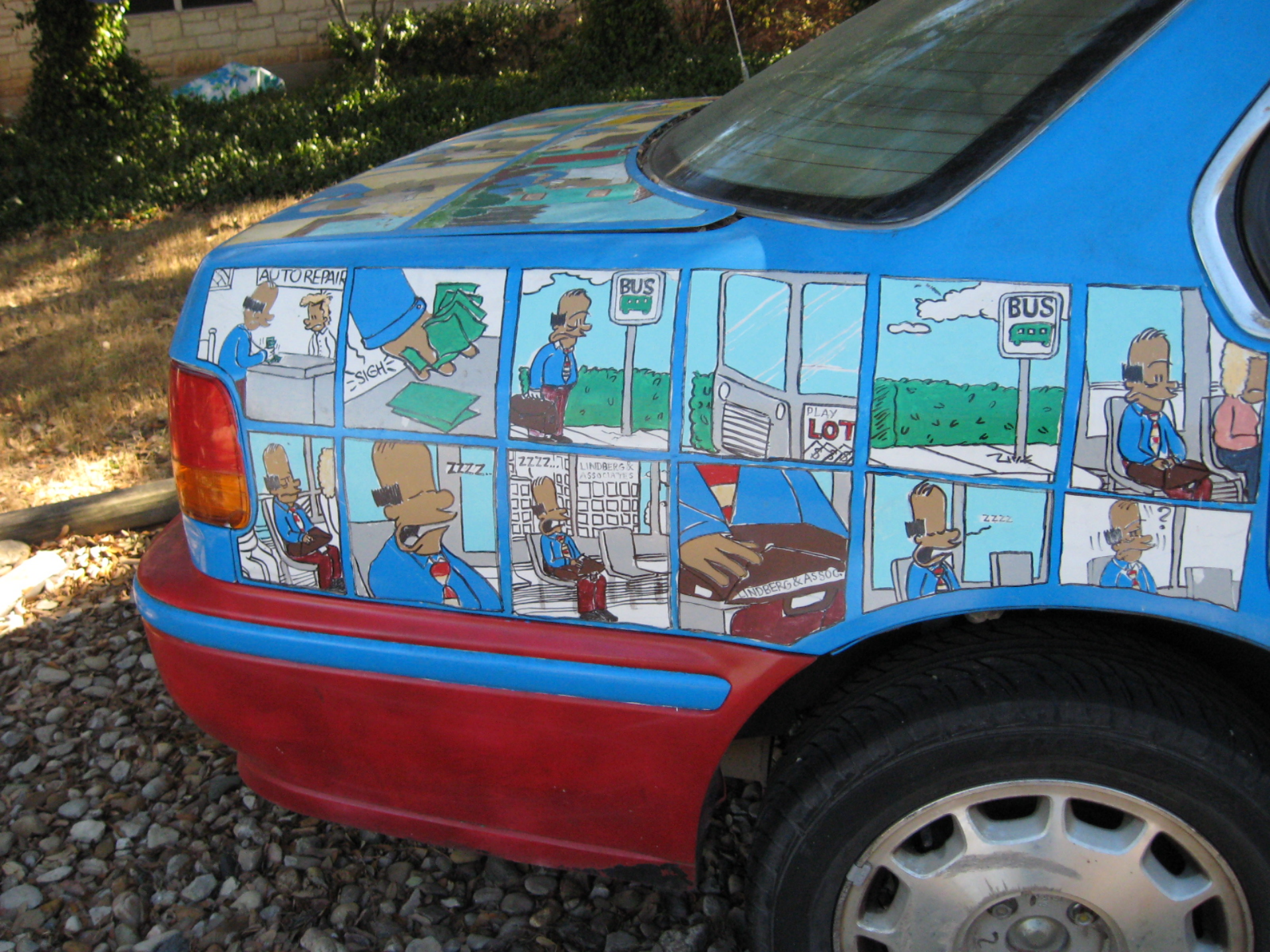
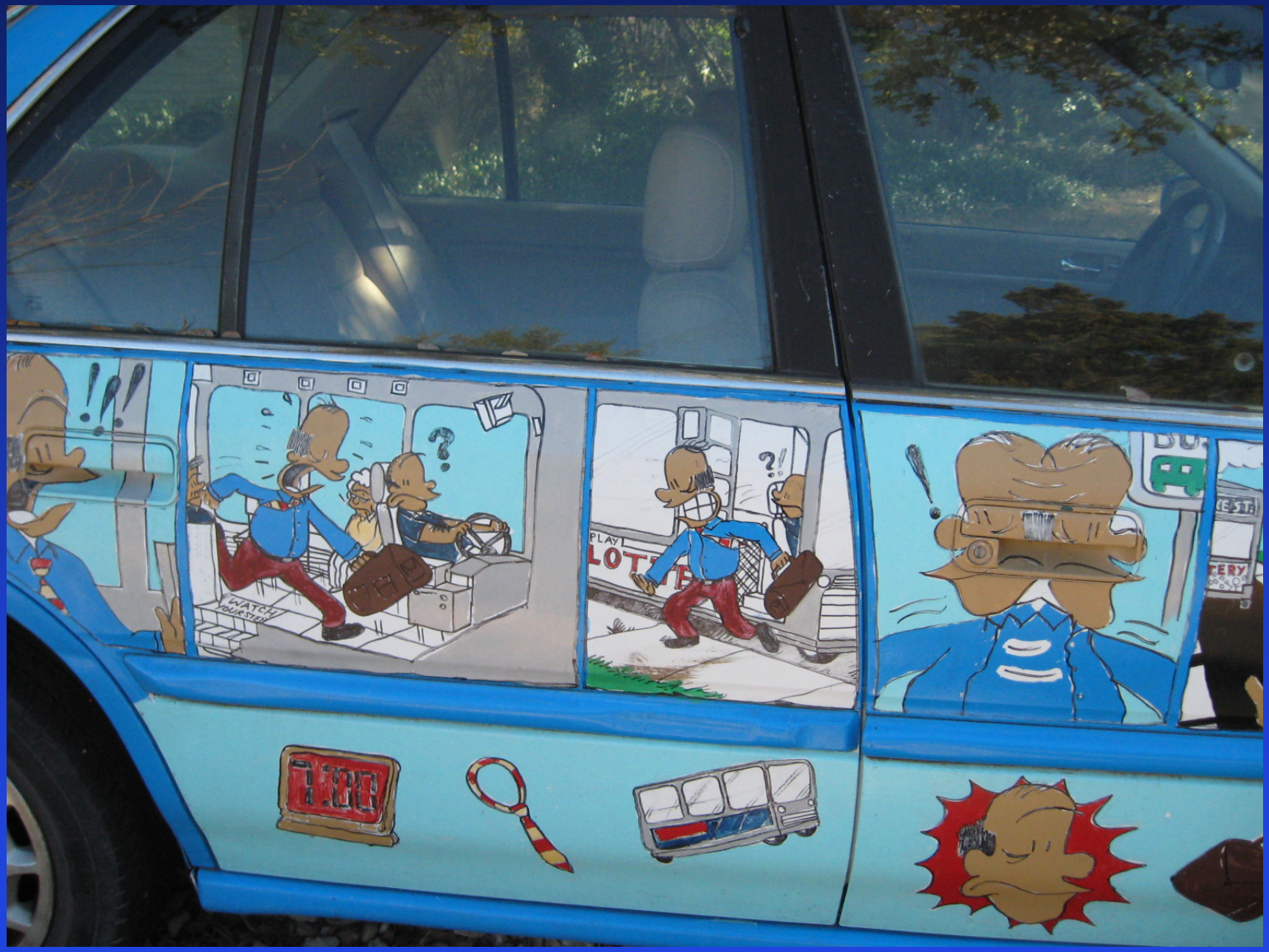
BRZZZZ
CLICK K-K-
CLICK
CLICK-
K-K-C-K
CLICK K-K-
CLICK


AUTO REPAIR
SIGH
BUS
PLAY
LOT
BUS
ZZZZ..
ZZZZ...
LINDBERG & ASSOCIATES
LINDBERG & ASSOC.
ZZZZ
?


WATCH YOUR STEP
PLAY

HOT DOGS $1
NO LOITERING
NO LOITERING
KWIK STOP

Freshwater Inflows

“ At any point in time, the scientific answer to a practical question, such as the determination of flows necessary to sustain an aquatic ecosystem, is provisional and approximate.

This does not mean that the answer is useless.”

SAC Report

David Buzan, PBS&J

January 15, 2009,
Galveston Bay/Trinity River Bay/Basin Expert Science Team

TAMU-Galveston

TEXAS WATER DEVELOPMENT BOARD

REPORT 43

A NEW CONCEPT--

WATER FOR PRESERVATION

OF BAYS AND ESTUARIES

Prepared by
Lockwood, Andrews and Newnam, Inc.
for the
Texas Water Development Board

April 1967

"Tentative…studies…indicate …Galveston Bay will have no specific freshwater needs during average annual and wetter years."

<u>5 million ac-ft</u>

"…low average climatic conditions are optimum…."

<u>3.2 million ac-ft</u>

TRINITY-SAN JACINTO ESTUARY:

A Study of the Influence of Freshwater Inflows

"Fundamental … is the concept of seasonal dynamics; … environmental needs of an estuarine ecosystem are not static annual needs. … dynamic equilibrium about the productive range is both realistic and desirable …."

The preparation of this report was financed in part through funds made available by Senate Bill 137 of the 64th Texas Legislature.

Texas Department of Water Resources
LP-113

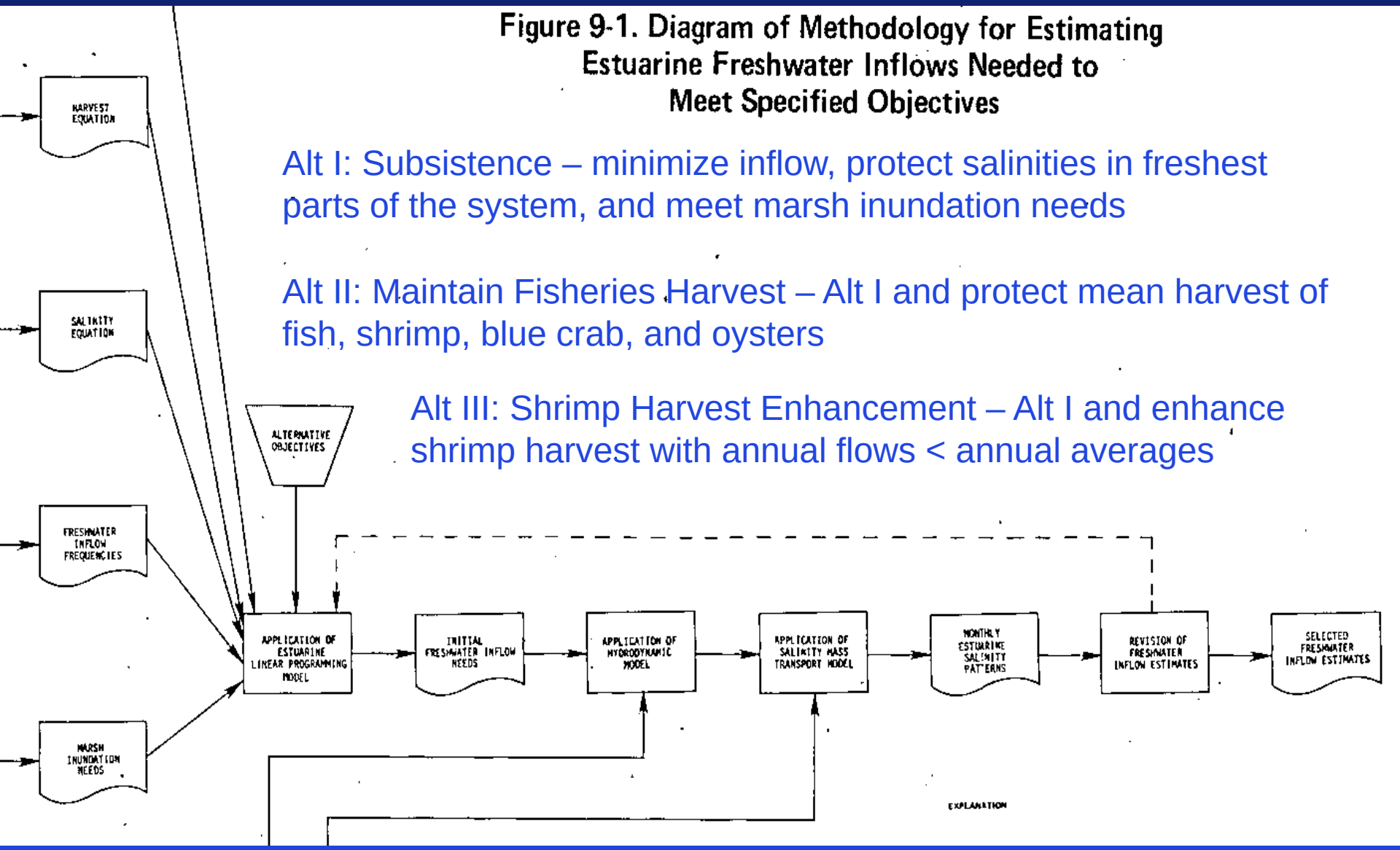
March 1981

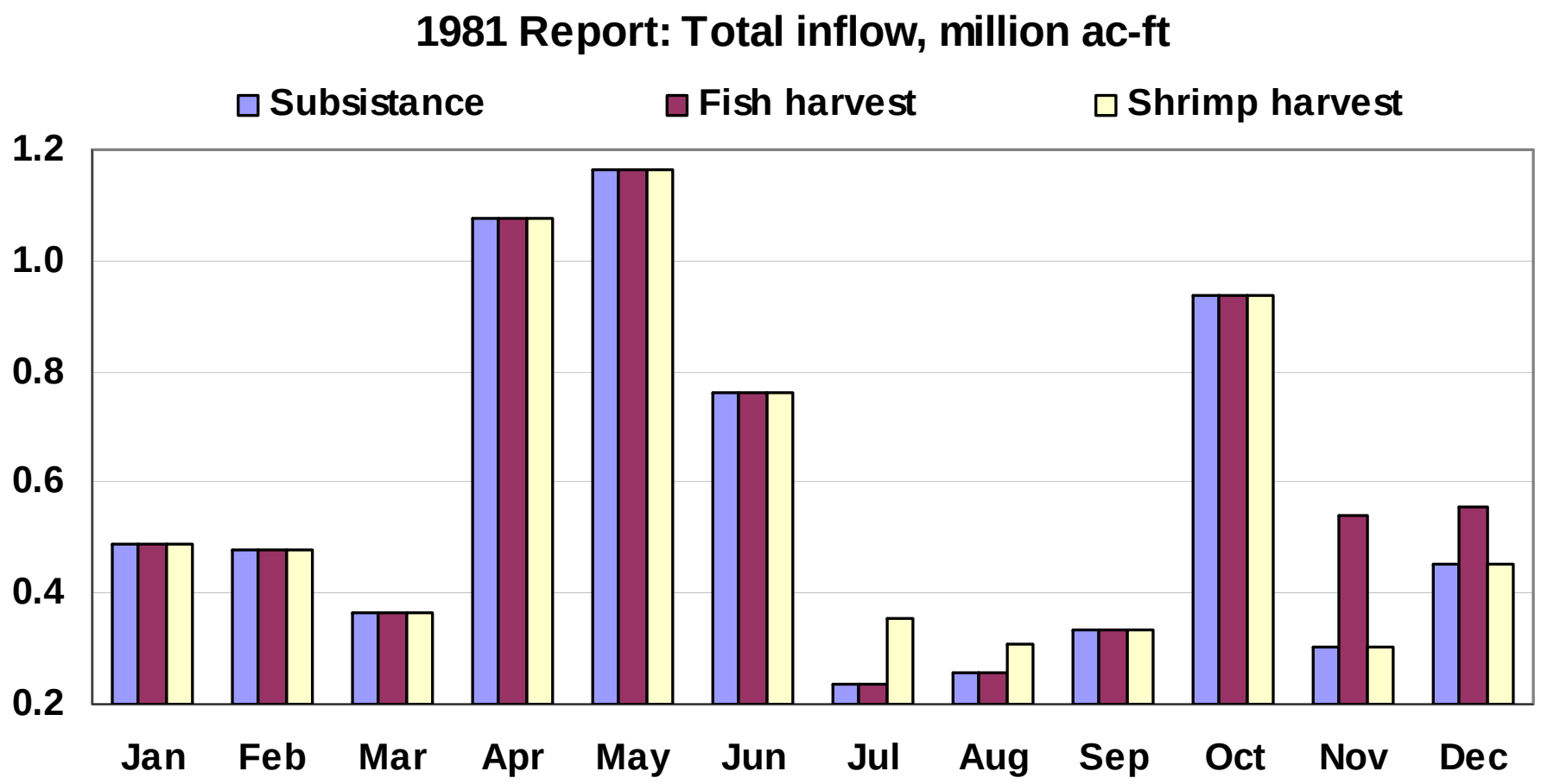
Figure 9-1. Diagram of Methodology for Estimating Estuarine Freshwater Inflows Needed to Meet Specified Objectives

Alt I: Subsistence – minimize inflow, protect salinities in freshest parts of the system, and meet marsh inundation needs

Alt II: Maintain Fisheries Harvest – Alt I and protect mean harvest of fish, shrimp, blue crab, and oysters

Alt III: Shrimp Harvest Enhancement – Alt I and enhance shrimp harvest with annual flows < annual averages




1981 Report: Total inflow, million ac-ft
Subsistance
Fish harvest
Shrimp harvest
1.2
1.0
0.8
0.6
0.4
0.2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

ESTURY: Habitat-based Estuary Ecological Model
(David Brock, TDWR, 1982)

Assume:

- Habitat quality - key to abundance
- Habitat change - easier to see than population change

Utilizes:

- Habitats, their distributions, hydrodynamic modeling, predicted inflows

TEXAS PARKS & WILDLIFE

Freshwater Inflow Recommendation for the Trinity-San Jacinto Estuary of Texas

By

Texas Parks and Wildlife Department
Coastal Studies Program
Resources Protection Division
Asutin, Texas 78744

Appendix

By

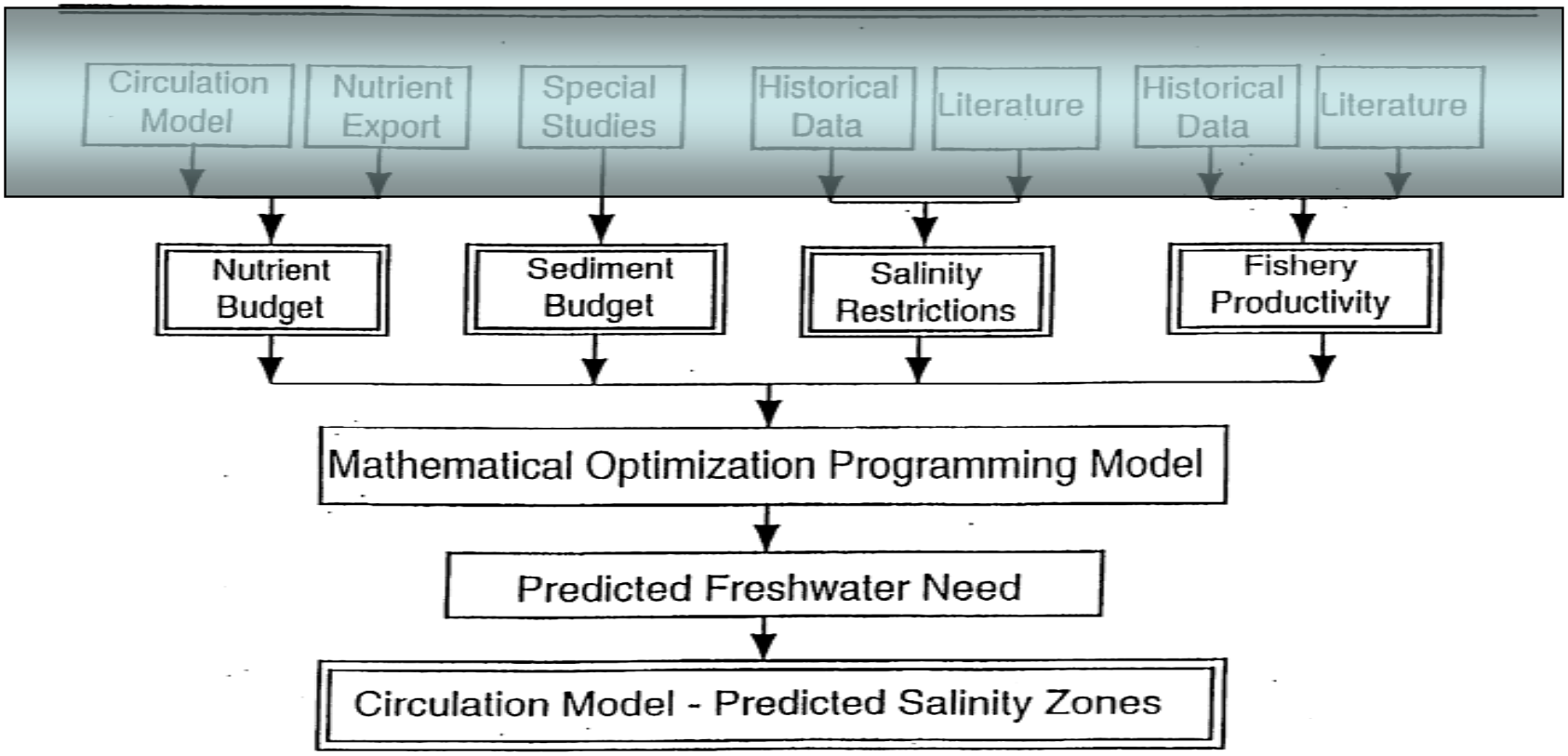
By Texas Water Development Board
Environmental Section
Austin, Texas 78711

February, 2001

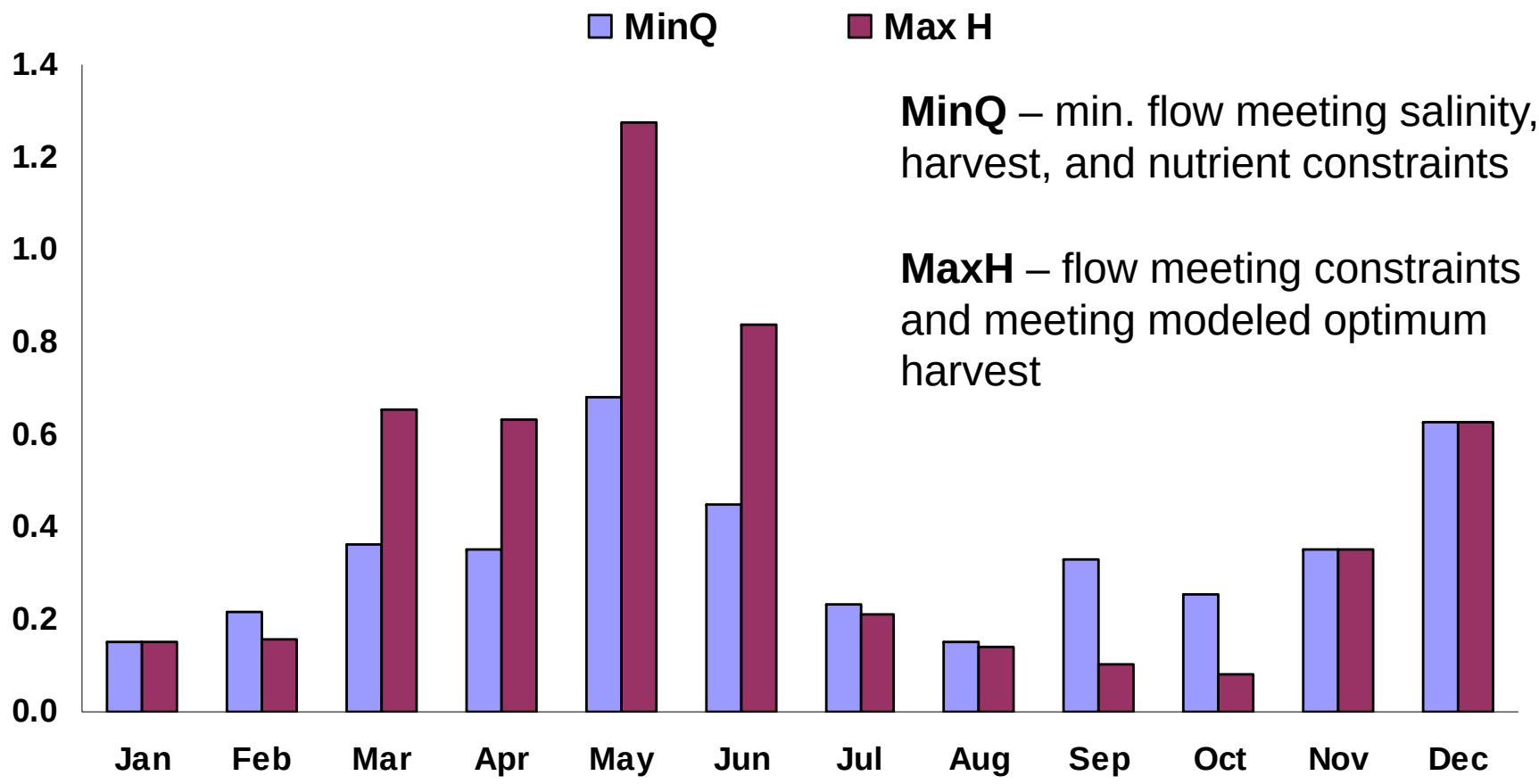
SPORT FISH & WILDLIFE RESTORATION

"Freshwater inflows …maintain … salinity gradients, nutrient loadings and sediment inputs…."

Figure 2.0A. Determining freshwater inflows for a healthy estuary.



2001 Report: Total inflow, million ac-ft



MinQ – min. flow meeting salinity, harvest, and nutrient constraints

MaxH – flow meeting constraints and meeting modeled optimum harvest

Region H Water Plan 2000 (based on Galveston Bay Freshwater Inflow Workgroup Recommendation)

Inflow, million ac-ft	Target, minimum frequency, % yrs	% Yrs above target
5.2	50	83
4.2	60	89
2.5	75	95
1.8	90	99

Bays in Peril
(National Wildlife Federation 2004)

Low-rainfall period

- 6 months during Mar-Oct
- 1.7 million ac-ft
- 95% of May-Oct flows (1941-2005) exceed 1.3 million ac-ft

Freshwater pulses in spring and early summer

- Mar-Jun
- 3.4 million ac-ft
- 66% of Mar-Jun flows (1941-2005) exceed 3.4 million ac-ft

Valued Ecosystem Component (VEC): (Footnote to the MFL Regulation)

VEC – has scientific importance to the ecosystem

Galveston Bay examples:

- Trinity River delta *Vallisneria* beds
- Hanna's Reef/oysters
- Christmas Bay seagrasses

Minimum Flow Levels (Florida)

MFL – "…at which further withdrawals would be significantly harmful to the water resources or ecology…."

Ex. MFL exceedance occurs when:

(a) 30-day ave salinity exceeds 20 psu at the upper Galveston Bay monitoring station

(b) One daily ave salinity exceeds 27 psu at the upper Galveston Bay monitoring station

An MFL violoation occurs when either (a) or (b) is exceeded for 2 consecutive yrs

The X_2 Factor (San Francisco Delta)

- Salinity at control point never exceeds a set value
- Salinity at down-estuary control points can only exceed the salinity value a certain number of days. Number of days is determined by rainfall and reservoir storage

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<u>Galveston Bay example:</u>

San Jacinto River salinity will never exceed 7 psu at bottom at IH 10.

San Jacinto River/HSC will not exceed 17 psu at bottom for more than 30 consecutive days during year of normal rainfall.

Calculating the Reserve (South Africa)

1. Set geographic bounds
2. Assess present state and reference condition for abiotic and biotic conditions
3. Assign present health score, A to F, and ecological importance
4. Assign Ecological Reserve Category, A to D
5. Model flows for reference, present, and future conditions (lowest flow that protects the estuary).

The Reserve Applied to Galveston Bay

1. Trinity and San Jacinto watersheds and Galveston Bay coastal watersheds
2. Fish species 50 yrs ago to present
3. Assign health score of C, moderately modified
4. Assign Ecological Reserve Category of B, highly important estuaries
5. Model flows

Flow Requirements from the Reserve Method

	Dec-Feb	Mar-May	Jun-Sep	Oct-Nov
90th percentile	6.1	8.0	5.2	1.8
50th percentile	1.3	7.2	1.7	0.4
10th percentile	.9	1.1	1.1	.1

Australian Method (page 1)

Preliminary evaluation

1. Define flow issue
2. Assess estuary value-commercial, recreational, etc.
3. Assess flow changes-withdrawals, groundwater additions, etc.
4. What will happen to VEC if flow is reduced

Australian Method (page 2)

Detailed evaluation

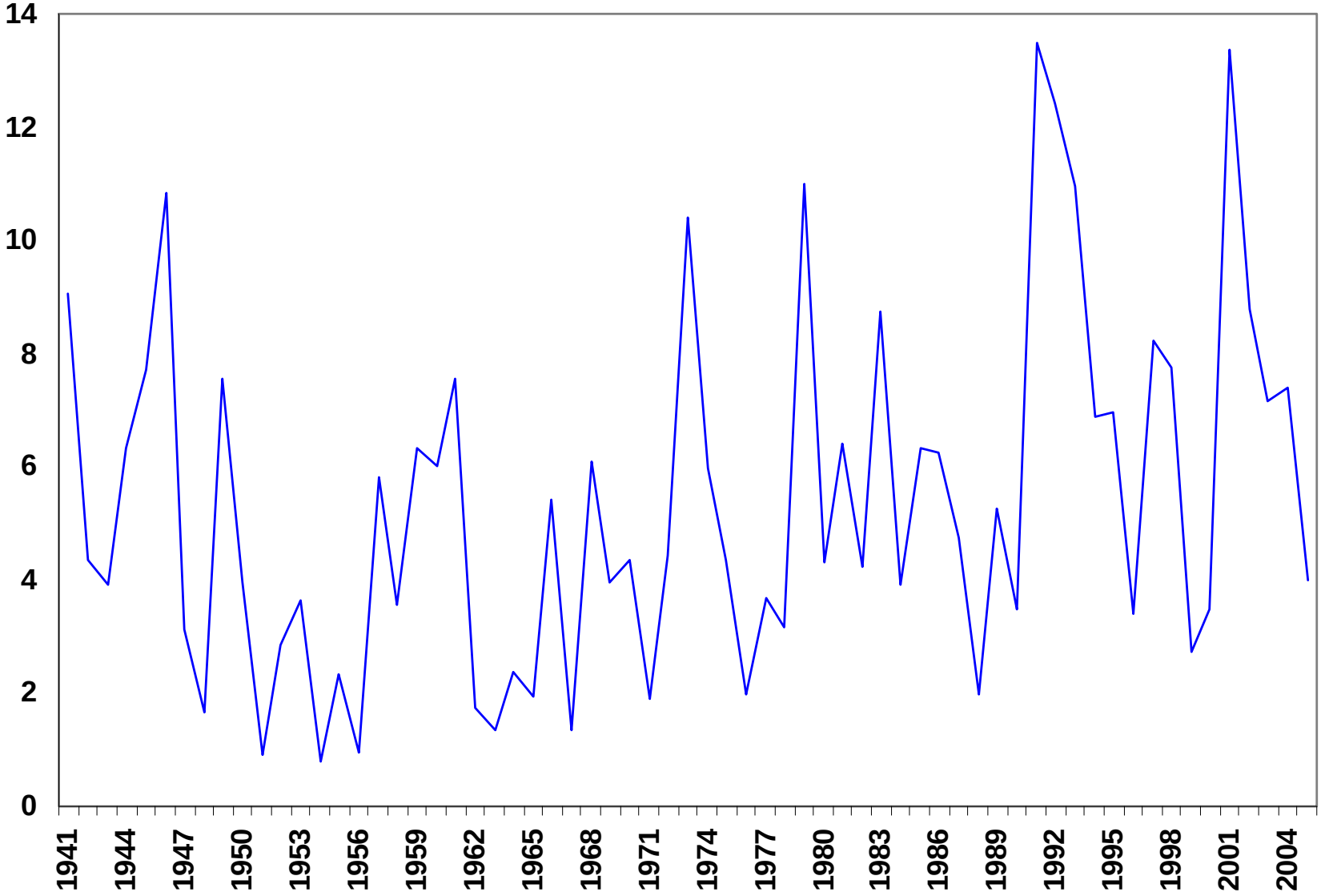
1. Establish models for flow, salinity, and circulation
2. Estimate future water use
3. Apply models to estimated future water use
4. Assess risk to biota

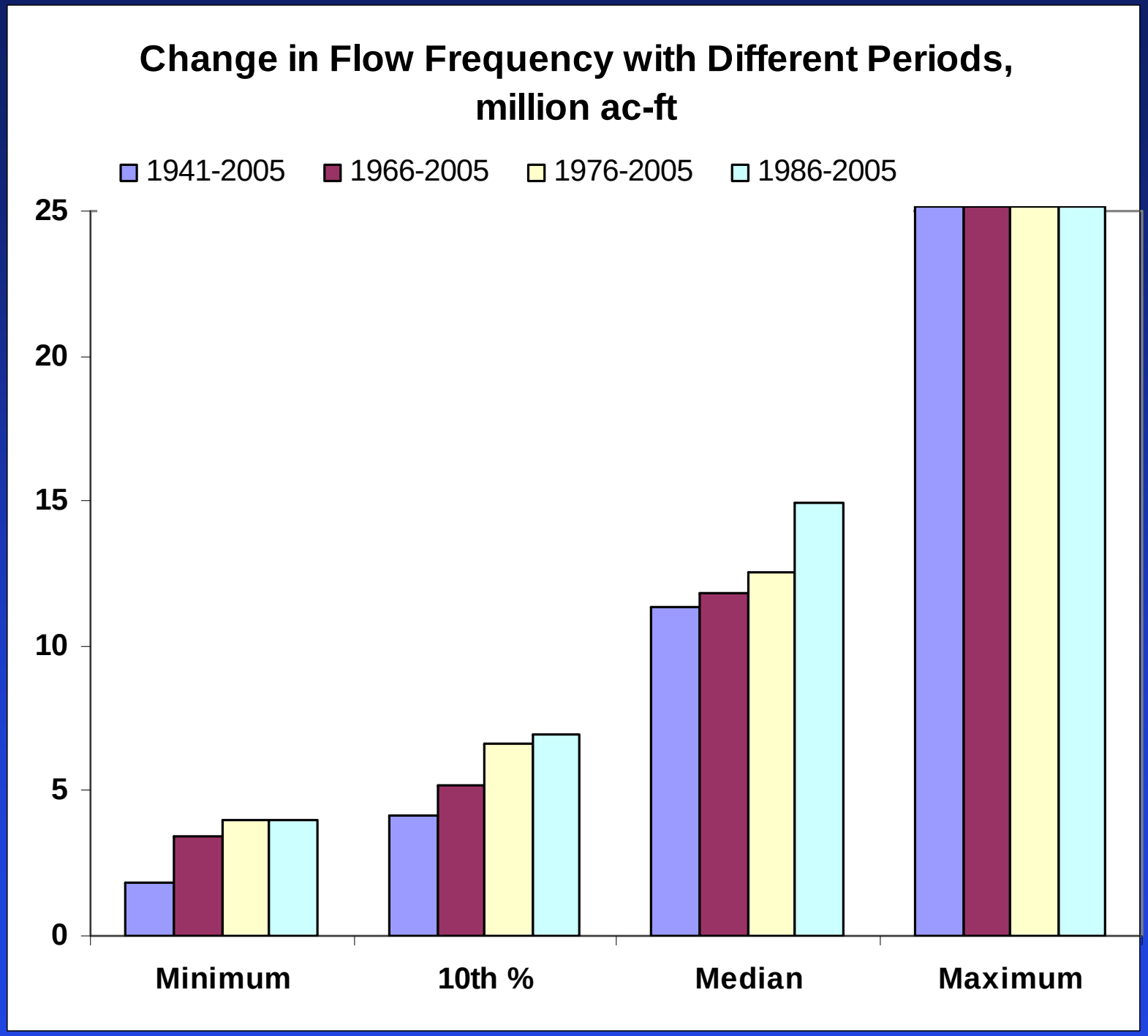
Matagorda Bay, LCRA-SAWS

- **Long-term Volume and Variability** –maintained with a specific coefficient ofvariation in flow over the long term. …based on maintaining nutrient loading … to achieve … historical level of primary productivity…. Used hydrodynamic modeling coupled with WASP nutrient modeling

- **MBHE Inflow Regime (4 levels)-** …a trophic level assessment…evaluates primary productivity, marsh productivity,…health of oyster reefs,…available habitat for juvenile shellfish and forage fish, and…benthic condition. Flows distributed over 3 seasons. Freshets evaluated.

- **Threshold** - … providing refuge conditions for oysters, shrimp, crab, and fish habitat within the Delta.


Difference between Total Annual Surface Inflow and Trinity at Romayor, million ac-ft
14
12
10
8
6
4
2
0
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004


Change in Flow Frequency with Different Periods, million ac-ft
1941-2005
1966-2005
1976-2005
1986-2005
25
20
15
10
5
0
Minimum
10th %
Median
Maximum

Additional thoughts

Relative sea level rise at current rate will increase bay volume by 69,000 ac-ft (2.5%) in 10 yrs.

One picture is worth a thousand words
One experiment is worth a thousand expert opinions
One model will start a thousand arguments

Our job – Trinity River/Galveston Bay!

By November 2009, provide to the Bay/Basin stakeholder committee, the state Environmental Flows Advisory Committee, and the Texas Commission on Environmental Quality:

- Environmental flow analyses
- Recommended environmental flow regime

After November 2009, help develop work plan to:

a) Review environmental flow analyses, environmental flow regime recommendations, environmental flow standards, and strategies to meet environmental flow standards at least every 10 yrs

b) Prescribe monitoring, studies, and activities

c) Set schedule to continue to validate/refine environmental flow analyses, environmental flow regime recommendations, environmental flow standards, and strategies to achieve standards

Context for our work

Definitions

- Environmental flow analysis – apply a process for predicting ecosystem response to changed flows to streams and bays
- Environmental flow regime – schedule of flows reflecting seasonal and yearly fluctuations (specific to location),which support a sound ecological environment and maintain the productivity, extent, and persistence of key aquatic habitats in and along the affected water bodies

Guidance

- Consider the recommendations of the Science Advisory Committee relating to environmental flow methodologies

A sound ecological environment

sustains the native species in perpetuity

sustains key habitat features required by these species

retains key features of the natural flow regime required to complete their life cycles

sustains key ecosystem processes and services, such as elemental cycling and the productivity of important plant and animal populations

SAC Report

densities of animals and plants not significantly different from the historical patterns of abundance or composition

physical and chemical properties sufficiently close to historical conditions

retention of the estuary's biological diversity

estuarine system remains resilient to natural and man-made disturbances

State Methodology

8.1 General Overview - SAC Report

… requires study of the total … aquatic ecosystem and, … emphasizes preservation of habitat for desired species as opposed to … species abundance.

One of the most important questions relating to management of inflows … is under drought conditions what inflows must a bay receive to maintain its ecosystem ….

Because coastal habitats provide the foundation for ecosystem productivity, simply protecting the habitats should provide protection for everything else in the ecosystem.

… accurately predict ecological sustainability in times of drought ….

Seasonal timing of … inflows to … estuaries is critically important for providing proper conditions for reproduction and growth.

Seasonal high-flow events, … must be of sufficient volume and duration to affect salinity along estuarine gradients.

… must measure quantifiable indicators of ecosystem health.

Some of the best indicators of ecosystem integrity are often the metrics of the structure of bottom dwelling plants and animal communities ….

The confidence in a scientific answer must be appraised, including not only the probable range of error, but also the degree of corroboration that the underlying science has received.

Legislation

- 1973-Resolution 101 "…a sufficient inflow of freshwater is necessary to protect and maintain the ecological health of Texas estuaries and related marine resources."
- 1975 – Senate Bill 137-mandated comprehensive studies of effects of freshwater inflow
- 1985, 1987 – collect and analyze data to determine sediments, nutrients, and salinity necessary for a sound ecological environment

One picture is worth a thousand words
One experiment is worth a thousand expert opinions
One model will start a thousand arguments