

Instream Flows vs. Freshwater Inflows



How do example HEFR numbers compare to Freshwater Inflow Study recommendations for the Guadalupe Estuary?

Presentation to
Science Advisory Committee
February 4, 2009

Texas Parks & Wildlife Department
Texas Water Development Board

Tale of the Tape

Instream Flows vs Freshwater Inflows

2001

DOB

1975

Daily

Time Step

Monthly

feet³/sec

Units

acre-feet

Subsistence

Min Q Sal

Base, High Pulse

Range

Min Q

Overbank

Max H

WQ, Habitat,

Salinity, Harvest,

Processes, ...

Objectives

Sediment, ...

Objectives

Freshwater Inflow Patterns for Bays

- **Min Q Sal:** Minimum flow volume that meets salinity constraints.
- **Min Q:** Minimum flow volume that meets all constraints.
- **Max H:** Flow pattern that meets all constraints and maximizes harvest.

Instream Flow Components for Rivers

- **Subsistence:** Maintain water quality and sufficient population of organisms to support recovery.
- **Base:** Provide suitable habitat conditions.
- **High Flow Pulse:** Maintain physical habitat features and connectivity along the river.
- **Overbank:** Maintain riparian areas and provide connectivity with floodplain.

Possible Outcomes

- If you take care of the river, it'll take care of the bay.
- If you take care of the bay, it'll take care of the river.
- Recommendations for the bay and river will conflict.
- With some effort, bay and river recommendations can be reconciled.



Example: Guadalupe Estuary (San Antonio Bay)

- Completed Freshwater Inflow Study
 - Inflow recommendations based on historical harvest data
 - Subject to constraints
- Example HEFR Instream Flow Numbers
 - Subsistence, Base, High Pulse, Overbank Flows



Example:

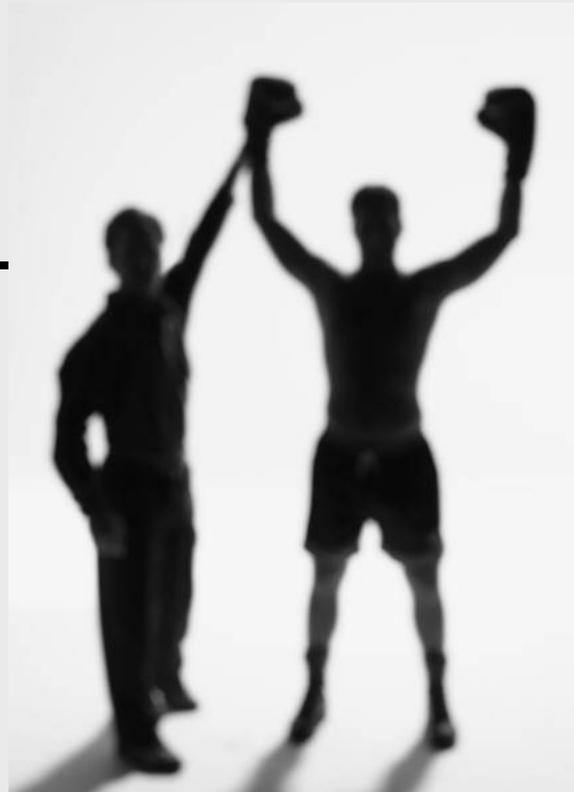
Watershed Area: More than 10,000 square miles
Average Annual Flow: Almost 2 million acre-feet



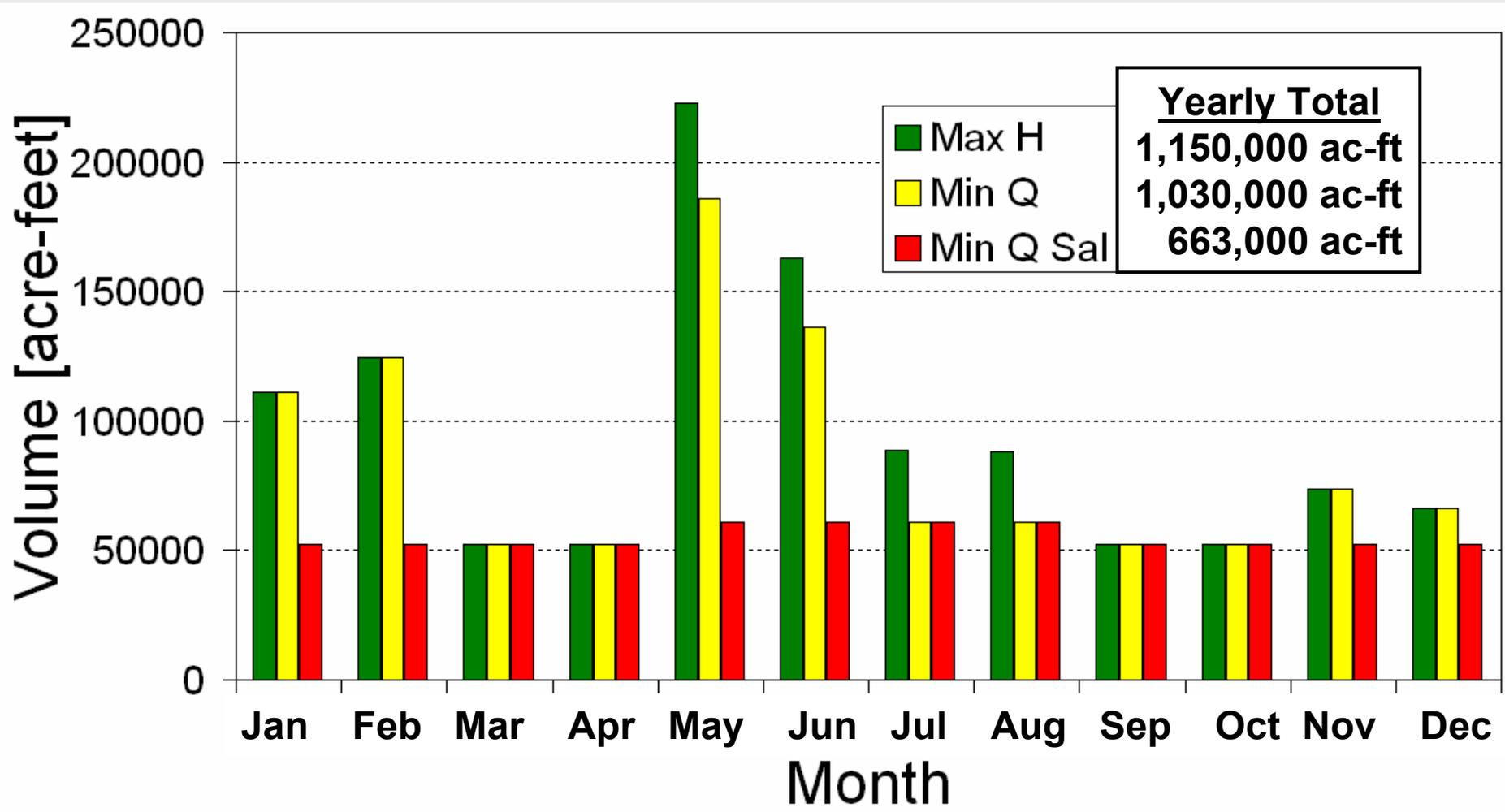
Freshwater Inflows to the Bay

- + **Guadalupe River @ Victoria, TX (56.9%)**
- + **San Antonio River @ Goliad, TX (22.7%)**
- + **Inflow from ungaged area**
 - **Diversions below gages**
- + **Return flows below gages**

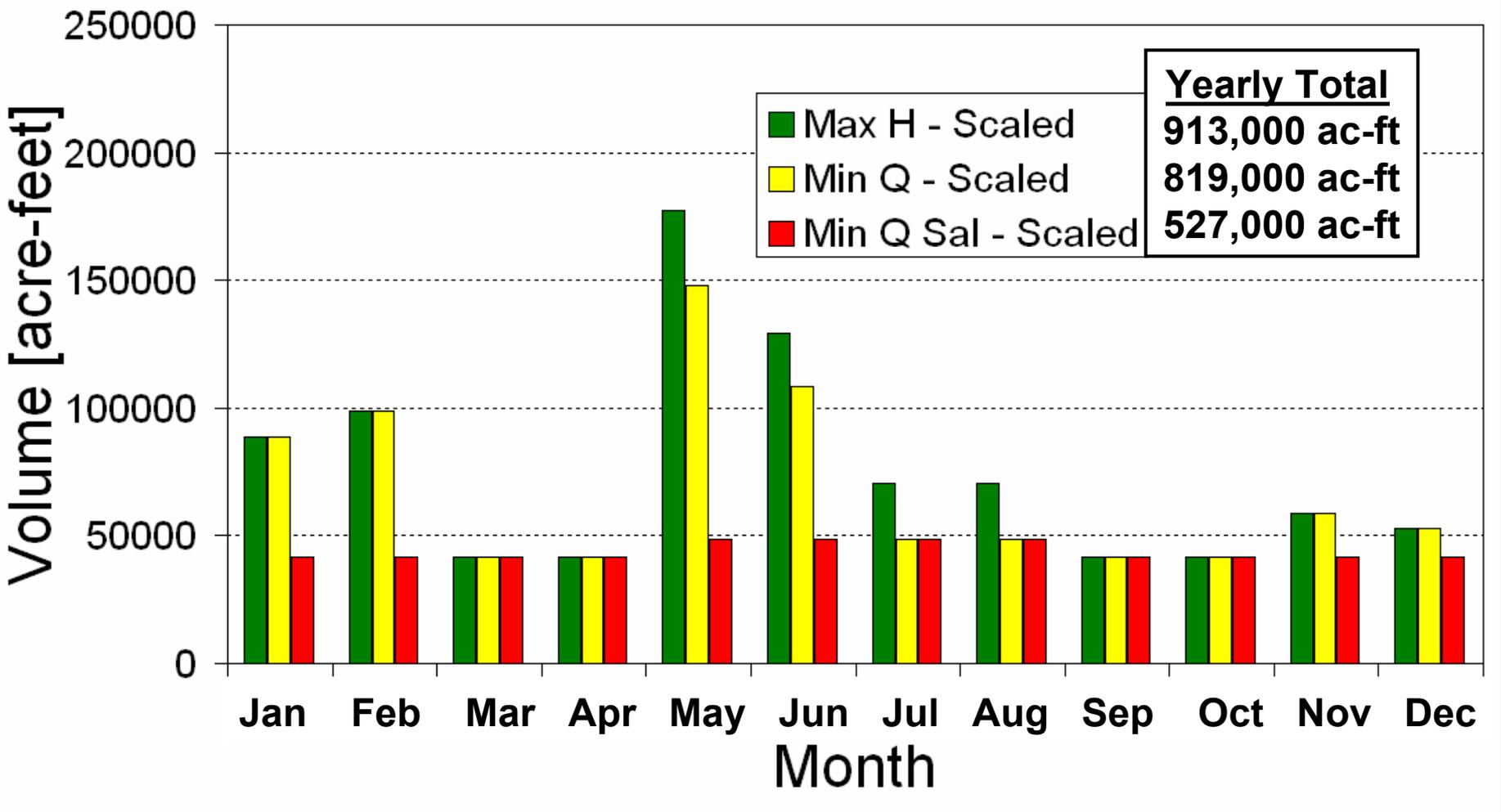
Total Freshwater Inflow to bay



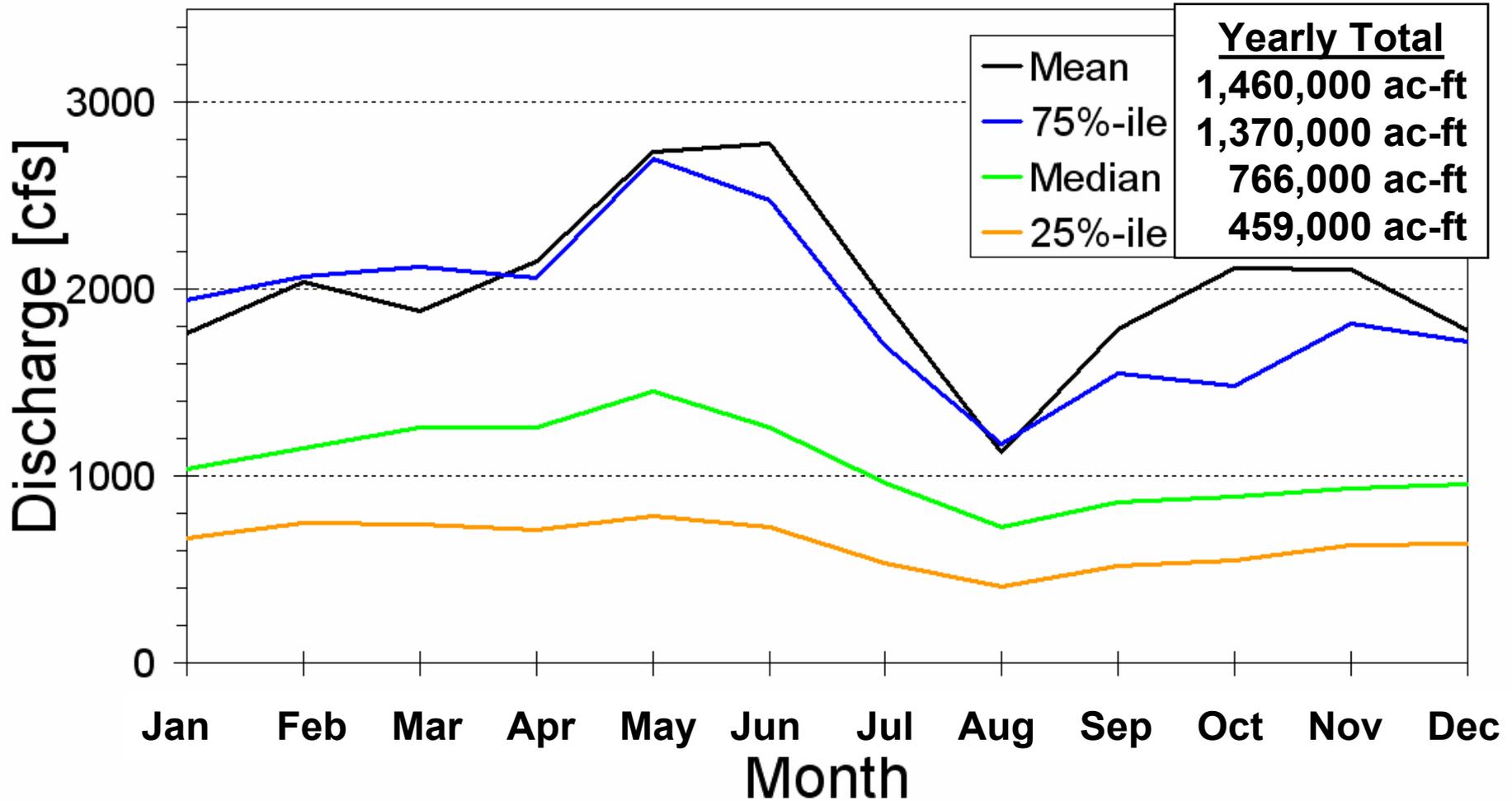
Freshwater Inflow Recommendations



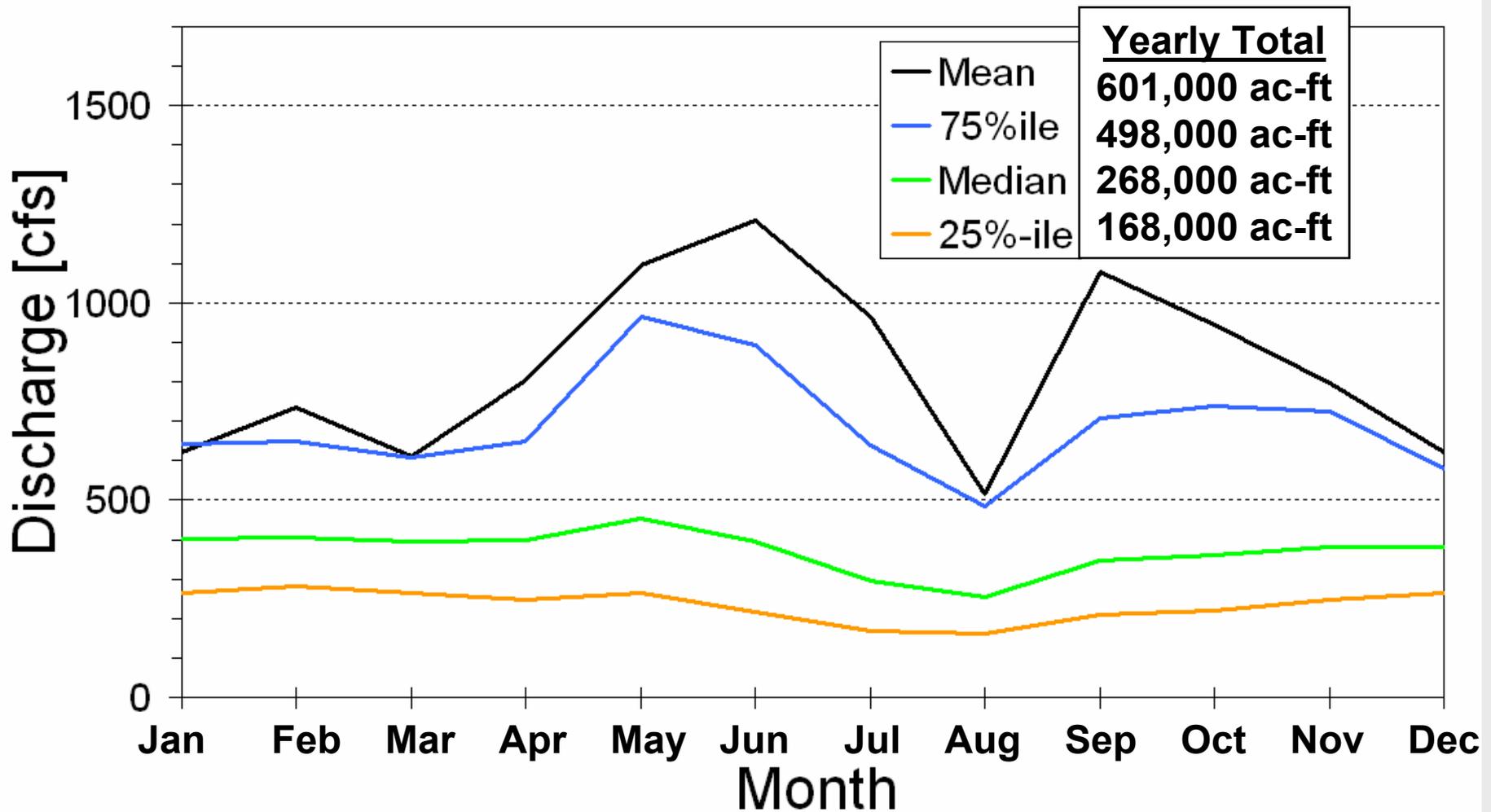
Freshwater Inflows: Scaled to Gage Locations



Guadalupe River at Victoria (1940-2007)



San Antonio River at Goliad (1940-2007)



Example HEFR Numbers

Caveats

- **Preliminary numbers** based only on daily flow data from gages and default criteria in IHA/HEFR.
- **No site or river basin specific knowledge** was used to adjust the numbers.
- Considering only **a few possible combinations of conditions** for the two rivers (both subsistence, both dry, both average, both wet).
- **Evaluating the HEFR numbers only**, not how they might be implemented in a water rights permit.

Example HEFR Numbers at Victoria

Overbank Flows	Return Period (R) : 0.7 (years)						Duration (D) : 26 (days)					
	Volume (V) : 318645 (ac-ft)						Peak Flow (Q) : 17400 (cfs)					
High Flow Pulses	F: 0	D: 8		F: 1	D: 9		F: 0	D: 7		F: 0	D: 7	
	Q: 4098	V: 38916		Q: 5143	V: 46877		Q: 3685	V: 34059		Q: 3980	V: 30762	
	F: 1	D: 5		F: 1	D: 6		F: 1	D: 5		F: 1	D: 5	
	Q: 2875	V: 22156		Q: 2905	V: 24635		Q: 2210	V: 17296		Q: 2650	V: 17762	
	F: 1	D: 4		F: 1	D: 4		F: 0	D: 3		F: 1	D: 4	
	Q: 1973	V: 12136		Q: 2050	V: 12977		Q: 1605	V: 7171		Q: 1963	V: 10424	
Base Flows (cfs)	1150	1190	1263	1230	1280	1250	1150	1020	1030	1130	1020	1050
	866	880	867	860	860	970	878	740	742	796	782	812
	631	640	641	610	610	608	608	608	608	608	608	608
Subsistence Flows (cfs)	608	608	608	608	608	608	608	608	608	608	608	608
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Winter			Spring			Summer			Fall		

Hydrologic Conditions	Wet
	Average
	Dry
	Subsistence

High Flow Pulse Characteristics	F = Frequency (per season)
	D = Duration (days)
	Q = Peak Flows (cfs)
	V = Volume (ac-ft)

Example HEFR Numbers at Goliad

Overbank Flows	Return Period (R) : 0.8 (years)						Duration (D) : 22 (days)					
	Volume (V) : 121032 (ac-ft)						Peak Flow (Q) : 9060 (cfs)					
High Flow Pulses	F: 1	D: 7	F: 1	D: 7	F: 1	D: 7	F: 1	D: 8				
	Q: 1603	V: 13324	Q: 1828	V: 13684	Q: 1363	V: 10096	Q: 2055	V: 15108				
	F: 1	D: 5	F: 1	D: 5	F: 1	D: 5	F: 1	D: 5				
	Q: 1005	V: 6226	Q: 964	V: 6267	Q: 785	V: 4756	Q: 1050	V: 7254				
	F: 1	D: 4	F: 1	D: 3	F: 1	D: 3	F: 1	D: 4				
	Q: 705	V: 4137	Q: 674	V: 3171	Q: 510	V: 2452	Q: 671	V: 3542				
Base Flows (cfs)	432	451	451	428	398	371	346	357	367	367	395	433
	336	344	330	318	303	279	239	244	247	261	287	324
	230	249	240	219	219	219	219	219	219	219	224	254
Subsistence Flows (cfs)	219	219	219	219	219	219	219	219	219	219	219	219
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Winter			Spring			Summer			Fall		

Hydrologic Conditions	Wet
	Average
	Dry
	Subsistence

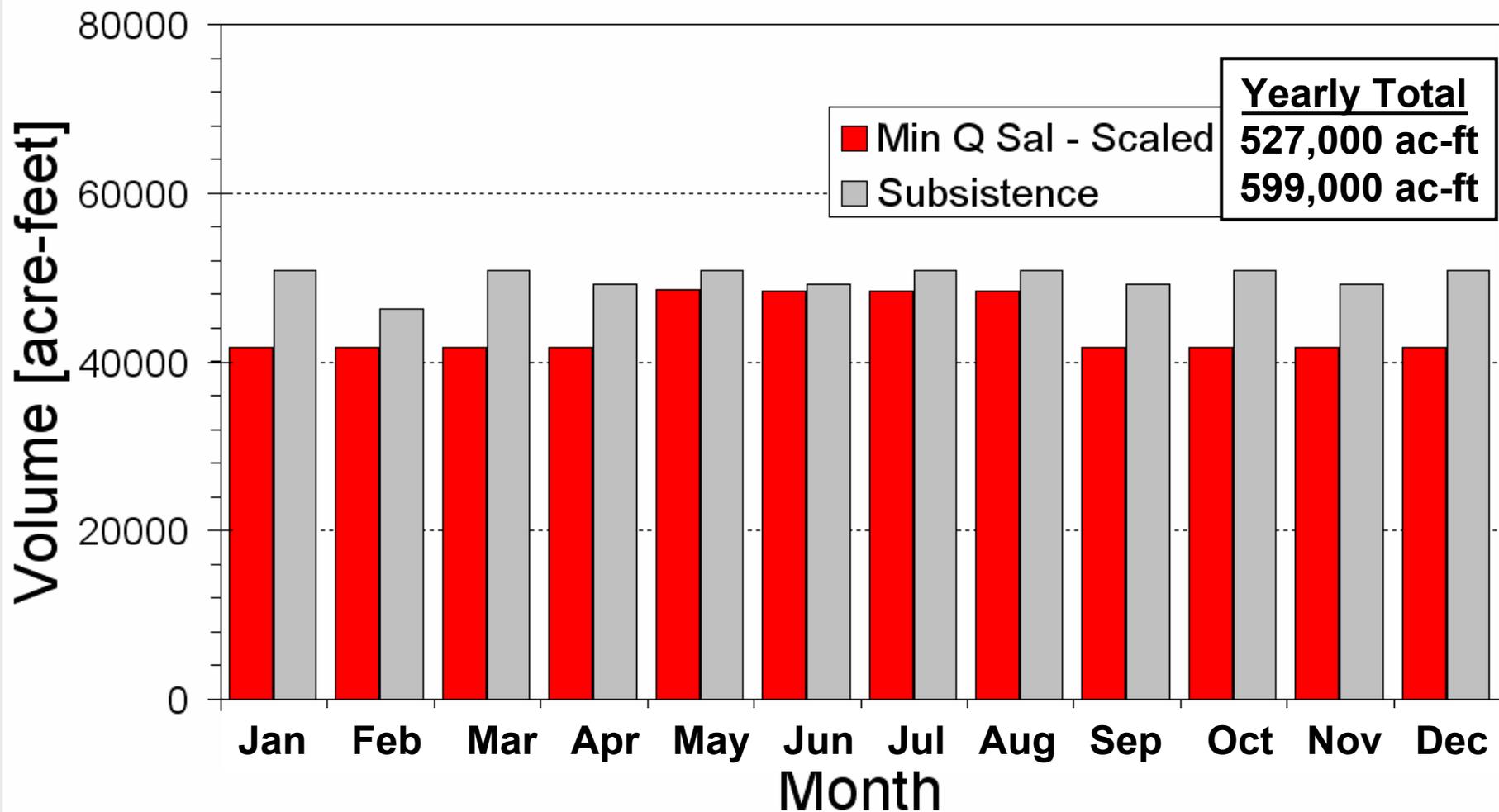
High Flow Pulse Characteristics	F = Frequency (per season)
	D = Duration (days)
	Q = Peak Flows (cfs)
	V = Volume (ac-ft)

Subsistence vs. Min Q Sal - Scaled

- Subsistence Flow Scenario:
 - Guadalupe River 7Q2 = 608 cfs
 - San Antonio River 7Q2 = 219 cfs
 - Combined River Flow = 827 cfs
- Total Yearly Flow Volumes:
 - Subsistence = 599,000 ac-ft
 - Min Q Sal - Scaled = 527,000 ac-ft



Subsistence vs. Min Q Sal - Scaled



Base Habitat vs. Min Q, Max H - Scaled

- **HEFR Base Habitat Flow Scenarios:**
 - Wet, Average, and Dry Conditions
 - Same condition assumed for both rivers

- **Total Yearly Flow Volumes:**

Base Flow (Wet) = 1,120,000 ac-ft

(Average) = 818,000 ac-ft

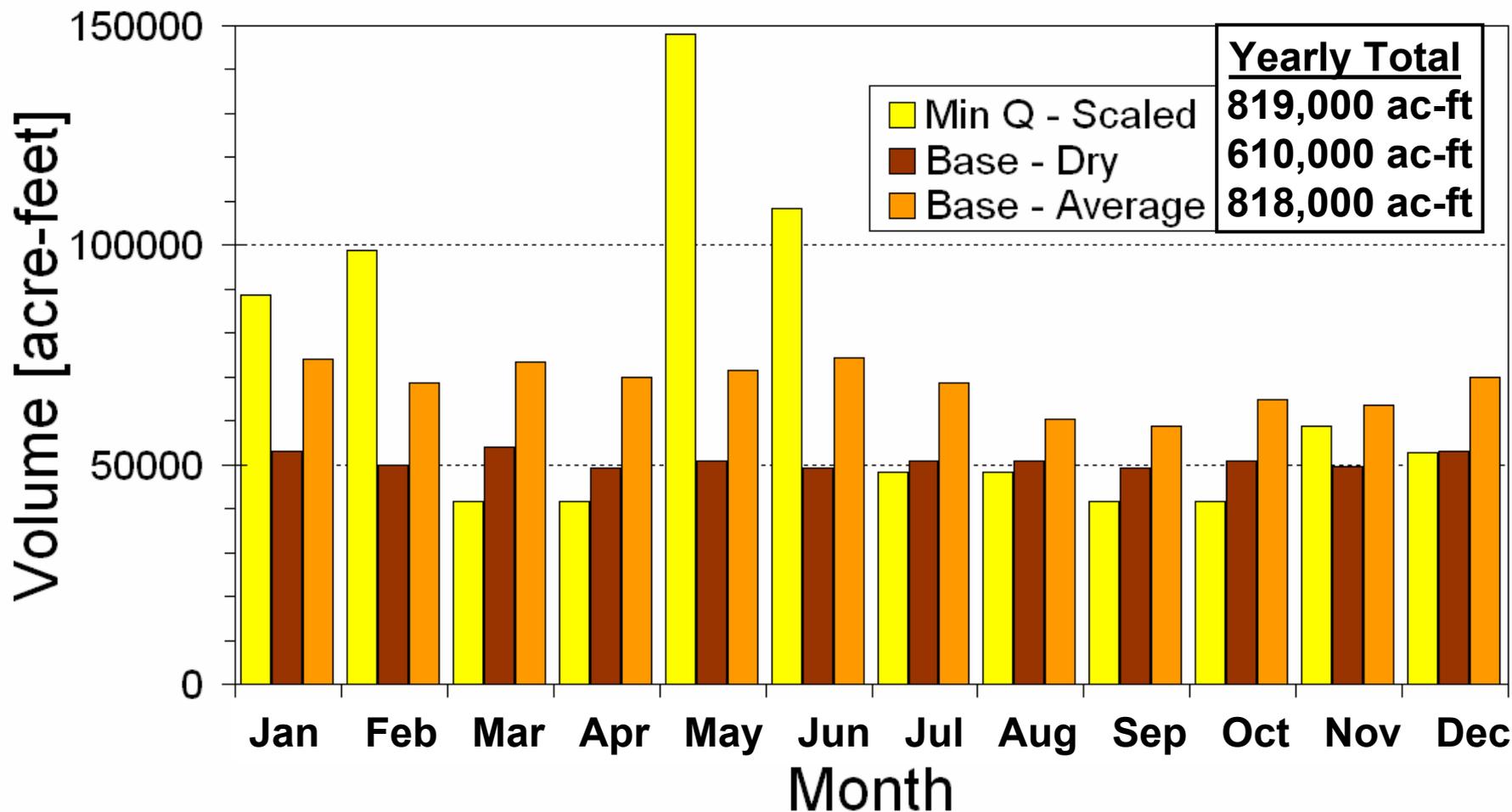
(Dry) = 610,000 ac-ft

Max H – Scaled = 913,000 ac-ft

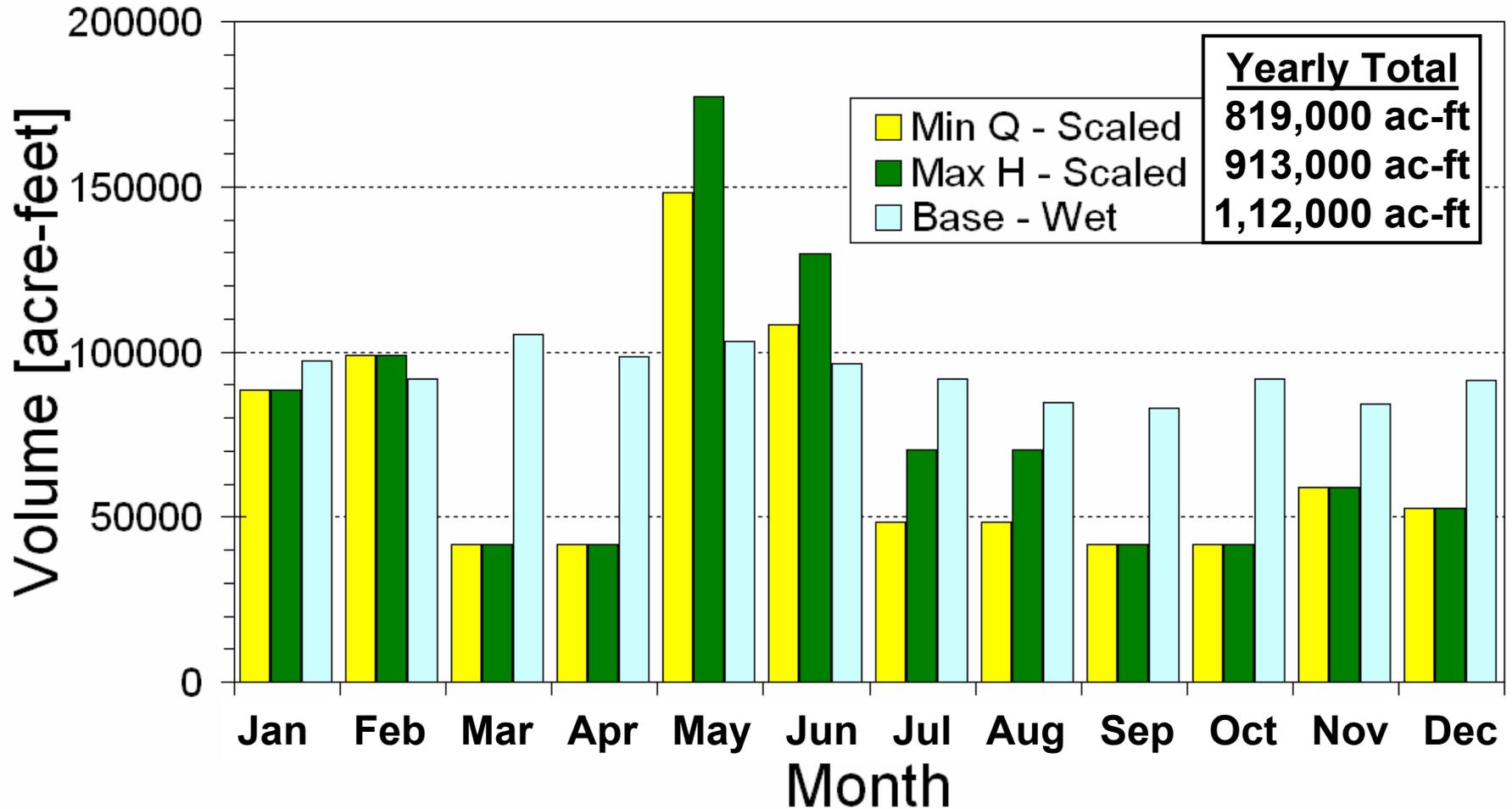
Min Q – Scaled = 819,000 ac-ft



Base Dry and Average vs. Min Q - Scaled



Base Wet vs. Min Q & Max H - Scaled



Base with High Pulse Flows vs. Min Q and Max H - Scaled

- **Total Yearly Flow Volume:**

Base (Wet) w/ High Pulse = 1,200,000 ac-ft

(Average) w/ High Pulse = 879,000 ac-ft

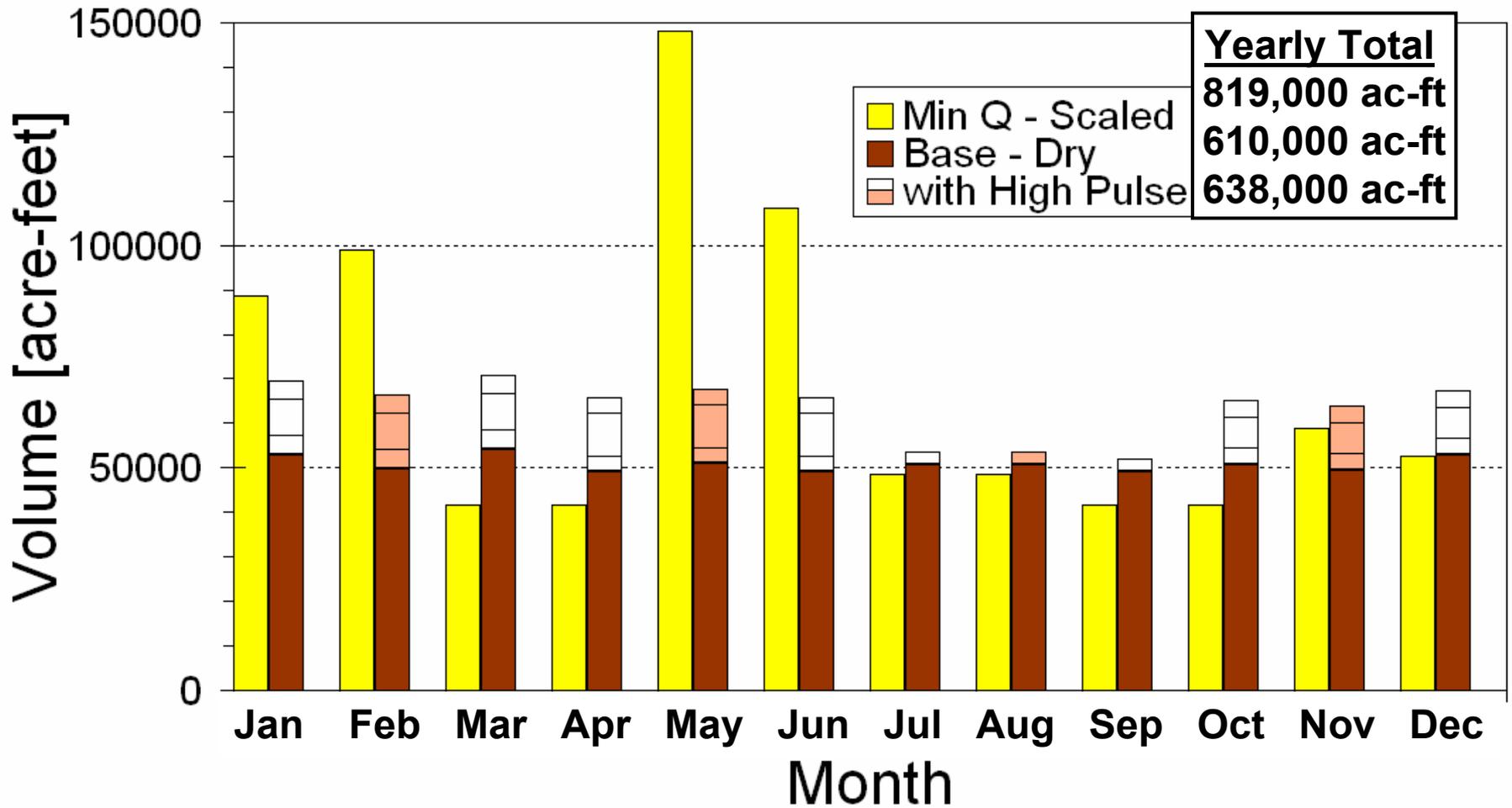
(Dry) w/ High Pulse = 638,000 ac-ft

Max H – Scaled = 913,000 ac-ft

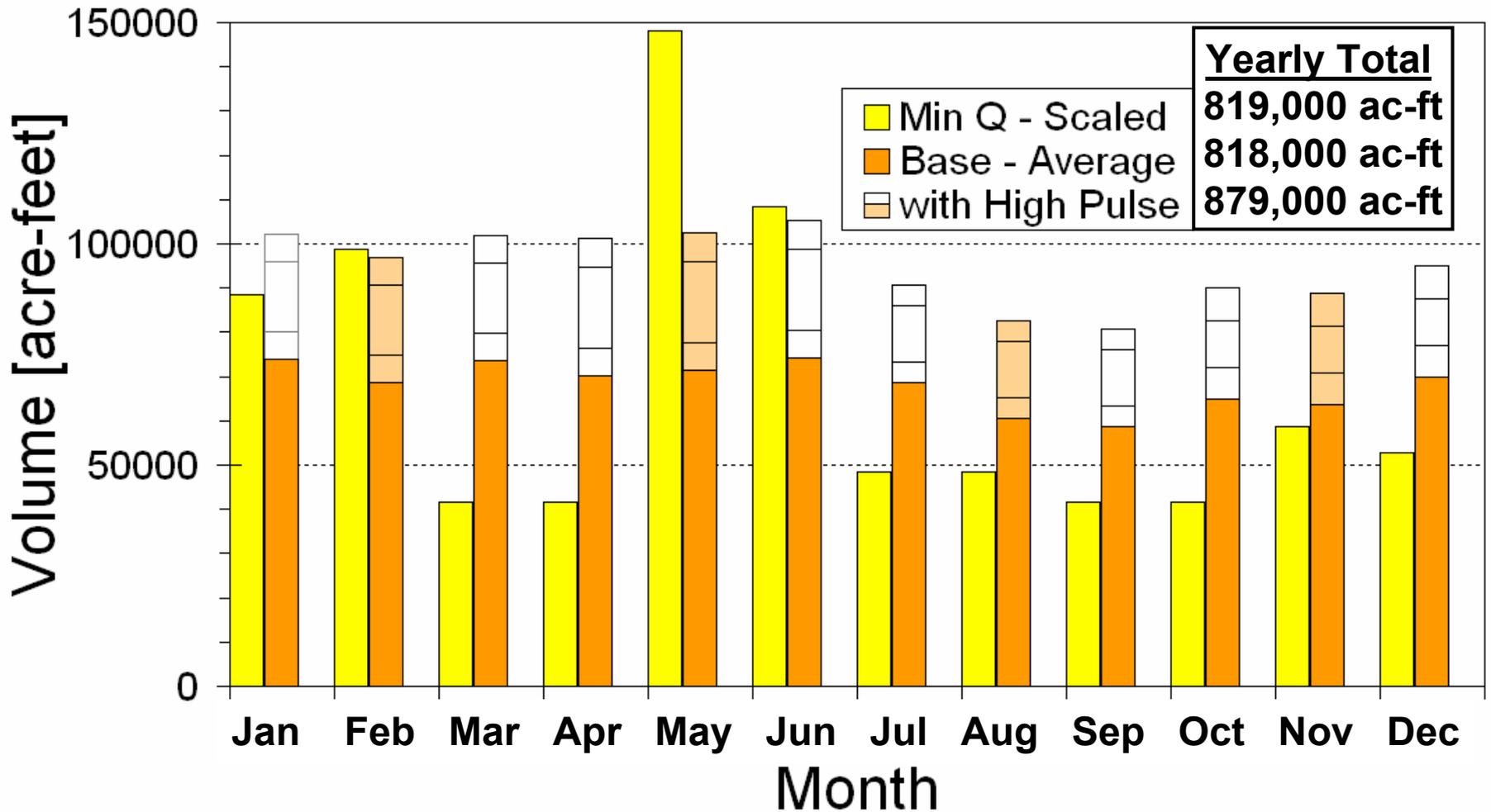
Min Q – Scaled = 819,000 ac-ft



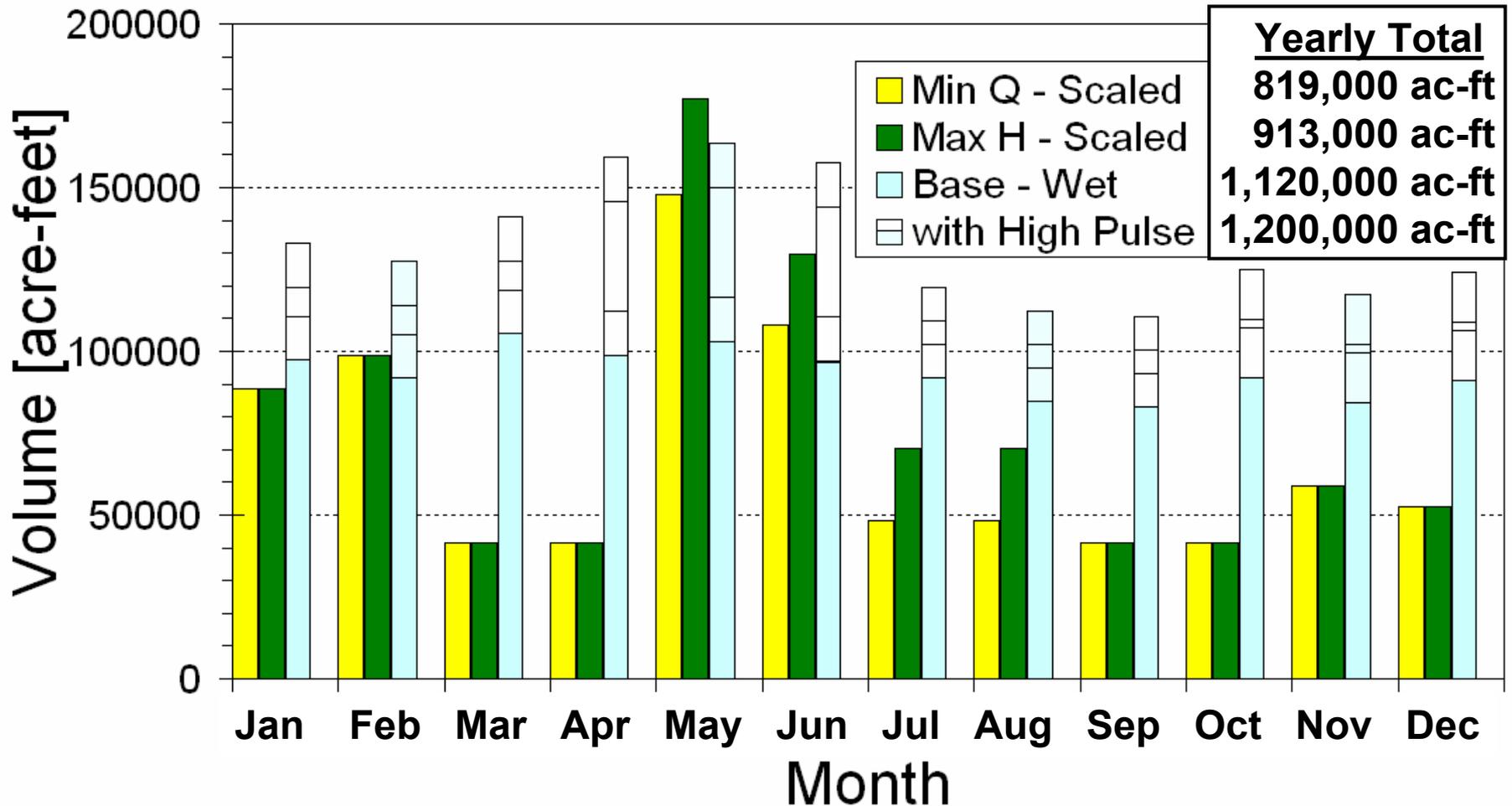
Base Dry with High Pulse Flows vs. Min Q - Scaled



Base Average with High Pulse Flows vs. Min Q - Scaled



Base Wet with High Pulse Flows vs. Min Q & Max H - Scaled



Base, High Pulse, and Overbank Flows vs. Max H - Scaled

- **Total Yearly Flow Volume:**

Base (Wet) w/ High Pulse = 1,200,000 ac-ft

(Average) w/ High Pulse = 879,000 ac-ft

(Dry) w/ High Pulse = 638,000 ac-ft

Overbank

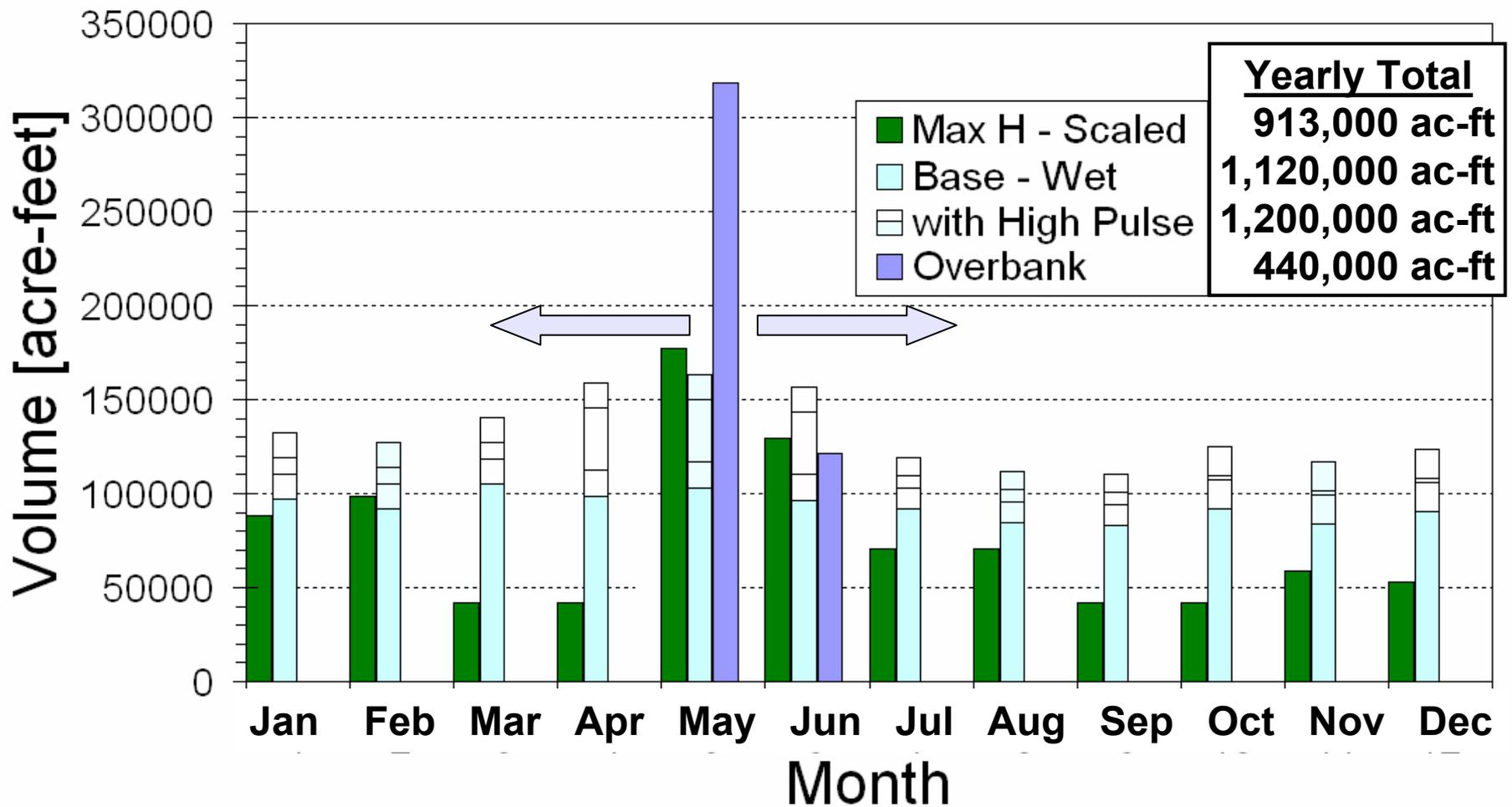
Guadalupe at Victoria = 319,000 ac-ft

San Antonio at Goliad = 121,000 ac-ft

Max H – Scaled = 913,000 ac-ft



Base Wet, High Pulse & Overbank Flows vs. Max H - Scaled

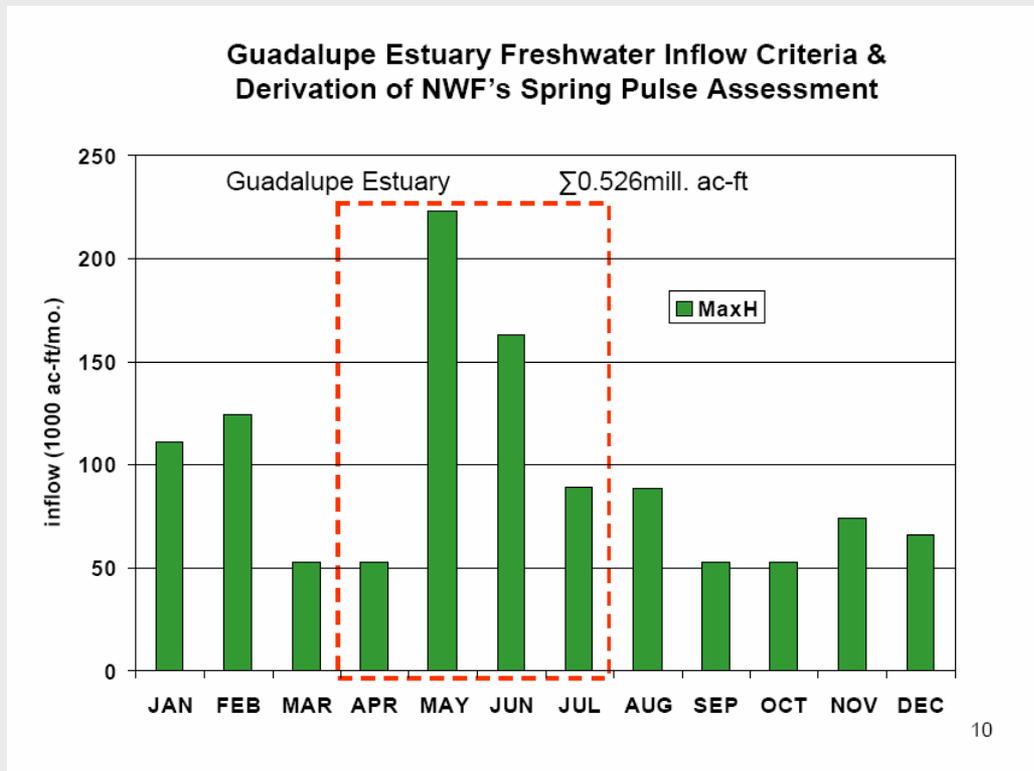


Example HEFR Numbers vs. Spring Freshwater Pulse to Bay

- NWF's Spring Pulse Assessment:

$$\sum \text{Max H (Apr-Jul)} = 526,000 \text{ ac-ft}$$

$$\sum \text{Max H (Apr-Jul) - Scaled} = 419,000 \text{ ac-ft}$$



Example HEFR Numbers vs. Spring Freshwater Pulse to Bay

- Example HEFR Numbers, Apr-Jul:

Base Conditions

	Dry	Average	Wet
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No High Flow Pulse	200,000	285,000	390,000 ac-ft
With Spring High Flow Pulses	210,000	302,000	422,000 ac-ft
W/ Spring & Summer High Flow Pulses	211,000	313,000	434,000 ac-ft
San Antonio Overbank	←	+121,000 ac-ft	→
Guadalupe Overbank	←	+319,000 ac-ft	→

Conclusions from Example

- River subsistence flow is in the ballpark of bay flow targets for Min Q Sal.
- Wet base flow with high pulses exceeds Min Q targets but is well below May targets for Max H.
- Overbank flows in combination with most river scenarios exceed Min Q and Max H targets.
- Timing of river flows to meet (but not exceed) bay targets throughout the year may take some work.

Conclusions from Example

- With some effort, bay and river recommendations can be reconciled.

