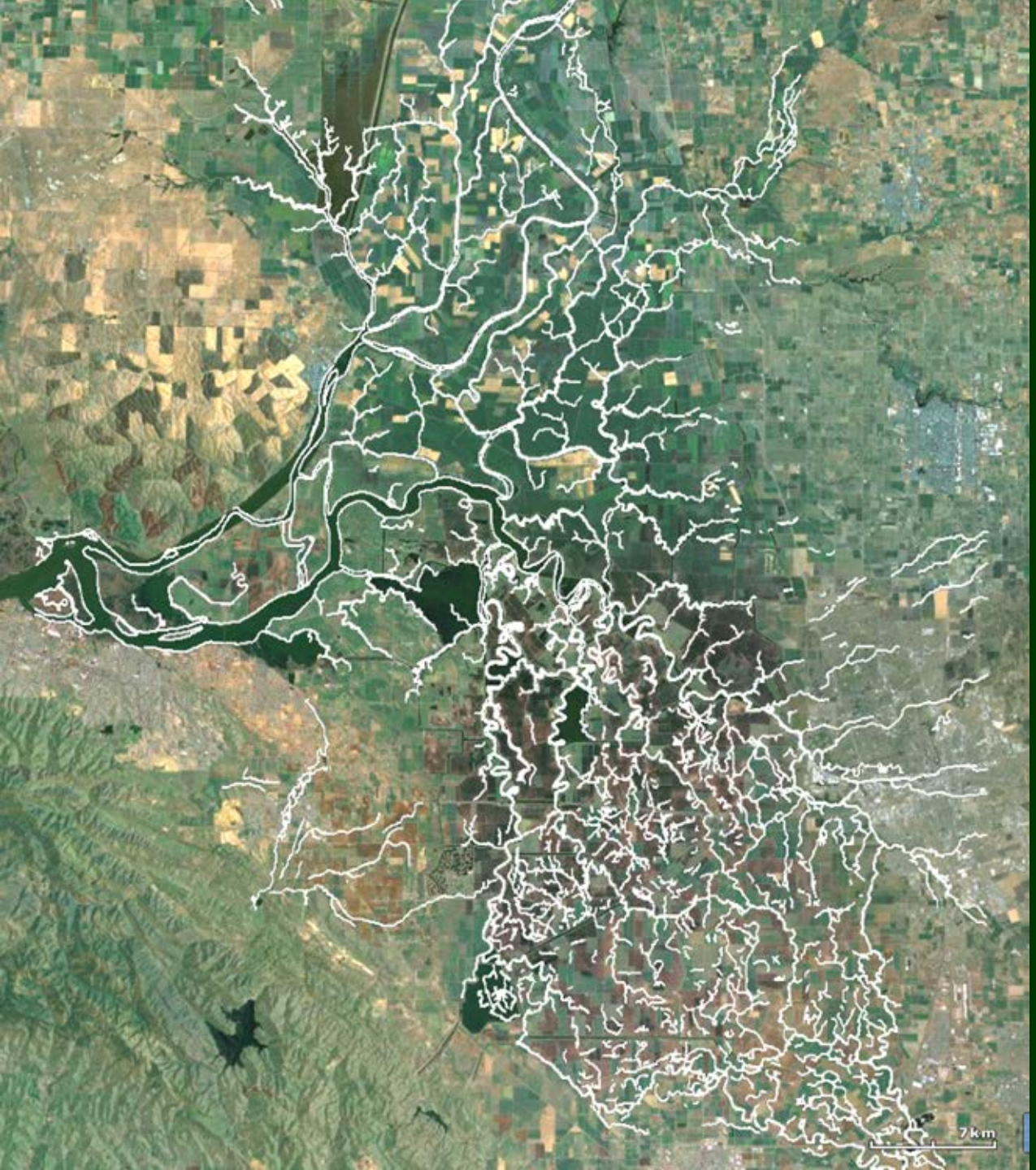


1873 Delta:

Long residence time

Marsh connections

Two rivers connect to bay

Waterways dendritic

Modern delta

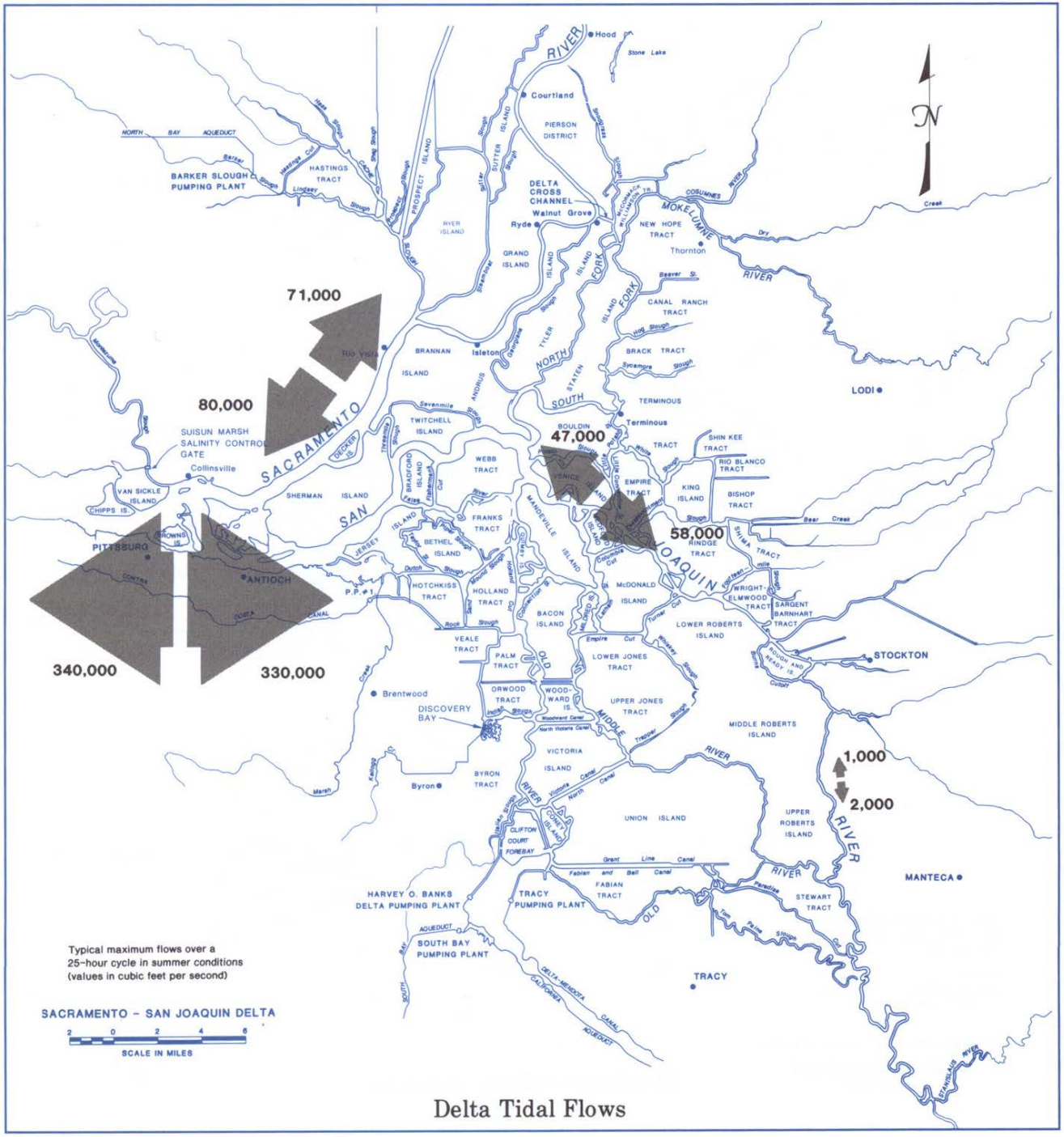
Short residence times

Rip-rapped

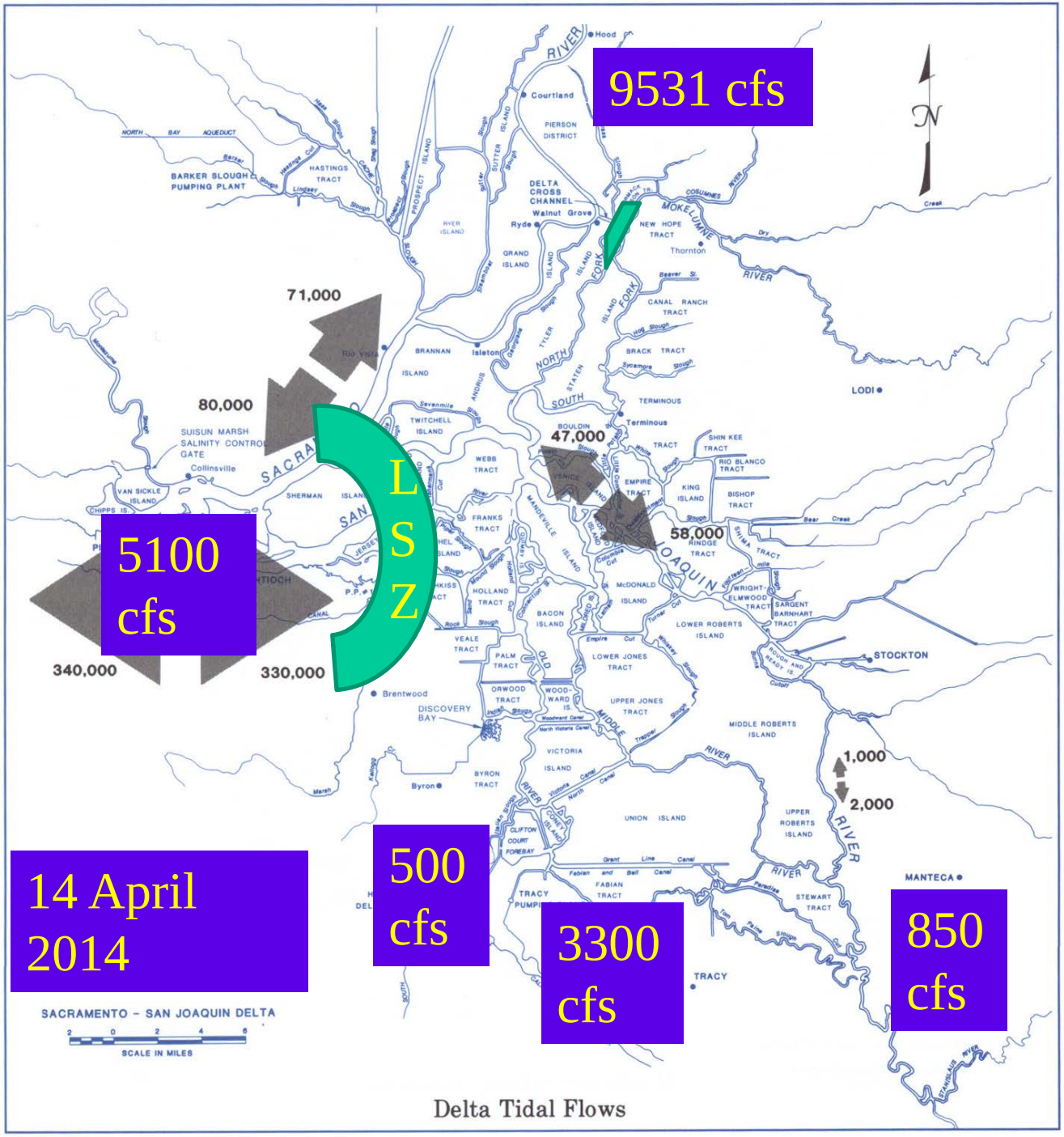
Cross Delta flows

Rare San Joaquin connection to bay

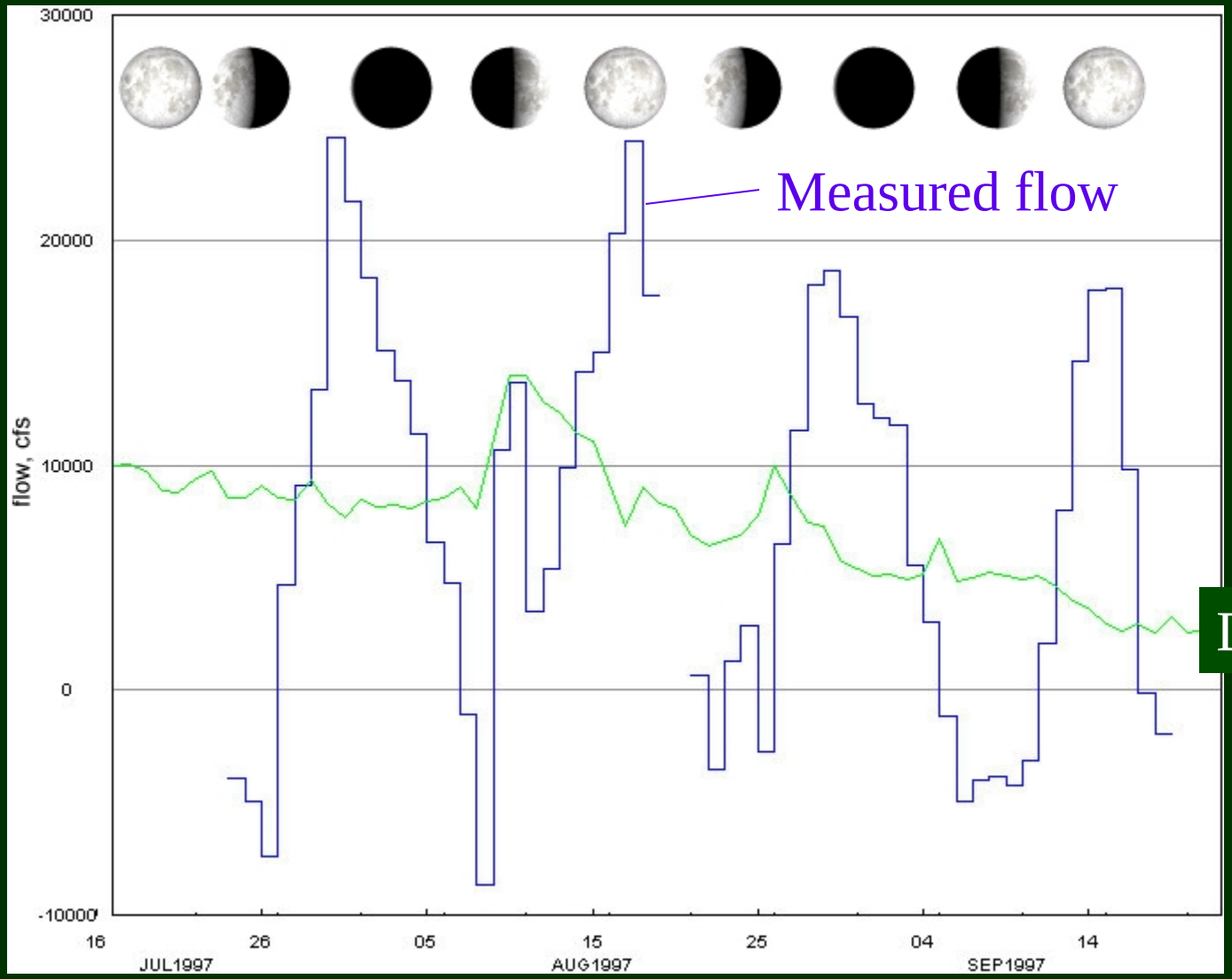
Waterways web-like

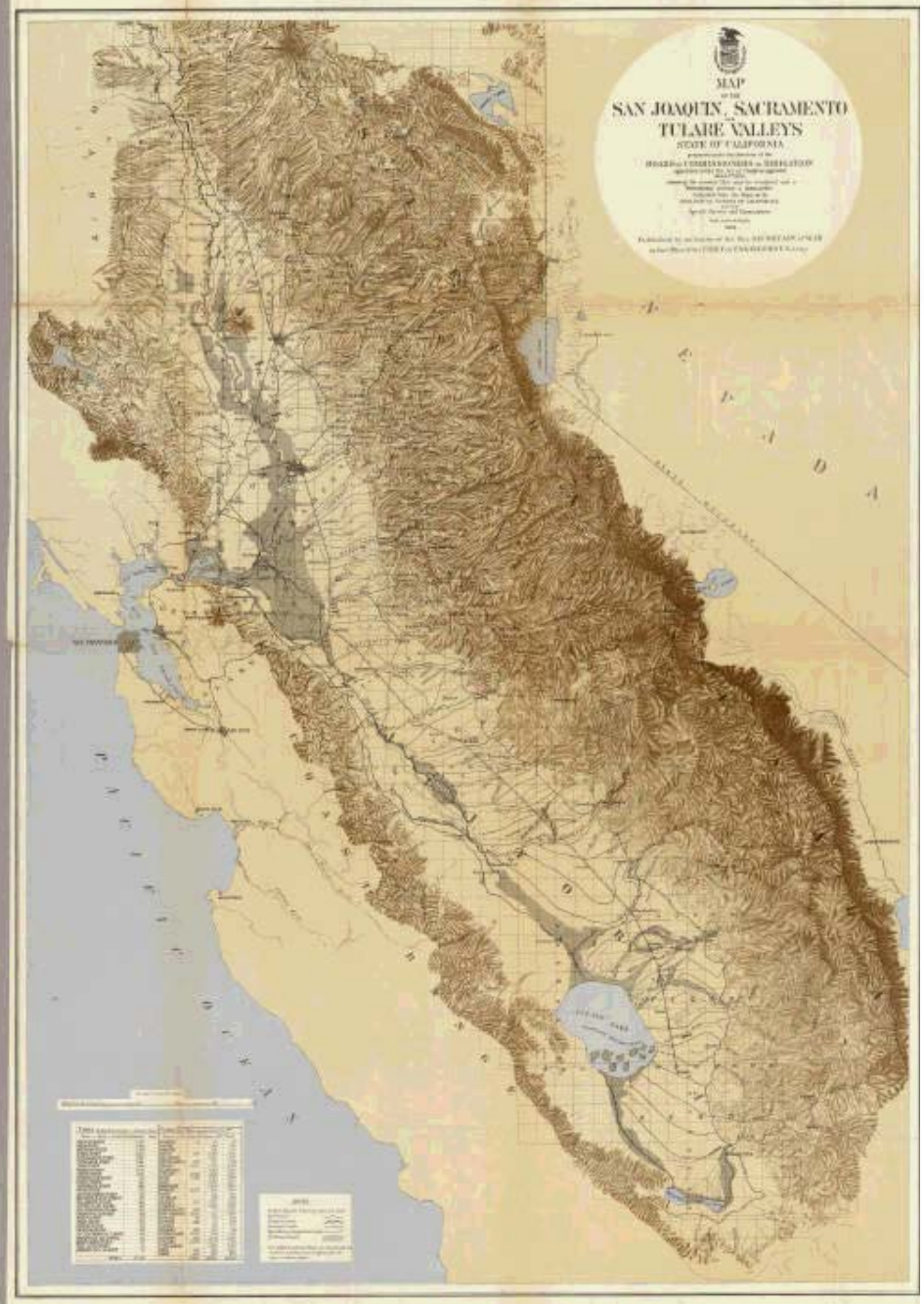


Delta Tidal Flows

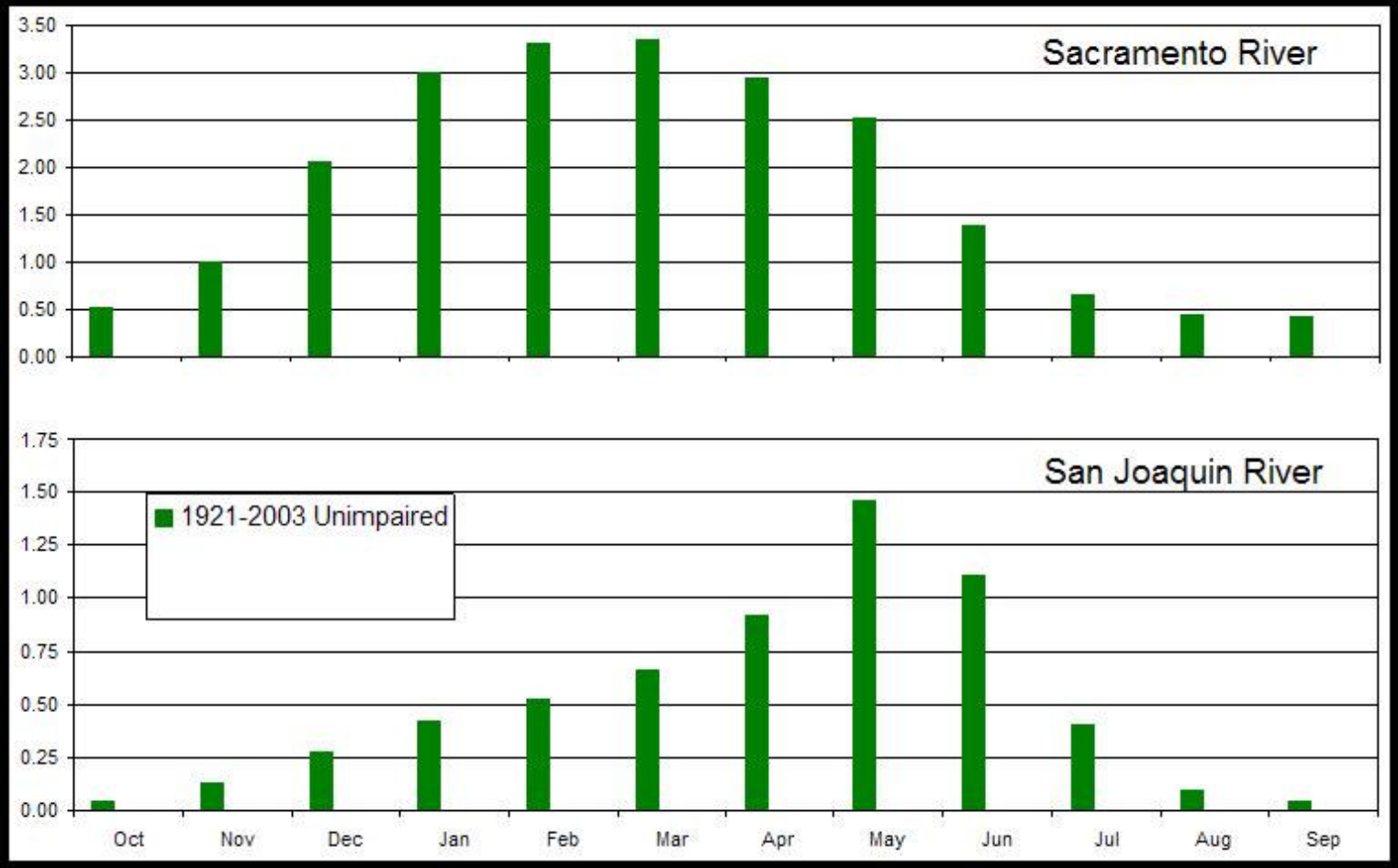


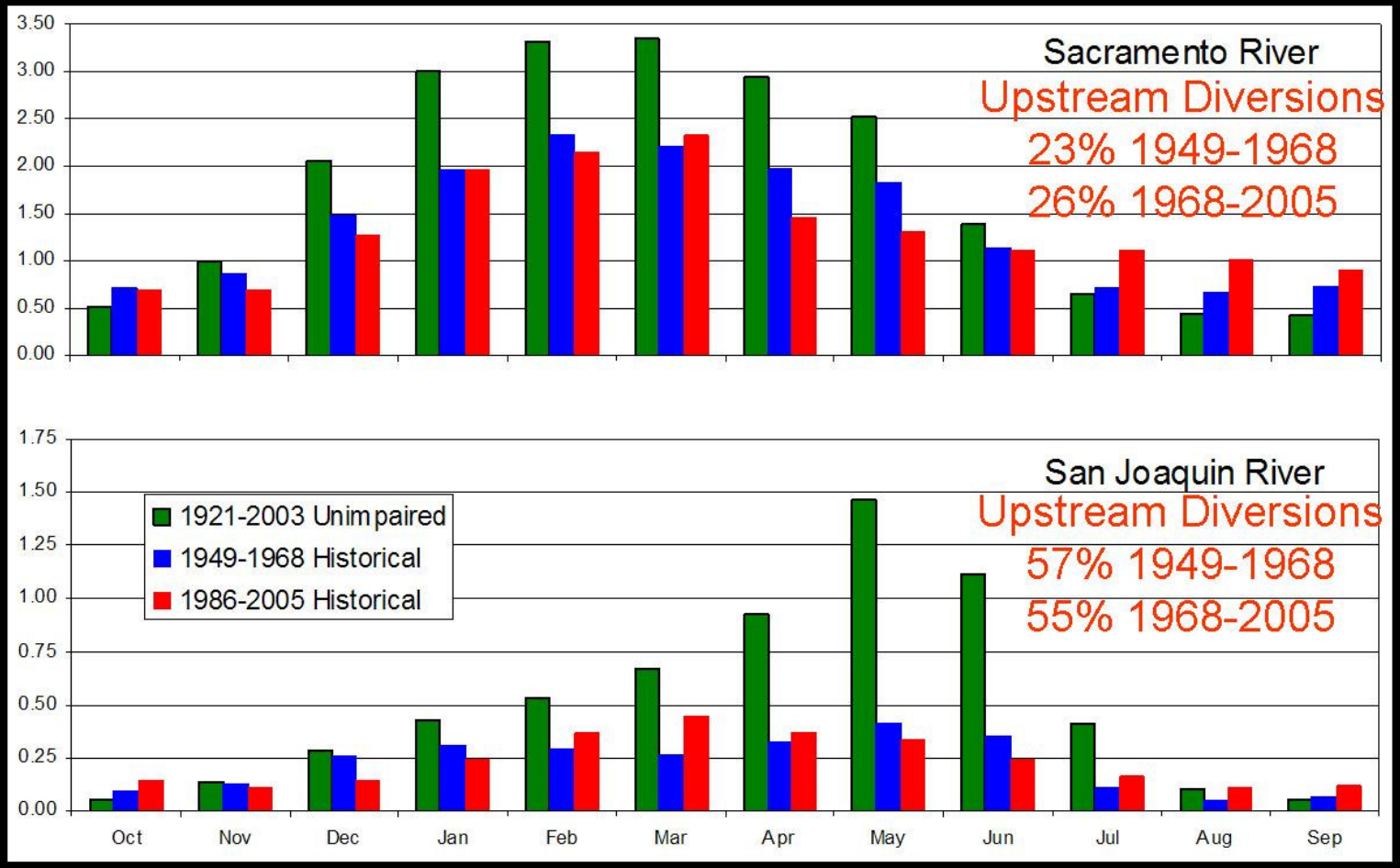
Delta Tidal Flows

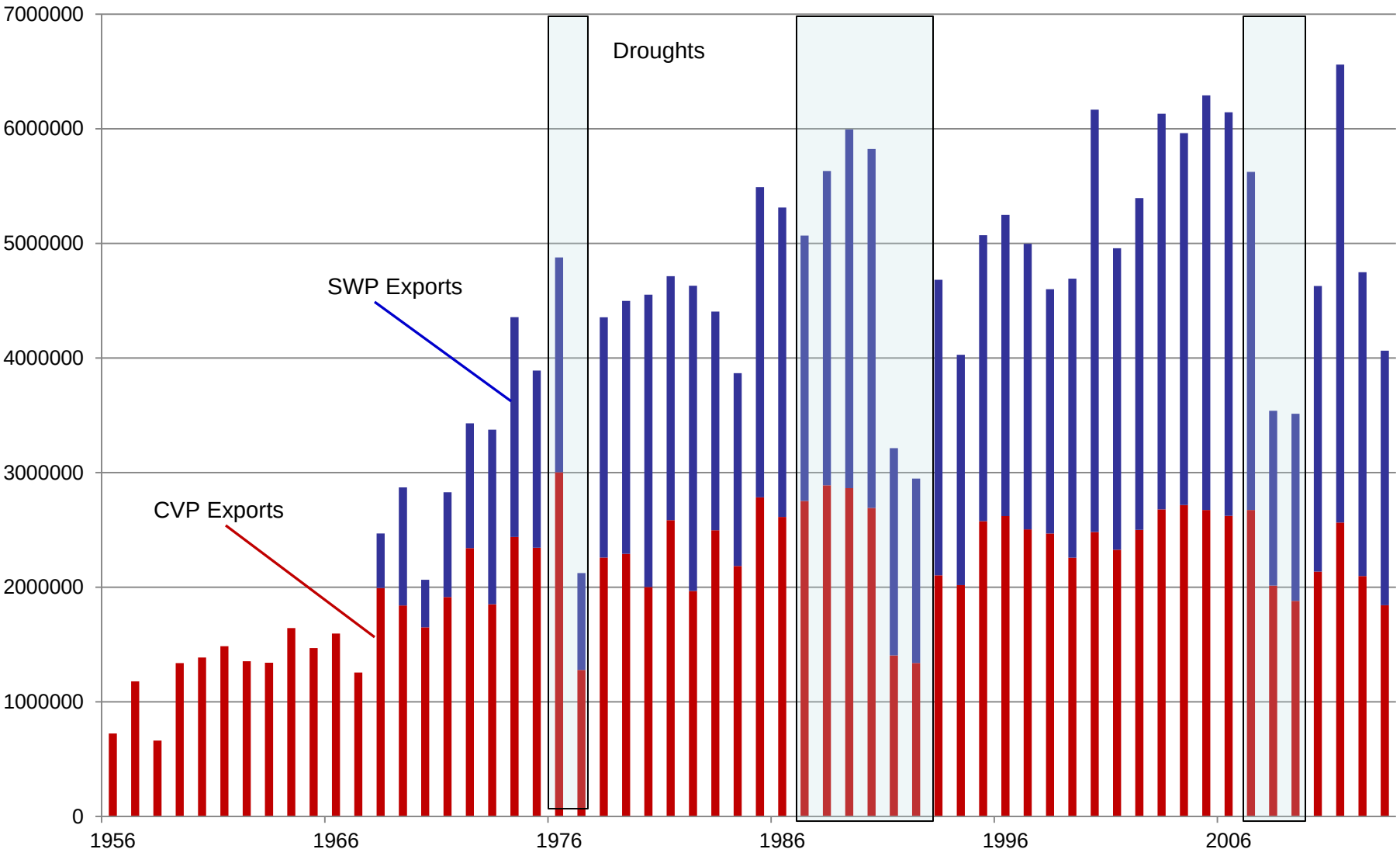

30000
20000
10000
0
-10000
flow, cfs
16
26
05
15
25
04
14
JUL1997
AUG1997
SEP1997
Measured flow
Dayflow


MAP
SAN JOAQUIN, SACRAMENTO
TULARE VALLEYS
STATE OF CALIFORNIA

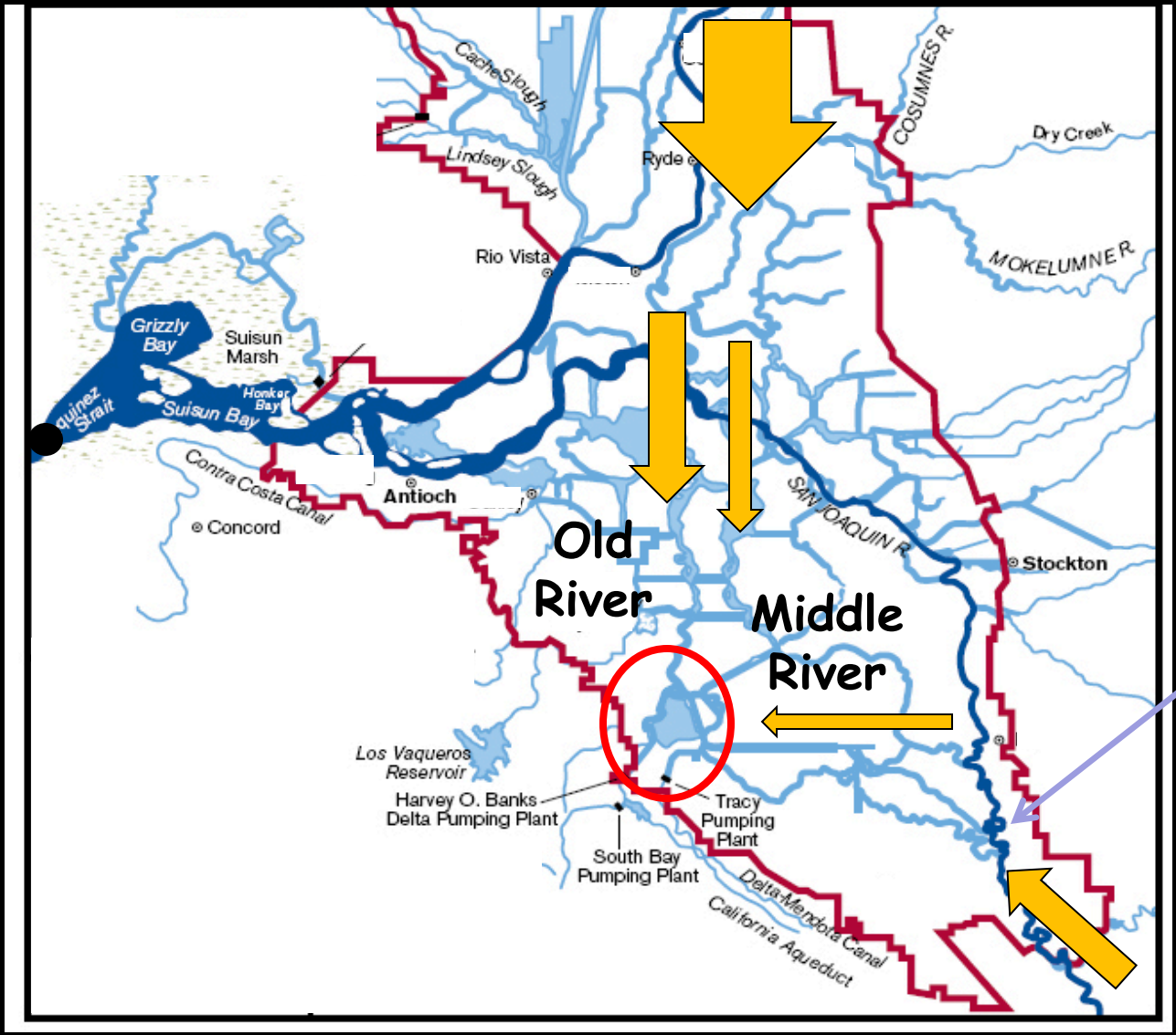
Redding
Sacramento
San
Francisco
Fresno


Sacramento River
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
San Joaquin River
1921-2003 Unimpaired
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep

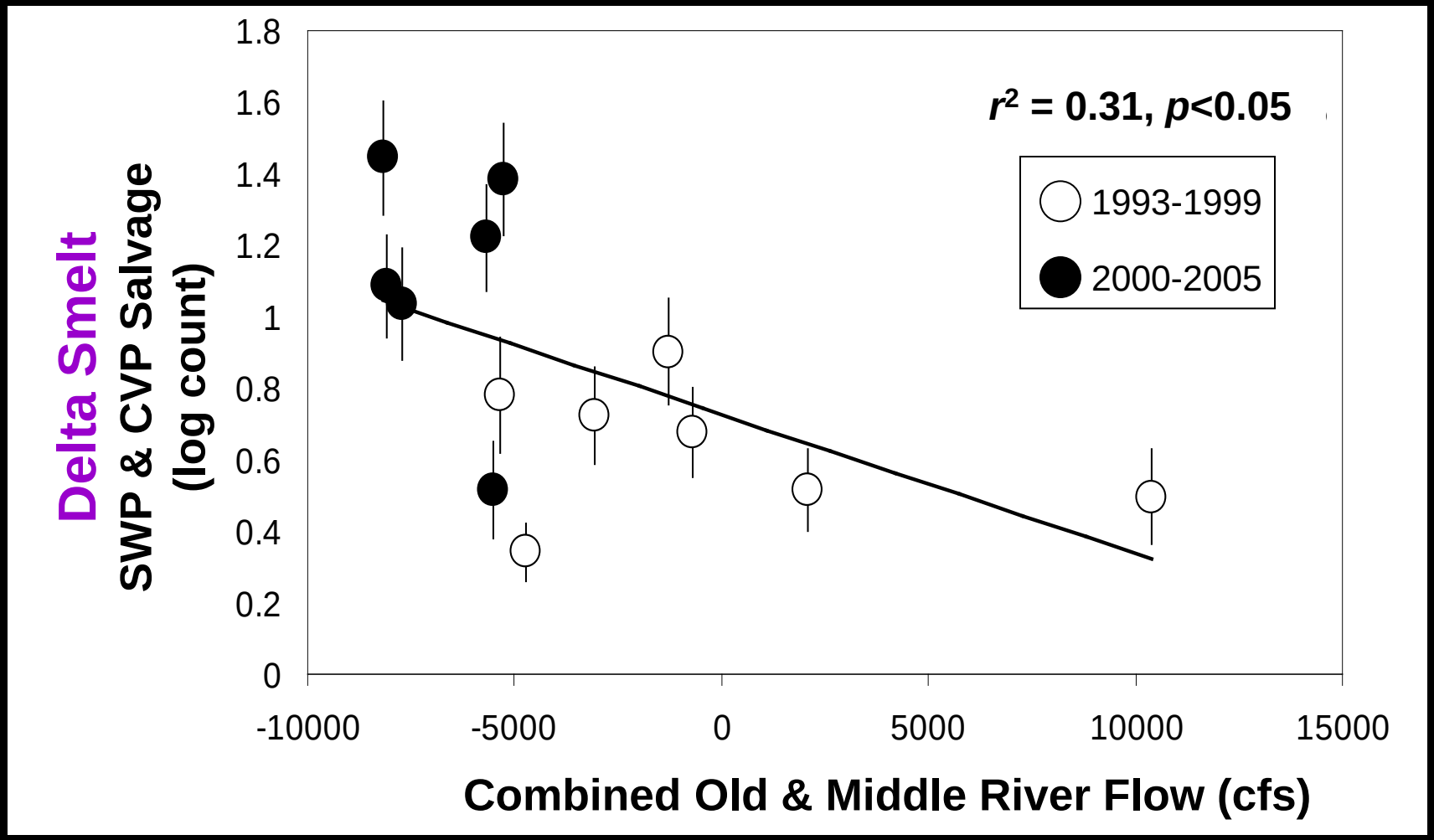

Sacramento River
Upstream Diversions
23% 1949-1968
26% 1968-2005
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
San Joaquin River
Upstream Diversions
57% 1949-1968
55% 1968-2005
1921-2003 Unimpaired
1949-1968 Historical
1986-2005 Historical
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep


7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
1956
1966
1976
1986
1996
2006
Droughts
SWP Exports
CVP Exports

OMR = Old and Middle River flows

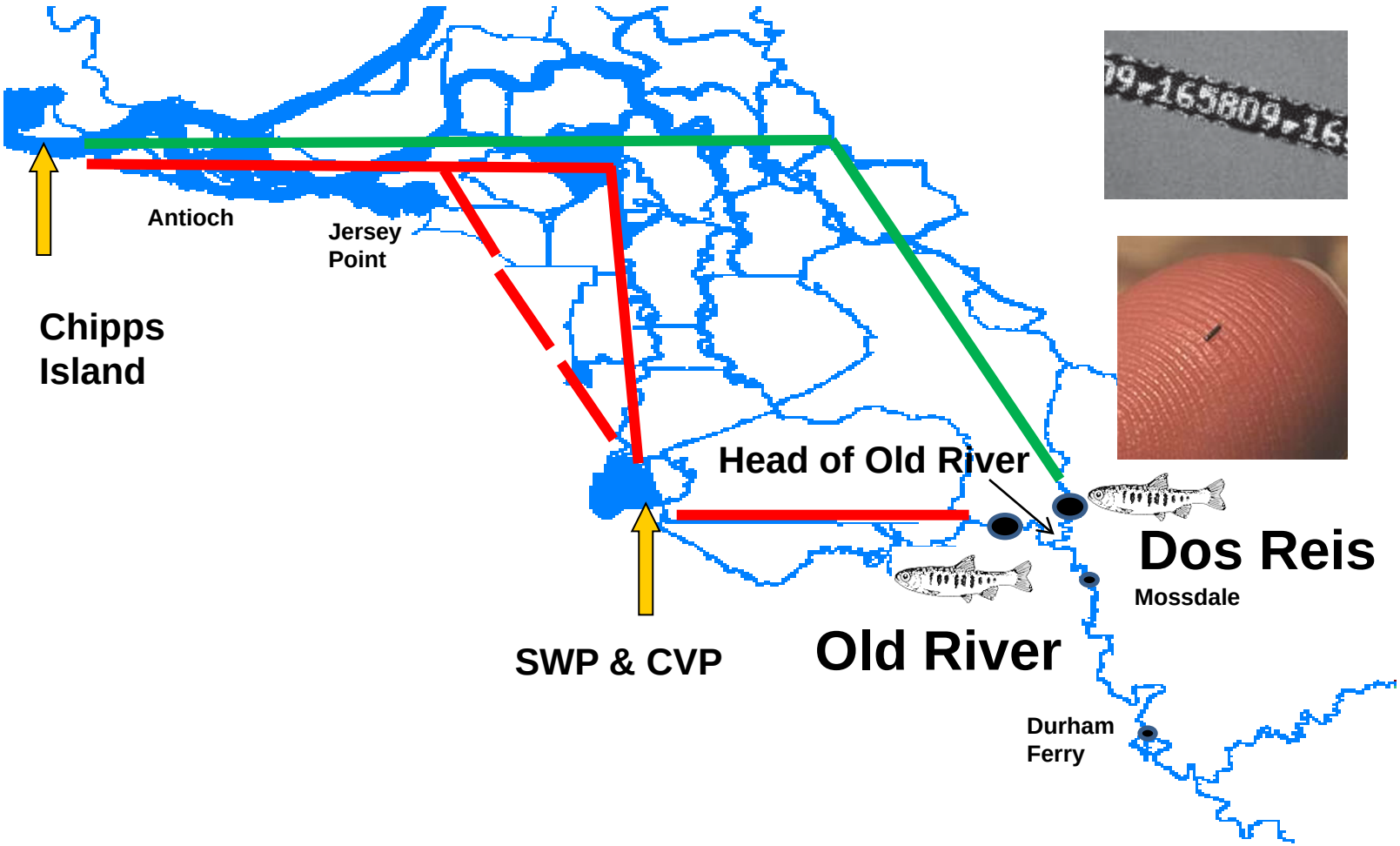


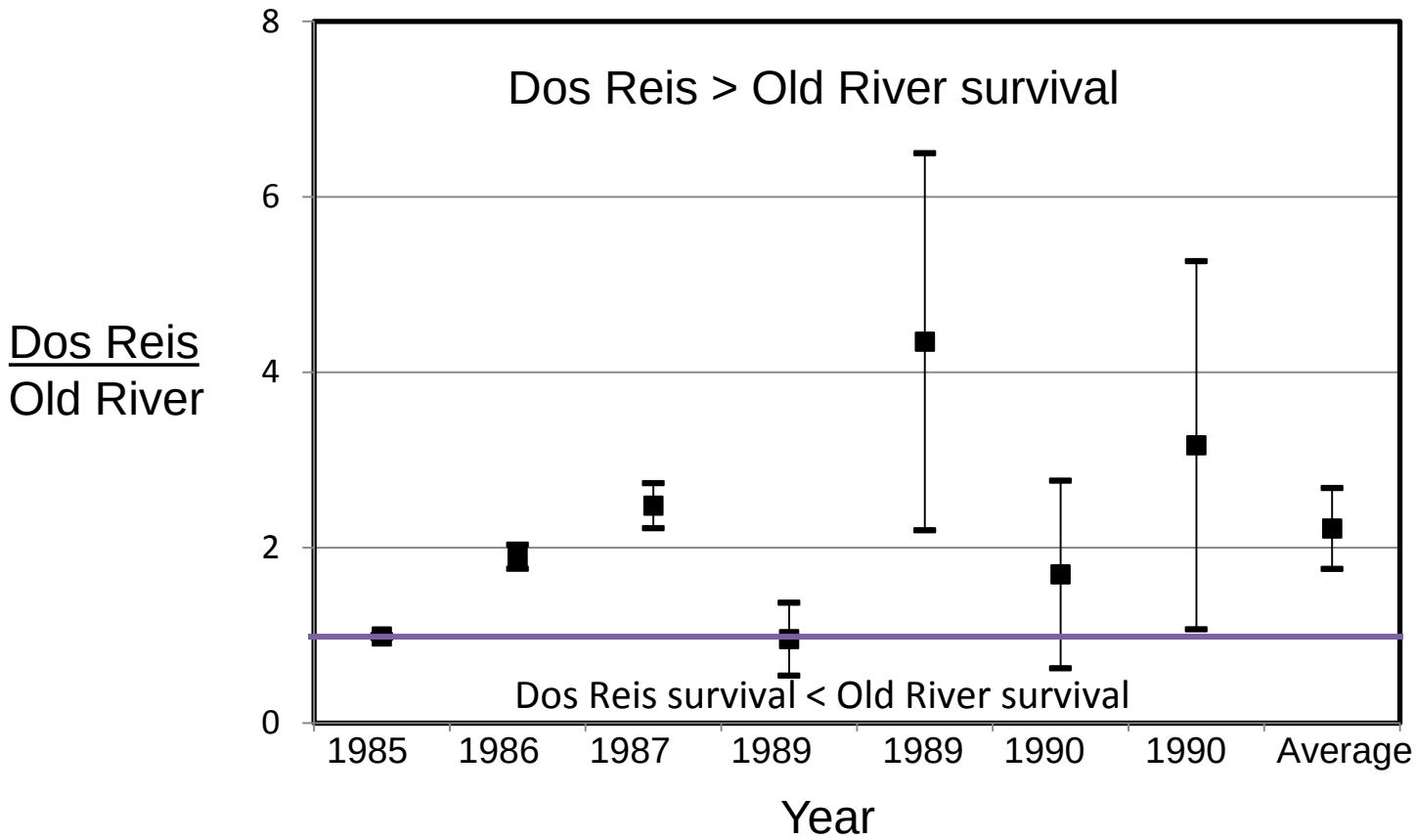
Head of Old River



Mean Values for December-March
1993-2005

Source: Source Lenny Grimaldo (In Review)


Antioch
Jersey Point
Chipps Island
Head of Old River
Dos Reis
Mossdale
SWP & CVP
Old River
Durham Ferry

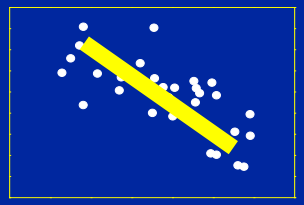


Recoveries at Chipps Island and in ocean fishery

Source: SJRG, 2007 – 2006 VAMP Annual Report

What Changes As Flow Increases?

Salinity
and X2



FLOW

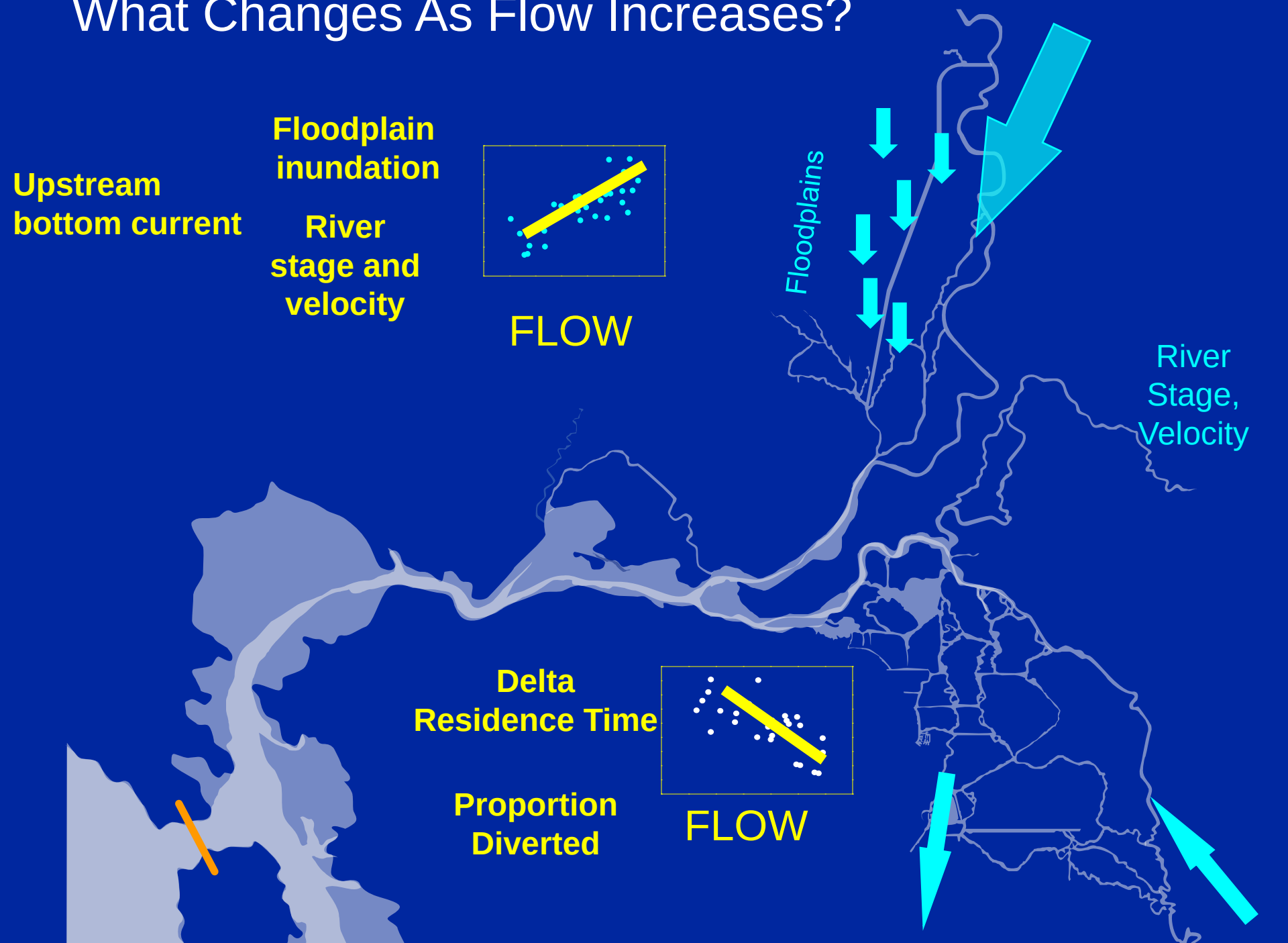
Location of
Any Salinity
Range

X2

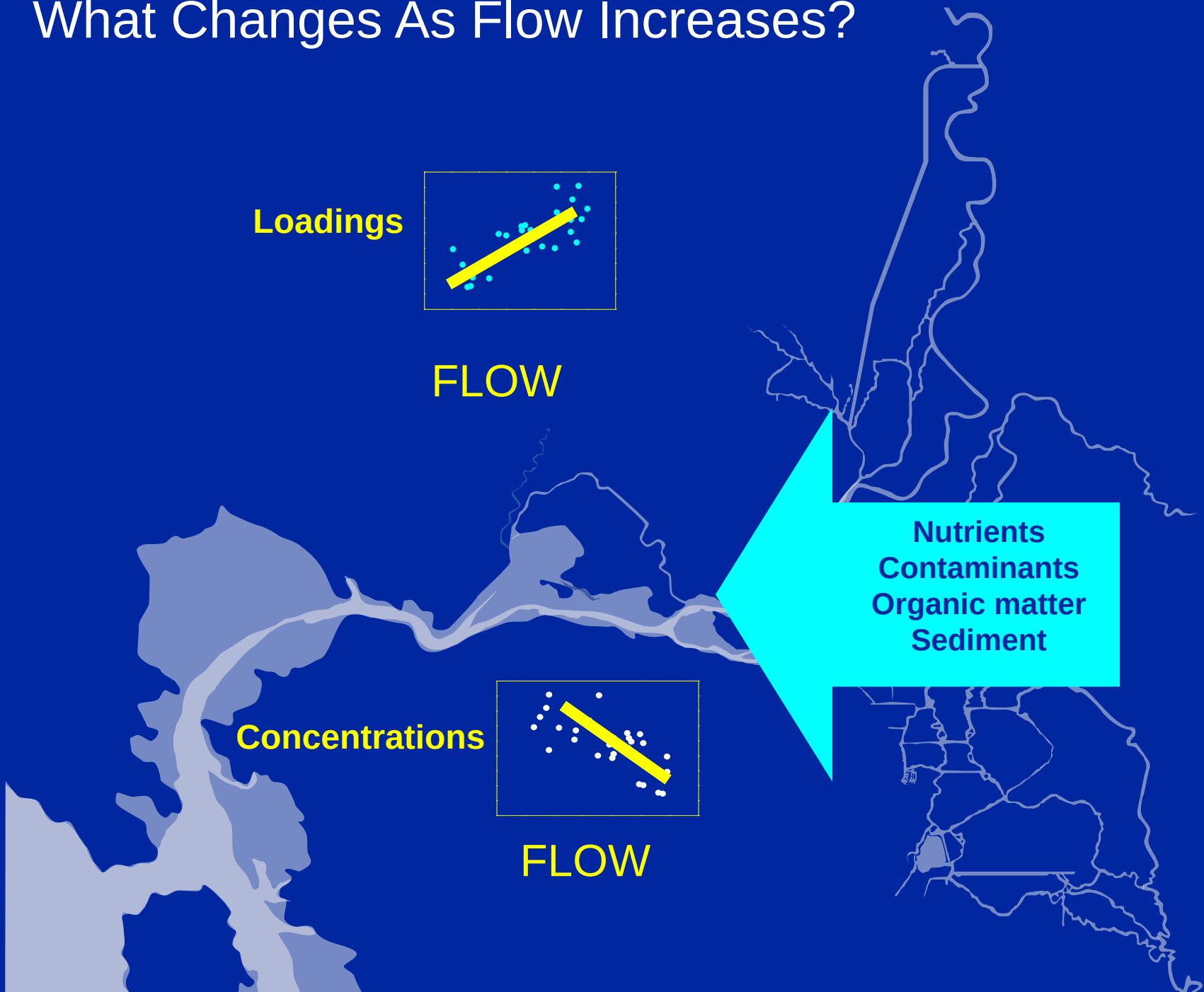
L
S
Z

stratification

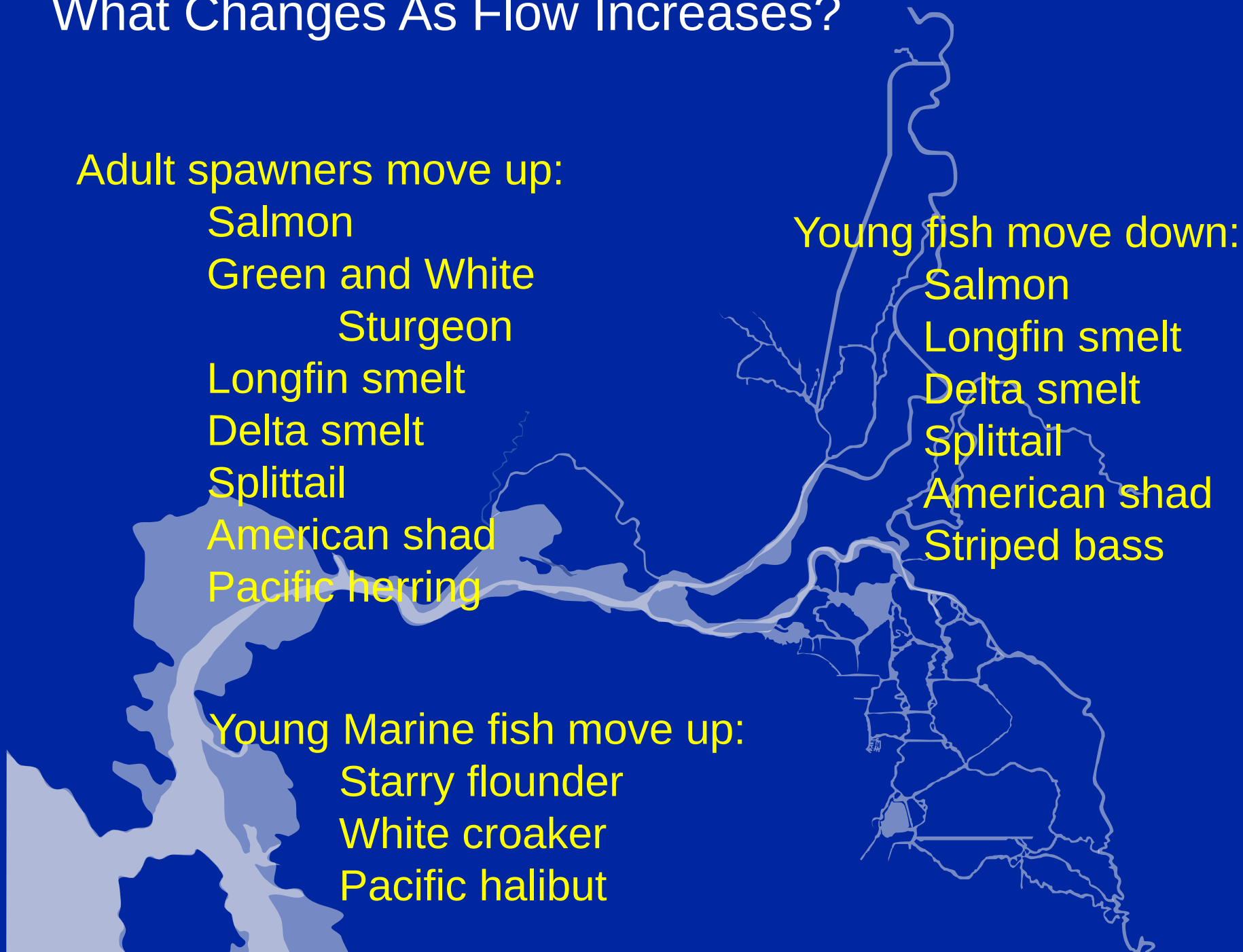
What Changes As Flow Increases?



What Changes As Flow Increases?



What Changes As Flow Increases?



Adult spawners move up:

- Salmon
- Green and White Sturgeon
- Longfin smelt
- Delta smelt
- Splittail
- American shad
- Pacific herring

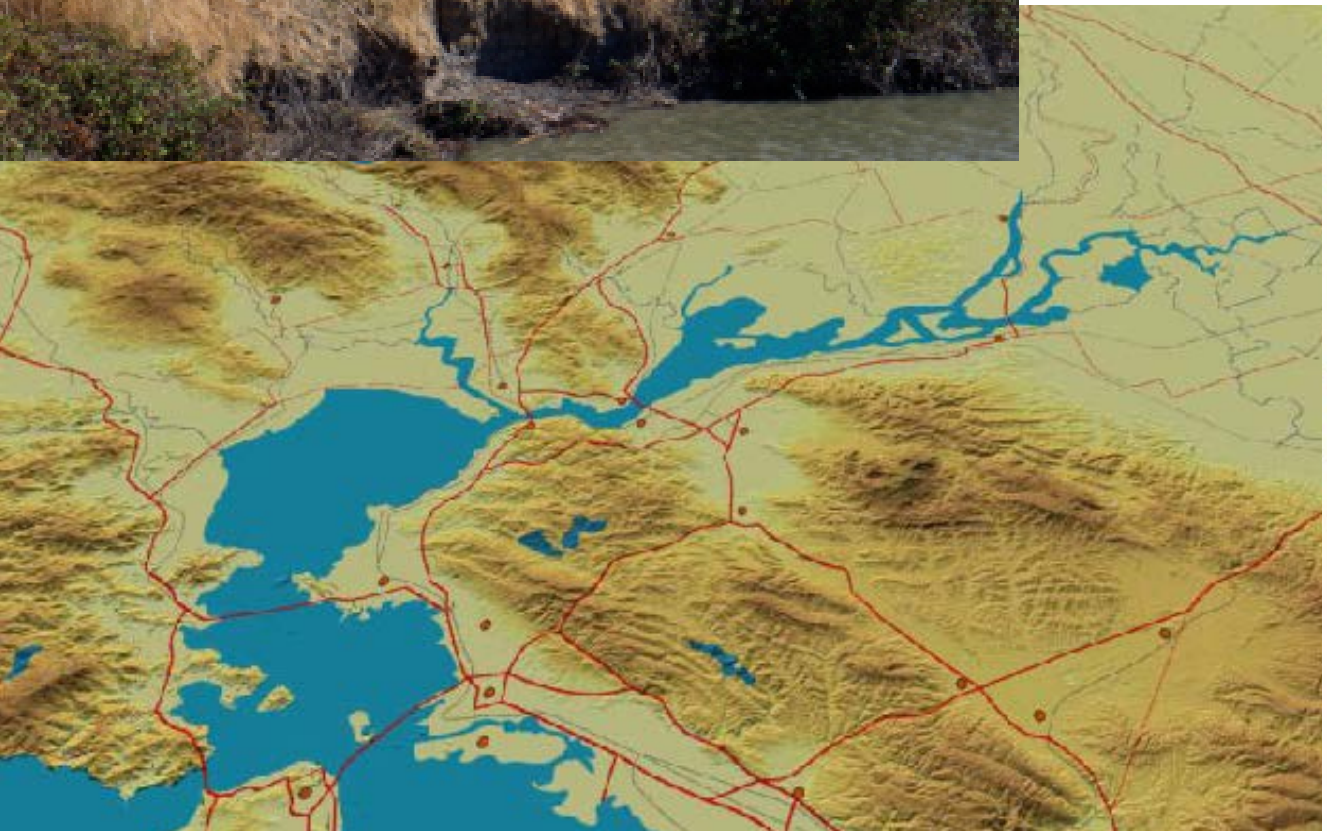
Young fish move down:

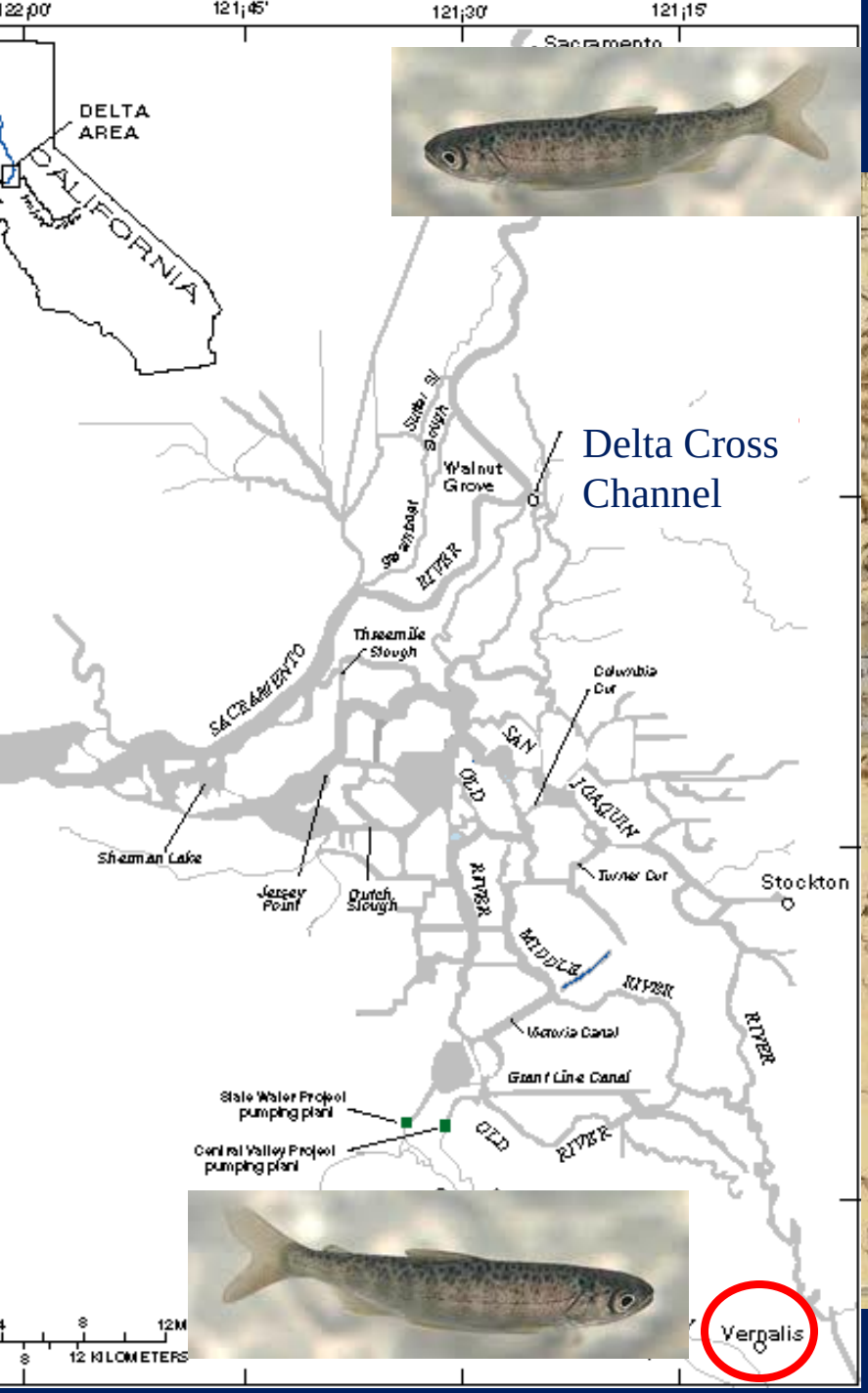
- Salmon
- Longfin smelt
- Delta smelt
- Splittail
- American shad
- Striped bass

Young Marine fish move up:

- Starry flounder
- White croaker
- Pacific halibut

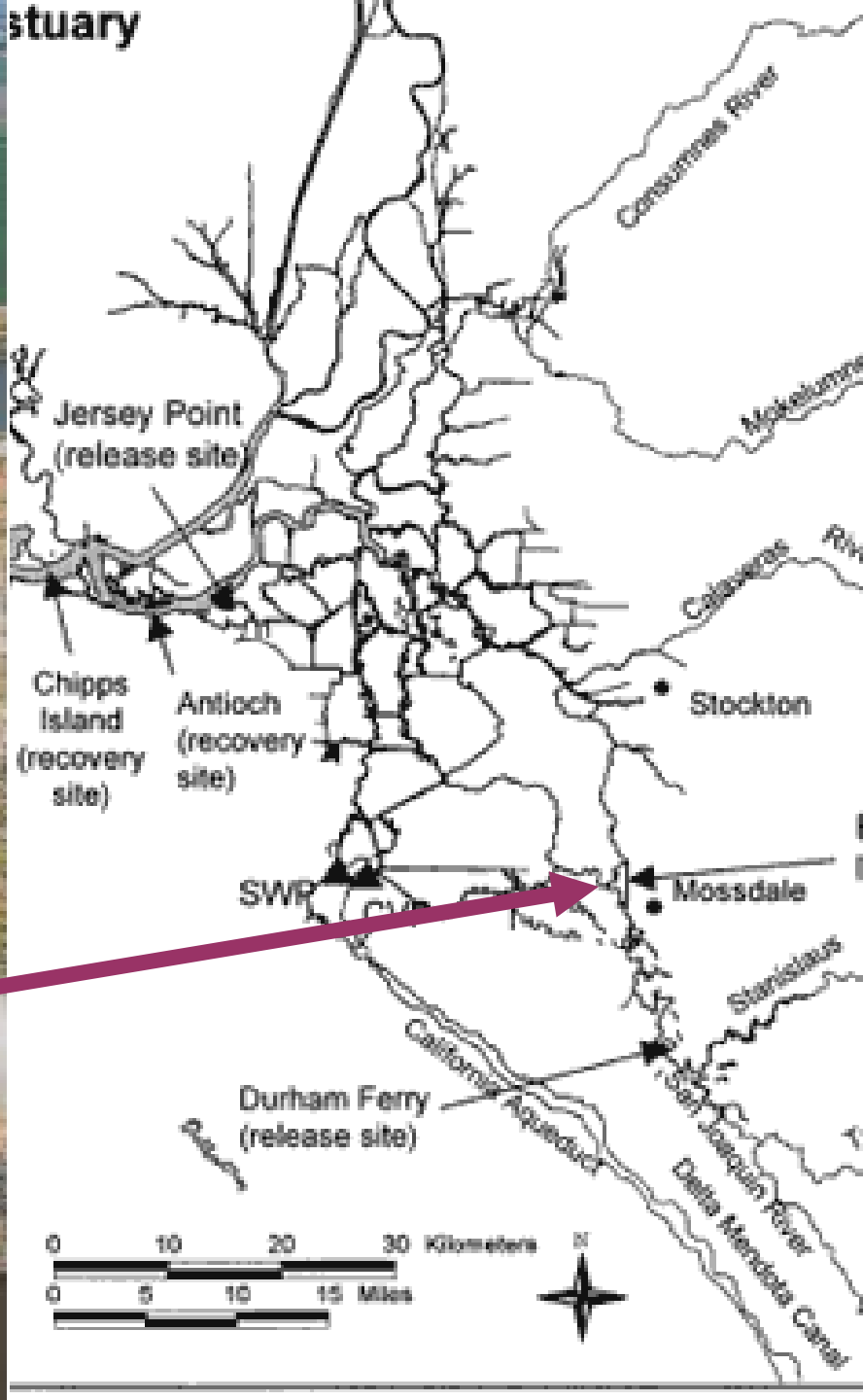
Flows are important but so is geometry

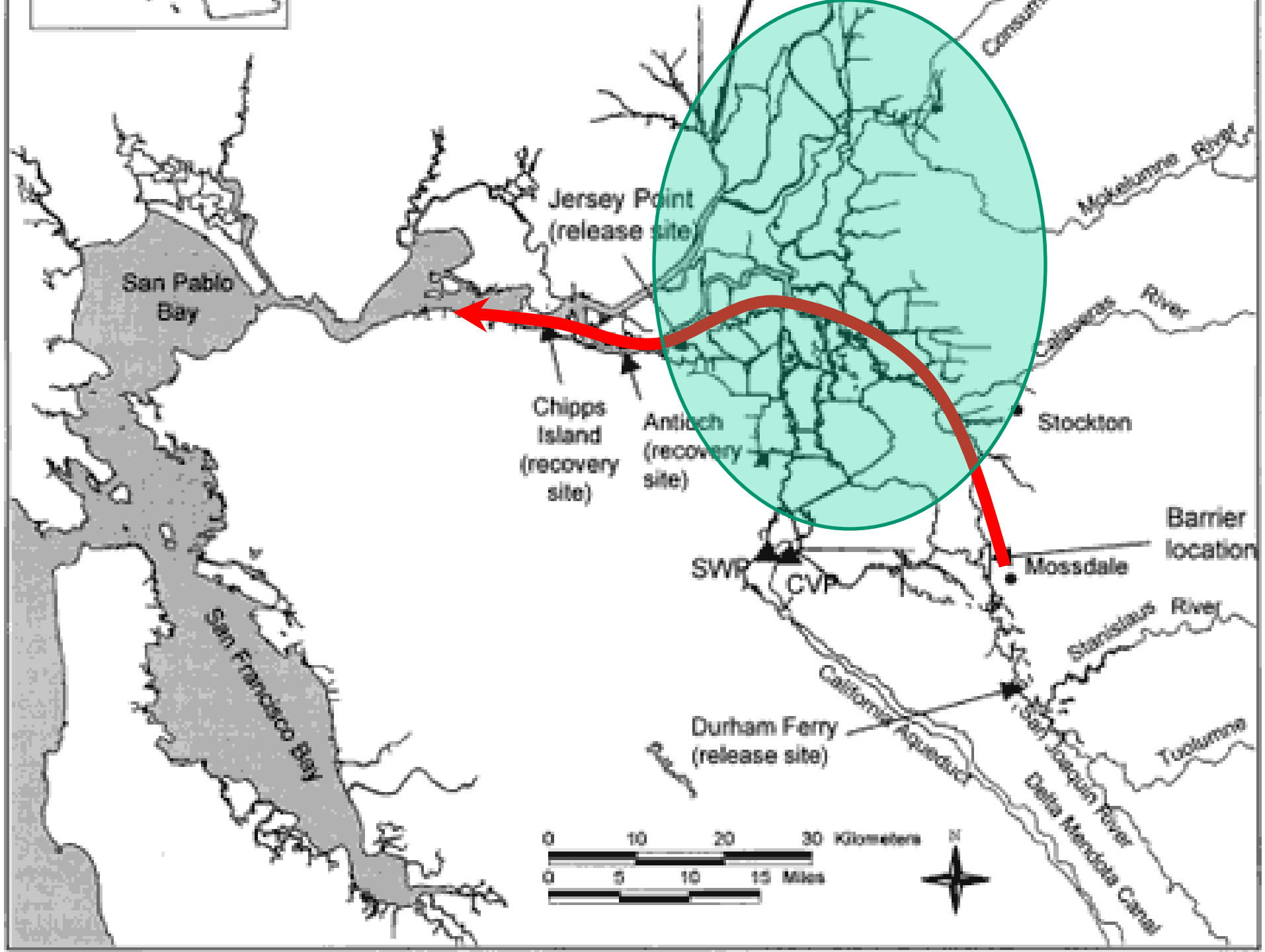


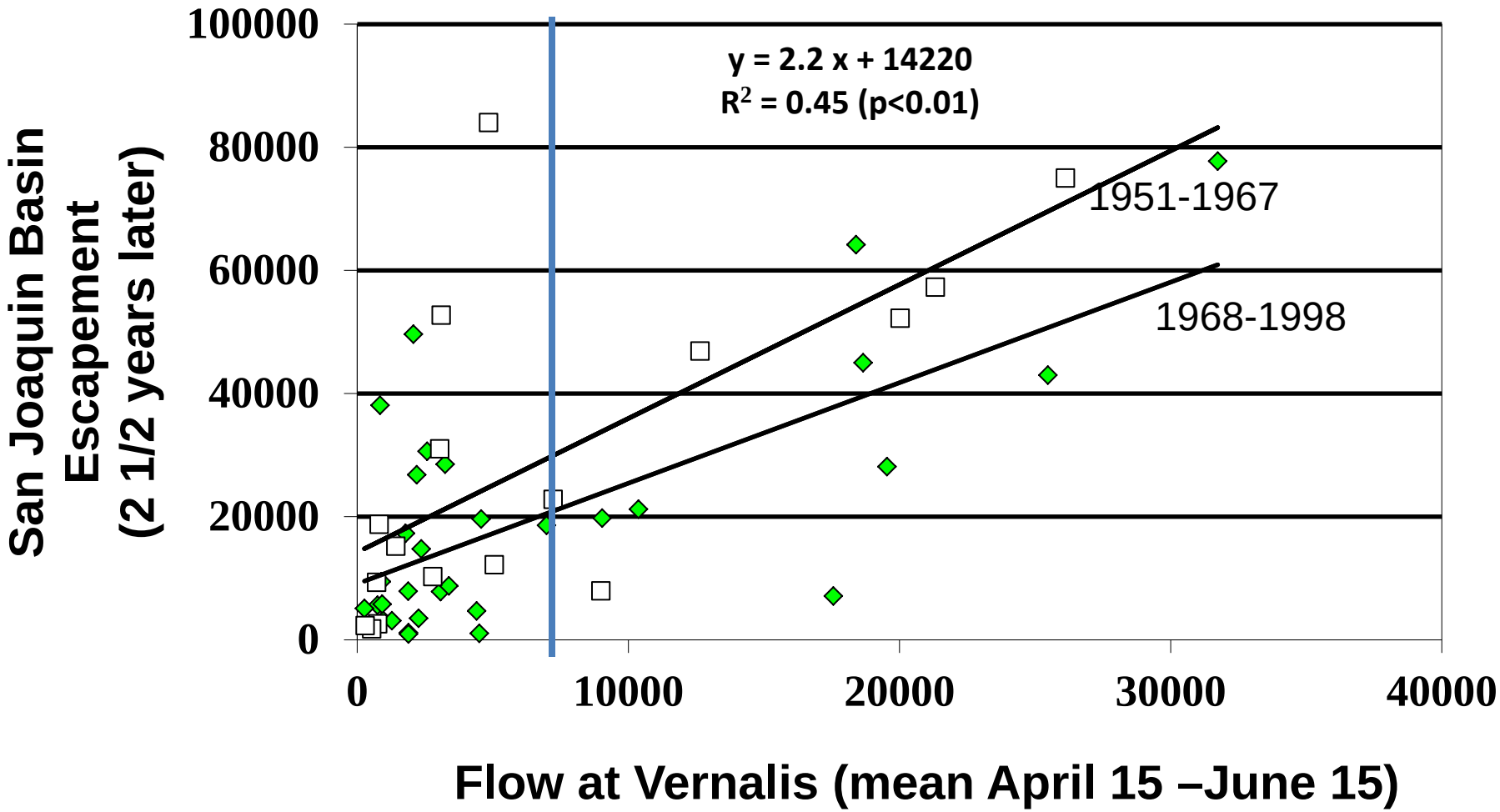

122°00'
121°45'
121°30'
121°15'
Sacramento
DELTA AREA
CALIFORNIA
Delta Cross Channel
Walnut Grove
Sutter Slough
Steamboat
RIVER
SACRAMENTO
Threemile Slough
Columbia Cut
SAN JOAQUIN
OLD
RIVER
Sherman Lake
Jersey Point
Dutch Slough
Turner Cut
Stockton
MIDDLE
RIVER
Victoria Canal
Grant Line Canal
State Water Project pumping plant
Central Valley Project pumping plant
OLD
RIVER
Vernalis
12 KILOMETERS

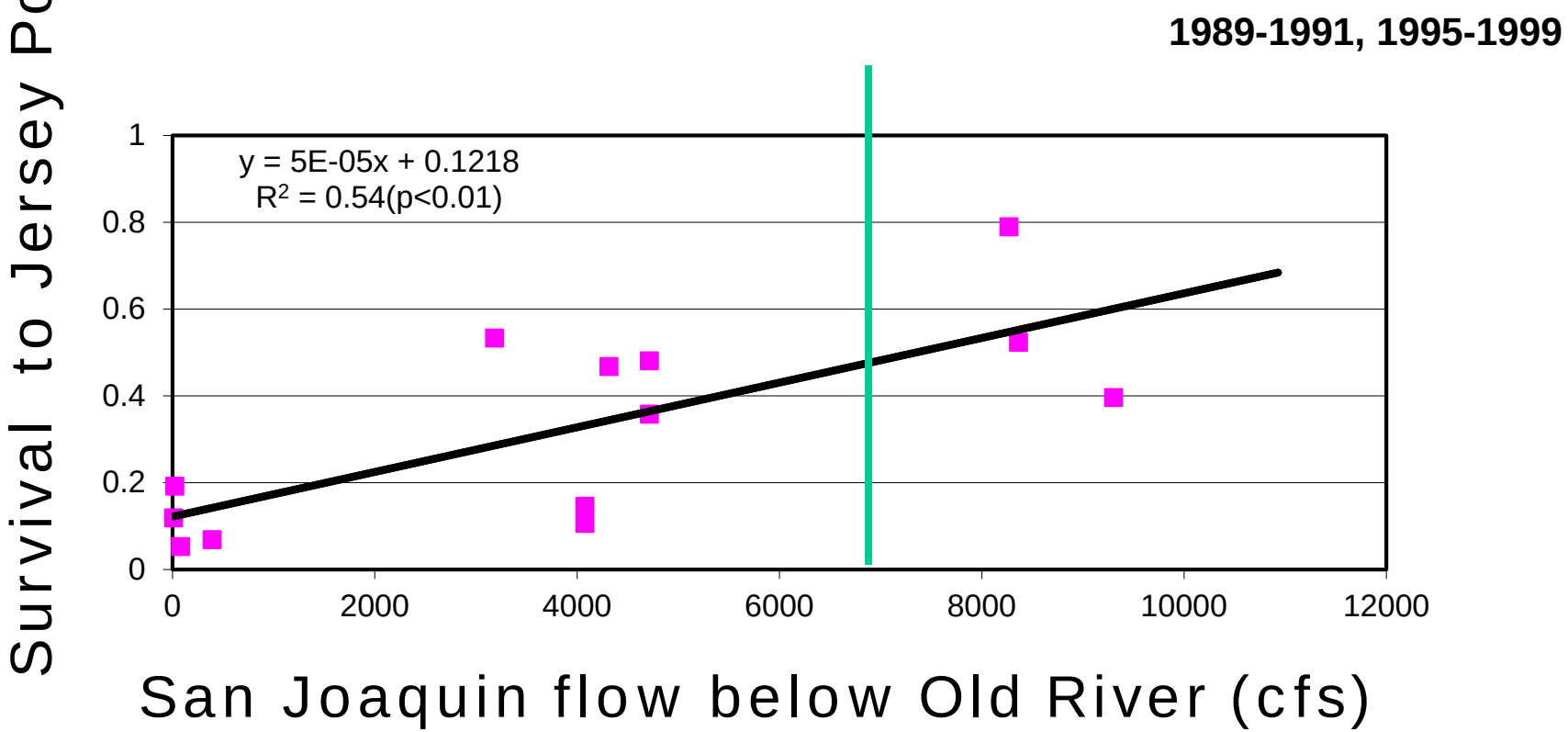
SACRAMENTO
Davisville
Batavia
Elk Grove
Galt
Rio Vista
Newport
Mokelumne
STOCKTON
Lathrop
Banta
Ellis
Holway
San Joaquin City
MODESTO
Empire City
Oak Dale
Knights Ferry
Farmington
Peters
Norton
Summersville
Pittsburgh
Antioch
Mt DIABLO BASE LINE
Mt DIABLO MERID.
Arcade
Latrobe
Bridgeport
Dry Creek
Willow Slough
MOKELUMNE
COSUMNES
CALAVERAS
STANISLAUS
JACKSON
Chili Camp
Cut Camp
Jersey Land
Brushville
Millers
Knights Ferry
Dickerson
Gravesville

Head of Old River Barrier


stuary
Consumnes River
Mokelumne
Calaveras
Jersey Point
(release site)
Chipps
Island
(recovery
site)
Antioch
(recovery
site)
Stockton
SWP
Mossdale
Stanislaus
California Aquaduct
Durham Ferry
(release site)
San Joaquin River
Delta Mendota Canal
0 10 20 30 Kilometers
0 5 10 15 Miles
N

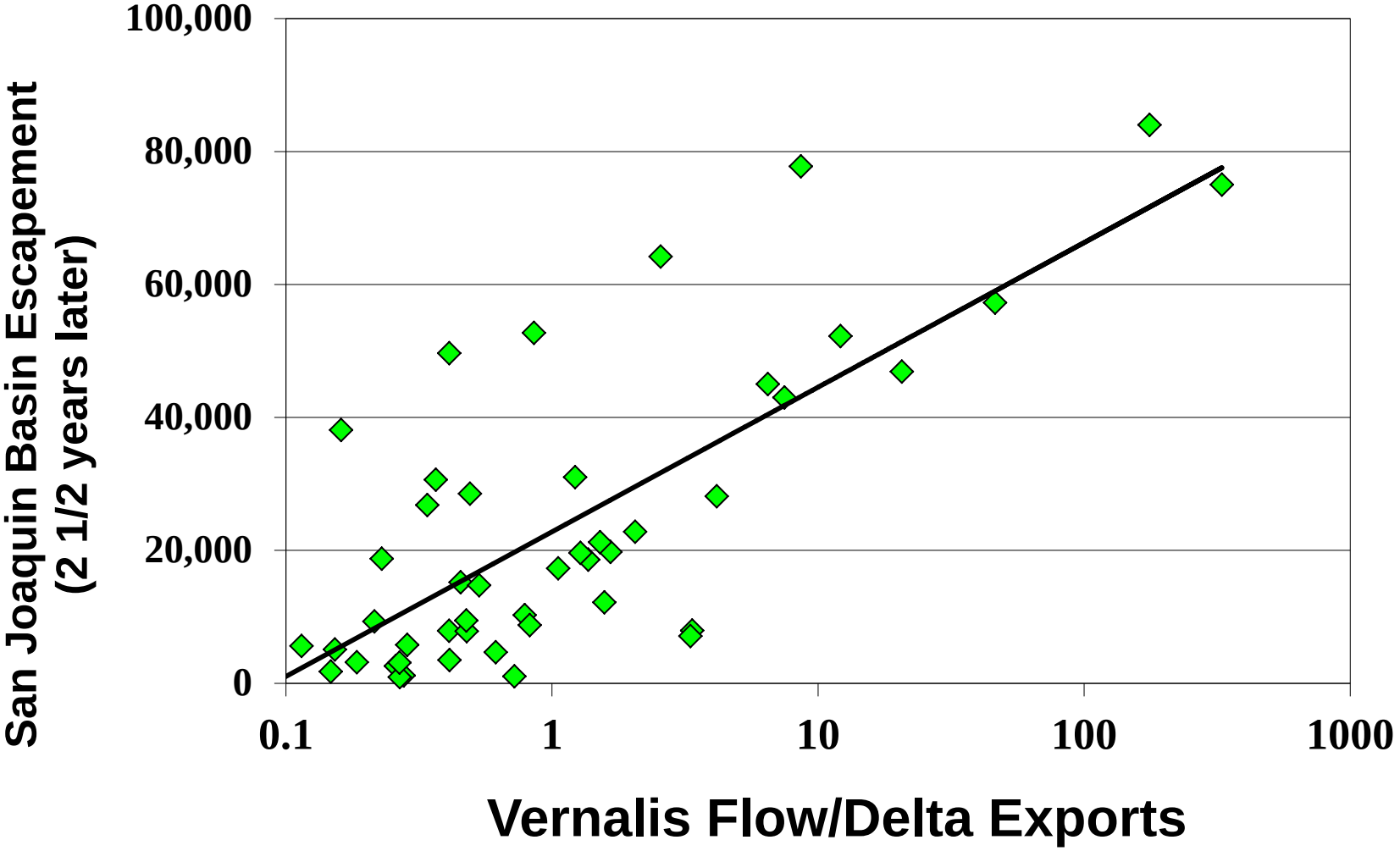

Jersey Point
(release site)
San Pablo
Bay
Chipps
Island
(recovery
site)
Antioch
(recovery
site)
Stockton
Mokelumne River
Calaveras River
Barrier
location
Mossdale
SWP
CVP
Stanislaus River
California Aquedut
Durham Ferry
(release site)
San Joaquin River
Tuolumne
Delta Mendota Canal
San Francisco Bay
0 10 20 30 Kilometers
0 5 10 15 Miles
N


y = 2.2 x + 14220
R2 = 0.45 (p<0.01)
1951-1967
1968-1998
100000
80000
60000
40000
20000
0
0
10000
20000
30000
40000
San Joaquin Basin Escapement (2 1/2 years later)
Flow at Vernalis (mean April 15 –June 15)



Chipps Island and ocean fishery recapture of fish released below Head of Old River

Source: SJRGA, 2007 – 2006 VAMP Annual Report



Mean spring flows /Delta exports (mean April 15- June 15) vs San Joaquin Basin Escapement (2 1/2 years later) from 1951-1998.

San Joaquin River
Upper Old River

VAMP

- 12 year study on delta survival
- 5 experimental flow/export combinations
- 8 years fit design (3 flood outs, 1 off-ramped)
- Midwater trawl, Kodiak trawl, and adult ocean captures supply data

Design Parameters

- Old River Barrier only at < 7000 cfs

- Smelt opinion requires:

Exports < half of Vernalis flow

- Minimal Exports = 1500 cfs

VAMP Target conditions

Flow at Vernalis (cfs)

Exports (cfs)	3200	4450	5700	7000
1500	***A***	***B***		***C***
2250			***D***	
3000				***E***

Actual VAMP flows

San Joaquin River near Vernalis

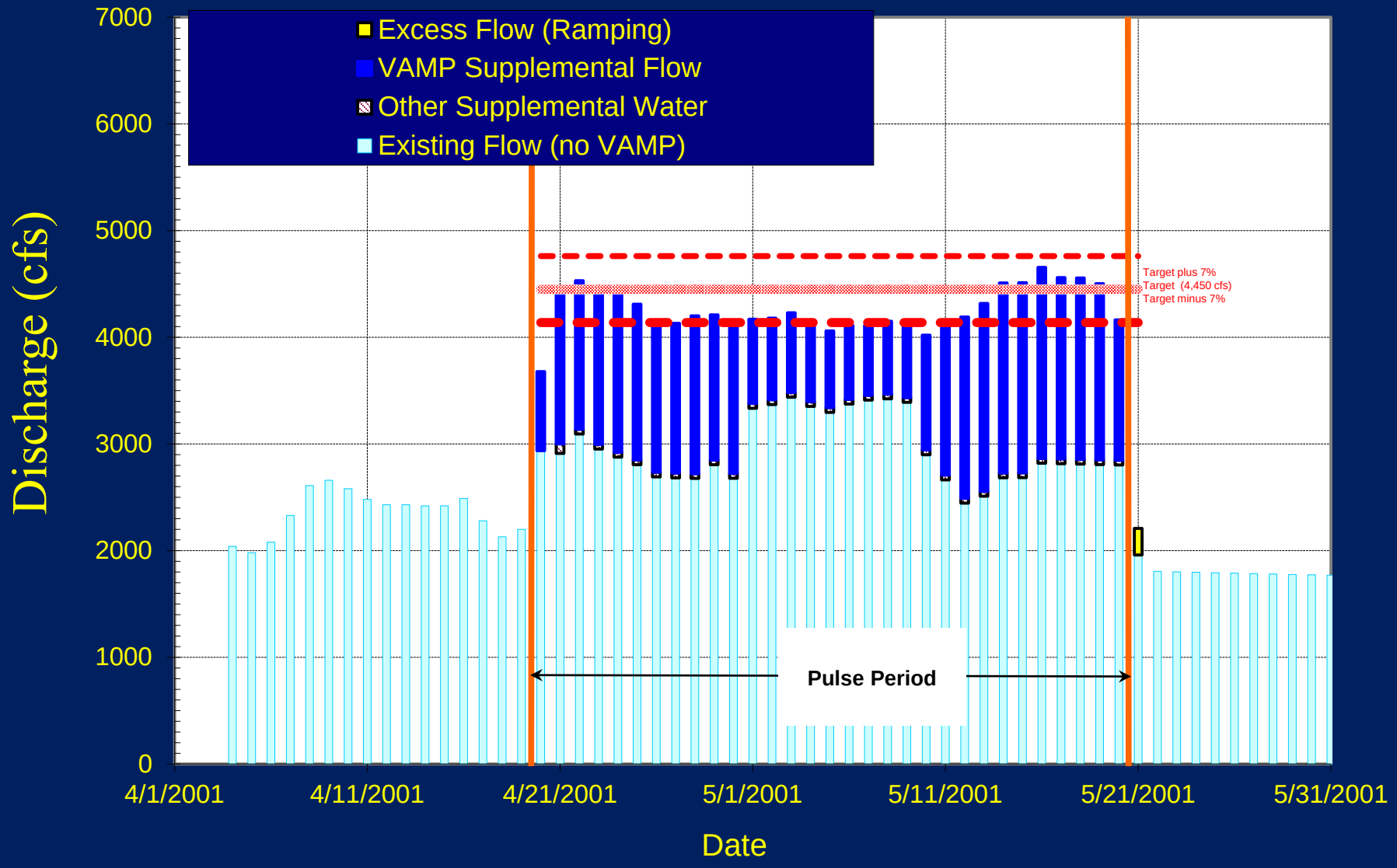


Figure 2-4

2007 VAMP: San Joaquin River near Vernalis
With Lagged Contributions from Primary Sources

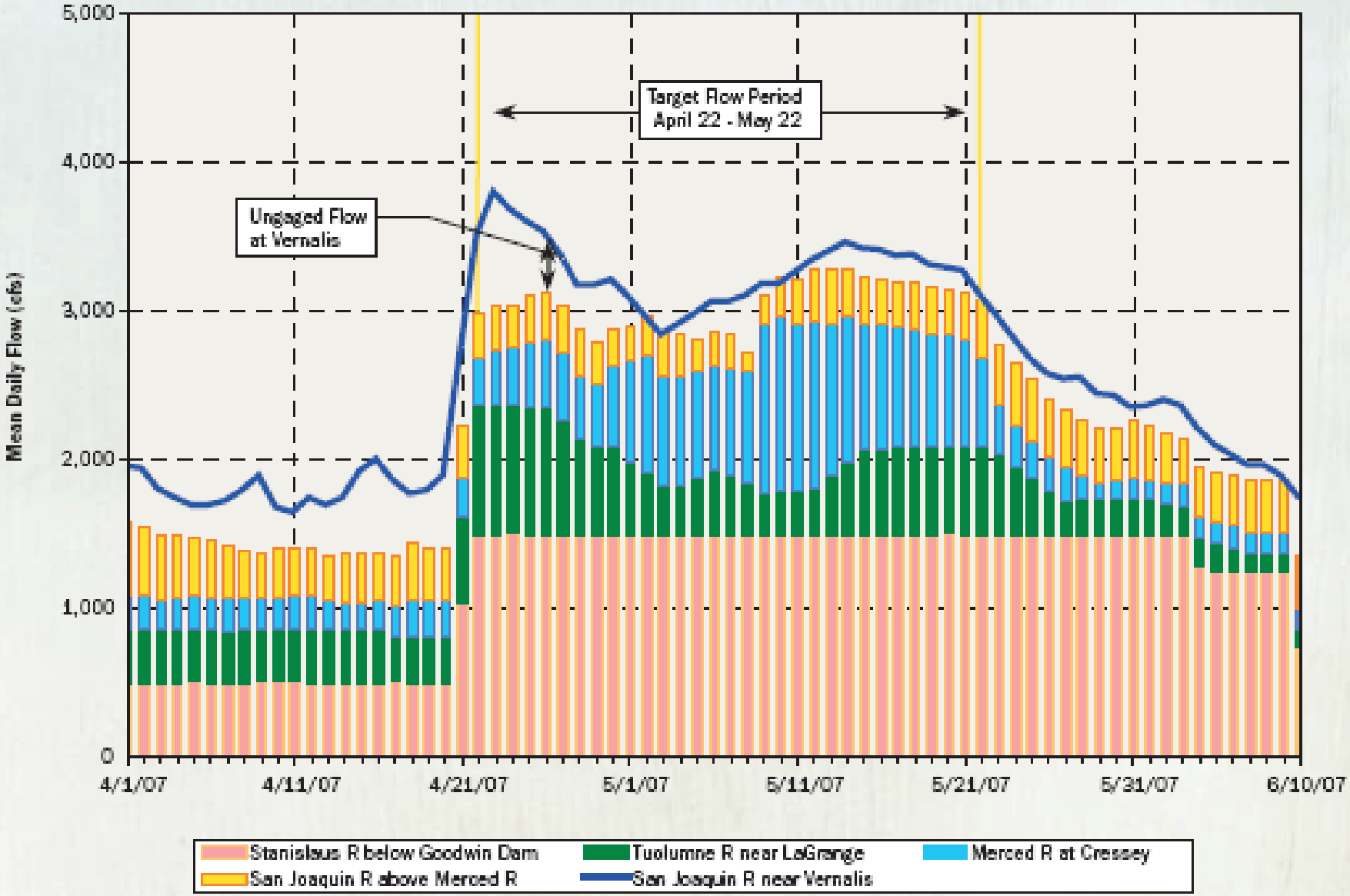
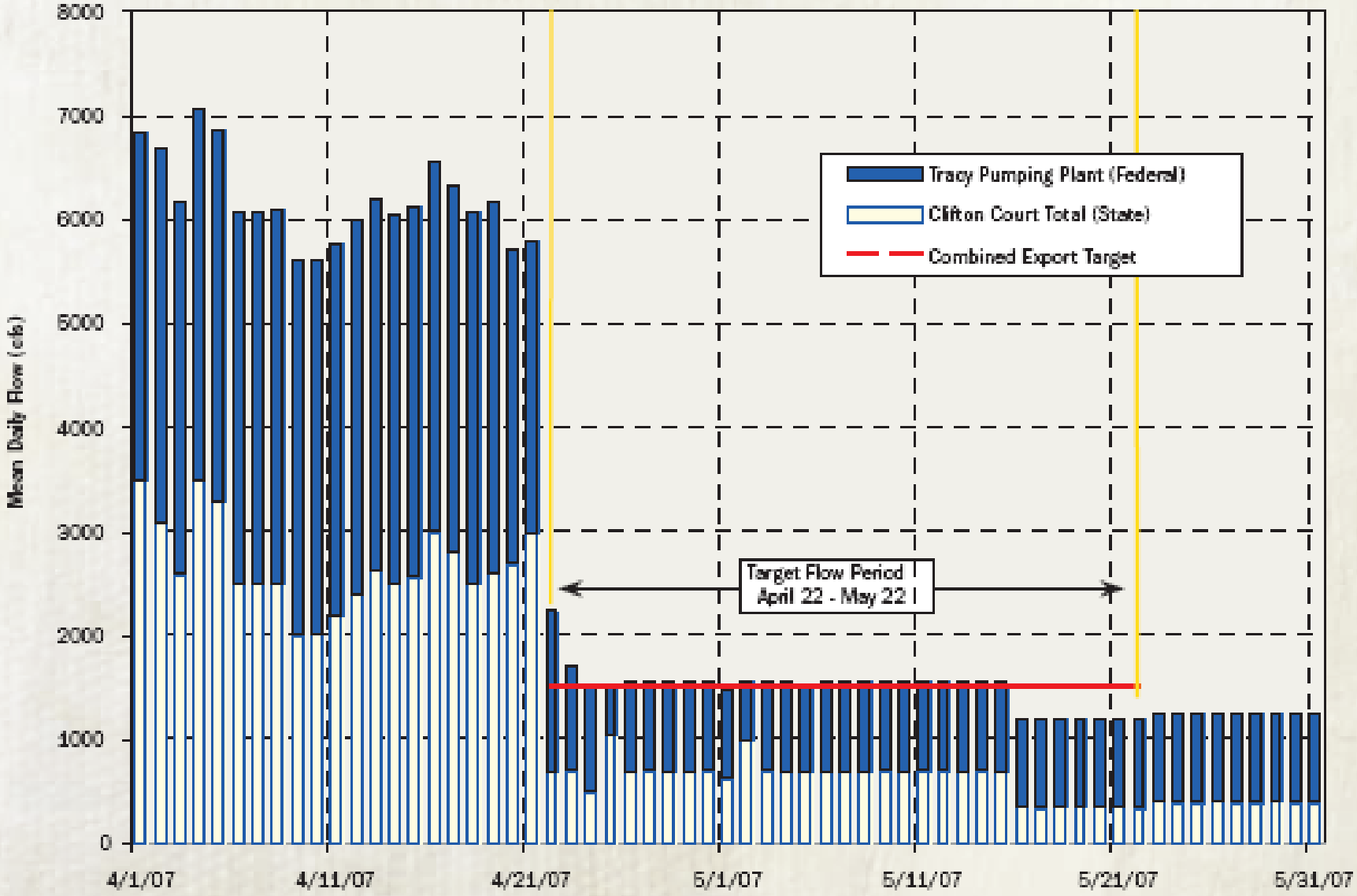


Figure 2-9
2007 VAMP - Federal and State Delta Exports



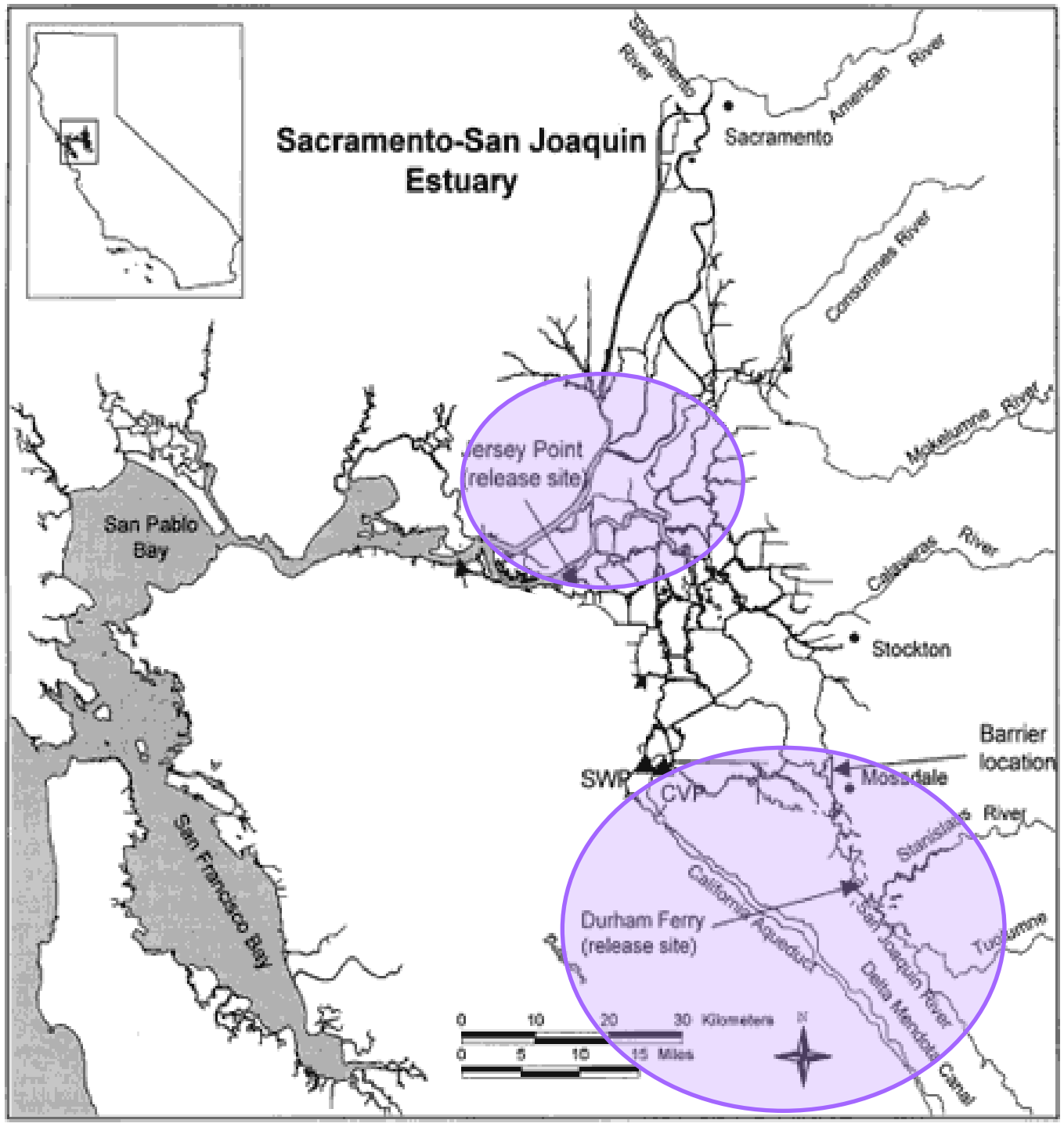
VAMP Conditions

Flow at Vernalis

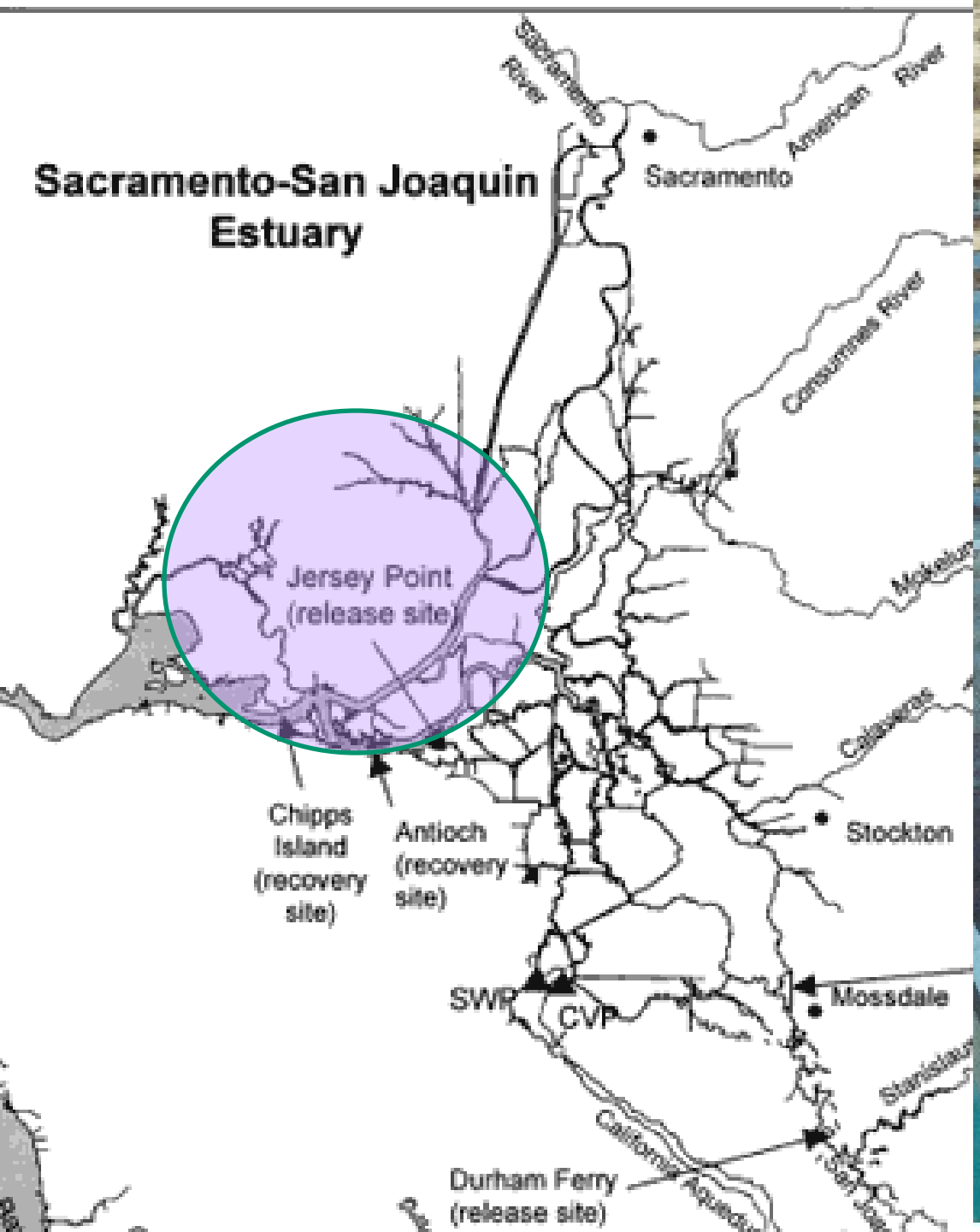
Exports	3200	4450	5700	7000
1500	2002 2003 2004 2007 2008	2001 2010		***C***
2250			2000	
3200				***E***

2009 – too dry 2005, 2006, & 2011 -- too wet

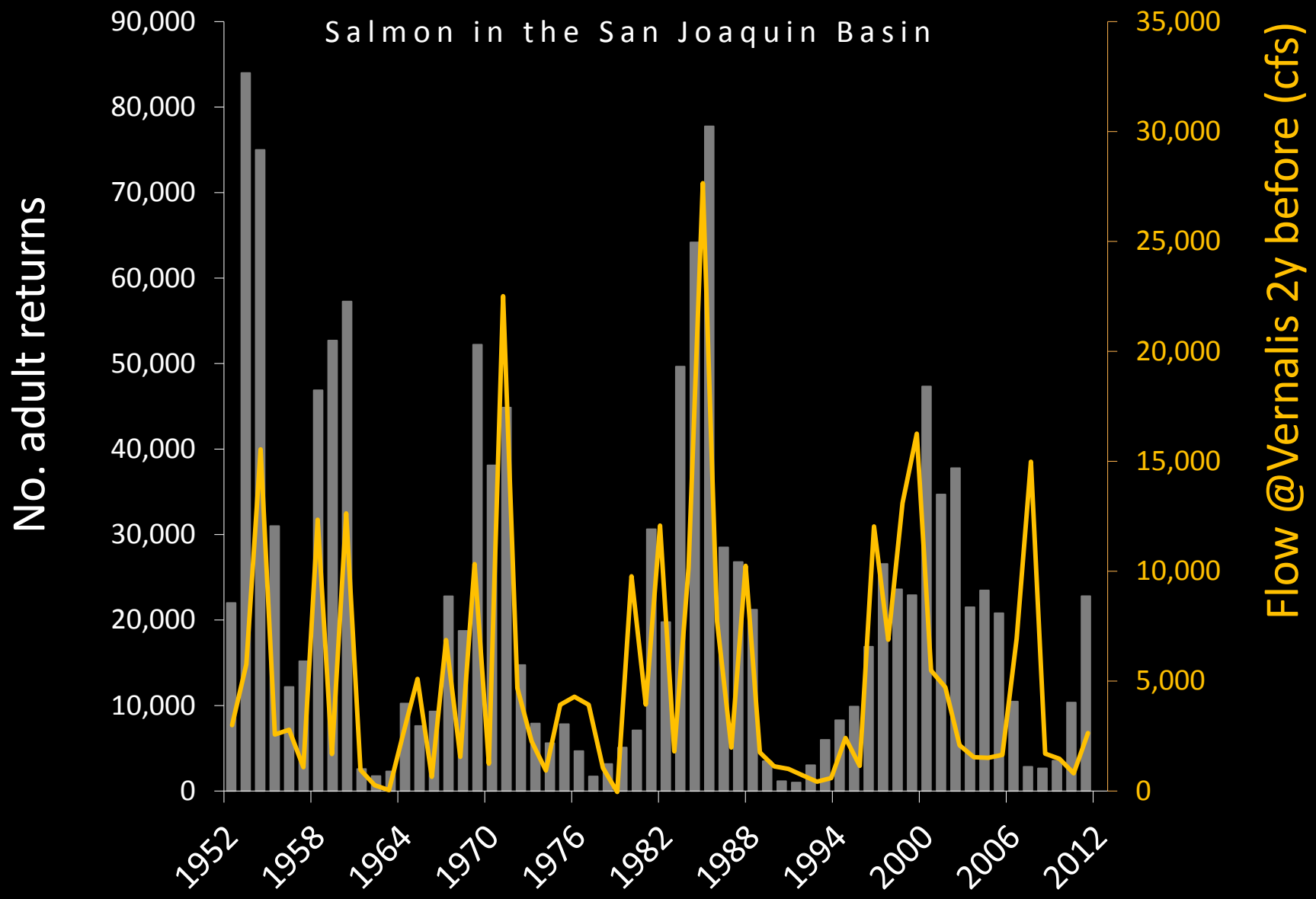
LIVE
FISH
15530


Sacramento-San Joaquin Estuary
Sacramento River
American River
Sacramento
Cosumnes River
Mokelumne River
Jersey Point (release site)
San Pablo Bay
Calaveras River
Stockton
Barrier location
SWP
CVP
Mossdale
Stanislaus River
California Aqueduct
Durham Ferry (release site)
San Joaquin River
Tuolumne
Delta Mendota Canal
San Francisco Bay
0 10 20 30 Kilometers
0 5 10 15 Miles
N

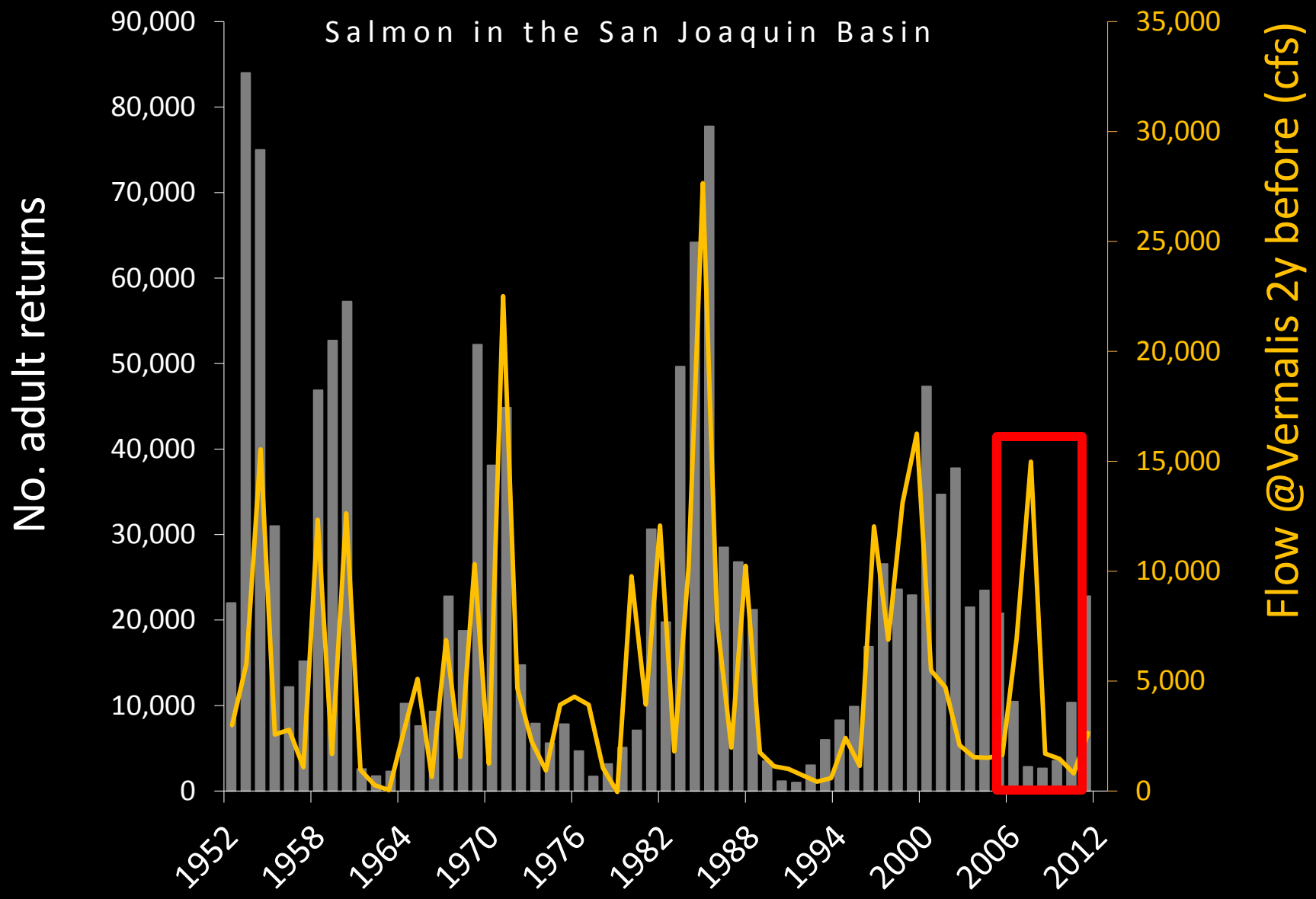
WHITESEL


Sacramento-San Joaquin Estuary
Sacramento River
American River
Sacramento
Cosumnes River
Mokelumne
Calaveras
Stockton
Jersey Point (release site)
Chipps Island (recovery site)
Antioch (recovery site)
SWP
CVP
Mossdale
Stanislaus
California Aqueduct
San Joaquin
Durham Ferry (release site)

Release site	Fish released	Fish recovered	Time sampled (%)
Mossdale	49018	9	38
Dos Reis	25062	3	41
Jersey Point	26193	26	38
Jersey Point	23980	14	36



Slide from A. Sturrock



Slide from A. Sturrock

Conclusions

- Long-term experimental design targeting management needs
- Successful massive and precise system manipulation
- Important experimental conditions unmet; conclusions limited
- New technology offers new options