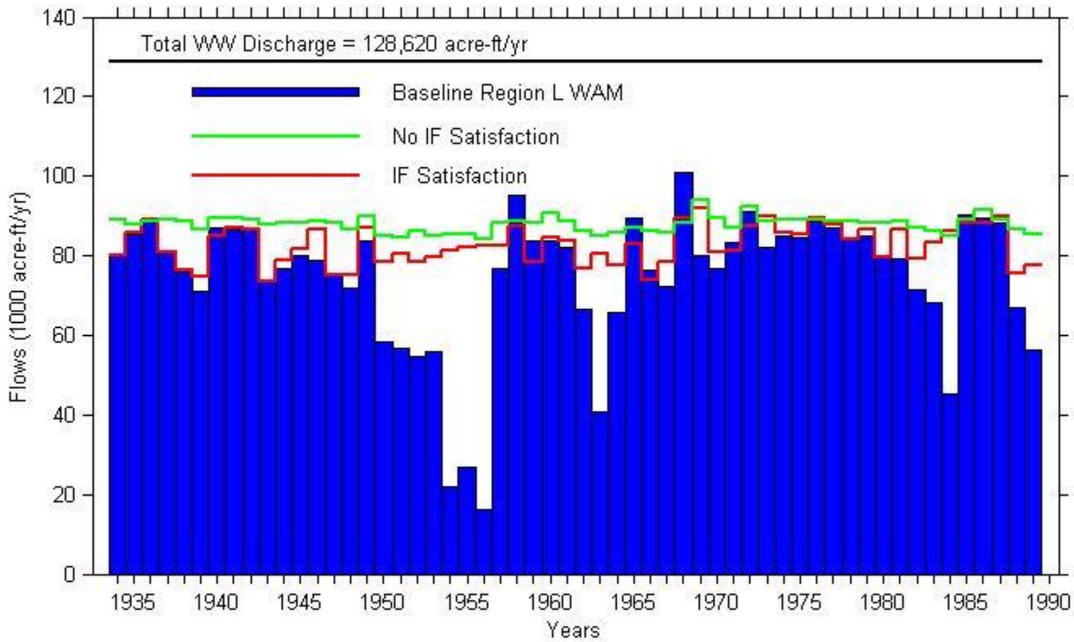

Figure B-3 – Inflows to Guadalupe Estuary from the baseline Region L WAM, and Strategy 1b with and without allowing the dedicated wastewater discharges to satisfy instream flow requirements.

INTERA recommends that much further investigation of these apparent interactions of wastewater flows, channel losses, and instream flow requirements of junior water rights be pursued should this strategy for environmental flow enhancement be considered. If the apparent mechanisms explaining the loss of dedicated wastewater are reflective of reality, then further modeling effort should be undertaken to identify high-priority periods in which the wastewater dedication is most effective at bolstering estuary inflow per the WAM modeling results. The WAM model should then be modified to only dedicate wastewater discharges during such periods. This revised modeling strategy would maximize the environmental flow benefit from the effort, and would minimize the impact that the strategy has on other water rights within the basin. Tables of modeled stream flows and estuary inflows resulting from Strategies 1a and 1b are presented in Appendix B-1. Water right reliabilities resulting from these strategy implementations are presented in Appendix B-2.

3.2 Strategy 2: Dry Year Option - Irrigation Right Dedication

For this strategy, portions of irrigation water rights were dedicated for environment flows into Guadalupe Estuary during only the 10 driest years of the period of record. Figure B-4 provides a map of the Guadalupe-San Antonio basin with the top 20 irrigation rights by volume. Rights selected for environmental dedication under this strategy are denoted with red squares, and were preferentially selected closer to the basin outlet so as to minimize the effect of channel losses. Environmental dedications occurred in 1950, 1954, 1956, 1963, 1965, 1969, 1982, 1984, 1988 and 1989. Under modeling Strategy 2a, a total of 16,599 acre-ft/yr was dedicated from 5 water rights. Under modeling Strategy 2b, a total of 31,836 acre-ft/yr was dedicated. Information on the dedicated water rights is provided in Table B-3.

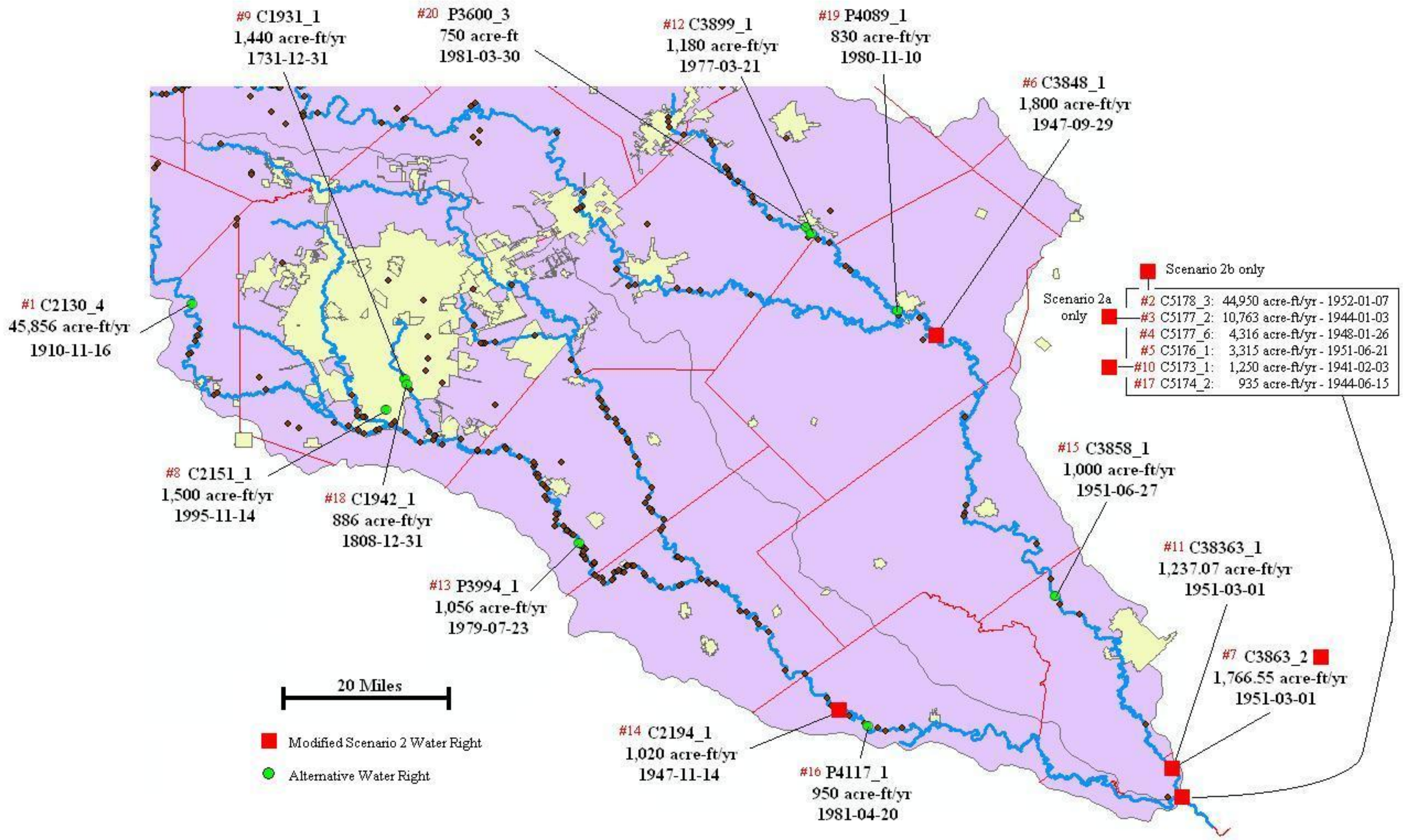

Figure B-4 - Guadalupe-San Antonio basin showing the locations of the top 20 WAM-modeled irrigation withdrawals/water rights. Red squares indicate the locations of irrigation rights dedicated to meet environmental flow needs. Original Region L WAM-modeled diversion amounts and priority dates are displayed adjacent to each diversion location. Basin, County, and City boundaries as provided by the Texas Water Development Board. Rivers derived from the National Hydrography Dataset. Diversion locations provided by the Texas Commission on

Environmental Quality. Note: Strategy 2a used water right C5177_2. Strategy 2b used a portion of water right C5178_3.

Table B-3 - WAM modeled Irrigation Water Rights Modified for Strategies 2a, 2b.

Water Right	Control Point	Permitted Diversion (acre-ft/yr)	Priority Date	Strategy 2a Dedication (acre-ft/yr)	Strategy 2b Dedication (acre-ft/yr)
C5177_2	517701	10,763	1/3/1944	10,763	Not Used
C5178_3	517801	44,950	1/7/1952	Not Used	26,000
C3848_1	384802	1,800	9/29/1947	1,800	1,800
C3863_2	386301	1,766	3/1/1951	1,766	1,766
C5173_1	517301	1,250	2/3/1941	1,250	1,250
C2194_1	219402	1,020	11/14/1947	1,020	1,020
			Totals	16,599	31,836

To dedicate irrigation rights for environmental flow purposes in the WAM model, each selected water right was “divided” into a coupled pair of rights, each with identical properties except differing diversion rates. Time-series “TS” values were used (with the “MUL” option) to dictate when each modeled right was to divert water. Therefore a TS value of “0” indicated that the right in question was not to divert water during the particular month, and a TS value of “1” indicated that the right would attempt to divert its full allotted diversion amount for that month. TS values were defined for each right for each month and year of the modeled period of record. For each coupled pair of rights, the sum of the TS values specified for any given month and year was set to equal “1”. In this manner, diversions were “turned-on” or “turned-off” during dry or wet years, and the fractional amount of a water right dedicated to environmental flow needs could be specified.

Out of each coupled pair of water rights, water diverted under the portion envisioned to participate the “dry year option” was immediately transferred into a dummy storage reservoir at the control point where the coupled pair of water rights was located. Only water actually available to this irrigation right vis-à-vis other water rights was transferred, by maintaining the same original priority. Similar to Strategy 1 computations, water was released from the dummy storage reservoir only in order to satisfy a dummy water right located at the Guadalupe Estuary. The dummy water right at the estuary could only receive water released from the dummy reservoir, and would drain the dummy reservoir during every modeled timestep. Water flowing from the dummy reservoir to the estuary was subject to channel losses and was used in assessing instream flow requirements within the WAM model. The priority date for the dummy water right at the estuary was set identical to that of the coupled water right pair from which the environmental flow dedication was made. Such a priority date ensures that all water released from the dummy reservoir is dedicated as environmental flows water at the estuary; senior priority dates would prevent dedications as WinWRAP would attempt to satisfy the dedications earlier in the priority-loop sequence when the dummy reservoirs were empty (i.e. before water had been transferred into the dummy reservoir by the modified water right in this strategy).

3.2a Modeling Results: Strategy 2

As shown in Figures 5 and 6, dedication of irrigation water rights to environmental flows during dry years does augment estuary inflows during those years. The increase in flows resulting from the modeled strategies, however, is a small percentage of the total modeled inflows to the estuary. Also as the irrigation diversions and dedications are subject to water availability within the normal water right priority system, there is no guarantee that any environmental flow water will be available for dedication in any dry year for which the strategy is implemented. This is evident in the varying amounts of environmental flow water resulting from Strategy 2b versus 2a(Figure B-6). During the year 1954, not much additional water was available for environmental flow dedication, although the total attempted dedication of 2b is essentially twice that of 2a (see Table B-3) thereby lessening the effectiveness of strategy 2b implementation. During the dry years, the increases in estuary inflow due to implementation of Strategy 2b amounted to between 2% and 32% of the estuary inflow for the respective year. If this strategy were pursued further, INTERA recommends that much further investigation of the effectiveness of various water rights subject to this strategy should be pursued.

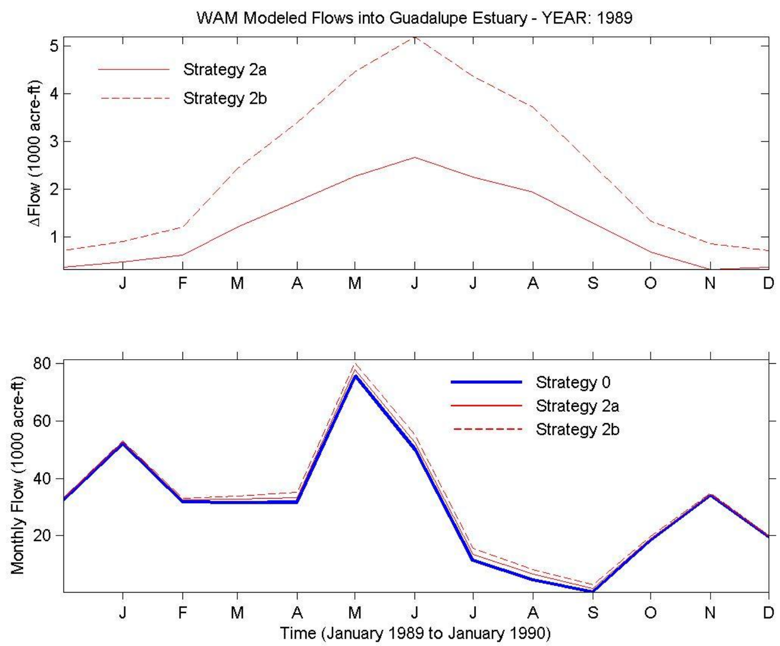

Figure B-5 - Modeled Guadalupe Estuary inflow results for 1989, including the original Region L WAM model results and those from Strategy 2a (dedication of up to 16,599 acre-ft/yr) and Strategy 2b (dedication of up to 31,836 acre-ft/yr).

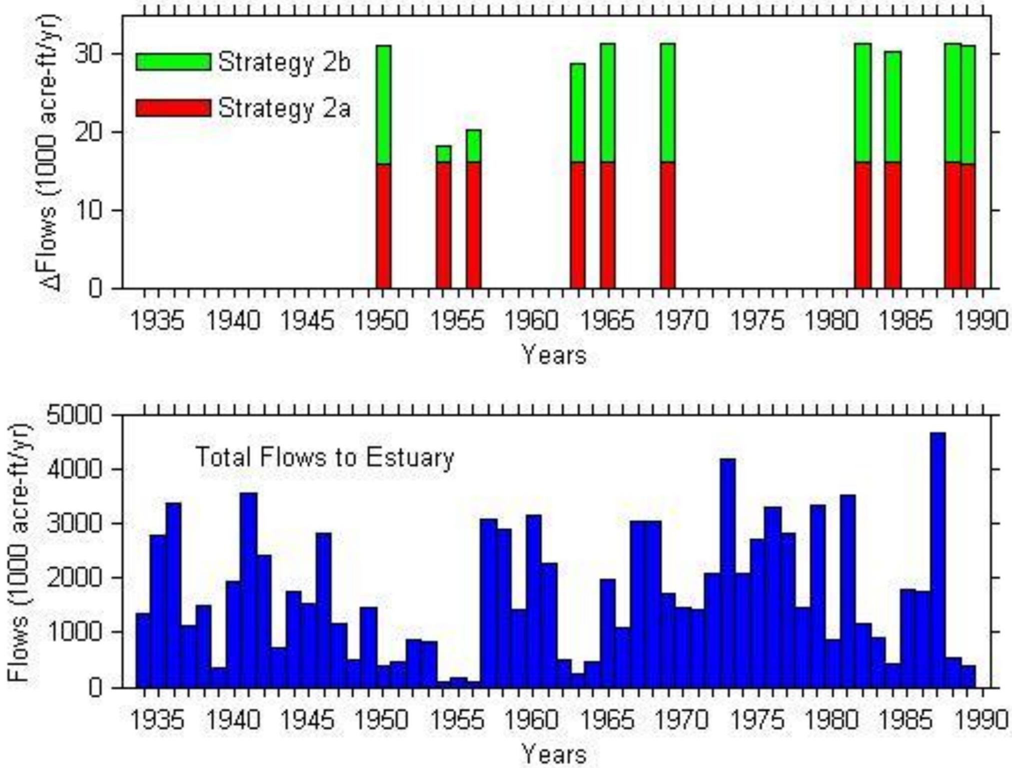

Figure B-6 - Inflows to Guadalupe Estuary from the baseline Region L WAM modified through implementation of Strategy 2a and 2b. Flow increases due to strategy implementation amounted to from 2% to 32% of the total estuary inflows.

3.3 Strategy 3: Unused Right Dedication

In this Strategy, the water dedicated for environmental flow needs was derived from under-utilized existing water rights. An "under-utilized" water right is one which does not typically divert its full permitted amount from the river system. For example, water right "A" could be permitted to withdraw 800 acre-ft per year, yet only actually uses 600 acre-ft/yr. The un-used portion (200 acre-ft/yr) could be left in the river and can therefore help augment environmental flow needs. Of course, in the baseline Region L WAM model, all water rights are assumed fully utilized; but in this strategy we assume that some portion of the existing set of water rights could be purchased / leased / or voluntarily dedicated. . However, to more realistically portray this strategy and find rights that may be more realistic for such conversion, INTERA and NWF did endeavor to find currently "under-utilized" rights. This was done by comparing known diversion amounts against permitted amounts for each water right of interest. It should be noted that in this discussion, "diversions" refer to the quantities of water that a WAM-modeled water right may withdraw from the river network, which might be subject to water availability. Water "demands," however, reflect the quantity of water needed, irrespective of water availability. Thus for 100% reliable water rights, WAM modeled diversions always equal modeled demands. For less reliable water rights, demands may exceed diversions. For Strategy 3, we are only considering rights for which recent water demands are less than the permitted maximum demands.

To assess under-utilization, INTERA compared WAM modeled diversions contained in the Guadalupe-San Antonio "Full Authorization" (Run 3) and "Current Conditions" (Run 8) models published by the Texas Commission on Environmental Quality (TCEQ- models downloaded on 6/8/2011). These WAM models differ from the Region L WAM model, yet are the officially endorsed WAM models used in Texas for assessing water right availability and permitting issues. The Region L WAM model is a modified version of the TCEQ-published WAM models. The TCEQ Full Authorization model includes all water rights with diversions at their fully permitted amount. In contrast, the Current Conditions model contains water right diversions based on reported diversion amounts over a recent 5-year period. Therefore the difference between the Full Authorization diversions and the Current Conditions diversions should reflect the amount of current "under-utilization" of each water right. For use in this WAM modeling strategy, one or more rights with under-utilization are treated as water available for dedication to enhancing estuary inflows. Figure B-7 shows the locations of the most under-utilized and reliable water rights in the Guadalupe-San Antonio basin. In this analysis, water rights were ranked based on the quantity of water available for dedication to environmental flows, as long as the water right is greater than 90% reliable (per the Region L WAM model).

Upon further examination, certain water rights with apparently large under-utilized fractions were eliminated from consideration. For instance, C3865_1 shows approximately 64,000 ac-ft/yr is unused, yet this is actually a hydropower water right which returns 100% of the "diverted" amount. Regardless of current utilization versus "full" permit difference, there would be no net benefit for this conversion. Other non-consumptive, or nearly non-consumptive water rights were also eliminated from consideration (e.g. C3859_1 which returns 98% of diverted water).

NWF, using information proved by the Guadalupe-Blanco River Authority (GBRA), determined there is extensive uncertainty in the amount of under-utilization of any given water right, and that the amounts of available water as determined through the above-described method using TCEQ-published WAM data may not reflect actual conditions within the basin. For example, GBRA suggests that water right C5178_2 may have water available, whereas the TCEQ WAMs suggest this right is fully utilized. Further investigation will be needed to assess the water rights most appropriate for this environmental flow dedication strategy. However, in order to demonstrate this strategy's potential, NWF selected the water rights shown with green squares on Figure B-7, and listed in Table B-4. The modeled available water amounts were determined by NWF based on their knowledge of water utilization, conversations with GBRA, and the analysis of TCEQ water rights performed by INTERA.

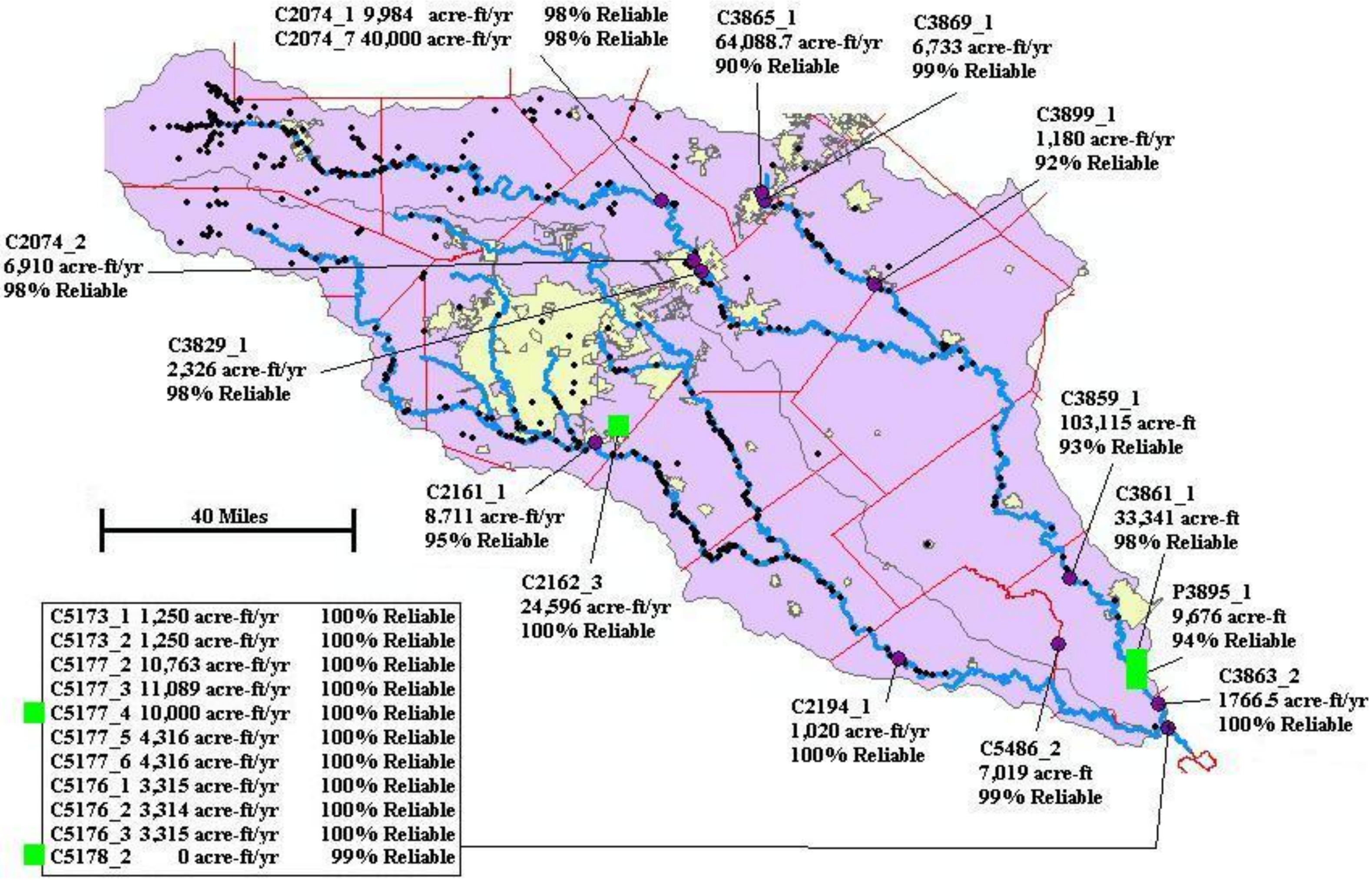

Figure B-7 - Guadalupe-San Antonio basin showing the locations of the top 20 WAM-modeled under-utilized water rights with over 1000 acre-ft/yr of "available" water and at least 90% reliability. Green squares indicate the locations of rights dedicated to meet environmental flow needs. Reliabilities based on results from the original Region L WAM model. Basin, County, and City boundaries as provided by the Texas Water Development Board. Rivers derived from the National Hydrography Dataset. Diversion locations provided by the Texas Commission on Environmental Quality.

Table B-4 - WAM modeled Under-utilized/Available Water Rights Modified for Strategies 3a, 3b.

Water Right ID	Control Point	Priority Date	Permitted Diversion (acre-ft/yr)	TCEQ-Based Availability (acre-ft/yr)	Environmental Flow Dedication (acre-ft/yr)	
					Strategy 3a	Strategy 3b
C2162_3	216231	4/25/1967	36,900	24,596	12,298	24,596
C3861_1	C38611	8/16/1948	60,000	33,341	16,671	33,341
P3895_1	P38951	7/10/1978	9,676	9,676	4,838	9,676
C5177_4	517701	1/3/1944	10,000	10,000	5,000	10,000
C5178_2	517801	1/7/1952	30,525	0**	10,000	20,000
				Total	48,807	97,613

** NWF sources suggest between 10,000 and 20,000 acre-ft/yr of availability.

To dedicate under-utilized rights for environmental flow purposes in the WAM model, each right was “divided” into a coupled pair of rights, each with identical properties except differing demands. Unlike the rights used in the Strategy 2 simulations, it was assumed that rights were under-utilized during all years of the modeled period of record. As such, it was not necessary to modify each right using TS records. Instead, the first of the coupled pair of rights was modeled with a demand equal to its apparent actual historical demand. The second right, that for the strategy, was modeled with a demand equal to the amount of right under-utilization (or availability). The sum of the demands for both rights equals the demand used in the Region L baseline WAM model.

Out of each coupled pair of water rights, water diverted under the second right was immediately transferred into a dummy storage reservoir at the control point where the coupled pair of water rights was located. Again, water was released from the dummy storage reservoir only in order to satisfy a dummy water right located at the Guadalupe Estuary. The dummy water right at the estuary could only receive water released from the dummy reservoir, and would drain the dummy reservoir during every modeled timestep. Water flowing from the dummy reservoir to the estuary was subject to channel losses and was used in assessing instream flow requirements within the WAM model. The priority date for the dummy water right at the estuary was set identical to that of the coupled water right pair from which the environmental flow dedication was made. Such a priority date ensures that all water released from the dummy reservoir is dedicated as environmental flows water at the estuary; senior priority dates would prevent dedications as WinWRAP would attempt to satisfy the dedications earlier in the priority-loop sequence when the dummy reservoirs were empty (i.e. before water had been transferred into the dummy reservoir by the modified water right in this strategy).

As the selected water rights, like all others, are subject to water availability within the WAM priority system, the actual amount of water dedicated to environmental flow purposes in any given month or year depends on the reliability of the water right at that time. Therefore the environmental flow dedications listed in Table B-3 represent maximum annual conversions assuming 100% reliability. In dry years, the diversions dedicated to environmental flows will be less than the amounts specified in Table 3.

3.3a Modeling Results: Strategy 3

As shown in Figures 8 and 9, the dedication of available water from under-utilized water rights to environmental flows does augment estuary inflows. In 1989, for example, monthly average inflows increased by 3,000 and 6,000 acre-ft under Strategy 3a and 3b, respectively (Figure B-8). During typical or wet years in the modeled period of record, the dedicated flows make up less than 5 percent of the overall inflows to the estuary. During the driest years, however, the dedicated flows can amount to up to 32% and 65% of estuary inflows for the 3a and 3b Strategies, respectively (Figure B-9).

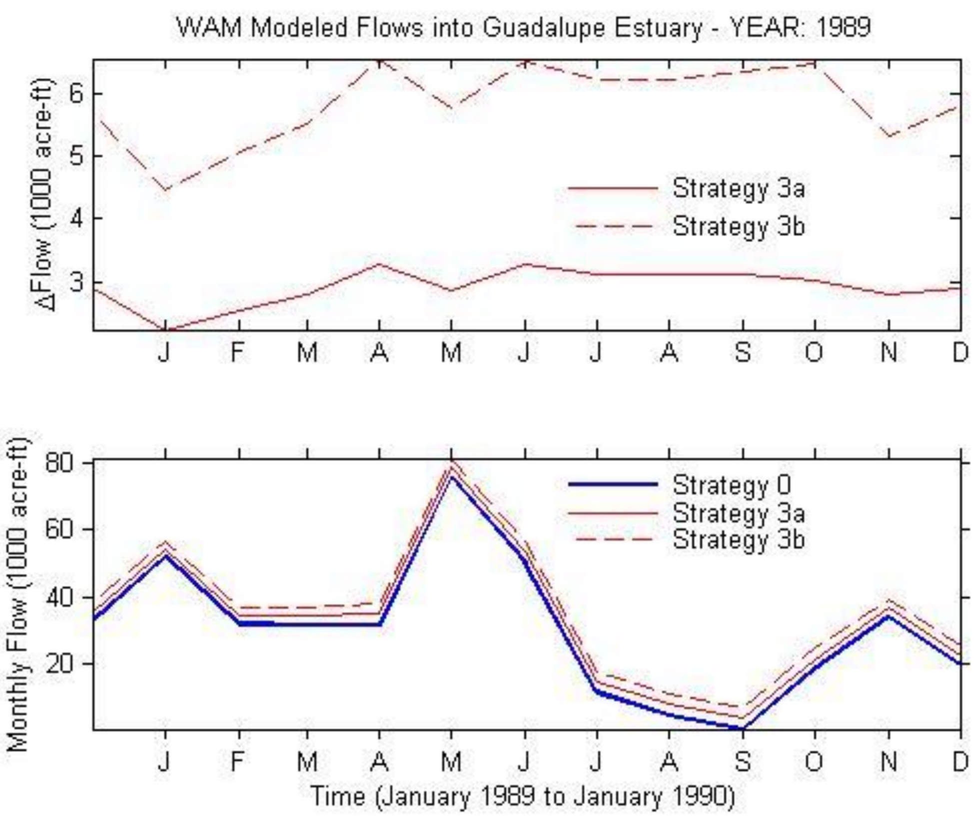

Figure B-8 - Modeled Guadalupe Estuary inflow results for 1989, including the original Region L WAM model results and those from Strategy 3a (dedication of up to 48,807 acre-ft/yr) and Strategy 3b (dedication of up to 97,613 acre-ft/yr).

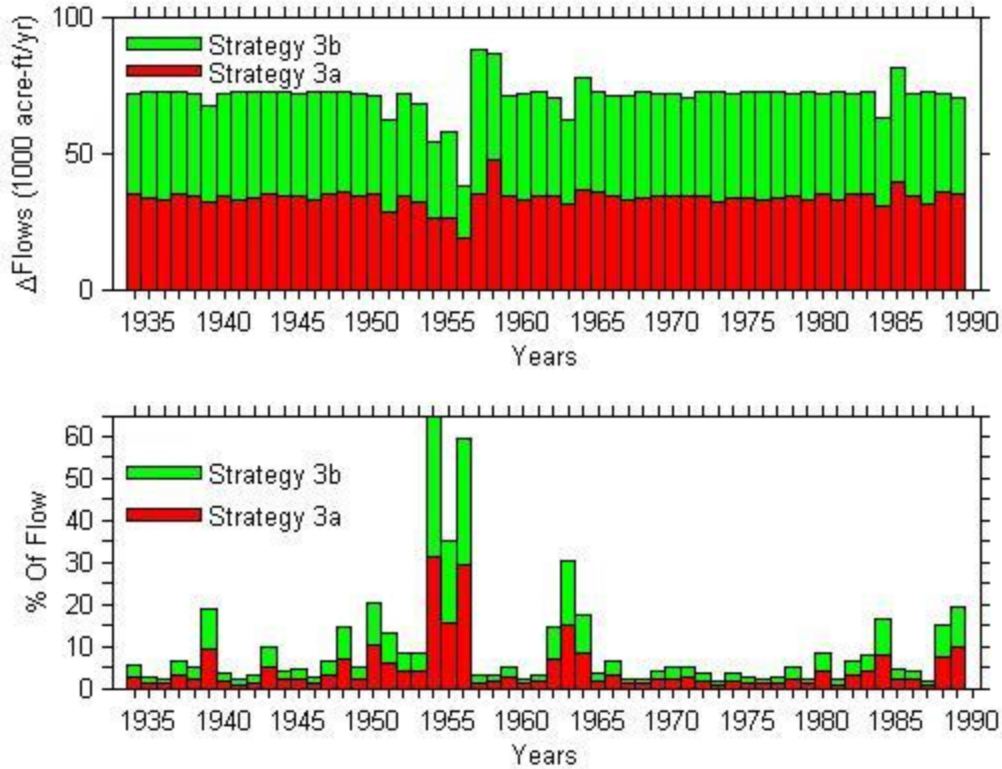

Figure B-9 – Increase in Inflows to Guadalupe Estuary from the baseline Region L WAM through implementation of Strategy 3a and 3b.

3.4 Strategy 4: Combined Strategy & Results

When implemented separately, Strategies 1, 2, and 3 each enhance environmental flows into the Guadalupe Estuary. To assess any possible synergistic or antagonistic effects of implementing multiple strategies, a combined strategy was analyzed. The combined strategy (Strategy 4) consisted of implementing Strategies 1a, 2a, and 3a within the same WAM model run. Results from the Strategy 4 (Figure B-10) show that combining the individual efforts further enhances the estuary inflow, although the total inflow increase is not always equal to the sum of the increases achieved when implementing each strategy separately. The cause for this semi-antagonistic effect was not conclusively identified, yet likely stems from how modification of wastewater discharges affect the reliability of other water rights within the basin, similar to the effects seen when implementing Strategy 1.

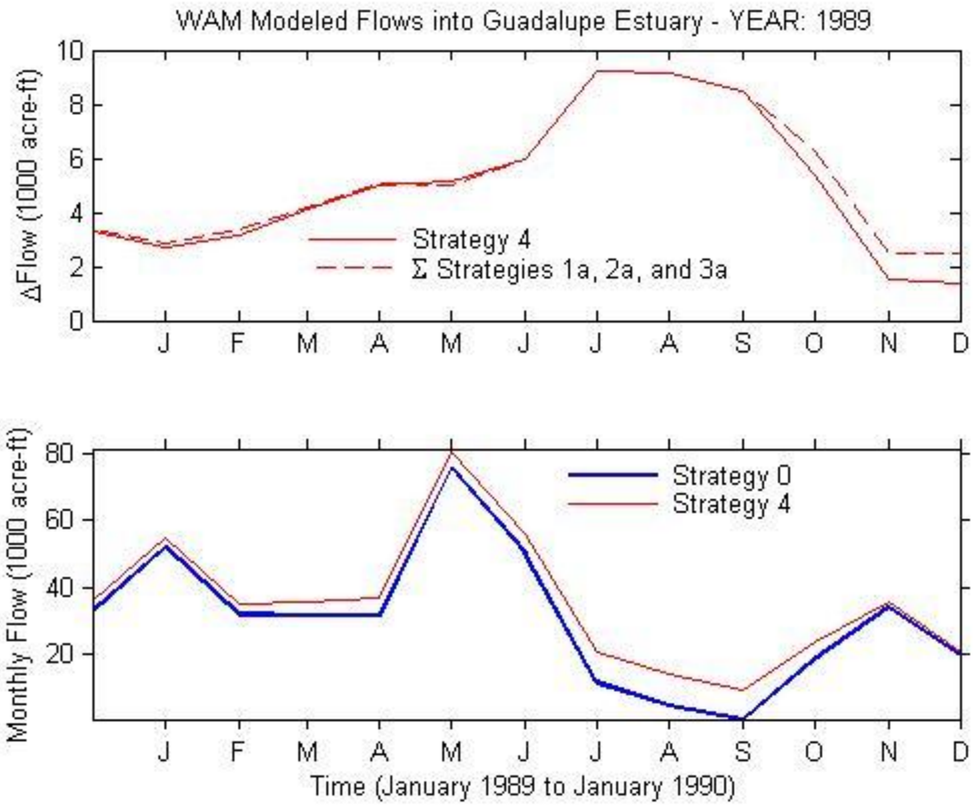

Figure B-10 - Modeled Guadalupe Estuary inflow results for 1989, including the original Region L WAM model results and those from Strategy 4, a combined WAM model incorporating Strategies 1a, 2a, and 3a.

Appendix B-1
WAM modeled output – streamflows & diversions

Table B-1-1 – Strategy 0 – Baseline – WAM Modeled Stream Flows – San Antonio River at Goliad (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	39241	24396	28835	46659	15415	9563	40776	11560	12590	14446	33855	41930	319267
1935	17286	28742	17609	39972	191705	279726	29590	18642	72726	35947	25964	33746	791654
1936	23212	21072	24148	19472	96811	34312	214926	23799	167462	90272	47109	40781	803377
1937	32825	25471	29219	21052	18049	136054	18267	16132	17275	19840	18561	71315	424060
1938	56073	19914	39429	110386	35394	18659	15971	13024	14516	13224	15802	17855	370248
1939	17942	14806	11525	11462	11566	11313	16498	10885	7150	7818	7999	9447	138411
1940	7385	12337	6383	19263	11570	31604	80773	22035	8197	18047	152671	103793	474058
1941	35146	60229	45493	91409	229296	94683	51118	24548	51853	34547	27575	18203	764101
1942	14494	13431	10828	30481	26727	13715	253773	21527	290285	133726	37335	29411	875733
1943	25361	17710	22766	19710	24614	47622	25680	12870	17791	13806	17708	16954	262594
1944	23964	17494	24197	13949	118595	27123	13455	17920	29338	14556	15655	26336	342582
1945	40342	43549	28359	64816	18711	23168	11606	10810	10361	23829	13174	14826	303551
1946	16716	17202	23958	39700	93058	58772	12232	47970	252554	338203	55069	32307	987741
1947	44383	20925	26030	21359	53037	17038	11797	17628	13502	12181	14534	16311	268725
1948	13059	14000	11779	11955	16737	6428	19993	41601	15815	19454	9844	10551	191218
1949	10176	13211	14384	133785	40941	59775	43673	15291	11362	70667	17362	25895	456522
1950	13850	8981	10273	13892	11585	31510	10069	11618	9375	8278	7588	8175	145193
1951	5200	7942	7603	10539	26876	61041	11433	9425	44242	9100	9094	8626	211121
1952	5379	7924	7023	15253	29471	9248	9614	8991	194403	9453	12730	13824	323312
1953	13704	5269	6573	10143	55515	8954	11223	17095	72560	15915	9411	11511	237873
1954	6629	3745	3425	7587	12649	10871	9744	8374	8659	7816	8957	6633	95090
1955	5451	14524	7404	9885	15955	9122	10344	9053	12425	7385	8500	6817	116865
1956	6482	5590	9774	10507	9692	7720	8984	8098	14974	20964	10168	23282	136234
1957	7534	5882	24148	140218	168357	129573	9086	9878	110083	56534	52277	16651	730220
1958	95002	149178	39083	18409	121550	36126	24547	8676	47075	69342	85724	30654	725367
1959	20733	20150	15903	30992	30939	15493	14023	9938	9303	37320	19425	16591	240812
1960	16955	13608	15077	15638	14728	27818	24828	32096	11885	150248	99727	50400	473010
1961	38947	57159	30945	22314	11266	72201	51177	16139	16063	26816	42987	16817	402832
1962	14090	11618	9147	14584	10225	34728	7074	9825	14006	7383	10142	18536	161359
1963	8217	15047	6715	8989	8083	5232	9572	8209	10360	12806	16361	11520	121111
1964	7200	22283	18103	7631	5976	11492	9217	24273	16665	15248	29372	10535	177995
1965	29233	90017	13938	22026	154995	35893	10040	6925	6571	32977	12263	39273	454149
1966	12777	14141	13409	23360	30924	11304	7785	11952	19270	10423	7832	9145	172323
1967	7866	5249	6731	9400	9872	3196	13781	21501	703564	61915	54252	20452	917780
1968	259991	50803	32731	35180	121817	42624	24928	12358	44449	15056	14052	31116	685106
1969	16425	48726	28064	37557	72717	27440	7461	7844	15107	25611	12554	17224	316729
1970	21121	18358	35179	14552	63832	68620	8473	8642	8404	12480	9909	10092	279663
1971	9850	6020	6474	7328	7257	9370	6247	102512	49358	62163	47476	43791	357847
1972	23977	18233	13668	26931	255628	52179	23151	22995	23228	31103	19832	17510	528435
1973	17324	24330	20291	96097	25735	242960	241204	65486	116148	415846	80180	45710	1391312
1974	37028	25505	25085	22461	40034	22140	9988	56062	85439	33276	52006	31737	440762
1975	30978	99169	41386	34496	140114	120934	44779	27643	23256	20387	16666	25748	625558
1976	22369	12828	15352	85735	158702	29565	50109	24235	41158	100741	121256	91828	753879
1977	66734	66065	41427	242604	128443	59853	29902	17237	36541	21227	73159	24591	807783
1978	19819	21604	20949	31390	20000	45689	6927	85666	98830	29115	50800	24483	455273
1979	81790	47581	60630	155036	120003	148586	49058	28904	18625	13766	16300	20485	760763
1980	22803	17431	11585	15403	71399	12401	6301	30699	55964	14565	16738	18248	293538
1981	16427	13698	17432	25230	44085	258411	73960	31909	134274	75506	53110	24711	768753
1982	18529	34594	21804	17532	55526	15341	9364	8912	6563	23758	23139	18666	253728
1983	16368	17210	27294	11078	15626	13954	10703	11009	40150	15405	22362	11275	212435
1984	13936	10871	14967	7984	8471	5759	9554	9152	8176	51929	27494	19063	187357
1985	33659	13527	38495	38194	18663	45295	48902	6976	15892	52807	71684	26280	410375
1986	15420	15242	8745	8290	18071	166297	21130	7806	23265	60308	30340	122128	497040
1987	70135	64417	76690	32497	92008	884281	87449	36864	31261	17633	25628	29748	1448611
1988	23639	19174	20128	17287	13183	13348	20872	7742	10776	8823	8860	9840	173672
1989	13234	11689	10806	15678	14001	12116	6577	6290	4949	4935	16188	12275	128738
MEAN	28293	26426	21418	36881	57789	65861	34102	20987	57251	45124	32442	26887	453462

Table B-1-2 – Strategy 0 – Baseline – WAM Modeled Stream Flows – Guadalupe River at Victoria (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	90092	79823	140810	105127	45672	27649	39086	25317	23305	25345	61468	98643	762339
1935	44465	102386	39907	62218	446333	525996	97492	55679	259342	109616	54480	119417	1917331
1936	76451	50923	52606	34706	283741	121905	1115649	60131	178917	254026	94821	85959	2409836
1937	76162	63878	163870	65511	43955	141300	39130	25955	23404	35606	27047	54253	760071
1938	143986	84767	75856	299569	288514	62315	38230	30664	26332	23859	26154	29439	1129686
1939	30395	25205	24261	21229	29047	29927	27767	14635	14922	15076	16016	19380	267859
1940	19629	28555	23964	32419	24496	39363	385519	17295	15017	24707	361754	311678	1284397
1941	145032	188764	257459	268488	782914	265892	135749	64366	49093	70561	55958	43688	2327964
1942	38447	31528	33457	139923	81250	34479	368882	37622	243771	159008	90477	75093	1333937
1943	72659	46983	53630	42937	37958	62107	37583	22678	27244	25816	24507	32148	486250
1944	65951	77987	164576	72766	196288	159413	49820	30083	84822	34026	61707	118841	1116280
1945	184611	169698	156249	315331	74043	59274	33919	23209	17448	60148	31232	49221	1174383
1946	63985	89720	174464	74893	111375	123620	27458	52317	269916	238019	203770	123330	1552868
1947	208947	103139	117409	112961	118509	48484	31740	60479	23673	22467	24499	31857	904165
1948	27439	37008	35312	19629	72767	18376	26234	19931	14480	16217	13123	15754	316270
1949	18430	32659	77044	215685	147683	44465	33515	19931	18034	150309	36595	45856	840206
1950	29335	35588	26254	60484	35858	118907	19516	11499	13341	9973	10626	14795	386177
1951	13981	14578	15274	16555	19931	113698	9499	3785	13405	5578	9291	9410	244985
1952	11289	15342	11637	19689	57854	60982	16004	3694	110296	26832	39860	98128	471606
1953	83568	31792	25493	28159	142019	12972	11431	19384	76118	85518	25276	35123	576853
1954	20065	16103	15014	19629	27433	8364	4004	3024	3068	1164	3488	5915	127271
1955	6766	39649	11597	10288	30200	35343	7742	7930	4758	2517	2922	4086	163799
1956	4176	6881	3987	4534	11227	1984	2015	1602	2118	4532	611	20737	64404
1957	3214	15646	51375	165921	378846	270573	24731	14634	206465	434916	234571	107647	1908540
1958	230269	443964	222802	102649	245787	89018	58387	32738	106670	103616	119720	77534	1833154
1959	67843	101844	67522	185992	90714	53915	60187	32828	29259	137668	65548	58463	951784
1960	76846	76926	62782	64329	129222	153839	142005	88164	45471	553615	447560	191441	2032199
1961	222823	247335	139997	83712	56607	395590	145105	53740	101188	53146	123246	52812	1675303
1962	45598	41612	38027	44607	33701	36088	21146	14634	29757	27187	30467	37786	400612
1963	32827	48205	30091	30758	21204	14635	14602	8932	9862	6991	36430	20848	275384
1964	19629	34579	57883	28798	19931	20543	11388	14088	27730	27504	37539	21601	321212
1965	87740	255482	61637	59011	260276	243201	45801	28587	25722	66568	104099	167129	1405253
1966	61064	80881	82863	114198	156053	50246	31486	32181	39298	34463	27197	27657	737587
1967	26048	22562	23004	19629	17902	14635	12291	14635	538288	113268	107268	52206	961735
1968	513090	147020	110494	158264	287186	342639	80200	41257	84620	39245	45898	116324	1966236
1969	46307	170936	166982	208434	185774	68827	33681	29233	36424	75915	53737	92299	1168549
1970	84277	90033	166318	88492	220497	131815	46052	33506	35051	52498	31791	33437	1013768

1971	30146	25910	29423	21213	19931	19885	14680	73168	144753	94929	69323	110317	653677
1972	72299	64085	50963	32472	771698	144146	65533	59956	40735	46037	47262	43075	1438262
1973	62017	85880	144855	292979	109575	444883	254813	128546	112932	669873	160232	103227	2569813
1974	205424	86143	75015	58096	133412	75340	35150	68086	215420	73885	267015	164241	1457227
1975	109684	243932	121337	120560	572123	329545	178461	91040	65674	65210	53071	71007	2021645
1976	47568	43395	48251	306111	375178	170253	126069	66814	75849	249946	291946	398701	2200080
1977	160356	244838	115689	629237	254345	128335	72839	56615	52713	48191	84091	51988	1899236
1978	49890	51689	50582	49339	37757	75184	27529	239985	193932	66272	104616	62979	1009752
1979	283536	195985	222911	310211	438697	331865	113379	89692	80826	49964	45429	46246	2208740
1980	60946	48168	41652	34142	159128	46597	25515	19931	60012	52312	40591	44316	633309
1981	43609	41174	79356	95852	112341	615768	195719	77631	655382	166307	239492	81409	2404041
1982	67776	84490	58753	48479	338172	65697	31040	21205	21304	31363	56610	37639	862528
1983	33677	72935	115938	59484	85164	67308	60562	22500	36485	37338	42774	28188	662356
1984	39405	31712	41381	23620	21098	18106	11001	10119	10367	32756	26678	38627	304872
1985	100025	81170	124411	134570	89474	193815	132067	36934	29944	107518	194406	183811	1408146
1986	93813	91132	66339	46885	98246	177165	45122	26601	68809	140089	127582	369910	1351692
1987	233749	180410	274939	108953	167834	1582105	293672	170648	99593	86431	94238	84508	3377080
1988	63879	57162	68665	46475	49674	47566	59030	39451	27903	27379	25611	31538	544330
1989	37038	34546	40132	37135	81965	32759	18247	14633	11893	14086	19604	20326	362365
MEAN	85505	87763	84866	104524	163010	153013	90098	42213	86306	92632	84488	79857	1154275

Table B-1-3 – Strategy 0 – Baseline – WAM Modeled Stream Flows – Estuary Inflows (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	312070	99406	171862	162622	41467	13386	127684	18105	45807	27861	158574	149258	1328101
1935	55182	136992	68943	107487	616657	780673	107868	50340	466055	131705	71517	175220	2768640
1936	88404	58545	66877	50526	572945	166400	1350410	77451	356140	327724	129921	117527	3362870
1937	107626	75287	187328	65396	40917	261087	44234	32057	36154	59433	43963	174397	1127879
1938	188290	96847	94291	440338	376071	64624	29426	40262	37464	25510	37515	64484	1495122
1939	50746	30647	21446	14959	34838	23488	70139	9569	47377	10324	11948	27090	352570
1940	20283	42853	19645	31583	28716	162514	454698	33167	9295	103663	577395	450441	1934254
1941	168221	276643	338305	460367	1155404	362447	299935	74301	92698	146683	77577	91215	3543796
1942	39556	104911	46807	145291	79397	20639	862482	109216	533849	275145	111739	89908	2418939
1943	114760	64090	96166	39137	63192	113226	54294	9879	35835	23110	49411	62768	725867
1944	216069	82702	263897	64130	430108	153298	34638	47266	135825	62330	70060	168574	1728897
1945	201310	192447	174418	401171	68037	93397	43276	192773	7426	79865	29271	47994	1531386
1946	69031	138722	203468	93032	203789	242051	24924	148375	555407	752059	257096	136308	2824261
1947	239034	105785	121074	135180	267882	52557	33380	55166	15813	24429	50690	40356	1141345
1948	50496	73496	59630	15233	101360	524	19065	52595	86798	19443	9596	12595	500830
1949	16101	39537	80161	501461	162450	76588	80015	14246	11755	364148	41331	76156	1463948
1950	33970	43933	17928	59779	23935	133900	5031	77	9167	3120	4951	9412	345201
1951	6894	8917	5263	5592	69003	162092	0	0	183668	9497	9262	5062	465250
1952	4537	18589	8380	54621	151153	59077	4496	36	347649	20423	76146	106135	851241
1953	81518	34512	13842	23505	216617	148	0	163479	148266	99538	21595	35654	838675
1954	14877	6487	848	7740	18509	0	0	0	0	30352	4545	31	83389
1955	2188	52144	1186	0	31986	17464	0	6870	48971	2691	31	597	164127
1956	0	0	588	3635	11183	0	0	87	0	13168	2576	32384	63621
1957	0	11056	176364	509566	622532	440616	6494	0	316432	484651	382424	106926	3057061
1958	413554	779786	239514	98118	353502	91905	52683	15023	243556	256555	189698	150009	2883903
1959	74538	247139	63072	221385	120764	73681	45614	88763	25871	301782	72865	76684	1412158
1960	78982	111991	85066	56755	126966	250377	151949	211405	40024	1071181	597733	357948	3140376
1961	303871	383744	146004	90075	43540	529033	245404	43928	196505	60372	172436	53504	2268415
1962	45062	39134	28215	48880	27573	98325	4305	31	48247	27022	35693	78332	480818
1963	28536	60190	18395	17758	6335	809	1	0	19	0	51082	21663	204788
1964	25781	68231	75929	14577	5410	22040	0	43018	83595	27186	49666	29079	444512
1965	118222	388064	55962	56158	436952	305371	28054	9843	12093	125469	128939	256294	1921422
1966	102974	124901	74752	159804	296057	74392	45338	24772	55711	57100	39216	36019	1091035
1967	43201	33145	24297	26988	49965	13344	6290	39470	2050710	404355	197384	133099	3022248
1968	736344	260847	146120	186060	488145	495012	197107	54050	140887	109204	74049	147040	3034863
1969	100593	230058	233546	350349	296599	106669	14678	18505	29979	86481	75375	127626	1670458
1970	12746	99509	22989	11934	256681	298481	54978	21811	70697	108018	29553	31459	144789

	3		8	7									6
1971	26529	17931	17301	15801	28233	9488	6403	139035	416249	315847	164613	246558	1403986
1972	109752	114823	60040	45825	1026404	217674	65035	77978	66550	125414	140123	44979	2094596
1973	64715	99464	145201	395924	127937	745808	433597	238789	268626	1197906	285415	165722	4169104
1974	229139	144840	112675	63433	244989	84326	17854	95521	304155	141001	355959	290052	2083944
1975	154374	314551	180543	155027	670513	507238	224646	114704	124538	66814	85940	88243	2687132
1976	76555	41112	44044	479829	513524	234162	232694	62045	98116	358481	492500	659854	3292916
1977	229847	313928	136823	858865	408239	332235	73697	51179	84028	71701	184610	61470	2806623
1978	62718	81057	51959	61234	33440	119939	10700	279983	458941	83212	151657	74450	1469290
1979	414237	246212	272053	446244	632988	481781	223404	101036	356620	52479	52742	57003	3336798
1980	110352	54798	38164	28322	247366	32031	6692	72096	109656	60752	45624	48357	854211
1981	58297	41725	75334	99838	240820	1025347	295854	135760	769182	293542	372244	103229	3511173
1982	72604	197872	64556	48074	440348	54307	13976	6791	10654	42076	150172	43022	1144452
1983	45280	102632	150805	49002	76503	59194	137372	15145	75469	82274	68449	27383	889508
1984	60249	30238	53445	11226	16664	77	605	5217	1857	111032	52293	43971	386875
1985	133751	81667	199642	244595	88310	231200	163544	21659	34028	146622	242882	196538	1784439
1986	96328	90874	55249	33099	115608	322759	36958	16144	72639	247436	173476	495200	1755769
1987	295150	263537	321728	114224	230157	2430666	376583	187794	119762	94477	131140	98961	4664178
1988	71835	60049	67567	40815	38317	35766	53388	21216	20652	21702	20348	32493	484148
1989	52169	31735	31464	31605	75721	50022	11278	4546	382	18364	33945	19415	360645
MEAN	118646	124113	102466	143957	234870	227387	122914	59867	177104	165406	127624	115645	1719999

Table B-1-4 – Strategy 1a – WAM Modeled Stream Flows – San Antonio River at Goliad (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	39493	24632	29097	46914	15683	9669	41044	11750	12604	14741	34122	42207	321957
1935	17536	28977	17893	40226	191973	279978	29858	18912	72988	36242	26231	34001	794816
1936	23485	21308	24411	19727	97079	34564	215194	24069	167724	90567	47361	41050	806539
1937	33098	25707	29481	21307	18316	136306	18535	16402	17538	20135	18827	71592	427243
1938	56325	20150	39691	110641	35661	18883	16235	13081	14779	13453	16175	18150	373224
1939	18194	14852	11478	11519	11566	11565	16781	11128	7412	8113	8264	9719	140590
1940	7637	12573	6645	19517	11570	31975	81062	22304	8459	18342	152937	104070	477093
1941	35398	60458	45755	91664	229563	94935	51386	24643	52130	34842	27603	18374	766752
1942	14769	13434	11104	30806	26994	13785	254219	21798	290547	134020	37601	29688	878766
1943	25613	17946	22903	20019	24801	47907	25966	13140	18054	13946	17882	17066	265243
1944	24892	18102	24465	14318	118884	27374	13455	17958	29547	14740	15776	27130	346641
1945	40302	43785	28621	65071	18976	23416	11606	11049	10654	24198	13440	14918	306036
1946	16903	17491	24229	40084	93326	59024	12490	51463	252815	338497	55335	32432	994088
1947	44788	21161	26292	21614	53305	17290	11843	17898	13480	12376	14867	16588	271501
1948	13311	14236	12041	12210	17002	8047	19734	41872	16062	19701	10110	10565	194891
1949	10445	13405	14313	134147	41221	62247	43941	15561	11074	71013	17628	26172	461167
1950	14101	9213	10536	14146	11585	31761	9592	15135	8916	8834	7766	7811	149397
1951	6440	6956	7642	10794	27070	61291	11670	9781	44204	9395	9360	8901	213504
1952	6120	8155	7285	15454	29567	9499	9866	9340	194616	9858	12942	14101	326802
1953	13955	6643	6592	10398	55725	9313	11601	16623	72797	16204	9677	11788	241315
1954	6791	5467	5383	7831	12807	11229	10136	8766	9028	8216	10493	10285	106434
1955	7358	14688	9327	10759	16332	9480	10722	10535	13750	8211	10046	11462	132670
1956	9644	8398	10146	10868	11492	8108	9387	8490	15236	19503	10793	24239	146304
1957	10352	7479	26110	137787	168572	129819	9340	12101	110424	56807	52543	16928	738261
1958	95253	149414	39346	18663	119070	35334	23421	9231	44910	67692	85741	31041	719116
1959	21095	20203	16191	31384	31207	15769	14226	9861	9192	37652	19687	16858	243326
1960	17269	13844	15339	15902	14995	28070	25086	32366	12254	150790	99993	50677	476586
1961	39288	57398	31211	22569	11627	72453	51447	16410	16039	27168	43015	17094	405718
1962	14212	11855	9409	14565	10578	34960	8112	10521	14269	7788	10296	18770	165334
1963	8464	14465	7488	8596	8478	6677	10801	8590	10602	17107	16330	11797	129396
1964	7452	22202	18168	7886	6338	11492	9595	24480	16928	15280	29884	10531	180235
1965	29478	88016	14211	22258	155027	36144	10308	7305	6825	33265	12164	39568	454568
1966	13034	14329	13407	23637	31192	11556	8039	12222	19334	10455	8098	9226	174529
1967	8115	6050	6438	9655	10139	3554	14656	21771	703362	62210	54510	20802	921262
1968	260514	51039	32993	35434	122085	42876	25196	12716	44712	15345	14319	31386	688614
1969	16677	48969	28225	37811	72989	27798	8304	10647	15941	25186	12588	17460	322596
1970	21382	18616	35441	14806	64081	68872	9011	8990	8501	12774	10282	10477	283234
1971	9940	6485	8030	6768	6750	9344	7087	102035	49620	62456	47742	44068	360326
1972	24229	18247	13930	26977	256038	52431	23419	23265	23372	31005	20183	17804	530899
1973	17622	24574	20553	96352	26002	243212	241468	65788	119640	416141	80553	46058	1397962
1974	37428	25840	25379	22716	40579	22235	10366	56371	85701	33571	52270	32014	444470
1975	31338	99405	41648	34799	140381	121186	45047	27913	23511	20792	16939	26025	628986
1976	22621	13064	15614	85989	158969	29817	50378	24506	41421	101036	121521	92105	757041
1977	66983	66301	41689	242859	128714	60211	30170	17331	36804	21750	73425	24918	811155
1978	20071	21840	21211	31645	20260	45941	7051	85833	99087	29409	51066	24621	458036
1979	82183	47817	61002	155290	120271	148838	49436	29205	18904	14132	16391	20897	764365
1980	23054	17666	11784	15463	71781	12510	7334	30328	55915	14971	16797	18250	295854
1981	16724	13708	17522	25546	44575	258682	74293	35402	134536	75801	53376	25098	775262
1982	18781	34830	21804	17787	55793	15387	9742	9292	8450	23388	22224	18943	256423
1983	16371	17286	27594	11381	15912	16425	10971	12583	40420	15686	22495	12480	219603
1984	14183	13210	15235	9923	9540	8365	9932	9533	8545	52175	27705	19340	197687
1985	33910	13763	38757	38449	18931	44957	48135	7234	16079	53101	71950	26557	411824
1986	15579	15478	9007	8545	18338	166576	21419	8143	23527	60603	30640	122406	500260
1987	70495	64648	77062	32863	92276	884532	87827	37166	31524	17927	26011	30025	1452356
1988	23890	19197	20525	17564	13450	13599	21140	8578	10595	9106	9126	9976	176747
1989	13366	11941	10970	15742	13898	12126	10383	10444	8823	7534	15567	11474	142270
MEAN	28713	26731	21761	37101	58024	66239	34455	21605	57575	45451	32691	27285	457630

Table B-1-5 – Strategy 1a –WAM Modeled Stream Flows – Guadalupe River at Victoria (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	90089	79820	140807	105124	45668	27649	39132	25317	23329	25305	61455	98640	762335
1935	44461	102382	39904	62314	446455	525876	97540	55675	259365	109576	54467	119414	1917429
1936	76448	50919	52602	34703	283862	121904	1115699	60127	178940	253991	94811	85955	2409961
1937	76159	63875	163866	65507	43951	141417	39176	25940	23426	35566	27033	54248	760166
1938	143985	84764	75853	299568	288513	62312	38276	30644	26352	23819	26140	29436	1129662
1939	30392	25201	24257	21226	29043	29924	27819	14635	15044	15160	16005	19377	268082
1940	19629	28552	23960	32416	24493	39360	385565	17295	15040	24668	361741	311675	1284393
1941	145029	188870	257459	268488	782914	266008	135794	64362	49113	70522	55945	43684	2328190
1942	38444	31524	33454	139922	81372	34476	368927	37618	243908	158876	90464	75089	1334075
1943	72656	46979	53627	42934	37955	62104	37629	22674	27264	25776	24493	32144	486236
1944	65948	77983	164687	72763	196284	159530	49866	30079	84841	33986	61694	118840	1116502
1945	184611	169696	156249	315331	74039	59272	33965	23208	17470	60108	31219	49217	1174384
1946	63981	89717	174461	74890	111372	123617	27504	52311	269936	237983	203760	123330	1552862
1947	208947	103246	117408	112957	118505	48481	31786	60475	23693	22427	24486	31853	904265
1948	27436	37005	35309	19629	72760	18803	26236	19931	14600	16177	13220	15751	316856
1949	18427	32645	77040	215682	147679	44462	33561	19931	18058	150270	36582	45852	840189
1950	29332	35585	26251	60481	35854	118904	19564	11590	13461	10219	10647	14792	386681
1951	14068	14575	15271	16552	19931	113696	9653	4047	13428	5660	9388	9418	245685
1952	11285	15339	11633	19686	57850	60980	16159	3904	110510	26793	39846	98124	472109
1953	83565	31789	25490	28155	142015	12972	11480	19501	76137	85479	25262	35120	576965
1954	20062	16100	15011	19629	27429	8461	4290	3402	3492	1453	4051	5996	129376
1955	6824	39645	11594	11092	30246	35315	7891	7930	4888	2953	3020	4664	166063
1956	4401	6913	4458	5036	11227	2177	2154	1892	2263	4615	900	20733	66770
1957	3340	15682	51371	165894	378843	270570	24731	16543	206443	431440	234675	107643	1907175
1958	230375	444070	222802	102646	245787	89017	58433	32734	106692	103576	119709	77531	1833373
1959	67840	101840	67519	185988	90710	53912	60234	32824	29279	137633	65534	58460	951773
1960	76842	76922	62779	64326	129218	153836	142051	88154	45491	553580	447550	191441	2032189
1961	222823	247335	139997	83709	56603	395589	145151	53736	101208	53107	123233	52809	1675300
1962	45595	41609	38024	44604	33697	36085	21190	14731	29764	27147	30454	37782	400683
1963	32824	48201	30087	30755	21204	14944	14635	8931	9885	7326	36213	20844	275850
1964	19629	34576	57879	28786	19931	20540	11437	14179	27750	27464	37525	21598	321292
1965	87737	255479	61633	59008	260397	243318	45847	28583	25742	66528	104085	167128	1405486
1966	61061	80878	82860	114194	156049	50243	31532	32177	39318	34423	27183	27654	737572
1967	26045	22559	23001	19629	17902	14635	12340	14635	538308	113229	107254	52202	961738
1968	513090	147020	110494	158264	287186	342636	80246	41253	84639	39205	45884	116320	1966238
1969	46304	170933	166978	208430	185773	68824	33727	29229	36444	75999	53723	92298	1168663
1970	84274	90030	166318	88488	220497	131812	46098	33502	35070	52459	31778	33434	1013760

1971	30143	25906	29420	21209	19931	19885	14730	73381	144772	94894	69309	110317	653898
1972	72295	64082	50960	32469	771699	144145	65579	59952	40755	45997	47249	43071	1438253
1973	62013	85877	144852	292978	109571	444883	254862	128541	112954	669838	160336	103223	2569930
1974	205423	86139	75011	58093	133413	75337	35196	68082	215443	73845	267005	164239	1457227
1975	109683	243932	121337	120669	572123	329545	178510	91036	65694	65171	53057	71003	2021760
1976	47565	43392	48247	306219	375178	170250	126249	66810	75869	249910	292050	398824	2200564
1977	160356	244838	115688	629237	254345	128307	72888	56611	52732	48152	84074	51985	1899211
1978	49886	51686	50579	49335	37753	75181	27575	239985	193955	66231	104602	62975	1009744
1979	283536	195987	222911	310211	438696	331865	113559	89688	80846	49924	45415	46243	2208882
1980	60943	48165	41649	34139	159124	46594	25561	19931	60032	52272	40577	44312	633298
1981	43606	41171	79356	95852	112336	615768	195931	77627	655402	166272	239479	81405	2404205
1982	67773	84487	58750	48475	338172	65694	31086	21204	21325	31323	56597	37635	862521
1983	33674	72932	115935	59481	85160	67305	60609	22497	36505	37298	42761	28185	662341
1984	39402	31709	41378	23617	21139	18427	11191	10119	10581	32670	26665	38623	305520
1985	100021	81165	124523	134567	89470	193815	132278	36930	29964	107482	194585	184004	1408804
1986	93810	91128	66336	46882	98242	177165	45168	26596	68828	140053	127572	369910	1351690
1987	233749	180410	274939	109062	167834	1582105	293721	170648	99612	86391	94226	84504	3377201
1988	63875	57158	68661	46471	49671	47563	59211	39447	27903	27339	25597	31535	544431
1989	37035	34542	40129	37132	81962	32756	18255	14633	12107	14046	19591	20323	362510
MEAN	85513	87767	84876	104552	163018	153040	90169	42275	86355	92564	84503	79872	1154506

Table B-1-6 – Strategy 1a –WAM Modeled Stream Flows – Estuary Inflows (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	312319	99638	172121	162874	41730	13492	127995	18295	45843	28119	158829	149531	1330788
1935	55429	137225	69224	107832	617038	780812	108181	50607	466339	131962	71772	175472	2771894
1936	88675	58778	67137	50778	573326	166650	1350724	77718	356424	327985	130163	117793	3366150
1937	107896	75520	187588	65648	41181	261448	44545	32313	36437	59690	44217	174669	1131152
1938	188541	97080	94550	440591	376338	64845	29733	40300	37745	25702	37875	64776	1498075
1939	50994	30689	21396	15012	34834	23737	70471	9813	47754	10698	12204	27358	354959
1940	20535	43086	19904	31834	28712	162882	455030	33436	9580	103921	577648	450714	1937285
1941	168470	276972	338567	460622	1155672	362809	300246	74392	92993	146941	77593	91383	3546659
1942	39829	104911	47081	145615	79779	20706	862971	109482	534240	275316	111993	90182	2422102
1943	115008	64323	96299	39443	63376	113508	54623	10146	36116	23213	49572	62876	728502
1944	216994	83307	264269	64496	430393	153660	34681	47300	136052	62476	70169	169367	1733165
1945	201271	192681	174680	401426	68299	93642	43319	193012	7740	80196	29525	48083	1533873
1946	69215	139008	203736	93412	204053	242300	25225	151862	555687	752319	257353	136432	2830602
1947	239439	106121	121335	135432	268146	52806	33469	55432	15810	24587	51010	40629	1144215
1948	50745	73728	59889	15488	101618	3033	18754	52862	87157	19653	9952	12606	505486
1949	16367	39717	80086	501820	162726	79057	80326	14516	11490	364457	41584	76429	1468576
1950	34218	44161	18188	60031	23931	134149	4600	4144	8808	4267	5149	9044	350689
1951	8215	7928	5300	5844	69197	162339	3866	4105	183621	9869	9619	5344	475245
1952	5275	18818	8639	54819	151245	59325	4894	4140	348062	20791	76345	106409	858762
1953	81767	35882	13858	23756	216824	3181	3866	163117	148521	99789	21849	35928	848339
1954	15037	8206	3142	7923	18664	3033	3866	4105	4075	31023	6930	3758	109760
1955	4268	52187	3142	3033	31018	17796	3866	8350	50418	4398	3790	4290	186554
1956	3188	2871	3730	6668	10536	3033	3866	4192	4075	11640	3790	33337	90926
1957	3188	12687	178322	507110	622744	440859	6747	4105	316663	481662	382788	107200	3064074
1958	413907	780123	239777	98370	351021	91112	51600	15573	241411	254868	189705	150393	2877858
1959	74897	247188	63357	221773	121027	73955	45860	88683	25778	302080	73114	76949	1414662
1960	79293	112224	85325	57016	127229	250625	152250	211666	40412	1071689	597989	358225	3143944
1961	304212	383982	146271	90326	43898	529283	245716	44194	196500	60687	172453	53778	2271299
1962	45181	39367	28474	48858	27922	98555	5384	4135	45292	27390	35834	78562	484954
1963	28781	59604	19165	17362	6730	3033	3866	4105	4075	4236	50822	21937	223716
1964	26032	68148	75990	14820	5773	22038	3866	43214	83876	27181	50165	29071	450174
1965	118464	386060	56231	56387	437098	305733	28366	10220	12365	125720	128827	256588	1922059
1966	103228	125086	74747	160078	296321	74641	45634	25038	55793	57095	39469	36096	1093228
1967	43447	33943	24000	27243	50233	13702	10156	36902	2050526	404612	197630	133445	3025840
1968	736867	261083	146382	186315	488412	495261	197419	54403	141168	109455	74303	147306	3038374
1969	100842	230298	233704	350600	296871	107024	15565	21305	30832	86135	75397	127861	1676433
1970	12772	99763	23016	11959	256929	298730	55559	22155	70813	108275	29913	31841	145145

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1971	26616	18392	18854	15237	27726	9461	7291	138758	416530	316106	164866	246835	1406672
1972	110000	114833	60299	45867	1026813	217925	65347	78244	66713	125278	140461	45270	2097051
1973	65010	99704	145460	396178	128200	746060	433907	239086	272139	1198168	285885	166067	4175864
1974	229538	145172	112966	63684	245534	84418	18276	95826	304438	141259	356213	290328	2087652
1975	154733	314787	180806	155432	670780	507490	224960	114971	124811	67182	86201	88516	2690669
1976	76804	41345	44303	480185	513792	234411	233132	62311	98397	358742	492863	660246	3296531
1977	230097	314164	137085	859120	408510	332567	74011	51269	84309	72187	184861	61793	2809972
1978	62967	81290	52218	61486	33697	120188	10868	280150	459220	83469	151911	74584	1472047
1979	414630	246450	272426	446499	633255	482033	223951	101334	356917	52808	52820	57412	3340534
1980	110600	55031	38360	28379	247745	32137	7769	71725	109626	61121	45670	48355	856517
1981	58591	41731	75425	100155	241305	1025618	296386	139249	769462	293803	372498	103612	3517835
1982	72853	198105	64553	48326	440616	54351	14397	7170	12561	41669	149245	43295	1147141
1983	45279	102705	151102	49301	76786	61662	137683	16716	75758	82518	68569	28585	896663
1984	60494	32574	53710	13162	17772	3110	4471	9322	5932	108119	52492	44244	405400
1985	133998	81898	200009	244847	88574	230862	162976	21913	34234	146883	243316	196996	1786506
1986	96484	91106	55509	33350	115871	323038	37291	16476	72919	247698	173767	495478	1758987
1987	295510	263768	322100	114692	230425	2430917	377007	188095	120042	94734	131512	99234	4668038
1988	72084	60069	67961	41088	38581	36015	53827	22048	20471	21947	20601	32625	487318
1989	52298	31985	31625	31666	75614	50030	15143	8651	4456	20926	33312	18611	374316
MEAN	119078	124420	102867	144266	235044	227948	123853	60940	177668	165620	127936	116031	1725670

Table B-1-7 – Strategy 1b – WAM Modeled Stream Flows – San Antonio River at Goliad (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	39242	24396	28835	46659	15467	9563	40755	11561	12590	14446	33855	41930	319299
1935	17286	28742	17609	39972	191738	279701	29590	18642	72726	35947	25964	33746	791662
1936	23212	21072	24148	19473	96811	34312	214926	23799	167462	90272	47109	40781	803378
1937	32825	25471	29219	21052	18049	136129	18210	16122	17275	19840	18561	71315	424069
1938	56073	19914	39429	110386	35394	18686	15947	13024	14516	13224	16018	18230	370842
1939	17944	14806	11525	11463	11566	11313	16498	11975	8526	8845	8369	8851	141682
1940	8344	11812	7458	17850	11512	29802	80771	22052	9685	16949	151975	103792	472002
1941	35146	60133	45493	91409	229296	94683	51118	24548	51853	34548	27575	18203	764005
1942	14494	13431	10825	30474	26727	13715	253773	21528	290285	133726	37335	29411	875724
1943	25361	17710	22766	19710	24614	47622	25680	12880	17782	13806	17764	16985	262681
1944	24653	17866	24197	14049	118617	27123	13455	17958	29317	14528	15655	26936	344353
1945	40333	43549	28359	64816	18711	23168	11606	10834	11072	24551	13174	14826	304998
1946	16712	17202	23958	39746	93058	58772	12232	54948	253316	338203	55069	32307	995522
1947	44383	20926	26029	21359	53037	17038	11797	17628	13502	12181	14534	16312	268726
1948	13059	14000	11779	11955	16737	11146	19441	40629	15242	18457	10120	10748	193314
1949	10105	12570	14402	133459	40941	64713	43673	15291	11965	69654	17370	25903	460044
1950	13839	9542	9720	13892	11585	31504	11869	16931	11761	12485	9654	9016	161797
1951	8821	8861	8013	10392	25023	59349	11484	9883	44241	10635	10178	10511	217392
1952	8502	8605	9441	15242	29447	9784	11813	9310	194265	12787	14386	14120	337702
1953	14562	8719	8871	10422	55579	9215	11520	17656	72356	16346	10610	12514	248370
1954	9058	7551	8056	8054	12669	11095	10132	9005	8936	10944	12951	10322	118774
1955	11124	16545	12031	10652	18242	10872	10556	13988	16526	11996	9912	11313	153756
1956	9599	9737	10023	10756	13332	8453	9604	8696	14956	22565	14074	27270	159064
1957	10429	9679	27976	136872	166451	129568	10984	12034	111252	56273	52277	16651	740446
1958	94995	149170	39083	18409	118802	35083	23153	11634	44750	67507	84920	29712	717218
1959	20215	18653	15281	29456	30616	15624	14251	11213	10804	34979	18533	15946	235571
1960	17133	13706	15075	15754	14728	27839	25018	32096	13656	148600	99727	50400	473732
1961	39146	57159	30995	22370	11686	72123	51752	16672	15786	26958	43015	16833	404495
1962	14203	12306	10491	12886	10117	34257	10536	10412	16333	9156	9970	18480	169145
1963	8865	13634	9522	8340	8369	9704	10713	8517	10341	19416	16071	12681	136172
1964	7835	22286	18103	8028	7008	11157	9490	26241	16618	15243	29352	10825	182188
1965	31127	87749	13116	20695	149495	35299	10750	9841	7920	32156	11996	37122	447265
1966	12375	12897	13046	22056	29634	10970	9545	11622	18417	11209	8662	9297	169731
1967	9263	8130	8403	9278	9806	5459	14434	23289	701759	61258	51409	19318	921808
1968	250714	49028	32731	35180	121817	42624	24928	14364	43066	15895	12957	30387	673690
1969	16442	48726	28064	37557	72717	27653	10669	13941	18770	24783	12924	16255	328500
1970	19991	16415	33954	14569	63841	68620	11301	11138	8793	12571	11353	11586	284133
1971	10713	8568	10433	7272	7399	9477	9504	95677	47401	60221	47304	41722	355690
1972	23107	15792	13617	26763	255573	52179	23151	22995	23228	31103	19832	17510	524851
1973	17324	24330	20291	96097	25735	242960	241204	65519	123125	415847	80393	45930	1398755
1974	37248	25703	25226	22462	40312	22140	10864	55402	85383	33277	52006	31737	441760
1975	31194	99170	41386	34651	140114	120934	44779	27643	23256	20607	16666	25748	626148
1976	22369	13007	15155	85735	158699	29565	50110	24236	41158	100742	121256	91829	753859
1977	66734	66065	41427	242604	128556	60066	29902	17282	36541	21455	73159	24751	808542
1978	19881	21604	20949	31390	20000	45689	10079	82592	98824	29115	50800	24484	455408
1979	81790	47625	60850	155036	120003	148586	49277	29045	18959	14949	15730	20310	762159
1980	22815	17431	11548	15403	71399	12401	9930	30056	54426	15024	15384	17754	293570
1981	16417	13698	17432	25223	44449	258374	74134	38871	134121	75135	53110	24839	775804
1982	18573	34594	21804	17532	55526	15341	10879	11289	11316	23365	21861	19115	261194
1983	18223	16067	25836	12755	14563	18893	13565	16077	39279	15222	22246	15013	227739
1984	13886	15432	16535	12338	12090	10729	9796	9392	8396	51879	27494	19072	207040
1985	34093	13527	38477	38187	18663	44705	47866	9831	15487	51499	69997	25322	407655
1986	14809	14797	9162	7922	18069	166284	21130	10189	22102	58911	30480	122128	495984
1987	70355	64417	76910	32710	92008	884281	87669	37006	31261	17633	25840	29748	1449837
1988	23639	19174	20128	17287	13183	13409	20814	11171	11855	10896	10152	10202	181910
1989	11609	13256	10427	14017	14245	11545	10244	12264	9981	10992	15562	11180	145322
MEAN	28611	26731	21886	36787	57747	66273	34801	22115	57759	45550	32583	27129	457973

Table B-1-8 – Strategy 1b –WAM Modeled Stream Flows – Guadalupe River at Victoria (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	90086	79817	140804	105121	45664	27649	39079	25317	23305	25337	61461	98636	762276
1935	44458	102379	39900	62410	446576	525751	97490	55672	259342	109609	54473	119410	1917470
1936	76445	50916	52599	34700	283983	121903	1115649	60123	178917	254026	94819	85952	2410034
1937	76156	63872	163863	65504	43948	141534	39123	25954	23402	35598	27040	54243	760235
1938	143984	84761	75849	299567	288511	62309	38222	30656	26325	23852	26147	29432	1129617
1939	30389	25198	24254	21222	29039	29921	27760	14635	15140	15198	16096	19373	268226
1940	19629	28549	23957	32413	24489	39357	385512	17295	15017	24700	361748	311671	1284335
1941	145026	188977	257459	268488	782915	266125	135741	64358	49086	70554	55951	43680	2328361
1942	38441	31521	33450	139930	81490	34473	368874	37615	243998	158912	90470	75086	1334260
1943	72653	46976	53623	42930	37951	62101	37576	22671	27236	25808	24500	32140	486167
1944	65945	77980	164798	72760	196259	159647	49812	30076	84815	34019	61700	118839	1116648
1945	184611	169696	156249	315331	74035	59269	33912	23206	17448	60140	31225	49214	1174335
1946	63978	89714	174458	74887	111368	123614	27451	52307	269909	238022	203766	123330	1552803
1947	208948	103352	117407	112954	118501	48478	31733	60472	23666	22459	24492	31850	904312
1948	27433	37001	35306	19629	72753	18726	26188	19931	14635	16209	13310	15747	316867
1949	18424	32641	77037	215683	147676	44459	33507	19931	18035	150302	36588	45849	840131
1950	29328	35582	26248	60478	35851	118902	19837	11698	13555	10791	10898	14581	387748
1951	14154	14572	15458	16670	19931	113662	9703	4407	13405	5793	9499	9592	246846
1952	11282	15336	11630	19683	57845	60977	16578	4085	110612	26825	39853	98121	472826
1953	83562	31785	25486	28152	142011	12972	11431	19619	76111	85511	25269	35116	577025
1954	20059	16096	15345	19629	27303	8558	4450	4131	3854	1906	4728	6876	132936
1955	8588	39569	11582	11092	30312	35312	8048	7930	5058	3083	3181	5241	168996
1956	5247	8106	5014	5587	11253	2625	2282	2210	2498	4754	1202	20731	71508
1957	3429	15788	51367	165890	378839	270567	24731	16566	206416	427043	234798	107639	1903074
1958	230482	444177	222802	102643	245787	89016	58379	32731	106668	103609	119717	77527	1833538
1959	67836	101837	67515	185985	90706	53909	60180	32821	29252	137669	65541	58456	951708
1960	76839	76919	62776	64322	129214	153834	141998	88075	45464	553615	447560	191441	2032056
1961	222823	247335	139997	83705	56600	395588	145098	53733	101181	53139	123239	52805	1675243
1962	45592	41606	38021	44601	33693	36082	21061	14753	29738	27179	30460	37779	400565
1963	32821	48198	30084	30752	21186	14942	14635	9077	9862	9210	35921	20841	277527
1964	19629	34572	57863	28782	20119	20538	11388	14287	27723	27496	37532	21594	321522
1965	87730	255475	61630	59005	260518	243434	45793	28580	25715	66561	104092	167127	1405660
1966	61058	80875	82856	114191	156045	50240	31478	32174	39291	34456	27190	27650	737504
1967	26042	22556	22998	19629	17902	14635	12291	14635	538281	113261	107261	52198	961687
1968	513090	147020	110494	158264	287186	342633	80192	41250	84612	39238	45891	116316	1966187
1969	46301	170929	166975	208427	185772	68821	33674	29225	36417	76154	53730	92297	1168722
1970	84271	90027	166318	88484	220497	131809	46045	33499	35043	52491	31784	33430	1013698

1971	30139	25903	29416	21206	19931	19885	14680	73577	144746	94929	69315	110317	654045
1972	72292	64078	50956	32466	771699	144156	65525	59949	40728	46030	47255	43067	1438201
1973	62010	85874	144848	292977	109568	444883	254813	128537	112930	669873	160459	103220	2569993
1974	205422	86136	75008	58089	133413	75334	35142	68079	215418	73877	267015	164238	1457173
1975	109682	243932	121337	120777	572123	329545	178461	91033	65667	65203	53064	71000	2021823
1976	47561	43388	48244	306328	375178	170247	126331	66806	75842	249946	292174	398946	2200992
1977	160356	244838	115687	629237	254345	128278	72834	56607	52706	48184	84081	51981	1899134
1978	49883	51683	50576	49332	37749	75178	27522	239985	193932	66263	104609	62972	1009683
1979	283536	195985	222911	310211	438697	331865	113641	89684	80819	49956	45422	46239	2208966
1980	60940	48162	41646	34136	159121	46591	25430	19931	60005	52304	40584	44341	633189
1981	43571	41168	79356	95852	112332	615768	196103	77623	655375	166308	239485	81433	2404374
1982	67770	84484	58747	48472	338172	65691	31033	21392	21314	31355	56580	37631	862640
1983	33671	72929	115932	59477	85157	67302	60555	22494	36478	37331	42767	28181	662273
1984	39399	31706	41375	23613	21137	19071	11363	10119	10752	32701	26671	38617	306524
1985	99359	81161	124629	134564	89467	193815	132450	36927	29937	107518	194778	184196	1408800
1986	93807	91125	66332	46878	98238	177165	45114	26592	68800	140089	127582	369910	1351633
1987	233749	180410	274939	109170	167834	1582105	293672	170648	99585	86423	94233	84500	3377268
1988	63872	57155	68658	46468	49667	47560	59293	39443	27896	27371	25604	31531	544518
1989	37031	34539	40126	37128	81958	32753	19461	14635	12278	14027	19597	20319	363852
MEAN	85550	87792	84896	104569	163027	153064	90184	42317	86361	92575	84543	79901	1154781

Table B-1-9 – Strategy 1b –WAM Modeled Stream Flows – Estuary Inflows (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	312065	99400	171856	162616	41512	13386	127655	18105	45807	27855	158567	149251	1328074
1935	55176	136986	68937	107667	616917	780419	107866	50333	466055	131698	71510	175213	2768778
1936	88398	58539	66871	50520	573172	166398	1350410	77444	356140	327724	129919	117520	3363056
1937	107620	75281	187322	65390	40910	261381	44170	32046	36152	59426	43957	174388	1128042
1938	188289	96841	94285	440336	376069	64645	29395	40255	37457	25503	37725	64853	1495651
1939	50742	30641	21440	14953	34831	23483	70132	10907	48955	11467	12395	26488	356431
1940	21242	42322	20714	30163	28650	160707	454690	33185	10784	102558	576692	450433	1932140
1941	168215	276747	338305	460368	1155404	362666	299928	74294	92691	146676	77570	91208	3544072
1942	39551	104905	46798	145291	79622	20633	862475	109209	534062	275054	111733	89901	2419233
1943	114754	64084	96160	39131	63185	113220	54287	9882	35819	23103	49460	62791	725876
1944	216752	83068	264106	64224	430102	153518	34631	47297	135797	62294	70053	169172	1731014
1945	201302	192445	174418	401171	68030	93392	43269	192794	8182	80579	29265	47987	1532833
1946	69021	138716	203461	93071	203782	242046	24917	155342	556162	752062	257092	136308	2831980
1947	239034	105985	121072	135174	267874	52552	33373	55159	15806	24422	50683	40349	1141484
1948	50490	73490	59624	15233	101346	6059	18416	51619	86369	18439	10048	12786	503919
1949	16023	38879	80172	501133	162443	81521	80008	14246	12358	363128	41331	76156	1467399
1950	33953	44487	17368	59773	23928	133889	7680	8240	10078	8494	7520	9988	365398
1951	10678	9830	6277	6059	67012	160365	7680	8201	183665	11234	10540	7478	489020
1952	7654	19265	10791	54604	151121	59607	7773	8236	347739	23750	77796	106424	874761
1953	82371	37955	16134	23777	216675	6207	7680	164260	148056	99962	22788	36650	862514
1954	17301	10286	6277	8101	18407	6059	7680	8201	8120	34176	10660	7478	142744
1955	7450	53118	6277	6059	29848	19184	7680	12151	53250	8625	7550	8010	219202
1956	6370	5736	6865	9695	12368	6059	7680	8288	8120	14832	7520	36203	129734
1957	6370	12234	180185	506191	620619	440605	8392	8201	313451	477003	382638	106920	3062808
1958	413749	779978	239514	98112	350754	90859	51282	17972	241229	254713	188892	149060	2876114
1959	74014	245636	62444	219843	120434	73806	45834	90031	27365	299441	71966	76032	1406846
1960	79154	112083	85057	56865	126958	250392	152132	211321	41788	1069532	597733	357948	3140964
1961	304070	383744	146055	90124	43953	528953	245971	44453	196221	60507	172459	53513	2270022
1962	45169	39815	29552	47176	27457	97849	7686	8231	45727	28788	35515	78269	491233
1963	29178	58770	21196	17102	6677	6059	7681	8201	8120	8494	50059	22817	244353
1964	26415	68229	75910	14960	6677	21661	7680	45075	83540	27174	49640	29362	456322
1965	120106	385791	55133	54821	431680	304997	28758	12752	13435	124641	128665	254141	1914920
1966	102566	123650	74383	158494	294760	74053	47090	24434	54852	57879	40040	36164	1088365
1967	44592	36020	25962	26867	49900	15607	13970	36508	2048897	403690	194535	131958	3028507
1968	727066	259072	146120	186060	488145	495006	197100	56048	139497	110036	72947	146304	3023401
1969	100604	230052	233540	350343	296597	106876	17880	24595	33636	85878	75739	126655	1682393
1970	12632	97559	22867	11935	256690	298476	57799	24300	71080	108102	30990	32946	145229

	8		3	7									9
1971	27386	20472	21255	15738	28375	9594	9660	132583	414285	313905	164433	244488	1402174
1972	108876	112376	59982	45651	1026348	217683	65029	77971	66544	125407	140116	44972	2090954
1973	64710	99458	145195	395922	127929	745808	433597	238813	275601	1197906	285841	165935	4176716
1974	229356	145032	112811	63426	245266	84321	18724	94854	304097	140994	355959	290050	2084891
1975	154588	314552	180543	155385	670513	507239	224646	114697	124531	67027	85934	88236	2687890
1976	76549	41285	43841	480032	513522	234156	232941	62038	98110	358481	492713	660084	3293752
1977	229847	313928	136822	858866	408352	332395	73693	51217	84021	71923	184601	61623	2807286
1978	62774	81051	51952	61228	33433	119934	13845	276909	458936	83204	151651	74444	1469361
1979	414237	246256	272273	446245	632988	481781	223870	101170	356947	53655	52166	56821	3338407
1980	110358	54792	38120	28316	247359	32025	10242	71453	108111	61204	44263	47886	854130
1981	58251	41719	75334	99832	241175	1025311	296389	142716	769022	293171	372238	103380	3518536
1982	72642	197866	64550	48068	440348	54302	15483	9343	15416	41676	148866	43463	1152024
1983	47128	101484	149341	50672	75433	64128	140227	20207	74590	82085	68327	31114	904735
1984	60194	34792	55006	15574	20321	6136	8285	13418	9977	107808	52287	43970	427767
1985	133559	81658	199829	244581	88303	230611	162868	24507	33617	145315	241544	195941	1782332
1986	95712	90423	55661	32725	115599	322746	36951	18518	71468	246040	173616	495200	1754658
1987	295369	263538	321948	114640	230157	2430666	376803	187935	119754	94470	131348	98954	4665582
1988	71829	60043	67561	40809	38310	35822	53578	24638	21724	23767	21634	32848	492562
1989	50538	33296	31078	29937	75957	49446	18957	12747	8477	19542	33313	18313	381602
MEAN	119067	124387	103078	144080	234718	228155	124902	62099	178066	165652	127947	116015	1728165

Table B-1-10 – Strategy 2a – WAM Modeled Stream Flows – San Antonio River at Goliad (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	39241	24396	28835	46659	15415	9563	40776	11560	12590	14446	33855	41930	319267
1935	17286	28742	17609	39972	191705	279726	29590	18642	72726	35947	25964	33746	791654
1936	23212	21072	24148	19472	96811	34312	214926	23799	167462	90272	47109	40781	803377
1937	32825	25471	29219	21052	18049	136054	18267	16132	17275	19840	18561	71315	424060
1938	56073	19914	39429	110386	35394	18659	15971	13024	14516	13224	15802	17855	370248
1939	17942	14806	11525	11462	11566	11313	16498	10885	7150	7818	7999	9447	138411
1940	7385	12337	6383	19263	11570	31604	80773	22035	8197	18047	152671	103793	474058
1941	35146	60229	45493	91409	229296	94683	51118	24548	51853	34547	27575	18203	764101
1942	14494	13431	10828	30481	26727	13715	253773	21527	290285	133726	37335	29411	875733
1943	25361	17710	22766	19710	24614	47622	25680	12870	17791	13806	17708	16954	262594
1944	23964	17494	24197	13949	118595	27123	13455	17920	29338	14556	15655	26336	342582
1945	40342	43549	28359	64816	18711	23168	11606	10810	10361	23829	13174	14826	303551
1946	16716	17202	23958	39700	93058	58772	12232	47970	252554	338203	55069	32307	987741
1947	44383	20925	26030	21359	53037	17038	11797	17628	13502	12181	14534	16311	268725
1948	13059	14000	11779	11955	16737	6428	19993	41601	15815	19454	9844	10551	191218
1949	10176	13211	14384	133785	40941	59775	43673	15291	11362	70667	17362	25895	456522
1950	13877	9020	10352	13998	11585	31673	10204	11681	9454	8321	7622	8198	145984
1951	5200	7942	7603	10539	26876	61041	11433	9425	44242	9100	9094	8626	211121
1952	5379	7924	7023	15253	29471	9248	9614	8991	194403	9453	12730	13824	323312
1953	13704	5269	6573	10143	55515	8954	11223	17095	72560	15915	9411	11511	237873
1954	6656	3784	3503	7693	12789	11034	9880	8489	8738	7858	8992	6656	96073
1955	5451	14524	7404	9885	15955	9122	10344	9053	12425	7385	8500	6817	116865
1956	6509	5629	9852	10613	9832	7883	9119	8213	15052	21006	10203	23305	137217
1957	7534	5882	24148	140218	168357	129573	9086	9878	110083	56534	52277	16651	730220
1958	95002	149178	39083	18409	121550	36126	24547	8676	47075	69342	85724	30654	725367
1959	20733	20150	15903	30992	30939	15493	14023	9938	9303	37320	19425	16591	240812
1960	16955	13608	15077	15638	14728	27818	24828	32096	11885	150248	99727	50400	473010
1961	38947	57159	30945	22314	11266	72201	51177	16139	16063	26816	42987	16817	402832
1962	14090	11618	9147	14584	10225	34728	7074	9825	14006	7383	10142	18536	161359
1963	8244	15085	6794	9095	8224	5396	9935	8324	10439	12848	16396	11543	122321
1964	7200	22283	18103	7631	5976	11492	9217	24273	16665	15248	29372	10535	177995
1965	29261	89866	14017	22132	155136	36056	10175	7040	6650	33019	12297	39295	454944
1966	12777	14141	13409	23360	30924	11304	7785	11952	19270	10423	7832	9145	172323
1967	7866	5249	6731	9400	9872	3196	13781	21501	703564	61915	54252	20452	917780
1968	259991	50803	32731	35180	121817	42624	24928	12358	44449	15056	14052	31116	685106
1969	16453	48764	28143	37663	72857	27603	7596	7959	15185	25653	12588	17246	317712
1970	21121	18358	35179	14552	63832	68620	8473	8642	8404	12480	9909	10092	279663
1971	9850	6020	6474	7328	7257	9370	6247	102512	49358	62163	47476	43791	357847
1972	23977	18233	13668	26931	255628	52179	23151	22995	23228	31103	19832	17510	528435
1973	17324	24330	20291	96097	25735	242960	241204	65486	116148	415846	80180	45710	1391312
1974	37028	25505	25085	22461	40034	22140	9988	56062	85439	33276	52006	31737	440762
1975	30978	99169	41386	34496	140114	120934	44779	27643	23256	20387	16666	25748	625558
1976	22369	12828	15352	85735	158702	29565	50109	24235	41158	100741	121256	91828	753879
1977	66734	66065	41427	242604	128443	59853	29902	17237	36541	21227	73159	24591	807783
1978	19819	21604	20949	31390	20000	45689	6927	85666	98830	29115	50800	24483	455273
1979	81790	47581	60630	155036	120003	148586	49058	28904	18625	13766	16300	20485	760763
1980	22803	17431	11585	15403	71399	12401	6301	30699	55964	14565	16738	18248	293538
1981	16427	13698	17432	25230	44085	258411	73960	31909	134274	75506	53110	24711	768753
1982	18557	34633	21883	17639	55666	15504	9500	9027	6642	23800	23173	18689	254711
1983	16368	17210	27294	11078	15626	13954	10703	11009	40150	15405	22362	11275	212435
1984	13963	10871	15049	8090	8611	5931	9690	9267	8255	51971	27529	19085	188313
1985	33659	13527	38495	38194	18663	45295	48902	6976	15892	52807	71684	26280	410375
1986	15420	15242	8745	8290	18071	166297	21130	7806	23265	60308	30340	122128	497040
1987	70135	64417	76690	32497	92008	884281	87449	36864	31261	17633	25628	29748	1448611
1988	23666	19212	20207	17394	13324	13511	21007	7857	10691	8866	8895	9863	174490
1989	13301	11727	10817	15797	14142	12279	6711	6617	5028	4977	16016	12298	129709
MEAN	28299	26429	21431	36900	57812	65891	34130	21010	57262	45131	32445	26891	453631

Table B-1-11 – Strategy 2a –WAM Modeled Stream Flows – Guadalupe River at Victoria (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	90092	79823	140810	105127	45672	27649	39086	25317	23305	25345	61468	98643	762339
1935	44465	102386	39907	62218	446333	525996	97492	55679	259342	109616	54480	119417	1917331
1936	76451	50923	52606	34706	283741	121905	1115649	60131	178917	254026	94821	85959	2409836
1937	76162	63878	163870	65511	43955	141300	39130	25955	23404	35606	27047	54253	760071
1938	143986	84767	75856	299569	288514	62315	38230	30664	26332	23859	26154	29439	1129686
1939	30395	25205	24261	21229	29047	29927	27767	14635	14922	15076	16016	19380	267859
1940	19629	28555	23964	32419	24496	39363	385519	17295	15017	24707	361754	311678	1284397
1941	145032	188764	257459	268488	782914	265892	135749	64366	49093	70561	55958	43688	2327964
1942	38447	31528	33457	139923	81250	34479	368882	37622	243771	159008	90477	75093	1333937
1943	72659	46983	53630	42937	37958	62107	37583	22678	27244	25816	24507	32148	486250
1944	65951	77987	164576	72766	196288	159413	49820	30083	84822	34026	61707	118841	1116280
1945	184611	169698	156249	315331	74043	59274	33919	23209	17448	60148	31232	49221	1174383
1946	63985	89720	174464	74893	111375	123620	27458	52317	269916	238019	203770	123330	1552868
1947	208947	103139	117409	112961	118509	48484	31740	60479	23673	22467	24499	31857	904165
1948	27439	37008	35312	19629	72767	18376	26234	19931	14480	16217	13123	15754	316270
1949	18430	32659	77044	215685	147683	44465	33515	19931	18034	150309	36595	45856	840206
1950	29375	35635	26359	60646	36038	119142	19686	11725	13461	10032	10674	14828	387601
1951	13981	14578	15274	16555	19931	113698	9499	3785	13405	5578	9291	9410	244985
1952	11289	15342	11637	19689	57854	60982	16004	3694	110296	26832	39860	98128	471606
1953	83568	31792	25493	28159	142019	12972	11431	19384	76118	85518	25276	35123	576853
1954	20106	16149	15118	19629	27612	8598	4246	3250	3187	1224	3535	5948	128603
1955	6766	39649	11597	10288	30200	35343	7742	7930	4758	2517	2922	4086	163799
1956	4216	6928	4091	4695	11406	2219	2257	1722	2253	4592	659	20770	65809
1957	3214	15646	51375	165921	378846	270573	24731	14634	206465	434916	234571	107647	1908540
1958	230269	443964	222802	102649	245787	89018	58387	32738	106670	103616	119720	77534	1833154
1959	67843	101844	67522	185992	90714	53915	60187	32828	29259	137668	65548	58463	951784
1960	76846	76926	62782	64329	129222	153839	142005	88164	45471	553615	447560	191441	2032199
1961	222823	247335	139997	83712	56607	395590	145105	53740	101188	53146	123246	52812	1675303
1962	45598	41612	38027	44607	33701	36088	21146	14634	29757	27187	30467	37786	400612
1963	32868	48251	30195	30920	21388	14848	14602	9157	9981	7051	36478	20881	276619
1964	19629	34579	57883	28798	19931	20543	11388	14088	27730	27504	37539	21601	321212
1965	87781	255528	61742	59173	260455	243435	46044	28814	25842	66628	104147	167162	1406750
1966	61064	80881	82863	114198	156053	50246	31486	32181	39298	34463	27197	27657	737587
1967	26048	22562	23004	19629	17902	14635	12291	14635	538288	113268	107268	52206	961735
1968	513090	147020	110494	158264	287186	342639	80200	41257	84620	39245	45898	116324	1966236
1969	46348	170982	167086	208595	185953	69063	33924	29460	36544	75975	53785	92332	1170047
1970	84277	90033	166318	88492	220497	131815	46052	33506	35051	52498	31791	33437	1013768

1971	30146	25910	29423	21213	19931	19885	14680	73168	144753	94929	69323	110317	653677
1972	72299	64085	50963	32472	771698	144146	65533	59956	40735	46037	47262	43075	1438262
1973	62017	85880	144855	292979	109575	444883	254813	128546	112932	669873	160232	103227	2569813
1974	205424	86143	75015	58096	133412	75340	35150	68086	215420	73885	267015	164241	1457227
1975	109684	243932	121337	120560	572123	329545	178461	91040	65674	65210	53071	71007	2021645
1976	47568	43395	48251	306111	375178	170253	126069	66814	75849	249946	291946	398701	2200080
1977	160356	244838	115689	629237	254345	128335	72839	56615	52713	48191	84091	51988	1899236
1978	49890	51689	50582	49339	37757	75184	27529	239985	193932	66272	104616	62979	1009752
1979	283536	195997	222911	310211	438697	331865	113379	89692	80826	49964	45429	46246	2208753
1980	60946	48168	41652	34142	159128	46597	25515	19931	60012	52312	40591	44316	633309
1981	43609	41174	79356	95852	112341	615768	195719	77631	655382	166307	239492	81409	2404041
1982	67817	84537	58858	48641	338351	65932	31283	21408	21414	31423	56660	37672	863995
1983	33677	72935	115938	59484	85164	67308	60562	22500	36485	37338	42774	28188	662356
1984	39446	31759	41486	23782	21321	18323	11243	10344	10487	32816	26726	38660	306393
1985	100025	81170	124411	134570	89474	193815	132067	36934	29944	107518	194406	183811	1408146
1986	93813	91132	66339	46885	98246	177165	45122	26601	68809	140089	127582	369910	1351692
1987	233749	180410	274939	108953	167834	1582105	293672	170648	99593	86431	94238	84508	3377080
1988	63919	57208	68770	46637	49854	47800	59273	39677	28023	27439	25659	31571	545829
1989	37078	34592	40237	37296	82145	32993	18491	14633	12013	14146	19629	20356	363610
MEAN	85512	87772	84885	104550	163043	153054	90135	42247	86328	92643	84496	79863	1154527

Table B-1-12 – Strategy 2a –WAM Modeled Stream Flows – Estuary Inflows (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	312070	99406	171862	162622	41467	13386	127684	18105	45807	27861	158574	149258	1328102
1935	55182	136992	68943	107487	616657	780673	107868	50340	466055	131705	71517	175220	2768640
1936	88404	58545	66877	50526	572945	166400	1350410	77451	356140	327724	129921	117527	3362870
1937	107626	75287	187328	65396	40917	261087	44234	32057	36154	59433	43963	174397	1127879
1938	188290	96847	94291	440338	376071	64624	29426	40262	37464	25510	37515	64484	1495122
1939	50746	30647	21446	14959	34838	23488	70139	9569	47377	10324	11948	27090	352570
1940	20283	42853	19645	31583	28716	162514	454698	33167	9295	103663	577395	450441	1934254
1941	168221	276643	338305	460367	1155404	362447	299935	74301	92698	146683	77577	91215	3543796
1942	39556	104911	46807	145291	79397	20639	862482	109216	533849	275145	111739	89908	2418939
1943	114760	64090	96166	39137	63192	113226	54294	9879	35835	23110	49411	62768	725867
1944	216069	82702	263897	64130	430108	153298	34638	47266	135825	62330	70060	168574	1728897
1945	201310	192447	174418	401171	68037	93397	43276	192773	7426	79865	29271	47994	1531386
1946	69031	138722	203468	93032	203789	242051	24924	148375	555407	752059	257096	136308	2824261
1947	239034	105785	121074	135180	267882	52557	33380	55166	15813	24429	50690	40356	1141345
1948	50496	73496	59630	15233	101360	524	19065	52595	86798	19443	9596	12595	500830
1949	16101	39537	80161	501461	162450	76588	80015	14246	11755	364148	41331	76156	1463948
1950	34420	44551	19206	61524	26071	136568	7226	1976	10446	3810	5512	9782	361091
1951	6894	8917	5263	5592	69003	162092	0	0	183668	9497	9262	5062	465250
1952	4537	18589	8380	54621	151153	59077	4496	36	347649	20423	76146	106135	851241
1953	81518	34512	13842	23505	216617	148	0	163479	148266	99538	21595	35654	838675
1954	15328	7105	2126	9333	20786	2668	2262	1937	1292	31042	5106	401	99386
1955	2188	52144	1186	0	31986	17464	0	6870	48971	2691	31	597	164127
1956	451	619	1866	5379	13460	2668	2262	1925	1292	13864	3137	32754	79676
1957	0	11056	176364	509566	622532	440616	6494	0	316432	484651	382424	106926	3057061
1958	413554	779786	239514	98118	353502	91905	52683	15023	243556	256555	189698	150009	2883903
1959	74538	247139	63072	221385	120764	73681	45614	88763	25871	301782	72865	76684	1412158
1960	78982	111991	85066	56755	126966	250377	151949	211405	40024	1071181	597733	357948	3140376
1961	303871	383744	146004	90075	43540	529033	245404	43928	196505	60372	172436	53504	2268415
1962	45062	39134	28215	48880	27573	98325	4305	31	48247	27022	35693	78332	480818
1963	28987	60808	19673	19502	8615	3457	2263	1937	1310	690	51643	22033	220920
1964	25781	68231	75929	14577	5410	22040	0	43018	83595	27186	49666	29079	444512
1965	118673	388494	57240	57903	439229	308039	30317	11781	13385	126159	129500	256664	1937384
1966	102974	124901	74752	159804	296057	74392	45338	24772	55711	57100	39216	36019	1091035
1967	43201	33145	24297	26988	49965	13344	6290	39470	2050710	404355	197384	133099	3022248
1968	736344	260847	146120	186060	488145	495012	197107	54050	140887	109204	74049	147040	3034863
1969	101044	230676	234823	352093	298876	109338	16941	20443	31271	87172	75936	127996	1686609
1970	12746	99509	22989	11934	256681	298481	54978	21811	70697	108018	29553	31459	144789

	3		8	7									6
1971	26529	17931	17301	15801	28233	9488	6403	139035	416249	315847	164613	246558	1403986
1972	109752	114823	60040	45825	1026404	217674	65035	77978	66550	125414	140123	44979	2094596
1973	64715	99464	145201	395924	127937	745808	433597	238789	268626	1197906	285415	165722	4169104
1974	229139	144840	112675	63433	244989	84326	17854	95521	304155	141001	355959	290052	2083944
1975	154374	314551	180543	155027	670513	507238	224646	114704	124538	66814	85940	88243	2687132
1976	76555	41112	44044	479829	513524	234162	232694	62045	98116	358481	492500	659854	3292916
1977	229847	313928	136823	858865	408239	332235	73697	51179	84028	71701	184610	61470	2806623
1978	62718	81057	51959	61234	33440	119939	10700	279983	458941	83212	151657	74450	1469290
1979	414237	246224	272053	446244	632988	481781	223404	101036	356620	52479	52742	57003	3336810
1980	110352	54798	38164	28322	247366	32031	6692	72096	109656	60752	45624	48357	854211
1981	58297	41725	75334	99838	240820	1025347	295854	135760	769182	293542	372244	103229	3511173
1982	73055	198490	65834	49819	442625	56976	16239	8707	11937	42767	150735	43392	1160574
1983	45280	102632	150805	49002	76503	59194	137372	15145	75469	82274	68449	27383	889508
1984	60700	30818	54726	12970	18982	2745	2867	7154	3149	111723	52854	44341	403029
1985	133751	81667	199642	244595	88310	231200	163544	21659	34028	146622	242882	196538	1784439
1986	96328	90874	55249	33099	115608	322759	36958	16144	72639	247436	173476	495200	1755769
1987	295150	263537	321728	114224	230157	2430666	376583	187794	119762	94477	131140	98961	4664178
1988	72286	60668	68845	42560	40594	38434	55651	23154	21779	22392	20909	32863	500136
1989	52659	32353	32674	33362	77998	52690	13540	6483	1674	19054	34278	19782	376547
MEAN	118727	124220	102693	144266	235275	227863	123316	60210	177332	165529	127720	115711	1722863

Table B-1-13 – Strategy 2b – WAM Modeled Stream Flows – San Antonio River at Goliad (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	39241	24396	28835	46659	15415	9563	40776	11560	12590	14446	33855	41930	319267
1935	17286	28742	17609	39972	191705	279726	29590	18642	72726	35947	25964	33746	791654
1936	23212	21072	24148	19472	96811	34312	214926	23799	167462	90272	47109	40781	803377
1937	32825	25471	29219	21052	18049	136054	18267	16132	17275	19840	18561	71315	424060
1938	56073	19914	39429	110386	35394	18659	15971	13024	14516	13224	15802	17855	370248
1939	17942	14806	11525	11462	11566	11313	16498	10885	7150	7818	7999	9447	138411
1940	7385	12337	6383	19263	11570	31604	80773	22035	8197	18047	152671	103793	474058
1941	35146	60229	45493	91409	229296	94683	51118	24548	51853	34547	27575	18203	764101
1942	14494	13431	10828	30481	26727	13715	253773	21527	290285	133726	37335	29411	875733
1943	25361	17710	22766	19710	24614	47622	25680	12870	17791	13806	17708	16954	262594
1944	23964	17494	24197	13949	118595	27123	13455	17920	29338	14556	15655	26336	342582
1945	40342	43549	28359	64816	18711	23168	11606	10810	10361	23829	13174	14826	303551
1946	16716	17202	23958	39700	93058	58772	12232	47970	252554	338203	55069	32307	987741
1947	44383	20925	26030	21359	53037	17038	11797	17628	13502	12181	14534	16311	268725
1948	13059	14000	11779	11955	16737	6428	19993	41601	15815	19454	9844	10551	191218
1949	10176	13211	14384	133785	40941	59775	43673	15291	11362	70667	17362	25895	456522
1950	13877	9020	10352	13998	11585	31673	10204	11681	9454	8321	7622	8198	145984
1951	5200	7942	7603	10539	26876	61041	11433	9425	44242	9100	9094	8626	211121
1952	5379	7924	7023	15253	29471	9248	9614	8991	194403	9453	12730	13824	323312
1953	13704	5269	6573	10143	55515	8954	11223	17095	72560	15915	9411	11511	237873
1954	6656	3784	3503	7693	12789	11034	9880	8489	8738	7858	8992	6656	96073
1955	5451	14524	7404	9885	15955	9122	10344	9053	12425	7385	8500	6817	116865
1956	6509	5629	9852	10613	9832	7883	9119	8213	15052	21006	10203	23305	137217
1957	7534	5882	24148	140218	168357	129573	9086	9878	110083	56534	52277	16651	730220
1958	95002	149178	39083	18409	121550	36126	24547	8676	47075	69342	85724	30654	725367
1959	20733	20150	15903	30992	30939	15493	14023	9938	9303	37320	19425	16591	240812
1960	16955	13608	15077	15638	14728	27818	24828	32096	11885	150248	99727	50400	473010
1961	38947	57159	30945	22314	11266	72201	51177	16139	16063	26816	42987	16817	402832
1962	14090	11618	9147	14584	10225	34728	7074	9825	14006	7383	10142	18536	161359
1963	8244	15085	6794	9095	8224	5396	9935	8324	10439	11465	16458	11544	121003
1964	7200	22283	18103	7631	5976	11492	9217	24273	16665	15248	29372	10535	177995
1965	29261	89888	14017	22132	155136	36056	10175	7040	6650	33019	12297	39295	454965
1966	12777	14141	13409	23360	30924	11304	7785	11952	19270	10423	7832	9145	172323
1967	7866	5249	6731	9400	9872	3196	13781	21501	703564	61915	54252	20452	917780
1968	259991	50803	32731	35180	121817	42624	24928	12358	44449	15056	14052	31116	685106
1969	16453	48764	28143	37663	72857	27603	7596	7959	15185	25653	12588	17246	317712
1970	21121	18358	35179	14552	63832	68620	8473	8642	8404	12480	9909	10092	279663
1971	9850	6020	6474	7328	7257	9370	6247	102512	49358	62163	47476	43791	357847
1972	23977	18233	13668	26931	255628	52179	23151	22995	23228	31103	19832	17510	528435
1973	17324	24330	20291	96097	25735	242960	241204	65486	116148	415846	80180	45710	1391312
1974	37028	25505	25085	22461	40034	22140	9988	56062	85439	33276	52006	31737	440762
1975	30978	99169	41386	34496	140114	120934	44779	27643	23256	20387	16666	25748	625558
1976	22369	12828	15352	85735	158702	29565	50109	24235	41158	100741	121256	91828	753879
1977	66734	66065	41427	242604	128443	59853	29902	17237	36541	21227	73159	24591	807783
1978	19819	21604	20949	31390	20000	45689	6927	85666	98830	29115	50800	24483	455273
1979	81790	47581	60630	155036	120003	148586	49058	28904	18625	13766	16300	20485	760763
1980	22803	17431	11585	15403	71399	12401	6301	30699	55964	14565	16738	18248	293538
1981	16427	13698	17432	25230	44085	258411	73960	31909	134274	75506	53110	24711	768753
1982	18557	34633	21883	17639	55666	15504	9500	9027	6642	23800	23173	18689	254711
1983	16368	17210	27294	11078	15626	13954	10703	11009	40150	15405	22362	11275	212435
1984	13963	10871	15049	8090	8611	5931	9690	8330	8241	51971	27529	19085	187363
1985	33662	13544	38514	38194	18663	46068	48902	6976	15892	52807	71684	26280	411187
1986	15420	15242	8745	8290	18071	166297	21130	7806	23265	60308	30340	122128	497040
1987	70135	64417	76690	32497	92008	884281	87449	36864	31261	17633	25628	29748	1448611
1988	23666	19212	20207	17394	13324	13511	21007	7857	10691	8866	8895	9863	174490
1989	13301	11727	10817	15797	14142	12279	6711	6617	5028	4977	16016	12298	129709
MEAN	28299	26430	21431	36900	57812	65905	34130	20993	57262	45107	32446	26891	453605

Table B-1-14 – Strategy 2b –WAM Modeled Stream Flows – Guadalupe River at Victoria (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	90092	79823	140810	105127	45672	27649	39086	25317	23305	25345	61468	98643	762339
1935	44465	102386	39907	62218	446333	525996	97492	55679	259342	109616	54480	119417	1917331
1936	76451	50923	52606	34706	283741	121905	1115649	60131	178917	254026	94821	85959	2409836
1937	76162	63878	163870	65511	43955	141300	39130	25955	23404	35606	27047	54253	760071
1938	143986	84767	75856	299569	288514	62315	38230	30664	26332	23859	26154	29439	1129686
1939	30395	25205	24261	21229	29047	29927	27767	14635	14922	15076	16016	19380	267859
1940	19629	28555	23964	32419	24496	39363	385519	17295	15017	24707	361754	311678	1284397
1941	145032	188764	257459	268488	782914	265892	135749	64366	49093	70561	55958	43688	2327964
1942	38447	31528	33457	139923	81250	34479	368882	37622	243771	159008	90477	75093	1333937
1943	72659	46983	53630	42937	37958	62107	37583	22678	27244	25816	24507	32148	486250
1944	65951	77987	164576	72766	196288	159413	49820	30083	84822	34026	61707	118841	1116280
1945	184611	169698	156249	315331	74043	59274	33919	23209	17448	60148	31232	49221	1174383
1946	63985	89720	174464	74893	111375	123620	27458	52317	269916	238019	203770	123330	1552868
1947	208947	103139	117409	112961	118509	48484	31740	60479	23673	22467	24499	31857	904165
1948	27439	37008	35312	19629	72767	18376	26234	19931	14480	16217	13123	15754	316270
1949	18430	32659	77044	215685	147683	44465	33515	19931	18034	150309	36595	45856	840206
1950	29375	35635	26359	60646	36038	119142	19686	11725	13461	10032	10674	14828	387601
1951	13981	14578	15274	16555	19931	113698	9499	3785	13405	5578	9291	9410	244985
1952	11289	15342	11637	19689	57854	60982	16004	3694	110296	26832	39860	98128	471606
1953	83568	31792	25493	28159	142019	12972	11431	19384	76118	85518	25276	35123	576853
1954	20106	16149	15118	19629	27612	8598	4246	3250	3187	1224	3535	5948	128603
1955	6766	39649	11597	10288	30200	35343	7742	7930	4758	2517	2922	4086	163799
1956	4216	6928	4091	4695	11406	2219	2257	1722	2253	4592	659	20770	65809
1957	3214	15646	51375	165921	378846	270573	24731	14634	206465	434916	234571	107647	1908540
1958	230269	443964	222802	102649	245787	89018	58387	32738	106670	103616	119720	77534	1833154
1959	67843	101844	67522	185992	90714	53915	60187	32828	29259	137668	65548	58463	951784
1960	76846	76926	62782	64329	129222	153839	142005	88164	45471	553615	447560	191441	2032199
1961	222823	247335	139997	83712	56607	395590	145105	53740	101188	53146	123246	52812	1675303
1962	45598	41612	38027	44607	33701	36088	21146	14634	29757	27187	30467	37786	400612
1963	32868	48251	30195	30920	21388	14848	14602	9157	9981	7051	36478	20881	276619
1964	19629	34579	57883	28798	19931	20543	11388	14088	27730	27504	37539	21601	321212
1965	87781	255528	61742	59173	260455	243435	46044	28814	25842	66628	104147	167162	1406750
1966	61064	80881	82863	114198	156053	50246	31486	32181	39298	34463	27197	27657	737587
1967	26048	22562	23004	19629	17902	14635	12291	14635	538288	113268	107268	52206	961735
1968	513090	147020	110494	158264	287186	342639	80200	41257	84620	39245	45898	116324	1966236
1969	46348	170982	167086	208595	185953	69063	33924	29460	36544	75975	53785	92332	1170047
1970	84277	90033	166318	88492	220497	131815	46052	33506	35051	52498	31791	33437	1013768

1971	30146	25910	29423	21213	19931	19885	14680	73168	144753	94929	69323	110317	653677
1972	72299	64085	50963	32472	771698	144146	65533	59956	40735	46037	47262	43075	1438262
1973	62017	85880	144855	292979	109575	444883	254813	128546	112932	669873	160232	103227	2569813
1974	205424	86143	75015	58096	133412	75340	35150	68086	215420	73885	267015	164241	1457227
1975	109684	243932	121337	120560	572123	329545	178461	91040	65674	65210	53071	71007	2021645
1976	47568	43395	48251	306111	375178	170253	126069	66814	75849	249946	291946	398701	2200080
1977	160356	244838	115689	629237	254345	128335	72839	56615	52713	48191	84091	51988	1899236
1978	49890	51689	50582	49339	37757	75184	27529	239985	193932	66272	104616	62979	1009752
1979	283536	195997	222911	310211	438697	331865	113379	89692	80826	49964	45429	46246	2208753
1980	60946	48168	41652	34142	159128	46597	25515	19931	60012	52312	40591	44316	633309
1981	43609	41174	79356	95852	112341	615768	195719	77631	655382	166307	239492	81409	2404041
1982	67817	84537	58858	48641	338351	65932	31283	21408	21414	31423	56660	37672	863995
1983	33677	72935	115938	59484	85164	67308	60562	22500	36485	37338	42774	28188	662356
1984	39446	31759	41486	23782	21321	18323	11243	10344	10487	32816	26726	38660	306393
1985	100025	81170	124411	134570	89474	193815	132067	36934	29944	107518	194406	183811	1408146
1986	93813	91132	66339	46885	98246	177165	45122	26601	68809	140089	127582	369910	1351692
1987	233749	180410	274939	108953	167834	1582105	293672	170648	99593	86431	94238	84508	3377080
1988	63919	57208	68770	46637	49854	47800	59273	39677	28023	27439	25659	31571	545829
1989	37078	34592	40237	37296	82145	32993	18491	14633	12013	14146	19629	20356	363610
MEAN	85512	87772	84885	104550	163043	153054	90135	42247	86328	92643	84496	79863	1154527

Table B-1-15 – Strategy 2b –WAM Modeled Stream Flows – Estuary Inflows (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	312070	99406	171862	162622	41467	13386	127684	18105	45807	27861	158574	149258	1328102
1935	55182	136992	68943	107487	616657	780673	107868	50340	466055	131705	71517	175220	2768640
1936	88404	58545	66877	50526	572945	166400	1350410	77451	356140	327724	129921	117527	3362870
1937	107626	75287	187328	65396	40917	261087	44234	32057	36154	59433	43963	174397	1127879
1938	188290	96847	94291	440338	376071	64624	29426	40262	37464	25510	37515	64484	1495122
1939	50746	30647	21446	14959	34838	23488	70139	9569	47377	10324	11948	27090	352570
1940	20283	42853	19645	31583	28716	162514	454698	33167	9295	103663	577395	450441	1934254
1941	168221	276643	338305	460367	1155404	362447	299935	74301	92698	146683	77577	91215	3543796
1942	39556	104911	46807	145291	79397	20639	862482	109216	533849	275145	111739	89908	2418939
1943	114760	64090	96166	39137	63192	113226	54294	9879	35835	23110	49411	62768	725867
1944	216069	82702	263897	64130	430108	153298	34638	47266	135825	62330	70060	168574	1728897
1945	201310	192447	174418	401171	68037	93397	43276	192773	7426	79865	29271	47994	1531386
1946	69031	138722	203468	93032	203789	242051	24924	148375	555407	752059	257096	136308	2824261
1947	239034	105785	121074	135180	267882	52557	33380	55166	15813	24429	50690	40356	1141345
1948	50496	73496	59630	15233	101360	524	19065	52595	86798	19443	9596	12595	500830
1949	16101	39537	80161	501461	162450	76588	80015	14246	11755	364148	41331	76156	1463948
1950	34847	45145	20424	63167	28247	139094	9326	3756	11663	4464	6044	10132	376309
1951	6894	8917	5263	5592	69003	162092	0	0	183668	9497	9262	5062	465250
1952	4537	18589	8380	54621	151153	59077	4496	36	347649	20423	76146	106135	851241
1953	81518	34512	13842	23505	216617	148	0	163479	148266	99538	21595	35654	838675
1954	15754	7699	3344	10977	22962	881	777	678	431	31697	5638	751	101587
1955	2188	52144	1186	0	31986	17464	0	6870	48971	2691	31	597	164127
1956	877	1212	2725	4984	17994	881	777	666	431	16529	3669	33104	83848
1957	0	11056	176364	509566	622532	440616	6493	0	316432	484651	382424	106926	3057061
1958	413554	779786	239514	98118	353502	91905	52683	15023	243556	256555	189698	150009	2883903
1959	74538	247139	63072	221385	120764	73681	45614	88763	25871	301782	72865	76684	1412158
1960	78982	111991	85066	56755	126966	250377	151949	211405	40024	1071181	597733	357948	3140376
1961	303871	383744	146004	90075	43540	529033	245404	43928	196505	60372	172436	53504	2268415
1962	45062	39134	28215	48880	27573	98325	4305	31	48247	27022	35693	78332	480818
1963	29413	61402	20891	21146	10792	5984	4363	678	449	3831	52239	22384	233570
1964	25781	68231	75929	14577	5410	22040	0	43018	83595	27186	49666	29079	444512
1965	119099	389109	58458	59546	441406	310565	32417	13562	14602	126813	130032	257014	1952623
1966	102974	124901	74752	159804	296057	74392	45338	24772	55711	57100	39216	36019	1091035
1967	43201	33145	24297	26988	49965	13344	6290	39470	2050710	404355	197384	133099	3022248
1968	736344	260847	146120	186060	488145	495012	197107	54050	140887	109204	74049	147040	3034863
1969	101470	231270	236041	353736	301052	111864	19041	22223	32489	87826	76469	128346	1701828
1970	12746	99509	22989	11934	256681	298481	54978	21811	70697	108018	29553	31459	144789

	3		8	7									6
1971	26529	17931	17301	15801	28233	9488	6403	139035	416249	315847	164613	246558	1403986
1972	109752	114823	60040	45825	1026404	217674	65035	77978	66550	125414	140123	44979	2094596
1973	64715	99464	145201	395924	127937	745808	433597	238789	268626	1197906	285415	165722	4169104
1974	229139	144840	112675	63433	244989	84326	17854	95521	304155	141001	355959	290052	2083944
1975	154374	314551	180543	155027	670513	507238	224646	114704	124538	66814	85940	88243	2687132
1976	76555	41112	44044	479829	513524	234162	232694	62045	98116	358481	492500	659854	3292916
1977	229847	313928	136823	858865	408239	332235	73697	51179	84028	71701	184610	61470	2806623
1978	62718	81057	51959	61234	33440	119939	10700	279983	458941	83212	151657	74450	1469290
1979	414237	246224	272053	446244	632988	481781	223404	101036	356620	52479	52742	57003	3336810
1980	110352	54798	38164	28322	247366	32031	6692	72096	109656	60752	45624	48357	854211
1981	58297	41725	75334	99838	240820	1025347	295854	135760	769182	293542	372244	103229	3511173
1982	73481	199084	67051	51462	444801	59502	18339	10487	13154	43421	151267	43742	1175792
1983	45280	102632	150805	49002	76503	59194	137372	15145	75469	82274	68449	27383	889508
1984	61126	31411	55944	14614	21158	5271	1966	8934	4366	114183	53387	44691	417053
1985	133753	81684	199661	244595	88310	231973	163544	21659	34028	146622	242882	196538	1785250
1986	96328	90874	55249	33099	115608	322759	36958	16144	72639	247436	173476	495200	1755769
1987	295150	263537	321728	114224	230157	2430666	376583	187794	119762	94477	131140	98961	4664178
1988	72712	61261	70063	44203	42770	40960	57752	24934	22997	23046	21442	33213	515354
1989	53085	32947	33891	35006	80174	55216	15640	8263	2891	19709	34811	20132	391765
MEAN	118803	124326	102904	144523	235706	228174	123510	60366	177438	165759	127817	115774	1725098

Table B-1-16 – Strategy 3a – WAM Modeled Stream Flows – San Antonio River at Goliad (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	39848	25103	29644	47568	16224	10078	42013	12296	13776	15255	34564	42739	329106
1935	17890	29449	18418	40881	192514	280636	30601	19652	73736	36755	26673	34555	801760
1936	23818	21780	24957	20382	97620	35222	215937	24809	168472	91081	47816	41589	813483
1937	33431	26178	30028	21962	18857	136963	19278	16991	18254	20725	19275	72124	434066
1938	56679	20622	40237	111295	36202	19417	16881	13697	15638	14032	16324	18805	379831
1939	18556	15514	11552	11590	11566	11597	17566	11595	8161	8232	8552	10238	144718
1940	7989	12865	7183	20197	12216	32539	81806	22797	9409	18896	153379	104603	483877
1941	35753	60937	46301	92319	230104	95593	51984	25572	52905	35356	28282	19011	774118
1942	15101	14074	11276	31407	27535	14625	254784	22518	291311	134534	38042	30219	885427
1943	25968	18417	23545	20530	25363	48564	26691	13329	19146	14614	18416	17755	272337
1944	24576	18201	25005	14822	119412	28032	14050	19258	30349	15365	16345	27233	352648
1945	40866	44256	29167	65726	19519	24078	12033	11685	11228	24671	13886	15631	312748
1946	17317	17910	24766	40610	93867	59681	12814	48981	253566	339011	55785	33116	997424
1947	44986	21633	26838	22268	53846	17948	12717	18696	14407	12912	15356	17139	278746
1948	13666	14707	12449	12865	17546	7610	21004	42612	16826	20262	10551	11171	201268
1949	10655	13953	15189	134696	41749	60684	44683	16248	11714	71564	18074	26711	465922
1950	14446	9685	10874	14781	11831	32537	10138	13395	10294	9087	8295	8984	154347
1951	5806	8645	8059	10796	27821	61982	11433	9425	44242	9100	9094	8626	215029
1952	5379	8616	8672	17470	30644	10453	10802	8991	194403	9453	13080	16285	334249
1953	14567	6853	7943	11333	56359	8954	11223	17095	72560	15915	9411	12541	244753
1954	7798	4265	4371	9049	13854	10871	9744	8374	8659	7816	8957	7218	100977
1955	5451	14524	7404	10297	15955	9122	10344	9053	12425	7385	8673	7293	117926
1956	6920	6088	9774	10507	9690	7720	8984	8098	14974	20613	10168	23282	136817
1957	8010	5882	24148	139742	168353	129573	9086	10609	113280	60373	55033	18605	742693
1958	99189	156428	41578	20589	123314	37036	25557	9531	48228	70151	86432	31463	749494
1959	21340	20858	16712	31902	31748	16403	14968	10416	9933	38171	20133	17399	249981
1960	17562	14316	15885	16547	15536	28441	25839	33111	12515	151082	100435	51208	482478
1961	39553	57867	31753	23224	12074	73110	52188	17150	17022	27656	43694	17618	412908
1962	14647	12155	9955	15506	10859	35598	7791	10140	14006	7383	11260	20873	170174
1963	9545	15753	7515	9810	8455	6129	10304	8210	10361	13329	16196	11520	127127
1964	7200	22290	20019	9086	7511	11998	9217	24273	16777	15718	31880	12182	188151
1965	30750	91248	14734	22935	156080	36802	10673	7796	7787	34080	12561	40121	465569
1966	13389	14850	14173	24248	31733	12084	8415	13321	20082	10875	8527	9765	181462
1967	8469	5957	7531	9866	10680	3809	14388	21511	706432	62724	54953	21336	927657
1968	260869	51510	33539	36089	122626	43534	25938	13369	45460	15787	14760	31929	695410
1969	17032	49433	28873	38466	73525	28350	7858	9104	16114	26419	13092	18032	326299
1970	21737	19066	35987	15344	64658	69530	9484	9653	8869	13234	10616	10871	289049
1971	10453	6728	7282	8238	8065	9952	6914	103577	50368	62973	48184	44600	367335
1972	24583	18927	14477	27604	256440	53089	24162	24005	24206	31911	20551	18319	538273
1973	17931	25038	21100	97006	26544	243870	242214	66496	117158	416655	80888	46518	1401418
1974	37635	26212	25894	23371	40843	23050	10508	57123	86473	34085	52713	32545	450452
1975	31584	99877	42195	35406	140922	121844	45790	28653	24267	21196	17373	26557	635663
1976	22975	13463	16137	86655	159510	30474	51120	25246	42169	101550	121963	92637	763900
1977	67340	66772	42235	243513	129251	60763	30913	18007	37787	22035	73866	25400	817883
1978	20426	22312	21758	32300	20809	46598	7507	86676	99844	29923	51508	25292	464952
1979	82396	48289	61439	155945	120812	149496	50068	29914	19603	14417	17085	21308	770771
1980	23412	18125	11978	16339	72210	13092	6869	32197	56975	15375	17446	19057	303073
1981	17033	14406	18064	26204	44896	259340	74970	32920	135284	76315	53818	25520	778770
1982	19136	35287	22586	18442	56345	16189	10143	9811	7488	24742	23846	19475	263488
1983	16975	17917	28103	11830	16457	14863	11501	11833	41216	16215	23084	12095	222091
1984	14527	11532	15781	8894	9279	6957	9554	9152	8176	51929	27494	19063	192338
1985	33659	14663	41329	40619	20133	47332	49912	7478	17388	53615	72392	27089	425610
1986	16026	15949	9186	9209	18886	167207	22140	8804	24275	61116	31047	122936	506782
1987	70742	65124	77498	33407	92817	885190	88460	37875	32272	18441	26335	30556	1458716
1988	24245	19881	20936	18197	13991	14169	21915	8753	11609	9424	9551	10649	183319
1989	13897	12392	11517	16606	14773	13025	7322	7020	5680	5871	17156	13075	138335
MEAN	28960	27228	22242	37794	58579	66675	34843	21766	58135	45847	33123	27723	462914

Table B-1-17 – Strategy 3a –WAM Modeled Stream Flows – Guadalupe River at Victoria (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	90092	79823	140810	105127	45672	27649	39086	25317	23305	25345	61468	98643	762339
1935	44465	102386	39907	62218	446333	525996	97492	55679	259342	109616	54480	119417	1917331
1936	76451	50923	52606	34706	283741	121905	1115649	60131	178917	254026	94821	85959	2409836
1937	76162	63878	163870	65511	43955	141300	39130	25955	23404	35606	27047	54253	760071
1938	143986	84767	75856	299569	288514	62315	38230	30664	26332	23859	26154	29439	1129686
1939	30395	25205	24261	21229	29047	29927	27767	14635	14922	15076	16016	19380	267859
1940	19629	28555	23964	32419	24496	39363	385519	17295	15017	24707	361754	311678	1284397
1941	145032	188764	257459	268488	782914	265892	135749	64366	49093	70561	55958	43688	2327964
1942	38447	31528	33457	139923	81250	34479	368882	37622	243771	159008	90477	75093	1333937
1943	72659	46983	53630	42937	37958	62107	37583	22678	27244	25816	24507	32148	486250
1944	65951	77987	164576	72766	196288	159413	49820	30083	84822	34026	61707	118841	1116280
1945	184611	169698	156249	315331	74043	59274	33919	23209	17448	60148	31232	49221	1174383
1946	63985	89720	174464	74893	111375	123620	27458	52317	269916	238019	203770	123330	1552868
1947	208947	103139	117409	112961	118509	48484	31740	60479	23673	22467	24499	31857	904165
1948	27439	37008	35312	19629	72767	18376	26234	19931	14480	16217	13123	15754	316270
1949	18430	32659	77044	215685	147683	44465	33515	19931	18034	150309	36595	45856	840206
1950	29335	35588	26254	60484	35858	118907	19516	11499	13341	9973	10626	14795	386177
1951	13981	14578	15274	16555	19931	113698	9499	3785	13405	5578	9291	9410	244985
1952	11289	15342	11637	19689	57854	60982	16004	3694	110296	26832	39860	98128	471606
1953	83568	31792	25493	28159	142019	12972	11431	19384	76118	85518	25276	35123	576853
1954	20065	16103	15014	19629	27433	8364	4004	3024	3068	1164	3488	5915	127271
1955	6766	39649	11597	10516	30200	35318	7742	7930	4758	2517	2922	4086	164001
1956	4176	6897	3987	4534	11227	1984	2015	1602	2118	4532	611	20737	64420
1957	3214	15646	51375	165903	378846	270573	24731	14634	206465	434779	234571	107647	1908385
1958	230269	443964	222802	102649	245787	89018	58387	32738	106670	103616	119720	77534	1833154
1959	67843	101844	67522	185992	90714	53915	60187	32828	29259	137668	65548	58463	951784
1960	76846	76926	62782	64329	129222	153839	142005	88164	45471	553615	447560	191441	2032199
1961	222823	247335	139997	83712	56607	395590	145105	53740	101188	53146	123246	52812	1675303
1962	45598	41612	38027	44607	33701	36088	21146	14731	29745	27187	30467	37786	400696
1963	32827	48205	30091	30758	21204	14635	14602	8932	9862	6991	36430	20848	275384
1964	19629	34579	57883	28798	19931	20543	11388	14088	27730	27504	37539	21601	321212
1965	87740	255482	61637	59011	260276	243201	45801	28587	25722	66568	104099	167129	1405253
1966	61064	80881	82863	114198	156053	50246	31486	32181	39298	34463	27197	27657	737587
1967	26048	22562	23004	19629	17902	14635	12291	14635	538288	113268	107268	52206	961735
1968	513090	147020	110494	158264	287186	342639	80200	41257	84620	39245	45898	116324	1966236
1969	46307	170936	166982	208434	185774	68827	33681	29233	36424	75915	53737	92299	1168549
1970	84277	90033	166318	88492	220497	131815	46052	33506	35051	52498	31791	33437	1013768

1971	30146	25910	29423	21213	19931	19885	14680	73168	144753	94929	69323	110317	653677
1972	72299	64085	50963	32472	771698	144146	65533	59956	40735	46037	47262	43075	1438262
1973	62017	85880	144855	292979	109575	444883	254813	128546	112932	669873	160232	103227	2569813
1974	205424	86143	75015	58096	133412	75340	35150	68086	215420	73885	267015	164241	1457227
1975	109684	243932	121337	120560	572123	329545	178461	91040	65674	65210	53071	71007	2021645
1976	47568	43395	48251	306111	375178	170253	126069	66814	75849	249946	291946	398701	2200080
1977	160356	244838	115689	629237	254345	128335	72839	56615	52713	48191	84091	51988	1899236
1978	49890	51689	50582	49339	37757	75184	27529	239985	193932	66272	104616	62979	1009752
1979	283536	195985	222911	310211	438697	331865	113379	89692	80826	49964	45429	46246	2208740
1980	60946	48168	41652	34142	159128	46597	25515	19931	60012	52312	40591	44316	633309
1981	43609	41174	79356	95852	112341	615768	195719	77631	655382	166307	239492	81409	2404041
1982	67776	84490	58753	48479	338172	65697	31040	21205	21304	31363	56610	37639	862528
1983	33677	72935	115938	59484	85164	67308	60562	22500	36485	37338	42774	28188	662356
1984	39405	31712	41381	23620	21098	18367	10979	10119	10367	32755	26678	38627	305110
1985	100025	81170	124411	134570	89474	193815	132067	36934	29944	107518	194406	183811	1408146
1986	93813	91132	66339	46885	98246	177165	45122	26601	68809	140089	127582	369910	1351692
1987	233749	180410	274939	108953	167834	1582105	293672	170648	99593	86431	94238	84508	3377080
1988	63879	57162	68665	46475	49674	47566	59030	39451	27903	27379	25611	31538	544330
1989	37038	34546	40132	37135	81965	32759	18232	14633	11893	14086	19604	20326	362349
MEAN	85505	87763	84866	104528	163010	153017	90097	42215	86306	92630	84488	79857	1154282

Table B-1-18 – Strategy 3a –WAM Modeled Stream Flows – Estuary Inflows (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	314247	101945	174764	165887	44369	16256	131537	21457	49610	30763	161115	152160	1364110
1935	57357	139531	71845	110752	619559	783938	111496	53968	469682	134607	74058	178122	2804914
1936	90581	61084	69779	53791	575846	169664	1354037	81079	359767	330626	132461	120429	3399145
1937	109802	77826	190230	68661	43819	264351	47861	35533	39750	62411	46510	177299	1164054
1938	190467	99386	97193	443602	378973	67738	32952	43551	41203	28412	39869	67527	1530873
1939	52930	33186	23566	17442	36931	26127	73824	12896	51004	12832	14334	29975	385046
1940	22457	45213	22539	34872	31456	165805	458348	36545	13124	106606	579934	453344	1970242
1941	170399	279182	341207	463632	1158306	365712	303417	77942	96367	149585	80116	94117	3579982
1942	41733	107386	49349	148572	82299	23903	866110	112823	537492	278047	114279	92810	2454802
1943	116936	66629	99038	42312	66035	116523	57921	12954	39807	26012	51950	65661	761779
1944	218251	85242	266799	67358	433019	156563	37849	51220	139452	65232	72582	171565	1765132
1945	203404	194986	177320	404436	70939	96662	46320	196266	10910	82800	31815	50893	1566751
1946	71202	141262	206370	96296	206691	245316	28123	152002	559036	754961	259644	139210	2860113
1947	241207	108324	123976	138445	270784	55822	36916	58851	19336	27254	53344	43277	1177535
1948	52672	76035	62393	18498	104262	4144	22638	56219	90425	22345	12135	15309	537076
1949	18150	42110	83059	504727	165352	79853	83642	17820	14724	367138	43875	79065	1499516
1950	36136	46468	20623	63023	26274	137283	7717	4485	12690	6022	7490	12314	380524
1951	9070	11452	7813	8204	72041	165387	3122	500	186284	11591	11094	7155	493715
1952	6108	21113	12122	59193	154420	62638	8301	713	350266	22516	78328	110690	886408
1953	83952	37927	17305	27050	219555	2958	2122	166096	150883	101631	23427	38778	871684
1954	17617	8839	3889	11557	21807	2810	599	500	500	32446	6377	2528	109468
1955	3758	53975	3280	2810	34048	19795	2122	9487	51588	4785	1432	3090	190171
1956	1873	2186	3086	6445	12065	450	500	587	500	15873	4408	34477	82449
1957	1873	12888	178457	511428	624622	442971	9110	3122	322246	490455	387012	110975	3095159
1958	419311	788868	244102	102654	357359	95170	56310	18494	247325	259457	192238	152911	2934199
1959	76715	249678	65974	224650	123666	76946	49176	91858	29118	304726	75404	79586	1447496
1960	81159	114530	87968	60020	129868	253354	155576	215038	43271	1074108	600272	360850	3176014
1961	306048	386283	148906	93339	46442	532297	249031	47555	200080	63305	174976	56398	2304661
1962	47189	41502	31117	52158	30300	101551	7638	3153	50537	29116	38642	82762	515665
1963	31435	62728	21289	20934	8801	4144	3123	2122	2122	2875	52724	23757	236053
1964	27351	70071	79938	18387	9039	24901	3122	45539	86323	29750	54006	32819	481247
1965	121309	391128	58851	59423	440131	308636	31305	13331	15926	128666	131069	259236	1959010
1966	105156	127441	77609	163047	298959	77528	48584	28758	59140	59646	41743	38733	1126344
1967	45375	35684	27191	29810	52867	16312	9412	41979	2056194	407257	199917	136076	3058074
1968	738792	263386	149022	189325	491047	498277	200735	57677	144514	112028	76588	149946	3071337
1969	102769	232597	236448	353614	299501	109933	17692	22382	33603	89383	77746	130528	1706198
1970	12964	10204	23280	12249	259600	301746	58606	25438	73779	110865	32093	34332	148345

	9	8	0	5									1
1971	28702	20470	20203	19065	31135	12424	9687	142717	419876	318751	167153	249460	1439644
1972	111928	117349	62942	48853	1029308	220939	68663	81605	70145	128316	142673	47881	2130603
1973	66892	102003	148103	399189	130839	749073	437224	242416	272254	1200808	287954	168624	4205378
1974	231315	147379	115577	66697	247891	87591	20991	99200	307807	143903	358498	292954	2119803
1975	156550	317091	183445	158292	673415	510503	228273	118332	128165	69716	88480	91145	2723407
1976	78731	43580	46922	483105	516427	237427	236322	65672	101744	361383	495039	662756	3329107
1977	232024	316467	139725	862130	411141	335500	77325	54566	87890	74603	187149	64372	2842892
1978	64895	83596	54861	64499	36342	123204	13897	283610	462572	86114	154197	77352	1505139
1979	416413	248751	274955	449509	635890	485046	227031	104663	360215	55223	55359	59919	3372976
1980	112531	57324	40651	31613	250271	35077	9877	76210	113284	63656	48163	51259	889916
1981	60474	44264	78060	103168	243724	1028631	299482	139388	772809	296444	374784	106131	3547358
1982	74781	200396	67431	51339	443261	57511	17371	10307	14196	45154	152711	45924	1180381
1983	47456	105172	153707	52109	79428	62458	140787	18586	79152	85178	71004	30297	925334
1984	62411	32730	56353	14491	19566	3797	3727	8339	4735	111301	54125	46064	417639
1985	135321	84635	204570	249375	91874	235593	167171	24778	38142	149524	245421	199440	1825844
1986	98504	93413	57785	36373	118516	326024	40585	19759	76266	250338	176015	498102	1791681
1987	297326	266077	324630	117489	233059	2433930	380211	191421	123390	97379	133680	101863	4700453
1988	74012	62588	70469	44080	41219	38943	57049	24843	24101	24395	22871	35395	519965
1989	54402	34270	34268	34889	78586	53287	14400	7668	3503	21394	36745	22308	395720
MEAN	120877	126744	105391	147234	237731	230543	126196	63108	180515	168209	130125	118571	1755244

Table B-1-19 – Strategy 3b – WAM Modeled Stream Flows – San Antonio River at Goliad (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	40454	25811	30452	48478	17032	10783	42894	13154	14786	15876	35412	43555	338687
1935	18497	30156	19226	41791	193324	281551	31611	20663	74747	37564	27380	35363	811873
1936	24424	22487	25765	21291	98428	36131	216945	25820	169483	91889	48524	42398	823587
1937	34037	26886	30836	22871	19666	137873	20288	18002	19265	21533	19983	72932	444172
1938	57286	21329	41046	112205	37011	20327	17891	14708	16485	14856	17073	19613	389829
1939	19162	16208	12360	12287	12229	11853	18677	12645	8810	9041	9263	10937	153472
1940	8595	13622	7991	21174	12977	33439	82795	23807	10058	19723	154086	105411	493680
1941	36360	61644	47109	93228	230913	96502	52994	26583	53916	36164	28978	19822	784214
1942	15707	14778	12018	32331	28344	15534	255795	23491	292329	135343	38751	31035	895456
1943	26566	19125	24354	21439	26171	49474	27702	14339	20157	15411	19132	18563	282432
1944	25182	18909	25814	15731	120221	28942	15061	20196	31401	16156	17058	28042	362712
1945	41472	44964	29975	66635	20328	24987	13011	12696	12152	25521	14592	16442	322775
1946	17922	18604	25577	41519	94675	60591	13825	49991	254577	339820	56494	33924	1007520
1947	45592	22340	27646	23178	54654	18857	13727	19706	15418	13721	16063	17948	288852
1948	14272	15400	13257	13774	18109	8741	22019	43623	17837	21071	11127	11963	211191
1949	11202	14676	15859	135618	42558	61594	45694	17259	12586	72375	18771	27524	475716
1950	15043	10392	11597	15703	12639	33375	10982	14598	11135	9597	8830	9671	163559
1951	6413	9353	8849	11648	28741	62891	11433	9425	44242	9100	9580	10876	222550
1952	7066	10108	9477	18412	31210	11165	11577	8991	194452	10529	15284	17104	345376
1953	15029	7437	8743	12097	57097	8954	11223	17095	72560	18276	11229	14108	253846
1954	8402	4973	5301	9858	14585	10871	9744	8374	8659	7816	8957	7802	105341
1955	5451	14524	7681	10398	15955	10838	10344	9053	13725	8535	9184	8307	123996
1956	7358	6547	9774	10507	9690	7720	8984	8098	14974	19965	10153	23282	137052
1957	8448	5882	24148	144520	175467	134108	10507	11339	116667	61182	55740	19414	767422
1958	99795	157135	42386	21498	124122	37945	26568	10541	49238	70959	87139	32271	759599
1959	21946	21565	17493	32817	32556	17251	15979	11138	10833	39037	20840	18208	259663
1960	18159	15023	16696	17420	16297	29350	26849	34141	13393	151897	101142	52017	492384
1961	40160	58574	32562	24133	12635	74026	53199	18161	18032	28464	44401	18426	422773
1962	15253	12837	10432	16428	11488	36514	8787	10140	14006	8947	12843	21612	179287
1963	10001	16496	8324	10724	9075	7257	10423	8210	10361	13903	16109	11520	132403
1964	9303	25253	21616	9908	8320	12827	9217	24273	19112	17120	32579	12991	202518
1965	31351	92056	15291	23890	157031	37712	10899	8794	8255	34814	13269	40981	474342
1966	13945	15564	14854	25179	32541	12710	9425	14141	21213	11684	8853	10569	190679
1967	9076	6664	8340	10721	10861	4719	14388	21511	709457	63532	55659	22204	937132
1968	261475	52217	34348	36999	123434	44443	26949	13849	46498	16595	15450	32746	705004
1969	17638	50141	29654	39339	74348	29259	8868	10115	16713	27277	13738	18830	335920
1970	22348	19773	36798	16202	65518	70439	10480	10651	9818	14042	11042	11645	298757
1971	10988	7315	7847	8718	8308	10862	7910	104615	51379	63824	48892	45408	376065
1972	25190	19635	15150	28514	257249	53998	25172	25016	25216	32703	21264	19127	548233
1973	18537	25745	21908	97916	27352	244779	243225	67507	118169	417463	81595	47327	1411524
1974	38241	26920	26702	24280	41651	23959	11165	58172	87484	34893	53421	33354	460242
1975	32190	100584	43003	36315	141731	122754	46800	29664	25278	22004	17935	27421	645680
1976	23589	14167	16945	87565	160319	31384	52131	26257	43179	102358	122674	93445	774014
1977	67944	67480	43044	244423	130060	61672	31923	19017	38797	22844	74574	26208	827987
1978	20890	23075	22574	33209	21617	47508	8518	87688	100858	30732	52215	26100	474983
1979	83002	48996	62247	156855	121620	150405	51079	30925	20614	15225	17776	22124	780867
1980	24018	18832	12777	17206	73033	14002	7591	33207	57985	16183	18153	19865	312854
1981	17640	15046	18873	27114	45705	260249	75981	33930	136295	77123	54525	26328	788809
1982	19742	35994	23394	19315	57162	17099	10582	10822	8498	25575	24554	20283	273019
1983	17581	18625	28911	12740	17266	15773	12512	12844	42227	17024	23792	12904	232197
1984	15134	12239	16590	9803	10088	8001	9554	9152	8176	51928	27494	20955	199114
1985	36005	16931	42140	41529	20942	48242	50923	8489	18399	54424	73099	27897	439019
1986	16632	16644	9991	10118	19697	168116	23151	9284	25286	61951	31754	123745	516370
1987	71348	65832	78307	34316	93625	886100	89470	38885	33282	19250	27042	31365	1468822
1988	24851	20588	21745	19106	14752	15089	22926	9751	12518	10223	10258	11339	193147
1989	14564	13099	12138	17533	15583	13935	8069	7751	6533	7244	17863	13884	148197
MEAN	29616	27986	22999	38724	59429	67598	35651	22541	59063	46648	33814	28556	472623

Table B-1-20 – Strategy 3b –WAM Modeled Stream Flows – Guadalupe River at Victoria (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	90092	79823	140810	105127	45672	27649	39086	25317	23305	25345	61468	98643	762339
1935	44465	102386	39907	62218	446333	525996	97492	55679	259342	109616	54480	119417	1917331
1936	76451	50923	52606	34706	283741	121905	1115649	60131	178917	254026	94821	85959	2409836
1937	76162	63878	163870	65511	43955	141300	39130	25955	23404	35606	27047	54253	760071
1938	143986	84767	75856	299569	288514	62315	38230	30664	26332	23859	26154	29439	1129686
1939	30395	25205	24261	21229	29047	29927	27767	14635	14922	15076	16016	19380	267859
1940	19629	28555	23964	32419	24496	39363	385519	17295	15017	24707	361754	311678	1284397
1941	145032	188764	257459	268488	782914	265892	135749	64366	49093	70561	55958	43688	2327964
1942	38447	31528	33457	139923	81250	34479	368882	37622	243771	159008	90477	75093	1333937
1943	72659	46983	53630	42937	37958	62107	37583	22678	27244	25816	24507	32148	486250
1944	65951	77987	164576	72766	196288	159413	49820	30083	84822	34026	61707	118841	1116280
1945	184611	169698	156249	315331	74043	59274	33919	23209	17448	60148	31232	49221	1174383
1946	63985	89720	174464	74893	111375	123620	27458	52317	269916	238019	203770	123330	1552868
1947	208947	103139	117409	112961	118509	48484	31740	60479	23673	22467	24499	31857	904165
1948	27439	37008	35312	19629	72767	18376	26234	19931	14480	16217	13123	15754	316270
1949	18430	32659	77044	215685	147683	44465	33515	19931	18034	150309	36595	45856	840206
1950	29335	35588	26254	60484	35858	118907	19516	11499	13341	9973	10626	14795	386177
1951	13981	14578	15274	16555	19931	113698	9499	3785	13405	5578	9291	9410	244985
1952	11289	15342	11637	19689	57854	60982	16004	3694	110296	26832	39860	98128	471606
1953	83568	31792	25493	28159	142019	12972	11431	19384	76118	85518	25276	35123	576853
1954	20065	16103	15014	19629	27433	8364	4004	3024	3068	1164	3488	5915	127271
1955	6766	39649	11597	11092	30200	35318	7742	7930	4758	2517	2922	4086	164577
1956	4176	6917	3987	4534	11227	1984	2015	1602	2118	4532	611	20737	64440
1957	3214	15646	51375	165898	378846	270573	24731	14634	206465	434333	234571	107647	1907935
1958	230269	443964	222802	102649	245787	89018	58387	32738	106670	103616	119720	77534	1833154
1959	67843	101844	67522	185992	90714	53915	60187	32828	29259	137668	65548	58463	951784
1960	76846	76926	62782	64329	129222	153839	142005	88164	45471	553615	447560	191441	2032199
1961	222823	247335	139997	83712	56607	395590	145105	53740	101188	53146	123246	52812	1675303
1962	45598	41612	38027	44607	33701	36088	21146	14731	29745	27187	30467	37786	400696
1963	32827	48205	30091	30758	21204	14635	14635	8931	9862	6991	36430	20848	275417
1964	19629	34579	57883	28798	19931	20543	11388	14088	27730	27504	37539	21601	321212
1965	87740	255482	61637	59011	260276	243201	45801	28587	25722	66568	104099	167129	1405253
1966	61064	80881	82863	114198	156053	50246	31486	32181	39298	34463	27197	27657	737587
1967	26048	22562	23004	19629	17902	14635	12291	14635	538288	113268	107268	52206	961735
1968	513090	147020	110494	158264	287186	342639	80200	41257	84620	39245	45898	116324	1966236
1969	46307	170936	166982	208434	185774	68827	33681	29233	36424	75915	53737	92299	1168549
1970	84277	90033	166318	88492	220497	131815	46052	33506	35051	52498	31791	33437	1013768

1971	30146	25910	29423	21213	19931	19885	14680	73168	144753	94929	69323	110317	653677
1972	72299	64085	50963	32472	771698	144146	65533	59956	40735	46037	47262	43075	1438262
1973	62017	85880	144855	292979	109575	444883	254813	128546	112932	669873	160232	103227	2569813
1974	205424	86143	75015	58096	133412	75340	35150	68086	215420	73885	267015	164241	1457227
1975	109684	243932	121337	120560	572123	329545	178461	91040	65674	65210	53071	71007	2021645
1976	47568	43395	48251	306111	375178	170253	126069	66814	75849	249946	291946	398701	2200080
1977	160356	244838	115689	629237	254345	128335	72839	56615	52713	48191	84091	51988	1899236
1978	49890	51689	50582	49339	37757	75184	27529	239985	193932	66272	104616	62979	1009752
1979	283536	195985	222911	310211	438697	331865	113379	89692	80826	49964	45429	46246	2208740
1980	60946	48168	41652	34142	159128	46597	25515	19931	60012	52312	40591	44316	633309
1981	43609	41174	79356	95852	112341	615768	195719	77631	655382	166307	239492	81409	2404041
1982	67776	84490	58753	48479	338172	65697	31040	21205	21304	31363	56610	37639	862528
1983	33677	72935	115938	59484	85164	67308	60562	22500	36485	37338	42774	28188	662356
1984	39405	31712	41381	23620	21098	18468	10979	10119	10367	32710	26678	38627	305167
1985	100025	81168	124411	134570	89474	193815	132067	36934	29944	107518	194406	183811	1408144
1986	93813	91132	66339	46885	98246	177165	45122	26601	68809	140089	127582	369910	1351692
1987	233749	180410	274939	108953	167834	1582105	293672	170648	99593	86431	94238	84508	3377080
1988	63879	57162	68665	46475	49674	47566	59030	39451	27903	27379	25611	31538	544330
1989	37038	34546	40132	37135	81965	32759	18214	14633	11893	14086	19604	20326	362332
MEAN	85505	87764	84866	104538	163010	153019	90097	42215	86306	92621	84488	79857	1154285

Table B-1-21 – Strategy 3b–WAM Modeled Stream Flows – Estuary Inflows (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	316423	104484	177666	169152	47270	19317	135035	24933	53237	33478	163794	155069	1399860
1935	59534	142070	74747	114017	622463	787208	115123	57595	473310	137509	76597	181024	2841197
1936	92757	63624	72681	57055	578748	172929	1357663	84706	363395	333528	135000	123331	3435417
1937	111979	80366	193132	71926	46721	267616	51489	39160	43377	65313	49049	180201	1200329
1938	192643	101926	100095	446867	381875	71002	36580	47179	44666	31329	42450	70429	1567040
1939	55106	35712	26468	20494	39688	28738	77552	16563	54270	15734	16876	32767	419969
1940	24633	47802	25441	38205	34310	169060	461954	40173	16391	109526	582473	456246	2006213
1941	172575	281721	344109	466897	1161208	368977	307045	81569	99994	152487	82644	97022	3616246
1942	43909	109922	52184	151851	85201	27168	869737	116413	541126	280949	116820	95720	2491000
1943	119104	69168	101940	45576	68937	119788	61548	16582	43435	28902	54498	68563	798042
1944	220427	87781	269701	70622	435920	159828	41477	54776	143122	68117	75127	174467	1801365
1945	205581	197525	180222	407700	73841	99927	49915	199893	14450	85743	34353	53797	1602947
1946	73377	143788	209274	99561	209593	248581	31750	155630	562663	757863	262185	142112	2896377
1947	243383	110863	126878	141710	273686	59086	40544	62478	22963	30156	55883	46179	1213810
1948	54849	78559	65295	21763	106919	7630	26271	59847	94053	25247	14542	18194	573167
1949	20267	44666	85823	508004	168254	83117	87270	21448	18213	370043	46403	81972	1535479
1950	38303	49007	23439	66300	29176	140476	11177	8304	16147	8625	9856	15094	415905
1951	11247	13991	10696	11412	75055	168652	6244	2546	188901	13684	13411	11499	527339
1952	9364	24438	15021	62490	157080	65705	11693	2835	352931	25685	82364	113602	923208
1953	85984	40343	20199	30169	222386	5768	4244	168713	153500	106085	27077	42438	906905
1954	19791	11378	7008	14643	24632	5620	2721	1869	2109	34538	8208	5026	137543
1955	5392	55744	5750	5620	36048	23867	4244	12098	55505	8029	3618	6017	221932
1956	3747	4371	5584	9255	12970	1104	1000	1087	2081	17440	6224	36571	101433
1957	3747	14720	180551	518557	633830	449862	13148	6244	328249	492939	389551	113876	3145273
1958	421487	791407	247004	105919	360261	98434	59938	22122	250953	262359	194777	155813	2970473
1959	78891	252217	68849	227921	126568	80149	52803	95197	32635	307686	77943	82488	1483347
1960	83326	117069	90872	63248	132721	256619	159204	218685	46766	1077016	602811	363752	3212088
1961	308224	388822	151808	96604	49096	535568	252659	51183	203708	66207	177515	59300	2340694
1962	49366	44016	33687	55435	33023	104822	11251	6275	52442	32773	42057	85594	550740
1963	33461	65302	24191	24203	11514	7627	6245	4244	4244	5750	54469	25850	267102
1964	31023	74865	83628	21565	11941	28086	6244	48156	91275	33245	56537	35721	522287
1965	123481	393767	61502	62732	443175	311901	34147	16946	19011	131493	133608	262189	1993952
1966	107282	129987	80384	166334	301861	80509	52211	32195	62888	62548	43901	41630	1161730
1967	47551	38224	30093	33020	55141	19577	12534	43889	2061836	410159	202455	139038	3093516
1968	740968	265925	151924	192589	493949	501541	204362	60774	148169	114930	79110	152856	3107099
1969	104946	235136	239323	356841	302418	113198	21320	26010	36819	92335	80223	133419	1741988
1970	13183	10458	23570	12570	262554	305010	62219	29054	77345	113767	34350	37199	151932

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1971	30808	22889	22862	21900	33471	15689	13300	146371	423504	321695	169692	252362	1474542
1972	114105	119888	65709	52118	1032210	224204	72290	85233	73773	131201	145218	50783	2166732
1973	69068	104542	151005	402454	133741	752337	440852	246044	275881	1203710	290493	171526	4241653
1974	233492	149918	118479	69962	250793	90856	24265	102865	311434	146805	361037	295856	2155762
1975	158727	319630	186347	161556	676317	513768	231901	121959	131793	72618	90873	94103	2759592
1976	80915	46116	49824	486370	519329	240691	239949	69299	105371	364285	497582	665658	3365390
1977	234198	319006	142627	865395	414043	338765	80952	58193	91518	77505	189689	67274	2879165
1978	66929	86192	57770	67764	39244	126468	17524	287239	466203	89016	156736	80254	1541339
1979	418590	251291	277857	452774	638792	488311	230659	108291	363842	58125	57881	62829	3409241
1980	114708	59864	43544	34835	253188	38342	13216	79838	116911	66558	50702	54161	925865
1981	62650	46736	80963	106433	246627	1031895	303109	143015	776437	299346	377323	109033	3583567
1982	76957	202935	70333	54567	446172	60776	20427	13934	17823	48081	155250	48826	1216080
1983	49633	107711	156609	55374	82330	65723	144415	22214	82779	88080	73543	33199	961608
1984	64587	35269	59255	17756	22468	7089	6849	11461	6101	113055	55957	50050	449898
1985	139236	88733	207475	252640	94776	238857	170799	28405	41769	152426	247961	202342	1865418
1986	100681	95939	60683	39637	121421	329288	44213	22856	79894	253267	178554	501004	1827436
1987	299502	268616	327532	120754	235961	2437195	383838	195049	127017	100281	136219	104765	4736728
1988	76188	65127	73371	47345	44073	42218	60676	28458	27627	27289	25410	38178	555962
1989	56639	36809	36982	38170	81490	56552	17522	10790	6748	24861	39284	25210	431058
MEAN	123099	129330	108252	150532	240651	233805	129595	66409	183975	171097	132646	121491	1790882

Table B-1-22 – Strategy 4 – WAM Modeled Stream Flows – San Antonio River at Goliad (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	39848	25103	29644	47568	16224	10078	42013	12296	13776	15255	34564	42739	329107
1935	17890	29449	18418	40881	192514	280636	30601	19653	73736	36756	26673	34555	801760
1936	23818	21780	24957	20382	97620	35222	215937	24809	168472	91081	47816	41589	813483
1937	33431	26178	30028	21962	18857	136964	19278	16991	18254	20725	19275	72124	434067
1938	56679	20622	40238	111295	36202	19418	16881	13697	15638	14032	16430	18805	379938
1939	18556	15514	11552	11590	11566	11597	17566	11595	8161	8232	8552	10238	144718
1940	7989	12865	7183	20197	12216	32539	81806	22797	9409	18896	153379	104603	483878
1941	35753	60937	46301	92319	230104	95593	51984	25572	52905	35356	28282	19011	774118
1942	15101	14074	11276	31407	27535	14625	254784	22518	291312	134534	38042	30219	885427
1943	25968	18417	23545	20530	25363	48564	26691	13329	19146	14614	18416	17755	272338
1944	25242	18573	25005	14822	119412	28032	14050	19295	30301	15361	16345	27254	353693
1945	40845	44256	29167	65726	19519	24078	12033	11685	11266	24746	13886	15631	312840
1946	17317	17910	24766	40610	93867	59681	12814	52473	253565	339011	55785	33116	1000916
1947	44986	21633	26838	22269	53846	17948	12717	18696	14408	12912	15356	17140	278747
1948	13666	14707	12449	12865	17546	8725	20438	42601	16826	20262	10551	11171	201807
1949	10655	13953	15189	134696	41750	63156	44683	16248	11714	71564	18074	26711	468394
1950	14473	9723	10953	14887	11971	32700	10989	15981	8734	9358	7952	9111	156833
1951	6440	7980	8059	10796	27700	61970	11433	9511	44242	9100	9095	8626	214952
1952	6120	7924	8626	17470	30644	10431	10887	9070	194403	9688	12910	16285	334458
1953	14567	6870	7948	11333	56359	9061	11333	17028	72508	15894	9411	12541	244854
1954	7850	5506	5634	7691	13600	11141	10004	8787	8844	8105	11009	10201	108371
1955	7482	14599	9689	10504	16065	9441	10454	10936	13750	8709	9780	11185	132595
1956	9510	9346	9962	10720	11632	8252	9449	8511	15052	19545	11280	24276	147535
1957	10301	7479	26110	137433	168279	129568	9086	11843	110162	56512	52277	16651	735700
1958	95002	151401	41578	20589	123314	37036	25557	9638	48228	70261	86538	31573	740714
1959	21450	20858	16712	31902	31748	16427	14969	10526	9931	38166	20133	17399	250220
1960	17627	14316	15887	16557	15536	28441	25839	33111	12622	151329	100435	51209	482908
1961	39643	57867	31753	23224	12168	73110	52189	17150	17022	27688	43723	17618	413155
1962	14685	12230	9964	15502	10773	35593	8112	10250	14007	7493	10940	20873	170421
1963	9572	15791	7703	9902	8626	7509	10669	8435	10418	17734	16099	11543	134002
1964	7200	22274	18103	8272	7600	11986	9327	24210	16666	15715	31860	12182	185394
1965	30773	91326	14813	23042	155632	36965	10809	8032	7866	34122	12596	40122	466097
1966	13389	14850	14173	24270	31733	12084	8415	13321	20082	10875	8527	9766	181485
1967	8469	6050	7514	9866	10680	3954	14388	21511	706282	62724	54952	21336	927726
1968	260869	51510	33539	36089	122626	43534	25939	13456	45460	15787	14761	31929	695499
1969	17059	49472	28951	38572	73666	28619	8440	11543	16368	26527	13068	18036	330321
1970	21736	19066	35987	15344	64658	69530	9603	9752	8822	13234	10723	10910	289366
1971	10292	6698	8030	7279	8169	9883	7087	103518	50369	62972	48184	44600	367079
1972	24583	18927	14477	27604	256440	53089	24162	24005	24206	31911	20551	18319	538274
1973	17931	25038	21100	97007	26544	243870	242214	66528	120651	416655	80994	46628	1405159
1974	37745	26311	25925	23371	41121	23050	10530	57124	86473	34085	52713	32545	450993
1975	31690	99877	42195	35454	140922	121844	45790	28654	24267	21306	17373	26557	635929
1976	22975	13463	16137	86656	159510	30474	51120	25246	42169	101550	121963	92637	763901
1977	67340	66772	42235	243514	129255	60869	30913	18039	37787	22264	73866	25450	818303
1978	20426	22312	21758	32300	20809	46599	7650	86666	99835	29923	51508	25292	465076
1979	82396	48289	61549	155945	120812	149496	50178	29946	19620	14488	17085	21418	771220
1980	23412	18125	11978	16339	72210	13092	7334	31523	56975	15485	17414	19057	302945
1981	17033	14406	18064	26205	44896	259340	75035	36412	135284	76315	53818	25630	782438
1982	19163	35325	22665	18548	56486	16352	10388	10036	8529	23898	23845	19497	264733
1983	16975	17918	28103	11937	16457	17335	11501	13603	41216	16207	23084	13296	227633
1984	14555	13956	15860	10909	10461	9206	9800	9378	8361	51945	27529	19086	201045
1985	33651	13527	40719	40619	20133	47332	49912	7479	17389	53615	72392	27089	423856
1986	16026	15949	9186	9209	18886	167207	22140	8874	24275	61116	31082	122936	506888
1987	70852	65124	77608	33513	92817	885190	88570	37907	32272	18441	26452	30556	1459302
1988	24273	19919	21015	18303	14132	14332	22051	8971	11578	9466	9585	10671	184298
1989	13925	12423	11595	16712	14914	13189	10253	11501	9633	7576	15405	11224	148351
MEAN	29057	27264	22329	37759	58645	66892	34979	22183	58237	45913	33113	27831	464201

Table B-1-23 – Strategy 4 –WAM Modeled Stream Flows – Guadalupe River at Victoria (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	90089	79820	140807	105124	45668	27649	39132	25317	23329	25305	61455	98640	762335
1935	44461	102382	39904	62314	446455	525876	97540	55675	259365	109576	54467	119414	1917429
1936	76448	50919	52602	34703	283862	121904	1115699	60127	178940	253991	94811	85955	2409961
1937	76159	63875	163866	65507	43951	141417	39176	25940	23426	35566	27033	54248	760166
1938	143985	84764	75853	299568	288513	62312	38276	30644	26352	23819	26140	29436	1129662
1939	30392	25201	24257	21226	29043	29924	27819	14635	15044	15148	16005	19377	268071
1940	19629	28552	23960	32416	24493	39360	385565	17295	15040	24668	361741	311675	1284393
1941	145029	188870	257459	268488	782914	266008	135794	64362	49113	70522	55945	43684	2328190
1942	38444	31524	33454	139922	81372	34476	368927	37618	243908	158876	90464	75089	1334075
1943	72656	46979	53627	42934	37955	62104	37629	22674	27264	25776	24493	32144	486236
1944	65948	77983	164687	72763	196284	159530	49866	30079	84841	33986	61694	118840	1116502
1945	184611	169696	156249	315331	74039	59272	33965	23208	17470	60108	31219	49217	1174384
1946	63981	89717	174461	74890	111372	123617	27504	52311	269936	237983	203760	123330	1552862
1947	208947	103246	117408	112957	118505	48481	31786	60475	23693	22427	24486	31853	904265
1948	27436	37005	35309	19629	72760	18782	26236	19931	14600	16177	13220	15751	316834
1949	18427	32645	77040	215682	147679	44462	33561	19931	18058	150270	36582	45852	840189
1950	29372	35631	26356	60643	36034	119139	19748	11816	13581	10388	10575	14824	388107
1951	14068	14575	15271	16533	19931	113691	9653	4092	13428	5660	9388	9418	245707
1952	11285	15339	11633	19686	57850	60980	16159	3904	110510	26793	39846	98124	472109
1953	83565	31789	25490	28155	142015	12972	11480	19501	76137	85479	25262	35120	576965
1954	20103	16146	15428	19629	27591	8696	4532	3673	3611	1513	4099	6742	131762
1955	6824	39645	11594	11092	30246	35315	7891	7930	4888	2953	3020	4664	166063
1956	5291	6946	4563	5198	11406	2458	2444	1906	2393	4675	948	20766	68994
1957	3340	15682	51371	165894	378843	270570	24731	16566	206443	430032	234675	107643	1905790
1958	230375	444070	222802	102646	245787	89017	58433	32734	106692	103576	119709	77531	1833373
1959	67840	101840	67519	185988	90710	53912	60234	32824	29279	137633	65534	58460	951773
1960	76842	76922	62779	64326	129218	153836	142051	88154	45491	553580	447550	191441	2032189
1961	222823	247335	139997	83709	56603	395589	145151	53736	101208	53107	123233	52809	1675300
1962	45595	41609	38024	44604	33697	36085	21188	14731	29764	27147	30454	37782	400681
1963	32864	48248	30192	30916	21419	15166	14635	9157	10004	7385	36261	20877	277124
1964	19629	34576	57879	28786	19931	20540	11437	14179	27750	27464	37525	21598	321292
1965	87777	255525	61738	59170	260576	243552	46090	28810	25862	66588	104133	167161	1406983
1966	61061	80878	82860	114194	156049	50243	31532	32177	39318	34423	27183	27654	737572
1967	26045	22559	23001	19629	17902	14635	12340	14635	538308	113229	107254	52202	961738
1968	513090	147020	110494	158264	287186	342636	80246	41253	84639	39205	45884	116320	1966238
1969	46345	170979	167083	208592	185952	69060	33970	29456	36564	76059	53771	92331	1170161
1970	84274	90030	166318	88488	220497	131812	46098	33502	35070	52459	31778	33434	1013760

1971	30143	25906	29420	21209	19931	19885	14730	73381	144772	94894	69309	110317	653898
1972	72295	64082	50960	32469	771699	144145	65579	59952	40755	45997	47249	43071	1438253
1973	62013	85877	144852	292978	109571	444883	254862	128541	112954	669838	160336	103223	2569930
1974	205423	86139	75011	58093	133413	75337	35196	68082	215443	73845	267005	164239	1457227
1975	109683	243932	121337	120669	572123	329545	178510	91036	65694	65171	53057	71003	2021760
1976	47565	43392	48247	306219	375178	170250	126249	66810	75869	249910	292050	398824	2200564
1977	160356	244838	115688	629237	254345	128307	72888	56611	52732	48152	84074	51985	1899211
1978	49886	51686	50579	49335	37753	75181	27575	239985	193955	66231	104602	62975	1009744
1979	283536	195999	222911	310211	438696	331865	113559	89688	80846	49924	45415	46243	2208894
1980	60943	48165	41649	34139	159124	46594	25561	19931	60032	52272	40577	44312	633298
1981	43606	41171	79356	95852	112336	615768	195931	77627	655402	166272	239479	81405	2404205
1982	67813	84533	58855	48637	338351	65929	31330	21408	21435	31383	56646	37668	863990
1983	33674	72932	115935	59481	85160	67305	60609	22497	36505	37298	42761	28185	662341
1984	39443	31756	41483	23778	21320	18640	11433	10344	10700	32730	26713	38656	306996
1985	100021	81165	124523	134567	89470	193815	132278	36930	29964	107482	194585	184004	1408804
1986	93810	91128	66336	46882	98242	177165	45168	26596	68828	140053	127572	369910	1351690
1987	233749	180410	274939	109062	167834	1582105	293721	170648	99612	86391	94226	84504	3377201
1988	63916	57205	68766	46633	49850	47797	59454	39673	28023	27399	25645	31568	545930
1989	37075	34589	40234	37293	82142	32990	19559	14633	12227	14094	19629	20352	364816
MEAN	85536	87776	84900	104577	163051	153082	90227	42310	86376	92551	84509	79890	1154785

Table B-1-24 – Strategy 4–WAM Modeled Stream Flows – Estuary Inflows (acre-ft)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1934	314245	101942	174761	165884	44365	16256	131580	21457	49632	30726	161102	152156	1364108
1935	57354	139528	71842	110842	619673	783825	111541	53964	469704	134570	74045	178119	2805007
1936	90578	61081	69776	53788	575961	169663	1354083	81075	359789	330592	132450	120425	3399263
1937	109800	77823	190227	68658	43816	264461	47904	35519	39771	62374	46497	177294	1164144
1938	190466	99383	97190	443602	378972	67735	32996	43533	41221	28375	39963	67524	1530958
1939	52927	33183	23563	17438	36928	26124	73872	12896	51119	12900	14324	29971	385246
1940	22457	45210	22536	34869	31452	165802	458391	36545	13147	106569	579922	453341	1970240
1941	170396	279282	341207	463632	1158306	365822	303460	77938	96385	149548	80103	94114	3580194
1942	41730	107383	49346	148571	82413	23901	866153	112820	537621	277923	114266	92807	2454932
1943	116933	66626	99035	42309	66031	116521	57964	12951	39826	25975	51938	65658	761766
1944	218914	85611	266904	67355	433015	156673	37893	51254	139423	65191	72569	171585	1766386
1945	203384	194984	177320	404436	70936	96659	46364	196265	10969	82838	31802	50889	1566845
1946	71199	141259	206367	96293	206688	245313	28166	155490	559053	754926	259635	139210	2863599
1947	241207	108424	123975	138442	270780	55819	36960	58847	19354	27217	53331	43274	1177631
1948	52669	76032	62390	18498	104255	5843	22075	56209	90538	22308	12226	15305	538348
1949	18147	42097	83056	504724	165349	82322	83685	17820	14746	367101	43862	79062	1501973
1950	36584	47083	21898	64765	28547	139948	10751	9203	12405	7455	7581	12784	399005
1951	9785	10784	7810	8184	71920	165369	5988	5104	186306	11668	11185	7163	501265
1952	6845	20418	12073	59190	154416	62613	8569	4640	350429	22714	78145	110686	890740
1953	83949	37941	17308	27047	219551	5991	5988	166140	150849	101573	23415	38775	878526
1954	18089	10656	6917	11608	23669	7610	6826	7173	5866	33652	9646	6626	148340
1955	6284	53642	5745	5843	31876	20111	5988	11407	52992	6704	4300	6788	211680
1956	5512	5675	7506	10322	14907	6332	6945	6812	5866	14424	6511	35782	126594
1957	4662	14142	180416	509111	624545	442963	9111	7227	318076	482139	384354	109017	3085761
1958	415225	783941	244102	102651	357359	95169	56354	18596	247346	259530	192334	153018	2925624
1959	76822	249675	65971	224647	123662	76968	49219	91965	29135	304688	75391	79583	1447725
1960	81221	114527	87967	60026	129864	253352	155620	215028	43396	1074321	600263	360850	3176435
1961	306137	386283	148907	93336	46533	532296	249075	47551	200099	63300	174992	56395	2304904
1962	47224	41574	31123	52150	30210	101543	7999	7258	46682	29189	38310	82759	516020
1963	31882	63343	22673	22661	11141	8510	9251	8164	7489	7424	52949	24123	269610
1964	27351	70051	78018	17562	9128	24887	5988	45561	86230	29710	53974	32816	481275
1965	121752	391782	60126	61164	441933	311413	33611	15387	17236	129319	131618	259583	1974925
1966	105153	127438	77606	163066	298955	77525	48627	28754	59159	59609	41730	38729	1126353
1967	45372	35775	27170	29810	52867	16457	13278	38305	2056062	407220	199904	136073	3058291
1968	738792	263386	149022	189325	491047	498274	200778	57761	144533	111991	76577	149943	3071428
1969	103217	233213	237723	355354	301777	112706	20445	26641	35090	90217	78235	130878	1725495
1970	12964	10204	23280	12249	259600	301743	58768	25534	73751	110828	32187	34367	148376

	6	5	0	2									0
1971	28538	20437	20948	18103	31238	12355	9908	142857	419895	318715	167140	249460	1439594
1972	111925	117346	62939	48850	1029308	220938	68706	81602	70164	128278	142661	47878	2130595
1973	66889	102000	148100	399188	130835	749073	437270	242443	275767	1200775	288158	168731	4209230
1974	231424	147475	115606	66694	248168	87588	21056	99196	307828	143866	358489	292953	2120344
1975	156656	317091	183445	158442	673415	510503	228320	118328	128184	69789	88467	91142	2723781
1976	78728	43577	46919	483207	516427	237424	236491	65668	101762	361349	495136	662871	3329561
1977	232024	316467	139725	862130	411145	335580	77370	54594	87909	74794	187134	64418	2843290
1978	64892	83593	54858	64496	36339	123201	14083	283600	462585	86077	154184	77349	1505256
1979	416413	248764	275065	449509	635890	485046	227311	104691	360249	55257	55346	60026	3373569
1980	112528	57321	40648	31610	250268	35074	10386	75537	113303	63728	48119	51255	889776
1981	60471	44261	78060	103169	243720	1028631	299745	142877	772828	296410	374771	106237	3551180
1982	75229	201011	68706	53080	445538	60177	19787	12333	16461	44921	153226	46290	1196760
1983	47453	105169	153704	52212	79425	64927	140831	20353	79170	85133	70991	31495	930862
1984	62859	35732	57628	18141	22924	8588	8855	13381	9346	110630	54673	46431	449188
1985	135309	83494	204065	249372	91870	235593	167370	24774	38160	149490	245589	199621	1824707
1986	98501	93410	57782	36370	118513	326024	40629	19825	76284	250305	176040	498102	1791784
1987	297436	266077	324740	117697	233059	2433930	380367	191453	123408	97342	133785	101859	4701153
1988	74460	63204	71744	45821	43493	41608	59482	26881	25284	25048	23419	35761	536206
1989	54850	34878	35543	36629	80860	55952	20527	13710	8870	23698	35499	20799	421817
MEAN	121080	126867	105761	147578	238123	231370	127335	64337	181049	168257	130258	118753	1760769

Appendix B-2
WAM modeled output
Selected water right reliabilities

Table B-2-1 – Average Shortages for Selected Water Rights – by Strategy

			Average Shortage by Strategy (acre-ft/yr)							
Water Right	Diversion (acre-ft/yr)	Priority	0	1a	1b	2a	2b	3a	3b	4
C5486_1	20000	19520107	1219.65	1252.03	1279.66	1210.63	1210.63	1219.65	1219.65	1243.41
C5486_2	12500	19770110	4	25.92	47.5	4	4	4	4	25.92
C5486_3	20000	19770110	19665.96	19665.92	19665.96	19665.73	19665.73	19665.96	19665.96	19665.71
C5173_2	1250	19410203	0	0	0	0	0	0	0	0
C5173_1	1250	19410203	0	0	0	0	0	0	0	0
C5177_1	10763	19440103	0	0	0	0	0	0	0	0
C5177_4	10000	19440103	0	0	32.2	0	0	0	0	0
C5177_2	10763	19440103	0	0	0	0	0	0	0	0
C5177_3	11089	19440103	0	0	0	0	0	0	0	0
C5174_3	935	19440615	0	0	6.45	0	0	0	0	0
C5174_2	935	19440615	0	0	6.21	0	0	0	0	0
C5177_6	4316	19480126	0	0	46.58	0	0	0	0	0
C5177_5	4316	19480126	0	0	36.69	0	0	0	0	0
C5175_2	470	19510213	0	0	5.79	0	0	0	0	3.27
C5175_1	470	19510213	0	0	7.64	0	0	0	0	4.52
C5176_3	3315	19510621	0	27.38	48.84	0	0	0	0	34.93
C5176_1	3315	19510621	0	26.02	58.6	0	0	0	0	32.59
C5176_2	3314	19510621	0	28.17	55.57	0	0	0	0	37.68
C5178_2	30525	19520107	310.35	416.57	850.02	310.35	267.94	187.13	93.97	283.14
C5178_3	44950	19520107	858.14	1561.54	2258.27	858.14	472.92	865.68	886.17	1579.34
C5178_1	30525	19520107	134.49	362.9	506.41	134.49	119.32	144.13	178.62	385.51

*****Right C5174_1 does not have a diversion specified in the Region L WAM model, and therefore its reliability & shortages cannot be calculated.***

Table B-2-2 – Average Period Reliability for Selected Water Rights – by Strategy

			Average Period Reliability by Strategy (%)							
Water Right	Diversion (acre-ft/yr)	Priority	0	1a	1b	2a	2b	3a	3b	4
C5486_1	20000	19520107	94.2	93.9	93.9	94.2	94.2	94.2	94.2	93.9
C5486_2	12500	19770110	99.85	99.7	99.55	99.85	99.85	99.85	99.85	99.7
C5486_3	20000	19770110	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
C5173_2	1250	19410203	100	100	100	100	100	100	100	100
C5173_1	1250	19410203	100	100	100	100	100	100	100	100
C5177_1	10763	19440103	100	100	100	100	100	100	100	100

C5177_4	10000	19440103	100	100	99.55	100	100	100	100	100
C5177_2	10763	19440103	100	100	100	100	100	100	100	100
C5177_3	11089	19440103	100	100	100	100	100	100	100	100
C5174_3	935	19440615	100	100	99.4	100	100	100	100	100
C5174_2	935	19440615	100	100	99.55	100	100	100	100	100
C5177_6	4316	19480126	100	100	99.26	100	100	100	100	100
C5177_5	4316	19480126	100	100	99.4	100	100	100	100	100
C5175_2	470	19510213	100	100	98.96	100	100	100	100	99.4
C5175_1	470	19510213	100	100	98.96	100	100	100	100	99.4
C5176_3	3315	19510621	100	99.11	98.66	100	100	100	100	99.11
C5176_1	3315	19510621	100	99.4	98.81	100	100	100	100	99.26
C5176_2	3314	19510621	100	99.4	98.81	100	100	100	100	99.11
C5178_2	30525	19520107	98.96	98.66	96.88	98.96	98.96	98.96	99.26	98.66
C5178_3	44950	19520107	98.21	96.88	95.54	98.21	98.51	97.92	97.77	96.88
C5178_1	30525	19520107	99.26	99.11	98.36	99.26	99.4	99.26	99.26	98.96

Right C5174_1 does not have a diversion specified in the Region L WAM model, and therefore its reliability & shortages cannot be calculated.

Table B-2-3 – Average Volume Reliability for Selected Water Rights – by Strategy

			Average Volume Reliability by Strategy (%)							
Water Right	Diversion (acre-ft/yr)	Priority	0	1a	1b	2a	2b	3a	3b	4
C5486_1	20000	19520107	93.9	93.74	93.6	94.2	93.95	93.9	93.9	93.78
C5486_2	12500	19770110	99.97	99.79	99.62	99.85	99.97	99.97	99.97	99.79
C5486_3	20000	19770110	1.67	1.67	1.67	0.15	1.67	1.67	1.67	1.67
C5173_2	1250	19410203	100	100	100	100	100	100	100	100
C5173_1	1250	19410203	100	100	100	100	100	100	100	100
C5177_1	10763	19440103	100	100	100	100	100	100	100	100
C5177_4	10000	19440103	100	100	99.68	100	100	100	100	100
C5177_2	10763	19440103	100	100	100	100	100	100	100	100
C5177_3	11089	19440103	100	100	100	100	100	100	100	100
C5174_3	935	19440615	100	100	99.31	100	100	100	100	100
C5174_2	935	19440615	100	100	99.34	100	100	100	100	100
C5177_6	4316	19480126	100	100	98.92	100	100	100	100	100
C5177_5	4316	19480126	100	100	99.15	100	100	100	100	100
C5175_2	470	19510213	100	100	98.77	100	100	100	100	99.3
C5175_1	470	19510213	100	100	98.38	100	100	100	100	99.04
C5176_3	3315	19510621	100	99.17	98.53	100	100	100	100	98.95
C5176_1	3315	19510621	100	99.22	98.23	100	100	100	100	99.02
C5176_2	3314	19510621	100	99.15	98.32	100	100	100	100	98.86
C5178_2	30525	19520107	98.98	98.64	97.22	98.96	99.12	99.09	99.11	98.62
C5178_3	44950	19520107	98.09	96.53	94.98	98.21	98.83	98.07	98.03	96.49
C5178_1	30525	19520107	99.56	98.81	98.34	99.26	99.61	99.53	99.41	98.74

Right C5174_1 does not have a diversion specified in the Region L WAM model, and therefore its reliability & shortages cannot be calculated.

Appendix I

GSA BBEST Chair / Vice-Chair Response to GSA BBASC Member Written Questions Submitted to TCEQ

July 17, 2011

Mr. Cory Horan
Texas Commission on Environmental Quality
Transmittal Via Electronic Mail (Cory.Horan@tceq.texas.gov)

Re: GSA BBEST Response to April 8, 2011 Letter from Guadalupe-Blanco River Authority

Dear Mr. Horan:

Pursuant to receipt of an attached April 8, 2011 letter from the Guadalupe-Blanco River Authority (GBRA) soliciting responses to four questions (A - D) regarding the GSA BBEST Environmental Flows Recommendations Report, Sam Vaugh (Chair) and Norman Johns (Vice-Chair) of the GSA BBEST offer the following numbered responses to each question.

A) Do the recommended flow regimes represent the minimum necessary to maintain a sound ecological environment?

1) Response to this question is more complex than a simple "yes" or "no" answer as it depends on the geographic location in question, the component of the flow regime recommendation in particular, the type of new appropriation potentially subject to the recommended instream and estuary flow regimes and the implementation procedure. There would also likely be differences in the professional judgment of each GSA BBEST member about how any particular regime component relates to a minimum.
2) In general, we believe that some components of the GSA BBEST flow regime recommendations may not represent the minimum necessary to maintain a sound ecological environment. Recognizing the uncertainties associated with best available science and how the recommendations may be implemented, we believe at the time the GSA BBEST formulated its recommendations, the members chose not to seek or specify such a minimum instream flow regime or estuarine inflow regime.

B) Do the tools and methods employed allow for a prediction of environmental conditions should future flows vary from those witnessed historically?

1) Responses to this question depend, in large part, on geographic location and component of the GSA BBEST flow regime recommendations.
2) More quantitative scientific data is available at some sites than others. Specifically, detailed multi-year studies have been performed for several locations on the lower San Antonio River through the Texas Instream Flows Program, flow-habitat investigations have been performed on the lower Guadalupe River, and only historical water quality data (relevant to subsistence flows) are available for many other sites.

3) At some locations, the tools and methods employed by the GSA BBEST provide for assessments of changes in habitat availability and suitability with instream flow or freshwater inflow to the Guadalupe Estuary. Such tools and methods, however, do not provide specific predictions of changes in species abundance associated with changes in flow.

C) How is such predictive capability quantified, or qualified, within the methods employed by the BBEST?

1) See third response to question B.

D) The BBEST was mandated to consider only the best available science in its deliberations; were decisions made to err protectively for the environment, and if so, where?

1) See responses to question A.
2) The GSA BBEST considered best available science and applied professional judgment to develop its environmental flow recommendations. We believe that implementation of our recommendations, as outlined in the GSA BBEST report, will support a sound ecological environment. As to whether alternative recommendations protecting less water for the environment would also support a sound ecological environment, opinions vary by member.

Should you or the GBRA need additional information, please do not hesitate to contact us at your convenience.

Sincerely,

Samuel K. Vaugh, P.E.
Chair, GSA BBEST

Norman D. Johns, Ph.D.
Vice-Chair, GSA BBEST

April 8, 2011

Cory Horan,
[TCEQ]

You indicated at the last Guadalupe-San Antonio Basin and Bay Area Stakeholder Committee (GSA BBASC) meeting that members should submit initial questions to the BBEST for their comment and response through you, and GBRA respectfully submits these comments in compliance therewith.

The GSA BBASC is presently considering the Guadalupe-San Antonio Basin and Bay Expert Science Team (BBEST) recommendations as it responds to its mandate under Senate Bill 3 to balance water needs for the environment narrowly defined with other needs dependent on the same sources of water. The characterization of projected human needs and uses has been underway for some time now by means of the studies conducted as part of the Region L water planning process. These needs are being separately considered in the Senate Bill 3 context through the identified scope of the technical consultants working for the GSA BBASC. In order to efficiently and properly comply with the mandate of "balancing," it is thus necessary to know and understand, to the maximum extent possible, the technical underpinnings of the methodologies employed by the BBEST in crafting its environmental recommendations.

It is, furthermore, important to understand what levels of conservatism are inherent in the assumptions and characterizations underlying the BBEST recommendations. The in-stream recommendations appear to be largely based upon the maintenance of historically observed flow conditions. The following questions therefore naturally arise:

- Do the recommended flow regimes represent the minimum necessary to maintain a sound ecologic environment?
- Do the tools and methods employed allow for a prediction of environmental conditions should future flows vary from those witnessed historically?
- How is such predictive capability quantified, or qualified, within the methods employed by the BBEST?
- The BBEST was mandated to consider only the best available science in its deliberations; were decisions made to err protectively for the environment, and if so, where?

The foregoing questions, while broad in nature, reflect GBRA's recognition of the varied technical analyses employed by the BBEST as well as the professional judgment of the BBEST members as they derived their environmental flow recommendations, and should not be viewed as criticism of the BBEST. On the contrary, for the GSA BBASC to effectively balance environmental needs with those of man, an open and frank characterization of the science behind

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GBRA Guadalupe-Blanco River Authority
flowing solutions

the BBEST's recommendations, both the strengths and the uncertainties, will allow the GSA BBASC to more effectively balance such needs in furtherance of its Senate Bill 3 mandate.

Sincerely,

James Lee Murphy

James Lee Murphy, Esq.
Executive Manager, Water Resources & Utility Operations

Appendix J

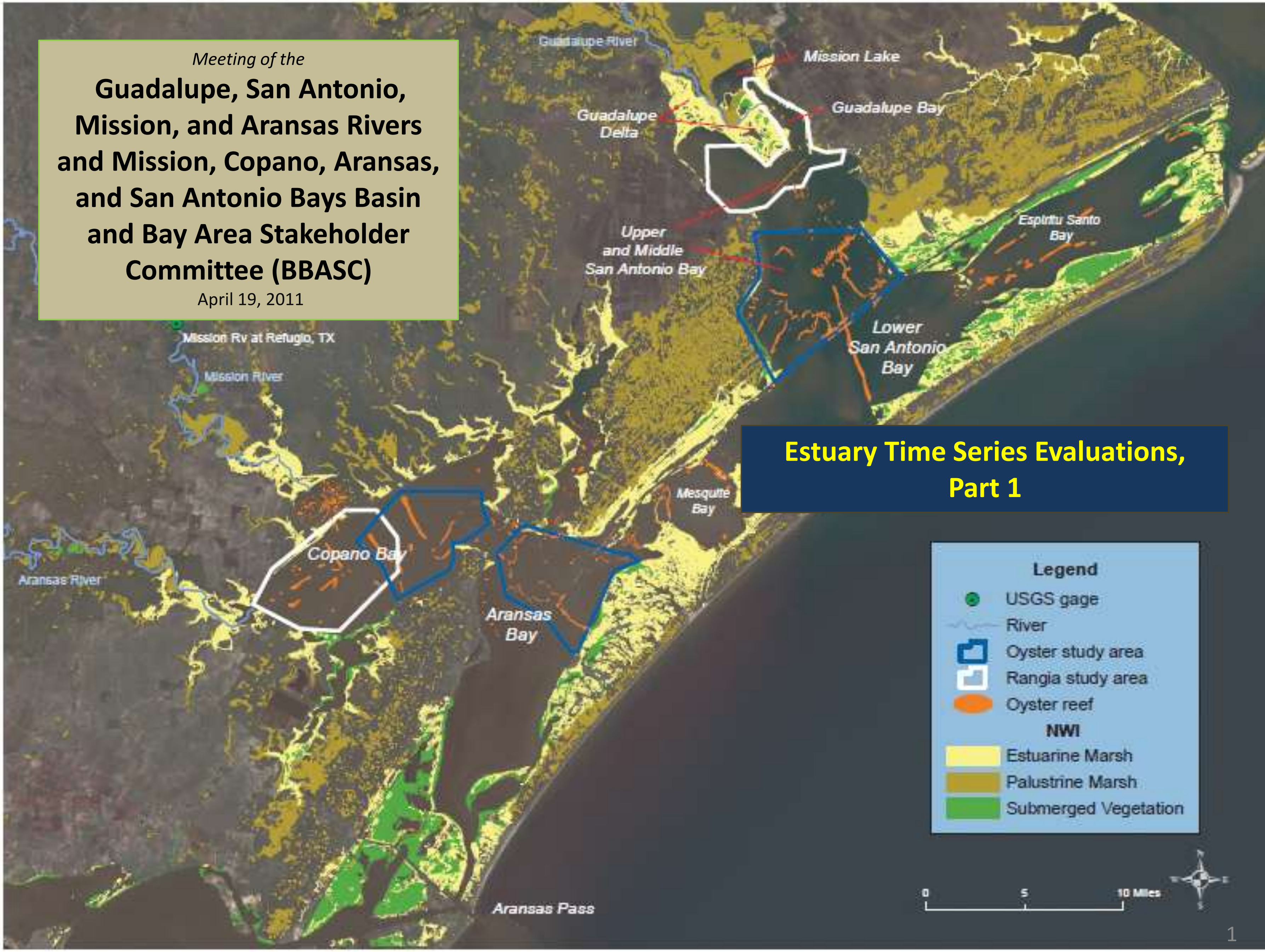
Technical Presentations Presented to the GSA BBASC Between March 1, 2011 and September 1, 2011

Meeting of the

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

April 19, 2011

Estuary Time Series Evaluations, Part 1



ROAD MAP

Topics:

1) Review of Estuary Criteria / Need for Time Series Evaluations

2) Evaluation approach

3) Results of Analyses

a) Attainment for the G1 criteria for rangia clams

b) Attainment for the G2 criteria for oysters

4) Summary

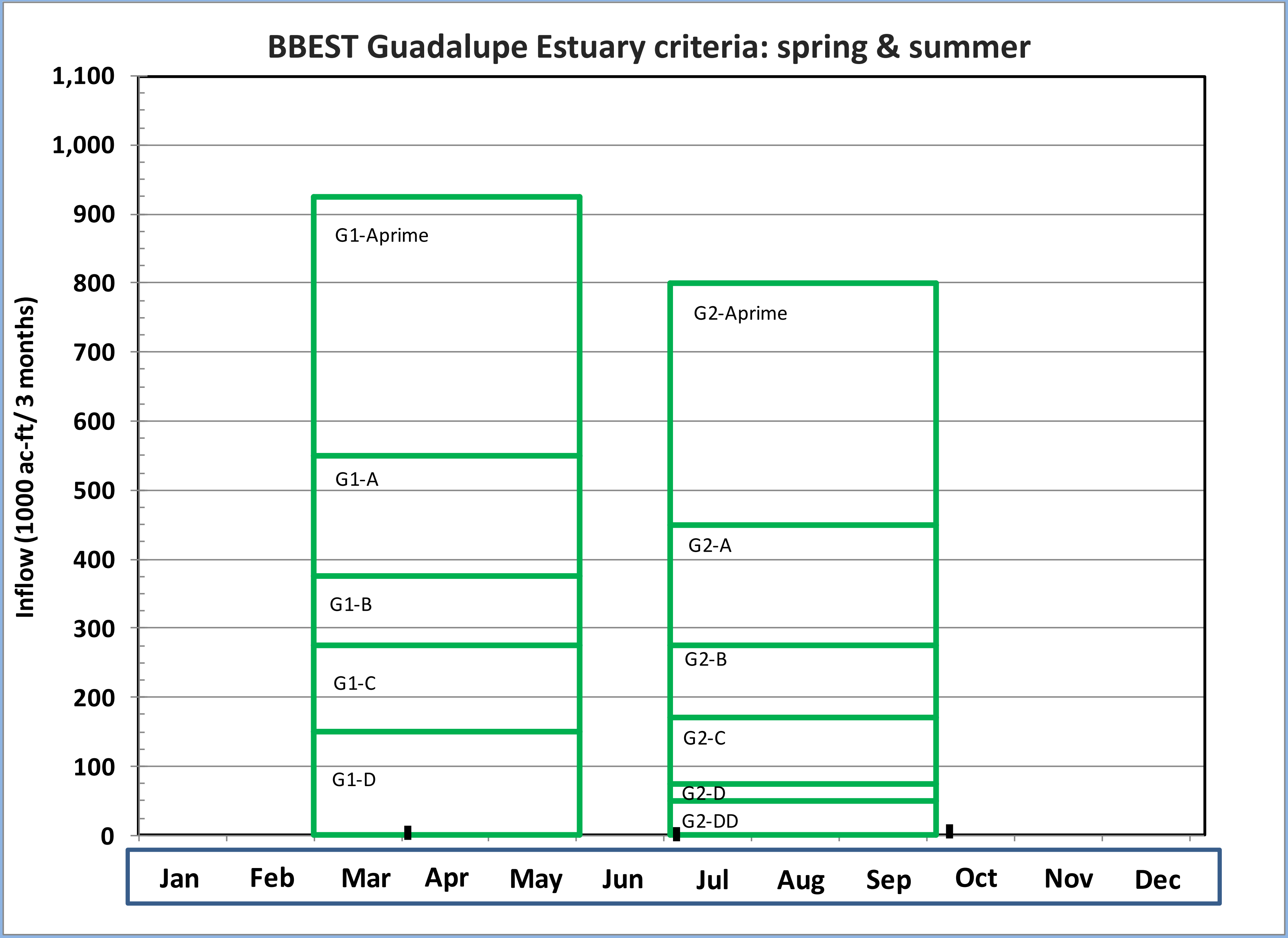
5) Next steps

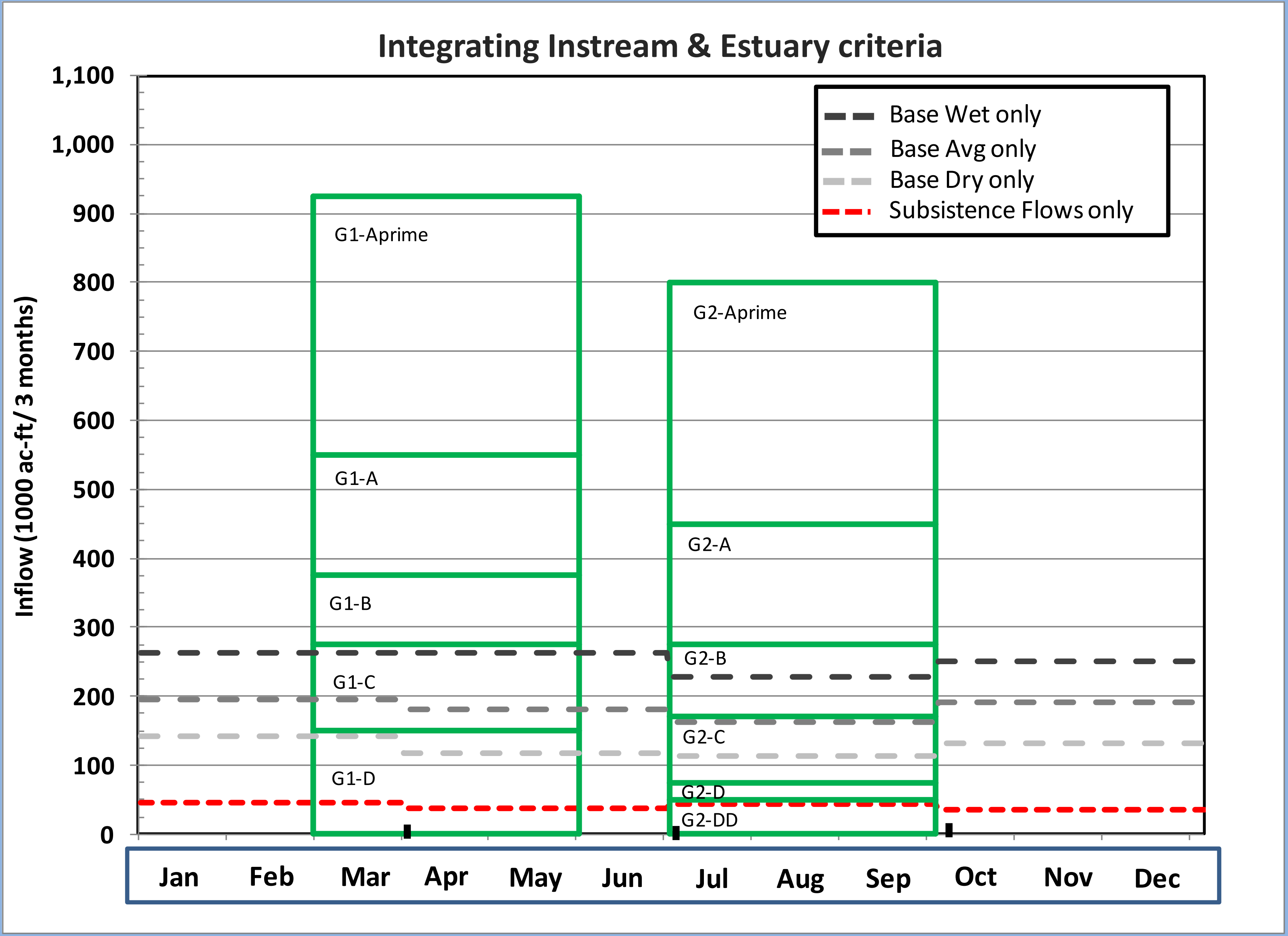
The BBEST Criteria

Table 6.1-17

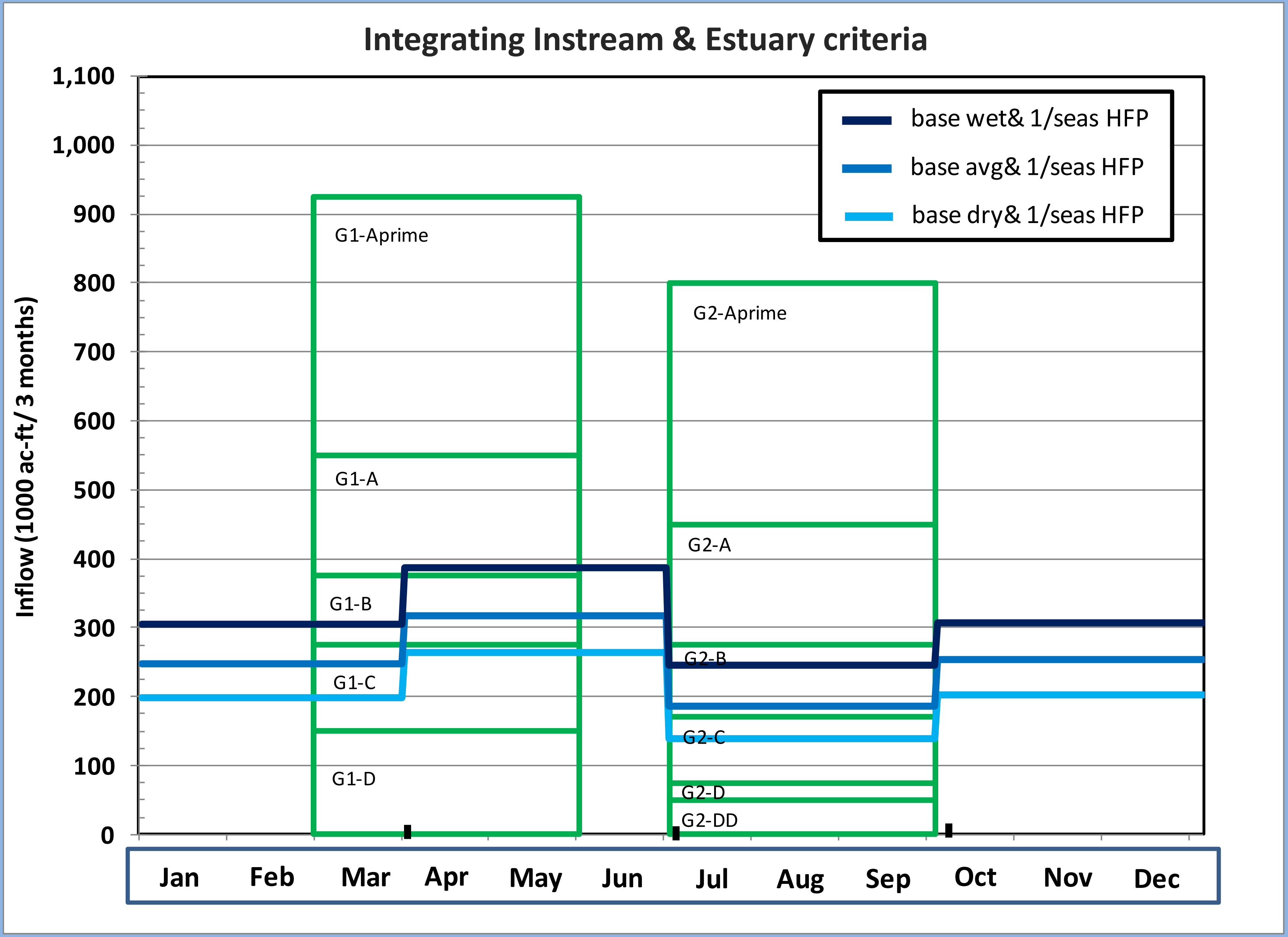
Guadalupe Estuary Criteria - Volumes				
	Inflow Criteria Volumes, suite G1 for Rangia clams		Inflow Criteria Volumes, suite G2 for Eastern oysters	
Criteria level	Feb. (1000 ac-ft/mon)	Mar.-May (1000 ac-ft/3mon)	June (1000 ac-ft/mon)	July-Sept. (1000 ac-ft/3mon)
G1-Aprime, G2-Aprime	n/a	550-925	n/a	450-800
G1-A, G2-A	n/a	375-550	n/a	275-450
G1-B, G2-B	n/a	275-375	n/a	170-275
G1-C, G2-C	≥75	150-275	≥40	75-170
G1-CC, G2-CC	0 - 75	150-275	0 - 40	75-170
G1-D, G2-D	n/a	0 - 150	n/a	50-75
G1-DD, G2-DD	n/a	n/a	n/a	0-50

Mission-Aransas Estuary Criteria - Volumes				
	Inflow Criteria Volumes, set MA1 for Rangia clams		Inflow Criteria Volumes, set MA2 for Eastern oysters	
Criteria level	Feb.	Mar.-May	June	July-Sept.
MA2 - Aprime	n/a	n/a	n/a	500-1000


BBEST Guadalupe Estuary criteria: spring & summer
Inflow (1000 ac-ft / 3 months)
1,100
1,000
900
800
700
600
500
400
300
200
100
0
G1-Aprime
G1-A
G1-B
G1-C
G1-D
G2-Aprime
G2-A
G2-B
G2-C
G2-D
G2-DD
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Integrating Instream & Estuary criteria
Inflow (1000 ac-ft/ 3 months)
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Base Wet only
Base Avg only
Base Dry only
Subsistence Flows only
G1-Aprime
G1-A
G1-B
G1-C
G1-D
G2-Aprime
G2-A
G2-B
G2-C
G2-D
G2-DD
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



Integrating Instream & Estuary criteria
Inflow (1000 ac-ft / 3 months)
1,100
1,000
900
800
700
600
500
400
300
200
100
0
base wet& 1/seas HFP
base avg& 1/seas HFP
base dry& 1/seas HFP
G1-Aprime
G1-A
G1-B
G1-C
G1-D
G2-Aprime
G2-A
G2-B
G2-C
G2-D
G2-DD
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

The BBEST Criteria

Table 6.1-17

Guadalupe Estuary Criteria - Volumes

Criteria level	Inflow Criteria Volumes, suite G1 for Rangia clams		Inflow Criteria Volumes, suite G2 for Eastern oysters	
	Feb. (1000 ac-ft/mon)	Mar.-May [illegible]	June	July-Sept.
G1-Aprime, G2-Aprime	n/a	[illegible]	[illegible]	[illegible]
G1-A, G2-A	n/a	[illegible]	[illegible]	[illegible]
G1-B, G2-B	n/a	[illegible]	[illegible]	[illegible]
G1-C, G2-C	≥75	[illegible]	[illegible]	[illegible]
G1-CC, G2-CC	0 - 75	[illegible]	[illegible]	[illegible]
G1-D, G2-D	n/a	[illegible]	[illegible]	[illegible]
G1-DD, G2-DD	n/a	[illegible]	[illegible]	[illegible]

Mission-Aransas Estuary Criteria - Volumes

Criteria level	Inflow Criteria Volumes, set MA1 for Rangia clams		Inflow Criteria Volumes, set MA2 for Eastern oysters	
	Feb.	Mar.-May	June	July-Sept.
MA2 - Aprime	n/a	n/a	n/a	500-1000

2 Sets, G1 and G2 (spring and summer, for Rangia & oysters)

each set is multi-tiered

each criteria is a 3 month sum of inflow volume (w./wo. antec.)

attainment goals of each criteria are either : a) individual, b) joint with another (e.g. G2-A and G2-B)

Table 6.1-18

Guadalupe Estuary Criteria -Attainment Recommendations

Criteria level	Specification	Inflow Criteria Attainment, G1 suite for Rangia clams	Inflow Criteria Attainment, G2 suite for Eastern oysters
[illegible]	...ment, G - Aprime	G1-Aprime at least 12% of years	G2-Aprime at least 12% of years
[illegible]	...ttainment, G - A	G1-A at least 12 % of years	G2-A at least 17 % of years
[illegible]	Attainment, G - A & G - B combined	G1-A and G1-B combined at least 17% of years	G2-A and G2-B combined at least 30% of years
[illegible]	... & G - CC ...d	G1-C and G1-CC equal to or greater than 19% of years. G1-CC no more than 2/3 of total	G2-C and G2-CC equal to or greater than10% of years. G2-CC no more than 1/6 of total
[illegible]	...1- D	no more than 9% of years	n/a
[illegible]	...2- DD	n/a	G2-D no more than 6% of years
[illegible]	...D & G2- ...ed	n/a	G2-D and G2-DD combined no more than 9% of years

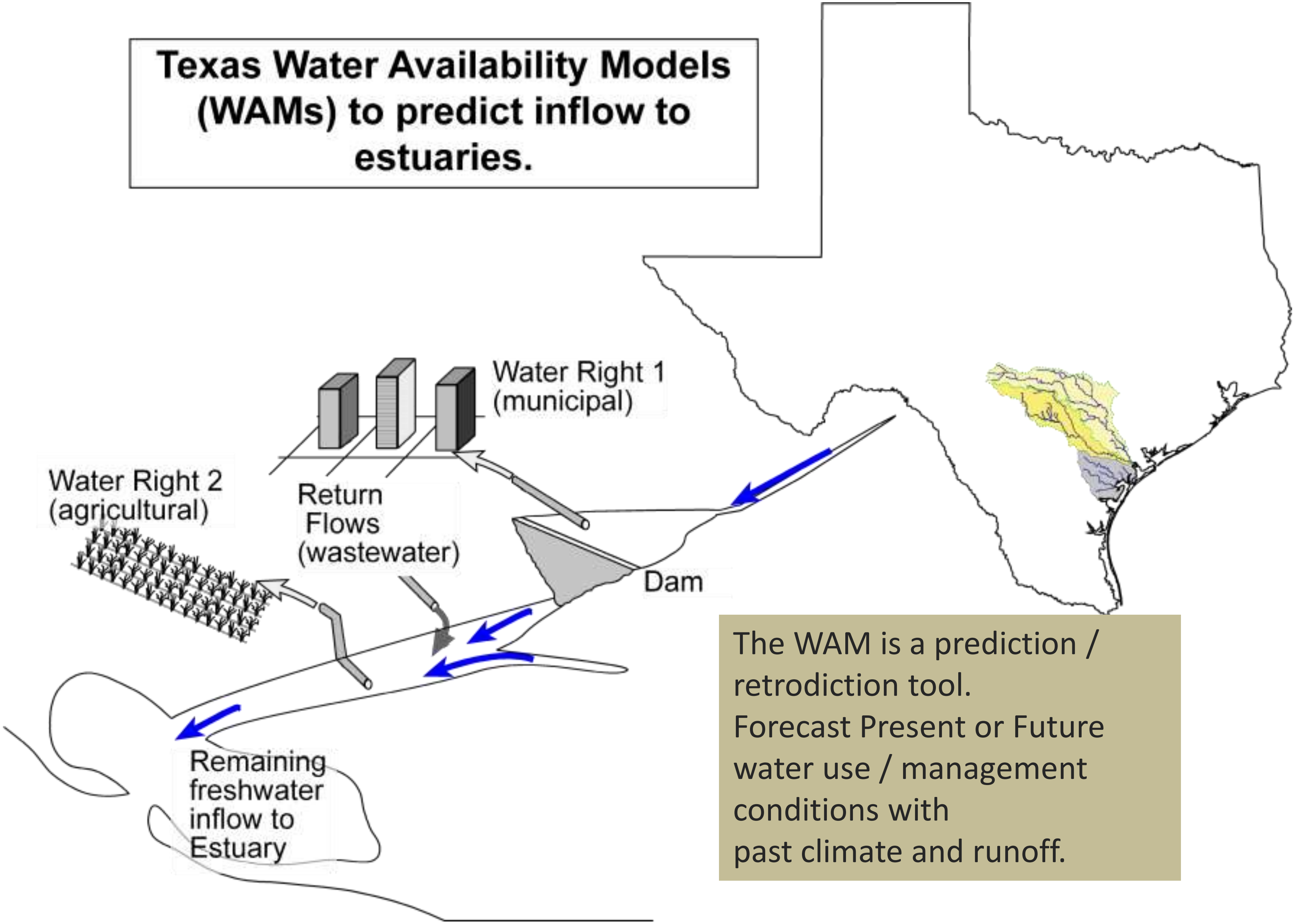
Mission-Aransas Estuary Criteria -Attainment Recommendations

Criteria level	Specification	Inflow Criteria Attainment, set MA1 for Rangia clams	Inflow Criteria Attainment, set MA2 for Eastern oysters
MA-Aprime	Attainment MA-Aprime	n/a	MA2-Aprime at least 2% of years

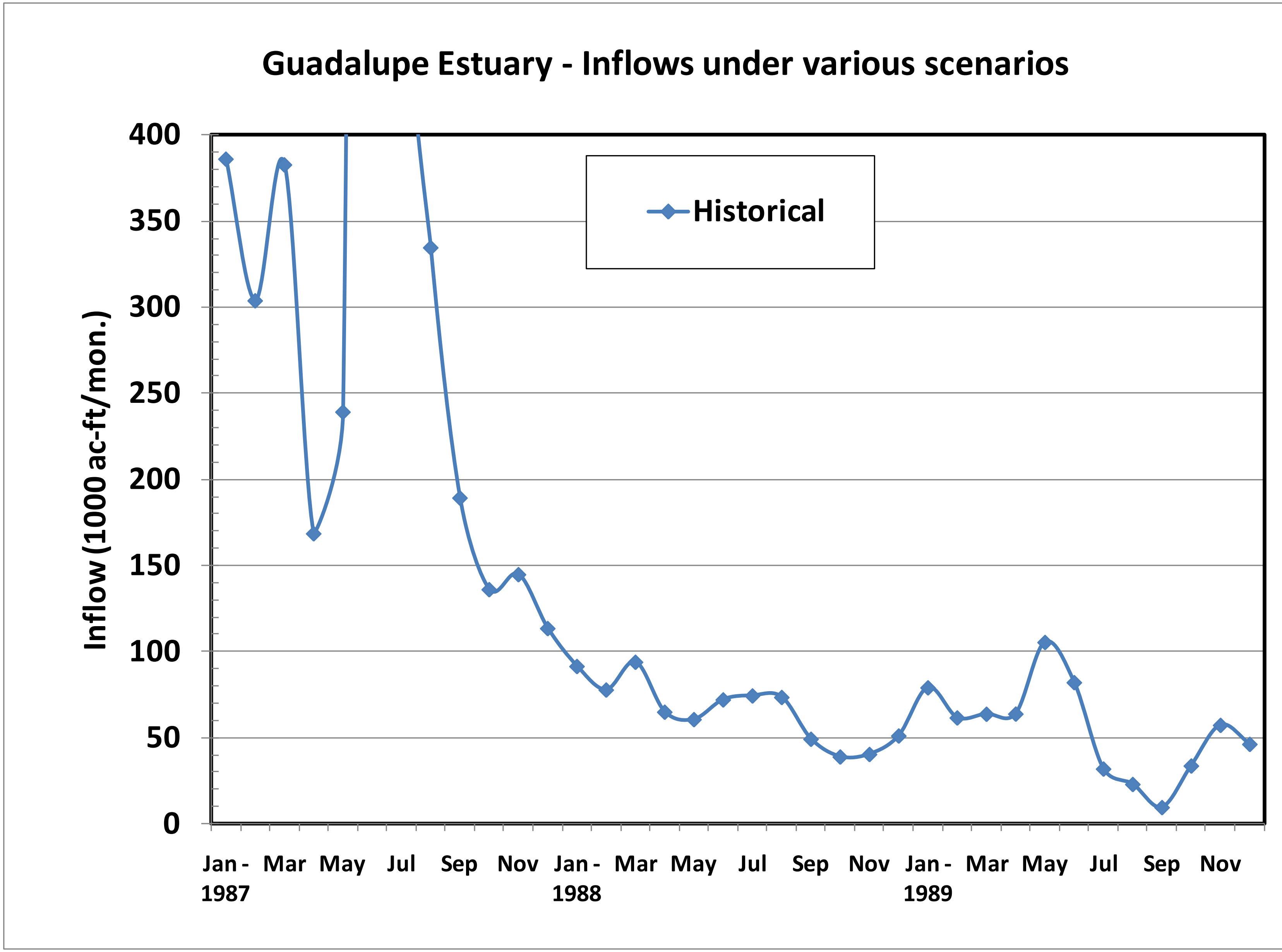
Time Series of Inflows to Guadalupe Estuary
Scenarios utilized (thus far) – principal characteristics

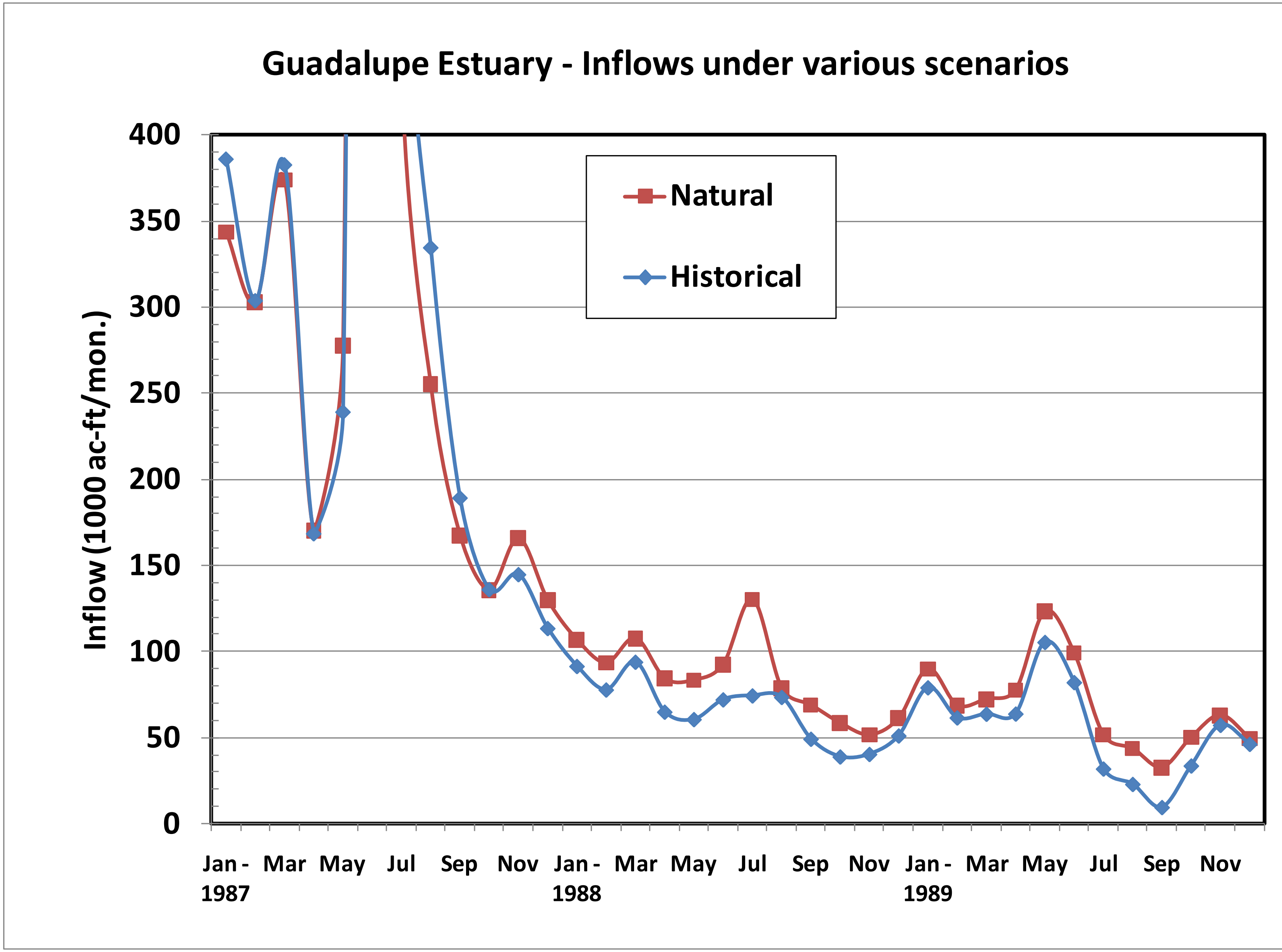
	Natural	Historical	Present	Region L	TCEQ Run3
Surface water use/demands	0	historical, transient	max. last 10yr, constant	Full use, constant	Full use, constant
WW Returns	0	historical, transient	min. last 5 yr, constant	recent ('96?) levels, constant	0
Edwards Aq. use / mgmt.	0	historical, transient	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.
Data source	model	data	model	model	model
Period of record	1934-1989	1941 - 2009	1934-1989	1934-1989	1934-1989

Texas Water Availability Models (WAMs) to predict inflow to estuaries.

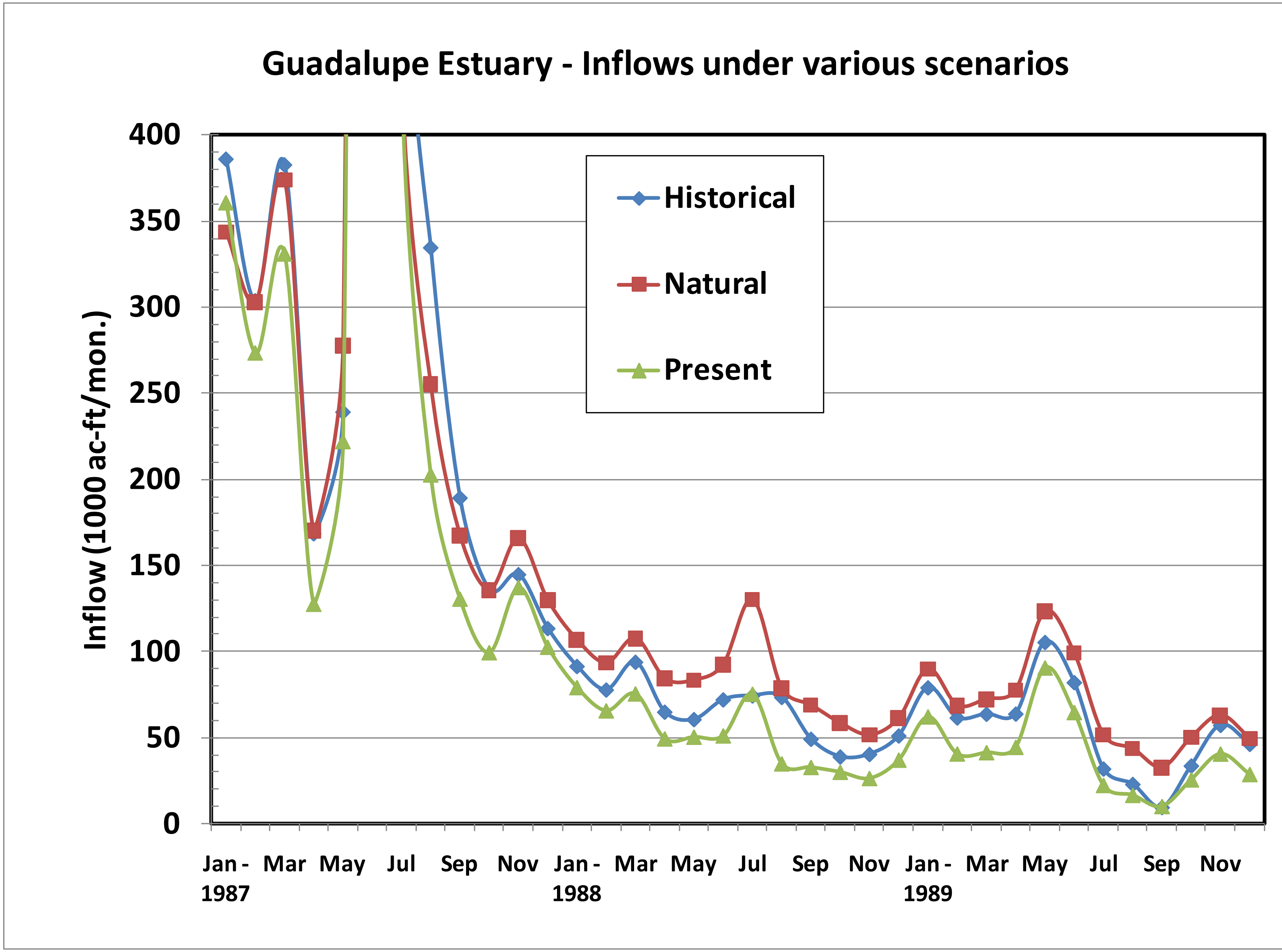


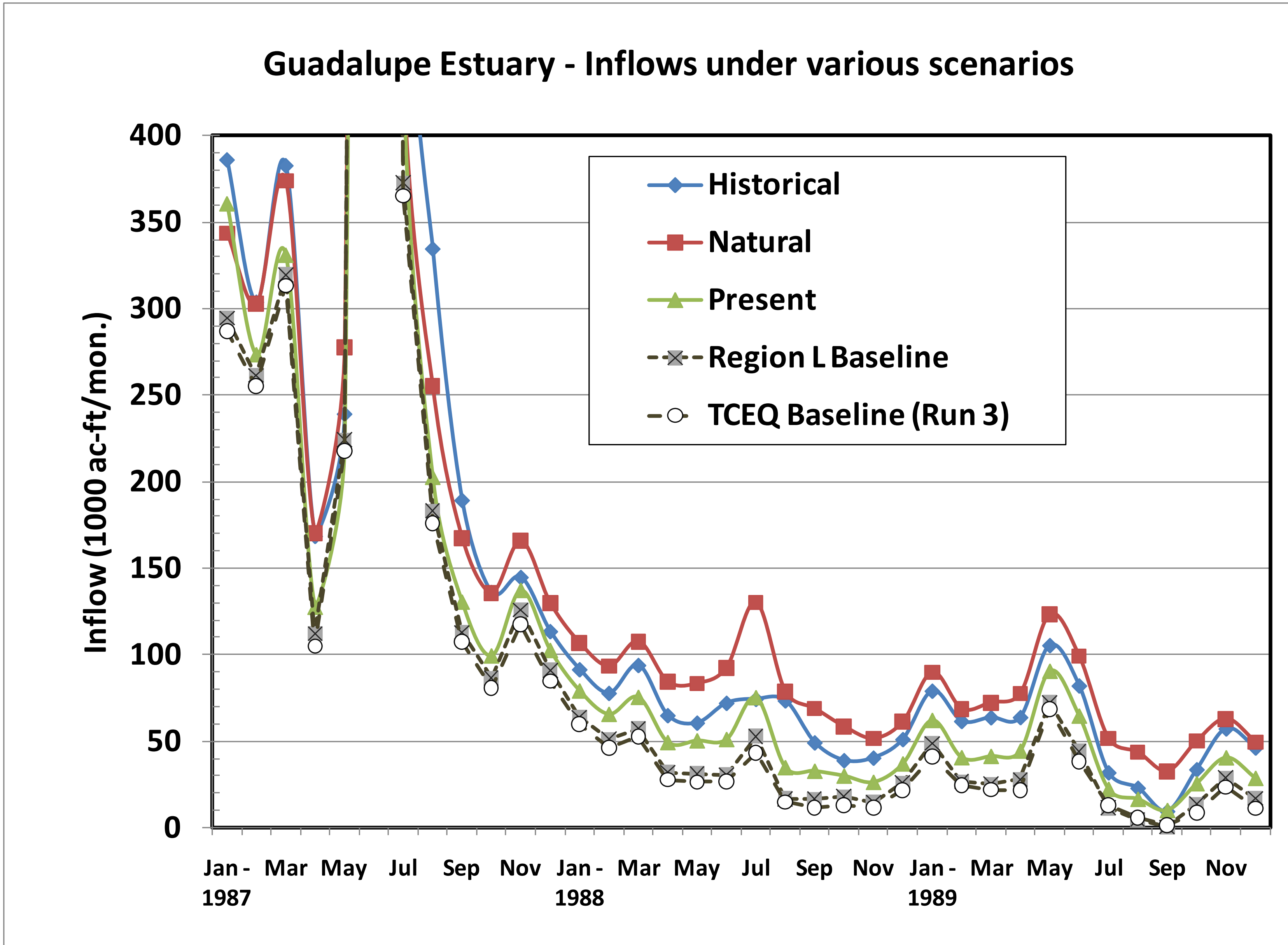
The WAM is a prediction / retrodiction tool.
Forecast Present or Future water use / management conditions with past climate and runoff.


Guadalupe Estuary - Inflows under various scenarios
Historical
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov

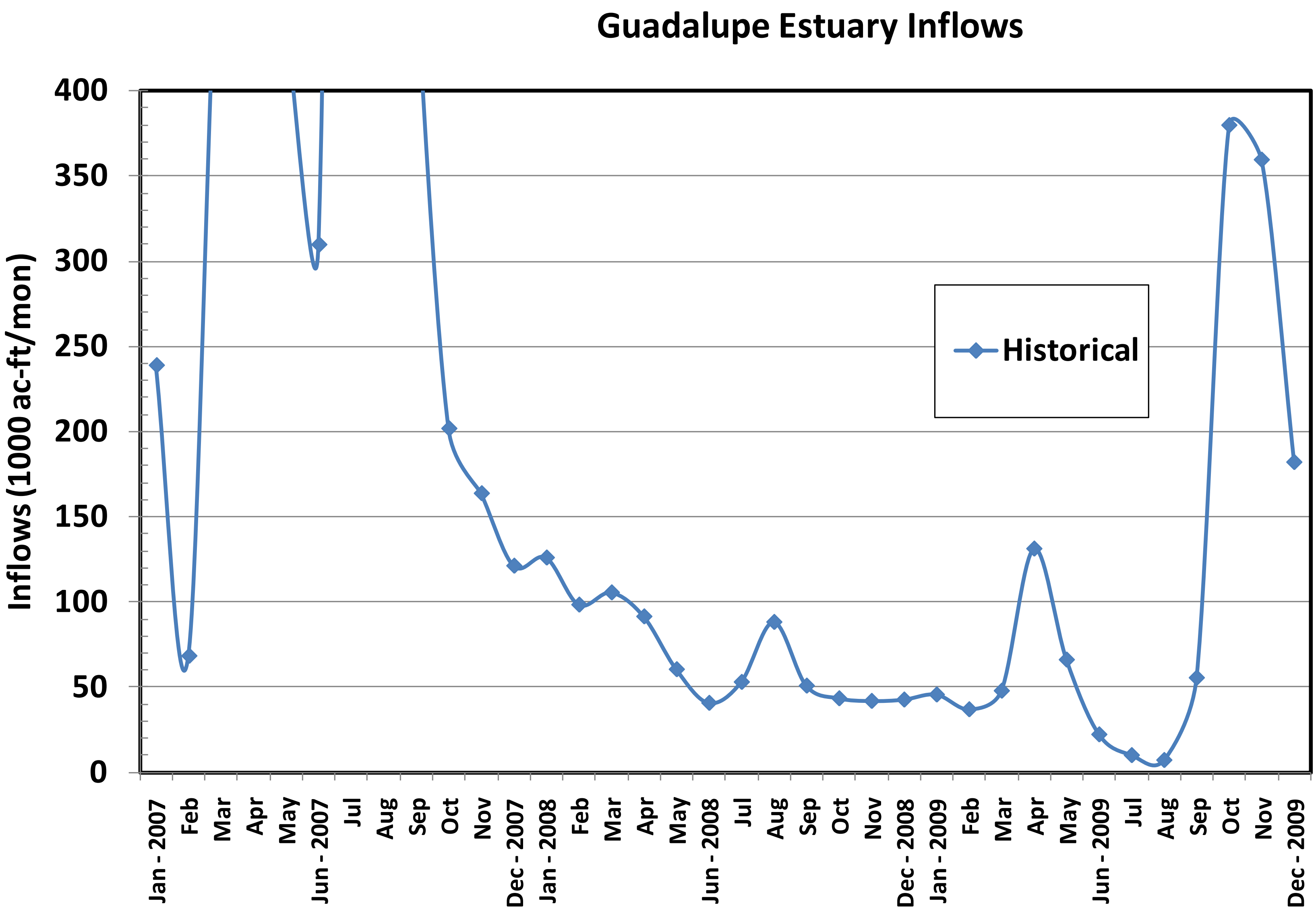


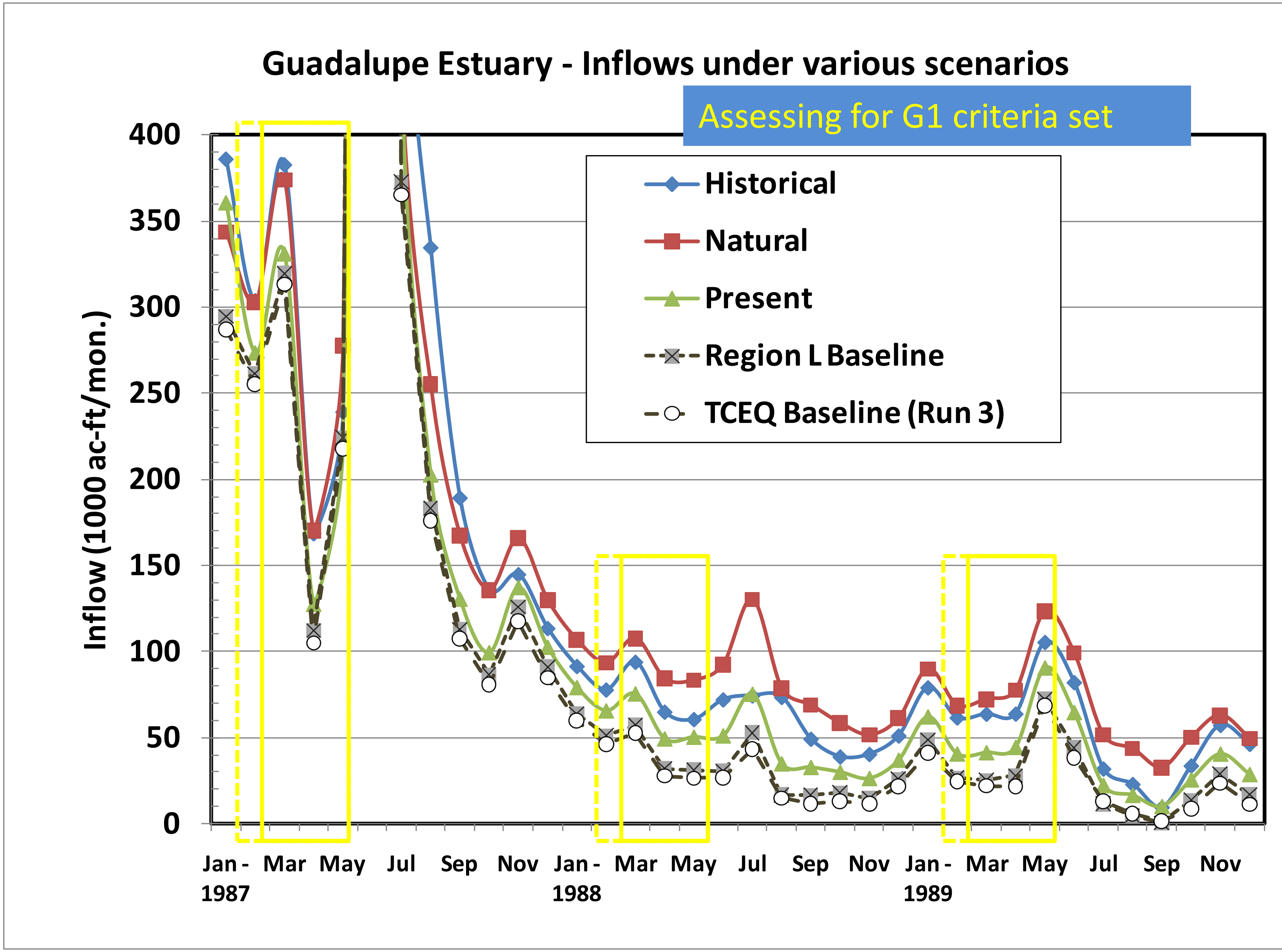
Guadalupe Estuary - Inflows under various scenarios
Natural
Historical
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov


Guadalupe Estuary - Inflows under various scenarios
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Historical
Natural
Present
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov

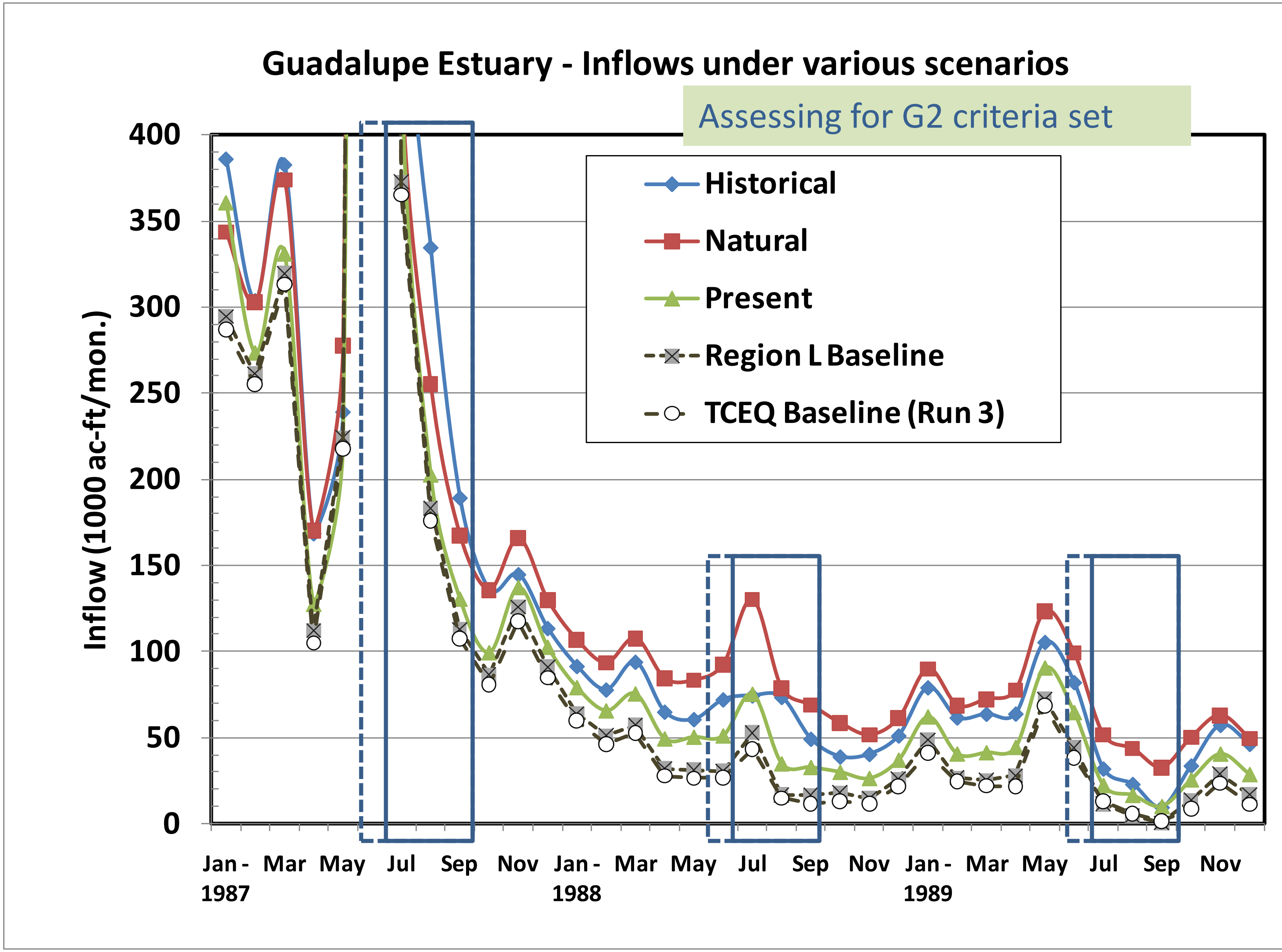


Guadalupe Estuary - Inflows under various scenarios
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Historical
Natural
Present
Region L Baseline
TCEQ Baseline (Run 3)
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov


Guadalupe Estuary Inflows
Inflows (1000 ac-ft/mon)
400
350
300
250
200
150
100
50
0
Historical
Jan - 2007
Feb
Mar
Apr
May
Jun - 2007
Jul
Aug
Sep
Oct
Nov
Dec - 2007
Jan - 2008
Feb
Mar
Apr
May
Jun - 2008
Jul
Aug
Sep
Oct
Nov
Dec - 2008
Jan - 2009
Feb
Mar
Apr
May
Jun - 2009
Jul
Aug
Sep
Oct
Nov
Dec - 2009



Guadalupe Estuary - Inflows under various scenarios
Assessing for G1 criteria set
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Historical
Natural
Present
Region L Baseline
TCEQ Baseline (Run 3)
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov


Guadalupe Estuary - Inflows under various scenarios
Assessing for G2 criteria set
Historical
Natural
Present
Region L Baseline
TCEQ Baseline (Run 3)
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov

ROAD MAP

Topics:

1) Review of Estuary Criteria / Need for Time Series Evaluations

2) Evaluation approach

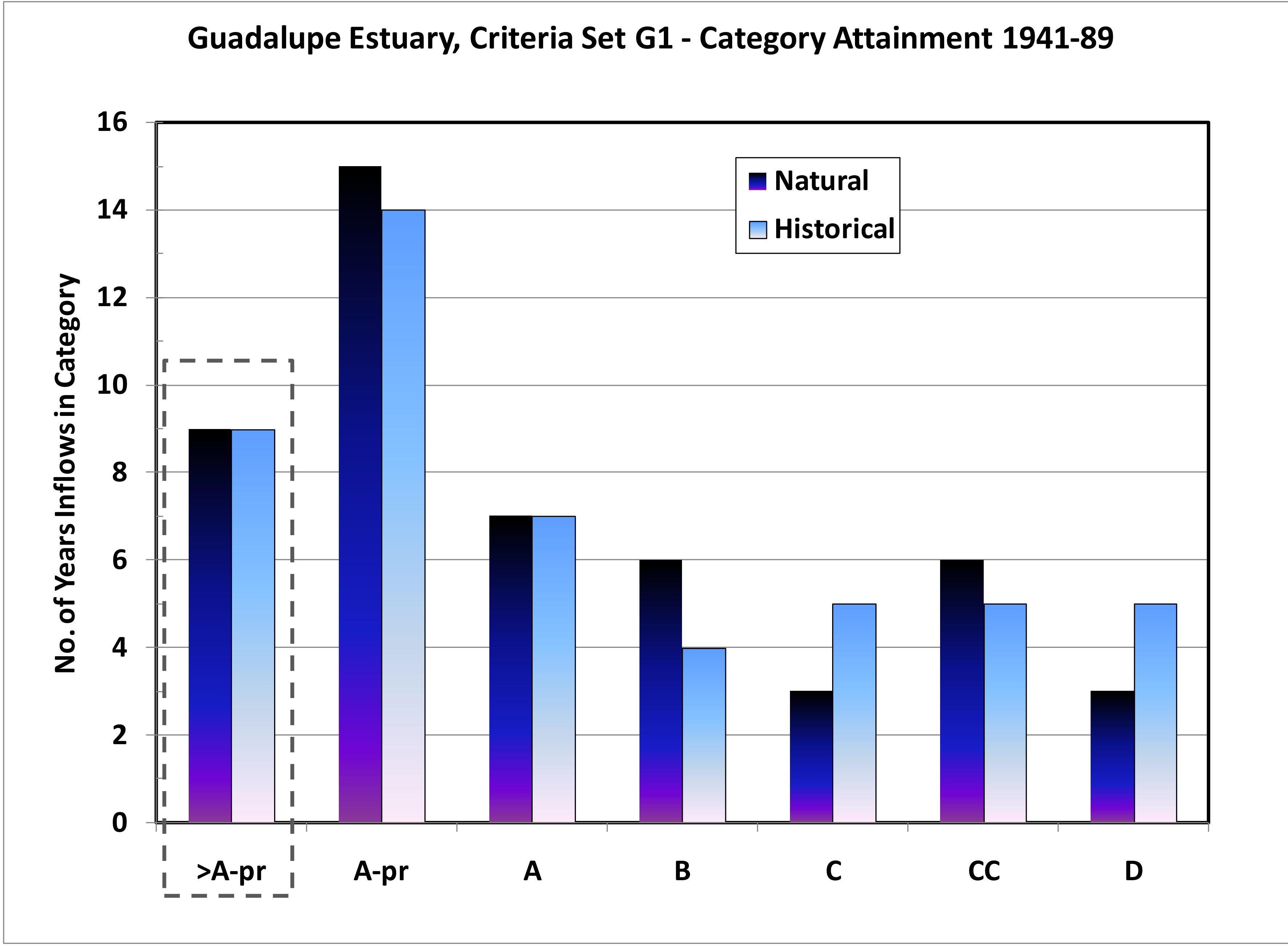
3) Results of Analyses

a) Attainment for the G1 criteria for rangia clams

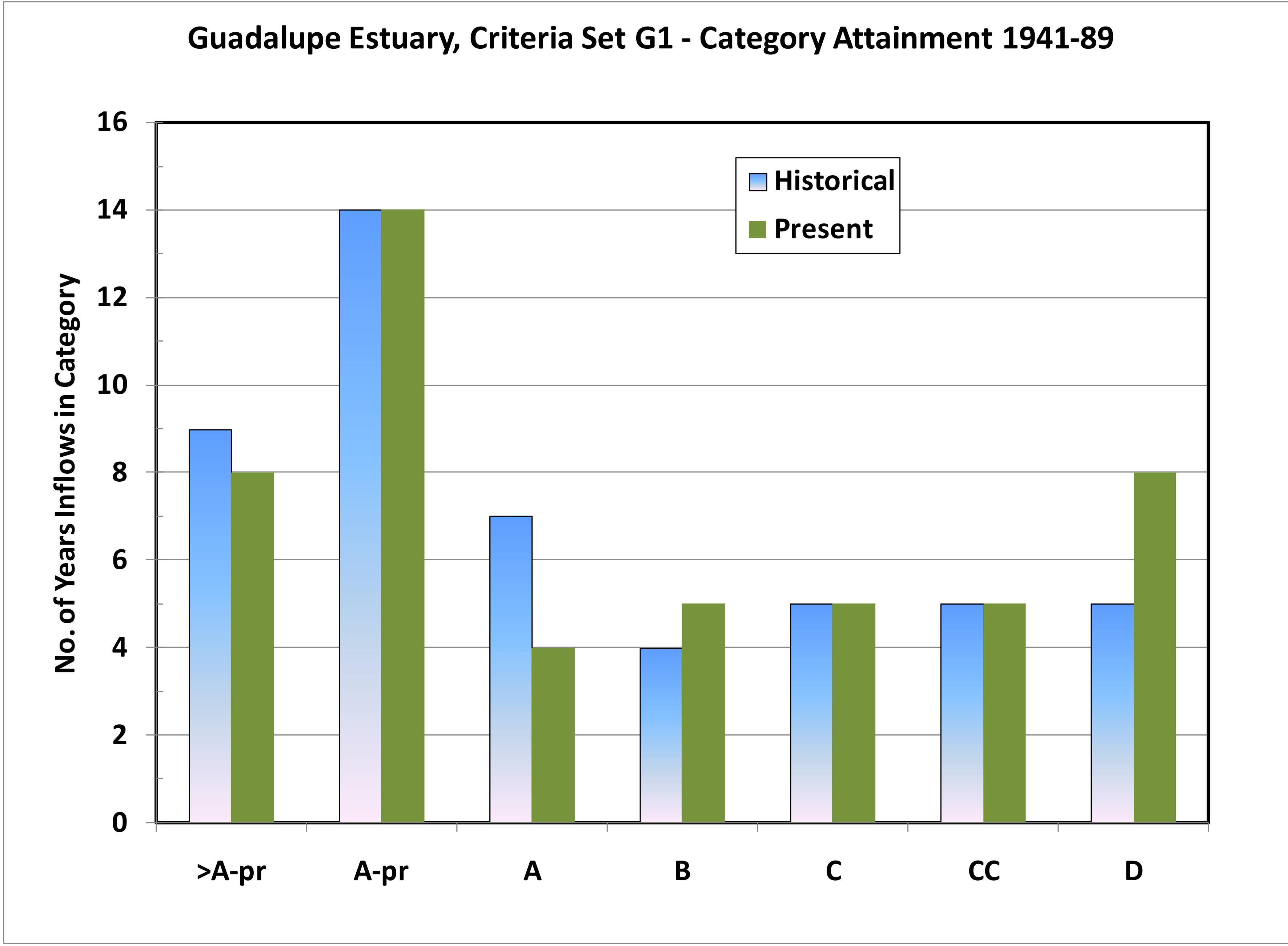
b) Attainment for the G2 criteria for oysters

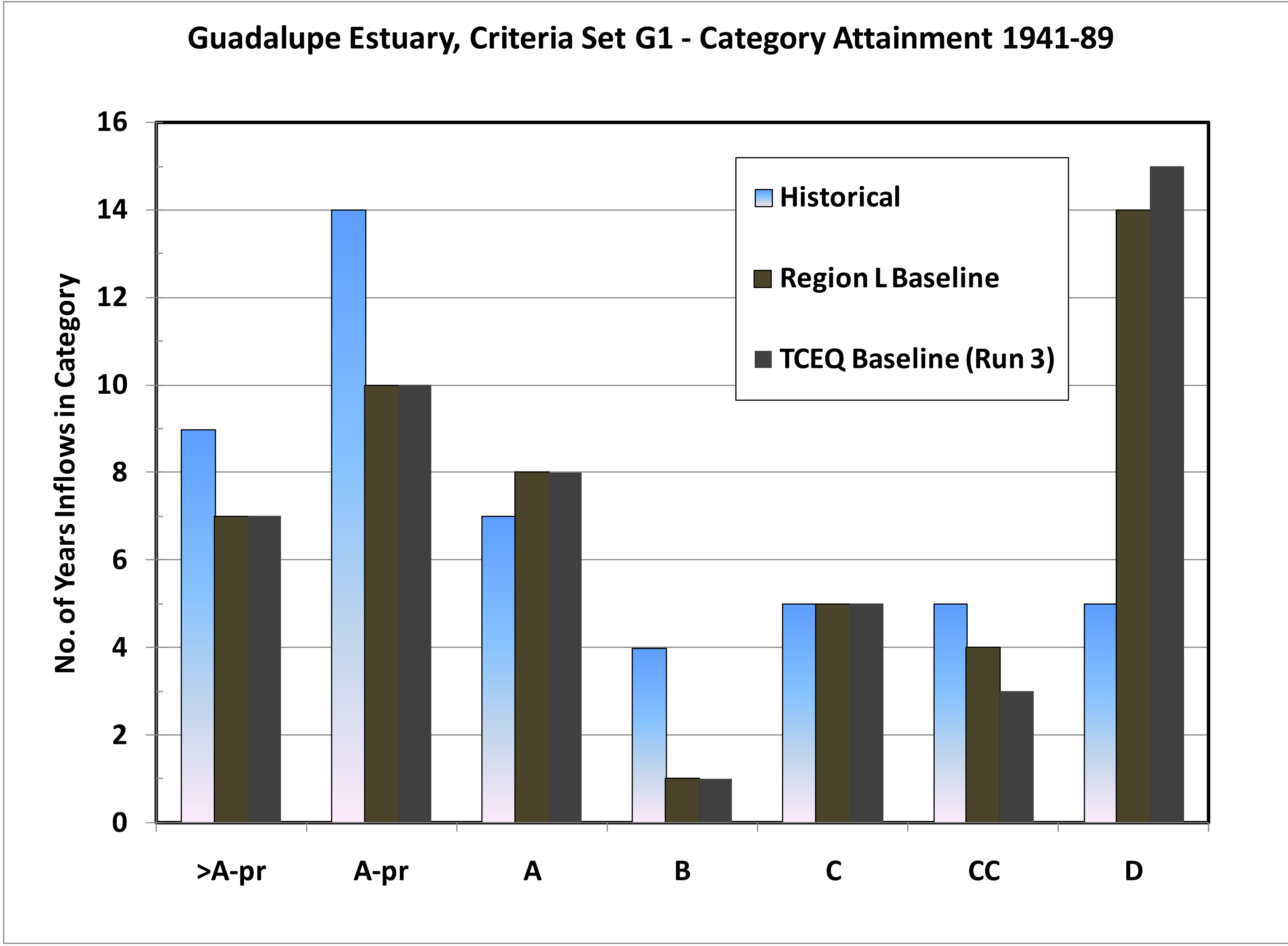
4) Summary

5) Next steps



Guadalupe Estuary, Criteria Set G1 - Category Attainment 1941-89
No. of Years Inflows in Category
0
2
4
6
8
10
12
14
16
Natural
Historical
>A-pr
A-pr
A
B
C
CC
D


Guadalupe Estuary, Criteria Set G1 - Category Attainment 1941-89
No. of Years Inflows in Category
0
2
4
6
8
10
12
14
16
Historical
Present
>A-pr
A-pr
A
B
C
CC
D


Guadalupe Estuary, Criteria Set G1 - Category Attainment 1941-89
No. of Years Inflows in Category
0
2
4
6
8
10
12
14
16
>A-pr
A-pr
A
B
C
CC
D
Historical
Region L Baseline
TCEQ Baseline (Run 3)

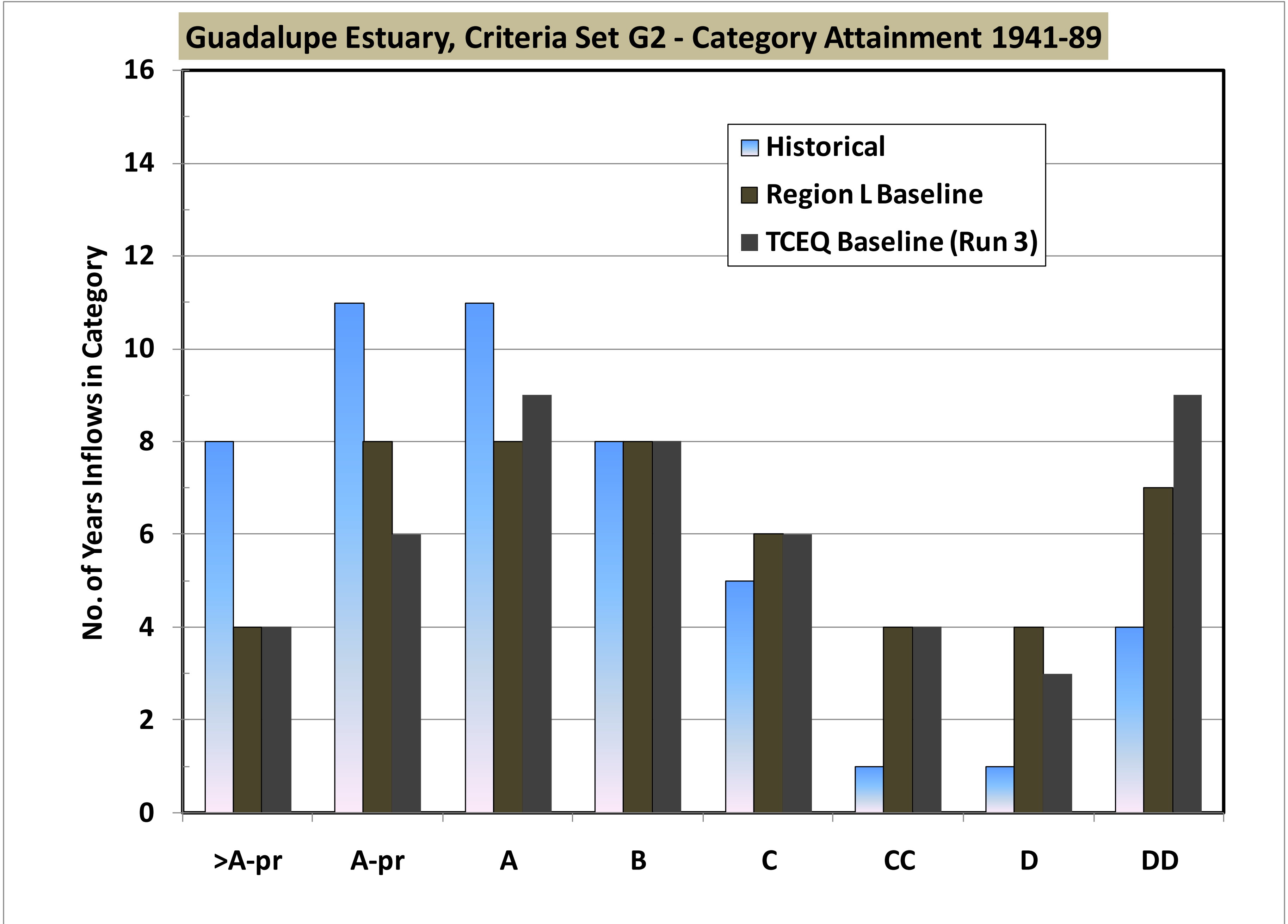
Summary – Attainment of G1 Springtime Criteria (Rangia)

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Natural	9	15	7	6	3	6	3	49
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline	7	10	8	1	5	4	14	49
TCEQ Baseline (Run 3)	7	10	8	1	5	3	15	49

see Tables 4.5-3 & 4.5-6		>12%	>12%				<=9%
Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Natural		30.6%	14.3%	12.2%	6.1%	12.2%	6.1%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline		20.4%	16.3%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

see Table 4.5-3			>17%		>=19%	<=2/3	
Attain. - Joints	Joint G1 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	
Natural			26.5%		18.4%	66.7%	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline			18.4%		18.4%	44.4%	
TCEQ Baseline (Run 3)			18.4%		16.3%	37.5%	

Color coding convention	
(green)	-OK, met criteria
(grey)	-Near miss. (rounding; p-o-record)
(orange)	-Not met, but departure not great
(brown)	-Very bad


Guadalupe Estuary, Criteria Set G2 - Category Attainment 1941-89
No. of Years Inflows in Category
0
2
4
6
8
10
12
14
16
Historical
Region L Baseline
TCEQ Baseline (Run 3)
>A-pr
A-pr
A
B
C
CC
D
DD

Summary – Attainment of G2 Summer Criteria (oysters)

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Natural	9	11	15	7	3	2	2	0	49
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline	4	8	8	8	6	4	4	7	49
TCEQ Baseline (Run 3)	4	6	9	8	6	4	3	9	49

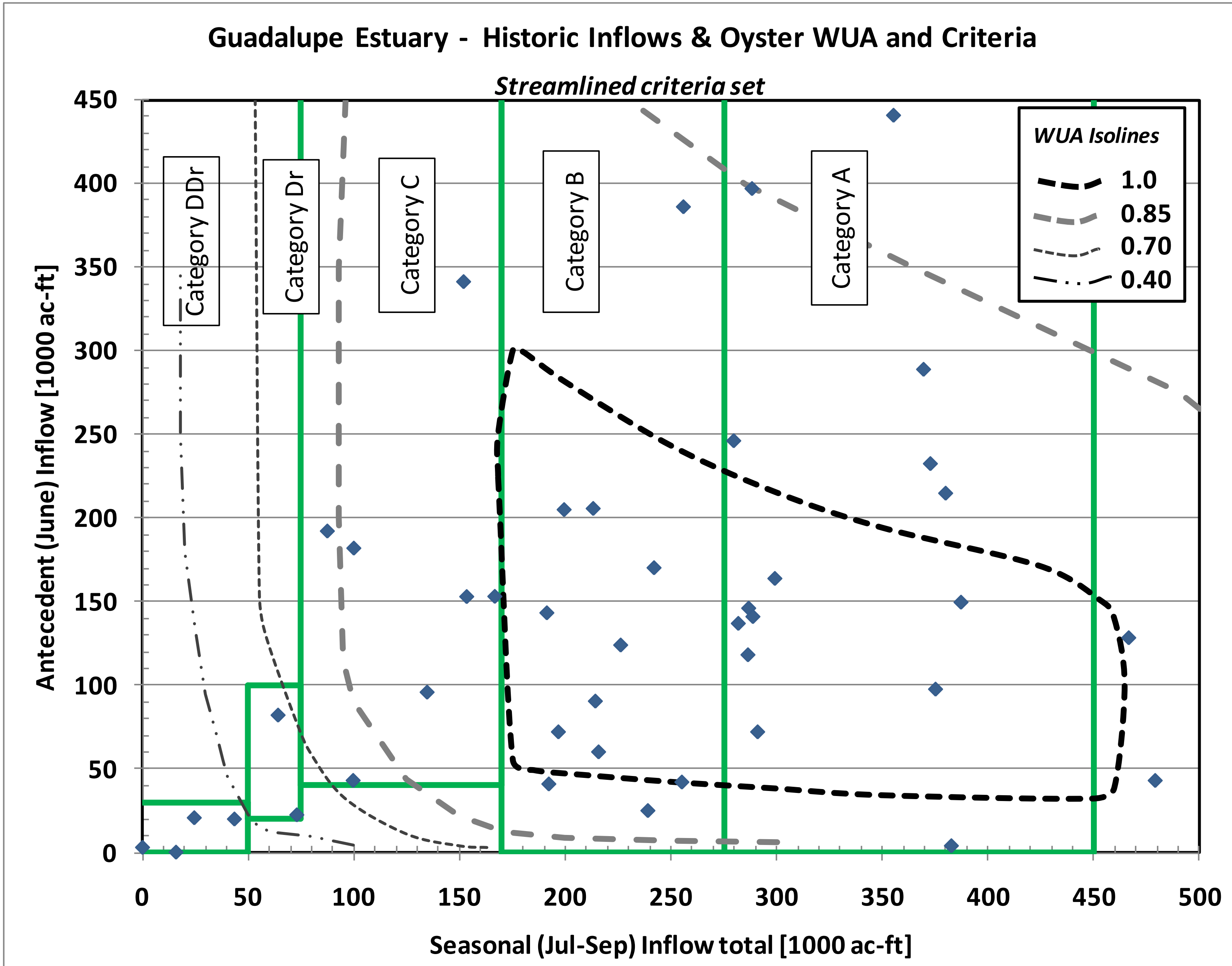
see Tables 4.5-2; 4.5-4		>12%	>17%				<=6%	
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Natural		22.4%	30.6%	14.3%	6.1%	4.1%	4.1%	0.0%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline		16.3%	16.3%	16.3%	12.2%	8.2%	8.2%	14.3%
TCEQ Baseline (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%	
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Natural			44.9%		10.2%	40.0%	4.1%	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline			32.7%		20.4%	40.0%	22.4%	
TCEQ Baseline (Run 3)			34.7%		20.4%	40.0%	24.5%	

Color coding convention	
	-OK, met criteria
	-Near miss. (rounding; p-o-record)
	-Not met, but departure not great
	-Very bad

To be continued …

Time Series analyses approach



Guadalupe, San Antonio, Mission, & Aransas Rivers and Mission, Copano, Aransas, & San Antonio Bays Basin and Bay Area Stakeholder Committee (GSA BBASC)

Technical Analyses of GSA BBEST Recommendations – Part 1: San Antonio River Project

Brian Perkins, PE

Ed Oborny

Norman Johns, PhD

May 4, 2011

Presentation Format

1) Project Description
2) Project Hydrology: Firm Yield
3) Project Cost
4) Instream Ecology
5) Estuary Ecology

6) Questions / Clarifications

7) Discussion by the BBASC

San Antonio River Project

San Antonio River Project

- Diversions from San Antonio River @ Goliad
- Maximum Diversion Rate of 800 cfs
- 2 - 120-inch Diversion Pipelines
- 150,000 acft of Off-Channel Storage near Goliad
- Uniform Delivery of Firm Yield to SAWS Twin Oaks WTP

- Scenarios:
  - No Environmental Flow
  - Lyons Method
  - CCEFN
  - BBEST Recommendations

San Antonio River Project

- No Environmental Flow
  - Theoretical maximum firm yield of project subject to downstream senior water rights only.
- Lyons Method
  - TCEQ desktop environmental flow used in permitting. Uses 40% (Oct – Feb) and 60% (Mar – Sept) of monthly medians as flow criteria.
- Consensus Criteria for Environmental Flow Needs (CCEFN)
  - TWDB default 3-tiered (Medians, Quartiles, and 7Q2) flow criteria used in regional planning.
- BBEST Recommendations
  - Full flow regime recommendation of the GSA BBEST.

San Antonio River Project

- No Environmental Flow (cfs)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

- Lyons Method (cfs)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
178.0	165.0	273.0	285.0	312.0	319.0	172.0	175.0	259.0	181.0	162.0	165.0

- Consensus Criteria for Environmental Flow Needs (CCEFN) (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Median	294.2	306.6	306.8	305.8	371.0	346.3	241.9	199.4	239.9	258.0	283.1	288.9
Quartile	183.3	197.4	176.1	157.0	175.4	145.9	89.9	77.3	103.4	134.0	140.3	150.8
7Q2	77.0	77.0	77.0	77.0	77.0	77.0	77.0	77.0	77.0	77.0	77.0	77.0

San Antonio River Project

❑ BBEST Recommendation

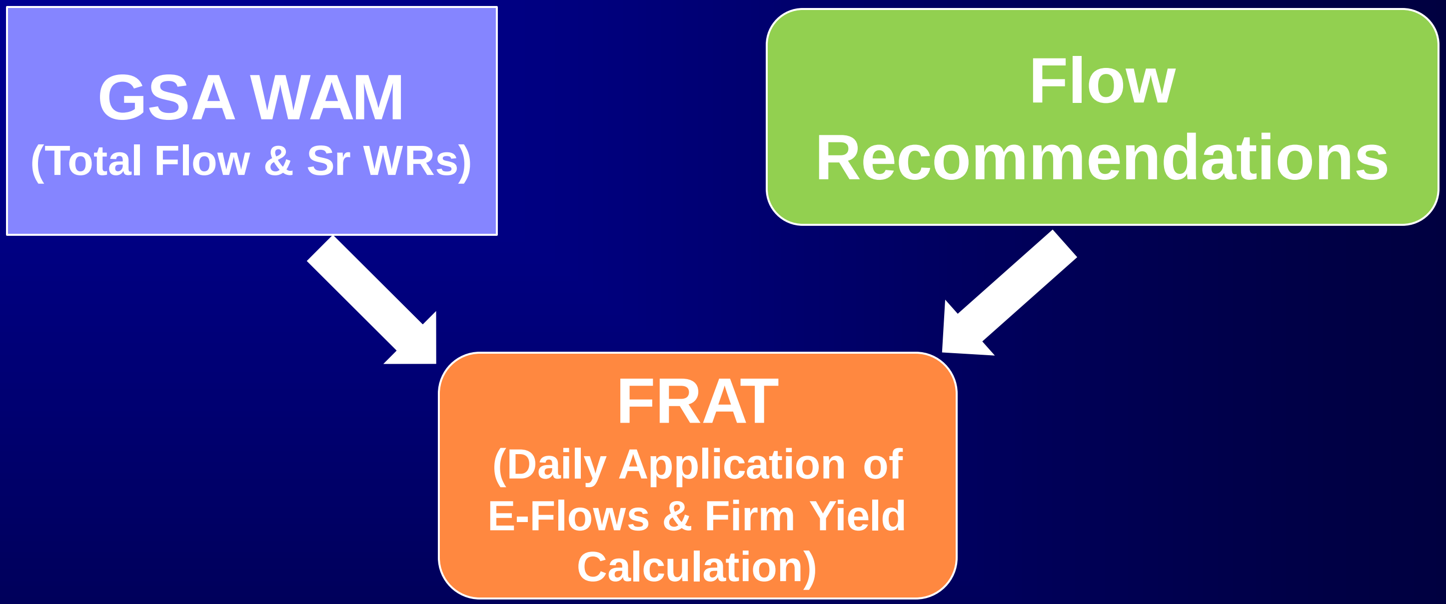
	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 273,000 Duration Bound is 69			
	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 107,000 Duration Bound is 45			
	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38			
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19
	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs)	290	280	220	270
	200	180	150	200
	140	130	120	130
Subsistence Flows (cfs)	76	60	54	66

Flow Levels	
	High (75th %ile)
	Medium (50th %ile)
	Low (25th %ile)
	Subsistence

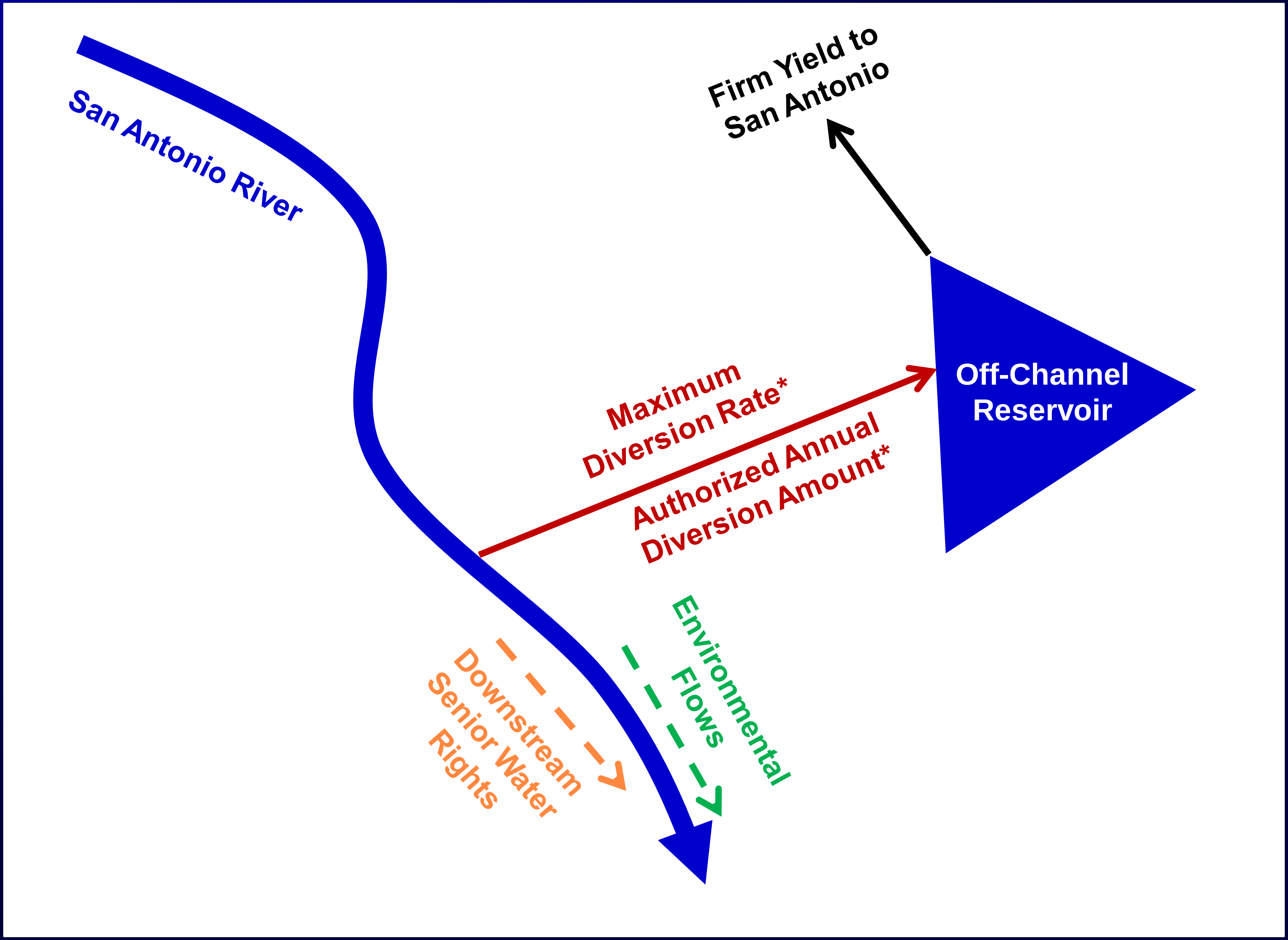
Notes:

1. Period of Record used: 1/1/1940 to 12/31/1969.
2. Volumes are in acre-feet and durations are in days.

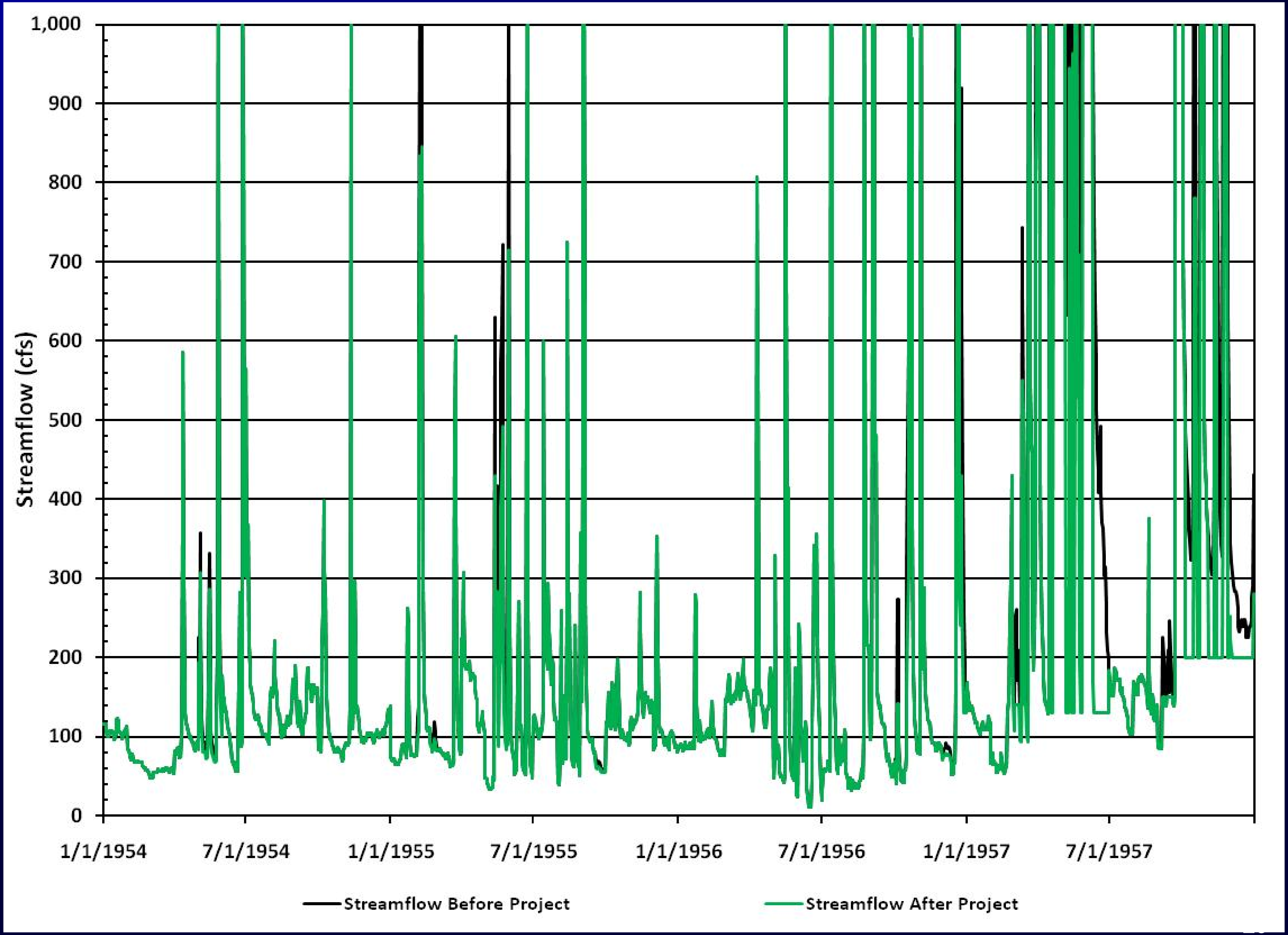
San Antonio River Project



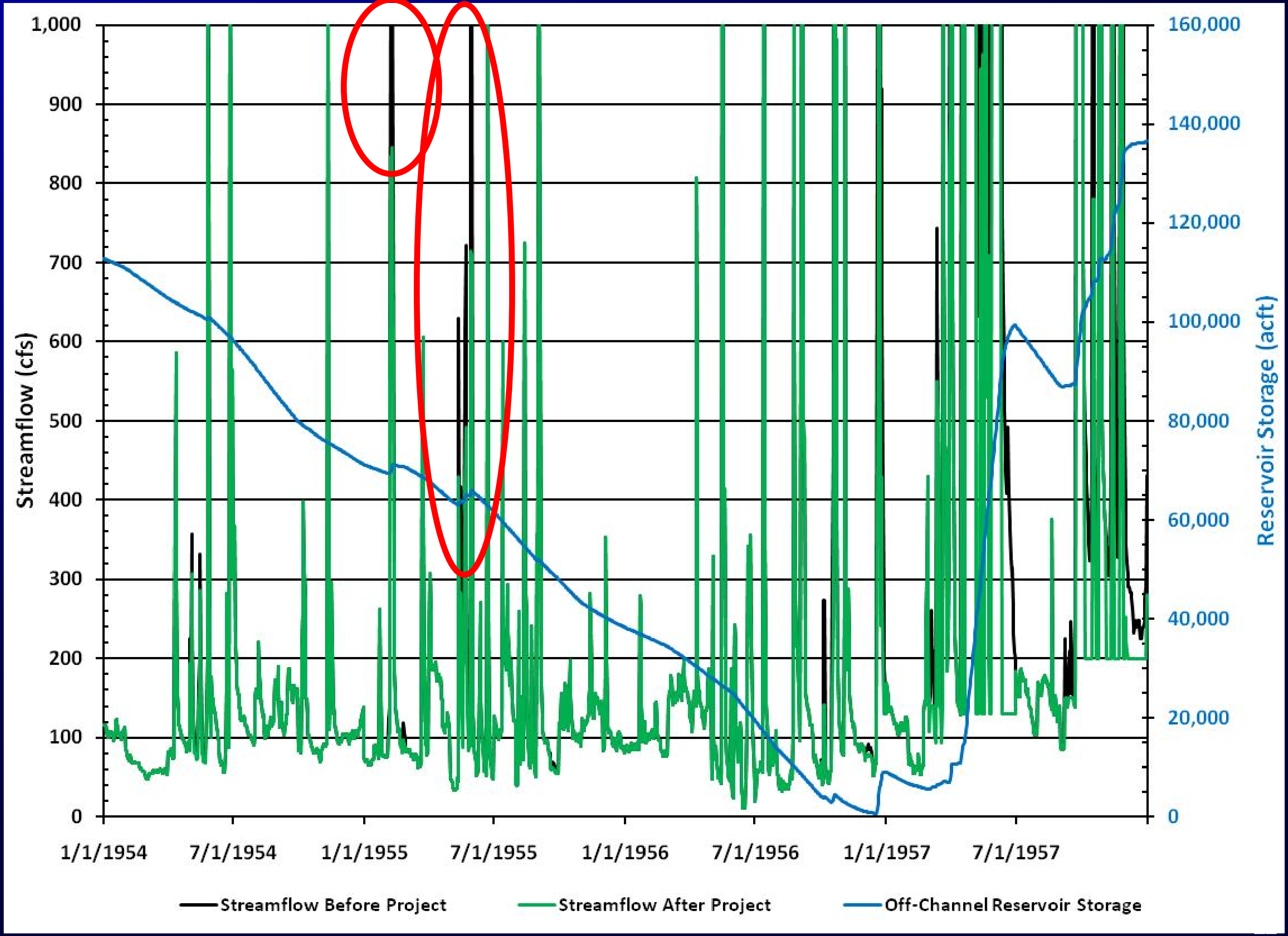
San Antonio River Project



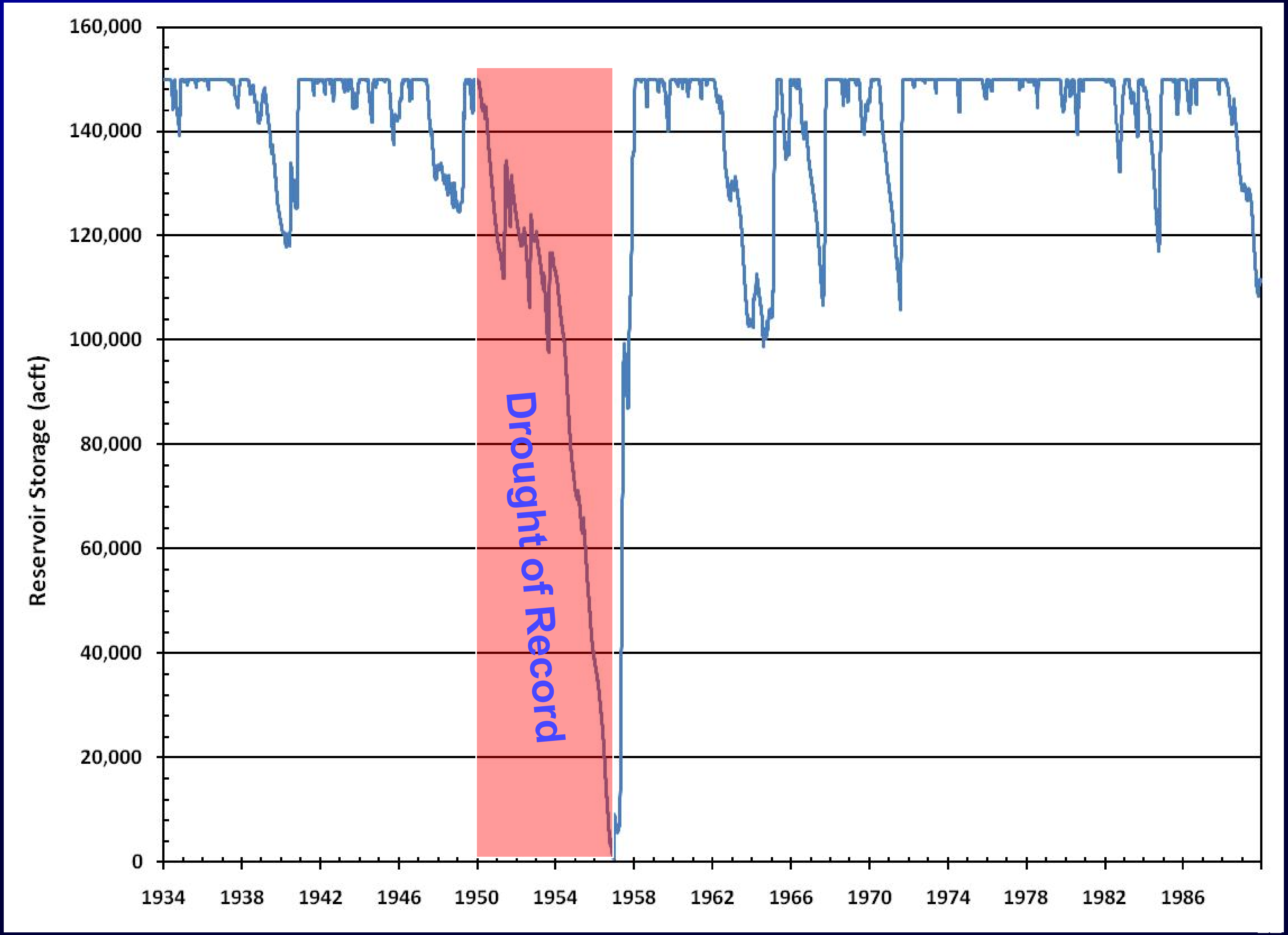
San Antonio River Project



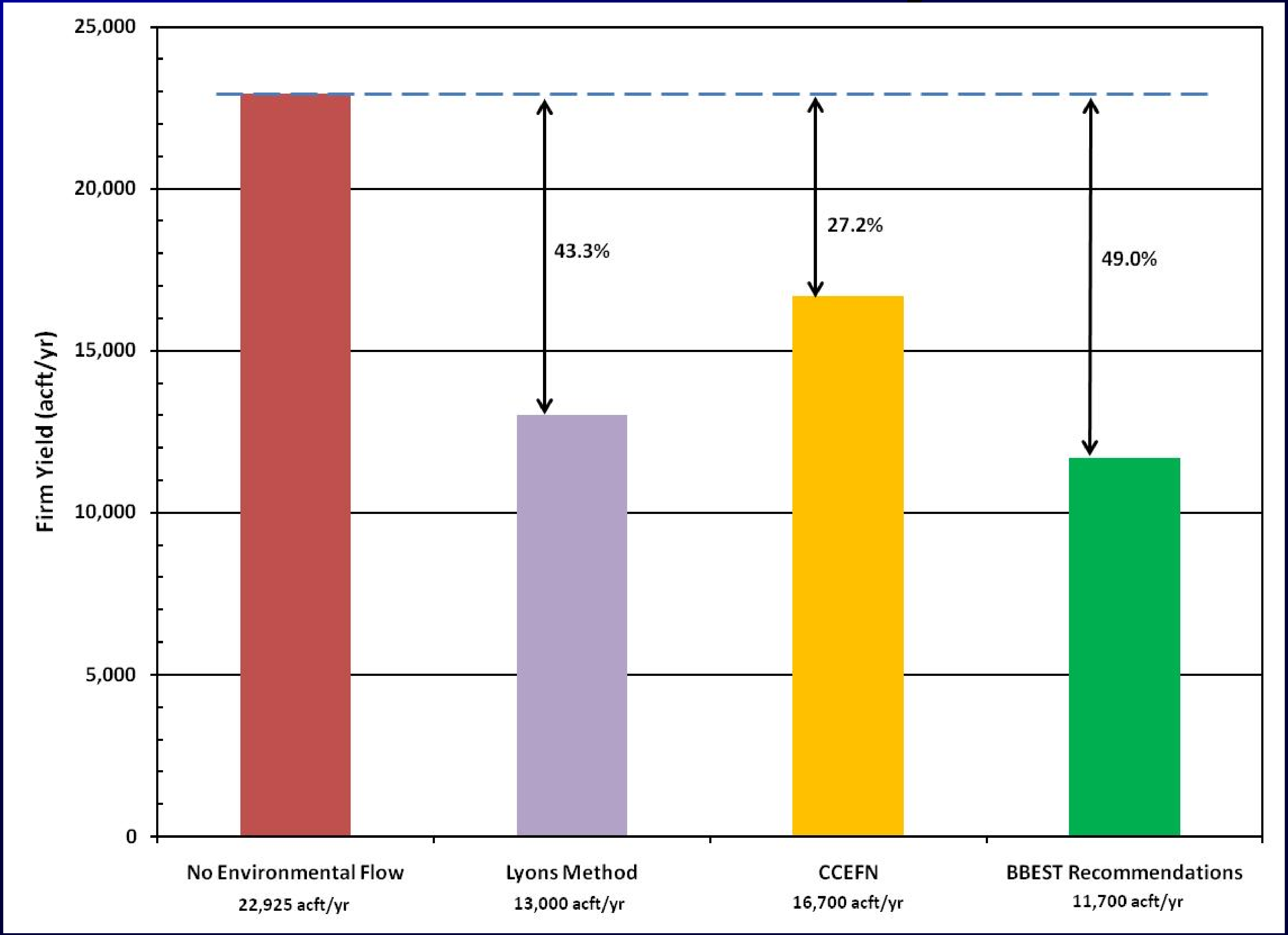
San Antonio River Project



San Antonio River Project



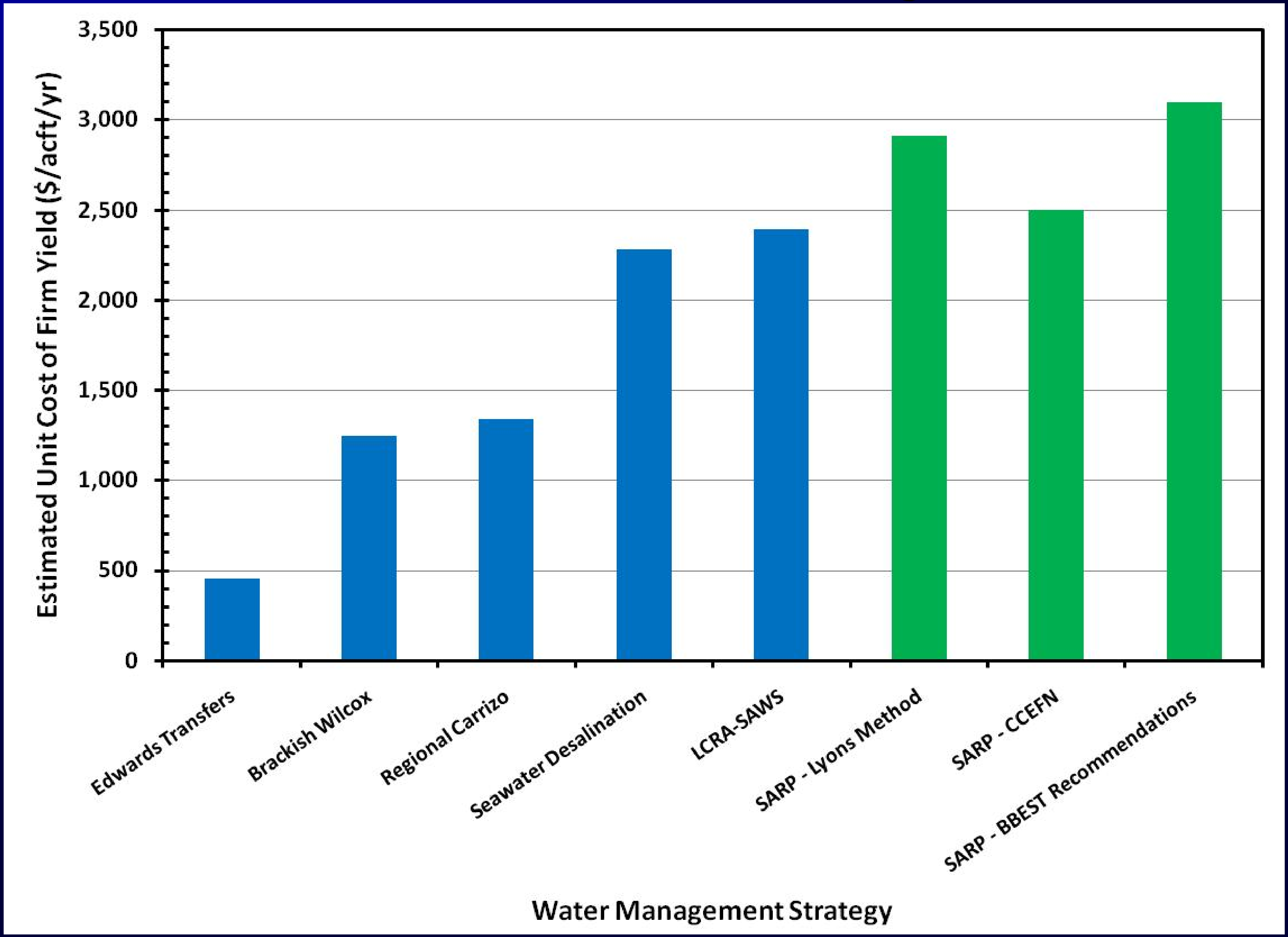
San Antonio River Project



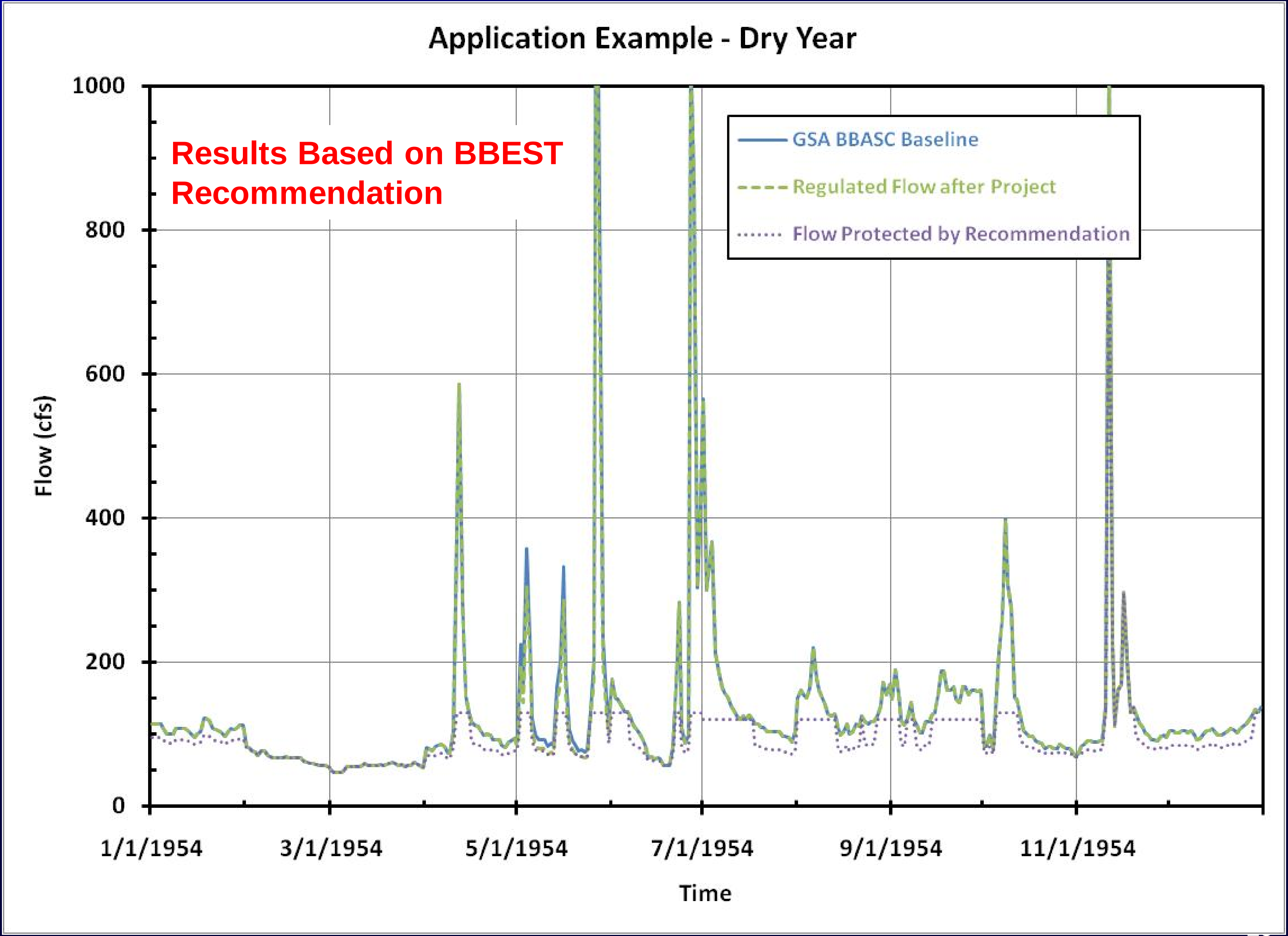
San Antonio River Project

	No Environmental Flow	Lyons Method	CCEFN	BBEST Recommendation
Available Project Yield (acft/yr)	22,925	13,000	16,700	11,700
Raw Water at Reservoir				
Total Project Cost	$205,650,000	$205,650,000	$205,650,000	$205,650,000
Total Annual Cost	$17,678,000	$17,558,000	$17,570,000	$17,461,000
Annual Cost of Raw Water ($ per acft)	$771	$1,351	$1,052	$1,492
Annual Cost of Raw Water ($ per 1,000 gallons)	$2.37	$4.14	$3.23	$4.58
Treated Water Delivered				
Total Project Cost	$455,737,000	$372,816,000	$403,471,000	$364,407,000
Total Annual Cost	$47,912,000	$37,814,000	$41,760,000	$36,236,000
Annual Cost of Water ($ per acft)	$2,090	$2,909	$2,501	$3,097
Annual Cost of Water ($ per 1,000 gallons)	$6.41	$8.93	$7.67	$9.50

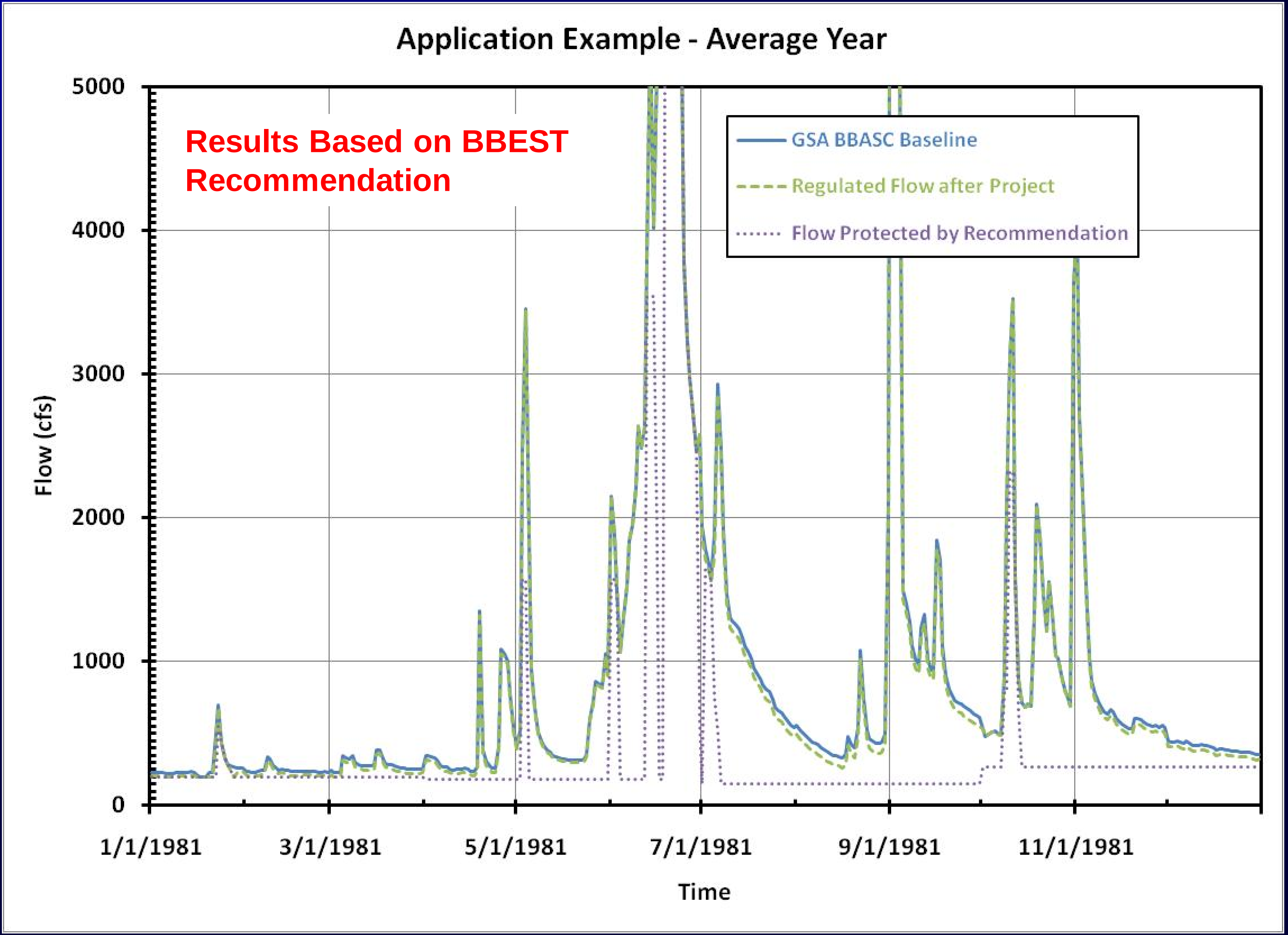
San Antonio River Project



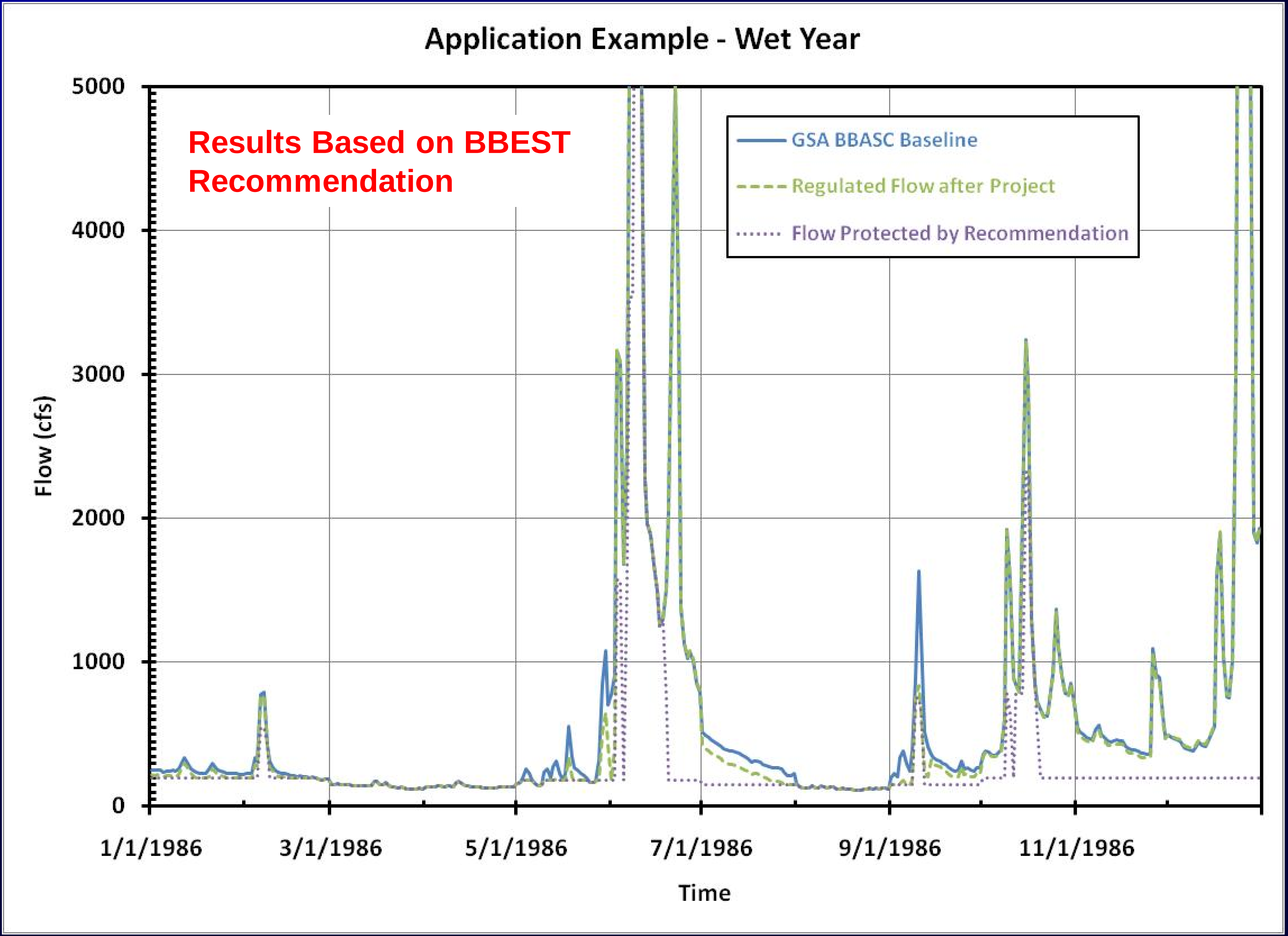
San Antonio River Project



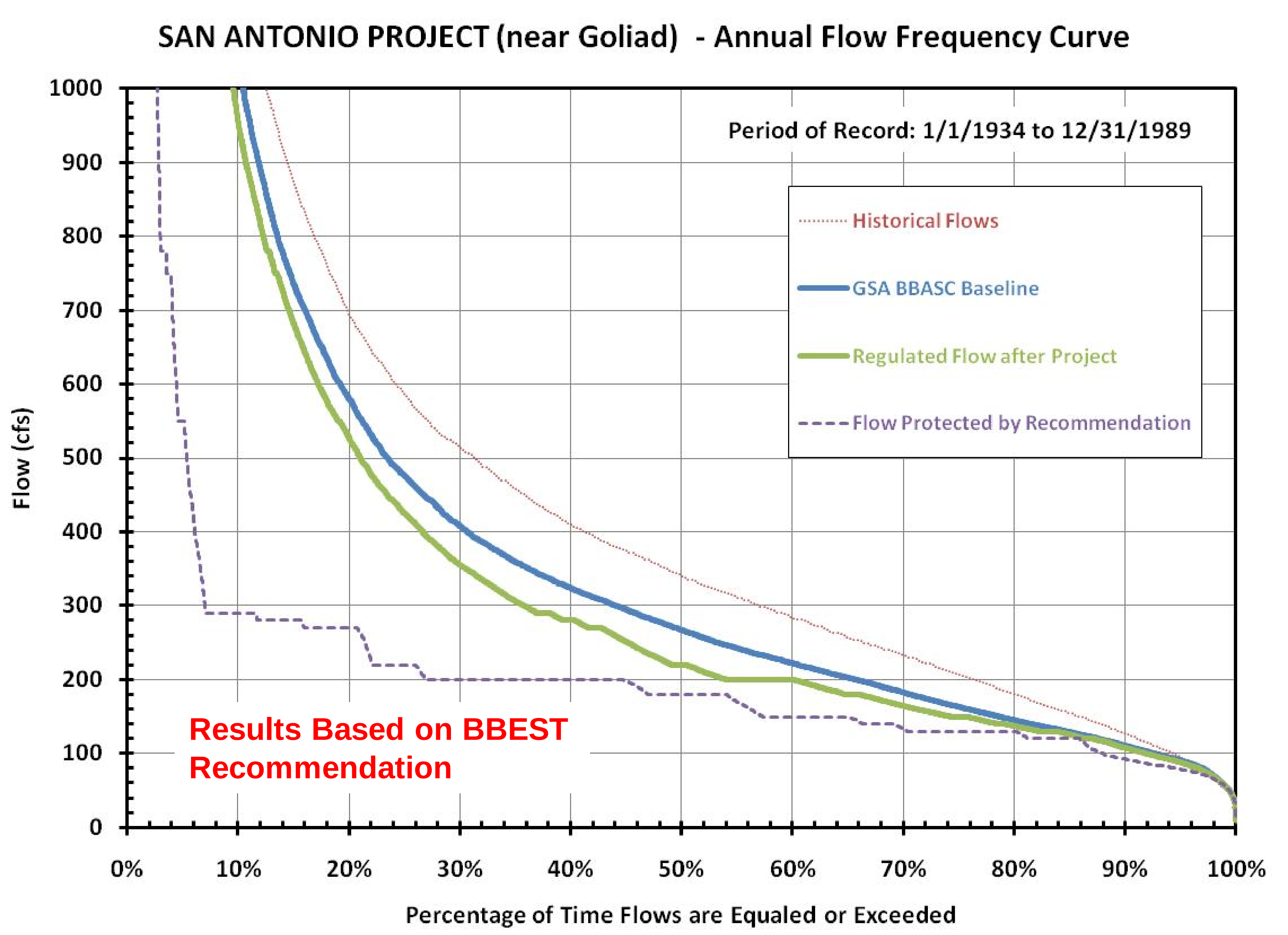
San Antonio River Project



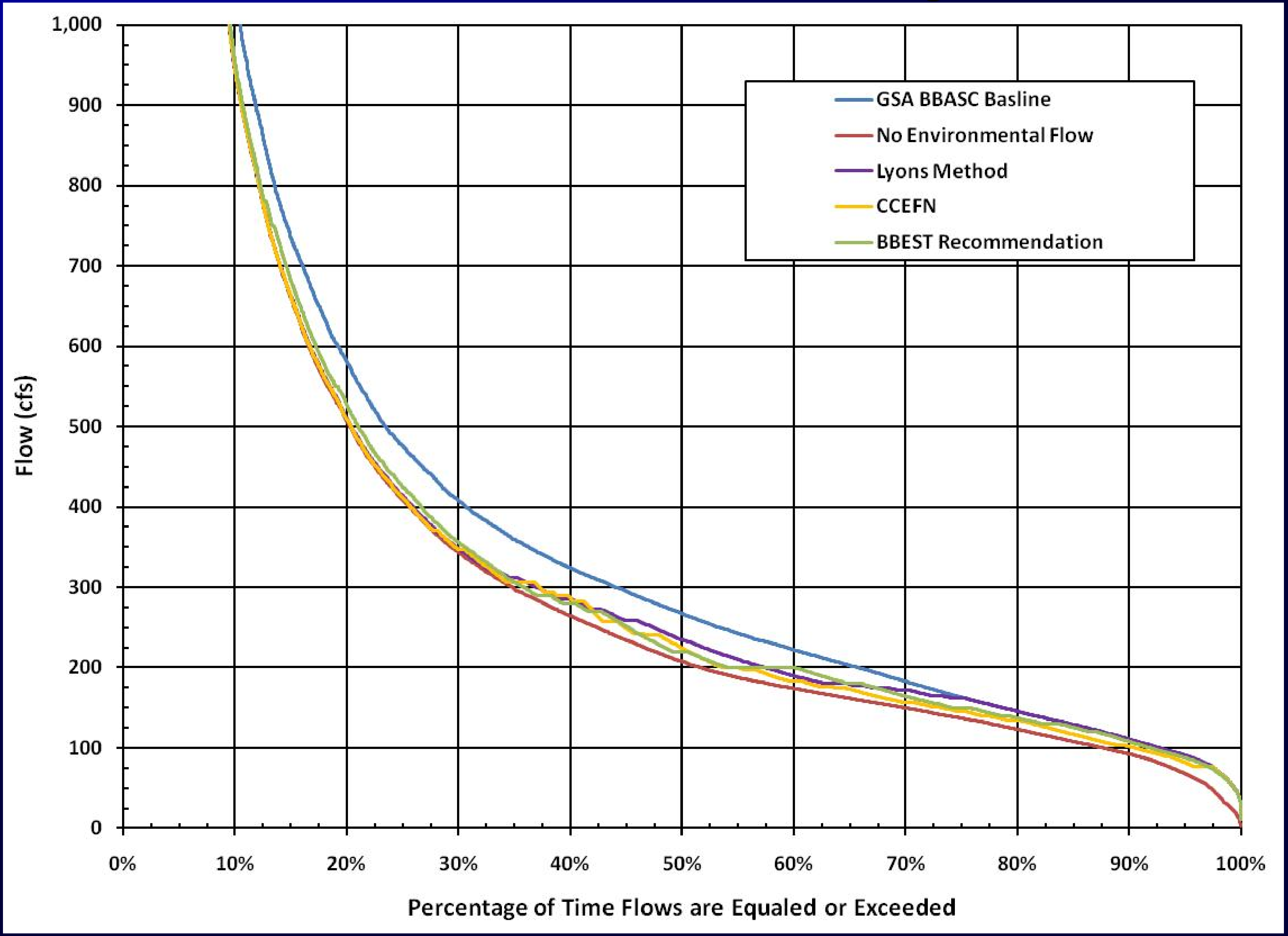
San Antonio River Project



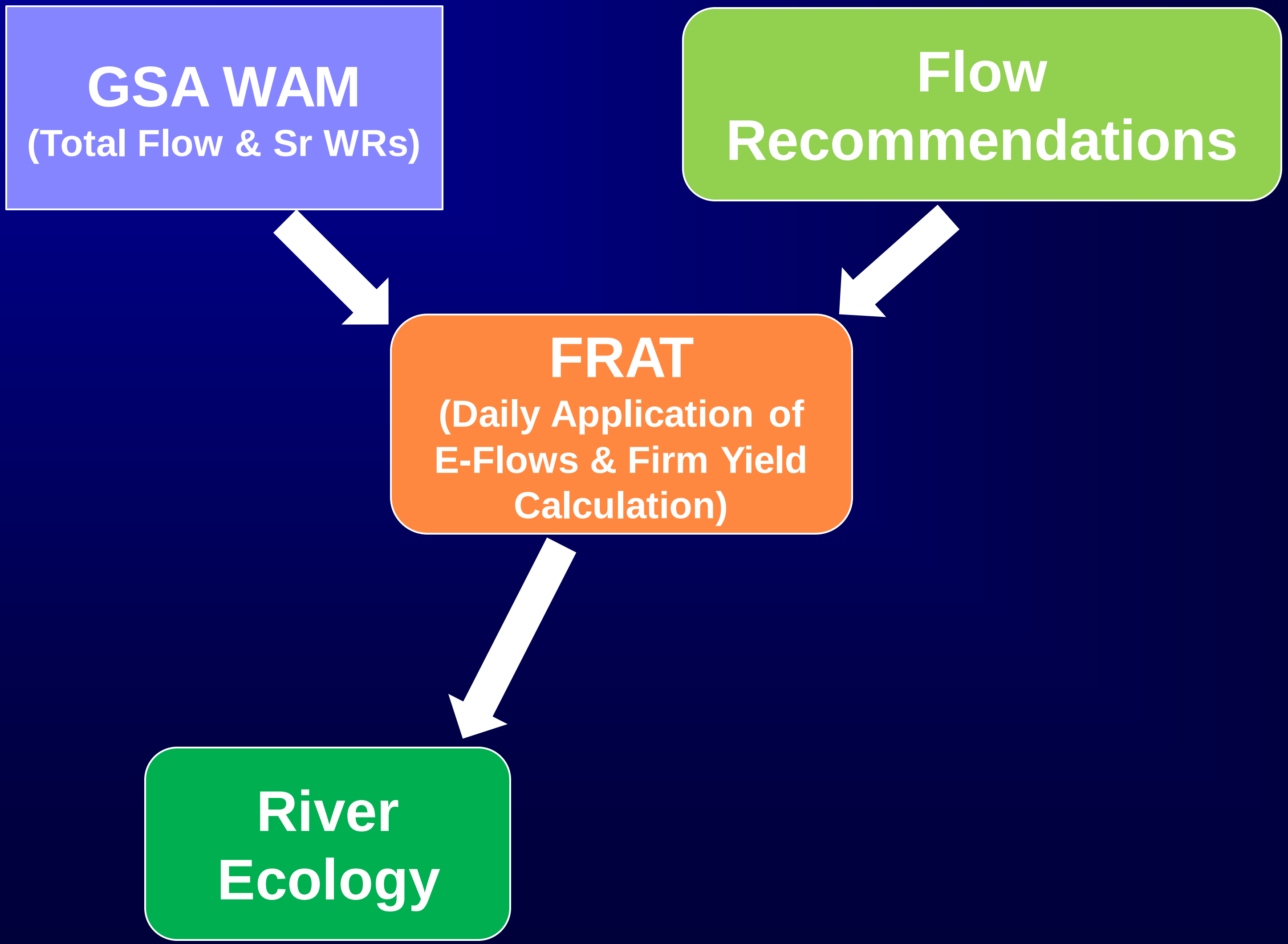
San Antonio River Project



San Antonio River Project



San Antonio River Project

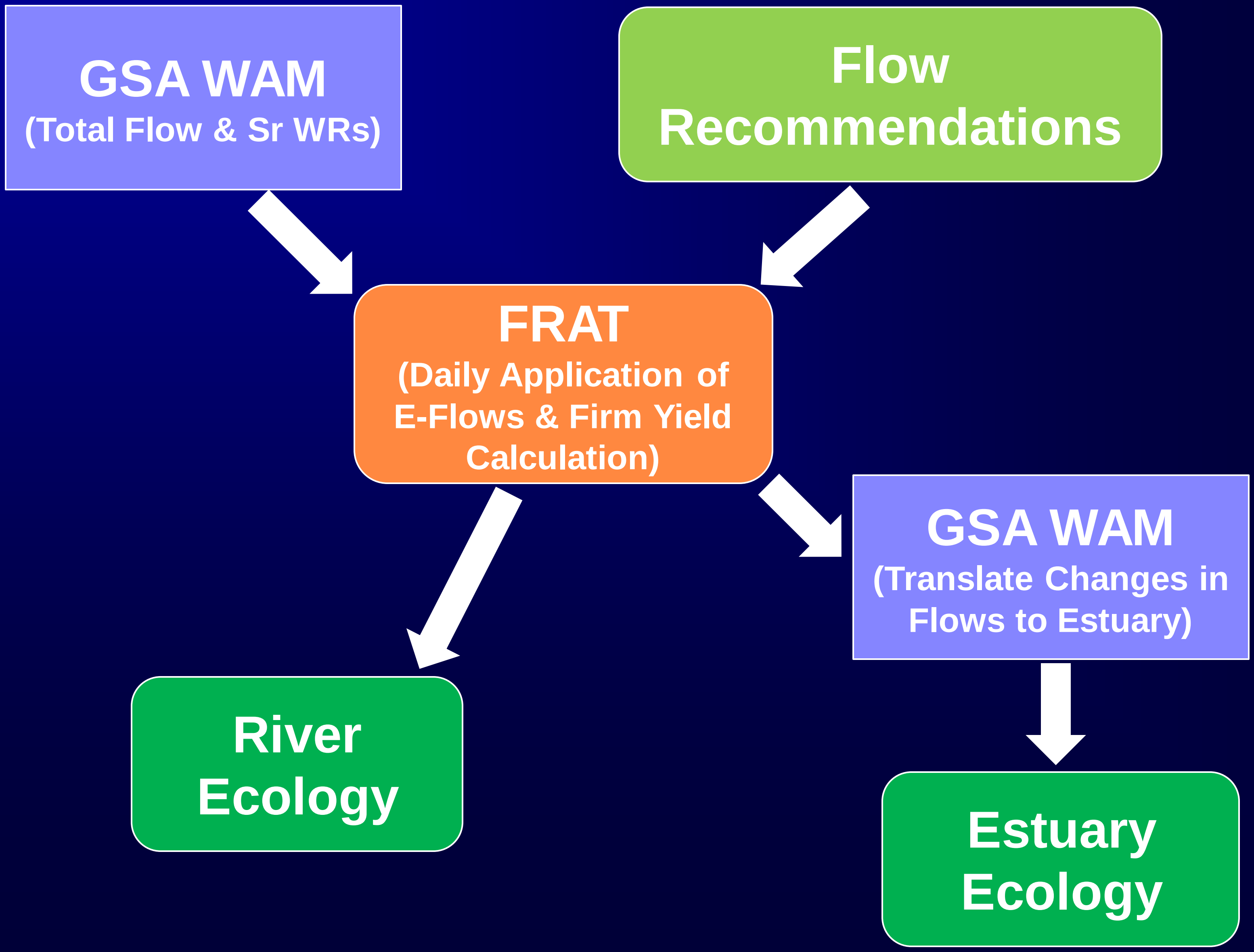


San Antonio River Project

BIO-WEST

Presentation

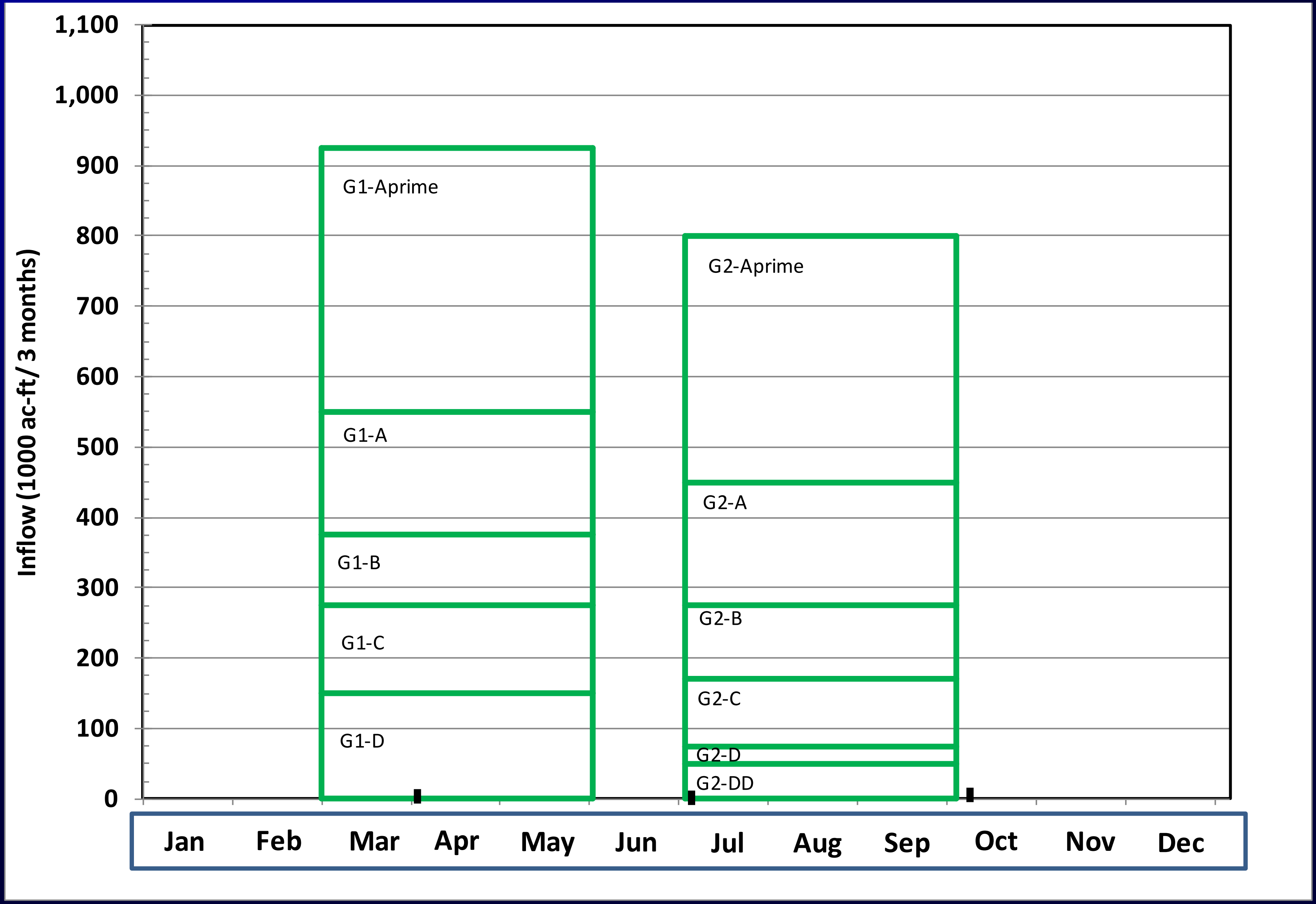
San Antonio River Project



San Antonio River Project

Orientation & Baseline Discussion

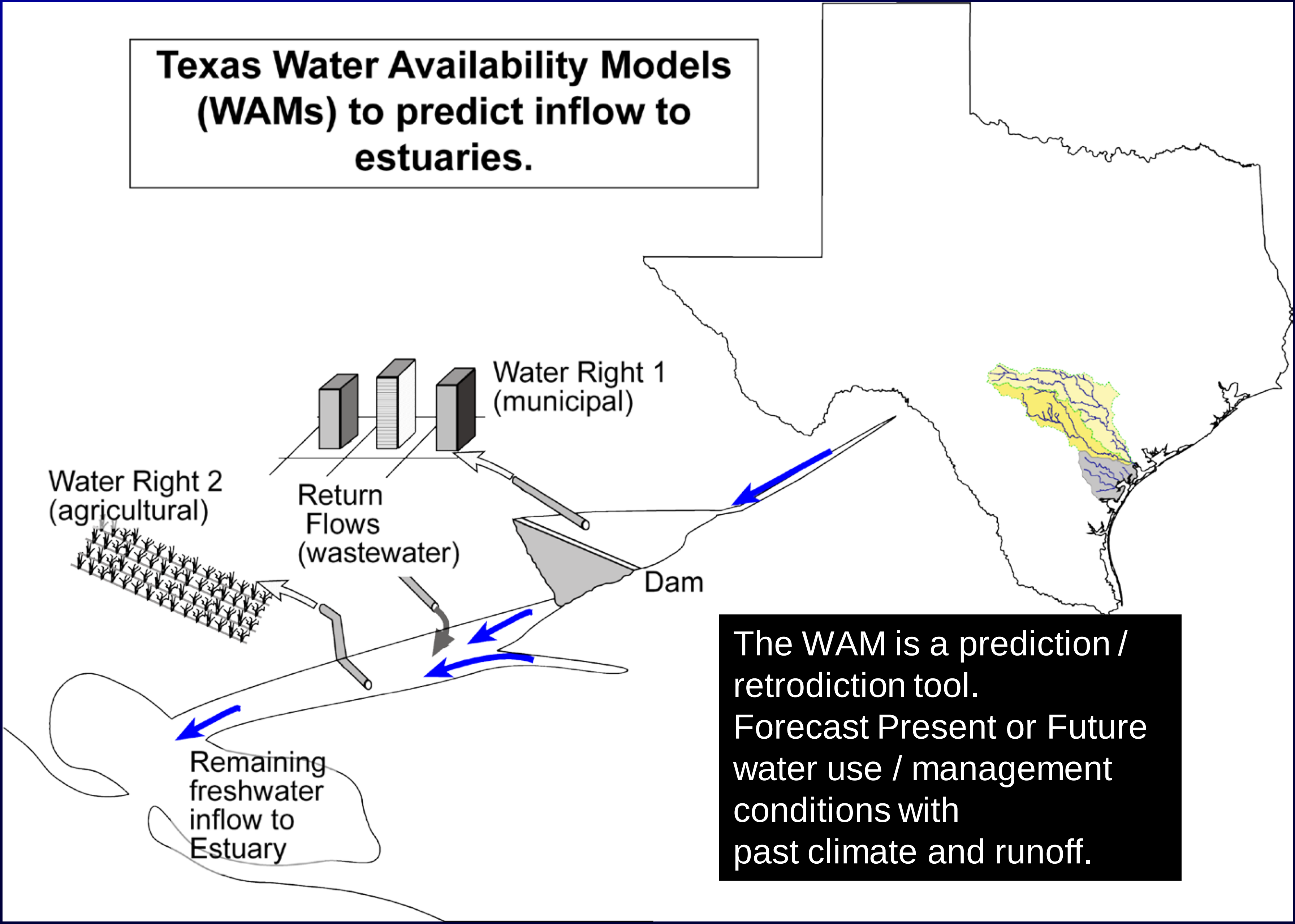
BBEST Guadalupe Estuary criteria: spring & summer



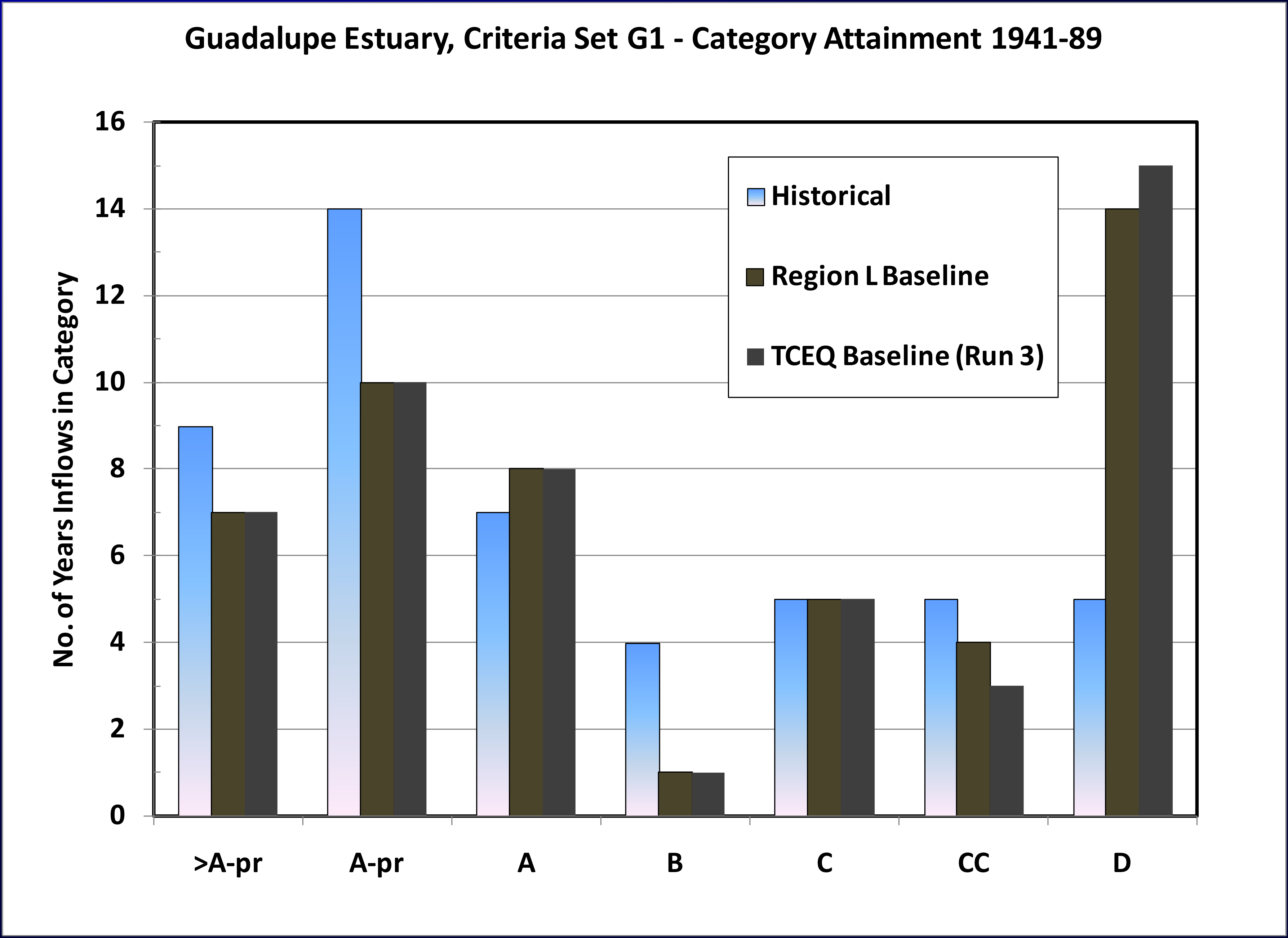
Time Series of Inflows to Guadalupe Estuary Scenarios utilized (@ 04/19) – principal characteristics

	Natural	Historical	Present	Region L	TCEQ Run3
Surface water use/demands	0	historical, transient	max. last 10yr, constant	Full use, constant	Full use, constant
WW Returns	0	historical, transient	min. last 5 yr, constant	recent ('06) levels, constant	0
Edwards Aq. use / mgmt.	0	historical, transient	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.
Data source	model	data	model	model	model
Period of record	1934-1989	1941 - 2009	1934-1989	1934-1989	1934-1989

Texas Water Availability Models (WAMs) to predict inflow to estuaries.



The WAM is a prediction / retrodiction tool.
Forecast Present or Future water use / management conditions with past climate and runoff.



Guadalupe Estuary, Criteria Set G1 - Category Attainment 1941-89
No. of Years Inflows in Category
16
14
12
10
8
6
4
2
0
Historical
Region L Baseline
TCEQ Baseline (Run 3)
>A-pr
A-pr
A
B
C
CC
D

Summary – Attainment of G1 Springtime Criteria (Rangia)

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Natural	9	15	7	6	3	6	3	49
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline	7	10	8	1	5	4	14	49
TCEQ Baseline (Run 3)	7	10	8	1	5	3	15	49

see Tables 4.5-3 & 4.5-6		>12%	>12%				<=9%
Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Natural		30.6%	14.3%	12.2%	6.1%	12.2%	6.1%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline		20.4%	16.3%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

Color coding convention
-OK, met criteria
-Near miss. (rounding; p-o-record)
-Not met, but departure not great
-Very bad

see Table 4.5-3			>17%		>=19%	<=2/3	
Attain. - Joints	Joint G1 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	
Natural			26.5%		18.4%	66.7%	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline			18.4%		18.4%	44.4%	
TCEQ Baseline (Run 3)			18.4%		16.3%	37.5%	

Time Series of Inflows to Guadalupe Estuary Scenarios utilized (@ 04/19) – principal characteristics

	Natural	Historical	Present	Region L	TCEQ Run3
Surface water use/demands	0	historical, transient	max. last 10yr, constant	Full use, constant	Full use, constant
WW Returns	0	historical, transient	min. last 5 yr, constant	recent ('06) levels, constant	0
Edwards Aq. use / mgmt.	0	historical, transient	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.
Data source	model	data	model	model	model
Period of record	1934-1989	1941 - 2009	1934-1989	1934-1989	1934-1989

Summary – Attainment of G1 Springtime Criteria (Rangia)

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline; BBEST	7	10	8	1	5	4	14	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

see Tables 4.5-3 & 4.5-6		>12%	>12%				<=9%
Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Natural		30.6%	14.3%	12.2%	6.1%	12.2%	6.1%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline; BBEST		20.4%	16.3%	2.0%	10.2%	8.2%	28.6%
Region L Baseline; BBASC		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

see Table 4.5-3			>17%		>=19%	<=2/3	
Attain. - Joints	Joint G1 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	
Natural			26.5%		18.4%	66.7%	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline; BBEST			18.4%		18.4%	44.4%	
Region L Baseline; BBASC			22.4%		14.3%	57.1%	
TCEQ Baseline; (Run 3)			18.4%		16.3%	37.5%	

1961: 270 (4/19) -> 279 (BBASC);
1983: 268 (4/19) -> 276 (BBASC)
B – C breakpoint = 275

Both moved from C up to B

Color coding convention	
(green)	-OK, met criteria
(grey)	-Near miss. (rounding; p-o-record)
(orange)	-Not met, but departure not great
(brown)	-Very bad

Summary – Attainment of G2 Summer Criteria (oysters)

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Natural	9	11	15	7	3	2	2	0	49
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline; BBEST	4	8	8	8	6	4	4	7	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

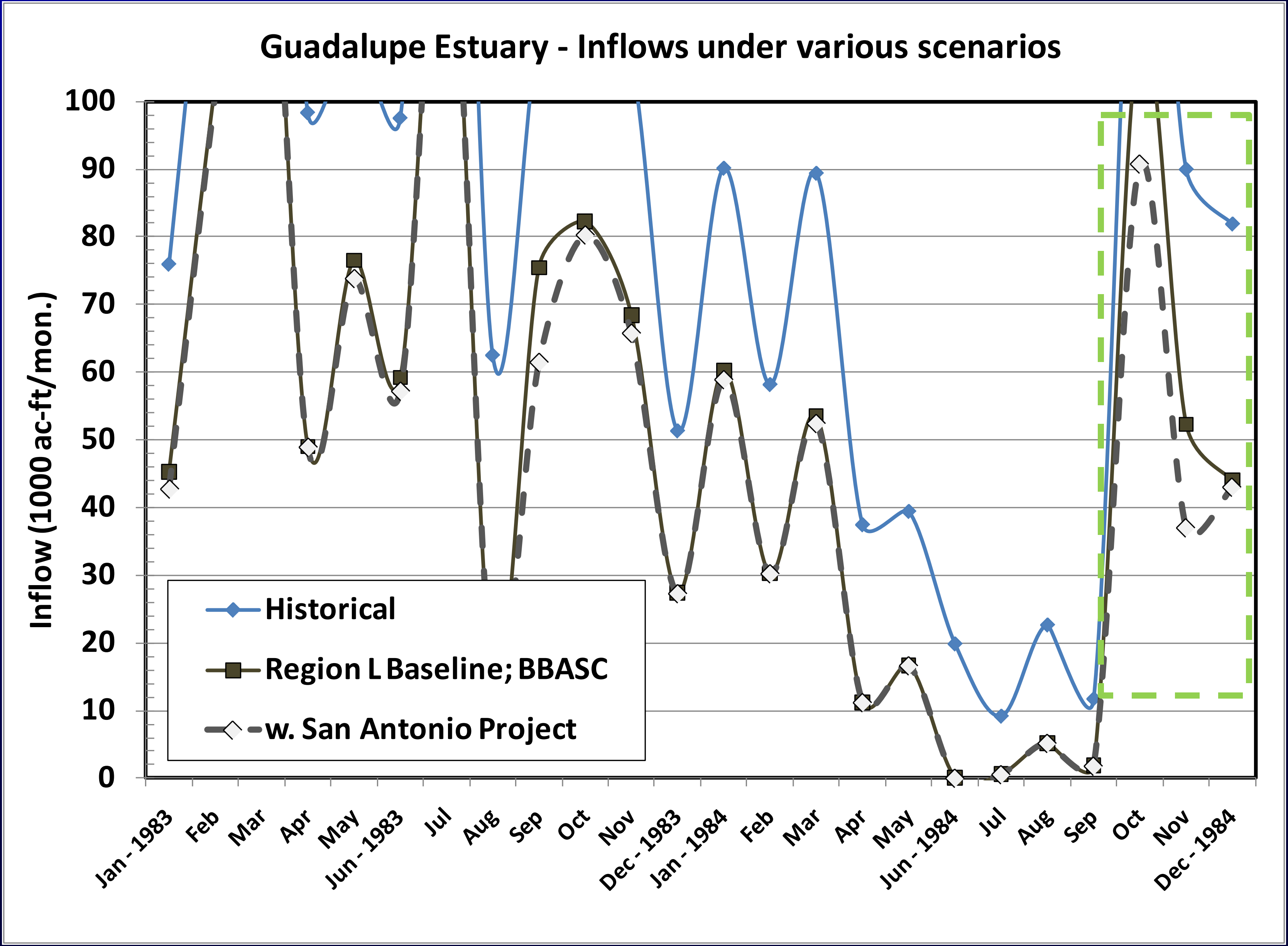
see Tables 4.5-2; 4.5-4		>12%	>17%				<=6%	
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Natural		22.4%	30.6%	14.3%	6.1%	4.1%	4.1%	0.0%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBEST		16.3%	16.3%	16.3%	12.2%	8.2%	8.2%	14.3%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%	
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Natural			44.9%		10.2%	40.0%	4.1%	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline; BBEST			32.7%		20.4%	40.0%	22.4%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

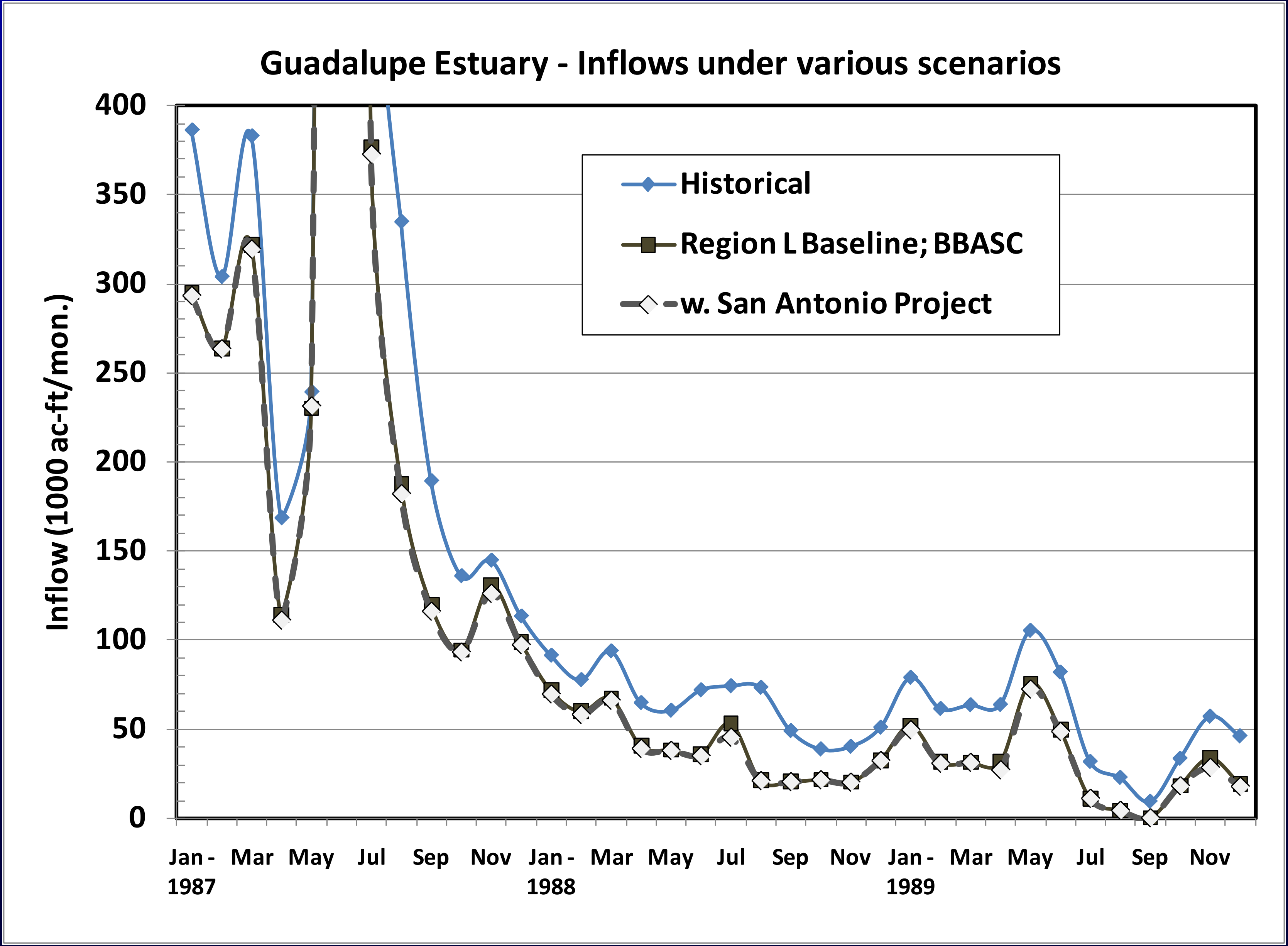
1947 Jun: 48 (4/19) -> 53 (BBASC);
CC – C breakpoint, June = 50
1947 moved from CC up to C

1965, Jul-Sep: 59 (4/19) -> 50 (BBASC)
D- DD breakpoint, Jul-Sep sum = 50
1965 moved from D to DD

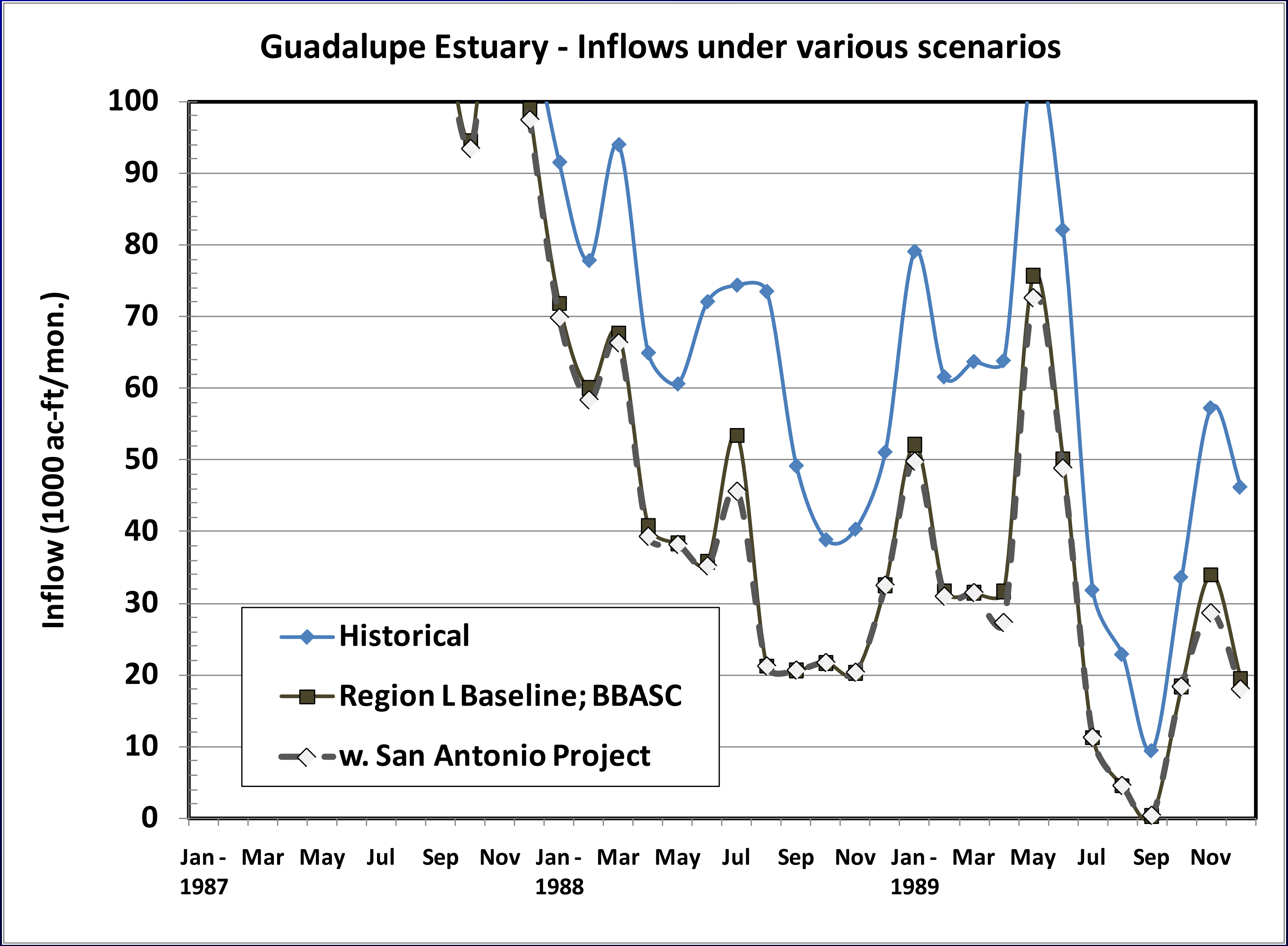
San Antonio River Project Slides



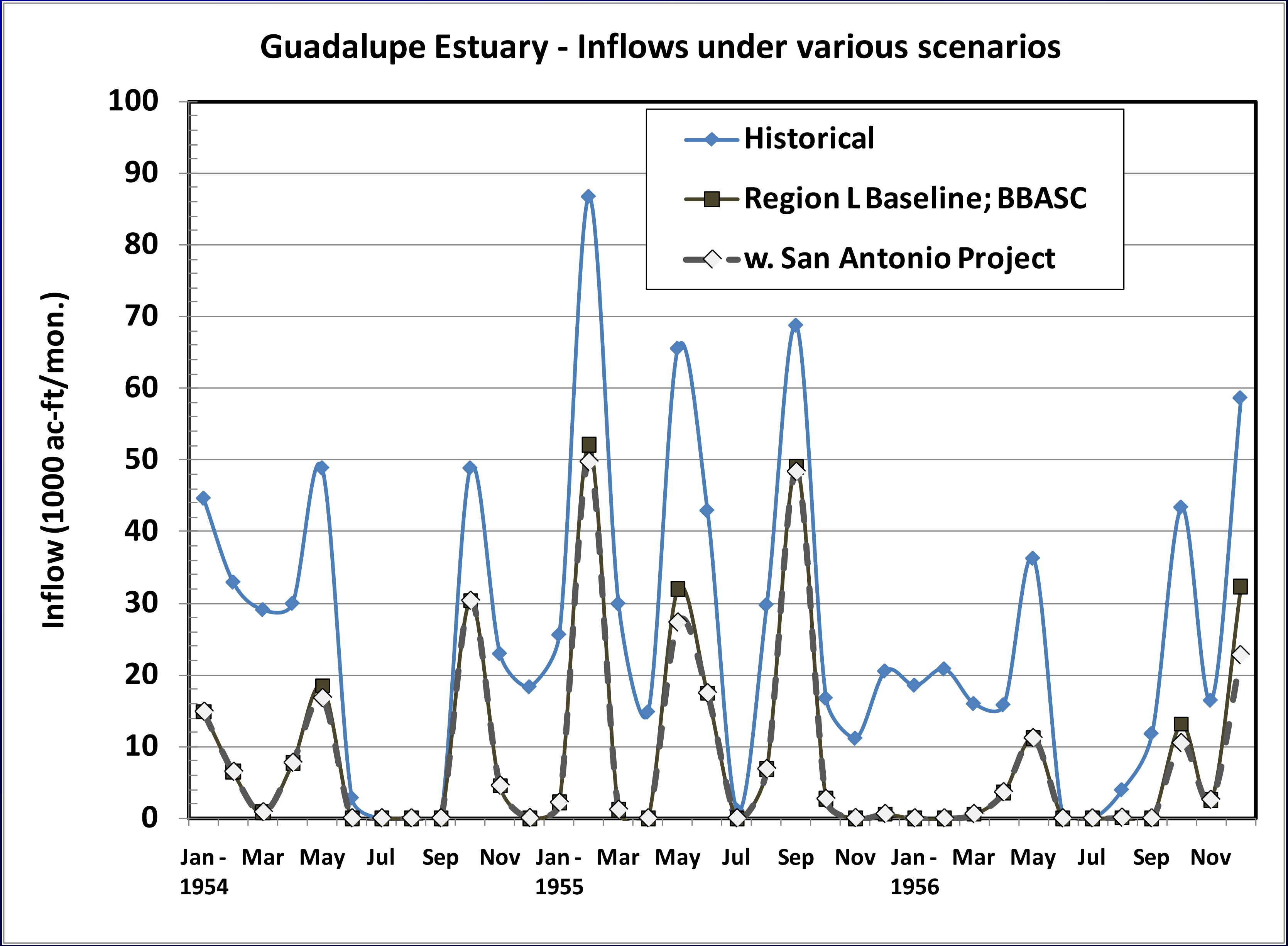
Guadalupe Estuary - Inflows under various scenarios
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Historical
Region L Baseline; BBASC
w. San Antonio Project
Jan - 1983
Feb
Mar
Apr
May
Jun - 1983
Jul
Aug
Sep
Oct
Nov
Dec - 1983
Jan - 1984
Feb
Mar
Apr
May
Jun - 1984
Jul
Aug
Sep
Oct
Nov
Dec - 1984



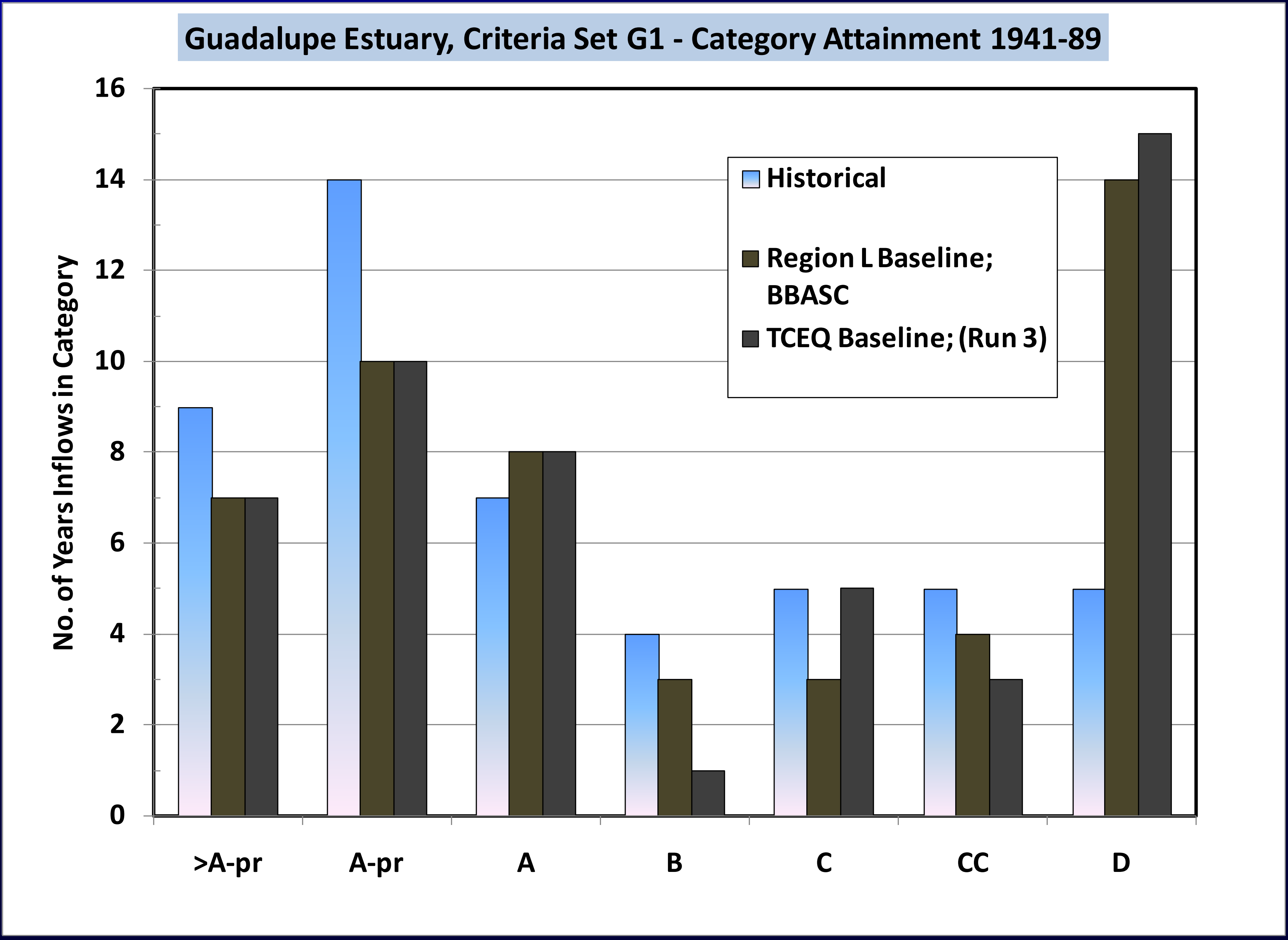
Guadalupe Estuary - Inflows under various scenarios
Historical
Region L Baseline; BBASC
w. San Antonio Project
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov

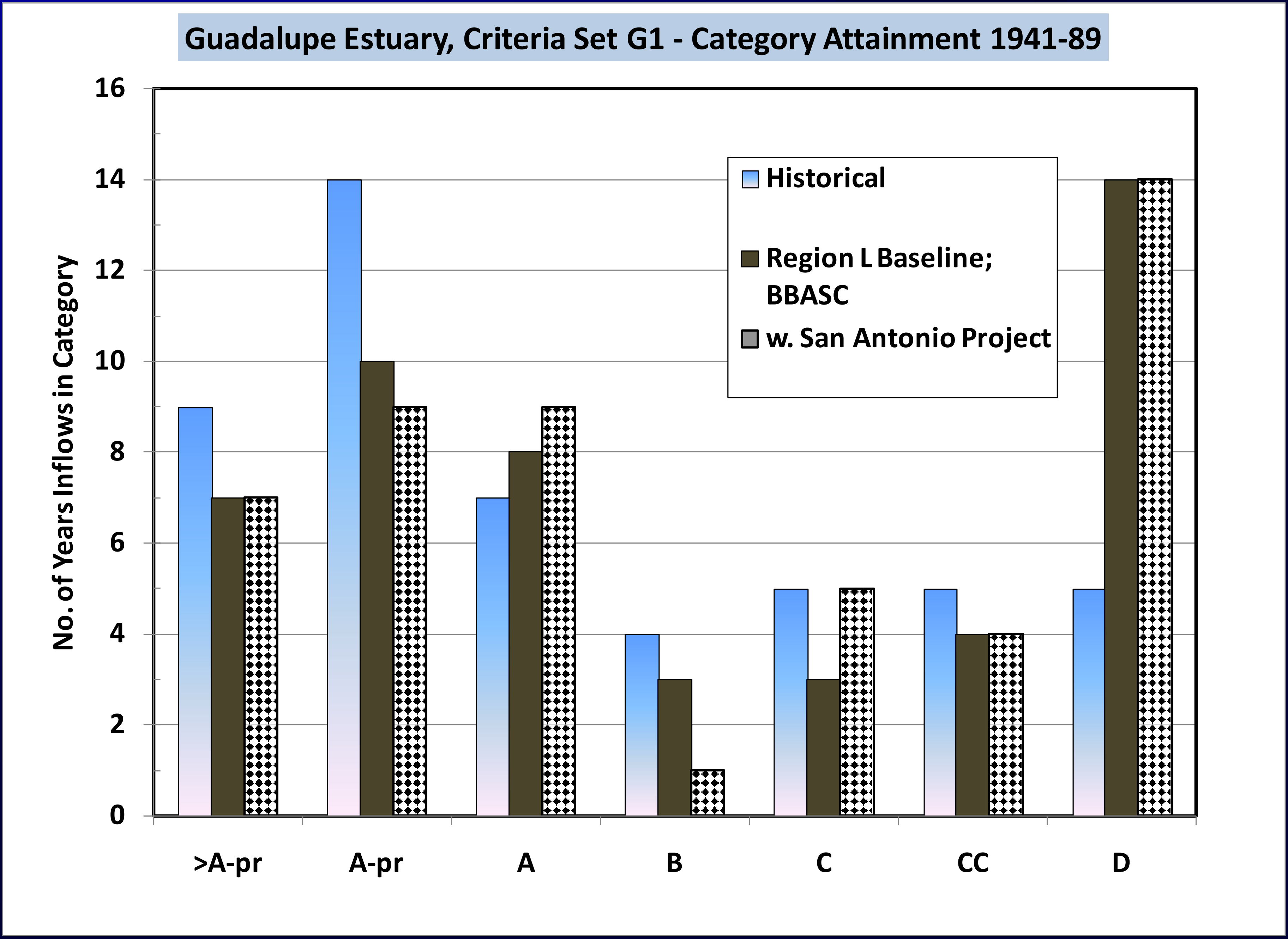


Guadalupe Estuary - Inflows under various scenarios
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov
Historical
Region L Baseline; BBASC
w. San Antonio Project

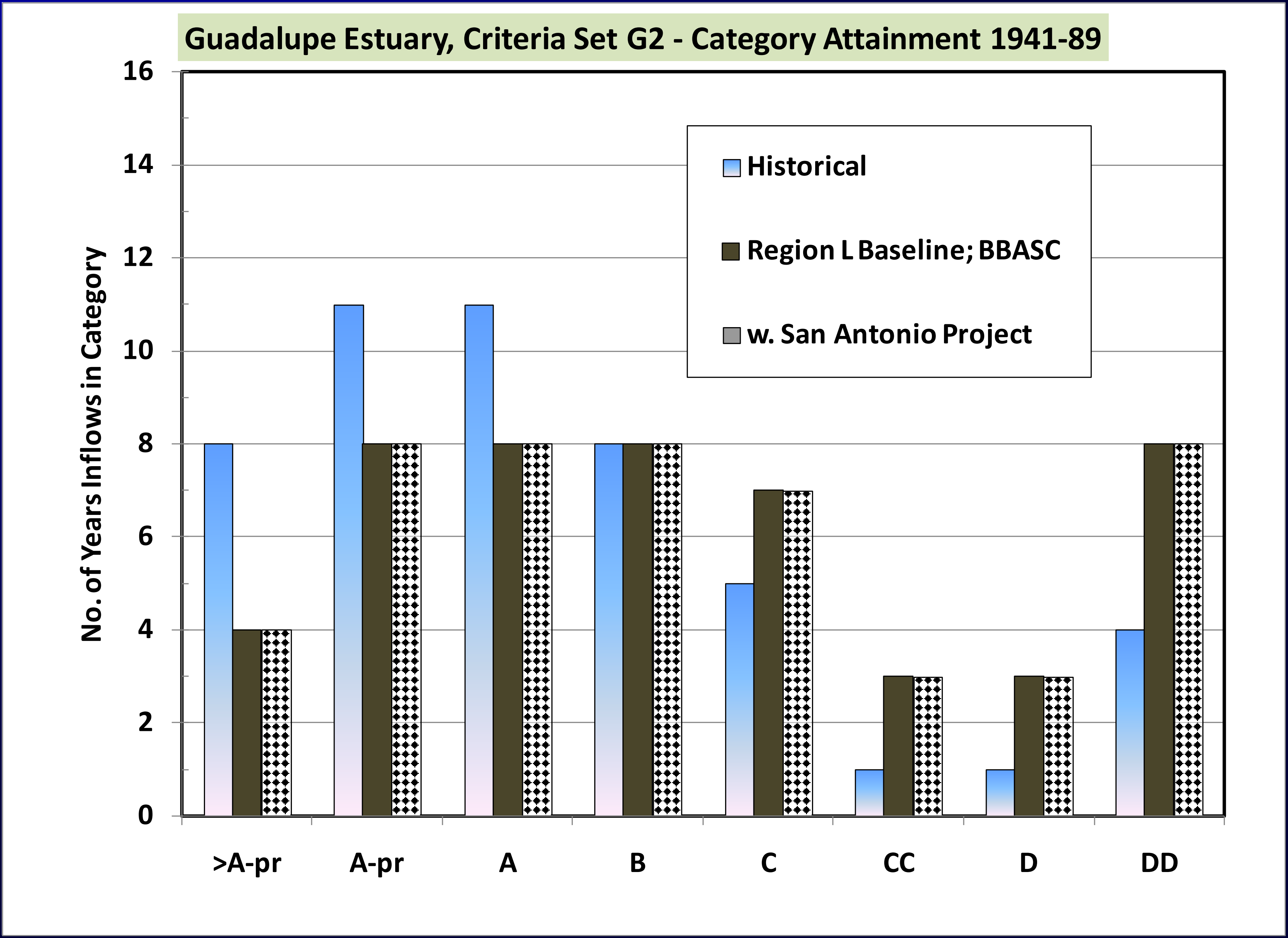


Guadalupe Estuary - Inflows under various scenarios
Historical
Region L Baseline; BBASC
w. San Antonio Project
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1954
Mar
May
Jul
Sep
Nov
Jan - 1955
Mar
May
Jul
Sep
Nov
Jan - 1956
Mar
May
Jul
Sep
Nov


Guadalupe Estuary, Criteria Set G1 - Category Attainment 1941-89
No. of Years Inflows in Category
0
2
4
6
8
10
12
14
16
Historical
Region L Baseline; BBASC
TCEQ Baseline; (Run 3)
>A-pr
A-pr
A
B
C
CC
D



Guadalupe Estuary, Criteria Set G1 - Category Attainment 1941-89
No. of Years Inflows in Category
0
2
4
6
8
10
12
14
16
>A-pr
A-pr
A
B
C
CC
D
Historical
Region L Baseline; BBASC
w. San Antonio Project



Guadalupe Estuary, Criteria Set G2 - Category Attainment 1941-89
No. of Years Inflows in Category
0
2
4
6
8
10
12
14
16
>A-pr
A-pr
A
B
C
CC
D
DD
Historical
Region L Baseline; BBASC
w. San Antonio Project

Summary – Attainment of G1 Springtime Criteria (Rangia) with the San Antonio River Project

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
w. San Antonio Project	7	9	9	1	5	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

see Tables 4.5-3 & 4.5-6		>12%	>12%				<=9%
Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline; BBASC		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. San Antonio Project		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

see Table 4.5-3			>17%		>=19%	<=2/3	
Attain. - Joints	Joint G1 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline; BBASC			22.4%		14.3%	57.1%	
w. San Antonio Project			20.4%		18.4%	44.4%	
TCEQ Baseline; (Run 3)			18.4%		16.3%	37.5%	

Color coding convention	
(green)	-OK, met criteria
(grey)	-Near miss. (rounding; p-o-record)
(orange)	-Not met, but departure not great
(brown)	-Very bad

Summary – Attainment of G2 Summer Criteria (oysters) with the San Antonio River Project

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. San Antonio Project	4	8	8	8	7	3	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

see Tables 4.5-2; 4.5-4		>12%	>17%				<=6%	
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Antonio Project		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%	
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
w. San Antonio Project			32.7%		20.4%	30.0%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

Color coding convention	
(green)	-OK, met criteria
(grey)	-Near miss. (rounding; p-o-record)
(orange)	-Not met, but departure not great
(brown)	-Very bad

Questions, Comments, & Discussion

Guadalupe, San Antonio, Mission, & Aransas Rivers and Mission, Copano, Aransas, & San Antonio Bays Basin and Bay Area Stakeholder Committee (GSA BBASC)

Technical Analyses of GSA BBEST Recommendations – Part 2: Mid-Basin Project

Brian Perkins, PE

Ed Oborny

Norman Johns, PhD

May 4, 2011

Presentation Format

1) Project Description
2) Project Hydrology: Firm Yield
3) Project Cost
4) Instream Ecology
5) Estuary Ecology

6) Questions / Clarifications

7) Discussion by the BBASC

Mid-Basin Project

Mid-Basin Project

- Diversions from Guadalupe River @ Gonzales
- Maximum Diversion Rate of 500 cfs
- 2 - 96-inch Diversion Pipelines
- 105,500 acft of Off-Channel Storage near Goliad
- Uniform Delivery of Firm Yield to Luling and San Marcos WTPs

- Scenarios:
  - No Environmental Flow
  - Lyons Method
  - CCEFN
  - BBEST Recommendations

Mid-Basin Project

- **No Environmental Flow**
  - **Theoretical maximum firm yield of project subject to downstream senior water rights only.**
- **Lyons Method**
  - **TCEQ desktop environmental flow used in permitting. Uses 40% (Oct – Feb) and 60% (Mar – Sept) of monthly medians as flow criteria.**
- **Consensus Criteria for Environmental Flow Needs (CCEFN)**
  - **TWDB default 3-tiered (Medians, Quartiles, and 7Q2) flow criteria used in regional planning.**
- **BBEST Recommendations**
  - **Full flow regime recommendation of the GSA BBEST.**

Mid-Basin Project

- No Environmental Flow (cfs)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

- Lyons Method (cfs)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
398.2	399.0	668.8	794.8	839.7	766.2	544.2	443.5	499.3	366.6	345.3	333.2

- Consensus Criteria for Environmental Flow Needs (CCEFN) (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Median	820.6	887.5	867.3	923.5	1068.6	945.0	755.3	641.0	691.8	733.1	742.6	793.7
Quartile	580.3	610.0	585.9	581.1	625.8	576.5	545.0	545.0	545.0	545.0	545.0	531.8
7Q2	545.0	545.0	545.0	545.0	545.0	545.0	545.0	545.0	545.0	545.0	545.0	545.0

Mid-Basin Project

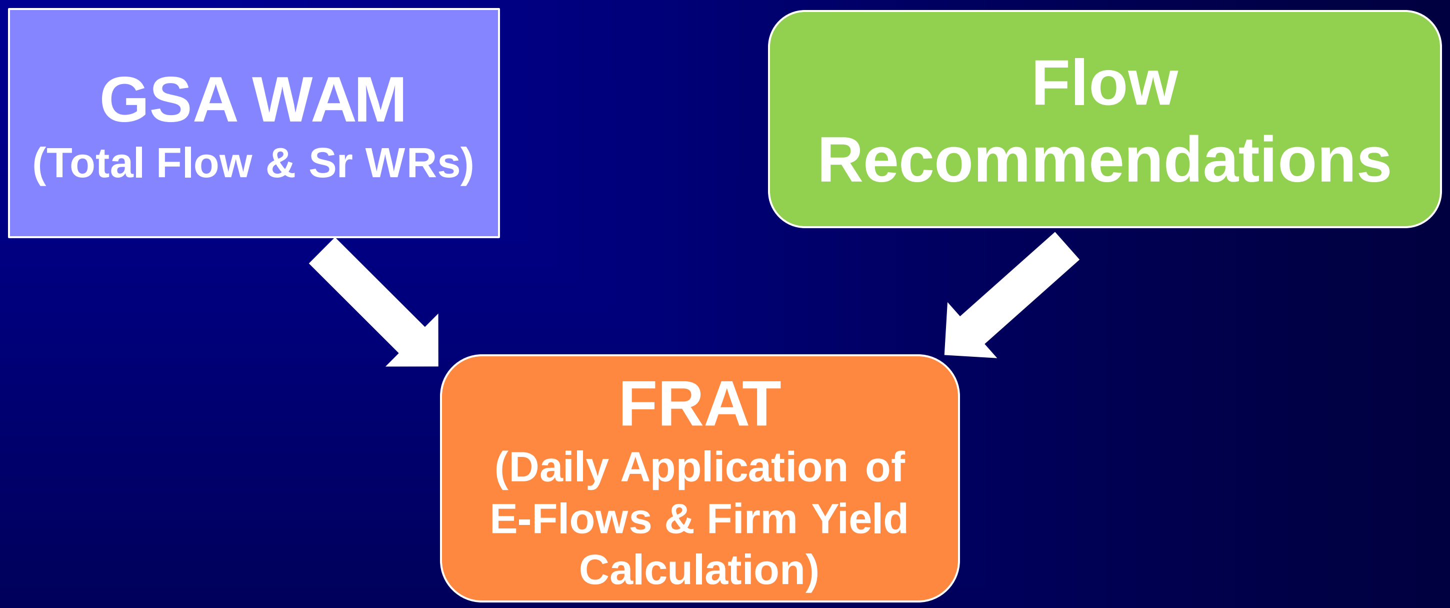
BBEST Recommendations

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 36,700 cfs with Average Frequency 1 per 5 years Regressed Volume is 492,000 Duration Bound is 70			
Overbank Flows	Qp: 24,400 cfs with Average Frequency 1 per 2 years Regressed Volume is 306,000 Duration Bound is 57			
Overbank Flows	Qp: 14,300 cfs with Average Frequency 1 per year Regressed Volume is 165,000 Duration Bound is 43			
High Flow Pulses	Qp: 4,140 cfs with Average Frequency 1 per season Regressed Volume is 48,300 Duration Bound is 29	Qp: 6,590 cfs with Average Frequency 1 per season Regressed Volume is 58,400 Duration Bound is 24	Qp: 1,760 cfs with Average Frequency 1 per season Regressed Volume is 14,800 Duration Bound is 14	Qp: 4,330 cfs with Average Frequency 1 per season Regressed Volume is 41,200 Duration Bound is 23
High Flow Pulses	Qp: 1,150 cfs with Average Frequency 2 per season Regressed Volume is 9,640 Duration Bound is 13	Qp: 3,250 cfs with Average Frequency 2 per season Regressed Volume is 26,900 Duration Bound is 17	Qp: 950 cfs with Average Frequency 2 per season Regressed Volume is 7,060 Duration Bound is 10	Qp: 1,410 cfs with Average Frequency 2 per season Regressed Volume is 11,400 Duration Bound is 13
Base Flows (cfs) – High	860	870	800	810
Base Flows (cfs) – Medium	690	650	650	690
Base Flows (cfs) – Low	540	440	440	510
Subsistence Flows (cfs)	210	210	210	180

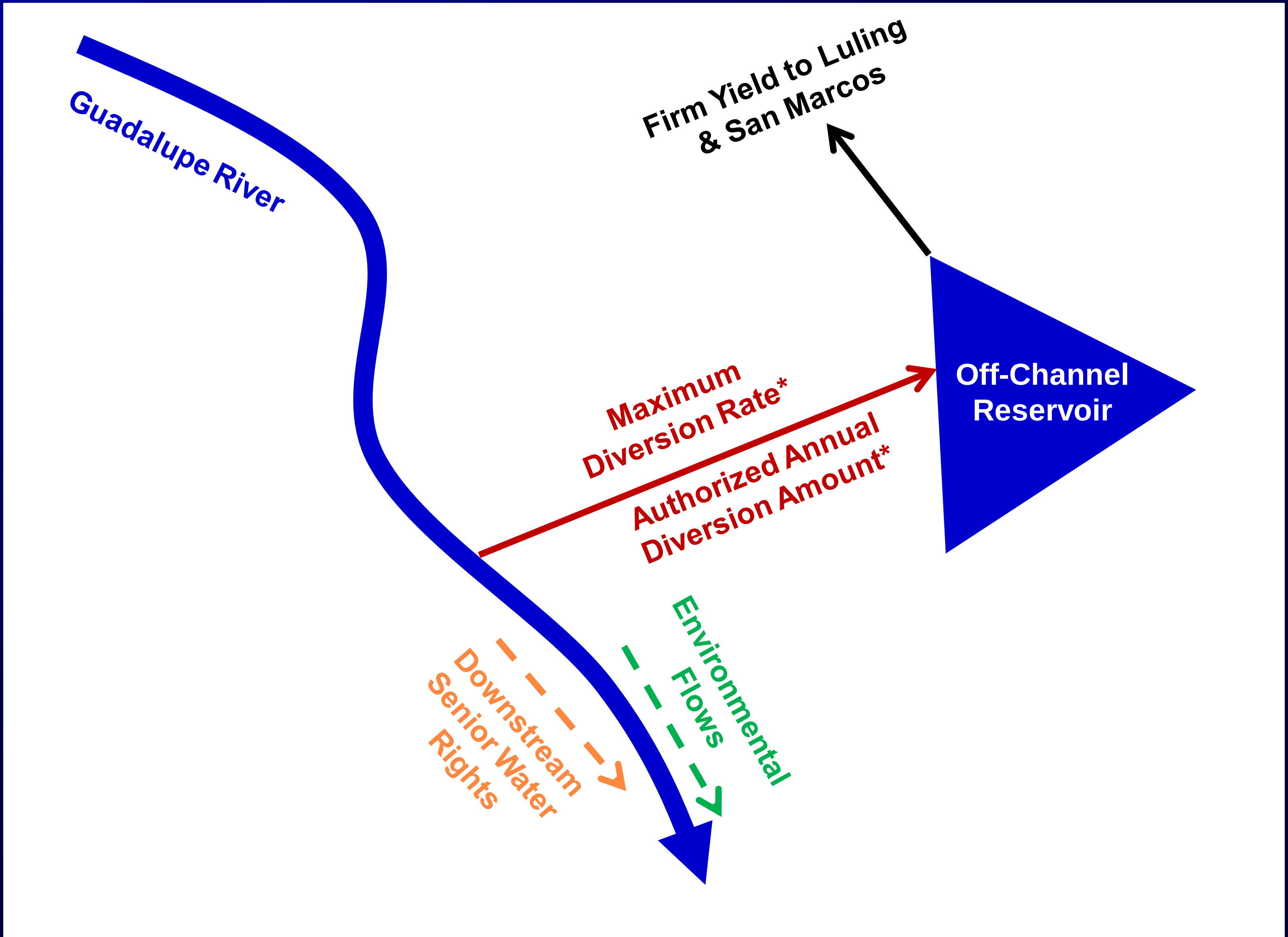
Flow Levels	
	High (75th %ile)
	Medium (50th %ile)
	Low (25th %ile)
	Subsistence

Notes:
1. Period of Record used : 1/1/1940 to 12/31/2009.
2. Volumes are in acre-feet and durations are in days.

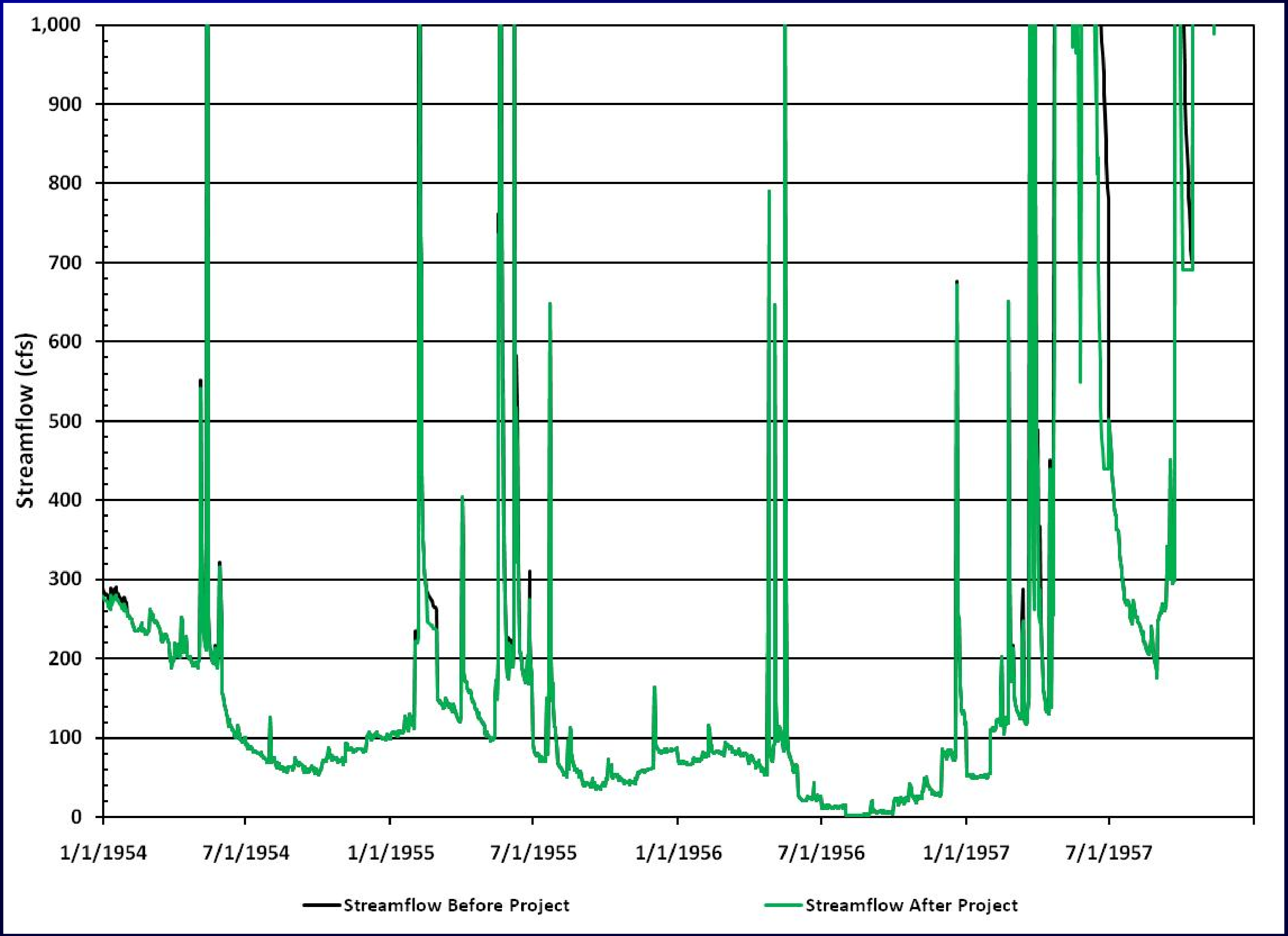
Mid-Basin Project



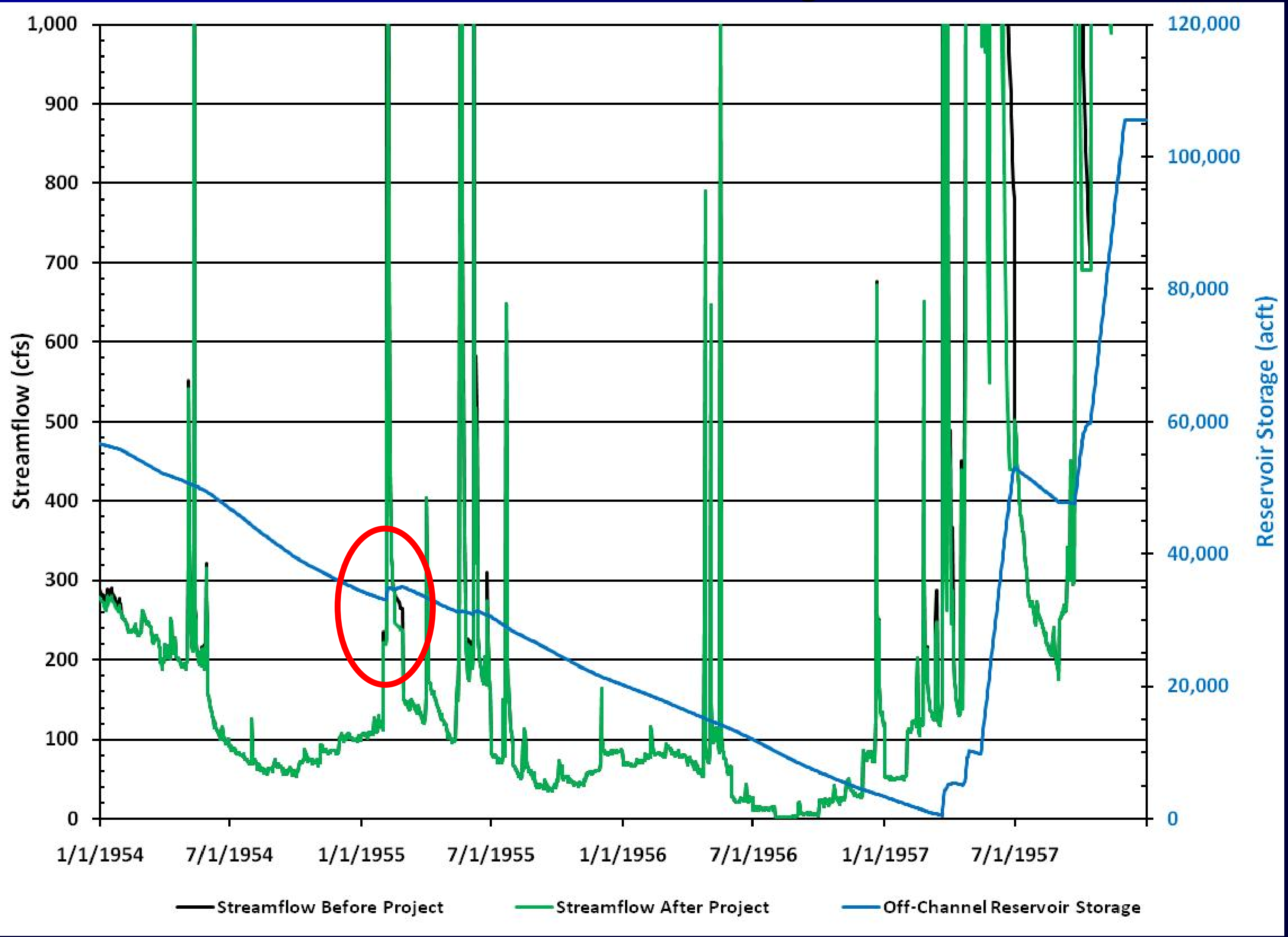
Mid-Basin Project



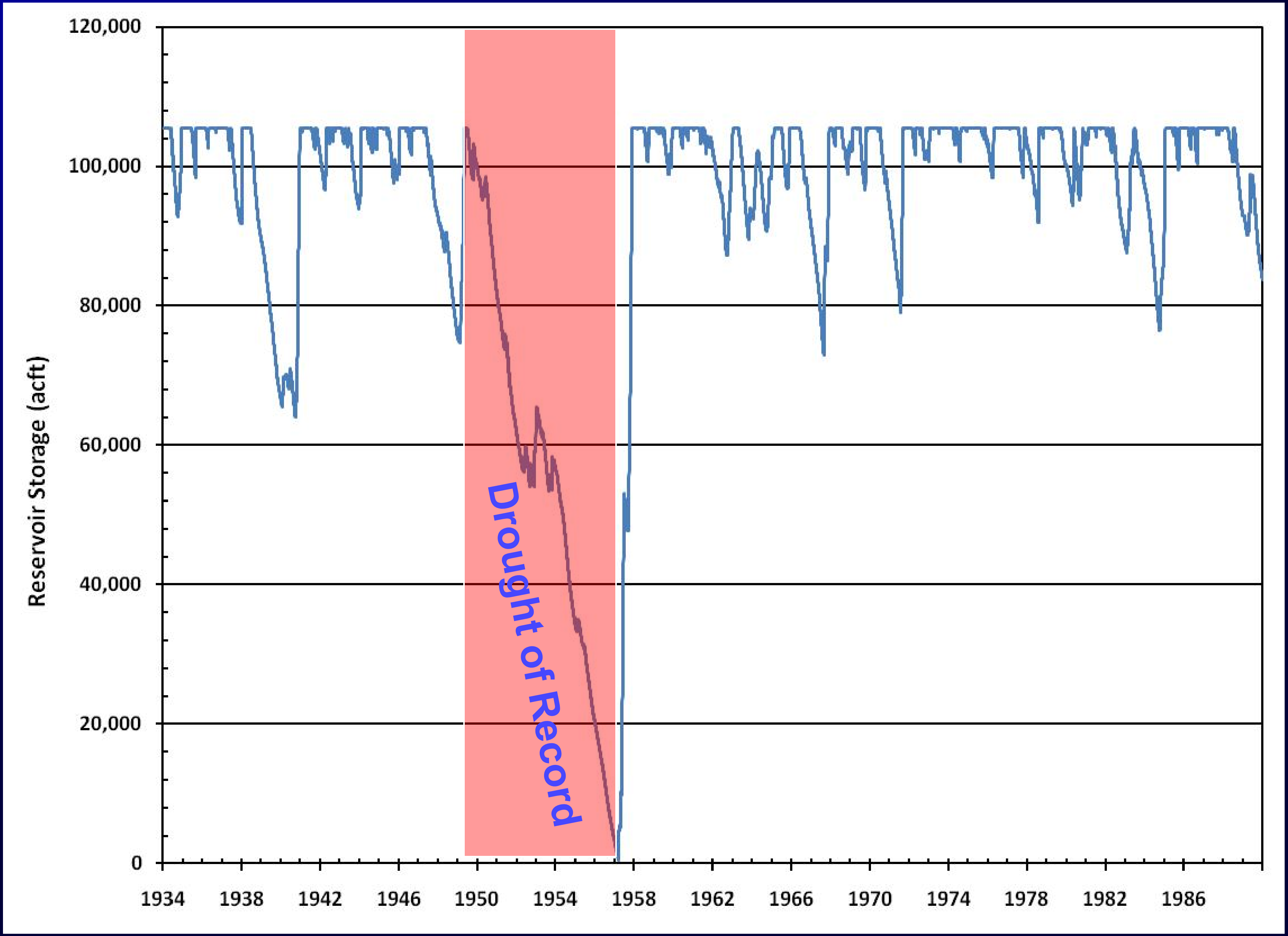
Mid-Basin Project



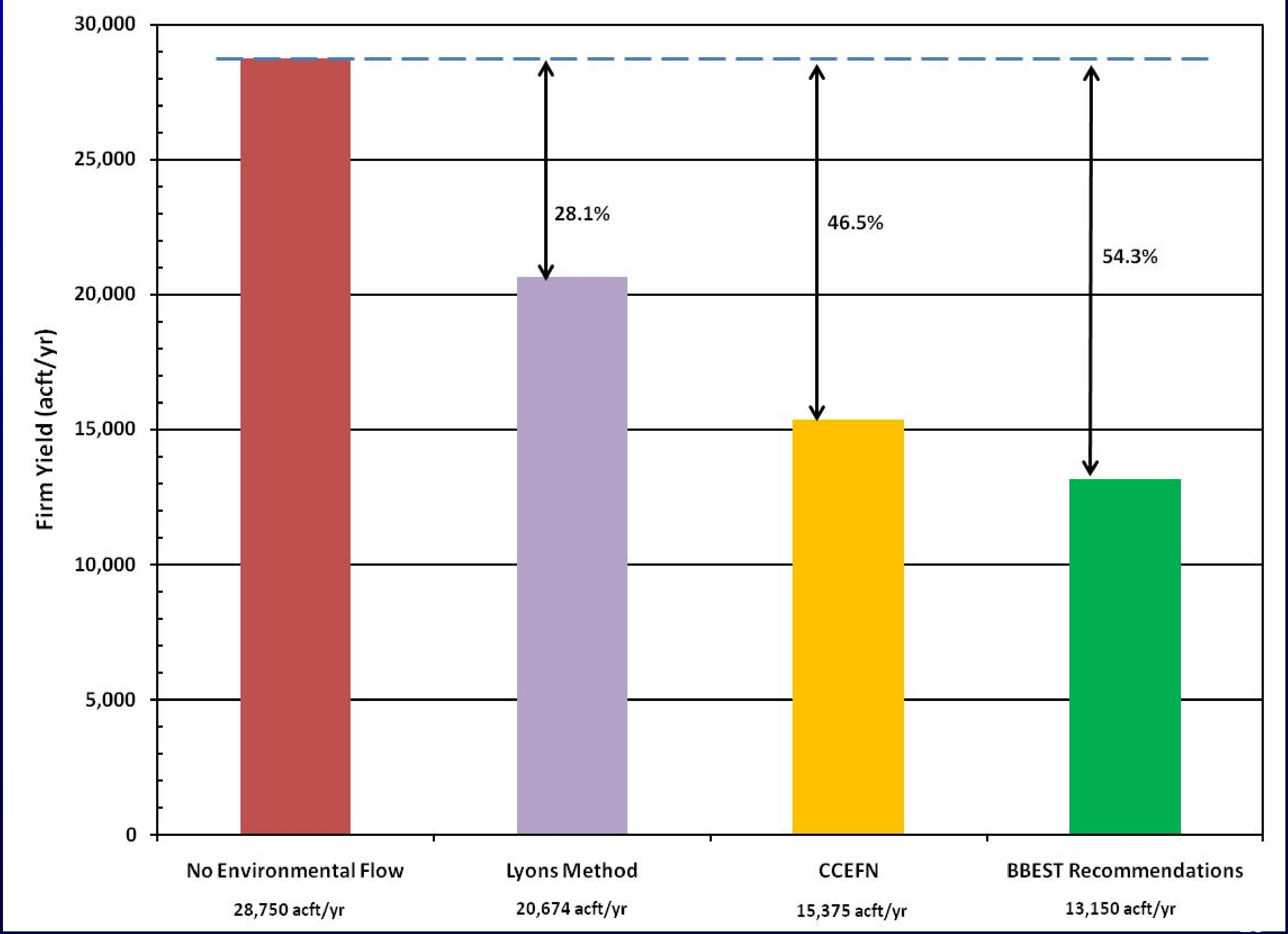
Mid-Basin Project



Mid-Basin Project



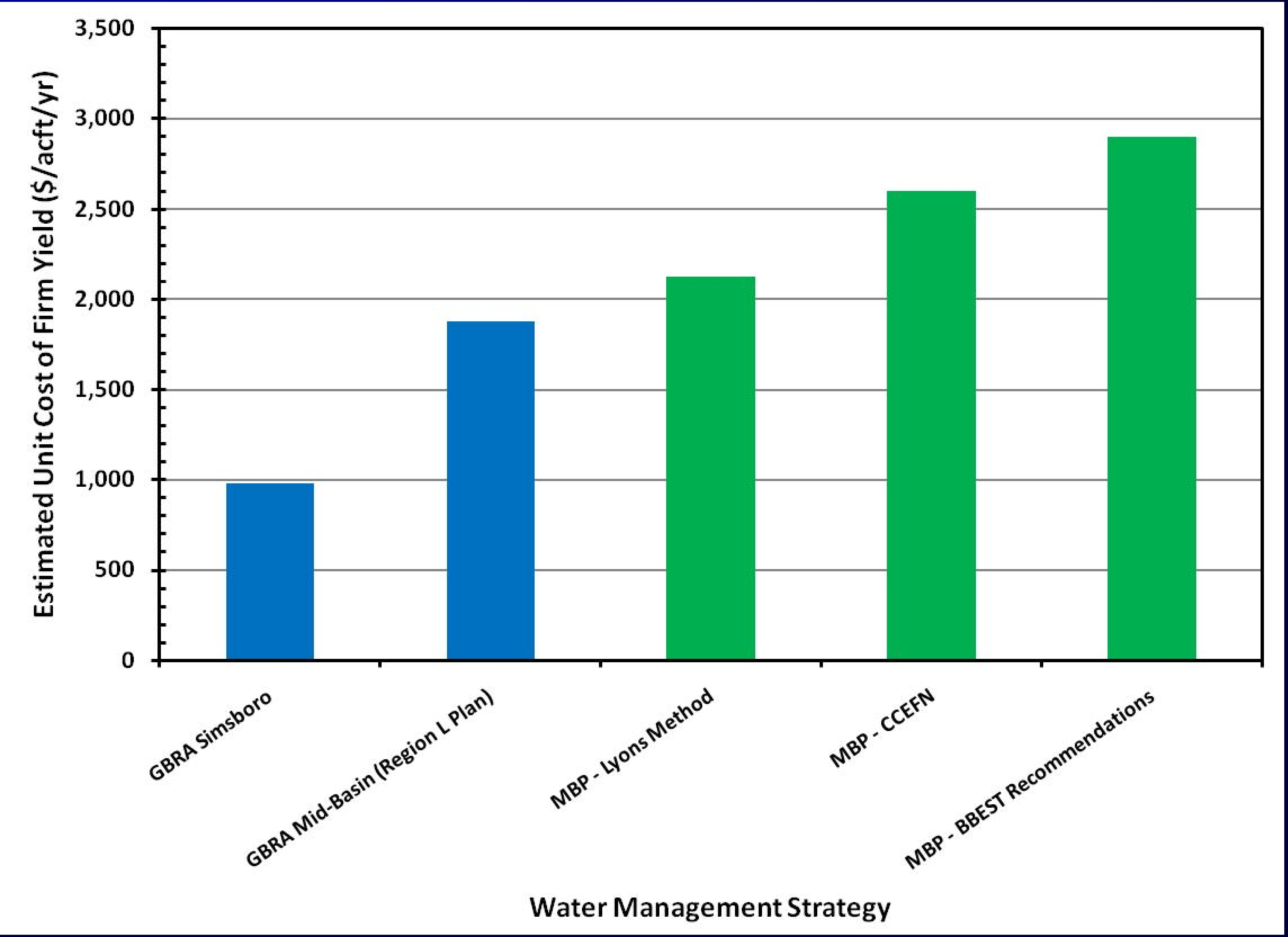
Mid-Basin Project



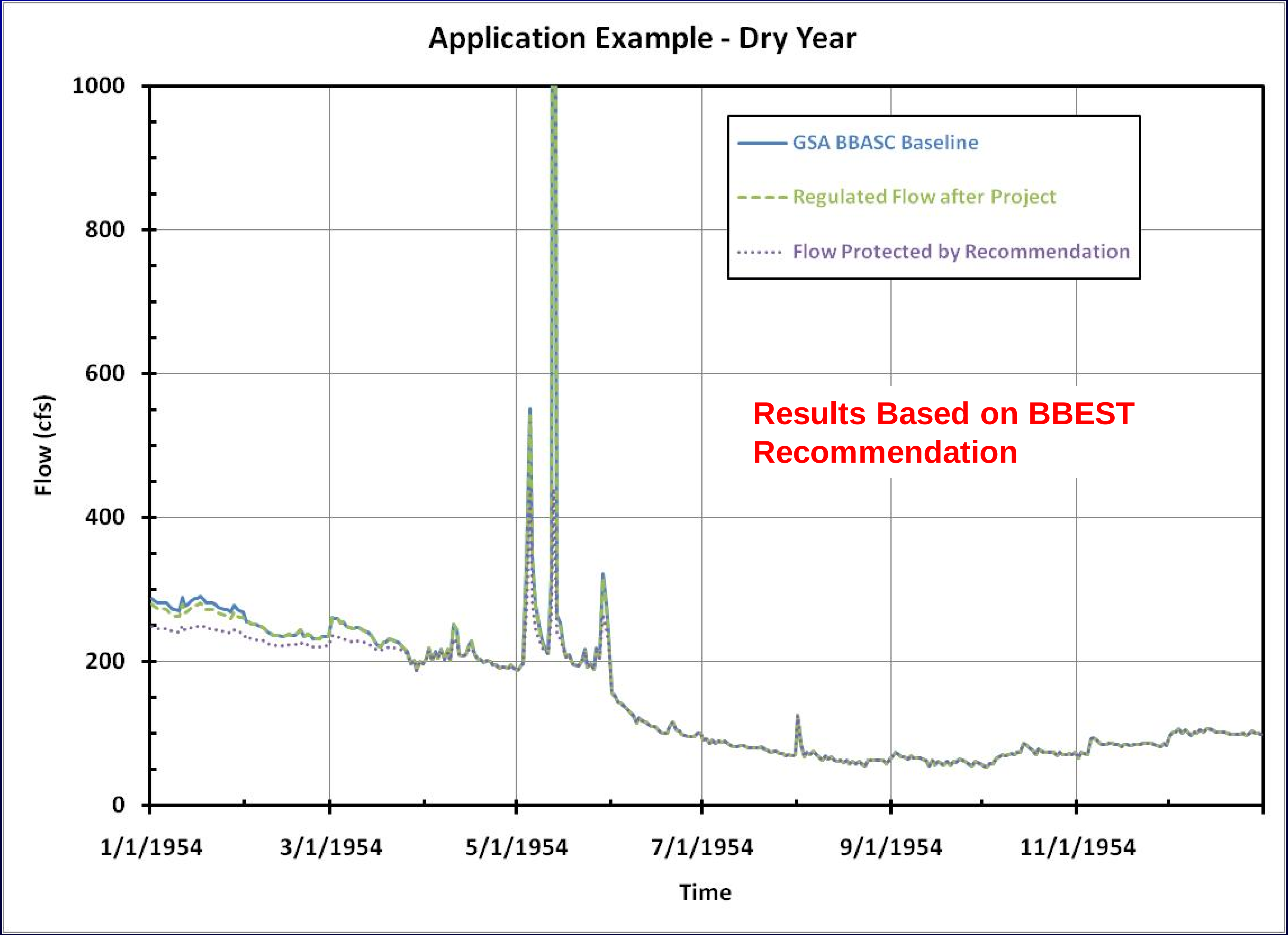
Mid-Basin Project

	No Environmental Flow	Lyons Method	CCEFN	BBEST Recommendation
Available Project Yield (acft/yr)	28,750	20,674	15,375	13,150
Raw Water at Reservoir				
Total Project Cost	$262,321,000	$262,321,000	$262,321,000	$262,321,000
Total Annual Cost	$23,929,000	$23,875,000	$23,657,000	$23,584,000
Annual Cost of Raw Water ($ per acft)	$832	$1,155	$1,539	$1,793
Annual Cost of Raw Water ($ per 1,000 gallons)	$2.55	$3.54	$4.72	$5.50
Treated Water Delivered				
Total Project Cost	$485,924,000	$424,777,000	$395,727,000	$380,758,000
Total Annual Cost	$50,735,000	$43,913,000	$39,933,000	$38,145,000
Annual Cost of Water ($ per acft)	$1,765	$2,124	$2,597	$2,901
Annual Cost of Water ($ per 1,000 gallons)	$5.42	$6.52	$7.97	$8.90

Mid-Basin Project



Mid-Basin Project



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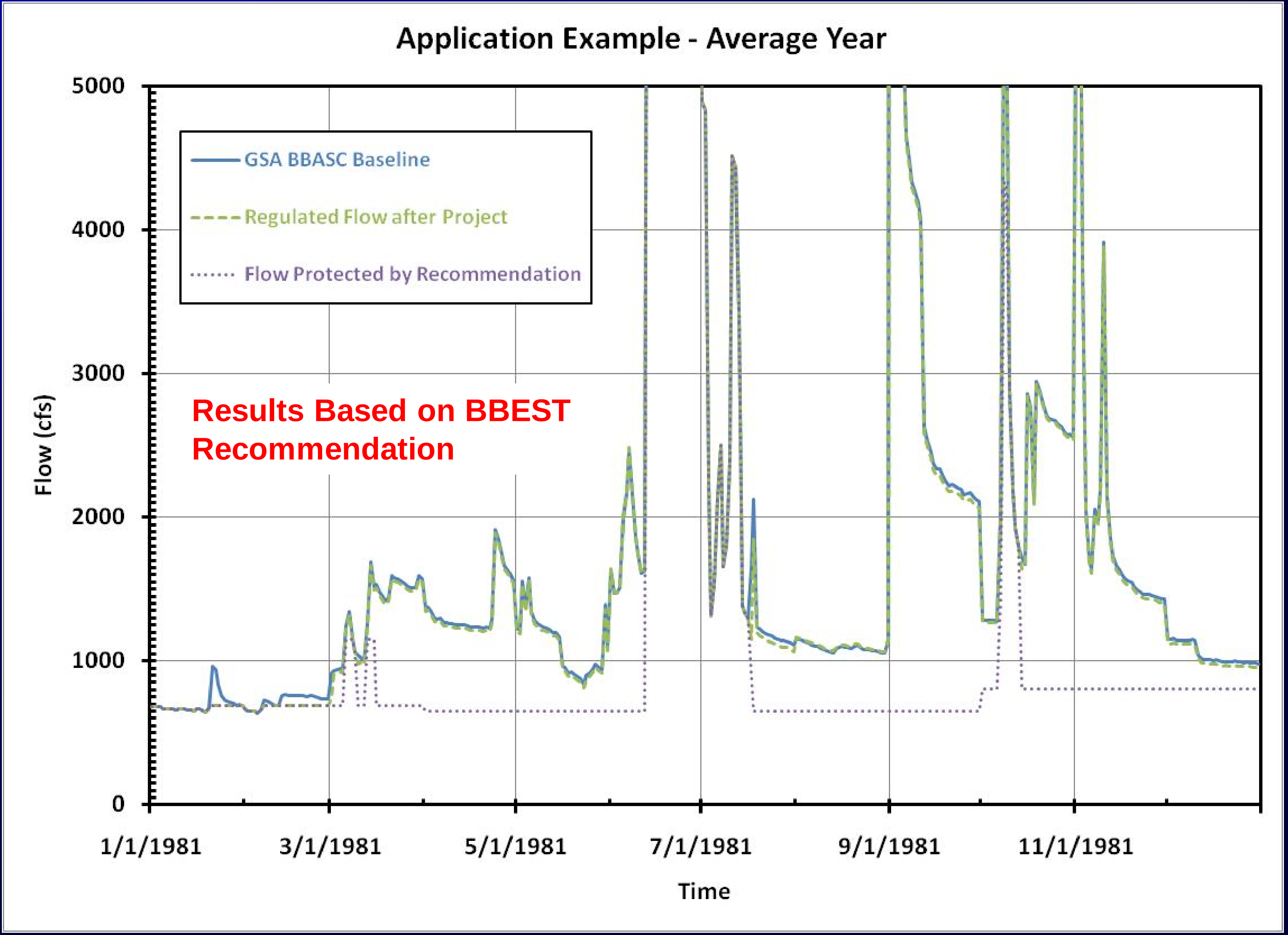
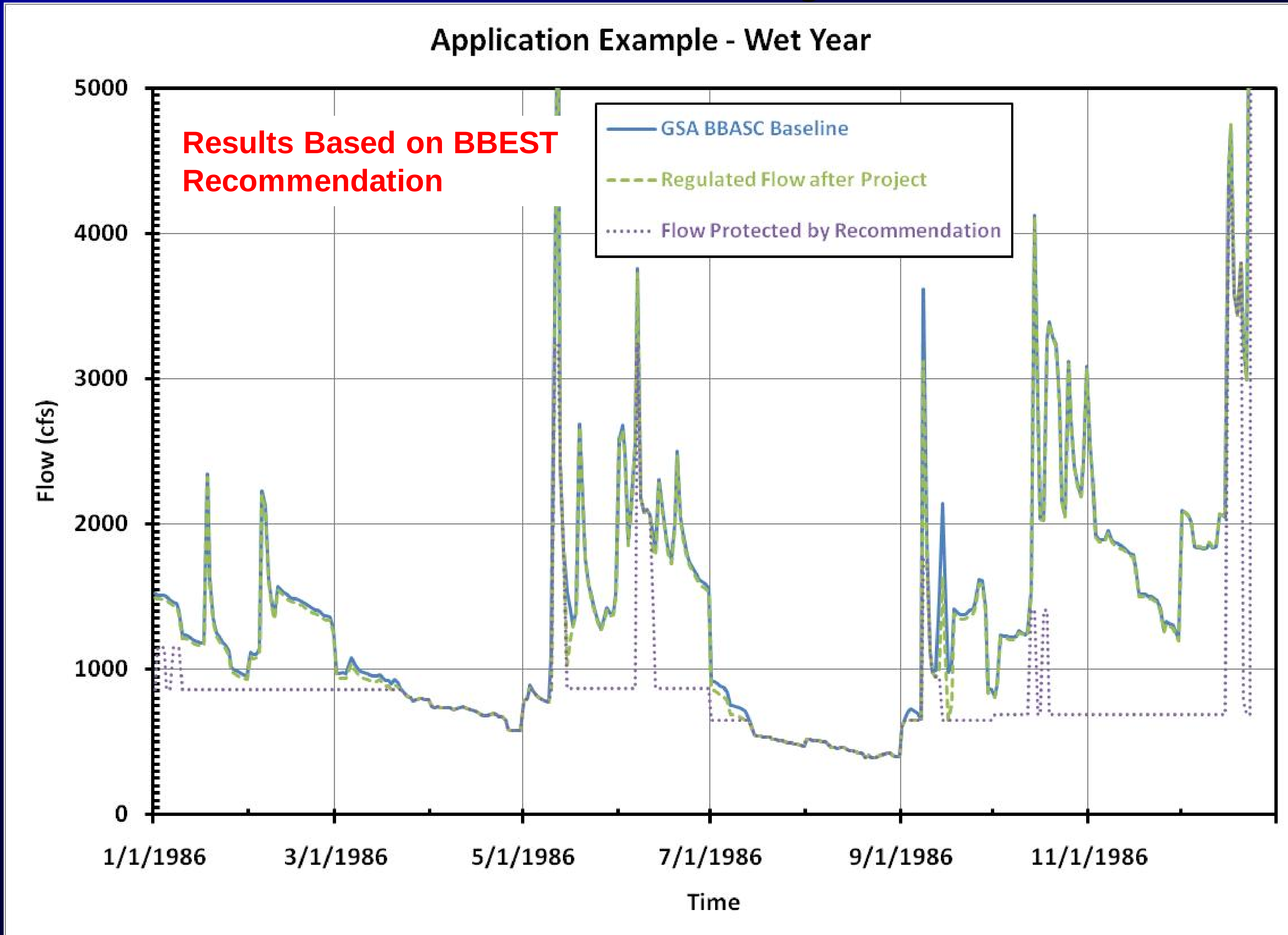
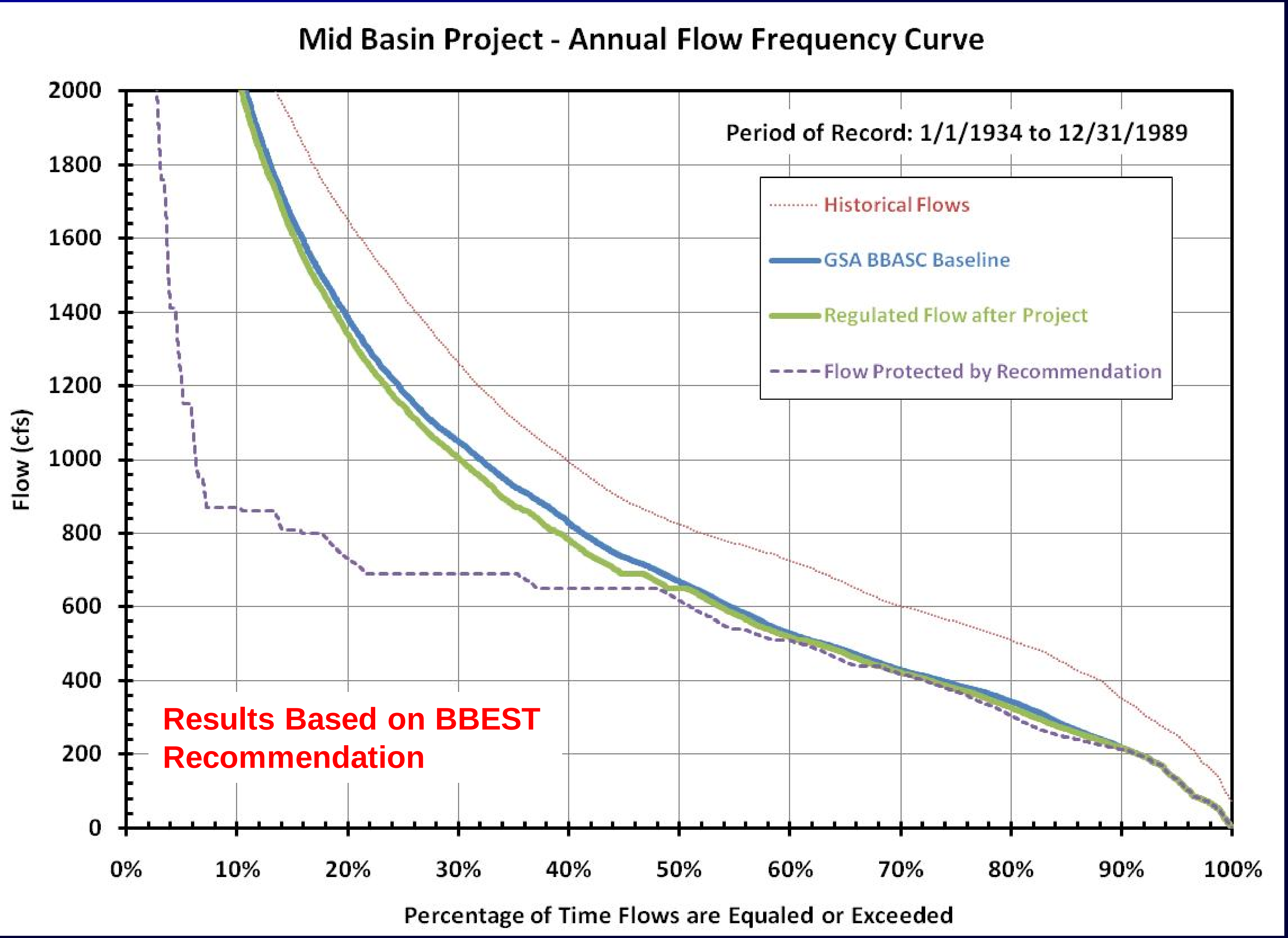


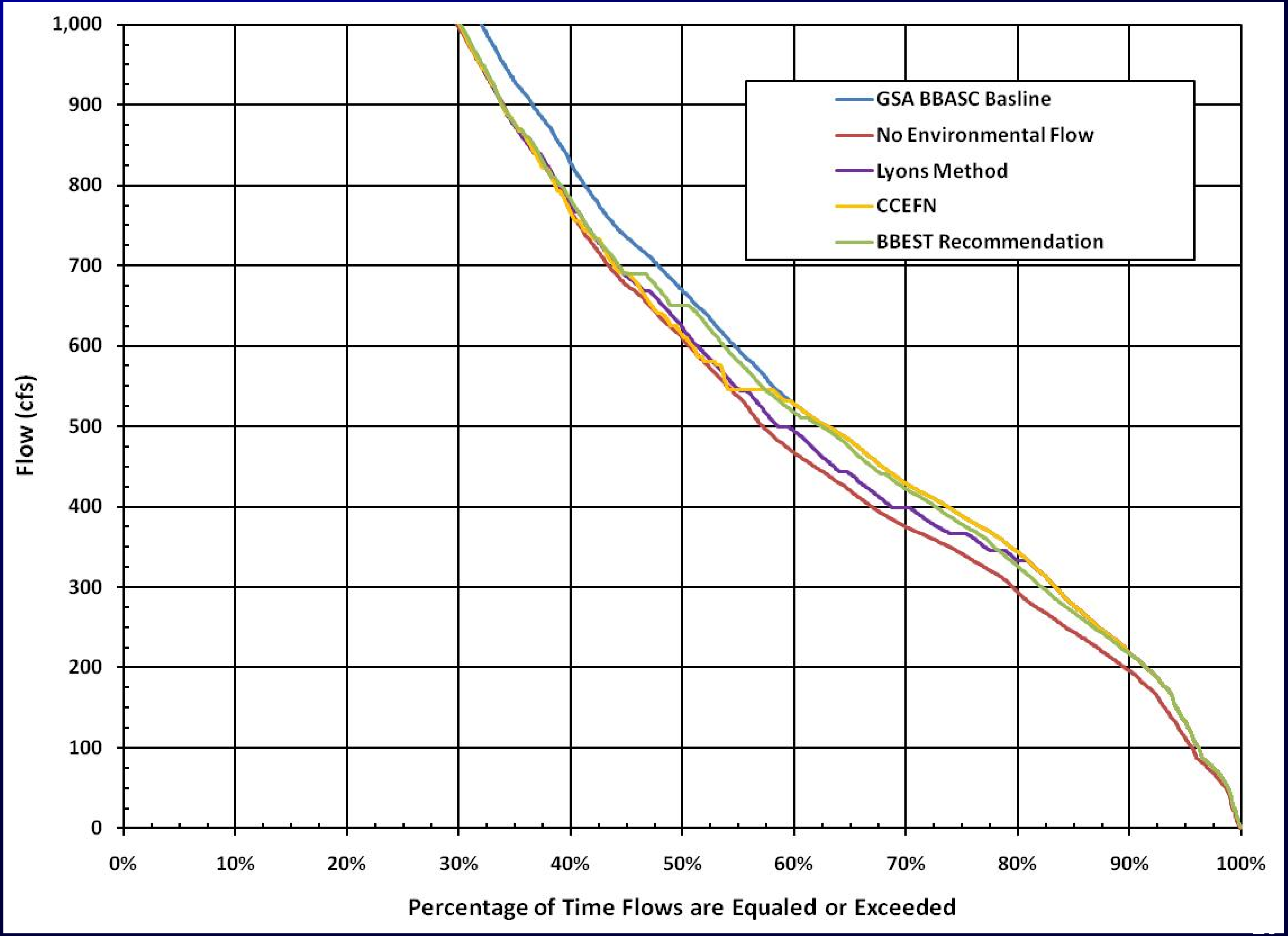
Mid-Basin Project



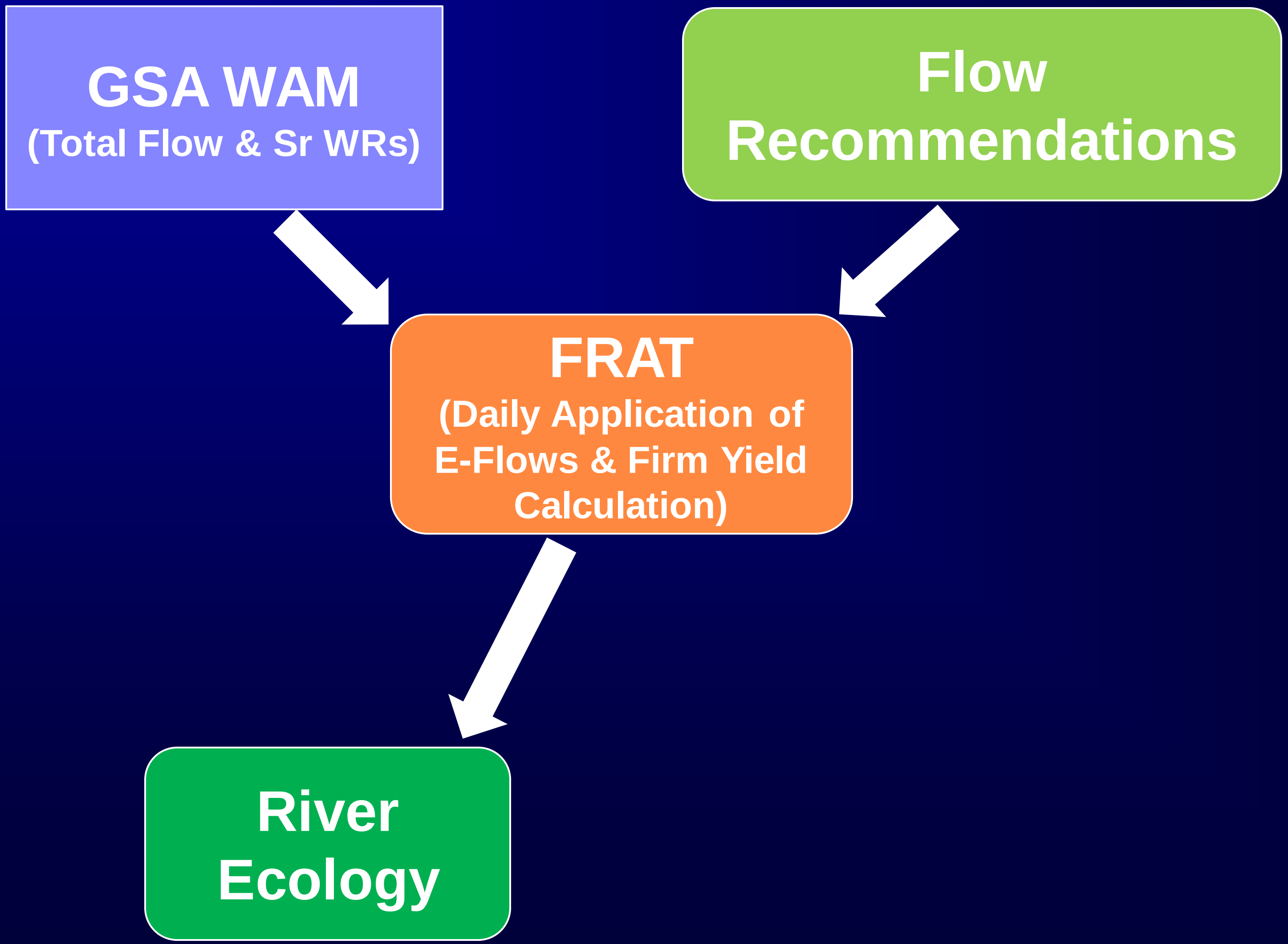
Mid-Basin Project



Mid-Basin Project



Mid-Basin Project

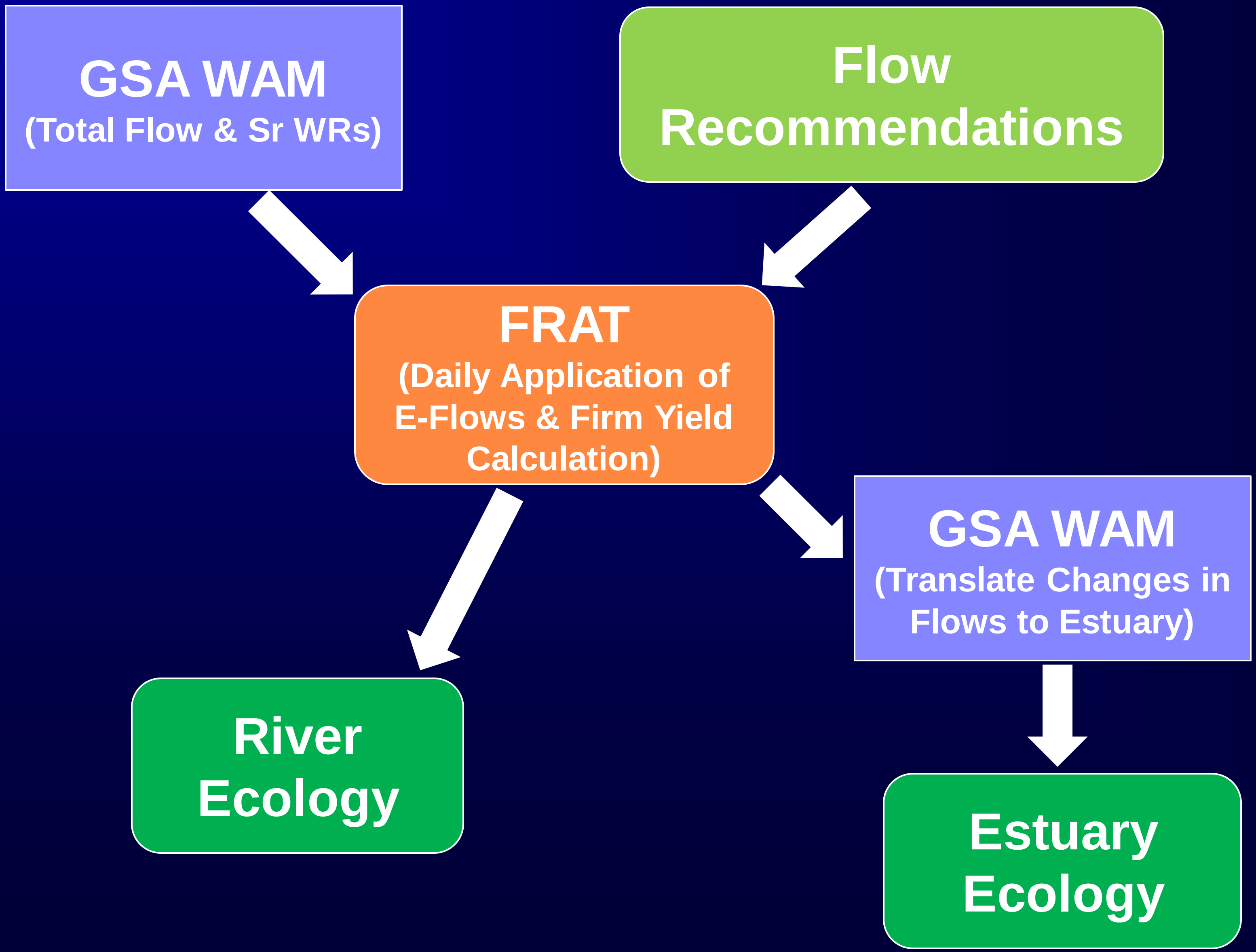


Mid-Basin Project

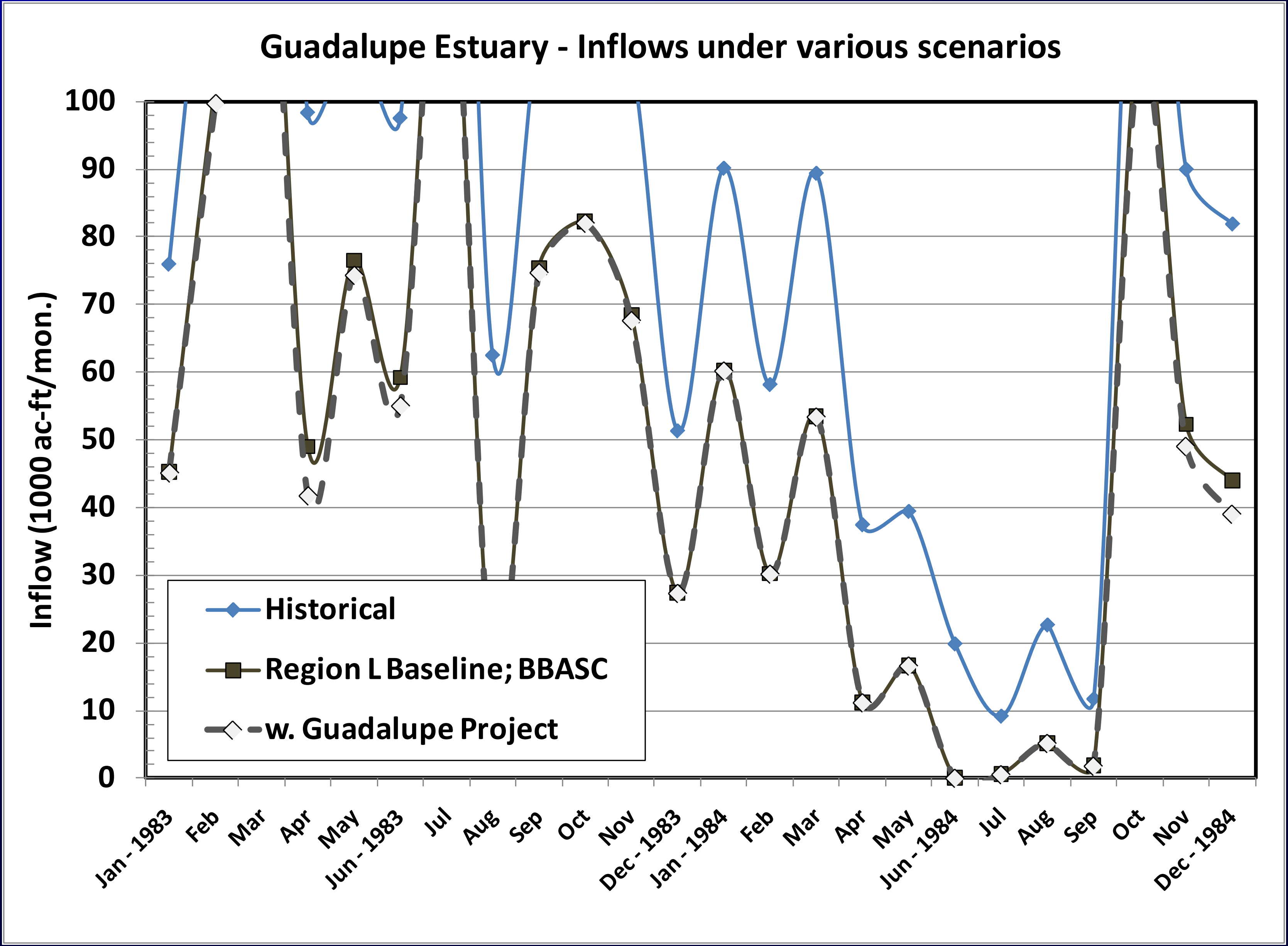
BIO-WEST

Presentation

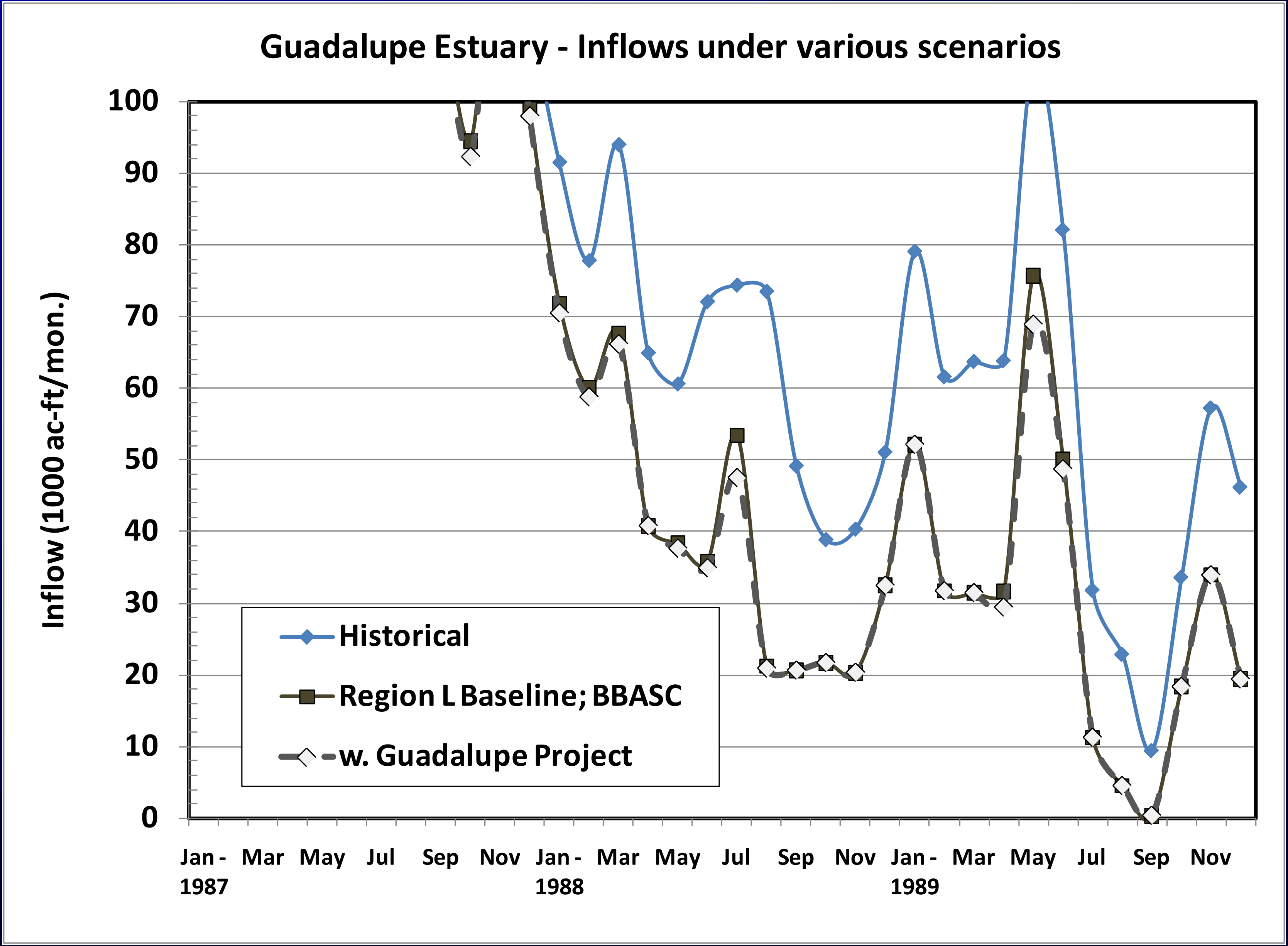
Mid-Basin Project



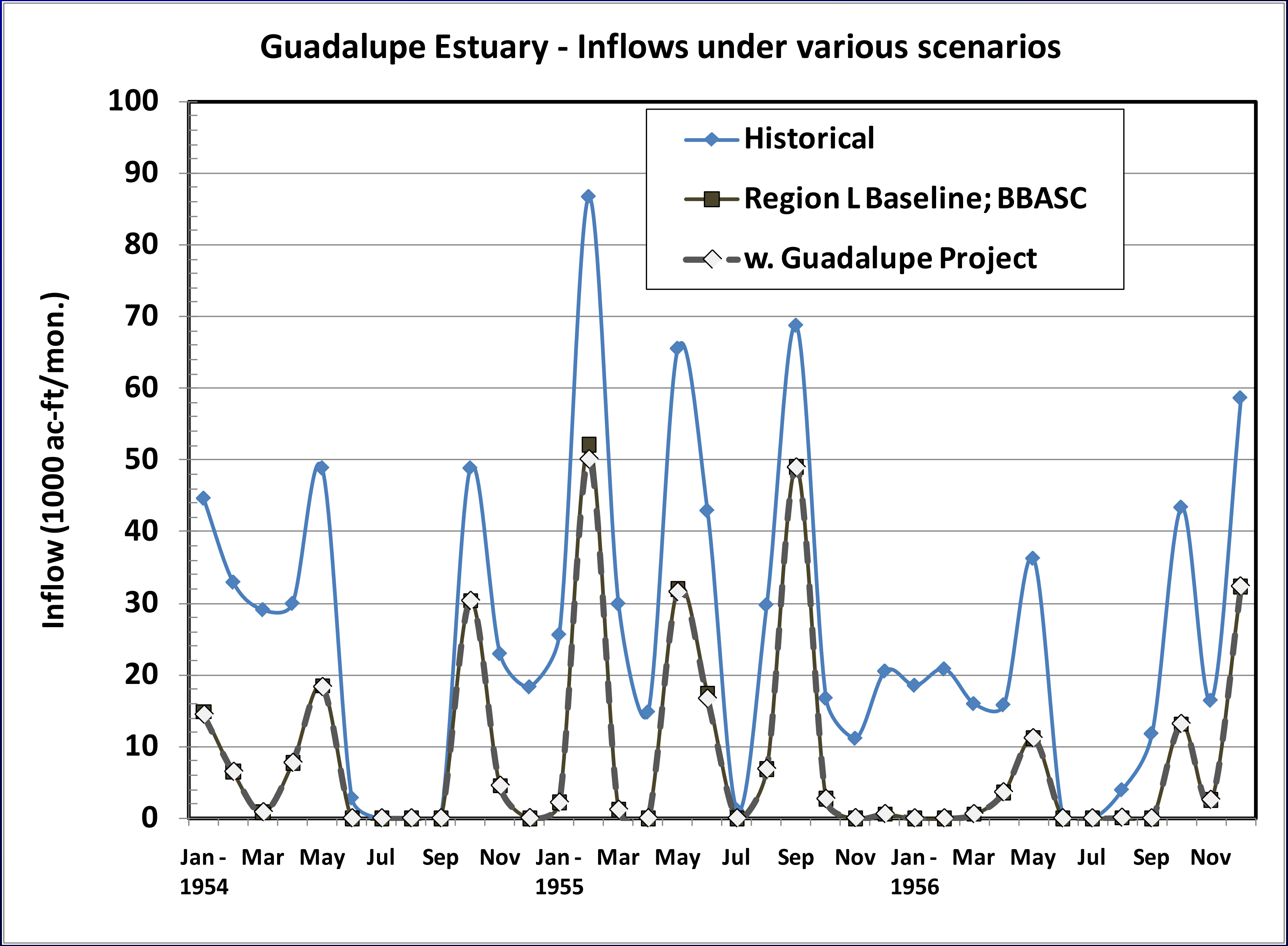
Mid-Basin Project Slides

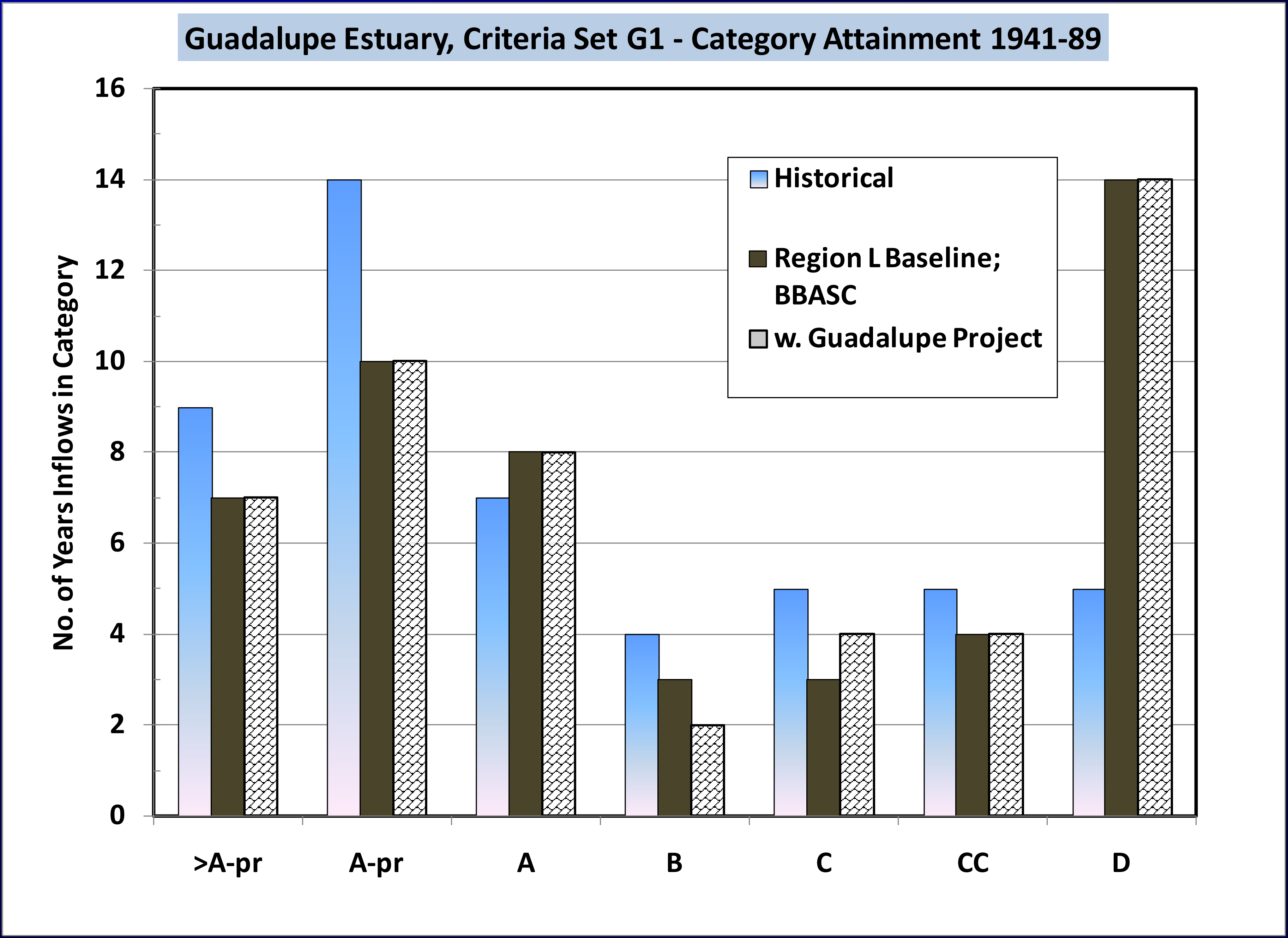


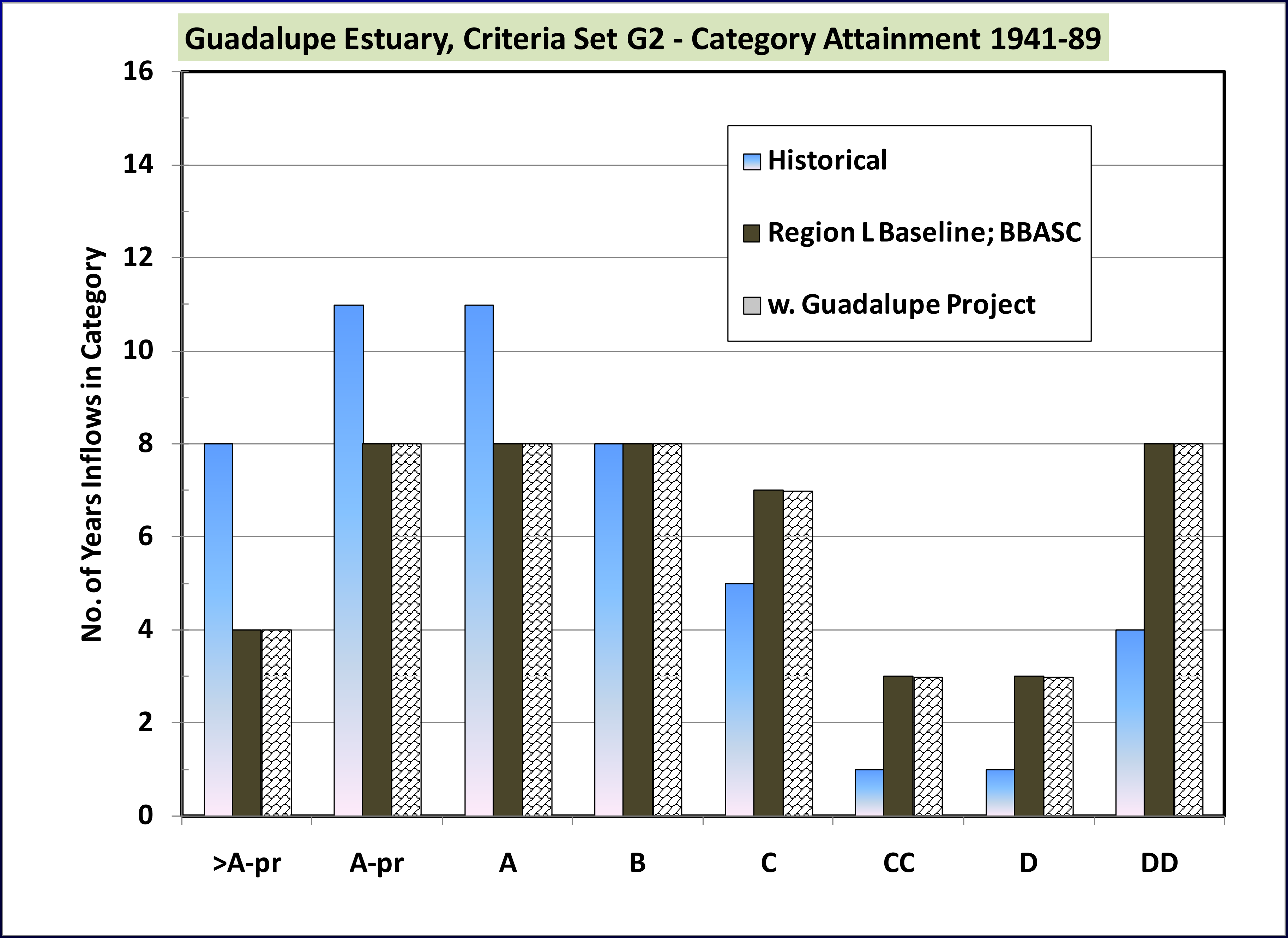
Guadalupe Estuary - Inflows under various scenarios
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1983
Feb
Mar
Apr
May
Jun - 1983
Jul
Aug
Sep
Oct
Nov
Dec - 1983
Jan - 1984
Feb
Mar
Apr
May
Jun - 1984
Jul
Aug
Sep
Oct
Nov
Dec - 1984
Historical
Region L Baseline; BBASC
w. Guadalupe Project



Guadalupe Estuary - Inflows under various scenarios
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Historical
Region L Baseline; BBASC
w. Guadalupe Project
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov


Guadalupe Estuary - Inflows under various scenarios
Historical
Region L Baseline; BBASC
w. Guadalupe Project
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1954
Mar
May
Jul
Sep
Nov
Jan - 1955
Mar
May
Jul
Sep
Nov
Jan - 1956
Mar
May
Jul
Sep
Nov


Guadalupe Estuary, Criteria Set G1 - Category Attainment 1941-89
No. of Years Inflows in Category
0
2
4
6
8
10
12
14
16
>A-pr
A-pr
A
B
C
CC
D
Historical
Region L Baseline; BBASC
w. Guadalupe Project



Guadalupe Estuary, Criteria Set G2 - Category Attainment 1941-89
No. of Years Inflows in Category
0
2
4
6
8
10
12
14
16
Historical
Region L Baseline; BBASC
w. Guadalupe Project
>A-pr
A-pr
A
B
C
CC
D
DD

Summary – Attainment of G1 Springtime Criteria (Rangia) with the Mid-Basin Project

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
w. Guadalupe Project	7	10	8	2	4	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

see Tables 4.5-3 & 4.5-6		>12%	>12%				<=9%

Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline; BBASC		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. Guadalupe Project		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

Color coding convention
-OK, met criteria
-Near miss. (rounding; p-o-record)
-Not met, but departure not great
-Very bad

see Table 4.5-3			>17%		>=19%	<=2/3	

Attain. - Joints	Joint G1 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline; BBASC			22.4%		14.3%	57.1%	
w. Guadalupe Project			20.4%		16.3%	50.0%	
TCEQ Baseline; (Run 3)			18.4%		16.3%	37.5%	

Summary – Attainment of G2 Summer Criteria (oysters) with the Mid-Basin Project

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. Guadalupe Project	4	8	8	8	7	3	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

Color coding convention
-OK, met criteria
-Near miss. (rounding; p-o-record)
-Not met, but departure not great
-Very bad

see Tables 4.5-2; 4.5-4		>12%	>17%				<=6%	
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guadalupe Project		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%	
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
w. Guadalupe Project			32.7%		20.4%	30.0%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

Questions, Comments, & Discussion

Instream Flows Assessment

May 4, 2011

Instream Assessment

- Evaluate the magnitude, frequencies, and durations of flows at the selected locations.
- Consider quantitative ecological ramifications in the forms of relative differences in species abundance, suitable habitat area, and/or other factors.

Instream Flow Components (TIFP)

Subsistence flows	
Definition:	Infrequent, seasonal periods of low flow
Objectives:	Maintain water quality criteria
Base flows	
Definition:	Normal flow conditions between storm events
Objectives:	Ensure adequate habitat conditions, including variability, to support the natural biological community
High flow pulses	
Definition:	Short-duration, in-channel, high flow events following storm events
Objectives:	Maintain important physical habitat features
	Provide longitudinal connectivity along the river channel
Overbank flows	
Definition:	Infrequent, high flow events that exceed the normal channel
Objectives:	Maintain riparian areas
	Provide lateral connectivity between the river channel and active floodplain

Lower San Antonio River - Goliad Project




Fieldwork

Fieldwork

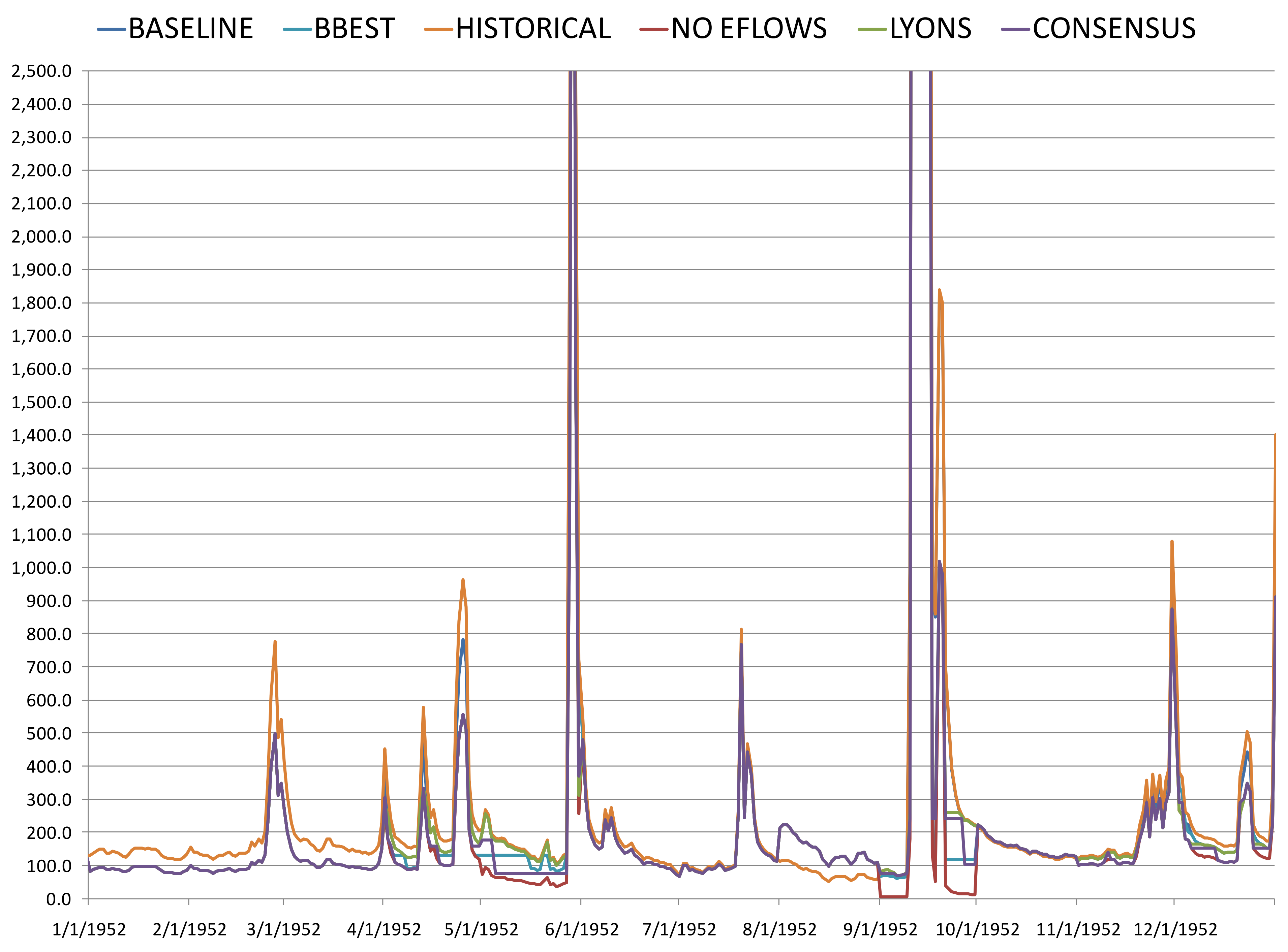
Photo: Clint Robertson (TPWD)

Fieldwork

Fieldwork

Goliad Evaluation

- Water Quality
  - Subsistence flow – focus on dissolved oxygen and temperature
- Habitat Availability
  - Subsistence and base flows – fish habitat
- Flow Pulses
  - Riparian communities
- Total Annual Volume
  - Riparian growth and sediment transport



BASELINE
BBEST
HISTORICAL
NO EFLOWS
LYONS
CONSENSUS
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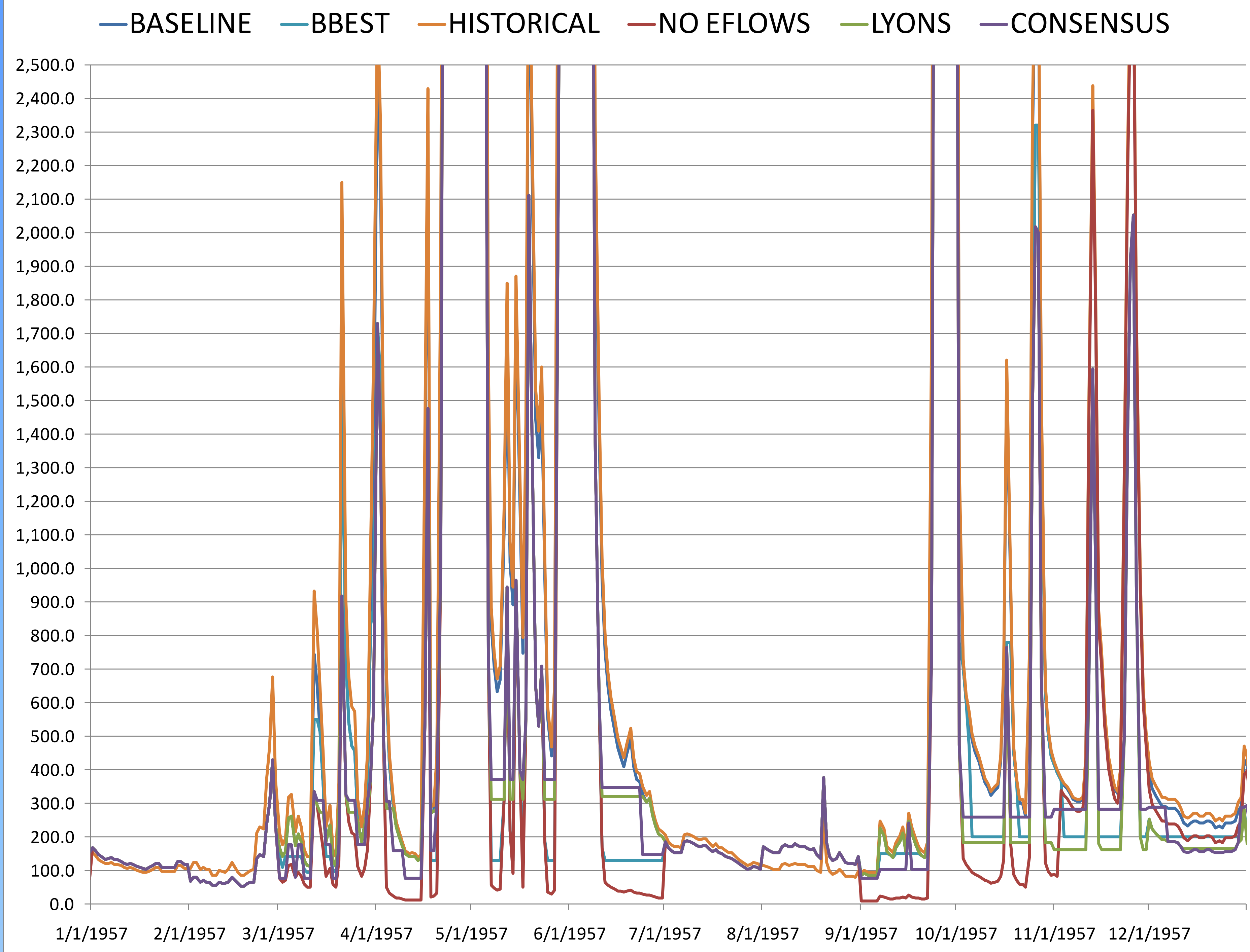
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BBEST
HISTORICAL
NO EFLOWS
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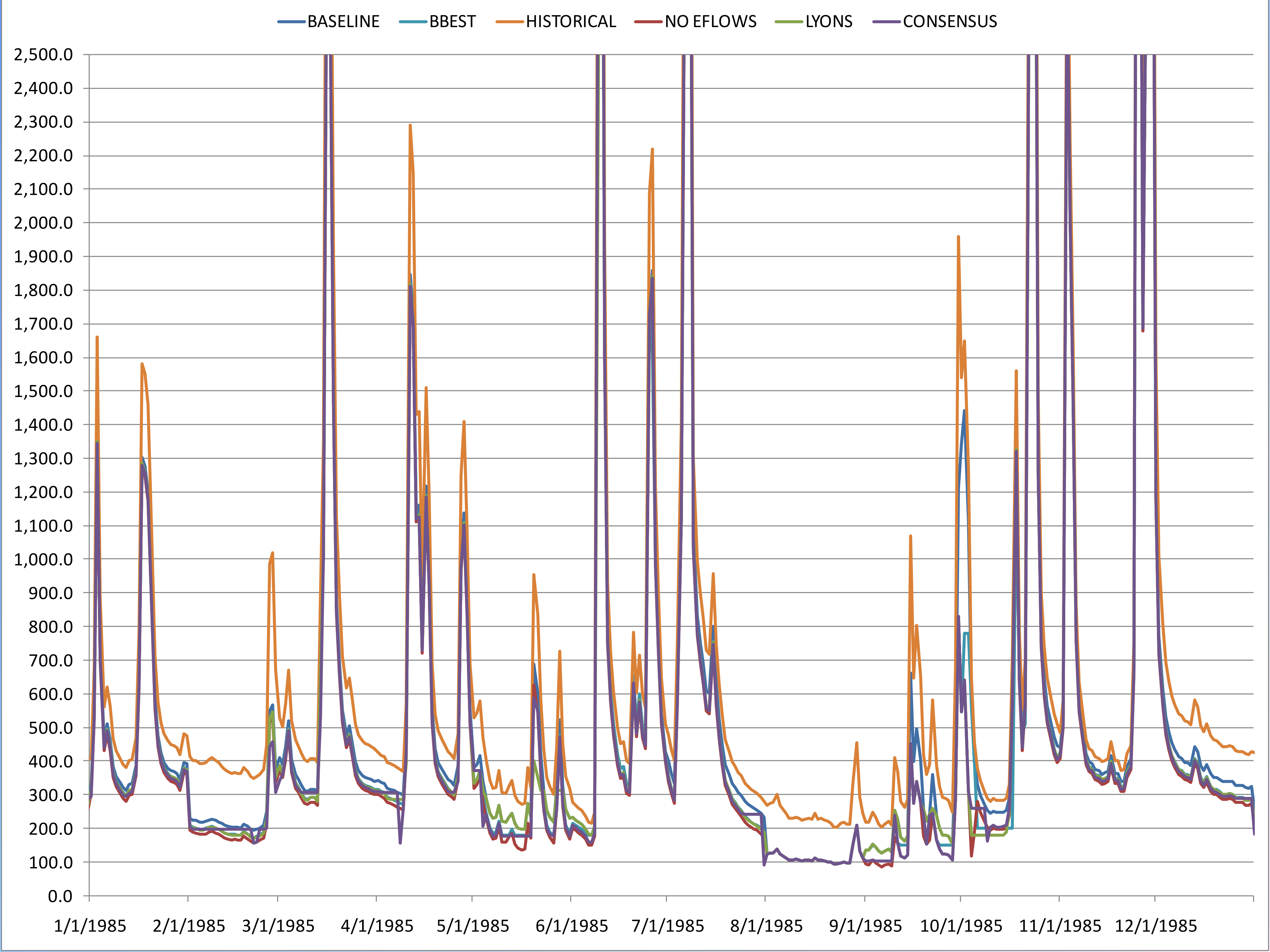
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BBEST
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NO EFLOWS
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Table 6.1-15. – Environmental Flow Regime Recommendation, San Antonio River at Goliad

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 273,000 Duration Bound is 69			
Overbank Flows	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 107,000 Duration Bound is 45			
Overbank Flows	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38			
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19
High Flow Pulses	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs) – High	290	280	220	270
Base Flows (cfs) – Medium	200	180	150	200
Base Flows (cfs) – Low	140	130	120	130
Subsistence Flows (cfs)	76	60	54	66

Flow Levels	
	High (75th %ile)
	Medium (50th %ile)
	Low (25th %ile)
	Subsistence

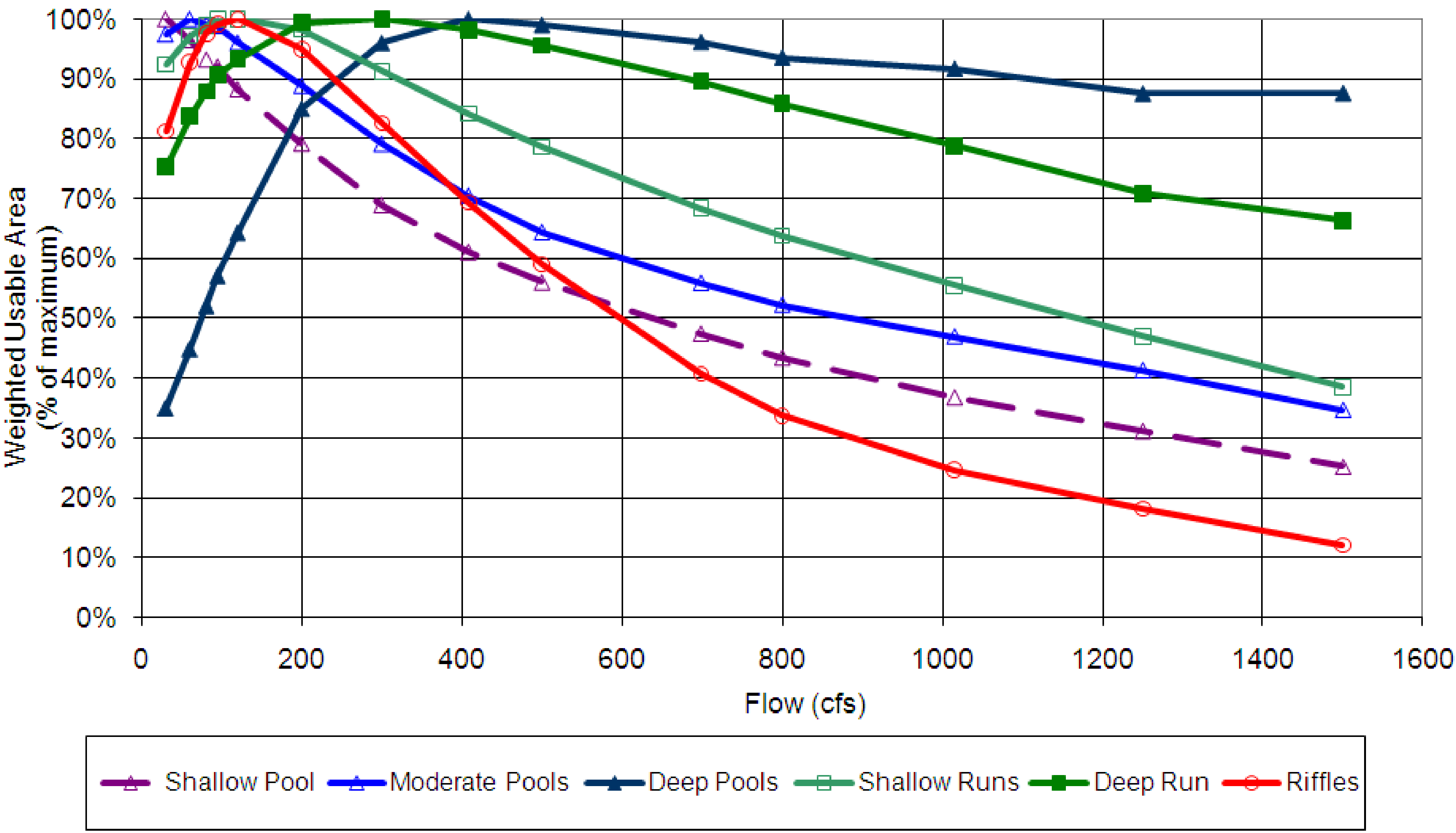
Notes:

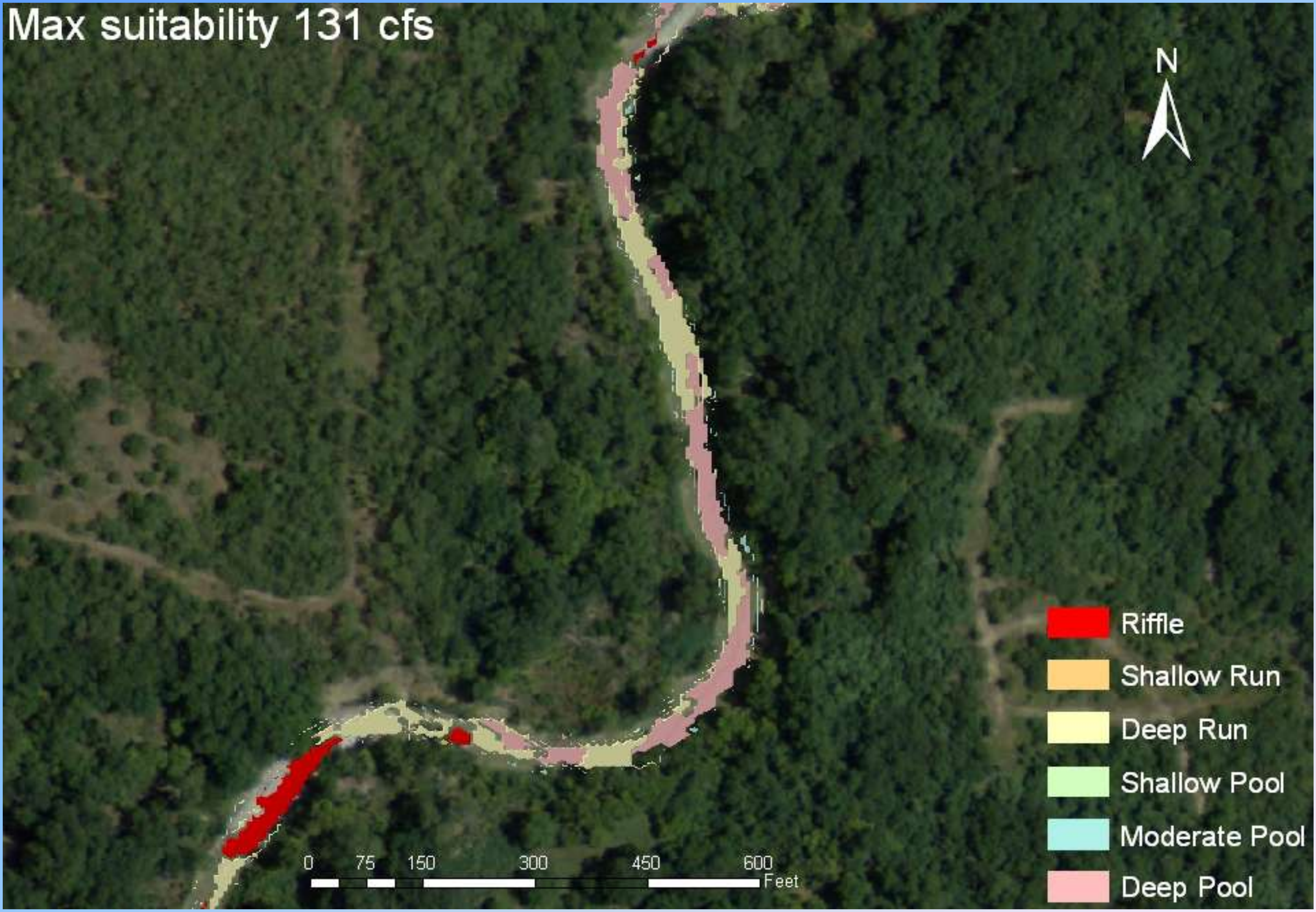
1. Period of Record used : 1/1/1940 to 12/31/1969.
2. Volumes are in acre-feet and durations are in days.

Goliad Tools for Evaluation

- Water Quality
  - Existing Data
  - Water quality model for the lower San Antonio River – Texas Instream Flow Program (TIFP) / SARA
- Aquatic Habitat
  - TIFP/SARA 2D hydraulic and habitat models
- Pulses and Total Annual Volume
  - Hydrology

DRAFT
LSAR Instream Flow Study
San Antonio River 19036_Goliad
WUA vs Flow

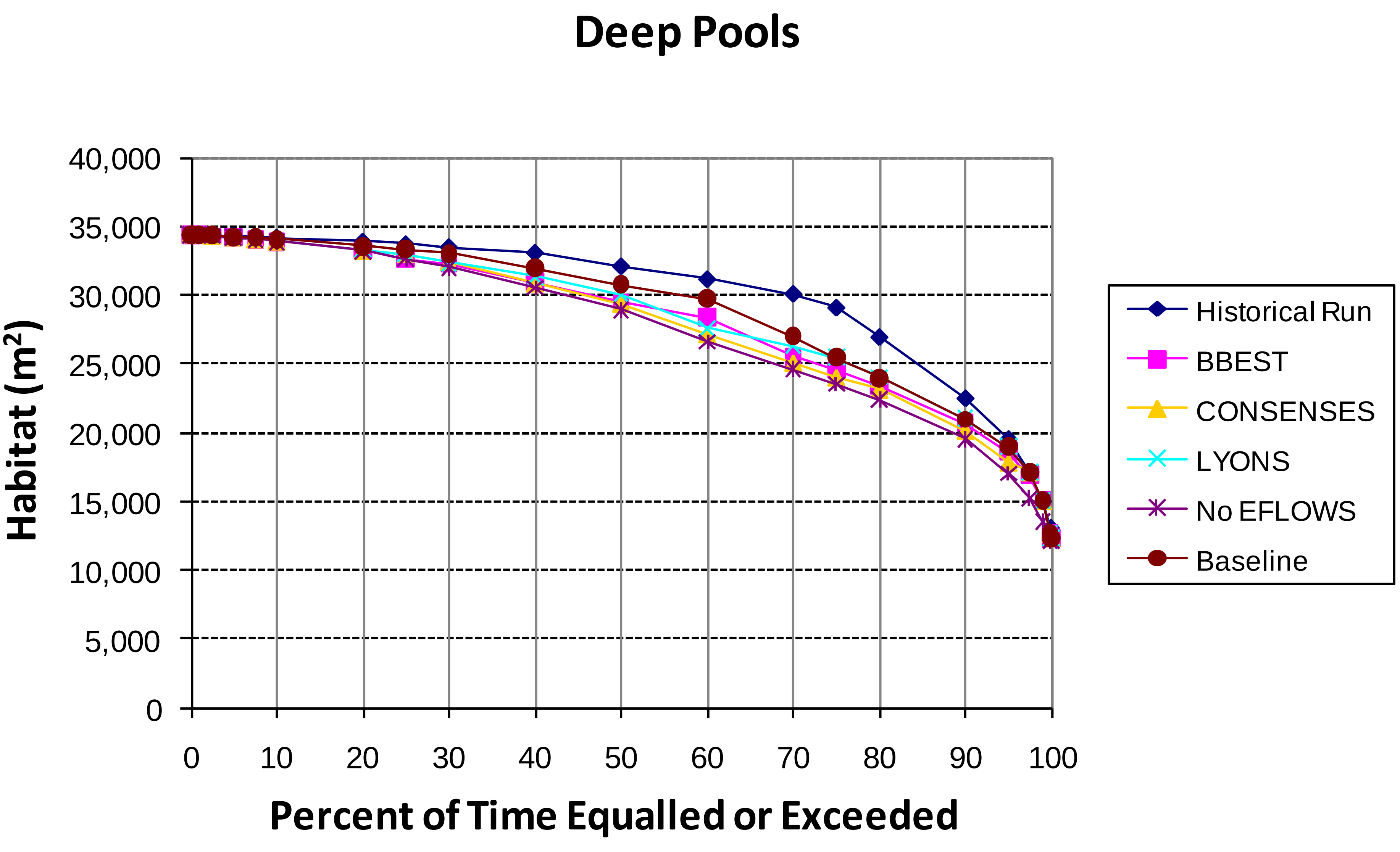



Max suitability 131 cfs
N
0
75
150
300
450
600
Feet
Riffle
Shallow Run
Deep Run
Shallow Pool
Moderate Pool
Deep Pool

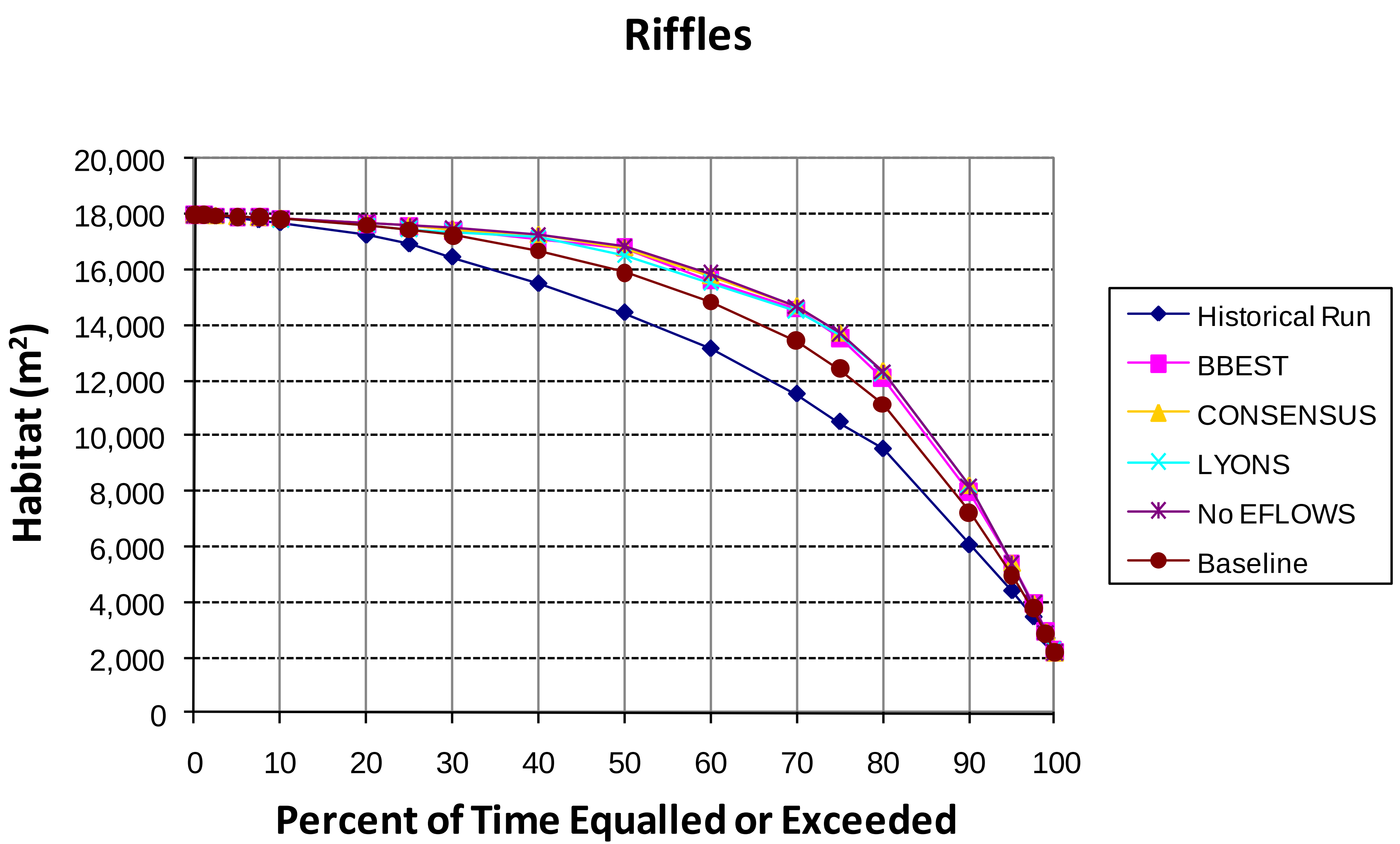
Habitat Time Series - BBEST

Percent of Maximum Available Habitat						
Percent Exceedance Level	**Moderate Pools**	**Deep Pools**	**Deep Run**	**Shallow Pool**	**Shallow Runs**	**Riffles**
0.01	100%	100%	100%	100%	100%	100%
0.1	100%	100%	100%	100%	100%	100%
1	100%	100%	100%	97%	100%	100%
2.5	99%	100%	100%	95%	100%	100%
5	99%	99%	100%	93%	100%	100%
7.5	99%	99%	100%	92%	100%	99%
10	98%	98%	100%	91%	100%	99%
20	95%	97%	100%	87%	99%	98%
25	94%	95%	99%	85%	99%	98%
30	93%	94%	99%	84%	99%	97%
40	90%	90%	98%	81%	98%	95%
50	88%	86%	97%	79%	97%	93%
60	83%	82%	95%	73%	94%	87%
70	78%	74%	94%	68%	91%	81%
75	74%	71%	93%	65%	87%	75%
80	69%	68%	91%	60%	83%	67%
90	58%	60%	87%	49%	70%	44%
95	50%	54%	81%	41%	60%	30%
97.5	45%	49%	76%	35%	52%	22%
99	39%	44%	70%	30%	45%	16%
99.9	35%	37%	67%	26%	39%	13%
99.99	35%	36%	66%	25%	39%	12%

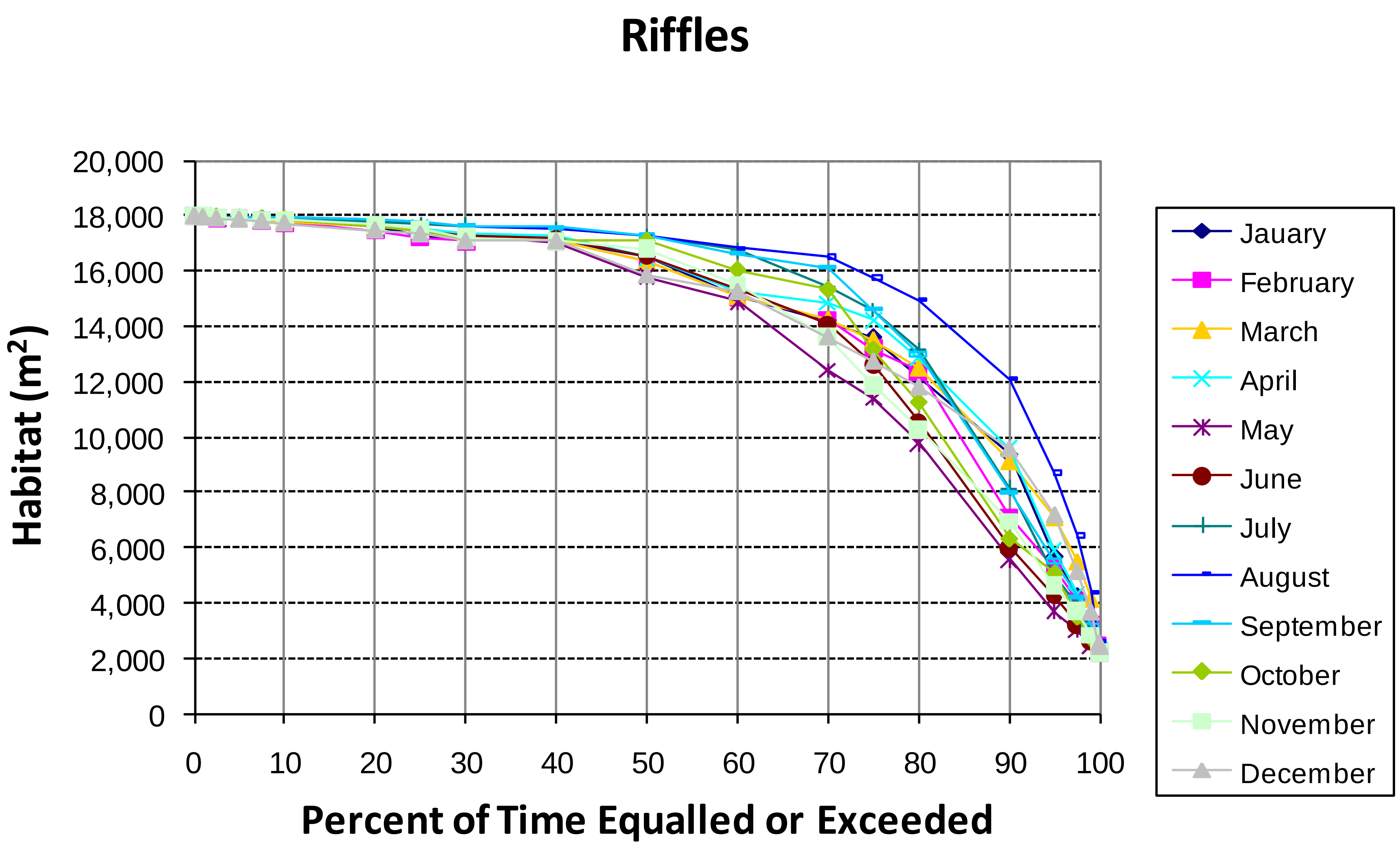
Habitat Duration Curves



Habitat Duration Curves



Habitat Duration Curves – BBEST Monthly



Flow Pulses

- BBEST Recommendations
  - HEFR default values
- TIFP Recommendations
  - Indicator species – ecological linkage to flow
  - Black willow (April – June)
  - Buttonbush (September – October)
  - Boxelder (August – October; recruit through the following spring)
  - Cottonwood (May – July)
  - Green ash (September – October; recruit for several years)
  - Sycamore (February – May; good seed crops only every 1 or 2 years)
  - Hardwood forest communities’ growing season (February – October)

Total Annual Volume (acre-feet)

- Riparian growth (TIFP)
- Sediment Transport (BBEST)

	Goliad		
	Baseline	**BBEST**	**Historical**
min	95,114	93,387	88,990
25th	212,162	180,914	269,041
median	364,144	329,577	411,304
75th	694,860	612,661	764,220
max	1,448,998	1,423,088	1,636,074
	Difference		
	BASE/His	**BBEST/Base**	**BBEST/His**
min	-7%	2%	-5%
25th	21%	15%	33%
median	11%	9%	20%
75th	9%	12%	20%
max	11%	2%	13%

Goliad Preliminary Conclusions of BBEST recommendations

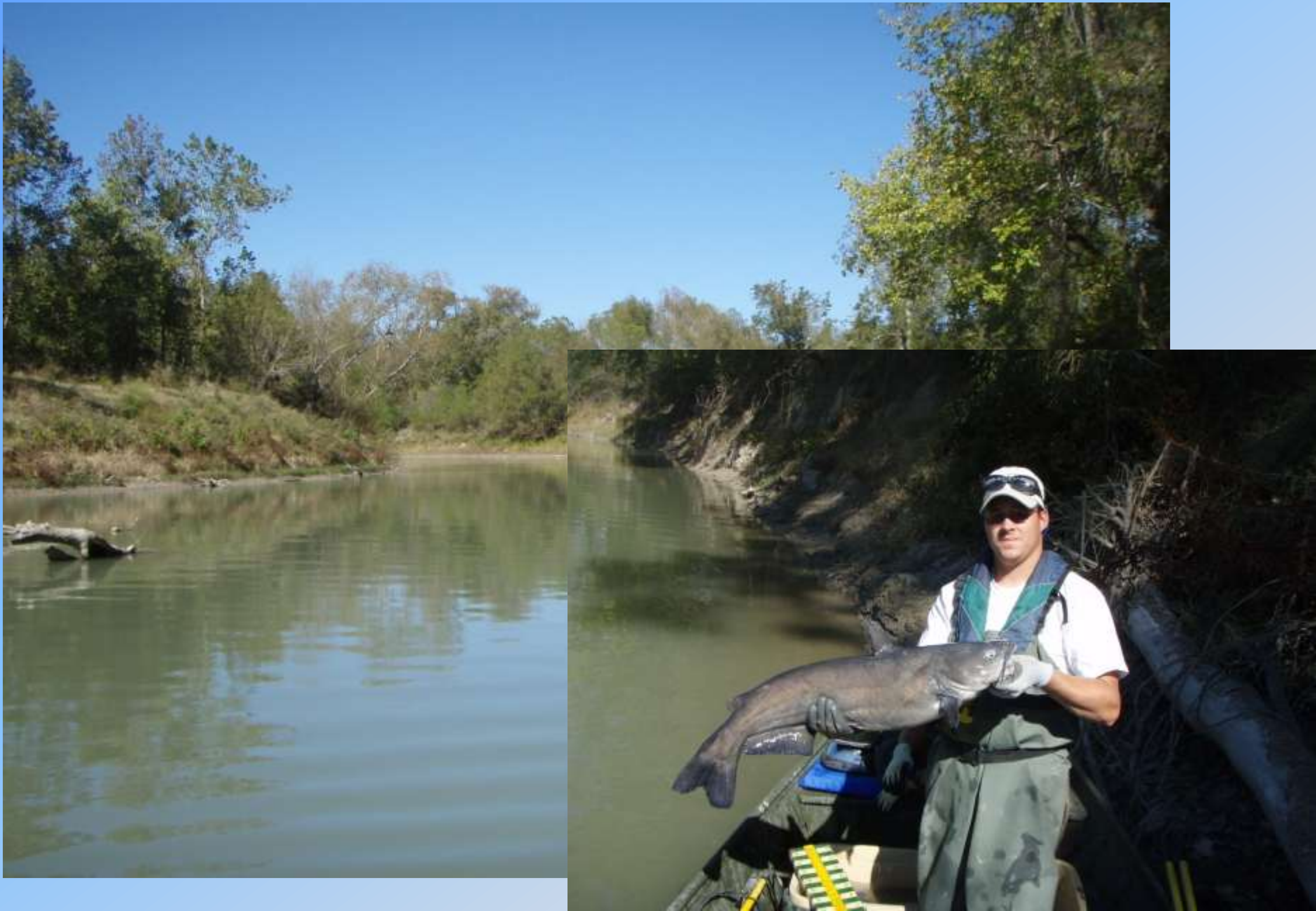
- **Water Quality**
  - Existing water quality data supportive
  - Modeling of water temperature shows stress at subsistence flows during extreme summertime conditions
- **Aquatic Habitat**
  - Supported by BBEST recommendations
  - Continued base flow evaluation for balancing possible.

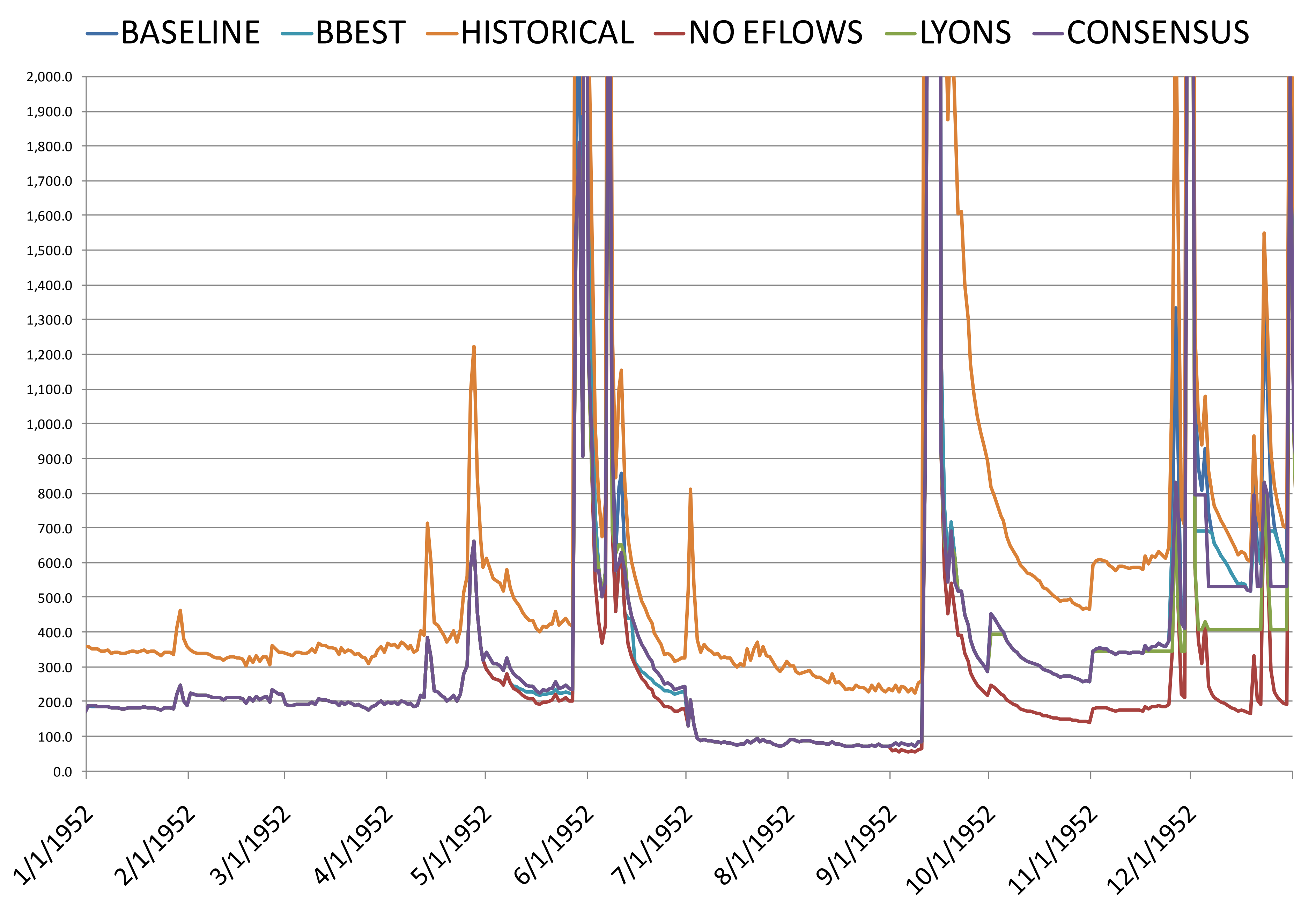
Goliad Preliminary Conclusions of BBEST recommendations

- **Pulses and Total Annual Volume**
  - Riparian (TIFP) supported
  - Sediment transport may not be supported if 10% change in annual sediment yield is considered part of the BBEST recommendation. Not a TIFP concern for the lower San Antonio River

Questions

Guadalupe River - Gonzales Project





BASELINE
BBEST
HISTORICAL
NO EFLOWS
LYONS
CONSENSUS
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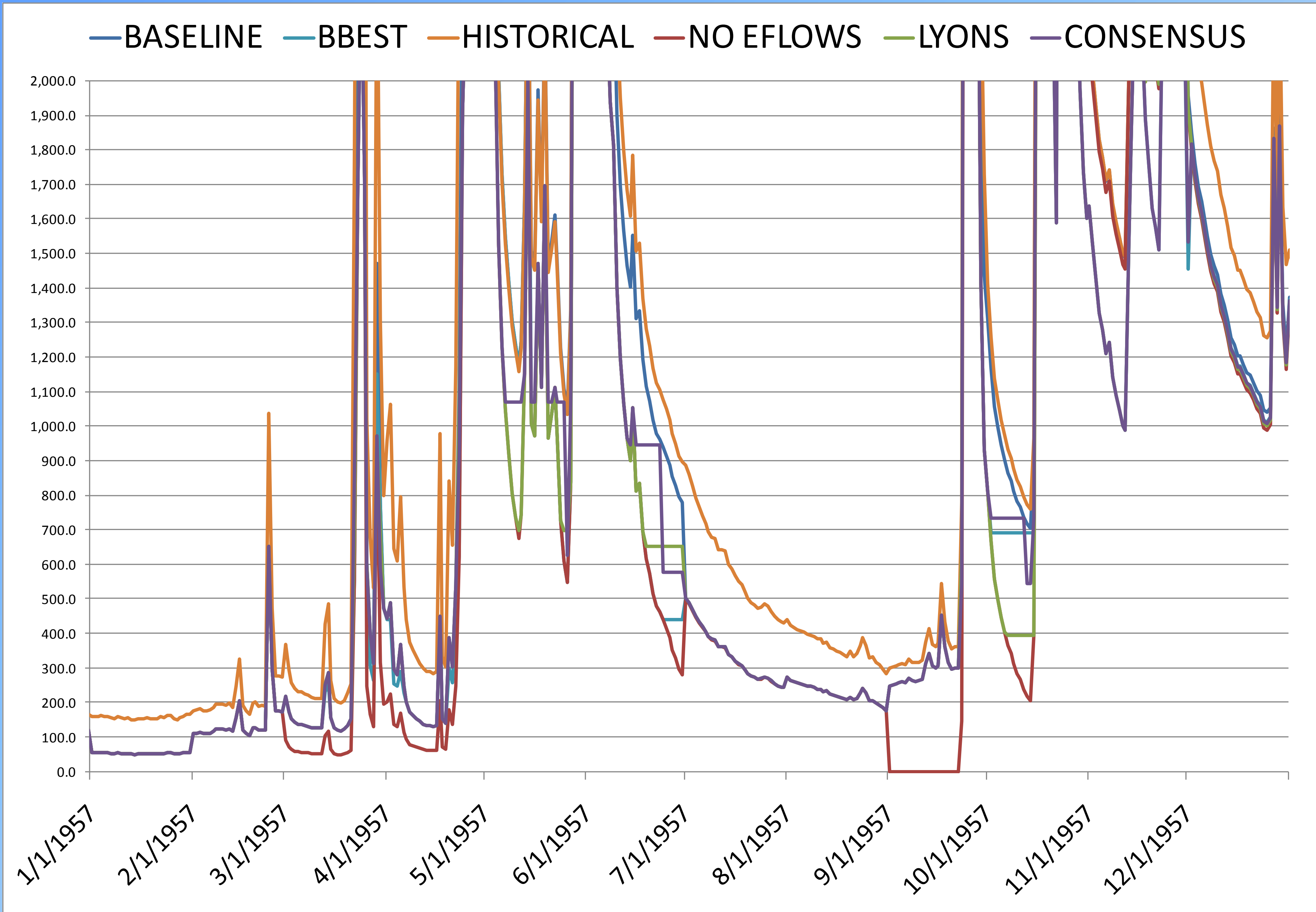

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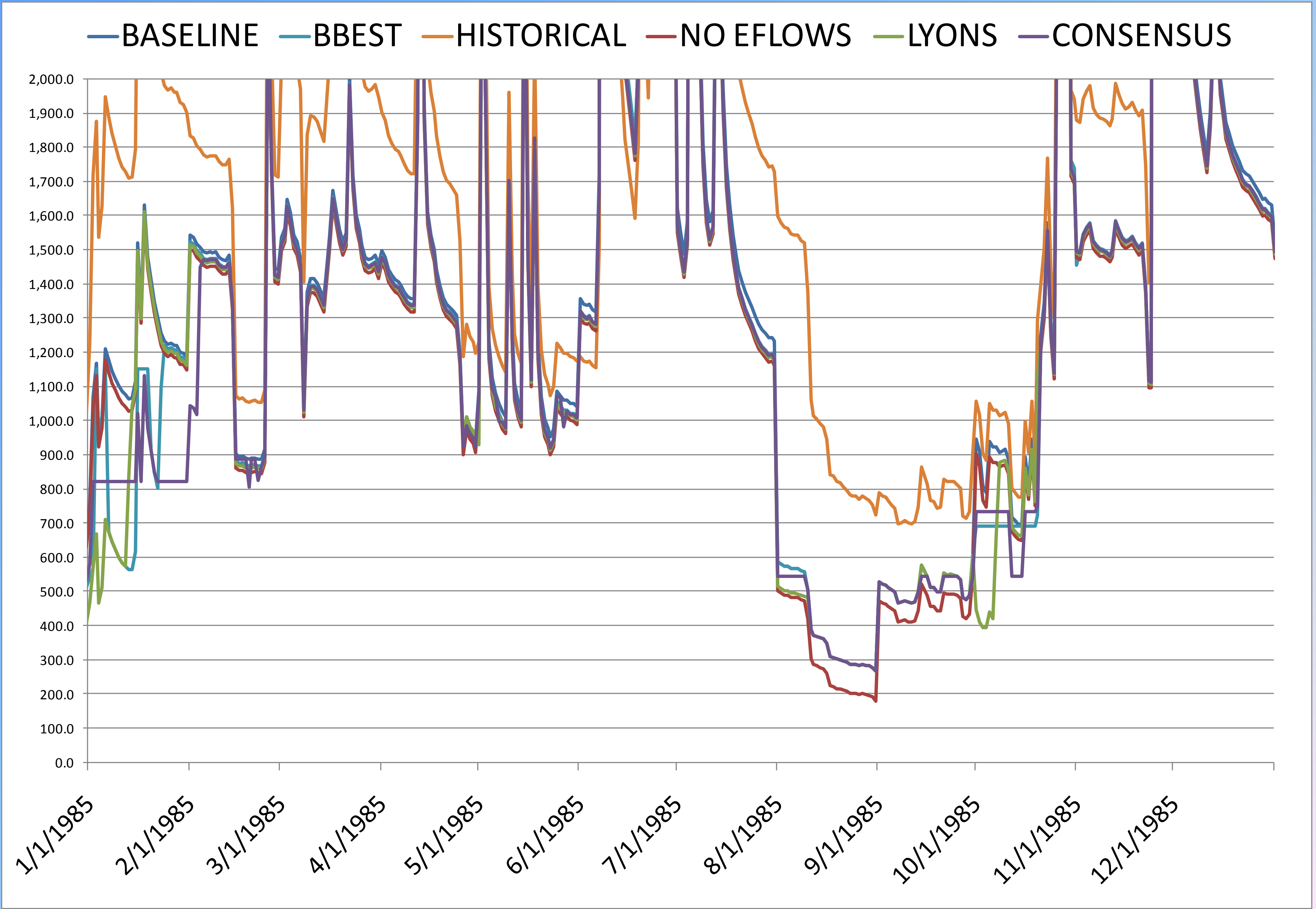

BASELINE
BBEST
HISTORICAL
NO EFLOWS
LYONS
CONSENSUS
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12/1/1985

Table 6.1-6. – Environmental Flow Regime Recommendation, Guadalupe River at Gonzales

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 36,700 cfs with Average Frequency 1 per 5 years Regressed Volume is 492,000 Duration Bound is 70			
Overbank Flows	Qp: 24,400 cfs with Average Frequency 1 per 2 years Regressed Volume is 306,000 Duration Bound is 57			
Overbank Flows	Qp: 14,300 cfs with Average Frequency 1 per year Regressed Volume is 165,000 Duration Bound is 43			
High Flow Pulses	Qp: 4,140 cfs with Average Frequency 1 per season Regressed Volume is 48,300 Duration Bound is 29	Qp: 6,590 cfs with Average Frequency 1 per season Regressed Volume is 58,400 Duration Bound is 24	Qp: 1,760 cfs with Average Frequency 1 per season Regressed Volume is 14,800 Duration Bound is 14	Qp: 4,330 cfs with Average Frequency 1 per season Regressed Volume is 41,200 Duration Bound is 23
High Flow Pulses	Qp: 1,150 cfs with Average Frequency 2 per season Regressed Volume is 9,640 Duration Bound is 13	Qp: 3,250 cfs with Average Frequency 2 per season Regressed Volume is 26,900 Duration Bound is 17	Qp: 950 cfs with Average Frequency 2 per season Regressed Volume is 7,060 Duration Bound is 10	Qp: 1,410 cfs with Average Frequency 2 per season Regressed Volume is 11,400 Duration Bound is 13
Base Flows (cfs) – High	860	870	800	810
Base Flows (cfs) – Medium	690	650	650	690
Base Flows (cfs) – Low	540	440	440	510
Subsistence Flows (cfs)	210	210	210	180

Flow Levels
High (75th %ile)
Medium (50th %ile)
Low (25th %ile)
Subsistence

Notes:

1. Period of Record used : 1/1/1940 to 12/31/2009.
2. Volumes are in acre-feet and durations are in days.

Gonzales Tools for Evaluation

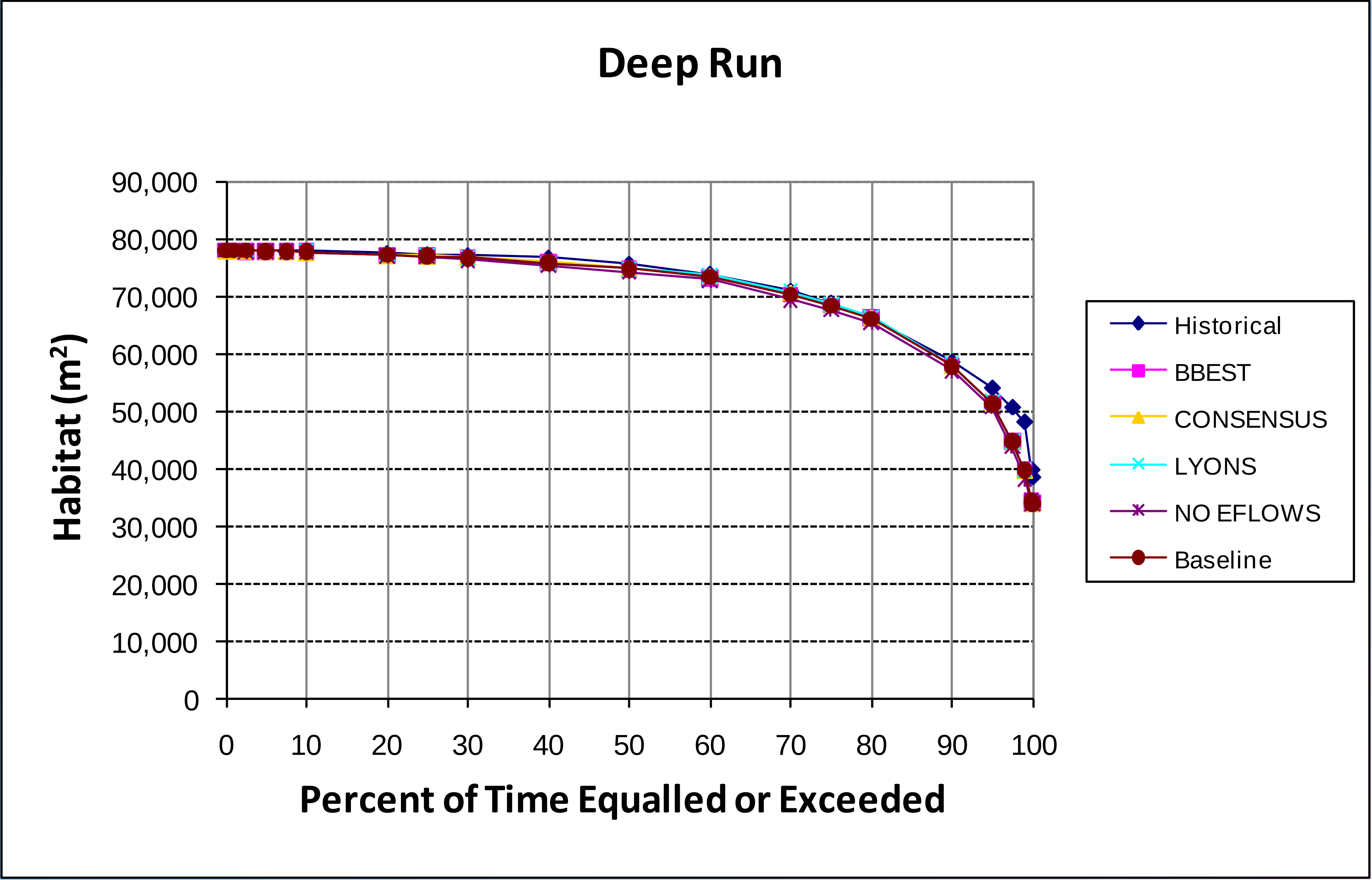
- Water Quality
  - Existing Data
- Aquatic Habitat
  - TIFP PHABSIM analysis (hydraulic and habitat models)
- Pulses and Total Annual Volume
  - Hydrology

Figure 3.3-15. Percent of maximum habitat versus discharge for habitat guilds at Guadalupe River at Gonzales.

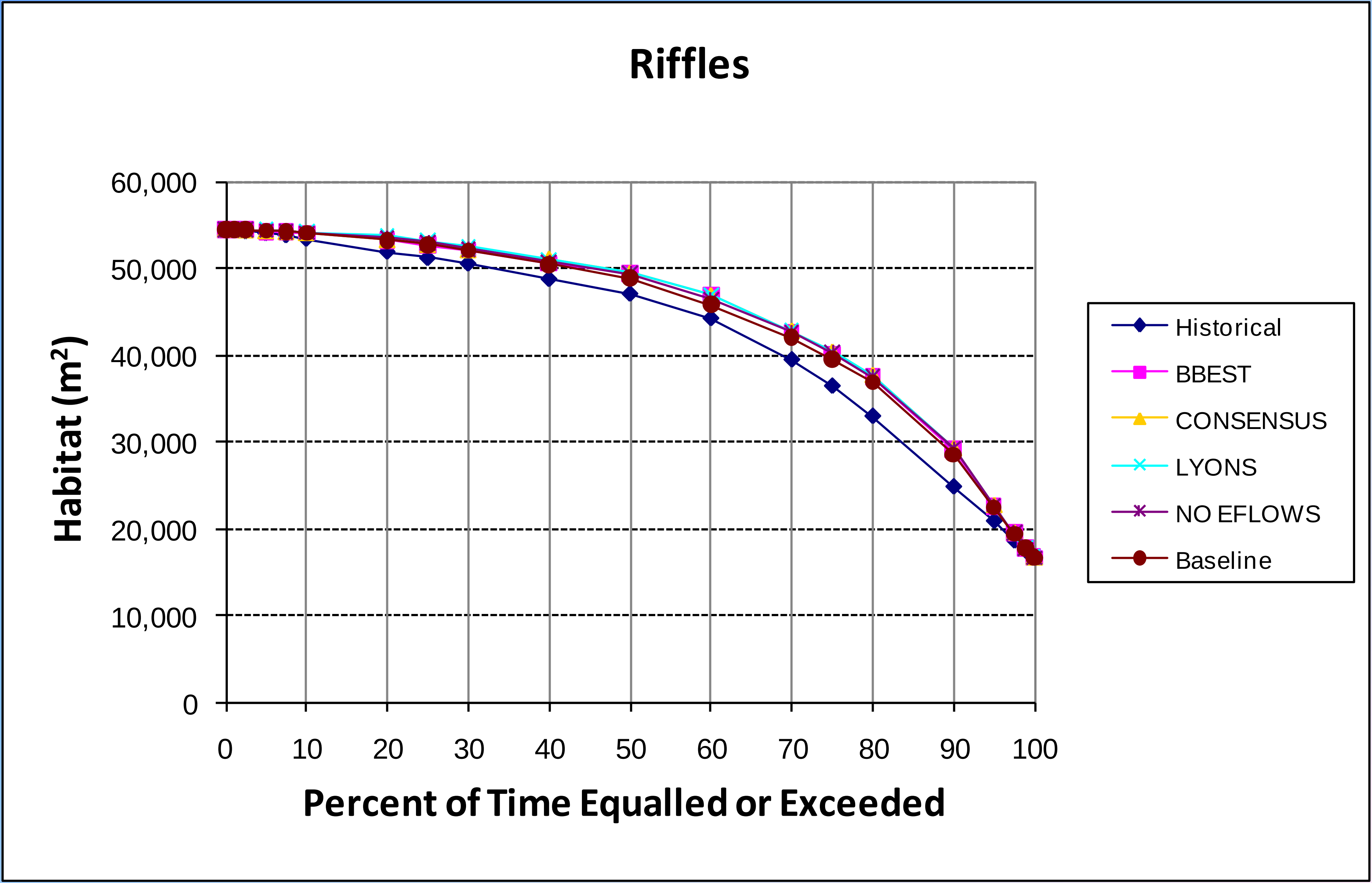
Habitat Time Series - BBEST

Percent of Maximum Available Habitat					
Percent Exceedance Level	**Deep Pool**	**Deep Run**	**Shallow Pool**	**Shallow Runs**	**Riffles**
0.01	100%	100%	100%	100%	100%
0.1	100%	100%	100%	100%	100%
1	100%	100%	100%	100%	100%
2.5	100%	100%	100%	100%	100%
5	99%	100%	99%	100%	100%
7.5	99%	100%	99%	99%	99%
10	98%	100%	99%	99%	99%
20	96%	99%	98%	98%	98%
25	95%	99%	98%	97%	97%
30	94%	99%	95%	95%	96%
40	91%	97%	90%	91%	93%
50	87%	96%	80%	85%	91%
60	81%	94%	74%	80%	86%
70	70%	90%	62%	72%	78%
75	64%	88%	57%	67%	74%
80	55%	85%	51%	62%	69%
90	28%	74%	41%	50%	53%
95	18%	66%	37%	41%	42%
97.5	16%	57%	31%	35%	36%
99	16%	51%	28%	32%	33%
99.9	15%	44%	28%	30%	31%
99.99	15%	43%	28%	30%	30%

Habitat Duration Curves



Habitat Duration Curves



Total Annual Volume (acre-feet)

- Sediment Transport (BBEST)

Gonzales T1		
Baseline	**BBEST**	**Historical**
42,854	42,835	108,723
398,558	386,293	545,396
765,604	743,999	923,220
1,140,478	1,116,898	1,269,547
2,282,683	2,265,432	2,529,590
Difference		
BASE/His	**BBEST/Base**	**BBEST/His**
61%	0%	61%
27%	3%	29%
17%	3%	19%
10%	2%	12%
10%	1%	10%

Gonzales Preliminary Conclusions of BBEST recommendations

- **Water Quality**
  - Existing water quality data supportive
- **Aquatic Habitat**
  - Supported by BBEST recommendations
  - Considerable room for further evaluation at base flows.
- **Pulses and Total Annual Volume**
  - BBEST HEFR default pulses met
  - Sediment transport may not be supported if 10% change in annual sediment yield is considered part of the BBEST recommendation.


Photo: James Dobson
DISCUSSION

Guadalupe, San Antonio, Mission, & Aransas Rivers and Mission, Copano, Aransas, & San Antonio Bays Basin and Bay Area Stakeholder Committee (GSA BBASC)

Technical Analyses of GSA BBEST Recommendations – Part 3: Run-Of-River Diversions

Sam Vaugh, PE

Ed Oborny

May 19, 2011

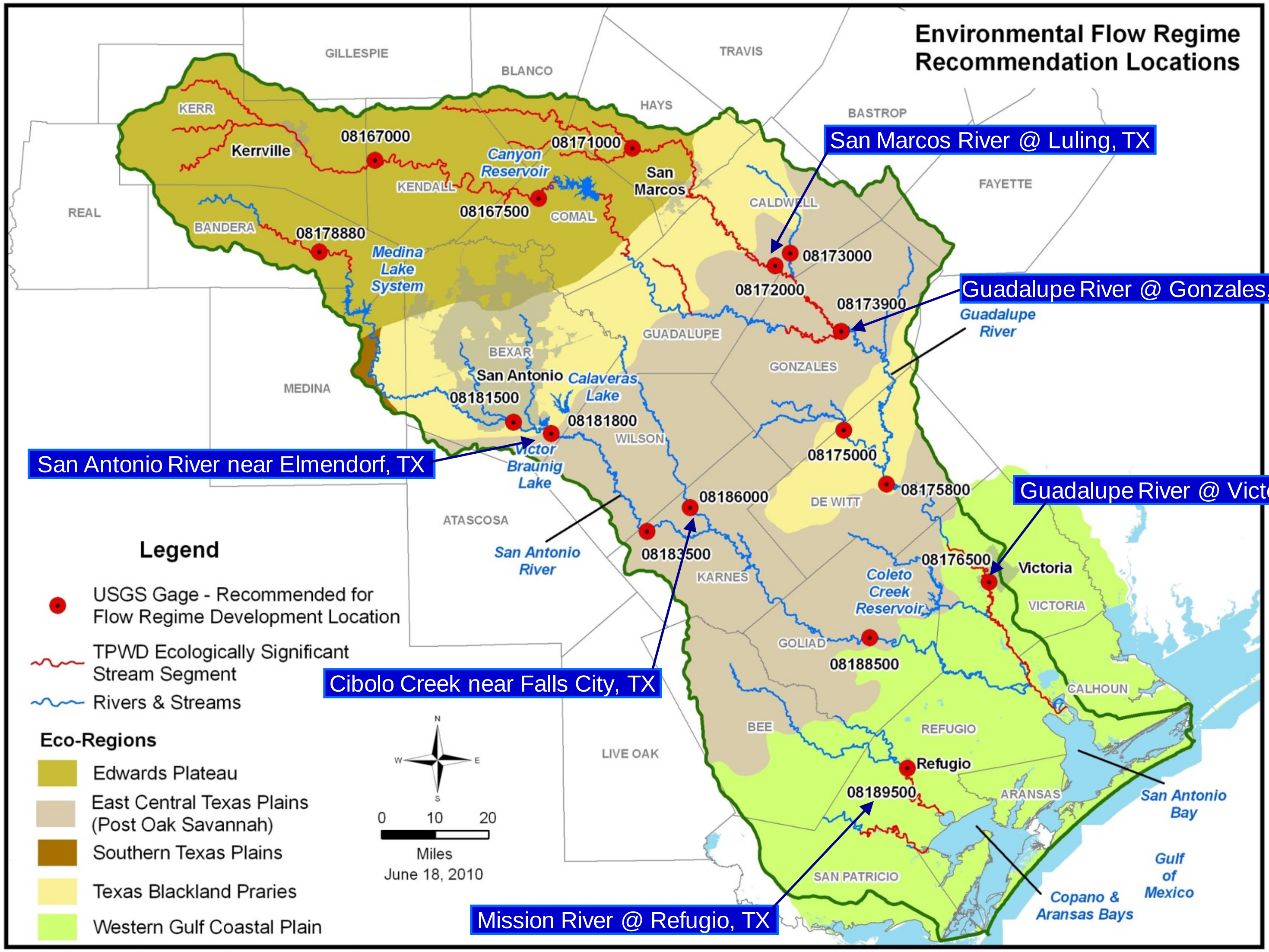
Presentation Format

1) Project Description
2) Project Hydrology: Availability for Diversion
3) Instream Ecology

4) Questions / Clarifications

5) Discussion by the BBASC

Run-Of-River Diversion Locations



R:\09109-140892 GSA BBEST\GIS\BBEST_GSA_TPWD_081010.mxd

Descriptions

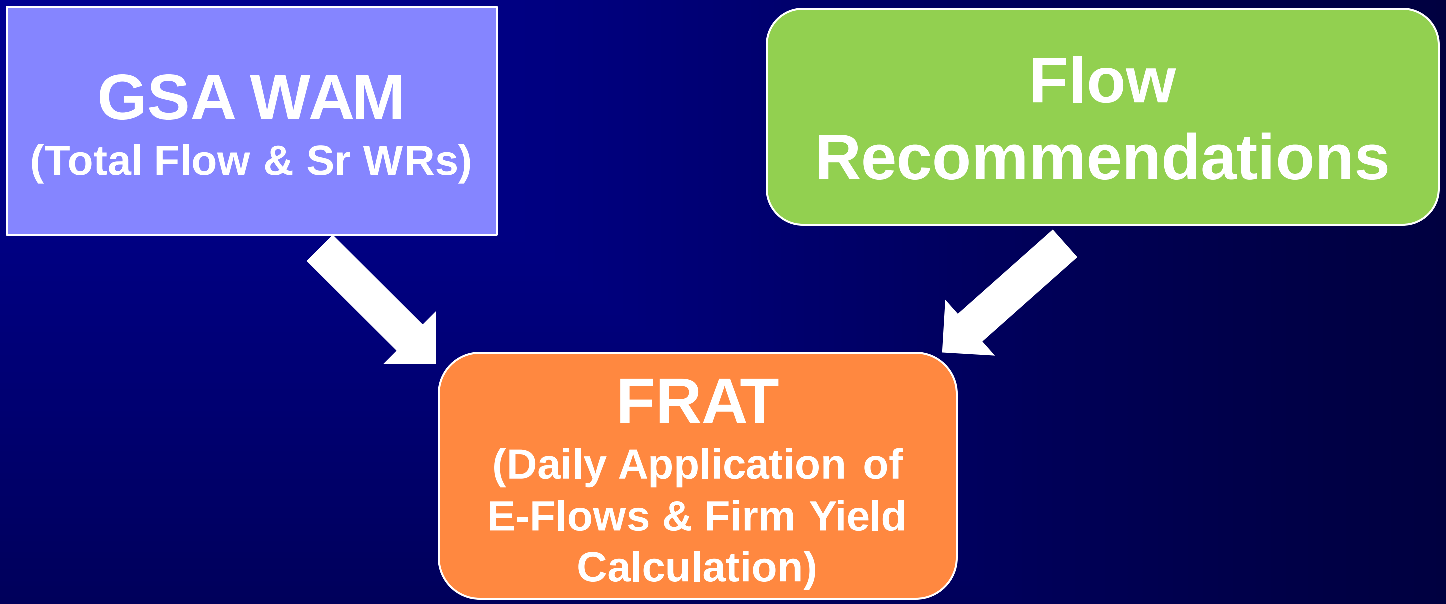
- Desired Run-Of-River Diversions of 10,000 acft/yr
- Uniform Diversion of Streamflow When Available, Subject to Downstream Senior Water Rights and Environmental Flow Criteria

- Scenarios:
  - No Environmental Flow
  - Lyons Method
  - BBEST Recommendations (Subsistence and Baseflow Only)

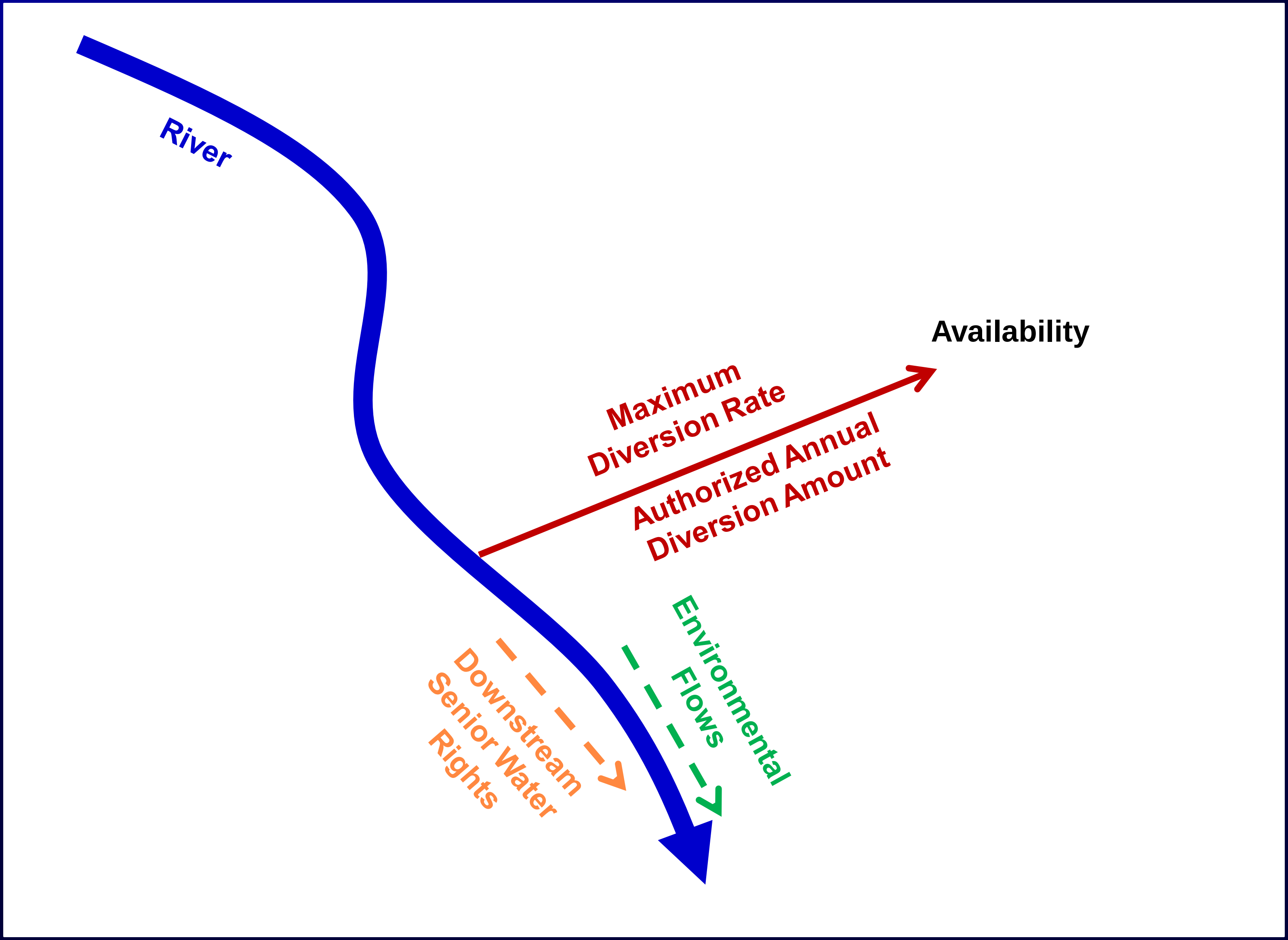
Run-Of-River Diversions

- **No Environmental Flow**
  - **Theoretical maximum diversion subject to downstream senior water rights only.**
- **Lyons Method**
  - **TCEQ desktop environmental flow used in permitting. Uses 40% (Oct – Feb) and 60% (Mar – Sept) of monthly medians as flow criteria.**
- **BBEST Recommendations (Subsistence and Baseflow Only)**
  - **Subsistence and Baseflow components from the recommended flow regime from the GSA BBEST Recommendation.**

Run-Of-River Diversions



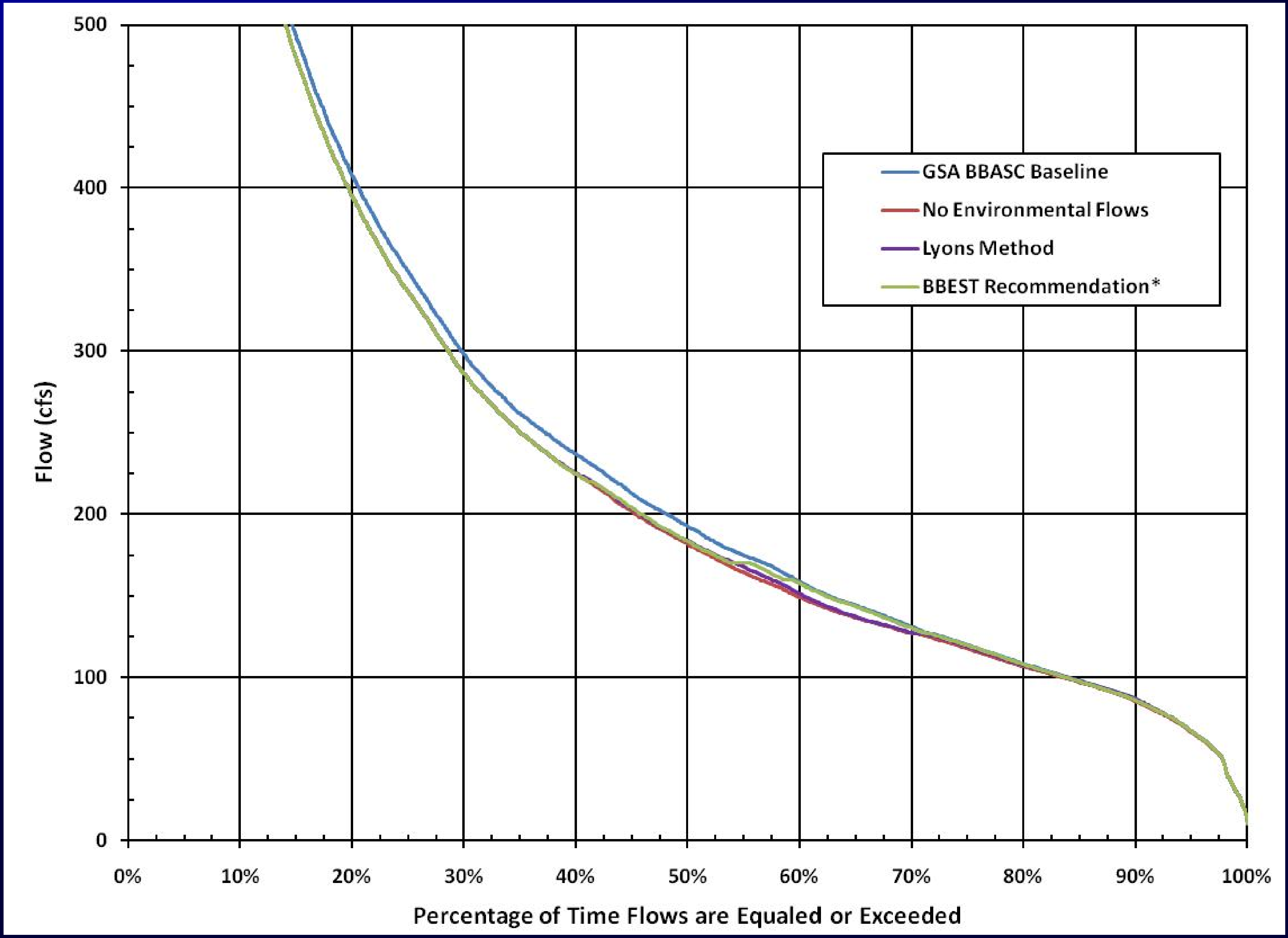
Run-Of-River Diversions



Run-Of-River Diversions – San Marcos River @ Luling

	No Environmental Flow	Lyons Method	BBEST Recommendation
Maximum Annual Diversion (acft/yr)	10,000	10,000	10,000
Average Annual Diversion (acft/yr)	6,161	5,542	5,015
Minimum Annual Diversion (acft/yr)	0	0	0
Monthly Reliability	56.6%	45.8%	37.0%
Daily Reliability	57.9%	52.8%	46.1%

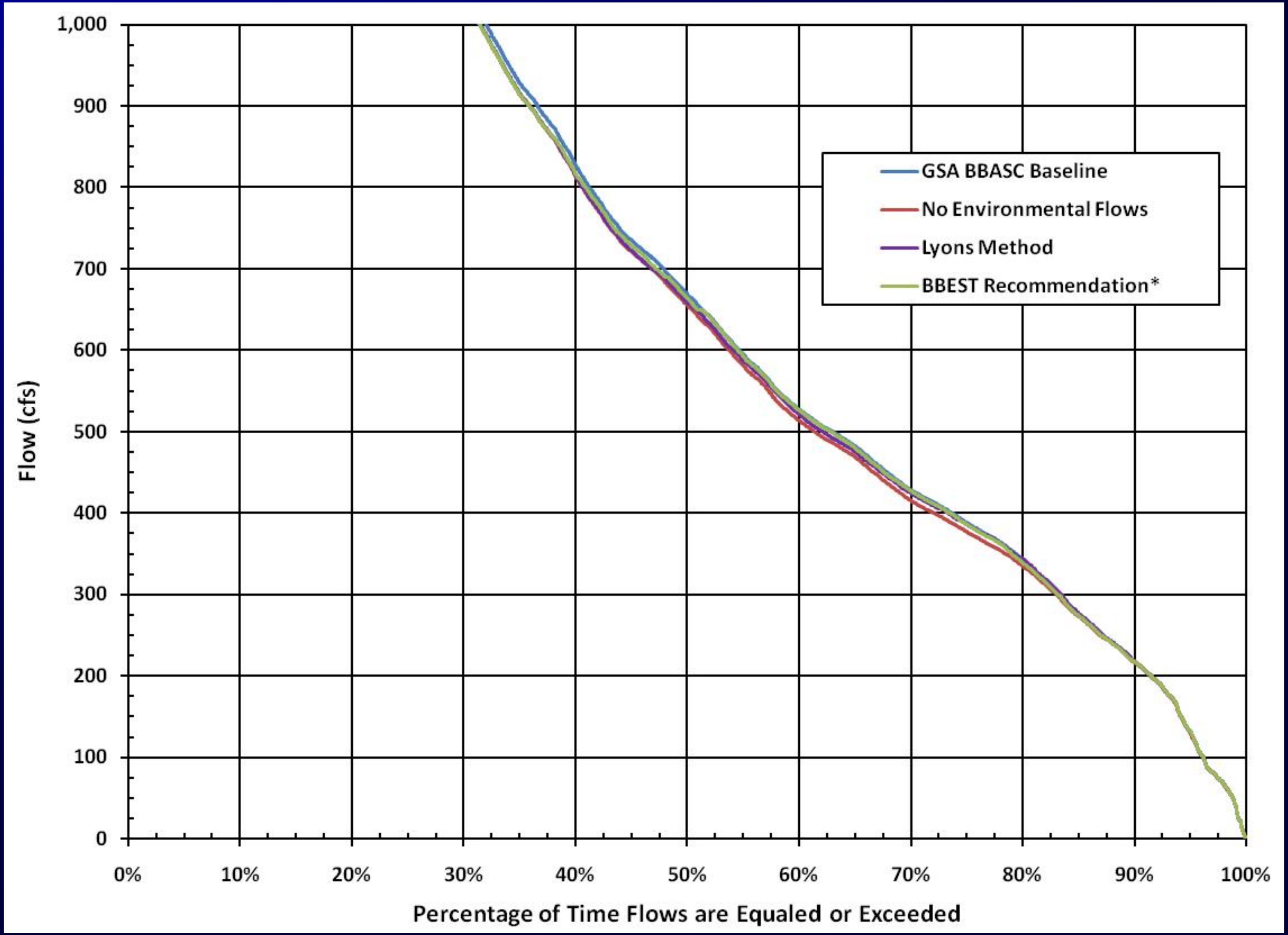
Run-Of-River Diversions – San Marcos River @ Luling



Run-Of-River Diversions – Guadalupe River @ Gonzales

	No Environmental Flow	Lyons Method	BBEST Recommendation
Maximum Annual Diversion (acft/yr)	10,000	10,000	10,000
Average Annual Diversion (acft/yr)	8,130	5,997	5,128
Minimum Annual Diversion (acft/yr)	54	10	22
Monthly Reliability	80.1%	49.5%	38.1%
Daily Reliability	80.4%	58.5%	49.8%

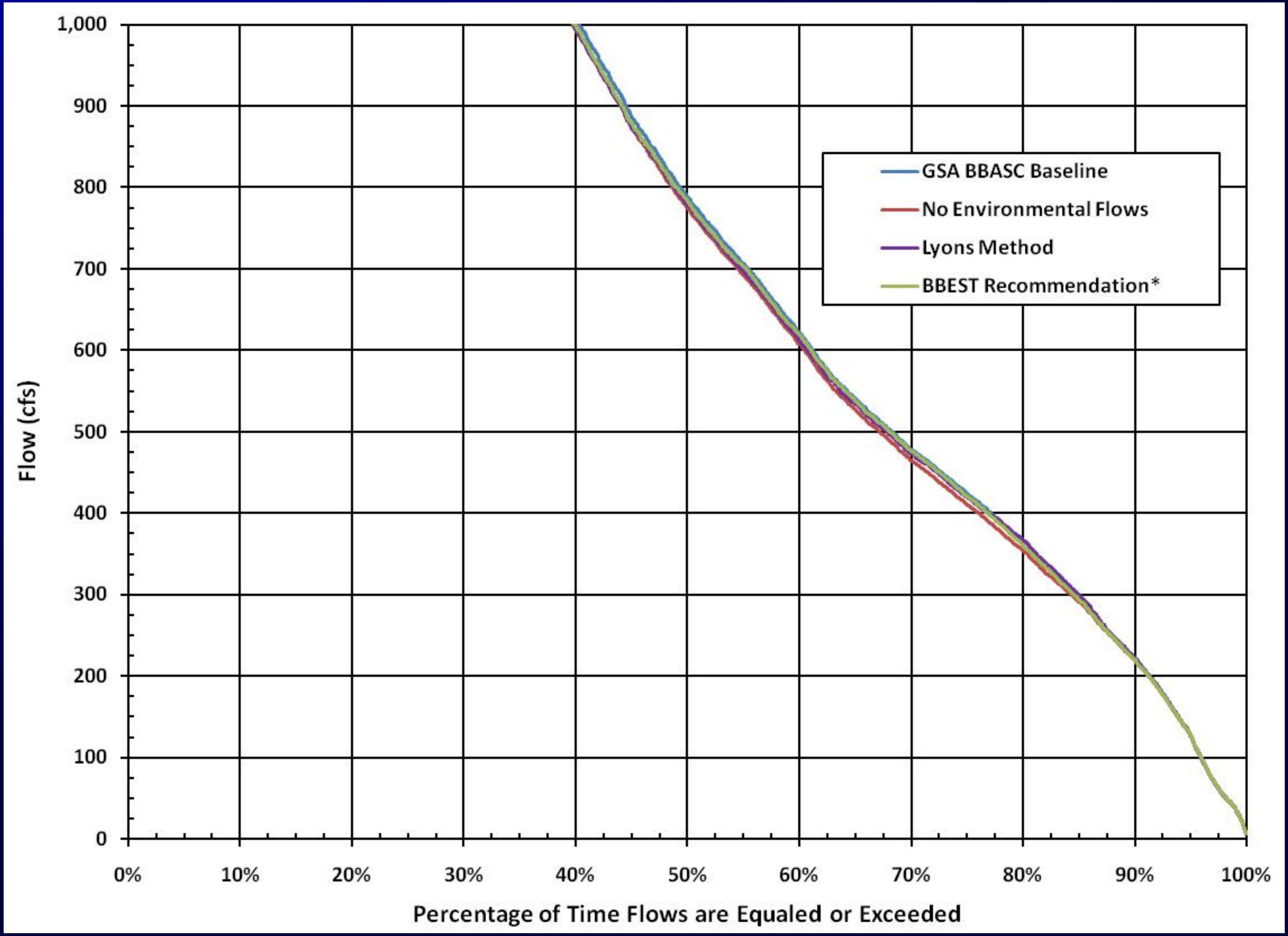
Run-Of-River Diversions – Guadalupe River @ Gonzales



Run-Of-River Diversions – Guadalupe River @ Victoria

	No Environmental Flow	Lyons Method	BBEST Recommendation
Maximum Annual Diversion (acft/yr)	10,000	10,000	10,000
Average Annual Diversion (acft/yr)	8,547	6,273	5,831
Minimum Annual Diversion (acft/yr)	584	82	311
Monthly Reliability	85.0%	48.3%	42.0%
Daily Reliability	85.3%	62.2%	57.0%

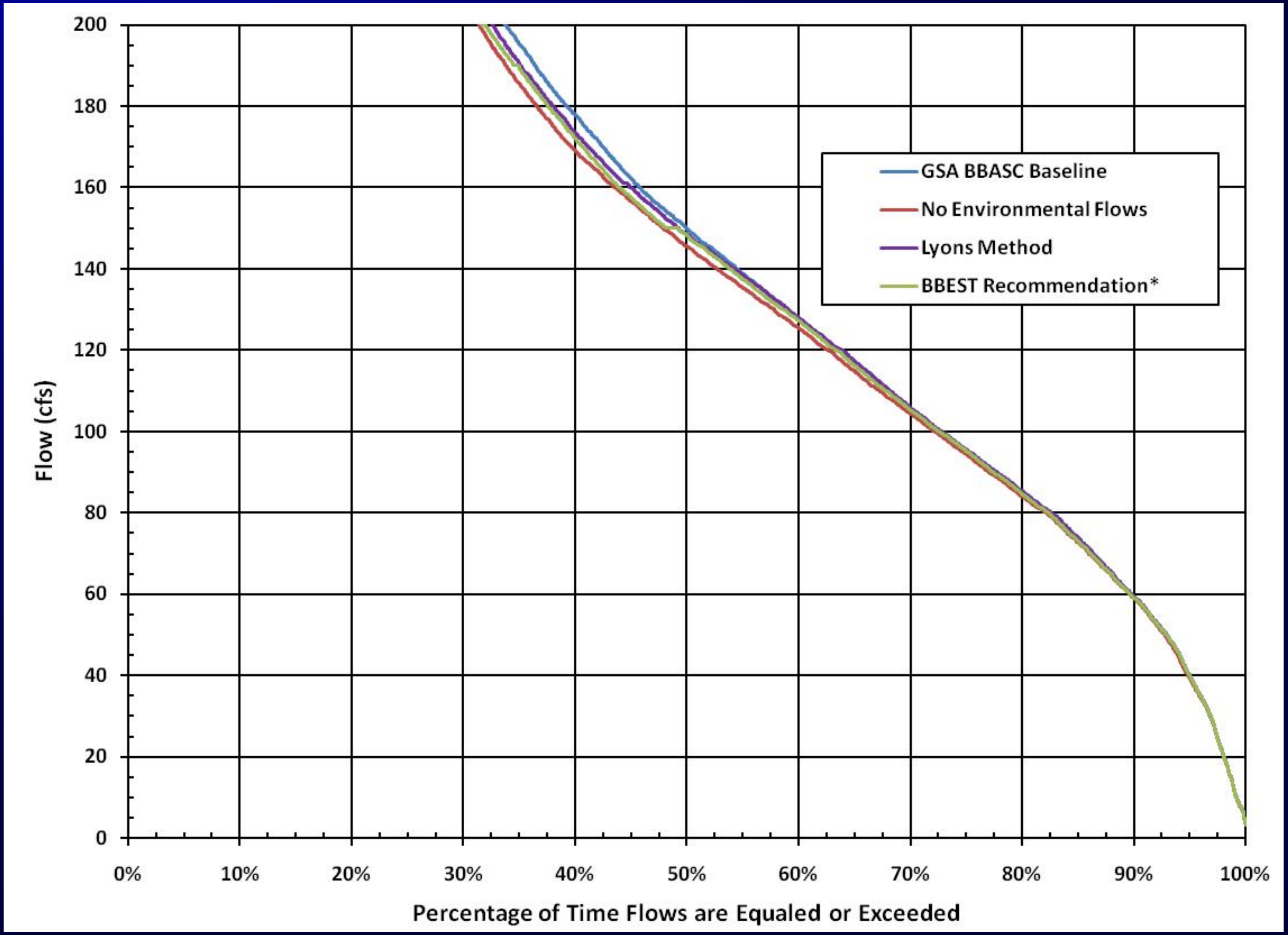
Run-Of-River Diversions – Guadalupe River @ Victoria



Run-Of-River Diversions – San Antonio River near Elmendorf

	No Environmental Flow	Lyons Method	BBEST Recommendation
Maximum Annual Diversion (acft/yr)	10,000	10,000	9,368
Average Annual Diversion (acft/yr)	4,437	3,066	3,797
Minimum Annual Diversion (acft/yr)	0	0	0
Monthly Reliability	41.2%	18.7%	24.7%
Daily Reliability	42.4%	29.2%	35.2%

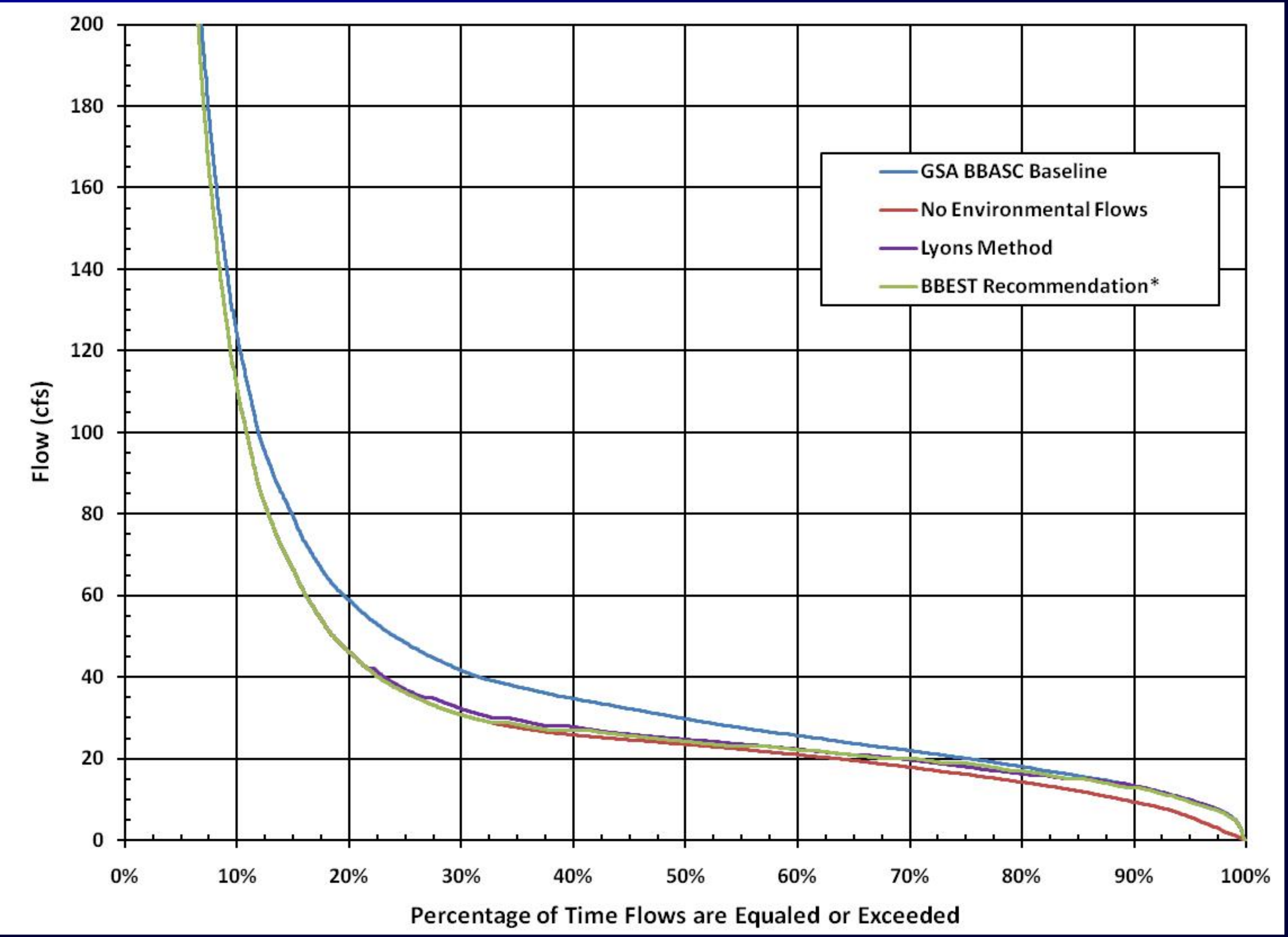
Run-Of-River Diversions – San Antonio River near Elmendorf



Run-Of-River Diversions – Cibolo Creek near Falls City

	No Environmental Flow	Lyons Method	BBEST Recommendation
Maximum Annual Diversion (acft/yr)	9,598	9,559	9,509
Average Annual Diversion (acft/yr)	5,575	4,440	4,676
Minimum Annual Diversion (acft/yr)	204	82	133
Monthly Reliability	32.7%	16.2%	15.0%
Daily Reliability	42.6%	32.9%	33.2%

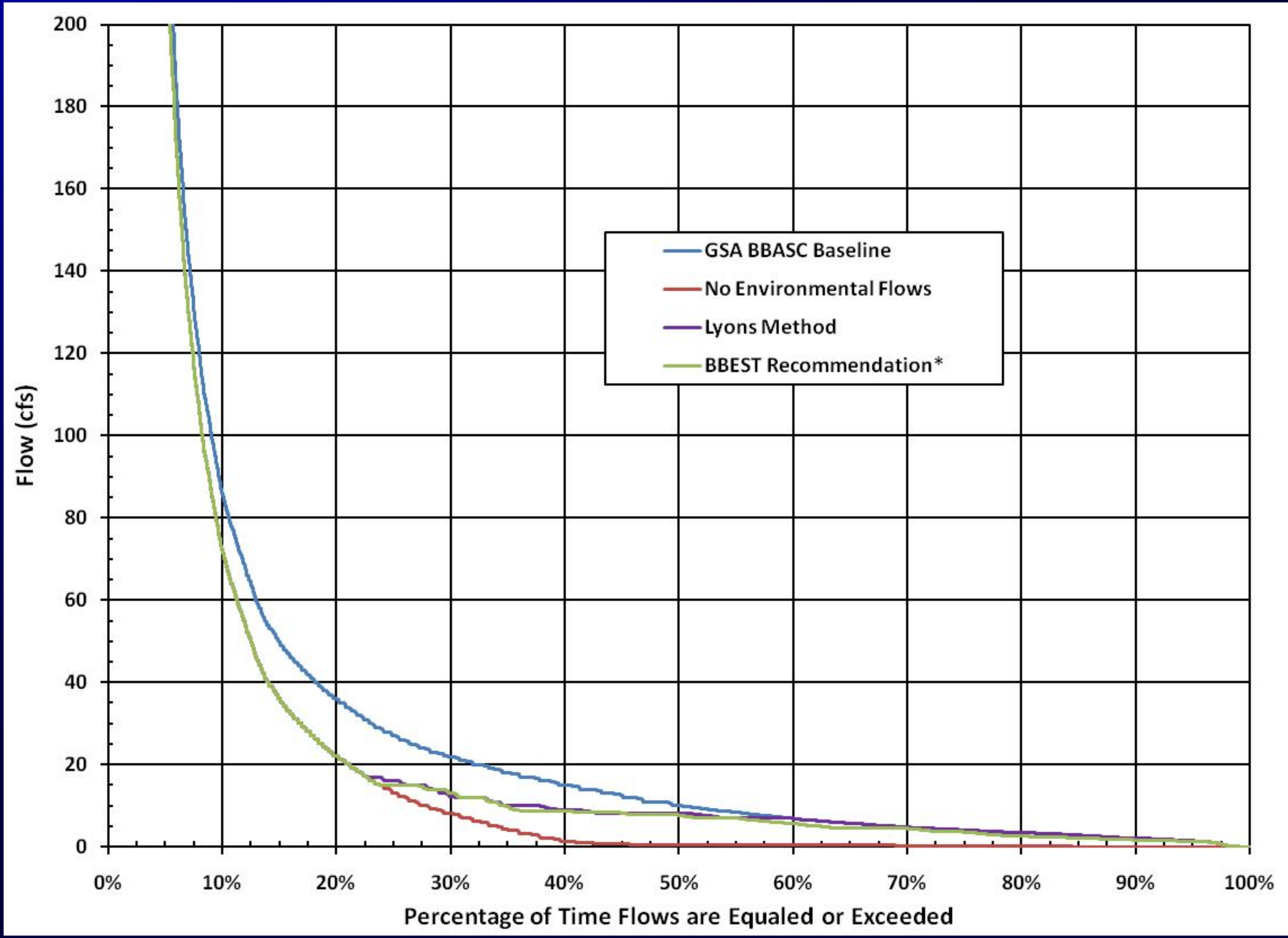
Run-Of-River Diversions – Cibolo Creek near Falls City



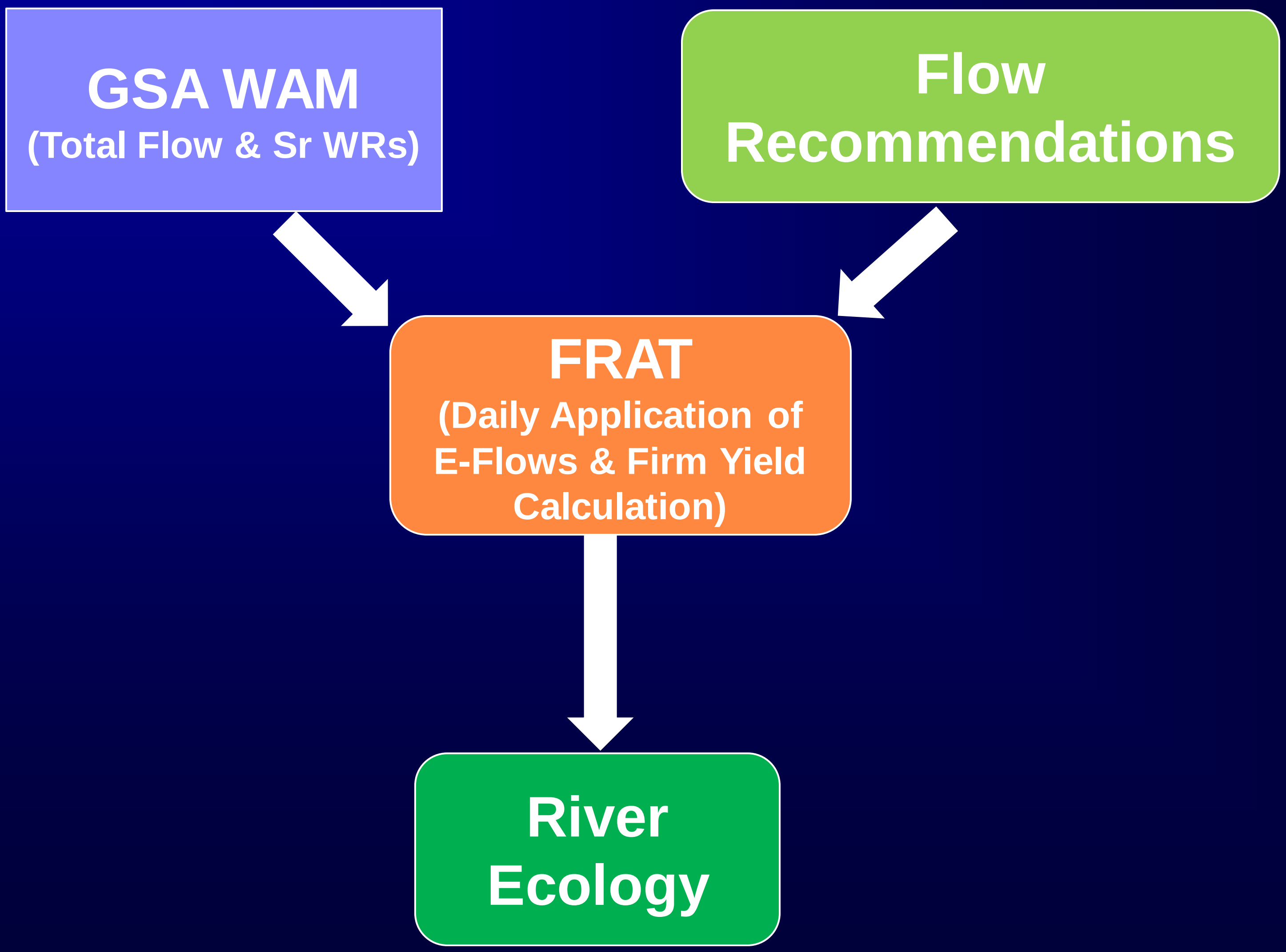
Run-Of-River Diversions – Mission River @ Refugio

	No Environmental Flow	Lyons Method	BBEST Recommendation
Maximum Annual Diversion (acft/yr)	10,000	9,699	9,896
Average Annual Diversion (acft/yr)	6,039	3,605	3,852
Minimum Annual Diversion (acft/yr)	0	0	0
Monthly Reliability	25.1%	11.7%	11.3%
Daily Reliability	44.6%	29.6%	30.2%

Run-Of-River Diversions – Mission River @ Refugio



Run-Of-River Diversions



Run-Of-River Diversions

BIO-WEST

Presentation

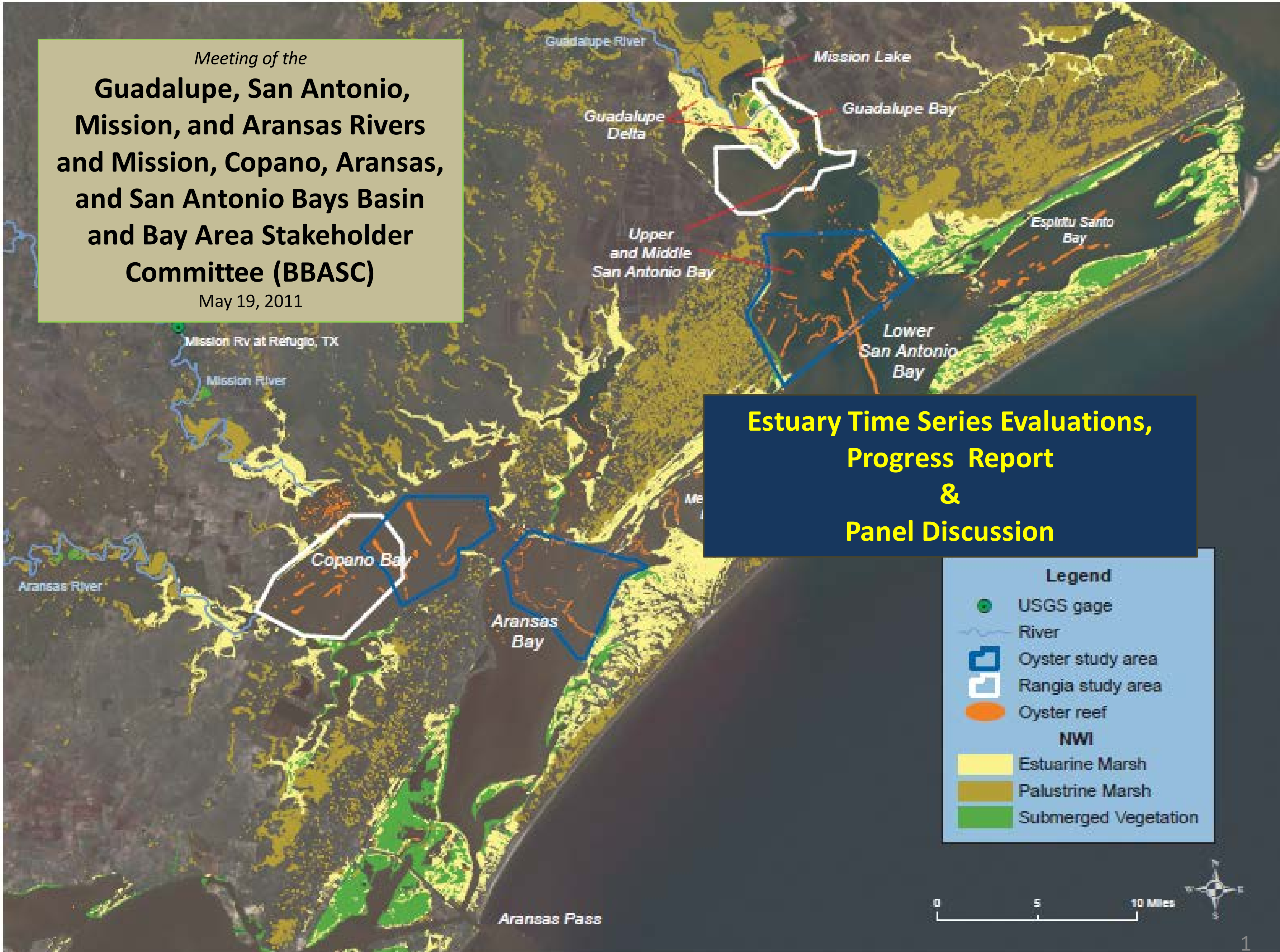
Questions, Comments, & Discussion

Meeting of the

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

May 19, 2011

Estuary Time Series Evaluations, Progress Report & Panel Discussion



Estuary Inflow Analyses - main biologic/ ecologic issue areas of importance:

a.) re. Rangia and oysters and the role/meaning of being an “indicator” species. How narrowly or broadly they should be viewed to indicate overall ecosystem health. Associated issues such as health of other directly-associated organisms (e.g. predator/prey) or other organisms that would be maintained via indicator maintenance, even if no direct connection;

b.) resiliency and capacity to withstand extremes has been maintained historically. Can this be maintained given scope of inflow changes among categories?;

c.) uncertainty in BBEST analyses and thus magnitudes/ attainment frequencies of our criteria is not insignificant. The mere knowledge of its existence though, does not support relaxing any particular criteria in one direction or another, due to the multi-faceted nature of uncertainty.

d.) implications of using categorical data in impacts analyses. Potential for modest changes in inflow to “jump” category bounds, and be ranked same as large changes. Looking at additional metrics of WUA performance.

e.)year-upon-year (aka sequent) considerations are substantial for evaluating effects of criteria non-attainment, though not reflected in our criteria.

f.) potential effects of modification of a criteria may not be same for rangia as it is for oysters. G1 criteria set addressed the reproductive requirement of a long-lived clam. G2 addressed disease effects on oysters, a very important species which also creates habitat for other species.

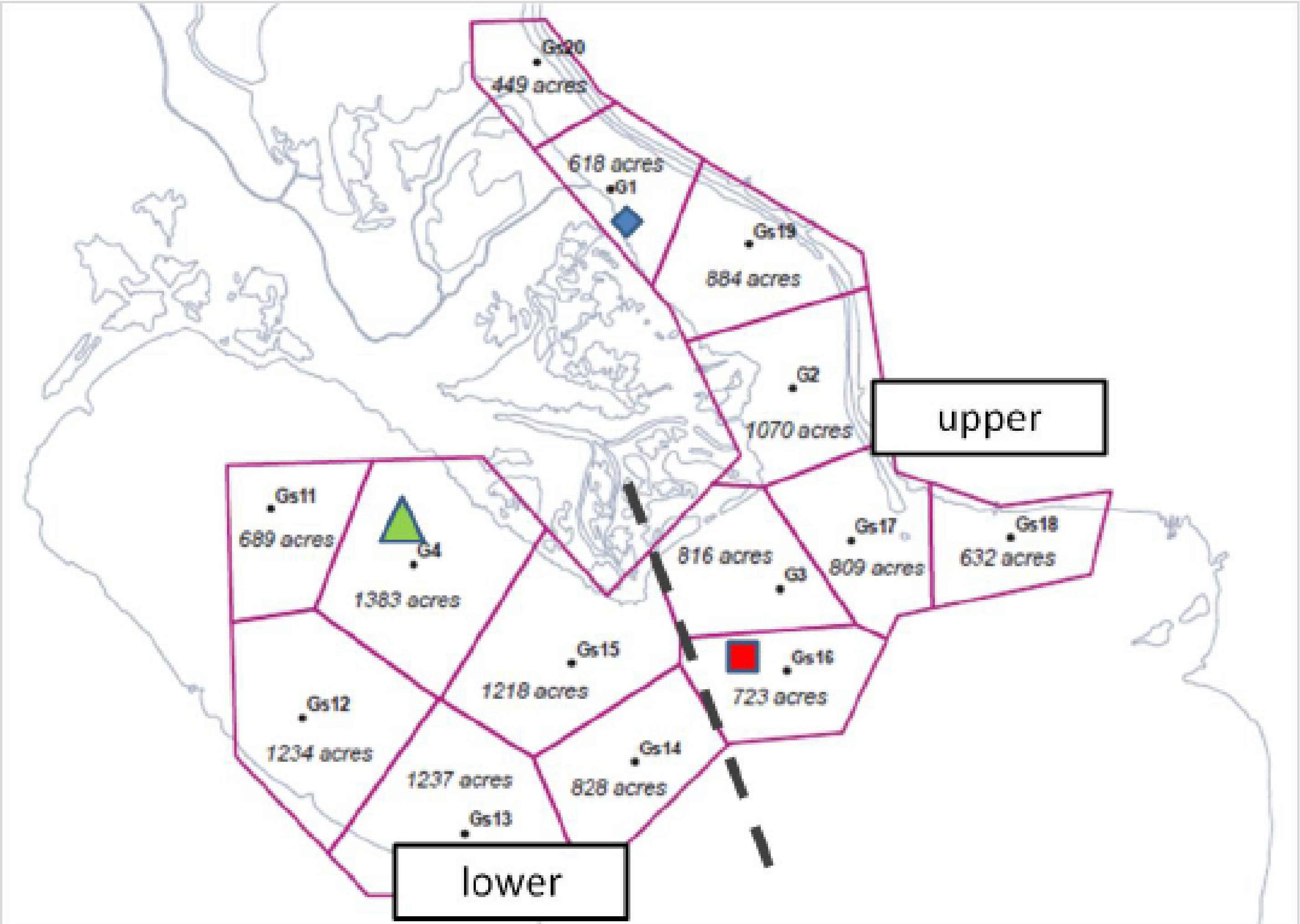
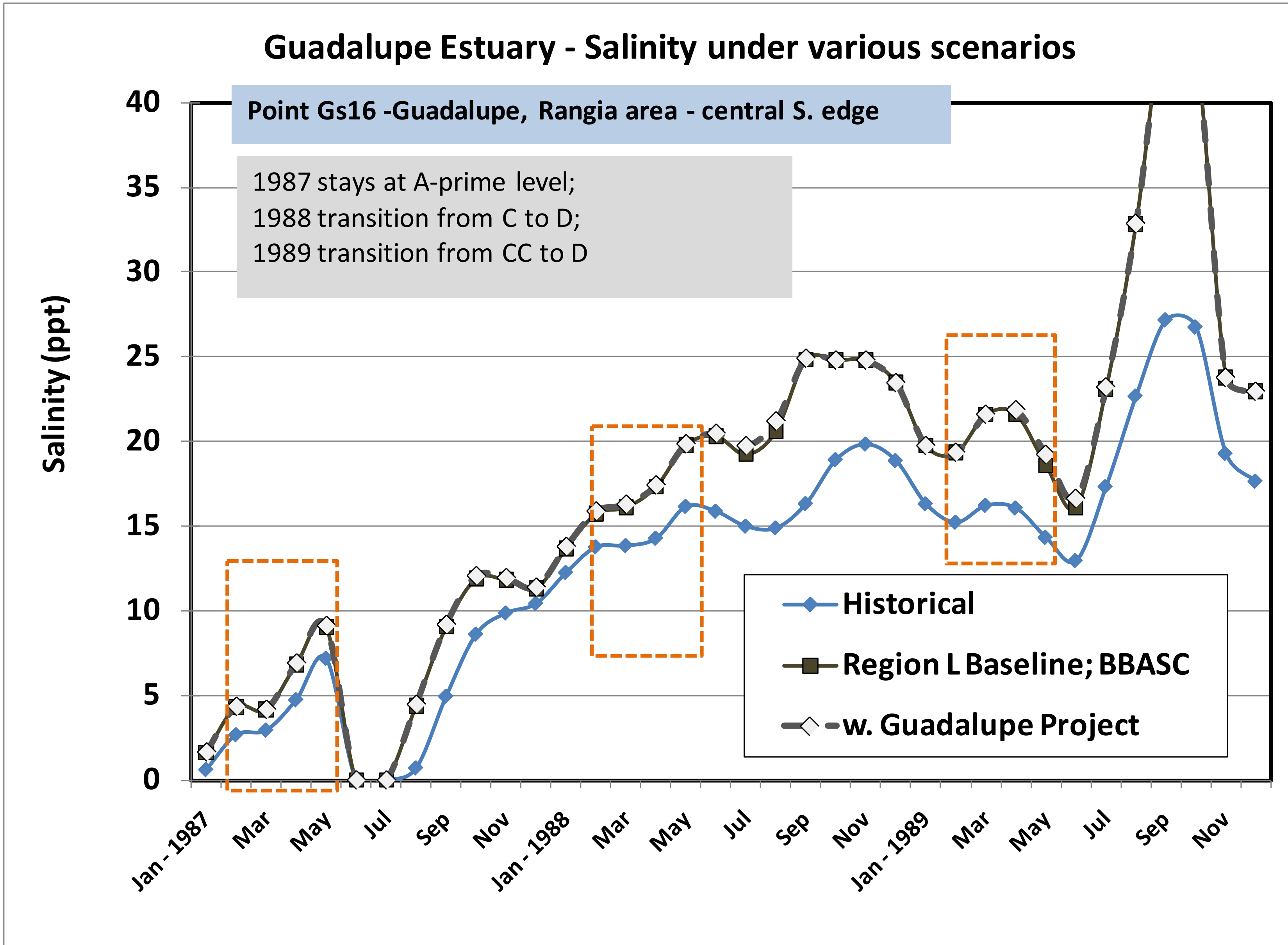
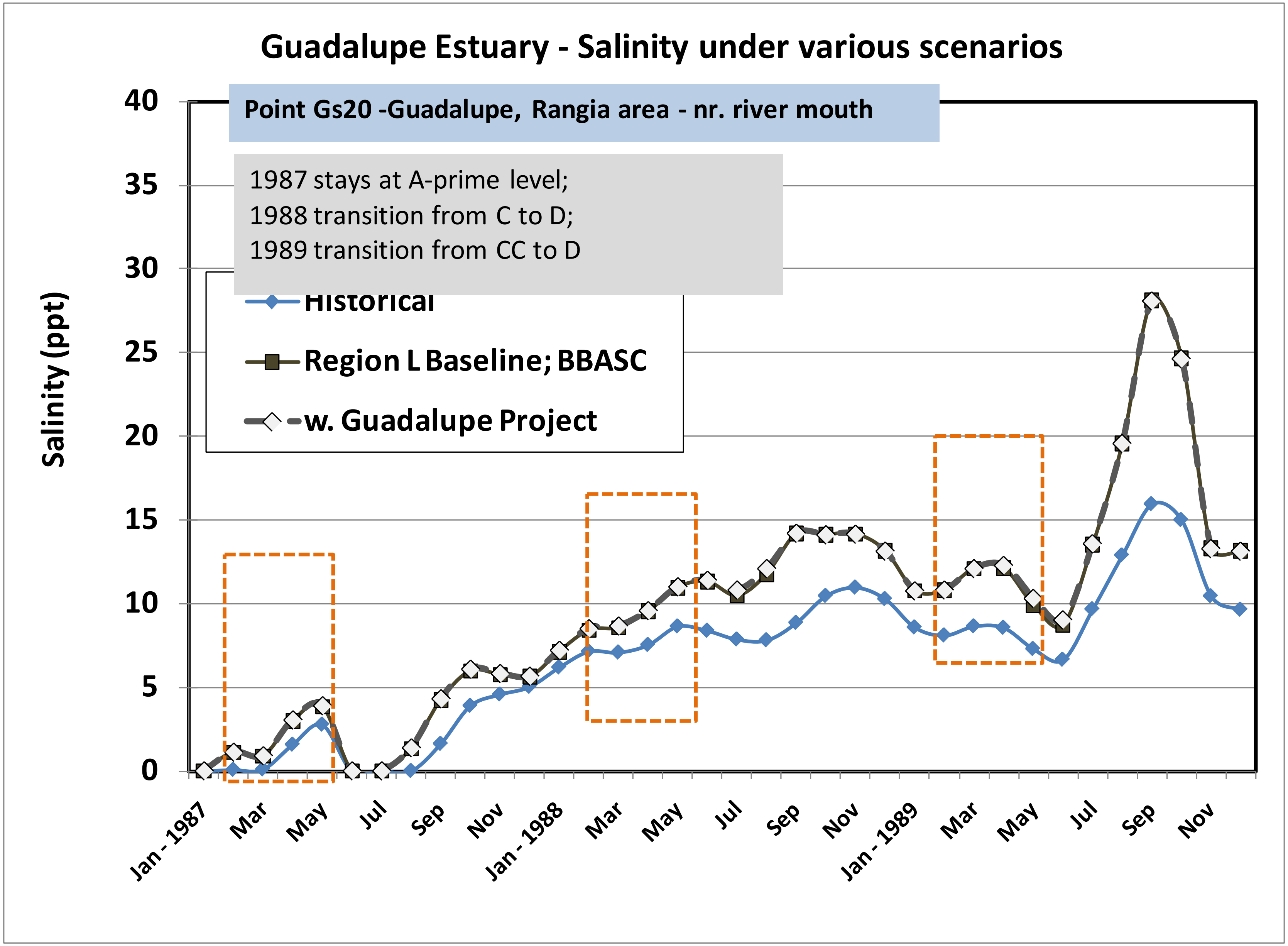
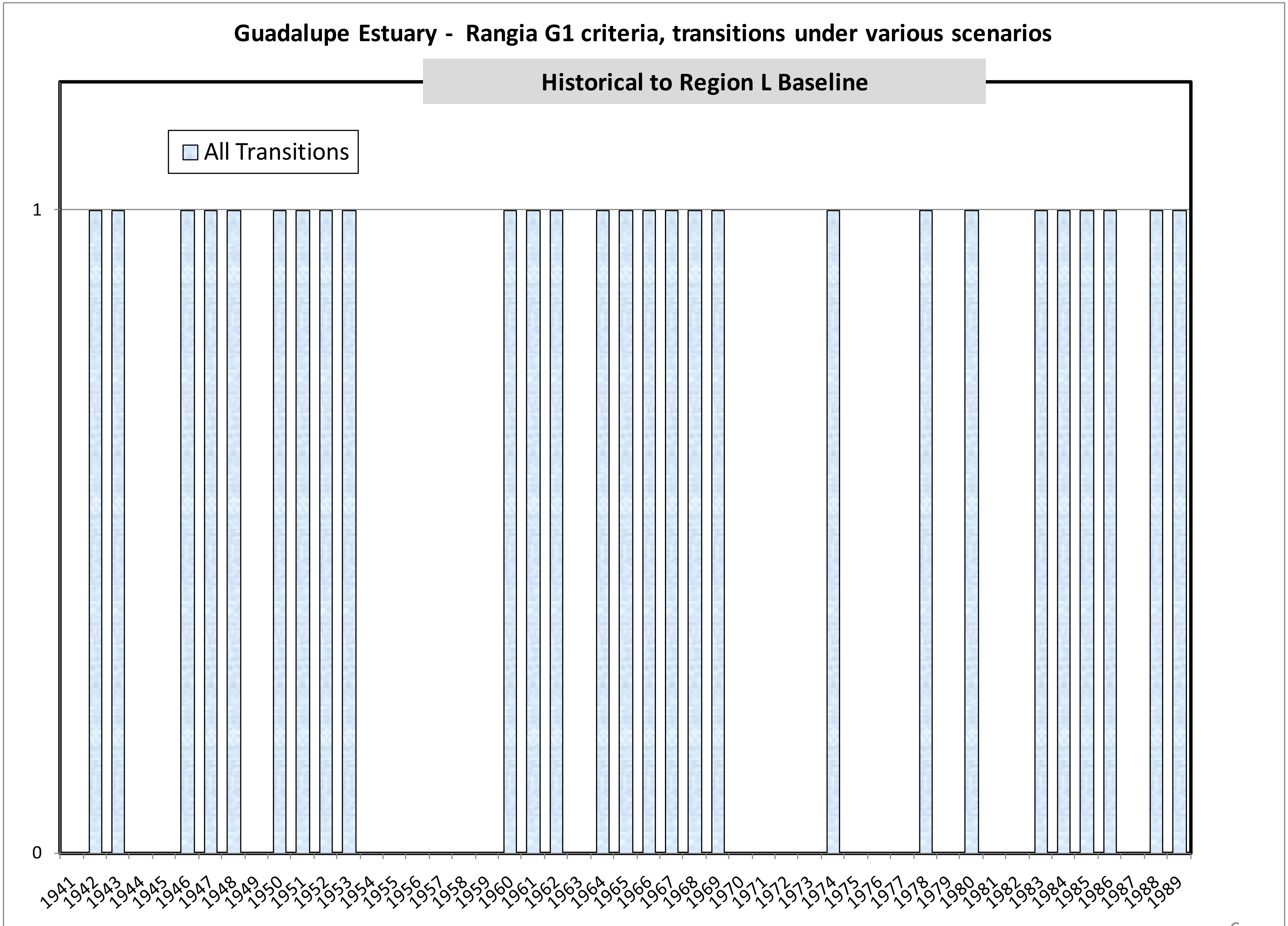


Figure 4.5-3. The area of the upper Guadalupe Estuary utilized for rangia analyses. Also shown are the subareas and points at which salinity-inflow regression equations were developed. Finally, this habitat was also subdivided into an upper and lower portion for analyses.



Guadalupe Estuary - Salinity under various scenarios
Point Gs16 -Guadalupe, Rangia area - central S. edge
1987 stays at A-prime level;
1988 transition from C to D;
1989 transition from CC to D
Salinity (ppt)
40
35
30
25
20
15
10
5
0
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov
Historical
Region L Baseline; BBASC
w. Guadalupe Project


Guadalupe Estuary - Salinity under various scenarios
Point Gs20 -Guadalupe, Rangia area - nr. river mouth
1987 stays at A-prime level;
1988 transition from C to D;
1989 transition from CC to D
Historical
Region L Baseline; BBASC
w. Guadalupe Project
Salinity (ppt)
40
35
30
25
20
15
10
5
0
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov



Guadalupe Estuary - Rangia G1 criteria, transitions under various scenarios
Historical to Region L Baseline
All Transitions
1
0
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
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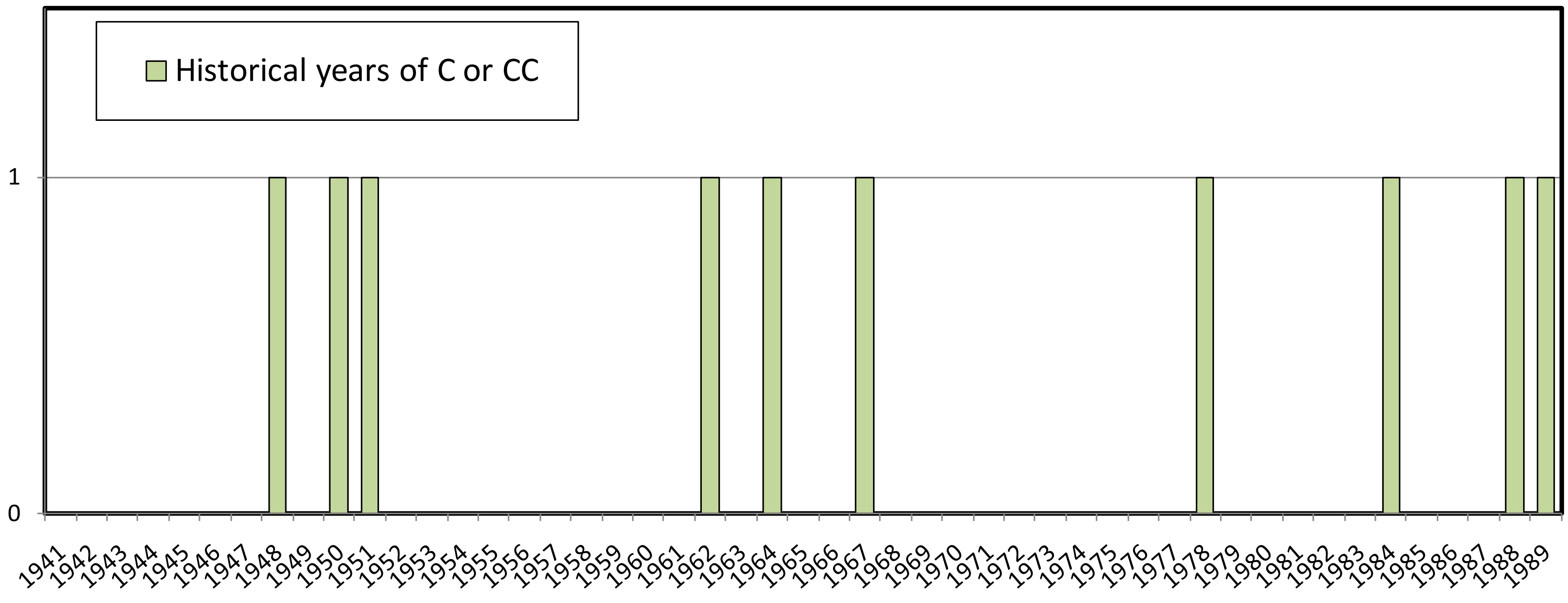
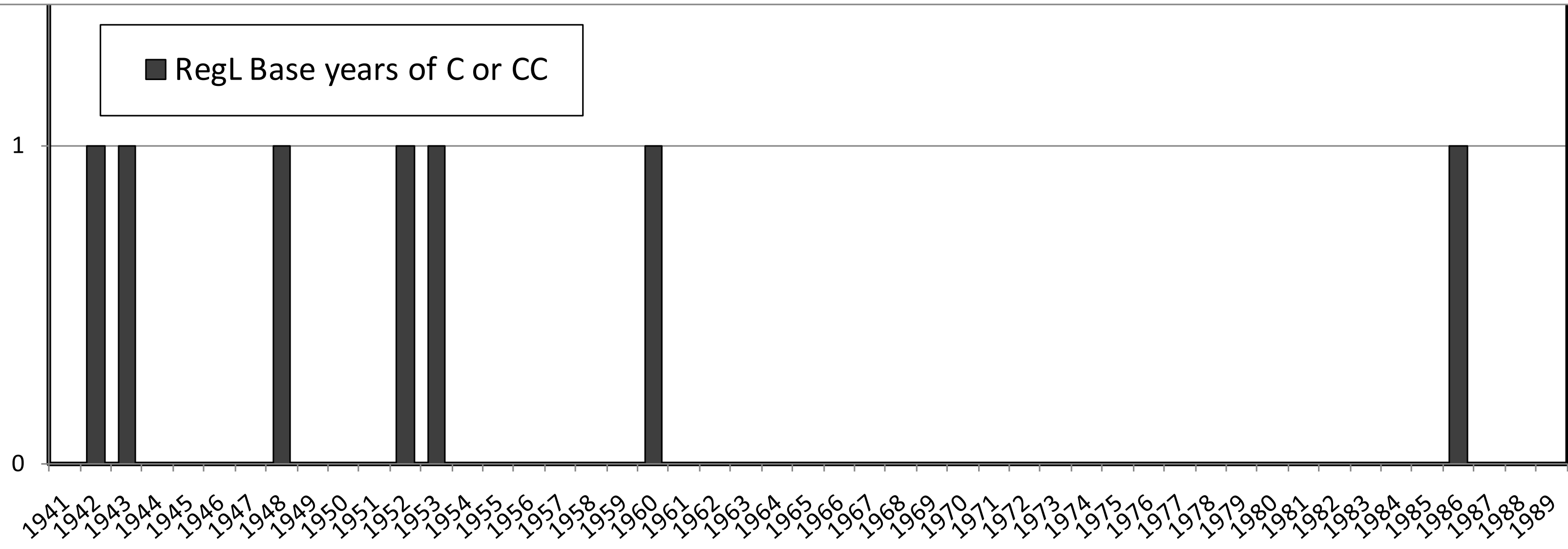
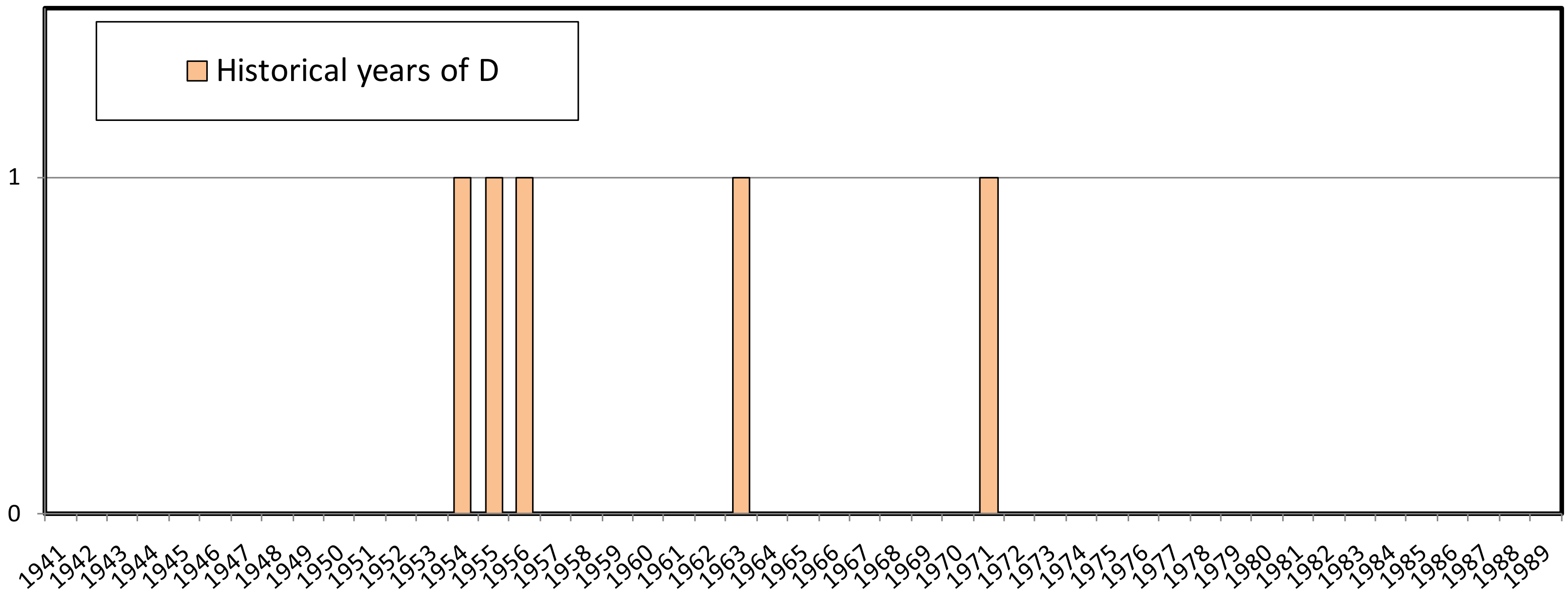
1988
1989

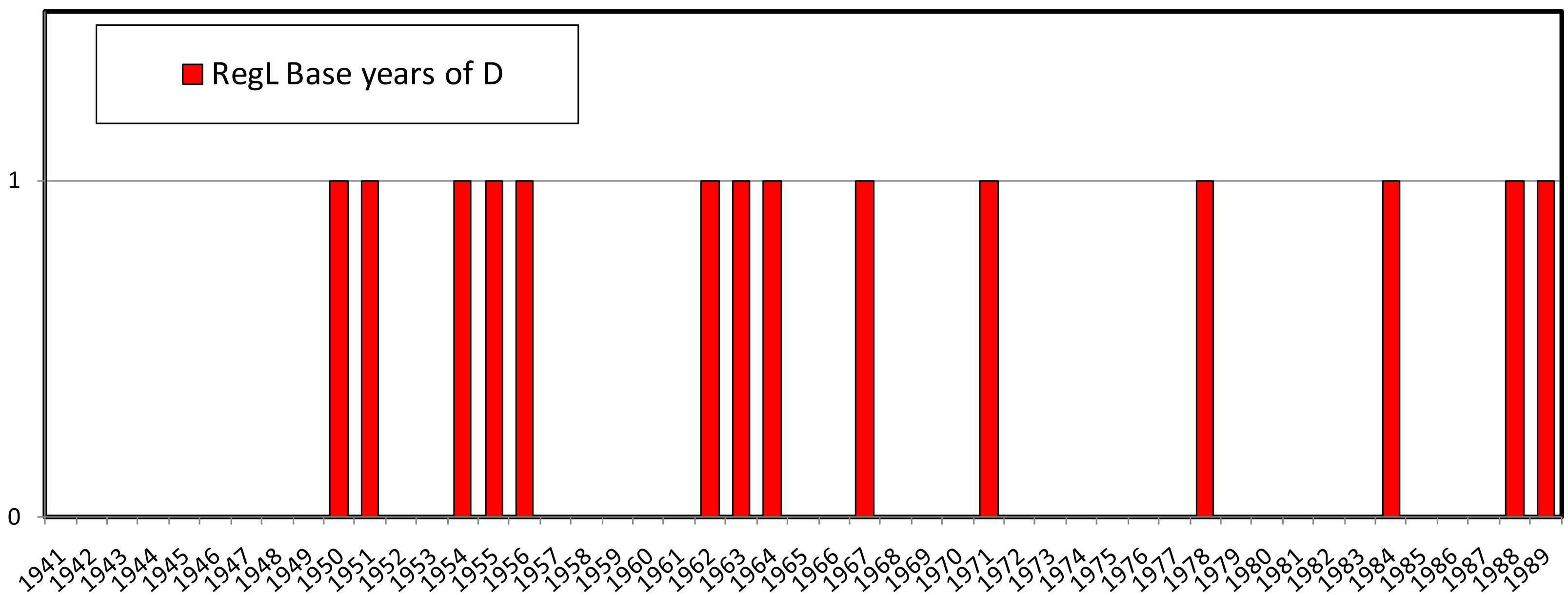
Guadalupe Estuary - Rangia G1 criteria, transitions under various scenarios



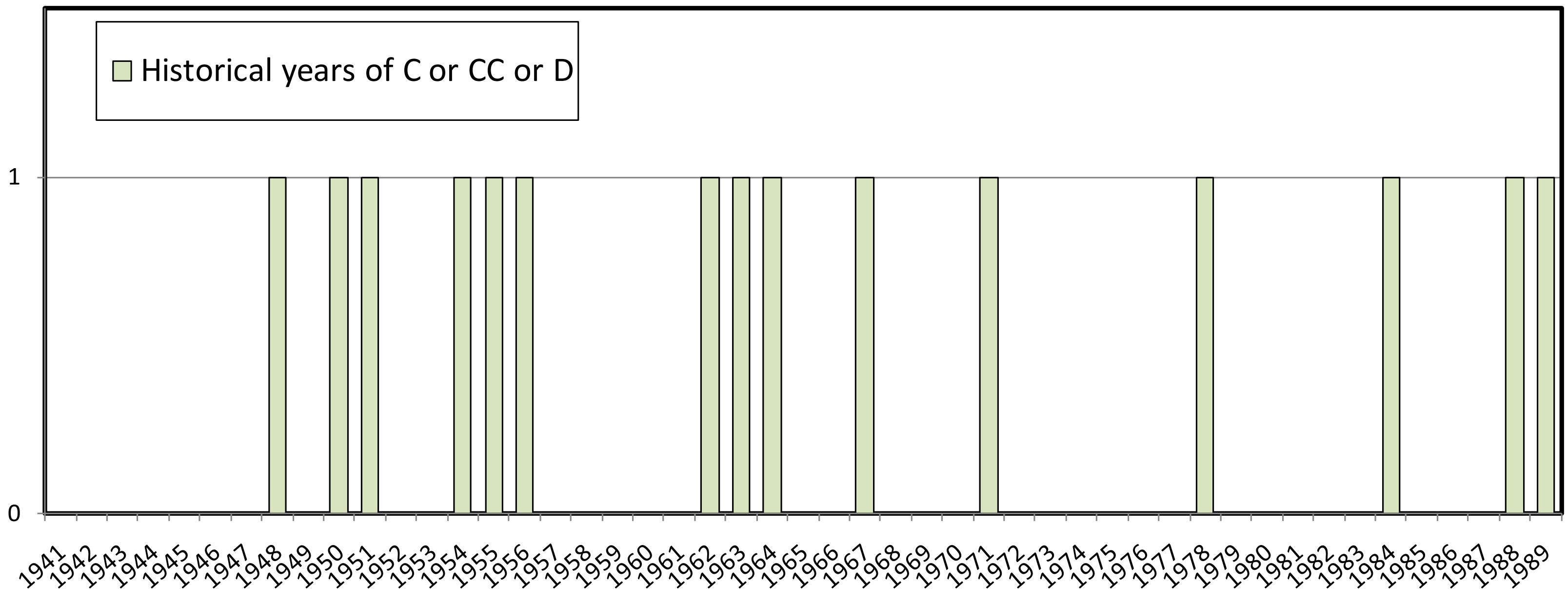


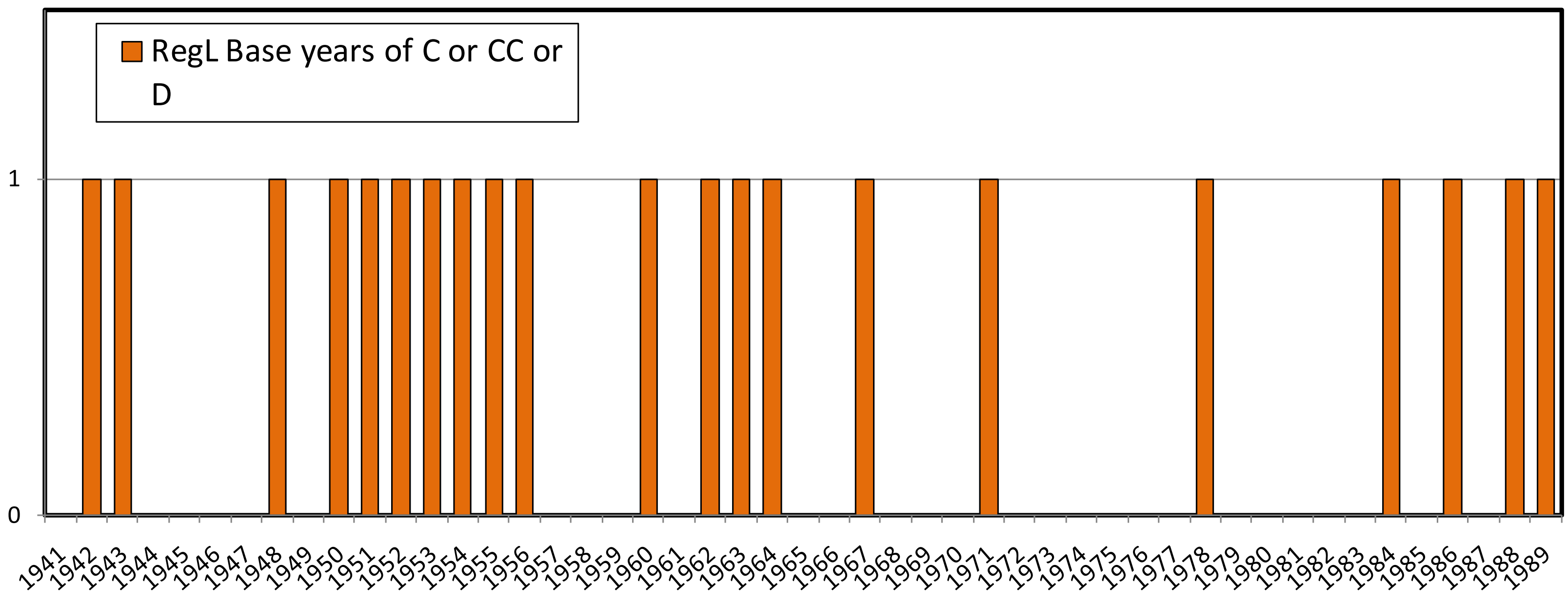
Guadalupe Estuary - Rangia G1 criteria, transitions under various scenarios

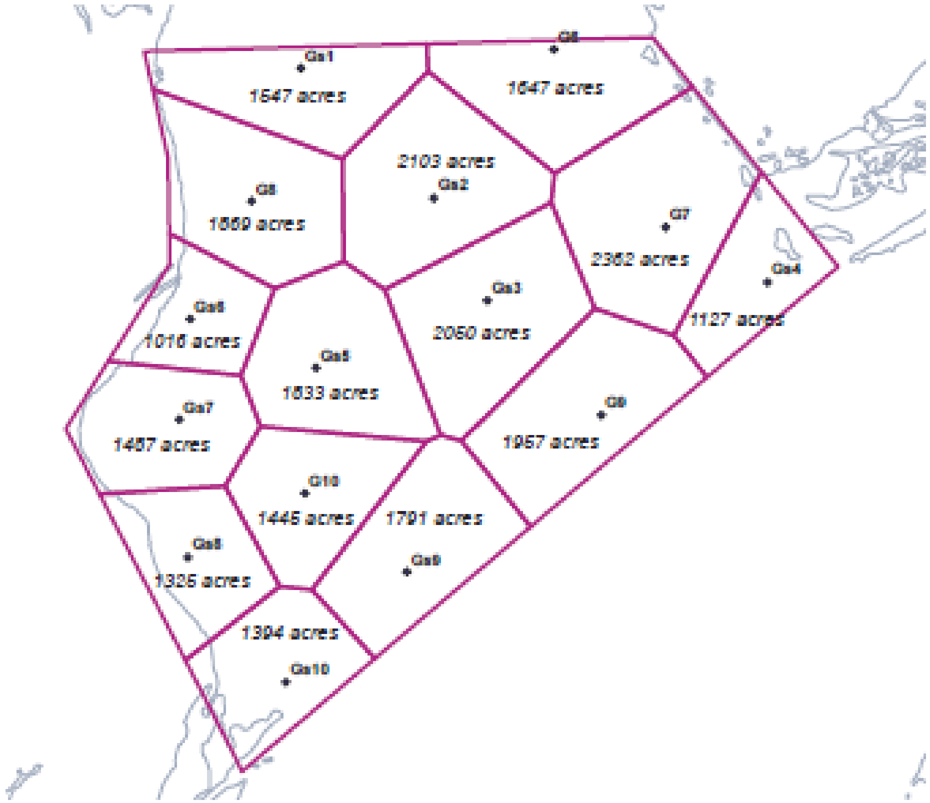




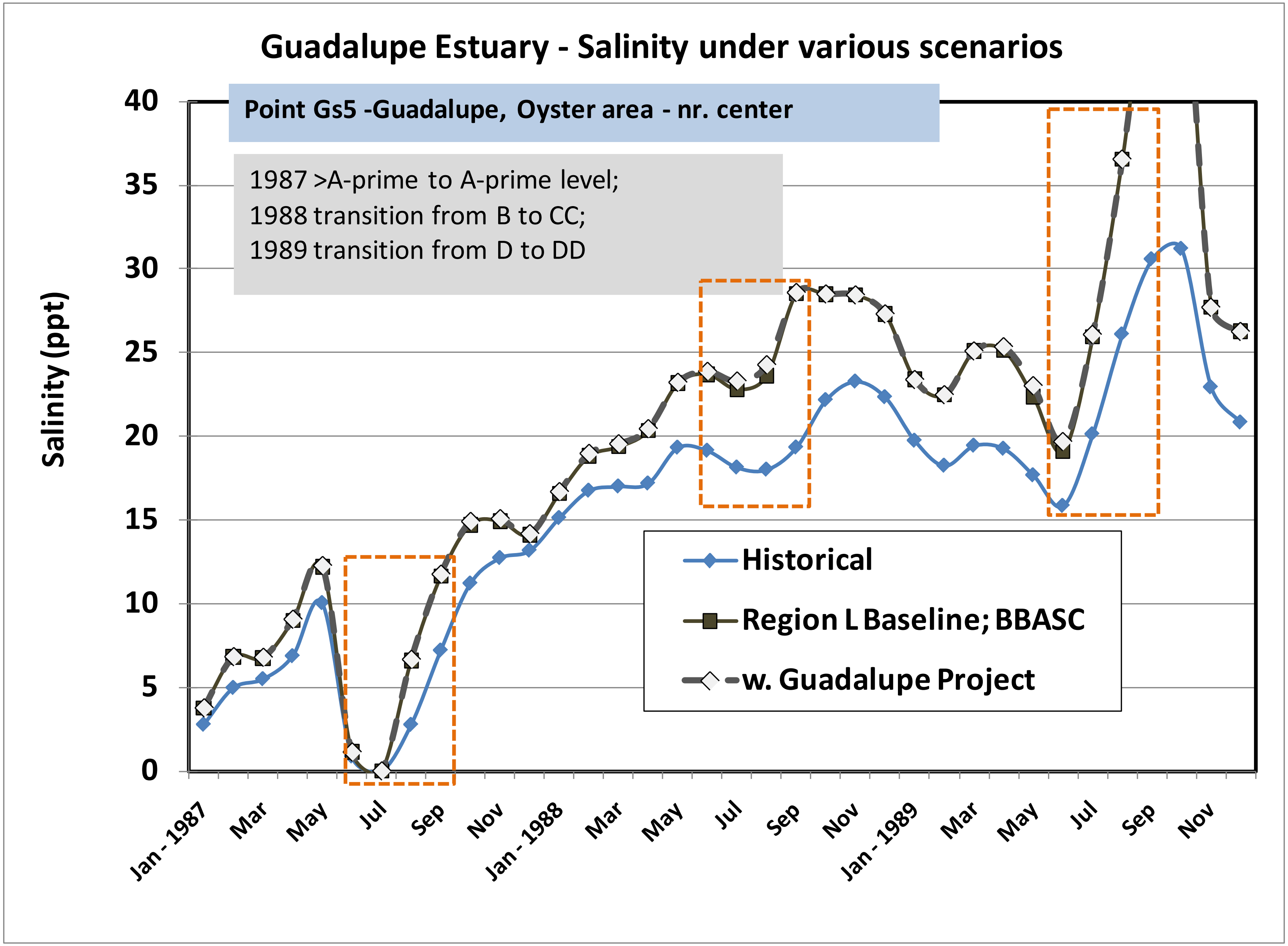
Guadalupe Estuary - Rangia G1 criteria, transitions under various scenarios



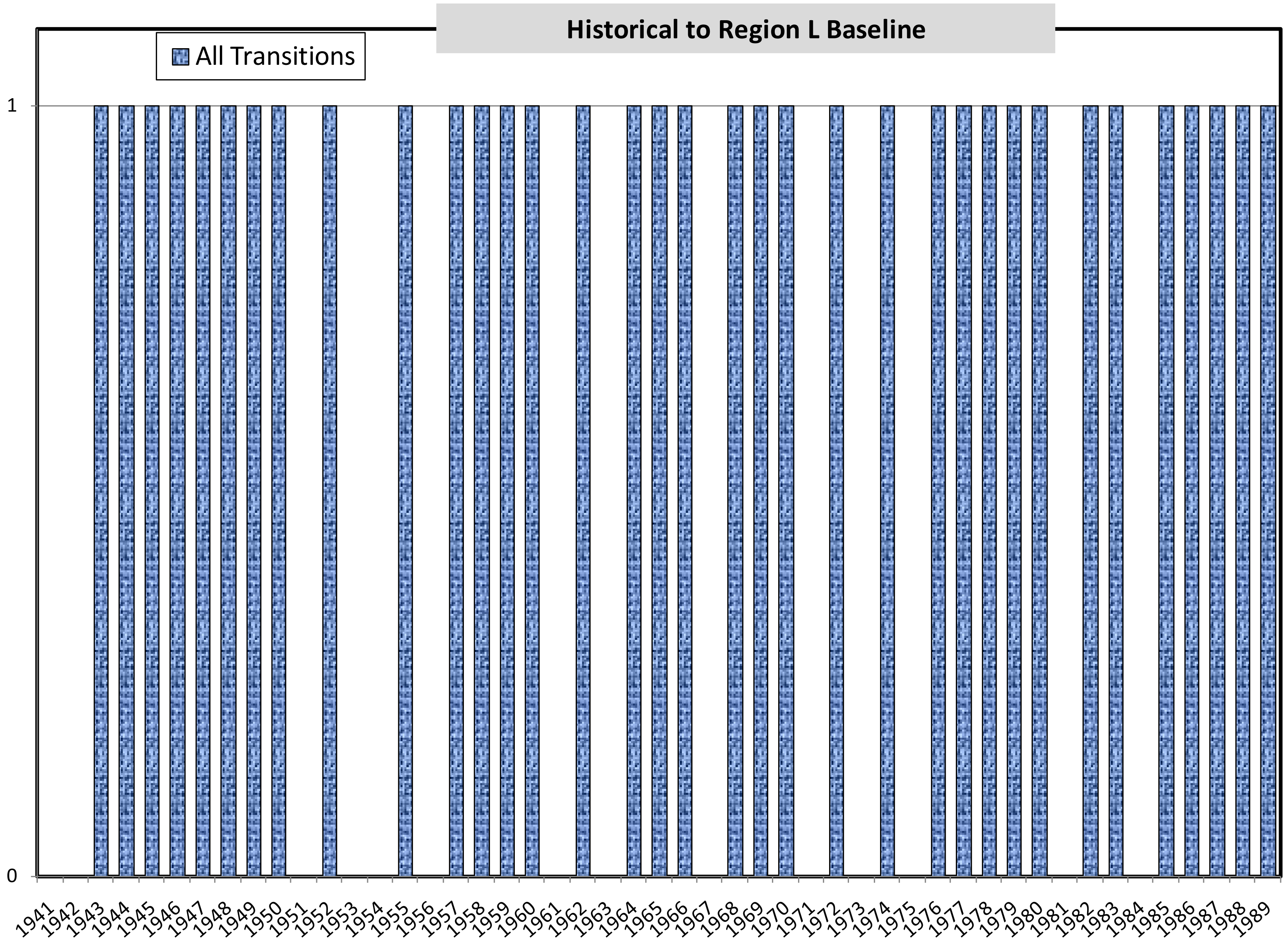




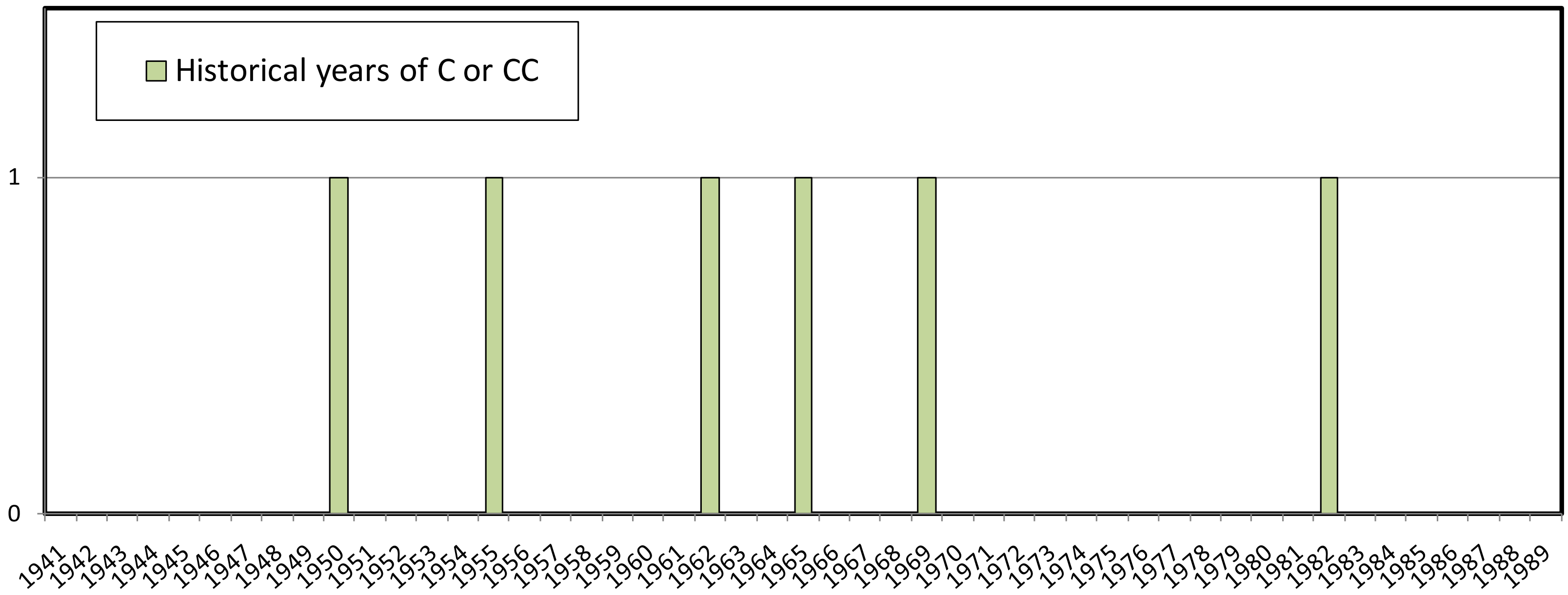
Ga1
1647 acres
1647 acres
2103 acres
Ga2
1869 acres
G7
2362 acres
Ga4
Ga3
1016 acres
2060 acres
1127 acres
1833 acres
Ga7
G9
1487 acres
1957 acres
G10
1445 acres
1791 acres
1326 acres
1394 acres
Ga10

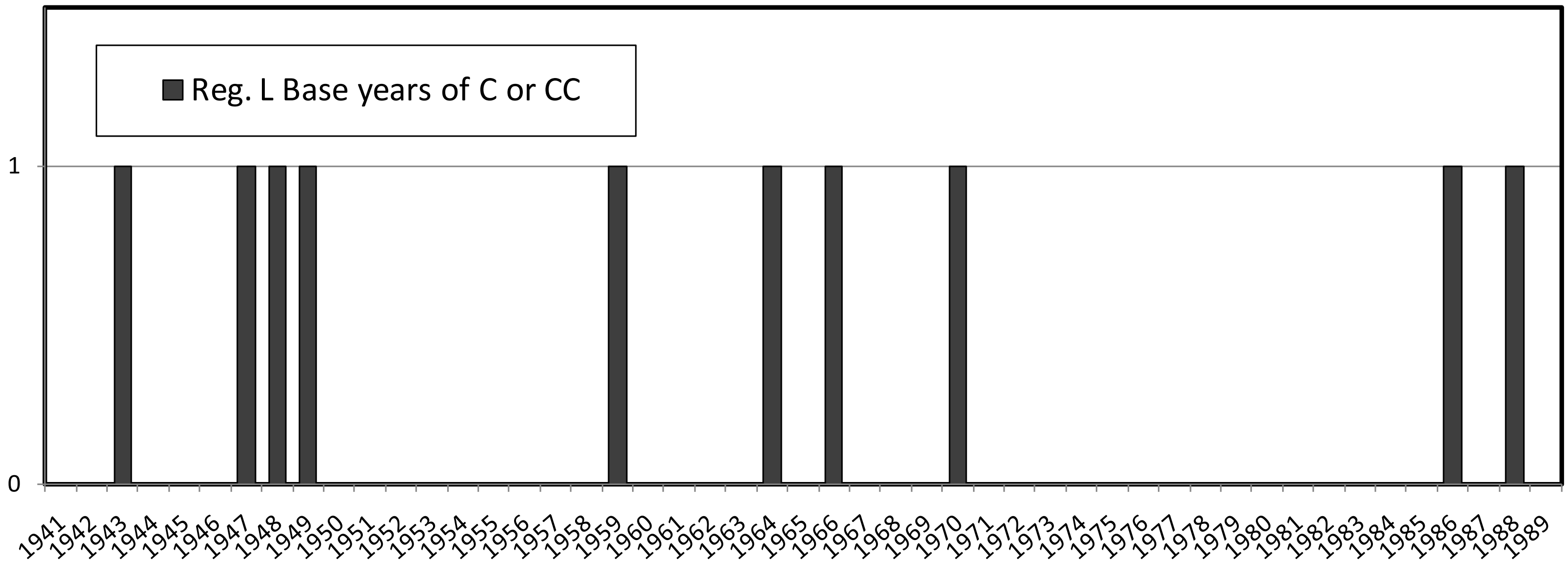

Guadalupe Estuary - Salinity under various scenarios
Point Gs5 -Guadalupe, Oyster area - nr. center
1987 >A-prime to A-prime level;
1988 transition from B to CC;
1989 transition from D to DD
Salinity (ppt)
40
35
30
25
20
15
10
5
0
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov
Historical
Region L Baseline; BBASC
w. Guadalupe Project

Guadalupe Estuary - Oyster G2 criteria, transitions under various scenarios

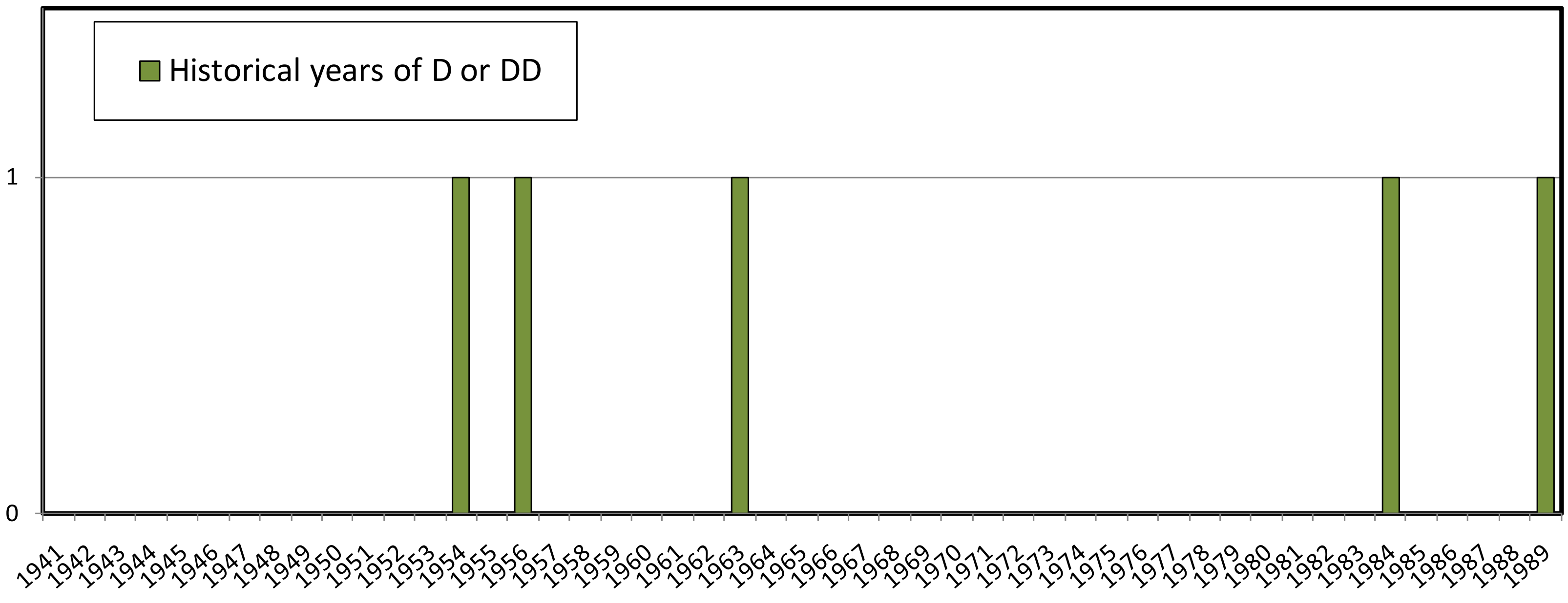


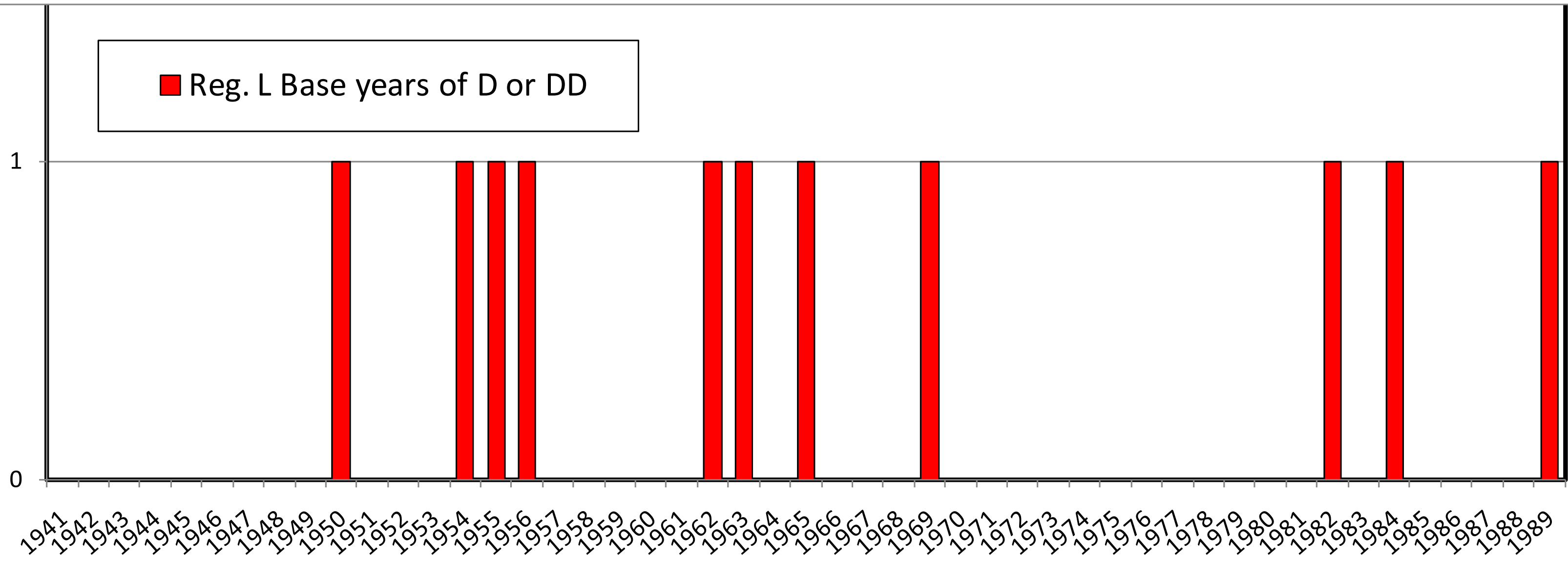
Guadalupe Estuary - Oyster G2 criteria, transitions under various scenarios



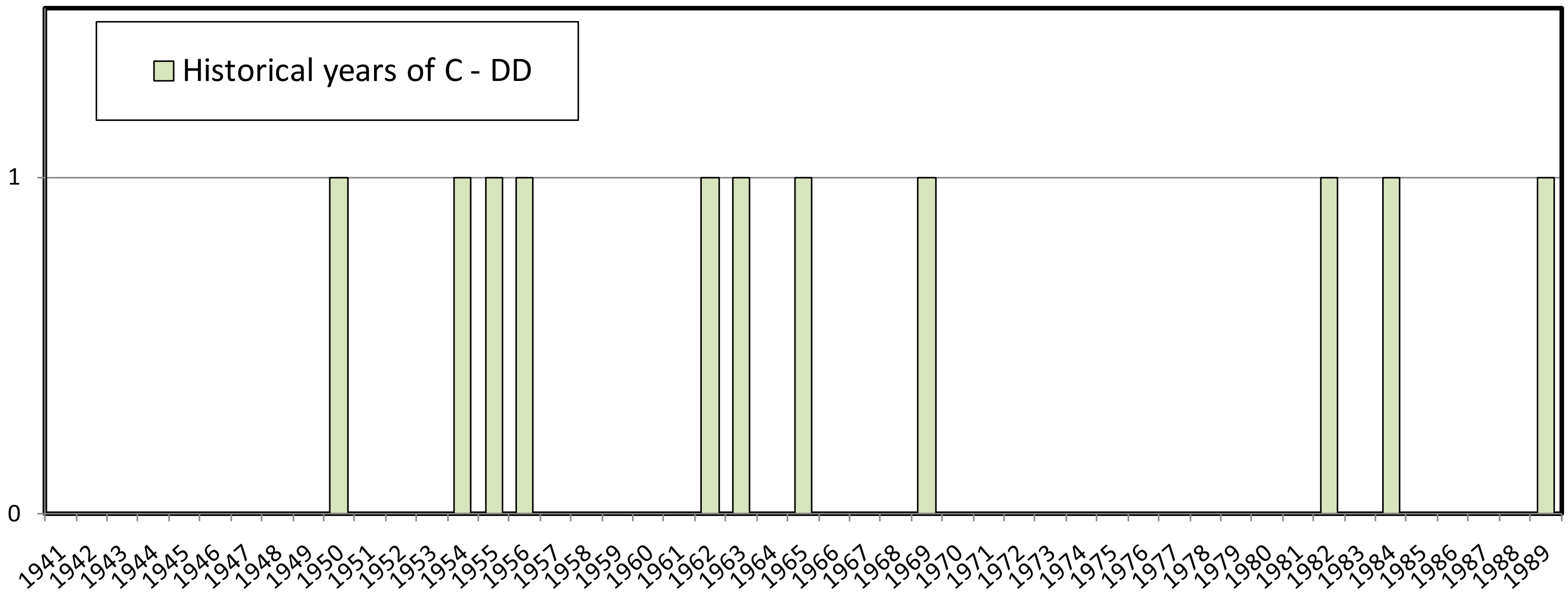


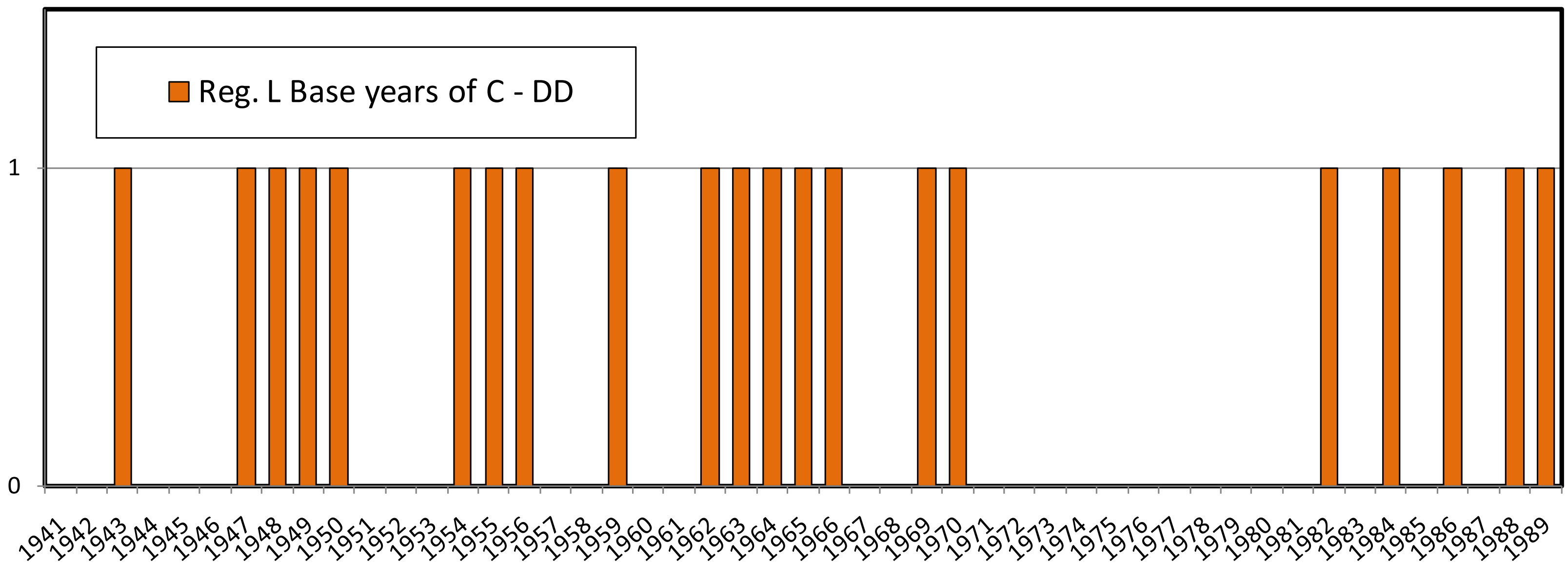
Guadalupe Estuary - Oyster G2 criteria, transitions under various scenarios





Guadalupe Estuary - Oyster G2 criteria, transitions under various scenarios





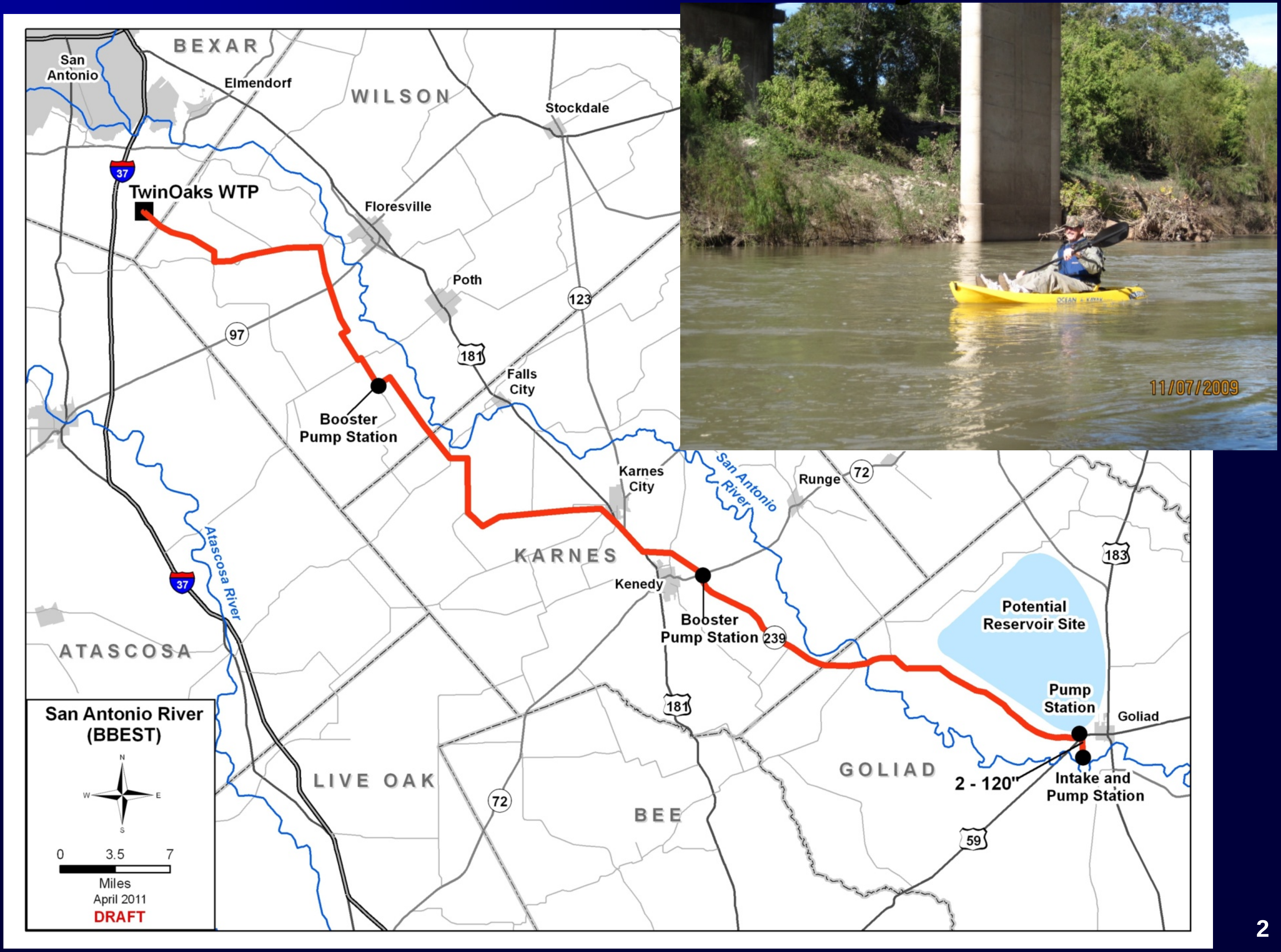
Guadalupe, San Antonio, Mission, & Aransas Rivers and Mission, Copano, Aransas, & San Antonio Bays Basin and Bay Area Stakeholder Committee (GSA BBASC)

Technical Analyses of GSA BBEST Recommendations: Two Firm Yield Projects

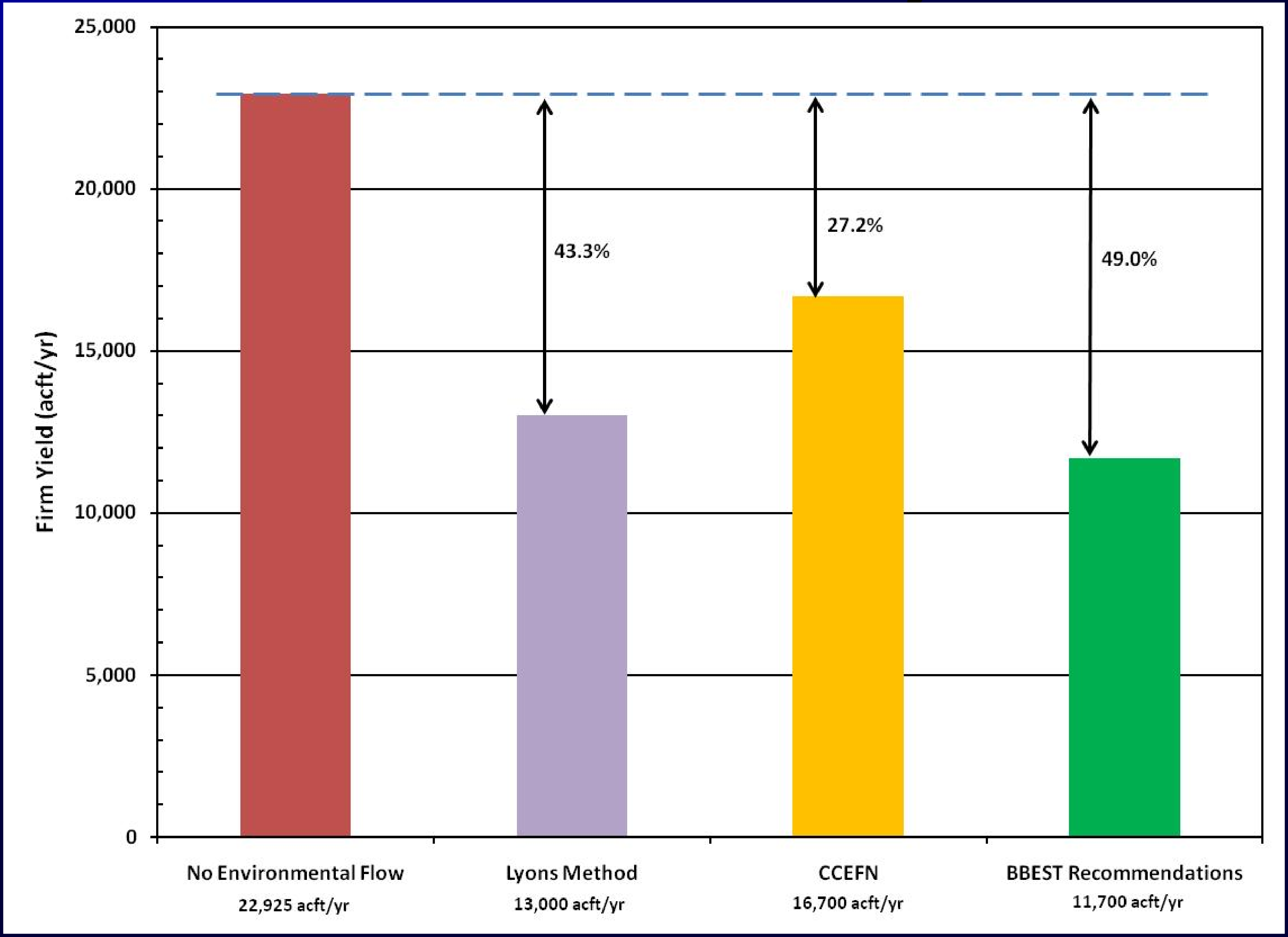
Sam Vaugh, PE

May 19, 2011

San Antonio River Project



San Antonio River Project



San Antonio River Project

	No Environmental Flow	Lyons Method	CCEFN	BBEST Recommendation
Available Project Yield (acft/yr)	22,925	13,000	16,700	11,700
Raw Water at Reservoir				
Total Project Cost	$273,450,000	$273,450,000	$273,450,000	$273,450,000
Total Annual Cost	$24,560,000	$24,378,000	$24,396,000	$24,232,000
Annual Cost of Raw Water ($ per acft)	$1,071	$1,875	$1,461	$2,071
Annual Cost of Raw Water ($ per 1,000 gallons)	$3.29	$5.75	$4.48	$6.36
Treated Water Delivered				
Total Project Cost	$523,535,000	$440,614,000	$471,271,000	$432,205,000
Total Annual Cost	$54,793,000	$44,634,000	$48,586,000	$43,006,000
Annual Cost of Water ($ per acft)	$2,390	$3,433	$2,909	$3,676
Annual Cost of Water ($ per 1,000 gallons)	$7.33	$10.54	$8.93	$11.28

Note: Costs corrected since May 4 Meeting

San Antonio River Project

Full BBEST Recommendation = 11,720 acft/yr

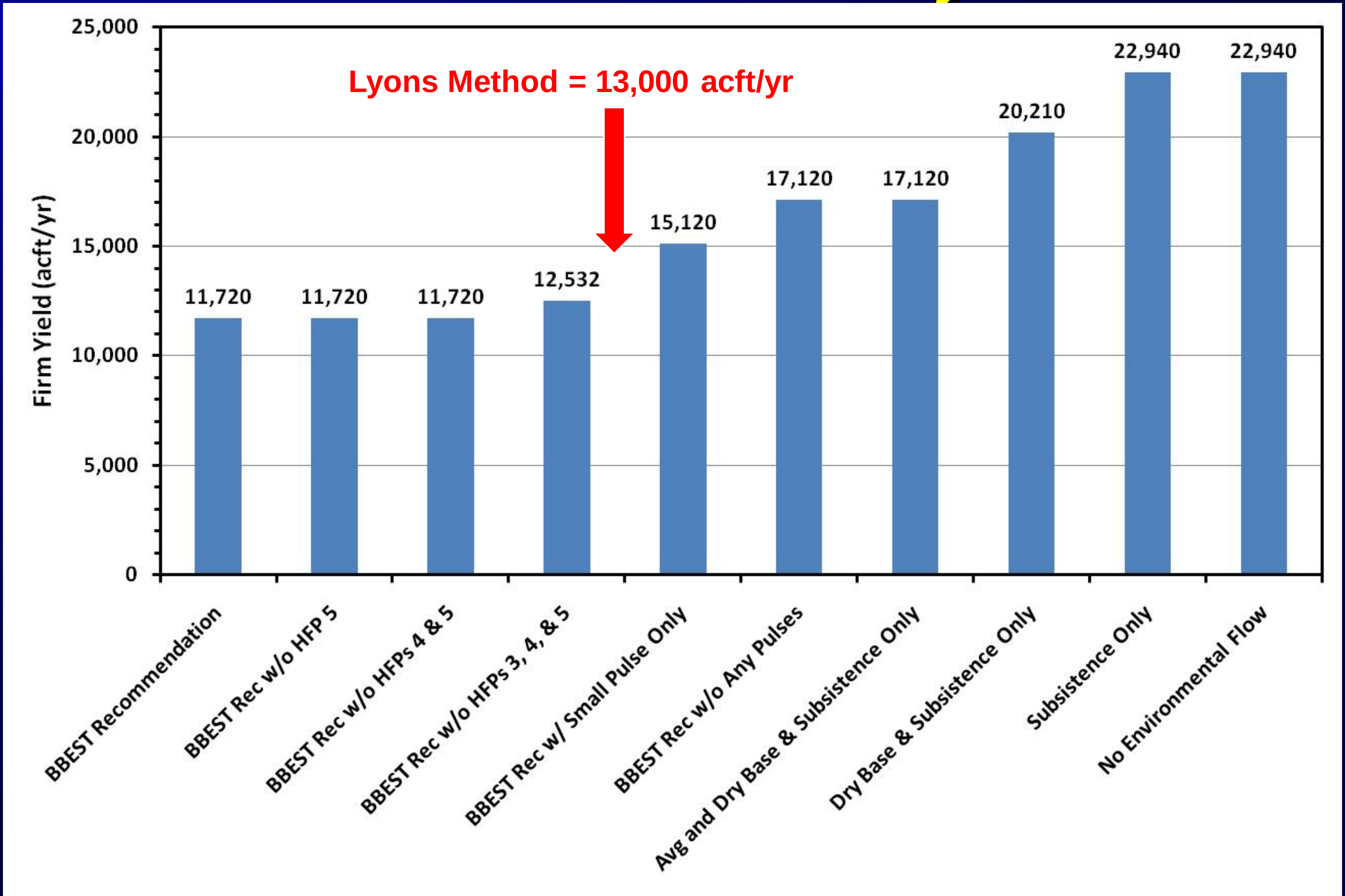
	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 years Regressed Volume is [illegible] Duration Bound is 69			
Overbank Flows	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 107,000 Duration Bound is 45			
Overbank Flows	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is [illegible] Duration Bound is 38			
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19
High Flow Pulses	Qp: 550 cfs with Average [illegible] Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average [illegible] Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average [illegible] Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average [illegible] Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs)	[illegible]	[illegible]	[illegible]	[illegible]
Base Flows (cfs)	[illegible]	[illegible]	[illegible]	[illegible]
Base Flows (cfs)	[illegible]	[illegible]	[illegible]	[illegible]
Subsistence Flows (cfs)	[illegible]	[illegible]	[illegible]	[illegible]

Flow Levels	
	High (75th %ile)
	Medium (50th %ile)
	Low (25th %ile)
	Subsistence

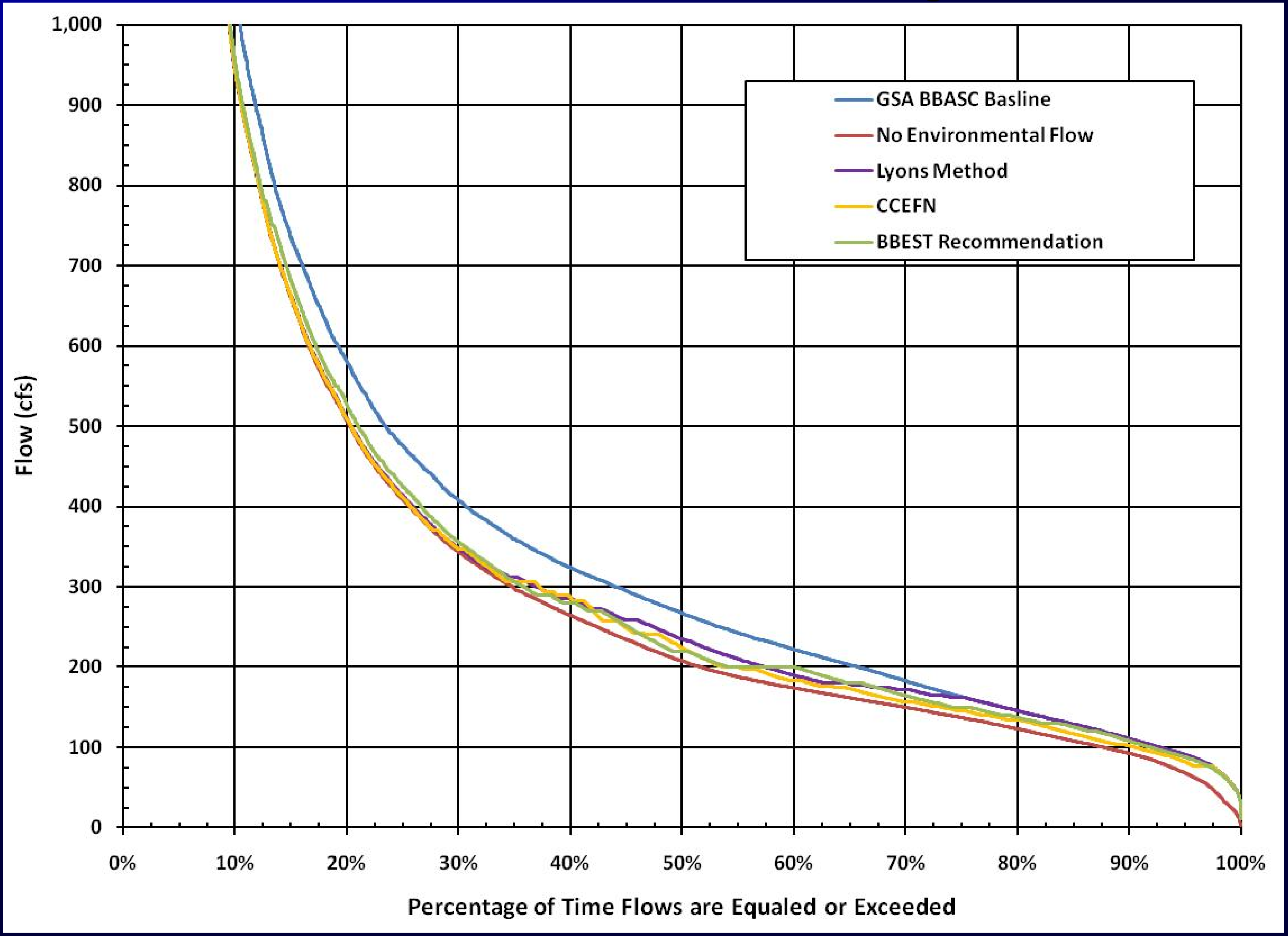
Notes:
1. Period of Record used: 1/1/1940 to 12/31/1969.
2. Volumes are in acre-feet and durations are in days.

11,720 acft/yr
11,720 acft/yr
12,532 acft/yr
15,120 acft/yr
17,120 acft/yr
17,120 acft/yr
20,210 acft/yr
22,925 acft/yr
22,925 acft/yr

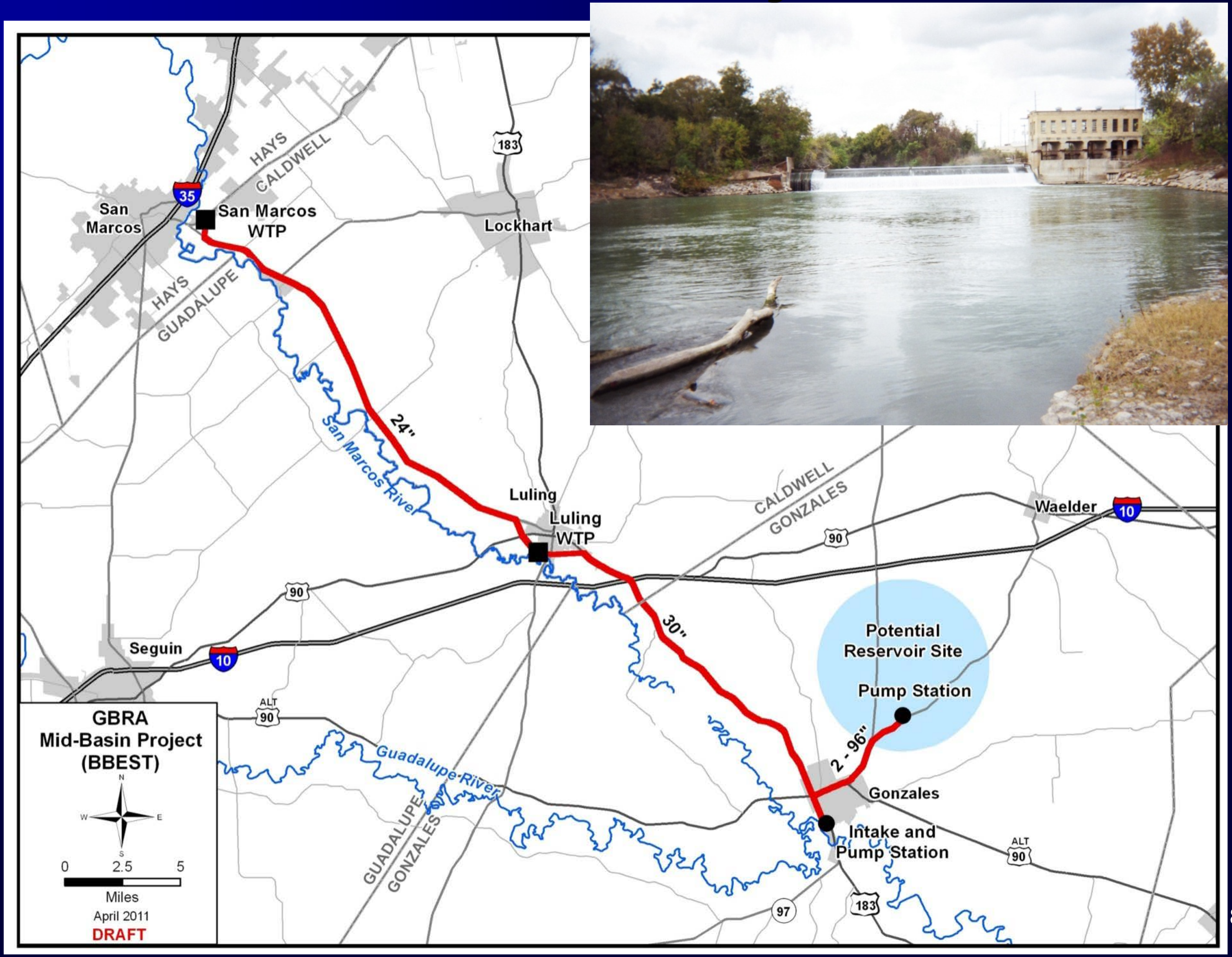
San Antonio River Project



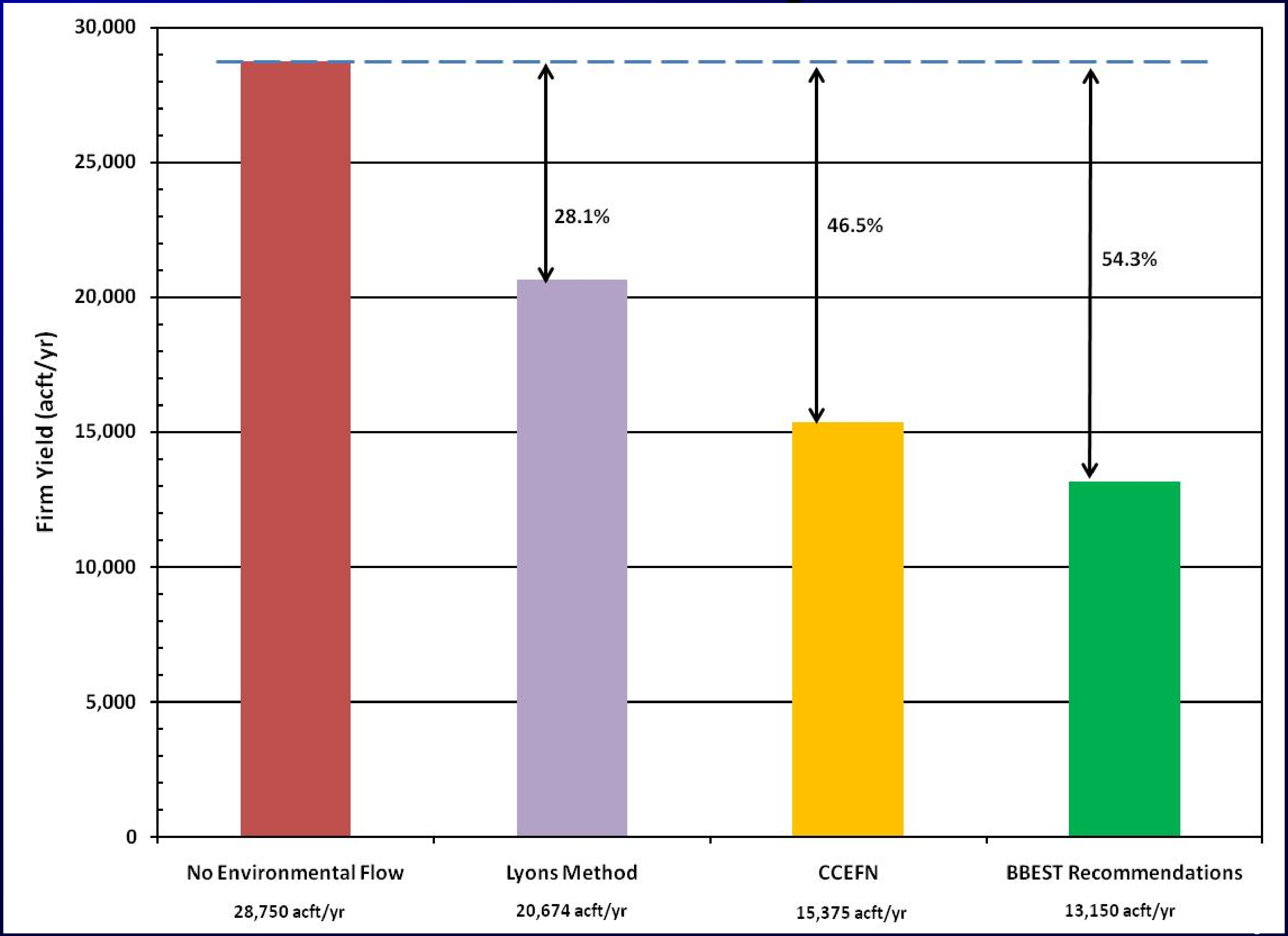
San Antonio River Project



Mid-Basin Project



Mid-Basin Project



Mid-Basin Project

	No Environmental Flow	Lyons Method	CCEFN	BBEST Recommendation
Available Project Yield (acft/yr)	28,750	20,674	15,375	13,150
Raw Water at Reservoir				
Total Project Cost	$253,801,000	$253,801,000	$253,801,000	$253,801,000
Total Annual Cost	$22,908,000	$22,854,000	$22,636,000	$22,563,000
Annual Cost of Raw Water ($ per acft)	$797	$1,105	$1,472	$1,716
Annual Cost of Raw Water ($ per 1,000 gallons)	$2.45	$3.39	$4.52	$5.27
Treated Water Delivered				
Total Project Cost	$475,090,000	$413,942,000	$384,892,000	$369,922,000
Total Annual Cost	$49,713,000	$42,891,000	$38,912,000	$37,123,000
Annual Cost of Water ($ per acft)	$1,729	$2,075	$2,531	$2,823
Annual Cost of Water ($ per 1,000 gallons)	$5.31	$6.37	$7.77	$8.66

Note: Costs corrected since May 4 Meeting

Mid-Basin Project

- ❑ How Big Does the Reservoir Need to Be to Get the Same Firm Yield of Lyons? And What's the Cost?

	105,500 acft Lyons Method	191,500 acft BBEST Recommendation*
Available Project Yield (acft/yr)	20,674	20,674
Raw Water at Reservoir		
Total Project Cost	$253,801,000	$279,391,000
Total Annual Cost	$22,854,000	$24,828,000
Annual Cost of Raw Water ($ per acft)	$1,105	$1,201
Annual Cost of Raw Water ($ per 1,000 gallons)	$3.39	$3.68
Treated Water Delivered		
Total Project Cost	$413,942,000	$441,845,071
Total Annual Cost	$42,891,000	$44,865,622
Annual Cost of Water ($ per acft)	$2,075	$2,170
Annual Cost of Water ($ per 1,000 gallons)	$6.37	$6.66

*Note: *Reservoir size increased to 191,500 acft to achieve same firm yield of Lyons Method*

Mid-Basin Project

Full BBEST Recommendation = 13,150 acft/yr

	Winter	Spring	Summer	Fall
Overbank Flows	Qp: 36,700 cfs with Average Frequency 1 per 5 years [illegible] Duration Bound is 70			
	Qp: 24,400 cfs with Average Frequency 1 per 2 years Regressed Volume is 306,000 Duration Bound is 57			
	Qp: 14,300 cfs with Average Frequency 1 per year [illegible] Duration Bound is 43			
High Flow Pulses	Qp: 4,140 cfs with Average Frequency 1 per season Regressed Volume is 48,300 Duration Bound is 29	Qp: 6,590 cfs with Average Frequency 1 per season Regressed Volume is 58,400 Duration Bound is 24	Qp: 1,760 cfs with Average Frequency 1 per season Regressed Volume is 14,800 Duration Bound is 14	Qp: 4,330 cfs with Average Frequency 1 per season Regressed Volume is 41,200 Duration Bound is 23
	Qp: 1,150 cfs with Average [illegible] Regressed Volume is 9,640 Duration Bound is 13	Qp: 3,250 cfs with Average [illegible] Regressed Volume is 26,900 Duration Bound is 17	Qp: 950 cfs with Average [illegible] Regressed Volume is 7,060 Duration Bound is 10	Qp: 1,410 cfs with Average [illegible] Regressed Volume is 11,400 Duration Bound is 13
Base Flows (cfs)	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
Subsistence Flows (cfs)	[illegible]	[illegible]	[illegible]	[illegible]
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec

13,150 acft/yr

13,150 acft/yr

13,910 acft/yr

15,375 acft/yr

16,790 acft/yr

16,790 acft/yr

25,410 acft/yr

26,600 acft/yr

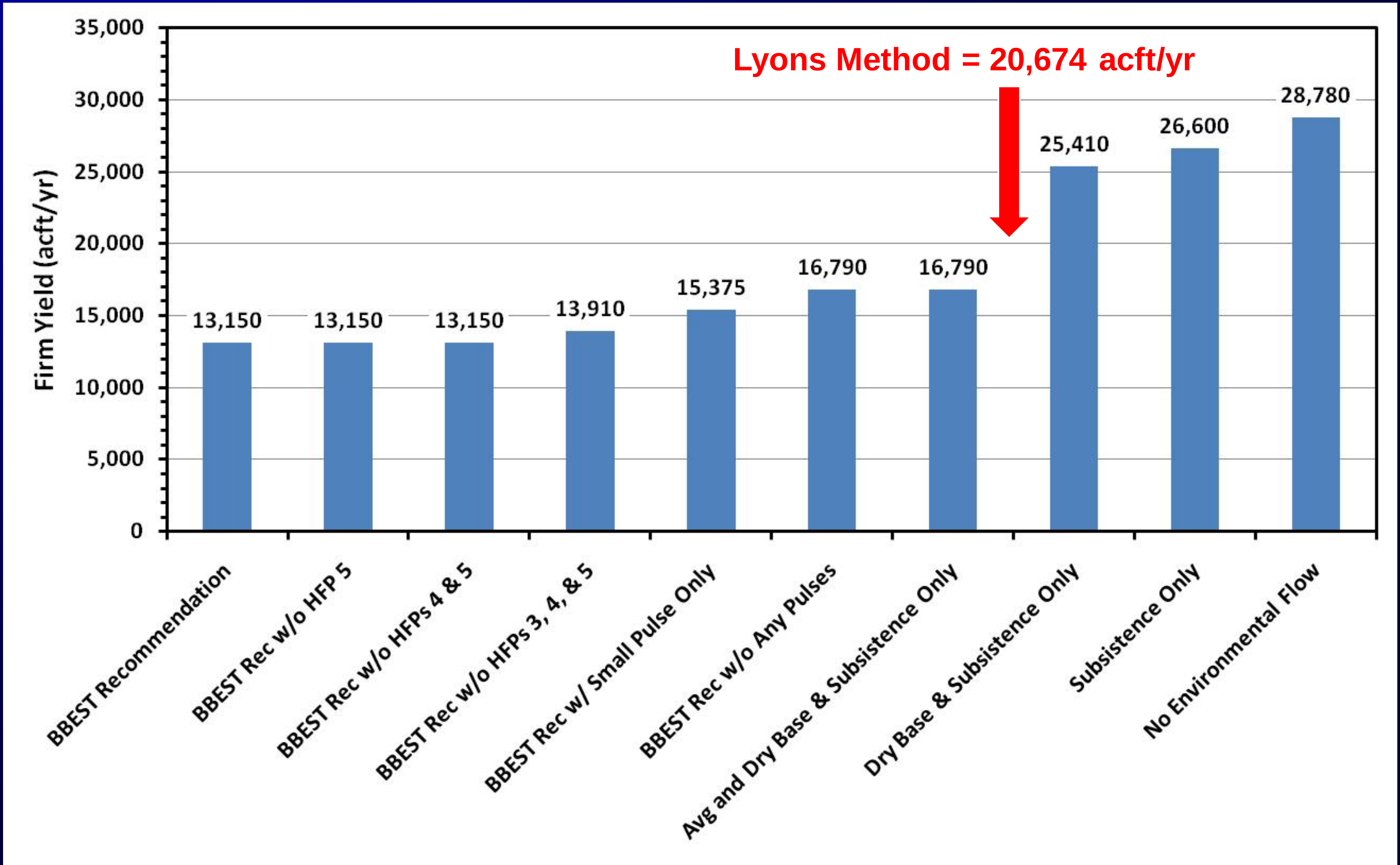
28,750 acft/yr

Flow Levels	
	High (75th %ile)
	Medium (50th %ile)
	Low (25th %ile)
	Subsistence

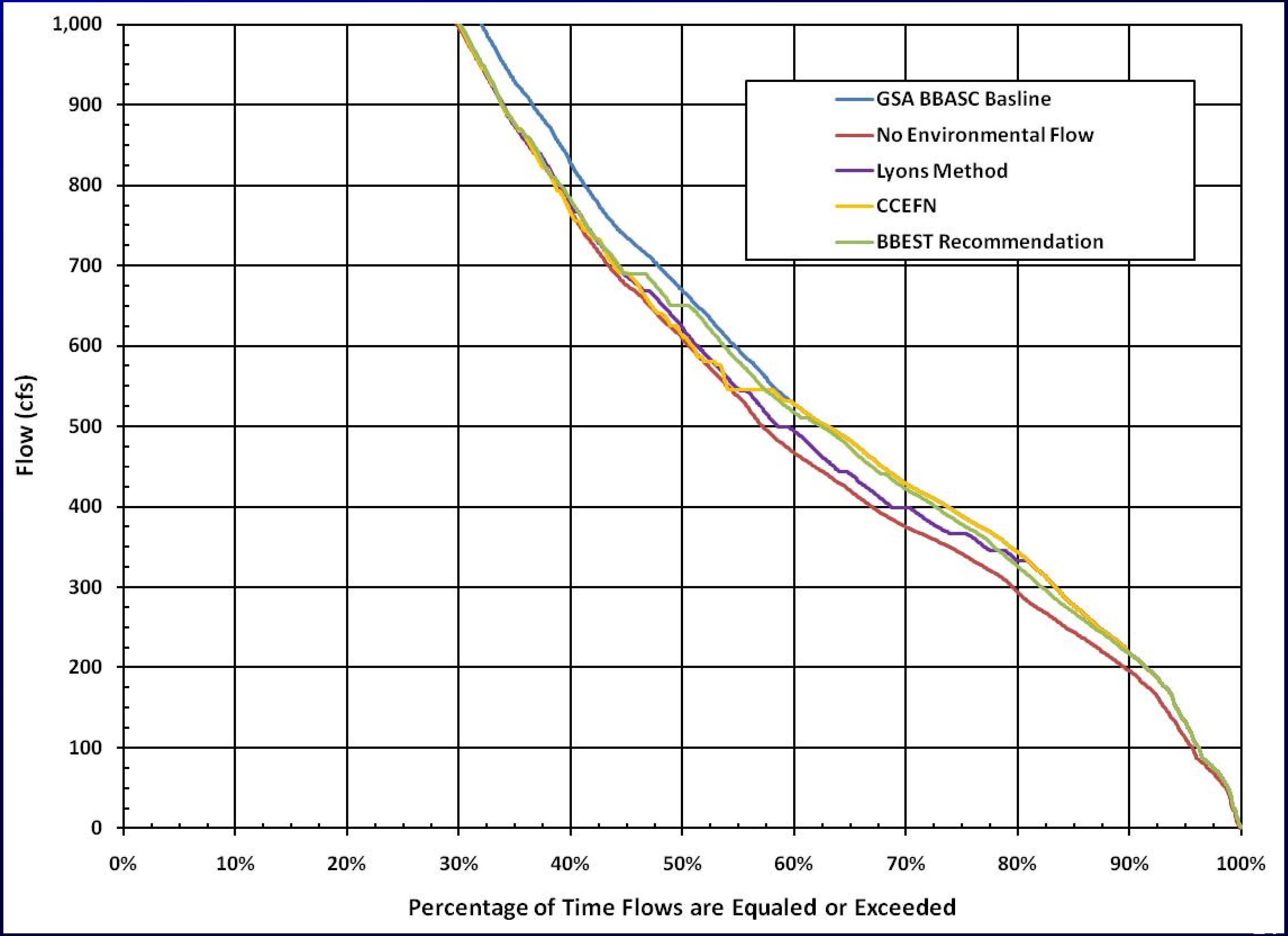
Notes:

1. Period of Record used : 1/1/1940 to 12/31/2009.
2. Volumes are in acre-feet and durations are in days.

Mid-Basin Project



Mid-Basin Project



Questions, Comments, & Discussion

Guadalupe, San Antonio, Mission, & Aransas Rivers and Mission, Copano, Aransas, & San Antonio Bays Basin and Bay Area Stakeholder Committee (GSA BBASC)

Technical Analyses of GSA BBEST Recommendations: Options for Hydrologic Conditions on Pulses

Sam Vaugh, PE

May 19, 2011

Developing Balance – Options

Weighted Too Heavy Toward Human Needs

1) Increase Subsistence Flows
2) Eliminate Diversions Below Baseflows
3) Increase Average or Wet Baseflows
4) Add More Pulses / Increase Pulses
5) Shift Period of Record for Flow Standard Recommendation

Weighted Too Heavy Toward Environmental Needs

1) Eliminate the 50% Requirement between Subsistence & Dry Base
2) Eliminate Wet and/or Average Baseflows
3) Eliminate Some/All Pulses
   - Annual / Multi-Year
   - Seasonal
4) Place Hydrologic Conditions on Pulses
5) Shift Period of Record for Flow Standard Recommendation

Consider TCEQ Adopted Environmental Flow Standards?

Structure of Adopted TCEQ Environmental Flow Standards*

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 36,700 cfs with Average Frequency 1 per 5 years [illegible] Duration Bound is 70			
Overbank Flows	Qp: 24,400 cfs with Average Frequency 1 per 2 years [illegible] Duration Bound is 57			
Overbank Flows	Qp: 14,300 cfs with Average Frequency 1 per year [illegible] Duration Bound is 43			
High Flow Pulses	Qp: 4,140 cfs with Average Frequency 1 per season Regressed Volume is 48,300 Duration Bound is 29	Qp: 6,590 cfs with Average Frequency 1 per season Regressed Volume is 58,400 Duration Bound is 24	Qp: 1,760 cfs with Average Frequency 1 per season Regressed Volume is 14,800 Duration Bound is 14	Qp: 4,330 cfs with Average Frequency 1 per season Regressed Volume is 41,200 Duration Bound is 23
High Flow Pulses	Qp: 1,150 cfs with Average Frequency 2 per season Regressed Volume is 9,640 Duration Bound is 13	Qp: 3,250 cfs with Average Frequency 2 per season Regressed Volume is 26,900 Duration Bound is 17	Qp: 950 cfs with Average Frequency 2 per season Regressed Volume is 7,060 Duration Bound is 10	Qp: 1,410 cfs with Average Frequency 2 per season Regressed Volume is 11,400 Duration Bound is 13
Base Flows (cfs)	[illegible]	[illegible]	[illegible]	[illegible]
Base Flows (cfs)	[illegible]	[illegible]	[illegible]	[illegible]
Base Flows (cfs)	540	440	440	510
Subsistence Flows (cfs)	210	210	210	180

Flow Levels	
	High (75th %ile)
	Medium (50th %ile)
	Low (25th %ile)
	Subsistence

*Sabine & Neches Rivers and Sabine Lake Bay

Structure of Adopted TCEQ Environmental Flow Standards*

	x1	x2	x1	x2	
Pulses	Qp: 1,150 cfs with Average Frequency 2 per season Regressed Volume is 9,640 Duration Bound is 13	Qp: 3,250 cfs with Average Frequency 2 per season Regressed Volume is 26,900 Duration Bound is 17	Qp: 950 cfs with Average Frequency 2 per season Regressed Volume is 7,060 Duration Bound is 10	Qp: 1,410 cfs with Average Frequency 2 per season Regressed Volume is 11,400 Duration Bound is 13	
Base Flows (cfs)	540	440	440	510	+10%
Subsistence Flows (cfs)	210	210	210	180	
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec	
	Winter	Spring	Summer	Fall	

*Sabine & Neches Rivers and Sabine Lake Bay

Option 1

- ❑ **Wet: HFPs 1, 2, & 3 Only**

	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38				x1
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19	x1
	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11	x2

- ❑ **Average: HFPs 2 & 3 Only**

	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38				x1
High Flow	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19	x1

- ❑ **Dry: HFPs 1 & 3 Only**

Pulses	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38				x1
	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11	x2

Option 2

❑ Wet: HFPs 1, 2, & 3 Only

	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38				x1
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19	x1
	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11	x1

❑ Average: HFPs 2 & 3 Only

	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38				x1
High Flow	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19	x1

❑ Dry: HFPs 1 & 3 Only

Pulses	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38				x1
	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11	x1

Option 3

❑ Wet: HFPs 1 & 2 Only

High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19	x1
	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11	x2

❑ Average: HFP 1 Only

Pulses	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11	x2

❑ Dry: HFP 1 Only

Pulses	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11	x1

Option 4

- Wet: HFP 2 Only

High Flow	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19	x1

- Average: HFP 1 Only

High Flow Pulses	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11	x2

- Dry: HFP 1 Only; Spring and Summer Only

High Flow Pulses		Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10		x1

Questions, Comments, & Discussion

Guadalupe, San Antonio, Mission, & Aransas Rivers and Mission, Copano, Aransas, & San Antonio Bays Basin and Bay Area Stakeholder Committee (GSA BBASC)

Technical Analyses of GSA BBEST Recommendations: Task 3 Results

R Brian Perkins, PE
Ed Oborny
Norman Johns, PhD

June 1, 2011

Developing Balance – Options

Weighted Too Heavy Toward Human Needs

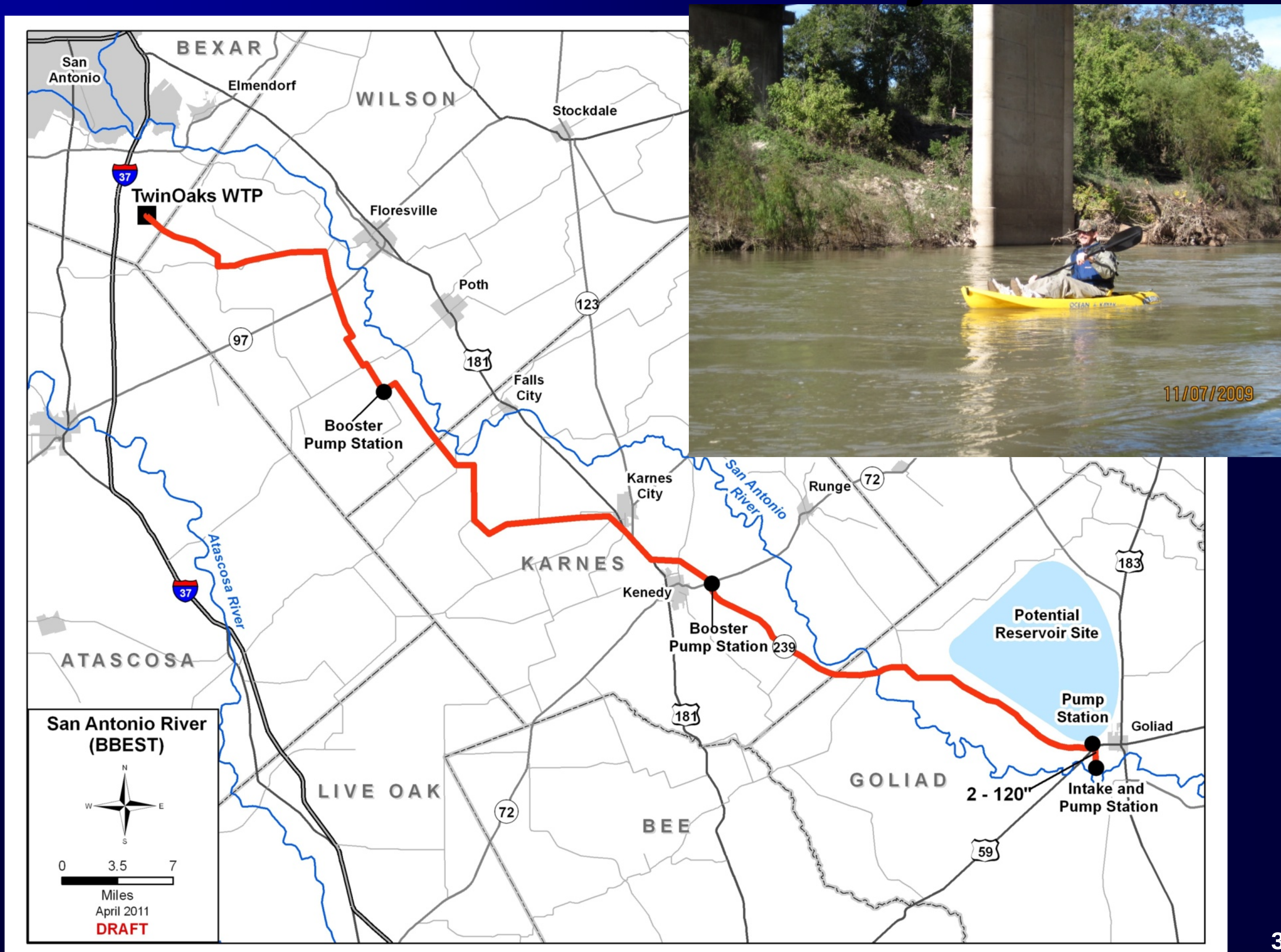
1) Increase Subsistence Flows
2) Eliminate Diversions Below Baseflows
3) Increase Average or Wet Baseflows
4) Add More Pulses / Increase Pulses
5) Shift Period of Record for Flow Standard Recommendation

Weighted Too Heavy Toward Environmental Needs

1) Eliminate the 50% Requirement between Subsistence & Dry Base
2) Eliminate Wet and/or Average Baseflows
3) Eliminate Some/All Pulses
   - Annual / Multi-Year
   - Seasonal
4) Place Hydrologic Conditions on Pulses
5) Shift Period of Record for Flow Standard Recommendation

Consider TCEQ Adopted Environmental Flow Standards

San Antonio River Project



San Antonio River Project

- BBEST Recommendation – Increase Subsistence to SB2 Recommendation:

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 273,000 Duration Bound is 69			
Overbank Flows	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 107,000 Duration Bound is 45			
Overbank Flows	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38			
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19
High Flow Pulses	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs)	290	280	220	270
Base Flows (cfs)	200	180	150	200
Base Flows (cfs)	140	130	120	130
Subsistence Flows (cfs)	80	80	80	80

Flow Levels	
	High (75th %ile)
	Medium (50th %ile)
	Low (25th %ile)
	Subsistence

Notes:

1. Period of Record used: 1/1/1940 to 12/31/1969.
2. Volumes are in acre-feet and durations are in days.

San Antonio River Project

- BBEST Recommendation – No Diversions Below Baseflows

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 273,000 Duration Bound is 69			
	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 107,000 Duration Bound is 45			
	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38			
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19
	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs)	290	280	220	270
	200	180	150	200
	140	130	120	130
Subsistence Flows (cfs)				

Months: Jan, Feb, Mar (Winter); Apr, May, Jun (Spring); Jul, Aug, Sep (Summer); Oct, Nov, Dec (Fall)

Flow Levels	
	High (75th %ile)
	Medium (50th %ile)
	Low (25th %ile)
	Subsistence

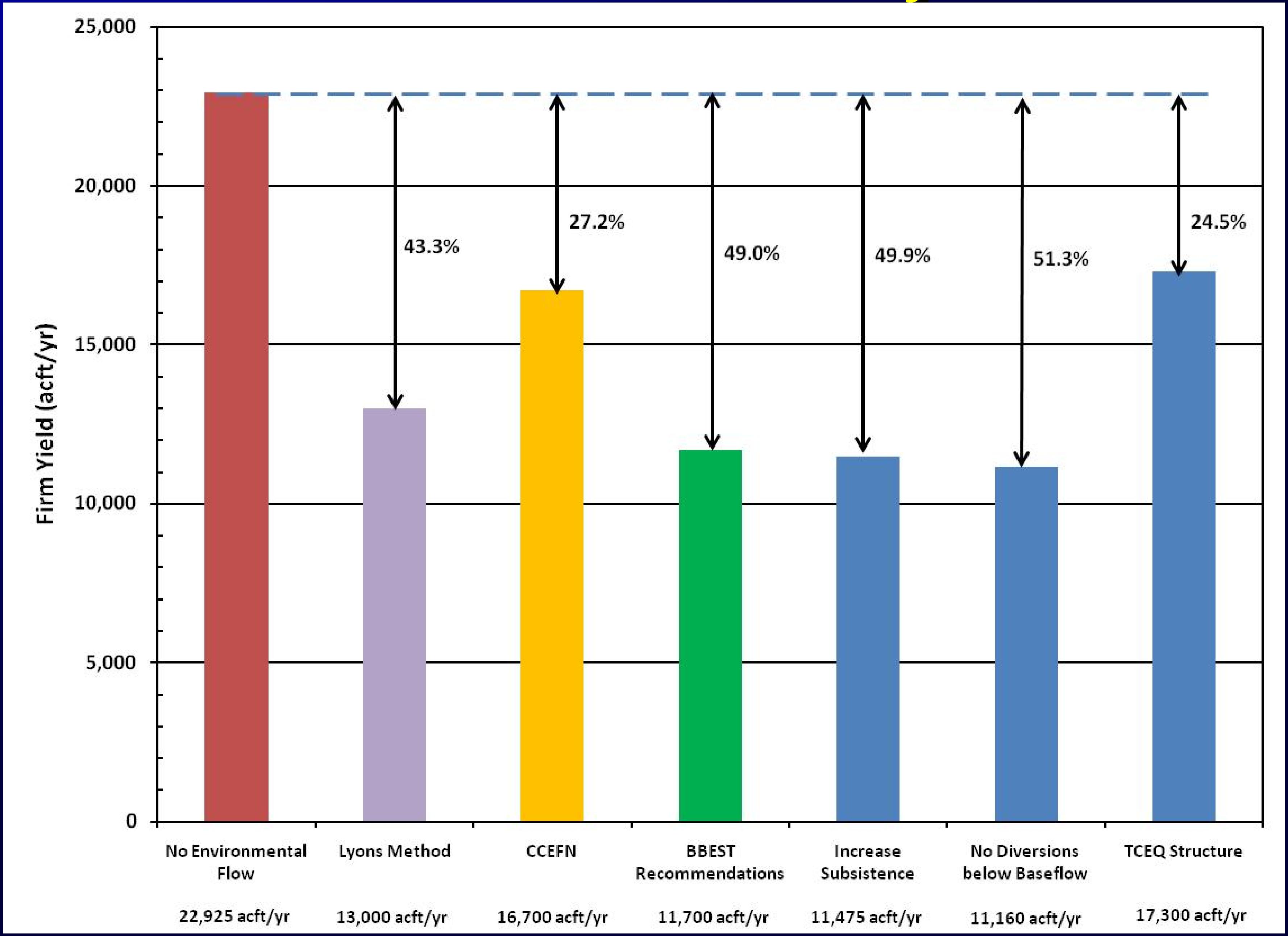
Notes:
1. Period of Record used: 1/1/1940 to 12/31/1969.
2. Volumes are in acre-feet and durations are in days.

San Antonio River Project

- Structure of Adopted TCEQ Environmental Flow Standards

	x1	x2	x1	x2	
Pulses	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11	
Base Flows (cfs)	140	130	120	130	+10%
Subsistence Flows (cfs)	76	60	54	66	
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec	
	Winter	Spring	Summer	Fall	

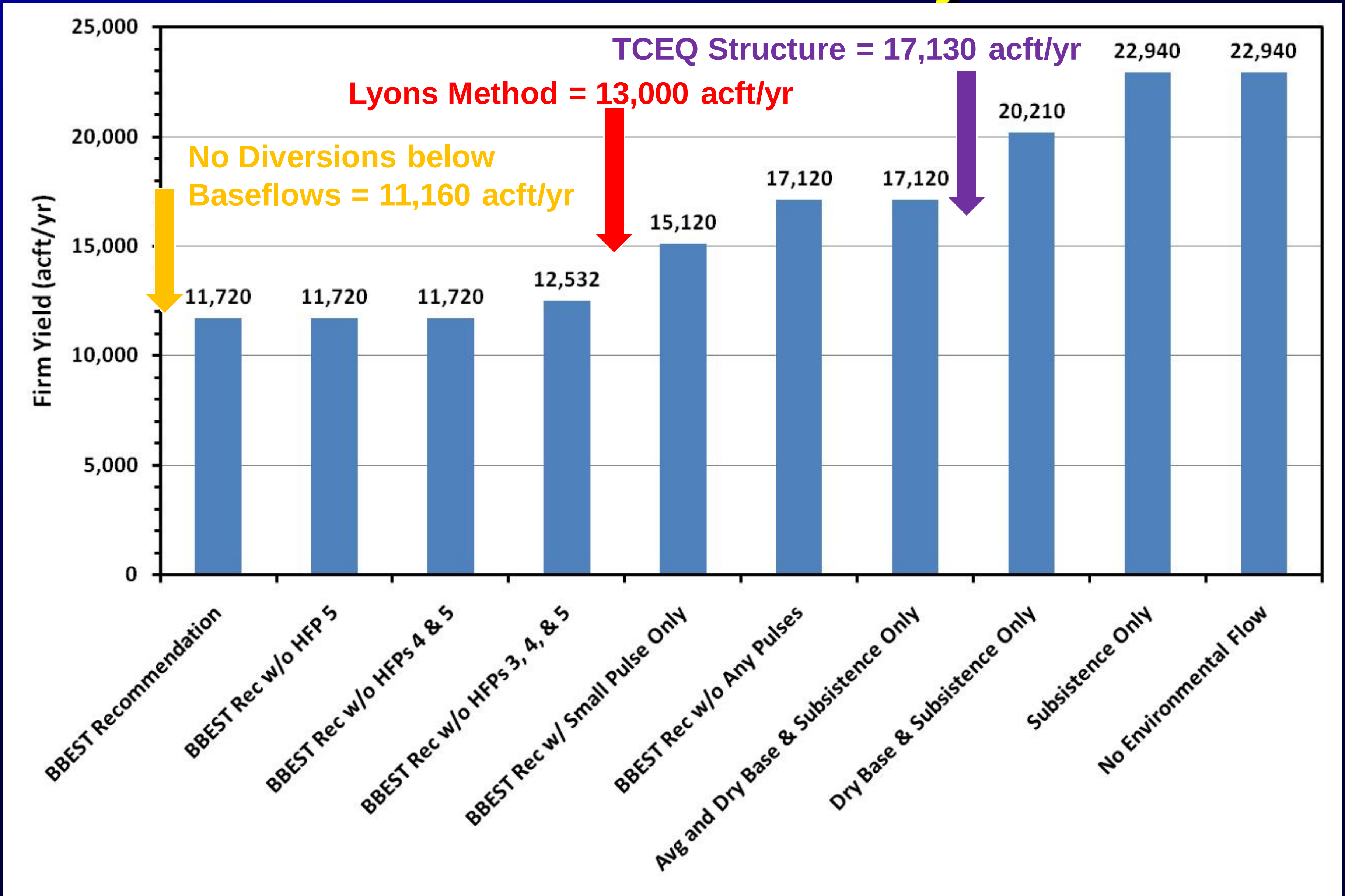
San Antonio River Project



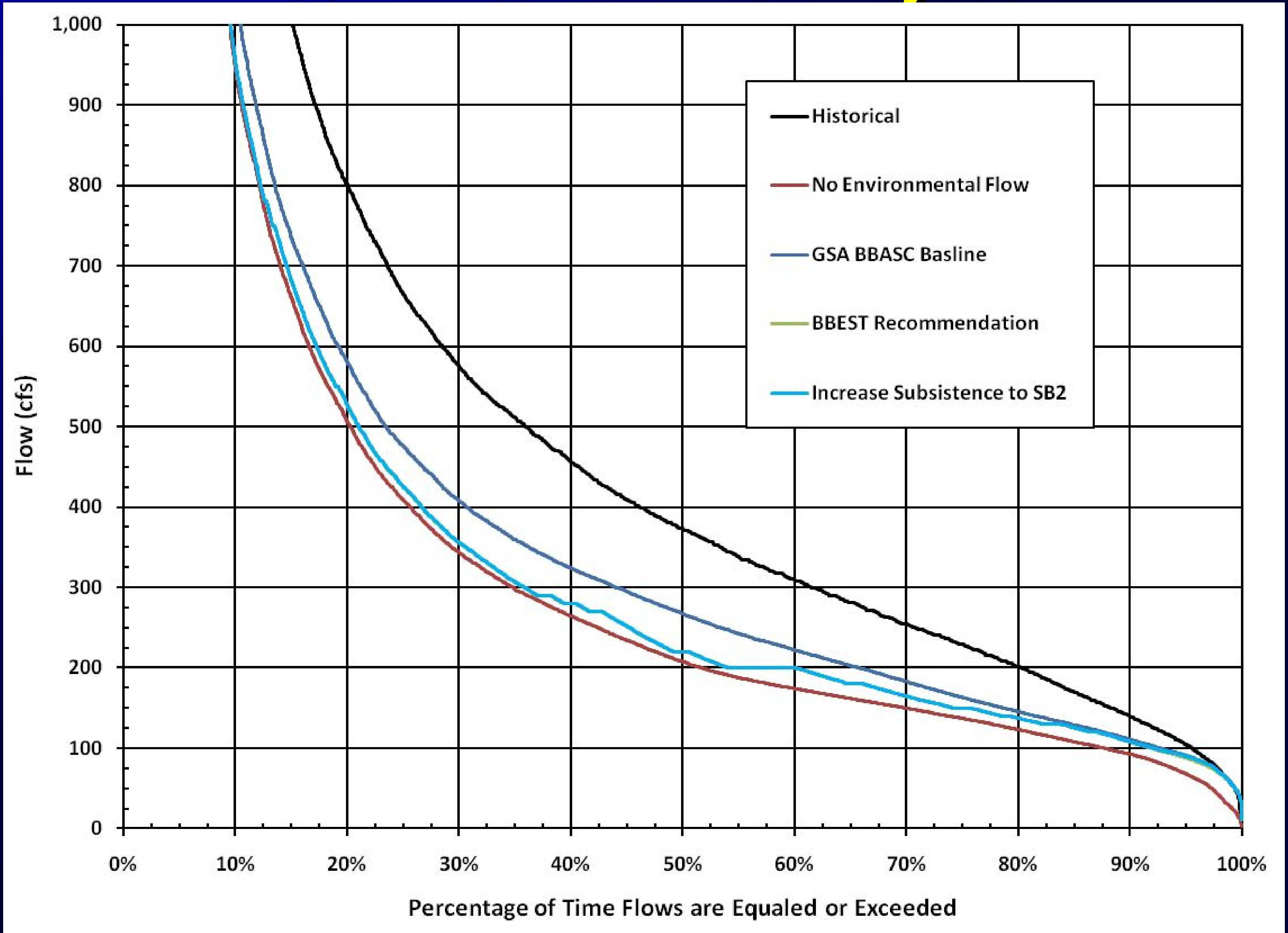
San Antonio River Project

	No Environmental Flow	Lyons Method	CCEFN	BBEST Recommendation	BBEST - No Diversions below Baseflow	TCEQ Structure
Available Project Yield (acft/yr)	22,925	13,000	16,700	11,700	11,160	17,300
Raw Water at Reservoir						
Total Project Cost	$273,450,000	$273,450,000	$273,450,000	$273,450,000	$273,450,000	$273,450,000
Total Annual Cost	$24,560,000	$24,378,000	$24,396,000	$24,232,000	$24,232,000	$24,396,000
Annual Cost of Raw Water ($ per acft)	$1,071	$1,875	$1,461	$2,071	$2,171	$1,410
Annual Cost of Raw Water ($ per 1,000 gallons)	$3.29	$5.75	$4.48	$6.36	$6.66	$4.33
Treated Water Delivered						
Total Project Cost	$523,535,000	$440,614,000	$471,271,000	$432,205,000	$428,764,000	$475,015,000
Total Annual Cost	$54,793,000	$44,634,000	$48,586,000	$43,006,000	$42,420,000	$49,272,000
Annual Cost of Water ($ per acft)	$2,390	$3,433	$2,909	$3,676	$3,801	$2,848
Annual Cost of Water ($ per 1,000 gallons)	$7.33	$10.54	$8.93	$11.28	$11.66	$8.74

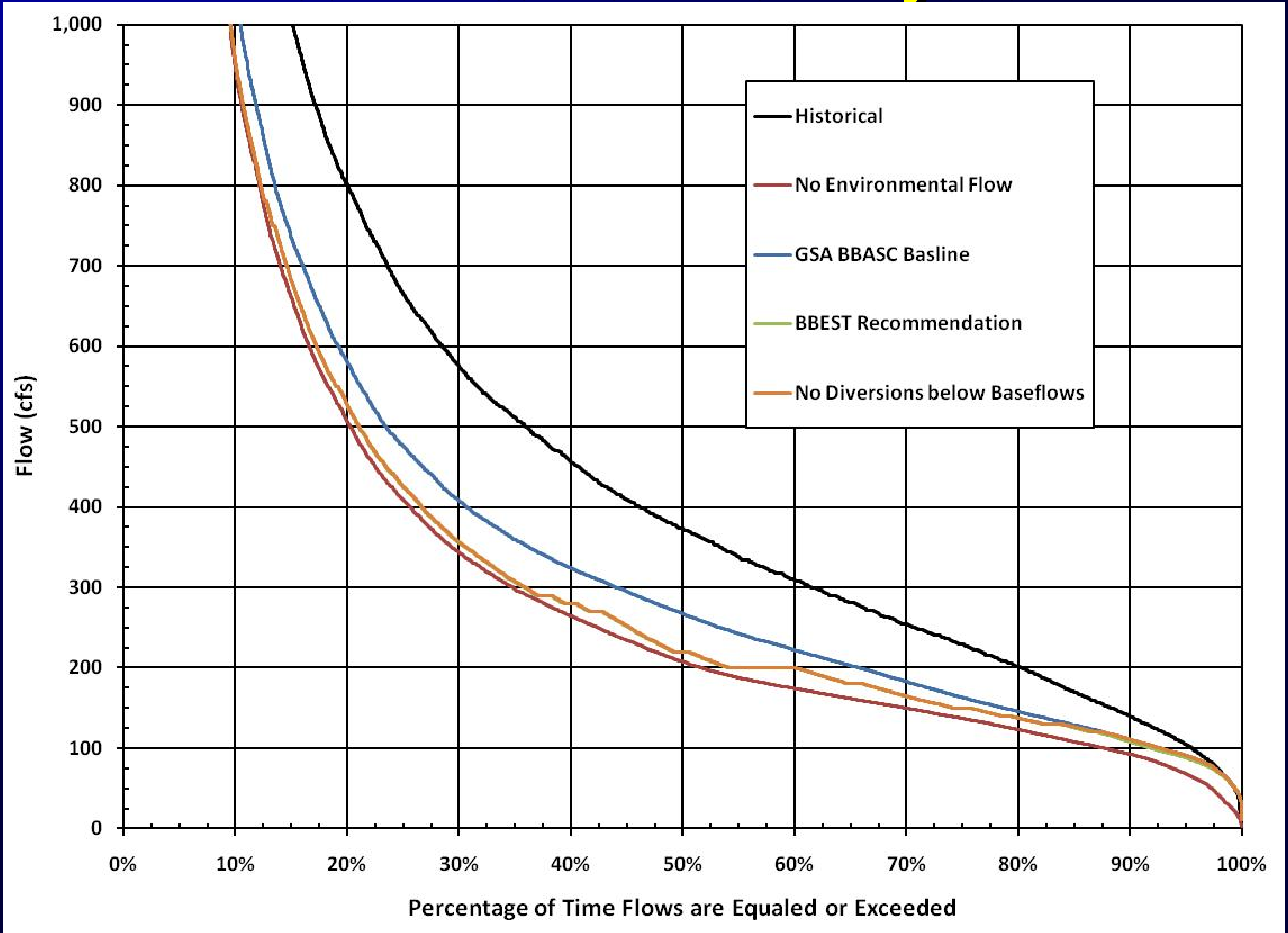
San Antonio River Project



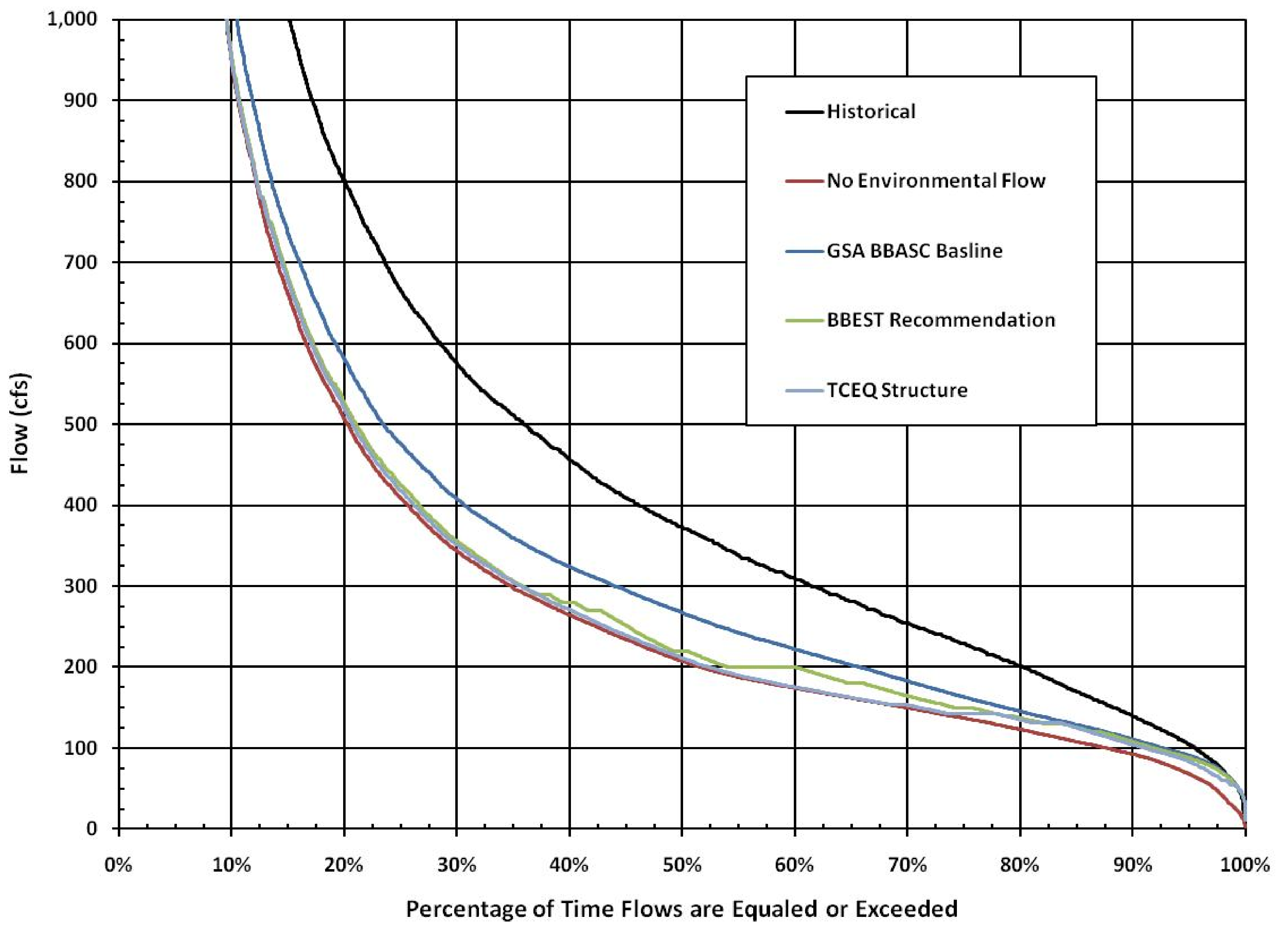
San Antonio River Project



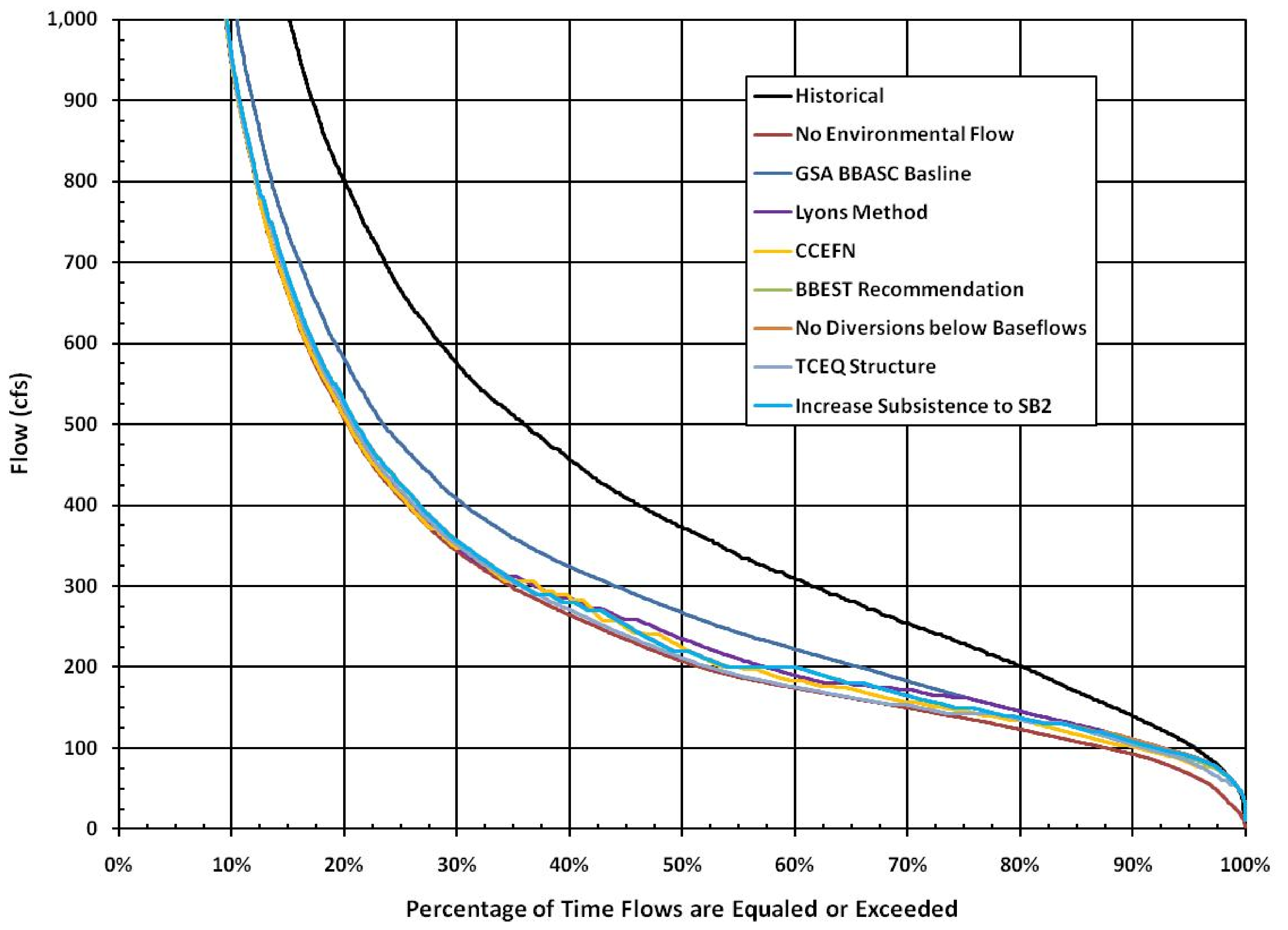
San Antonio River Project



San Antonio River Project

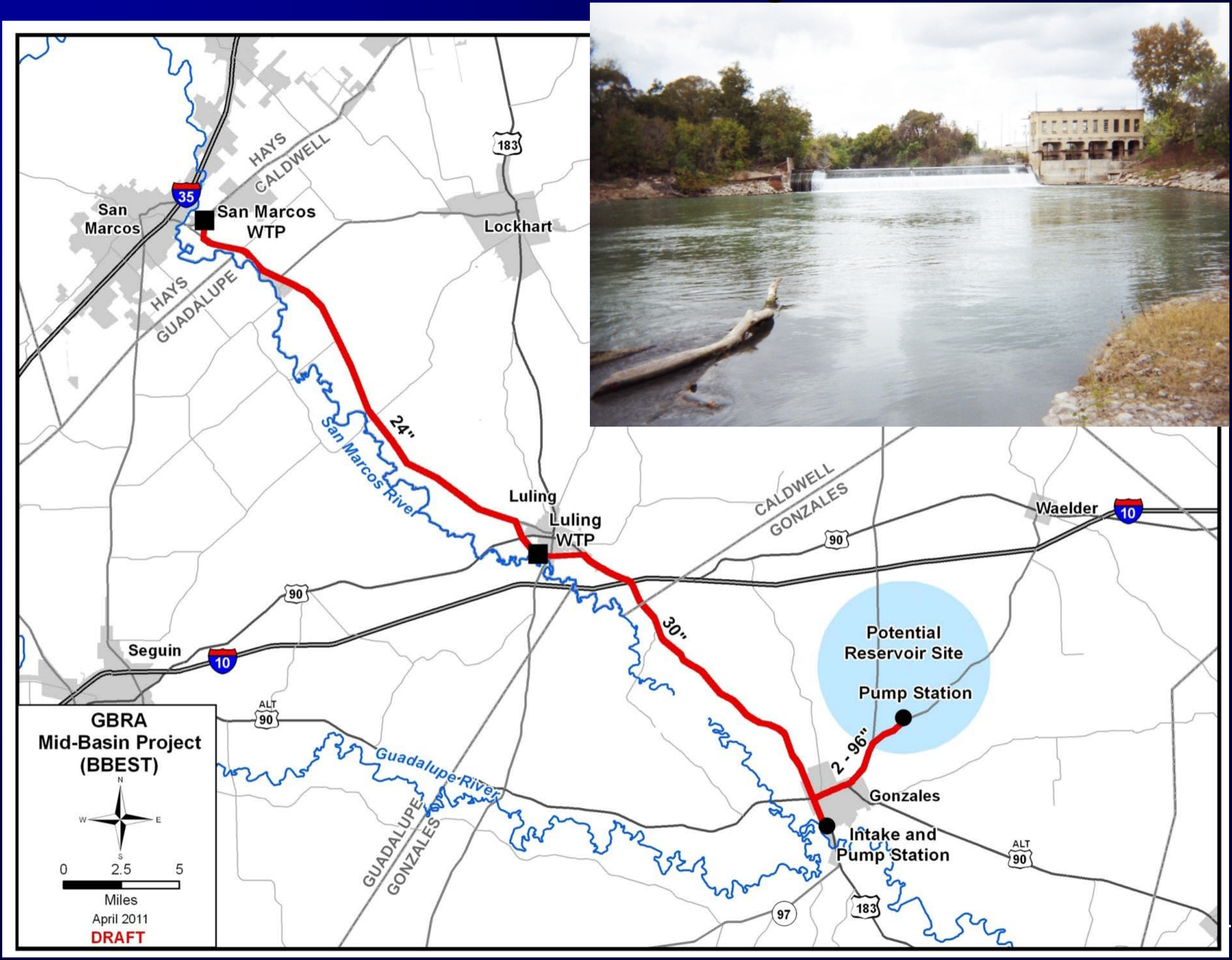


San Antonio River Project



San Antonio River Project

Mid-Basin Project



Mid-Basin Project

❑ BBEST Recommendation – Increase Subsistence to Q95

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Overbank Flows	Qp: 36,700 cfs with Average Frequency 1 per 5 years Regressed Volume is 492,000 Duration Bound is 70											
	Qp: 24,400 cfs with Average Frequency 1 per 2 years Regressed Volume is 306,000 Duration Bound is 57											
	Qp: 14,300 cfs with Average Frequency 1 per year Regressed Volume is 165,000 Duration Bound is 43											
High Flow Pulses	Qp: 4,140 cfs with Average Frequency 1 per season Regressed Volume is 48,300 Duration Bound is 29			Qp: 6,590 cfs with Average Frequency 1 per season Regressed Volume is 58,400 Duration Bound is 24			Qp: 1,760 cfs with Average Frequency 1 per season Regressed Volume is 14,800 Duration Bound is 14			Qp: 4,330 cfs with Average Frequency 1 per season Regressed Volume is 41,200 Duration Bound is 23		
	Qp: 1,150 cfs with Average Frequency 2 per season Regressed Volume is 9,640 Duration Bound is 13			Qp: 3,250 cfs with Average Frequency 2 per season Regressed Volume is 26,900 Duration Bound is 17			Qp: 950 cfs with Average Frequency 2 per season Regressed Volume is 7,060 Duration Bound is 10			Qp: 1,410 cfs with Average Frequency 2 per season Regressed Volume is 11,400 Duration Bound is 13		
Base Flows (cfs)	860			870			800			810		
	690			650			650			690		
	540			440			440			510		
Subsistence Flows (cfs)	258			258			258			258		
	Winter			Spring			Summer			Fall		

Flow Levels	
	High (75th %ile)
	Medium (50th %ile)
	Low (25th %ile)
	Subsistence

Notes:
1. Period of Record used : 1/1/1940 to 12/31/2009.
2. Volumes are in acre-feet and durations are in days.

Mid-Basin Project

❑ BBEST Recommendation – No Diversions Below Baseflows

	Winter			Spring			Summer			Fall		
Overbank Flows	Qp: 36,700 cfs with Average Frequency 1 per 5 years Regressed Volume is 492,000 Duration Bound is 70											
	Qp: 24,400 cfs with Average Frequency 1 per 2 years Regressed Volume is 306,000 Duration Bound is 57											
	Qp: 14,300 cfs with Average Frequency 1 per year Regressed Volume is 165,000 Duration Bound is 43											
High Flow Pulses	Qp: 4,140 cfs with Average Frequency 1 per season Regressed Volume is 48,300 Duration Bound is 29			Qp: 6,590 cfs with Average Frequency 1 per season Regressed Volume is 58,400 Duration Bound is 24			Qp: 1,760 cfs with Average Frequency 1 per season Regressed Volume is 14,800 Duration Bound is 14			Qp: 4,330 cfs with Average Frequency 1 per season Regressed Volume is 41,200 Duration Bound is 23		
	Qp: 1,150 cfs with Average Frequency 2 per season Regressed Volume is 9,640 Duration Bound is 13			Qp: 3,250 cfs with Average Frequency 2 per season Regressed Volume is 26,900 Duration Bound is 17			Qp: 950 cfs with Average Frequency 2 per season Regressed Volume is 7,060 Duration Bound is 10			Qp: 1,410 cfs with Average Frequency 2 per season Regressed Volume is 11,400 Duration Bound is 13		
Base Flows (cfs)	860			870			800			810		
	690			650			650			690		
	540			440			440			510		
Subsistence Flows (cfs)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Flow Levels	
	High (75th %ile)
	Medium (50th %ile)
	Low (25th %ile)
	Subsistence

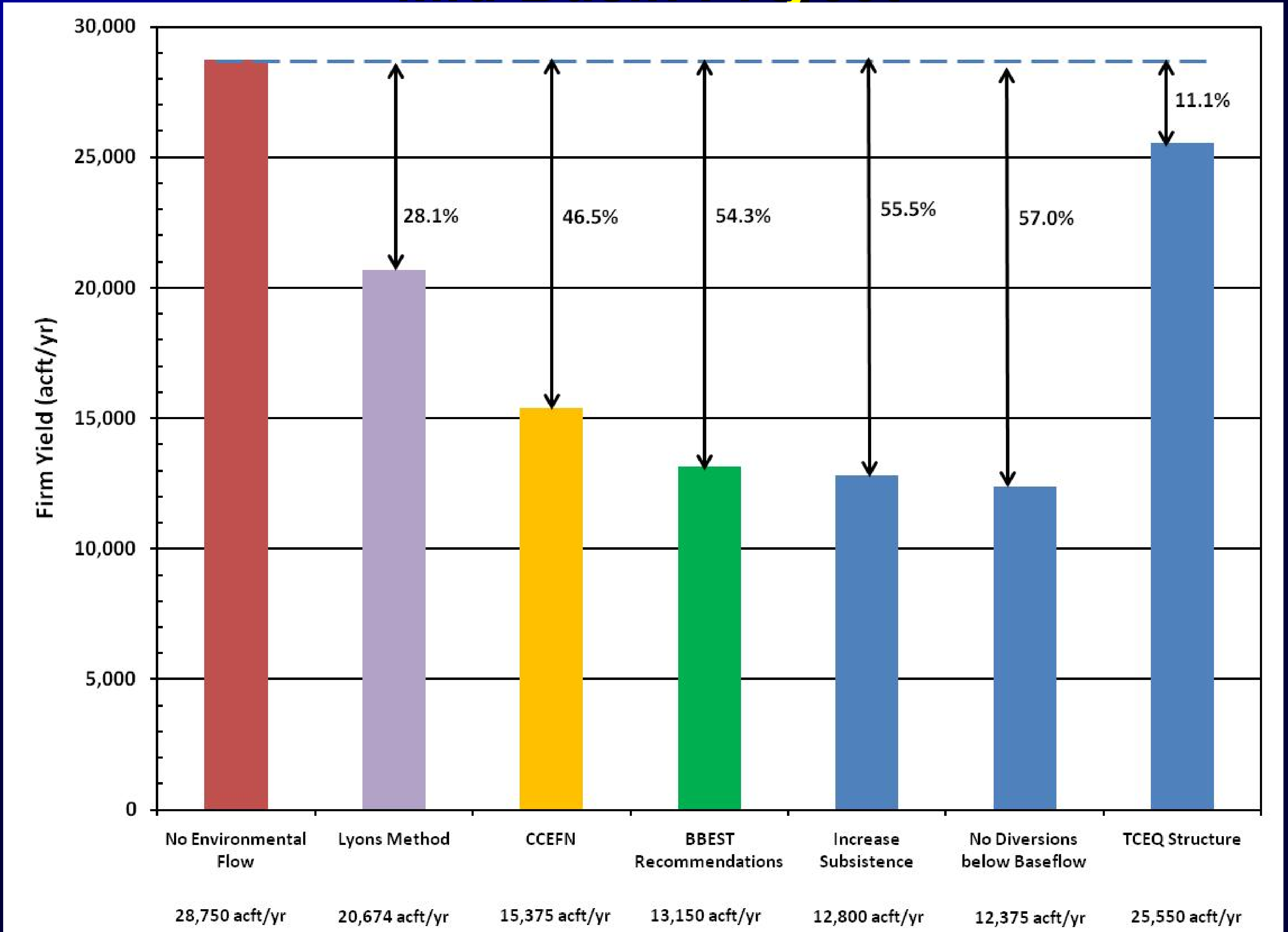
Notes:
1. Period of Record used : 1/1/1940 to 12/31/2009.
2. Volumes are in acre-feet and durations are in days.

Mid-Basin Project

- ❑ Structure of Adopted TCEQ Environmental Flow Standards

	x1	x2	x1	x2	
Pulses	Qp: 1,150 cfs with Average Frequency 2 per season Regressed Volume is 9,640 Duration Bound is 13	Qp: 3,250 cfs with Average Frequency 2 per season Regressed Volume is 26,900 Duration Bound is 17	Qp: 950 cfs with Average Frequency 2 per season Regressed Volume is 7,060 Duration Bound is 10	Qp: 1,410 cfs with Average Frequency 2 per season Regressed Volume is 11,400 Duration Bound is 13	
Base Flows (cfs)	540	440	440	510	+10%
Subsistence Flows (cfs)	210	210	210	180	
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec	
	Winter	Spring	Summer	Fall	

Mid-Basin Project



Mid-Basin Project

	No Environmental Flow	Lyons Method	CCEFN	BBEST Recommendation	BBEST - No Diversions below Baseflow	TCEQ Structure
Available Project Yield (acft/yr)	28,750	20,674	15,375	13,150	12,375	25,550
Raw Water at Reservoir						
Total Project Cost	$253,801,000	$253,801,000	$253,801,000	$253,801,000	$253,801,000	$253,801,000
Total Annual Cost	$22,908,000	$22,854,000	$22,636,000	$22,563,000	$22,564,000	$22,854,000
Annual Cost of Raw Water ($ per acft)	$797	$1,105	$1,472	$1,716	$1,823	$894
Annual Cost of Raw Water ($ per 1,000 gallons)	$2.45	$3.39	$4.52	$5.27	$5.59	$2.74
Treated Water Delivered						
Total Project Cost	$475,090,000	$413,942,000	$384,892,000	$369,922,000	$365,148,000	$445,076,000
Total Annual Cost	$49,713,000	$42,891,000	$38,912,000	$37,123,000	$36,385,000	$47,142,000
Annual Cost of Water ($ per acft)	$1,729	$2,075	$2,531	$2,823	$2,940	$1,849
Annual Cost of Water ($ per 1,000 gallons)	$5.31	$6.37	$7.77	$8.66	$9.02	$5.67

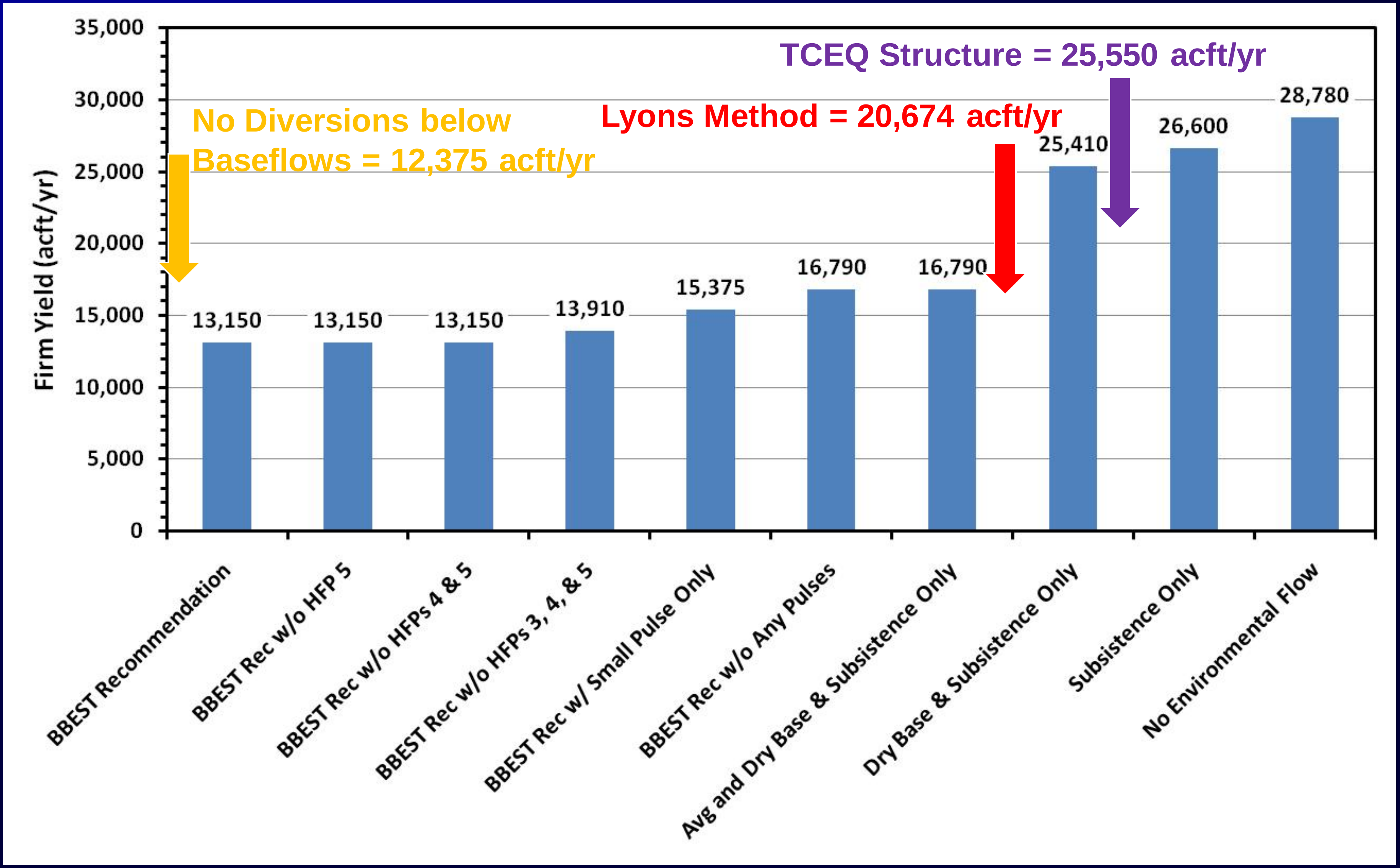
Mid-Basin Project

- How Big Does the Reservoir Need to Be to Get the Same Firm Yield of Lyons? And What's the Cost?

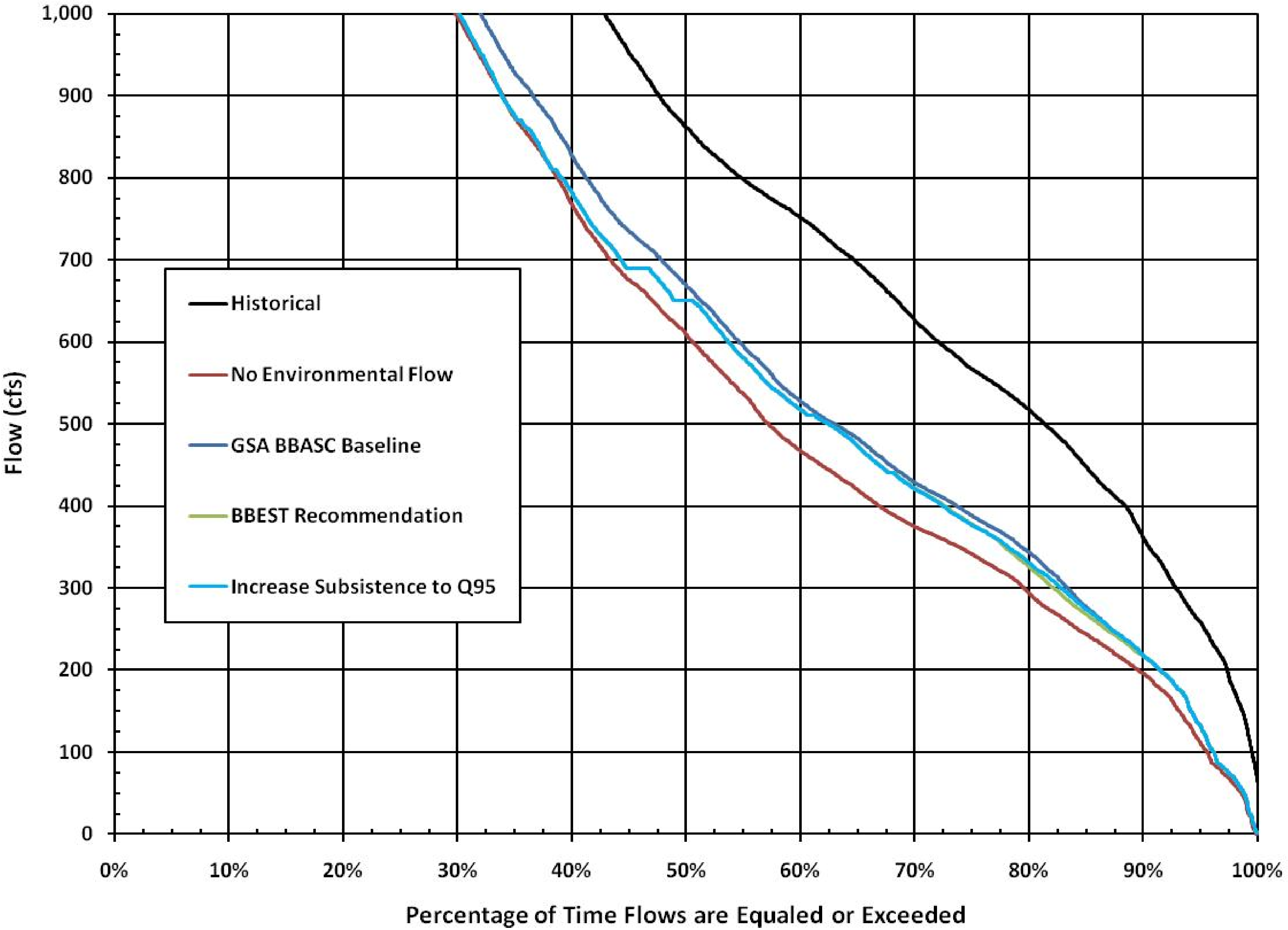
	105,500 acft Lyons Method	191,500 acft BBEST Recommendation*	86,000 acft TCEQ Structure*
Available Project Yield (acft/yr)	20,674	20,674	20,674
Raw Water at Reservoir			
Total Project Cost	$253,801,000	$279,391,000	$224,299,000
Total Annual Cost	$22,854,000	$24,828,000	$22,349,000
Annual Cost of Raw Water ($ per acft)	$1,105	$1,201	$1,081
Annual Cost of Raw Water ($ per 1,000 gallons)	$3.39	$3.68	$3.32
Treated Water Delivered			
Total Project Cost	$413,942,000	$441,845,071	$406,753,000
Total Annual Cost	$42,891,000	$44,865,622	$42,387,000
Annual Cost of Water ($ per acft)	$2,075	$2,170	$2,050
Annual Cost of Water ($ per 1,000 gallons)	$6.37	$6.66	$6.29

*Note: *Reservoir size adjusted to achieve same firm yield of Lyons Method*

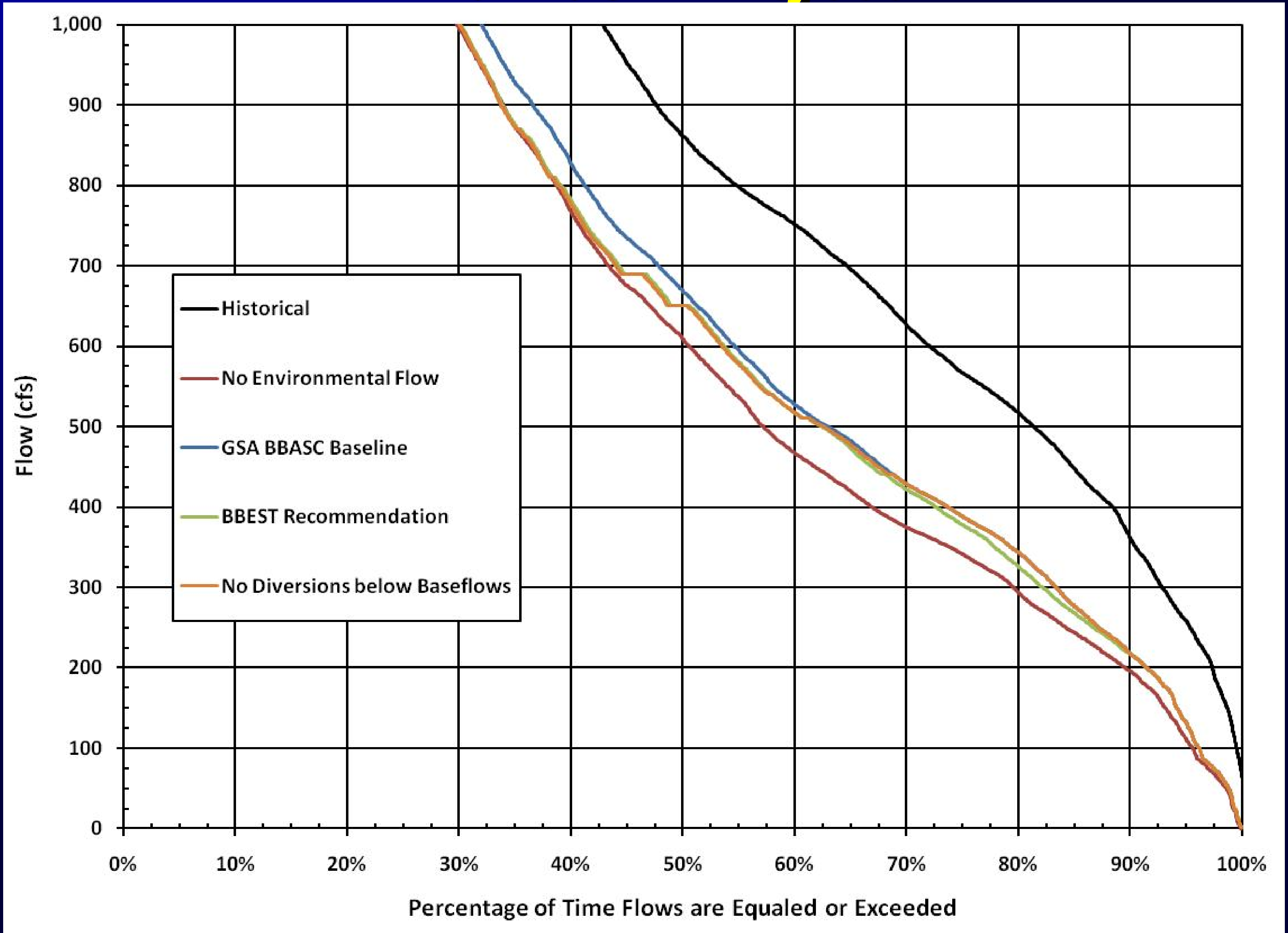
Mid-Basin Project



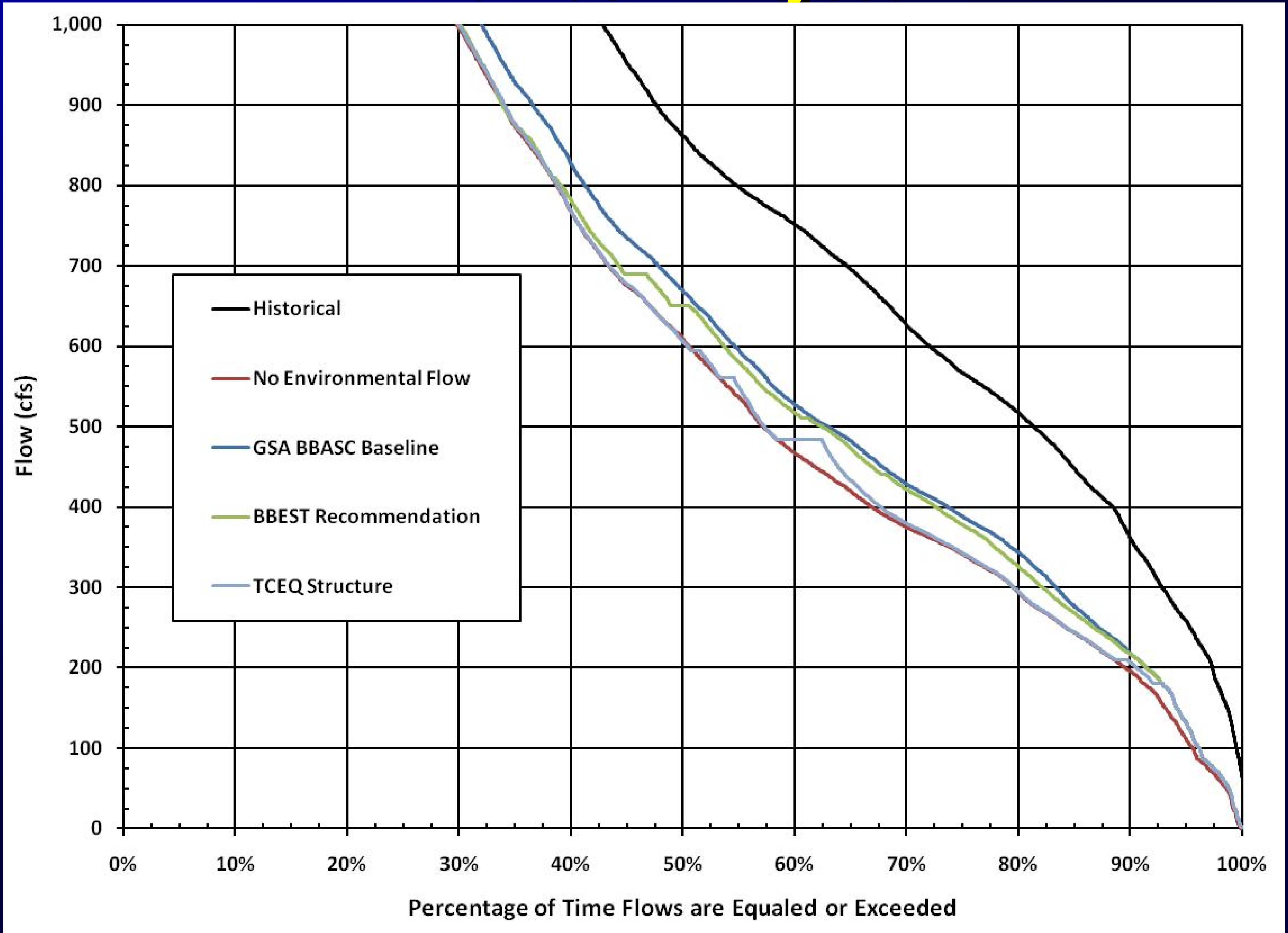
Mid-Basin Project



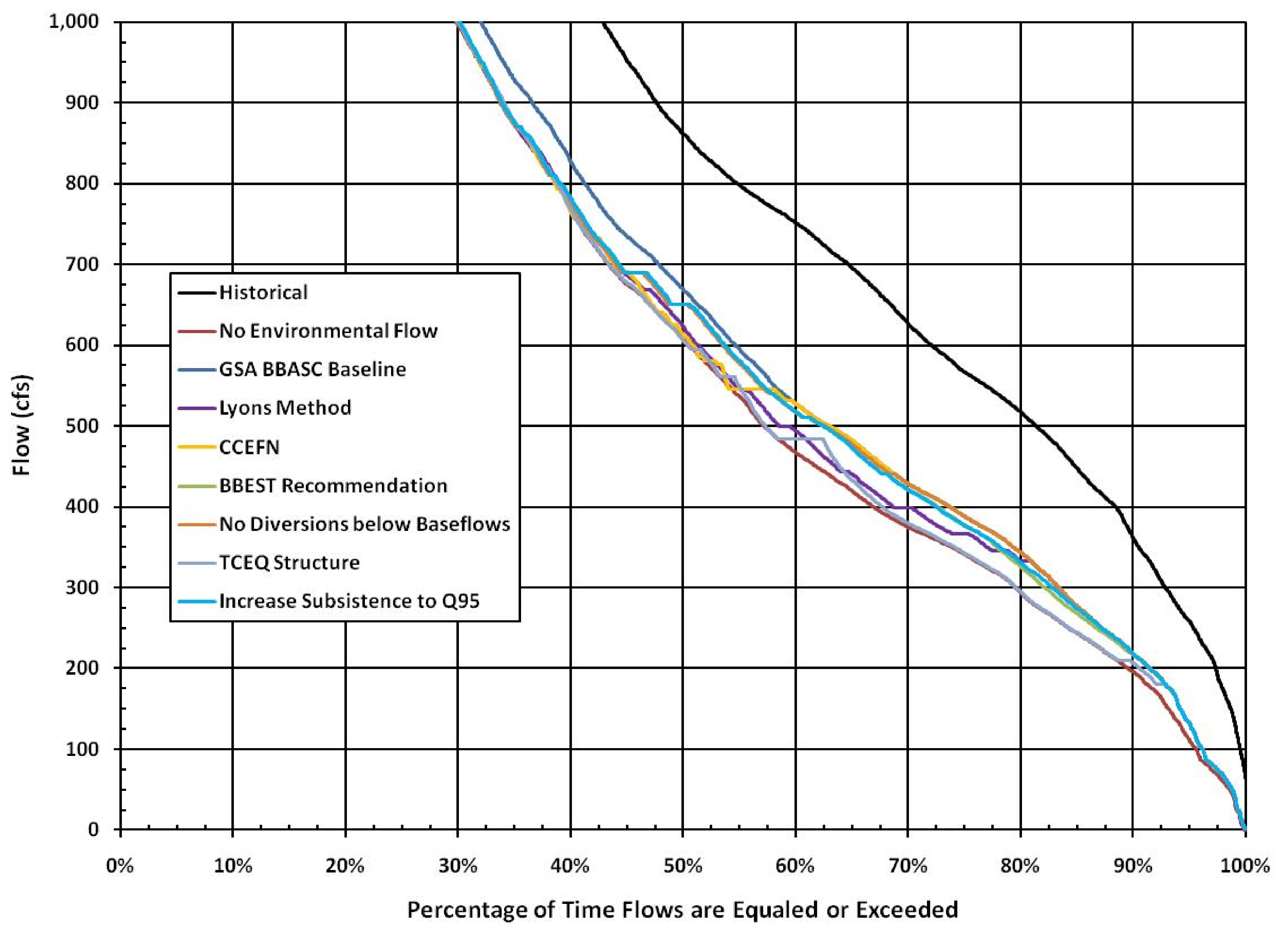
Mid-Basin Project



Mid-Basin Project



Mid-Basin Project



Mid-Basin Project

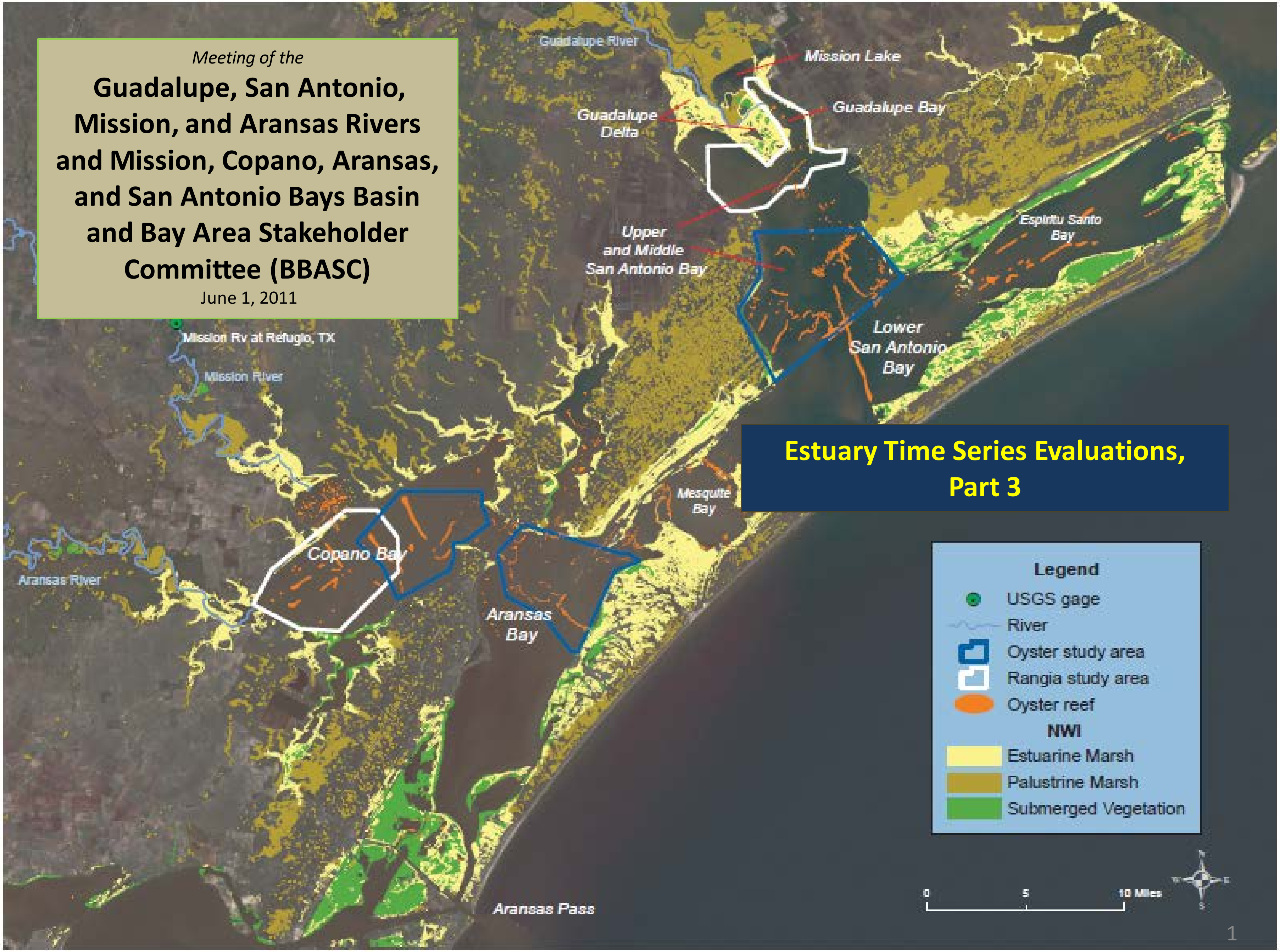
Questions, Comments, & Discussion

Meeting of the

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

June 1, 2011

Estuary Time Series Evaluations, Part 3



The BBEST Criteria

Table 6.1-17

Guadalupe Estuary Criteria - Volumes				
	Inflow Criteria Volumes, suite G1 for Rangia clams		Inflow Criteria Volumes, suite G2 for Eastern oysters	
Criteria level	Feb. (1000 ac-ft/mon)	Mar.-May (1000 ac-ft/3mon)	June (1000 ac-ft/mon)	July-Sept. (1000 ac-ft/3mon)
G1-Aprime, G2-Aprime	n/a	550-925	n/a	450-800
G1-A, G2-A	n/a	375-550	n/a	275-450
G1-B, G2-B	n/a	275-375	n/a	170-275
G1-C, G2-C	≥75	150-275	≥40	75-170
G1-CC, G2-CC	0 - 75	150-275	0 - 40	75-170
G1-D, G2-D	n/a	0 - 150	n/a	50-75
G1-DD, G2-DD	n/a	n/a	n/a	0-50

Mission-Aransas Estuary Criteria - Volumes				
Criteria level	Inflow Criteria Volumes, set MA1 for Rangia clams		Inflow Criteria Volumes, set MA2 for Eastern oysters	
	Feb.	Mar.-May	June	July-Sept.
MA2 - Aprime	n/a	n/a	n/a	500-1000

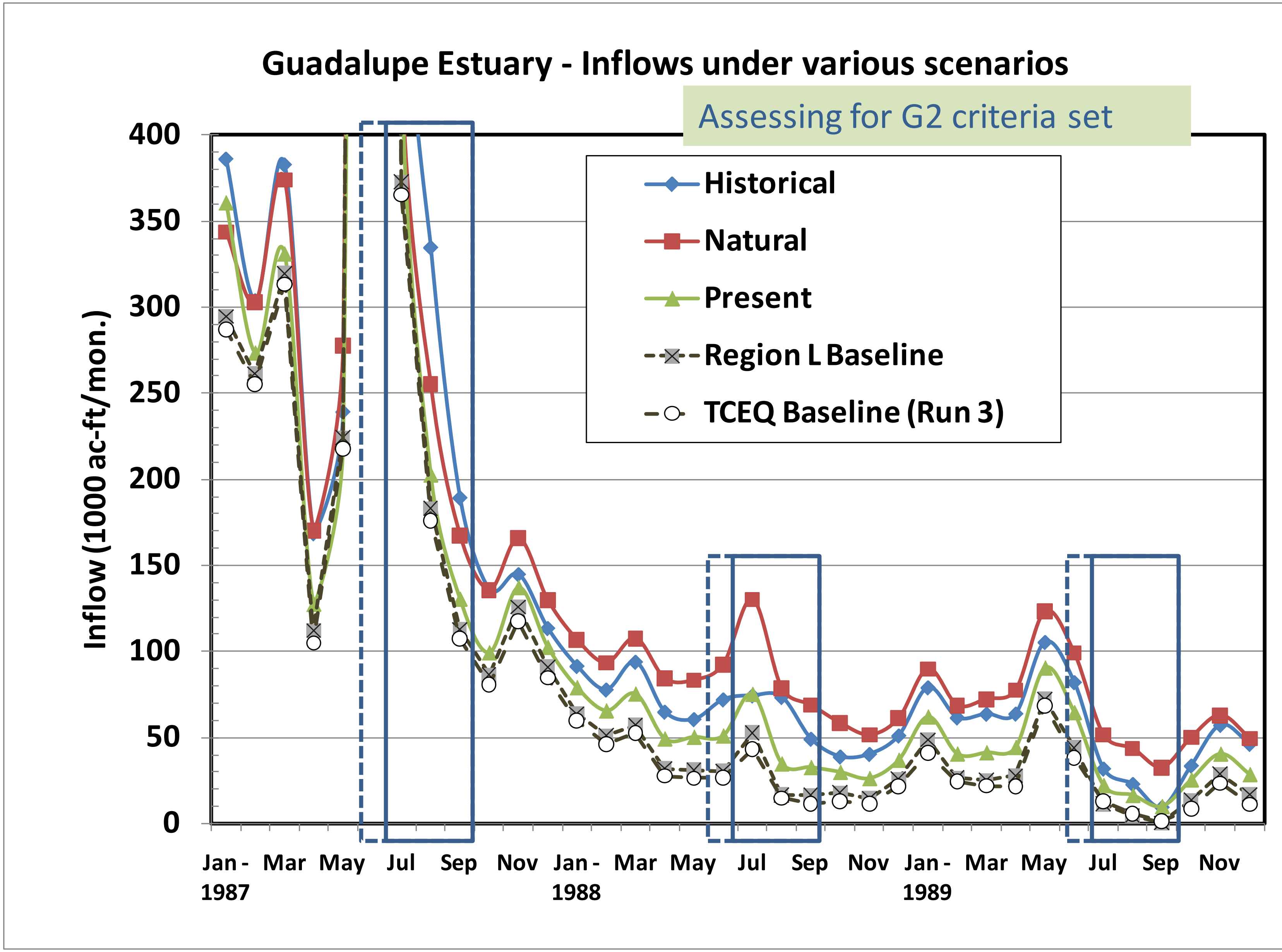
Table 6.1-18

Guadalupe Estuary Criteria -Attainment Recommendations			
Criteria level	Specification	Inflow Criteria Attainment, G1 suite for Rangia clams	Inflow Criteria Attainment, G2 suite for Eastern oysters
G1-Aprime, G2-Aprime	Attainment, G - Aprime	G1-Aprime at least 12% of years	G2-Aprime at least 12% of years
G1-A, G2-A	Attainment, G - A	G1-A at least 12 % of years	G2-A at least 17 % of years
G1-A&G1-B, G2-A&G2-B	Attainment, G - A & G - B combined	G1-A and G1-B combined at least 17% of years	G2-A and G2-B combined at least 30% of years
G1-C&G1-CC, G2-C&G2-CC	Attainment, G - C & G - CC combined	G1-C and G1-CC equal to or greater than 19% of years. G1-CC no more than 2/3 of total	G2-C and G2-CC equal to or greater than10% of years. G2-CC no more than 1/6 of total
G1-D	Attainment, G1- D	no more than 9% of years	n/a
G2-DD	Attainment, G2- DD	n/a	G2-D no more than 6% of years
G2-D&G2-DD	Attainment, G2-D & G2-DD combined	n/a	G2-D and G2-DD combined no more than 9% of years

Mission-Aransas Estuary Criteria -Attainment Recommendations			
Criteria level	Specification	Inflow Criteria Attainment, set MA1 for Rangia clams	Inflow Criteria Attainment, set MA2 for Eastern oysters
MA-Aprime	Attainment MA-Aprime	n/a	MA2-Aprime at least 2% of years

Time Series of Inflows to Guadalupe Estuary
Scenarios utilized (thus far) – principal characteristics

	Natural	Historical	Present	Region L	TCEQ Run3
Surface water use/demands	0	historical, transient	max. last 10yr, constant	Full use, constant	Full use, constant
WW Returns	0	historical, transient	min. last 5 yr, constant	recent ('96?) levels, constant	0
Edwards Aq. use / mgmt.	0	historical, transient	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.
Data source	model	data	model	model	model
Period of record	1934-1989	1941 - 2009	1934-1989	1934-1989	1934-1989


Guadalupe Estuary - Inflows under various scenarios
Assessing for G2 criteria set
Historical
Natural
Present
Region L Baseline
TCEQ Baseline (Run 3)
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov

Summary – Attainment of G1 Springtime Criteria (Rangia)

with the San Antonio River Project

Previously presented, 05/04/11

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
w. San Antonio Project	7	9	9	1	5	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

see Tables 4.5-3 & 4.5-6		>12%	>12%				<=9%
Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline; BBASC		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. San Antonio Project		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

see Table 4.5-3			>17%		>=19%	<=2/3	
Attain. - Joints	Joint G1 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline; BBASC			22.4%		14.3%	57.1%	
w. San Antonio Project			20.4%		18.4%	44.4%	
TCEQ Baseline; (Run 3)			18.4%		16.3%	37.5%	

Color coding convention	
(green)	-OK, met criteria
(gray)	-Near miss. (rounding; p-o-record)
(orange)	-Not met, but departure not great
(brown)	-Very bad

Summary – Attainment of G2 Summer Criteria (oysters)

with the Guadalupe River Project

Previously presented, 05/04/11

Counts	Criteria G2								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. Guadalupe Project	4	8	8	8	7	3	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

Color coding convention
-OK, met criteria
-Near miss. (rounding; p-o-record)
-Not met, but departure not great
-Very bad

see Tables 4.5-2; 4.5-4		>12%	>17%				<=6%	
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guadalupe Project		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%	
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
w. Guadalupe Project			32.7%		20.4%	30.0%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

Summary – Guadalupe Project, Attainment of G1 Springtime Criteria (Rangia)

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Natural	9	15	7	6	3	6	3	49
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
w. Guad. Project, BBEST Recomm.	7	10	8	2	4	4	14	49
w. Guad. Project, CCEFN	7	9	9	1	5	4	14	49
w. Guad. Project, Lyons	7	9	9	2	4	4	14	49
w. Guad. Project, No Div <Base	7	10	8	2	4	4	14	49
w. Guad. Project, TCEQ Struc.	7	10	8	1	5	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

Summary – Guadalupe Project, Attainment of G1 Springtime Criteria (Rangia)

see Tables 4.5-3 & 4.5-6		>12%	>12%				<=9%
Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Natural		30.6%	14.3%	12.2%	6.1%	12.2%	6.1%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline; BBASC		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. Guad. Project, BBEST Recomm.		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
w. Guad. Project, CCEFN		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. Guad. Project, Lyons		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. Guad. Project, No Div <Base		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
w. Guad. Project, TCEQ Struc.		20.4%	16.3%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

Color coding convention
-OK, met criteria
-Near miss. (rounding; p-o-record)
-Not met, but departure not great
-Very bad

see Table 4.5-3			>17%		>=19%	<=2/3	
Attain. - Joints	Joint G1 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	
Natural			26.5%		18.4%	66.7%	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline; BBASC			22.4%		14.3%	57.1%	
w. Guad. Project, BBEST Recomm.			20.4%		16.3%	50.0%	
w. Guad. Project, CCEFN			20.4%		18.4%	44.4%	
w. Guad. Project, Lyons			22.4%		16.3%	50.0%	
w. Guad. Project, No Div <Base			20.4%		16.3%	50.0%	
w. Guad. Project, TCEQ Struc.			18.4%		18.4%	44.4%	
TCEQ Baseline; (Run 3)			18.4%		16.3%	37.5%	

Summary – Guadalupe Project, Attainment of G2 Summer Criteria (oysters)

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Natural	9	11	15	7	3	2	2	0	49
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. Guad. Project, BBEST Recomm.	4	8	8	8	7	3	3	8	49
w. Guad. Project, CCEFN	4	8	8	8	7	3	3	8	49
w. Guad. Project, Lyons	4	8	8	8	7	3	3	8	49
w. Guad. Project, No Div <Base	4	8	8	8	7	3	3	8	49
w. Guad. Project, TCEQ Struc.	4	8	8	8	6	4	2	9	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

Summary – Guadalupe Project, Attainment of G2 Summer Criteria (oysters)

see Tables 4.5-2; 4.5-4		>12%	>17%				<=6%	
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Natural		22.4%	30.6%	14.3%	6.1%	4.1%	4.1%	0.0%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, BBEST Recomm.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, CCEFN		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, Lyons		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, No Div <Base		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, TCEQ Struc.		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%	
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Natural			44.9%		10.2%	40.0%	4.1%	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
w. Guad. Project, BBEST Recomm.			32.7%		20.4%	30.0%	22.4%	
w. Guad. Project, CCEFN			32.7%		20.4%	30.0%	22.4%	
w. Guad. Project, Lyons			32.7%		20.4%	30.0%	22.4%	
w. Guad. Project, No Div <Base			32.7%		20.4%	30.0%	22.4%	
w. Guad. Project, TCEQ Struc.			32.7%		20.4%	40.0%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

Color coding convention	
(green)	-OK, met criteria
(grey)	-Near miss. (rounding; p-o-record)
(orange)	-Not met, but departure not great
(brown)	-Very bad

Summary – San Antonio Project, Attainment of G1 Springtime Criteria (Rangia)

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Natural	9	15	7	6	3	6	3	49
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
w. San Ant. Project, BBEST Recomr	7	9	9	1	5	4	14	49
w. San Ant. Project, CCEFN	7	9	9	1	5	4	14	49
w. San Ant. Project, Lyons	7	9	9	2	4	4	14	49
w. San Ant. Project, No Div <Base	7	9	9	1	5	4	14	49
w. San Ant. Project, TCEQ Struc.	7	9	9	1	5	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

Summary – San Antonio Project, Attainment of G1 Springtime Criteria (Rangia)

Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Natural		30.6%	14.3%	12.2%	6.1%	12.2%	6.1%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline; BBASC		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. San Ant. Project, BBEST Recomm.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Project, CCEFN		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Project, Lyons		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. San Ant. Project, No Div <Base		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Project, TCEQ Struc.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%
see Table 4.5-3			>17%		>=19%	<=2/3	

Attain. - Joints	Joint G1 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	
Natural			26.5%		18.4%	66.7%	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline; BBASC			22.4%		14.3%	57.1%	
w. San Ant. Project, BBEST Recomm.			20.4%		18.4%	44.4%	
w. San Ant. Project, CCEFN			20.4%		18.4%	44.4%	
w. San Ant. Project, Lyons			22.4%		16.3%	50.0%	
w. San Ant. Project, No Div <Base			20.4%		18.4%	44.4%	
w. San Ant. Project, TCEQ Struc.			20.4%		18.4%	44.4%	
TCEQ Baseline; (Run 3)			18.4%		16.3%	37.5%	

Color coding convention	
(green)	-OK, met criteria
(grey)	-Near miss. (rounding; p-o-record)
(orange)	-Not met, but departure not great
(brown)	-Very bad

Summary – San Antonio Project, Attainment of G2 Summer Criteria (oysters)

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Natural	9	11	15	7	3	2	2	0	49
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. San Ant. Project, BBEST Recomm	4	8	8	8	7	3	3	8	49
w. San Ant. Project, CCEFN	4	8	8	8	6	4	2	9	49
w. San Ant. Project, Lyons	4	8	8	8	7	3	3	8	49
w. San Ant. Project, No Div <Base	4	8	8	8	7	3	3	8	49
w. San Ant. Project, TCEQ Struc.	4	8	8	7	7	4	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

Summary – San Antonio Project, Attainment of G2 Summer Criteria (oysters)

see Tables 4.5-2; 4.5-4		>12%	>17%				<=6%	
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Natural		22.4%	30.6%	14.3%	6.1%	4.1%	4.1%	0.0%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Ant. Project, BBEST Recomm.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Ant. Project, CCEFN		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
w. San Ant. Project, Lyons		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Ant. Project, No Div <Base		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Ant. Project, TCEQ Struc.		16.3%	16.3%	14.3%	14.3%	8.2%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%	
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Natural			44.9%		10.2%	40.0%	4.1%	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
w. San Ant. Project, BBEST Recomm.			32.7%		20.4%	30.0%	22.4%	
w. San Ant. Project, CCEFN			32.7%		20.4%	40.0%	22.4%	
w. San Ant. Project, Lyons			32.7%		20.4%	30.0%	22.4%	
w. San Ant. Project, No Div <Base			32.7%		20.4%	30.0%	22.4%	
w. San Ant. Project, TCEQ Struc.			30.6%		22.4%	36.4%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

Color coding convention
-OK, met criteria
-Near miss. (rounding; p-o-record)
-Not met, but departure not great
-Very bad

Meeting of the

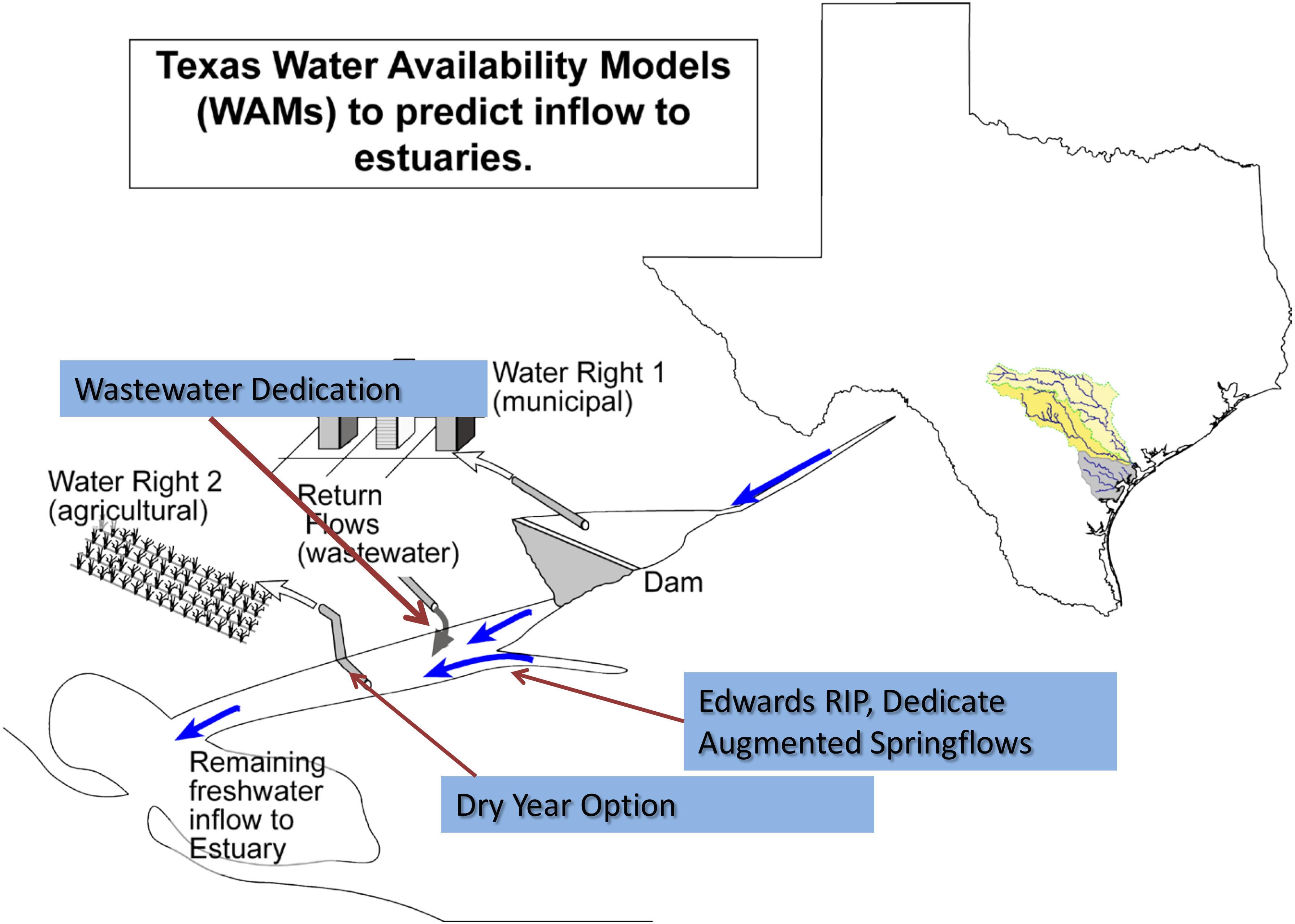
Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

SB3 "Strategies"- Proposal for Evaluations and Report to BBASC

June 01, 2011

NATIONAL WILDLIFE FEDERATION

Texas Water Availability Models (WAMs) to predict inflow to estuaries.



Summary – Attainment of G2 Summer Criteria (oysters)

with the Guadalupe River Project

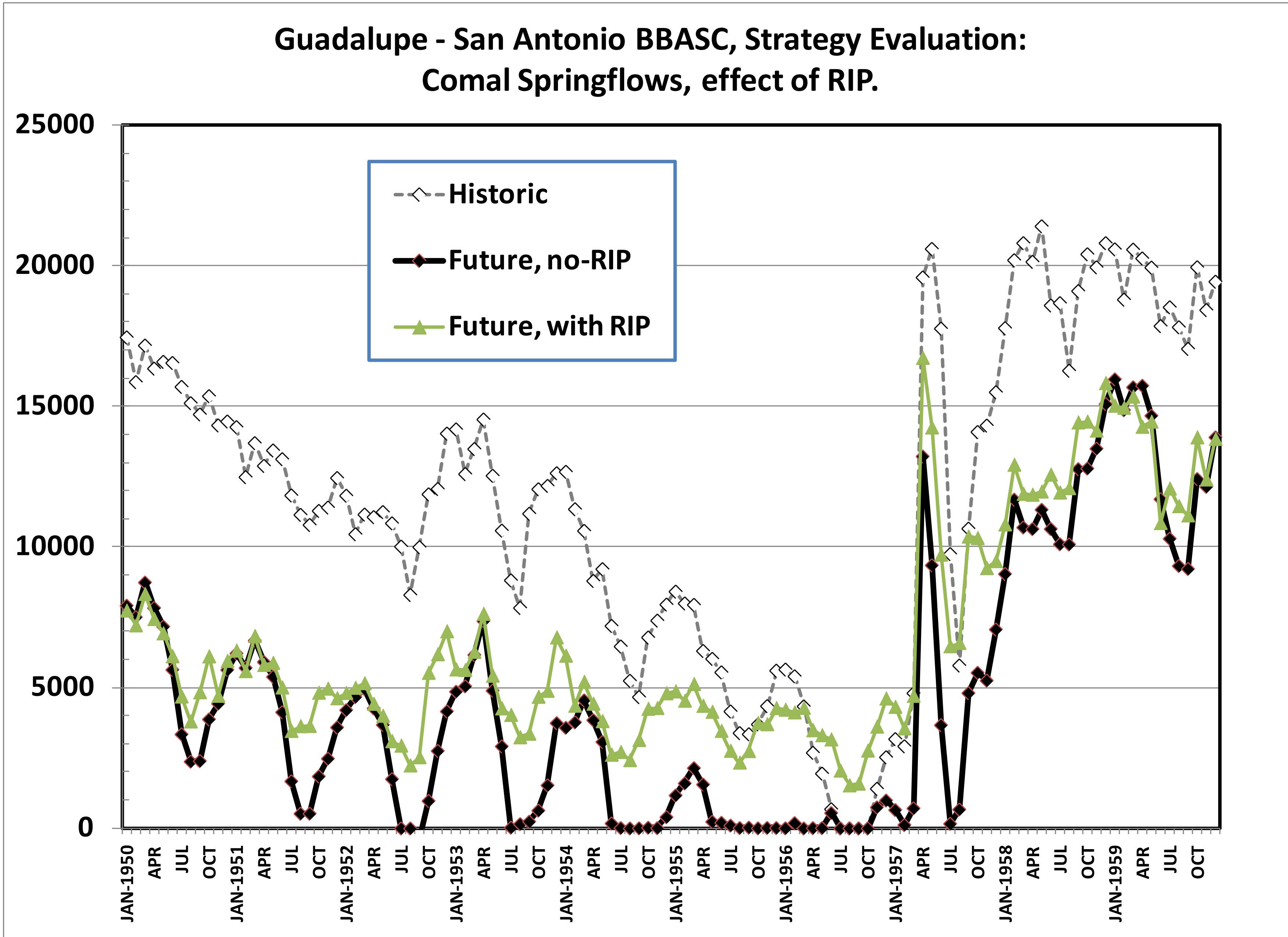
Previously presented, 05/04/11

Counts	Criteria G2								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. Guadalupe Project	4	8	8	8	7	3	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

see Tables 4.5-2; 4.5-4		>12%	>17%				<=6%	
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guadalupe Project		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%	
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
w. Guadalupe Project			32.7%		20.4%	30.0%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

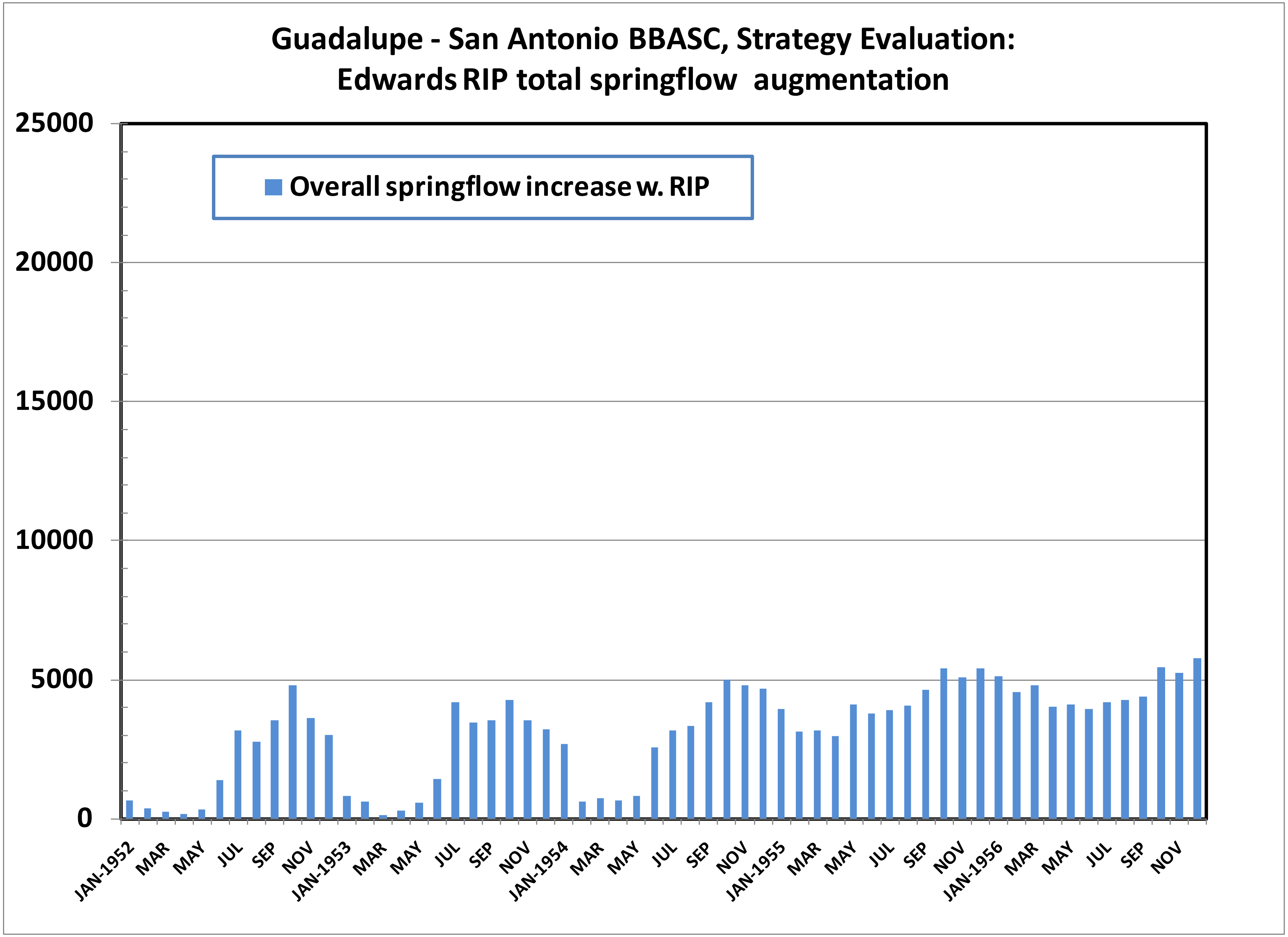
Color coding convention	
(green)	-OK, met criteria
(gray)	-Near miss. (rounding; p-o-record)
(orange)	-Not met, but departure not great
(brown)	-Very bad



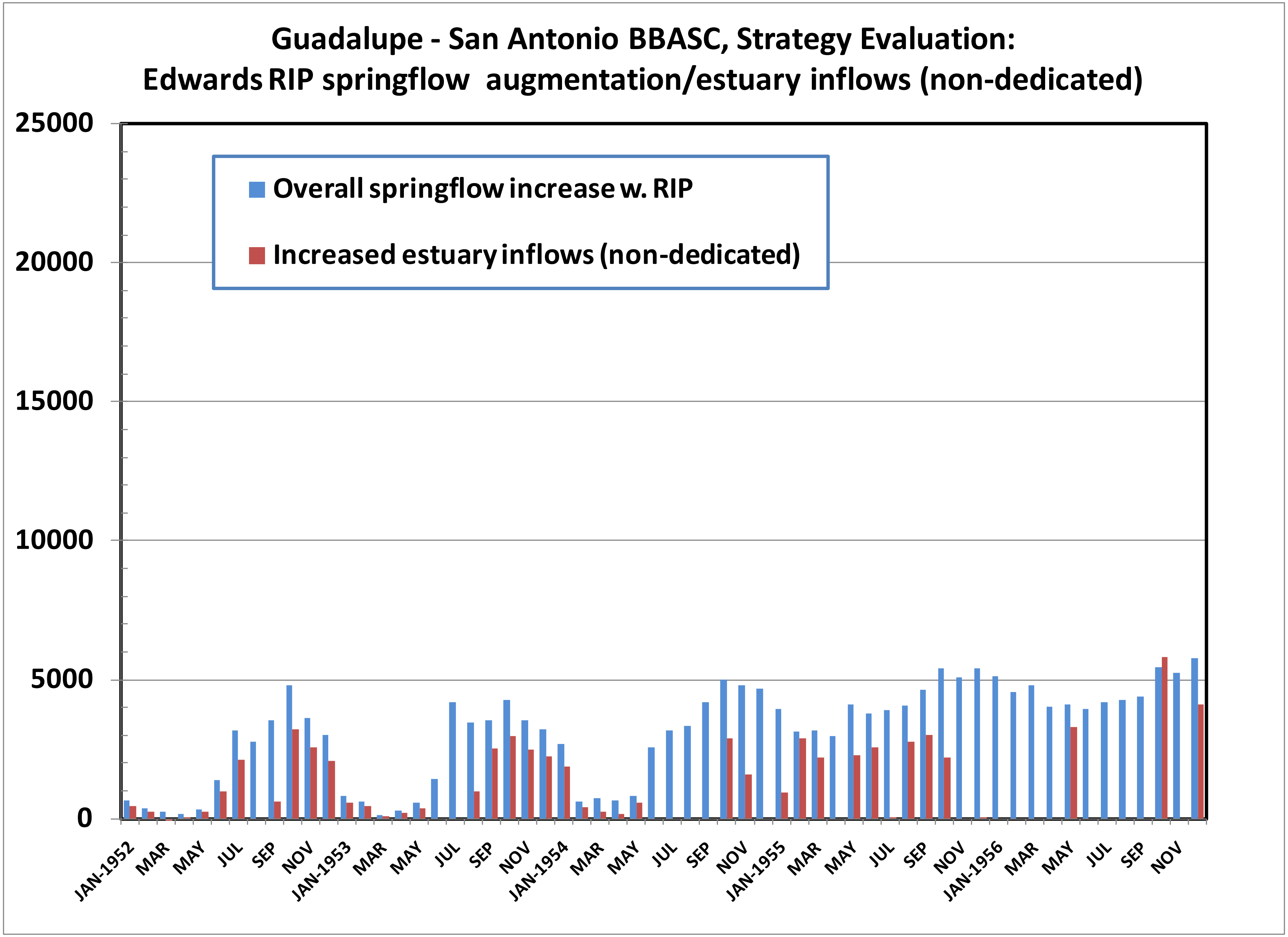
Guadalupe - San Antonio BBASC, Strategy Evaluation:
Comal Springflows, effect of RIP.
25000
20000
15000
10000
5000
0
Historic
Future, no-RIP
Future, with RIP
JAN-1950
APR
JUL
OCT
JAN-1951
JAN-1952
JAN-1953
JAN-1954
JAN-1955
JAN-1956
JAN-1957
JAN-1958
JAN-1959

Time Series of Inflows to Guadalupe Estuary
Scenarios utilized (thus far) – principal characteristics

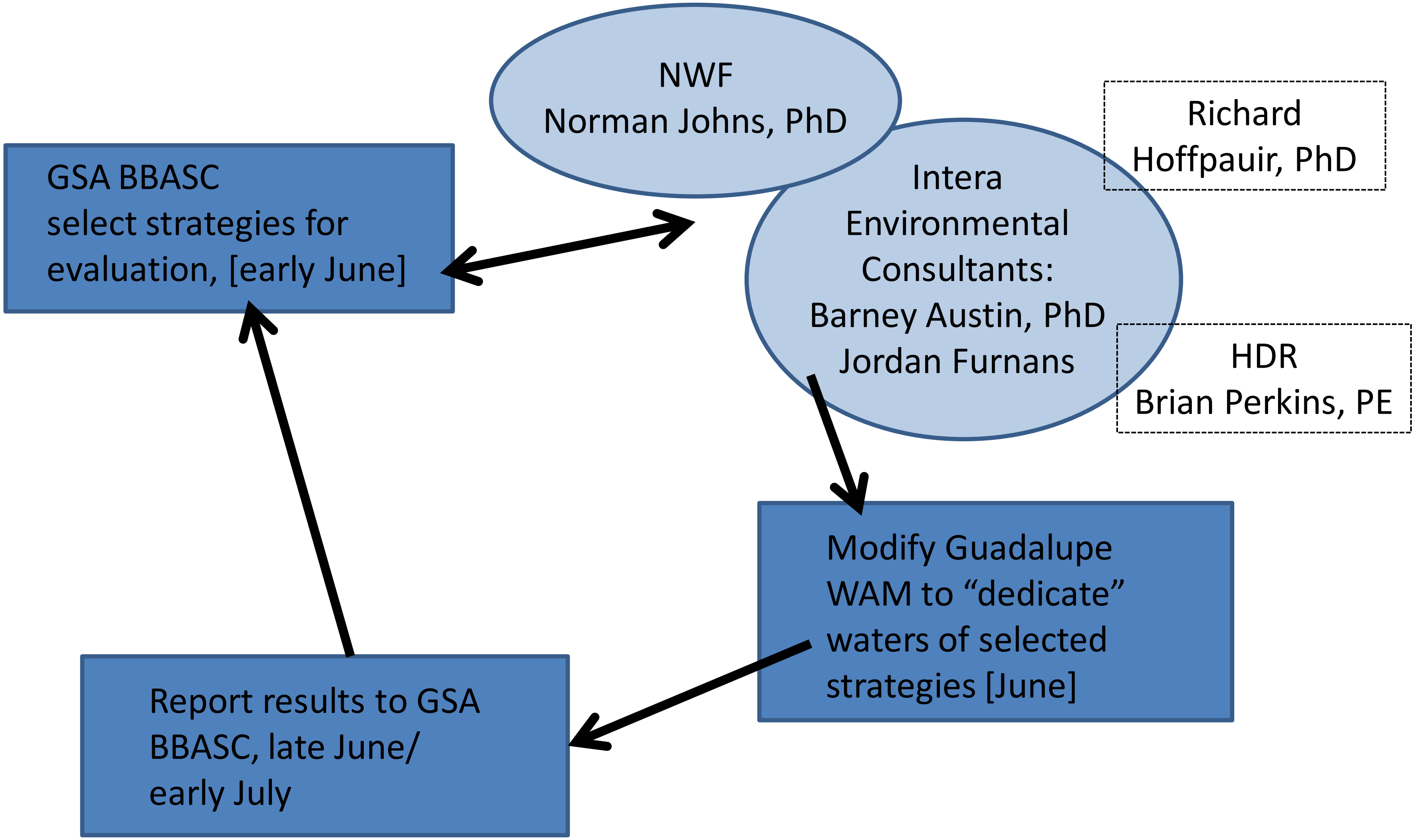
	Natural	Historical	Present	Region L	TCEQ Run3
Surface water use/demands	0	historical, transient	max. last 10yr, constant	Full use, constant	Full use, constant
WW Returns	0	historical, transient	min. last 5 yr, constant	recent ('06) levels, constant	0
Edwards Aq. use / mgmt.	0	historical, transient	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.	SB 3 , constant w. drought mgmt.
Data source	model	data	model	model	model
Period of record	1934-1989	1941 - 2009	1934-1989	1934-1989	1934-1989



Guadalupe - San Antonio BBASC, Strategy Evaluation:
Edwards RIP total springflow augmentation
Overall springflow increase w. RIP
25000
20000
15000
10000
5000
0
JAN-1952
MAR
MAY
JUL
SEP
NOV
JAN-1953
MAR
MAY
JUL
SEP
NOV
JAN-1954
MAR
MAY
JUL
SEP
NOV
JAN-1955
MAR
MAY
JUL
SEP
NOV
JAN-1956
MAR
MAY
JUL
SEP
NOV



Guadalupe - San Antonio BBASC, Strategy Evaluation:
Edwards RIP springflow augmentation/estuary inflows (non-dedicated)
Overall springflow increase w. RIP
Increased estuary inflows (non-dedicated)
25000
20000
15000
10000
5000
0
JAN-1952
MAR
MAY
JUL
SEP
NOV
JAN-1953
MAR
MAY
JUL
SEP
NOV
JAN-1954
MAR
MAY
JUL
SEP
NOV
JAN-1955
MAR
MAY
JUL
SEP
NOV
JAN-1956
MAR
MAY
JUL
SEP
NOV


NWF
Norman Johns, PhD
Richard
Hoffpauir, PhD
GSA BBASC
select strategies for
evaluation, [early June]
Intera
Environmental
Consultants:
Barney Austin, PhD
Jordan Furnans
HDR
Brian Perkins, PE
Modify Guadalupe
WAM to "dedicate"
waters of selected
strategies [June]
Report results to GSA
BBASC, late June/
early July

Approaches for balancing human water supply & environmental needs in SB3 flow standards process

[when it appears there is inadequate water for both]

New / Existing Permits	Criteria-Standards actions	Permit / Management actions
new water use permits	alter the environmental flow criteria (= adopt weaker standards)	alter the new permit(s) specifics (e.g. modify diversion rate or storage)
existing water use permits	"	examine voluntary strategies • wastewater dedication • dry-year option • lease, sale, donation of permit to environ-mental flow purpose • dedication of conserved water • re-management • •

May 2011

NATIONAL WILDLIFE FEDERATION

GSA BBEST Environmental Flow Regime Recommendation Locations - Summary of Low Flow Values

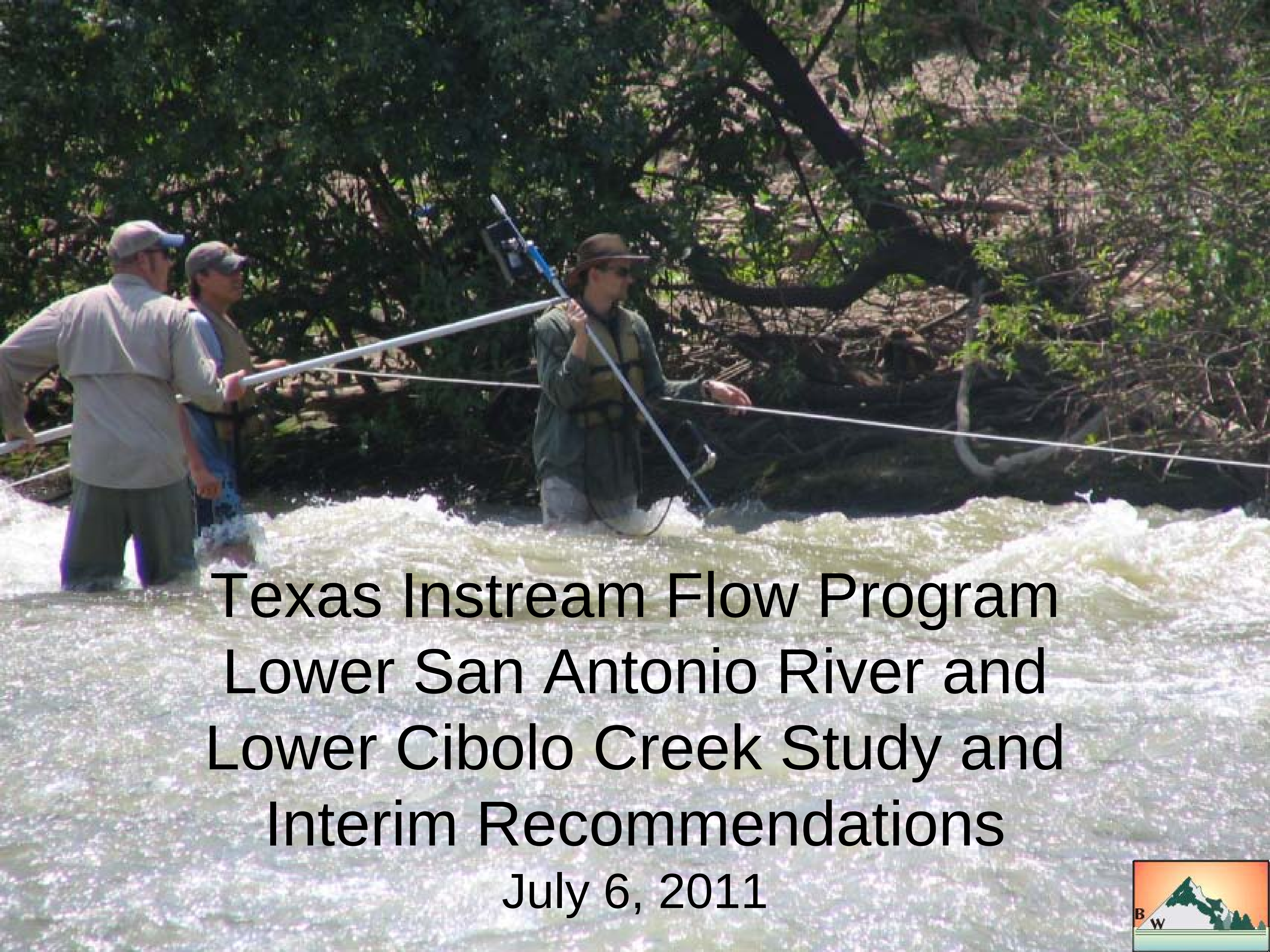
River Basin	USGS Streamflow Gage Name	USGS#	First Full Year of Record	Full Years of Record	Drainage Area (sq mi)	TCEQ Stream Segment	BBEST Subsistence Flow Range (cfs)	Q95 (Winter)	Q95 (Spring)	Q95 (Summer)	Q95 (Fall)	Q95 (Annual)	7Q2 Flow (cfs)	TPWD Level of Concern	TPWD Ecologically Significant Segment	TCEQ Aquatic Life Uses	TPWD Notes on Subsistence Flow
Guadalupe	Guadalupe River at Comfort, TX	08167000	1940	70	839	1806	2.0 - 10	31.0	18.0	1.1	25.0	14.0	55.0	High	Yes	Exceptional	Habitat minimal - less than 20% of max
Guadalupe	Guadalupe River near Spring Branch, TX	08167500	1923	87	1,315	1806	4.6 - 13	41.0	27.0	2.2	24.0	18.0	74.0	High	Yes	Exceptional	Habitat minimal for some types - less than 20%; all less than 50%
Guadalupe	Blanco River at Wimberley, TX	08171000	1929	81	355	1813	6.7 - 7.9	10.0	13.0	7.6	9.5	9.4	32.0	High	Yes	Exceptional	Habitat minimal for some types - less than 20%; all less than 50%
Guadalupe	San Marcos River at Luling, TX	08172000	1940	70	838	1808	73 - 78	89.0	88.6	72.0	81.0	81.0	161.3	Moderate	Yes	High	No habitat model available; subsistance less than seasonal Q95 and/or TCEQ critical low flow
Guadalupe	Plum Creek near Luling, TX	08173000	1931	73	309	1810	1.0	2.7	1.5	0.1	0.6	0.7	2.3	High	No	High	Model uncertainty high; subsistance not modeled; habitat may all be less than 20% if trends continue
Guadalupe	Guadalupe River at Gonzales, TX*	08173900	1997	13	3,490	1803	180 - 210	346.4	312.7	192.8	294.0	258.3	489.0	Low-Moderate	Yes	High	All habitat types greater than 80% of max although recommendations less than some seasonal Q95 and TCEQ critical low flow; no water quality model available
Guadalupe	Sandies Creek near Westhoff, TX	08175000	1960	50	549	1803B	1.0	3.5	1.4	0.4	1.7	1.1	N/A	High	No		Habitat minimal for some types - less than 20%; all less than 50% (or so)
Guadalupe	Guadalupe River at Cuero, TX*	08175800	1964	46	4,934	1803	86 - 130	345.2	283.3	126.9	231.1	197.3	606.6	Moderate	No	High	Model uncertainty high
Guadalupe	Guadalupe River at Victoria, TX	08176500	1935	75	5,198	1803	110 - 160	375.0	316.6	140.0	257.1	223.0	641.9	Moderate	Yes	High	Some habitat less than 80% of max
San Antonio	Medina River at Bandera, TX**	08178880	1983	70	427	1905	1.0 - 1.2	5.5	6.6	1.4	1.7	2.4	8.2	High	Yes	Exceptional	Habitat model did not extend to subsistence flow; dry base results in some habitat types less than 20% of max
San Antonio	Medina River at San Antonio, TX	08181500	1940	70	1,317	1903	7.0 - 7.9	14.0	12.0	8.3	13.0	12.0	78.0	High	No	High	Habitat minimal for some types - less than 20%; all less than 50%
San Antonio	San Antonio River near Elmendorf, TX*	08181800	1963	48	1,743	1911	49 - 61	82.0	62.0	46.2	64.7	62.0	136.0	Moderate	No	High	One habitat type less than 80%; LSAR interim recommendation = 80 cfs (based on water quality model)
San Antonio	San Antonio River near Falls City, TX	08183500	1926	84	2,113	1911	52 - 60	89.0	67.0	50.0	69.0	64.0	144.0	Moderate	No	High	No habitat model available; recommendations less than some seasonal Q95 and TCEQ critical low flow; LSAR interim recommendation = 80 cfs
San Antonio	Cibolo Creek near Falls City, TX	08186000	1931	79	827	1902	4.9 - 6.5	13.0	7.4	4.6	8.9	7.6	15.0	Moderate	No	High	Some habitat types less than 80% of max; LSAR interim recommendation = 7.5 cfs
San Antonio	San Antonio River at Goliad, TX	08188500	1940	70	3,921	1901	54 - 76	105.5	69.0	52.0	84.0	76.0	205.0	Moderate	No	High	One habitat type less than 80%; LSAR interim recommendation = 80 cfs
San Antonio - Nueces	Mission River at Refugio, TX	08189500	1940	70	690	2002	1.0 - 1.3	2.5	1.5	0.7	1.8	1.5	4.7	High	Yes	High	Habitat minimal - less than 20% of max

* USGS streamflow records for this location have been supplemented by regression techniques.

GSA BBEST Environmental Flow Regime Recommendation Locations - Summary of Low Flow Values

River Basin	USGS Streamflow Gage Name	USGS#	First Full Year of Record	Full Years of Record	Drainage Area (sq mi)	TCEQ Stream Segment	BBEST Subsistence Flow Range (cfs)	Q95 (Winter)	Q95 (Spring)	Q95 (Summer)	Q95 (Fall)	Q95 (Annual)	7Q2 Flow (cfs)	TPWD Level of Concern	TPWD Ecologically Significant Segment	TCEQ Aquatic Life Uses	TPWD Notes on Subsistence Flow
Guadalupe	Guadalupe River at Comfort, TX	08167000	1940	70	839	1806	2.0 - 10	31.0	18.0	1.1	25.0	14.0	55.0	High	Yes	Exceptional	Habitat minimal - less than 20% of max
Guadalupe	Guadalupe River near Spring Branch, TX	08167500	1923	87	1,315	1806	4.6 - 13	41.0	27.0	2.2	24.0	18.0	74.0	High	Yes	Exceptional	Habitat minimal for some types - less than 20%; all less than 50%
Guadalupe	Blanco River at Wimberley, TX	08171000	1929	81	355	1813	6.7 - 7.9	10.0	13.0	7.6	9.5	9.4	32.0	High	Yes	Exceptional	Habitat minimal for some types - less than 20%; all less than 50%
Guadalupe	San Marcos River at Luling, TX	08172000	1940	70	838	1808	73 - 78	89.0	88.6	72.0	81.0	81.0	161.3	Moderate	Yes	High	No habitat model available; subsistance less than seasonal Q95 and/or TCEQ critical low flow
Guadalupe	Plum Creek near Luling, TX	08173000	1931	73	309	1810	1.0	2.7	1.5	0.1	0.6	0.7	2.3	High	No	High	Model uncertainty high; subsistance not modeled; habitat may all be less than 20% if trends continue
Guadalupe	Guadalupe River at Gonzales, TX*	08173900	1997	13	3,490	1803	180 - 210	346.4	312.7	192.8	294.0	258.3	489.0	Low-Moderate	Yes	High	All habitat types greater than 80% of max although recommendations less than some seasonal Q95 and TCEQ critical low flow; no water quality model available
Guadalupe	Sandies Creek near Westhoff, TX	08175000	1960	50	549	1803B	1.0	3.5	1.4	0.4	1.7	1.1	N/A	High	No		Habitat minimal for some types - less than 20%; all less than 50% (or so)
Guadalupe	Guadalupe River at Cuero, TX*	08175800	1964	46	4,934	1803	86 - 130	345.2	283.3	126.9	231.1	197.3	606.6	Moderate	No	High	Model uncertainty high
Guadalupe	Guadalupe River at Victoria, TX	08176500	1935	75	5,198	1803	110 - 160	375.0	316.6	140.0	257.1	223.0	641.9	Moderate	Yes	High	Some habitat less than 80% of max
San Antonio	Medina River at Bandera, TX**	08178880	1983	70	427	1905	1.0 - 1.2	5.5	6.6	1.4	1.7	2.4	8.2	High	Yes	Exceptional	Habitat model did not extend to subsistence flow; dry base results in some habitat types less than 20% of max
San Antonio	Medina River at San Antonio, TX	08181500	1940	70	1,317	1903	7.0 - 7.9	14.0	12.0	8.3	13.0	12.0	78.0	High	No	High	Habitat minimal for some types - less than 20%; all less than 50%
San Antonio	San Antonio River near Elmendorf, TX*	08181800	1963	48	1,743	1911	49 - 61	82.0	62.0	46.2	64.7	62.0	136.0	Moderate	No	High	One habitat type less than 80%; LSAR interim recommendation = 80 cfs (based on water quality model)
San Antonio	San Antonio River near Falls City, TX	08183500	1926	84	2,113	1911	52 - 60	89.0	67.0	50.0	69.0	64.0	144.0	Moderate	No	High	No habitat model available; recommendations less than some seasonal Q95 and TCEQ critical low flow; LSAR interim recommendation = 80 cfs
San Antonio	Cibolo Creek near Falls City, TX	08186000	1931	79	827	1902	4.9 - 6.5	13.0	7.4	4.6	8.9	7.6	15.0	Moderate	No	High	Some habitat types less than 80% of max; LSAR interim recommendation = 7.5 cfs
San Antonio	San Antonio River at Goliad, TX	08188500	1940	70	3,921	1901	54 - 76	105.5	69.0	52.0	84.0	76.0	205.0	Moderate	No	High	One habitat type less than 80%; LSAR interim recommendation = 80 cfs
San Antonio - Nueces	Mission River at Refugio, TX	08189500	1940	70	690	2002	1.0 - 1.3	2.5	1.5	0.7	1.8	1.5	4.7	High	Yes	High	Habitat minimal - less than 20% of max

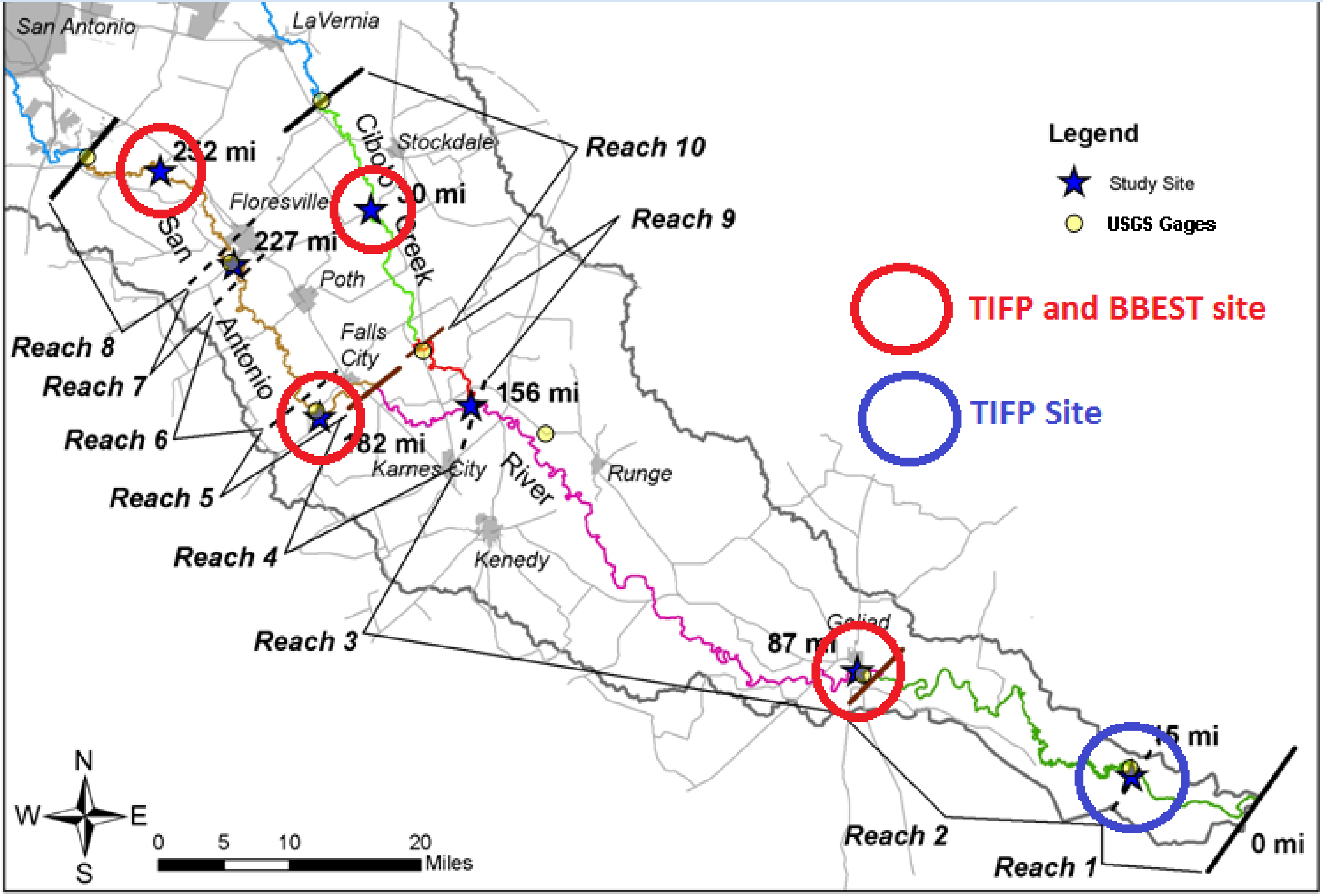
* USGS streamflow records for this location have been supplemented by regression techniques.



Texas Instream Flow Program Lower San Antonio River and Lower Cibolo Creek Study and Interim Recommendations

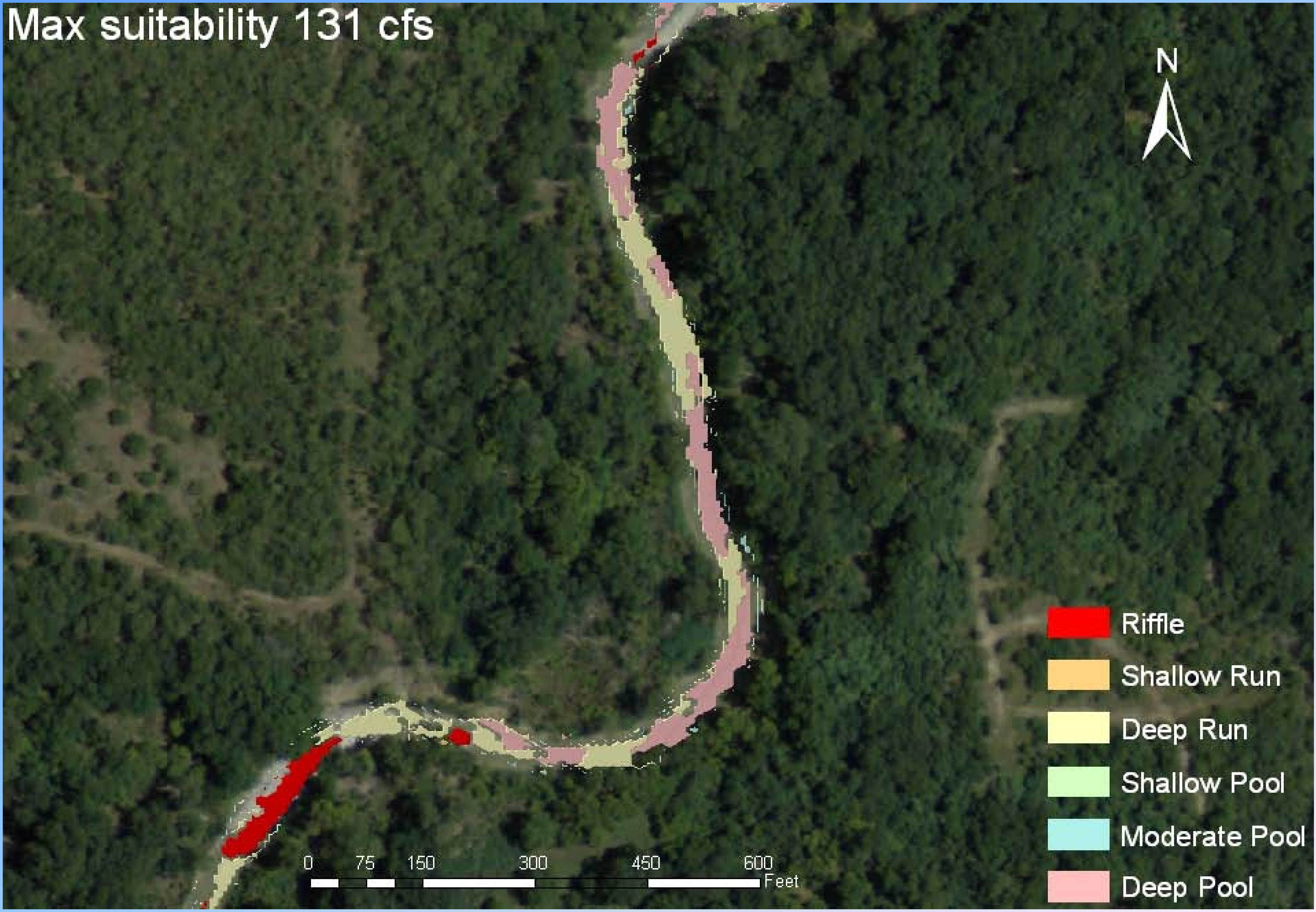
July 6, 2011

TIFP and BBEST Instream Flow Recommendation Sites



TIFP Methodology

- **Aquatic Biology**
  - **Mesohabitat mapping, Fish habitat suitability, preliminary mussels evaluation**
- **Hydrology and Hydraulics**
  - **River 2D hydraulic models developed for each site**
- **Habitat Modeling**
  - **Linked hydraulic models with habitat models allowing analysis of Weighted Usable Area, Habitat time series, Habitat duration curves, and spatial evaluation using GIS**



Max suitability 131 cfs
N
0
75
150
300
450
600
Feet
Riffle
Shallow Run
Deep Run
Shallow Pool
Moderate Pool
Deep Pool

TIFP Methodology (cont.)

- **Riparian**
  - **Species and life stage data from each site; Hec-Ras model for floodplain inundation and linkage to transect data; tree-ring aging study by Baylor University**
- **Sediment Transport**
  - **UTSA sediment transport evaluation**
- **Water Quality**
  - **Comprehensive water quality modeling with emphasis on water temperature and dissolved oxygen**

TIFP and BBEST comparison

- **4 sites**
  - Lower San Antonio River
    - **(1) Elmendorf**
    - **(2) Falls City**
    - **(3) Goliad**
  - Lower Cibolo Creek
    - **(4) Cibolo Creek near Falls City**

TIFP and BBEST Recommendations Development

- **TIFP** – Biological Data driven with site-specific data and modeling – *Hydrology used only as an overlay.*
  - Subsistence - Water Quality modeling linked to biological response
  - Base-flows: Habitat modeling linked to biological response
  - Pulse and Overbank flow: Riparian evaluation for indicator species driven by hydraulic modeling, tree-ring study, and species life history requirements

TIFP and **BBEST** Recommendations Development

- **BBEST** – Historical Hydrology driven - *Biology used as an overlay.*
    - Subsistence – HEFR
    - Base-Flows – HEFR
    - Pulses and Overbank flows – HEFR
  - Hydrologic time period used
    - Pre-1970
      - Elmendorf, Falls City, and Goliad
    - Full Period of Record
      - Cibolo Creek

TIFP Interim Recommendations

GOLIAD

Overbank Flow

Magnitude = 14,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 65% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Magnitude = 8,000 cfs
Frequency = 2 events
Duration = 2-3 days

Key Indicators:
Riparian: Green Ash / Box Elder

Key Indicators: Riparian - Sycamore
Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-5 days

Magnitude = 4,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) **Key Indicators: Aquatic Habitat, Water Quality**

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
Base Wet	475	460	471	470	538	498	503	434	507	531	579	535
Base Average	325	340	323	305	326	308	248	212	252	272	287	282
Base Dry	200	203	197	178	190	154	121	111	186	155	169	176

SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat **Key Indicators: Water Quality, Aquatic Habitat**

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80

BBEST Recommendations

Table 6.1-15. – Environmental Flow Regime Recommendation, San Antonio River at Goliad

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 273,000 Duration Bound is 69			
Overbank Flows	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 107,000 Duration Bound is 45			
Overbank Flows	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38			
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19
High Flow Pulses	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs)	290	280	220	270
Base Flows (cfs)	200	180	150	200
Base Flows (cfs)	140	130	120	130
Subsistence Flows (cfs)	76	60	54	66

Notes:

1. Period of Record used : 1/1/1940 to 12/31/1969.
2. Volumes are in acre-feet and durations are in days.

TIFP and BBEST Recommendations

- **Key differences**
  - Foundation
    - TIFP – Biology based
    - BBEST – Hydrology based
  - Subsistence recommendation
    - TIFP – one subsistence recommendation for the year
    - BBEST – seasonal recommendations within year
  - Implementation of pulses and overbank flows
    - TIFP – no hydrologic condition – across seasons
    - BBEST – tiers of pulses with seasonal distribution

Questions

TIFP – Goliad Recommendations

GOLIAD

Overbank Flow

Magnitude = 14,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 65% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Magnitude = 8,000 cfs
Frequency = 2 events
Duration = 2-3 days

Key Indicators:
Riparian: Green Ash / Box Elder

Key Indicators: Riparian - Sycamore
Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-5 days

Magnitude = 4,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) Key Indicators: Aquatic Habitat, Water Quality												
Base Wet	475	460	471	470	538	498	503	434	507	531	579	535
Base Average	325	340	323	305	326	308	248	212	252	272	287	282
Base Dry	200	203	197	178	190	154	121	111	186	155	169	176
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat Key Indicators: Water Quality, Aquatic Habitat												
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80
MONTH	January	February	March	April	May	June	July	August	September	October	November	December

BBEST – Goliad Recommendations

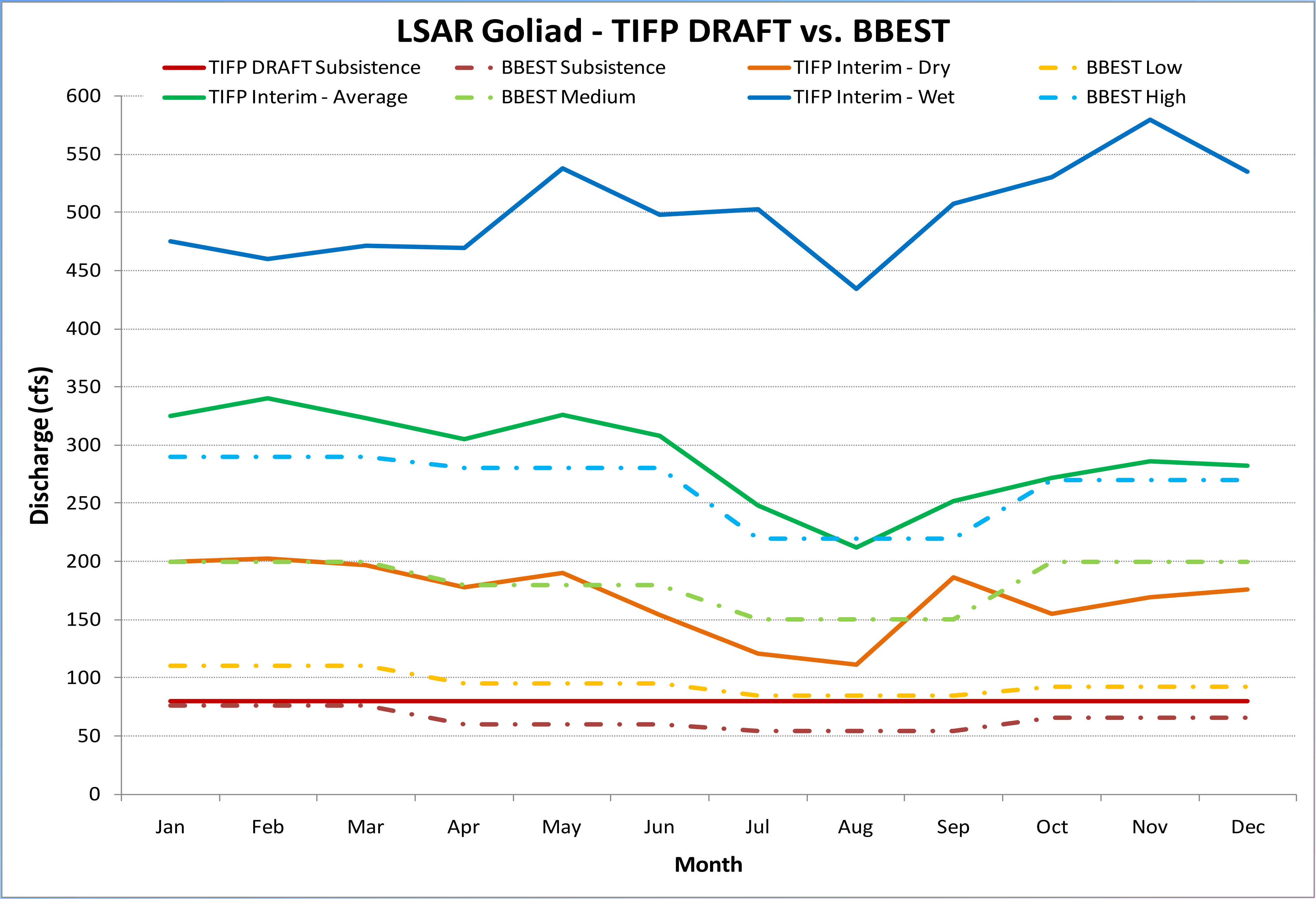
Table 6.1-15. – Environmental Flow Regime Recommendation, San Antonio River at Goliad

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 273,000 Duration Bound is 69			
Overbank Flows	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 107,000 Duration Bound is 45			
Overbank Flows	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38			
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19
High Flow Pulses	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs)	290	280	220	270
Base Flows (cfs)	200	180	150	200
Base Flows (cfs)	140	130	120	130
Subsistence Flows (cfs)	76	60	54	66

Notes:

1. Period of Record used : 1/1/1940 to 12/31/1969.
2. Volumes are in acre-feet and durations are in days.

LSAR - Goliad



LSAR Goliad - TIFP DRAFT vs. BBEST
TIFP DRAFT Subsistence
BBEST Subsistence
TIFP Interim - Dry
BBEST Low
TIFP Interim - Average
BBEST Medium
TIFP Interim - Wet
BBEST High
Discharge (cfs)
600
550
500
450
400
350
300
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

TIFP – Falls City Recommendations

FALLS CITY

Overbank Flow

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 8,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 80% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Magnitude = 6,500 cfs
Frequency = 2 events
Duration = 2-3 days

Key Indicators:
Riparian: Green Ash / Box Elder

Key Indicators: Riparian - Sycamore
Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-5 days

Magnitude = 4,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) **Key Indicators: Aquatic Habitat, Water Quality**

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
Base Wet	429	429	413	427	487	489	489	380	422	459	511	466
Base Average	292	296	288	261	281	249	200	177	218	242	244	251
Base Dry	152	158	147	142	145	125	103	96	141	105	119	127

SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat **Key Indicators: Water Quality, Aquatic Habitat**

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80

BBEST – Falls City Recommendations

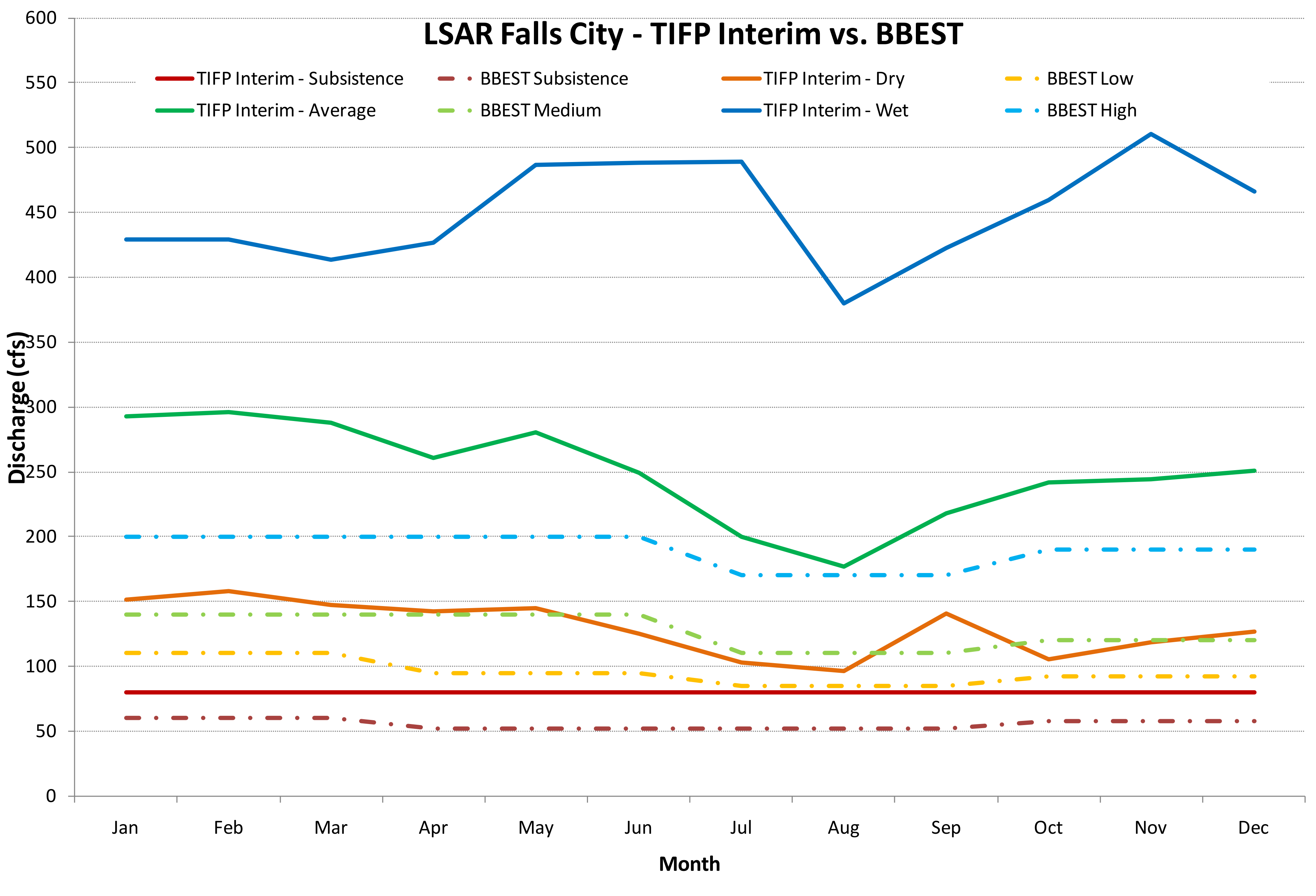
Table 6.1-13. – Environmental Flow Regime Recommendation, San Antonio River near Falls City

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 10,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 110,000 Duration Bound is 57			
Overbank Flows	Qp: 6,000 cfs with Average Frequency 1 per 2 years Regressed Volume is 56,500 Duration Bound is 41			
High Flow Pulses	Qp: 3,160 cfs with Average Frequency 1 per year Regressed Volume is 26,600 Duration Bound is 29			
High Flow Pulses	Qp: 830 cfs with Average Frequency 1 per season Regressed Volume is 6,330 Duration Bound is 16	Qp: 1,670 cfs with Average Frequency 1 per season Regressed Volume is 12,300 Duration Bound is 19	Qp: 1,030 cfs with Average Frequency 1 per season Regressed Volume is 6,440 Duration Bound is 14	Qp: 850 cfs with Average Frequency 1 per season Regressed Volume is 5,690 Duration Bound is 14
High Flow Pulses	Qp: 420 cfs with Average Frequency 2 per season Regressed Volume is 2,740 Duration Bound is 10	Qp: 840 cfs with Average Frequency 2 per season Regressed Volume is 5,630 Duration Bound is 13	Qp: 470 cfs with Average Frequency 2 per season Regressed Volume is 2,650 Duration Bound is 10	Qp: 440 cfs with Average Frequency 2 per season Regressed Volume is 2,520 Duration Bound is 9
Base Flows (cfs)	200	200	170	190
Base Flows (cfs)	140	140	110	120
Base Flows (cfs)	110	95	85	92
Subsistence Flows (cfs)	60	52	52	58

Notes:

1. Period of Record used : 1/1/1926 to 12/31/1969.
2. Volumes are in acre-feet and durations are in days.

LSAR – Falls City



TIFP - Elmendorf Recommendations

ELMENDORF

Overbank Flow

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 8,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 75% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indicators: Cottonwood

Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indicators:
Riparian: Green Ash / Box Elder

Magnitude = 3,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability)								**Key Indicators: Aquatic Habitat, Water Quality**				
Base Wet	319	336	329	338	372	382	384	303	336	357	390	355
Base Average	264	268	256	235	259	216	177	160	195	220	226	225
Base Dry	119	113	114	109	113	98	90	90	107	90	91	101
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat									**Key Indicators: Water Quality, Aquatic Habitat**			
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80
MONTH	January	February	March	April	May	June	July	August	September	October	November	December

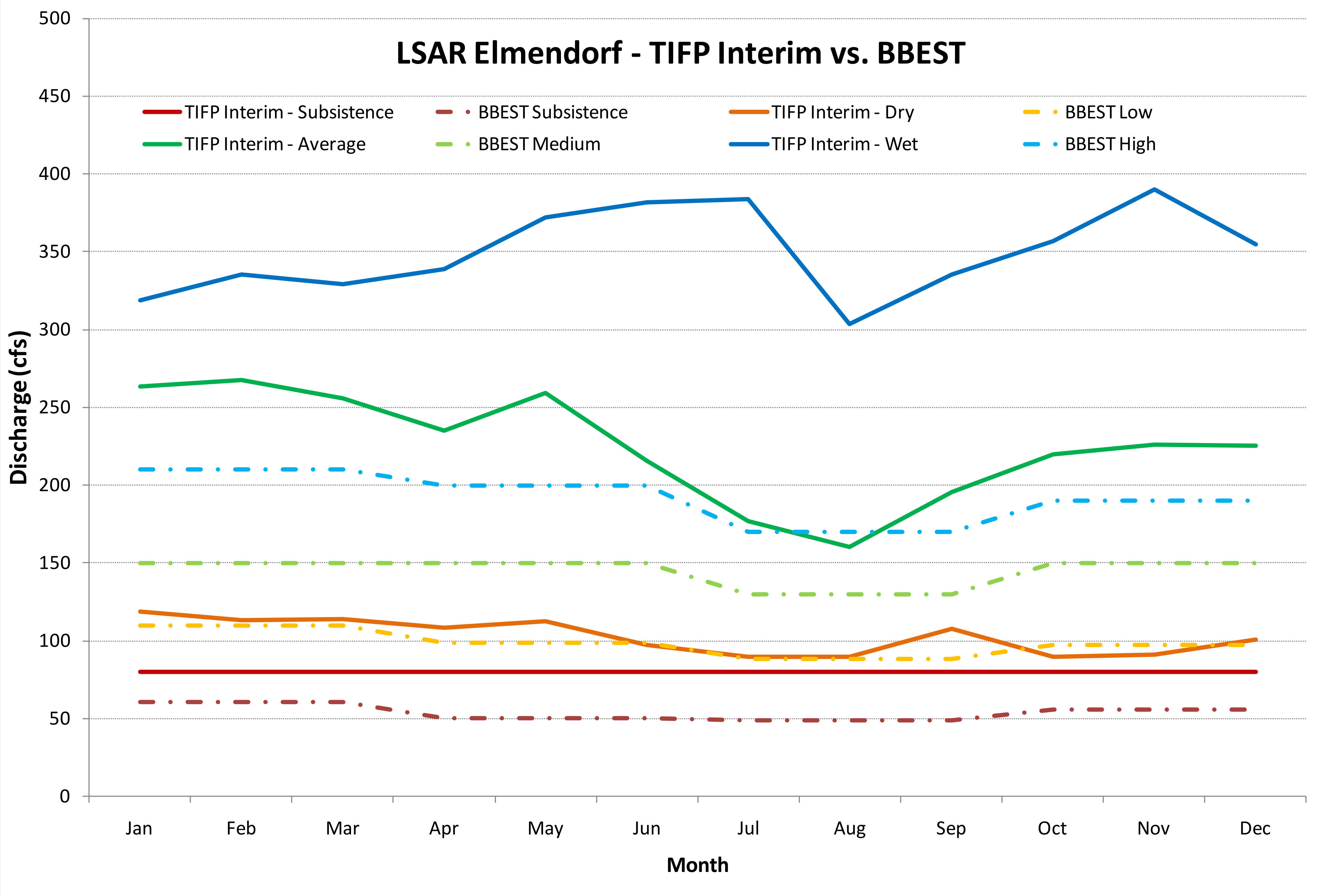
BBEST – Elmendorf Recommendations

Table 6.1-12. – Environmental Flow Regime Recommendation, San Antonio River near Elmendorf

	Jan / Feb / Mar (Winter)	Apr / May / Jun (Spring)	Jul / Aug / Sep (Summer)	Oct / Nov / Dec (Fall)
Overbank Flows	Qp: 12,200 cfs with Average Frequency 1 per 5 years Regressed Volume is 123,000 Duration Bound is 52			
High Flow Pulses	Qp: 5,640 cfs with Average Frequency 1 per 2 years Regressed Volume is 49,400 Duration Bound is 34			
High Flow Pulses	Qp: 3,310 cfs with Average Frequency 1 per year Regressed Volume is 26,400 Duration Bound is 25			
High Flow Pulses	Qp: 830 cfs with Average Frequency 1 per season Regressed Volume is 6,210 Duration Bound is 14	Qp: 1,560 cfs with Average Frequency 1 per season Regressed Volume is 10,700 Duration Bound is 16	Qp: 1,110 cfs with Average Frequency 1 per season Regressed Volume is 6,460 Duration Bound is 12	Qp: 1,010 cfs with Average Frequency 1 per season Regressed Volume is 6,570 Duration Bound is 13
High Flow Pulses	Qp: 440 cfs with Average Frequency 2 per season Regressed Volume is 2,940 Duration Bound is 10	Qp: 820 cfs with Average Frequency 2 per season Regressed Volume is 5,060 Duration Bound is 11	Qp: 540 cfs with Average Frequency 2 per season Regressed Volume is 2,870 Duration Bound is 9	Qp: 480 cfs with Average Frequency 2 per season Regressed Volume is 2,630 Duration Bound is 8
Base Flows (cfs)	210	200	170	190
Base Flows (cfs)	150	150	130	150
Base Flows (cfs)	110	99	88	97
Subsistence Flows (cfs)	61	50	49	56

Notes:
1. Period of Record used : 1/1/1934 to 12/31/1969.
2. Volumes are in acre-feet and durations are in days.

LSAR - Elmendorf



TIFP - Cibolo Creek Recommendations

CIBOLO CREEK

Overbank Flow		Magnitude = 8,000 cfs Frequency = 1 event Duration = 2 days *Key Indicators:* *Riparian: Inundates approx. 90% of hardwood forest community* *Sediment transport: Channel maintenance*										
		Magnitude = 5,000 cfs Frequency = 1 event Duration = 2 days *Key Indicators:* *Riparian: Inundates approx. 75% of hardwood forest community* *Sediment transport: Channel maintenance*										
High Flow Pulses							Magnitude = 2,500 cfs Frequency = 2 events Duration = 2-3 days *Key Indicators:* *Riparian: Green Ash / Box Elder*					
				Magnitude = 1,000 cfs Frequency = 3 events Duration = 2-5 days *Key Indicators: Riparian - Black Willow*			Magnitude = 1,000 cfs Frequency = 2 events Duration = 2-3 days *Key Indictors: Riparian - Buttonbush*					
BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability)							**Key Indicators: Aquatic Habitat, Water Quality**					
Base Wet	39	41	38	38	48	45	44	31	35	35	43	42
Base Average	29	28	27	26	29	28	21	17	20	23	25	25
Base Dry	19	20	19	18	17	14	11	9	12	13	13	15
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat								**Key Indicators: Water Quality, Aquatic Habitat**				
Subsistence	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
MONTH	January	February	March	April	May	June	July	August	September	October	November	December

BBEST – Cibolo Creek

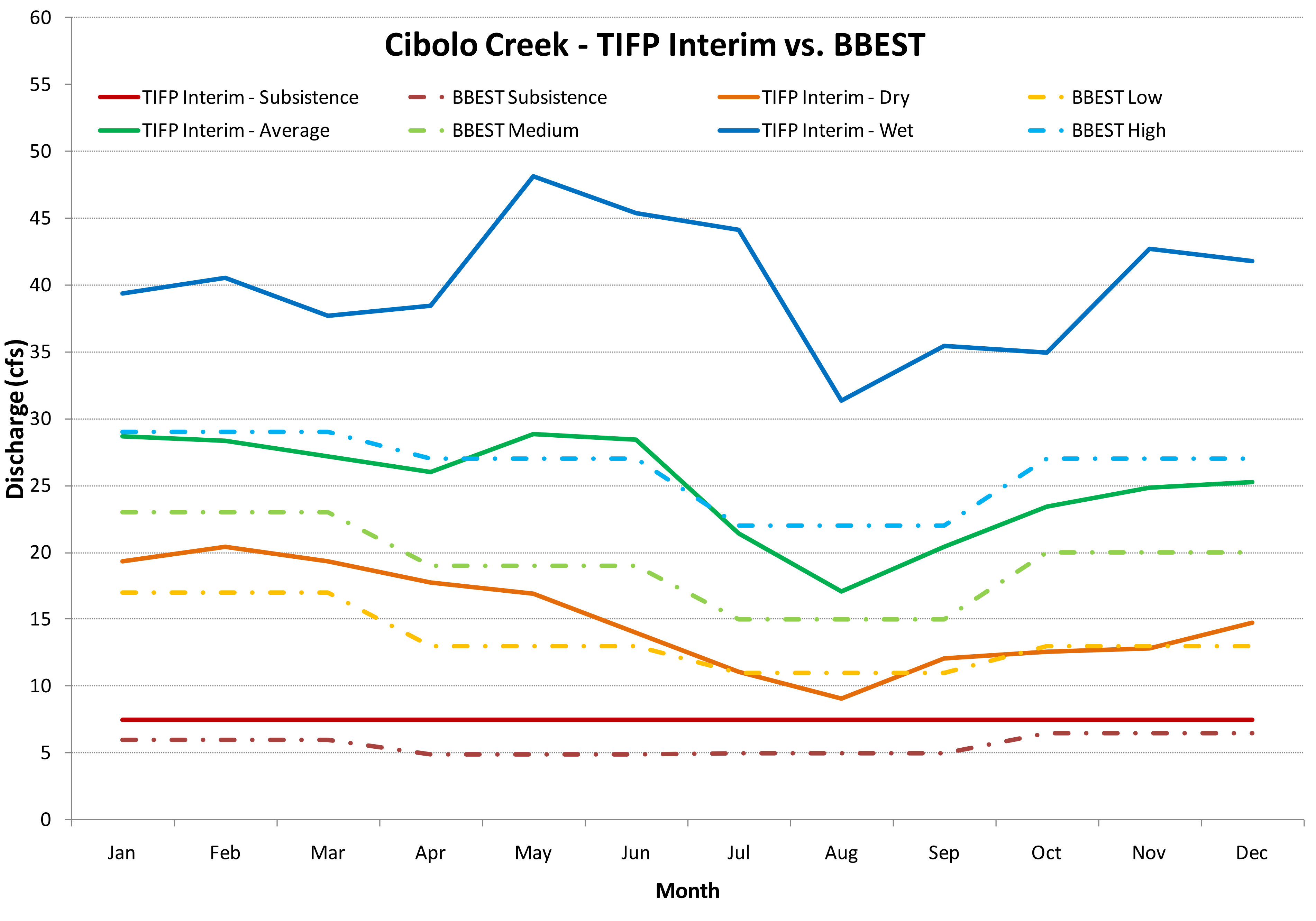
Table 6.1-14. – Environmental Flow Regime Recommendation, Cibolo Creek near Falls City

Overbank Flows	Qp: 13,500 cfs with Average Frequency 1 per 5 years Regressed Volume is 62,800 Duration Bound is 42			
	Qp: 7,220 cfs with Average Frequency 1 per 2 years Regressed Volume is 34,200 Duration Bound is 35			
	Qp: 5,160 cfs with Average Frequency 1 per year Regressed Volume is 24,700 Duration Bound is 32			
High Flow Pulses	Qp: 570 cfs with Average Frequency 1 per season Regressed Volume is 3,200 Duration Bound is 20	Qp: 2,280* cfs with Average Frequency 1 per season Regressed Volume is 10,400 Duration Bound is 21	Qp: 390 cfs with Average Frequency 1 per season Regressed Volume is 1,990 Duration Bound is 15	Qp: 1,000* cfs with Average Frequency 1 per season Regressed Volume is 5,000 Duration Bound is 22
	Qp: 140 cfs with Average Frequency 2 per season Regressed Volume is 820 Duration Bound is 13	Qp: 670 cfs with Average Frequency 2 per season Regressed Volume is 3,230 Duration Bound is 16	Qp: 110 cfs with Average Frequency 2 per season Regressed Volume is 580 Duration Bound is 10	Qp: 190 cfs with Average Frequency 2 per season Regressed Volume is 1,000 Duration Bound is 13
Base Flows (cfs)	29	27	22	27
	23	19	15	20
	17	13	11	13
Subsistence Flows (cfs)	6.0	4.9	5.0	6.5
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

Notes:

1. Period of Record used : 1/1/1931 to 12/31/2009.
2. Volumes are in acre-feet and durations are in days.
3. * values are estimated to be overbank.

Cibolo Creek



Evaluation of Aquatic Habitat Relationships in the Guadalupe River at the Gonzales and Victoria Study Sites

Dr. Thomas B. Hardy
Chief Science Officer
River Systems Institute
Texas State University

7/7/2011

Objectives

- Provide a comparison of the GSA and LSAR habitat suitability curves
- Conduct Supplemental evaluations of the habitat versus discharge relationships in the Guadalupe River at Gonzales and Victoria study sites
- Examine the relationship between habitat quantity and quality
- Provide insights on the implication of the analyses and findings

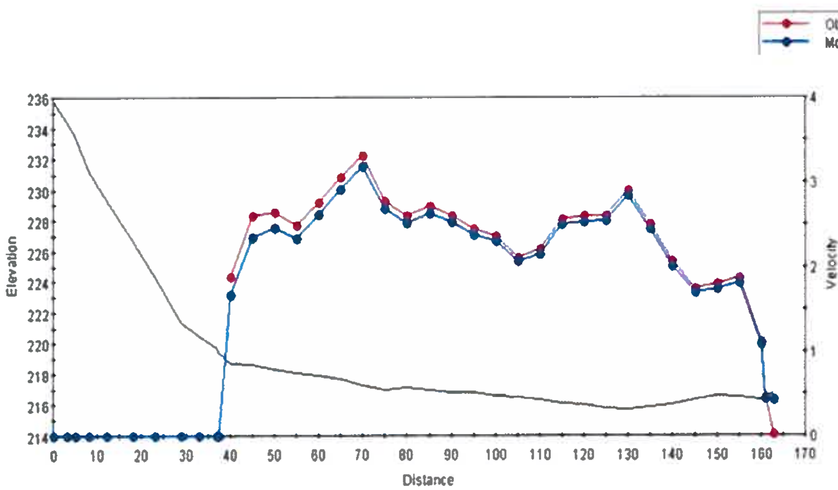
Reevaluated Hydraulic Models

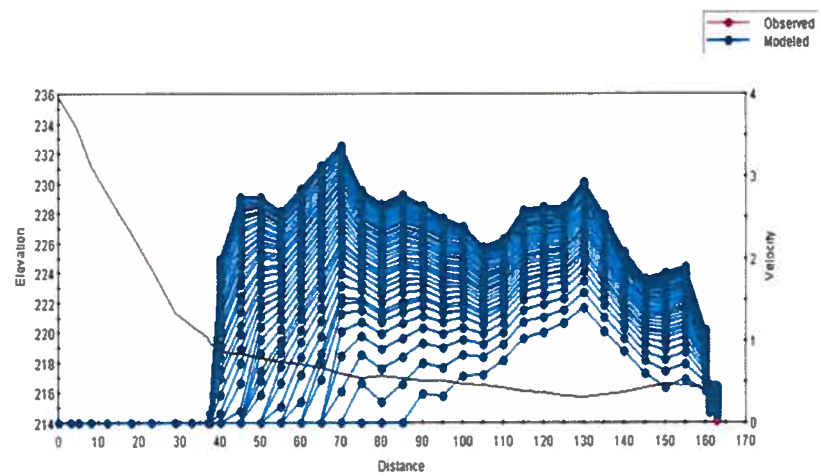
Gonzales		Victoria	
Xsec	MesoHabitat	Xsec	MesoHabitat
1	Run	1	Transition from pool to fast run
2	Fast Run	2	Deep Pool
3	Riffle	3	Deep Pool
4	Shallow Run	4	Run
5	Slow Run	5	Run
6	Shallow Run	6	Run
7	Run	7	Pool
8	Pool	8	Run
9	Pool	9	Run
10	Run	10	Shallow Pool / Slow Run
11	Woody Run	11	Riffle
12	Slow Deep Run	12	Riffle
13	Fast Run	13	Run
14	Fast Run	14	Deep Pool
		15	Fast R w/ Side Pool and Channel
		16	Riffle

Water Surface Modeling

	Gonzales - Calibration Flows (cfs)			Victoria	Victoria - Calibration Flows (cfs)		
	337.59	190.6	936.2		567.8	267.75	1473.4
XSec	WSL-Error (feet)	WSL-Error (feet)	WSL-Error (feet)	XSec	WSL-Error (feet)	WSL-Error (feet)	WSL-Error (feet)
1	0.00	0.00	0.00	1	0.00	0.00	0.00
2	0.00	-0.03	0.04	2	0.00	0.03	-0.16
3	-0.01	-0.07	0.19	3	0.01	0.03	-0.14
4	0.00	-0.02	0.06	4	0.00	0.24	-0.03
5	0.00	0.01	0.05	5	0.01	0.21	-0.02
6	0.00	-0.01	0.11	6	0.02	0.25	0.09
7	0.00	0.04	0.03	7	0.01	0.19	0.08
8	-0.01	0.04	-0.07	8	0.00	0.08	0.42
9	0.00	0.01	0.03	9	0.00	0.15	0.09
10	0.00	0.02	0.02	10	0.00	0.12	-0.06
11	0.01	0.10	-0.09	11	0.00	-0.09	0.09
12	0.00	0.08	-0.06	12	0.00	-0.10	0.03
13	0.00	0.09	-0.06	13	0.00	0.19	0.14
14	0.00	0.10	0.10	14	0.00	0.15	-0.08
				15	0.00	0.02	-0.63
				16	0.00	0.04	-0.10

Velocity Modeling





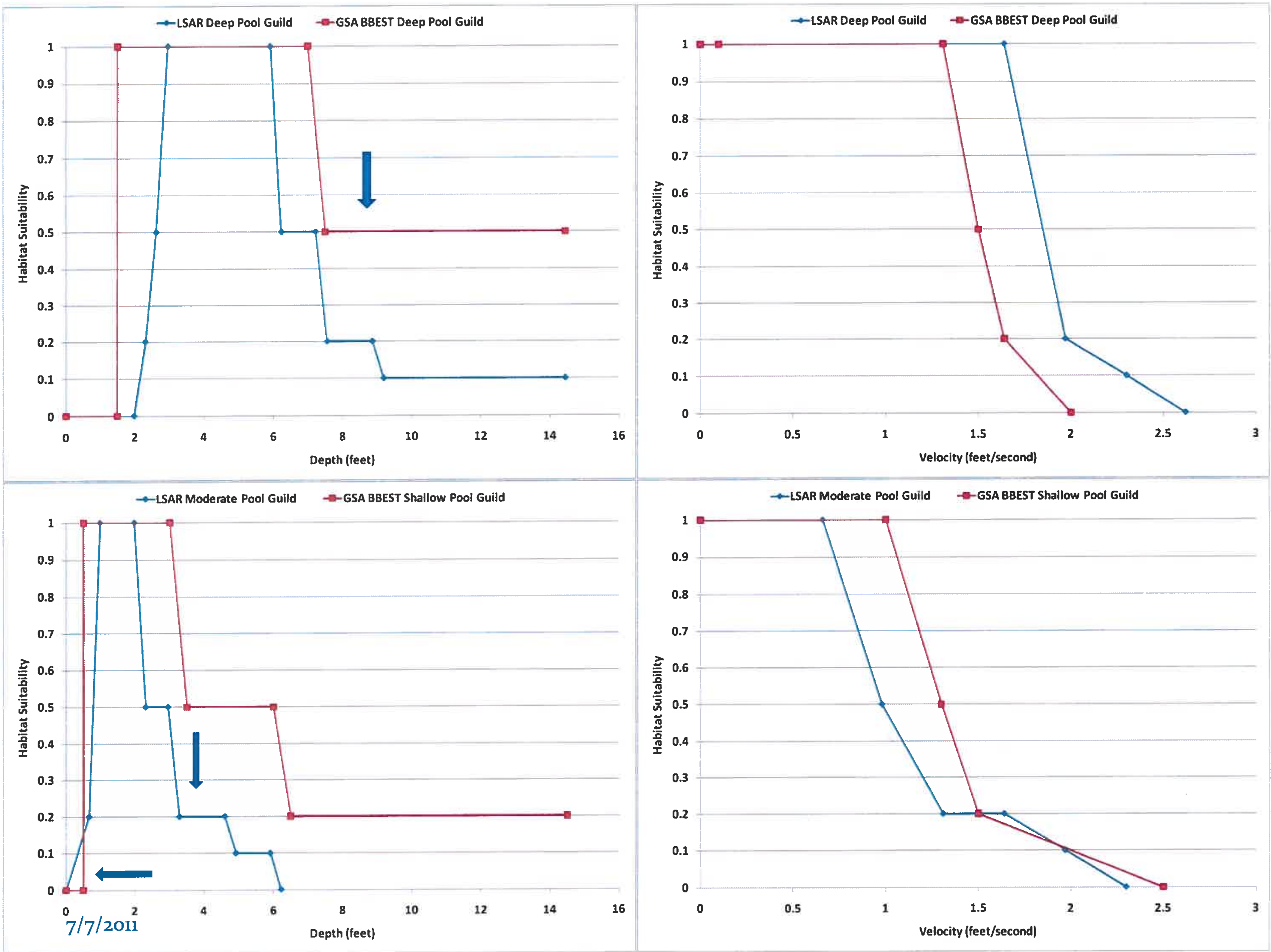
GSA versus LSAR Guilds

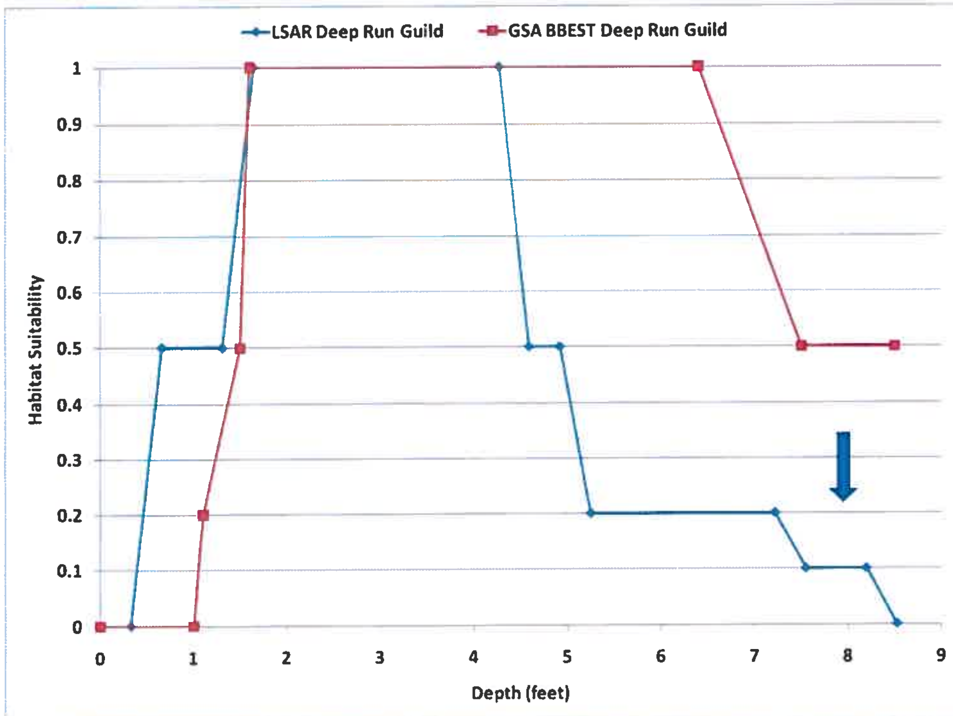
- Differences in Habitat Guild definitions are inconsequential when results are viewed in their totality (i.e., all guilds are considered concurrently)
- Differences in GSA and LSAR guilds are typical of differences based on site specific versus regional curves

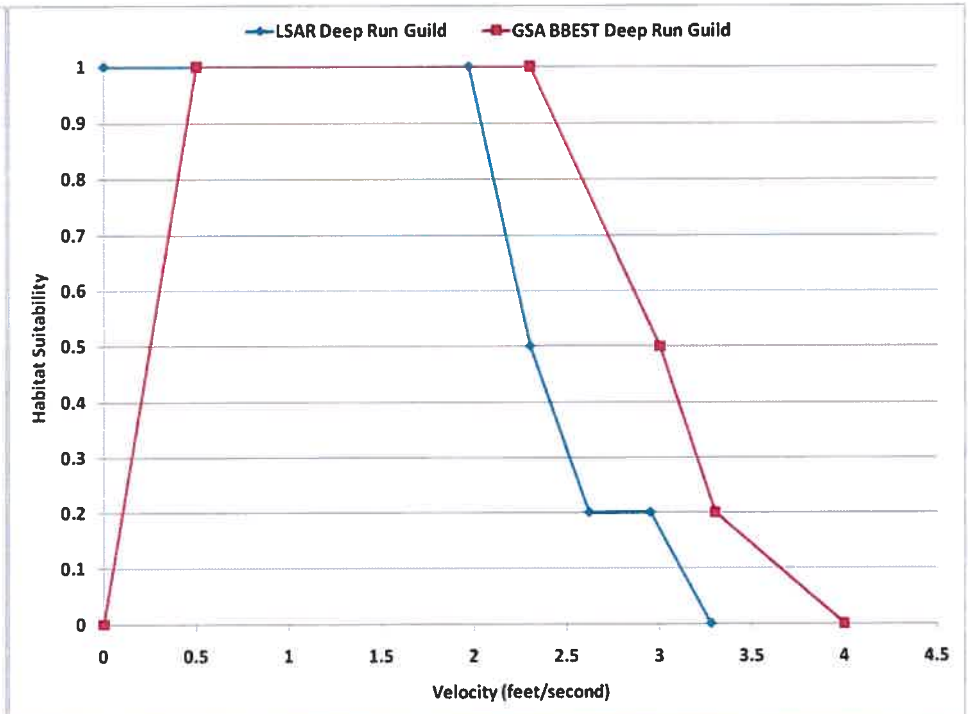
LSAR	GSA BBEST
Deep Pool	Deep Pool
Mod Pool	Shallow Pool
Back Water	n/a
Deep Run	Deep Run
Shallow Run	Shallow Run
Riffle	Shallow Riffle

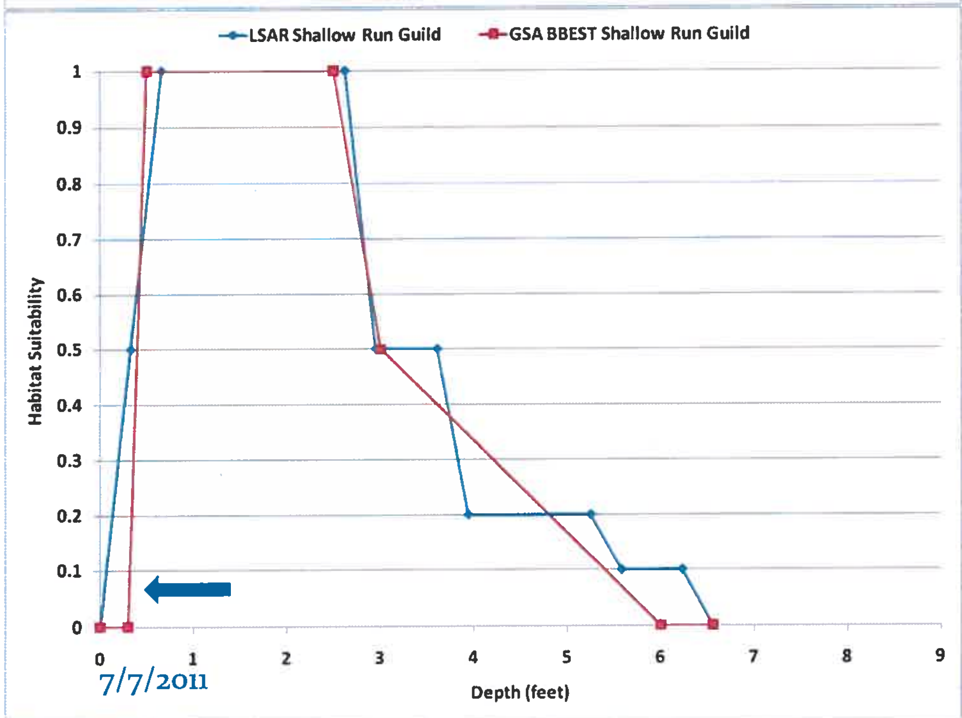
GSA and LSAR habitat suitability curves

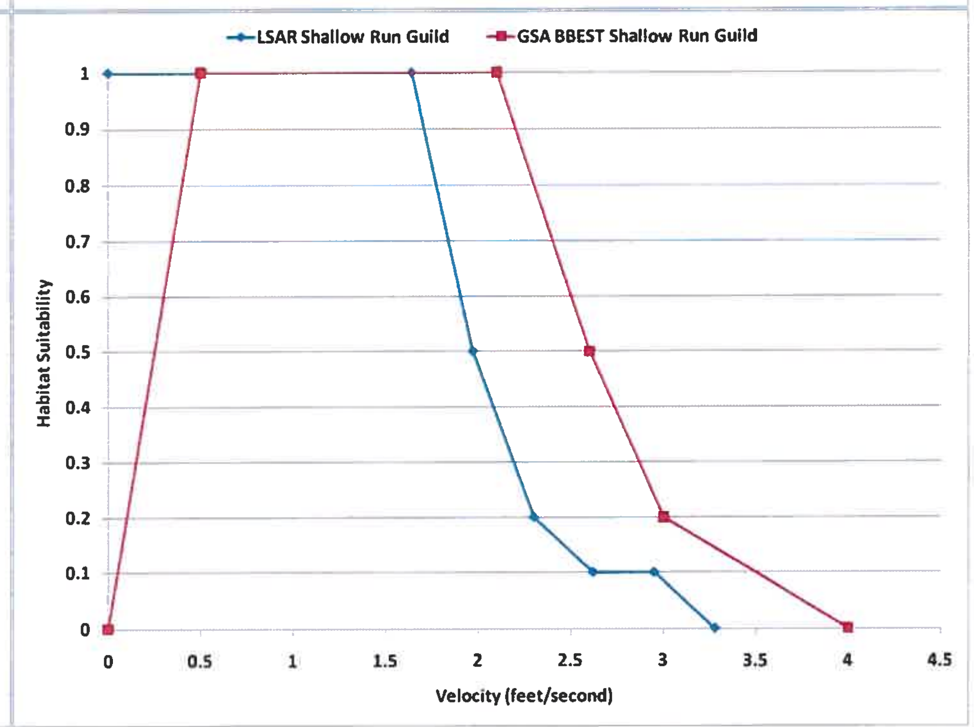
- Both curve sets are based on field observations of fish utilization of depth, velocity and substrate
  - GSA curves are derived from collections throughout river systems in Texas
  - LSAR curves are derived from collections in the San Antonio River and Cibolo Creek
- Both curve sets represent envelope curves of each guild type
- Choice of species within each guild IS NOT the primary factor in their differences
- Development of both curve sets involve an overlay of professional judgment
- Differences in Habitat Guild definitions are inconsequential when results are viewed in their totality (i.e., all guilds are considered concurrently)
- Differences in GSA and LSAR guilds are typical of differences based on site specific versus regional curves

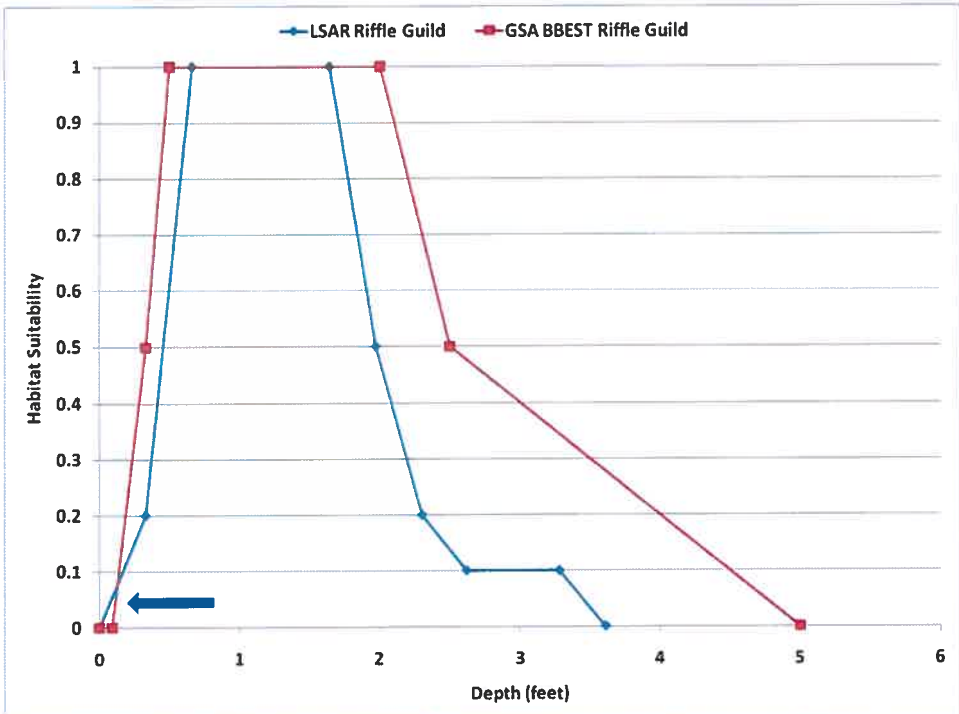

LSAR Deep Pool Guild
GSA BBEST Deep Pool Guild
Habitat Suitability
Depth (feet)
Velocity (feet/second)
LSAR Moderate Pool Guild
GSA BBEST Shallow Pool Guild
7/7/2011

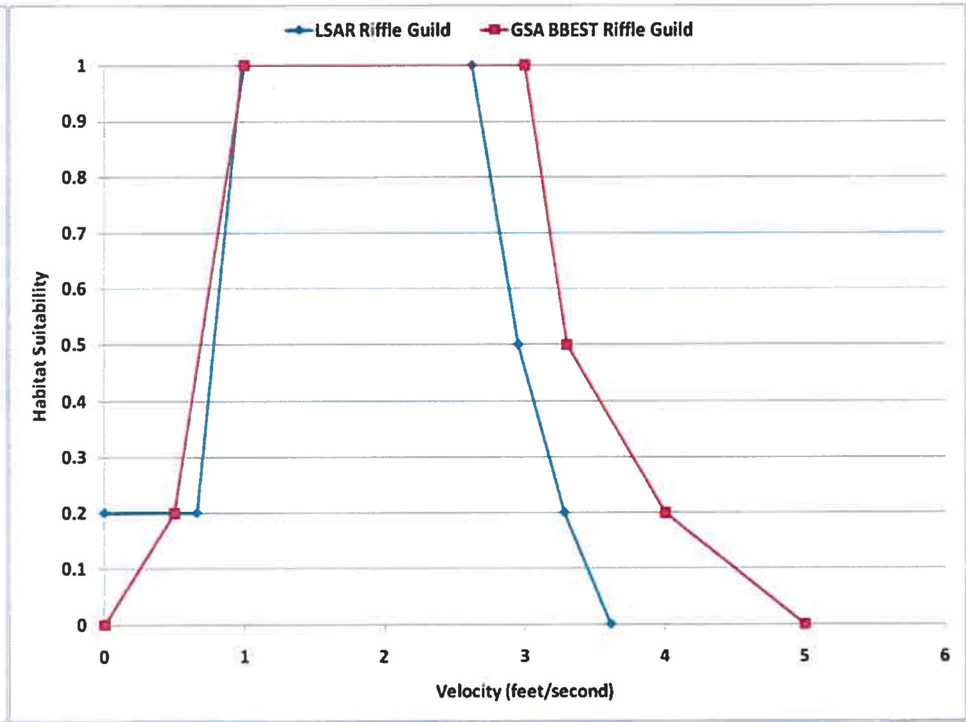

LSAR Deep Run Guild
GSA BBEST Deep Run Guild
Habitat Suitability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 1 2 3 4 5 6 7 8 9
Depth (feet)

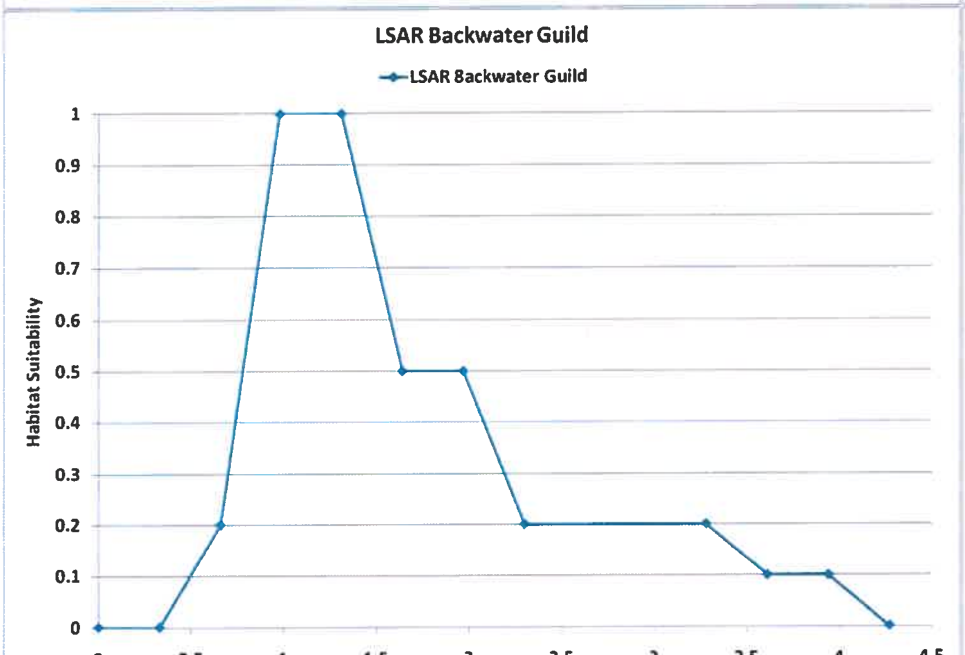

LSAR Deep Run Guild
GSA BBEST Deep Run Guild
Habitat Suitability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5
Velocity (feet/second)

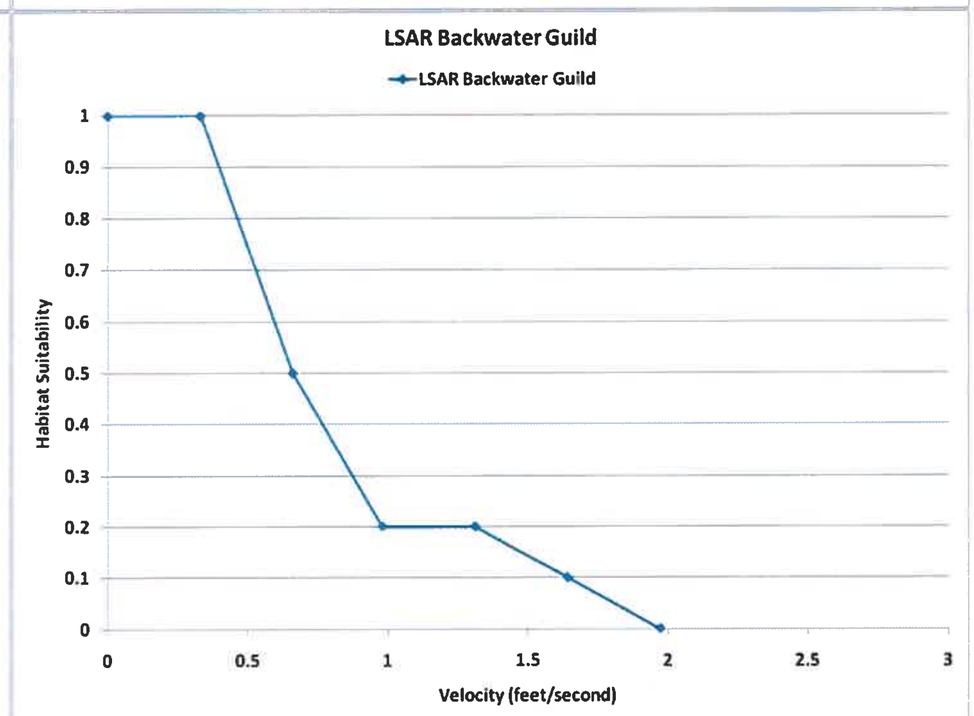

LSAR Shallow Run Guild
GSA BBEST Shallow Run Guild
Habitat Suitability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 1 2 3 4 5 6 7 8 9
Depth (feet)
7/7/2011


LSAR Shallow Run Guild
GSA BBEST Shallow Run Guild
Habitat Suitability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5
Velocity (feet/second)


LSAR Riffle Guild
GSA BBEST Riffle Guild
Habitat Suitability
Depth (feet)

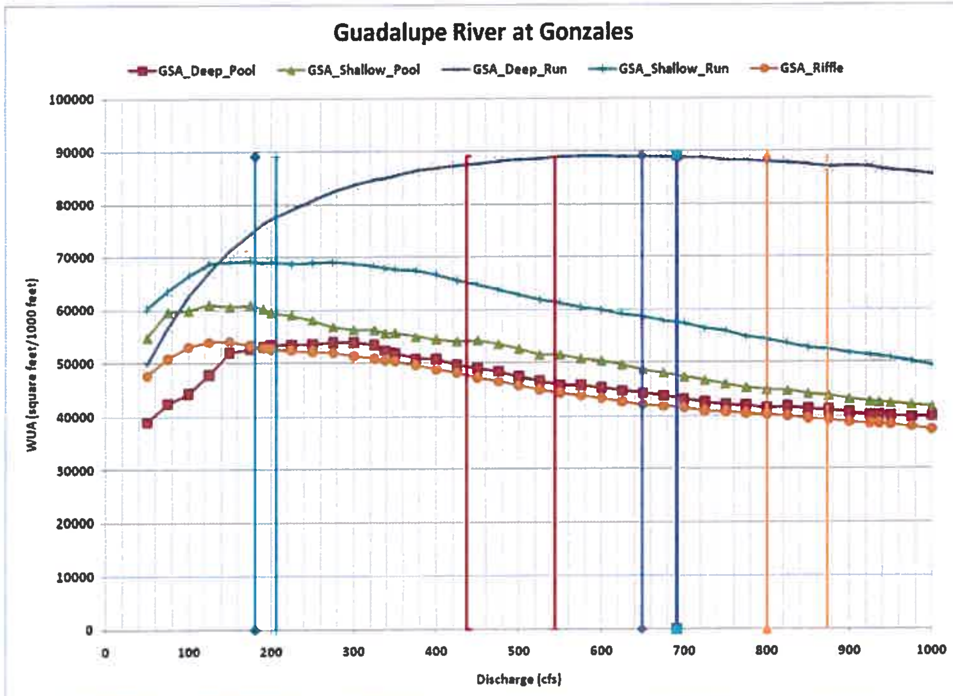

LSAR Riffle Guild
GSA BBEST Riffle Guild
Habitat Suitability
Velocity (feet/second)

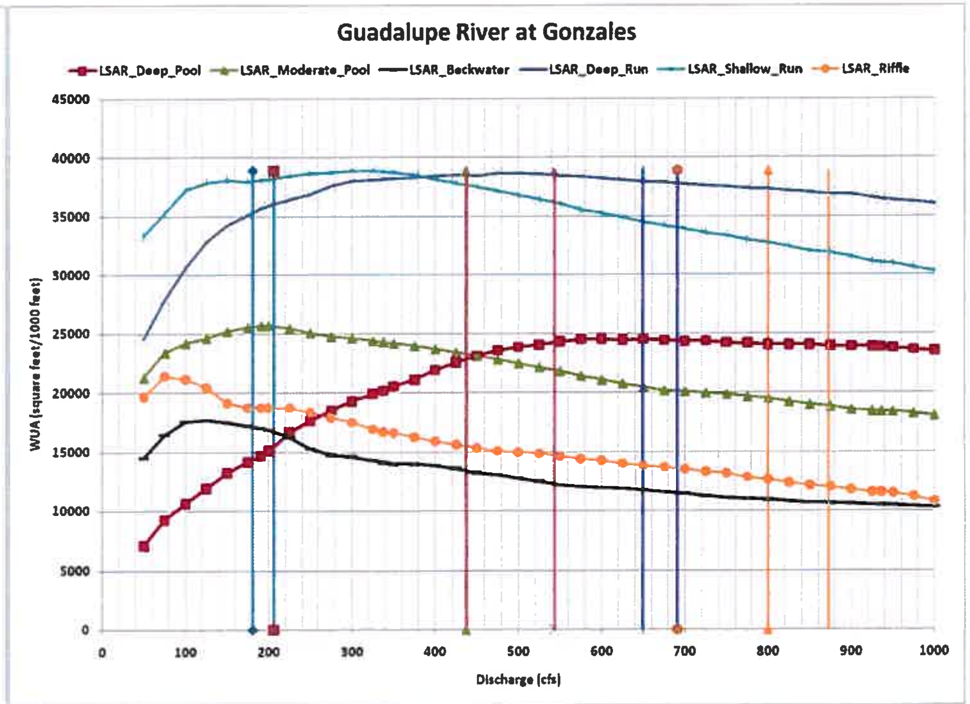

LSAR Backwater Guild
LSAR Backwater Guild
Habitat Suitability
Depth (feet)

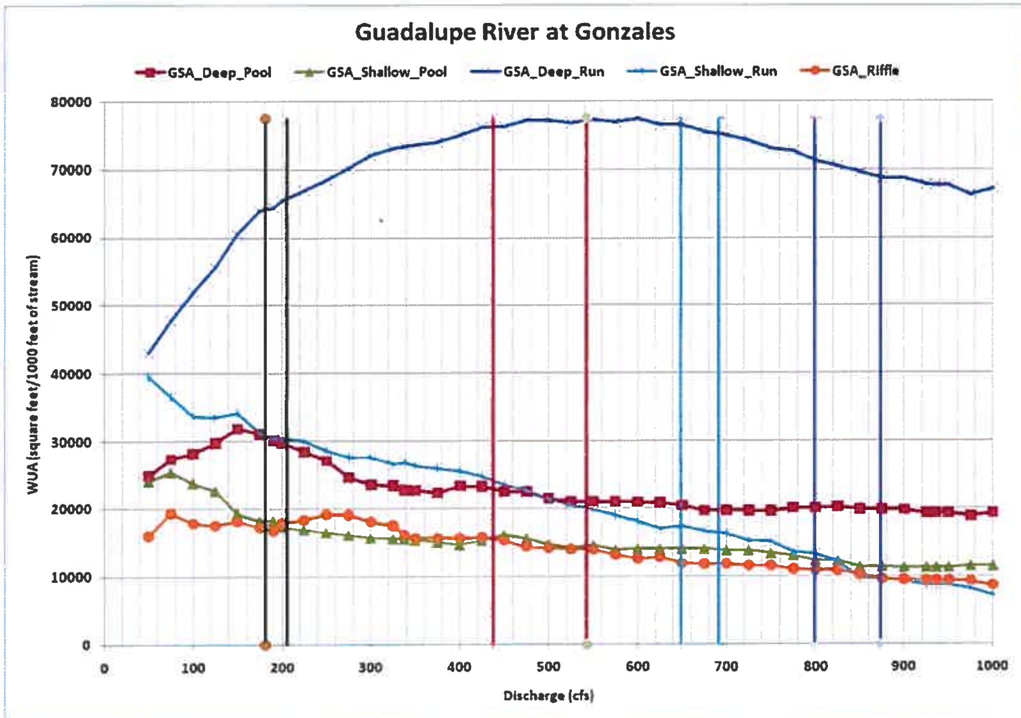

LSAR Backwater Guild
LSAR Backwater Guild
Habitat Suitability
Velocity (feet/second)

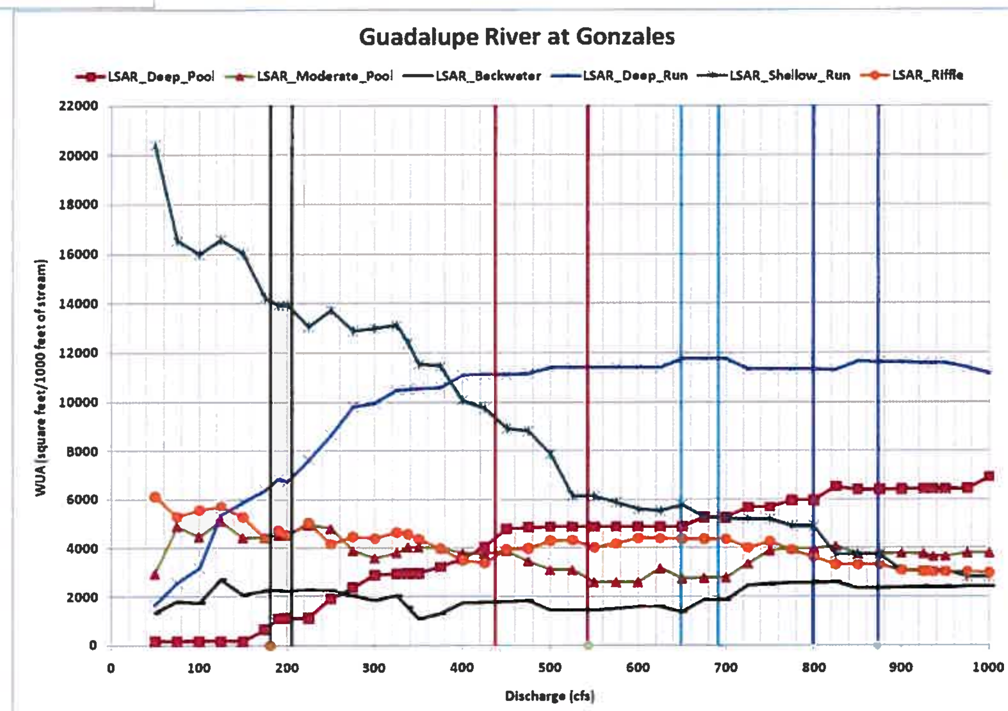
7/7/2011

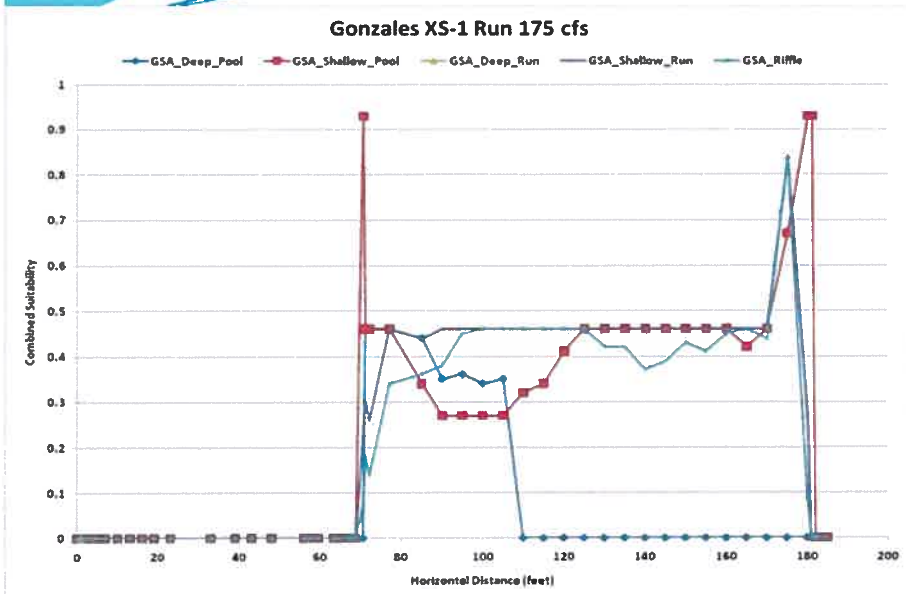
Guadalupe at Gonzales

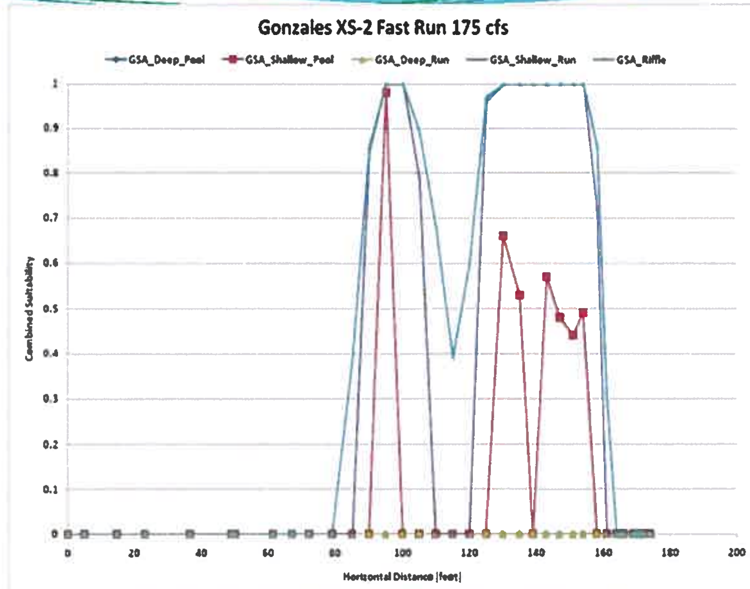


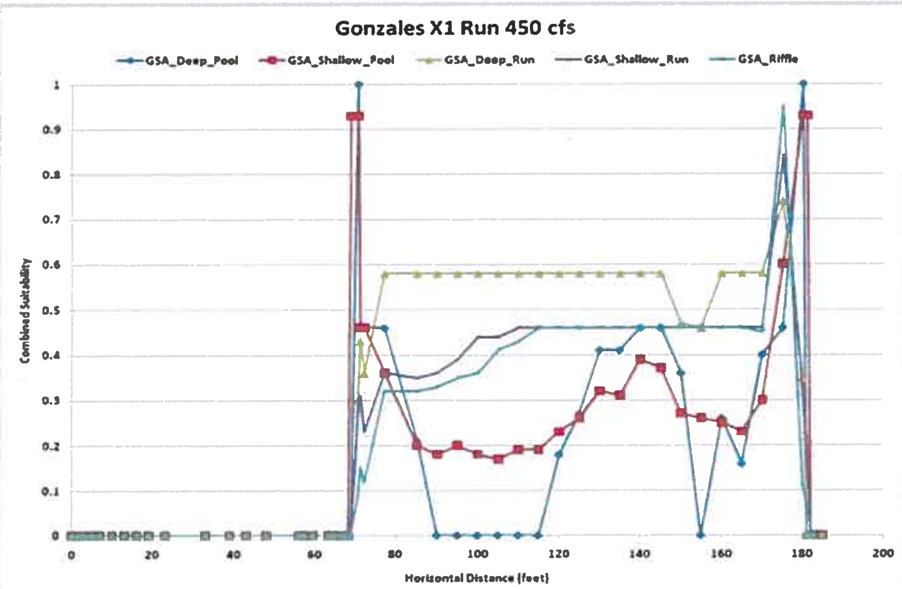


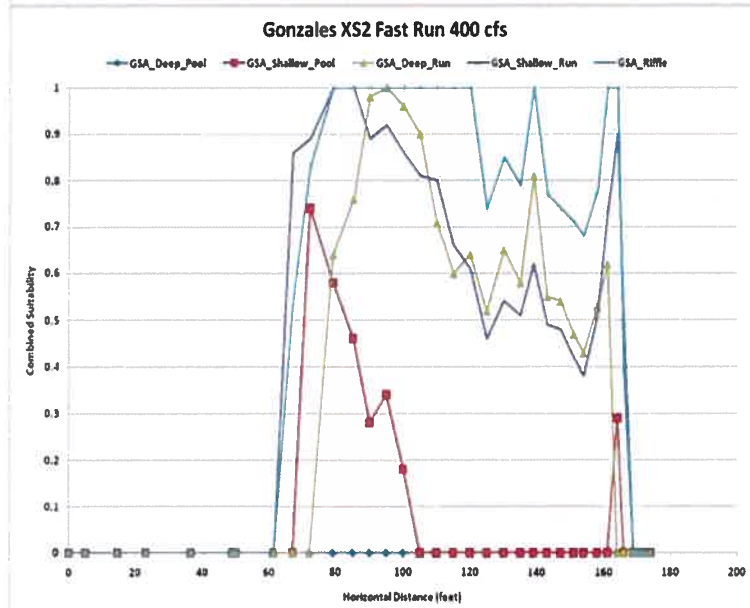

Guadalupe River at Gonzales
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
WUA (square feet/1000 feet of stream)
Discharge (cfs)
80000
70000
60000
50000
40000
30000
20000
10000
0
0
100
200
300
400
500
600
700
800
900
1000


Guadalupe River at Gonzales
LSAR_Deep_Pool
LSAR_Moderate_Pool
LSAR_Backwater
LSAR_Deep_Run
LSAR_Shallow_Run
LSAR_Riffle
WUA (square feet/1000 feet of stream)
Discharge (cfs)
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
100
200
300
400
500
600
700
800
900
1000

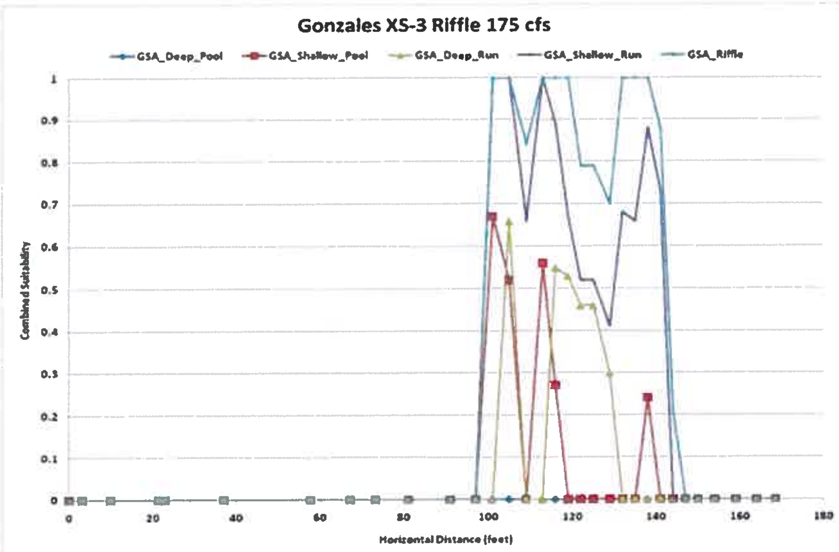

Gonzales XS-1 Run 175 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)

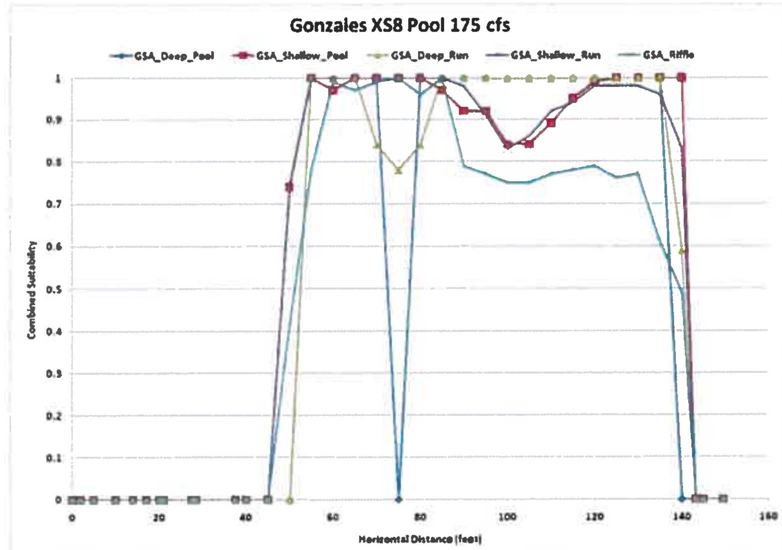

Gonzales XS-2 Fast Run 175 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)

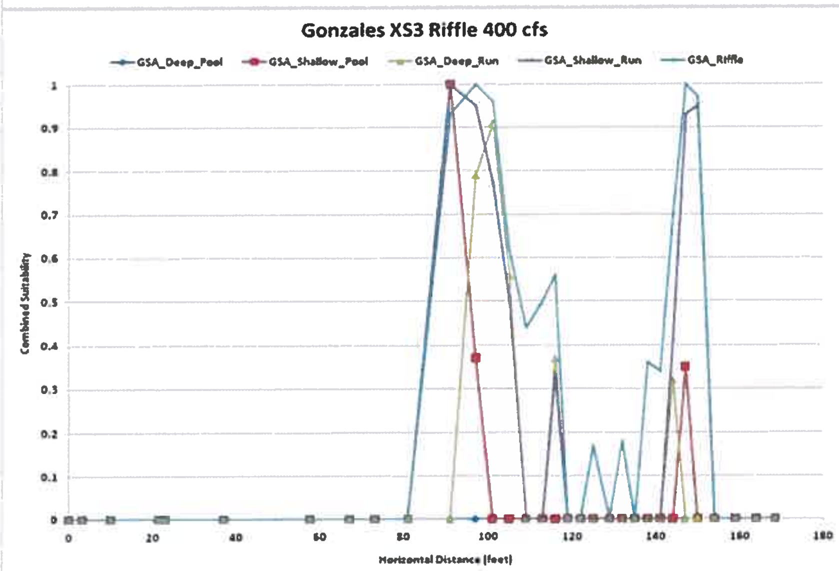

Gonzales X1 Run 450 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)

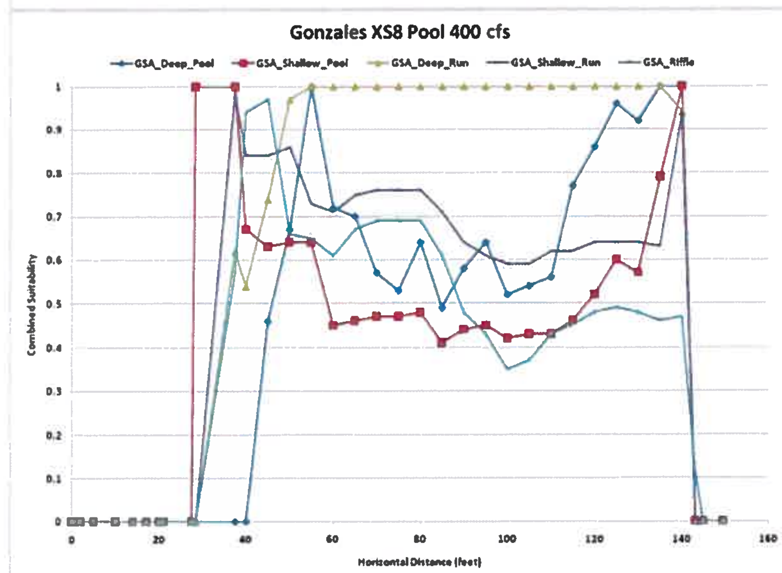

Gonzales XS2 Fast Run 400 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)

7/7/2011

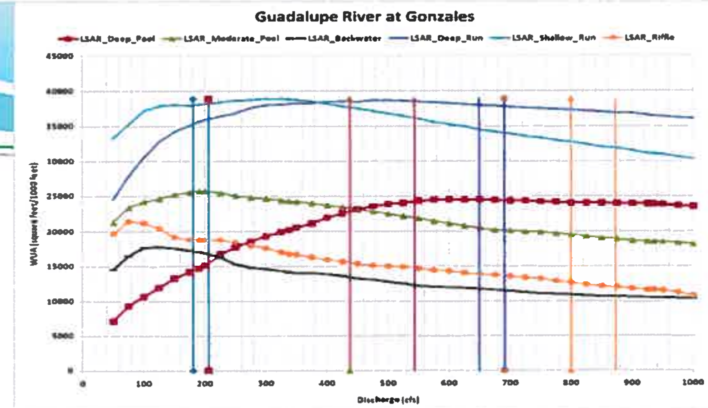

Gonzales XS-3 Riffle 175 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)


Gonzales XS8 Pool 175 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)


Gonzales XS3 Riffle 400 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)

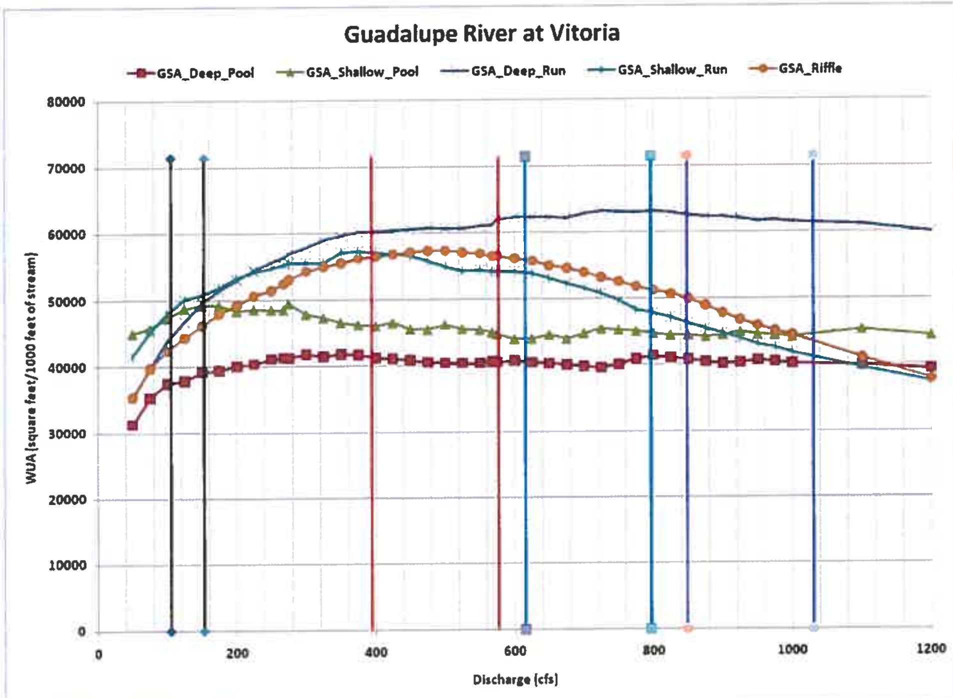

Gonzales XS8 Pool 400 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)

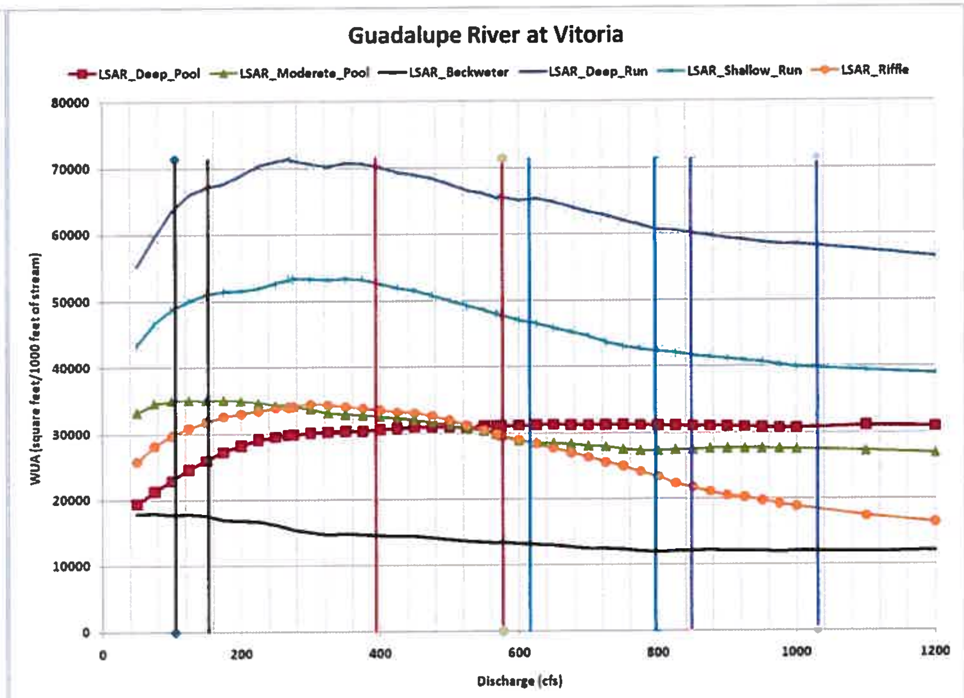
Summary for Gonzales

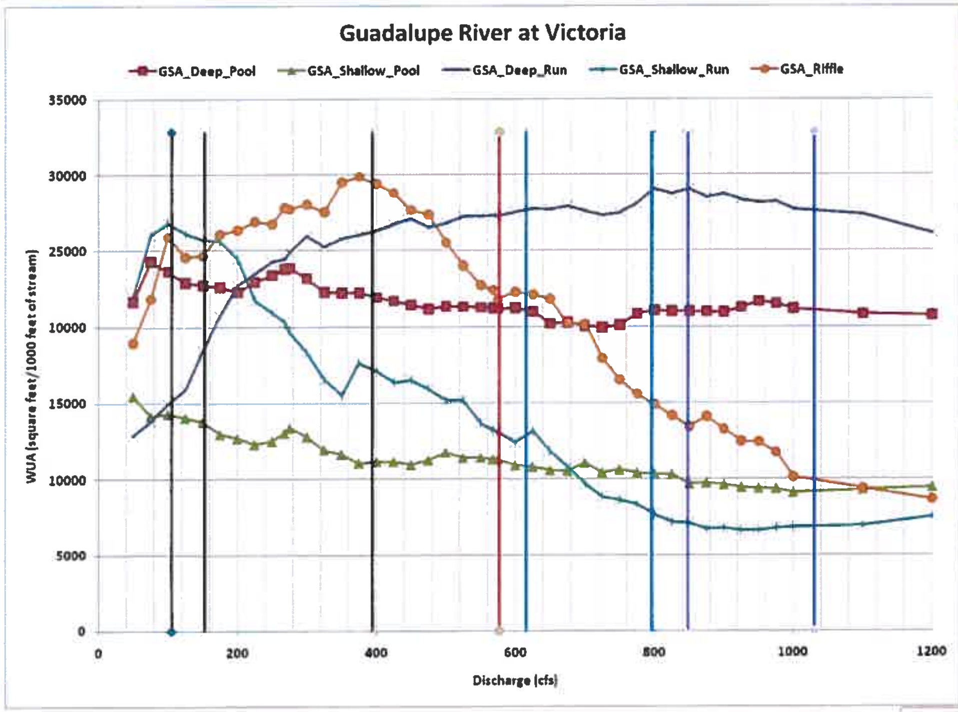


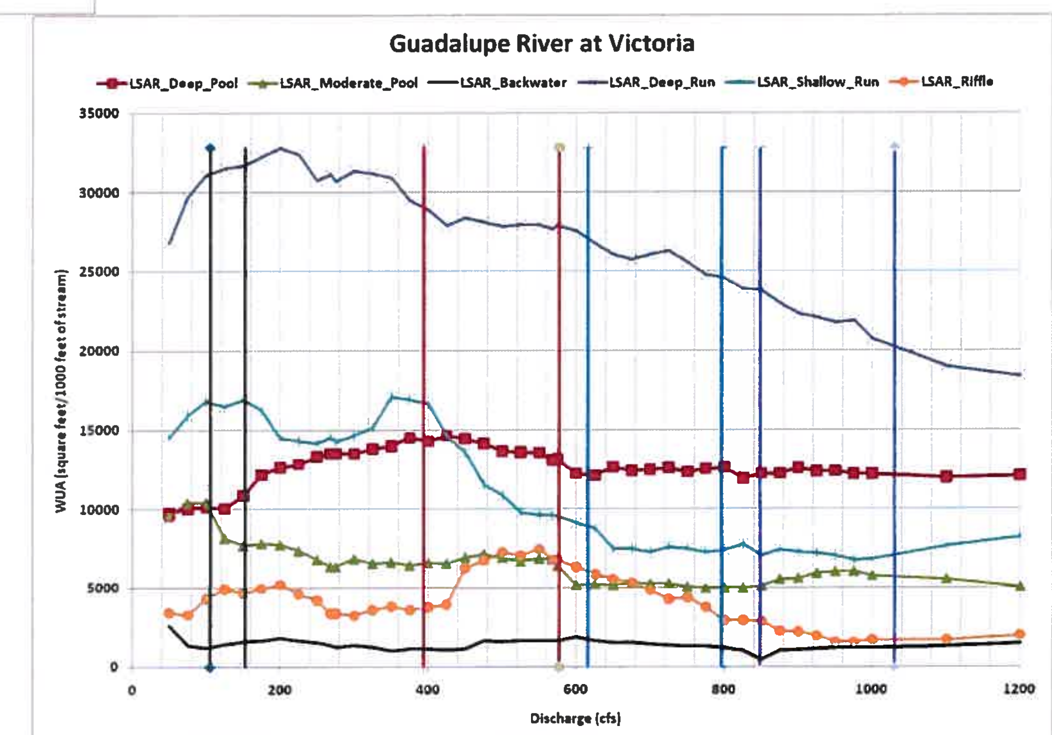
- Some adjustments to the HEFR base flow regime numbers could be considered.
- HEFR Low Base flows might be set at ~400 cfs while the maximum seasonal discharge might be adjusted down to ~500 cfs.
- Similar shifts in the Medium and High Base flow seasonal minimum and maximum could also be considered.
- However, it must be stressed that these analyses do not have the benefit of water quality and temperature simulation overlays
- Large reductions in flows at any of the HEFR Low, Medium or High base regimes based solely on these results are discouraged.
- Any reductions of the seasonal Low, Medium, and High Base flow regimes must also consider the potential implications on the required Bay and Estuary flow regimes.

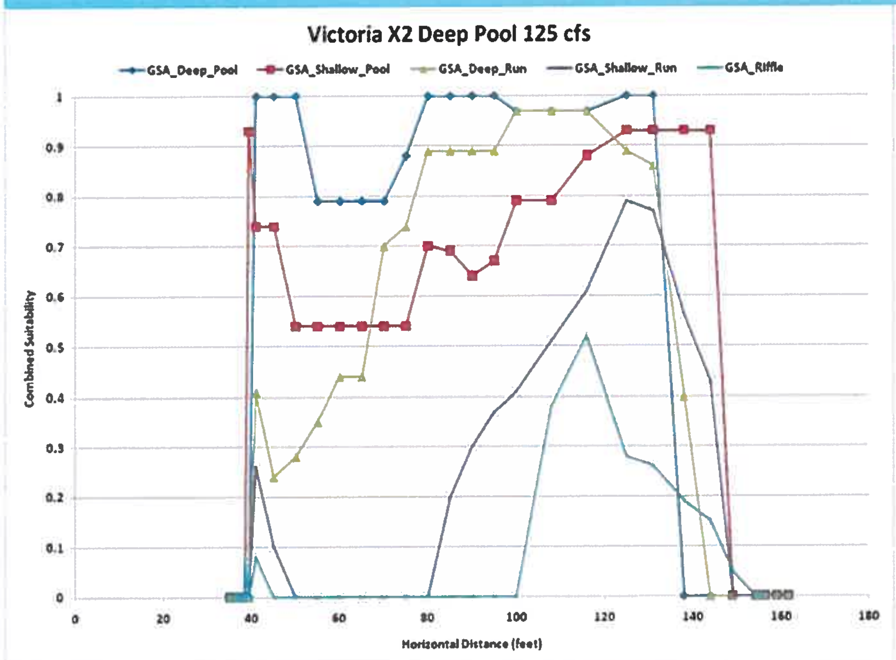
Guadalupe at Victoria

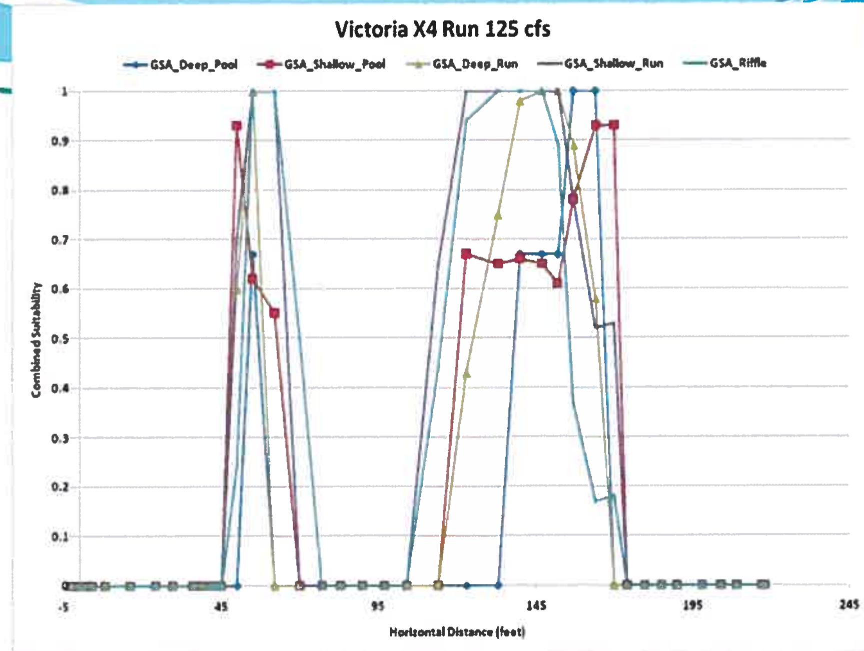


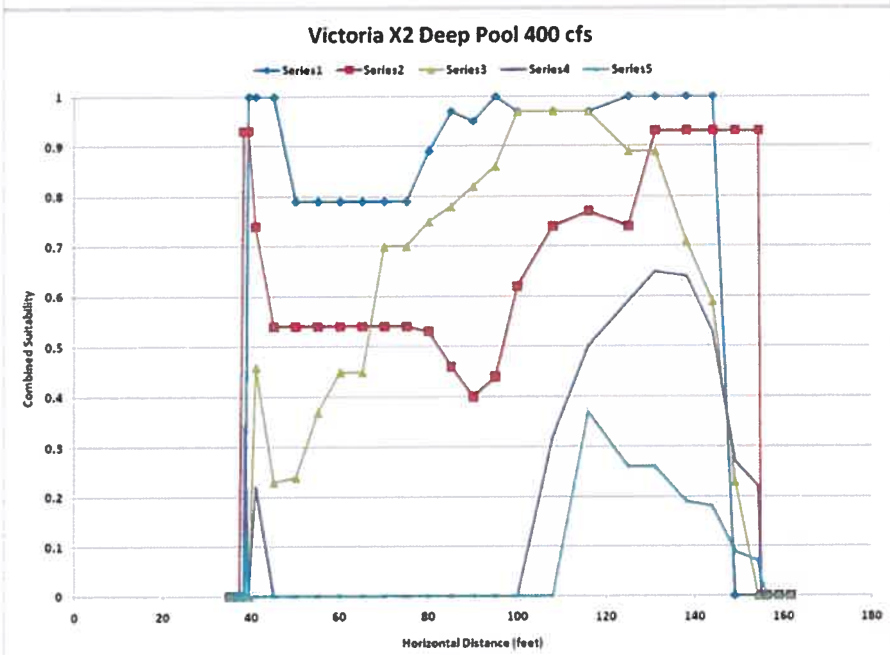


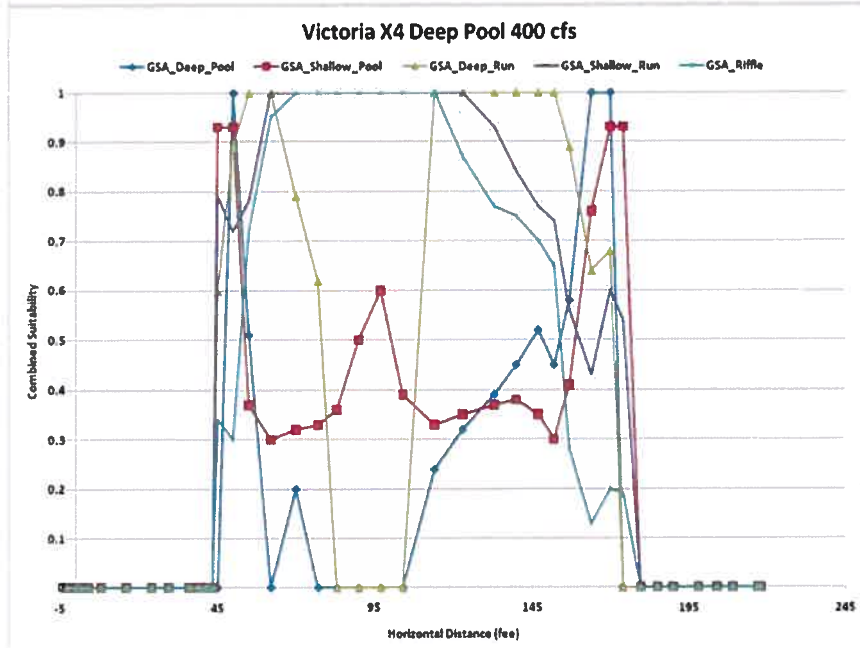

Guadalupe River at Victoria
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
WUA (square feet/1000 feet of stream)
Discharge (cfs)

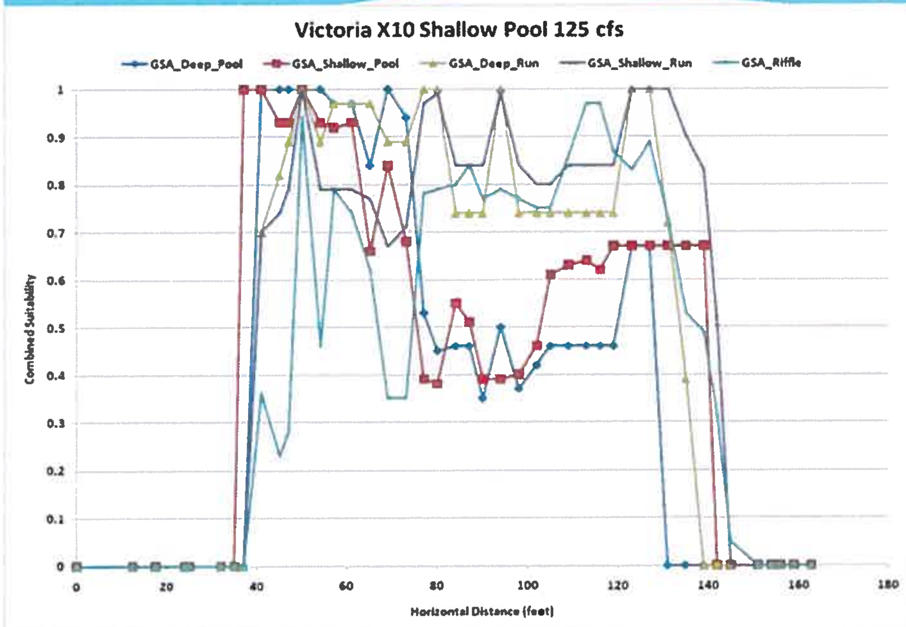

Guadalupe River at Victoria
LSAR_Deep_Pool
LSAR_Moderate_Pool
LSAR_Backwater
LSAR_Deep_Run
LSAR_Shallow_Run
LSAR_Riffle
WUA (square feet/1000 feet of stream)
Discharge (cfs)

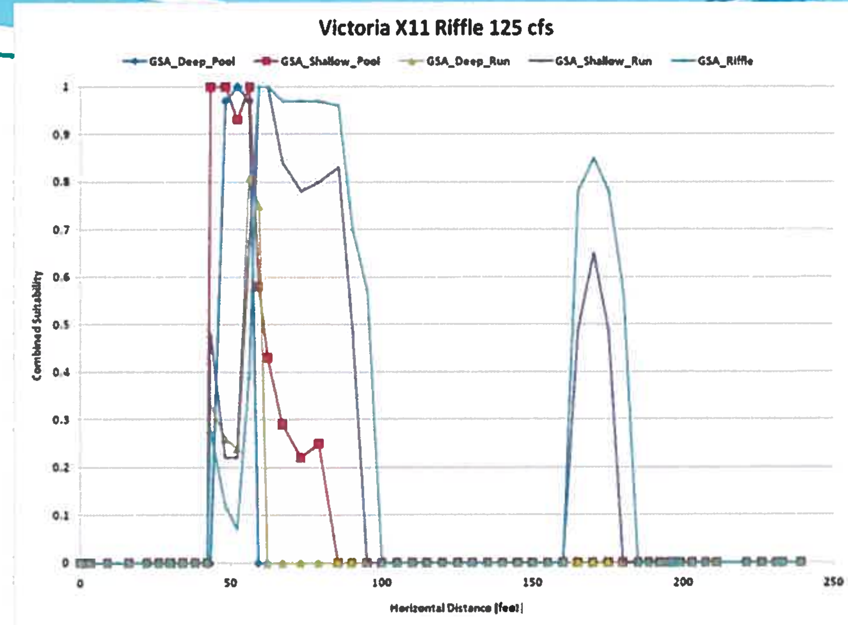

Victoria X2 Deep Pool 125 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)

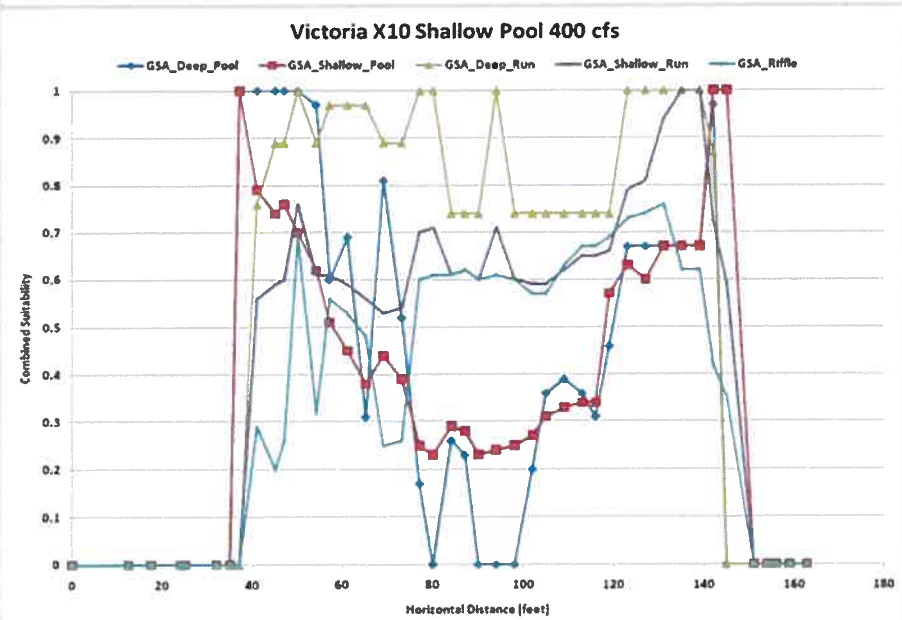

Victoria X4 Run 125 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)

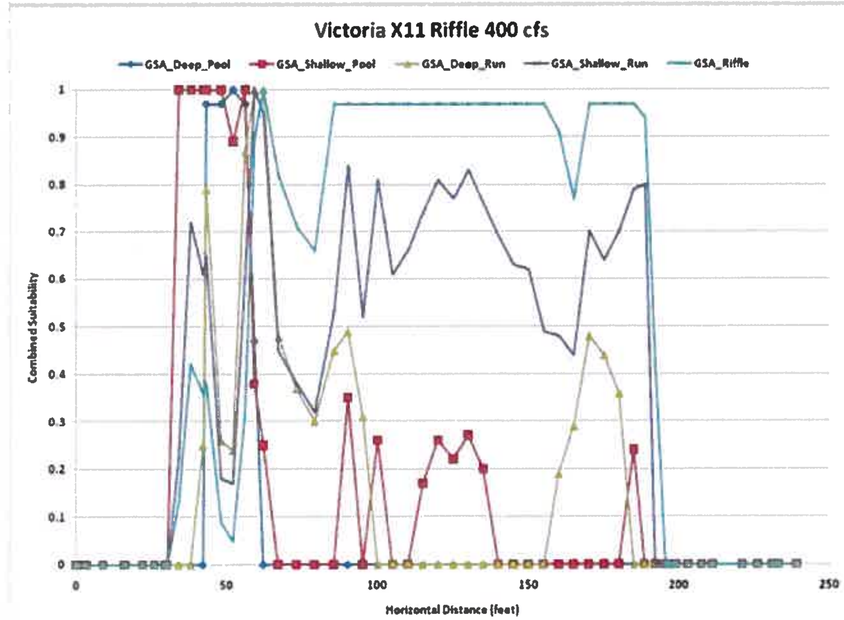

Victoria X2 Deep Pool 400 cfs
Series1
Series2
Series3
Series4
Series5
Combined Suitability
Horizontal Distance (feet)

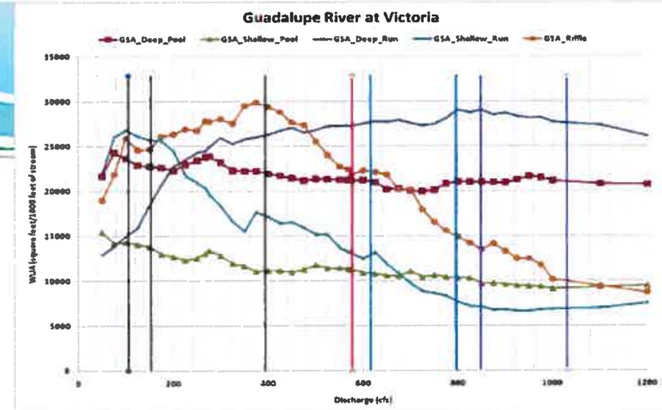

Victoria X4 Deep Pool 400 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (fee)


Victoria X10 Shallow Pool 125 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)


Victoria X11 Riffle 125 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)


Victoria X10 Shallow Pool 400 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)


Victoria X11 Riffle 400 cfs
GSA_Deep_Pool
GSA_Shallow_Pool
GSA_Deep_Run
GSA_Shallow_Run
GSA_Riffle
Combined Suitability
Horizontal Distance (feet)

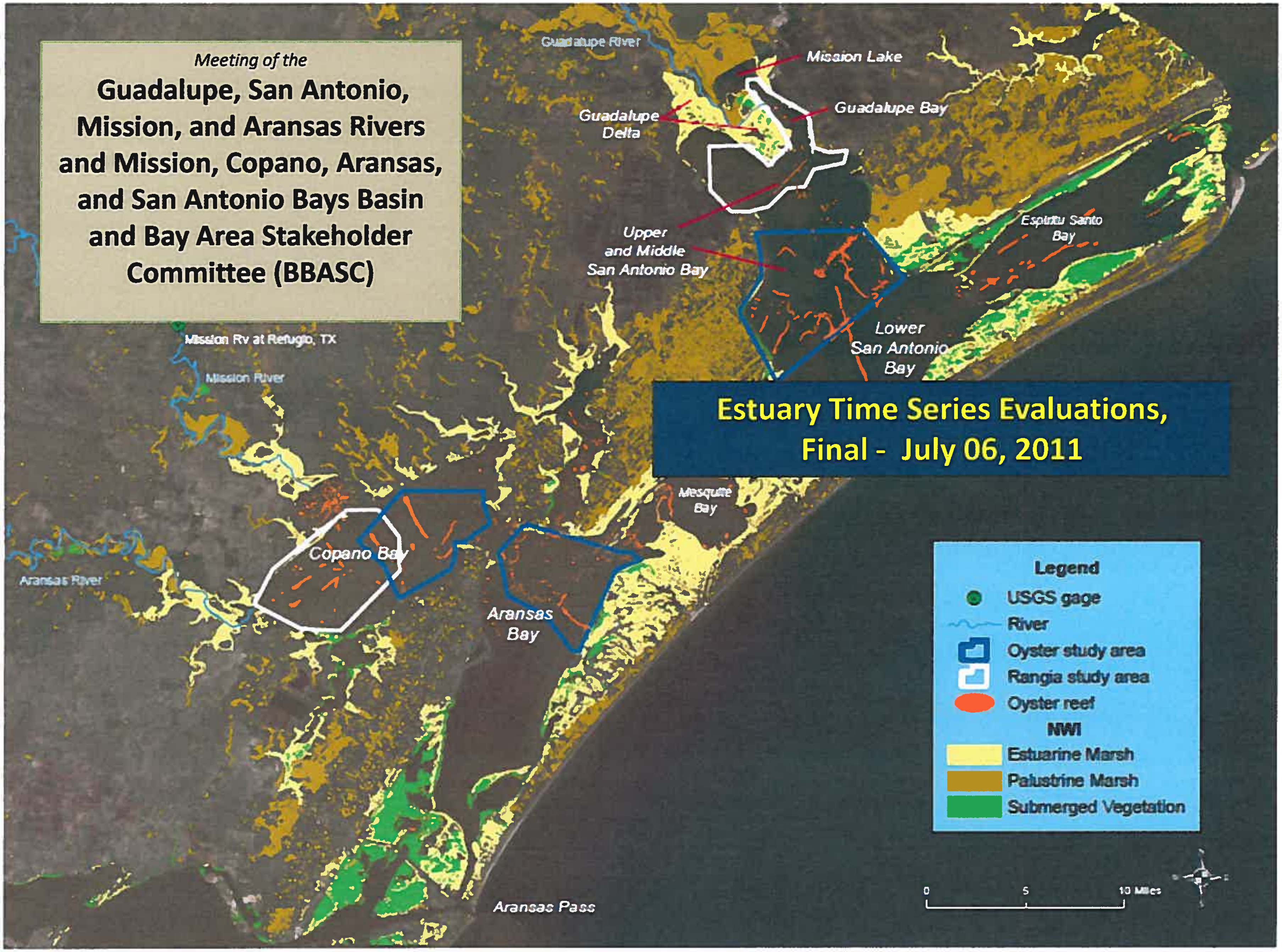


Summary for Victoria

- Some adjustments to the HEFR base flow regime numbers could be considered.
- Adjustments to HEFR Low, Medium and High Base flow regime discharges could be considered.
- Shifts to flows by ~ 50 to 75 cfs within these flow regime seasonal discharges would likely maintain the relative contribution of high quality habitat whether one considers GSA or LSAR habitat guild results.
- However, it must be stressed that these analyses do not have the benefit of water quality and temperature simulation overlays
- Large reductions in flows at any of the HEFR Low, Medium or High base regimes based solely on these results are discouraged.
- Any reductions of the seasonal Low, Medium, and High Base flow regimes must also consider the potential implications on the required Bay and Estuary flow regimes.

Summary

- The analyses provided above would suggest that some reductions in the seasonal HEFR Low, Medium and High Base flow discharges could be entertained as part of the BBASC deliberations without substantially affecting the likelihood of maintaining a sound ecological environment based on physical habitat.
- Large scale reductions in the flow regime however would likely raise the ecological risk of maintaining a sound ecological environment to unacceptable levels.
- The results should also not be interpreted, in this authors opinion to eliminate the three base flow regimes (i.e., collapse them into two or one regime recommendation).



Meeting of the
Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)
Estuary Time Series Evaluations, Final - July 06, 2011
Guadalupe River
Mission Lake
Guadalupe Bay
Guadalupe Delta
Upper and Middle San Antonio Bay
Espiritu Santo Bay
Lower San Antonio Bay
Mission Rv at Refugio, TX
Mission River
Mesquite Bay
Copano Bay
Aransas River
Aransas Bay
Aransas Pass
Legend
USGS gage
River
Oyster study area
Rangia study area
Oyster reef
NWI
Estuarine Marsh
Palustrine Marsh
Submerged Vegetation
0
5
10 Miles

ROAD MAP

Topics:

1) The Estuary Criteria (another view) / and Characteristics of Non-Attainment

2) Subcommittee's Evaluation Approach

3) Implications (Conclusions) with Region L Baseline

a) Non-Attainment of the G1 criteria for *Rangia* clams

b) Non-Attainment of the G2 criteria for oysters

4) Implications (Conclusions) with Additional Projects

a) ΔNon-Attainment: G1 and G2 with Guadalupe r-o-r Project

b) ΔNon-Attainment: G1 and G2 with San Antonio r-o-r Project

The BBEST Criteria

Table 6.1-17

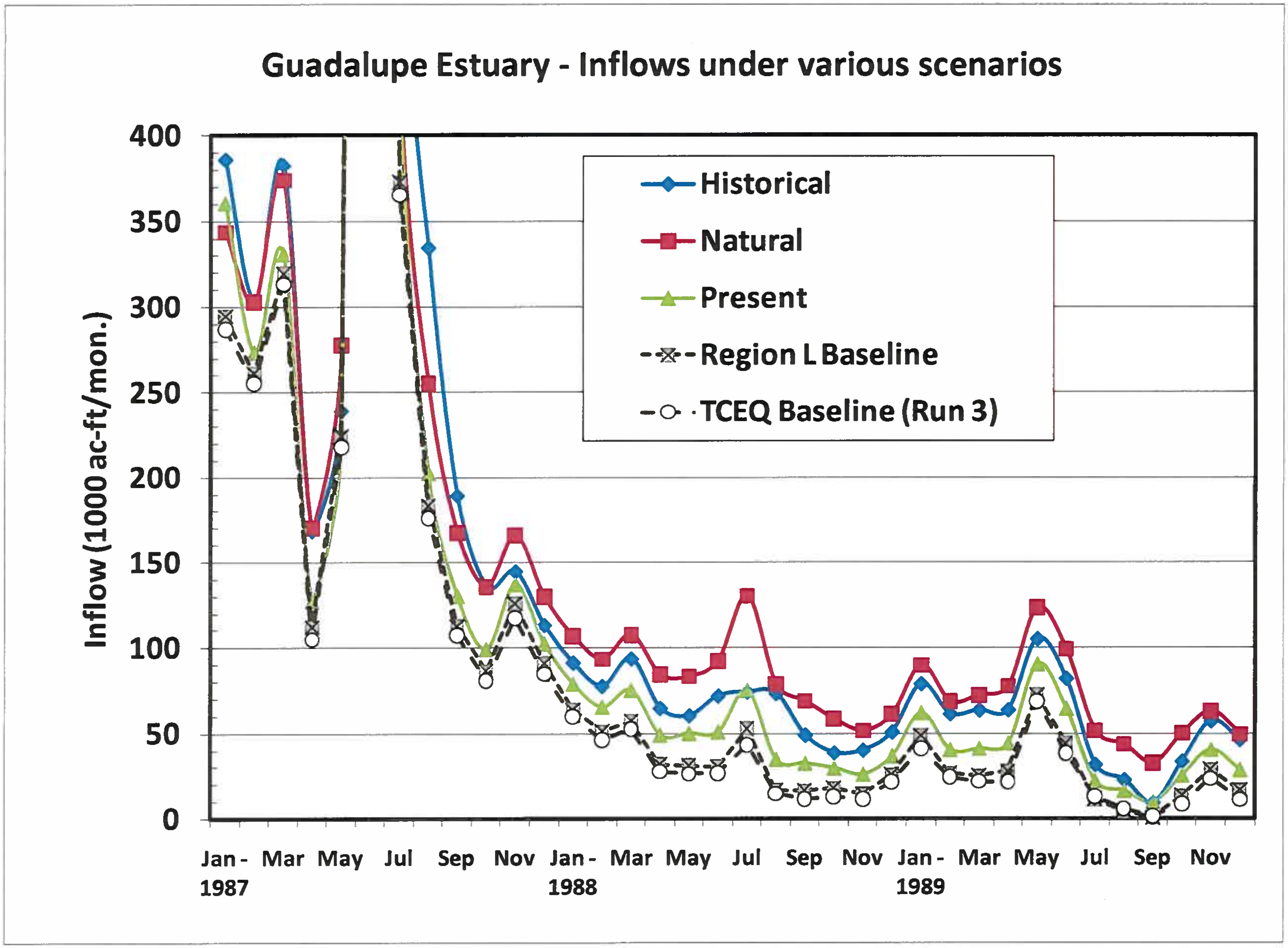
Guadalupe Estuary Criteria - Volumes				
Criteria level	Inflow Criteria Volumes, suite G1 for Rangia clams		Inflow Criteria Volumes, suite G2 for Eastern oysters	
	Feb. (1000 ac-ft/mon)	Mar.-May (1000 ac-ft/3mon)	June (1000 ac-ft/mon)	July-Sept. (1000 ac-ft/3mon)
G1-Aprime, G2-Aprime	n/a	550-925	n/a	450-800
G1-A, G2-A	n/a	375-550	n/a	275-450
G1-B, G2-B	n/a	275-375	n/a	170-275
G1-C, G2-C	≥75	150-275	≥40	75-170
G1-CC, G2-CC	0 - 75	150-275	0 - 40	75-170
G1-D, G2-D	n/a	0 - 150	n/a	50-75
G1-DD, G2-DD	n/a	n/a	n/a	0-50

Mission-Aransas Estuary Criteria - Volumes				
Criteria level	Inflow Criteria Volumes, set MA1 for Rangia clams		Inflow Criteria Volumes, set MA2 for Eastern oysters	
	Feb.	Mar.-May	June	July-Sept.
MA2 - Aprime	n/a	n/a	n/a	500-1000

Table 6.1-18

Guadalupe Estuary Criteria -Attainment Recommendations			
Criteria level	Specification	Inflow Criteria Attainment, G1 suite for Rangia clams	Inflow Criteria Attainment, G2 suite for Eastern oysters
G1-Aprime, G2-Aprime	Attainment, G - Aprime	G1-Aprime at least 12% of years	G2-Aprime at least 12% of years
G1-A, G2-A	Attainment, G - A	G1-A at least 12 % of years	G2-A at least 17 % of years
G1-A&G1-B, G2-A&G2-B	Attainment, G - A & G - B combined	G1-A and G1-B combined at least 17% of years	G2-A and G2-B combined at least 30% of years
G1-C&G1-CC, G2-C&G2-CC	Attainment, G - C & G - CC combined	G1-C and G1-CC equal to or greater than 19% of years. G1-CC no more than 2/3 of total	G2-C and G2-CC equal to or greater than10% of years. G2-CC no more than 1/6 of total
G1-D	Attainment, G1- D	no more than 9% of years	n/a
G2-DD	Attainment, G2- DD	n/a	G2-D no more than 6% of years
G2-D&G2-DD	Attainment, G2-D & G2-DD combined	n/a	G2-D and G2-DD combined no more than 9% of years

Mission-Aransas Estuary Criteria -Attainment Recommendations			
Criteria level	Specification	Inflow Criteria Attainment, set MA1 for Rangia clams	Inflow Criteria Attainment, set MA2 for Eastern oysters
MA-Aprime	Attainment MA-Aprime	n/a	MA2-Aprime at least 2% of years



Guadalupe Estuary - Inflows under various scenarios
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Historical
Natural
Present
Region L Baseline
TCEQ Baseline (Run 3)
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov

Table 2 – Attainment of G1 Springtime Criteria (Rangia)

Part a) Counts	Criteria G1 Attainment (no. years 1941-89)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline	7	10	8	3	3	4	14	49
w. Guadalupe Project	7	10	8	2	4	4	14	49
w. San Antonio Project	7	9	9	1	5	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

Criteria met	criteria nearly met. rounding & period of record change probable causes.	criteria not met, departure from BBEST recommendations not great	criteria not met, departure of concern from BBEST recommendations			

Part b) Attainment - single criteria measures	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
goal	n/a	>12%	>12%	n/a	n/a	n/a	≤9%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
~~Present~~		~~28.6%~~	~~8.2%~~	~~10.2%~~	~~10.2%~~	~~10.2%~~	~~16.3%~~
Region L Baseline		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. Guadalupe Project		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
w. San Antonio Project		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

Part c) Attainment - joint measures	Joint G1 criteria attainment (% of years and fractions)					
Scenario	>A-pr		A & B		C & CC	frac. CC
goal	n/a		>17%		19%	≤67%
Historical			22.4%		20.4%	50.0%
Present			18.4%		20.4%	50.0%
Region L Baseline			22.4%		14.3%	57.1%
w. Guadalupe Project			20.4%		16.3%	50.0%
w. San Antonio Project			20.4%		18.4%	44.4%
TCEQ Baseline; (Run 3)			18.4%		16.3%	37.5%

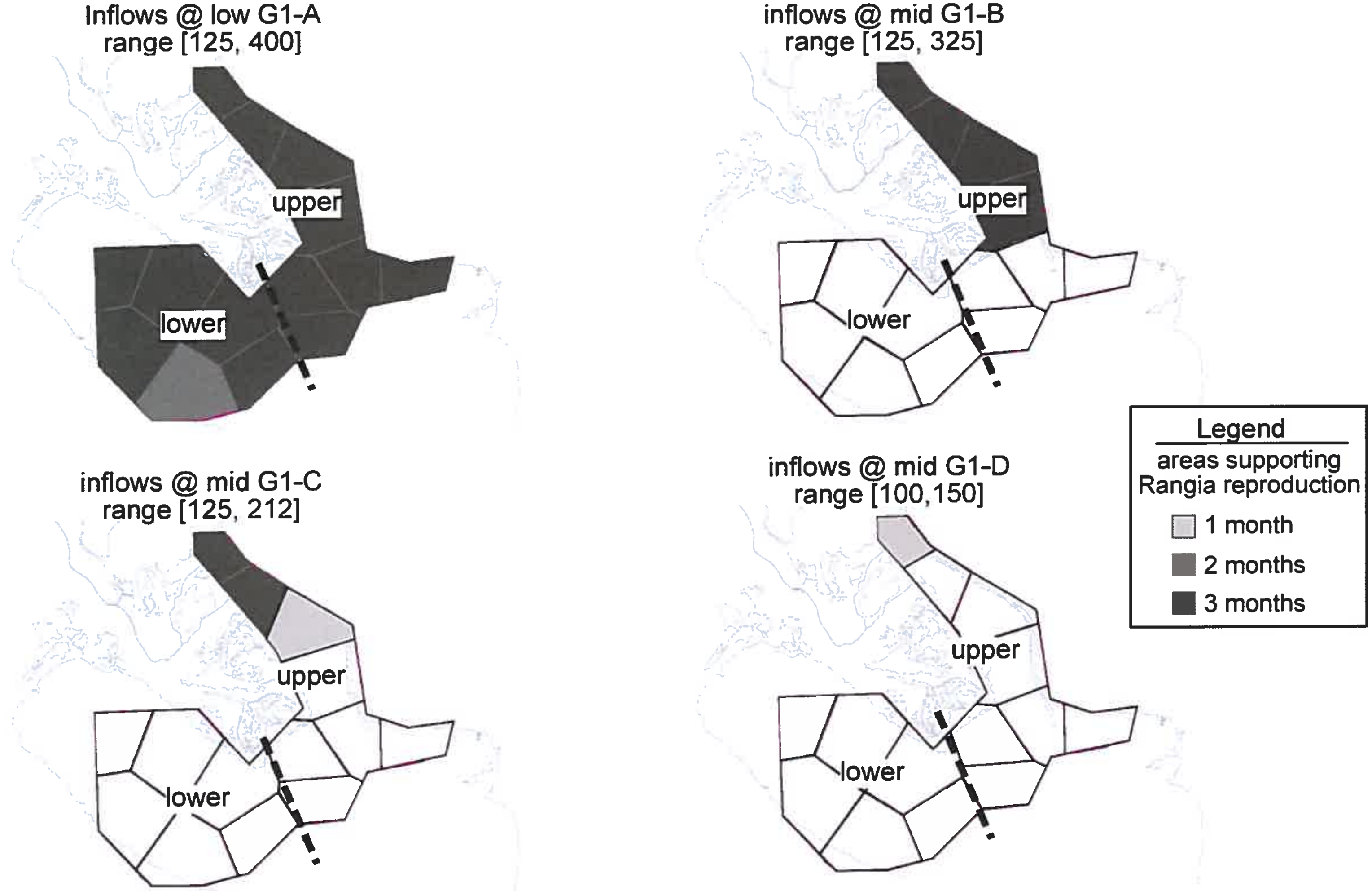
Table 3 – Attainment of G2 Summer Criteria (oysters)

Part a) Counts	Criteria G2 Attainment (no. years 1941-89)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline	4	8	8	8	7	3	3	8	49
w. Guadalupe Project	4	8	8	8	7	3	3	8	49
w. San Antonio Project	4	8	8	8	7	3	3	8	49
TCEQ Baseline: (Run 3)	4	6	9	8	6	4	3	9	49

Part b) Attainment - single criteria measures	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
goal	n/a	>12%	>17%	n/a	n/a	n/a	≤6%	n/a
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guadalupe Project		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Antonio Project		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

Part c) Attainment - joint measures	Joint G2 criteria attainment (% of years and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
goal			≥30%		≥10%	≤17%	≤9%	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
w. Guadalupe Project			32.7%		20.4%	30.0%	22.4%	
w. San Antonio Project			32.7%		20.4%	30.0%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

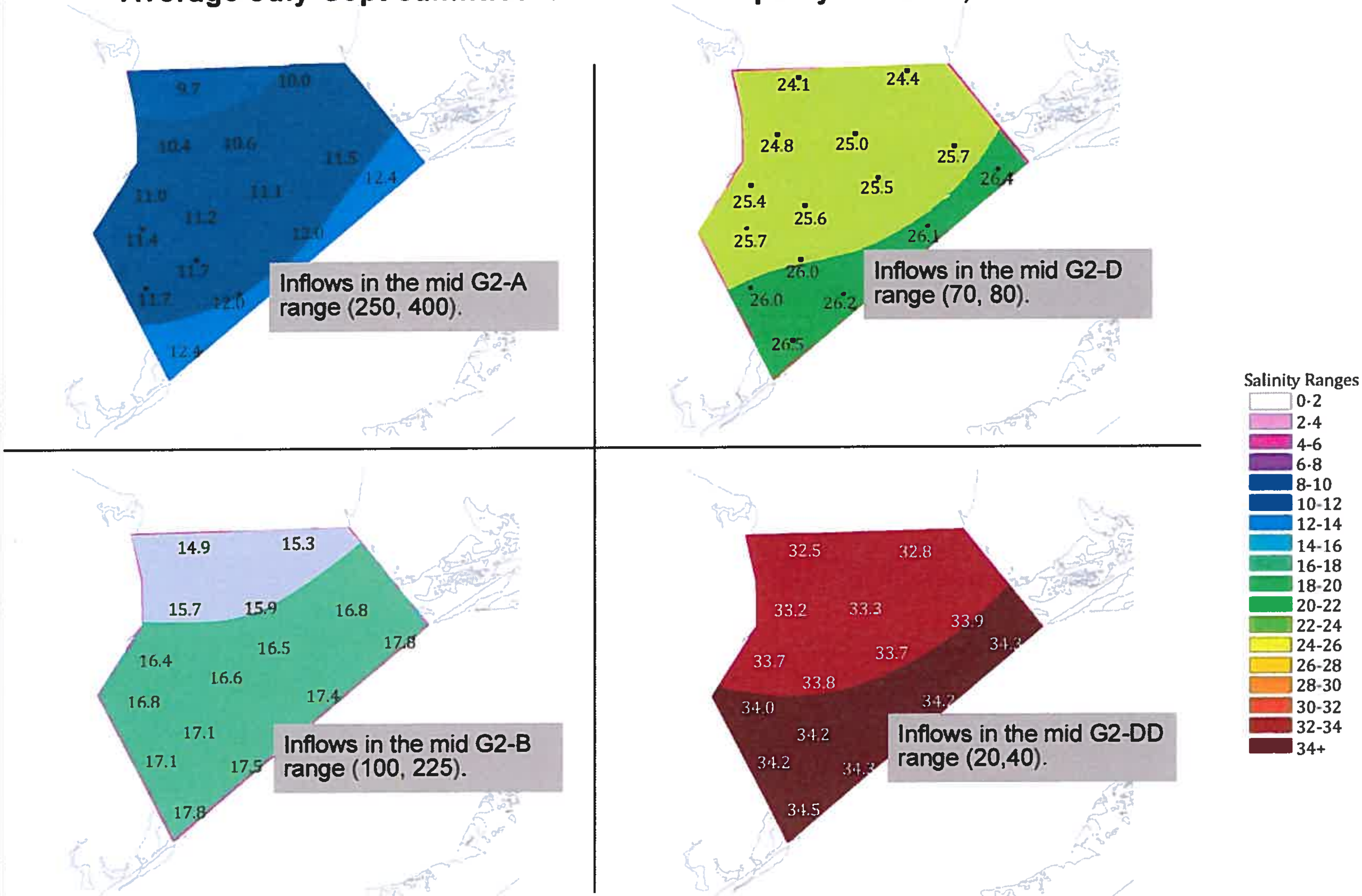
Another view of the G1 Springtime Criteria (Rangia)



note: the values in brackets at each inflow range represent the Feb. inflows and the Mar.-May total inflows measured in 1000 ac-ft that yield the areas shown.

Another view of the G2 Summer Criteria (Oysters)

Average July-Sept salinities in the Guadalupe oyster area, various inflows levels.



note: the values in brackets at each inflow range represent the June inflows and the July-Sept. total inflows measured in 1000 ac-ft that yield the salinities shown.

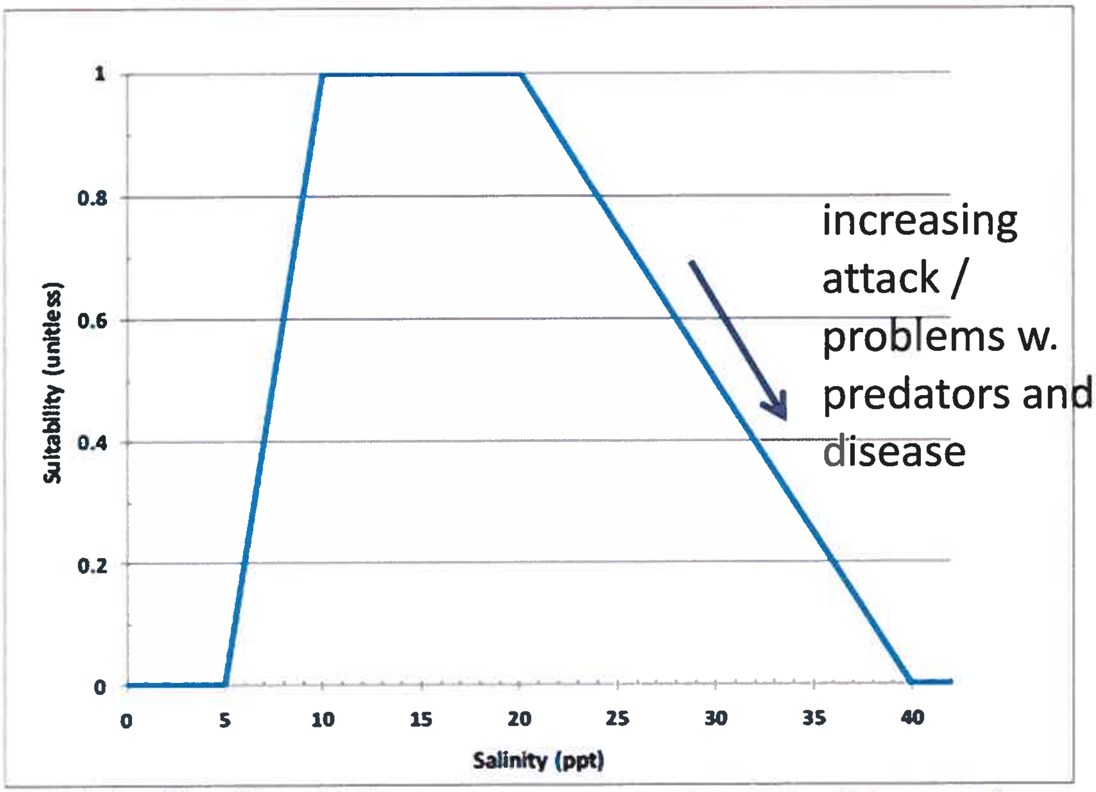


Figure 4.4-2. The salinity suitability curve for Eastern oysters utilized in the salinity zone analyses in the Guadalupe and Mission-Aransas Estuaries. An index of 1.0 indicates optimum salinity conditions and 0 indicates very bad conditions. This curve is from Cake (1985).

ROAD MAP

Topics:

1) The Estuary Criteria (another view) / and

Characteristics of Non-Attainment

2) Subcommittee's Evaluation Approach

3) Implications (Conclusions) with Region L Baseline

a) Non-Attainment of the G1 criteria for *Rangia* clams

b) Non-Attainment of the G2 criteria for oysters

4) Implications (Conclusions) with Additional Projects

a) ΔNon-Attainment: G1 and G2 with Guadalupe r-o-r Project

b) ΔNon-Attainment: G1 and G2 with San Antonio r-o-r Project

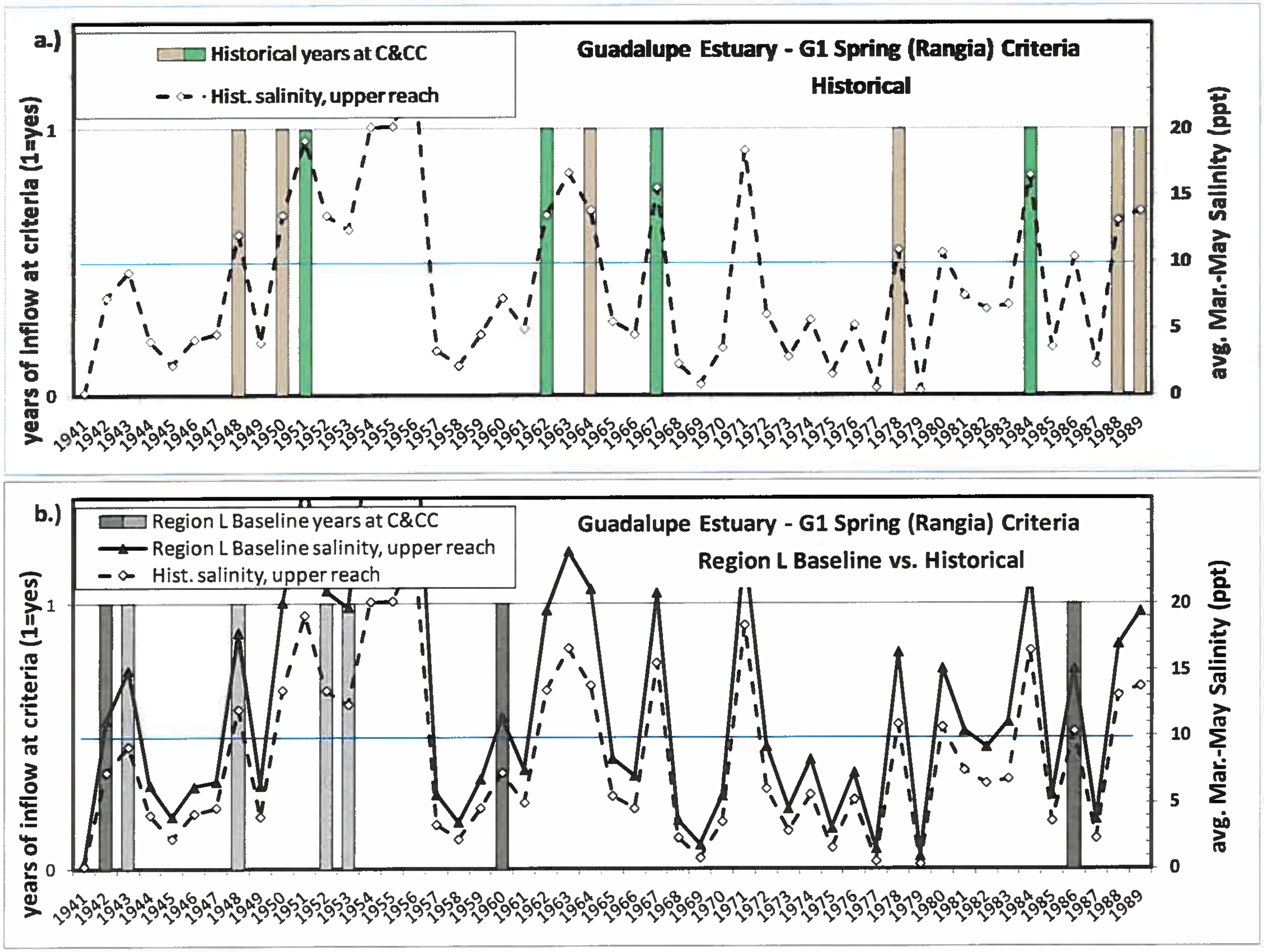


Figure 4- Upper panel illustrates the historical occurrence of spring inflows in the G1-C and G1-CC criteria range[lighter shading for CC]. Lower panel shows the changes predicted with the Region L Baseline inflow scenario. Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe *Rangia* habitat area under that scenario. Lower panel also contrast to historical salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

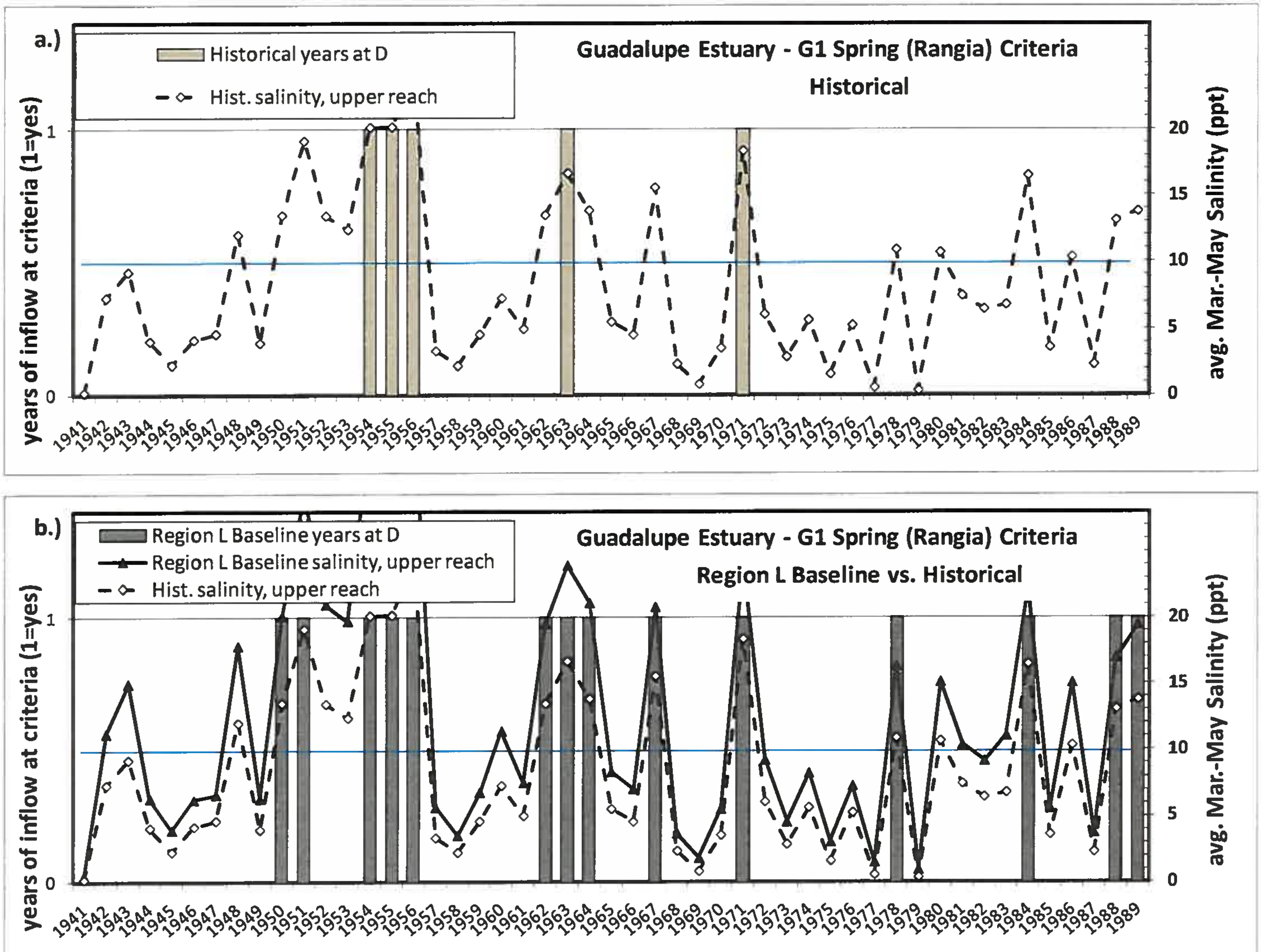


Figure 5- Upper panel illustrates the historical occurrence of spring inflows in the G1-D criteria range. Lower panel shows the changes predicted with the Region L Baseline inflow scenario. Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe *Rangia* habitat area under that scenario. Lower panel also contrast to historical salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

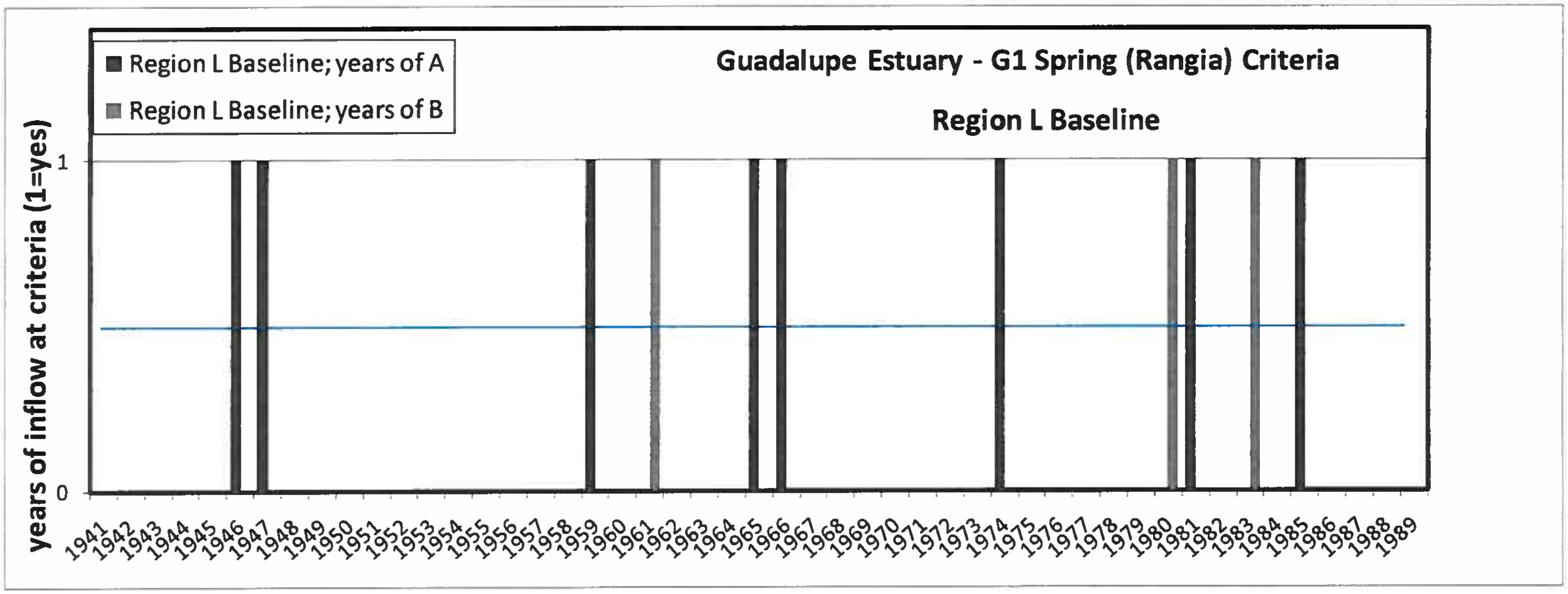


Figure 6- Illustration of the continuing projected occurrence of G1-A or G1-B inflows with the Region L Baseline scenario.

ROAD MAP

Topics:

1) The Estuary Criteria (another view) / and Characteristics of Non-Attainment

2) Subcommittee's Evaluation Approach

3) Implications (Conclusions) with Region L Baseline

a) Non-Attainment of the G1 criteria for *Rangia* clams

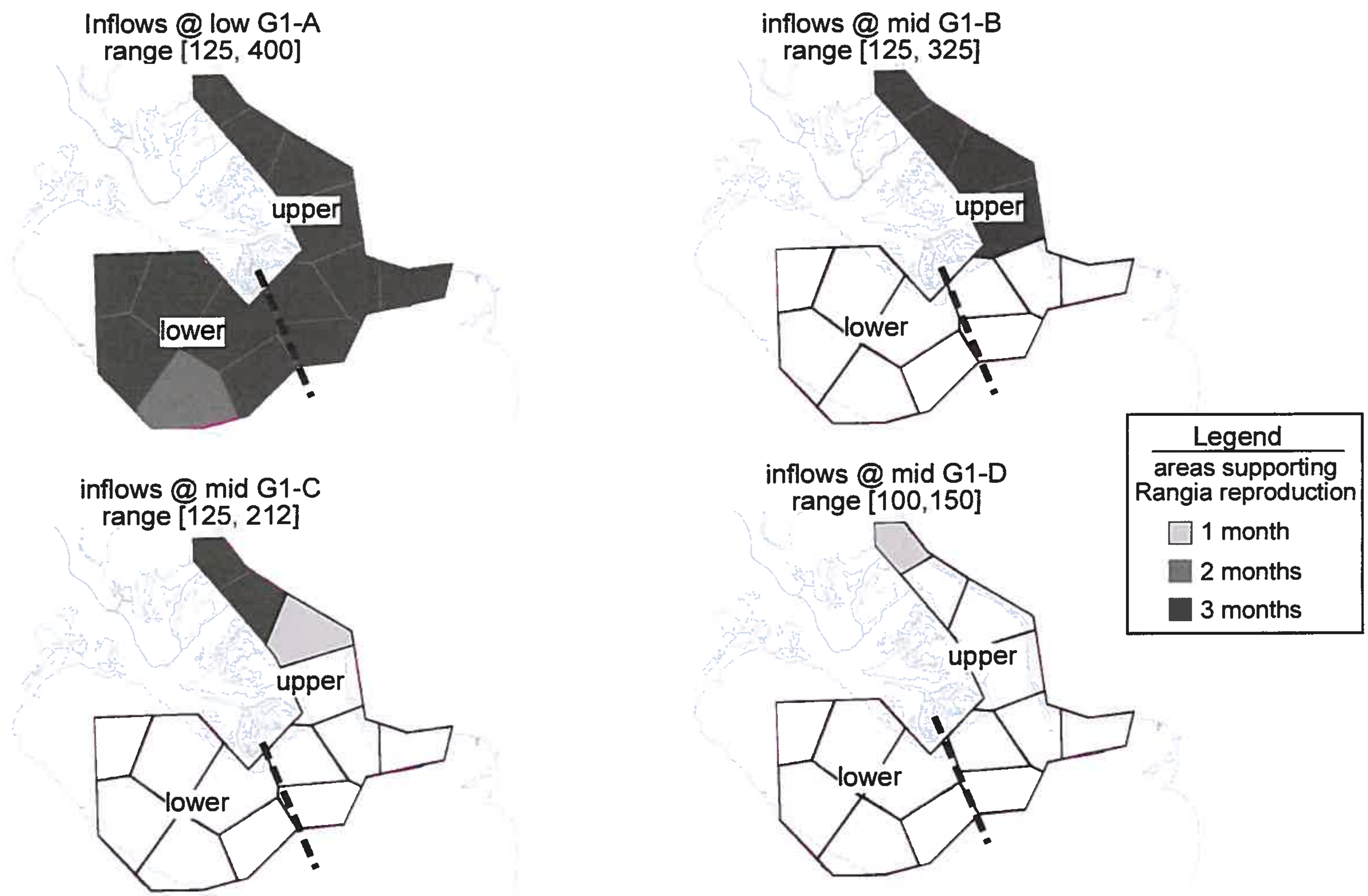
b) Non-Attainment of the G2 criteria for oysters

4) Implications (Conclusions) with Additional Projects

a) ΔNon-Attainment: G1 and G2 with Guadalupe r-o-r Project

b) ΔNon-Attainment: G1 and G2 with San Antonio r-o-r Project

Another view of the G1 Springtime Criteria (Rangia)



note: the values in brackets at each inflow range represent the Feb. inflows and the Mar.-May total inflows measured in 1000 ac-ft that yield the areas shown.

Implications - Rangia

The Estuary Subcommittee, in our best professional judgment, believes that these changes in springtime inflow characteristics of the Region L Baseline indicate the following for *Rangia* clams:

a) there is the potential for long-term alteration in the area or density of clams, especially in the lower part of the current habitat area used as a focal area by the BBEST. This is due to the increasing prevalence of G1-C & CC and D inflows which do not support reproduction of the clams in this portion of the habitat area.

b) since the *Rangia* clams are long-lived, and there are continuing higher levels of inflows in the G1-B and G1-A range at a sufficiently short return interval, the clams would not likely be eliminated from any of the focal area.

c) because of the importance of *Rangia* as a filter feeder and as an apparent food source for other organisms, we would expect some concomitant impacts if their abundance were reduced. Filter feeding is a broad ecosystem service provided by *Rangia*'s removal of suspended particulate matter, which contributes to water clarity. Scientific literature indicates that *Rangia* are a food source for fish, waterfowl, and crustaceans, thus a reduction in the clams abundance could affect other species. Further investigation of the ecological role of *Rangia* in the Guadalupe Estuary is warranted.

Oysters
Additional Insights into 1950's Drought

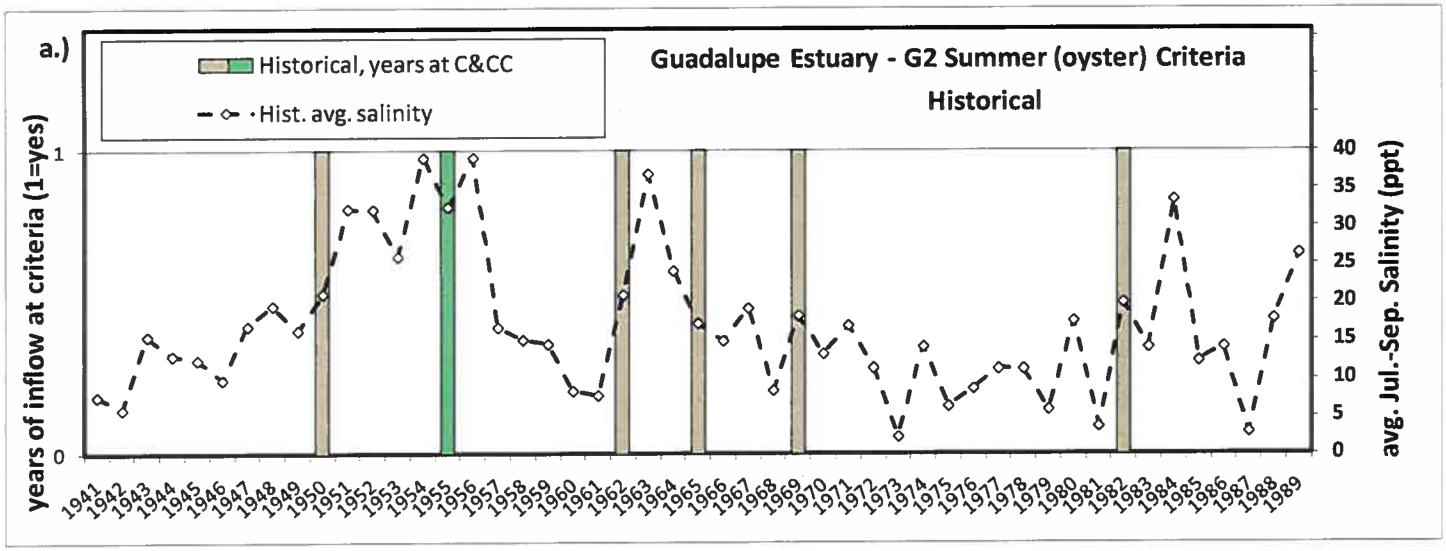
Hoese (1960) –
-limited sampling in Mesquite Bay, fall -winter 1956
-more extensive sampling 1st year after end of the 1950's drought.

FINDINGS

- Mesquite Bay , 35 to 50 ppt, "normal" 4-28 ppt;
- nearly 100% eastern oysters dead;
- dead shells colonized by a high-salinity-tolerant community of other species of oysters and mussels.
- other salinity tolerant species widely established;
- composition of mobile fish and invertebrates, not much change

-a year after drought ended, eastern oysters not yet returned.

Hoese, H.D. 1960. Biotic changes in a bay associated with the end of a drought. Limnology and Oceanography 5(3):326-336.



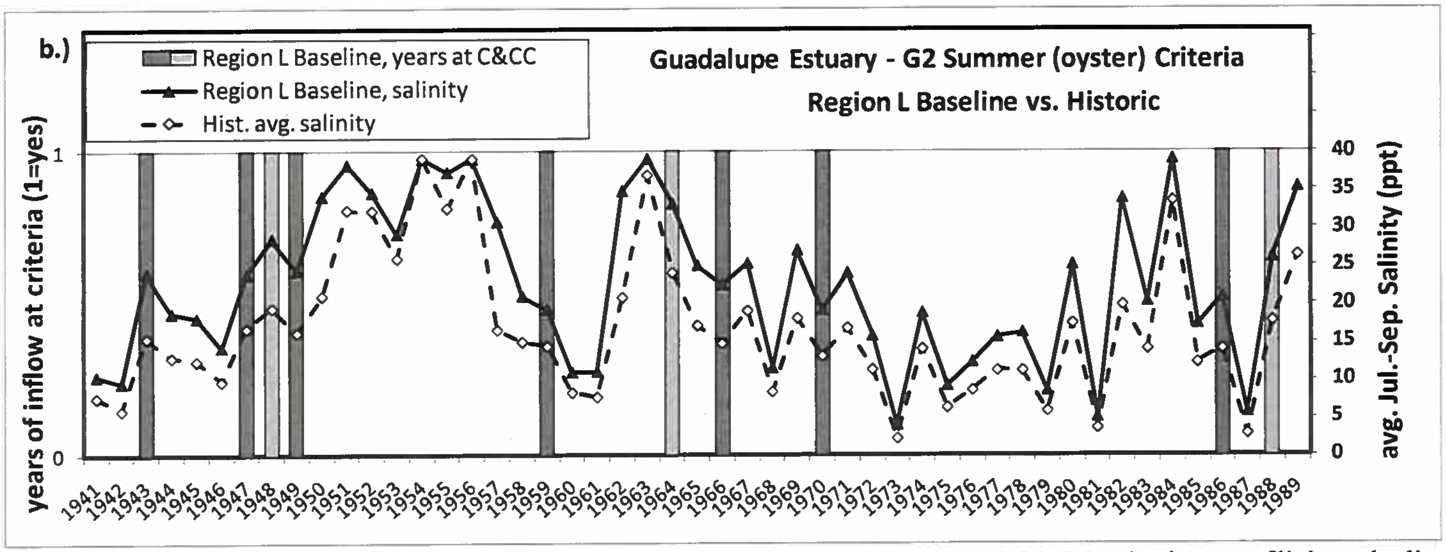
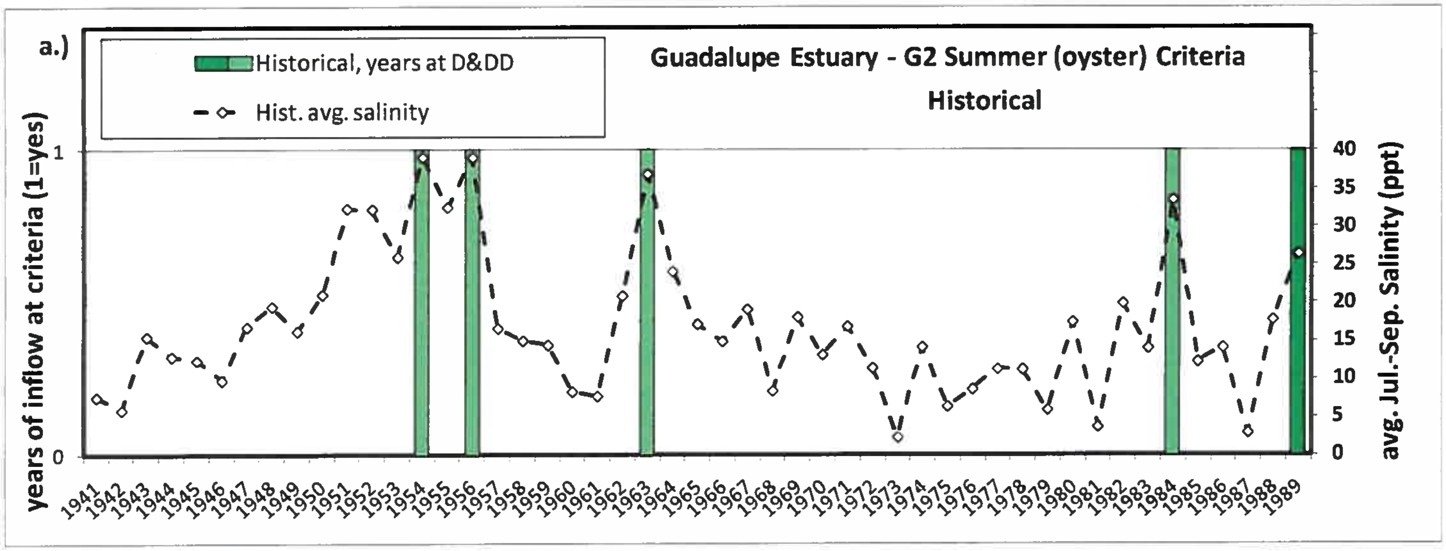


Figure 7- Upper panel: the historical occurrence of Summer inflows (Jul.-Sept.) in the G2-C and G2-CC criteria range [lighter shading for CC]. Lower panel:changes predicted with the Region L Baseline inflow scenario. Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast to historical salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.



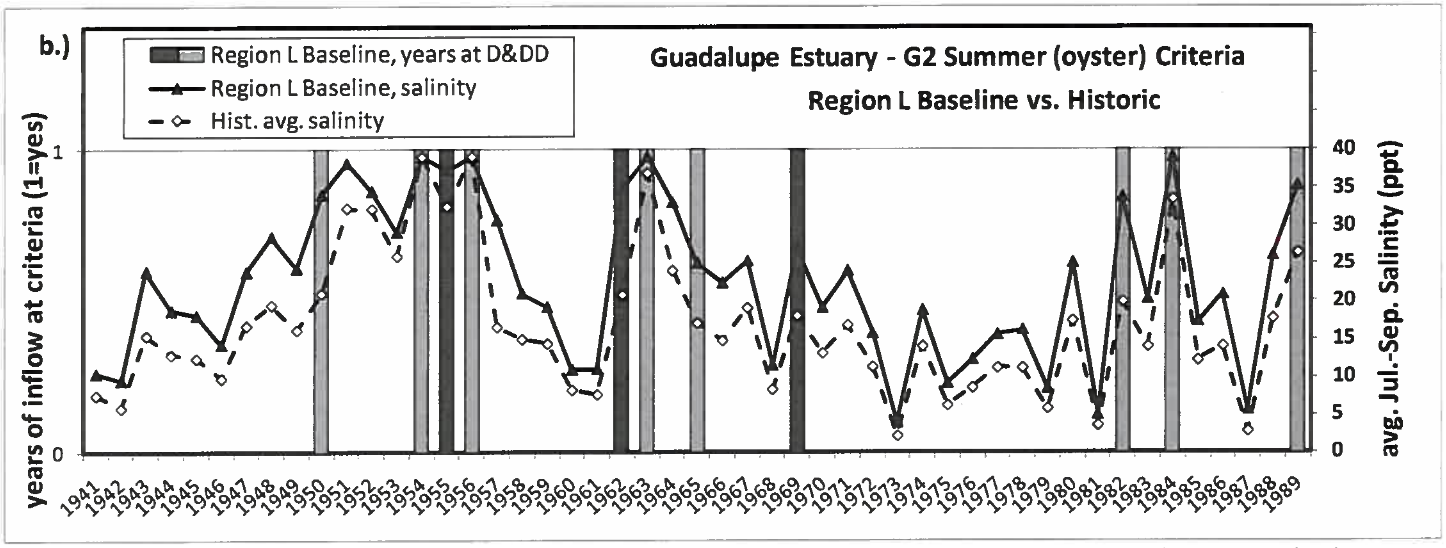


Figure 8- Upper panel illustrates the historical occurrence of Summer inflows (Jul.-Sept.) in the G2-D and G2-DD criteria range (DD in lighter shade). Lower panel shows the changes predicted with the Region L Baseline inflow scenario. Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast to historical salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

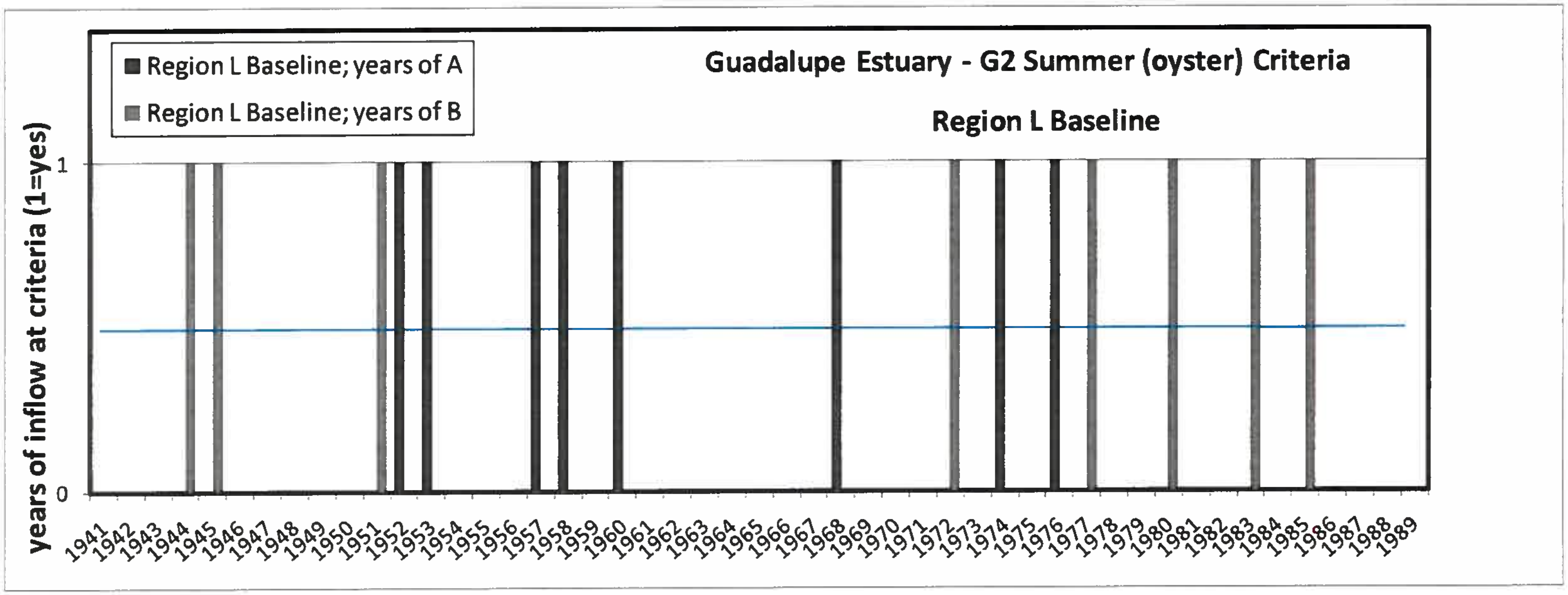
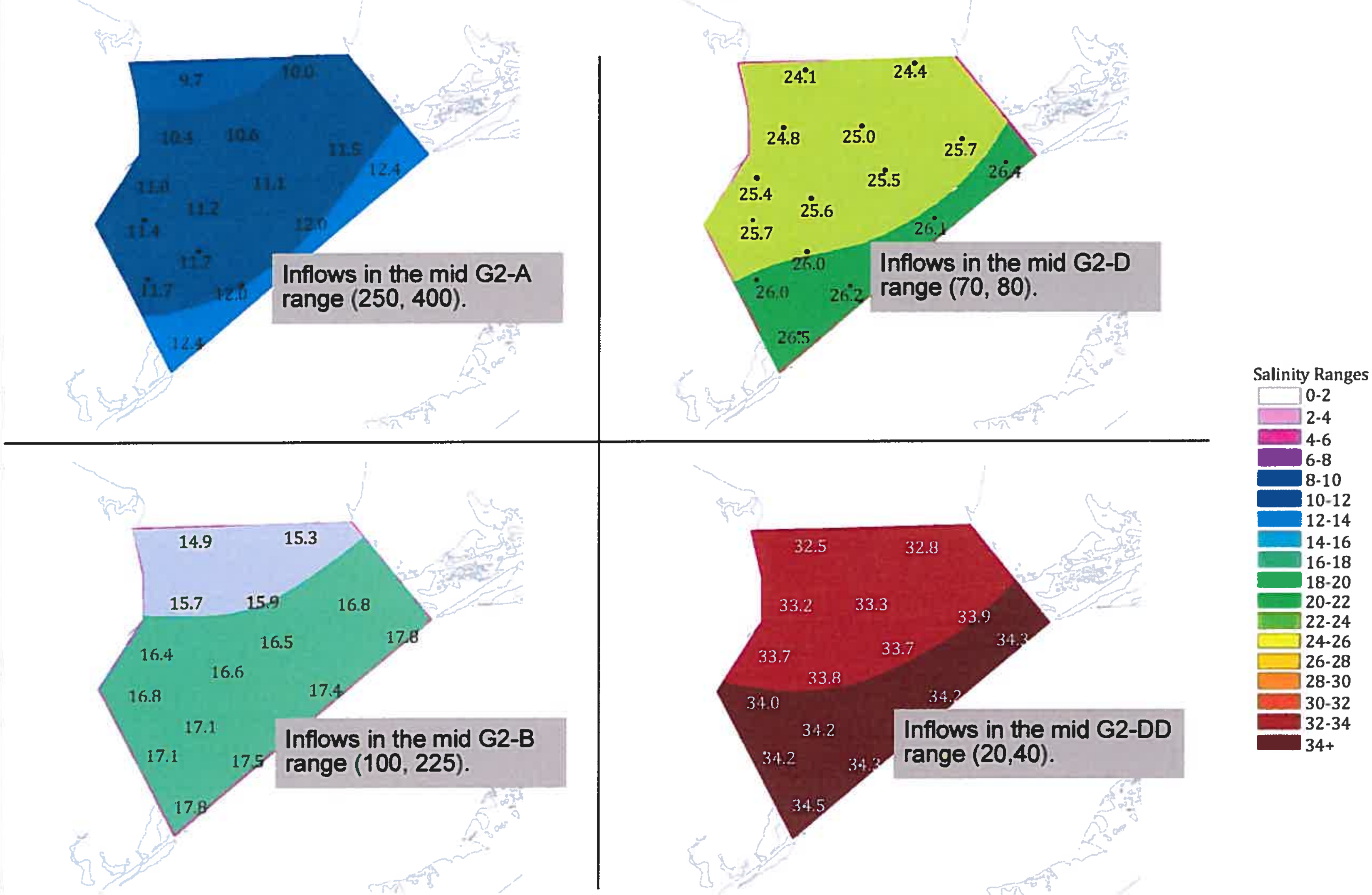


Figure 9- Illustration of the continuing projected occurrence of G2-A or G2-B inflows with the Region L Baseline scenario.

Another view of the G2 Summer Criteria (Oysters)

Average July-Sept salinities in the Guadalupe oyster area, various inflows levels.



note: the values in brackets at each inflow range represent the June inflows and the July-Sept. total inflows measured in 1000 ac-ft that yield the salinities shown.

Implications - Oysters

The Estuary Subcommittee, in our best professional judgment, believes that the predicted changes in summer period inflow characteristics of the Region L Baseline indicate the following for oysters:

a) the effects of the extension of duration of a drought such as that which would result from the same hydro-climatology of the historic 1950's period, could be detrimental, but likely transitory, for the oyster reefs in the Guadalupe Estuary. There is the potential for significant mortality of oysters over a greater period within the estuary during the drought;

b) given that oyster parasites and the Dermo pathogen are known to be eliminated from oyster reefs during high inflow / low salinity events, and given that high G2-A and G2-B levels of inflow are predicted to continue with some regularity (Figure 9), we believe that the cycle of oyster decline and rejuvenation of the historic period will continue;

c) the larger proportion than recommended of the lower G2-CC level inflows also represents an increase in the prevalence of stressed, albeit not drought, conditions for oysters. The principal concern with the increase in G2-CC years is the evident sequencing of these with other years that are more formally in drought, G2- D and G2-DD, likely hastening the onset of, or lengthening duration of, the already deleterious effects of those years.

ROAD MAP

Topics:

1) The Estuary Criteria (another view) / and Characteristics of Non-Attainment

2) Subcommittee's Evaluation Approach

3) Implications (Conclusions) with Region L Baseline

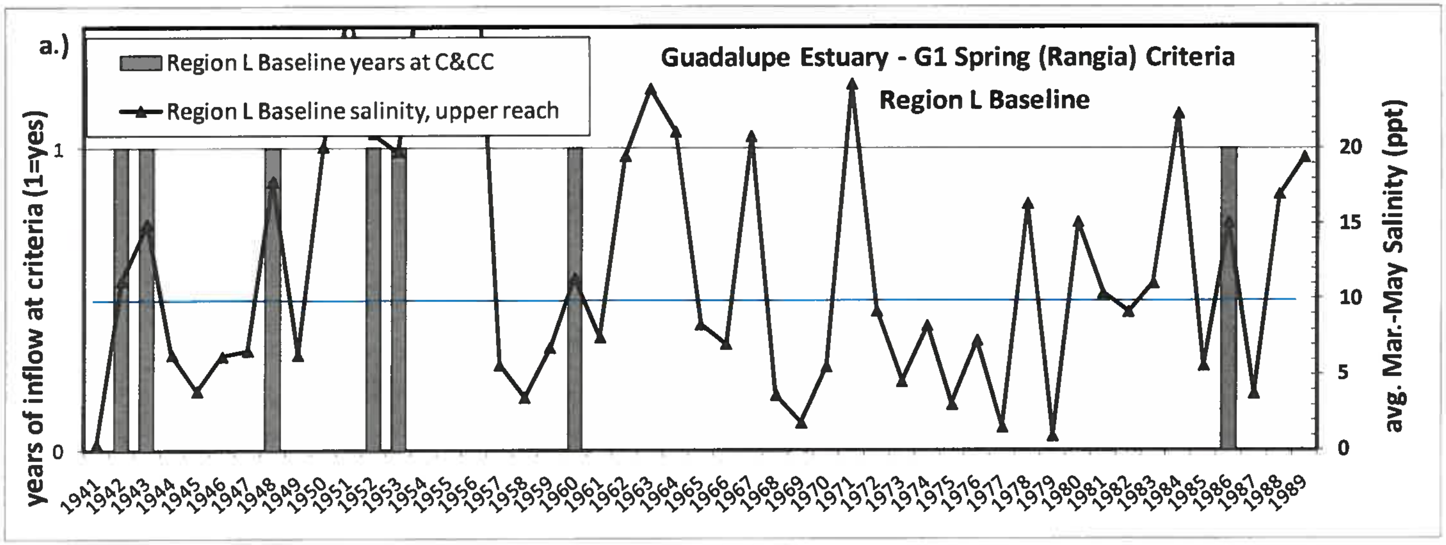
a) Non-Attainment of the G1 criteria for *Rangia* clams

b) Non-Attainment of the G2 criteria for oysters

4) Implications (Conclusions) with Additional Projects

a) ΔNon-Attainment: G1 and G2 with Guadalupe r-o-r Project

b) ΔNon-Attainment: G1 and G2 with San Antonio r-o-r Project



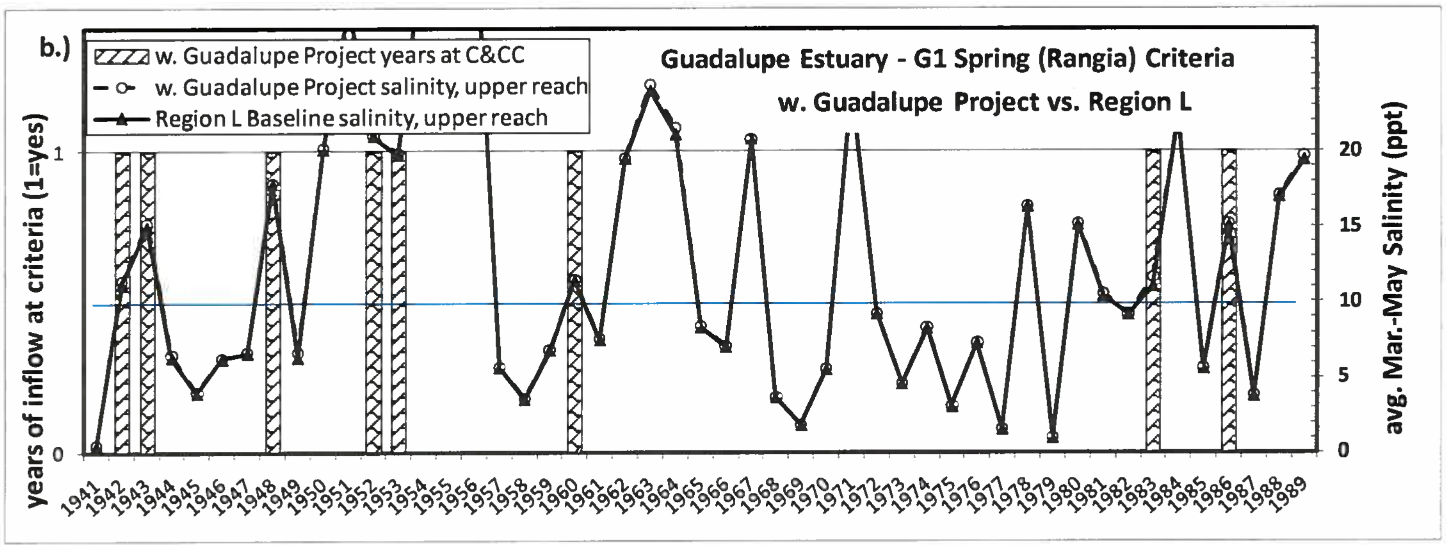


Figure 10- Illustration of the additional springtime impacts of the Guadalupe run-of-river diversion project subject to the BBEST instream criteria. Spring inflows (Mar.-May) in the G1-C and G1-CC criteria range are shown for the Region L Baseline (upper panel) and with the project (lower panel). Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast the with project and Region L salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

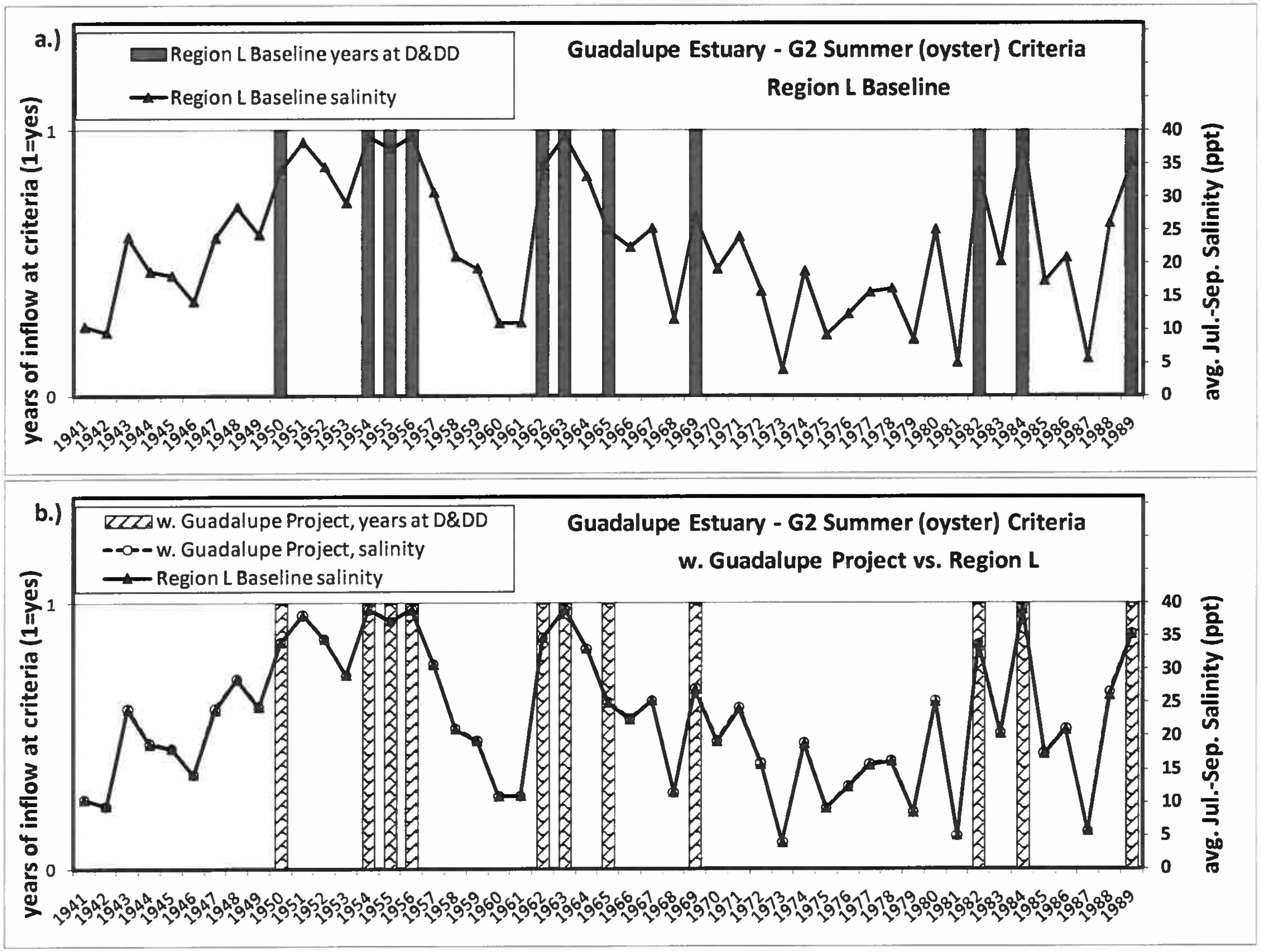


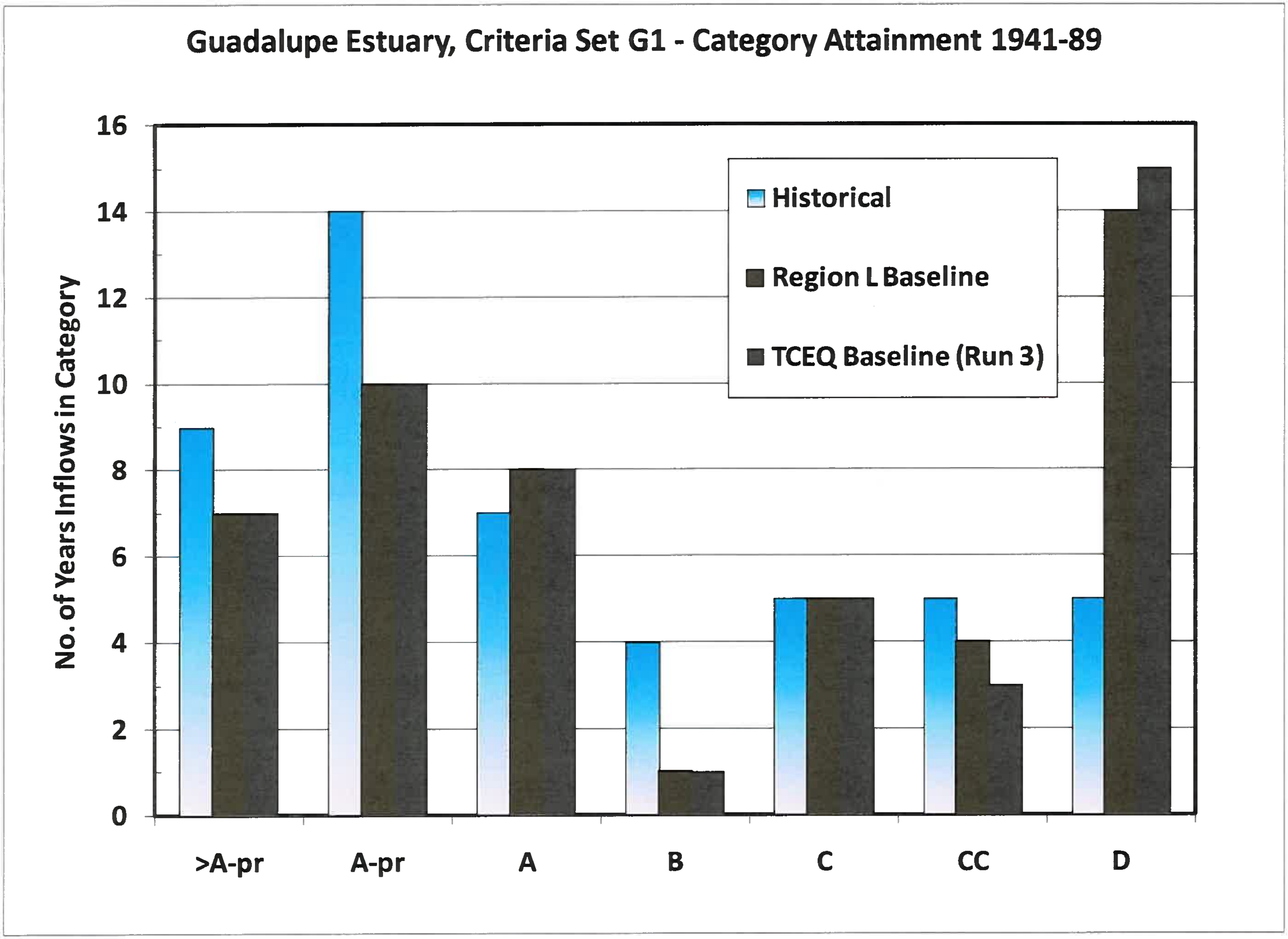
Figure 13- Illustration of the additional summer impacts of the Guadalupe run-of-river diversion project subject to the BBEST instream criteria. Summer inflows (Jul.-Sept.) the G2-D and G2-DD criteria range are shown for the Region L Baseline (upper panel) and with the project (lower panel). Each panel shows the occurrence of inflows at the criteria level and average salinity across the Guadalupe oyster habitat area under that scenario. Lower panel also contrast the with project and Region L salinity. Salinities here are predicted with regression equations of the BBEST and the upper limit of salinity is capped at 39ppt.

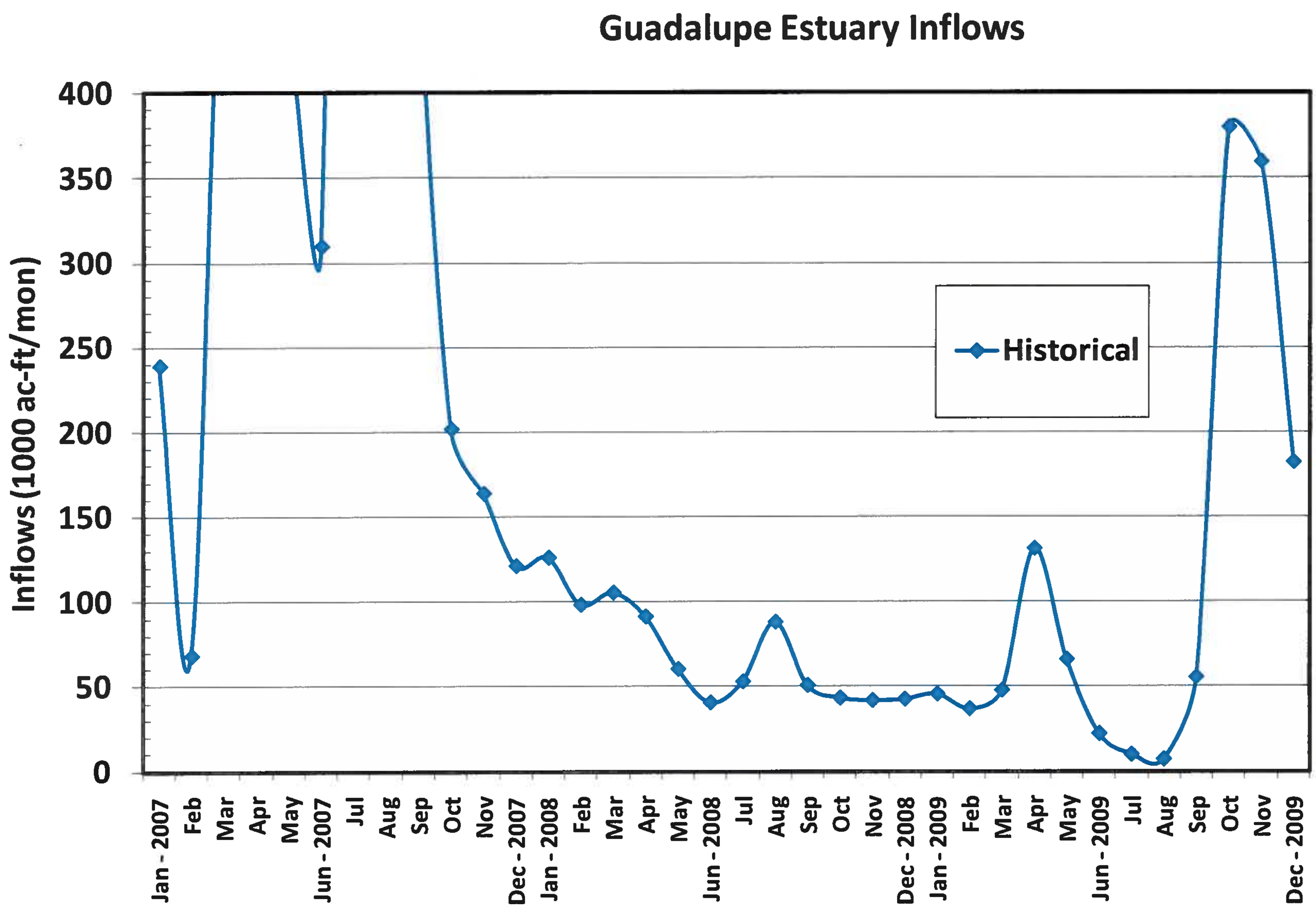
	G1	G2
Guadalupe Project	no change in the overall occurrence of the problematic G1-D spring seasons compared to the Baseline	minimal incremental change in the summertime salinity response in the Guadalupe Estuary as compared to the sometimes problematic levels evident in the Region L Baseline
San Antonio Project	non-attainment occurrences evident in the Region L Baseline that are cause for concern are only slightly increased	would only be very minimal incremental change in the summertime salinity response in the Guadalupe Estuary as compared to the sometimes problematic levels already evident in the Region L Baseline.

subject to the BBEST Criteria & the conditions of Region L WAM

END

ARCHIVE


Guadalupe Estuary, Criteria Set G1 - Category Attainment 1941-89
No. of Years Inflows in Category
0
2
4
6
8
10
12
14
16
Historical
Region L Baseline
TCEQ Baseline (Run 3)
>A-pr
A-pr
A
B
C
CC
D


Guadalupe Estuary Inflows
Inflows (1000 ac-ft/mon)
400
350
300
250
200
150
100
50
0
Historical
Jan - 2007
Feb
Mar
Apr
May
Jun - 2007
Jul
Aug
Sep
Oct
Nov
Dec - 2007
Jan - 2008
Feb
Mar
Apr
May
Jun - 2008
Jul
Aug
Sep
Oct
Nov
Dec - 2008
Jan - 2009
Feb
Mar
Apr
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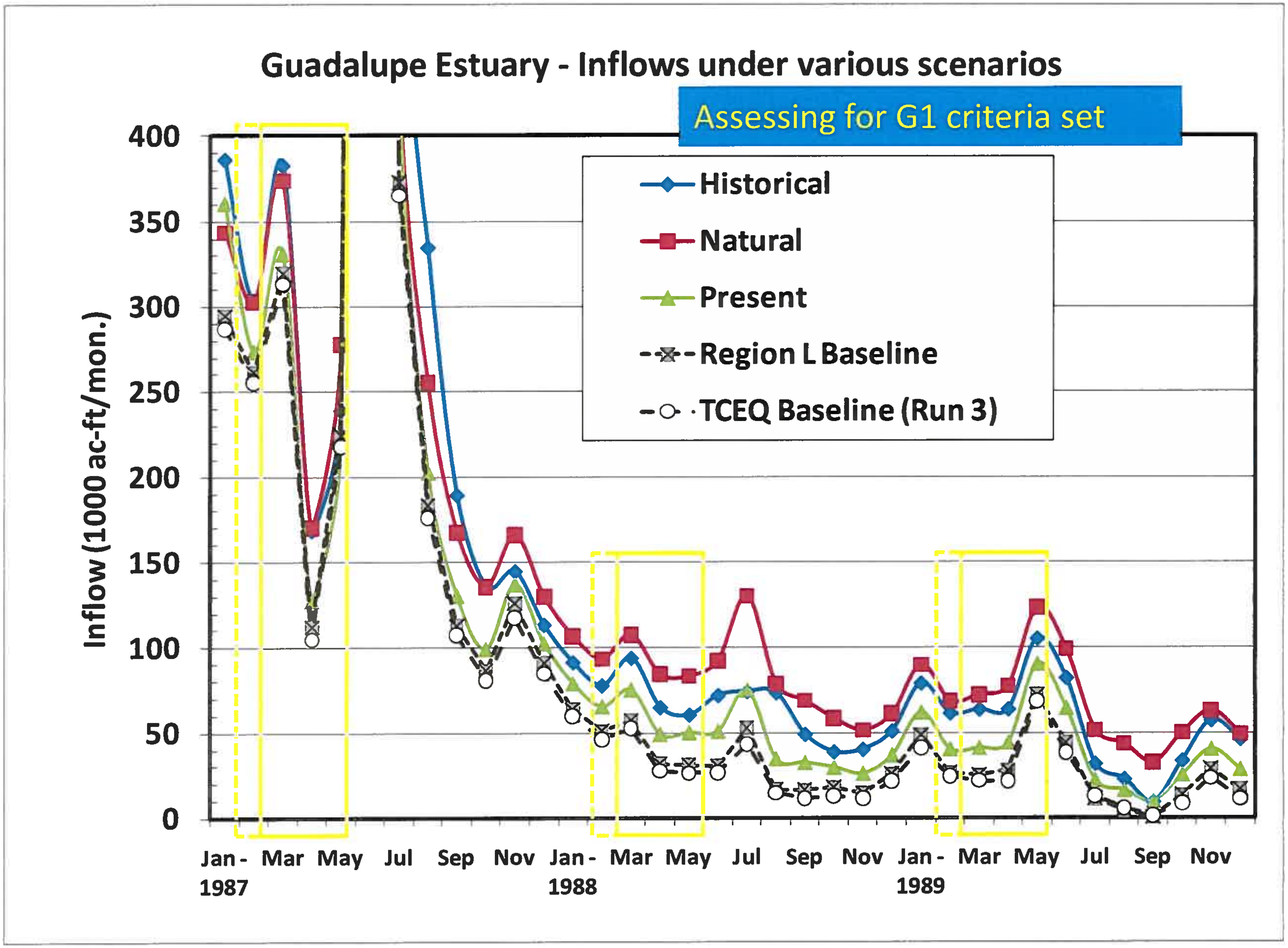
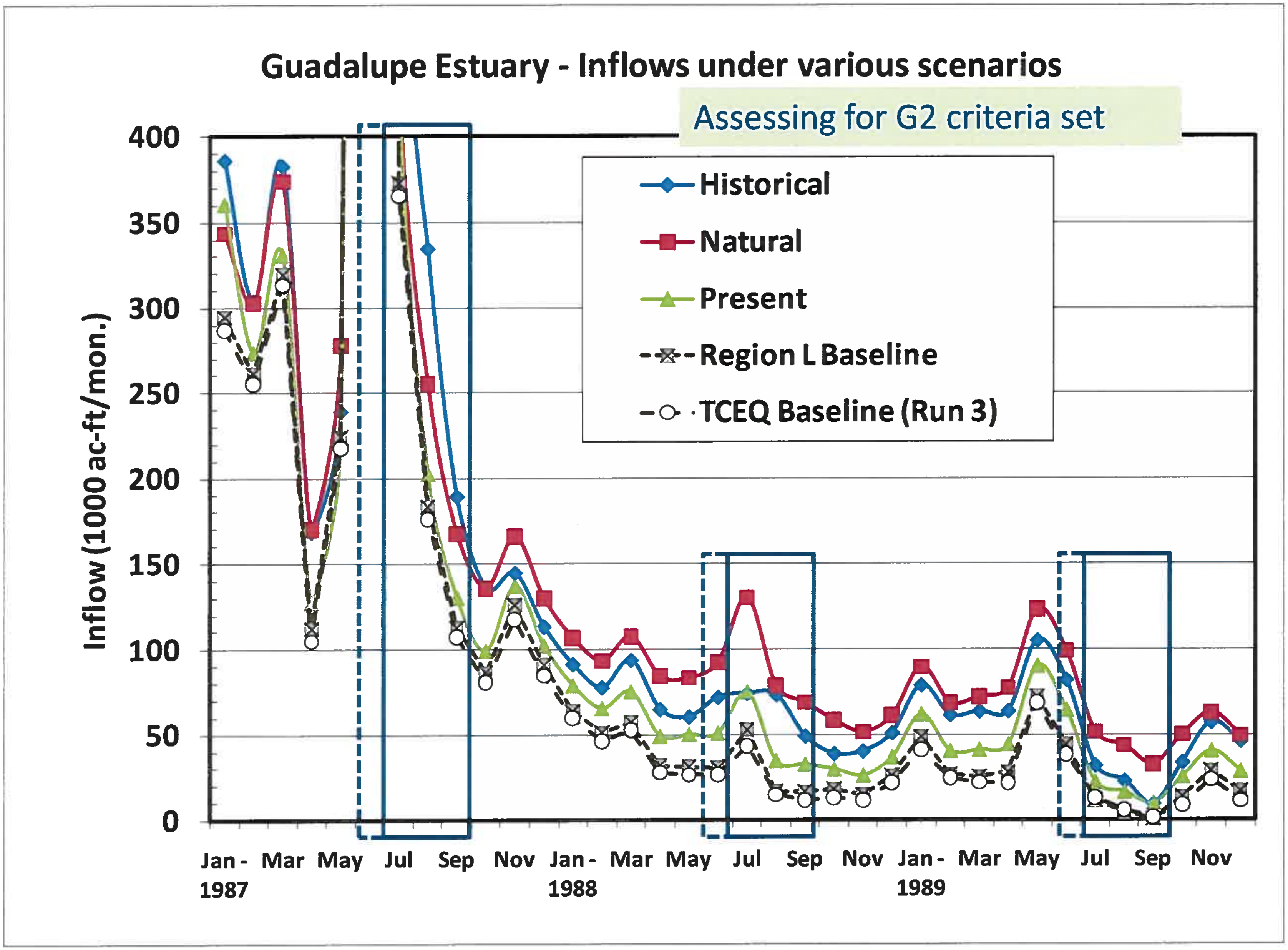
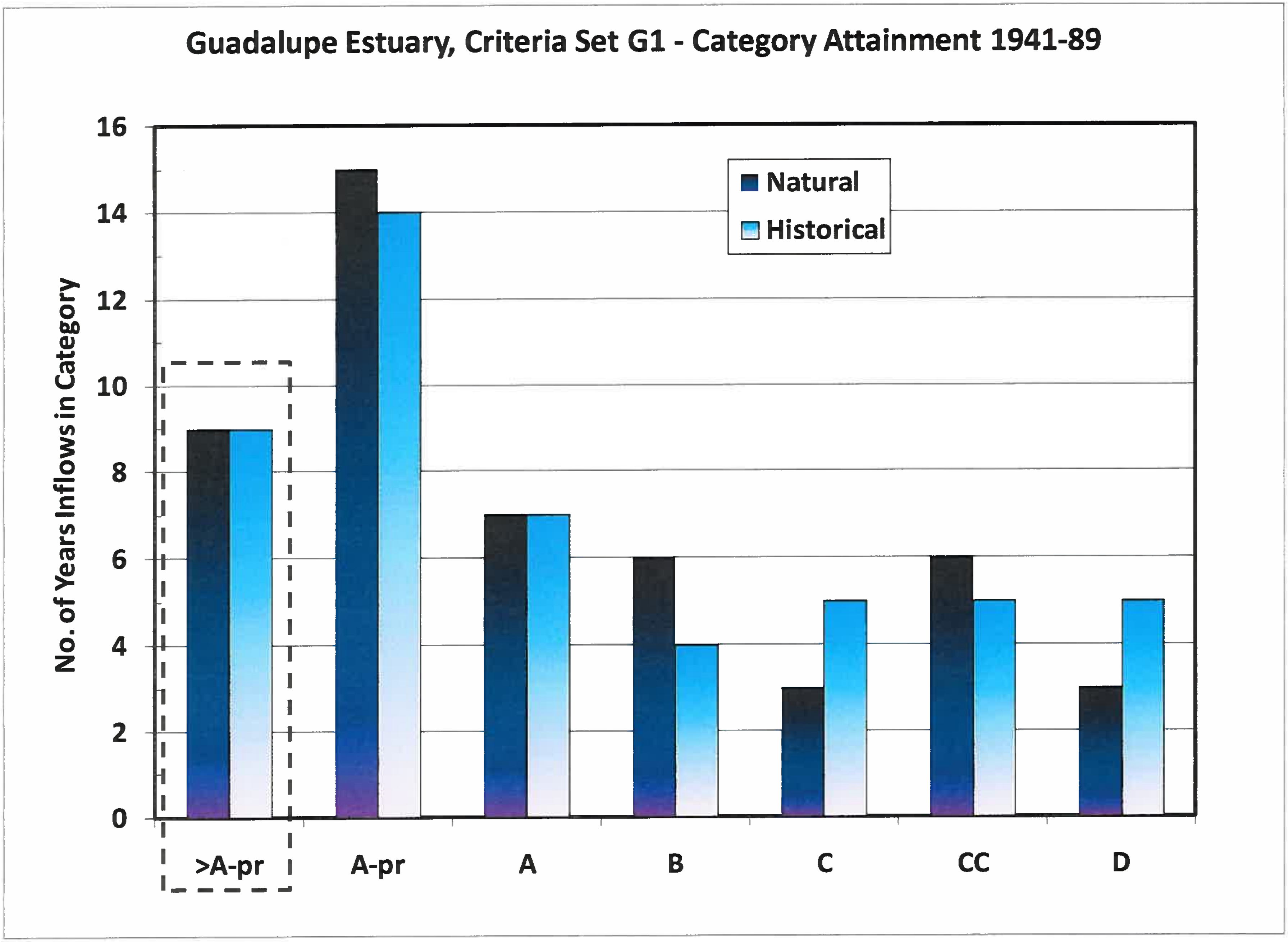
Jun - 2009
Jul
Aug
Sep
Oct
Nov
Dec - 2009



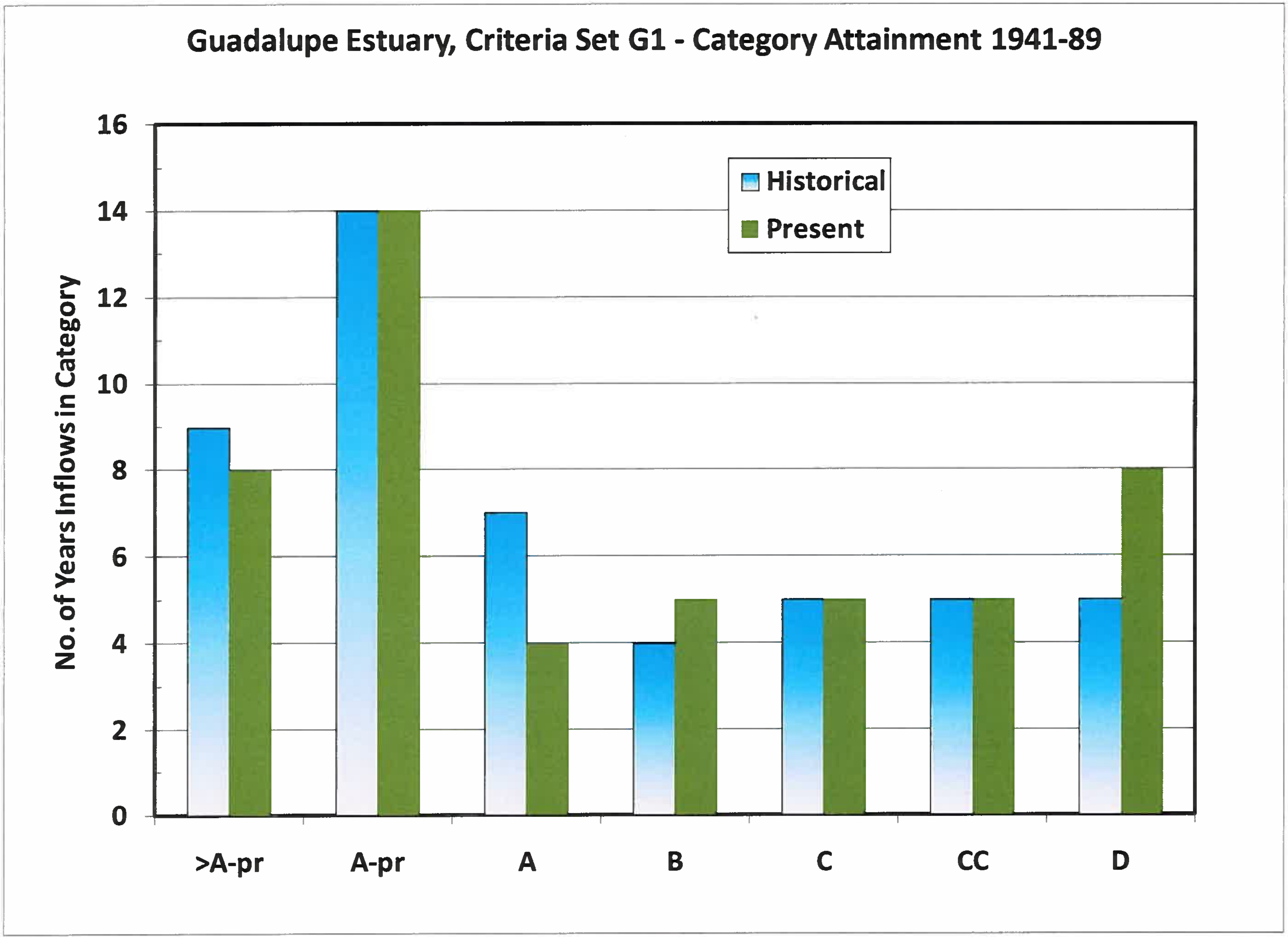
Guadalupe Estuary - Inflows under various scenarios
Assessing for G1 criteria set
Historical
Natural
Present
Region L Baseline
TCEQ Baseline (Run 3)
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov



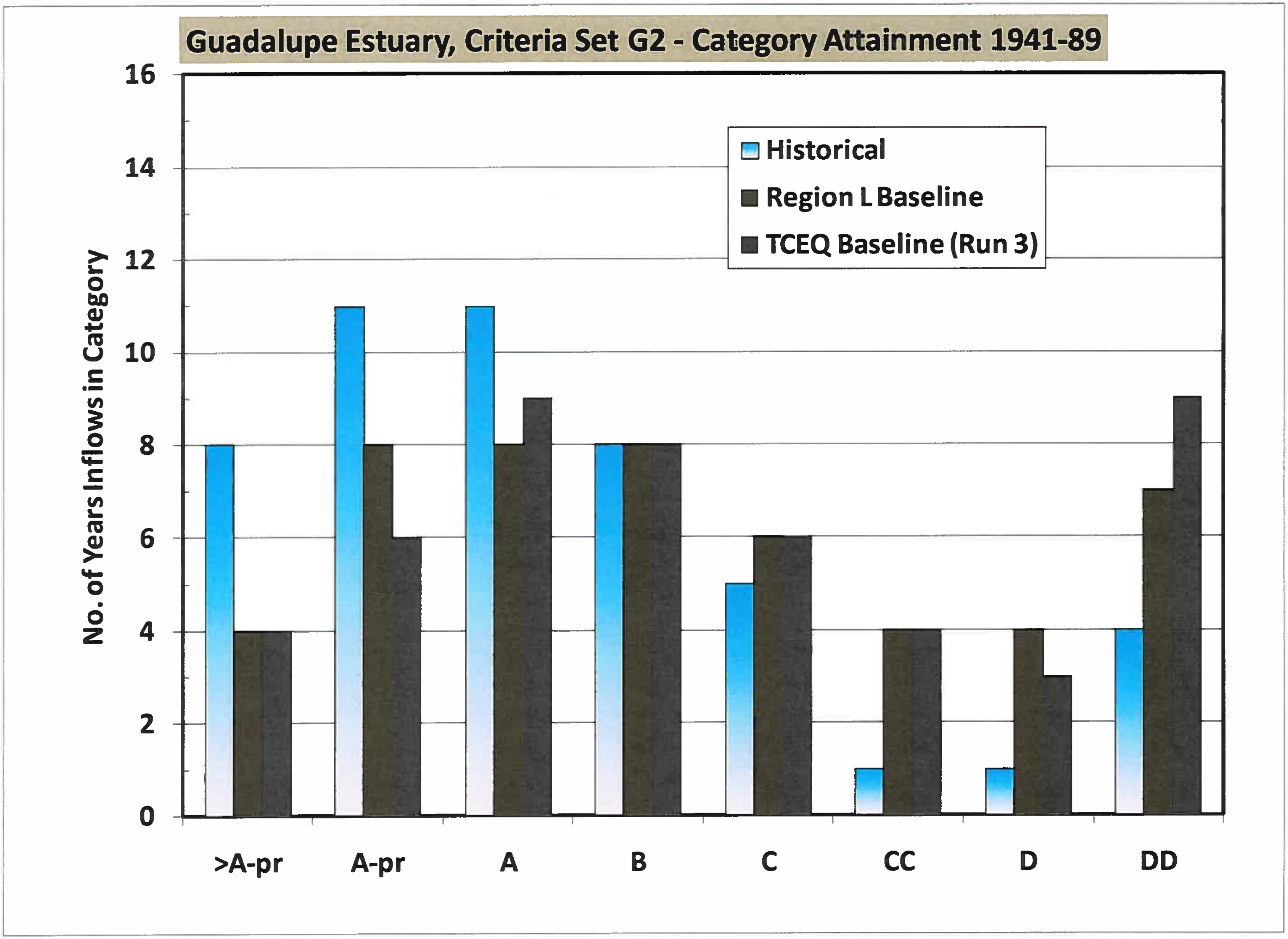
Guadalupe Estuary - Inflows under various scenarios
Assessing for G2 criteria set
Historical
Natural
Present
Region L Baseline
TCEQ Baseline (Run 3)
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov



Guadalupe Estuary, Criteria Set G1 - Category Attainment 1941-89
No. of Years Inflows in Category
16
14
12
10
8
6
4
2
0
Natural
Historical
>A-pr
A-pr
A
B
C
CC
D



Guadalupe Estuary, Criteria Set G1 - Category Attainment 1941-89
No. of Years Inflows in Category
16
14
12
10
8
6
4
2
0
Historical
Present
>A-pr
A-pr
A
B
C
CC
D


Guadalupe Estuary, Criteria Set G2 - Category Attainment 1941-89
No. of Years Inflows in Category
0
2
4
6
8
10
12
14
16
Historical
Region L Baseline
TCEQ Baseline (Run 3)
>A-pr
A-pr
A
B
C
CC
D
DD

Meeting of the

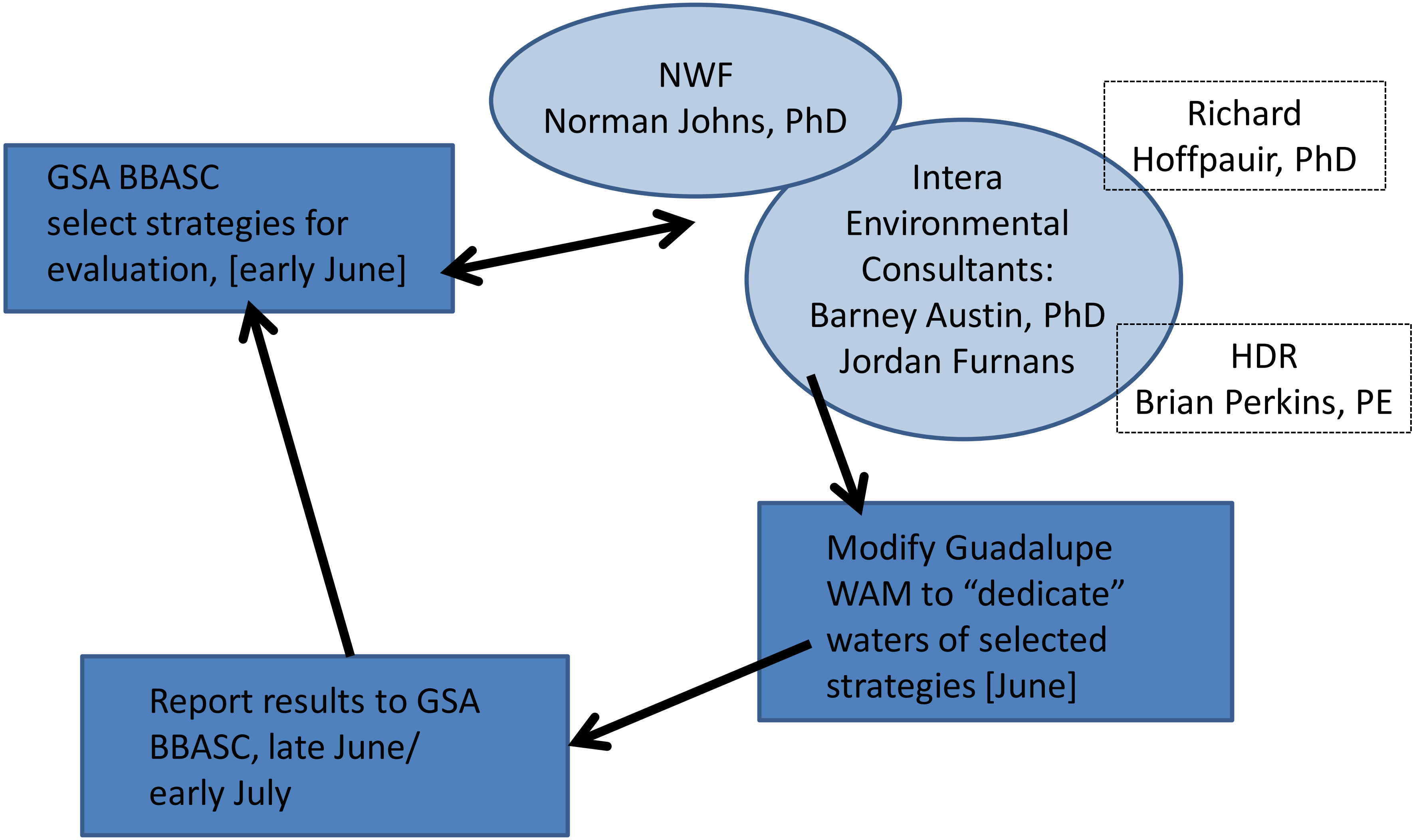
Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Report on Evaluations of "Strategies" To Meet Environmental Flow Standards

July 6, 2011

NATIONAL WILDLIFE FEDERATION

INTERA Geosciences & Engineering


NWF
Norman Johns, PhD
Richard
Hoffpauir, PhD
GSA BBASC
select strategies for
evaluation, [early June]
Intera
Environmental
Consultants:
Barney Austin, PhD
Jordan Furnans
HDR
Brian Perkins, PE
Modify Guadalupe
WAM to "dedicate"
waters of selected
strategies [June]
Report results to GSA
BBASC, late June/
early July

Summary – Attainment of G2 Summer Criteria (oysters)

with the Guadalupe River Project

Previously presented by BBEST

Counts	Criteria G2								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. Guadalupe Project	4	8	8	8	7	3	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

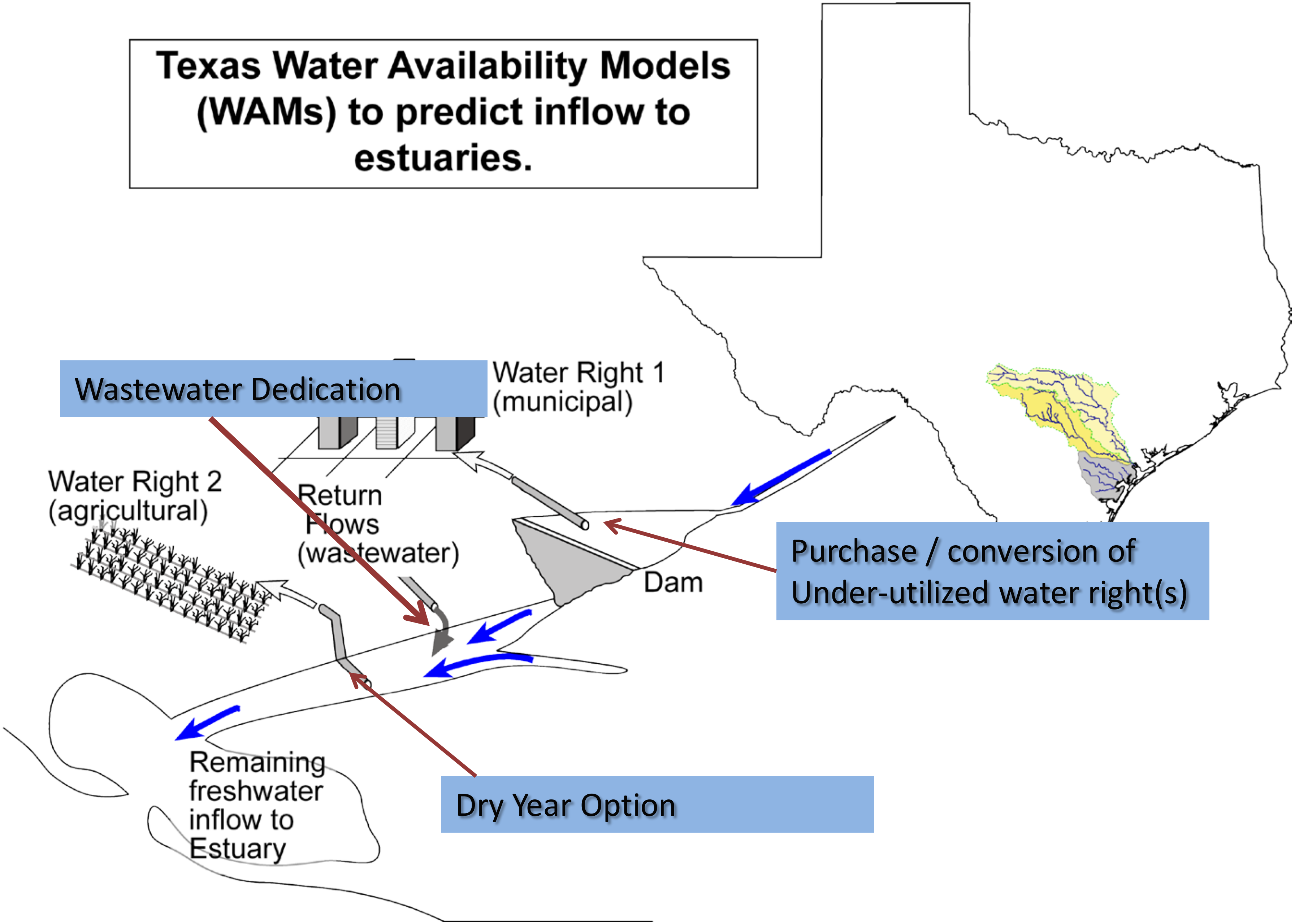
see Tables 4.5-2; 4.5-4

Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
		>12%	>17%				<=6%	
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guadalupe Project		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2

Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
			>=30%		>10%	<=1/6	<=9%	
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
w. Guadalupe Project			32.7%		20.4%	30.0%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

Color coding convention	
(green)	-OK, met criteria
(gray)	-Near miss. (rounding; p-o-record)
(orange)	-Not met, but departure not great
(brown)	-Very bad


Texas Water Availability Models (WAMs) to predict inflow to estuaries.
Wastewater Dedication
Water Right 1 (municipal)
Water Right 2 (agricultural)
Return Flows (wastewater)
Dam
Purchase / conversion of Under-utilized water right(s)
Remaining freshwater inflow to Estuary
Dry Year Option

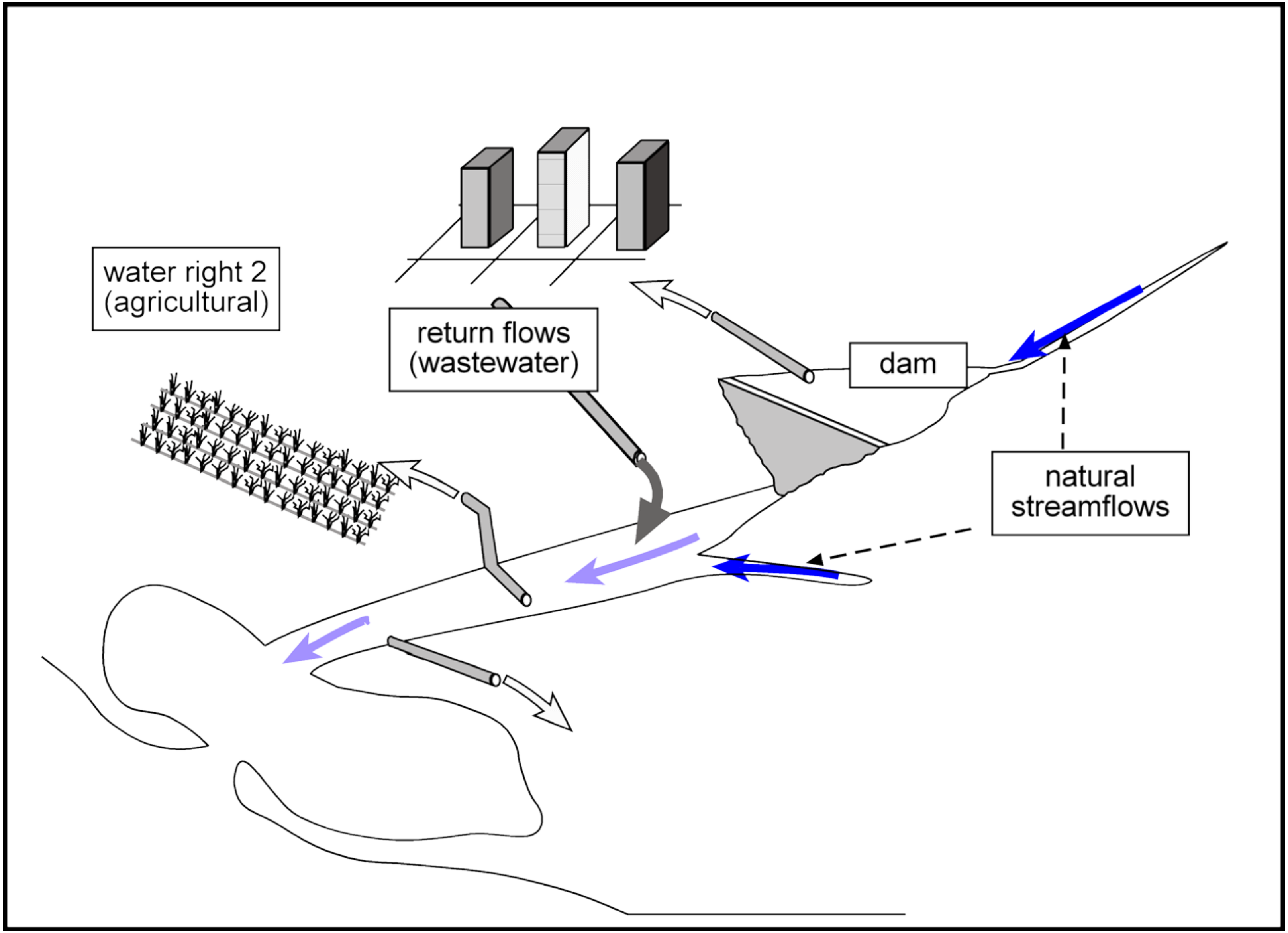
Strategies Evaluated

#1 Wastewater Dedication [up to 10]
1a – 60,000 ac-ft/yr
1b – 120,000 ac-ft/yr

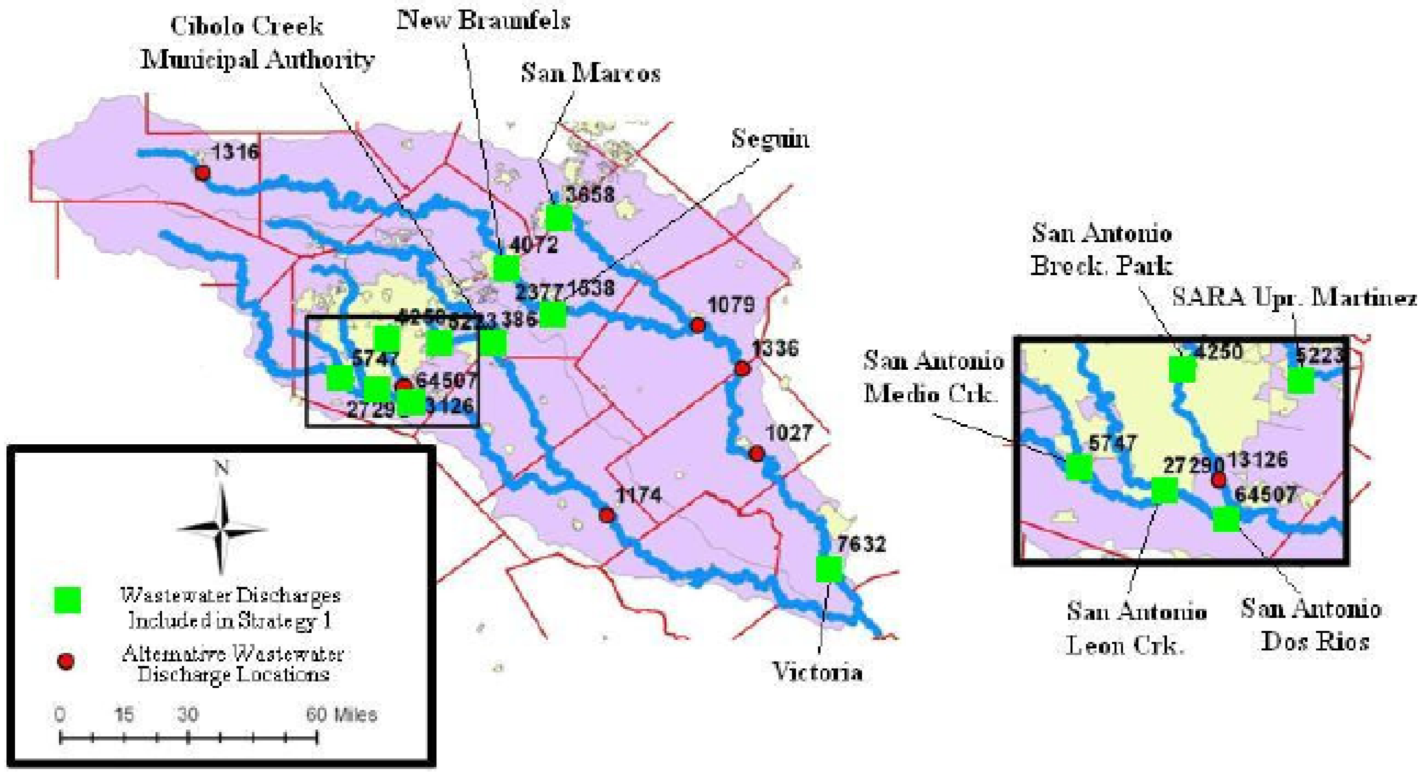
#2 Dry Year Option [up to 5]
2a – 16,000 ac-ft/yr
2b – 32,000 ac-ft/yr

#3 Conversion of Under-utilized Water Rights [up to 5]
3a – 48,000 ac-ft/yr
3b – 96,000 ac-ft/yr

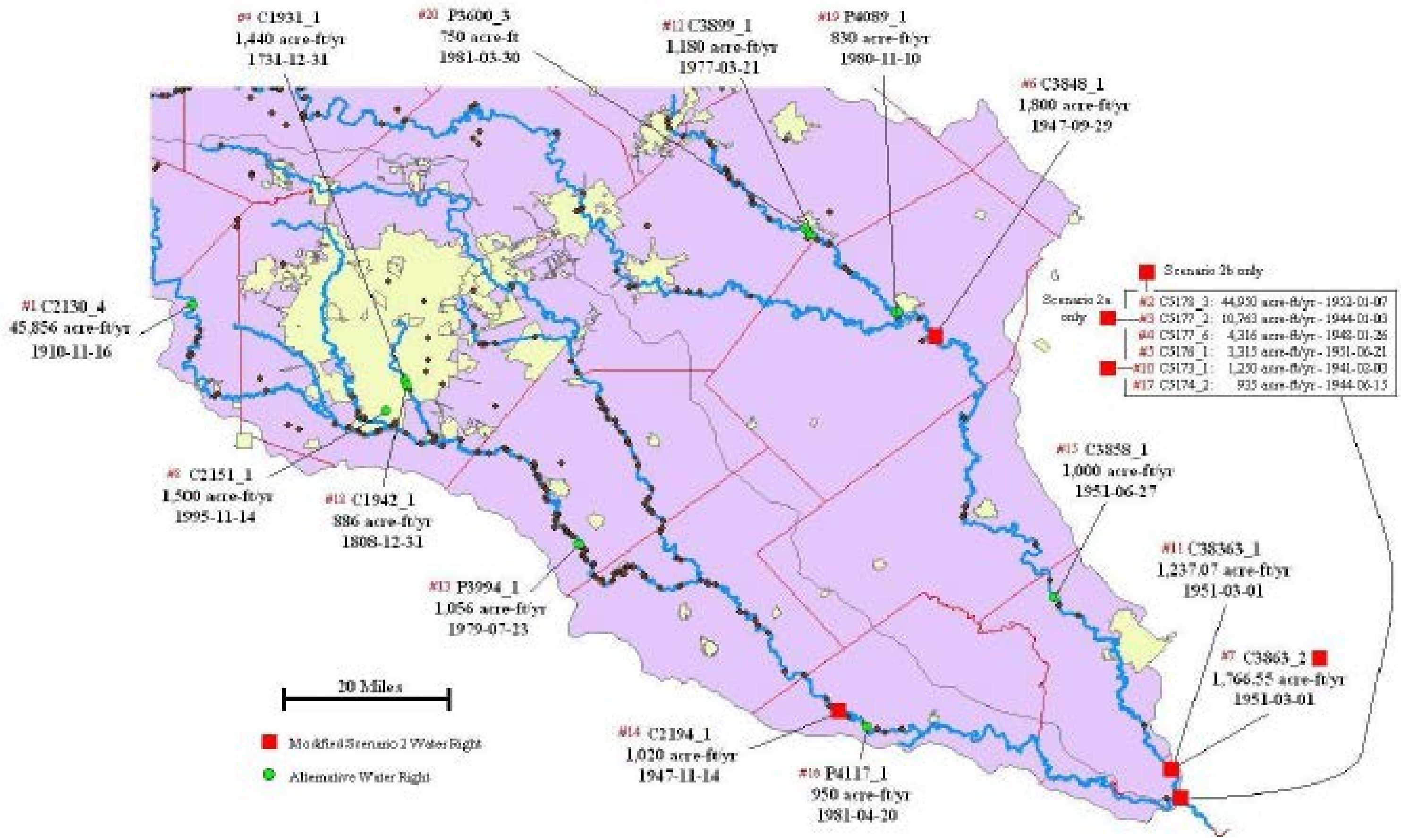
#4 Combination Strategy
1a & 2a & 3a simultaneously

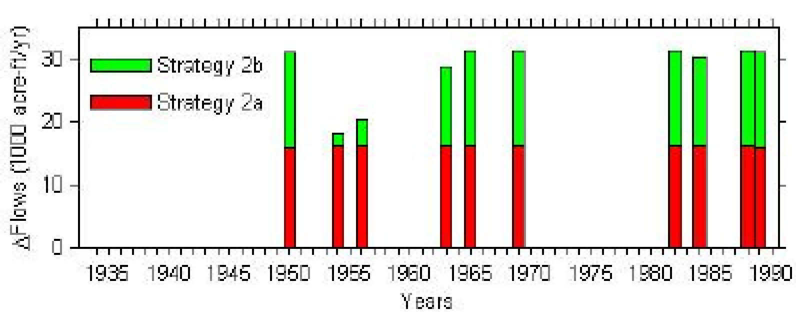

water right 2
(agricultural)
return flows
(wastewater)
dam
natural
streamflows

Strategy #1 Wastewater Dedication – selected discharges

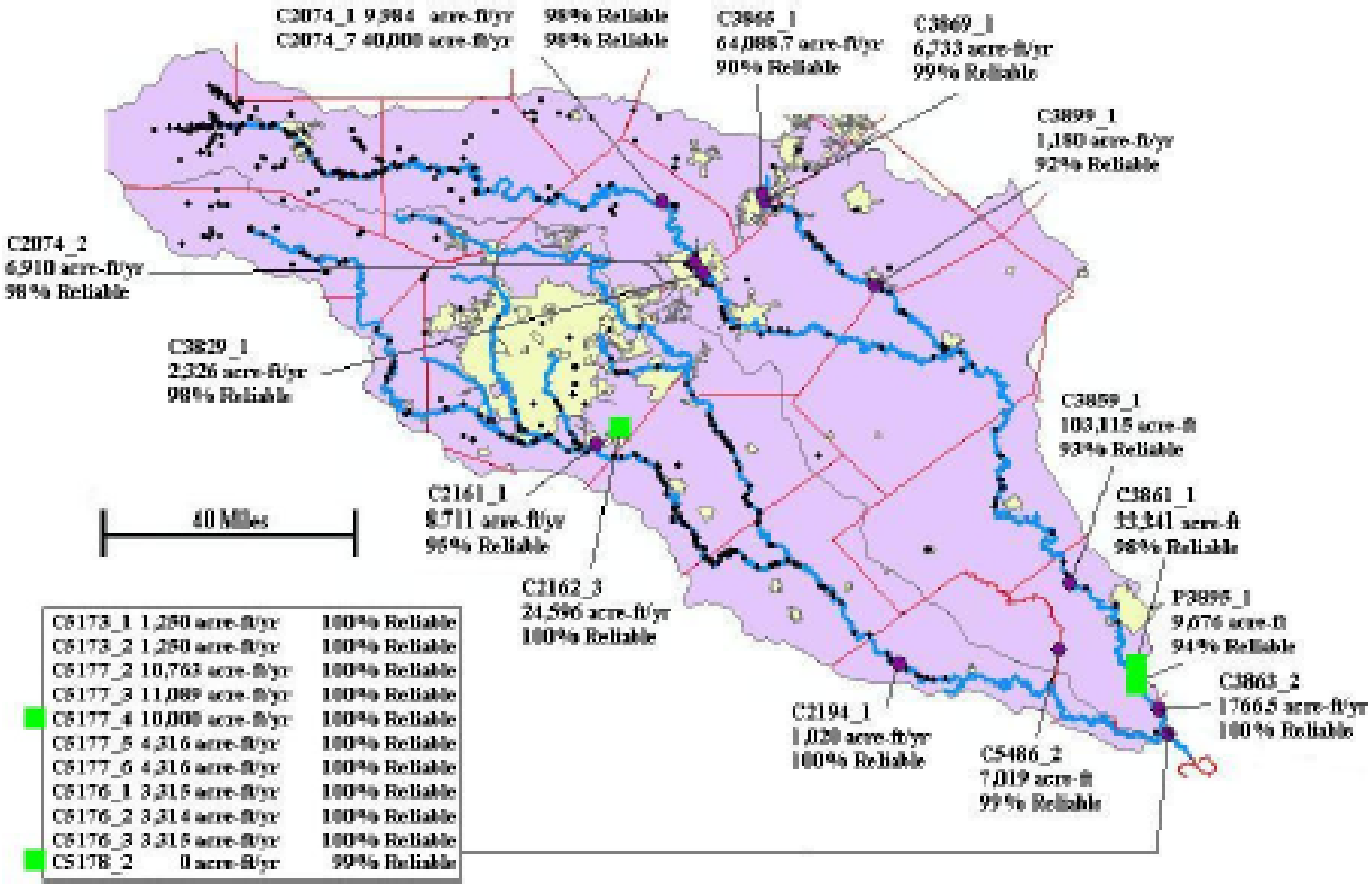


Strategy #2 Dry Year Option – selected irrigation rights

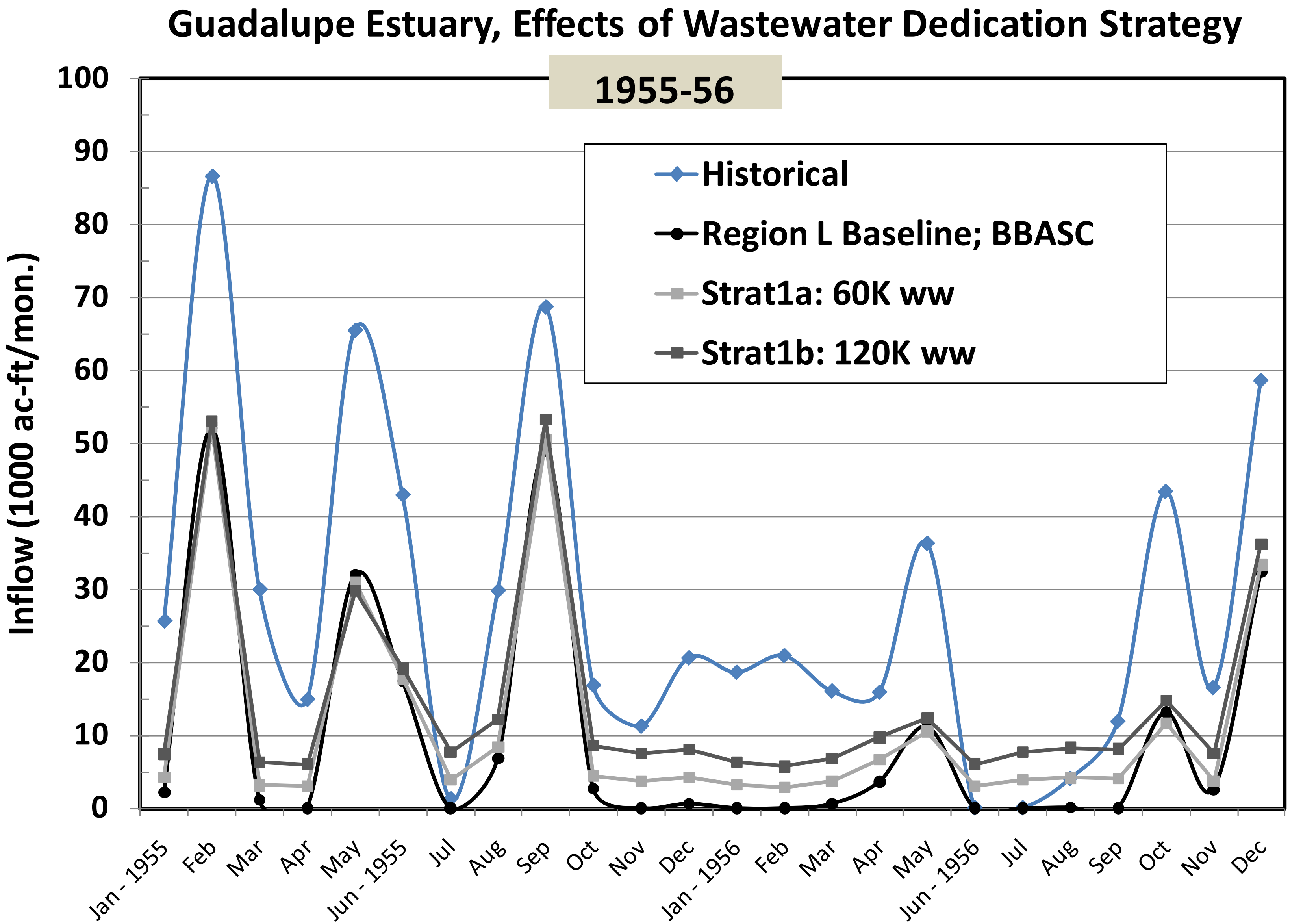




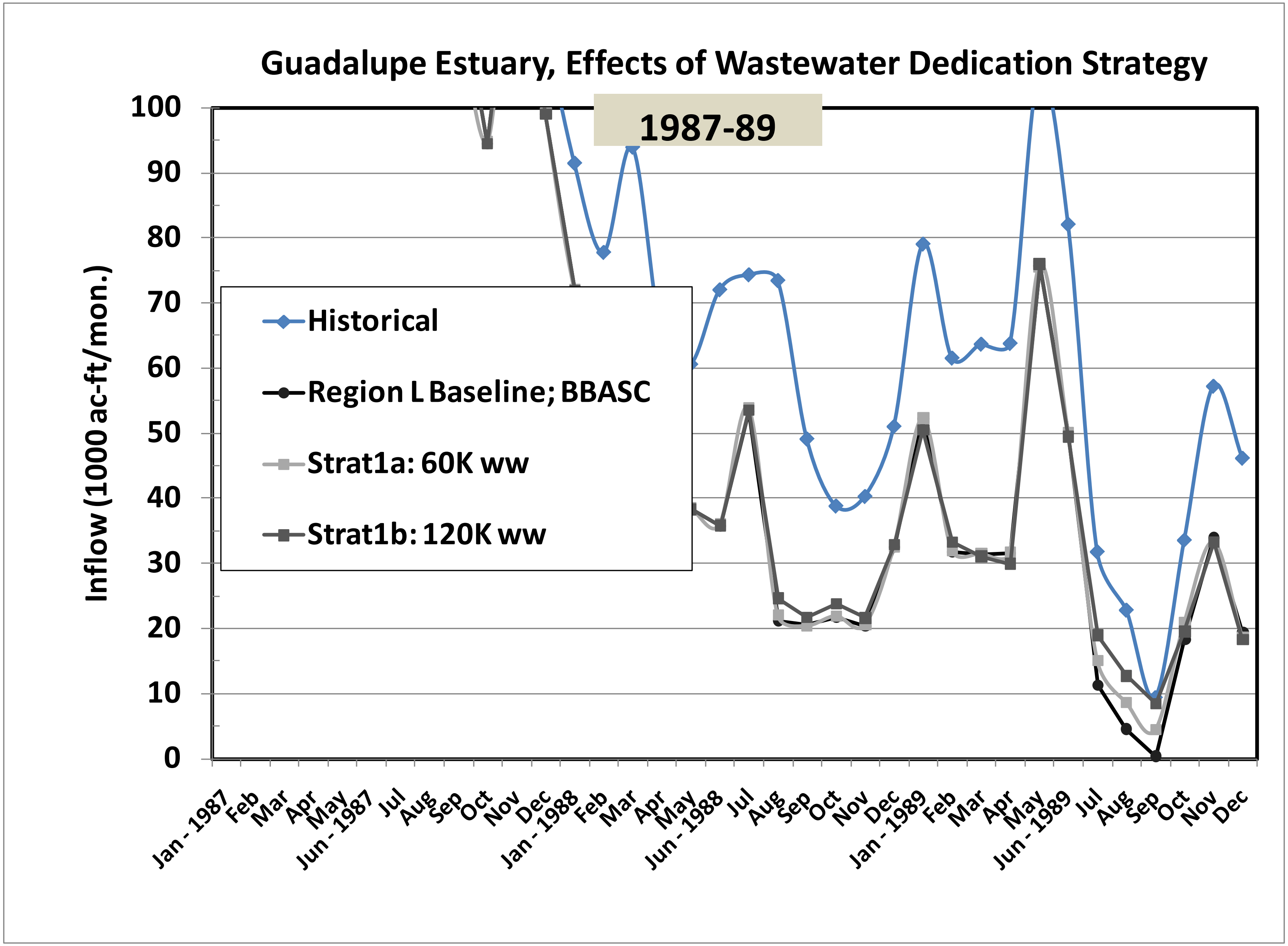
Strategy #3 Under-utilized Rights– selected water rights



C5173_1	1,250 acre-ft/yr	100% Reliable
C5173_2	1,250 acre-ft/yr	100% Reliable
C5177_2	10,763 acre-ft/yr	100% Reliable
C5177_3	11,089 acre-ft/yr	100% Reliable
C5177_4	10,000 acre-ft/yr	100% Reliable
C5177_5	4,316 acre-ft/yr	100% Reliable
C5177_6	4,316 acre-ft/yr	100% Reliable
C5176_1	3,315 acre-ft/yr	100% Reliable
C5176_2	3,314 acre-ft/yr	100% Reliable
C5176_3	3,315 acre-ft/yr	100% Reliable
C5178_2	0 acre-ft/yr	99% Reliable



Guadalupe Estuary, Effects of Wastewater Dedication Strategy
1955-56
Historical
Region L Baseline; BBASC
Strat1a: 60K ww
Strat1b: 120K ww
Inflow (1000 ac-ft/mon.)
0
10
20
30
40
50
60
70
80
90
100
Jan - 1955
Feb
Mar
Apr
May
Jun - 1955
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1956
Feb
Mar
Apr
May
Jun - 1956
Jul
Aug
Sep
Oct
Nov
Dec



Guadalupe Estuary, Effects of Wastewater Dedication Strategy
1987-89
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Historical
Region L Baseline; BBASC
Strat1a: 60K ww
Strat1b: 120K ww
Jan - 1987
Feb
Mar
Apr
May
Jun - 1987
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1988
Feb
Mar
Apr
May
Jun - 1988
Jul
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Oct
Nov
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Jan - 1989
Feb
Mar
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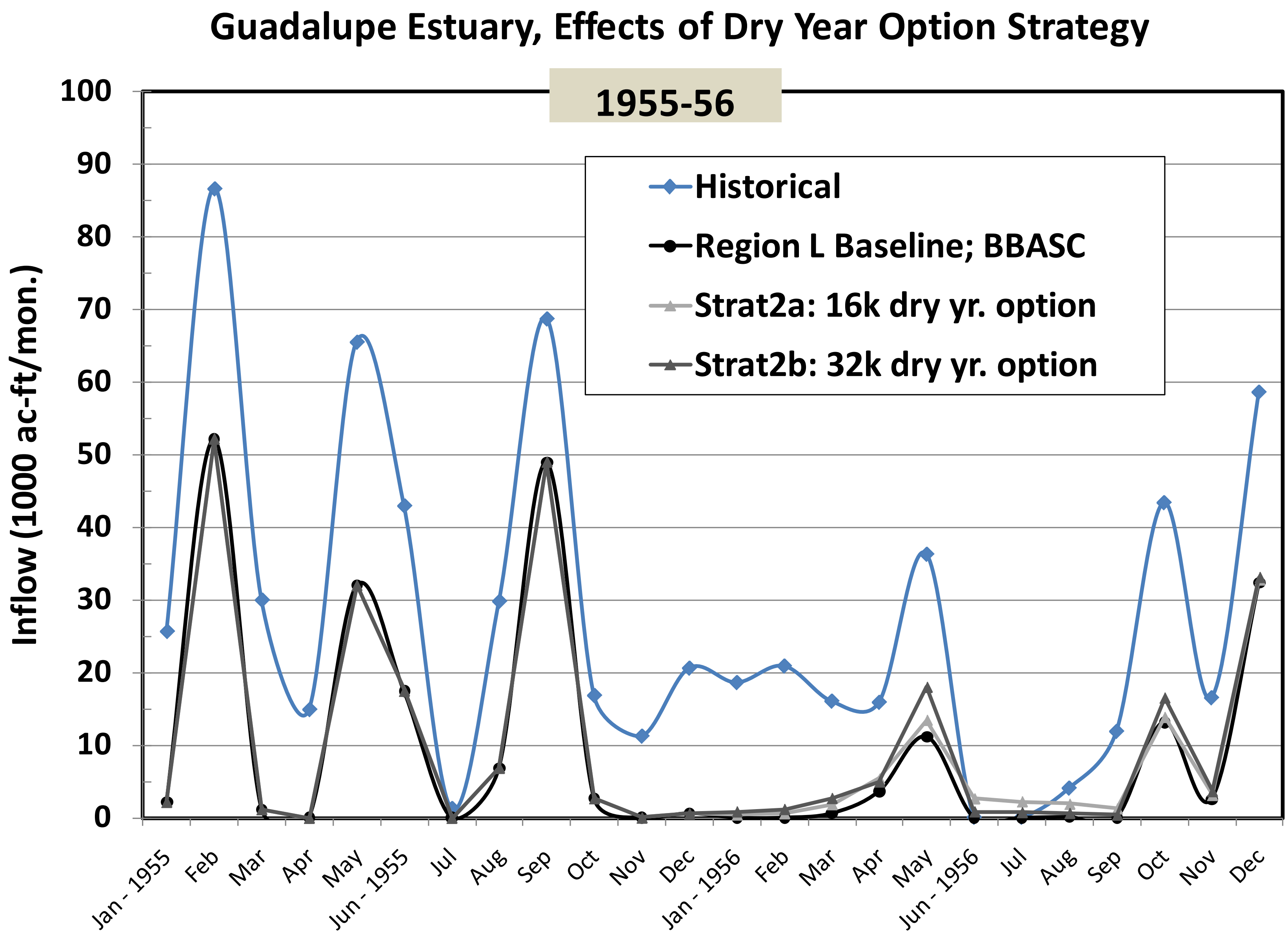
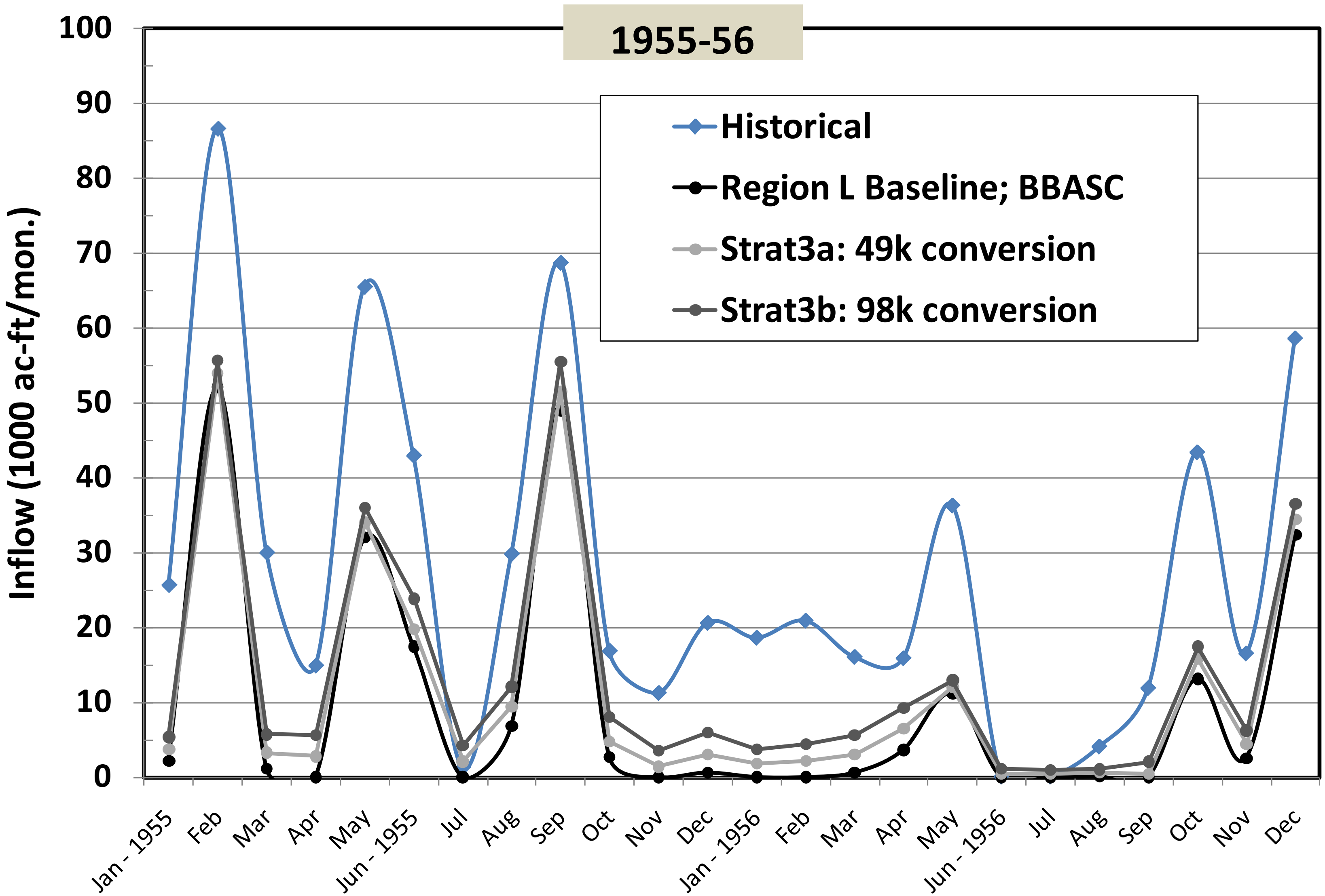
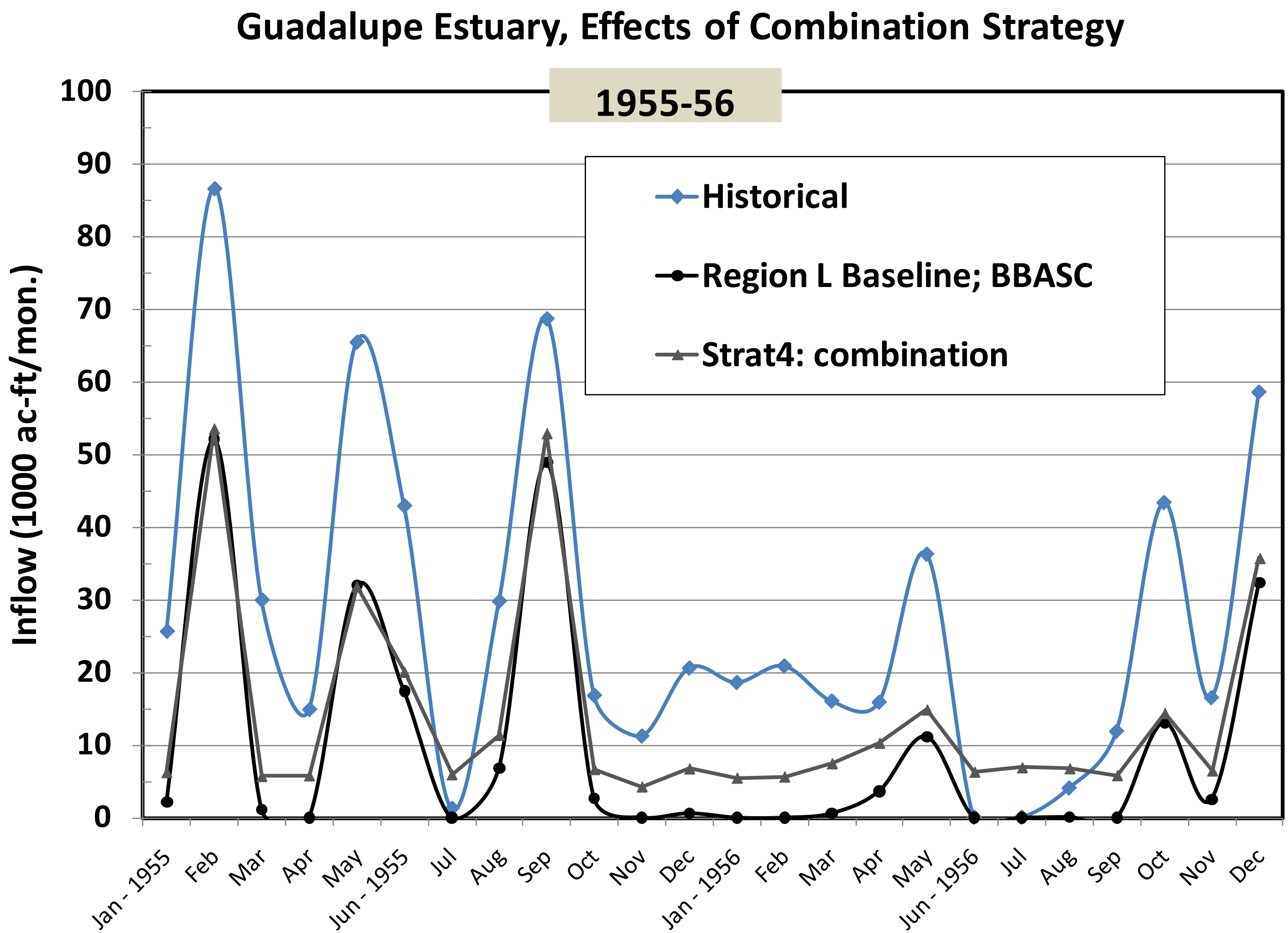
Aug
Sep
Oct
Nov
Dec



Guadalupe Estuary, Effects of Dry Year Option Strategy
1955-56
Historical
Region L Baseline; BBASC
Strat2a: 16k dry yr. option
Strat2b: 32k dry yr. option
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1955
Feb
Mar
Apr
May
Jun - 1955
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1956
Feb
Mar
Apr
May
Jun - 1956
Jul
Aug
Sep
Oct
Nov
Dec

Guadalupe Estuary, Effects of Under-Utilized Rights Conversion Strategy





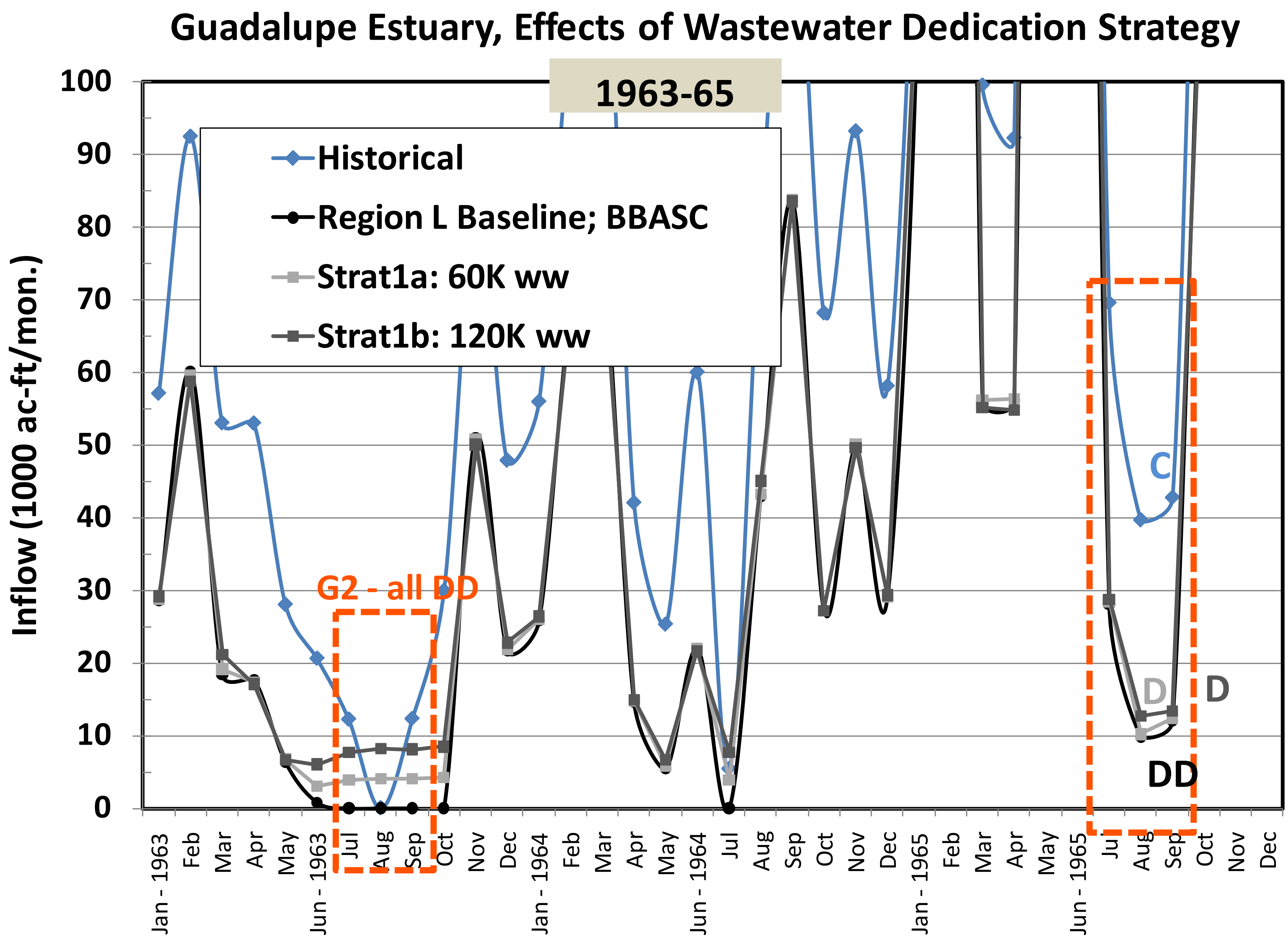
Guadalupe Estuary, Effects of Combination Strategy
1955-56
Historical
Region L Baseline; BBASC
Strat4: combination
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1955
Feb
Mar
Apr
May
Jun - 1955
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1956
Feb
Mar
Apr
May
Jun - 1956
Jul
Aug
Sep
Oct
Nov
Dec

Strategy Effects: #1 Wastewater Dedication
Attainment of G1 Springtime Criteria (Rangia)

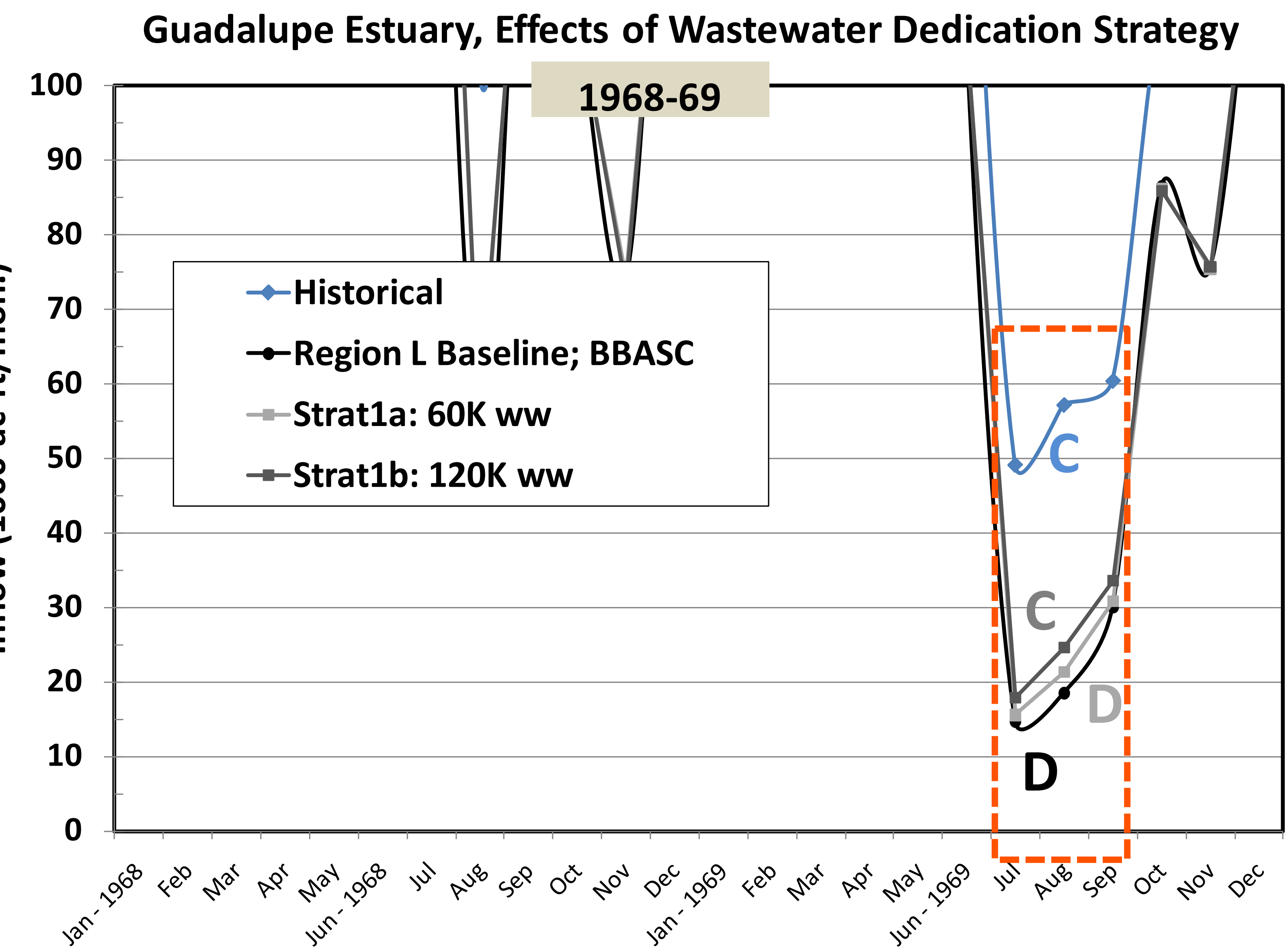
Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Region L Baseline; BBASC	7	10	8	3	3	4	**14**	49
Strat1a - Ww Ded. 60k/yr	7	10	8	3	3	4	14	49
Strat1b - Ww Ded. 120k/yr	7	10	8	3	3	4	14	49

Strategy Effects: #1 Wastewater Dedication
Attainment of G2 Summer Criteria (oysters)

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Region L Baseline; BBASC	4	8	8	8	7	**3**	**3**	**8**	49
Strat1a - Ww Ded. 60k/yr	4	8	8	8	7	3	4	7	49
Strat1b - Ww Ded. 120k/yr	4	8	8	8	8	3	3	7	49



Guadalupe Estuary, Effects of Wastewater Dedication Strategy
1963-65
Historical
Region L Baseline; BBASC
Strat1a: 60K ww
Strat1b: 120K ww
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1963
Feb
Mar
Apr
May
Jun - 1963
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1964
Feb
Mar
Apr
May
Jun - 1964
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1965
Feb
Mar
Apr
May
Jun - 1965
Jul
Aug
Sep
Oct
Nov
Dec
G2 - all DD
C
D
D
DD


Guadalupe Estuary, Effects of Wastewater Dedication Strategy
1968-69
Historical
Region L Baseline; BBASC
Strat1a: 60K ww
Strat1b: 120K ww
C
C
D
D
100
90
80
70
60
50
40
30
20
10
0
Jan - 1968
Feb
Mar
Apr
May
Jun - 1968
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1969
Feb
Mar
Apr
May
Jun - 1969
Jul
Aug
Sep
Oct
Nov
Dec

Strategy Effects: #2 Dry Year Option
Attainment of G1 Springtime Criteria (Rangia)

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Region L Baseline; BBASC	7	10	8	3	3	4	**14**	49
Strat2a: 16k dry yr. option	7	11	7	3	3	5	13	49
Strat2b: 32k dry yr. option	7	11	7	3	3	5	13	49

Strategy Effects: #2 Dry Year Option
Attainment of G2 Summer Criteria (oysters)

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Region L Baseline; BBASC	4	8	8	8	7	**3**	**3**	**8**	49
Strat2a: 16k dry yr. option	4	8	8	8	7	3	4	7	49
Strat2b: 32k dry yr. option	4	8	8	8	7	3	4	7	49

Strategy Effects: #3 Convert Under-utilized
#4 Combination (1a, 2a, 3a)
Attainment of G1 Springtime Criteria (Rangia)

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Region L Baseline; BBASC	7	10	8	3	3	4	**14**	49
Strat3a: 49k conversion	7	11	7	5	3	4	12	49
Strat3b: 98k conversion	7	12	6	5	3	5	11	49
Strat4: combination	7	11	7	5	3	5	11	49

Strategy Effects: #3 Convert Under-utilized
#4 Combination (1a, 2a, 3a)
Attainment of G2 Summer Criteria (oysters)

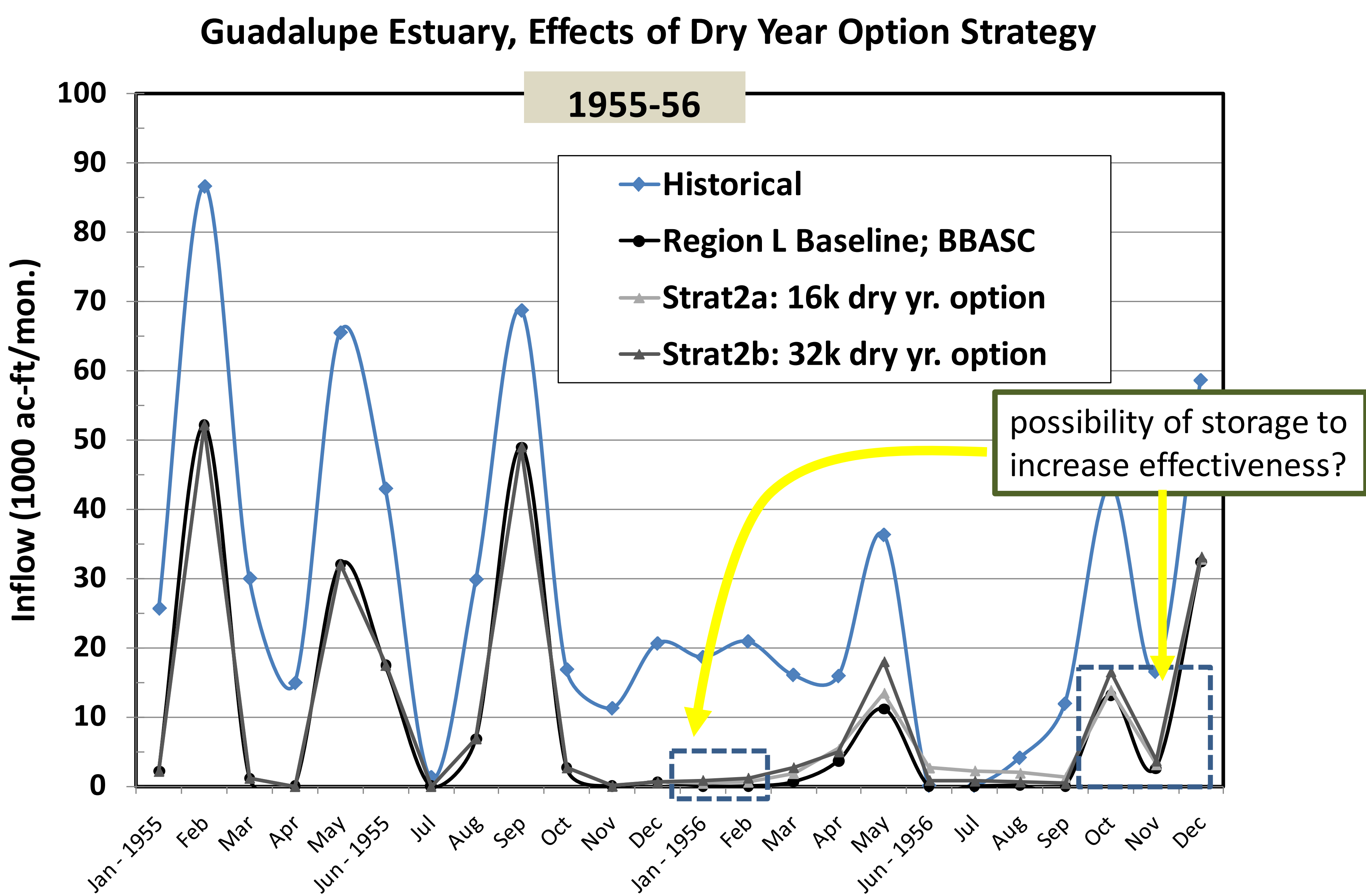
Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Region L Baseline; BBASC	4	8	8	8	7	**3**	**3**	**8**	49
Strat3a: 49k conversion	4	8	8	9	6	3	4	7	49
Strat3b: 98k conversion	4	8	8	10	7	2	4	6	49
Strat4: combination	4	8	8	9	7	3	3	7	49

CONCLUSIONS

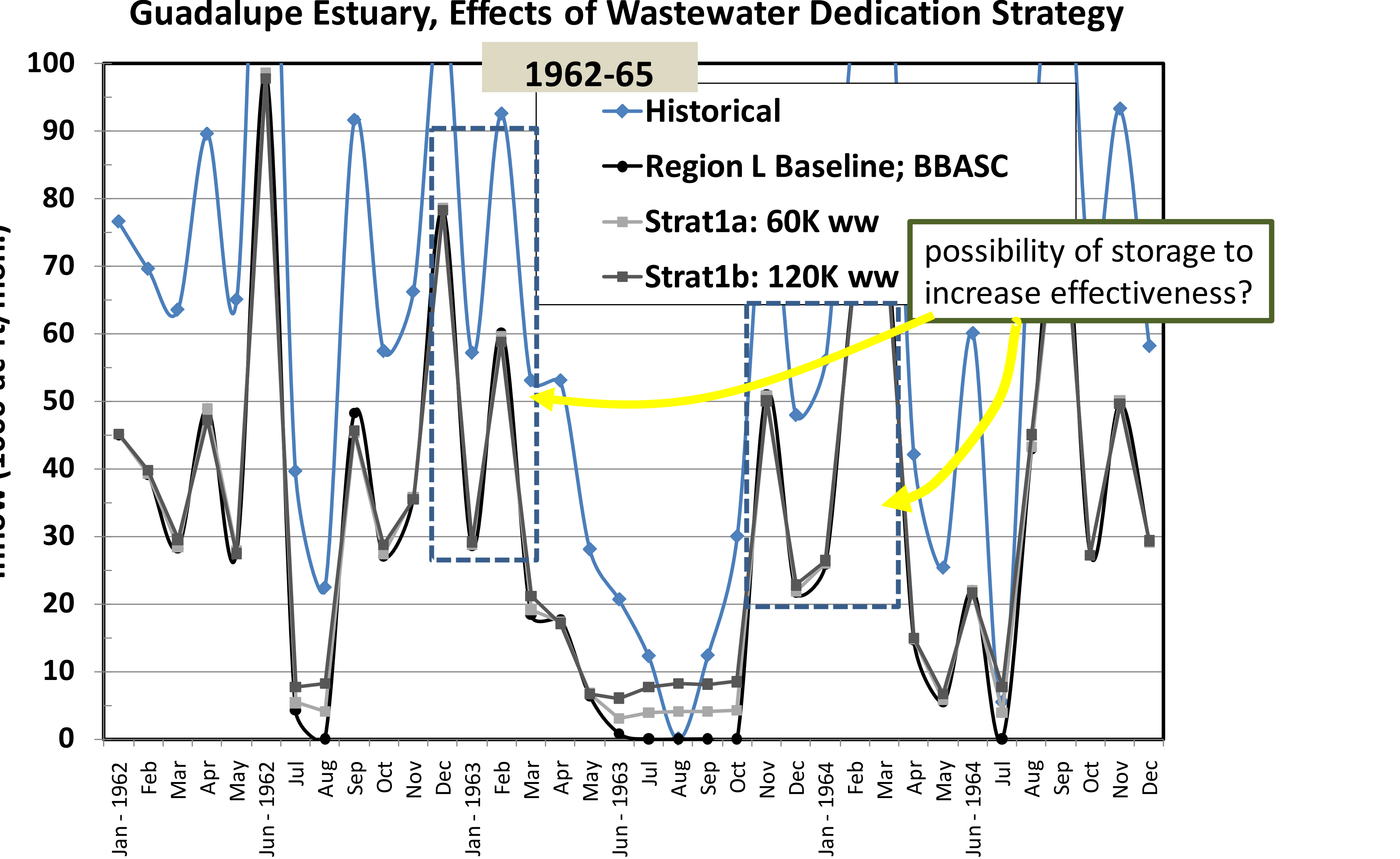
- a) Strategies with most effect of those examined, were wastewater dedication and conversion of under-utilized rights [and combination];

-b) Strategies, if implemented as modeled here, would lead to modest changes in categorical attainment in both the G1 and G2 criteria suites;

- c) For many years without categorical improvement, especially the driest, many positive changes in inflow would still benefit the estuary;



Guadalupe Estuary, Effects of Dry Year Option Strategy
1955-56
Historical
Region L Baseline; BBASC
Strat2a: 16k dry yr. option
Strat2b: 32k dry yr. option
possibility of storage to increase effectiveness?
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1955
Feb
Mar
Apr
May
Jun - 1955
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1956
Feb
Mar
Apr
May
Jun - 1956
Jul
Aug
Sep
Oct
Nov
Dec


Guadalupe Estuary, Effects of Wastewater Dedication Strategy
1962-65
Historical
Region L Baseline; BBASC
Strat1a: 60K ww
Strat1b: 120K ww
possibility of storage to increase effectiveness?
0
10
20
30
40
50
60
70
80
90
100
Jan - 1962
Feb
Mar
Apr
May
Jun - 1962
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1963
Feb
Mar
Apr
May
Jun - 1963
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1964
Feb
Mar
Apr
May
Jun - 1964
Jul
Aug
Sep
Oct
Nov
Dec

CONCLUSIONS

- a) Strategies with most effect of those examined, were wastewater dedication and conversion of under-utilized rights [and combination];

-b) Strategies, if implemented as modeled here, would lead to modest changes in categorical attainment in both the G1 and G2 criteria suites;

- c) For many years without categorical improvement, especially the driest, many positive changes in inflow would still benefit the estuary;

- d) Potential for synergistic effects if Strategy(ies) could be coupled with storage.

Guadalupe, San Antonio, Mission, & Aransas Rivers and Mission, Copano, Aransas, & San Antonio Bays Basin and Bay Area Stakeholder Committee (GSA BBASC)

GSA BBASC Recommendations: Pulse Implementation Sub-Committee

R Brian Perkins, PE

July 18-19, 2011

Concept Ideas

- **Concept 1: Diversion Rate – Pulse Peak Ratio Method**
  - **Use of a Project's Maximum Diversion Rate to determine which pulses are applicable.**

- **Concept 2: Permitting Test Method**
  - **Post-processing analysis that would be used to see if project impacted pulses with only Subsistence and Baseflow Recommendations.**

Concept 1: Diversion Rate – Pulse Peak Ratio Method

- **General Concept:**
  - **All 5 tiers of pulses in the recommendation**
  - **However, allows water right applicants to be exempt from some or all of the tiers based on the applicant's ability to divert/impound streamflow due to infrastructure and maximum diversion rate constraints**
- **Exemption Test for each tier would be based on a ratio of their ability to divert/impound streamflow over the recommended pulse peak**
- **For on-channel reservoir, the ability to impound may be quite large, so site-specific studies and/or all 5 tiers of pulses may be necessary**

Concept 1:
Diversion Rate – Pulse Peak Ratio Method

- For a run-of-river diversion (either with or without off-channel storage), the ability to divert streamflow is limited by maximum diversion rate. The ratio of the maximum diversion rate to each seasonal, annual, or multi-year pulse peak would be used to determine which of the pulse tiers would apply.
  - If ratio > prescribed standard (TBD), then pulse applies
  - If the ratio < prescribed standard, then pulse does not apply
  - Only applicable pulses would be used in determining if a permit could be granted and subsequently included as special conditions in the applicant’s permit.

Concept 1: Run-Of-River Example 1

- For example, say prescribed standard = 10% ratio of maximum diversion rate / pulse peak

Maximum Diversion Rate = 100 cfs

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 yea[illegible] Regressed Volume is 273,000 Duration Bound is 69			
	Qp: 10,600 cfs with Average Frequen[illegible] 1 [illegible] 2 years Regressed Volume is 107,[illegible] Duration Bound is 4[illegible]			
	Qp: 7,680 cfs with A[illegible]requency 1 per year Regressed V[illegible]e is 73,500 Duratio[illegible] is 38			
High Flow Pulses	Qp: 1,520 c[illegible] with [illegible]erage Frequency 1 [illegible] season Regressed Vol[illegible] 12,800 Duratio[illegible]ound [illegible] 19	Qp: 3,540 c[illegible]ith [illegible]erage Frequency 1 [illegible]eason Regressed Volu[illegible] 30,000 Duration [illegible]nd 1[illegible]4	Qp: 1,640 c[illegible]ith [illegible]rage Frequency 1 [illegible]eason Regressed Volu[illegible] 11,200 Duration [illegible]nd 1[illegible]6	Qp: 2,320 [illegible] wi[illegible] Average Frequency [illegible] season Regressed V[illegible]is 17,600 Durati[illegible] Bound[illegible] 19
	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cf[illegible]ith [illegible]erage Frequency 2 [illegible]eason Regressed Volu[illegible]11,300 Duration [illegible]nd is[illegible]	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs)	290	280	220	270
	200	180	150	200
	140	130	120	130
Subsistence Flows (cfs)	76	60	54	66

Concept 1: Run-Of-River Example 2

- For example, say prescribed standard = 10% ratio of maximum diversion rate / pulse peak

Maximum Diversion Rate = 500 cfs

Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 yea[illegible] Regressed Volume is 273,000 Duration Bound is 69			
	Qp: 10,600 cfs with Average Frequen[illegible] 1 [illegible] 2 years Regressed Volume is 107,[illegible] Duration Bound is 4[illegible]			
	Qp: 7,680 cfs with A[illegible]ag[illegible] requency 1 per year Regressed V[illegible]e is 73,500 Duratio[illegible] is 38			
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19
	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs)	290	280	220	270
	200	180	150	200
	140	130	120	130
Subsistence Flows (cfs)	76	60	54	66
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

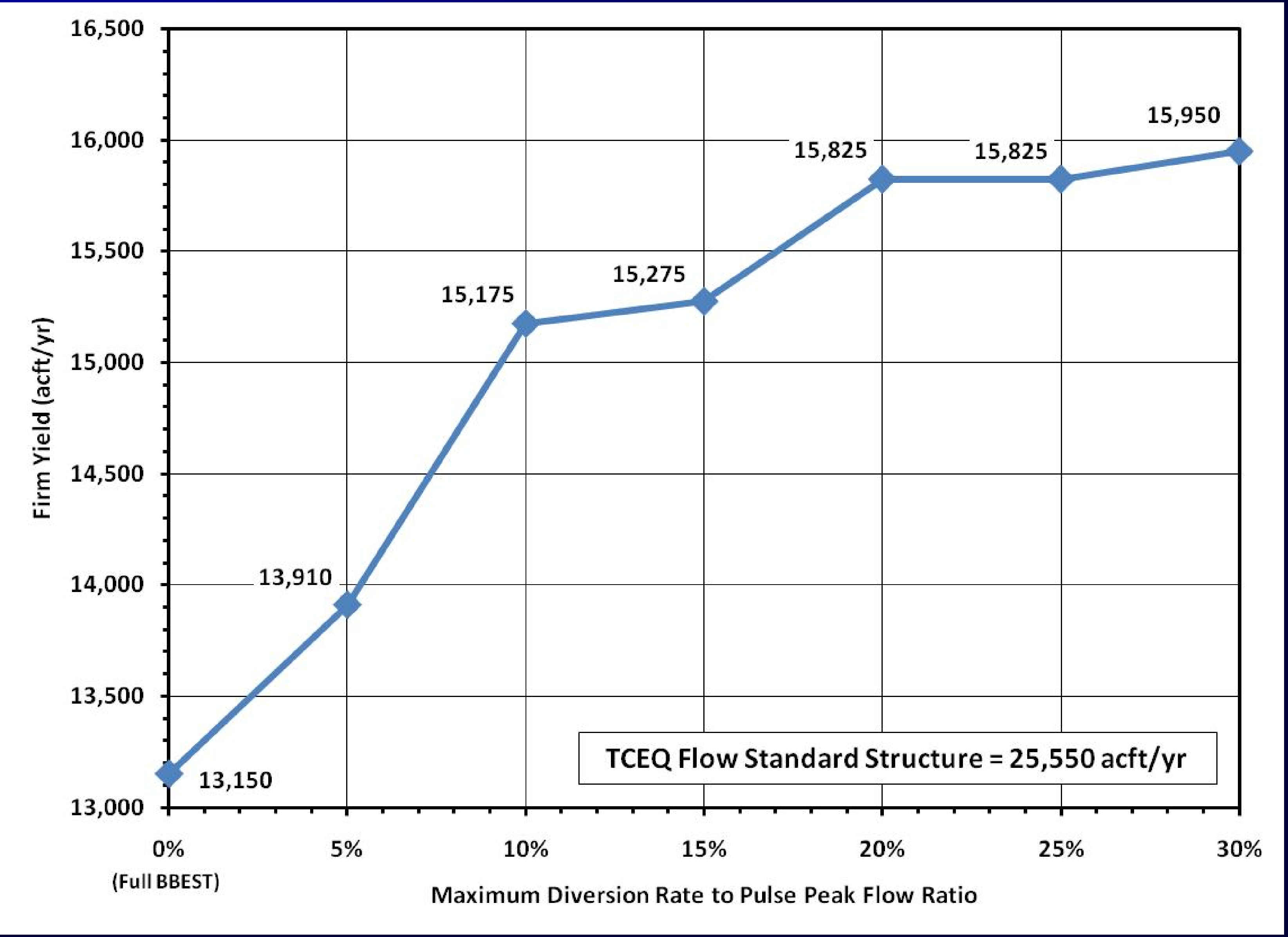
Concept 1: Run-Of-River Example 3

- For example, say prescribed standard = 10% ratio of maximum diversion rate / pulse peak

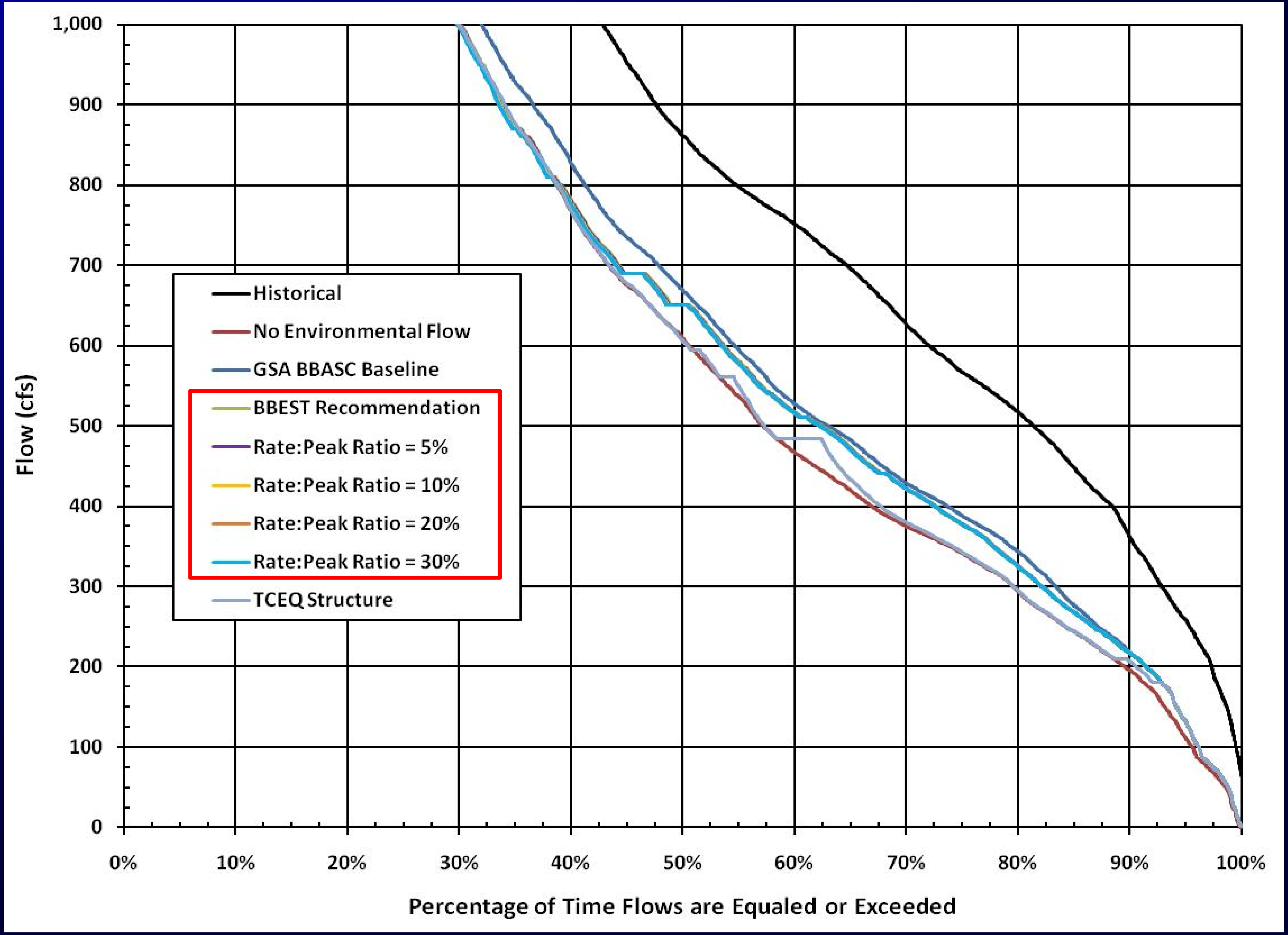
Maximum Diversion Rate = 1600 cfs

Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 yea Regressed Volume is 273,000 Duration Bound is 69			
	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 107,000 Duration Bound is 45			
	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38			
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19
	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs)	290	280	220	270
	200	180	150	200
	140	130	120	130
Subsistence Flows (cfs)	76	60	54	66
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

What Should The Prescribed Ratio Standard Be?



What Should The Prescribed Ratio Standard Be?

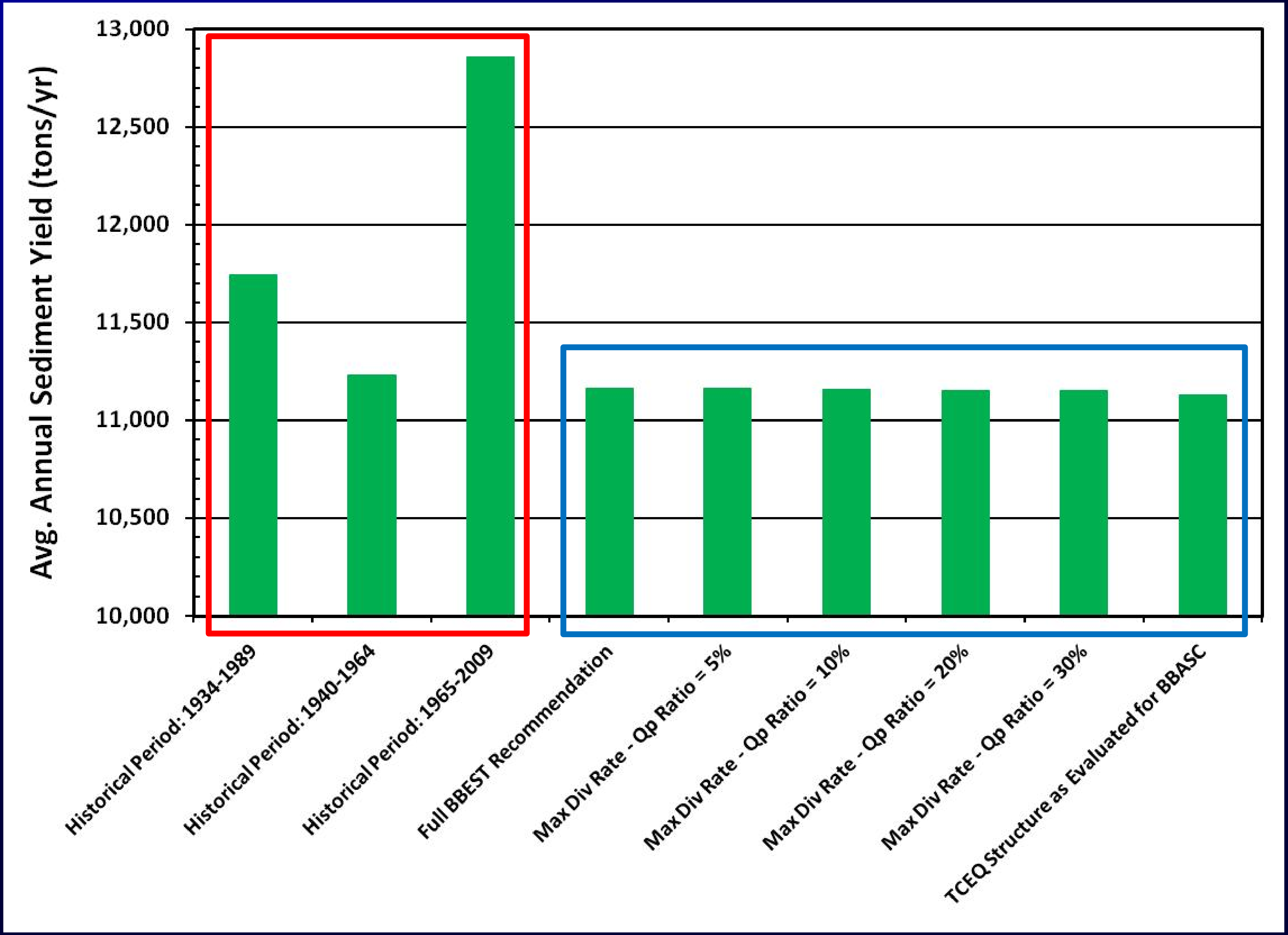


What Should The Prescribed Ratio Standard Be?

Guadalupe River at Gonzales[1]		
Flow Scenario	Avg. Annual Water Yield (acft/yr)	Avg. Annual Sediment Yield (tons/yr)
Historical Period: 1934-1989	938,300	11,745
Historical Period: 1940-1964	800,041	11,230
Historical Period: 1965-2009	1,183,283	12,858
Full BBEST Recommendation	768,027	11,163
Max Div Rate - Qp Ratio = 5%	767,058	11,162
Max Div Rate - Qp Ratio = 10%	765,880	11,158
Max Div Rate - Qp Ratio = 20%	765,105	11,152
Max Div Rate - Qp Ratio = 30%	765,011	11,151
TCEQ Structure as Evaluated for BBASC	755,908	11,129

[1] *Calculated using Ackers-White*

What Should The Prescribed Ratio Standard Be?



Concept 2: Permitting Test Method

- Look at the pulses as a litmus test to determine if the application may be granted as submitted. If not, mitigation and/or limitations of authorized annual diversion, maximum diversion, etc. could be included prior to issuance.

- In simulating a new water right application:
  - TCEQ would put the new water right in the WAM, with the appropriate baseflow(s) and subsistence flow(s) only
  - TCEQ would then look at the resulting downstream flow with the project in place and see if pulse standards are being met (on average for the entire period of record) at the frequencies in the adopted standards (i.e. 1 per season, 1 per year, etc)

Concept 2: Permitting Test Method

- Test would be applied to all the pulse tiers
- If the new water right application met the standards for all the pulse tiers with just the baseflow(s) and subsistence flow(s), there would be no need to place special conditions in the water right permit for meeting pulses (as TCEQ would have demonstrated that the standards would be met without them)
- If the new water right would result in not meeting one or more of the pulse attainment frequencies, TCEQ could then place special conditions in the water right to meet that/those pulse(s) and/or provide for mitigation

Concept 2: Example

- Highest tiered pulse in the BBEST recommendation is set at a 1 per 5 year frequency, or 20% of the time

- TCEQ would look at the resulting downstream flow with the new water right (per the application) in place to see if a pulse of that magnitude (and possibly volume) would be met 20% of the time

- It's important to note that the BBEST Recommendation was derived (using HEFR) on a 20% of time basis, not an actual occurrence in every 5-year period.

Questions

Questions

- Is the BBASC going to be recommending Overbank Pulses as a permit condition? (Liability Issues)
- Which of these concepts appropriately simplifies operations and management under environmental flow permit conditions for future permit holders?
- Which of these concepts appropriately addresses the need for Pulses and Overbank Flows?

- For Concept #1, what is the prescribed ratio standard?
  - Should it be based on geomorphology?

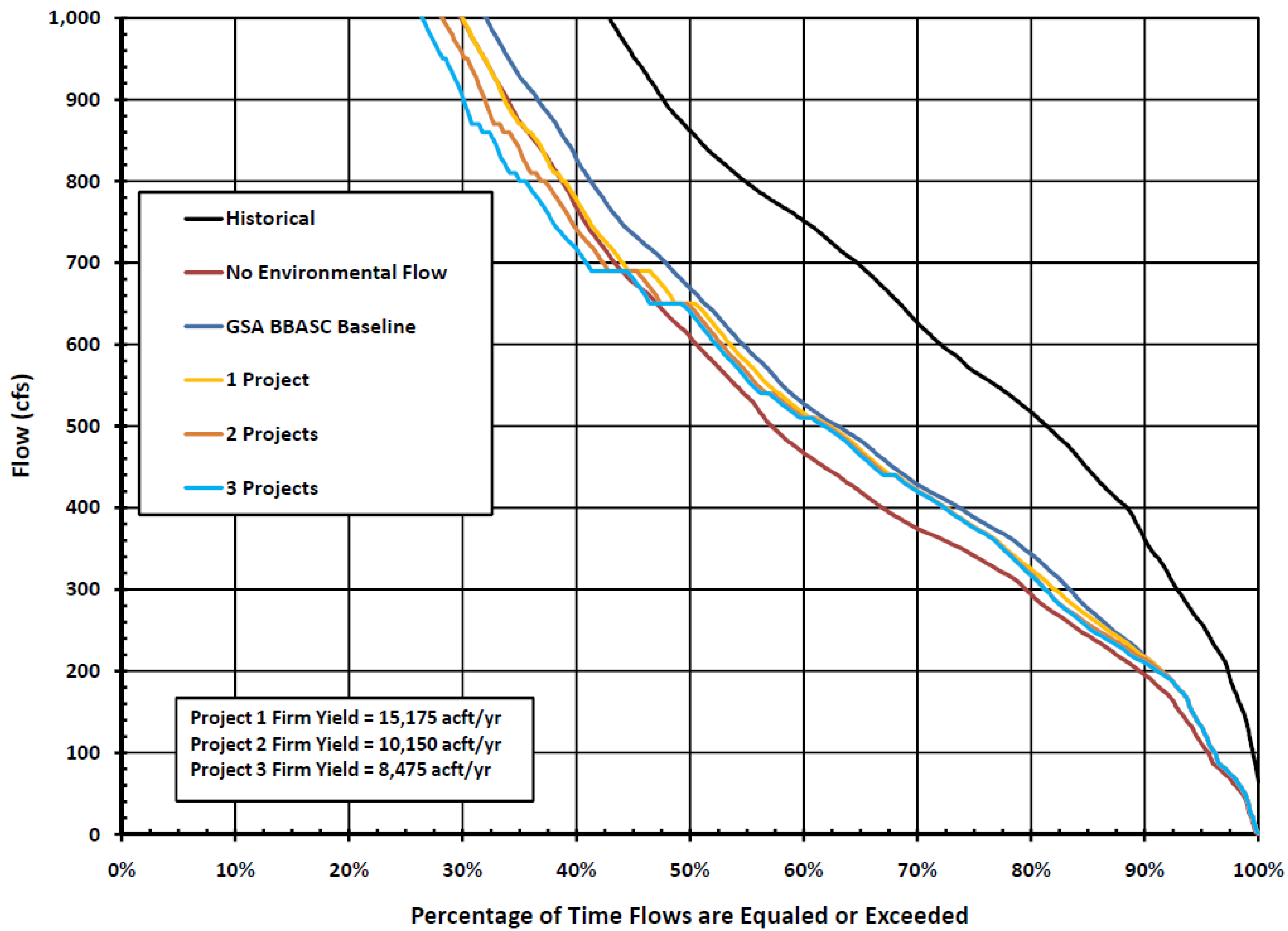
Guadalupe, San Antonio, Mission, & Aransas Rivers and Mission, Copano, Aransas, & San Antonio Bays Basin and Bay Area Stakeholder Committee (GSA BBASC)

GSA BBASC Recommendations: Pulse Implementation Supplemental Information

R Brian Perkins, PE

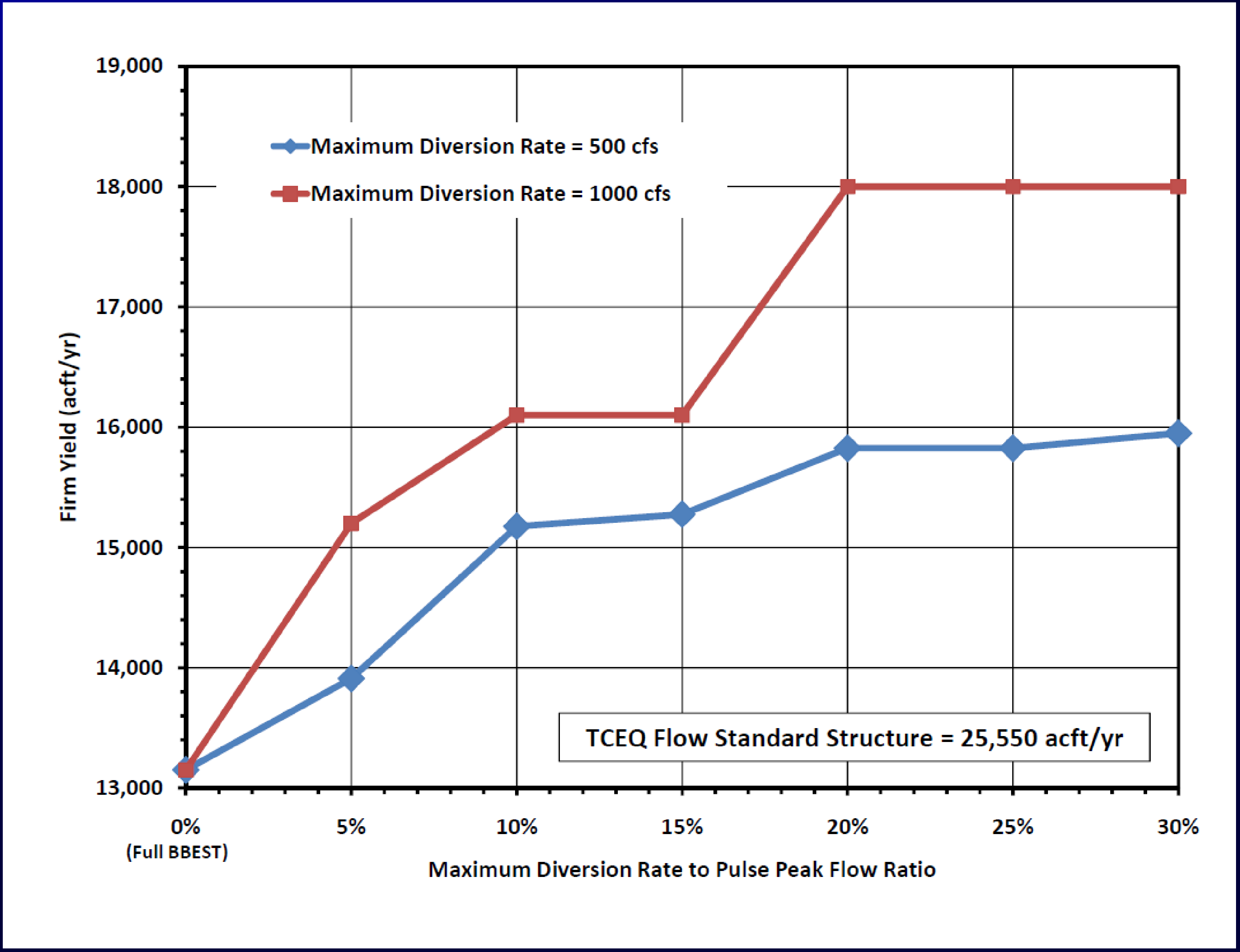
July 18-19, 2011

Mid-Basin Project: 3 Identical Projects

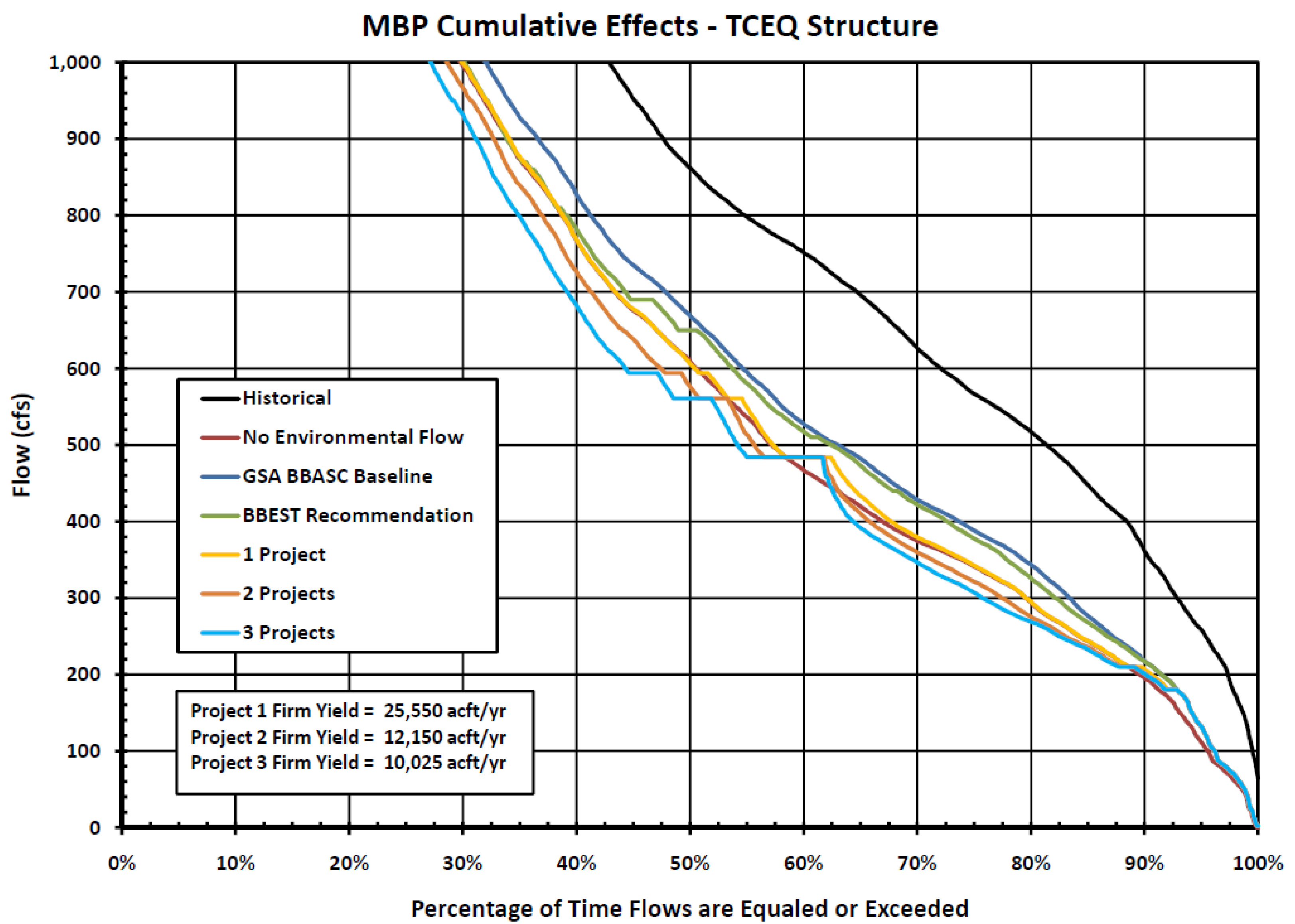


Pulse Exemption Rule @ 10% Ratio

Mid-Basin Project: Doubling Diversion Rate

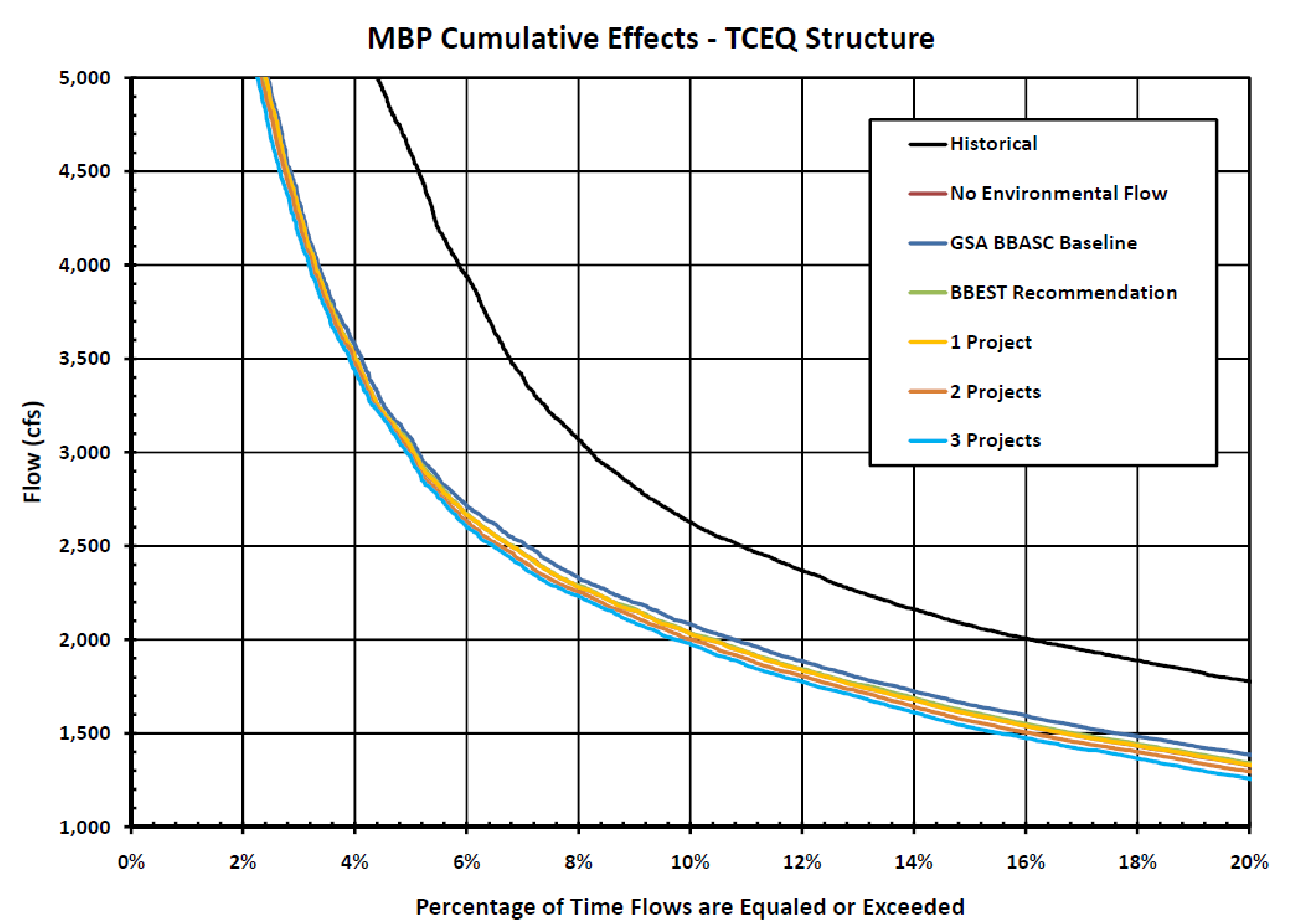


Mid-Basin Project: Cumulative Effects of "TCEQ East Texas Structure" – Lower Flows



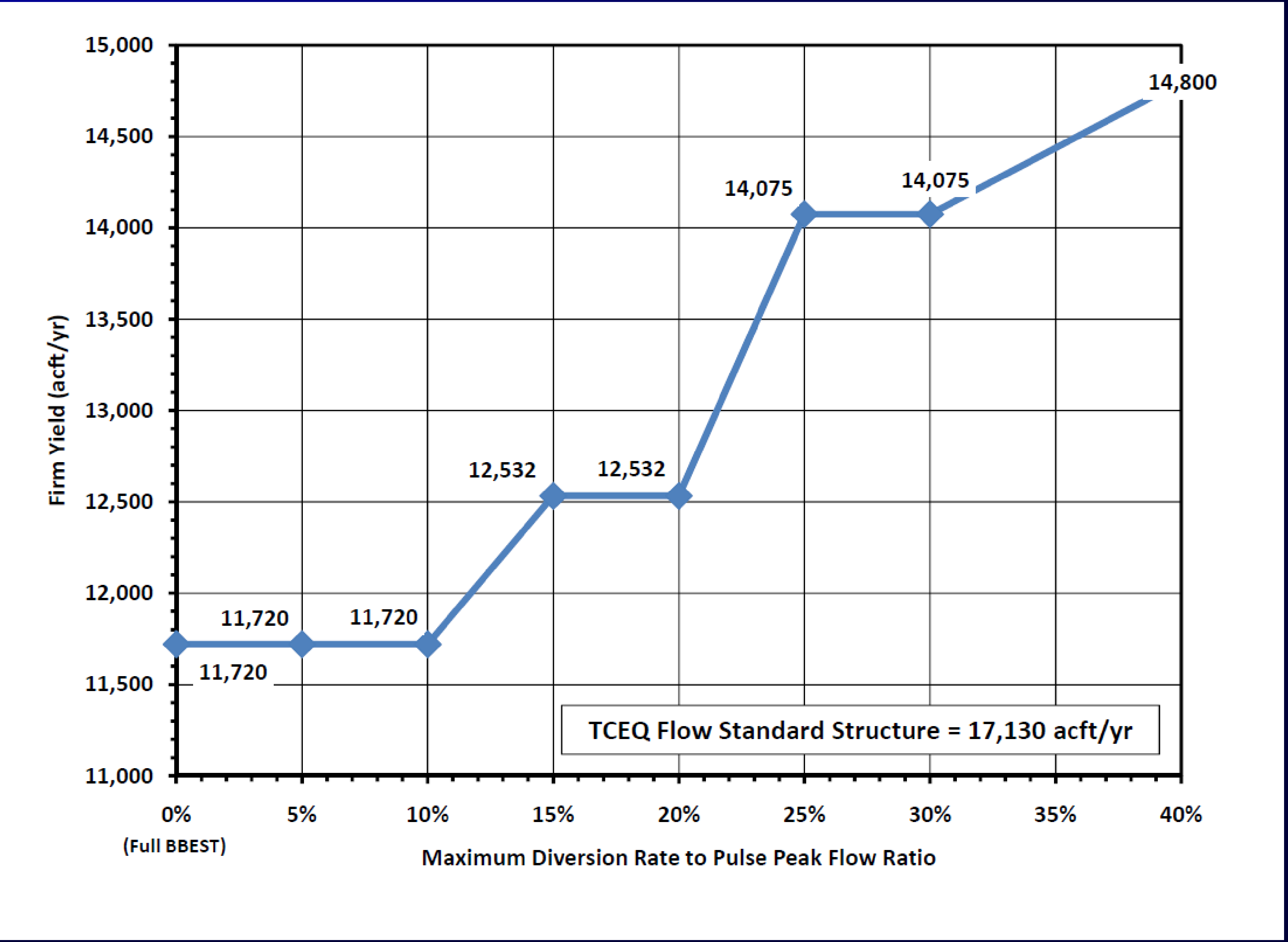
Pulse Exemption Rule @ 10% Ratio

Mid-Basin Project: Cumulative Effects of "TCEQ East Texas Structure" – Higher Flows



Pulse Exemption Rule @ 10% Ratio

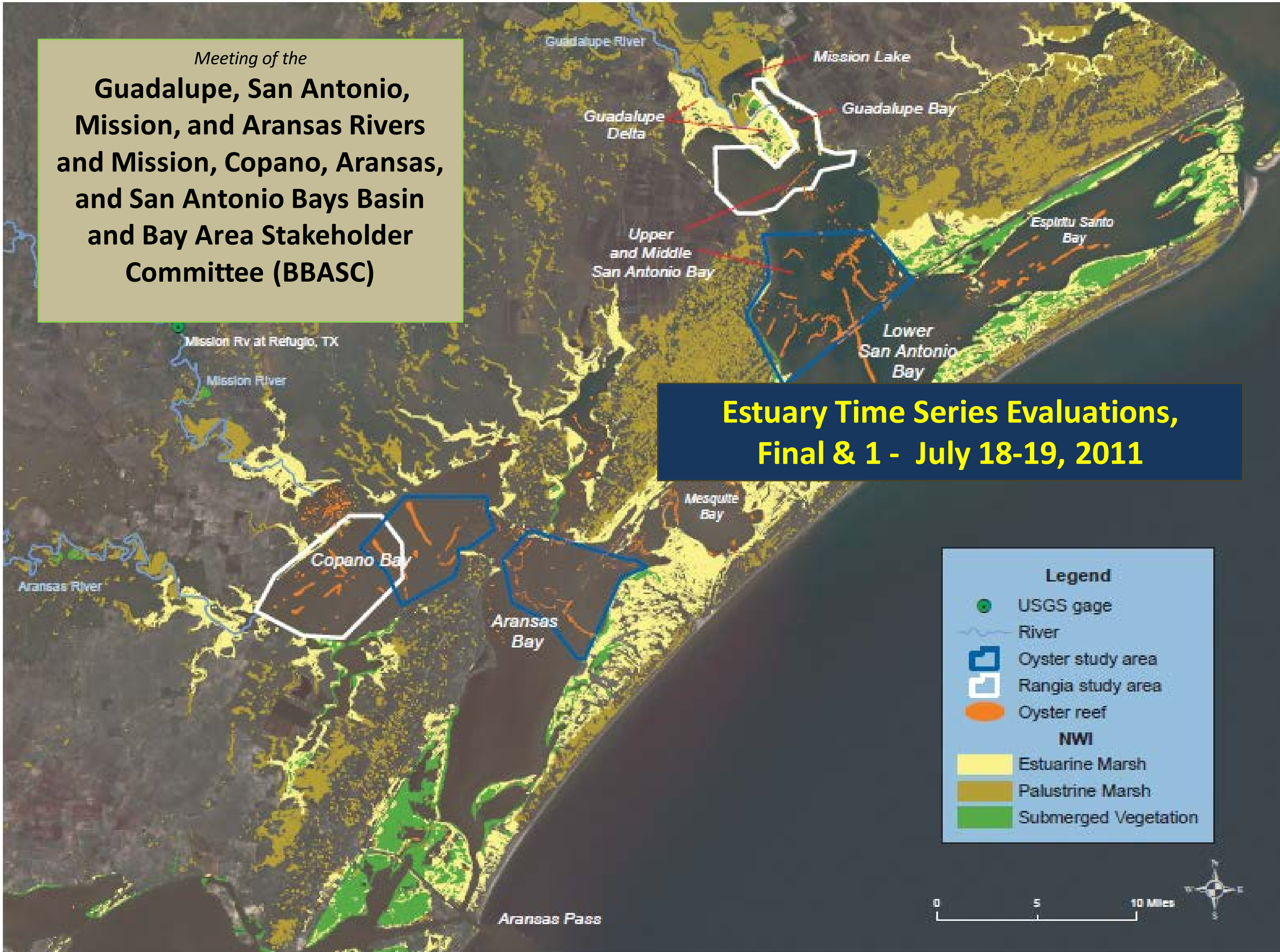
San Antonio River Project: Pulse Exemption Rule



Meeting of the

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Estuary Time Series Evaluations, Final & 1 - July 18-19, 2011



Summary – Attainment of G1 Springtime Criteria (Rangia)

with the San Antonio River Project

Previously presented, 05/04/11

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
w. San Antonio Project & BBEST recs.	7	9	9	1	5	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

see Tables 4.5-3 & 4.5-6		>12%	>12%				<=9%
Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline; BBASC		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. San Antonio Project & BBEST recs.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

see Table 4.5-3			>17%		>=19%	<=2/3	
Attain. - Joints	Joint G1 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline; BBASC			22.4%		14.3%	57.1%	
w. San Antonio Project & BBEST recs.			20.4%		18.4%	44.4%	
TCEQ Baseline; (Run 3)			18.4%		16.3%	37.5%	

Color coding convention
-OK, met criteria
-Near miss. (rounding; p-o-record)
-Not met, but departure not great
-Very bad

Summary – Attainment of G2 Summer Criteria (oysters)

with the Guadalupe River Project

Previously presented, 05/04/11

Counts	Criteria G2								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. Guadalupe Project (& BBEST recs.)	4	8	8	8	7	3	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

Color coding convention
-OK, met criteria (green)
-Near miss. (rounding; p-o-record) (grey)
-Not met, but departure not great (orange)
-Very bad (brown)

see Tables 4.5-2; 4.5-4

Attain. - Singles	Single G2 criteria attainment (% of yrs.)						
		>12%	>17%				<=6%	
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guadalupe Project (& BBEST recs.)		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2

Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
			>=30%		>10%	<=1/6	<=9%	
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
w. Guadalupe Project (& BBEST recs.)			32.7%		20.4%	30.0%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

Summary – Guadalupe Project, Attainment of G1 Springtime Criteria (Rangia)

Previously presented, 06/01/11

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Natural	9	15	7	6	3	6	3	49
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
w. Guad. Project, BBEST Recomm.	7	10	8	2	4	4	14	49
w. Guad. Project, CCEFN	7	9	9	1	5	4	14	49
w. Guad. Project, Lyons	7	9	9	2	4	4	14	49
w. Guad. Project, No Div <Base	7	10	8	2	4	4	14	49
w. Guad. Project, TCEQ Struc.	7	10	8	1	5	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

Summary – Guadalupe Project, Attainment of G1 Springtime Criteria (Rangia)

Previously presented, 06/01/11

see Tables 4.5-3 & 4.5-6		>12					
Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Natural		30.6%	14.3%	12.2%	6.1%	12.2%	6.1%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline; BBASC		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. Guad. Project, BBEST Recomm.		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
w. Guad. Project, CCEFN		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. Guad. Project, Lyons		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. Guad. Project, No Div <Base		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
w. Guad. Project, TCEQ Struc.		20.4%	16.3%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

Color coding convention	
	-OK, met criteria
	-Near miss. (rounding; p-o-record)
	-Not met, but departure not great
	-Very bad

see Table 4.5-3			>17%		>=19%	<=2/3	
Attain. - Joints	Joint G1 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	
Natural			26.5%		18.4%	66.7%	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline; BBASC			22.4%		14.3%	57.1%	
w. Guad. Project, BBEST Recomm.			20.4%		16.3%	50.0%	
w. Guad. Project, CCEFN			20.4%		18.4%	44.4%	
w. Guad. Project, Lyons			22.4%		16.3%	50.0%	
w. Guad. Project, No Div <Base			20.4%		16.3%	50.0%	
w. Guad. Project, TCEQ Struc.			18.4%		18.4%	44.4%	
TCEQ Baseline; (Run 3)			18.4%		16.3%	37.5%	

Summary – Guadalupe Project, Attainment of G2 Summer Criteria (oysters)

Previously presented, 06/01/11

see Tables 4.5-2; 4.5-4		>12%						
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Natural		22.4%	30.6%	14.3%	6.1%	4.1%	4.1%	0.0%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, BBEST Recomm.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, CCEFN		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, Lyons		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, No Div <Base		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, TCEQ Struc.		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD
Natural			44.9%		10.2%	40.0%	4.1%
Historical			38.8%		12.2%	16.7%	10.2%
Present			36.7%		18.4%	11.1%	12.2%
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%
w. Guad. Project, BBEST Recomm.			32.7%		20.4%	30.0%	22.4%
w. Guad. Project, CCEFN			32.7%		20.4%	30.0%	22.4%
w. Guad. Project, Lyons			32.7%		20.4%	30.0%	22.4%
w. Guad. Project, No Div <Base			32.7%		20.4%	30.0%	22.4%
w. Guad. Project, TCEQ Struc.			32.7%		20.4%	40.0%	22.4%
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%

Color coding convention	
(green)	-OK, met criteria
(grey)	-Near miss. (rounding; p-o-record)
(orange)	-Not met, but departure not great
(brown)	-Very bad

Summary – Guadalupe Project, Attainment of G2 Summer Criteria (oysters)

Previously presented, 06/01/11

see Tables 4.5-2; 4.5-4		>12%						
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Natural		22.4%	30.6%	14.3%	6.1%	4.1%	4.1%	0.0%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, BBEST Recomm.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, CCEFN		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, Lyons		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, No Div <Base		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Project, TCEQ Struc.		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD
Natural			44.9%		10.2%	40.0%	4.1%
Historical			38.8%		12.2%	16.7%	10.2%
Present			36.7%		18.4%	11.1%	12.2%
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%
w. Guad. Project, BBEST Recomm.			32.7%		20.4%	30.0%	22.4%
w. Guad. Project, CCEFN			32.7%		20.4%	30.0%	22.4%
w. Guad. Project, Lyons			32.7%		20.4%	30.0%	22.4%
w. Guad. Project, No Div <Base			32.7%		20.4%	30.0%	22.4%
w. Guad. Project, TCEQ Struc.			32.7%		20.4%	40.0%	22.4%
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%

Color coding convention	
(green)	-OK, met criteria
(grey)	-Near miss. (rounding; p-o-record)
(orange)	-Not met, but departure not great
(brown)	-Very bad

NEW

Summary – Guadalupe & San Antonio Projects, Attainment of G1 Springtime Criteria (Rangia)

New Scenarios 07/18/11

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
w. Guad. Proj., No envl. flows	7	9	9	1	5	4	14	49
w. Guad. Proj., BBEST Recomm.	7	10	8	2	4	4	14	49
w. Guad. Proj., HFP 10% div rule	7	9	9	2	4	4	14	49
w. Guad. Proj., HFP 20% div rule	7	9	9	2	4	4	14	49
w. Guad. Proj., HFP 30% div rule	7	9	9	2	4	4	14	49
w. Guad. Proj., TCEQ Struc.	7	10	8	1	5	4	14	49
w. San Ant. Proj., No Envl. Flows	7	9	9	1	5	4	14	49
w. San Ant. Proj., BBEST Recomm.	7	9	9	1	5	4	14	49
w. San Ant. Proj., TIFP (SB2)	7	9	9	2	4	4	14	49
w. San Ant. Proj., TCEQ Struc.	7	9	9	1	5	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

Summary – Guadalupe & San Antonio Projects, Attainment of G1 Springtime Criteria (Rangia)

New Scenarios 07/18/11

Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Region L Baseline; BBASC		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. Guad. Proj., No envl. flows		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. Guad. Proj., BBEST Recomm.		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., HFP 10% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., HFP 20% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., HFP 30% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., TCEQ Struc.		20.4%	16.3%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Proj., No Envl. Flows		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Proj., BBEST Recomm.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Proj., TIFP (SB2)		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. San Ant. Proj., TCEQ Struc.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

Summary – Guadalupe & San Antonio Projects, Attainment of G2 Summer Criteria (Oysters)

New Scenarios 07/18/11

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. Guad. Proj., No envl. flows	4	8	8	8	6	4	2	9	49
w. Guad. Proj., BBEST Recomm.	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 10% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 20% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 30% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., TCEQ Struc.	4	8	8	8	6	4	2	9	49
w. San Ant. Proj., No Envl. Flows	4	7	9	7	7	4	2	9	49
w. San Ant. Proj., BBEST Recomm.	4	8	8	8	7	3	3	8	49
w. San Ant. Proj., TIFP (SB2)	4	8	8	6	8	4	3	8	49
w. San Ant. Proj., TCEQ Struc.	4	8	8	7	7	4	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

Summary – Guadalupe & San Antonio Projects,
Attainment of G2 Summer Criteria (Oysters)

New Scenarios 07/18/11

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%	
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Historical			38.8%		12.2%	16.7%	10.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
w. Guad. Proj., No envl. flows			32.7%		20.4%	40.0%	22.4%	
w. Guad. Proj., BBEST Recomm.			32.7%		20.4%	30.0%	22.4%	
w. Guad. Proj., HFP 10% div rule			32.7%		20.4%	30.0%	22.4%	
w. Guad. Proj., HFP 20% div rule			32.7%		20.4%	30.0%	22.4%	
w. Guad. Proj., HFP 30% div rule			32.7%		20.4%	30.0%	22.4%	
w. Guad. Proj., TCEQ Struc.			32.7%		20.4%	40.0%	22.4%	
w. San Ant. Proj., No Envl. Flows			32.7%		22.4%	36.4%	22.4%	
w. San Ant. Proj., BBEST Recomm.			32.7%		20.4%	30.0%	22.4%	
w. San Ant. Proj., TIFP (SB2)			28.6%		24.5%	33.3%	22.4%	
w. San Ant. Proj., TCEQ Struc.			30.6%		22.4%	36.4%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

END

ARCHIVE

The BBEST Criteria

Table 6.1-17

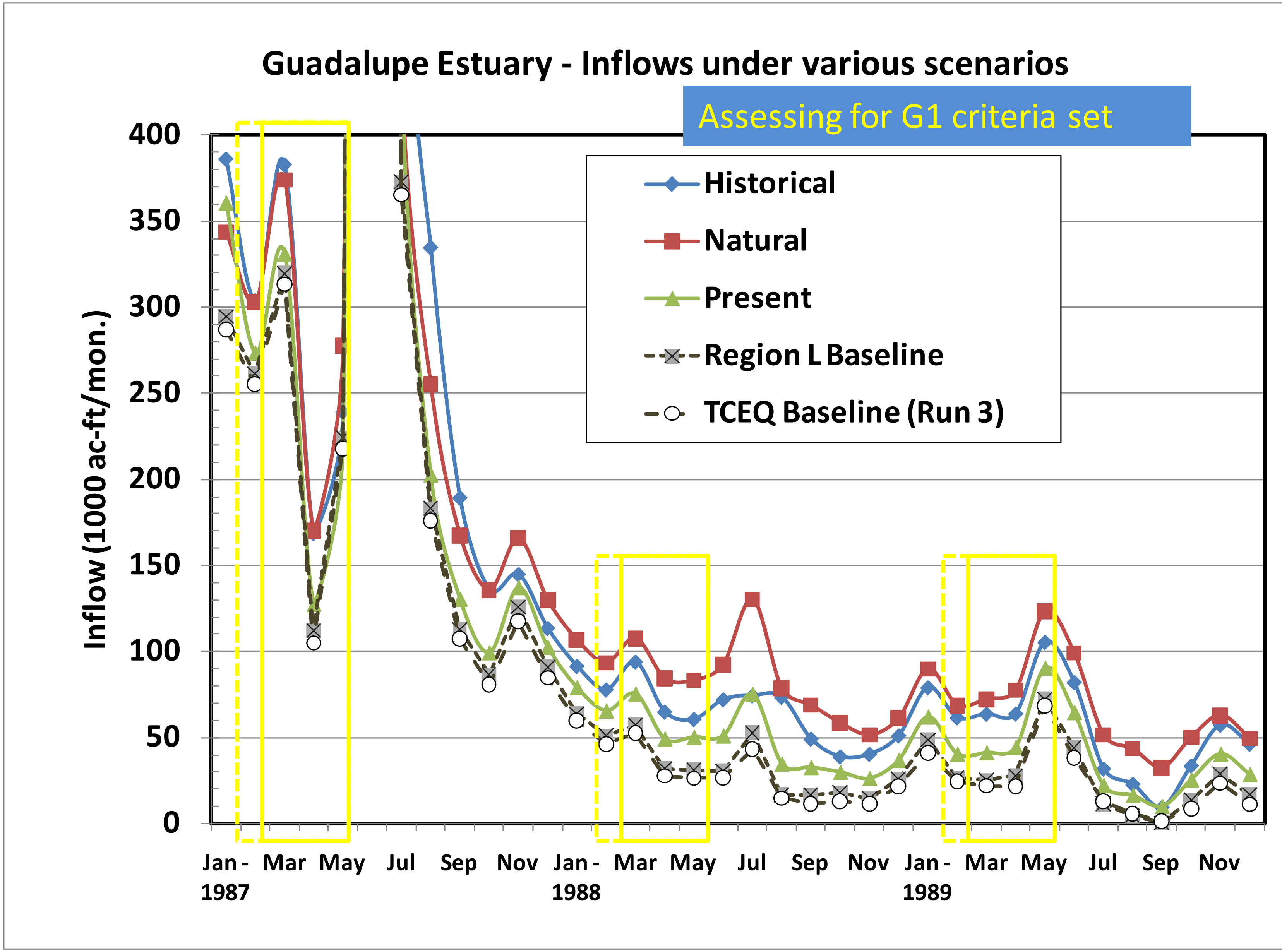
Guadalupe Estuary Criteria - Volumes				
Criteria level	Inflow Criteria Volumes, suite G1 for Rangia clams		Inflow Criteria Volumes, suite G2 for Eastern oysters	
	Feb. (1000 ac-ft/mon)	Mar.-May (1000 ac-ft/3mon)	June (1000 ac-ft/mon)	July-Sept. (1000 ac-ft/3mon)
G1-Aprime, G2-Aprime	n/a	550-925	n/a	450-800
G1-A, G2-A	n/a	375-550	n/a	275-450
G1-B, G2-B	n/a	275-375	n/a	170-275
G1-C, G2-C	≥75	150-275	≥40	75-170
G1-CC, G2-CC	0 - 75	150-275	0 - 40	75-170
G1-D, G2-D	n/a	0 - 150	n/a	50-75
G1-DD, G2-DD	n/a	n/a	n/a	0-50

Mission-Aransas Estuary Criteria - Volumes				
Criteria level	Inflow Criteria Volumes, set MA1 for Rangia clams		Inflow Criteria Volumes, set MA2 for Eastern oysters	
	Feb.	Mar.-May	June	July-Sept.
MA2 - Aprime	n/a	n/a	n/a	500-1000

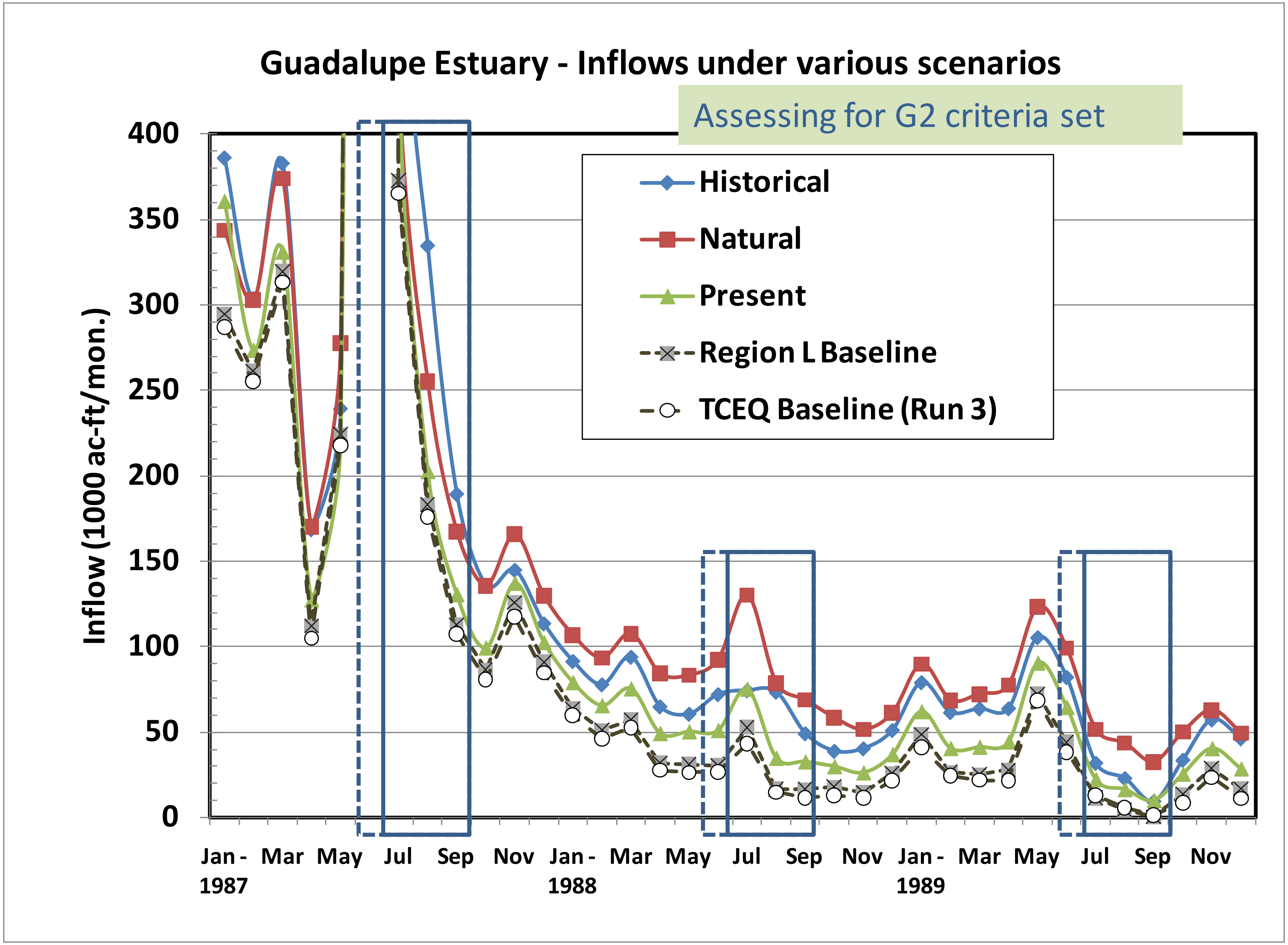
Table 6.1-18

Guadalupe Estuary Criteria -Attainment Recommendations			
Criteria level	Specification	Inflow Criteria Attainment, G1 suite for Rangia clams	Inflow Criteria Attainment, G2 suite for Eastern oysters
G1-Aprime, G2-Aprime	Attainment, G - Aprime	G1-Aprime at least 12% of years	G2-Aprime at least 12% of years
G1-A, G2-A	Attainment, G - A	G1-A at least 12 % of years	G2-A at least 17 % of years
G1-A&G1-B, G2-A&G2-B	Attainment, G - A & G - B combined	G1-A and G1-B combined at least 17% of years	G2-A and G2-B combined at least 30% of years
G1-C&G1-CC, G2-C&G2-CC	Attainment, G - C & G - CC combined	G1-C and G1-CC equal to or greater than 19% of years. G1-CC no more than 2/3 of total	G2-C and G2-CC equal to or greater than10% of years. G2-CC no more than 1/6 of total
G1-D	Attainment, G1- D	no more than 9% of years	n/a
G2-DD	Attainment, G2- DD	n/a	G2-D no more than 6% of years
G2-D&G2-DD	Attainment, G2-D & G2-DD combined	n/a	G2-D and G2-DD combined no more than 9% of years

Mission-Aransas Estuary Criteria -Attainment Recommendations			
Criteria level	Specification	Inflow Criteria Attainment, set MA1 for Rangia clams	Inflow Criteria Attainment, set MA2 for Eastern oysters
MA-Aprime	Attainment MA-Aprime	n/a	MA2-Aprime at least 2% of years



Guadalupe Estuary - Inflows under various scenarios
Assessing for G1 criteria set
Historical
Natural
Present
Region L Baseline
TCEQ Baseline (Run 3)
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov



Guadalupe Estuary - Inflows under various scenarios
Assessing for G2 criteria set
Inflow (1000 ac-ft/mon.)
400
350
300
250
200
150
100
50
0
Historical
Natural
Present
Region L Baseline
TCEQ Baseline (Run 3)
Jan - 1987
Mar
May
Jul
Sep
Nov
Jan - 1988
Mar
May
Jul
Sep
Nov
Jan - 1989
Mar
May
Jul
Sep
Nov

Guadalupe, San Antonio, Mission, & Aransas Rivers and Mission, Copano, Aransas, & San Antonio Bays Basin and Bay Area Stakeholder Committee (GSA BBASC)

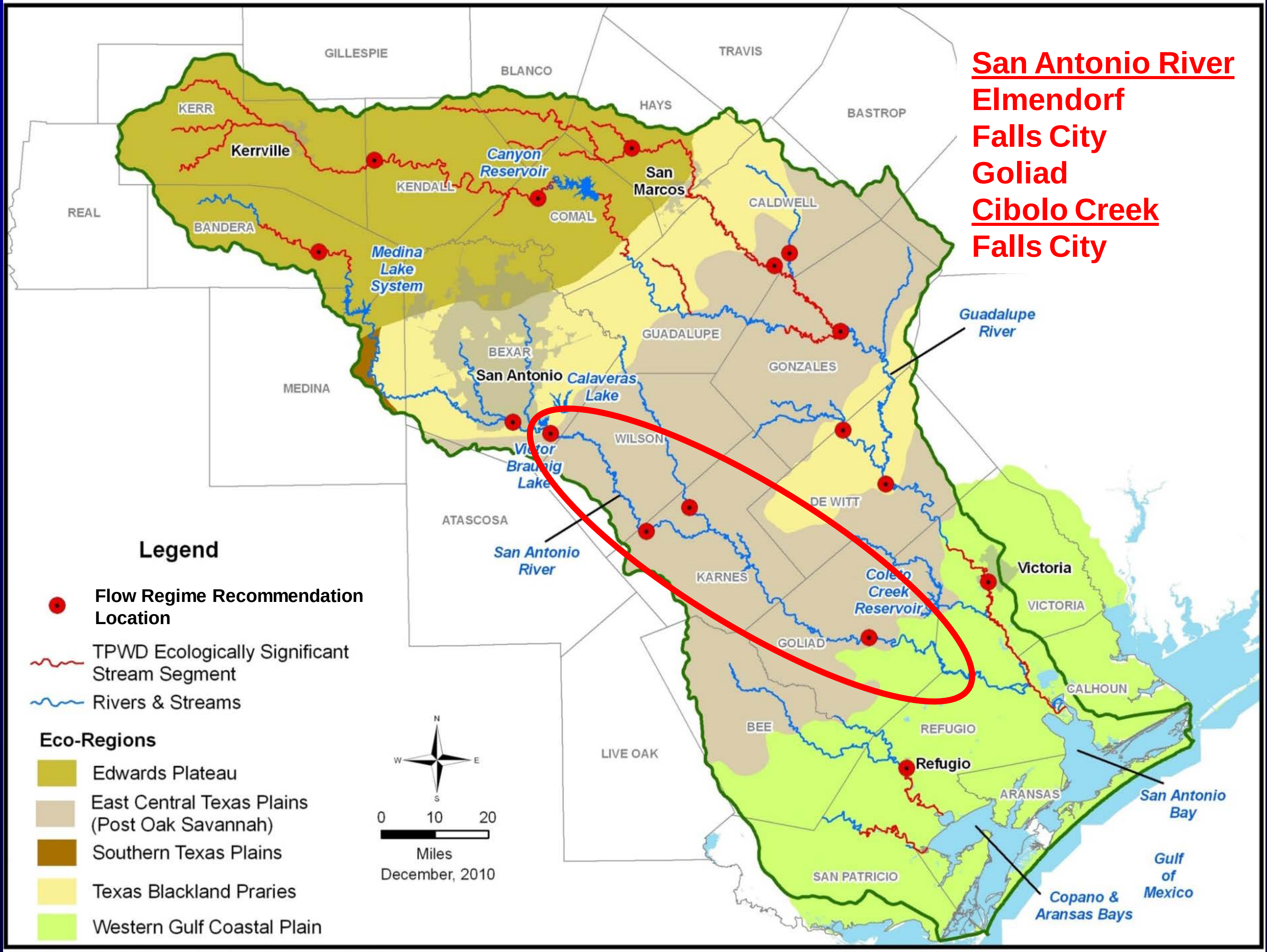
GSA BBASC Recommendations: Summary Information for All 16 Sites

R Brian Perkins, PE

July 6, 2011

Updated for July 18-19, 2011

Group 1:
San Antonio River Basin Locations w/ Site-Specific Habitat Information



<u>**San Antonio River**</u>

Elmendorf

Falls City

Goliad

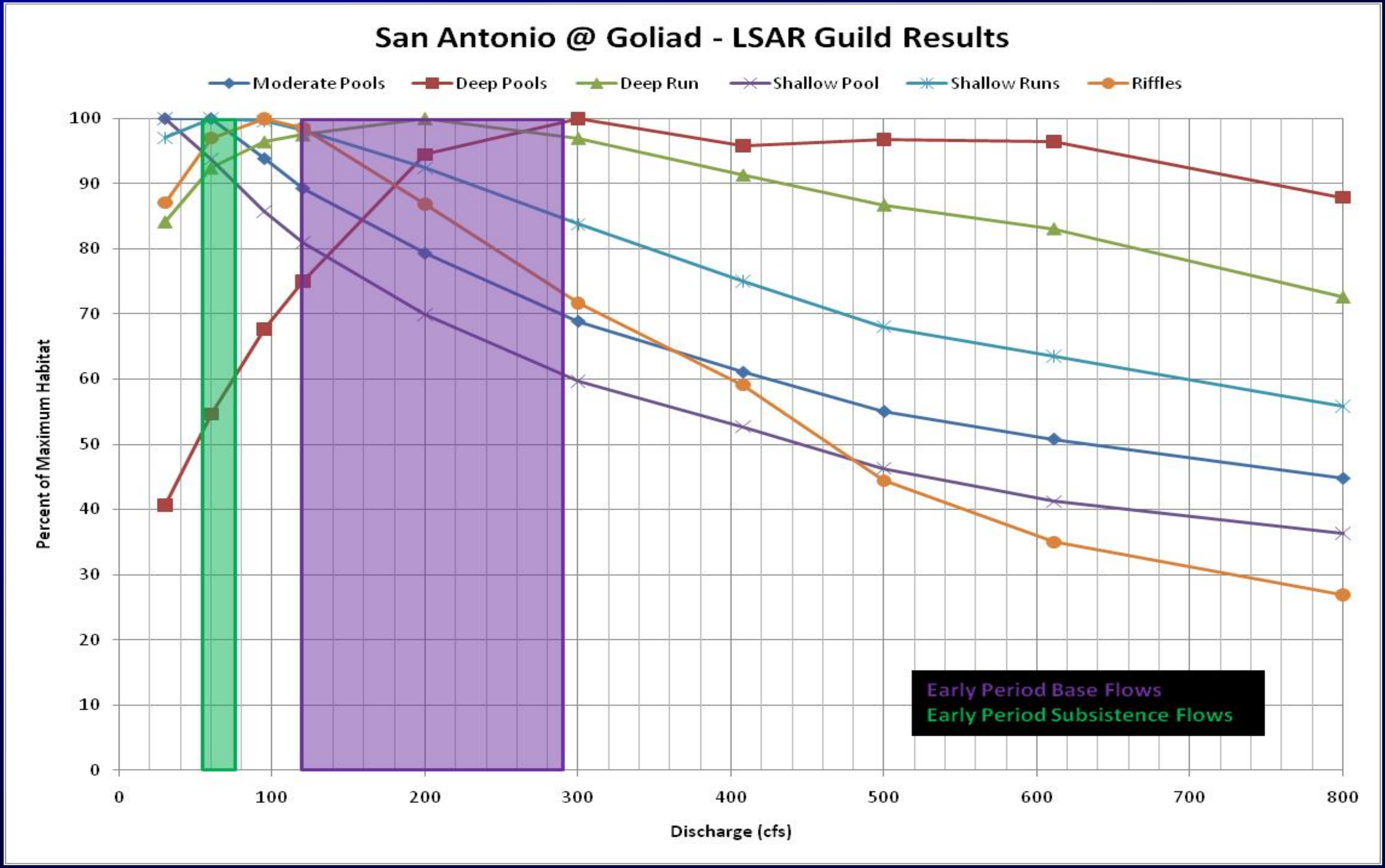
<u>**Cibolo Creek**</u>

Falls City

San Antonio River at Goliad (BBEST)

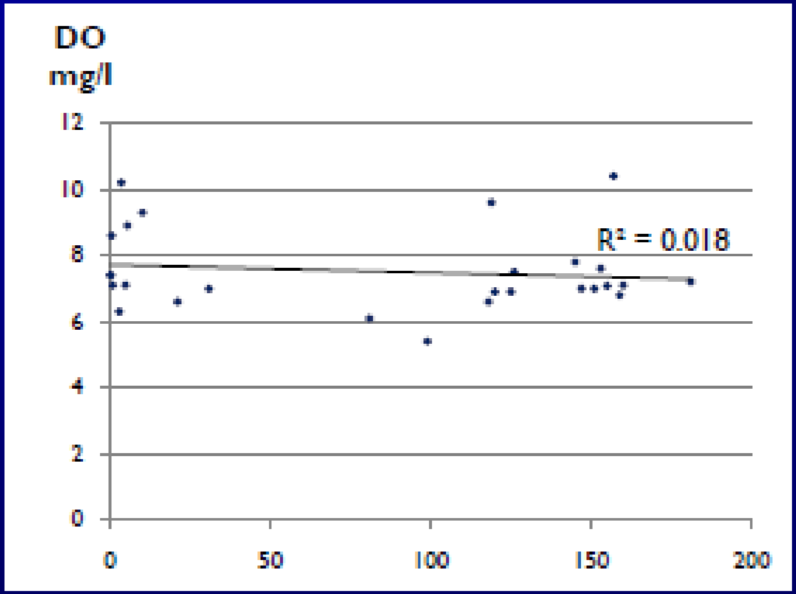
	Jan–Mar (Winter)	Apr–Jun (Spring)	Jul–Sep (Summer)	Oct–Dec (Fall)
Overbank Flows	Qp: 23,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 273,000 Duration Bound is 69			
	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 107,000 Duration Bound is 45			
	Qp: 7,680 cfs with Average Frequency 1 per year Regressed Volume is 73,500 Duration Bound is 38			
High Flow Pulses	Qp: 1,520 cfs with Average Frequency 1 per season Regressed Volume is 12,800 Duration Bound is 19	Qp: 3,540 cfs with Average Frequency 1 per season Regressed Volume is 30,000 Duration Bound is 24	Qp: 1,640 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 16	Qp: 2,320 cfs with Average Frequency 1 per season Regressed Volume is 17,600 Duration Bound is 19
	Qp: 550 cfs with Average Frequency 2 per season Regressed Volume is 3,940 Duration Bound is 11	Qp: 1,570 cfs with Average Frequency 2 per season Regressed Volume is 11,300 Duration Bound is 16	Qp: 750 cfs with Average Frequency 2 per season Regressed Volume is 4,450 Duration Bound is 10	Qp: 780 cfs with Average Frequency 2 per season Regressed Volume is 5,070 Duration Bound is 11
Base Flows (cfs)	290	280	220	270
	200	180	150	200
	140	130	120	130
Subsistence Flows (cfs)	76	60	54	66
	Jan / Feb / Mar	Apr / May / Jun	Jul / Aug / Sep	Oct / Nov / Dec
	Winter	Spring	Summer	Fall

San Antonio River at Goliad (BBEST)



• High percentages of maximum habitat maintained at BBEST subsistence and base flows.

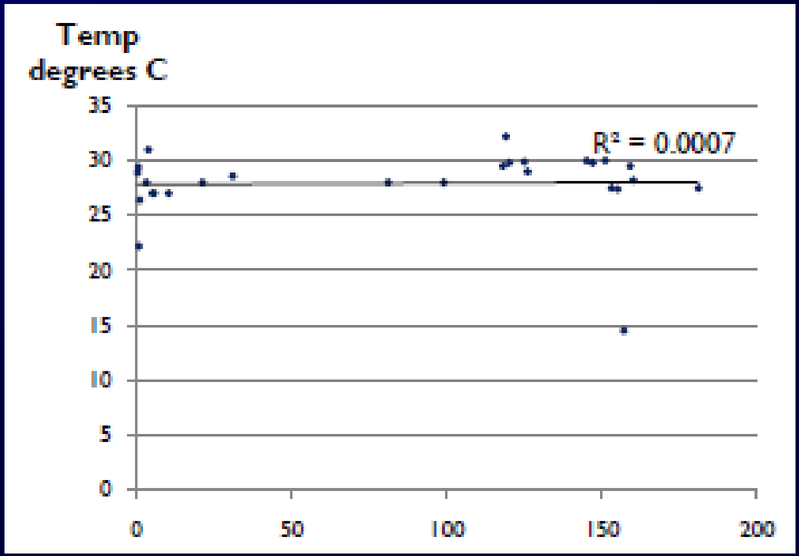
San Antonio River at Goliad (BBEST)



• No violations of 5 mg/l TCEQ stream standard for dissolved oxygen measured at lowest flows (cfs).

• TPWD has Moderate concern with BBEST subsistence flows (1 Habitat Guild < 80% max, LSAR WQ Model = 80 cfs).

• No violations of 90 degF TCEQ stream standard for temperature measured at lowest flows (cfs).



San Antonio River at Goliad (TIFP)

GOLIAD

Overbank Flow

Magnitude = 14,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 65% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Magnitude = 8,000 cfs
Frequency = 2 events
Duration = 2-3 days

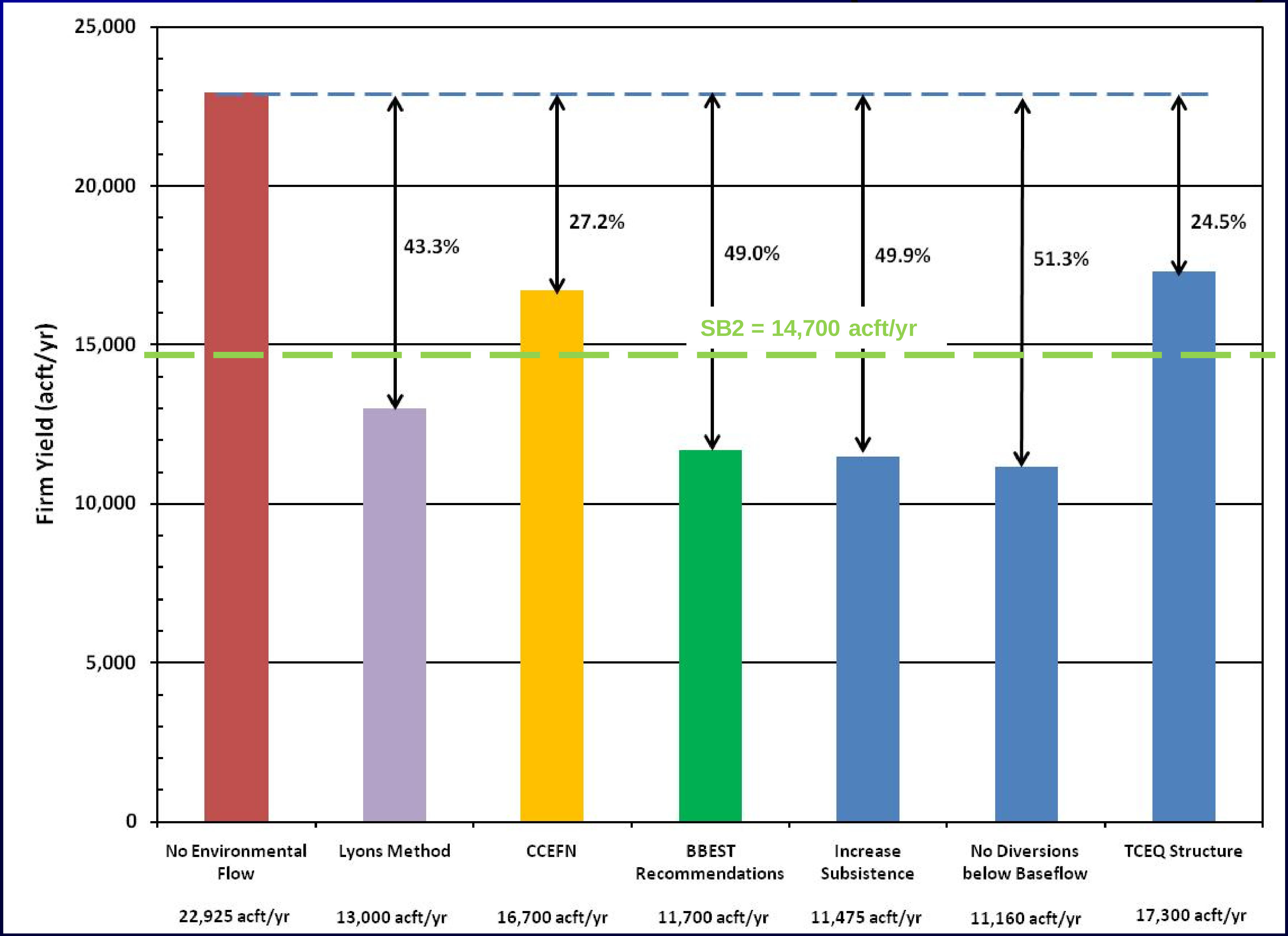
Key Indicators:
Riparian: Green Ash / Box Elder

Key Indicators: Riparian - Sycamore
Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-5 days

Magnitude = 4,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) Key Indicators: Aquatic Habitat, Water Quality												
Base Wet	475	460	471	470	538	498	503	434	507	531	579	535
Base Average	325	340	323	305	326	308	248	212	252	272	287	282
Base Dry	200	203	197	178	190	154	121	111	186	155	169	176
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat Key Indicators: Water Quality, Aquatic Habitat												
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80

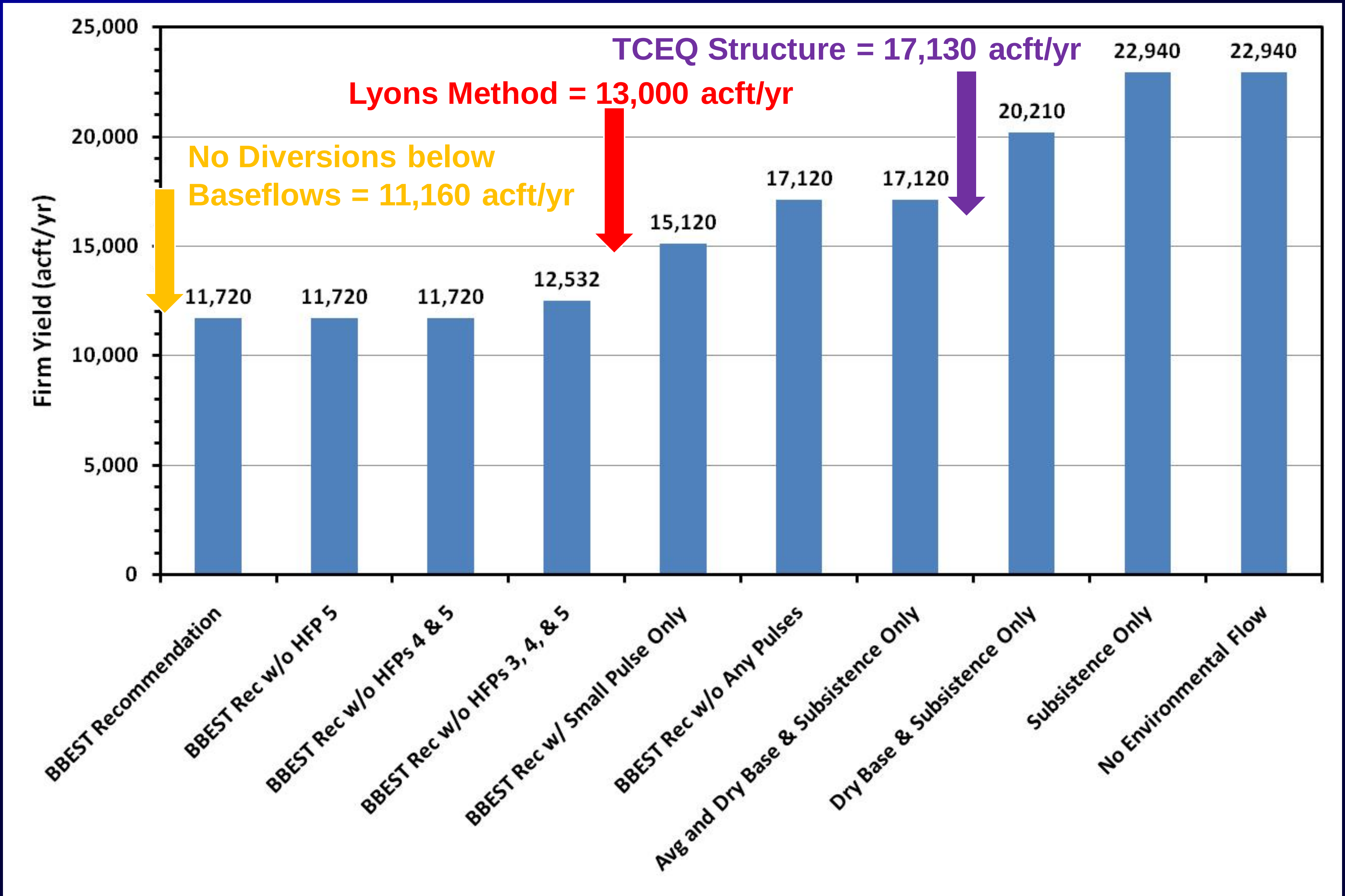
San Antonio River at Goliad (BBASC Work)



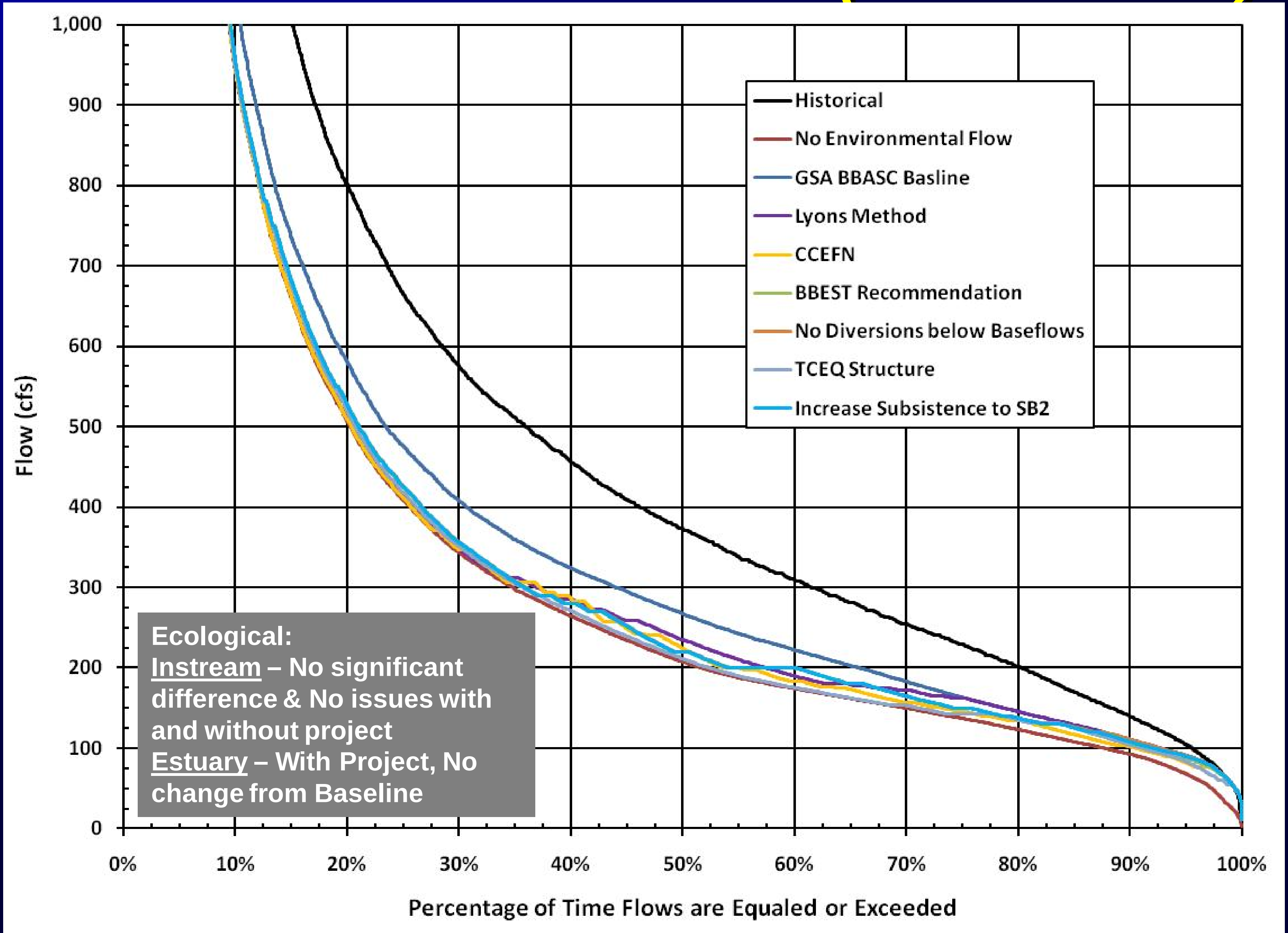
San Antonio River at Goliad (BBASC Work)

	No Environmental Flow	Lyons Method	CCEFN	BBEST Recommendation	BBEST - No Diversions below Baseflow	TCEQ Structure
Available Project Yield (acft/yr)	22,925	13,000	16,700	11,700	11,160	17,300
Raw Water at Reservoir						
Total Project Cost	$273,450,000	$273,450,000	$273,450,000	$273,450,000	$273,450,000	$273,450,000
Total Annual Cost	$24,560,000	$24,378,000	$24,396,000	$24,232,000	$24,232,000	$24,396,000
Annual Cost of Raw Water ($ per acft)	$1,071	$1,875	$1,461	$2,071	$2,171	$1,410
Annual Cost of Raw Water ($ per 1,000 gallons)	$3.29	$5.75	$4.48	$6.36	$6.66	$4.33
Treated Water Delivered						
Total Project Cost	$523,535,000	$440,614,000	$471,271,000	$432,205,000	$428,764,000	$475,015,000
Total Annual Cost	$54,793,000	$44,634,000	$48,586,000	$43,006,000	$42,420,000	$49,272,000
Annual Cost of Water ($ per acft)	$2,390	$3,433	$2,909	$3,676	$3,801	$2,848
Annual Cost of Water ($ per 1,000 gallons)	$7.33	$10.54	$8.93	$11.28	$11.66	$8.74

San Antonio River at Goliad (BBASC Work)



San Antonio River at Goliad (BBASC Work)



San Antonio River at Goliad (BBASC Work) Preliminary Recommendation

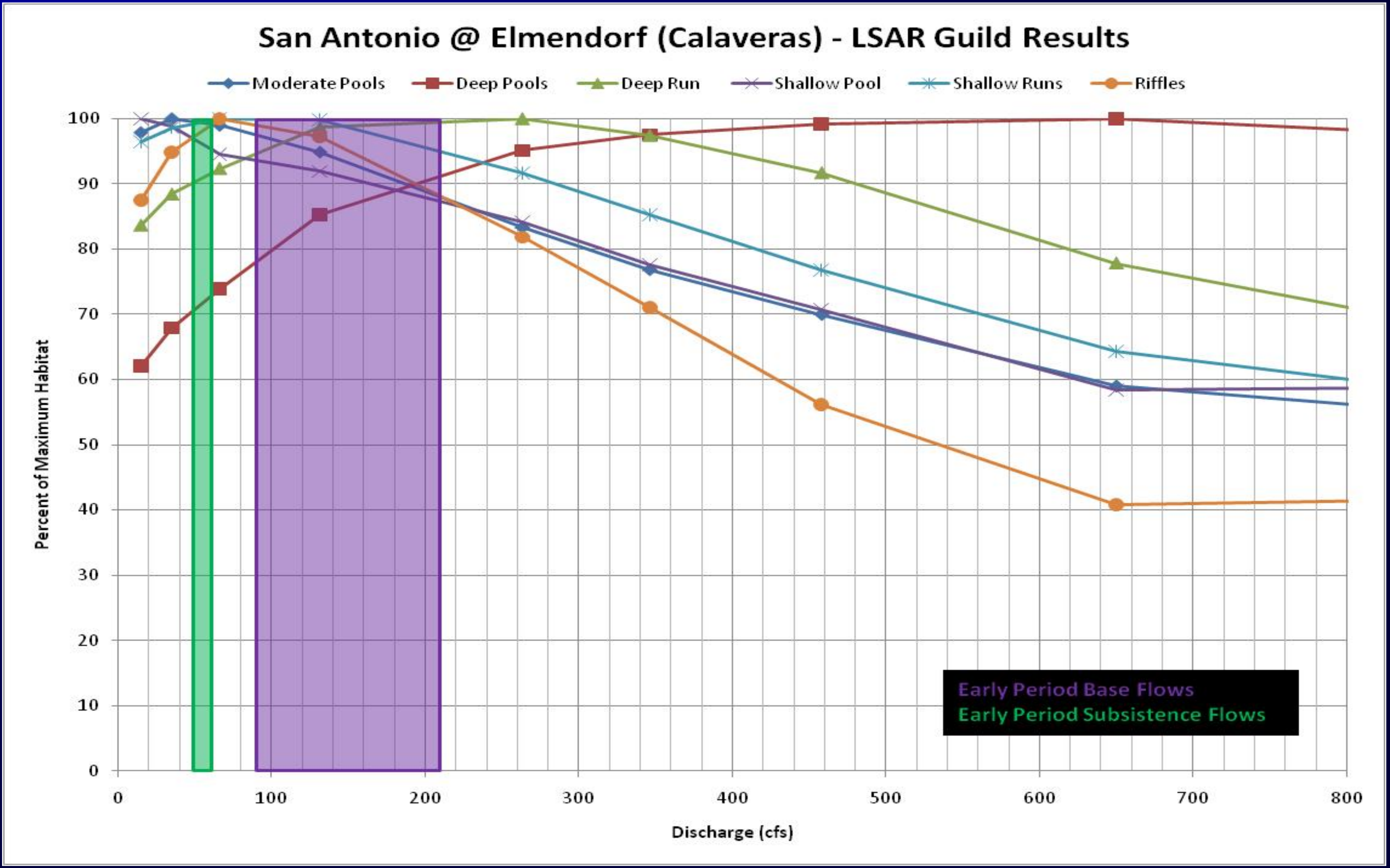
SARP (OCR = 150,000 acft)

- ❑ **Subsistence: 60 cfs, with 50% Rule**
- ❑ **Baseflows and Pulses per TIFP (SB2) Interim Recommendations**
- ❑ **Concept 1 for Pulses with 10% Ratio**
- ❑ **Firm Yield = 14,475 acft/yr**

San Antonio River near Elmendorf (BBEST)

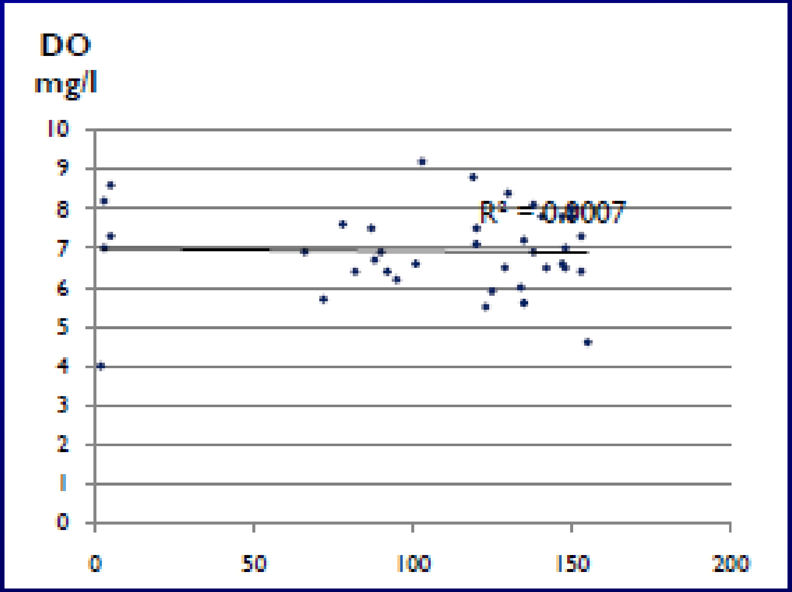
Overbank Flows	Qp: 12,200 cfs with Average Frequency 1 per 5 years Regressed Volume is 123,000 Duration Bound is 52			
High Flow Pulses	Qp: 5,640 cfs with Average Frequency 1 per 2 years Regressed Volume is 49,400 Duration Bound is 34			
	Qp: 3,310 cfs with Average Frequency 1 per year Regressed Volume is 26,400 Duration Bound is 25			
	Qp: 830 cfs with Average Frequency 1 per season Regressed Volume is 6,210 Duration Bound is 14	Qp: 1,560 cfs with Average Frequency 1 per season Regressed Volume is 10,700 Duration Bound is 16	Qp: 1,110 cfs with Average Frequency 1 per season Regressed Volume is 6,460 Duration Bound is 12	Qp: 1,010 cfs with Average Frequency 1 per season Regressed Volume is 6,570 Duration Bound is 13
	Qp: 440 cfs with Average Frequency 2 per season Regressed Volume is 2,940 Duration Bound is 10	Qp: 820 cfs with Average Frequency 2 per season Regressed Volume is 5,060 Duration Bound is 11	Qp: 540 cfs with Average Frequency 2 per season Regressed Volume is 2,870 Duration Bound is 9	Qp: 480 cfs with Average Frequency 2 per season Regressed Volume is 2,630 Duration Bound is 8
Base Flows (cfs)	210	200	170	190
	150	150	130	150
	110	99	88	97
Subsistence Flows (cfs)	61	50	49	56
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

San Antonio River near Elmendorf (BBEST)



- High percentages of maximum habitat maintained at BBEST subsistence and base flows.

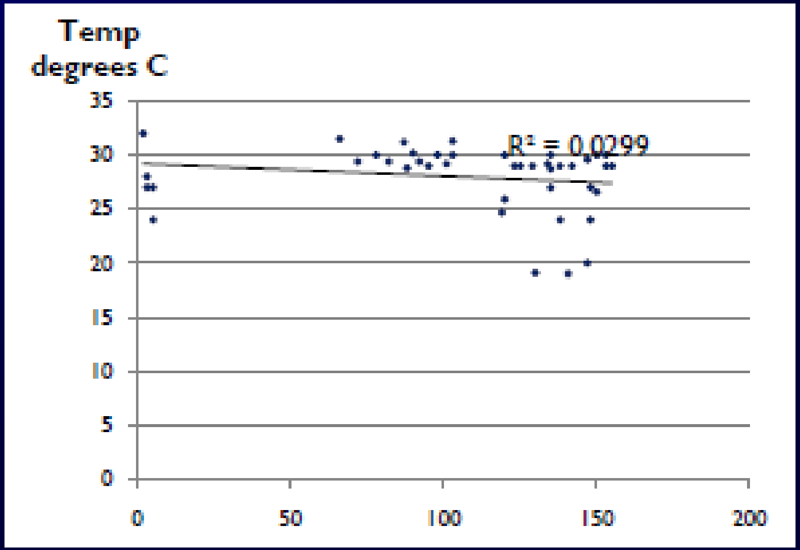
San Antonio River near Elmendorf (BBEST)



• Two violations of 5 mg/l TCEQ stream standard for dissolved oxygen measured at lowest flows (cfs).

• TPWD has Moderate concern with BBEST subsistence flows (1 Habitat Guild < 80% max, LSAR WQ Model = 80 cfs).

• No violations of 90 degF TCEQ stream standard for temperature measured at lowest flows (cfs).



San Antonio River near Elmendorf (TIFP)

ELMENDORF

Overbank Flow

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 8,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 75% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indicators: Cottonwood

Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indicators:
Riparian: Green Ash / Box Elder

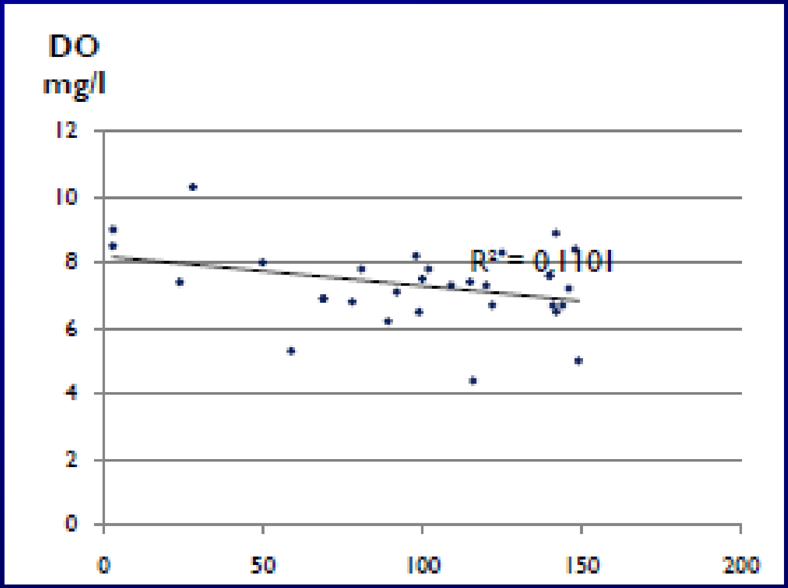
Magnitude = 3,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) Key Indicators: Aquatic Habitat, Water Quality												
Base Wet	319	336	329	338	372	382	384	303	336	357	390	355
Base Average	264	268	256	235	259	216	177	160	195	220	226	225
Base Dry	119	113	114	109	113	98	90	90	107	90	91	101
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat Key Indicators: Water Quality, Aquatic Habitat												
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80

San Antonio River near Falls City (BBEST)

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 10,600 cfs with Average Frequency 1 per 5 years Regressed Volume is 110,000 Duration Bound is 57			
	Qp: 6,000 cfs with Average Frequency 1 per 2 years Regressed Volume is 56,500 Duration Bound is 41			
High Flow Pulses	Qp: 3,160 cfs with Average Frequency 1 per year Regressed Volume is 26,600 Duration Bound is 29			
	Qp: 830 cfs with Average Frequency 1 per season Regressed Volume is 6,330 Duration Bound is 16	Qp: 1,670 cfs with Average Frequency 1 per season Regressed Volume is 12,300 Duration Bound is 19	Qp: 1,030 cfs with Average Frequency 1 per season Regressed Volume is 6,440 Duration Bound is 14	Qp: 850 cfs with Average Frequency 1 per season Regressed Volume is 5,690 Duration Bound is 14
	Qp: 420 cfs with Average Frequency 2 per season Regressed Volume is 2,740 Duration Bound is 10	Qp: 840 cfs with Average Frequency 2 per season Regressed Volume is 5,630 Duration Bound is 13	Qp: 470 cfs with Average Frequency 2 per season Regressed Volume is 2,650 Duration Bound is 10	Qp: 440 cfs with Average Frequency 2 per season Regressed Volume is 2,520 Duration Bound is 9
Base Flows (cfs)	200	200	170	190
	140	140	110	120
	110	95	85	92
Subsistence Flows (cfs)	60	52	52	58

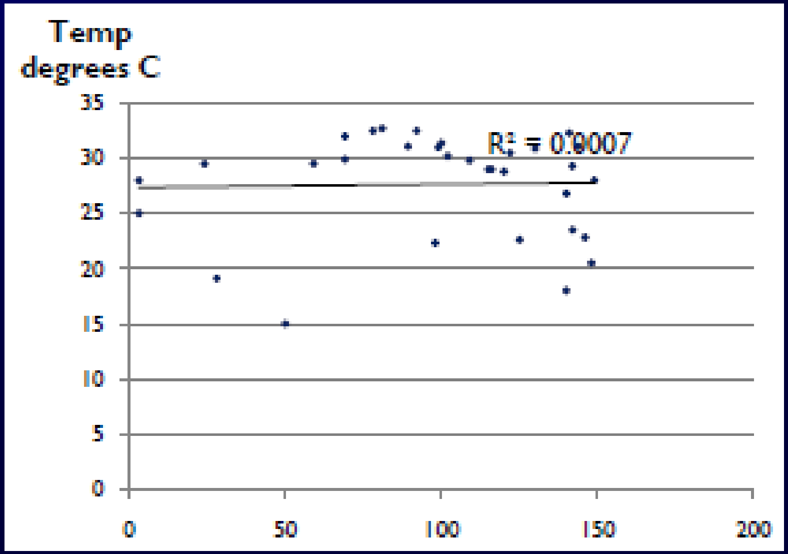
San Antonio River near Falls City (BBEST)



• One violation of 5 mg/l TCEQ stream standard for dissolved oxygen measured at lowest flows (cfs).

• TPWD has Moderate concern with BBEST subsistence flows (No Habitat Model, LSAR WQ Model = 80 cfs).

• Some violations of 90 degF TCEQ stream standard for temperature measured at lowest flows (cfs).



San Antonio River near Falls City (TIFP)

FALLS CITY

Overbank Flow

(February – October)

Magnitude = 11,500 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

(February – October)

Magnitude = 8,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 80% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

(February – April)

Key Indicators: Riparian - Sycamore
Magnitude = 4,000 cfs
Frequency = 2 events
Duration = 2-5 days

(April – June)

Magnitude = 4,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

(July – November)

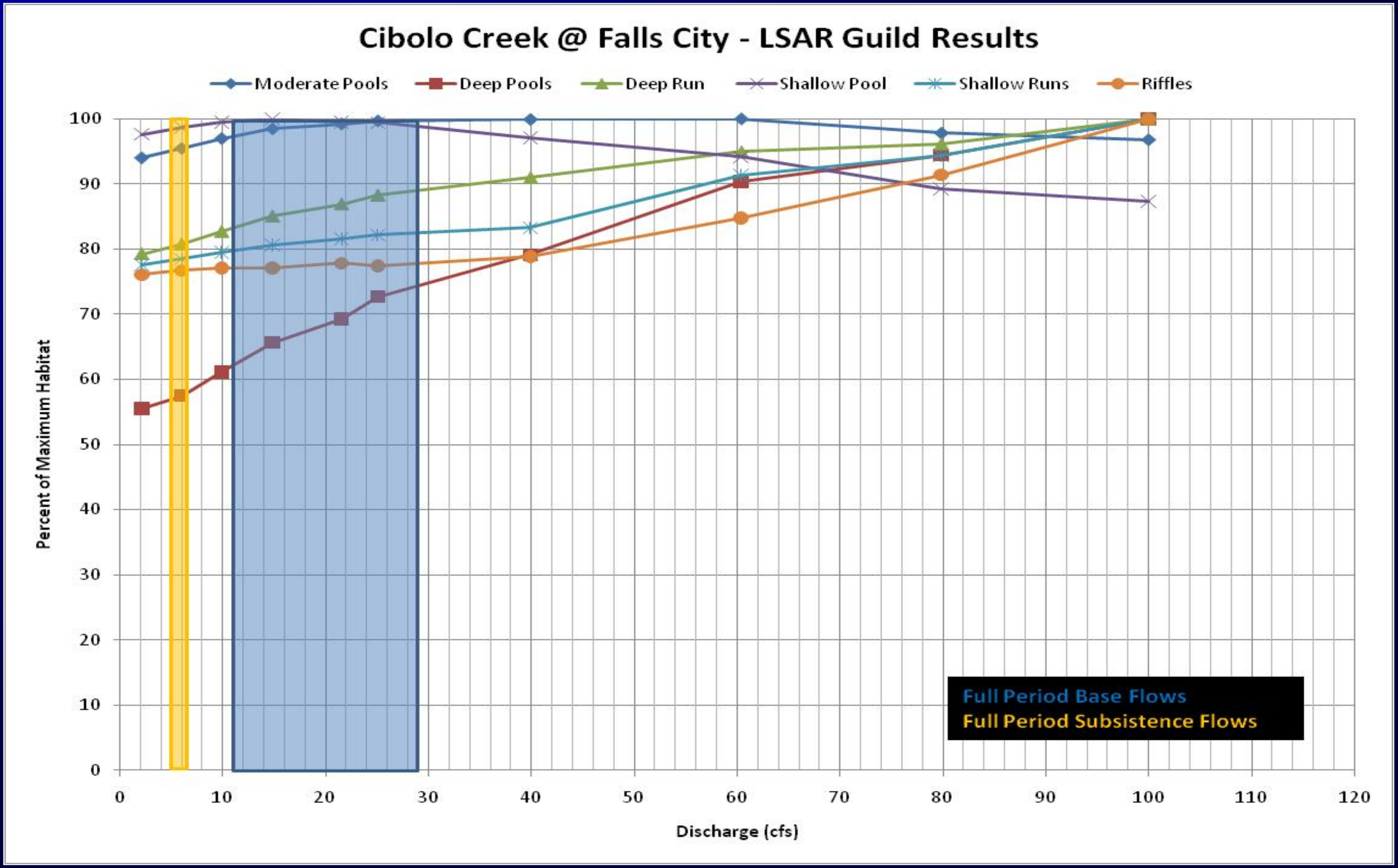
Magnitude = 6,500 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indicators:
Riparian: Green Ash / Box Elder

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability)								**Key Indicators: Aquatic Habitat, Water Quality**				
Base Wet	429	429	413	427	487	489	489	380	422	459	511	466
Base Average	292	296	288	261	281	249	200	177	218	242	244	251
Base Dry	152	158	147	142	145	125	103	96	141	105	119	127
SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat								**Key Indicators: Water Quality, Aquatic Habitat**				
Subsistence	80	80	80	80	80	80	80	80	80	80	80	80

Cibolo Creek near Falls City (BBEST)

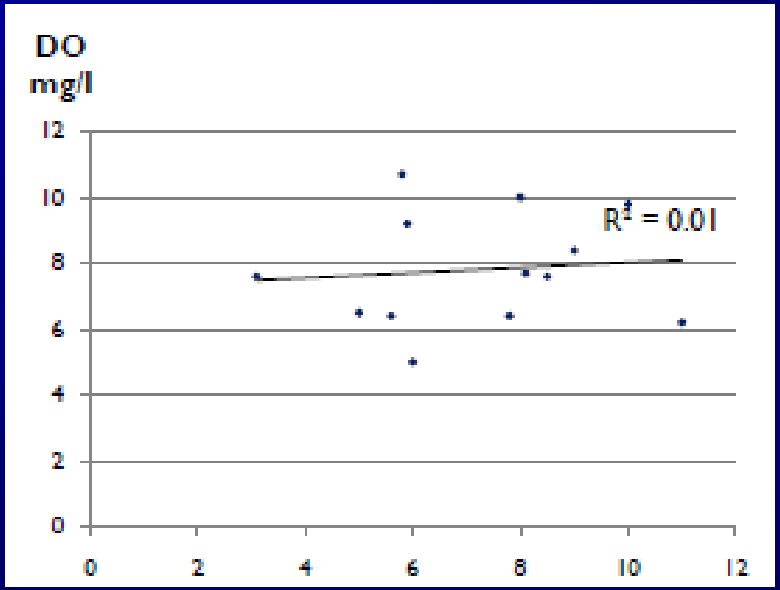
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Overbank Flows	Qp: 13,500 cfs with Average Frequency 1 per 5 years Regressed Volume is 62,800 Duration Bound is 42											
	Qp: 7,220 cfs with Average Frequency 1 per 2 years Regressed Volume is 34,200 Duration Bound is 35											
	Qp: 5,160 cfs with Average Frequency 1 per year Regressed Volume is 24,700 Duration Bound is 32											
High Flow Pulses	Qp: 570 cfs with Average Frequency 1 per season Regressed Volume is 3,200 Duration Bound is 20			Qp: 2,280* cfs with Average Frequency 1 per season Regressed Volume is 10,400 Duration Bound is 21			Qp: 390 cfs with Average Frequency 1 per season Regressed Volume is 1,990 Duration Bound is 15			Qp: 1,000* cfs with Average Frequency 1 per season Regressed Volume is 5,000 Duration Bound is 22		
	Qp: 140 cfs with Average Frequency 2 per season Regressed Volume is 820 Duration Bound is 13			Qp: 670 cfs with Average Frequency 2 per season Regressed Volume is 3,230 Duration Bound is 16			Qp: 110 cfs with Average Frequency 2 per season Regressed Volume is 580 Duration Bound is 10			Qp: 190 cfs with Average Frequency 2 per season Regressed Volume is 1,000 Duration Bound is 13		
Base Flows (cfs)	29			27			22			27		
	23			19			15			20		
	17			13			11			13		
Subsistence Flows (cfs)	6.0			4.9			5.0			6.5		
	Winter			Spring			Summer			Fall		

Cibolo Creek near Falls City (BBEST)



- Reasonably high percentages of maximum habitat maintained at BBEST subsistence and base flows.

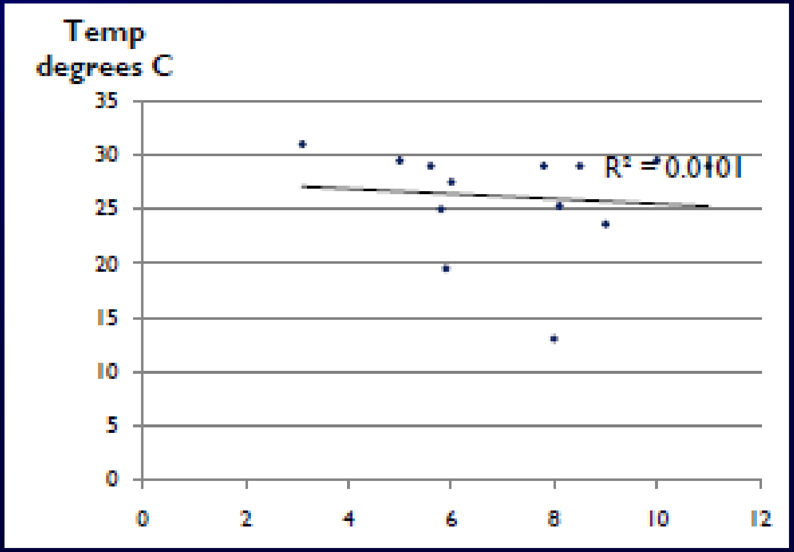
Cibolo Creek near Falls City (BBEST)



• No violations of 5 mg/l TCEQ stream standard for dissolved oxygen measured at lowest flows (cfs).

• TPWD has Moderate concern with subsistence flows (Some Habitat Guilds < 80% max, Only 1 Habitat Guild < 75% max, LSAR = 7.5 cfs).

• No violations of 90 degF TCEQ stream standard for temperature measured at lowest flows (cfs).



Cibolo Creek near Falls City (TIFP)

CIBOLO CREEK

Overbank Flow

Magnitude = 8,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 90% of hardwood forest community
Sediment transport: Channel maintenance

Magnitude = 5,000 cfs
Frequency = 1 event
Duration = 2 days

Key Indicators:
Riparian: Inundates approx. 75% of hardwood forest community
Sediment transport: Channel maintenance

High Flow Pulses

Magnitude = 2,500 cfs
Frequency = 2 events
Duration = 2-3 days

Key Indicators:
Riparian: Green Ash / Box Elder

Magnitude = 1,000 cfs
Frequency = 3 events
Duration = 2-5 days
Key Indicators: Riparian - Black Willow

Magnitude = 1,000 cfs
Frequency = 2 events
Duration = 2-3 days
Key Indictors: Riparian - Buttonbush

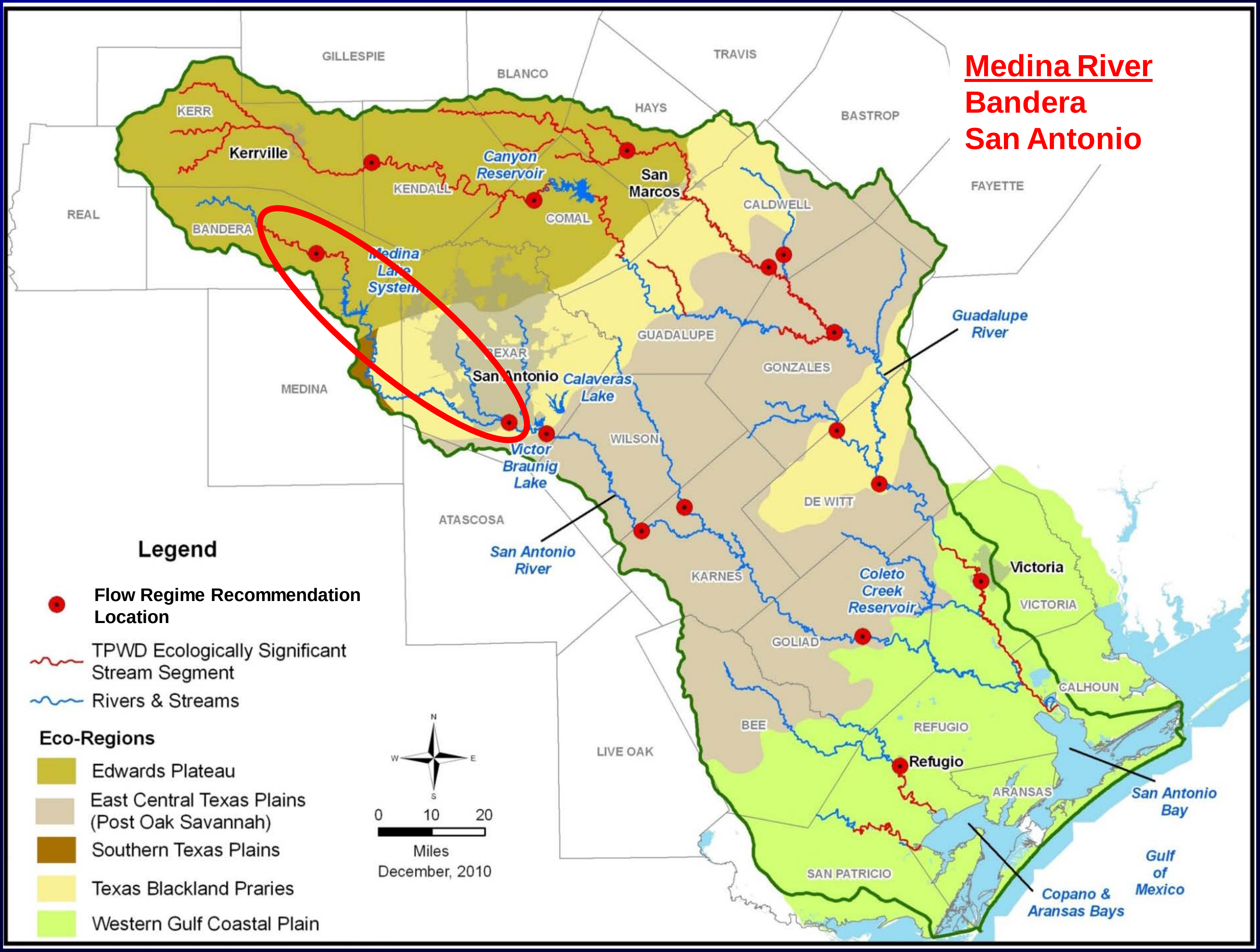
BASE FLOWS (cfs) - Aquatic Habitat protection (intra- and interannual variability) **Key Indicators: Aquatic Habitat, Water Quality**

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
Base Wet	39	41	38	38	48	45	44	31	35	35	43	42
Base Average	29	28	27	26	29	28	21	17	20	23	25	25
Base Dry	19	20	19	18	17	14	11	9	12	13	13	15

SUBSISTENCE FLOWS (cfs) - Water quality protection and maintainence of limited aquatic habitat **Key Indicators: Water Quality, Aquatic Habitat**

MONTH	January	February	March	April	May	June	July	August	September	October	November	December
Subsistence	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5

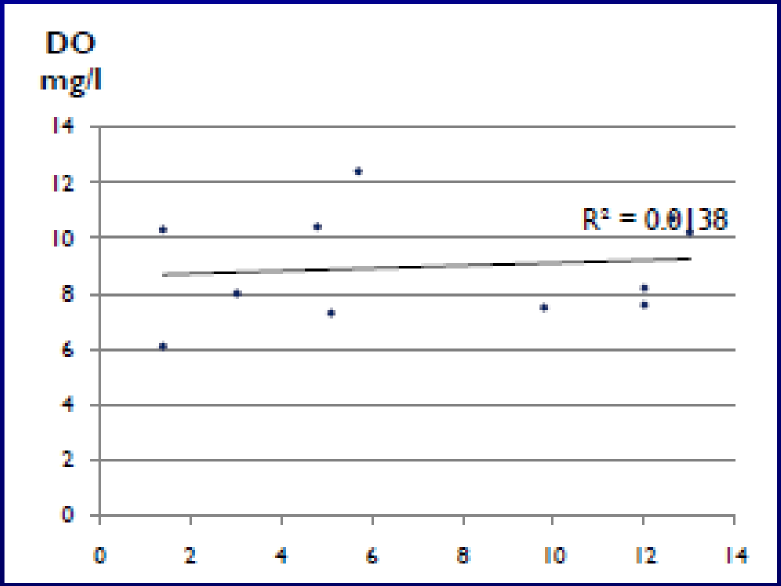
Group 2:
Other San Antonio River Basin Locations



Medina River at Bandera (BBEST)

Overbank Flows	Qp: 6,920 cfs with Average Frequency 1 per 5 years Regressed Volume is 50,000 Duration Bound is 83			
	Qp: 3,470 cfs with Average Frequency 1 per 2 years Regressed Volume is 34,500 Duration Bound is 63			
High Flow Pulses	Qp: 1,890 cfs with Average Frequency 1 per year Regressed Volume is 18,000 Duration Bound is 50			
	Qp: 110 cfs with Average Frequency 1 per season Regressed Volume is 960 Duration Bound is 17	Qp: 480 cfs with Average Frequency 1 per season Regressed Volume is 4,190 Duration Bound is 28	Qp: 340 cfs with Average Frequency 1 per season Regressed Volume is 2,310 Duration Bound is 21	Qp: 220 cfs with Average Frequency 1 per season Regressed Volume is 1,930 Duration Bound is 24
	Qp: 53 cfs with Average Frequency 2 per season Regressed Volume is 400 Duration Bound is 12	Qp: 110 cfs with Average Frequency 2 per season Regressed Volume is 900 Duration Bound is 17	Qp: 94 cfs with Average Frequency 2 per season Regressed Volume is 670 Duration Bound is 14	Qp: 68 cfs with Average Frequency 2 per season Regressed Volume is 500 Duration Bound is 14
Base Flows (cfs)	54	48	41	49
	32	22	16	33
	17	9.8	6.2	16
Subsistence Flows (cfs)	1.1	1.0	1.2	1.0
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

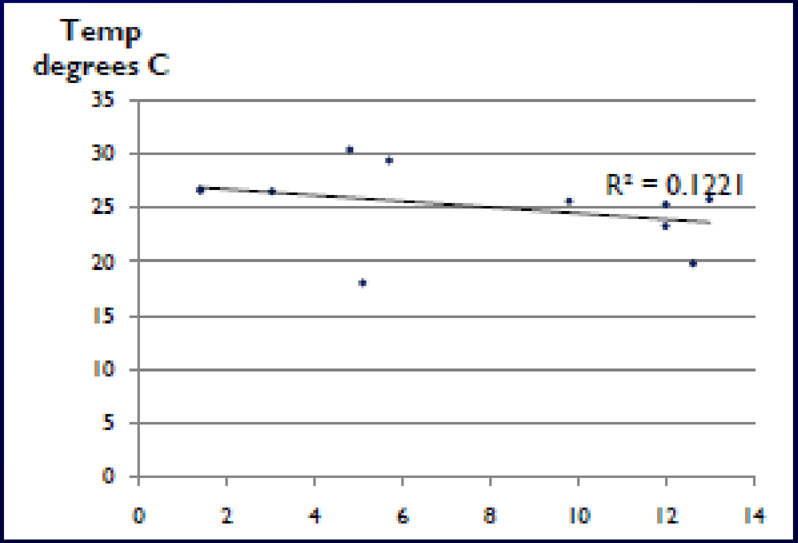
Medina River at Bandera (BBEST)



- No violations of 6 mg/l TCEQ stream standard for dissolved oxygen measured at lowest flows (cfs).

- TPWD has High concern with BBEST subsistence flows (Some Habitat Guilds < 20% max). Comparative Cross-section Method (CCM) flow-habitat relationships only.

- No violations of 88 degF TCEQ stream standard for temperature measured at lowest flows (cfs).



Medina River at San Antonio (BBEST)

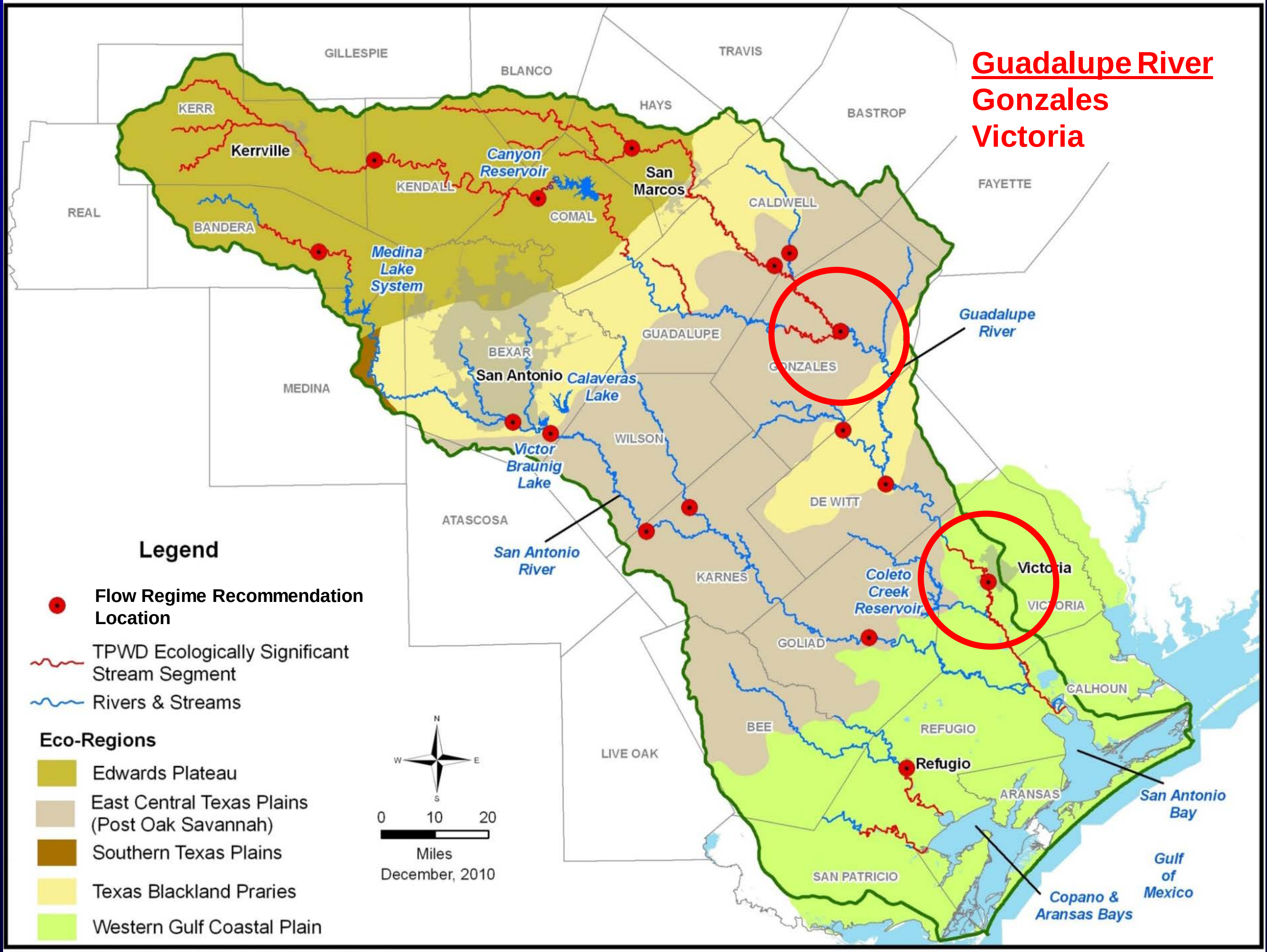
Overbank Flows	Qp: 9,940 cfs with Average Frequency 1 per 5 years Regressed Volume is 123,000 Duration Bound is 107			
	Qp: 6,020 cfs with Average Frequency 1 per 2 years Regressed Volume is 69,300 Duration Bound is 83			
High Flow Pulses	Qp: 2,920 cfs with Average Frequency 1 per year Regressed Volume is 30,400 Duration Bound is 58			
	Qp: 350 cfs with Average Frequency 1 per season Regressed Volume is 3,570 Duration Bound is 27	Qp: 1,000 cfs with Average Frequency 1 per season Regressed Volume is 7,950 Duration Bound is 27	Qp: 440 cfs with Average Frequency 1 per season Regressed Volume is 3,050 Duration Bound is 21	Qp: 450 cfs with Average Frequency 1 per season Regressed Volume is 3,890 Duration Bound is 28
	Qp: 120 cfs with Average Frequency 2 per season Regressed Volume is 970 Duration Bound is 15	Qp: 380 cfs with Average Frequency 2 per season Regressed Volume is 2,680 Duration Bound is 17	Qp: 140 cfs with Average Frequency 2 per season Regressed Volume is 860 Duration Bound is 12	Qp: 130 cfs with Average Frequency 2 per season Regressed Volume is 930 Duration Bound is 14
Base Flows (cfs)	71	77	72	74
	53	62	57	60
	20	37	33	27
Subsistence Flows (cfs)	7.9	7.6	7.0	7.4
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

Medina River at San Antonio (BBEST)

• No available measurements of dissolved oxygen or temperature at BBEST subsistence flow levels.

• TPWD has High concern with BBEST subsistence flows (All Habitat Guilds < 50% max, 1 Habitat Guild < 20% max). Comparative Cross-section Method (CCM) flow-habitat relationships only.

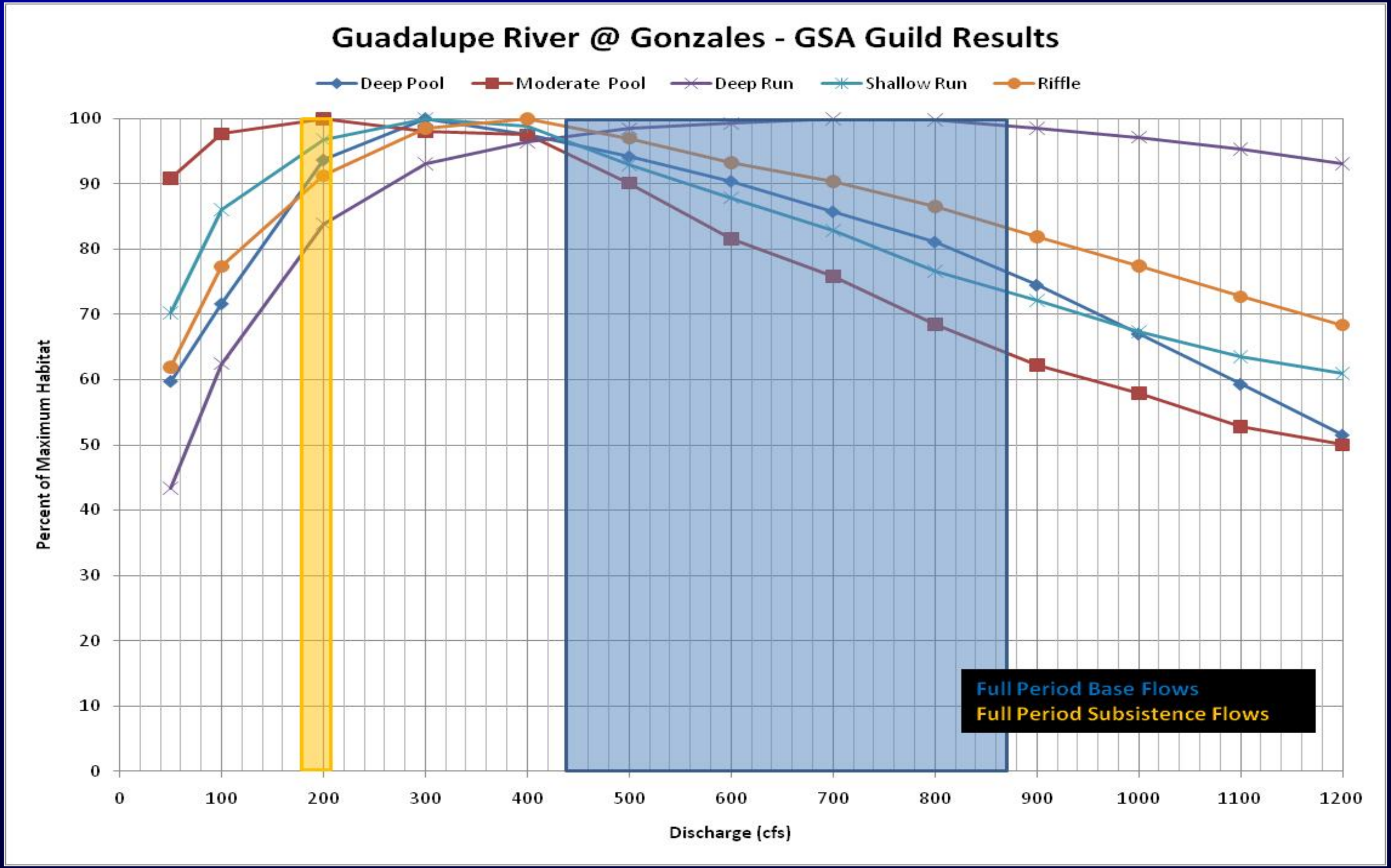
Group 3:
Guadalupe River Basin Locations w/ Site-Specific Habitat Information



Guadalupe River at Gonzales (BBEST)

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 36,700 cfs with Average Frequency 1 per 5 years Regressed Volume is 492,000 Duration Bound is 70			
	Qp: 24,400 cfs with Average Frequency 1 per 2 years Regressed Volume is 306,000 Duration Bound is 57			
	Qp: 14,300 cfs with Average Frequency 1 per year Regressed Volume is 165,000 Duration Bound is 43			
High Flow Pulses	Qp: 4,140 cfs with Average Frequency 1 per season Regressed Volume is 48,300 Duration Bound is 29	Qp: 6,590 cfs with Average Frequency 1 per season Regressed Volume is 58,400 Duration Bound is 24	Qp: 1,760 cfs with Average Frequency 1 per season Regressed Volume is 14,800 Duration Bound is 14	Qp: 4,330 cfs with Average Frequency 1 per season Regressed Volume is 41,200 Duration Bound is 23
	Qp: 1,150 cfs with Average Frequency 2 per season Regressed Volume is 9,640 Duration Bound is 13	Qp: 3,250 cfs with Average Frequency 2 per season Regressed Volume is 26,900 Duration Bound is 17	Qp: 950 cfs with Average Frequency 2 per season Regressed Volume is 7,060 Duration Bound is 10	Qp: 1,410 cfs with Average Frequency 2 per season Regressed Volume is 11,400 Duration Bound is 13
Base Flows (cfs)	860	870	800	810
	690	650	650	690
	540	440	440	510
Subsistence Flows (cfs)	210	210	210	180
	Jan / Feb / Mar	Apr / May / Jun	Jul / Aug / Sep	Oct / Nov / Dec
	Winter	Spring	Summer	Fall

Guadalupe River at Gonzales (BBEST)



• High percentages of maximum habitat maintained at BBEST subsistence and base flows.

Guadalupe River at Gonzales (BBEST)

- No available measurements of dissolved oxygen or temperature at BBEST subsistence flow levels.

- TPWD has Low-Moderate concern with BBEST subsistence flows (All Habitat Guilds > 80% max).

- Supplemental evaluations of flow-habitat relationships by Dr. Hardy indicate that:

  - HEFR Low Base flows might be set at ~400 cfs while the maximum seasonal discharge might be adjusted down to ~500 cfs.
  - Similar shifts in the Medium and High Base flow seasonal minimum and maximum could also be considered.

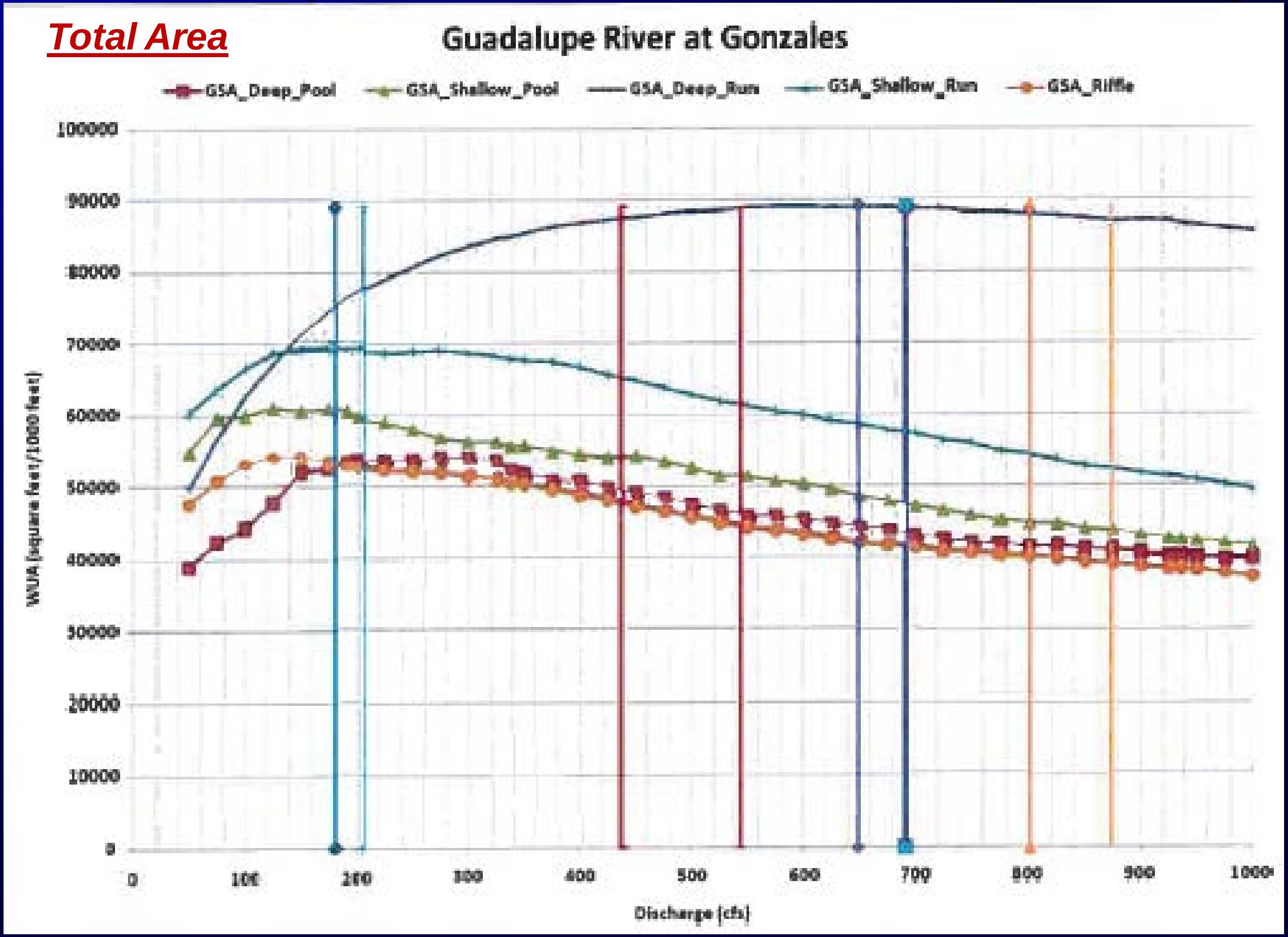
Mid-Basin Project Firm Yield:

1. Full BBEST Recommendation = 13,150 acft/yr

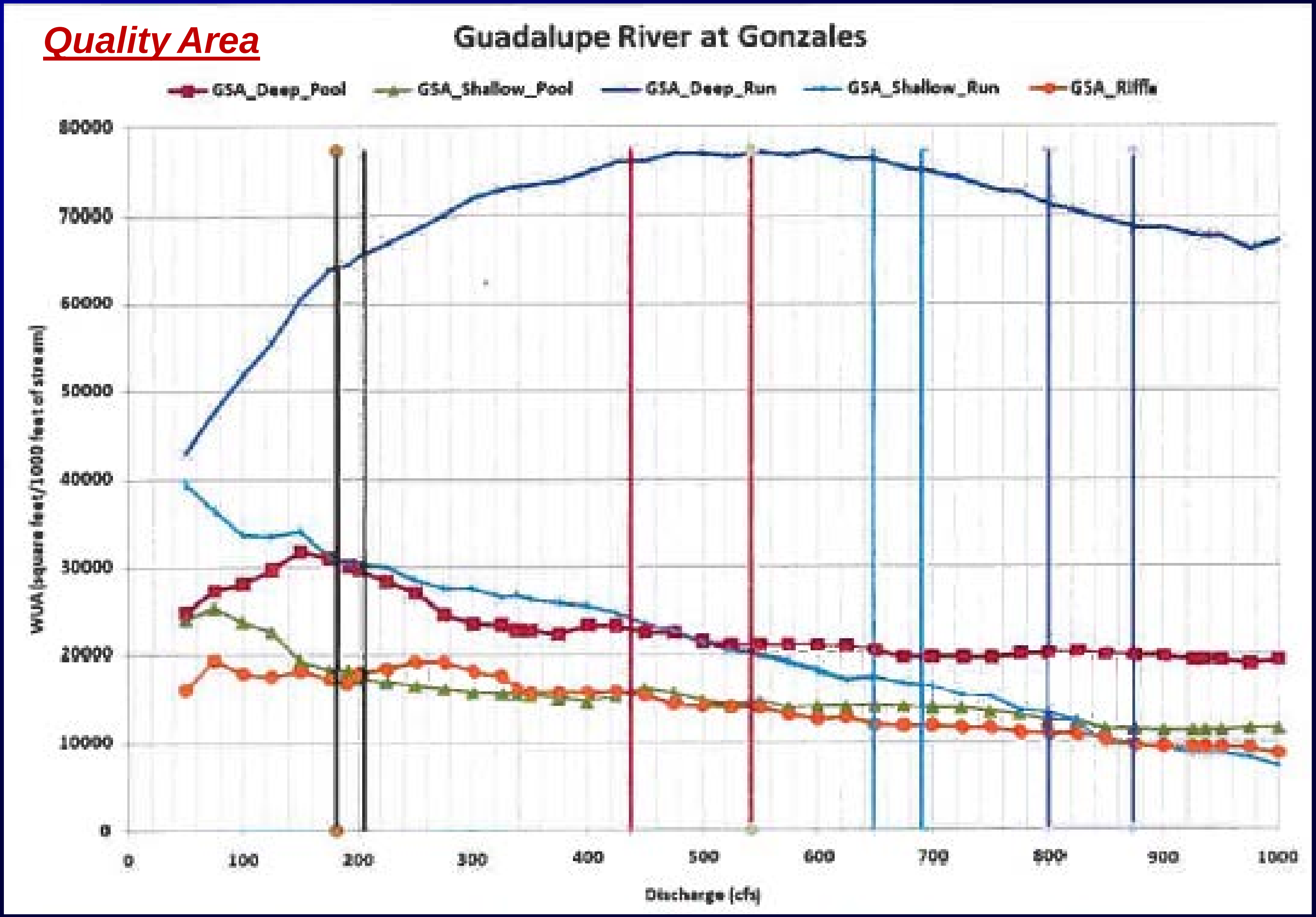
2a. 40 cfs Adjustment to all Baseflows = 13,525 acft/yr

2b. 40 cfs Adjustment to Dry Baseflows and Proportional Adjustment to Wet and Average Baseflows = 13,650 acft/yr

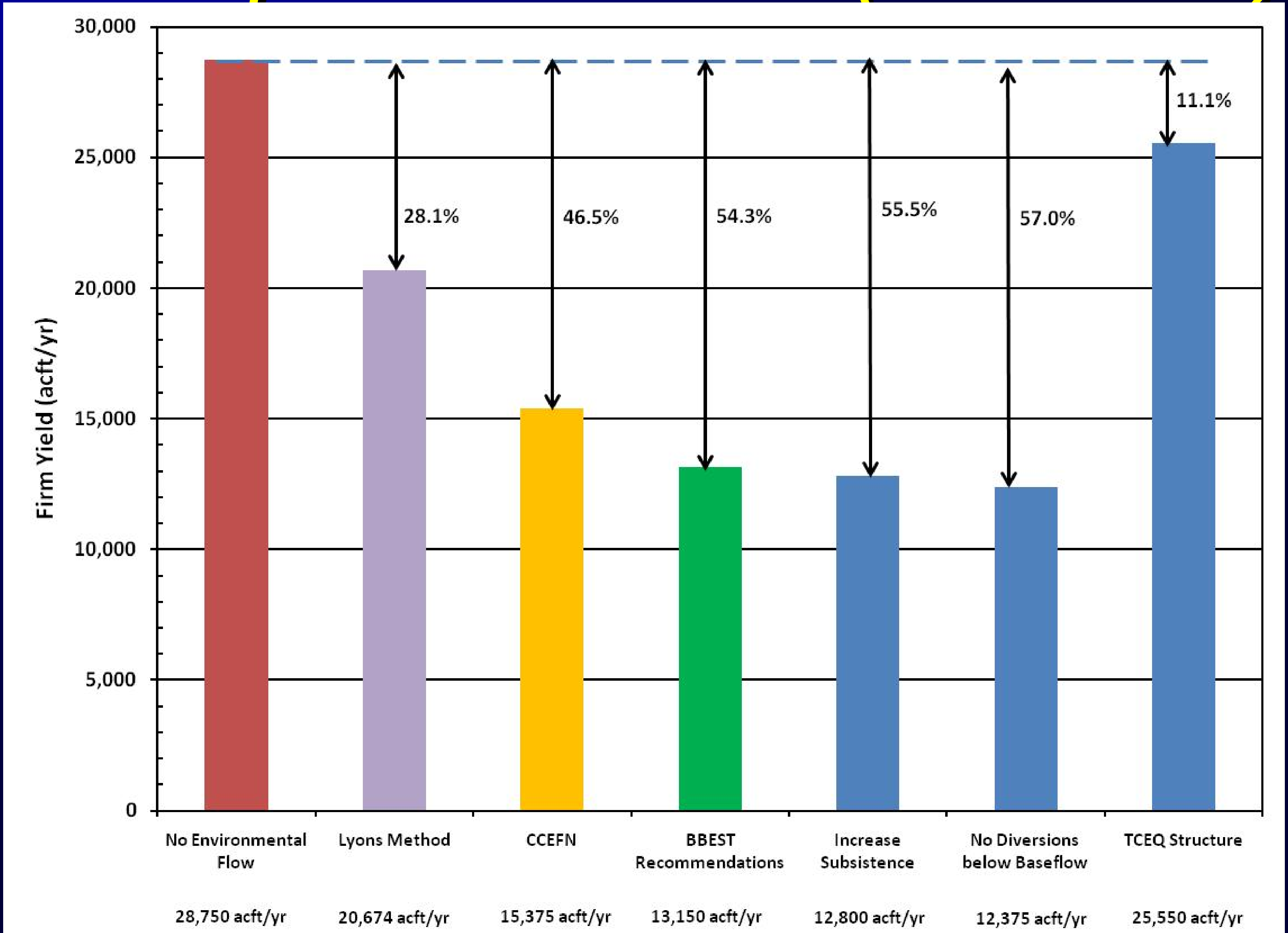
Guadalupe River at Gonzales (BBEST)



Guadalupe River at Gonzales (BBEST)



Guadalupe River at Gonzales (BBASC Work)



Guadalupe River at Gonzales (BBASC Work)

	No Environmental Flow	Lyons Method	CCEFN	BBEST Recommendation	BBEST - No Diversions below Baseflow	TCEQ Structure
Available Project Yield (acft/yr)	28,750	20,674	15,375	13,150	12,375	25,550
Raw Water at Reservoir						
Total Project Cost	$253,801,000	$253,801,000	$253,801,000	$253,801,000	$253,801,000	$253,801,000
Total Annual Cost	$22,908,000	$22,854,000	$22,636,000	$22,563,000	$22,564,000	$22,854,000
Annual Cost of Raw Water ($ per acft)	$797	$1,105	$1,472	$1,716	$1,823	$894
Annual Cost of Raw Water ($ per 1,000 gallons)	$2.45	$3.39	$4.52	$5.27	$5.59	$2.74
Treated Water Delivered						
Total Project Cost	$475,090,000	$413,942,000	$384,892,000	$369,922,000	$365,148,000	$445,076,000
Total Annual Cost	$49,713,000	$42,891,000	$38,912,000	$37,123,000	$36,385,000	$47,142,000
Annual Cost of Water ($ per acft)	$1,729	$2,075	$2,531	$2,823	$2,940	$1,849
Annual Cost of Water ($ per 1,000 gallons)	$5.31	$6.37	$7.77	$8.66	$9.02	$5.67

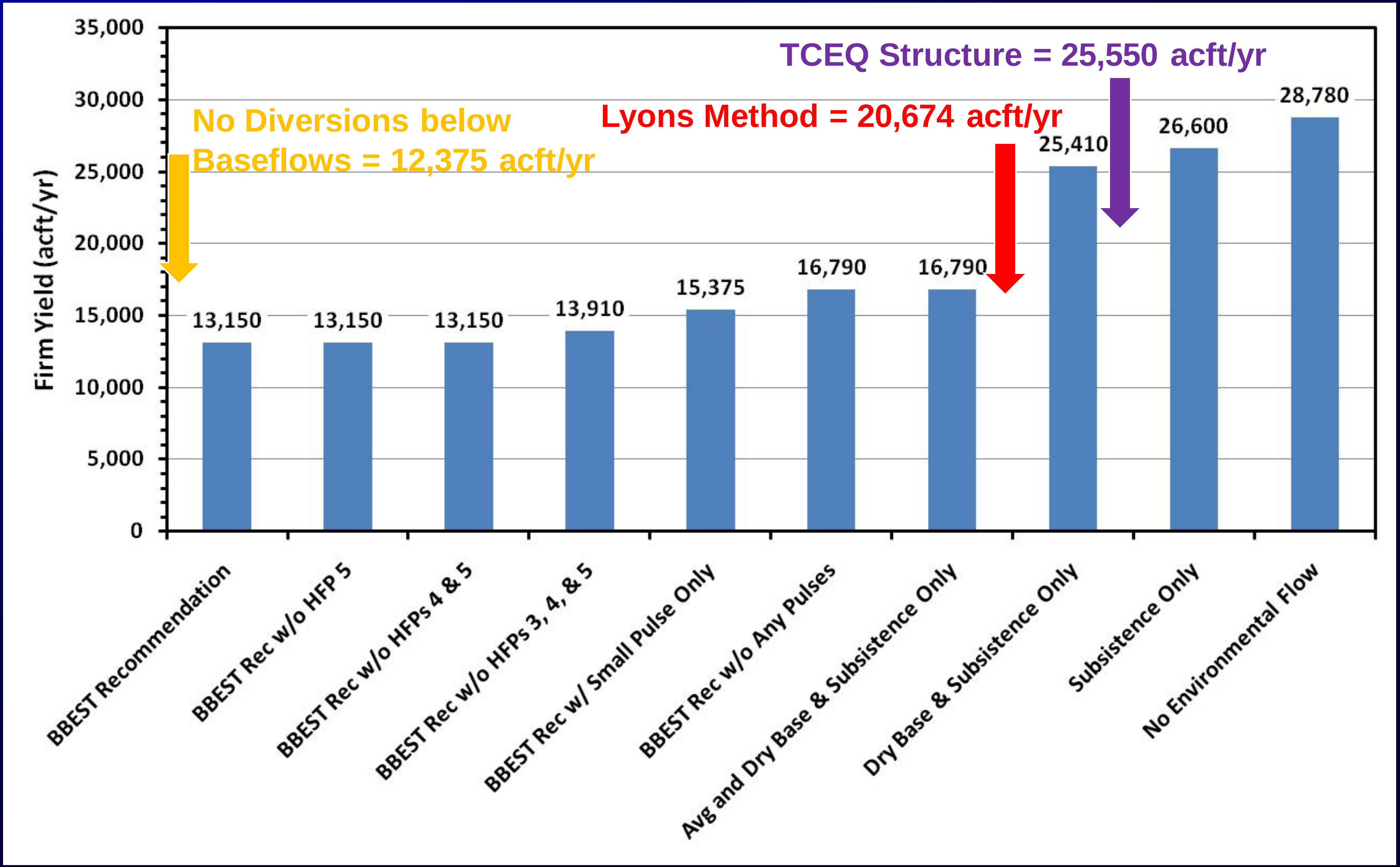
Mid-Basin Project

- How Big Does the Reservoir Need to Be to Get the Same Firm Yield of Lyons? And What's the Cost?

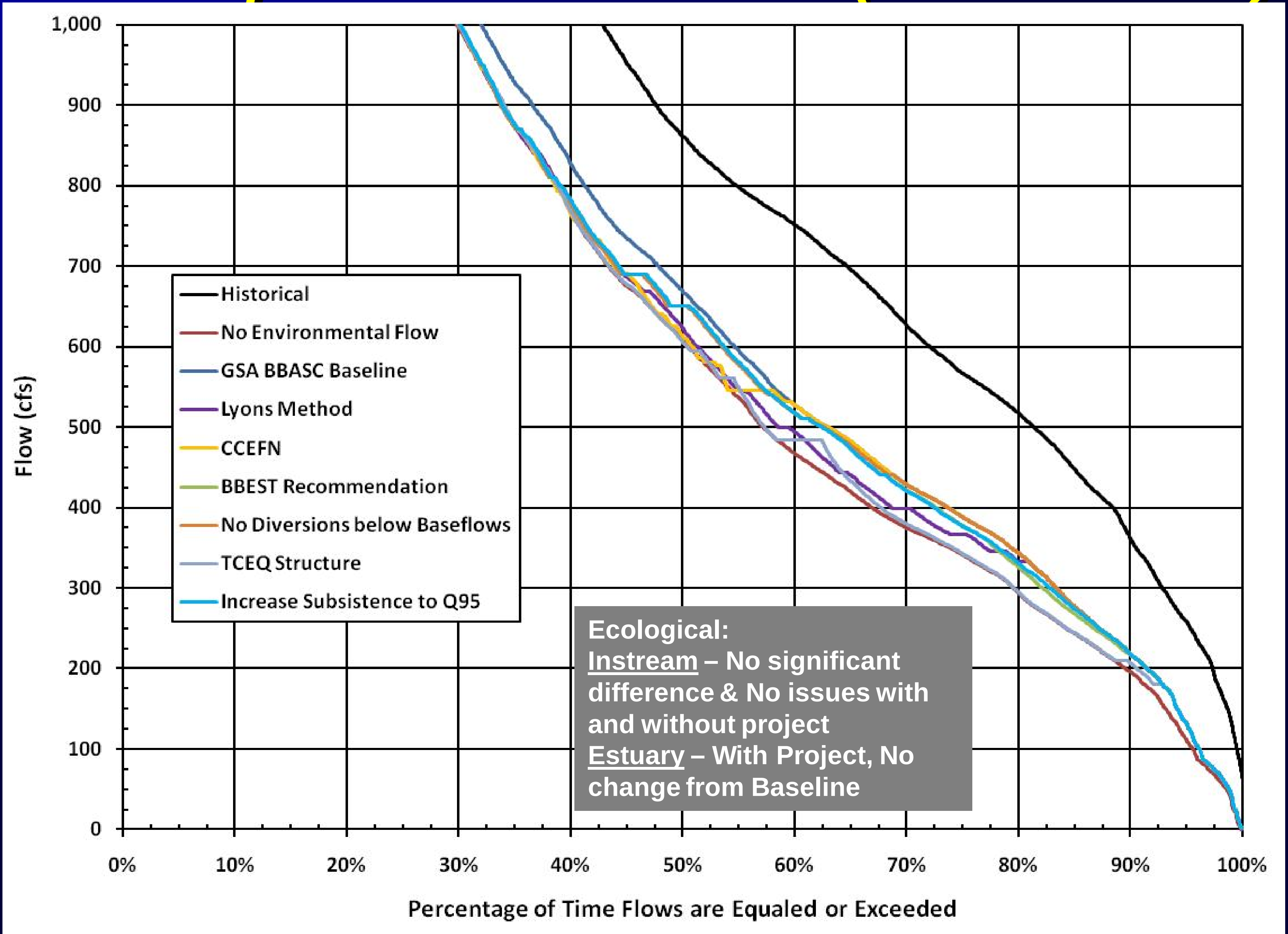
	105,500 acft Lyons Method	191,500 acft BBEST Recommendation*	86,000 acft TCEQ Structure*
Available Project Yield (acft/yr)	20,674	20,674	20,674
Raw Water at Reservoir			
Total Project Cost	$253,801,000	$279,391,000	$224,299,000
Total Annual Cost	$22,854,000	$24,828,000	$22,349,000
Annual Cost of Raw Water ($ per acft)	$1,105	$1,201	$1,081
Annual Cost of Raw Water ($ per 1,000 gallons)	$3.39	$3.68	$3.32
Treated Water Delivered			
Total Project Cost	$413,942,000	$441,845,071	$406,753,000
Total Annual Cost	$42,891,000	$44,865,622	$42,387,000
Annual Cost of Water ($ per acft)	$2,075	$2,170	$2,050
Annual Cost of Water ($ per 1,000 gallons)	$6.37	$6.66	$6.29

*Note: *Reservoir size adjusted to achieve same firm yield of Lyons Method*

Guadalupe River at Gonzales (BBASC Work)



Guadalupe River at Gonzales (BBASC Work)



Ecological:
Instream – No significant difference & No issues with and without project
Estuary – With Project, No change from Baseline

Guadalupe River at Gonzales (BBASC Work) Preliminary Recommendation

1. MBP (OCR = 105,500 acft)

- Subsistence: Spring, Summer, Fall = 210 cfs; Winter = 180 cfs, With 50% Rule
- Baseflows with Dr Hardy Recommendation (40 cfs Proportioned)
- Concept 1 for Pulses with 10% Ratio
- Firm Yield = _____ acft/yr

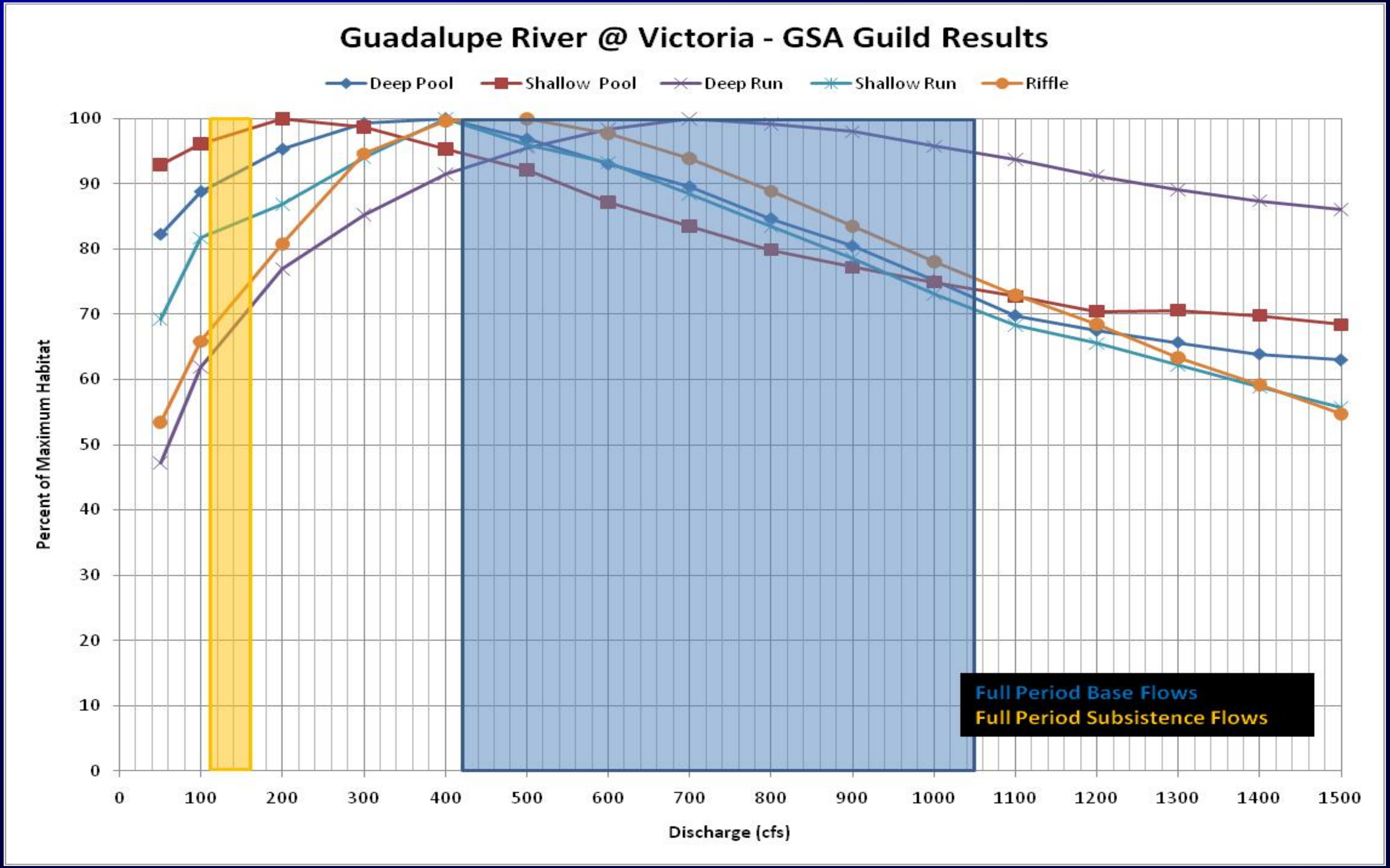
2. MBP (OCR = 191,500 acft)

- Subsistence: Spring, Summer, Fall = 210 cfs; Winter = 180 cfs, With 50% Rule
- Baseflows with Dr Hardy Recommendation (40 cfs Proportioned)
- Concept 1 for Pulses with 10% Ratio
- Firm Yield = 23,450 acft/yr

Guadalupe River at Victoria (BBEST)

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 48,000 cfs with Average Frequency 1 per 5 years Regressed Volume is 971,000 Duration Bound is 96			
	Qp: 25,500 cfs with Average Frequency 1 per 2 years Regressed Volume is 438,000 Duration Bound is 66			
	Qp: 16,700 cfs with Average Frequency 1 per year Regressed Volume is 257,000 Duration Bound is 51			
High Flow Pulses	Qp: 4,620 cfs with Average Frequency 1 per season Regressed Volume is 56,100 Duration Bound is 26	Qp: 9,020* cfs with Average Frequency 1 per season Regressed Volume is 119,000 Duration Bound is 34	Qp: 2,060 cfs with Average Frequency 1 per season Regressed Volume is 19,200 Duration Bound is 16	Qp: 5,370 cfs with Average Frequency 1 per season Regressed Volume is 57,800 Duration Bound is 23
	Qp: 1,690 cfs with Average Frequency 2 per season Regressed Volume is 14,400 Duration Bound is 13	Qp: 3,300 cfs with Average Frequency 2 per season Regressed Volume is 33,000 Duration Bound is 18	Qp: 1,040 cfs with Average Frequency 2 per season Regressed Volume is 8,570 Duration Bound is 11	Qp: 1,880 cfs with Average Frequency 2 per season Regressed Volume is 15,600 Duration Bound is 13
Base Flows (cfs)	1,050	1,020	870	940
	800	710	630	720
	580	450	420	510
Subsistence Flows (cfs)	160	130	150	110

Guadalupe River at Victoria (BBEST)



• High percentages of maximum habitat maintained at BBEST subsistence and base flows.

Guadalupe River at Victoria (BBEST)

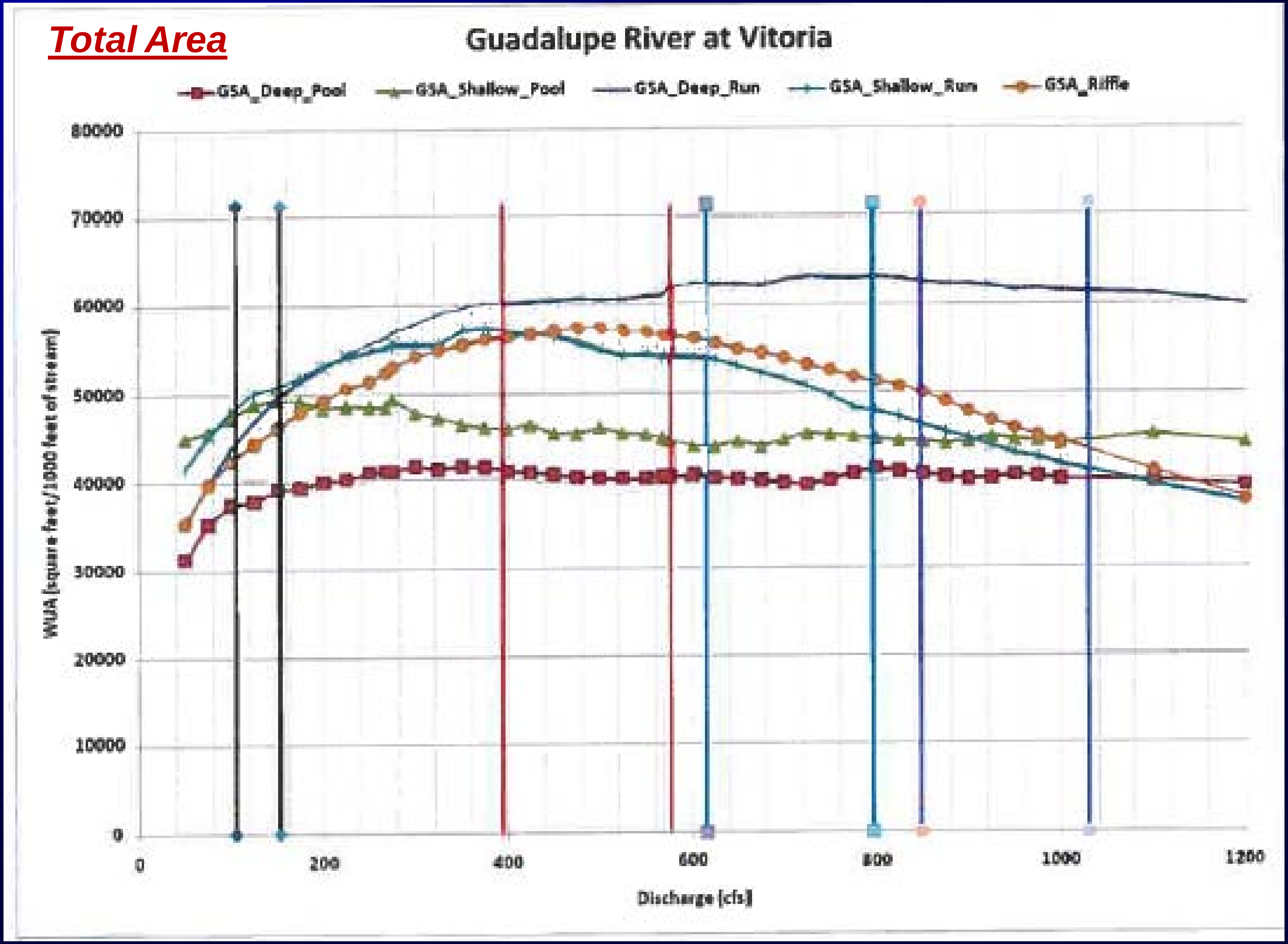
- No available measurements of dissolved oxygen or temperature at BBEST subsistence flow levels.

- TPWD has Moderate concern with BBEST subsistence flows (Some Habitat Guilds < 80% max).

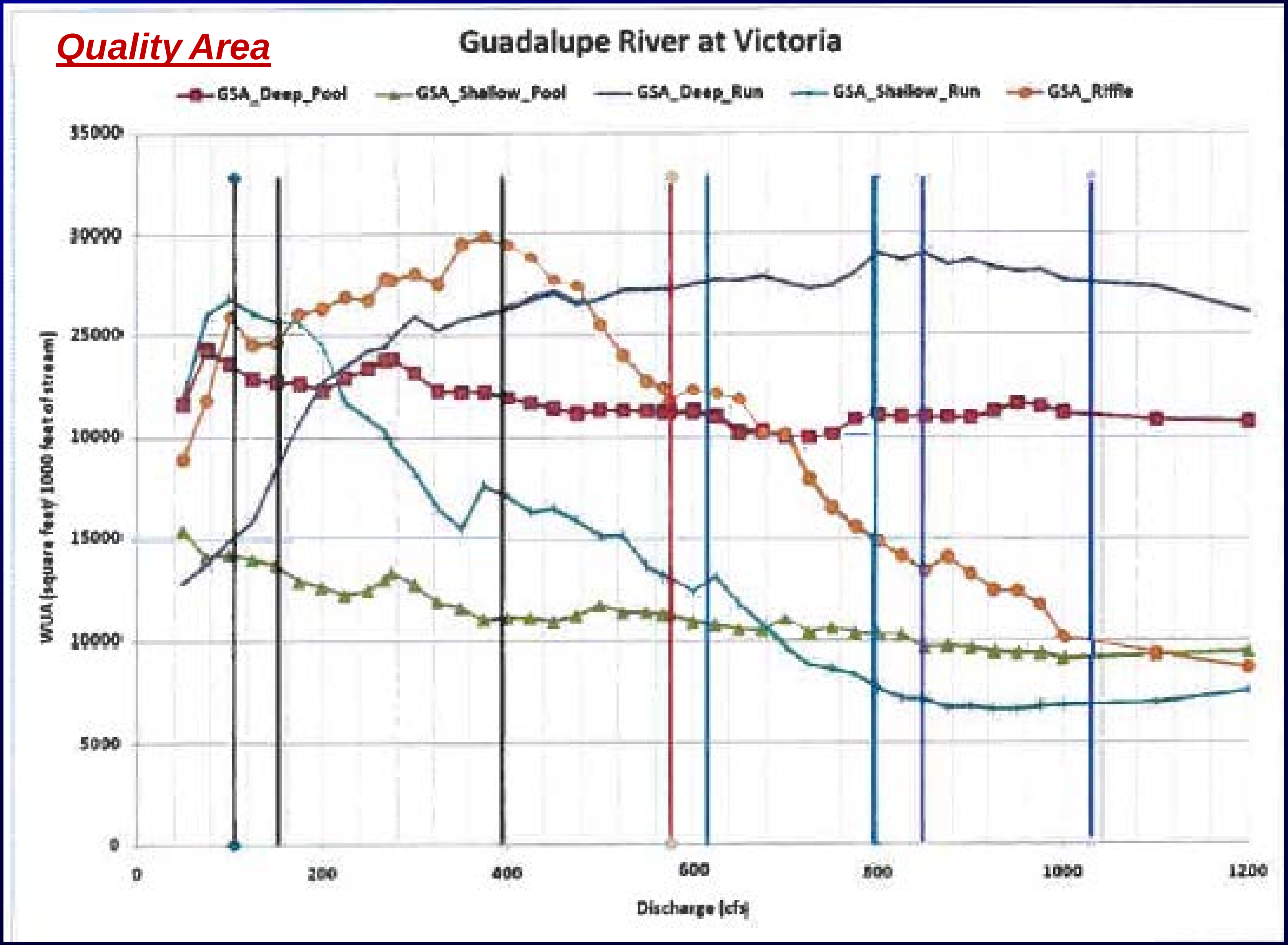
- Supplemental evaluations of flow-habitat relationships by Dr. Hardy indicate that:

- Adjustments to HEFR Low, Medium and High Base flow regime discharges could be considered.
- Shifts to flows by ~ 50 to 75 cfs within these flow regime seasonal discharges would likely maintain the relative contribution of high quality habitat whether one considers GSA or LSAR habitat guild results.

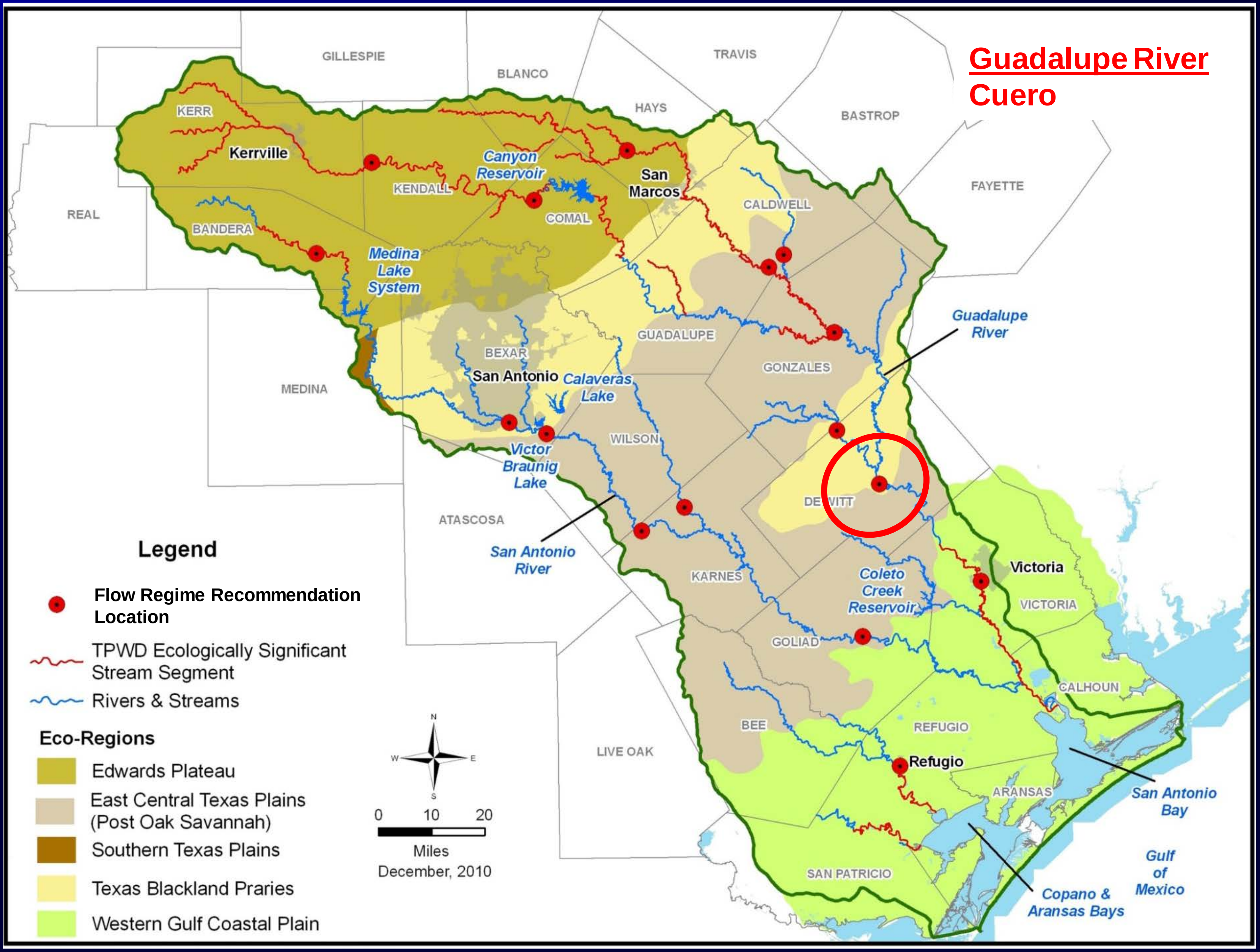
Guadalupe River at Victoria (BBEST)



Guadalupe River at Victoria (BBEST)



Group 4:
Guadalupe River Basin Locations – Cuero



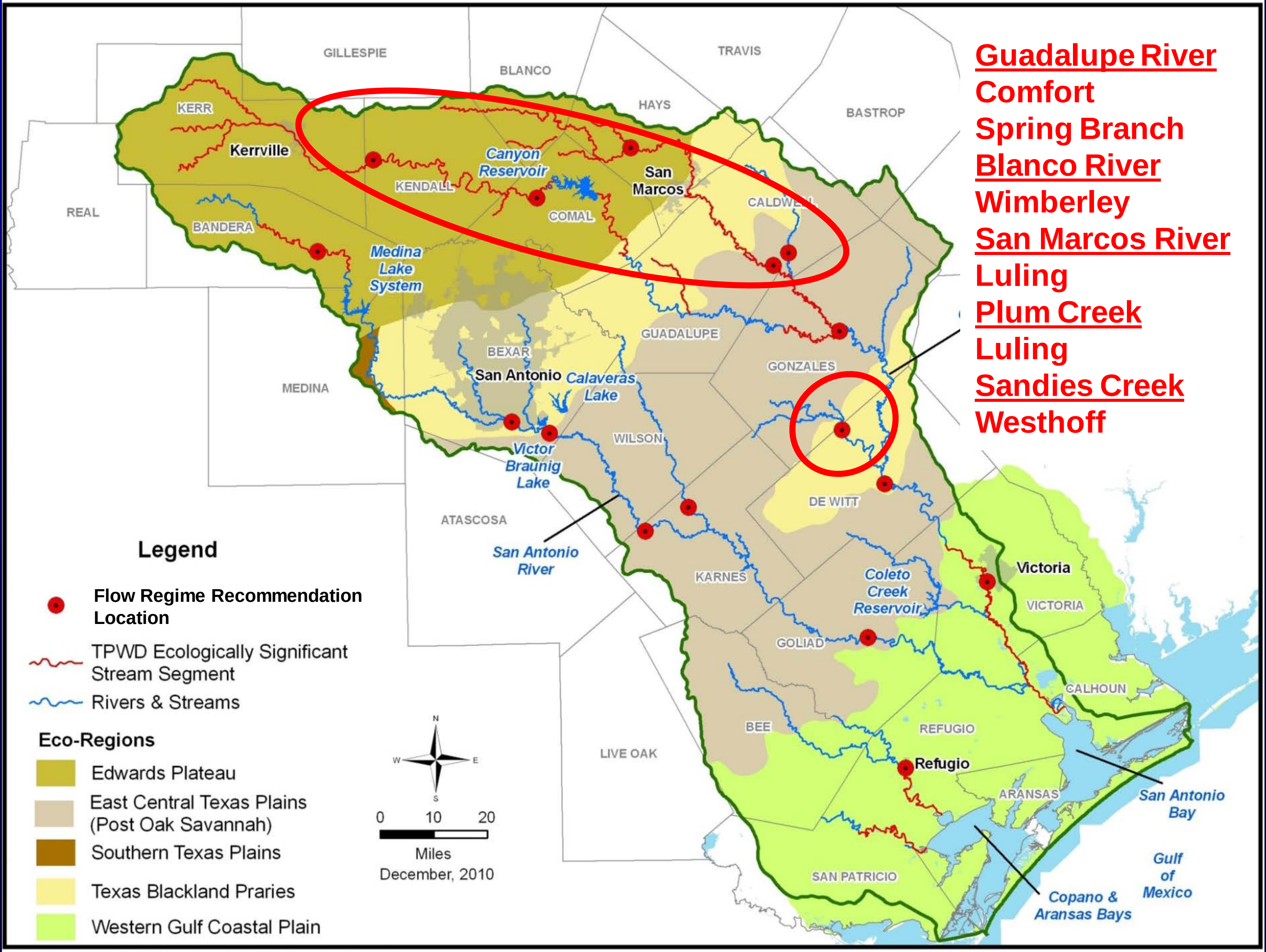
Guadalupe River at Cuero (BBEST)

	Winter			Spring			Summer			Fall		
Overbank Flows	Qp: 45,400 cfs with Average Frequency 1 per 5 years Regressed Volume is 869,000 Duration Bound is 91											
	Qp: 24,700 cfs with Average Frequency 1 per 2 years Regressed Volume is 406,000 Duration Bound is 64											
	Qp: 16,600 cfs with Average Frequency 1 per year Regressed Volume is 247,000 Duration Bound is 50											
High Flow Pulses	Qp: 4,610 cfs with Average Frequency 1 per season Regressed Volume is 55,300 Duration Bound is 26			Qp: 8,870 cfs with Average Frequency 1 per season Regressed Volume is 110,000 Duration Bound is 32			Qp: 2,110 cfs with Average Frequency 1 per season Regressed Volume is 19,300 Duration Bound is 17			Qp: 5,200 cfs with Average Frequency 1 per season Regressed Volume is 54,700 Duration Bound is 23		
	Qp: 1,610 cfs with Average Frequency 2 per season Regressed Volume is 14,100 Duration Bound is 13			Qp: 3,370 cfs with Average Frequency 2 per season Regressed Volume is 31,800 Duration Bound is 18			Qp: 1,050 cfs with Average Frequency 2 per season Regressed Volume is 8,300 Duration Bound is 12			Qp: 1,730 cfs with Average Frequency 2 per season Regressed Volume is 14,100 Duration Bound is 13		
Base Flows (cfs)	980			940			800			870		
	760			680			600			670		
	550			410			390			480		
Subsistence Flows (cfs)	130			120			130			86		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Guadalupe River at Cuero (BBEST)

- No available measurements of dissolved oxygen or temperature at BBEST subsistence flow levels.
- TPWD has Moderate concern with BBEST subsistence flows (Model uncertainty high). Comparative Cross-section Method (CCM) flow-habitat relationships only.

Group 5:
Other Guadalupe River Basin Locations



Guadalupe River
Comfort
Spring Branch
Blanco River
Wimberley
San Marcos River
Luling
Plum Creek
Luling
Sandies Creek
Westhoff

Guadalupe River at Comfort (BBEST)

Overbank Flows	Qp: 15,900 cfs with Average Frequency 1 per 5 years Regressed Volume is 100,000 Duration Bound is 97											
	Qp: 7,420 cfs with Average Frequency 1 per 2 years Regressed Volume is 72,400 Duration Bound is 69											
High Flow Pulses	Qp: 4,020 cfs with Average Frequency 1 per year Regressed Volume is 37,400 Duration Bound is 53											
	Qp: 350 cfs with Average Frequency 1 per season Regressed Volume is 3,390 Duration Bound is 20			Qp: 1,190 cfs with Average Frequency 1 per season Regressed Volume is 8,950 Duration Bound is 26			Qp: 570 cfs with Average Frequency 1 per season Regressed Volume is 4,110 Duration Bound is 19			Qp: 500 cfs with Average Frequency 1 per season Regressed Volume is 4,060 Duration Bound is 24		
	Qp: 140 cfs with Average Frequency 2 per season Regressed Volume is 1,030 Duration Bound is 11			Qp: 400 cfs with Average Frequency 2 per season Regressed Volume is 2,980 Duration Bound is 17			Qp: 160 cfs with Average Frequency 2 per season Regressed Volume is 1,130 Duration Bound is 12			Qp: 160 cfs with Average Frequency 2 per season Regressed Volume is 1,110 Duration Bound is 13		
Base Flows (cfs)	110			100			75			110		
	77			69			50			77		
	54			35			25			48		
Subsistence Flows (cfs)	10			5.2			2.0			2.7		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Winter			Spring			Summer			Fall		

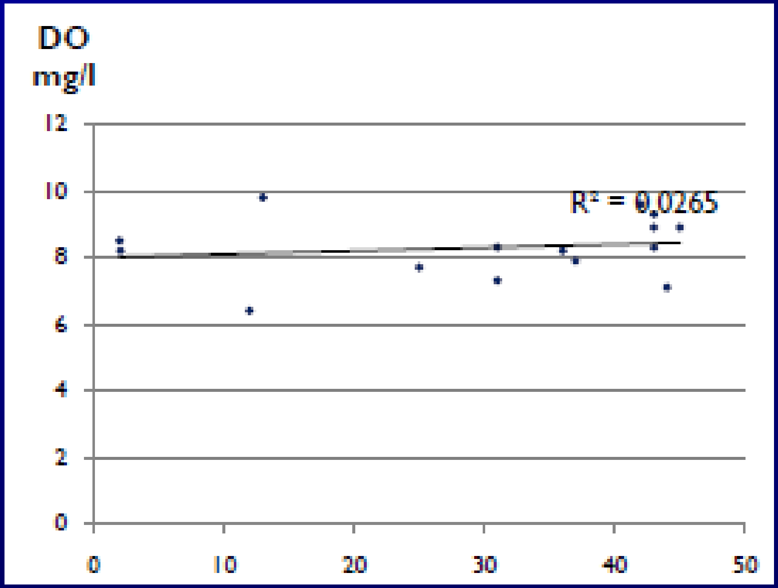
Guadalupe River at Comfort (BBEST)

- No available measurements of dissolved oxygen or temperature at BBEST subsistence flow levels.
- TPWD has High concern with BBEST subsistence flows (Minimal habitat). Comparative Cross-section Method (CCM) flow-habitat relationships only.

Guadalupe River near Spring Branch (BBEST)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High Flow Pulses	Qp: 23,700 cfs with Average Frequency 1 per 5 years Regressed Volume is 242,000 Duration Bound is 82											
	Qp: 11,300 cfs with Average Frequency 1 per 2 years Regressed Volume is 109,000 Duration Bound is 60											
	Qp: 5,720 cfs with Average Frequency 1 per year Regressed Volume is 51,900 Duration Bound is 45											
	Qp: 570 cfs with Average Frequency 1 per season Regressed Volume is 5,150 Duration Bound is 19			Qp: 2,310 cfs with Average Frequency 1 per season Regressed Volume is 17,500 Duration Bound is 26			Qp: 870 cfs with Average Frequency 1 per season Regressed Volume is 5,970 Duration Bound is 19			Qp: 1,000 cfs with Average Frequency 1 per season Regressed Volume is 8,060 Duration Bound is 23		
	Qp: 210 cfs with Average Frequency 2 per season Regressed Volume is 1,520 Duration Bound is 11			Qp: 870 cfs with Average Frequency 2 per season Regressed Volume is 6,500 Duration Bound is 19			Qp: 240 cfs with Average Frequency 2 per season Regressed Volume is 1,520 Duration Bound is 11			Qp: 230 cfs with Average Frequency 2 per season Regressed Volume is 1,660 Duration Bound is 12		
Base Flows (cfs)	160			160			110			150		
	100			91			64			100		
	70			44			36			57		
Subsistence Flows (cfs)	13			6.6			4.6			6.6		
	Winter			Spring			Summer			Fall		

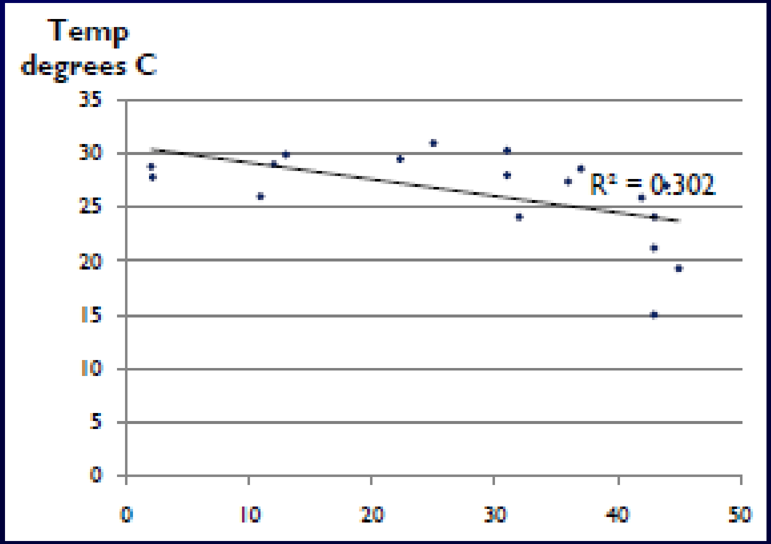
Guadalupe River near Spring Branch (BBEST)



• No violations of 6 mg/l TCEQ stream standard for dissolved oxygen measured at lowest flows (cfs).

• TPWD has High concern with BBEST subsistence flows (Minimal to Limited Habitat). Comparative Cross-section Method (CCM) flow-habitat relationships only.

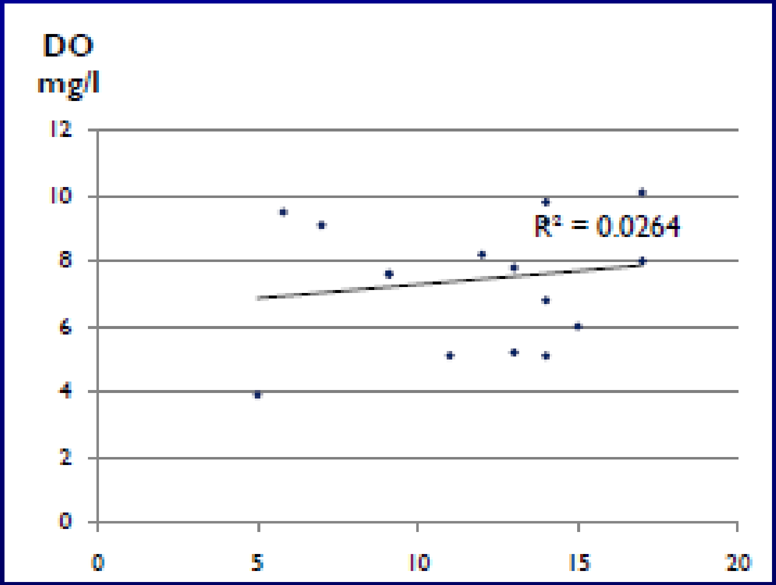
• No violations of 90 degF TCEQ stream standard for temperature measured at lowest flows (cfs).



Blanco River at Wimberley (BBEST)

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
High Flow Pulses	Qp: 8,310 cfs with Average Frequency 1 per 5 years Regressed Volume is 82,000 Duration Bound is 74			
	Qp: 4,640 cfs with Average Frequency 1 per 2 years Regressed Volume is 43,100 Duration Bound is 58			
	Qp: 2,820 cfs with Average Frequency 1 per year Regressed Volume is 24,900 Duration Bound is 47			
	Qp: 380 cfs with Average Frequency 1 per season Regressed Volume is 3,840 Duration Bound is 28	Qp: 960 cfs with Average Frequency 1 per season Regressed Volume is 6,540 Duration Bound is 26	Qp: 190 cfs with Average Frequency 1 per season Regressed Volume is 1,130 Duration Bound is 13	Qp: 440 cfs with Average Frequency 1 per season Regressed Volume is 3,220 Duration Bound is 21
	Qp: 54 cfs with Average Frequency 2 per season Regressed Volume is 360 Duration Bound is 10	Qp: 360 cfs with Average Frequency 2 per season Regressed Volume is 2,370 Duration Bound is 18	Qp: 74 cfs with Average Frequency 2 per season Regressed Volume is 410 Duration Bound is 9	Qp: 82 cfs with Average Frequency 2 per season Regressed Volume is 500 Duration Bound is 10
Base Flows (cfs)	52	64	56	54
	34	40	36	36
	20	18	18	18
Subsistence Flows (cfs)	7.9	6.7	7.6	7.1

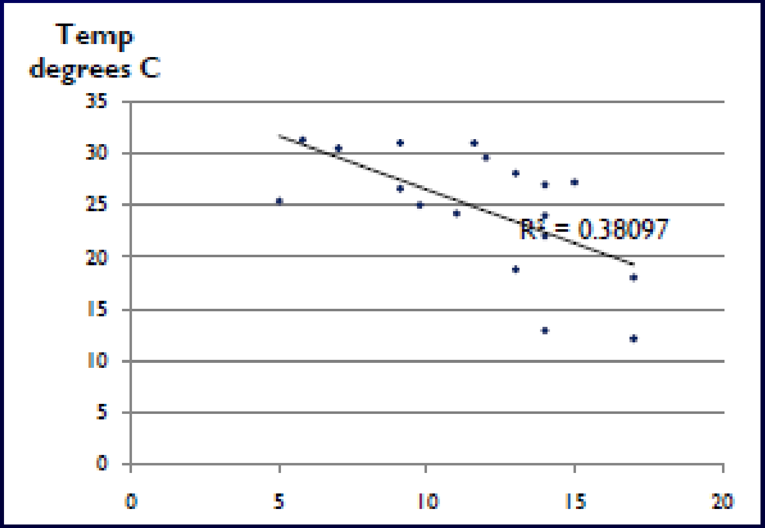
Blanco River at Wimberley (BBEST)



• Several violations of 6 mg/l TCEQ stream standard for dissolved oxygen measured at lowest flows (cfs).

• TPWD has High concern with BBEST subsistence flows (Minimal to Limited Habitat). Comparative Cross-section Method (CCM) flow-habitat relationships only.

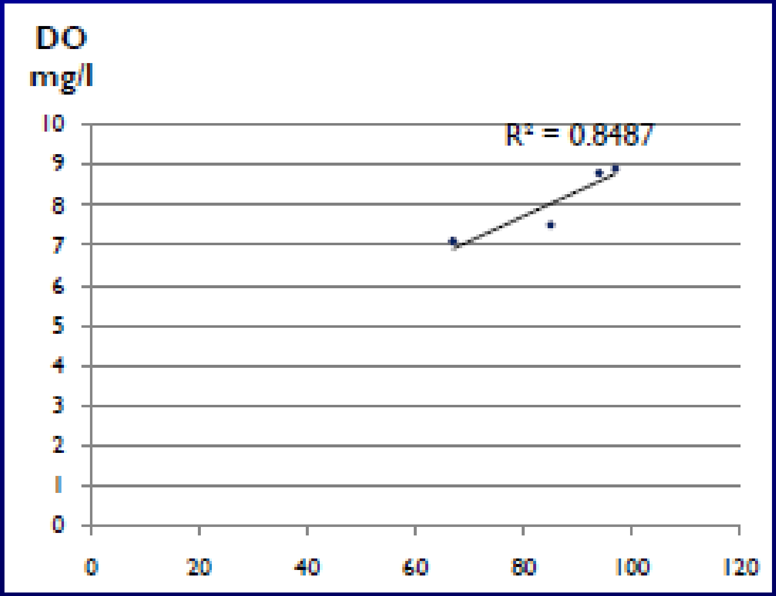
• No violations of 92 degF TCEQ stream standard for temperature measured at lowest flows (cfs).



San Marcos River at Luling (BBEST)

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 17,900 cfs with Average Frequency 1 per 5 years Regressed Volume is 208,000 Duration Bound is 78			
Overbank Flows	Qp: 10,600 cfs with Average Frequency 1 per 2 years Regressed Volume is 110,000 Duration Bound is 57			
Overbank Flows	Qp: 6,120 cfs with Average Frequency 1 per year Regressed Volume is 56,400 Duration Bound is 41			
High Flow Pulses	Qp: 1,330 cfs with Average Frequency 1 per season Regressed Volume is 11,400 Duration Bound is 23	Qp: 2,740 cfs with Average Frequency 1 per season Regressed Volume is 18,400 Duration Bound is 21	Qp: 500 cfs with Average Frequency 1 per season Regressed Volume is 2,670 Duration Bound is 9	Qp: 1,710 cfs with Average Frequency 1 per season Regressed Volume is 11,200 Duration Bound is 18
High Flow Pulses	Qp: 340 cfs with Average Frequency 2 per season Regressed Volume is 1,800 Duration Bound is 8	Qp: 1,140 cfs with Average Frequency 2 per season Regressed Volume is 6,800 Duration Bound is 14	Qp: 240 cfs with Average Frequency 2 per season Regressed Volume is 1,090 Duration Bound is 6	Qp: 540 cfs with Average Frequency 2 per season Regressed Volume is 2,740 Duration Bound is 9
Base Flows (cfs)	210	220	220	200
Base Flows (cfs)	160	160	170	170
Base Flows (cfs)	120	110	110	120
Subsistence Flows (cfs)	78	75	73	77

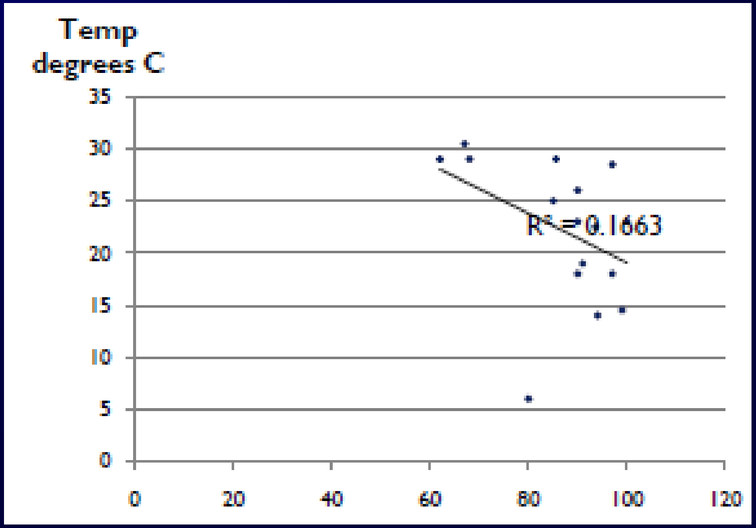
San Marcos River at Luling (BBEST)



• No violations of 5 mg/l TCEQ stream standard for dissolved oxygen measured at lowest flows (cfs).

• TPWD has Moderate concern with BBEST subsistence flows (No Habitat Model).

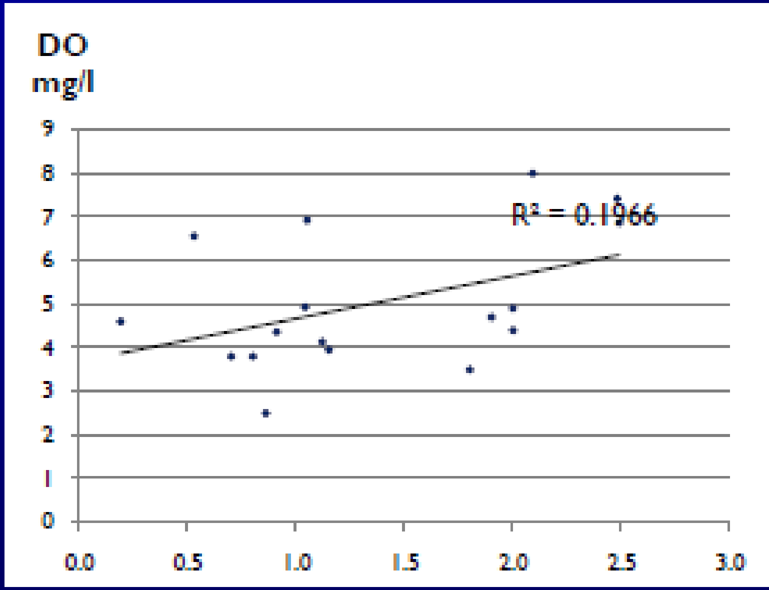
• No violations of 90 degF TCEQ stream standard for temperature measured at lowest flows (cfs).



Plum Creek near Luling (BBEST)

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 10,800 cfs with Average Frequency 1 per 5 years Regressed Volume is 43,100 Duration Bound is 32			
	Qp: 7,280 cfs with Average Frequency 1 per 2 years Regressed Volume is 29,700 Duration Bound is 29			
High Flow Pulses	Qp: 4,550 cfs with Average Frequency 1 per year Regressed Volume is 19,000 Duration Bound is 26			
	Qp: 1,470 cfs with Average Frequency 1 per season Regressed Volume is 6,870 Duration Bound is 23	Qp: 2,100 cfs with Average Frequency 1 per season Regressed Volume is 8,860 Duration Bound is 21	Qp: 230 cfs with Average Frequency 1 per season Regressed Volume is 1,080 Duration Bound is 15	Qp: 750 cfs with Average Frequency 1 per season Regressed Volume is 3,280 Duration Bound is 17
	Qp: 350 cfs with Average Frequency 2 per season Regressed Volume is 1,800 Duration Bound is 17	Qp: 720 cfs with Average Frequency 2 per season Regressed Volume is 3,300 Duration Bound is 17	Qp: 48 cfs with Average Frequency 2 per season Regressed Volume is 230 Duration Bound is 10	Qp: 150 cfs with Average Frequency 2 per season Regressed Volume is 720 Duration Bound is 13
Base Flows (cfs)	12	10	5.0	8.3
	8.4	5.6	2.5	5.2
	4.6	2.6	1.6	2.5
Subsistence Flows (cfs)	1.0	1.0	1.0	1.0

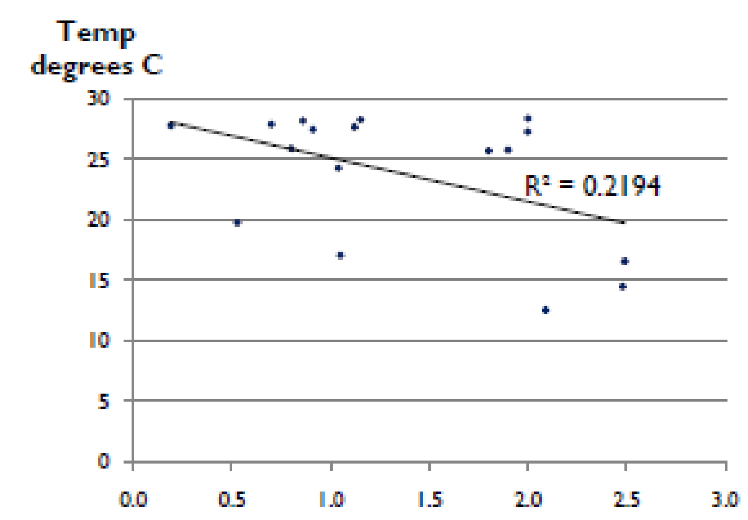
Plum Creek near Luling (BBEST)



- Many violations of 5 mg/l TCEQ stream standard for dissolved oxygen measured at lowest flows (cfs).

- TPWD has High concern with BBEST subsistence flows (Minimal Habitat). Comparative Cross-section Method (CCM) flow-habitat relationships only.

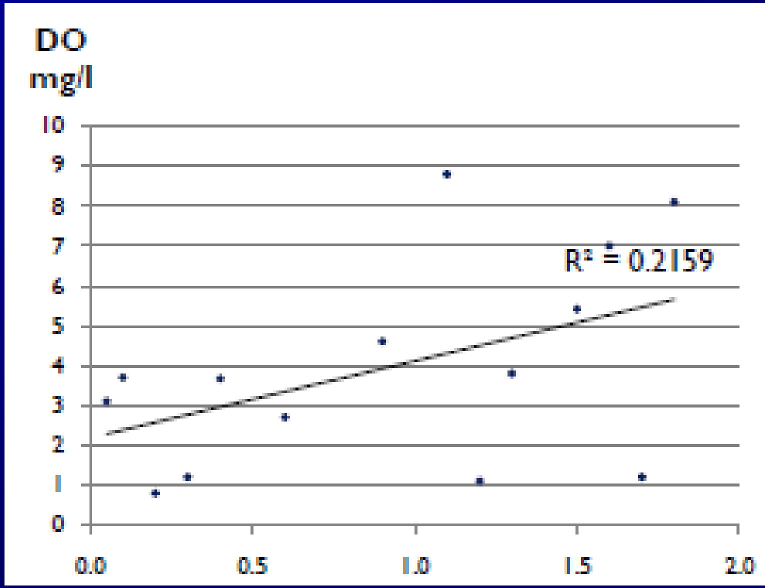
- No violations of 90 degF TCEQ stream standard for temperature measured at lowest flows (cfs).



Sandies Creek near Westhoff (BBEST)

	Winter (Jan, Feb, Mar)	Spring (Apr, May, Jun)	Summer (Jul, Aug, Sep)	Fall (Oct, Nov, Dec)
Overbank Flows	Qp: 14,300 cfs with Average Frequency 1 per 5 years Regressed Volume is 86,700 Duration Bound is 39			
Overbank Flows	Qp: 6,240 cfs with Average Frequency 1 per 2 years Regressed Volume is 38,000 Duration Bound is 32			
Overbank Flows	Qp: 4,020 cfs with Average Frequency 1 per year Regressed Volume is 24,500 Duration Bound is 29			
High Flow Pulses	Qp: 770 cfs with Average Frequency 1 per season Regressed Volume is 4,840 Duration Bound is 21	Qp: 1,670 cfs with Average Frequency 1 per season Regressed Volume is 10,100 Duration Bound is 24	Qp: 250 cfs with Average Frequency 1 per season Regressed Volume is 1,430 Duration Bound is 16	Qp: 570 cfs with Average Frequency 1 per season Regressed Volume is 3,650 Duration Bound is 18
High Flow Pulses	Qp: 300 cfs with Average Frequency 2 per season Regressed Volume is 1,880 Duration Bound is 16	Qp: 440 cfs with Average Frequency 2 per season Regressed Volume is 2,710 Duration Bound is 18	Qp: 59 cfs with Average Frequency 2 per season Regressed Volume is 330 Duration Bound is 11	Qp: 150 cfs with Average Frequency 2 per season Regressed Volume is 960 Duration Bound is 14
Base Flows (cfs)	12	9.0	3.8	9.4
Base Flows (cfs)	9.9	6.0	2.7	5.9
Base Flows (cfs)	6.3	3.1	1.8	3.2
Subsistence Flows (cfs)	1.0	1.0	1.0	1.0

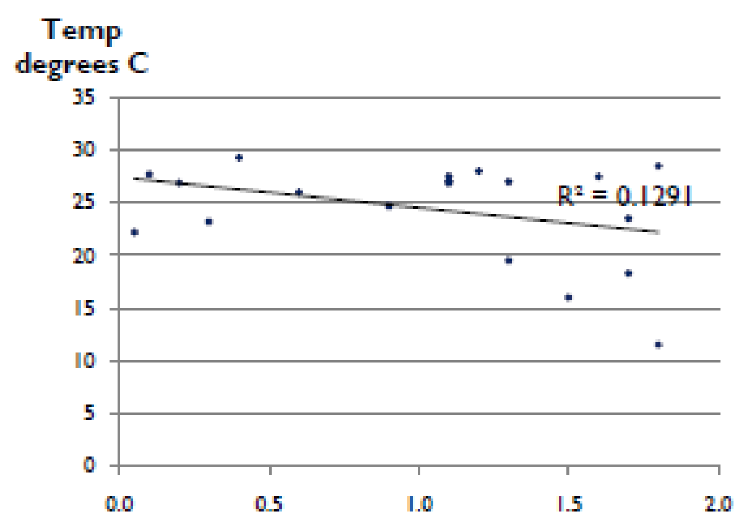
Sandies Creek near Westhoff (BBEST)



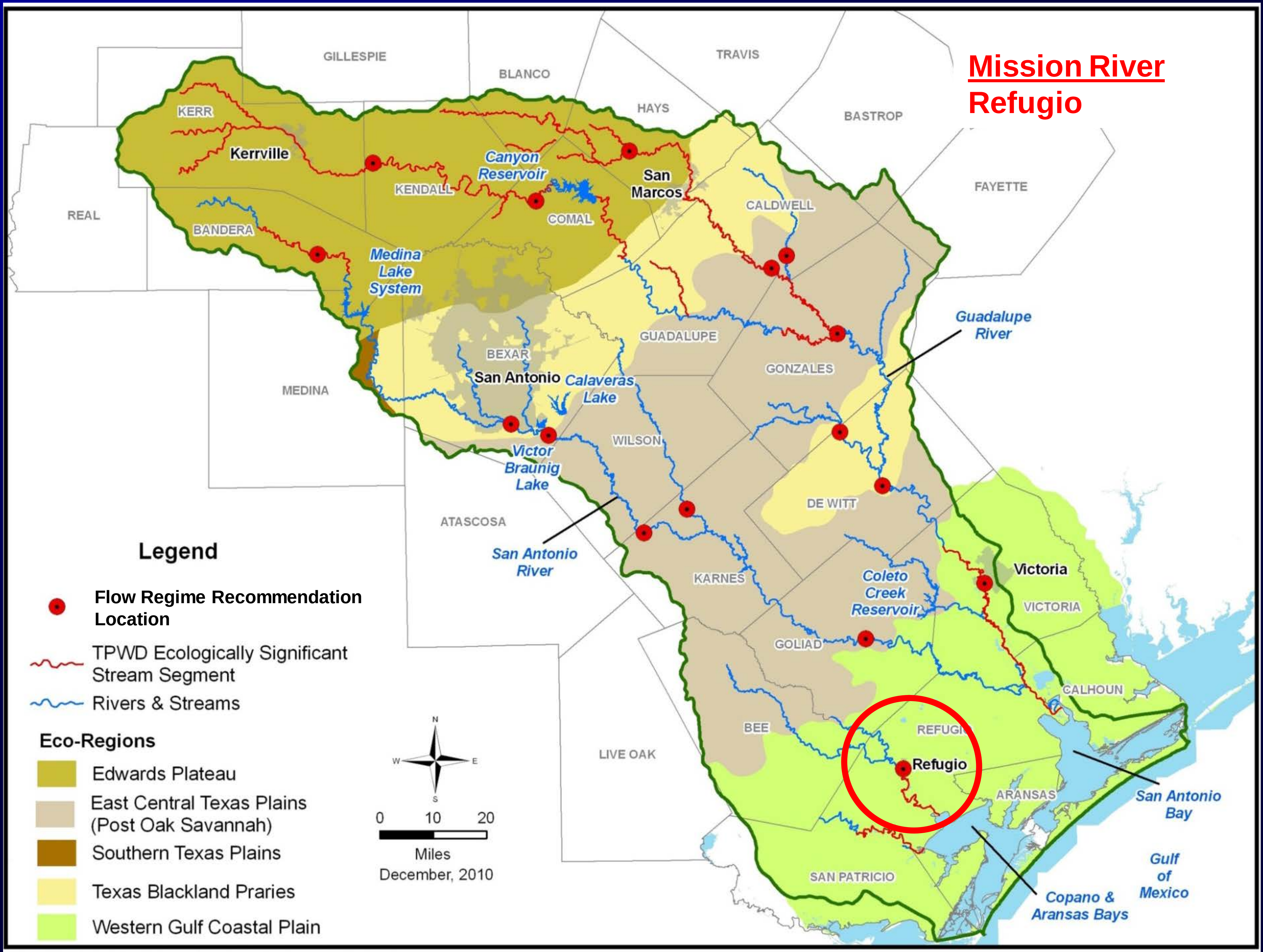
- Many violations of 5 mg/l TCEQ stream standard for dissolved oxygen measured at lowest flows (cfs).

- TPWD has High concern with BBEST subsistence flows (Minimal to Limited Habitat). Comparative Cross-section Method (CCM) flow-habitat relationships only.

- No violations of 93 degF TCEQ stream standard for temperature measured at lowest flows (cfs).



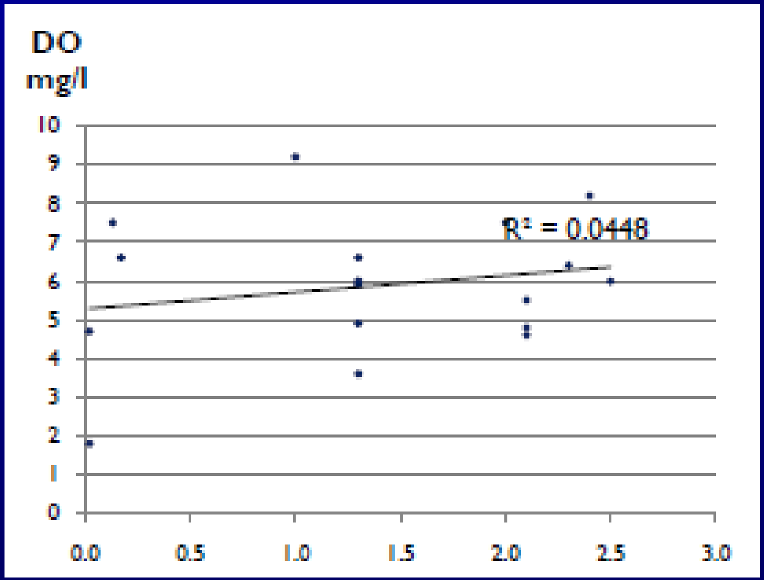
Group 6: Mission River Basin Location



Mission River at Refugio (BBEST)

Overbank Flows	Qp: 11,500 cfs with Average Frequency 1 per 5 years Regressed Volume is 66,200 Duration Bound is 44			
	Qp: 6,830 cfs with Average Frequency 1 per 2 years Regressed Volume is 38,400 Duration Bound is 36			
	Qp: 4,160 cfs with Average Frequency 1 per year Regressed Volume is 22,800 Duration Bound is 30			
High Flow Pulses	Qp: 450 cfs with Average Frequency 1 per season Regressed Volume is 2,340 Duration Bound is 15	Qp: 1,560 cfs with Average Frequency 1 per season Regressed Volume is 7,910 Duration Bound is 18	Qp: 420 cfs with Average Frequency 1 per season Regressed Volume is 2,010 Duration Bound is 12	Qp: 410 cfs with Average Frequency 1 per season Regressed Volume is 2,090 Duration Bound is 14
	Qp: 60 cfs with Average Frequency 2 per season Regressed Volume is 310 Duration Bound is 8	Qp: 320 cfs with Average Frequency 2 per season Regressed Volume is 1,440 Duration Bound is 10	Qp: 57 cfs with Average Frequency 2 per season Regressed Volume is 240 Duration Bound is 6	Qp: 45 cfs with Average Frequency 2 per season Regressed Volume is 200 Duration Bound is 6
Base Flows (cfs)	15	14	12	15
	8.6	8.3	7.0	7.8
	4.7	4.5	3.8	4.5
Subsistence Flows (cfs)	1.0	1.3	1.0	1.3
	Jan Feb Mar	Apr May Jun	Jul Aug Sep	Oct Nov Dec
	Winter	Spring	Summer	Fall

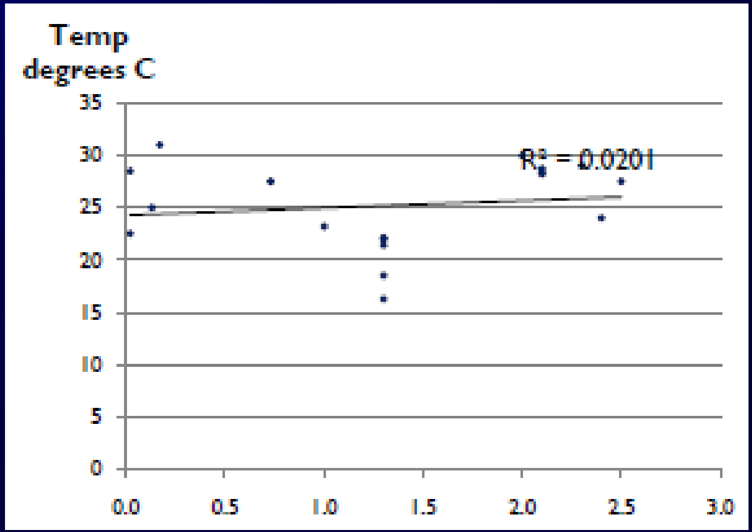
Mission River at Refugio (BBEST)



- Several violations of 5 mg/l TCEQ stream standard for dissolved oxygen measured at lowest flows (cfs).

- TPWD has High concern with BBEST subsistence flows (Minimal Habitat). Comparative Cross-section Method (CCM) flow-habitat relationships only.

- No violations of 95 degF TCEQ stream standard for temperature measured at lowest flows (cfs).



Meeting of the

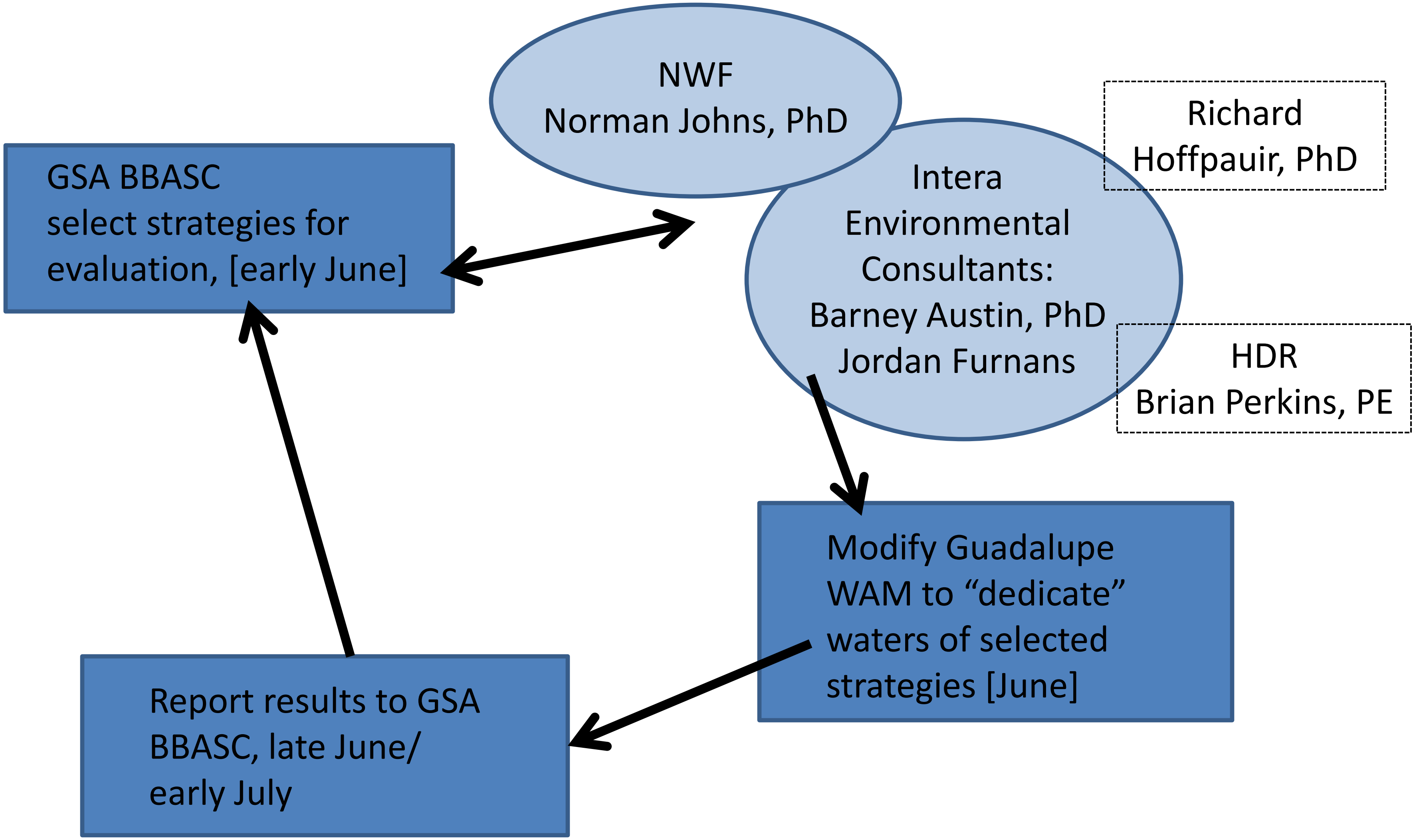
Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Report on Evaluations of "Strategies" To Meet Environmental Flow Standards

July 6, 2011

NATIONAL WILDLIFE FEDERATION

INTERA Geosciences & Engineering


NWF
Norman Johns, PhD
Richard
Hoffpauir, PhD
GSA BBASC
select strategies for
evaluation, [early June]
Intera
Environmental
Consultants:
Barney Austin, PhD
Jordan Furnans
HDR
Brian Perkins, PE
Modify Guadalupe
WAM to “dedicate”
waters of selected
strategies [June]
Report results to GSA
BBASC, late June/
early July

Summary – Attainment of G2 Summer Criteria (oysters)

with the Guadalupe River Project

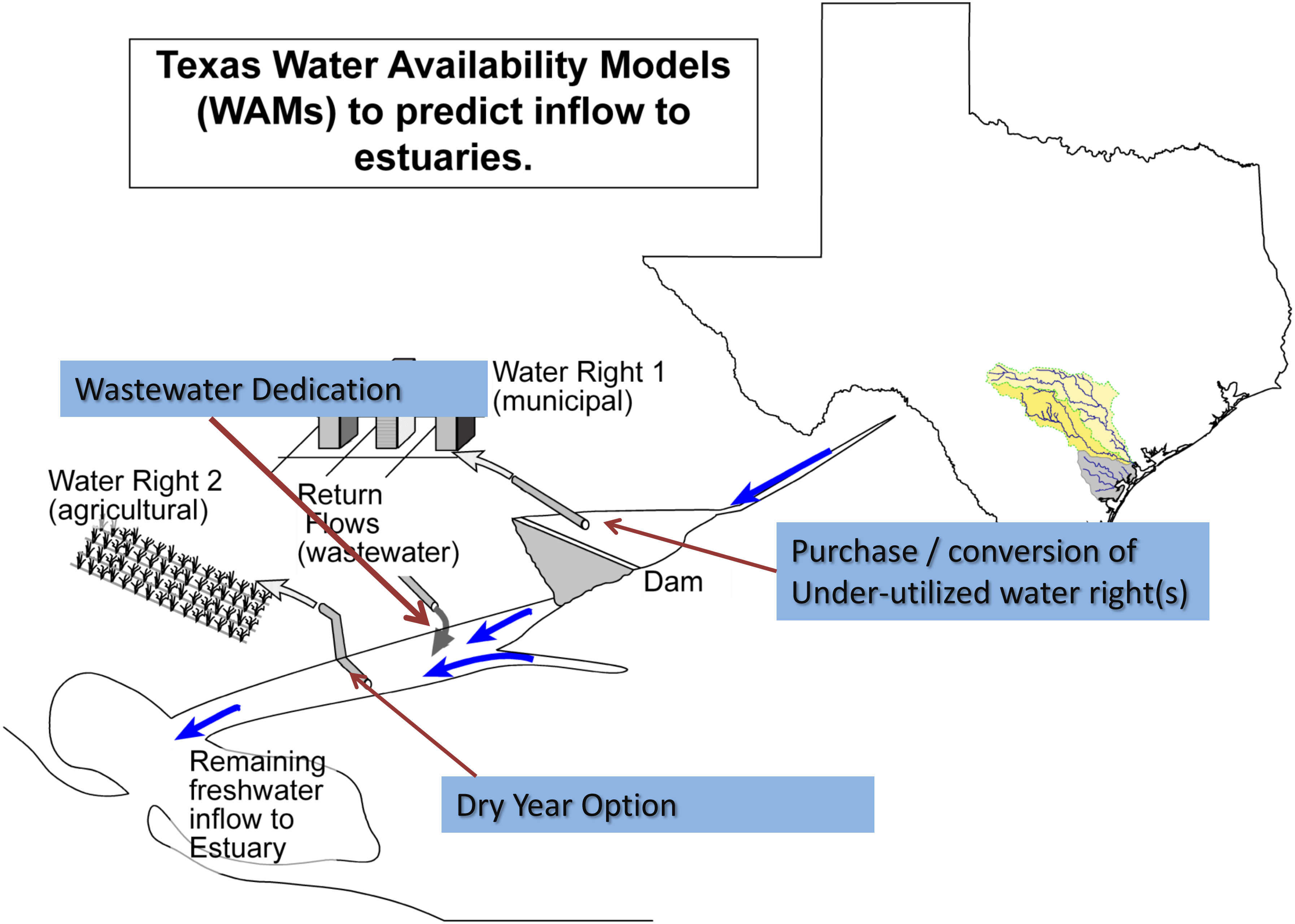
Previously presented by BBEST

Counts	Criteria G2								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. Guadalupe Project	4	8	8	8	7	3	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

see Tables 4.5-2; 4.5-4		>12%	>17%				<=6%	
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guadalupe Project		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%	
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Historical			38.8%		12.2%	16.7%	10.2%	
Present			36.7%		18.4%	11.1%	12.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
w. Guadalupe Project			32.7%		20.4%	30.0%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

Color coding convention	
	-OK, met criteria
	-Near miss. (rounding; p-o-record)
	-Not met, but departure not great
	-Very bad



Texas Water Availability Models (WAMs) to predict inflow to estuaries.
Wastewater Dedication
Water Right 1 (municipal)
Water Right 2 (agricultural)
Return Flows (wastewater)
Dam
Purchase / conversion of Under-utilized water right(s)
Remaining freshwater inflow to Estuary
Dry Year Option

Strategies Evaluated

#1 Wastewater Dedication [up to 10]

1a – 60,000 ac-ft/yr

1b – 120,000 ac-ft/yr

#2 Dry Year Option [up to 5]

2a – 16,000 ac-ft/yr

2b – 32,000 ac-ft/yr

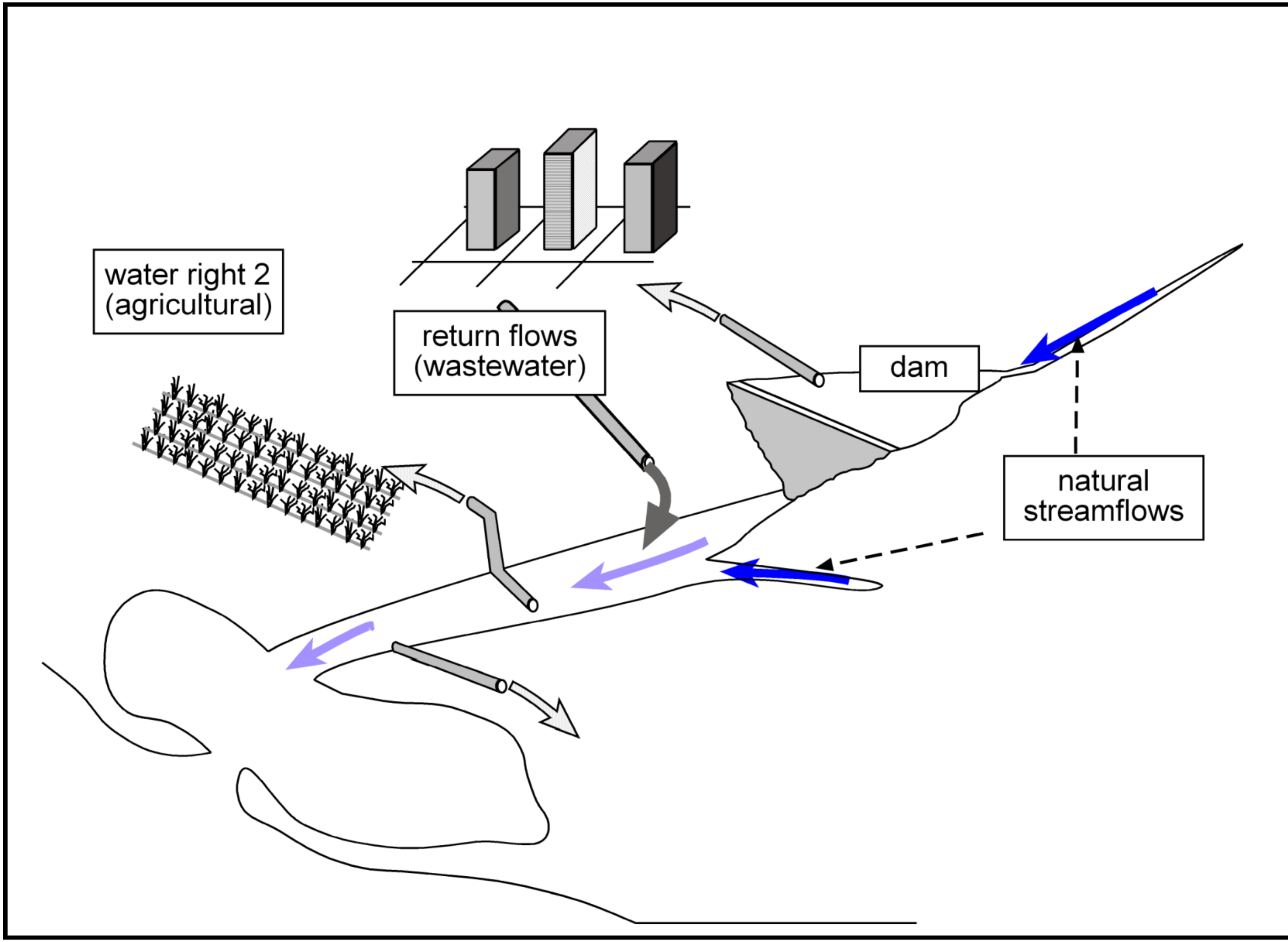
#3 Conversion of Under-utilized Water Rights [up to 5]

3a – 48,000 ac-ft/yr

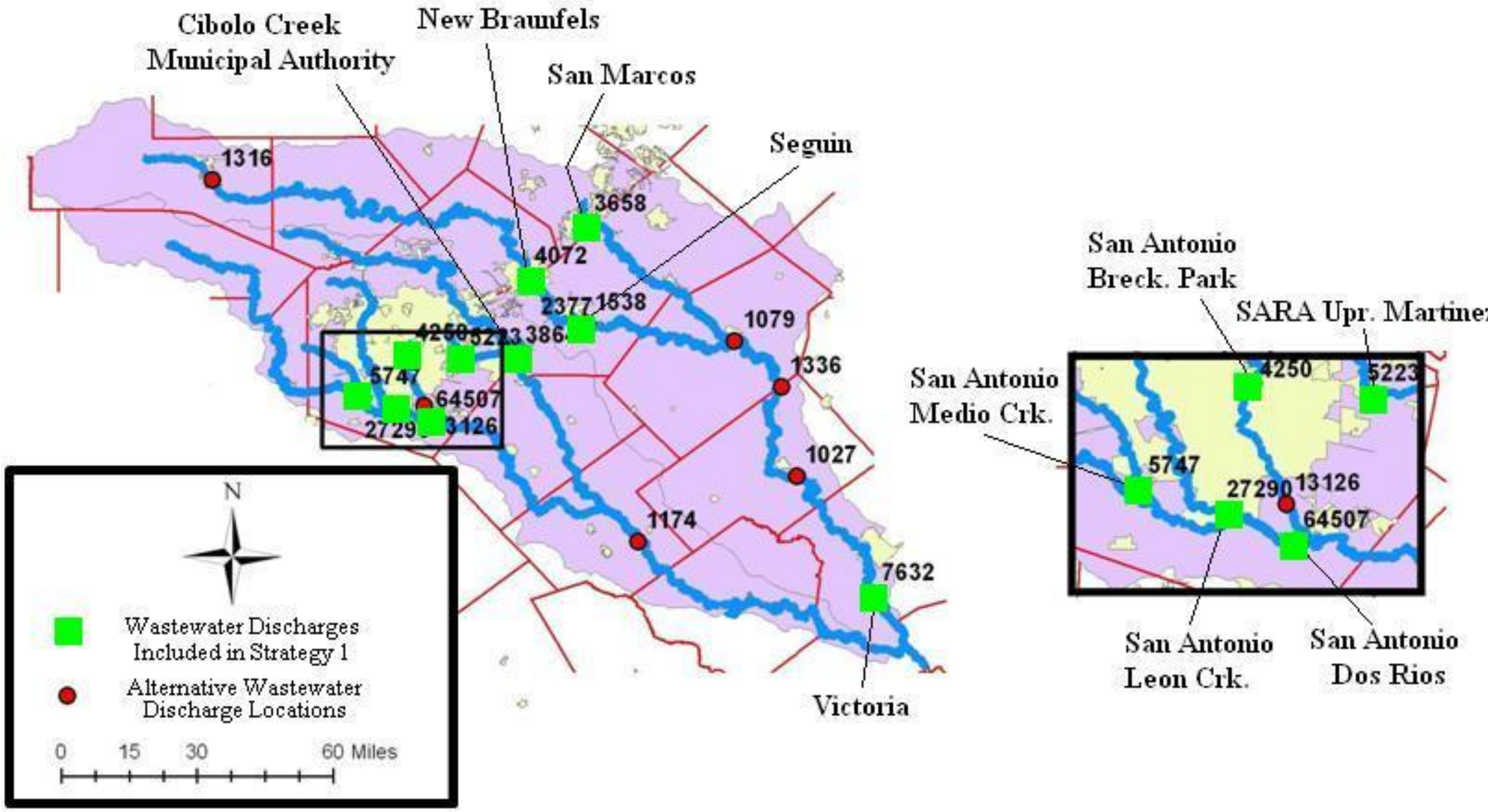
3b – 96,000 ac-ft/yr

#4 Combination Strategy

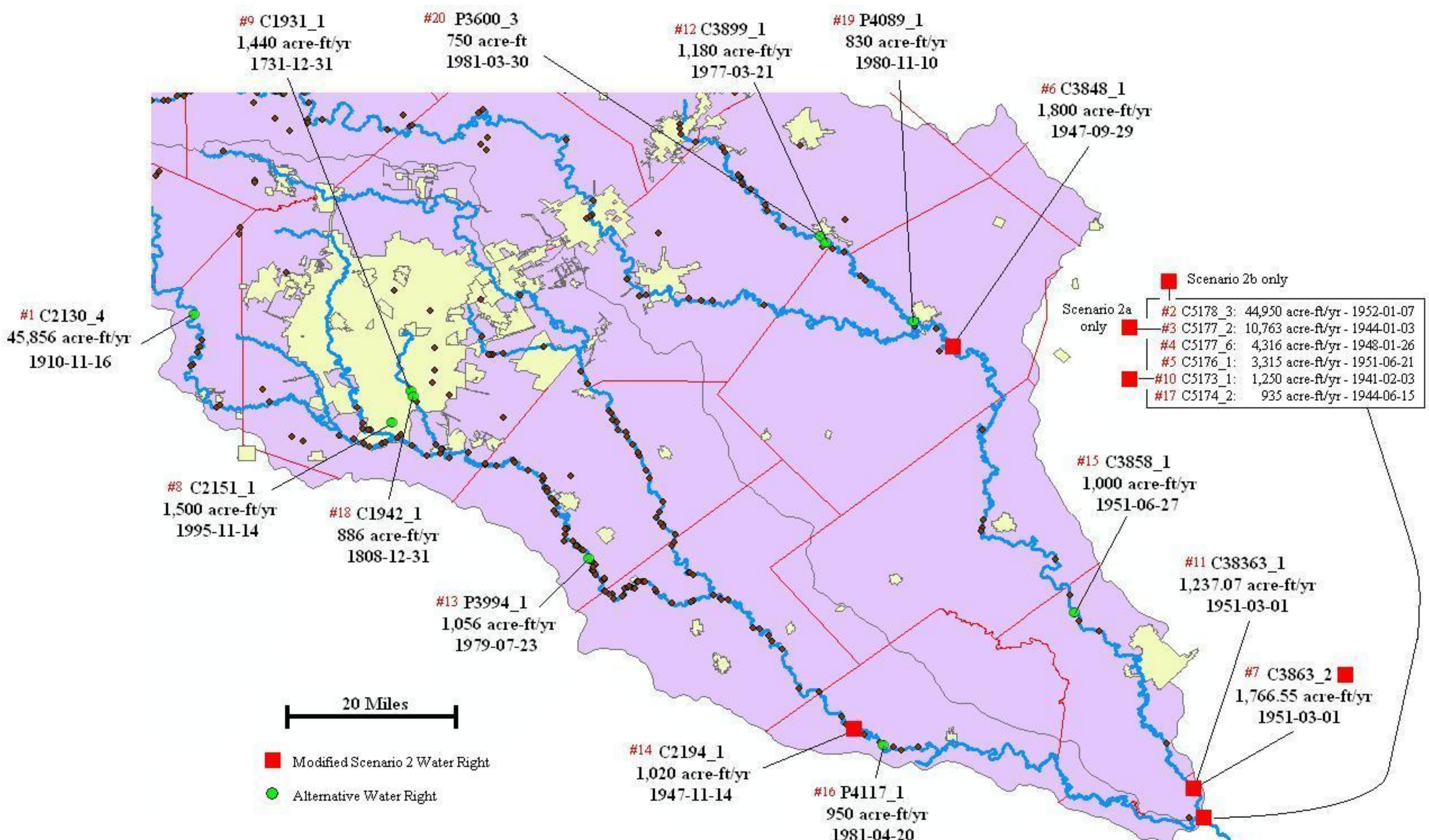
1a & 2a & 3a simultaneously


water right 2
(agricultural)
return flows
(wastewater)
dam
natural
streamflows

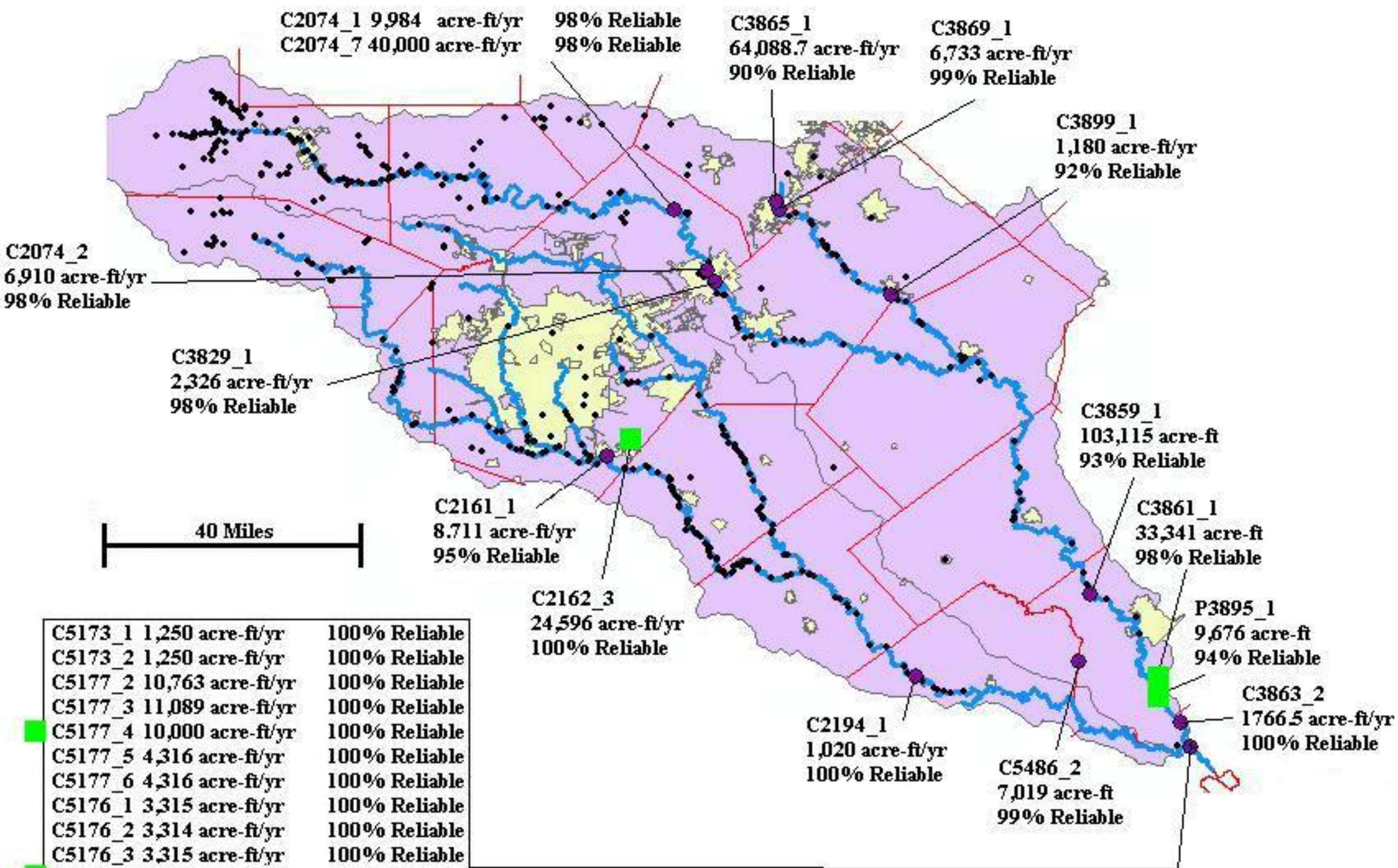
Strategy #1 Wastewater Dedication – selected discharges



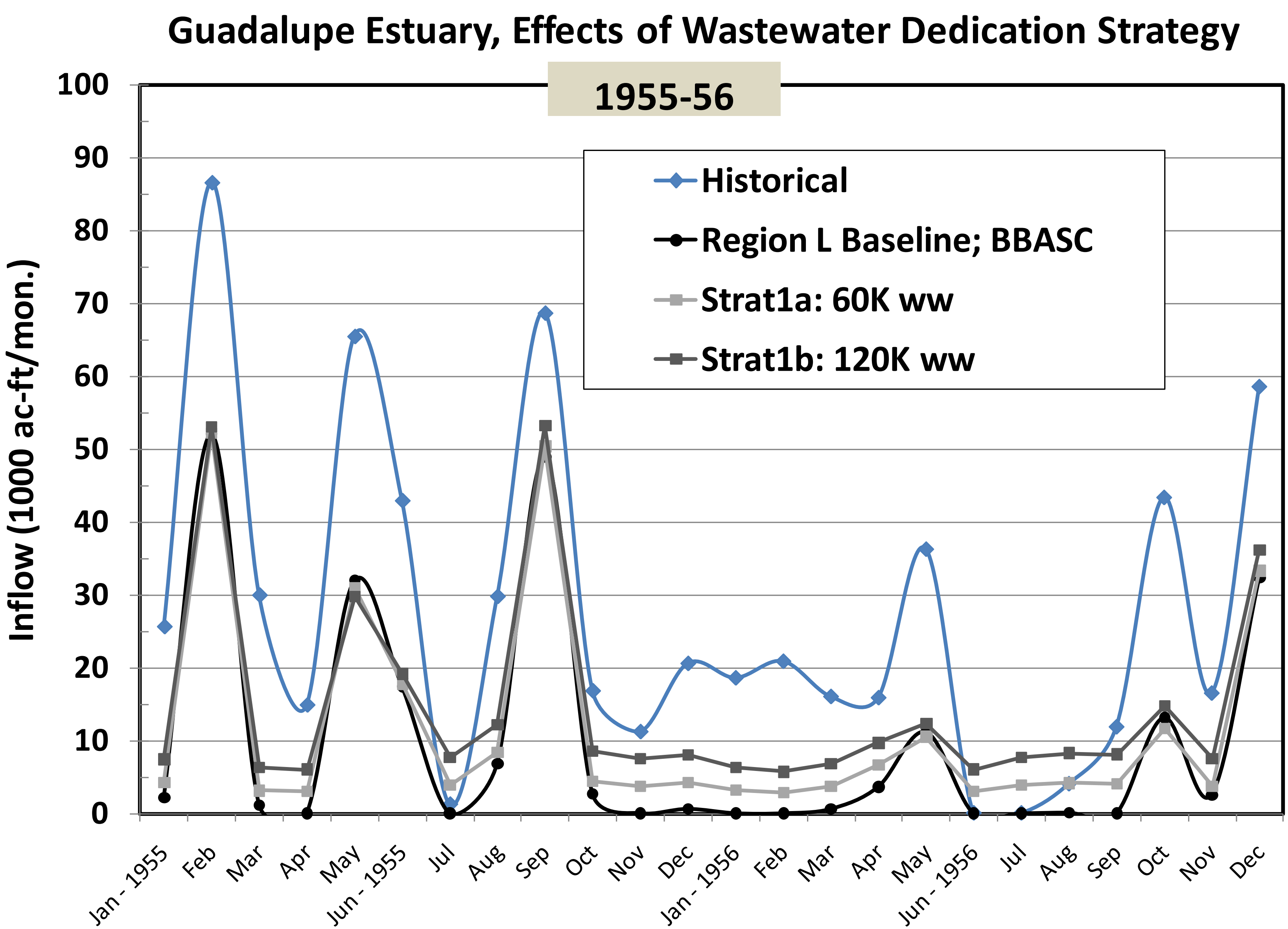
Strategy #2 Dry Year Option – selected irrigation rights



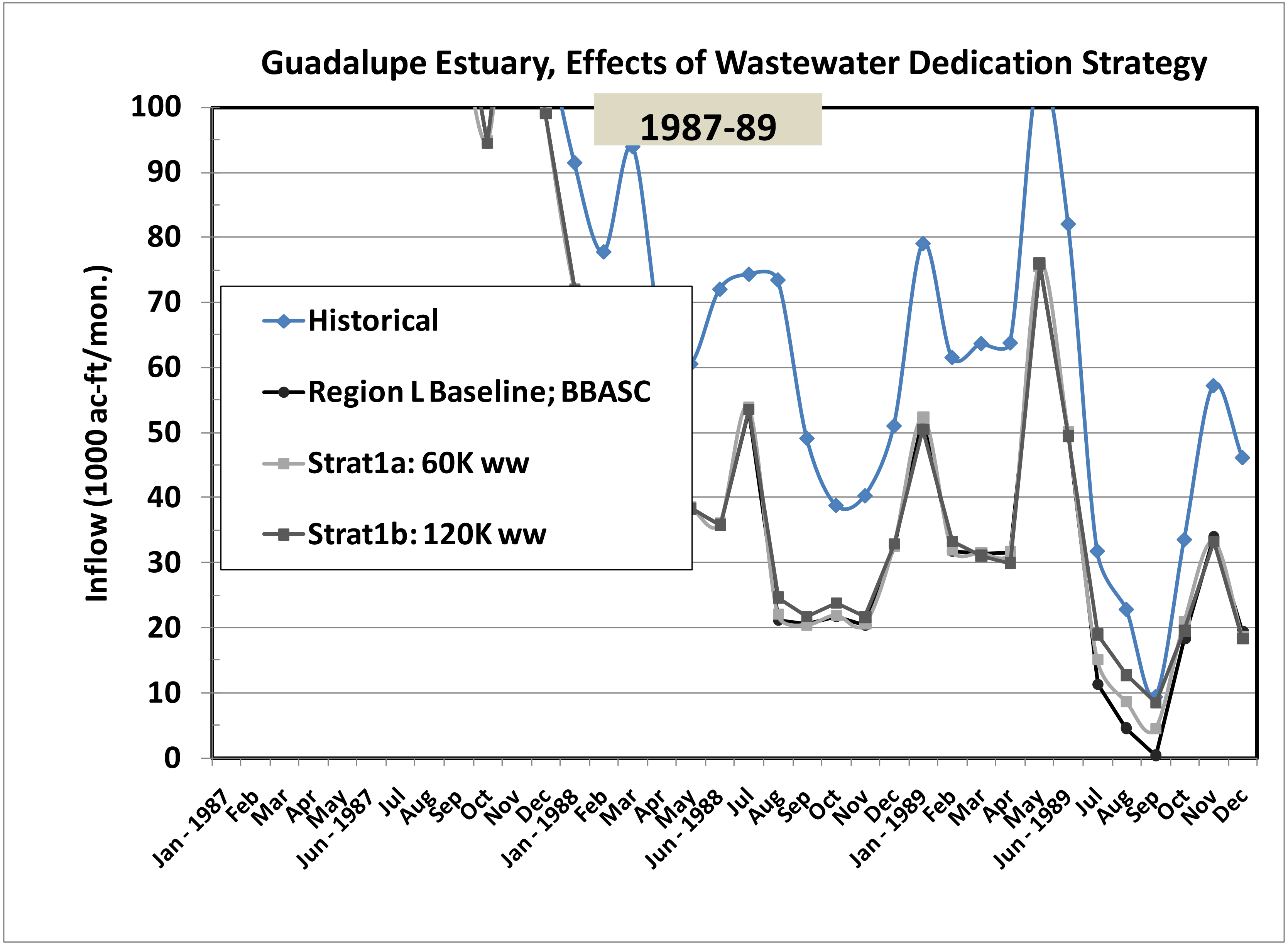
Strategy #3 Under-utilized Rights– selected water rights



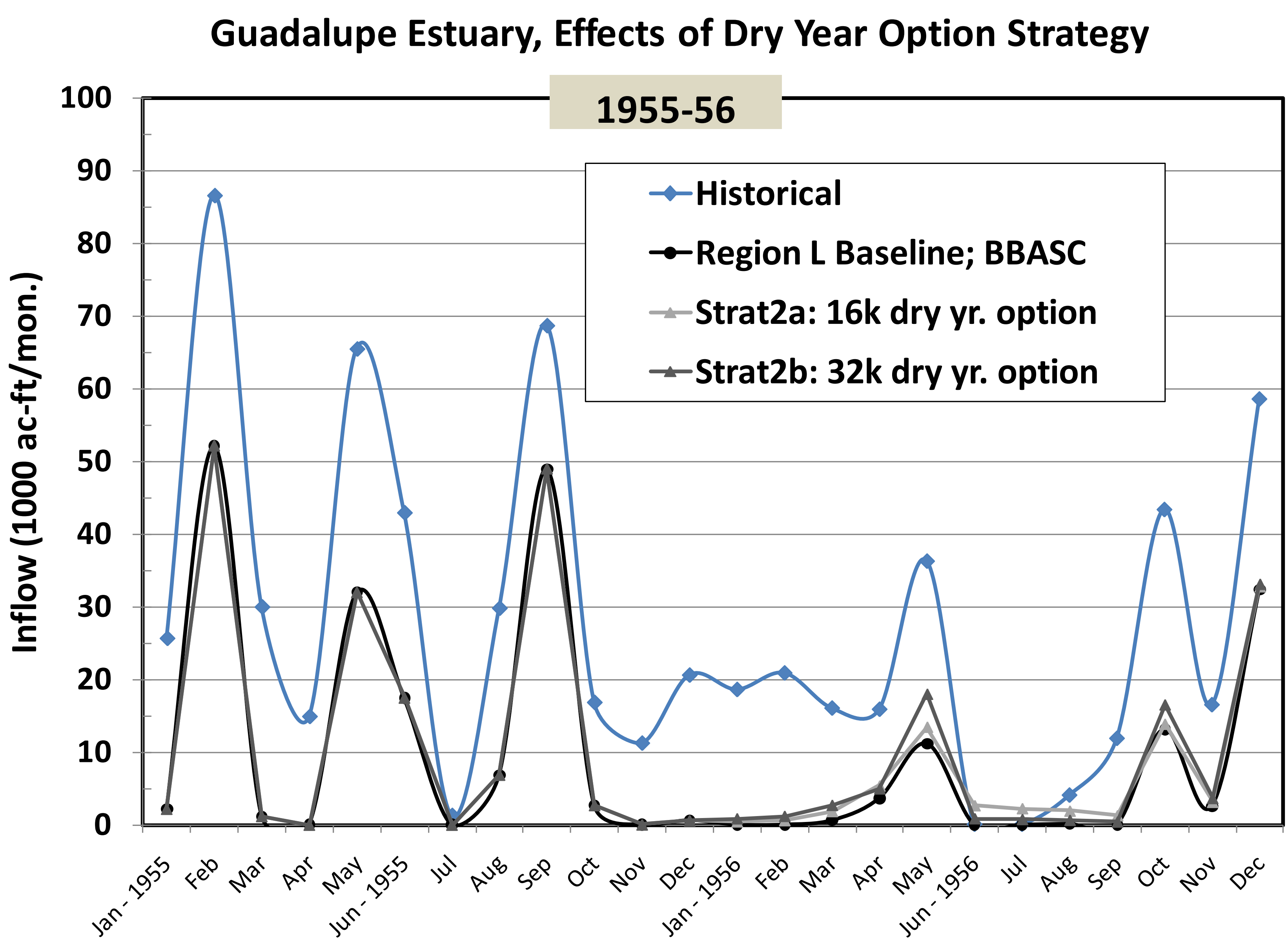
C5173_1	1,250 acre-ft/yr	100% Reliable
C5173_2	1,250 acre-ft/yr	100% Reliable
C5177_2	10,763 acre-ft/yr	100% Reliable
C5177_3	11,089 acre-ft/yr	100% Reliable
C5177_4	10,000 acre-ft/yr	100% Reliable
C5177_5	4,316 acre-ft/yr	100% Reliable
C5177_6	4,316 acre-ft/yr	100% Reliable
C5176_1	3,315 acre-ft/yr	100% Reliable
C5176_2	3,314 acre-ft/yr	100% Reliable
C5176_3	3,315 acre-ft/yr	100% Reliable
C5178_2	0 acre-ft/yr	99% Reliable



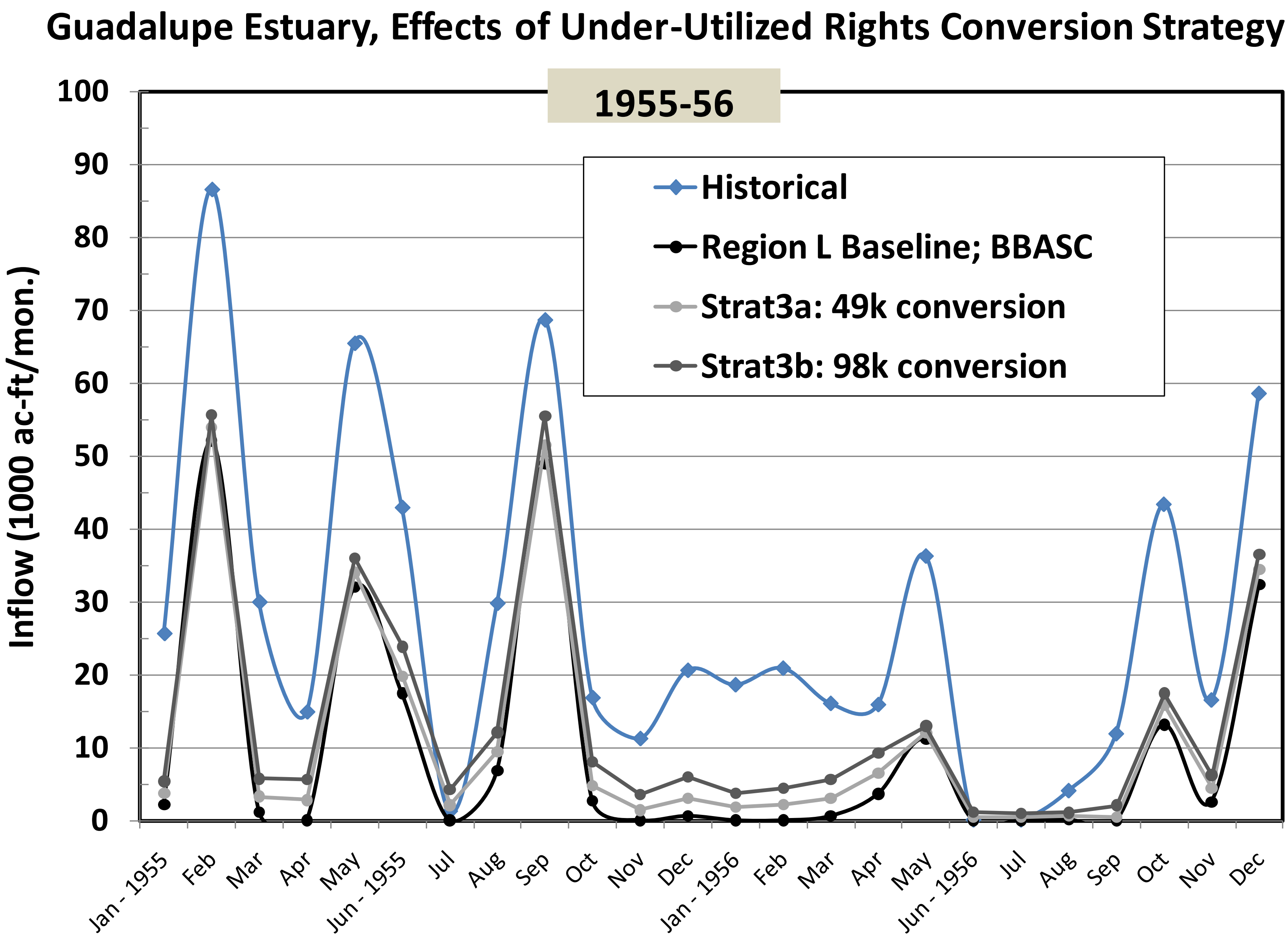
Guadalupe Estuary, Effects of Wastewater Dedication Strategy
1955-56
Historical
Region L Baseline; BBASC
Strat1a: 60K ww
Strat1b: 120K ww
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1955
Feb
Mar
Apr
May
Jun - 1955
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1956
Feb
Mar
Apr
May
Jun - 1956
Jul
Aug
Sep
Oct
Nov
Dec



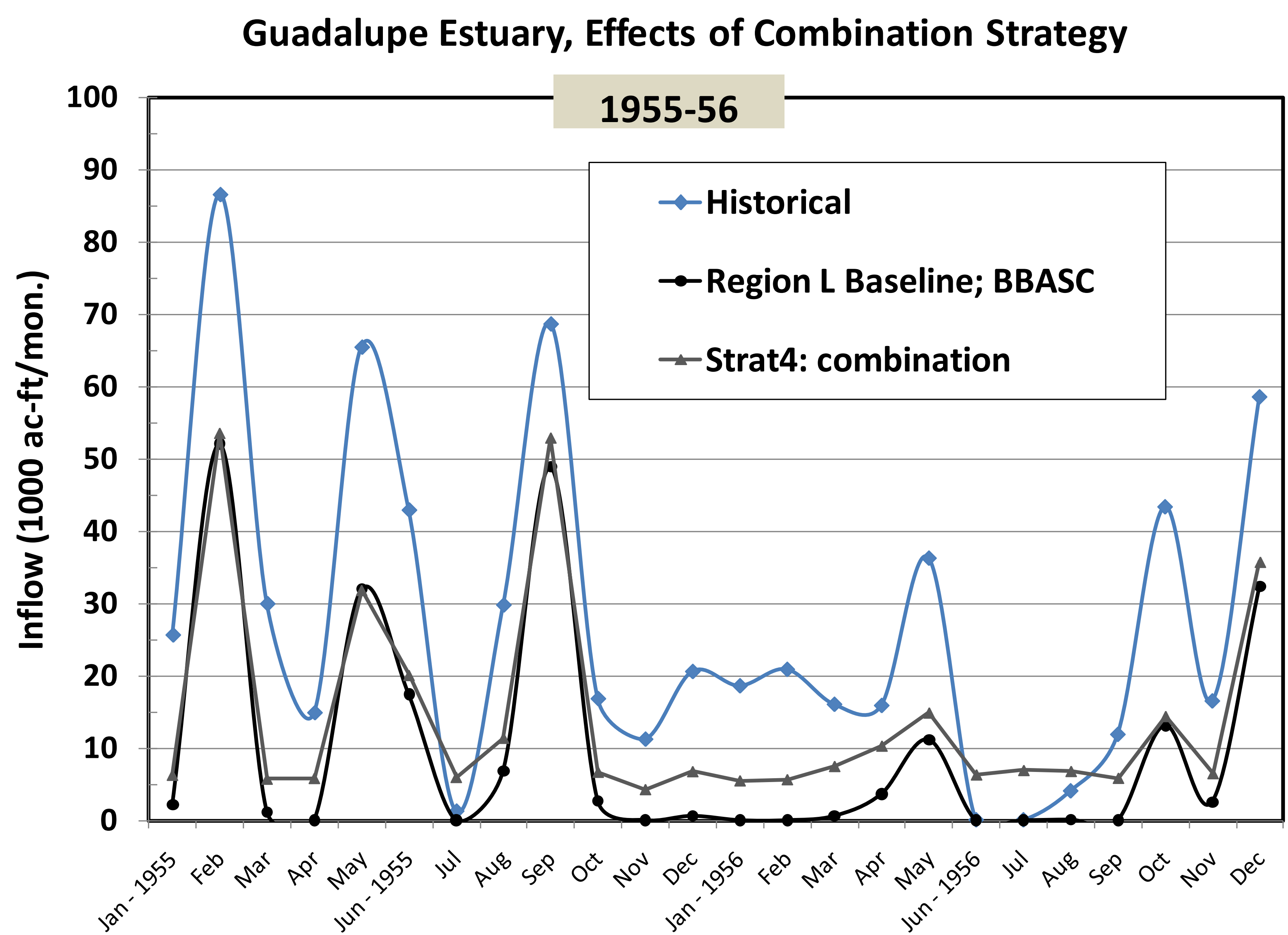
Guadalupe Estuary, Effects of Wastewater Dedication Strategy
1987-89
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Historical
Region L Baseline; BBASC
Strat1a: 60K ww
Strat1b: 120K ww
Jan - 1987
Feb
Mar
Apr
May
Jun - 1987
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1988
Feb
Mar
Apr
May
Jun - 1988
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1989
Feb
Mar
Apr
May
Jun - 1989
Jul
Aug
Sep
Oct
Nov
Dec



Guadalupe Estuary, Effects of Dry Year Option Strategy
1955-56
Historical
Region L Baseline; BBASC
Strat2a: 16k dry yr. option
Strat2b: 32k dry yr. option
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1955
Feb
Mar
Apr
May
Jun - 1955
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1956
Feb
Mar
Apr
May
Jun - 1956
Jul
Aug
Sep
Oct
Nov
Dec



Guadalupe Estuary, Effects of Under-Utilized Rights Conversion Strategy
1955-56
Historical
Region L Baseline; BBASC
Strat3a: 49k conversion
Strat3b: 98k conversion
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1955
Feb
Mar
Apr
May
Jun - 1955
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1956
Feb
Mar
Apr
May
Jun - 1956
Jul
Aug
Sep
Oct
Nov
Dec

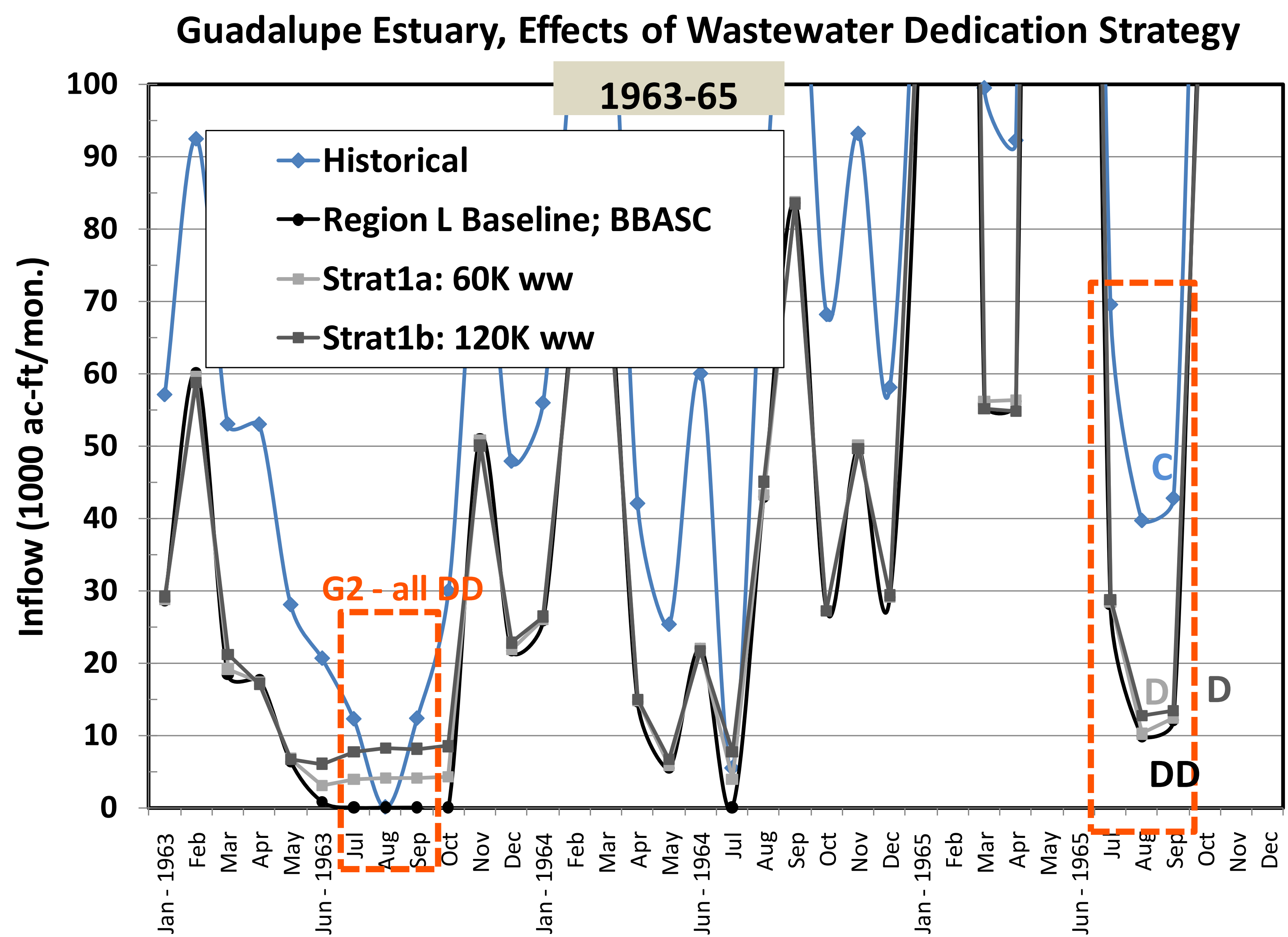

Guadalupe Estuary, Effects of Combination Strategy
1955-56
Historical
Region L Baseline; BBASC
Strat4: combination
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1955
Feb
Mar
Apr
May
Jun - 1955
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1956
Feb
Mar
Apr
May
Jun - 1956
Jul
Aug
Sep
Oct
Nov
Dec

Strategy Effects: #1 Wastewater Dedication
Attainment of G1 Springtime Criteria (Rangia)

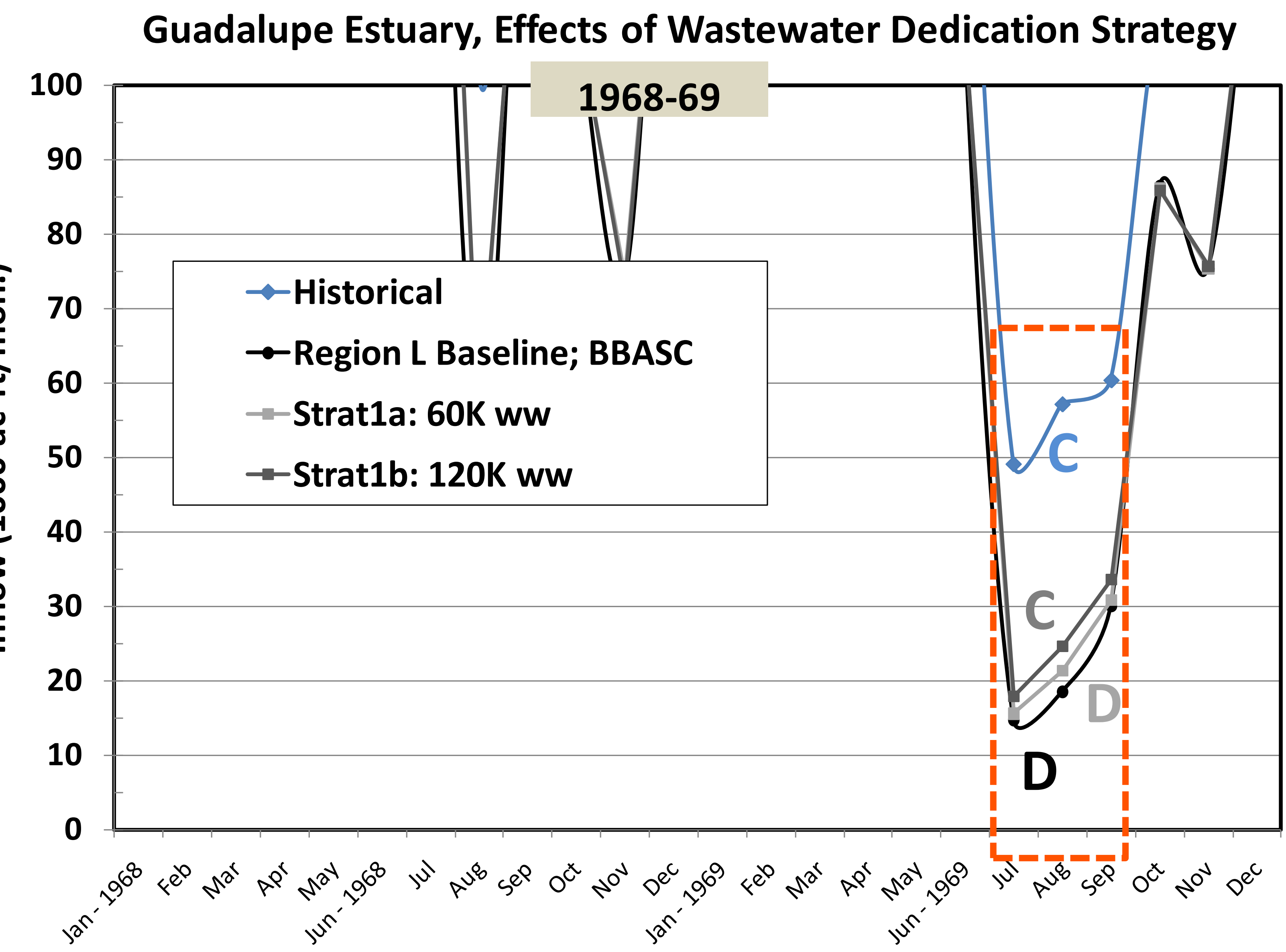
Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Region L Baseline; BBASC	7	10	8	3	3	4	**14**	49
Strat1a - Ww Ded. 60k/yr	7	10	8	3	3	4	14	49
Strat1b - Ww Ded. 120k/yr	7	10	8	3	3	4	14	49

Strategy Effects: #1 Wastewater Dedication
Attainment of G2 Summer Criteria (oysters)

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Region L Baseline; BBASC	4	8	8	8	7	**3**	**3**	**8**	49
Strat1a - Ww Ded. 60k/yr	4	8	8	8	7	3	4	7	49
Strat1b - Ww Ded. 120k/yr	4	8	8	8	8	3	3	7	49



Guadalupe Estuary, Effects of Wastewater Dedication Strategy
1963-65
Historical
Region L Baseline; BBASC
Strat1a: 60K ww
Strat1b: 120K ww
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
G2 - all DD
C
D
D
DD
Jan - 1963
Feb
Mar
Apr
May
Jun - 1963
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1964
Feb
Mar
Apr
May
Jun - 1964
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1965
Feb
Mar
Apr
May
Jun - 1965
Jul
Aug
Sep
Oct
Nov
Dec


Guadalupe Estuary, Effects of Wastewater Dedication Strategy
1968-69
Historical
Region L Baseline; BBASC
Strat1a: 60K ww
Strat1b: 120K ww
C
C
D
D
100
90
80
70
60
50
40
30
20
10
0
Jan - 1968
Feb
Mar
Apr
May
Jun - 1968
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1969
Feb
Mar
Apr
May
Jun - 1969
Jul
Aug
Sep
Oct
Nov
Dec

Strategy Effects: #2 Dry Year Option
Attainment of G1 Springtime Criteria (Rangia)

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Region L Baseline; BBASC	7	10	8	3	3	4	**14**	49
Strat2a: 16k dry yr. option	7	11	7	3	3	5	13	49
Strat2b: 32k dry yr. option	7	11	7	3	3	5	13	49

Strategy Effects: #2 Dry Year Option
Attainment of G2 Summer Criteria (oysters)

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Region L Baseline; BBASC	4	8	8	8	7	**3**	**3**	**8**	49
Strat2a: 16k dry yr. option	4	8	8	8	7	3	4	7	49
Strat2b: 32k dry yr. option	4	8	8	8	7	3	4	7	49

Strategy Effects: #3 Convert Under-utilized
#4 Combination (1a, 2a, 3a)
Attainment of G1 Springtime Criteria (Rangia)

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
Strat3a: 49k conversion	7	11	7	5	3	4	12	49
Strat3b: 98k conversion	7	12	6	5	3	5	11	49
Strat4: combination	7	11	7	5	3	5	11	49

Strategy Effects: #3 Convert Under-utilized
#4 Combination (1a, 2a, 3a)
Attainment of G2 Summer Criteria (oysters)

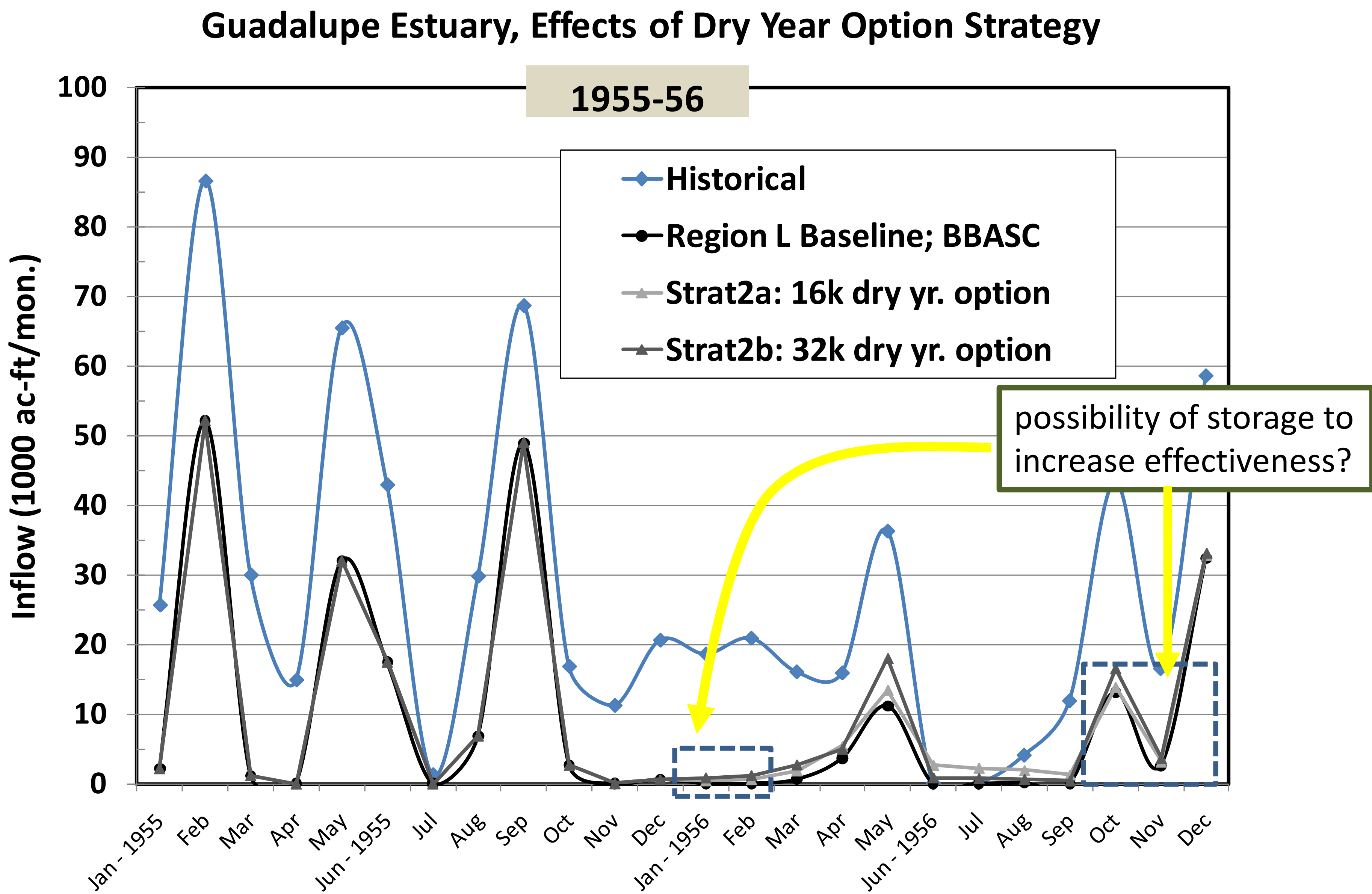
Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Region L Baseline; BBASC	4	8	8	8	7	**3**	**3**	**8**	49
Strat3a: 49k conversion	4	8	8	9	6	3	4	7	49
Strat3b: 98k conversion	4	8	8	10	7	2	4	6	49
Strat4: combination	4	8	8	9	7	3	3	7	49

CONCLUSIONS

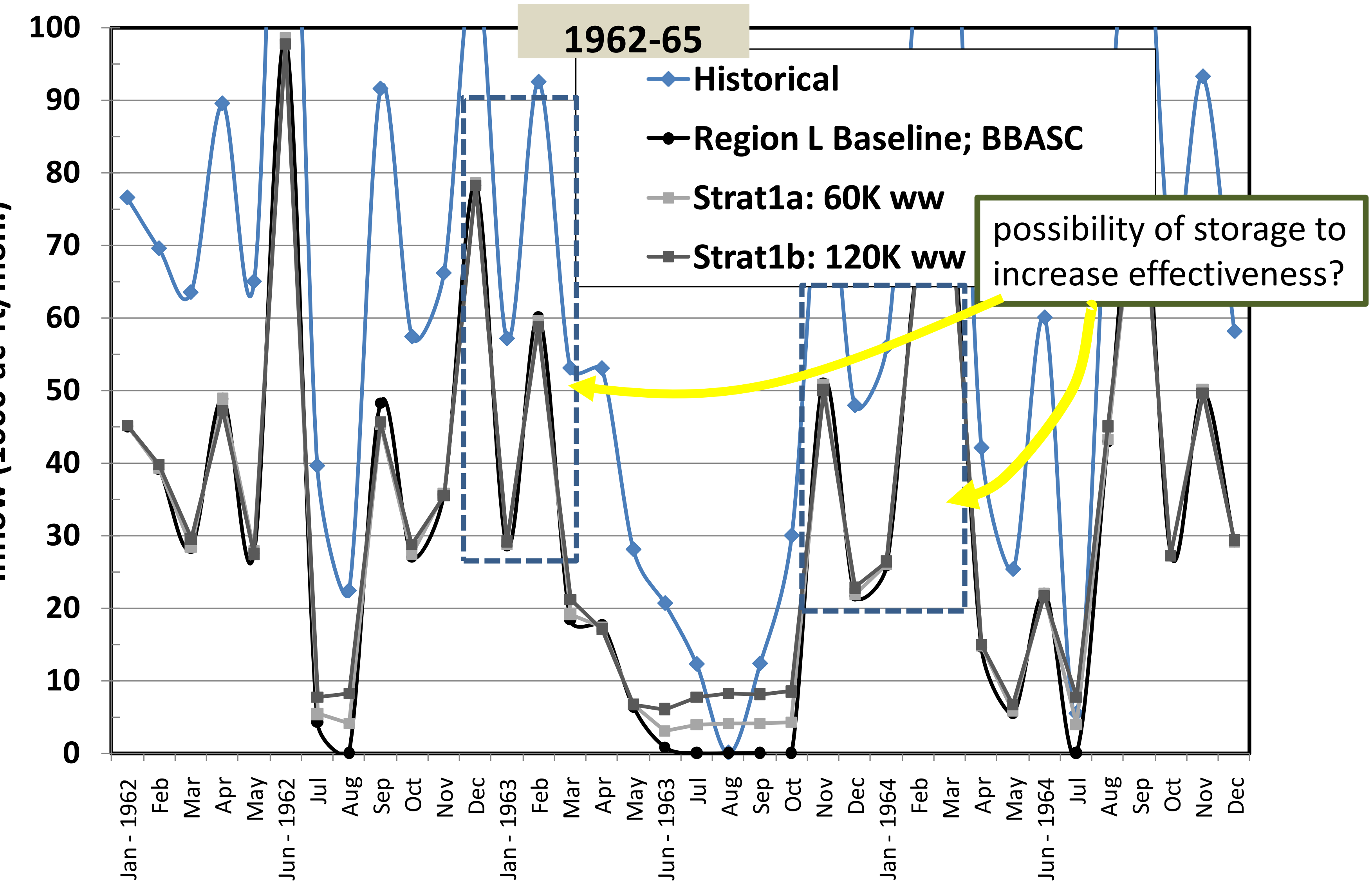
- a) Strategies with most effect of those examined, were wastewater dedication and conversion of under-utilized rights [and combination];

-b) Strategies, if implemented as modeled here, would lead to modest changes in categorical attainment in both the G1 and G2 criteria suites;

- c) For many years without categorical improvement, especially the driest, many positive changes in inflow would still benefit the estuary;


Guadalupe Estuary, Effects of Dry Year Option Strategy
1955-56
Historical
Region L Baseline; BBASC
Strat2a: 16k dry yr. option
Strat2b: 32k dry yr. option
possibility of storage to increase effectiveness?
Inflow (1000 ac-ft/mon.)
100
90
80
70
60
50
40
30
20
10
0
Jan - 1955
Feb
Mar
Apr
May
Jun - 1955
Jul
Aug
Sep
Oct
Nov
Dec
Jan - 1956
Feb
Mar
Apr
May
Jun - 1956
Jul
Aug
Sep
Oct
Nov
Dec

Guadalupe Estuary, Effects of Wastewater Dedication Strategy



CONCLUSIONS

- a) Strategies with most effect of those examined, were wastewater dedication and conversion of under-utilized rights [and combination];

-b) Strategies, if implemented as modeled here, would lead to modest changes in categorical attainment in both the G1 and G2 criteria suites;

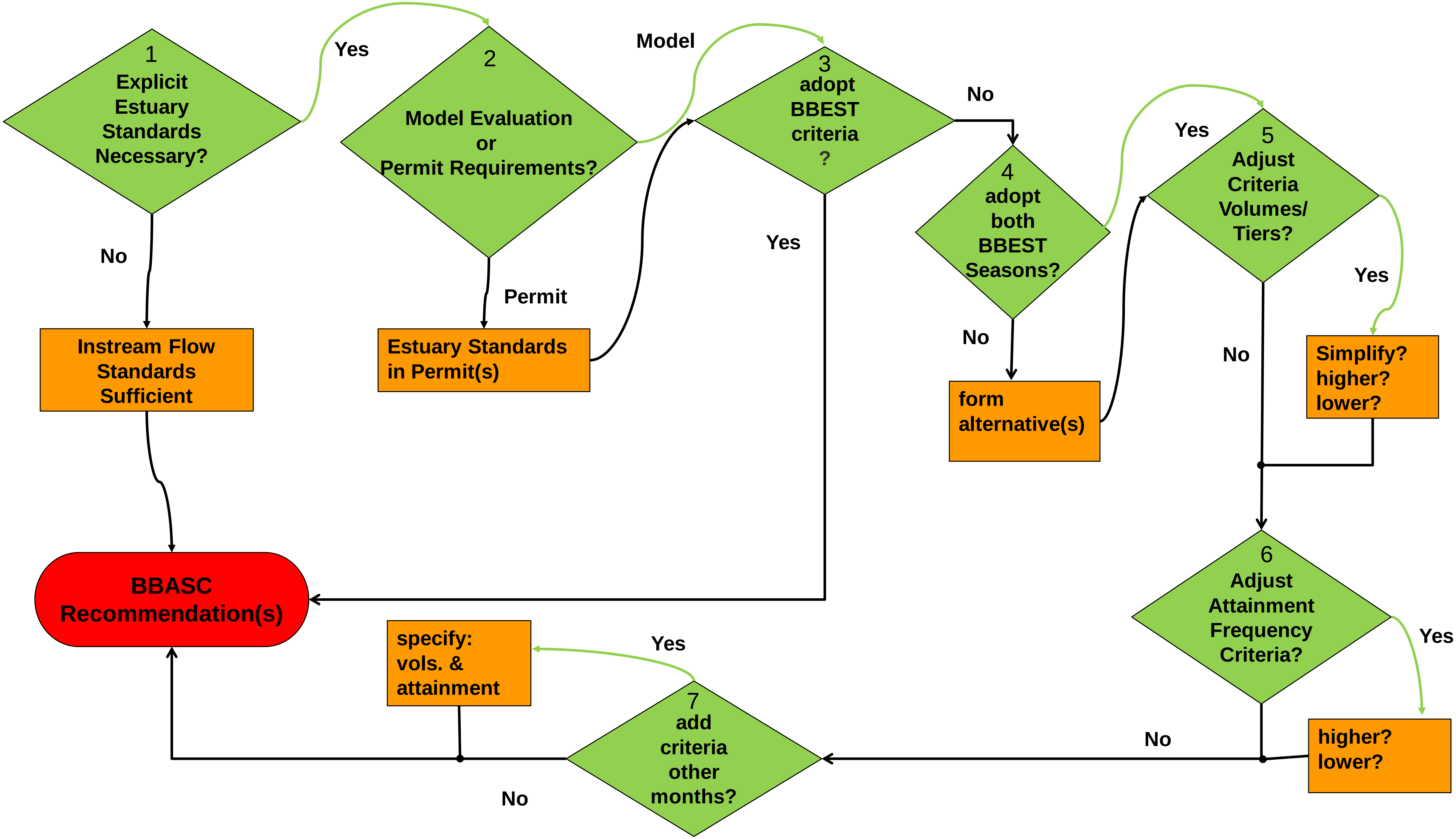
- c) For many years without categorical improvement, especially the driest, many positive changes in inflow would still benefit the estuary;

- d) Potential for synergistic effects if Strategy(ies) could be coupled with storage.

Guadalupe, San Antonio, Mission, & Aransas Rivers and Mission, Copano, Aransas, & San Antonio Bays Basin and Bay Area Stakeholder Committee (GSA BBASC)

GSA BBASC Recommendations: Estuary Recommendation Structure Decision Process

July 28, 2011



1 Explicit Estuary Standards Necessary?
Yes
No
Instream Flow Standards Sufficient
2 Model Evaluation or Permit Requirements?
Model
Permit
Estuary Standards in Permit(s)
3 adopt BBEST criteria ?
Yes
No
4 adopt both BBEST Seasons?
No
form alternative(s)
Yes
5 Adjust Criteria Volumes/ Tiers?
Yes
Simplify? higher? lower?
No
6 Adjust Attainment Frequency Criteria?
Yes
higher? lower?
No
BBASC Recommendation(s)
7 add criteria other months?
Yes
specify: vols. & attainment
No

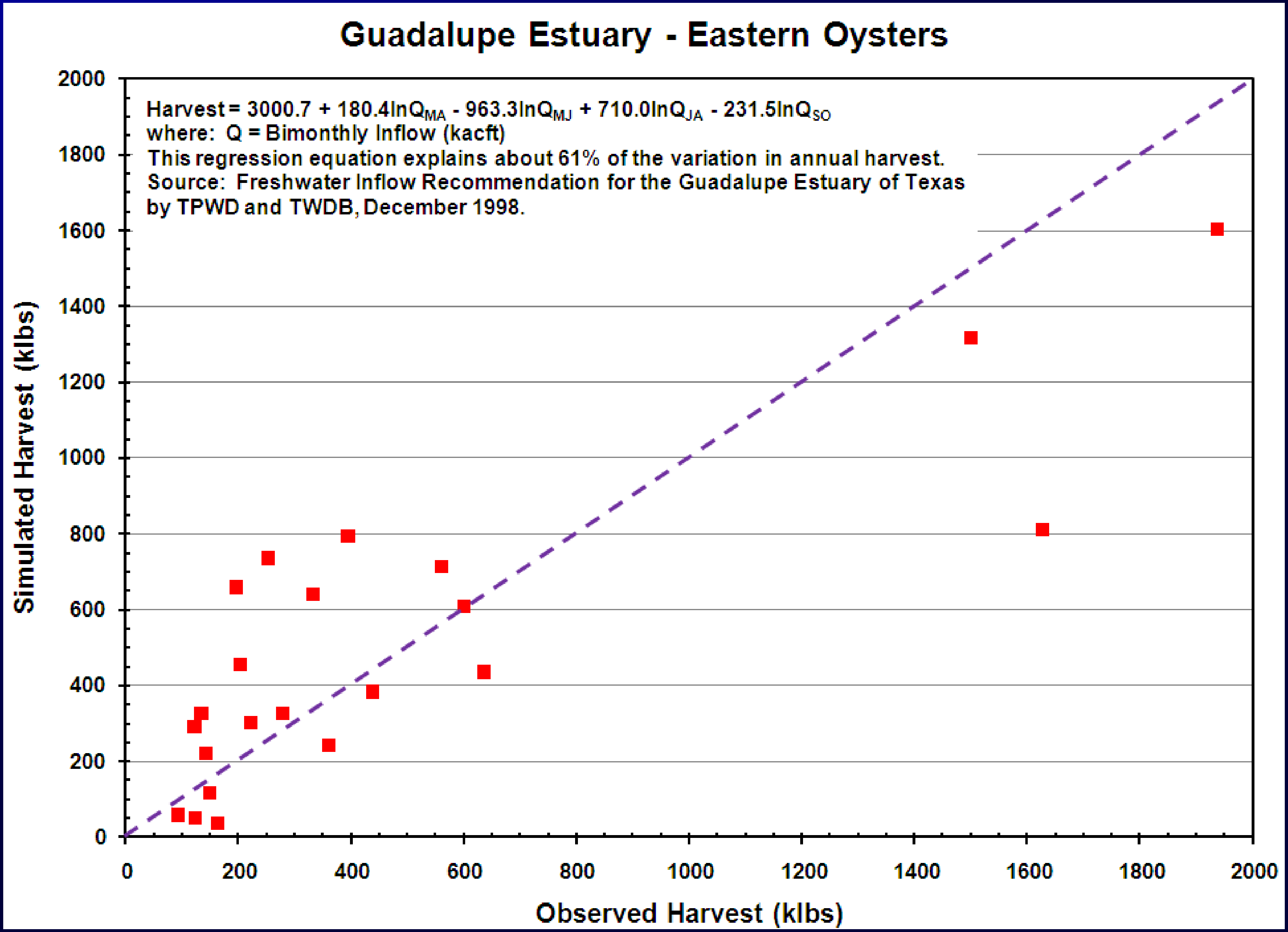
Guadalupe, San Antonio, Mission, & Aransas Rivers and Mission, Copano, Aransas, & San Antonio Bays Basin and Bay Area Stakeholder Committee (GSA BBASC)

Guadalupe Estuary Eastern Oyster Harvest Analyses

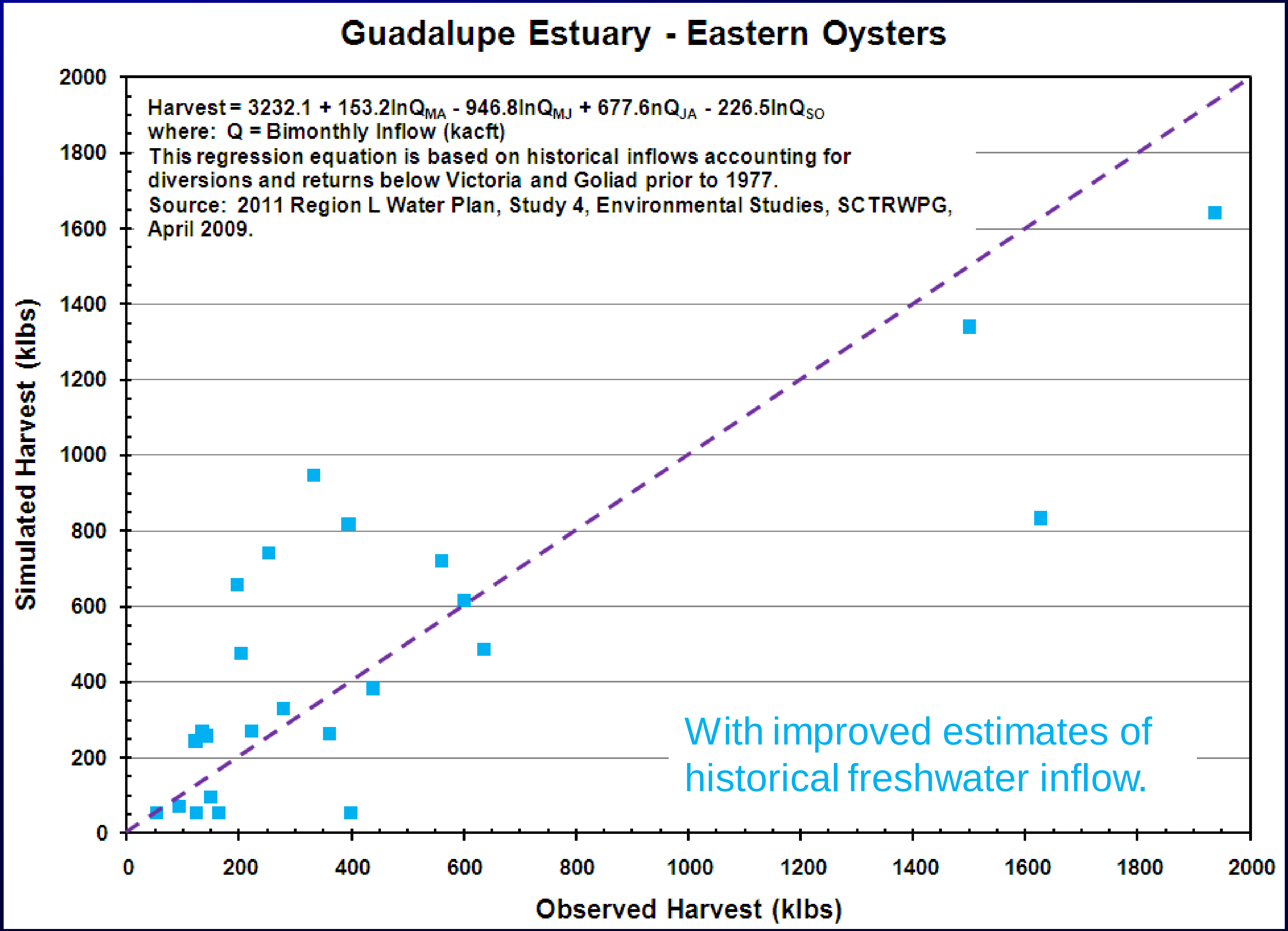
DRAFT

July 17, 2011

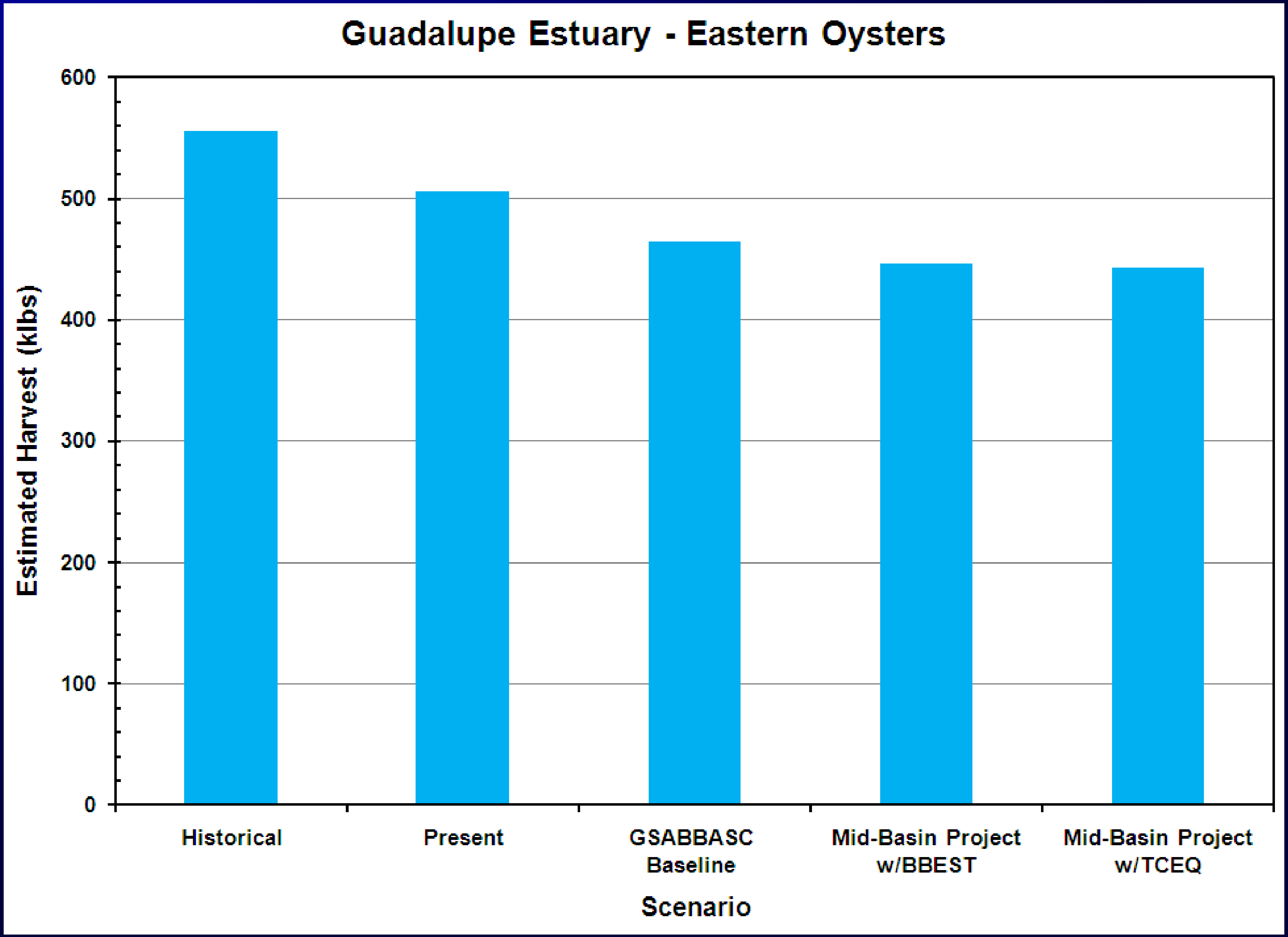
Oyster Harvest Estimation from Inflow



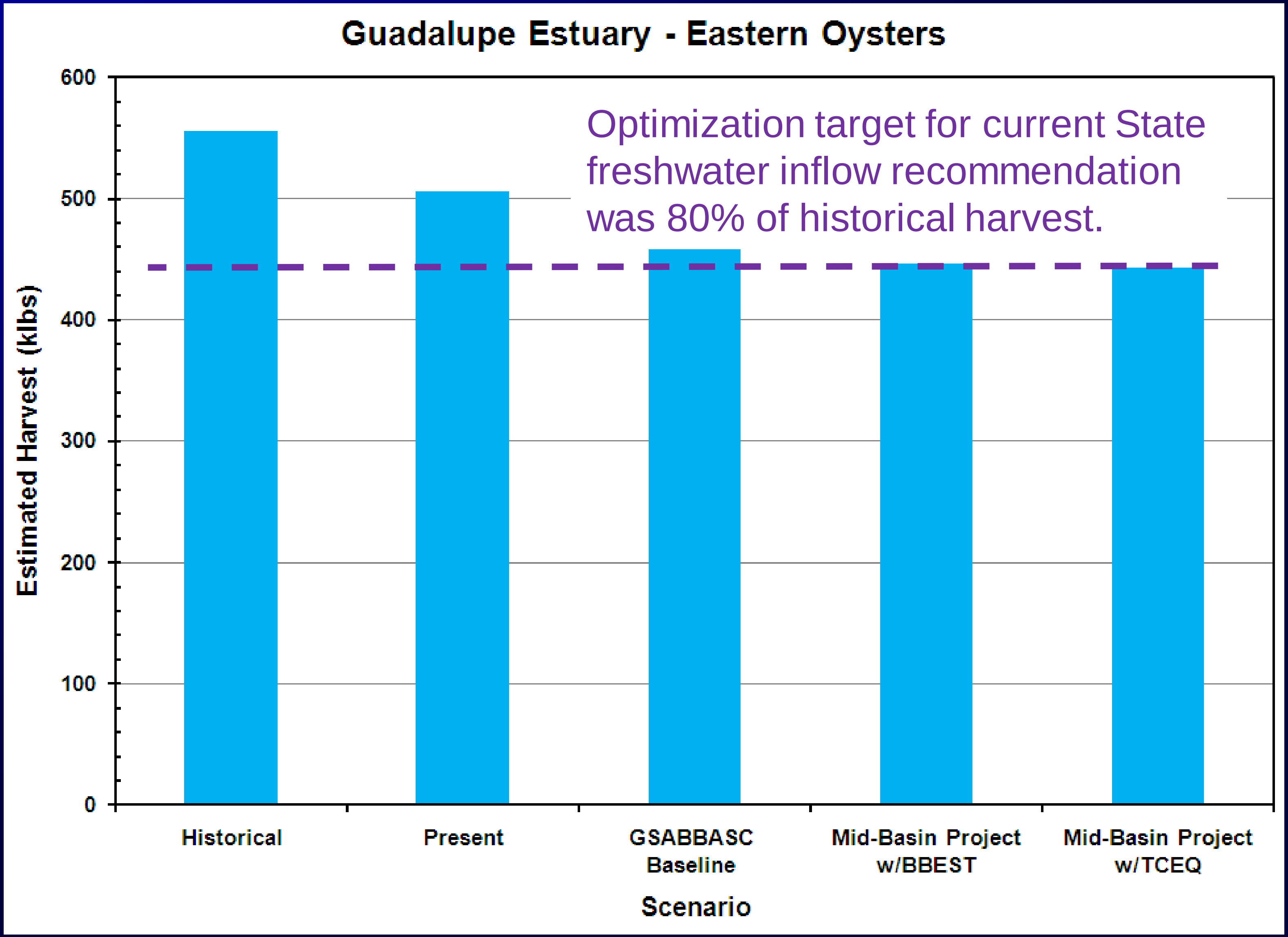
Oyster Harvest Estimation from Inflow



Long-term Average Oyster Harvest



Long-term Average Oyster Harvest



Summary of BBEST Estuary Inflow Recommendations.

All information from Tables 4.5-3 or 4.6-1 or 6.1-17 in BBEST report.

Summary of Guadalupe Estuary G1 recommended inflow volumes for the Feb. - May period.

Criteria level	Inflow Volumes (1000 ac-ft)	
	Feb.	Mar.-May
G1-Aprime,	n/a	550-925
G1-A	n/a	375-550
G1-B	n/a	275-375
G1-C	≥75	150-275
G1-CC	0 - 75	150-275
G1-D	n/a	0 - 150

Summary of Guadalupe Estuary G1 attainment goals for the above recommended inflow volumes for the Feb. - May period.

Criteria level	Specification	Inflow Criteria Attainment[1]
G1-Aprime	Attainment, G1-Aprime	at least 12% of years
G1-A	Attainment, G1-A	at least 12 % of years
G1-A & G1-B	Attainment, G1-A & G1-B combined	G1-A and G1-B combined at least 17% of years
G1-C & G1-CC	Attainment, G1-C & G1-CC combined[1]	G1-C and G1-CC <u>can be</u> equal to or greater than 19% of years. G1-CC no more than 2/3 of total
G1-D	Attainment, G1-D	no more than 9% of years

Notes:

1) The attainment goals for categories G1-C, G1-CC are contingent upon other criteria level attainment goals being met.

Summary of Guadalupe Estuary G2 recommended inflow volumes for the June - Sept. period.

Criteria level	Inflow Volumes (1000 ac-ft)	
	June	July-Sept.
G2-Aprime	n/a	450-800
G2-A	n/a	275-450
G2-B	n/a	170-275
G2-C	≥40	75-170
G2-CC	0 - 40	75-170
G2-D	n/a	50-75
G2-DD	n/a	0-50

Summary of Guadalupe Estuary G2 attainment goals for the above recommended inflow volumes for the June - Sept. period.

Criteria level	Specification	Inflow Criteria Attainment
G2-Aprime	Attainment, G2-Aprime	at least 12% of years
G2-A	Attainment, G2-A	at least 17 % of years
G2-A & G2-B	Attainment, G2-A & G2-B combined	G2-A and G2-B combined at least 30% of years
G2-C & G2-CC	Attainment, G2-C & G2-CC combined[1]	G2-C and G2-CC can be equal to or greater than 10% of years. G2-CC no more than 1/6 of total
G2-DD	Attainment, G2-DD	G2-D no more than 6% of years
G2-D &G 2-DD	Attainment, G2-D & G2-DD combined	G2-D and G2-DD combined no more than 9% of years

Notes:

1) the attainment goals for categories G2-C,and G2-CC are contingent upon other criteria level attainment goals being met.

Summary of Mission-Aransas Estuary recommended inflow volumes for the June - Sept. period.

Criteria level	Inflow Volumes (1000 ac-ft)	
	June	July-Sept.
MA2-Aprime	n/a	500-1000

Summary of Mission-Aransas Estuary attainment goals for the recommended inflow volumes for the June - Sept. period.

Criteria level	Specification	Inflow Criteria Attainment
MA2-Aprime	Attainment MA2-Aprime	at least 2% of years

6.1.7. Attainment Goals for Estuarine Inflow Recommendations

"Compliance … is expected to be evaluated with modeling approaches."

WAM should :

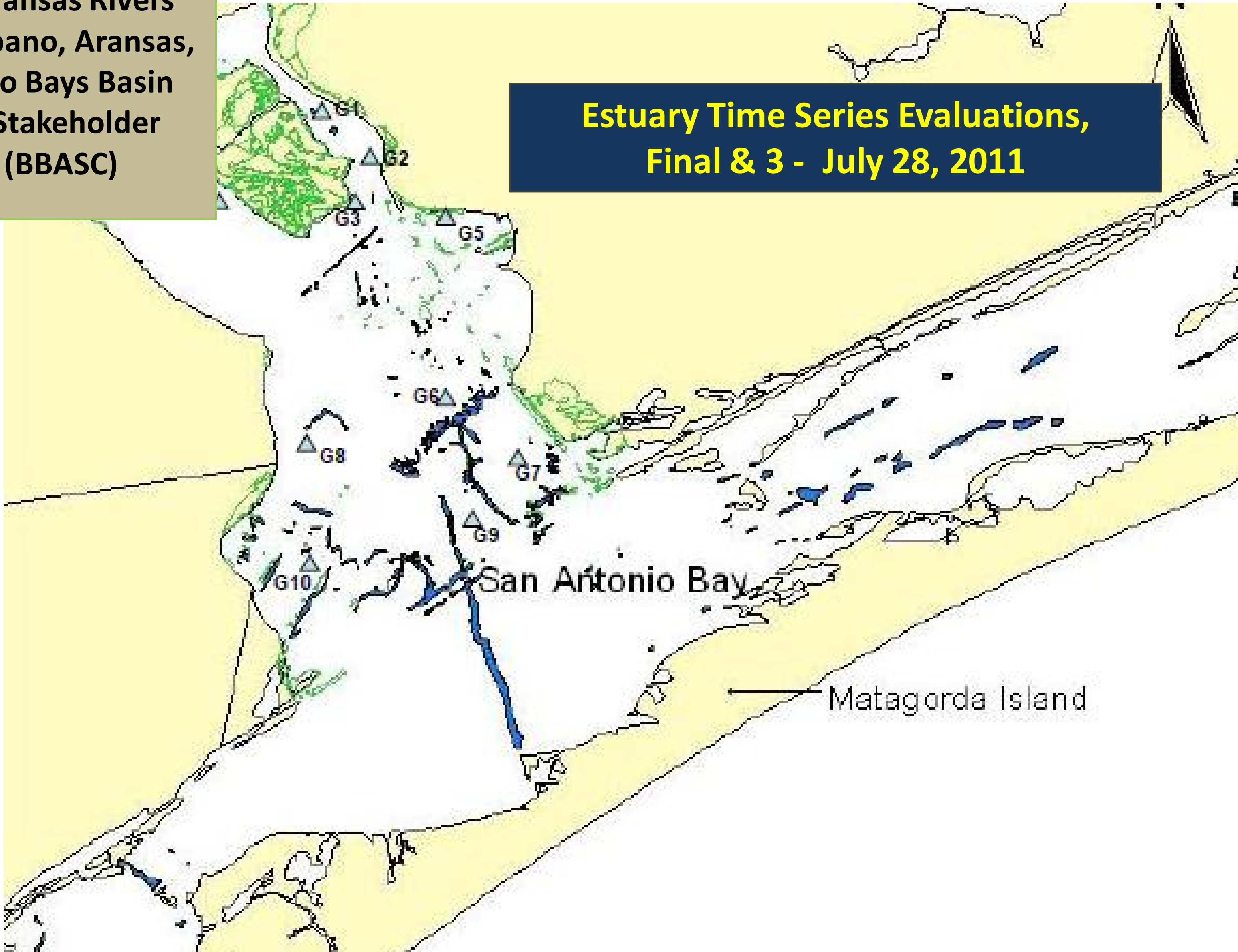
1) predict comprehensive total inflow quantities to the estuarine systems, including contributions from ungaged coastal drainages and corrections for diversions and return flows below the most downstream gaging stations; and

2) use a long-term period of record (65+ years) with an underlying variable climate and hydrological regime similar to, or the same as, that used in the derivation of the GSA BBEST recommendations.

Meeting of the

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Estuary Time Series Evaluations, Final & 3 - July 28, 2011



Summary – Guadalupe & San Antonio Projects,
Attainment of G1 Springtime Criteria (Rangia)

New Scenarios 07/18/11

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
w. Guad. Proj., No envl. flows	7	9	9	1	5	4	14	49
w. Guad. Proj., BBEST Recomm.	7	10	8	2	4	4	14	49
w. Guad. Proj., HFP 10% div rule	7	9	9	2	4	4	14	49
w. Guad. Proj., HFP 20% div rule	7	9	9	2	4	4	14	49
w. Guad. Proj., HFP 30% div rule	7	9	9	2	4	4	14	49
w. Guad. Proj., TCEQ Struc.	7	10	8	1	5	4	14	49
w. San Ant. Proj., No Envl. Flows	7	9	9	1	5	4	14	49
w. San Ant. Proj., BBEST Recomm.	7	9	9	1	5	4	14	49
w. San Ant. Proj., TIFP (SB2)	7	9	9	2	4	4	14	49
w. San Ant. Proj., TCEQ Struc.	7	9	9	1	5	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

Summary – Guadalupe & San Antonio Projects, Attainment of G1 Springtime Criteria (Rangia)

New Scenarios 07/18/11

Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Region L Baseline; BBASC		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. Guad. Proj., No envl. flows		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. Guad. Proj., BBEST Recomm.		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., HFP 10% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., HFP 20% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., HFP 30% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., TCEQ Struc.		20.4%	16.3%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Proj., No Envl. Flows		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Proj., BBEST Recomm.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Proj., TIFP (SB2)		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. San Ant. Proj., TCEQ Struc.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

Summary – Guadalupe & San Antonio Projects, Attainment of G2 Summer Criteria (Oysters)

New Scenarios 07/18/11

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. Guad. Proj., No envl. flows	4	8	8	8	6	4	2	9	49
w. Guad. Proj., BBEST Recomm.	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 10% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 20% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 30% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., TCEQ Struc.	4	8	8	8	6	4	2	9	49
w. San Ant. Proj., No Envl. Flows	4	7	9	7	7	4	2	9	49
w. San Ant. Proj., BBEST Recomm.	4	8	8	8	7	3	3	8	49
w. San Ant. Proj., TIFP (SB2)	4	8	8	6	8	4	3	8	49
w. San Ant. Proj., TCEQ Struc.	4	8	8	7	7	4	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

Summary – Guadalupe & San Antonio Projects, Attainment of G2 Summer Criteria (Oysters)

New Scenarios 07/18/11

see Table 4.5-2			>=30%		>10%	<=1/6	<=9%	
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)							
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD	
Historical			38.8%		12.2%	16.7%	10.2%	
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%	
w. Guad. Proj., No envl. flows			32.7%		20.4%	40.0%	22.4%	
w. Guad. Proj., BBEST Recomm.			32.7%		20.4%	30.0%	22.4%	
w. Guad. Proj., HFP 10% div rule			32.7%		20.4%	30.0%	22.4%	
w. Guad. Proj., HFP 20% div rule			32.7%		20.4%	30.0%	22.4%	
w. Guad. Proj., HFP 30% div rule			32.7%		20.4%	30.0%	22.4%	
w. Guad. Proj., TCEQ Struc.			32.7%		20.4%	40.0%	22.4%	
w. San Ant. Proj., No Envl. Flows			32.7%		22.4%	36.4%	22.4%	
w. San Ant. Proj., BBEST Recomm.			32.7%		20.4%	30.0%	22.4%	
w. San Ant. Proj., TIFP (SB2)			28.6%		24.5%	33.3%	22.4%	
w. San Ant. Proj., TCEQ Struc.			30.6%		22.4%	36.4%	22.4%	
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%	

Revised San Antonio Project:

-same reservoir size and diversion rate;

-with 60cfs subsistence level in river;

-the TIFP base flow tiers values;

-50% diversion rule between subsistence / base low;

- 25/50/25 hydro condition;

-Concept 1 applied to pulses

Revised San Antonio Project 07/28/11

Criteria G1 for rangia - summarize the attainment across various scenarios

no years in record (1941-89)= 49

Counts	Criteria G1 Attainment (no. years)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
w. Guad. Proj., No envl. flows	7	9	9	1	5	4	14	49
w. Guad. Proj., BBEST Recomm.	7	10	8	2	4	4	14	49
w. Guad. Proj., HFP 10% div rule	7	9	9	2	4	4	14	49
w. Guad. Proj., HFP 20% div rule	7	9	9	2	4	4	14	49
w. Guad. Proj., HFP 30% div rule	7	9	9	2	4	4	14	49
w. Guad. Proj., TCEQ Struc.	7	10	8	1	5	4	14	49
w. San Ant. Proj., No Envl. Flows	7	9	9	1	5	4	14	49
w. San Ant. Proj., BBEST Recomm.	7	9	9	1	5	4	14	49
w. San Ant. Proj., TIFP (SB2) org.	7	9	9	2	4	4	14	49
w. San Ant. Proj., TIFP (SB2) rvsd.	7	9	9	2	4	4	14	
w. San Ant. Proj., TCEQ Struc.	7	9	9	1	5	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

Revised San Antonio Project 07/28/11

Criteria G2 for oysters - summarize the attainment across various scenarios

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. Guad. Proj., No envl. flows	4	8	8	8	6	4	2	9	49
w. Guad. Proj., BBEST Recomm.	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 10% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 20% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 30% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., TCEQ Struc.	4	8	8	8	6	4	2	9	49
w. San Ant. Proj., No Envl. Flows	4	7	9	7	7	4	2	9	49
w. San Ant. Proj., BBEST Recomm.	4	8	8	8	7	3	3	8	49
w. San Ant. Proj., TIFP (SB2) org.	4	8	8	6	8	4	3	8	49
w. San Ant. Proj., TIFP (SB2) rvsd.	4	8	8	6	8	4	3	8	49
w. San Ant. Proj., TCEQ Struc.	4	8	8	7	7	4	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

Comprehensive:

All scenarios evaluated up through 07/28/11

G1 attainment, all scenarios as of 07/28/11

Criteria G1 for rangia - summarize the attainment across various scenarios

no years in record (1941-89)= 49

Counts

Scenario	Criteria G1 Attainment (no. years) >A-pr	A-pr	A	B	C	CC	D	sum
Natural	9	15	7	6	3	6	3	49
Historical	9	14	7	4	5	5	5	49
Present	8	14	4	5	5	5	8	49
Region L Baseline; BBASC	7	10	8	3	3	4	14	49
w. Guad. Proj., No envl. flows	7	9	9	1	5	4	14	49
w. Guad. Proj., BBEST Recomm.	7	10	8	2	4	4	14	49
w. Guad. Proj., CCEFN	7	9	9	1	5	4	14	49
w. Guad. Proj., Lyons	7	9	9	2	4	4	14	49
w. Guad. Proj., No Div <Base	7	10	8	2	4	4	14	49
w. Guad. Proj., HFP 10% div rule	7	9	9	2	4	4	14	49
w. Guad. Proj., HFP 20% div rule	7	9	9	2	4	4	14	49
w. Guad. Proj., HFP 30% div rule	7	9	9	2	4	4	14	49
w. Guad. Proj., TCEQ Struc.	7	10	8	1	5	4	14	49
w. San Ant. Proj., No Envl. Flows	7	9	9	1	5	4	14	49
w. San Ant. Proj., BBEST Recomm.	7	9	9	1	5	4	14	49
w. San Ant. Proj., CCEFN	7	9	9	1	5	4	14	49
w. San Ant. Proj., Lyons	7	9	9	2	4	4	14	49
w. San Ant. Proj., No Div <Base	7	9	9	1	5	4	14	49
w. San Ant. Proj., TIFP (SB2) org.	7	9	9	2	4	4	14	49
w. San Ant. Proj., TIFP (SB2) rvsd.	7	9	9	2	4	4	14	
w. San Ant. Proj., TCEQ Struc.	7	9	9	1	5	4	14	49
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49

G1 attainment, all scenarios as of 07/28/11

Criteria G1 for rangia - summarize the attainment across various scenarios							
goals - see Tables 4.5-3 & 4.5-6		>12%	>12%				<=9%
Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Natural		30.6%	14.3%	12.2%	6.1%	12.2%	6.1%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline; BBASC		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
w. Guad. Proj., No envl. flows		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. Guad. Proj., BBEST Recomm.		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., CCEFN		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. Guad. Proj., Lyons		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., No Div <Base		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., HFP 10% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., HFP 20% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., HFP 30% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. Guad. Proj., TCEQ Struc.		20.4%	16.3%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Proj., No Envl. Flows		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Proj., BBEST Recomm.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Proj., CCEFN		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Proj., Lyons		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. San Ant. Proj., No Div <Base		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
w. San Ant. Proj., TIFP (SB2) org.		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. San Ant. Proj., TIFP (SB2) rvsd.		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
w. San Ant. Proj., TCEQ Struc.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

G1 attainment, all scenarios as of 07/28/11

Criteria G1 for rangia - summarize the attainment across various scenarios

goals - see Table 4.5-3			>17%		>=19%	<=2/3	
Attain. - Joints	Joint G1 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	
Natural			26.5%		18.4%	66.7%	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline; BBASC			22.4%		14.3%	57.1%	
w. Guad. Proj., No envl. flows			20.4%		18.4%	44.4%	
w. Guad. Proj., BBEST Recomm.			20.4%		16.3%	50.0%	
w. Guad. Proj., CCEFN			20.4%		18.4%	44.4%	
w. Guad. Proj., Lyons			22.4%		16.3%	50.0%	
w. Guad. Proj., No Div <Base			20.4%		16.3%	50.0%	
w. Guad. Proj., HFP 10% div rule			22.4%		16.3%	50.0%	
w. Guad. Proj., HFP 20% div rule			22.4%		16.3%	50.0%	
w. Guad. Proj., HFP 30% div rule			22.4%		16.3%	50.0%	
w. Guad. Proj., TCEQ Struc.			18.4%		18.4%	44.4%	
w. San Ant. Proj., No Envl. Flows			20.4%		18.4%	44.4%	
w. San Ant. Proj., BBEST Recomm.			20.4%		18.4%	44.4%	
w. San Ant. Proj., CCEFN			20.4%		18.4%	44.4%	
w. San Ant. Proj., Lyons			22.4%		16.3%	50.0%	
w. San Ant. Proj., No Div <Base			20.4%		18.4%	44.4%	
w. San Ant. Proj., TIFP (SB2) org.			22.4%		16.3%	50.0%	
w. San Ant. Proj., TIFP (SB2) rvsd.			22.4%		16.3%	50.0%	
w. San Ant. Proj., TCEQ Struc.			20.4%		18.4%	44.4%	
TCEQ Baseline; (Run 3)			18.4%		16.3%	37.5%	

G2 attainment, all scenarios as of 07/28/11

Criteria G2 for oysters - summarize the attainment across various scenarios

Counts	Criteria G2 Attainment (no. years)								
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum
Natural	9	11	15	7	3	2	2	0	49
Historical	8	11	11	8	5	1	1	4	49
Present	5	11	8	10	8	1	1	5	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. Guad. Proj., No envl. flows	4	8	8	8	6	4	2	9	49
w. Guad. Proj., BBEST Recomm.	4	8	8	8	7	3	3	8	49
w. Guad. Proj., CCEFN	4	8	8	8	7	3	3	8	49
w. Guad. Proj., Lyons	4	8	8	8	7	3	3	8	49
w. Guad. Proj., No Div <Base	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 10% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 20% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 30% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., TCEQ Struc.	4	8	8	8	6	4	2	9	49
w. San Ant. Proj., No Envl. Flows	4	7	9	7	7	4	2	9	49
w. San Ant. Proj., BBEST Recomm.	4	8	8	8	7	3	3	8	49
w. San Ant. Proj., CCEFN	4	8	8	8	6	4	2	9	49
w. San Ant. Proj., Lyons	4	8	8	8	7	3	3	8	49
w. San Ant. Proj., No Div <Base	4	8	8	8	7	3	3	8	49
w. San Ant. Proj., TIFP (SB2) org.	4	8	8	6	8	4	3	8	49
w. San Ant. Proj., TIFP (SB2) rvsd.	4	8	8	6	8	4	3	8	49
w. San Ant. Proj., TCEQ Struc.	4	8	8	7	7	4	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

G2 attainment, all scenarios as of 07/28/11

Criteria G2 for oysters - summarize the attainment across various scenarios

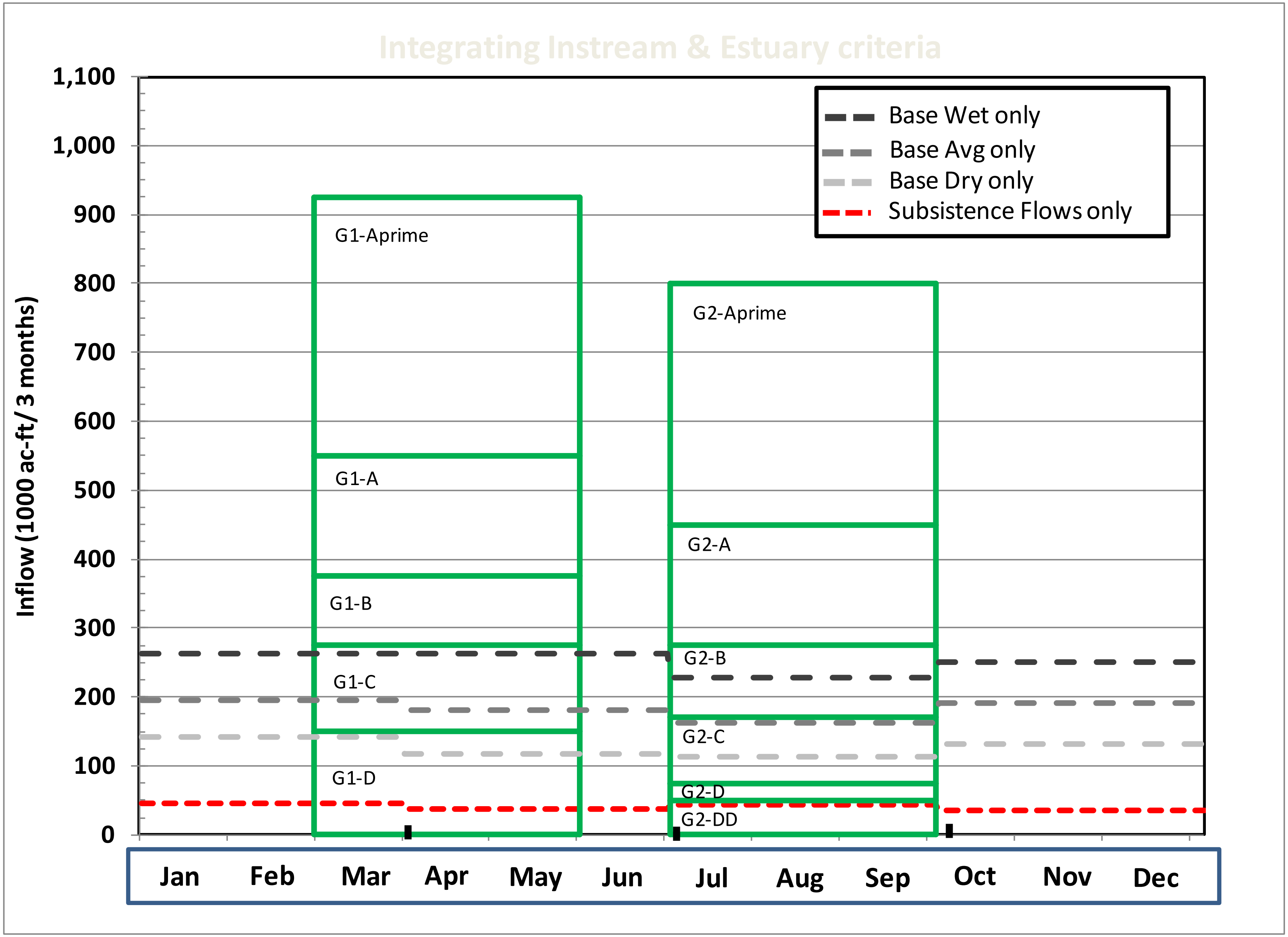
goals - see Tables 4.5-2; 4.5-4		>12%	>17%				<=6%	
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Natural		22.4%	30.6%	14.3%	6.1%	4.1%	4.1%	0.0%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Proj., No envl. flows		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
w. Guad. Proj., BBEST Recomm.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Proj., CCEFN		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Proj., Lyons		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Proj., No Div <Base		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Proj., HFP 10% div rule		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Proj., HFP 20% div rule		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Proj., HFP 30% div rule		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. Guad. Proj., TCEQ Struc.		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
w. San Ant. Proj., No Envl. Flows		14.3%	18.4%	14.3%	14.3%	8.2%	4.1%	18.4%
w. San Ant. Proj., BBEST Recomm.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Ant. Proj., CCEFN		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
w. San Ant. Proj., Lyons		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Ant. Proj., No Div <Base		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
w. San Ant. Proj., TIFP (SB2) org.		16.3%	16.3%	12.2%	16.3%	8.2%	6.1%	16.3%
w. San Ant. Proj., TIFP (SB2) rvsd.		16.3%	16.3%	12.2%	16.3%	8.2%	6.1%	16.3%
w. San Ant. Proj., TCEQ Struc.		16.3%	16.3%	14.3%	14.3%	8.2%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

G2 attainment, all scenarios as of 07/28/11

Criteria G2 for oysters - summarize the attainment across various scenarios

goals - see Table 4.5-2			>=30%		>10%	<=1/6	<=9%
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD
Natural			44.9%		10.2%	40.0%	4.1%
Historical			38.8%		12.2%	16.7%	10.2%
Present			36.7%		18.4%	11.1%	12.2%
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%
w. Guad. Proj., No envl. flows			32.7%		20.4%	40.0%	22.4%
w. Guad. Proj., BBEST Recomm.			32.7%		20.4%	30.0%	22.4%
w. Guad. Proj., CCEFN			32.7%		20.4%	30.0%	22.4%
w. Guad. Proj., Lyons			32.7%		20.4%	30.0%	22.4%
w. Guad. Proj., No Div <Base			32.7%		20.4%	30.0%	22.4%
w. Guad. Proj., HFP 10% div rule			32.7%		20.4%	30.0%	22.4%
w. Guad. Proj., HFP 20% div rule			32.7%		20.4%	30.0%	22.4%
w. Guad. Proj., HFP 30% div rule			32.7%		20.4%	30.0%	22.4%
w. Guad. Proj., TCEQ Struc.			32.7%		20.4%	40.0%	22.4%
w. San Ant. Proj., No Envl. Flows			32.7%		22.4%	36.4%	22.4%
w. San Ant. Proj., BBEST Recomm.			32.7%		20.4%	30.0%	22.4%
w. San Ant. Proj., CCEFN			32.7%		20.4%	40.0%	22.4%
w. San Ant. Proj., Lyons			32.7%		20.4%	30.0%	22.4%
w. San Ant. Proj., No Div <Base			32.7%		20.4%	30.0%	22.4%
w. San Ant. Proj., TIFP (SB2) org.			28.6%		24.5%	33.3%	22.4%
w. San Ant. Proj., TIFP (SB2) rvsd.			28.6%		24.5%	33.3%	22.4%
w. San Ant. Proj., TCEQ Struc.			30.6%		22.4%	36.4%	22.4%
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%

**Salinity response
at inflow levels equivalent to
Instream Flow Components**



Integrating Instream & Estuary criteria
Inflow (1000 ac-ft/ 3 months)
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Base Wet only
Base Avg only
Base Dry only
Subsistence Flows only
G1-Aprime
G1-A
G1-B
G1-C
G1-D
G2-Aprime
G2-A
G2-B
G2-C
G2-D
G2-DD
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Table 4.5-2. A multi-tiered suite of inflow criteria covering the June-September period in the Guadalupe Estuary oyster area determined via the salinity zone approach.

Criteria level	Inflow ranges (1000 ac-ft) [cfs equivalent]		Salinity and Weighted Useable Area objectives, Jul-Sep		Occurrence [/ Co-] of seasonal [/and antecedent]	
	July-Sept. total inflows	June inflows if applicable	WUA within oyster habitat.	Approx. avg. salinity (ppt.)	No. years 1941-2009 [% yrs]	example years
G2-A	275-450 [1507-2466]	-	100% WUA[1]	11-18	16 / 23.2%	'06,'05,'95
G2-B	170-275 [932-1507]	-	85-100% WUA[2]	13-23	12 / 17.4%	'08,'99,'96
Criteria levels G2-A & G2-B, total historic occurrence 28 years (41%).						
Recommended occurrence in future: Criteria levels G2-A and G2-B total occurrence >= 21 years (30%)[3]; Criteria level G2-A occurrence >= 12 years (17%)[3].						
G2-C	75-170 [411-932]	>=50 [>=840]	65-100% WUA[4]	16-27	6 / 8.7%	'00,'82,'69
G2-CC	75-170 [411-932]	<50 [<840]	36-99% WUA[4]	20-39	1 / 1.5%	1955
Criteria levels G2-C & G2-CC, total historic occurrence 7 years (10%).						
Recommended occurrence in future: Overall occurrence of Criteria level G2-C and G2-CC may increase beyond 7[5] years (10%)if the constraints on other categories are met, and G2-CC comprises no more than 1/6 of total. .						
G2-D	50-75	-	39-73% WUA	25->40	2 / 2.9%	'09,'89
G2-DD	0-50	-	0-43% WUA	31->40	4 / 5.8%	'84,'63,'56
Criteria levels G2-D & G2-DD, total historic occurrence 6 years (9%)						
Recommended occurrence in future: Criteria level G3-D and G3-DD together should occur no more than a total of 6 (9%)years; Criteria level G3-DD should occur no more than 4 (6%)years.						

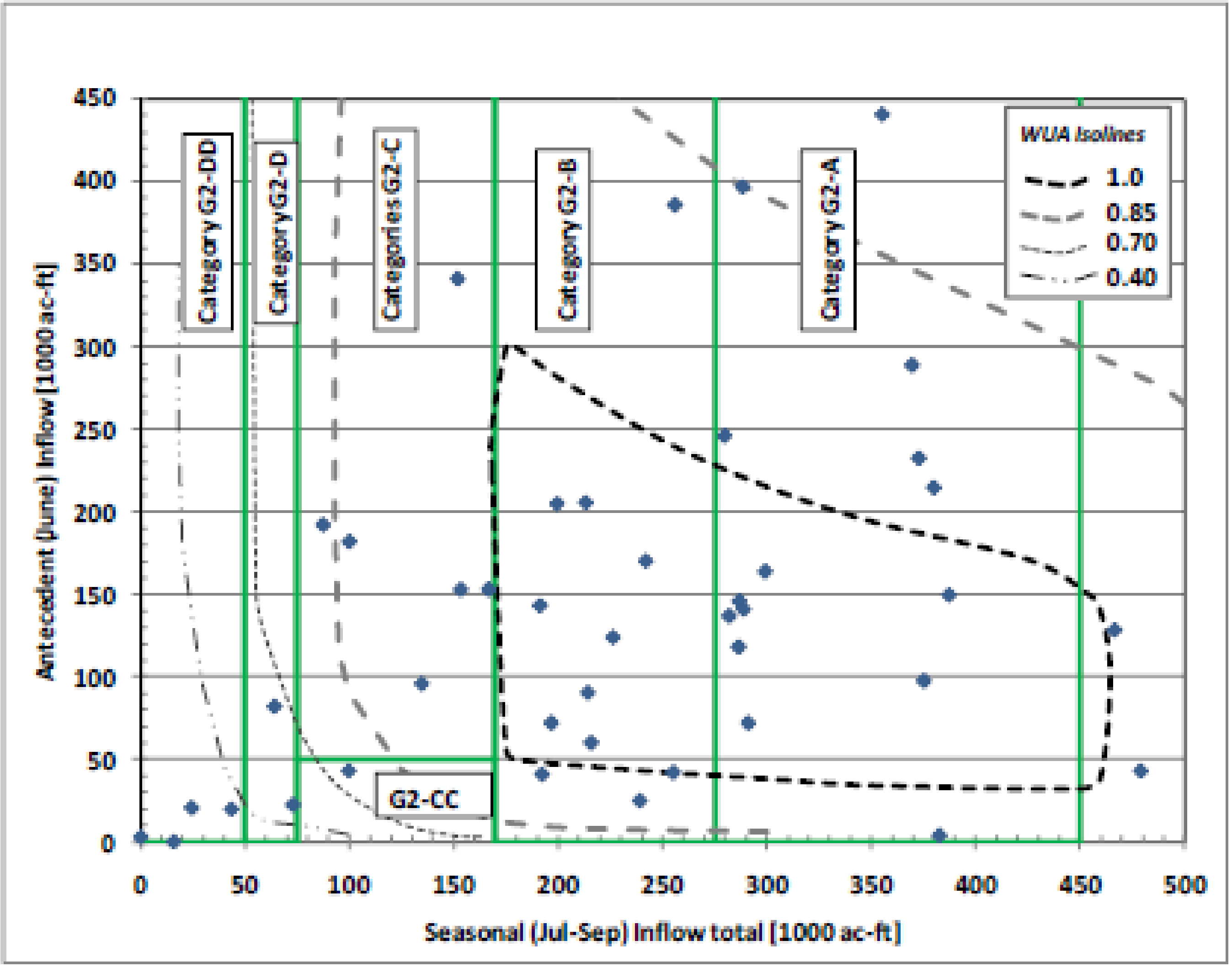


Figure 4.5-1. Employing the weighted useable area response in the oyster habitat of the Guadalupe Estuary to derive a multi-tiered suite of inflow criteria.

Standards

vs.

Baseline for Permit Evaluation

Summary – Guadalupe & San Antonio Projects, Attainment of G2 Summer Criteria (Oysters)

New Scenarios 07/18/11

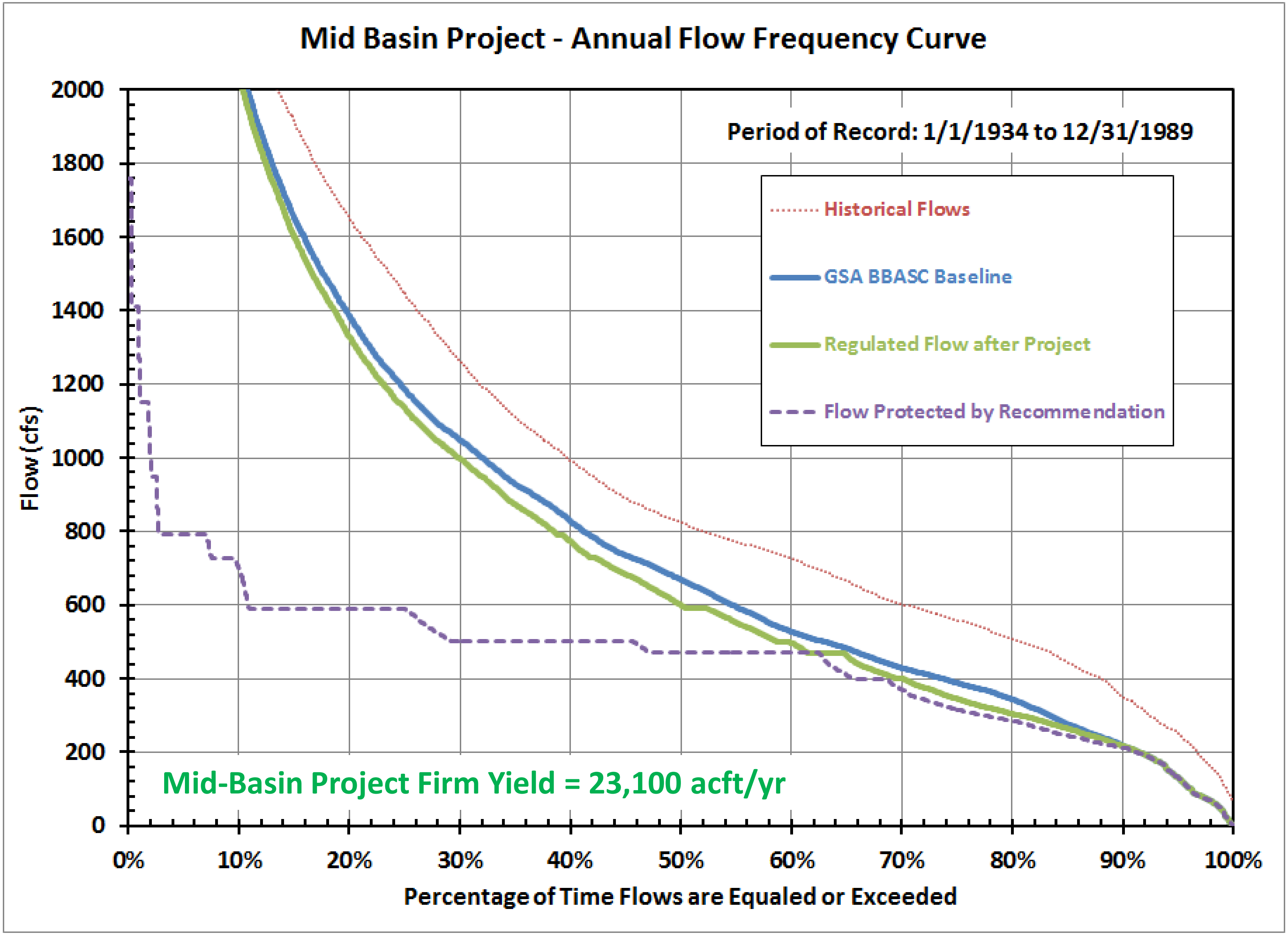
Counts	Criteria G2 Attainment (no. years)								
Scenario	>A pr	A pr	A	B	C	CC	D	DD	sum
Historical	8	11	11	8	5	1	1	4	49
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49
w. Guad. Proj., No envl. flows	4	8	8	8	6	4	2	9	49
w. Guad. Proj., BBEST Recomm.	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 10% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 20% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., HFP 30% div rule	4	8	8	8	7	3	3	8	49
w. Guad. Proj., TCEQ Struc.	4	8	8	8	6	4	2	9	49
w. San Ant. Proj., No Envl. Flows	4	7	9	7	7	4	2	9	49
w. San Ant. Proj., BBEST Recomm.	4	8	8	8	7	3	3	8	49
w. San Ant. Proj., TIFP (SB2)	4	8	8	6	8	4	3	8	49
w. San Ant. Proj., TCEQ Struc.	4	8	8	7	7	4	3	8	49
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49

Stds. basis

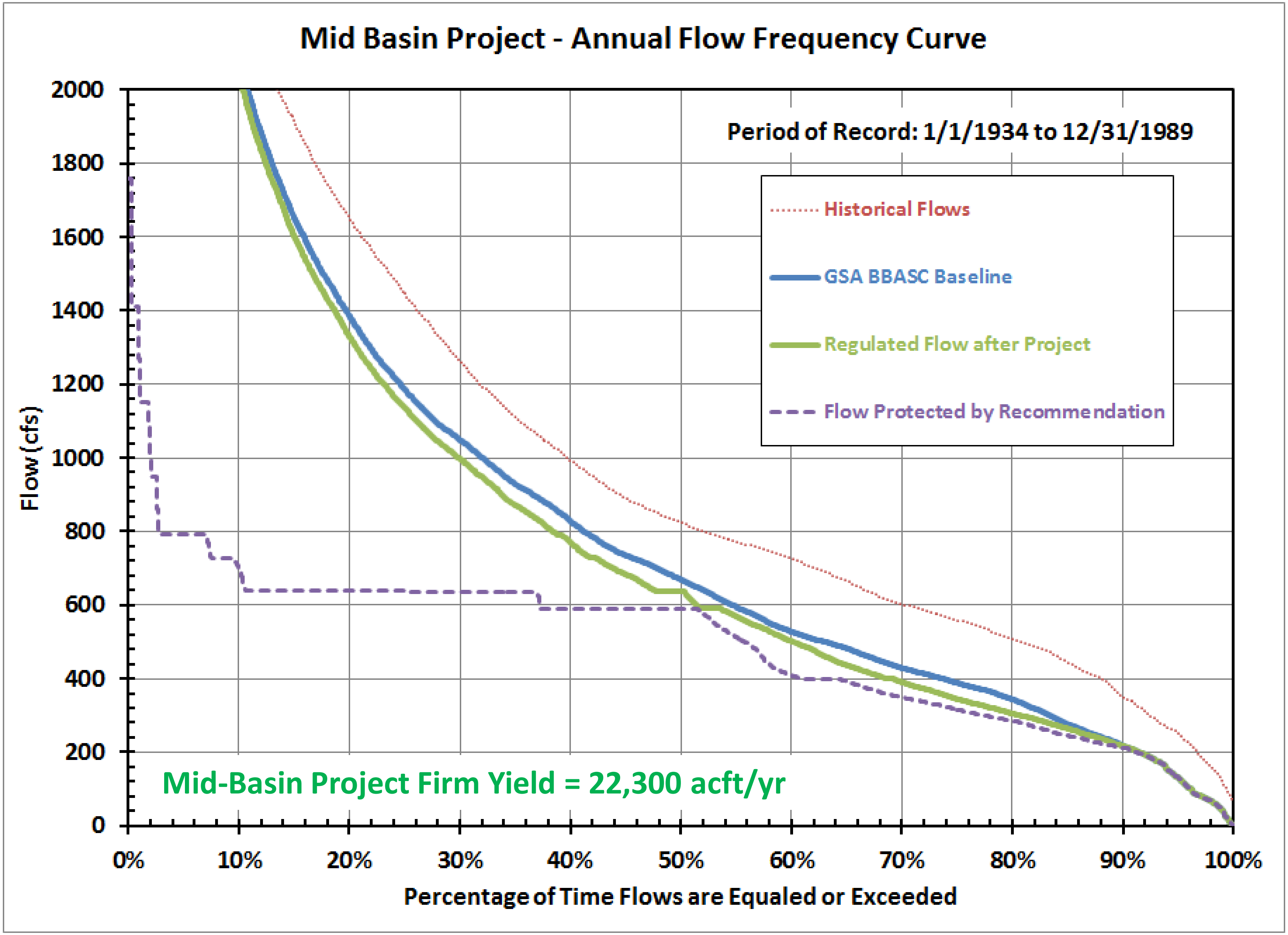
permit Δ basis

Resulting Flows from FRAT Simulations Regarding Tiers of Baseflows at Gonzales

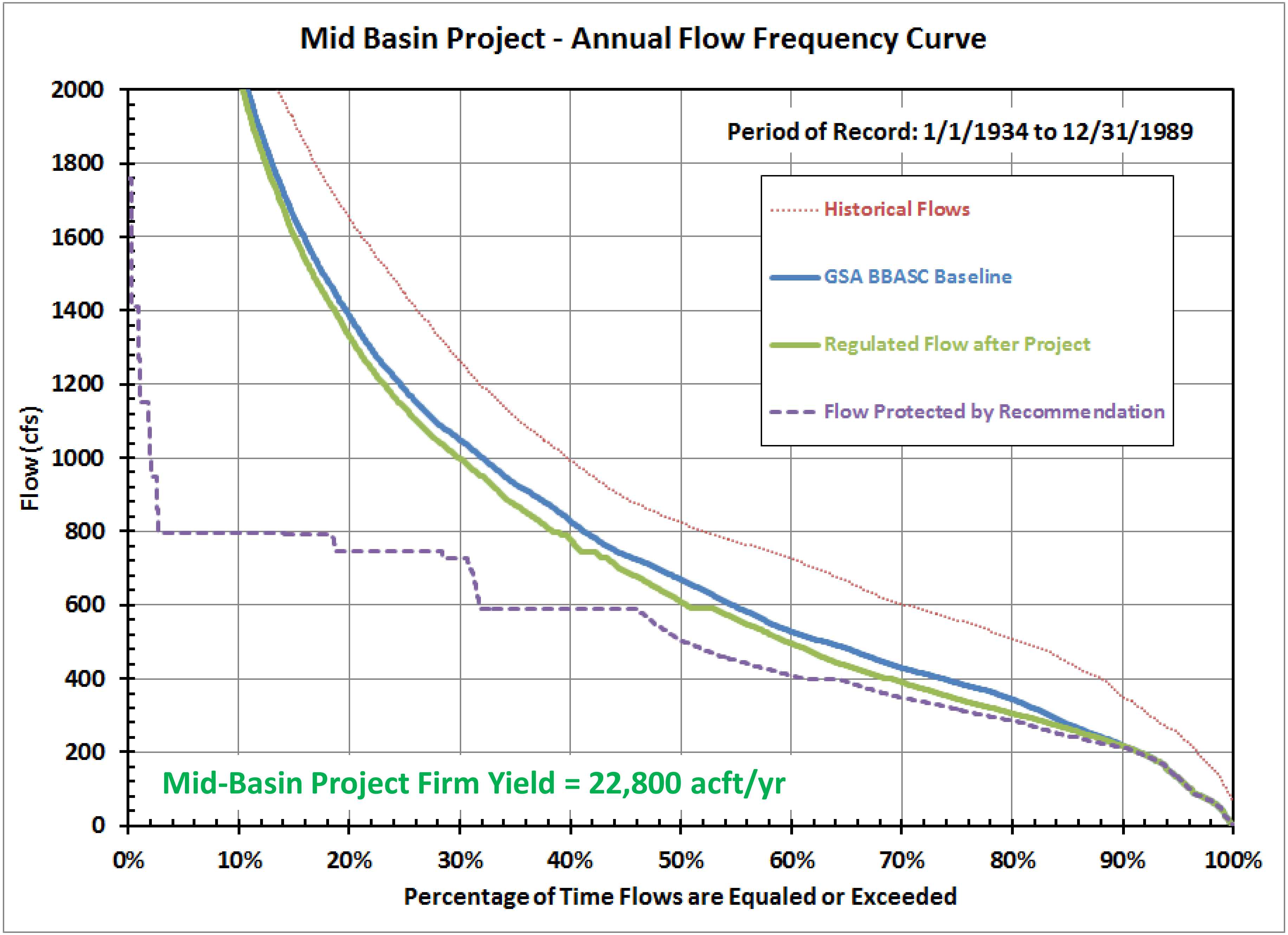
Performed at the August 3rd, 2011 GSA BBASC Meeting



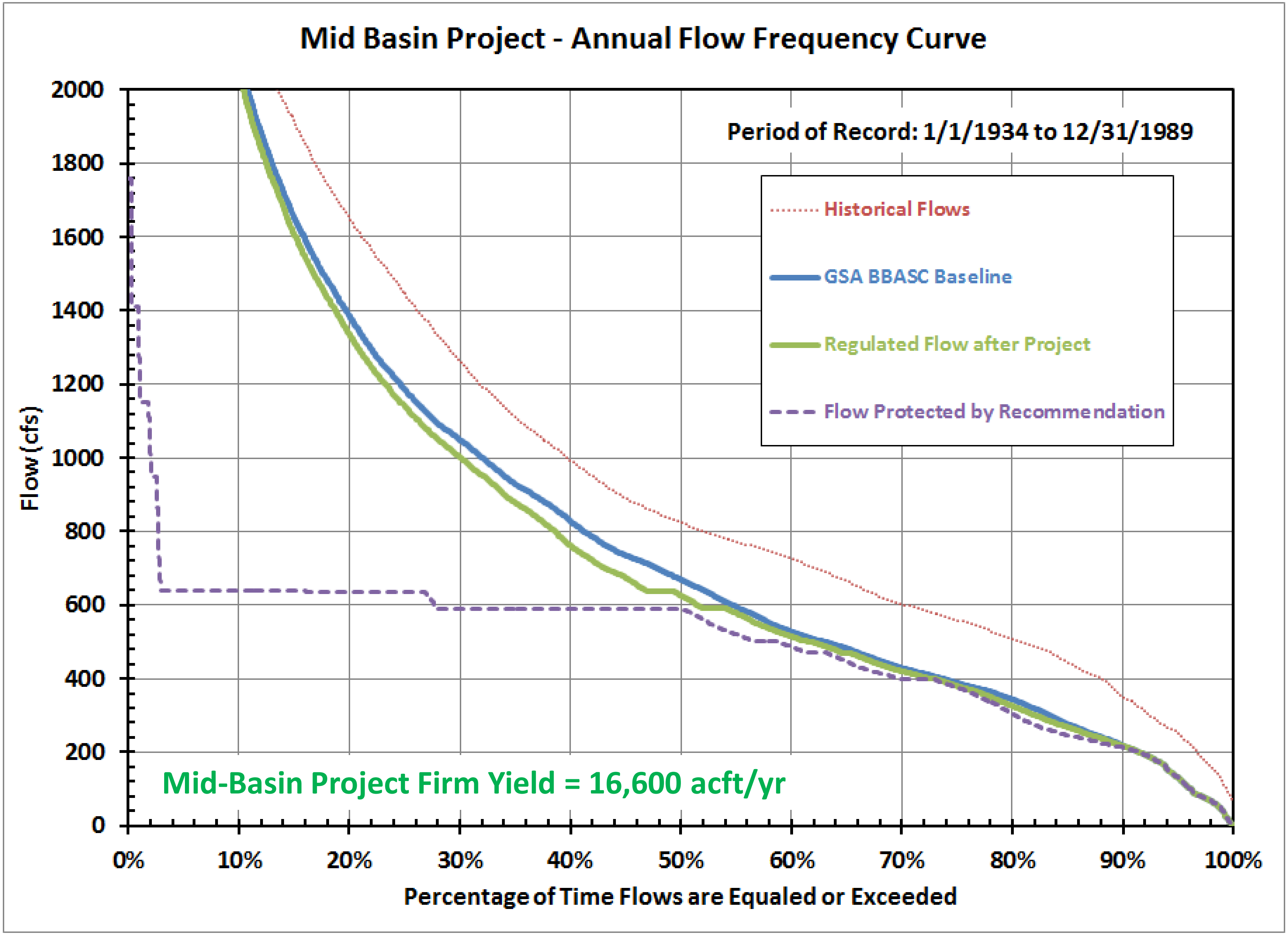
Single-Tiered in Winter and Fall (Dry) & 3-Tiered in Spring and Summer



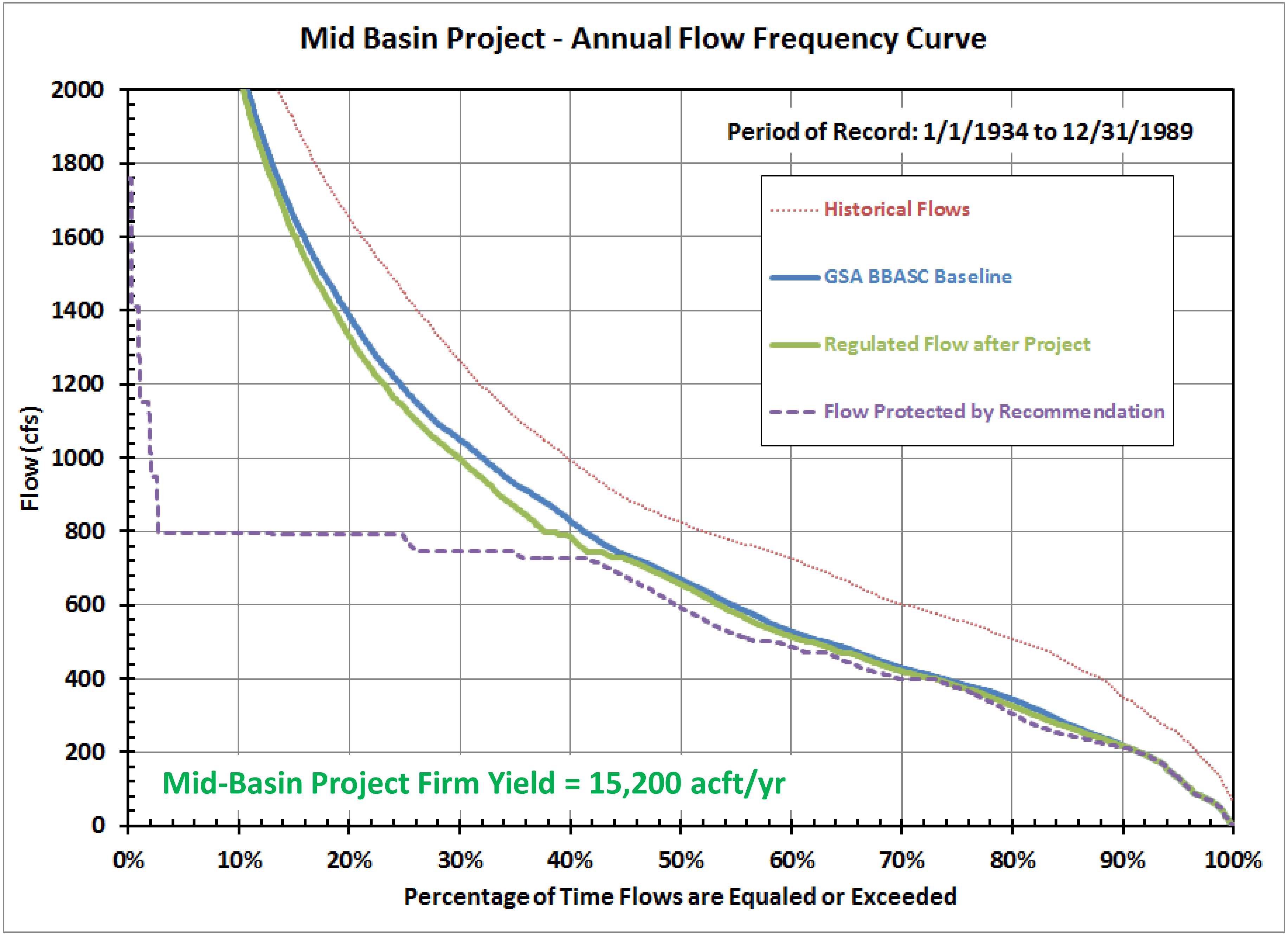
Single-Tiered in Winter and Fall (Average) & 3-Tiered in Spring and Summer



Single-Tiered in Winter and Fall (Wet) & 3-Tiered in Spring and Summer



2 Tiers of Base: Average and Dry



2 Tiers of Base: Wet and Dry

Summary of BBEST Estuary Inflow Recommendations.

All information from Tables 4.5-3 or 4.6-1 or 6.1-17 in BBEST report.

Summary of Guadalupe Estuary G1 recommended inflow volumes for the Feb. - May period.

Criteria level	Inflow Volumes (1000 ac-ft)	
	Feb.	Mar.-May
G1-Aprime,	n/a	550-925
G1-A	n/a	375-550
G1-B	n/a	275-375
G1-C	≥75	150-275
G1-CC	0 - 75	150-275
G1-D	n/a	0 - 150

Summary of Guadalupe Estuary G1 attainment goals for the above recommended inflow volumes for the Feb. - May period.

Criteria level	Specification	Inflow Criteria Attainment[1]
G1-Aprime	Attainment, G1-Aprime	at least 12% of years
G1-A	Attainment, G1-A	at least 12 % of years
G1-A & G1-B	Attainment, G1-A & G1-B combined	G1-A and G1-B combined at least 17% of years
G1-C & G1-CC	Attainment, G1-C & G1-CC combined[1]	G1-C and G1-CC can be equal to or greater than 19% of years. G1-CC no more than 2/3 of total
G1-D	Attainment, G1-D	no more than 9% of years

Notes:

1) The attainment goals for categories G1-C, G1-CC are contingent upon other criteria level attainment goals being met.

Summary of Guadalupe Estuary G2 recommended inflow volumes for the June - Sept. period.

Criteria level	Inflow Volumes (1000 ac-ft)	
	June	July-Sept.
G2-Aprime	n/a	450-800
G2-A	n/a	275-450
G2-B	n/a	170-275
G2-C	≥40	75-170
G2-CC	0 - 40	75-170
G2-D	n/a	50-75
G2-DD	n/a	0-50

Summary of Guadalupe Estuary G2 attainment goals for the above recommended inflow volumes for the June - Sept. period.

Criteria level	Specification	Inflow Criteria Attainment
G2-Aprime	Attainment, G2-Aprime	at least 12% of years
G2-A	Attainment, G2-A	at least 17 % of years
G2-A & G2-B	Attainment, G2-A & G2-B combined	G2-A and G2-B combined at least 30% of years
G2-C & G2-CC	Attainment, G2-C & G2-CC combined[1]	G2-C and G2-CC can be equal to or greater than 10% of years. G2-CC no more than 1/6 of total
G2-DD	Attainment, G2-DD	G2-DD no more than 6% of years
G2-D &G 2-DD	Attainment, G2-D & G2-DD combined	G2-D and G2-DD combined no more than 9% of years

Notes:

1) the attainment goals for categories G2-C,and G2-CC are contingent upon other criteria level attainment goals being met.

Summary of Mission-Aransas Estuary recommended inflow volumes for the June - Sept. period.

Criteria level	Inflow Volumes (1000 ac-ft)	
	June	July-Sept.
MA2-Aprime	n/a	500-1000

Summary of Mission-Aransas Estuary attainment goals for the recommended inflow volumes for the June - Sept. period.

Criteria level	Specification	Inflow Criteria Attainment
MA2-Aprime	Attainment MA2-Aprime	at least 2% of years

6.1.7. Attainment Goals for Estuarine Inflow Recommendations

"Compliance … is expected to be evaluated with modeling approaches."

WAM should :

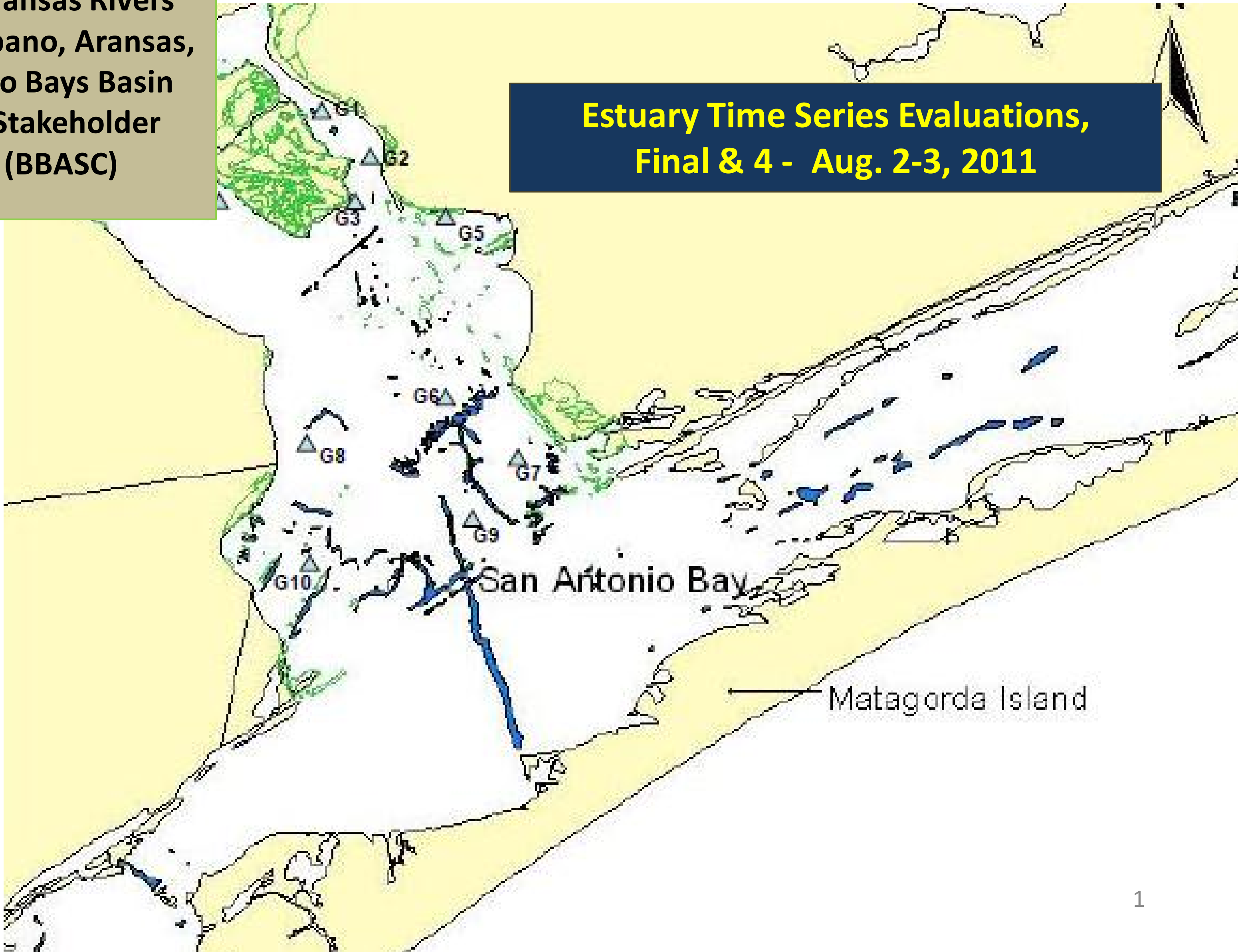
1) predict comprehensive total inflow quantities to the estuarine systems, including contributions from ungaged coastal drainages and corrections for diversions and return flows below the most downstream gaging stations; and

2) use a long-term period of record (65+ years) with an underlying variable climate and hydrological regime similar to, or the same as, that used in the derivation of the GSA BBEST recommendations.

Meeting of the

Guadalupe, San Antonio, Mission, and Aransas Rivers and Mission, Copano, Aransas, and San Antonio Bays Basin and Bay Area Stakeholder Committee (BBASC)

Estuary Time Series Evaluations, Final & 4 - Aug. 2-3, 2011



Summary of Guadalupe Estuary G2 recommended inflow volumes for the June - Sept. period.

Criteria level	Inflow Volumes (1000 ac-ft)	
	June	July-Sept.
G2-Aprime	n/a	450-800
G2-A	n/a	275-450
G2-B	n/a	170-275
G2-C	≥40	75-170
G2-CC	0 - 40	75-170
G2-D	n/a	50-75
G2-DD	n/a	0-50

Summary of Guadalupe Estuary G2 attainment goals for the above recommended inflow volumes for the June - Sept. period.

Criteria level	Specification	Inflow Criteria Attainment
G2-Aprime	Attainment, G2-Aprime	at least 12% of years
G2-A	Attainment, G2-A	at least 17 % of years
G2-A & G2-B	Attainment, G2-A & G2-B combined	G2-A and G2-B combined at least 30% of years
G2-C & G2-CC	Attainment, G2-C & G2-CC combined[1]	G2-C and G2-CC can be equal to or greater than 10% of years. G2-CC no more than 1/6 of total
G2-DD	Attainment, G2-DD	G2-DD no more than 6% of years
G2-D &G 2-DD	Attainment, G2-D & G2-DD combined	G2-D and G2-DD combined no more than 9% of years

Criteria G1 for rangia - summarize the attainment across various scenarios

no years in record (1941-89)= 49

Counts	Criteria G1 Attainment (no. years)								Firm Yield
Scenario	>A-pr	A-pr	A	B	C	CC	D	sum	(ac-ft/yr)
Natural	9	15	7	6	3	6	3	49	
Historical	9	14	7	4	5	5	5	49	n/a
Present	8	14	4	5	5	5	8	49	n/a
Region L Baseline; BBASC	7	10	8	3	3	4	14	49	n/a
Guadalupe Mid-Basin Project, Dv=500cfs									
1: 105k V, No envl. flows	7	9	9	1	5	4	14	49	28,750
2: 105k V, BBEST Full Instream (IF) Recomms.	7	10	8	2	4	4	14	49	13,150
3: 105k V, Consensus CEFN	7	9	9	1	5	4	14	49	15,375
4: 105k V, Lyons Criteria	7	9	9	2	4	4	14	49	20,674
5: 105k V, BBEST IF & No Dv <Base	7	10	8	2	4	4	14	49	12,375
6: 105k V, BBEST IF & Con. 1- 10% div rule	7	9	9	2	4	4	14	49	15,175
7: 105k V, BBEST IF & Con. 1- 20% div rule	7	9	9	2	4	4	14	49	15,825
8: 105k V, BBEST IF & Con. 1- 30% div rule	7	9	9	2	4	4	14	49	15,950
9: 105k V, TCEQ one Base & Pulse Struc.	7	10	8	1	5	4	14	49	25,550
10: 105k V, Prelim BBASC Gonzales IF Recomm.	7	9	9	2	4	4	14	49	15,975
11: 192k V, BBEST Full Instream (IF) Recomms.	7	10	8	2	4	4	14	49	20,674
12: 192k V, Prelim BBASC Gonzales IF Recomm.	7	9	9	1	5	4	14	49	23,450
San Antonio Rv. Project, Dv=800cfs									
A: 150k V, No Envl. Flows	7	9	9	1	5	4	14	49	22,925
B: 150k V, BBEST Full Instream (IF) Recomms.	7	9	9	1	5	4	14	49	11,700
C: 150k V, Consensus CEFN	7	9	9	1	5	4	14	49	16,700
D: 150k V, Lyons Criteria	7	9	9	2	4	4	14	49	13,000
E: 150k V, BBEST IF & No Dv <Base	7	9	9	1	5	4	14	49	11,160
F: 150k V, TIFP (SB2) original: 80cfs subs., no 50%	7	9	9	2	4	4	14	49	
G: 150k V, TIFP (SB2) rvsd.: 60cfs subs., 50% rl, Con.1	7	9	9	2	4	4	14	49	14,475
H: 150k V, TCEQ Struc.	7	9	9	1	5	4	14	49	17,300
TCEQ Baseline; (Run 3)	7	10	8	1	5	3	15	49	n/a

Criteria G1 for rangia - summarize the attainment across various scenarios

goals - see Tables 4.5-3 & 4.5-6		>12%	>12%				<=9%
Attain. - Singles	Single G1 criteria attainment (% of yrs.)						
Scenario	>A-pr	A-pr	A	B	C	CC	D
Natural		30.6%	14.3%	12.2%	6.1%	12.2%	6.1%
Historical		28.6%	14.3%	8.2%	10.2%	10.2%	10.2%
Present		28.6%	8.2%	10.2%	10.2%	10.2%	16.3%
Region L Baseline; BBASC		20.4%	16.3%	6.1%	6.1%	8.2%	28.6%
Guadalupe Mid-Basin Project, Dv=500cfs							
1: 105k V, No envl. flows		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
2: 105k V, BBEST Full Instream (IF) Recomms.		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
3: 105k V, Consensus CEFN		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
4: 105k V, Lyons Criteria		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
5: 105k V, BBEST IF & No Dv <Base		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
6: 105k V, BBEST IF & Con. 1- 10% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
7: 105k V, BBEST IF & Con. 1- 20% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
8: 105k V, BBEST IF & Con. 1- 30% div rule		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
9: 105k V, TCEQ one Base & Pulse Struc.		20.4%	16.3%	2.0%	10.2%	8.2%	28.6%
10: 105k V, Prelim BBASC Gonzales IF Recomm.		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
11: 192k V, BBEST Full Instream (IF) Recomms.		20.4%	16.3%	4.1%	8.2%	8.2%	28.6%
12: 192k V, Prelim BBASC Gonzales IF Recomm.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
San Antonio Rv. Project, Dv=800cfs							
A: 150k V, No Envl. Flows		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
B: 150k V, BBEST Full Instream (IF) Recomms.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
C: 150k V, Consensus CEFN		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
D: 150k V, Lyons Criteria		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
E: 150k V, BBEST IF & No Dv <Base		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
F: 150k V, TIFP (SB2) original: 80cfs subs., no 50%		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
G: 150k V, TIFP (SB2) rvsd.: 60cfs subs., 50% rl, Con.1		18.4%	18.4%	4.1%	8.2%	8.2%	28.6%
H: 150k V, TCEQ Struc.		18.4%	18.4%	2.0%	10.2%	8.2%	28.6%
TCEQ Baseline; (Run 3)		20.4%	16.3%	2.0%	10.2%	6.1%	30.6%

Criteria G1 for rangia - summarize the attainment across various scenarios

Attain. - Joints	Joint G1 criteria attainment (% of yrs. and fractions)						
goals - see Table 4.5-3			>17%		>=19%	<=2/3	
Scenario	>A-pr		A & B		C & CC	frac. CC	
Natural			26.5%		18.4%	66.7%	
Historical			22.4%		20.4%	50.0%	
Present			18.4%		20.4%	50.0%	
Region L Baseline; BBASC			22.4%		14.3%	57.1%	
Guadalupe Mid-Basin Project, Dv=500cfs							
1: 105k V, No envl. flows			20.4%		18.4%	44.4%	
2: 105k V, BBEST Full Instream (IF) Recomms.			20.4%		16.3%	50.0%	
3: 105k V, Consensus CEFN			20.4%		18.4%	44.4%	
4: 105k V, Lyons Criteria			22.4%		16.3%	50.0%	
5: 105k V, BBEST IF & No Dv <Base			20.4%		16.3%	50.0%	
6: 105k V, BBEST IF & Con. 1- 10% div rule			22.4%		16.3%	50.0%	
7: 105k V, BBEST IF & Con. 1- 20% div rule			22.4%		16.3%	50.0%	
8: 105k V, BBEST IF & Con. 1- 30% div rule			22.4%		16.3%	50.0%	
9: 105k V, TCEQ one Base & Pulse Struc.			18.4%		18.4%	44.4%	
10: 105k V, Prelim BBASC Gonzales IF Recomm.			22.4%		16.3%	50.0%	
11: 192k V, BBEST Full Instream (IF) Recomms.			20.4%		16.3%	50.0%	
12: 192k V, Prelim BBASC Gonzales IF Recomm.			20.4%		18.4%	44.4%	
San Antonio Rv. Project, Dv=800cfs							
A: 150k V, No Envl. Flows			20.4%		18.4%	44.4%	
B: 150k V, BBEST Full Instream (IF) Recomms.			20.4%		18.4%	44.4%	
C: 150k V, Consensus CEFN			20.4%		18.4%	44.4%	
D: 150k V, Lyons Criteria			22.4%		16.3%	50.0%	
E: 150k V, BBEST IF & No Dv <Base			20.4%		18.4%	44.4%	
F: 150k V, TIFP (SB2) original: 80cfs subs., no 50%			22.4%		16.3%	50.0%	
G: 150k V, TIFP (SB2) rvsd.: 60cfs subs., 50% rl, Con.1			22.4%		16.3%	50.0%	
H: 150k V, TCEQ Struc.			20.4%		18.4%	44.4%	
TCEQ Baseline; (Run 3)			18.4%		16.3%	37.5%	

Criteria G2 for oysters - summarize the attainment across various scenarios

Counts	Criteria G2 Attainment (no. years)									Firm Yield
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD	sum	(ac-ft/yr)
Natural	9	11	15	7	3	2	2	0	49	
Historical	8	11	11	8	5	1	1	4	49	n/a
Present	5	11	8	10	8	1	1	5	49	n/a
Region L Baseline; BBASC	4	8	8	8	7	3	3	8	49	n/a
Guadalupe Mid-Basin Project, Dv=500cfs										
1: 105k V, No envl. flows	4	8	8	8	6	4	2	9	49	28,750
2: 105k V, BBEST Full Instream (IF) Recomms.	4	8	8	8	7	3	3	8	49	13,150
3: 105k V, Consensus CEFN	4	8	8	8	7	3	3	8	49	15,375
4: 105k V, Lyons Criteria	4	8	8	8	7	3	3	8	49	20,674
5: 105k V, BBEST IF & No Dv <Base	4	8	8	8	7	3	3	8	49	12,375
6: 105k V, BBEST IF & Con. 1- 10% div rule	4	8	8	8	7	3	3	8	49	15,175
7: 105k V, BBEST IF & Con. 1- 20% div rule	4	8	8	8	7	3	3	8	49	15,825
8: 105k V, BBEST IF & Con. 1- 30% div rule	4	8	8	8	7	3	3	8	49	15,950
9: 105k V, TCEQ one Base & Pulse Struc.	4	8	8	8	6	4	2	9	49	25,550
10: 105k V, Prelim BBASC Gonzales IF Recomm.	4	8	8	8	7	3	3	8	49	15,975
11: 192k V, BBEST Full Instream (IF) Recomms.	4	8	8	8	7	3	3	8	49	20,674
12: 192k V, Prelim BBASC Gonzales IF Recomm.	4	8	8	8	7	3	3	8	49	23,450
San Antonio Rv. Project, Dv=800cfs										
A: 150k V, No Envl. Flows	4	7	9	7	7	4	2	9	49	22,925
B: 150k V, BBEST Full Instream (IF) Recomms.	4	8	8	8	7	3	3	8	49	11,700
C: 150k V, Consensus CEFN	4	8	8	8	6	4	2	9	49	16,700
D: 150k V, Lyons Criteria	4	8	8	8	7	3	3	8	49	13,000
E: 150k V, BBEST IF & No Dv <Base	4	8	8	8	7	3	3	8	49	11,160
F: 150k V, TIFP (SB2) original: 80cfs subs., no 50%	4	8	8	6	8	4	3	8	49	
G: 150k V, TIFP (SB2) rvsd.: 60cfs subs., 50% rl, Con.1	4	8	8	6	8	4	3	8	49	14,475
H: 150k V, TCEQ Struc.	4	8	8	7	7	4	3	8	49	17,300
TCEQ Baseline; (Run 3)	4	6	9	8	6	4	3	9	49	n/a

Criteria G2 for oysters - summarize the attainment across various scenarios

goals - see Tables 4.5-2; 4.5-4		>12%	>17%					<=6%
Attain. - Singles	Single G2 criteria attainment (% of yrs.)							
Scenario	>A-pr	A-pr	A	B	C	CC	D	DD
Natural		22.4%	30.6%	14.3%	6.1%	4.1%	4.1%	0.0%
Historical		22.4%	22.4%	16.3%	10.2%	2.0%	2.0%	8.2%
Present		22.4%	16.3%	20.4%	16.3%	2.0%	2.0%	10.2%
Region L Baseline; BBASC		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
Guadalupe Mid-Basin Project, Dv=500cfs								
1: 105k V, No envl. flows		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
2: 105k V, BBEST Full Instream (IF) Recomms.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
3: 105k V, Consensus CEFN		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
4: 105k V, Lyons Criteria		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
5: 105k V, BBEST IF & No Dv <Base		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
6: 105k V, BBEST IF & Con. 1- 10% div rule		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
7: 105k V, BBEST IF & Con. 1- 20% div rule		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
8: 105k V, BBEST IF & Con. 1- 30% div rule		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
9: 105k V, TCEQ one Base & Pulse Struc.		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
10: 105k V, Prelim BBASC Gonzales IF Recomm.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
11: 192k V, BBEST Full Instream (IF) Recomms.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
12: 192k V, Prelim BBASC Gonzales IF Recomm.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
San Antonio Rv. Project, Dv=800cfs								
A: 150k V, No Envl. Flows		14.3%	18.4%	14.3%	14.3%	8.2%	4.1%	18.4%
B: 150k V, BBEST Full Instream (IF) Recomms.		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
C: 150k V, Consensus CEFN		16.3%	16.3%	16.3%	12.2%	8.2%	4.1%	18.4%
D: 150k V, Lyons Criteria		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
E: 150k V, BBEST IF & No Dv <Base		16.3%	16.3%	16.3%	14.3%	6.1%	6.1%	16.3%
F: 150k V, TIFP (SB2) original: 80cfs subs., no 50%		16.3%	16.3%	12.2%	16.3%	8.2%	6.1%	16.3%
G: 150k V, TIFP (SB2) rvsd.: 60cfs subs., 50% rl, Con.1		16.3%	16.3%	12.2%	16.3%	8.2%	6.1%	16.3%
H: 150k V, TCEQ Struc.		16.3%	16.3%	14.3%	14.3%	8.2%	6.1%	16.3%
TCEQ Baseline; (Run 3)		12.2%	18.4%	16.3%	12.2%	8.2%	6.1%	18.4%

Criteria G2 for oysters - summarize the attainment across various scenarios

goals - see Table 4.5-2			>=30%		>10%	<=1/6	<=9%
Attain. - Joints	Joint G2 criteria attainment (% of yrs. and fractions)						
Scenario	>A-pr		A & B		C & CC	frac. CC	D & DD
Natural			44.9%		10.2%	40.0%	4.1%
Historical			38.8%		12.2%	16.7%	10.2%
Present			36.7%		18.4%	11.1%	12.2%
Region L Baseline; BBASC			32.7%		20.4%	30.0%	22.4%
Guadalupe Mid-Basin Project, Dv=500cfs							
1: 105k V, No envl. flows			32.7%		20.4%	40.0%	22.4%
2: 105k V, BBEST Full Instream (IF) Recomms.			32.7%		20.4%	30.0%	22.4%
3: 105k V, Consensus CEFN			32.7%		20.4%	30.0%	22.4%
4: 105k V, Lyons Criteria			32.7%		20.4%	30.0%	22.4%
5: 105k V, BBEST IF & No Dv <Base			32.7%		20.4%	30.0%	22.4%
6: 105k V, BBEST IF & Con. 1- 10% div rule			32.7%		20.4%	30.0%	22.4%
7: 105k V, BBEST IF & Con. 1- 20% div rule			32.7%		20.4%	30.0%	22.4%
8: 105k V, BBEST IF & Con. 1- 30% div rule			32.7%		20.4%	30.0%	22.4%
9: 105k V, TCEQ one Base & Pulse Struc.			32.7%		20.4%	40.0%	22.4%
10: 105k V, Prelim BBASC Gonzales IF Recomm.			32.7%		20.4%	30.0%	22.4%
11: 192k V, BBEST Full Instream (IF) Recomms.			32.7%		20.4%	30.0%	22.4%
12: 192k V, Prelim BBASC Gonzales IF Recomm.			32.7%		20.4%	30.0%	22.4%
San Antonio Rv. Project, Dv=800cfs							
A: 150k V, No Envl. Flows			32.7%		22.4%	36.4%	22.4%
B: 150k V, BBEST Full Instream (IF) Recomms.			32.7%		20.4%	30.0%	22.4%
C: 150k V, Consensus CEFN			32.7%		20.4%	40.0%	22.4%
D: 150k V, Lyons Criteria			32.7%		20.4%	30.0%	22.4%
E: 150k V, BBEST IF & No Dv <Base			32.7%		20.4%	30.0%	22.4%
F: 150k V, TIFP (SB2) original: 80cfs subs., no 50%			28.6%		24.5%	33.3%	22.4%
G: 150k V, TIFP (SB2) rvsd.: 60cfs subs., 50% rl, Con.1			28.6%		24.5%	33.3%	22.4%
H: 150k V, TCEQ Struc.			30.6%		22.4%	36.4%	22.4%
TCEQ Baseline; (Run 3)			34.7%		20.4%	40.0%	24.5%


Proposal for
Guadalupe Estuary
Inflow Standards
Seadrift
Calhoun
San Antonio Bay
© 2011 Europa Technologies
© 2011 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
5.73 mi
Matagorda Isla


BAY
ANIMAL
HOSPITAL

KEEP IT SIMPLE SIERRAclub

<---Proposal--->

- Allow some additional water supply development
- Need for pursuing strategies to attempt to attain BBEST recommendations for estuary

BBEST CRITERIA

Table X-2. Summary of Guadalupe Estuary attainment goals for the recommended inflow volumes for the Feb. -May period

Criteria level	Frequency of Attainment Requirements[1]	
	A) Strategies Target [BBEST Recommendations]	B) New Permits Permitting Requirement [TCEQ Run3]
G1-Aprime	at least 12% of years	at least 12% of years
G1-A	at least 12 % of years	at least 12 % of years
G1-A & G1-B combined	at least 17% of years	at least 17% of years
G1-C & G1-CC combined	G1-CC no more than 2/3 of total	G1-CC no more than 2/3 of total
G1-D	no more than 9% of years	no more than 31% of years

Table X-1. Summary of Guadalupe Es period.

Criteria level	Inflow Volumes[1] (1000 ac-ft)	
	Feb.	Mar.-May
G1-Aprime,	n/a	550-925
G1-A	n/a	375-550
G1-B	n/a	275-375
G1-C	≥75	150-275
G1-CC	0 - 75	150-275
G1-D	n/a	0 - 150

Notes: 1) volume is the monthly amount for February as applicable or the total three-month amount for the March-May period.

Table Y-2. Summary of Guadalupe Estuary attainment goals for the recommended inflow volumes for the June-Sept. period.

Criteria level	Frequency of Attainment Requirements[1]	
	A) Strategies Target [BBEST Recommendations]	B) New Permits Permitting Requirement [TCEQ Run3]
G2-Aprime	at least 12% of years	at least 12% of years
G2-A	at least 17 % of years	at least 17 % of years
G2-A & G2-B	at least 30% of years	at least 30% of years
G2-C & G2-CC combined	G2-CC no more than 17% of total	G2-CC no more than 40% total
G2-DD	no more than 6% of years	no more than 18% of yea
G2-D &G 2-DD combined	no more than 9% of years	no more than 25% of yea

Table Y-1. Summary of Guadalupe Estuary
period.

Criteria level	Inflow Volumes[1] (1000 ac-ft)	
	June	July-Sept.
G2-Aprime	n/a	450-800
G2-A	n/a	275-450
G2-B	n/a	170-275
G2-C	≥40	75-170
G2-CC	0 - 40	75-170
G2-D	n/a	50-75
G2-DD	n/a	0-50

Notes: 1) volume is the monthly amount for June as applicable or the total three-month amount for the July-September period.

We are Here

Initial Concept Paper

- Presented to Estuary Workgroup August 9th
- Discussion of Concept Overview
- Received Comments
- Reworked Concepts and Comments to include all suggestions

The Simple Basics

- TCEQ runs modeling exercise utilizing WAM Run 3 (full utilization of water rights/no return flows)
- Proposed project can not make BBEST criteria worse than already modeled in Column B

Criteria level	Frequency of Attainment Requirements[1]	
	A) Strategies Target [BBEST Recommendations]	B) New Permits Permitting Requirement [TCEQ Run3]
G2-Aprime	at least 12% of years	at least 12% of years
G2-A	at least 17 % of years	at least 17 % of years
G2-A & G2-B	at least 30% of years	at least 30% of years
G2-C & G2-CC combined	G2-CC no more than 17% of total	G2-CC no more than 40% of total
G2-DD	no more than 6% of years	no more than 18% of years
G2-D &G 2-DD combined	no more than 9% of years	no more than 25% of years

Table Y-1. Summary of Guadalupe Estuary recommended inflow period.

Criteria level	Inflow Volumes[1] (1000 ac-ft)	
	June	July-Sept.
G2-Aprime	n/a	450-800
G2-A	n/a	275-450
G2-B	n/a	170-275
G2-C	≥40	75-170
G2-CC	0 - 40	75-170
G2-D	n/a	50-75
G2-DD	n/a	0-50

Notes: 1) volume is the monthly amount for

We are Here

The Simple Basics

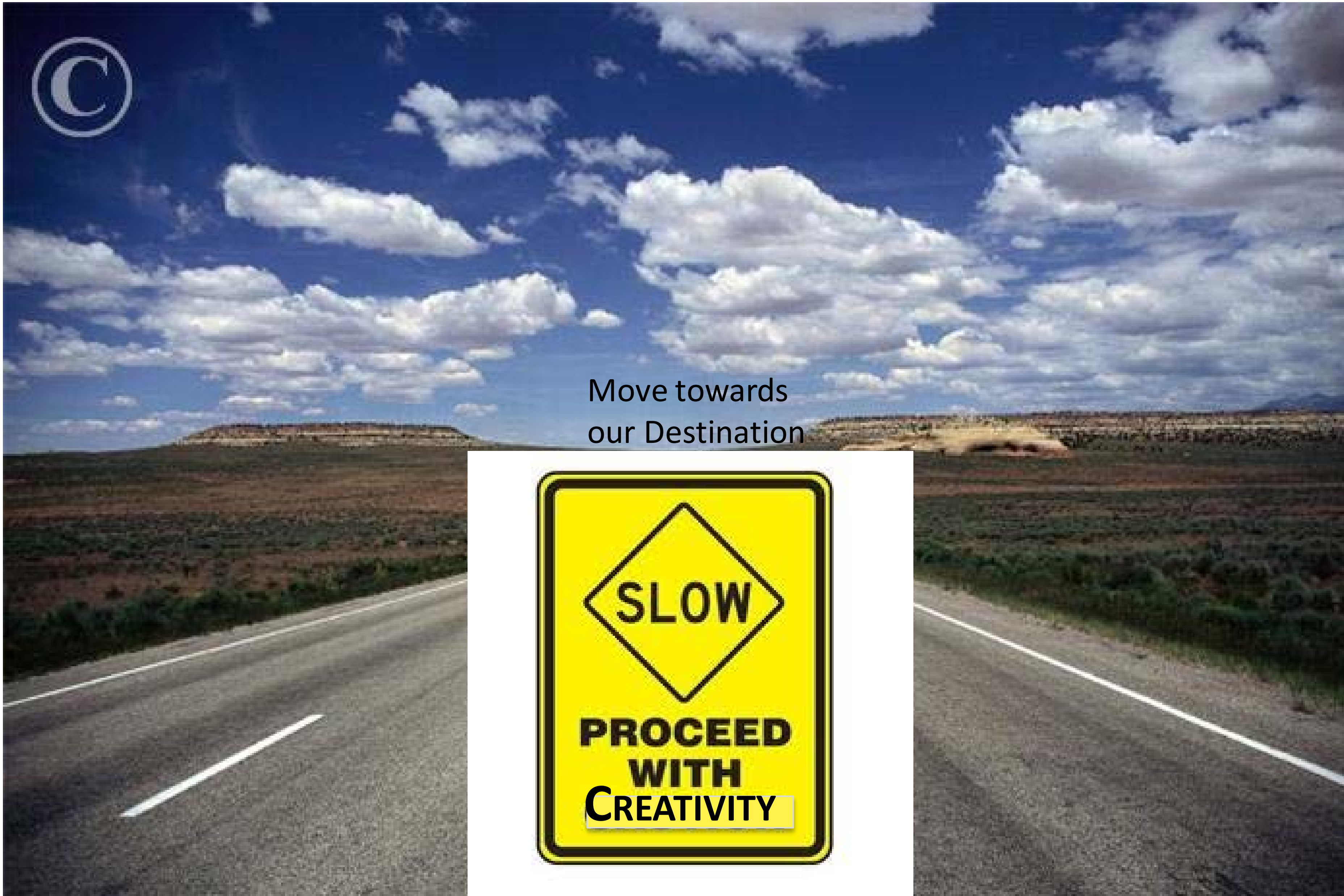
- New authorization moves towards improving the frequency of attainment from WAM Run 3 toward BBEST recommendation

Criteria level	Frequency of Attainment Requirements[1]	
	A) Strategies Target [BBEST Recommendations]	B) New Permits Permitting Requirement [TCEQ Run3]
G2-Aprime	at least 12% of years	at least 12% of years
G2-A	at least 17 % of years	at least 17 % of years
G2-A & G2-B	at least 30% of years	at least 30% of years
G2-C & G2-CC combined	G2-CC no more than 17% of total	G2-CC no more than 40% of total
G2-DD	no more than 6% of years	no more than 18% of years
G2-D &G 2-DD combined	no more than 9% of years	no more than 25% of years

Table Y-1. Summary of Guadalupe Estuary recommended inflow volun period.

Criteria level	Inflow Volumes[1] (1000 ac-ft)	
	June	July-Sept.
G2-Aprime	n/a	450-800
G2-A	n/a	275-450
G2-B	n/a	170-275
G2-C	≥40	75-170
G2-CC	0 - 40	75-170
G2-D	n/a	50-75
G2-DD	n/a	0-50

Notes: 1) volume is the monthly amount for June as applicable or the total three-month amount for the July-September period.


Move towards
our Destination
SLOW
PROCEED
WITH
CREATIVITY

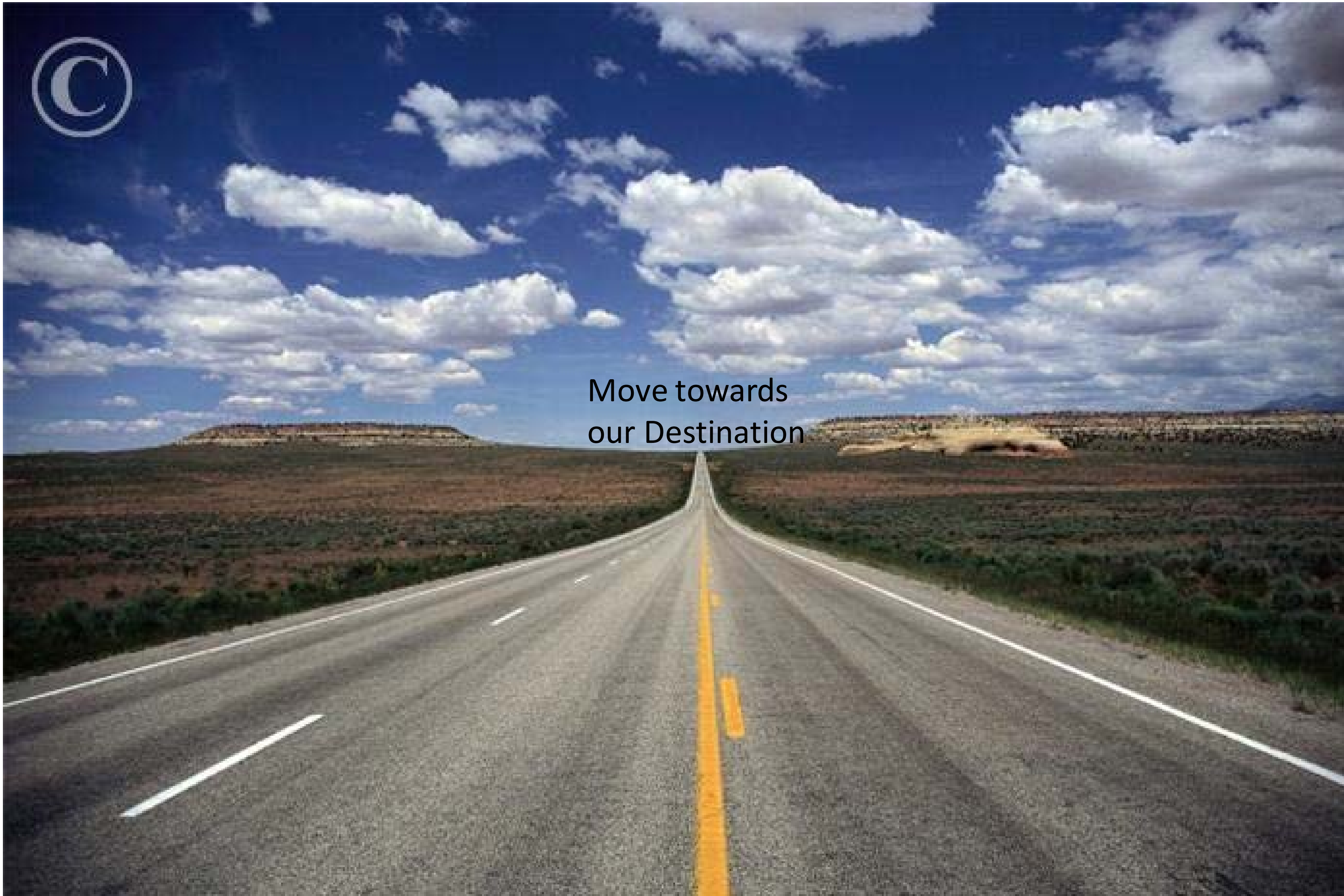
We are Here

The Exceptions

- B&E criteria only apply to diversions ≥ 1,000 ac-ft diversion or to ≥ 10,000 ac-ft storage
- Permit applicant only required to dedicate volume of water specified in 10% dedication
- Water developed through strategies is considered equivalent to this dedication
- Only consider 10% of available amount for permits without firm yield
- Applicant not penalized for channel losses

How is this done?

- Creation of an Consensus-based Advisory Committee w/ balanced representation
- Similar to Nueces Estuary Advisory Council
  - Make recommendations to guide the actions of the permit applicant to ensure the use of dedicated water is utilized during periods of greatest environmental benefit, as indicated by the attainment levels of the BBEST criteria



We were Here


Move towards
our Destination
We Can
Be Here