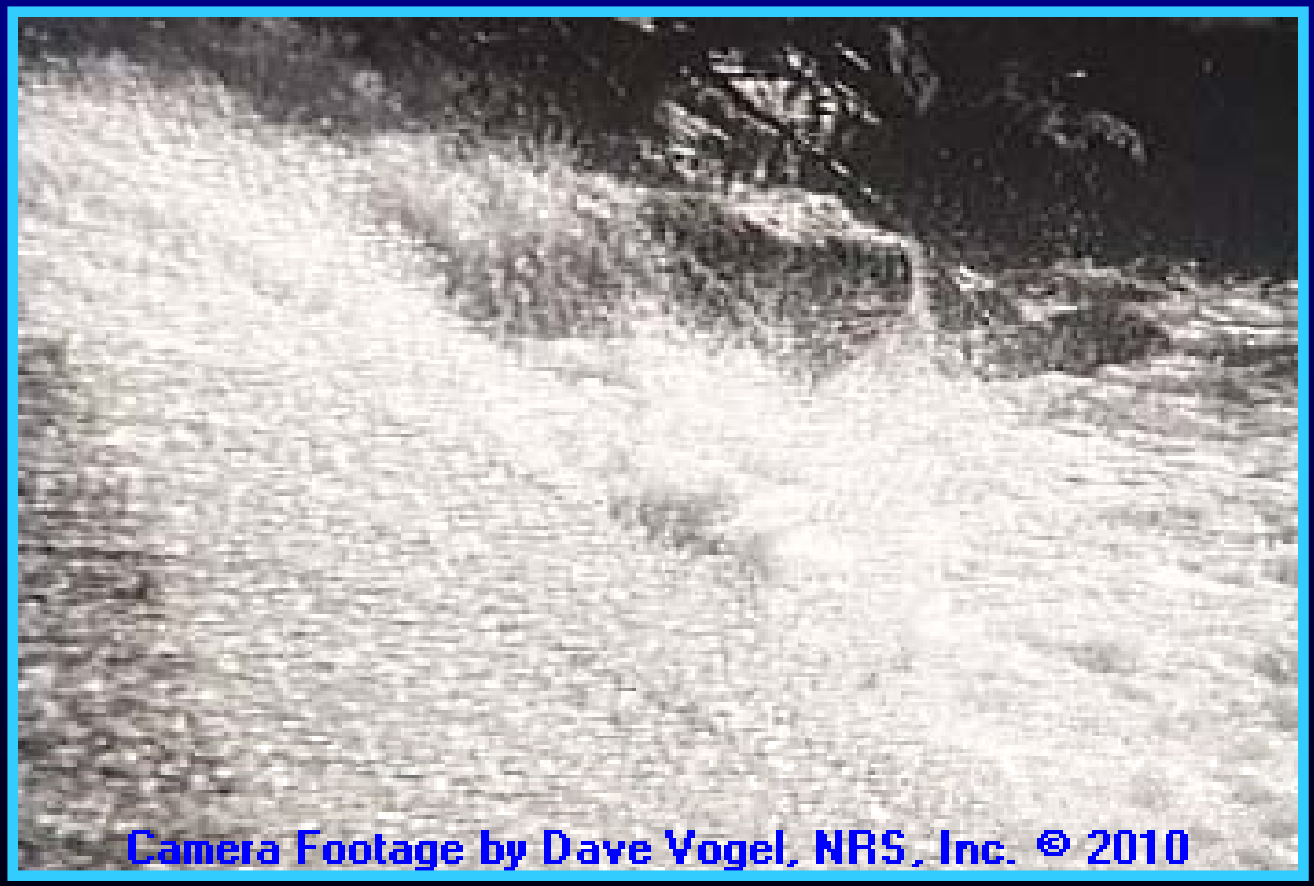
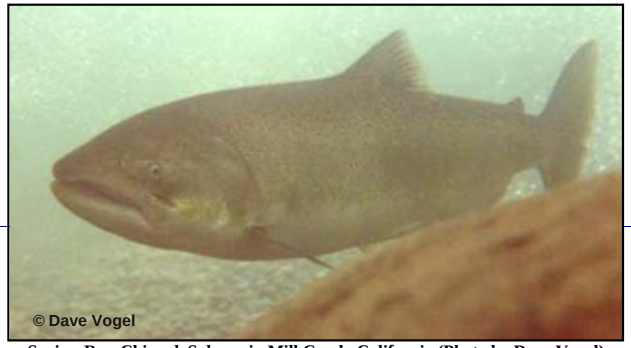
Insights into the Problems, Progress, and Potential Solutions for Salmon Restoration

Dave Vogel
Natural Resource Scientists, Inc.
Water Education Foundation Tour – October 24, 2014



Insights into the Problems, Progress, and Potential Solutions for Sacramento River Basin Native Anadromous Fish Restoration



Spring-Run Chinook Salmon in Mill Creek, California (Photo by Dave Vogel)

April 2011

Prepared for:

Northern California Water Association
and
Sacramento Valley Water Users

Prepared by:

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Red Bluff, CA 96080
dvogel@resourcescientists.com

Technical Report Available at:

Norcalwater.org

Recent Stakeholder Initiatives

- Northern California Water Association
- Glenn-Colusa Irrigation District
- Golden Gate Salmon Association
- The Nature Conservancy
- American Rivers

Sacramento River Basin Salmonids

Endangered Species Act Status

- Fall-Run Chinook Salmon (Candidate)
- Late-Fall-Run Chinook Salmon (Candidate)
- Winter-Run Chinook Salmon (Endangered)
- Spring-Run Chinook Salmon (Threatened)
- Steelhead Trout (Threatened)

Anadromous Salmonid Life Phases

- Upstream Migration and Holding
- Spawning and Egg Incubation
- Fry and Juvenile Rearing
- Fry and Juvenile Outmigration
- Ocean Rearing

Upstream Migration

Holding

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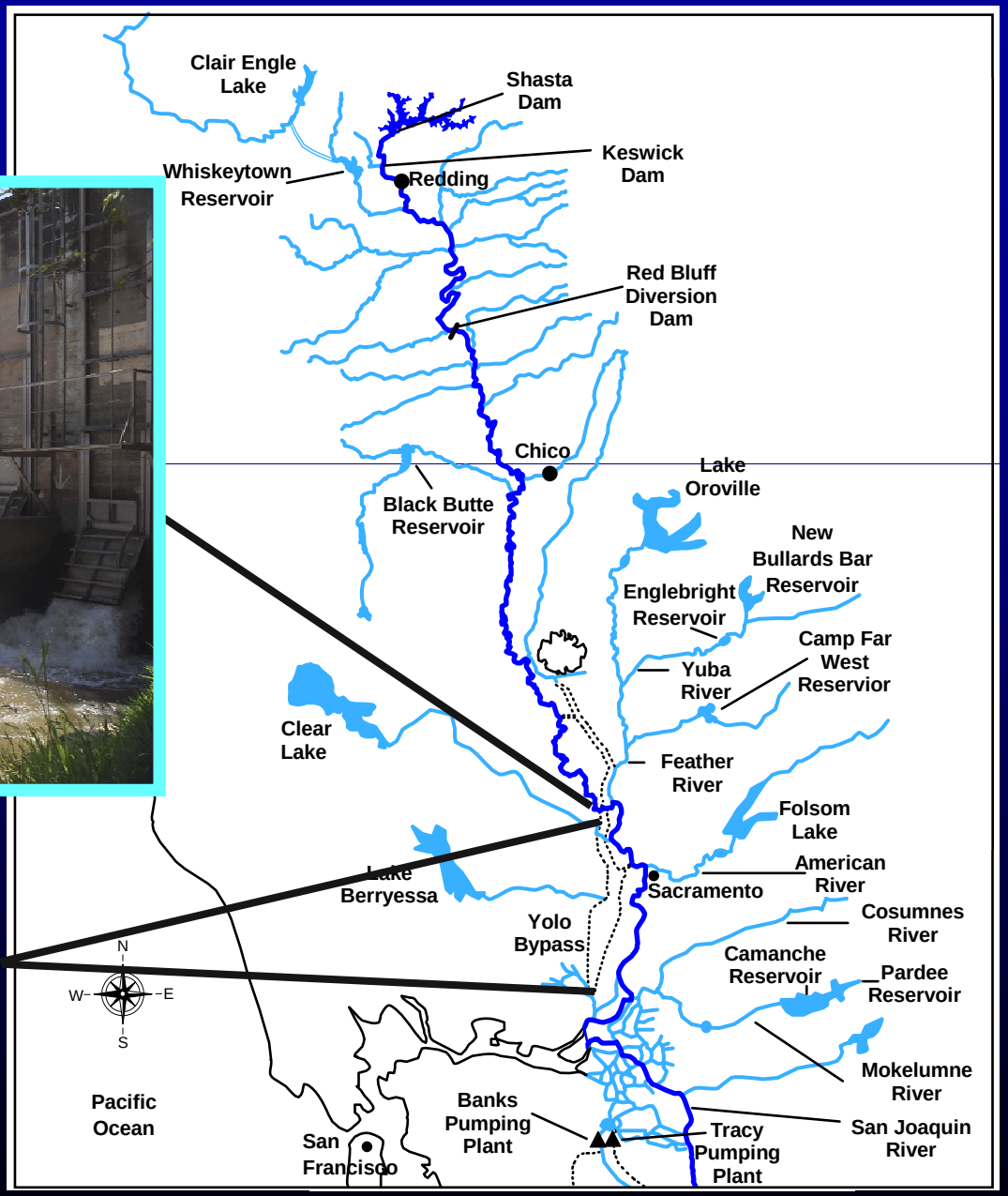
Upstream Migration

Colusa Basin Drain Outfall Gates

Yolo Bypass and Ridge Cut



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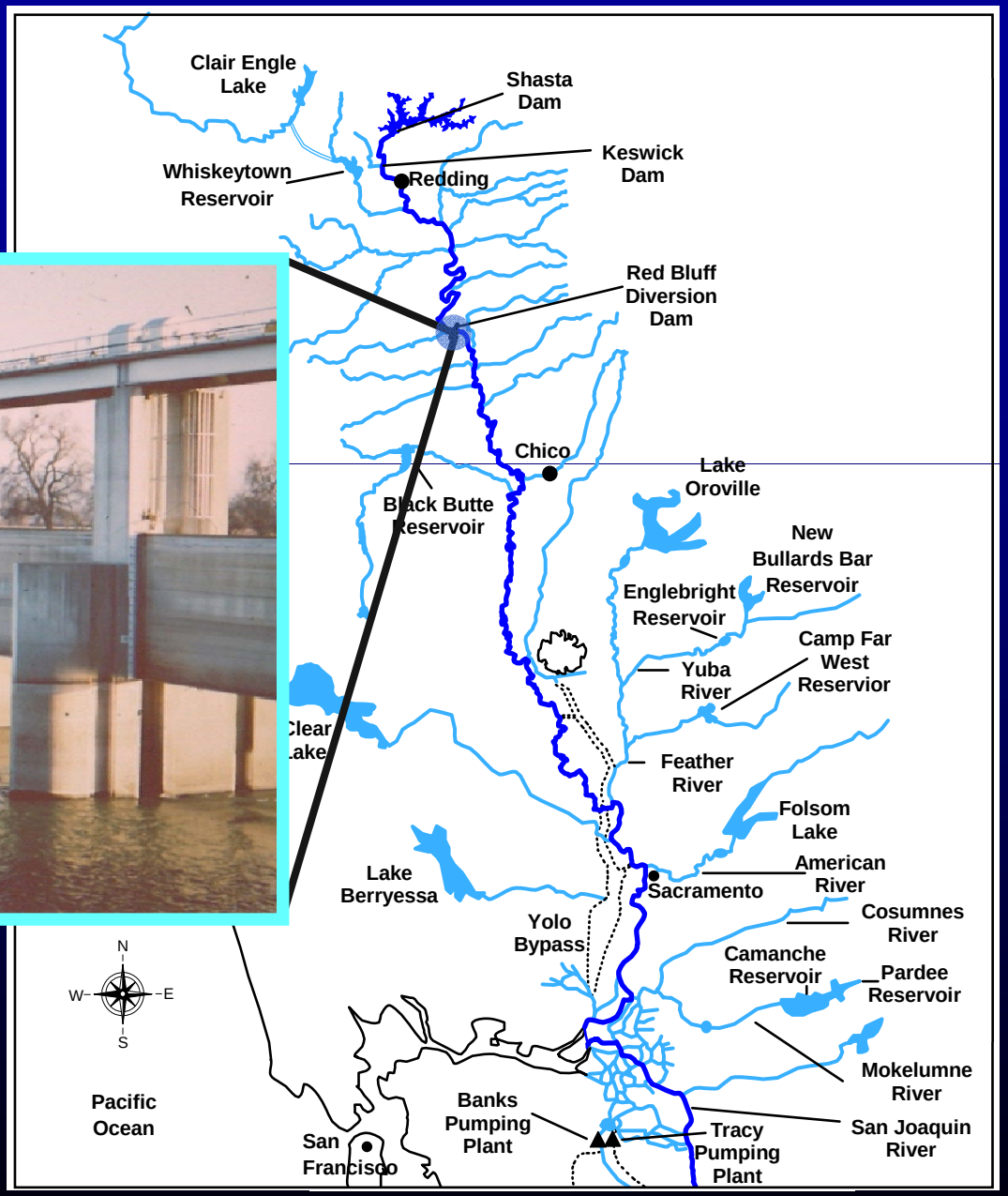
Progress – Upstream Migration

Red Bluff Diversion Dam

1987 - Dam Gates Out 6 months/yr

1993 - Dam Gates Out 8 months/yr

2012 - Dam Gates Out Year Round



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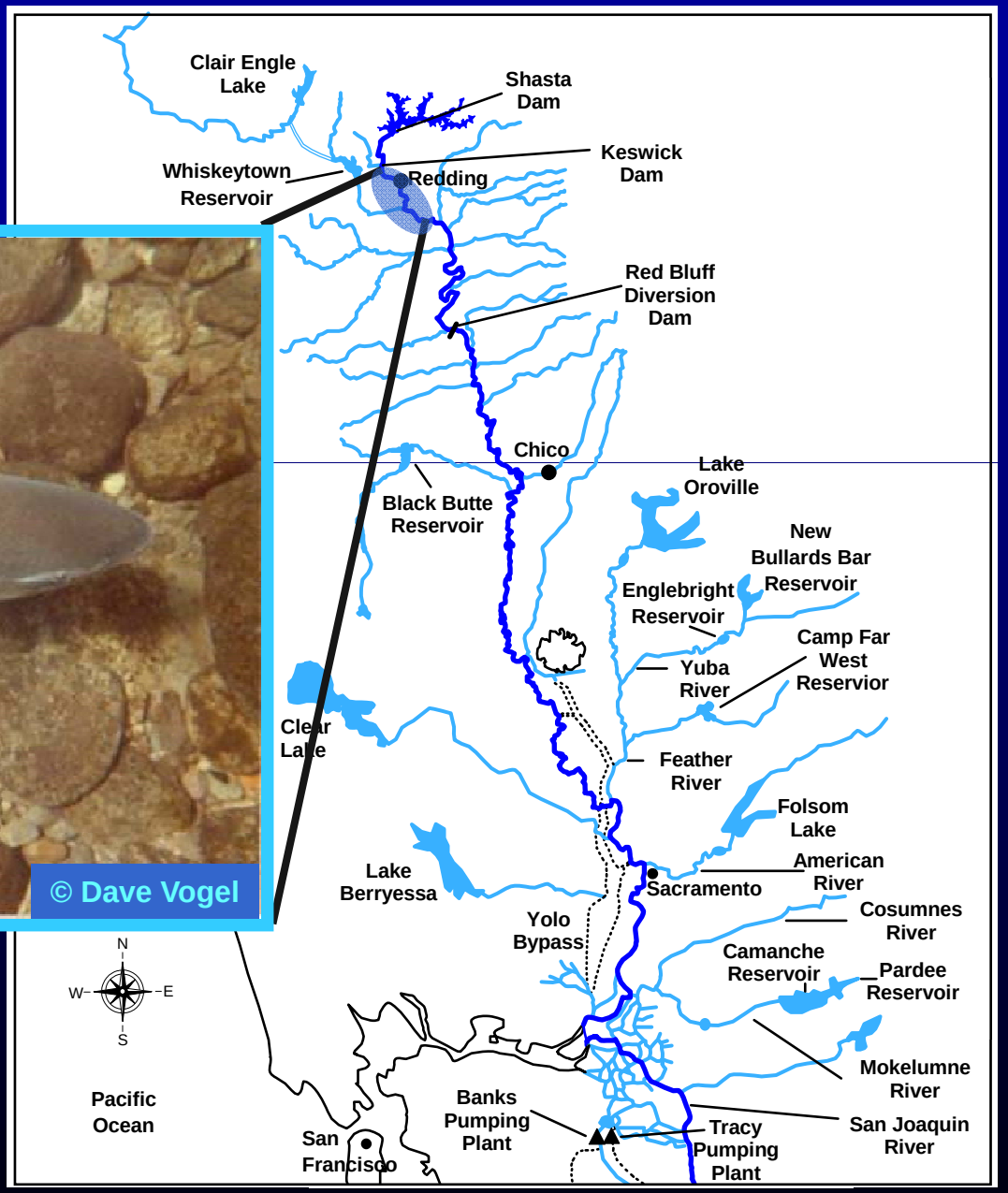
Progress – Salmon Spawning Habitats

Female Chinook Salmon



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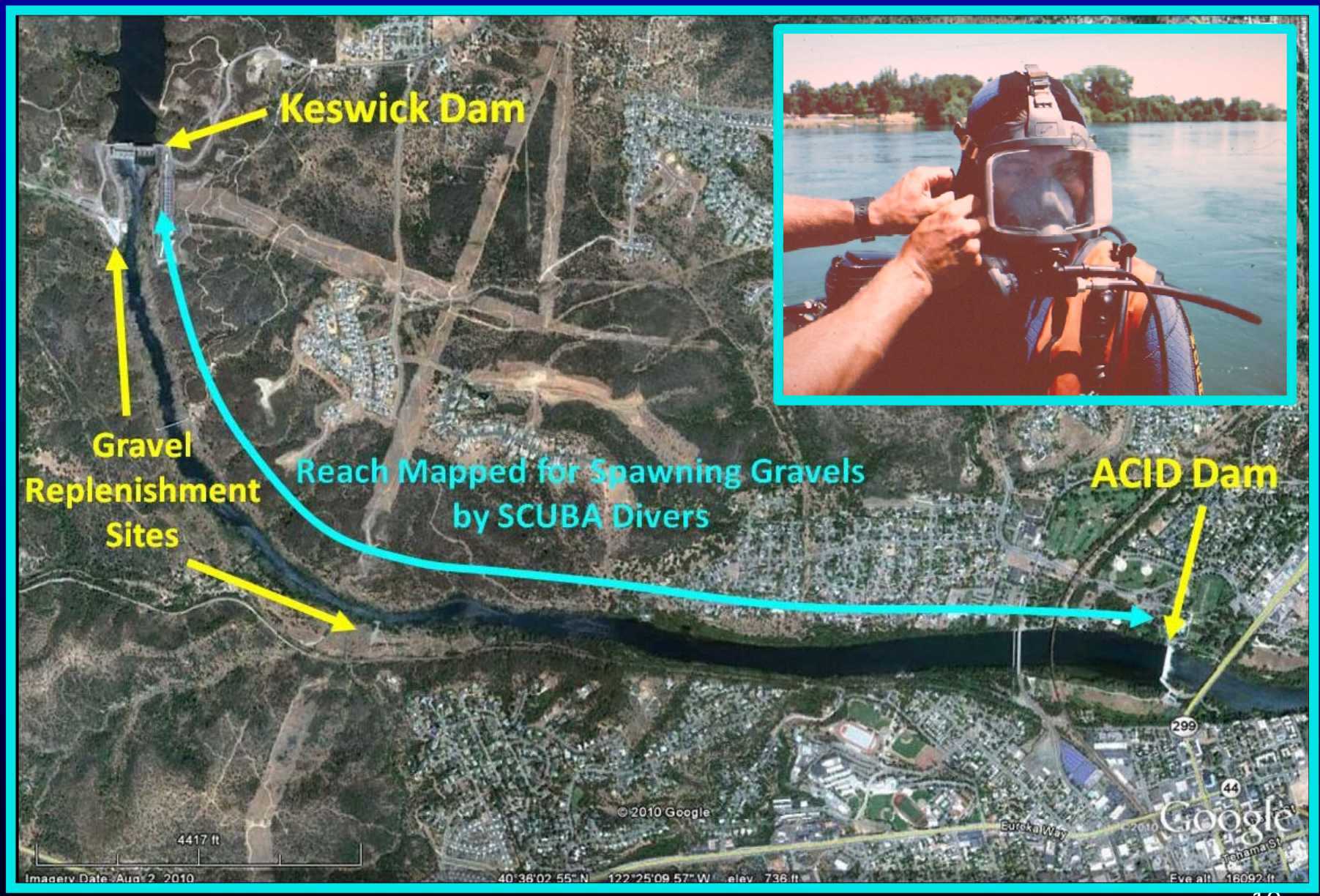
Progress – Salmon Spawning Habitats



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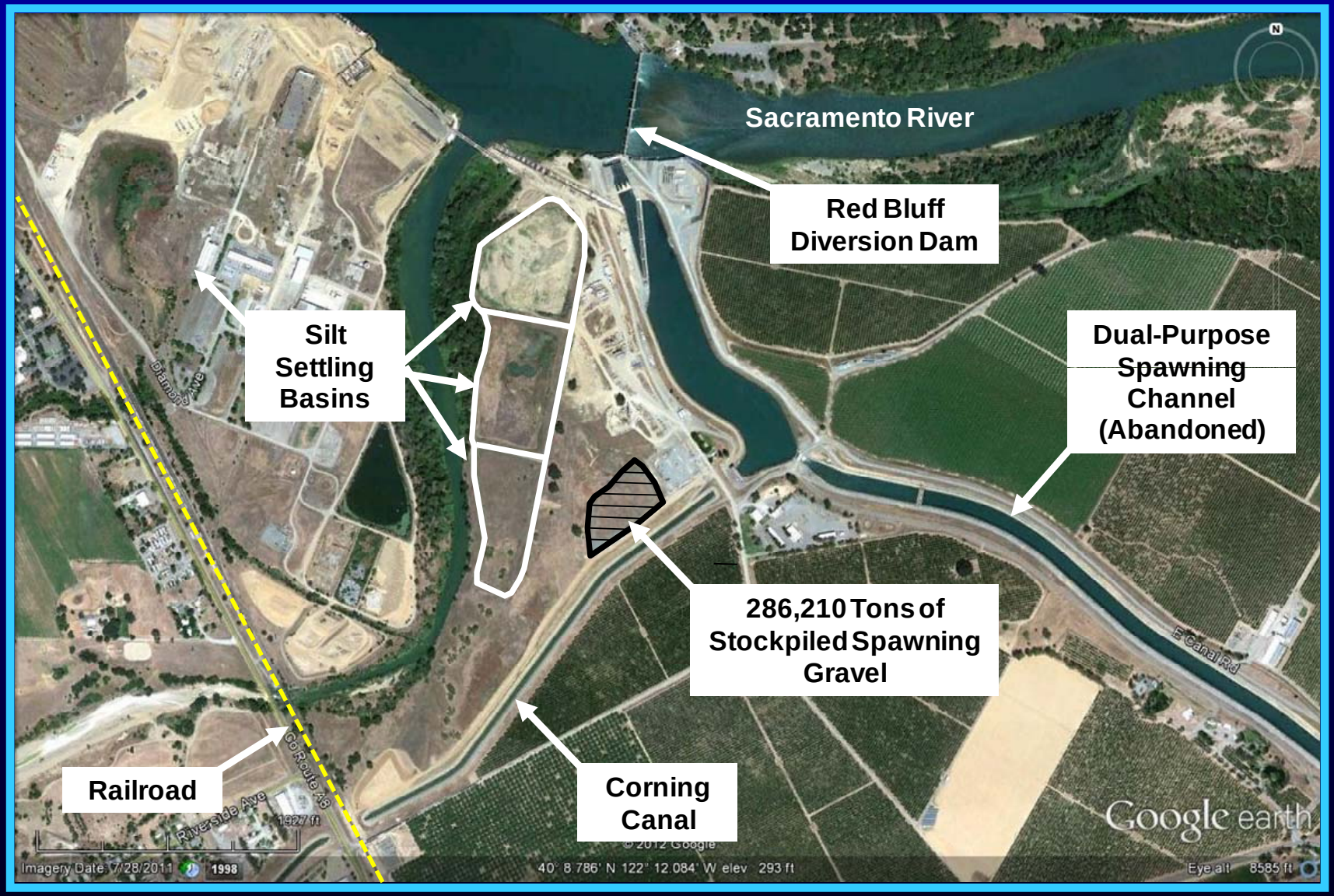
Progress – Salmon Spawning Habitats

Large-Scale Spawning Gravel Injections

Large-Scale Spawning Gravel Injections

>300,000 Tons of Spawning Gravel Available (Free)

Large-Scale Spawning Gravel Injections



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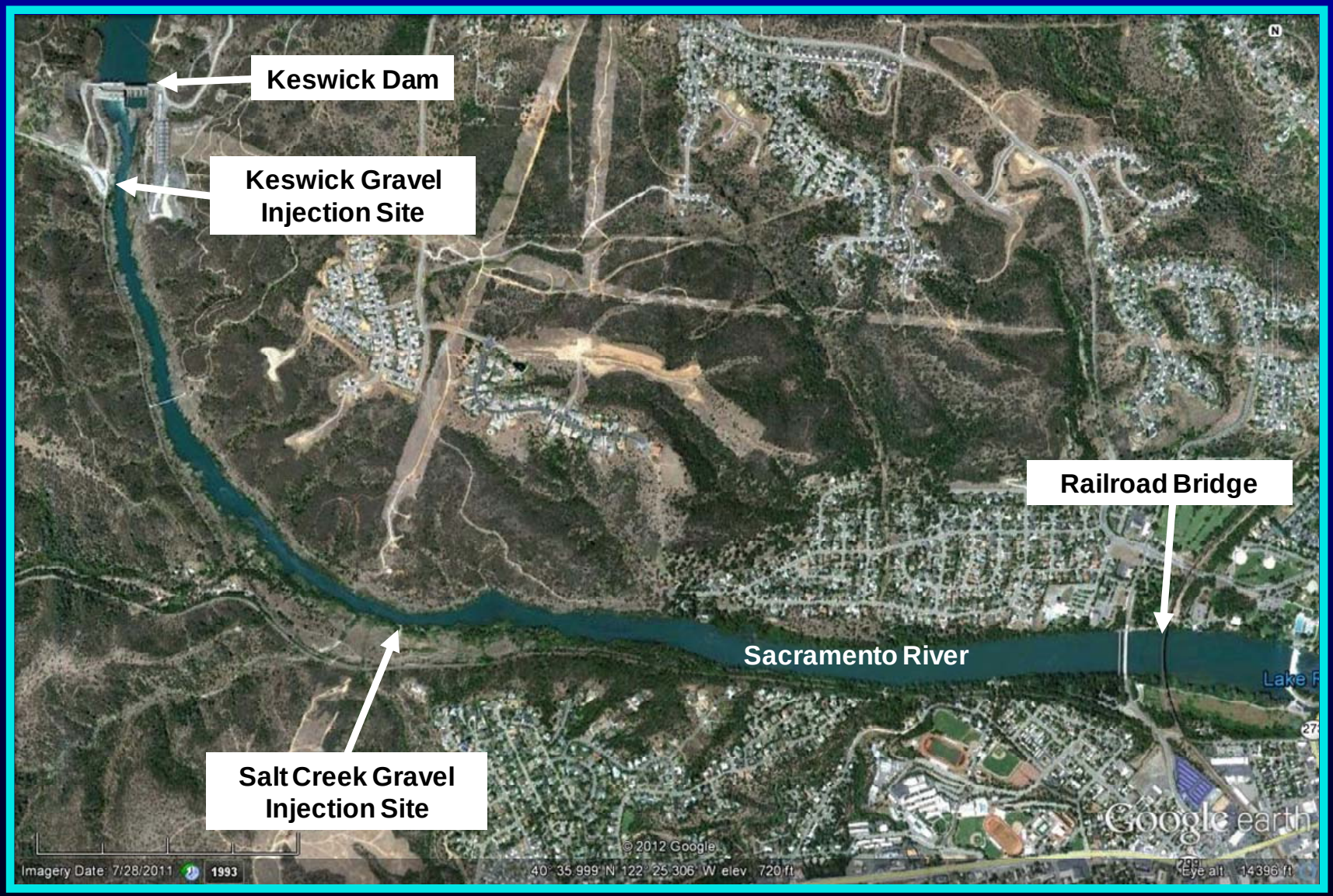
Large-Scale Spawning Gravel Injections



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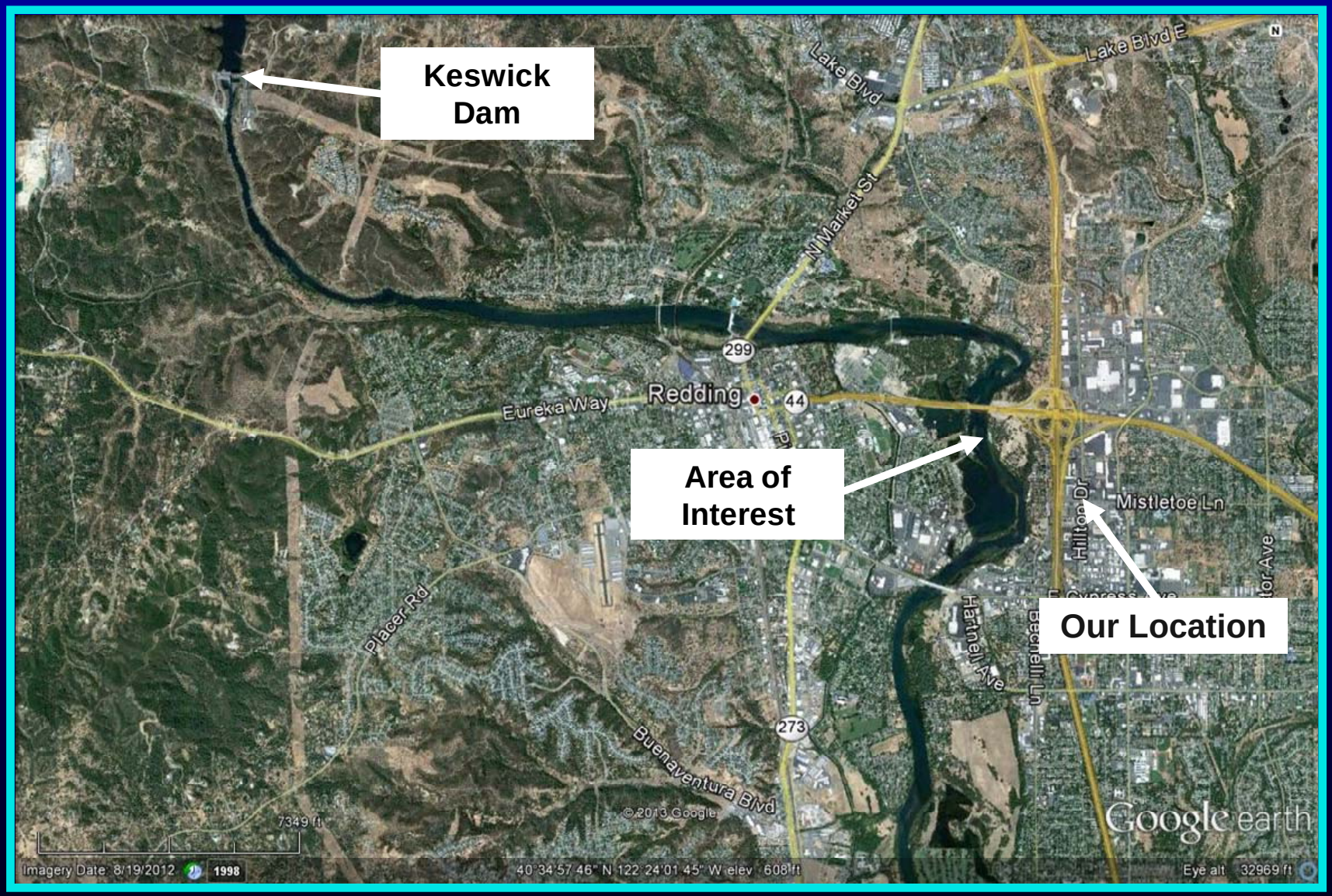
Large-Scale Spawning Gravel Injections

Progress - Spawning Riffle Restoration



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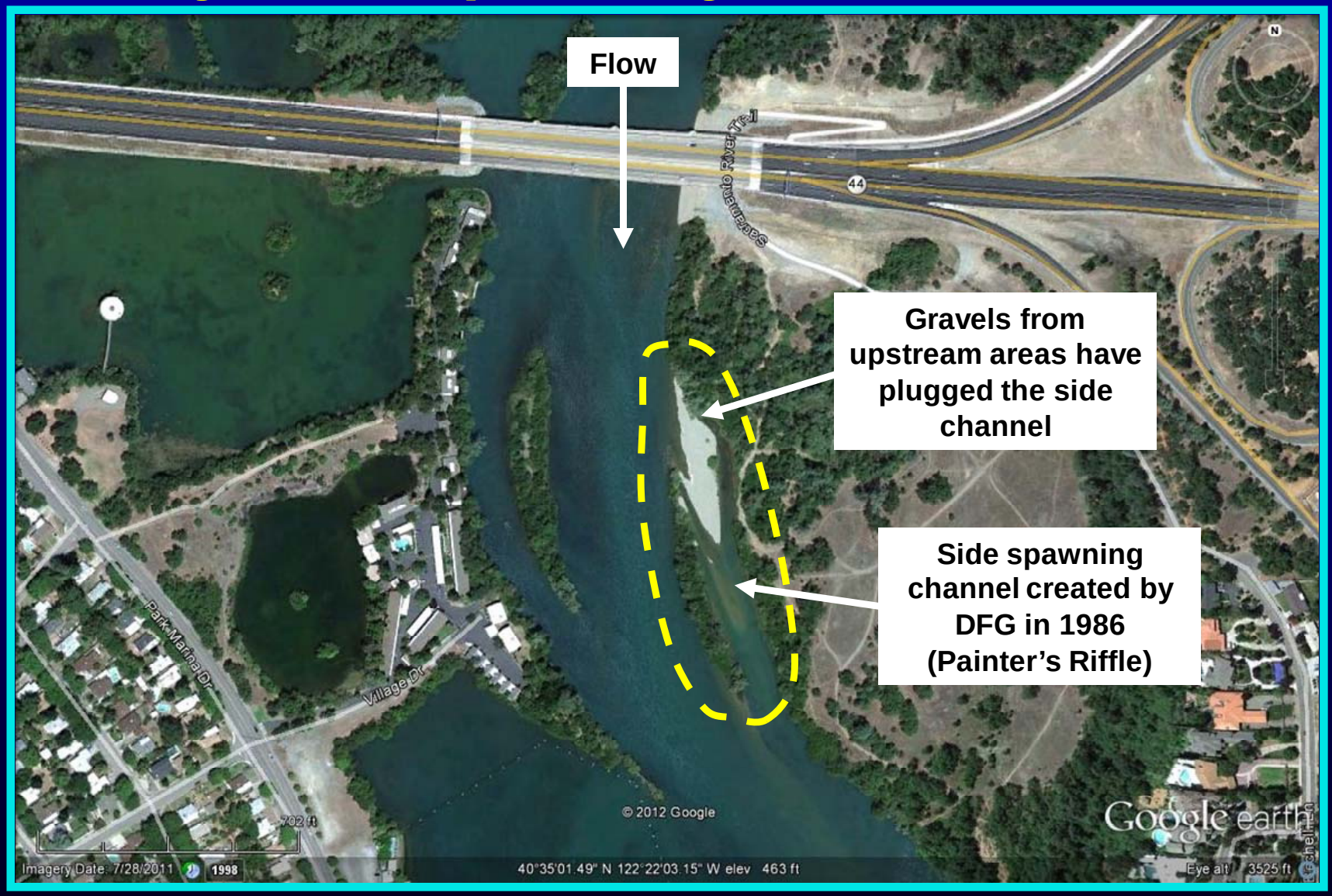
Progress - Spawning Riffle Restoration



Progress - Spawning Riffle Restoration

August 2010 **July 2011**

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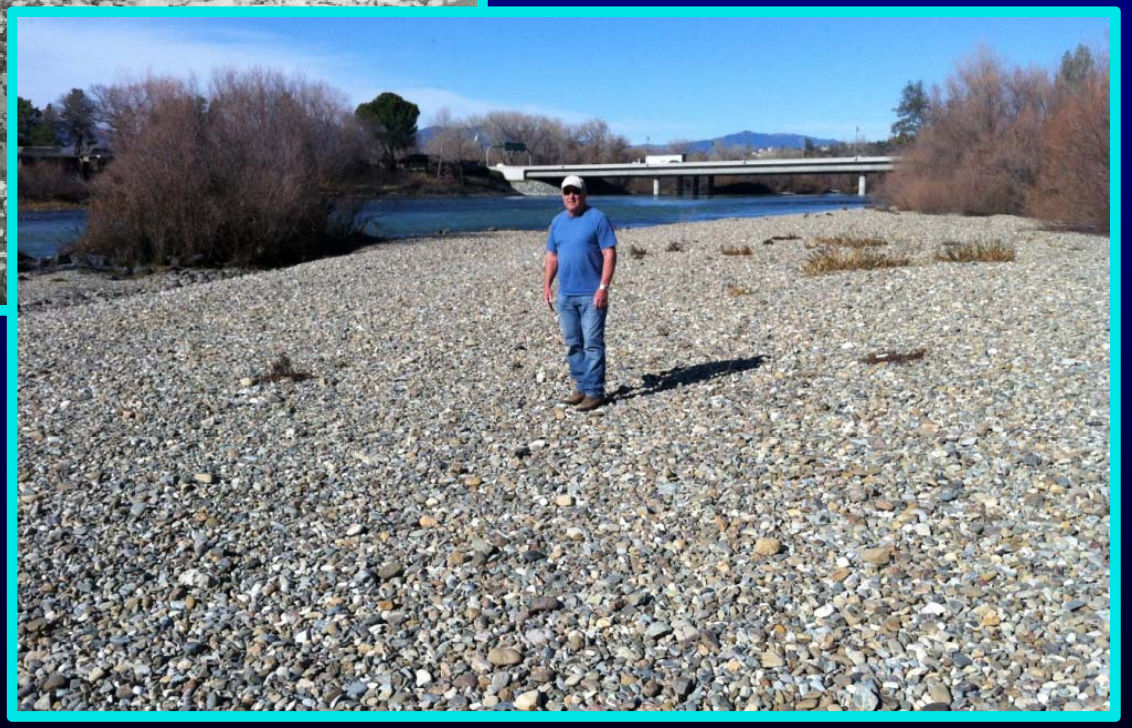
Progress - Spawning Riffle Restoration

1986



2013 (8,000 yds^3)

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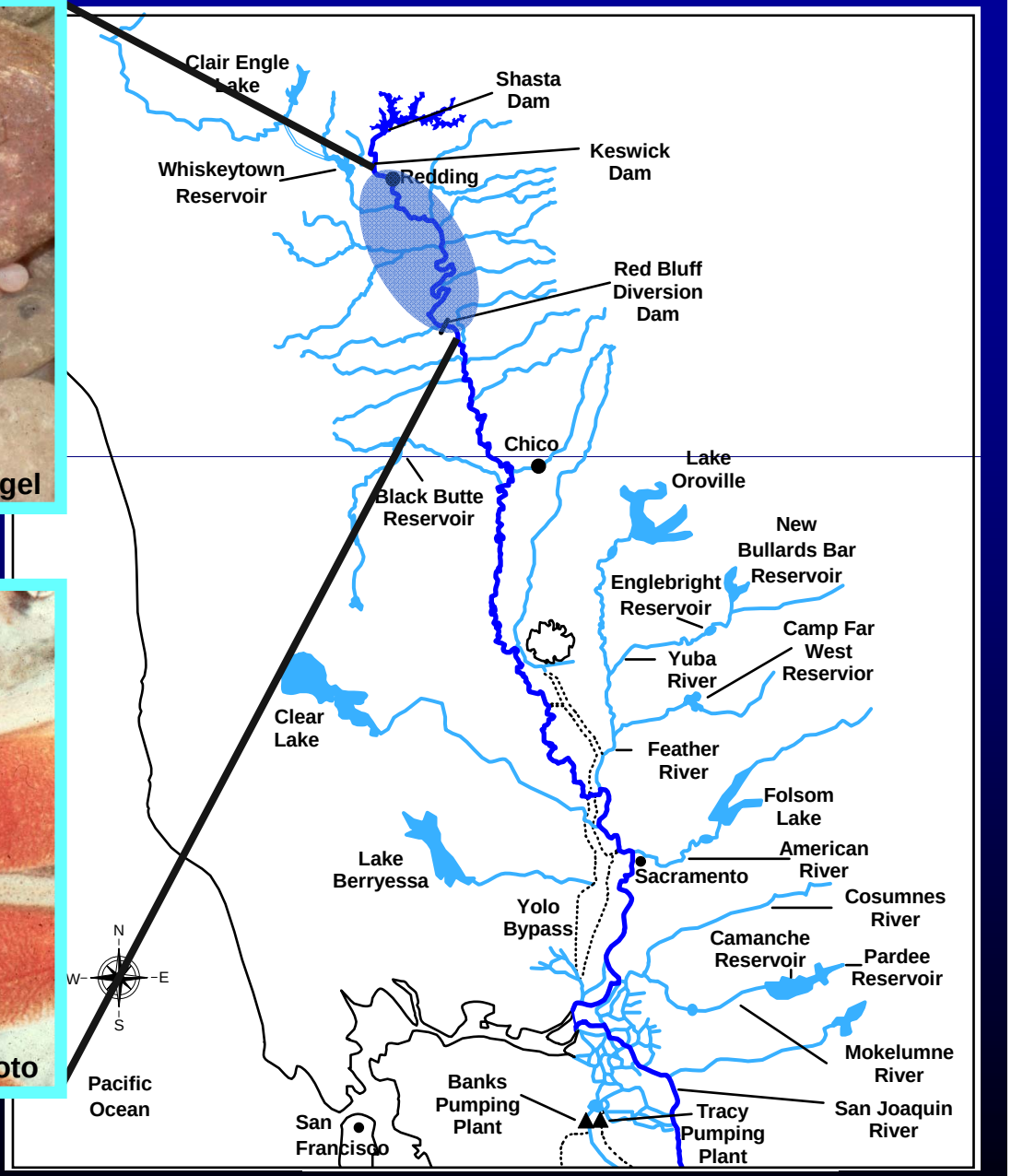
Progress – Water Temperatures

Salmon Eggs

Salmon Alevins



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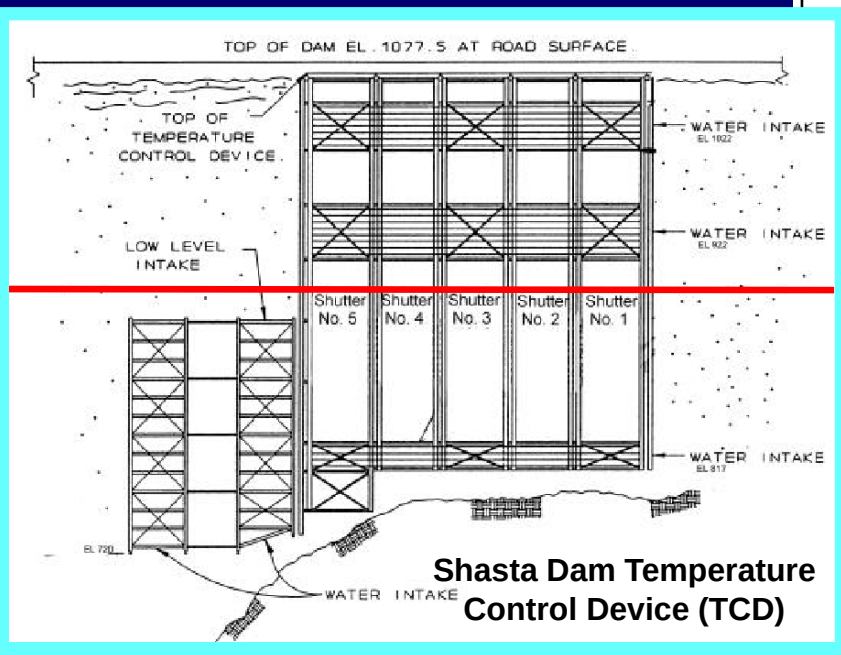
Progress – Water Temperatures

U.S. Bureau of Reclamation Photo and Schematic



Shasta Dam Temperature Control Device (TCD)

1987 - Spillway Bypass
1997 – Temperature Control Device

Clair Engle Lake
Shasta Dam
Keswick Dam
Whiskeytown Reservoir
Redding
Red Bluff Diversion Dam
Chico
Lake Oroville
Black Butte Reservoir
New Bullards Bar Reservoir
Englebright Reservoir
Camp Far West Reservior
Yuba River
Clear Lake
Feather River
Folsom Lake
Lake Berryessa
American River
Sacramento
Cosumnes River
Yolo Bypass
Camanche Reservoir
Pardee Reservoir
Mokelumne River
San Joaquin River
Tracy Pumping Plant
Banks Pumping Plant
San Francisco
Pacific Ocean
N
W
E
S

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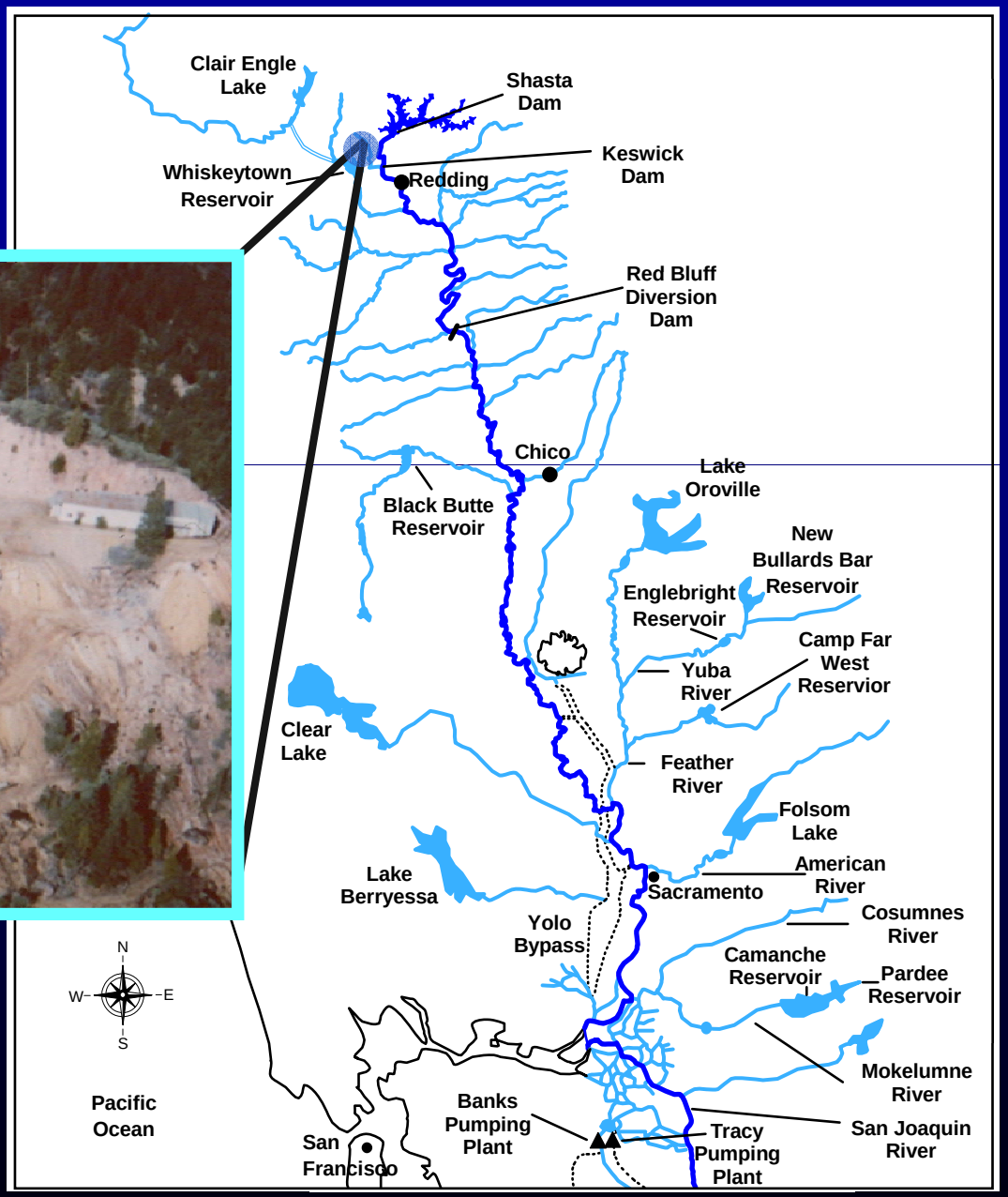
Progress – Pollution Control

Acid Mine Drainage from
Iron Mountain Mine



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Winter-Run Chinook 10-Point Action Plan

Developed in 1986 by
Dave Vogel (USFWS) and John Hayes (DFG)

1) Raise the Red Bluff Diversion Dam gates: Completed

2) Develop winter-run Chinook salmon propagation program: Completed

3) Restore spawning habitat in Redding area: Partially Completed

4) Control pikeminnow at Red Bluff Diversion Dam: Completed

5) Restrict in-river fishery: Completed

6) Develop water temperature control: Completed

7) Correct Iron Mountain Mine pollution problem: Completed

8) Fix problems at Anderson-Cottonwood Irrigation District dam: Completed

9) Correct stilling basin problem at Keswick Dam: Completed

10) Continue and expand studies on winter-run Chinook: Ongoing

Progress – Tributary Restoration

Clear Creek

– Dam Removal, Flows, & Spawning Gravels

Battle Creek

– Large-Scale Watershed Restoration

Lower Feather River

– FERC Settlement Flows and Actions

Lower Yuba River

– Lower Yuba River Accord

Lower American River

– Water Forum Flows in NMFS 2009 Biological Opinion

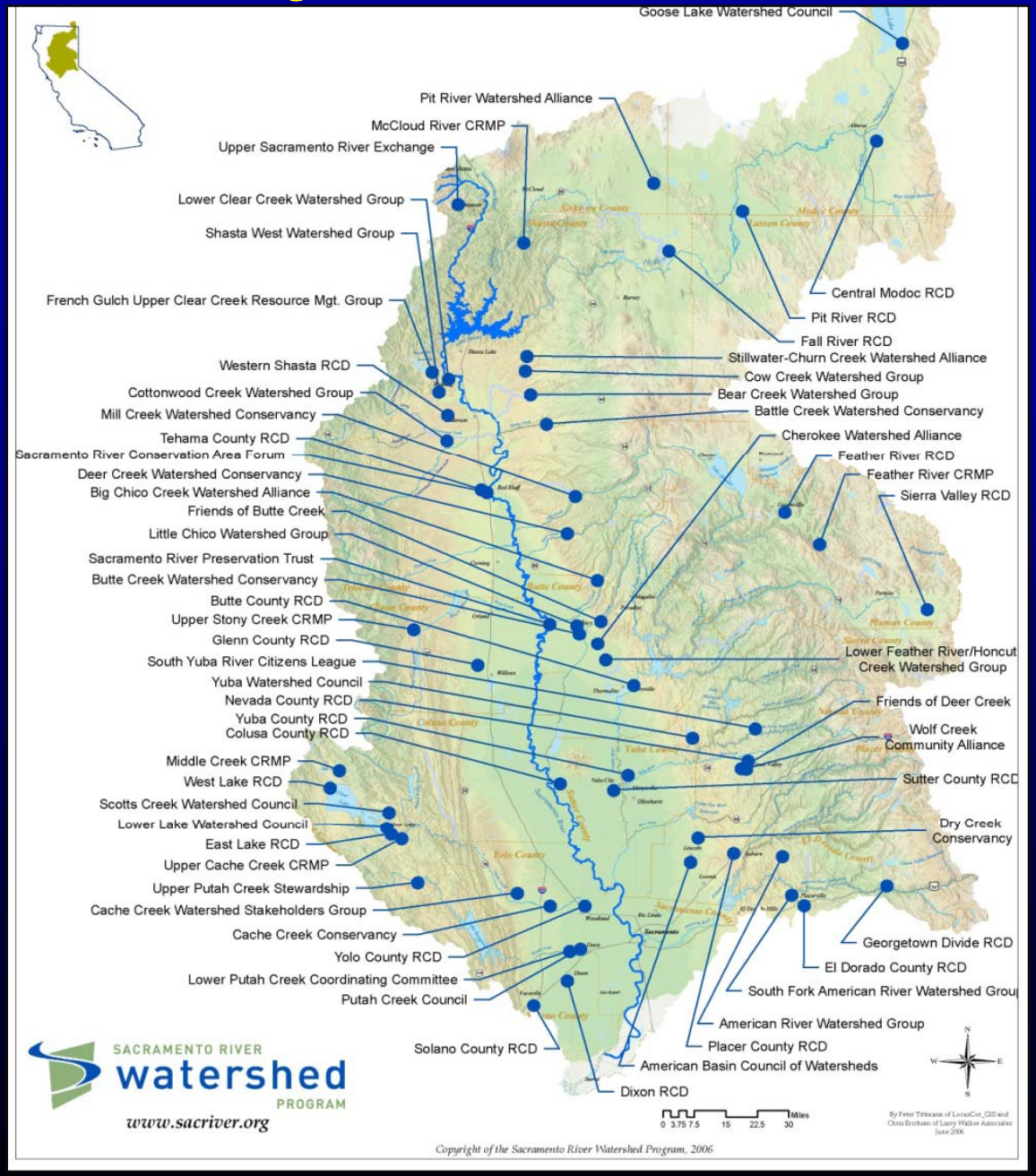
Numerous Smaller Tributaries

– Flows, Fish Screens, Habitat and Fish Passage Improvements

Progress – Tributary Restoration

Watershed Groups

Improved Watershed Conditions



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Mainstem Salmon Fry Rearing Habitats

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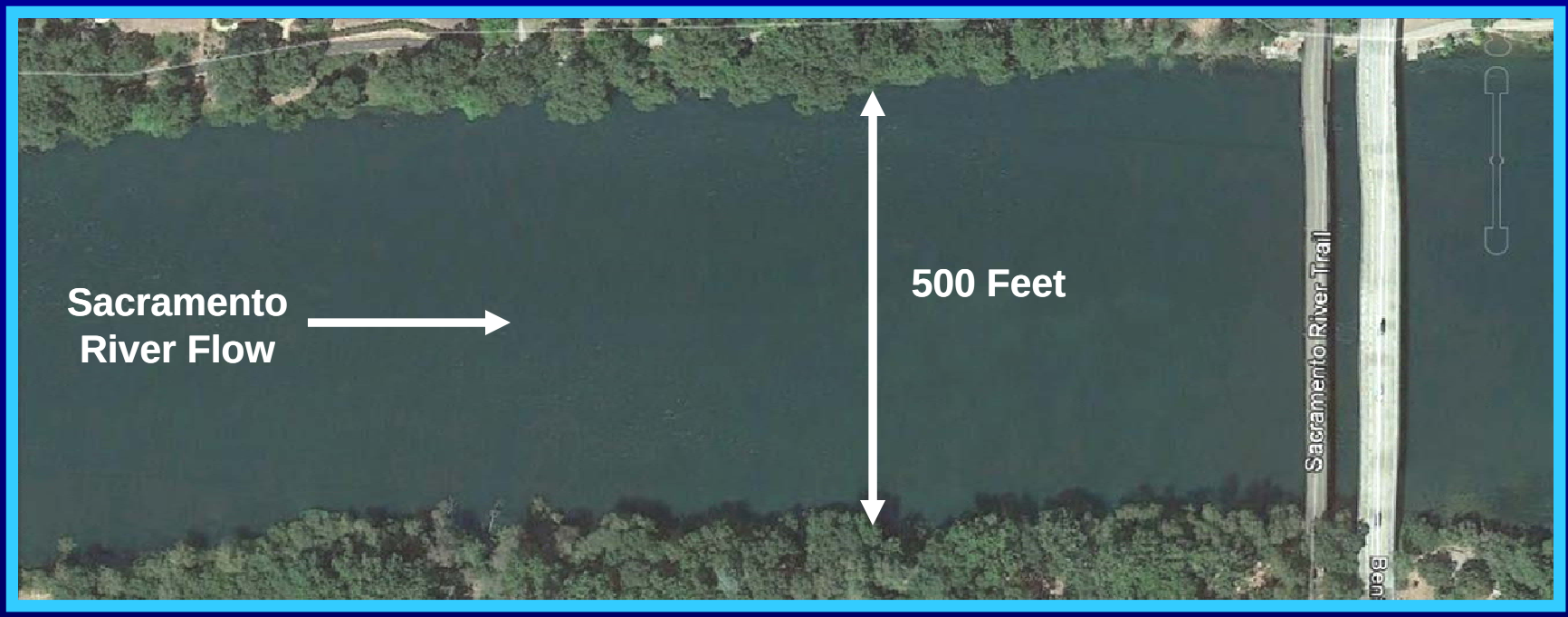
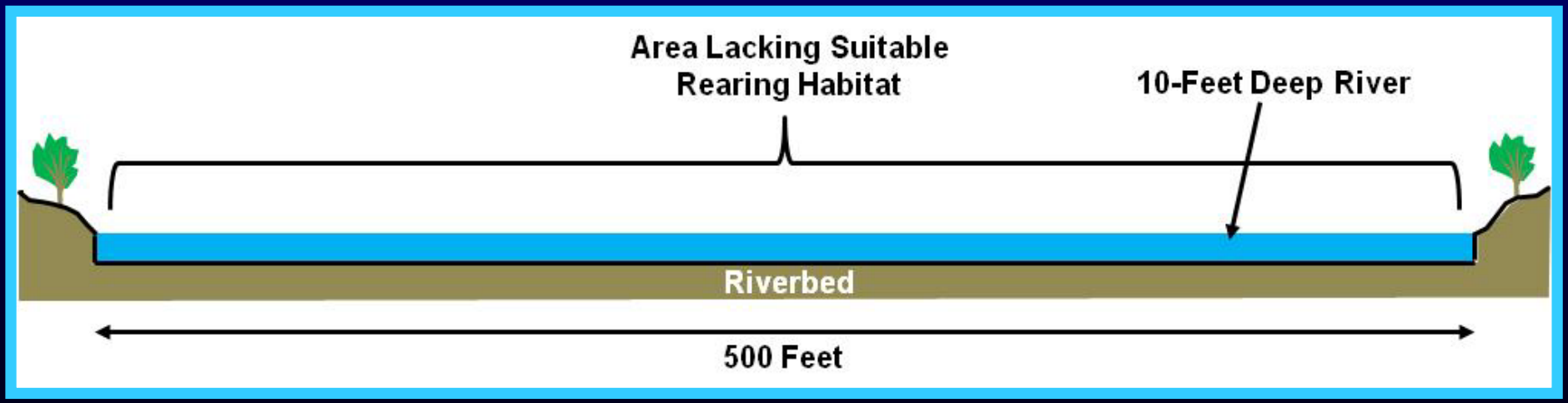
Mainstem Salmon Fry Rearing Habitats





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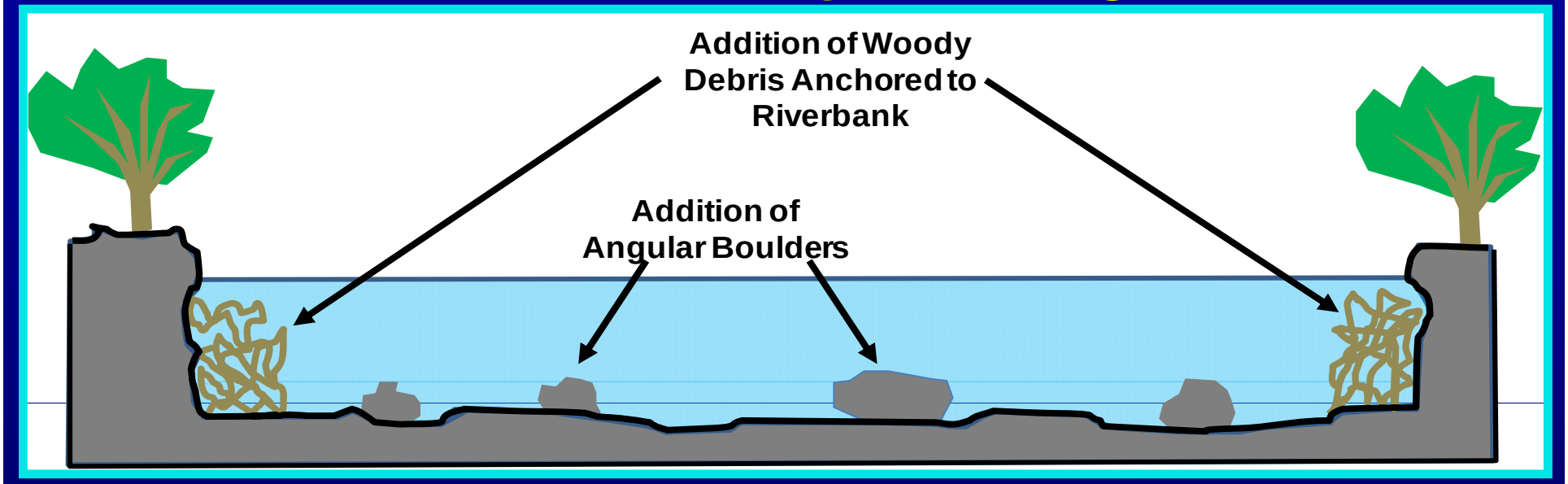
Mainstem Salmon Fry Rearing Habitats



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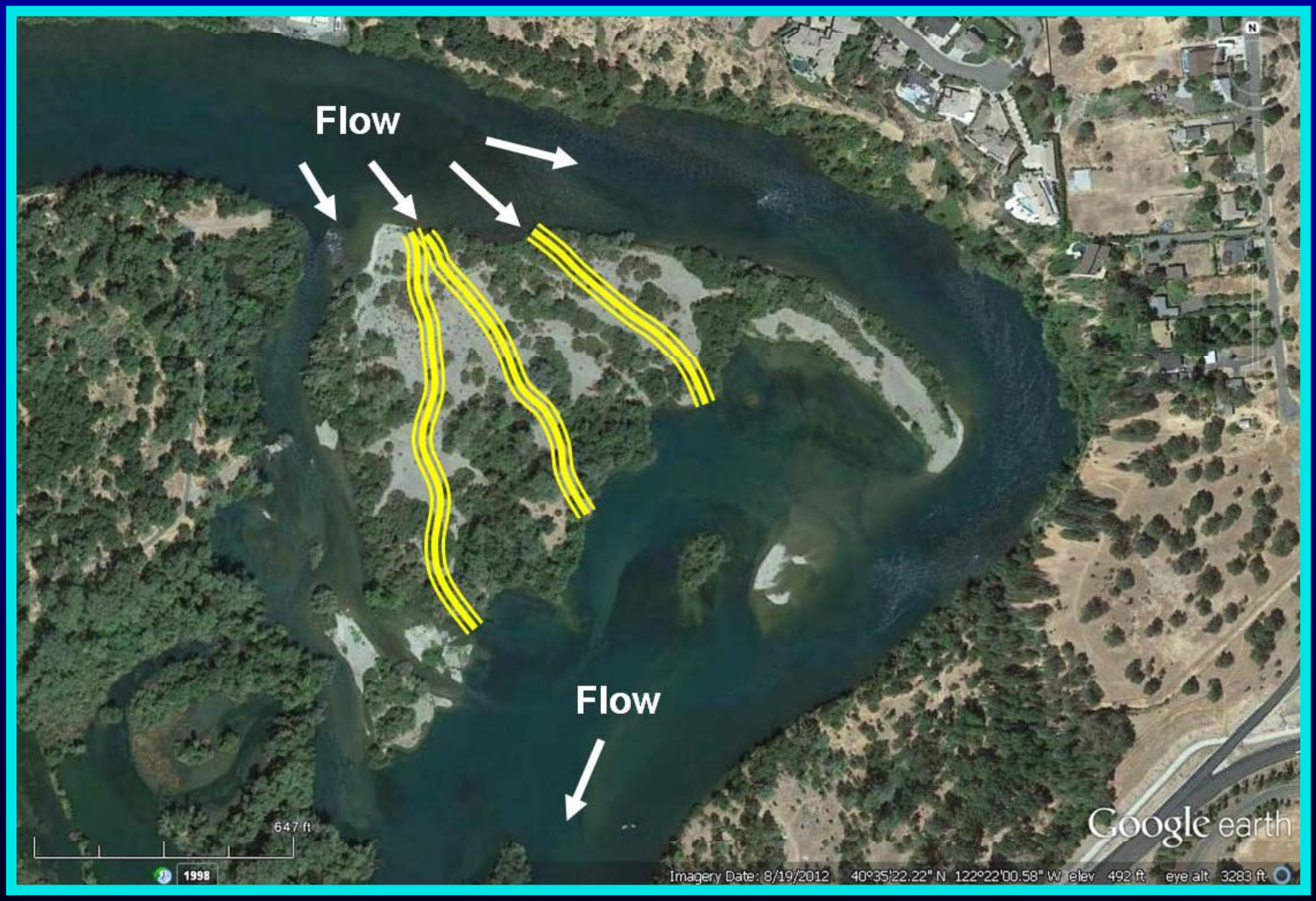
Spawning Riffle and Rearing Habitat Restoration



Creation of New Side Channels

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Reduce or Eliminate Nighttime Lighting on Riverine Structures – In Progress

Bridges

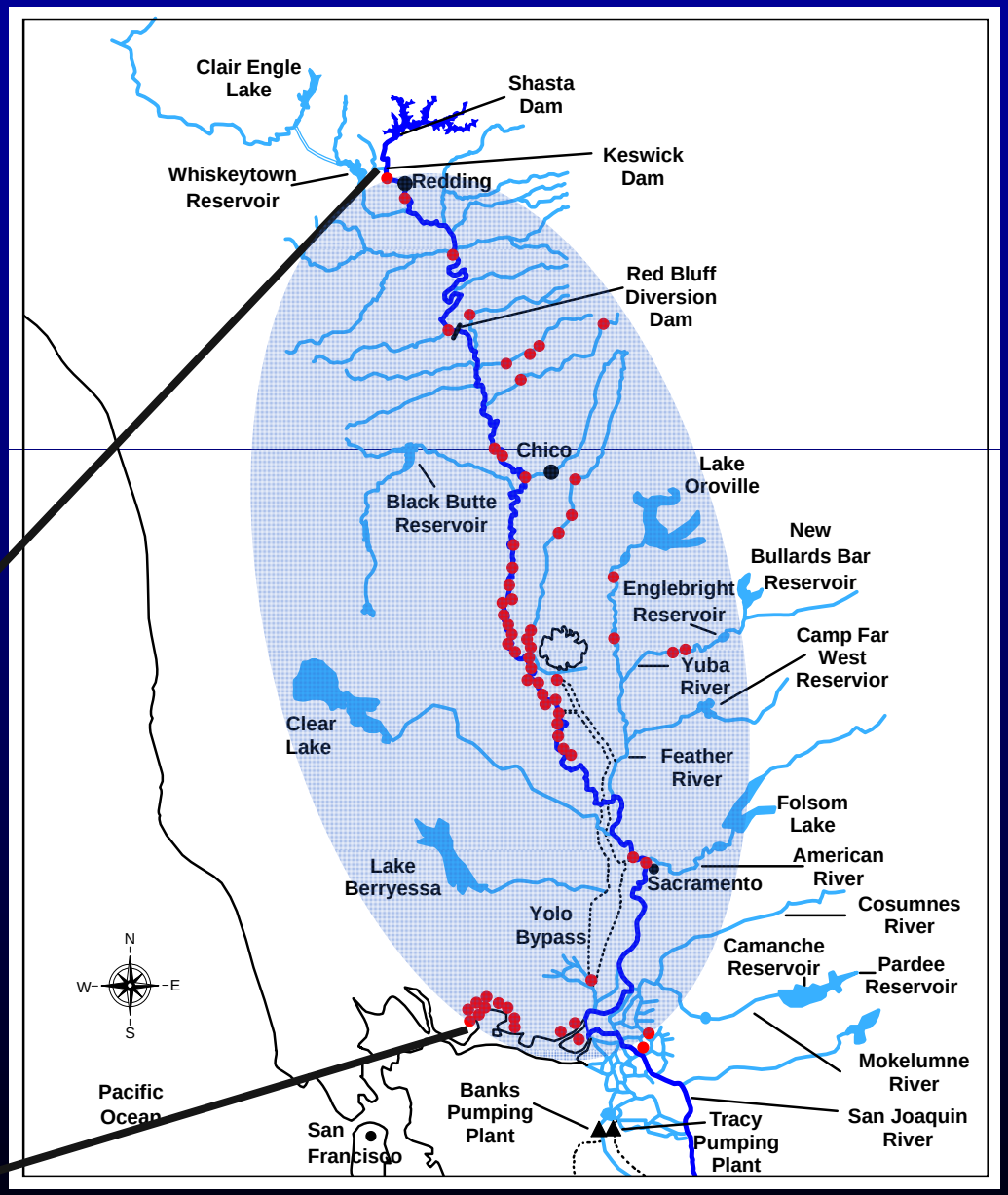
Fish Screens

Reduces Abnormal Nocturnal Predation on Juvenile Salmon

Sonar Image of Striped Bass in Front of a Fish Screen at Night (Dave Jacobs Photo)

Progress – Fish Screens

Recent Fish Screen Projects through 2012



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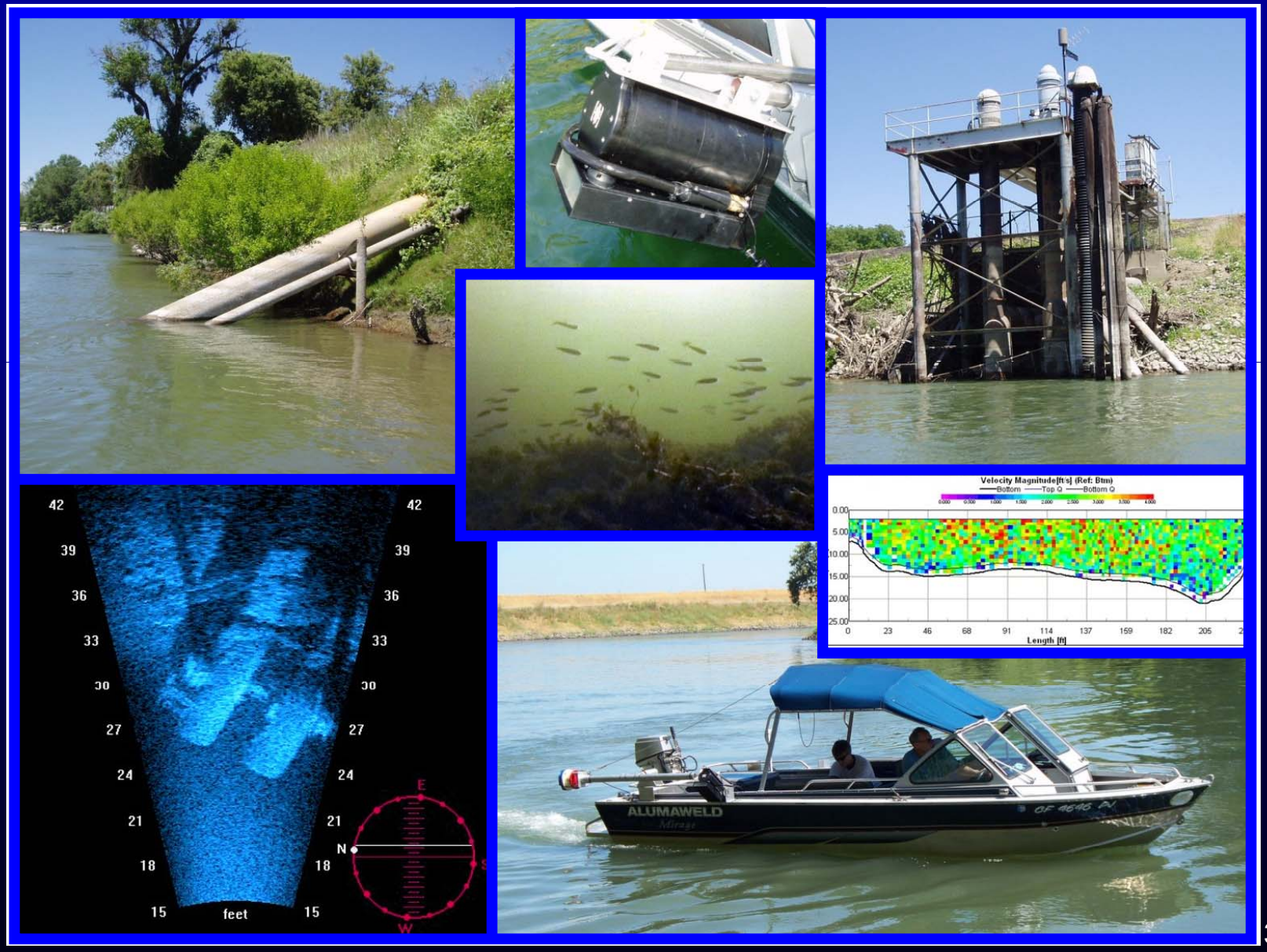
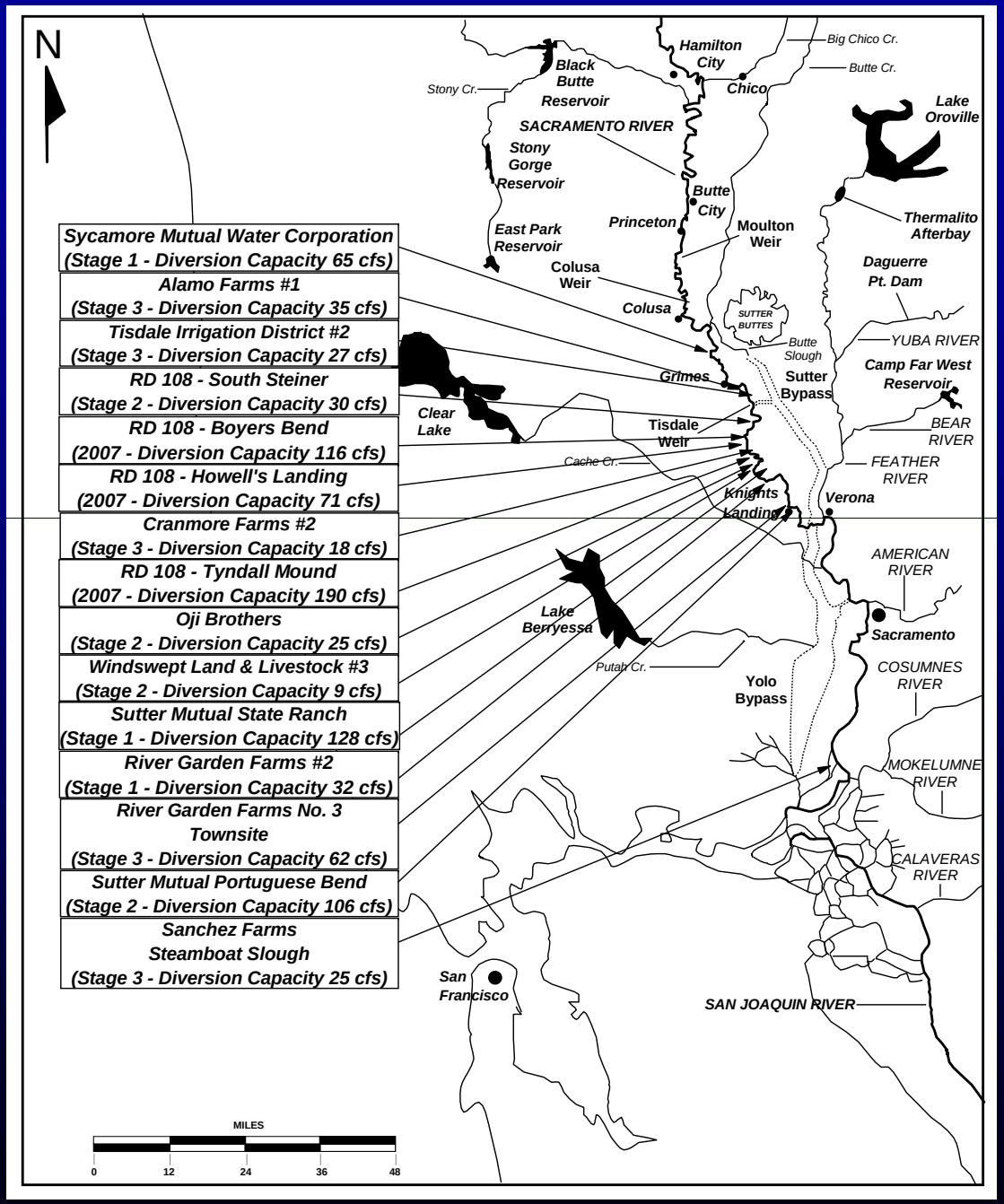
In-River Surveys of Unscreened Diversions



Evaluation of Fish Entrainment in Unscreened Sacramento River Water Diversions

CVPIA Anadromous Fish Screen Program

Natural Resource Scientists, Inc.



12 Fish Entrainment Study Sites

2009

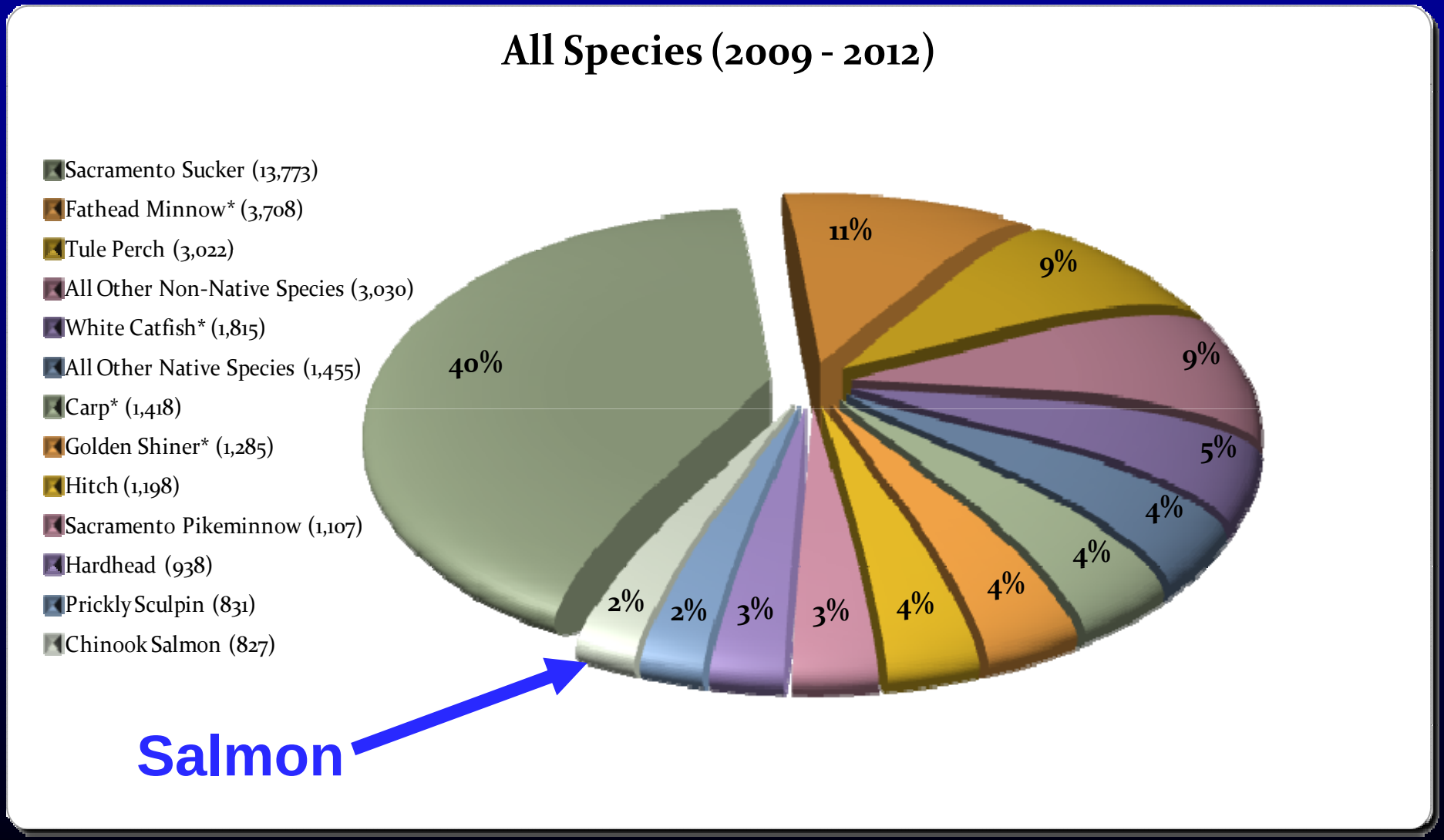
2010

2011

2012

Evaluation of Fish Entrainment in 12 Unscreened Sacramento River Water Diversions

CVPIA Anadromous Fish Screen Program



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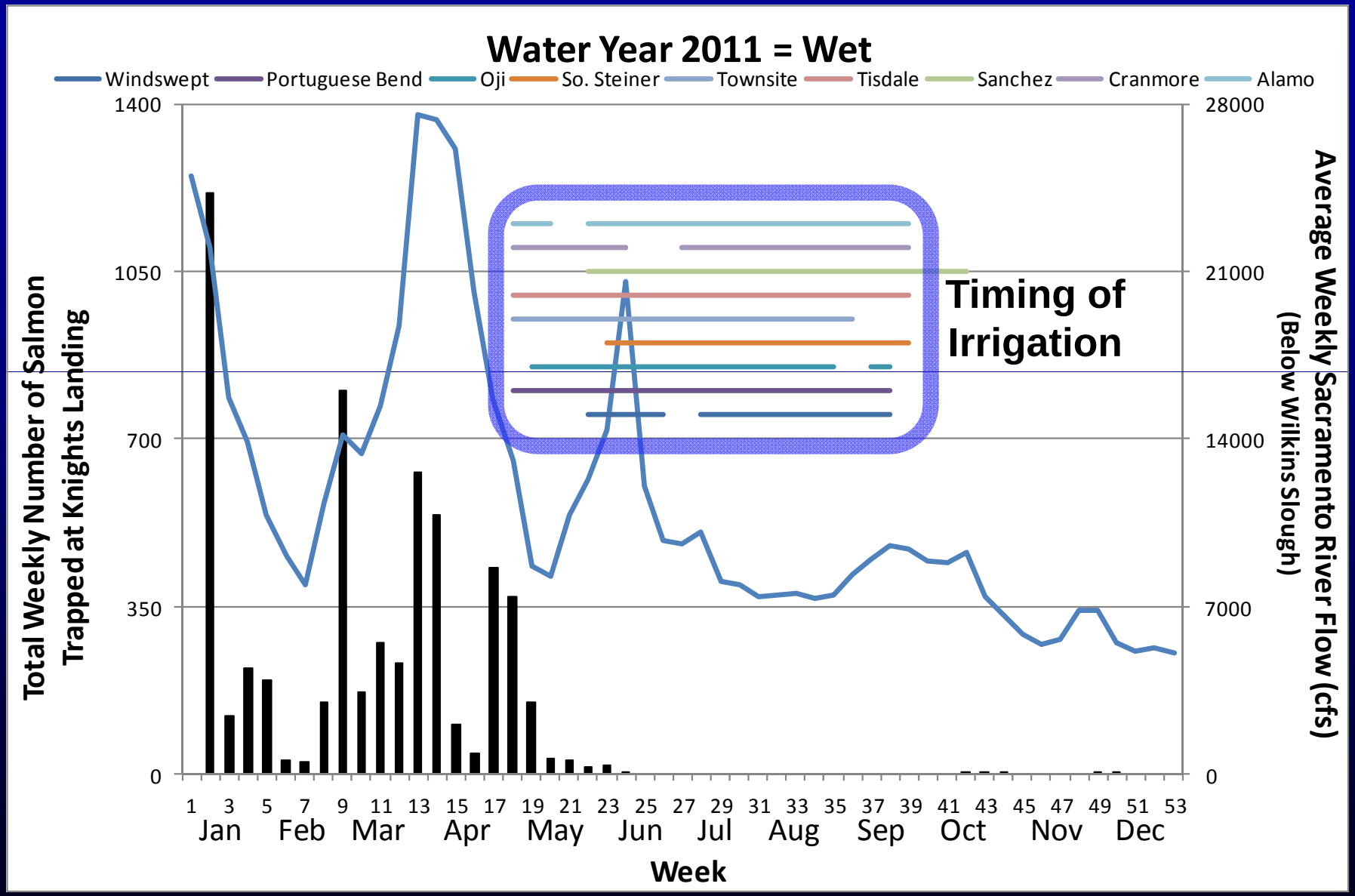
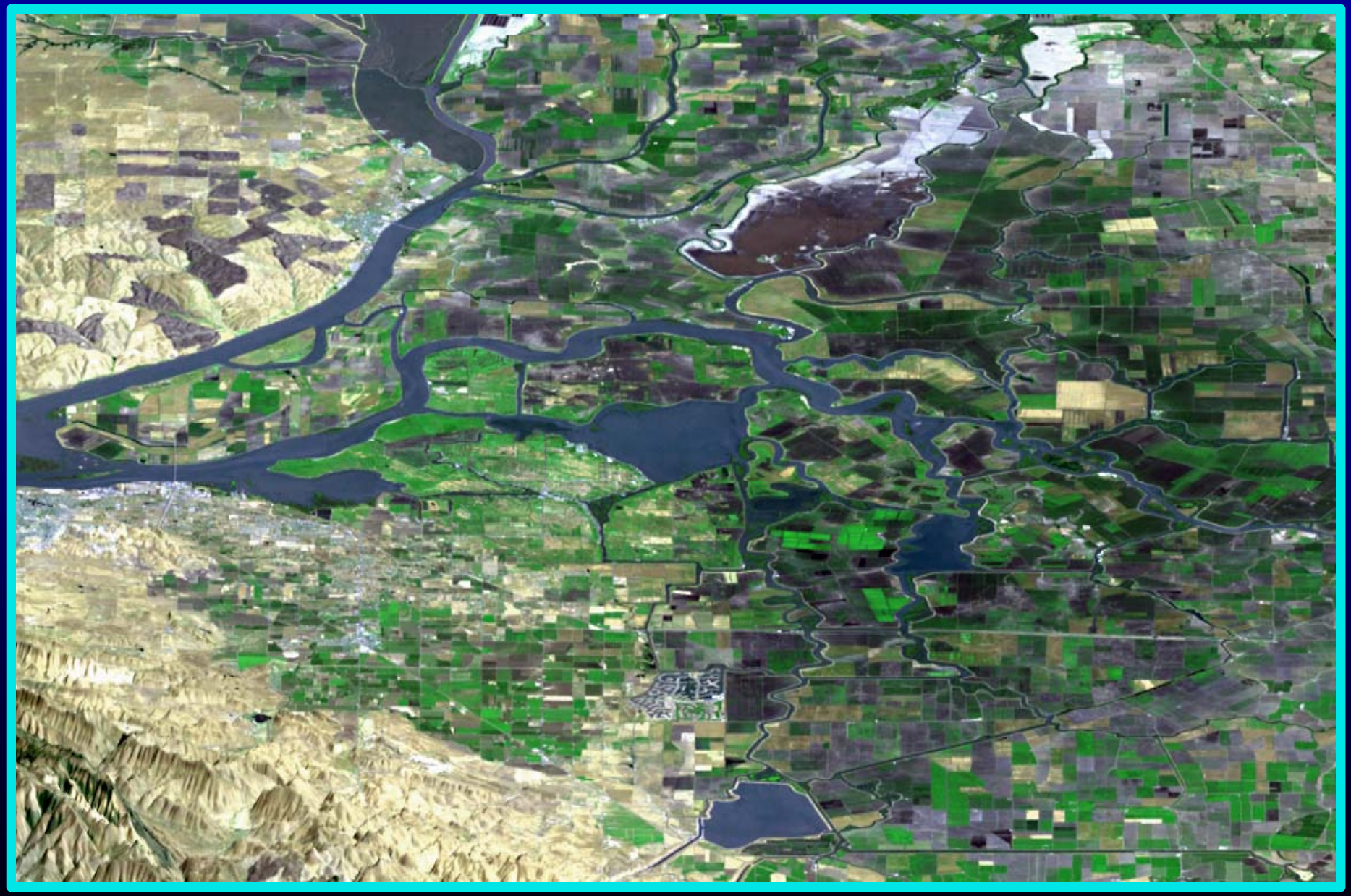

Water Year 2011 = Wet
Windswept
Portuguese Bend
Oji
So. Steiner
Townsite
Tisdale
Sanchez
Cranmore
Alamo
Timing of Irrigation
Total Weekly Number of Salmon Trapped at Knights Landing
Average Weekly Sacramento River Flow (cfs) (Below Wilkins Slough)
1400
1050
700
350
0
28000
21000
14000
7000
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Week

Well Over $1,000,000,000 Has Been Spent on Anadromous Fish Restoration

Why Have the Fish Runs Not Recovered?

Sacramento – San Joaquin Delta



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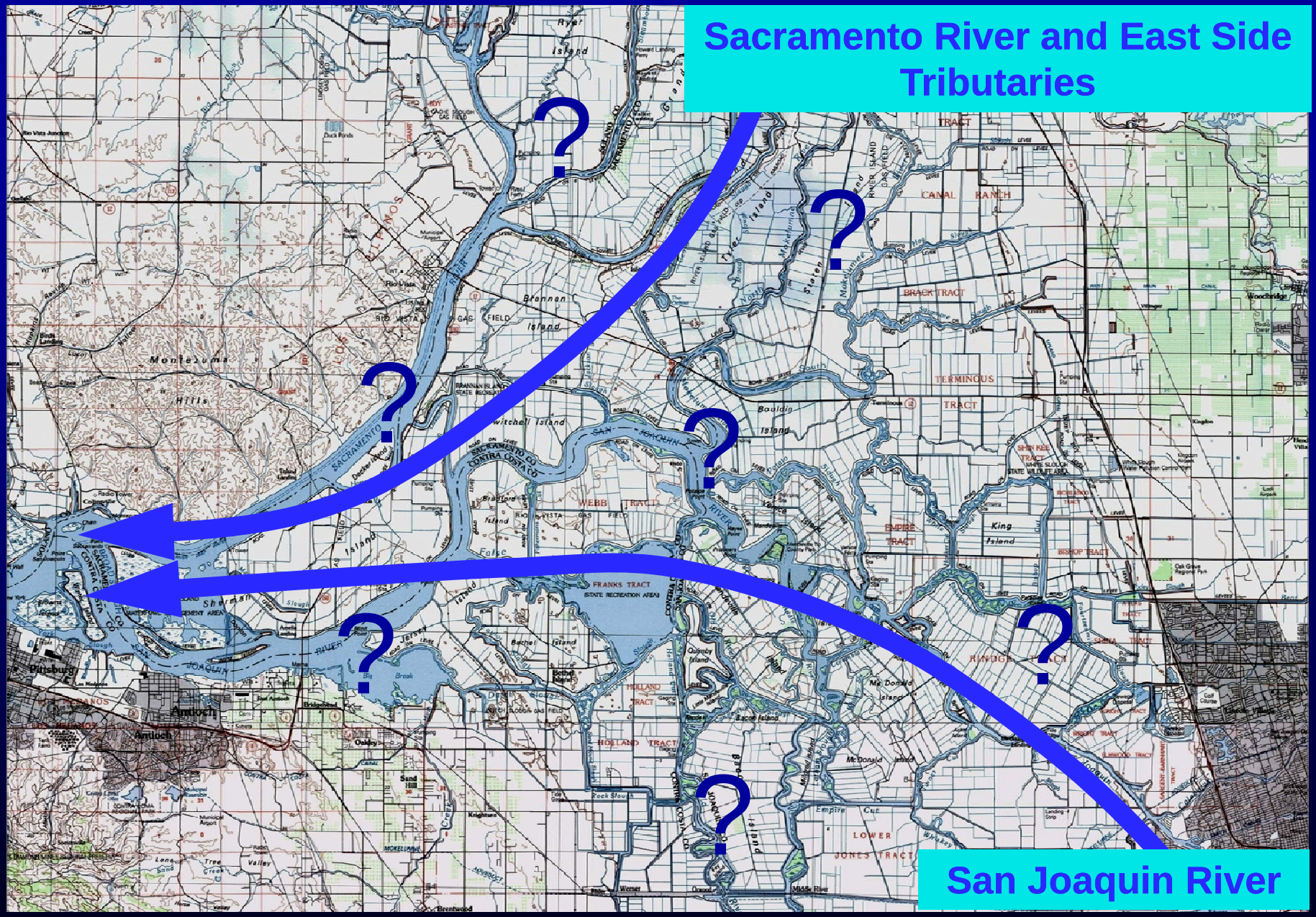
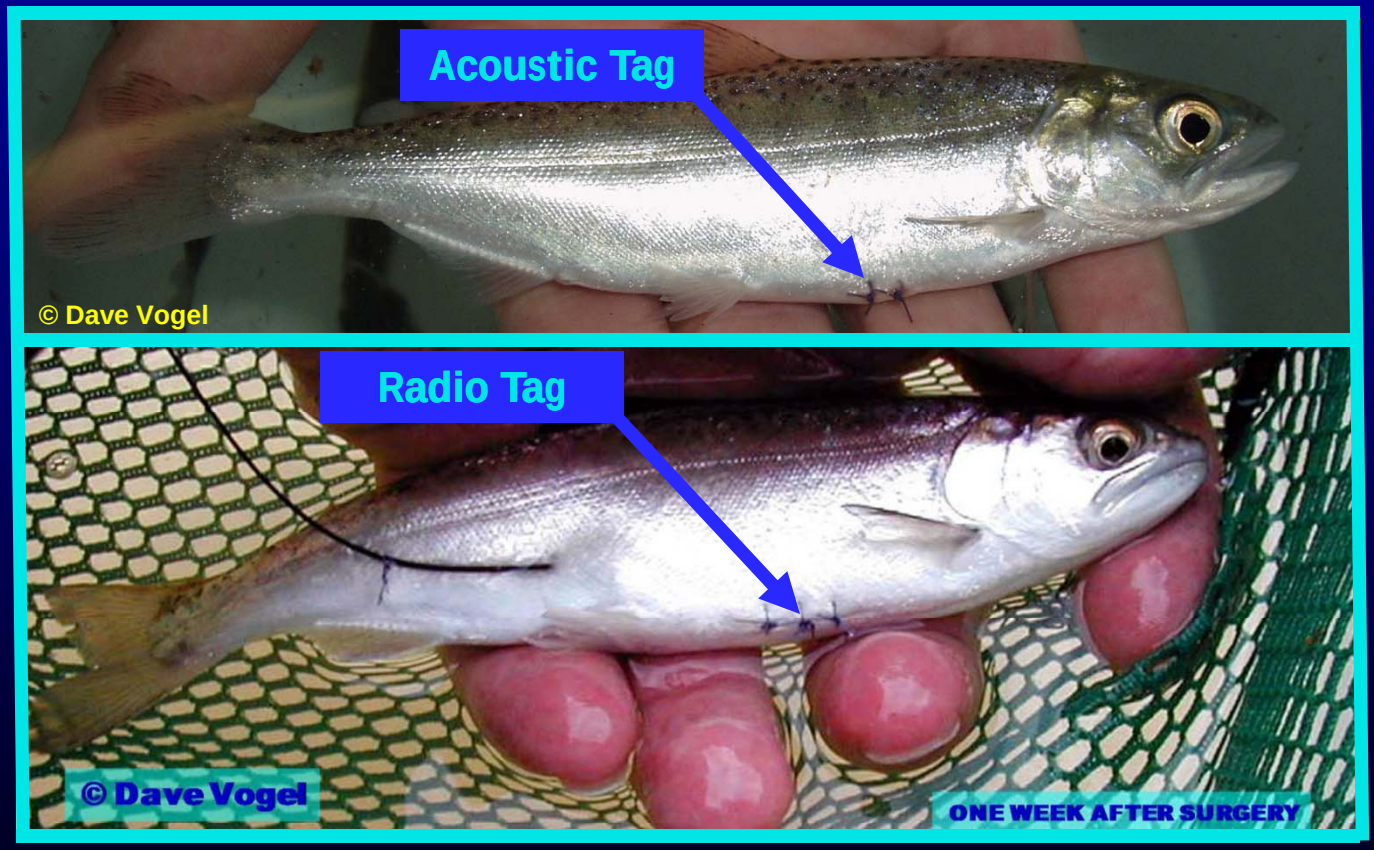
Predators on Salmonids

Pikeminnow **Striped Bass** **Largemouth Bass**

Predation


Sacramento River and East Side Tributaries
San Joaquin River
?
?
?
?
?
?
?

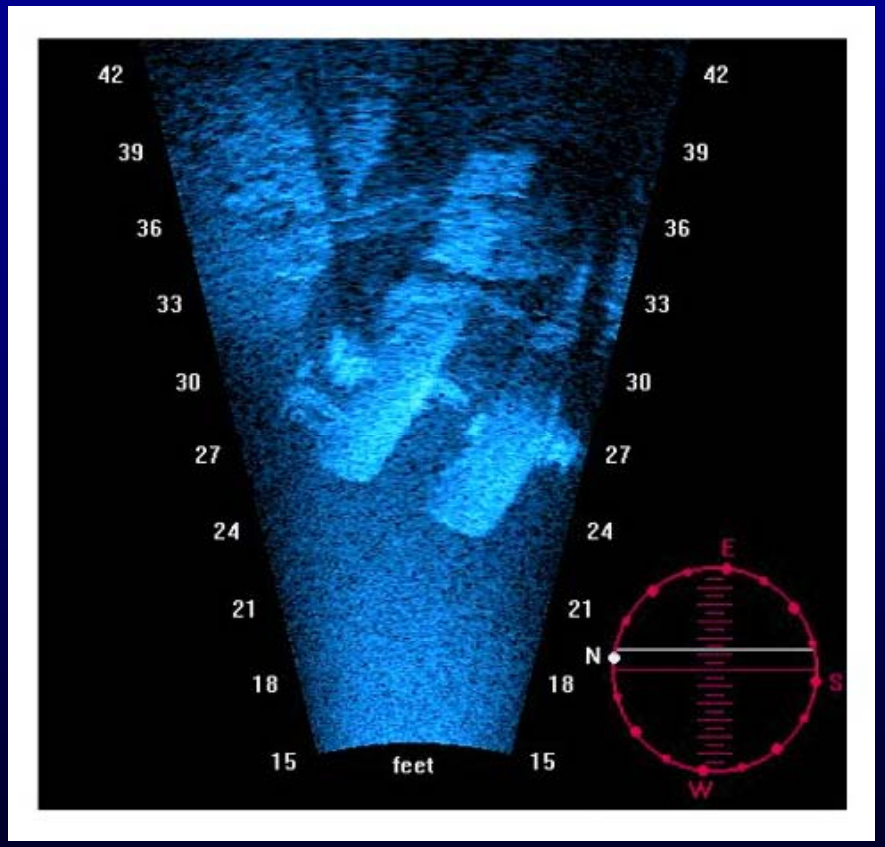
Juvenile Salmon Telemetry Studies in the Delta



Sonar Camera Surveys in the Delta

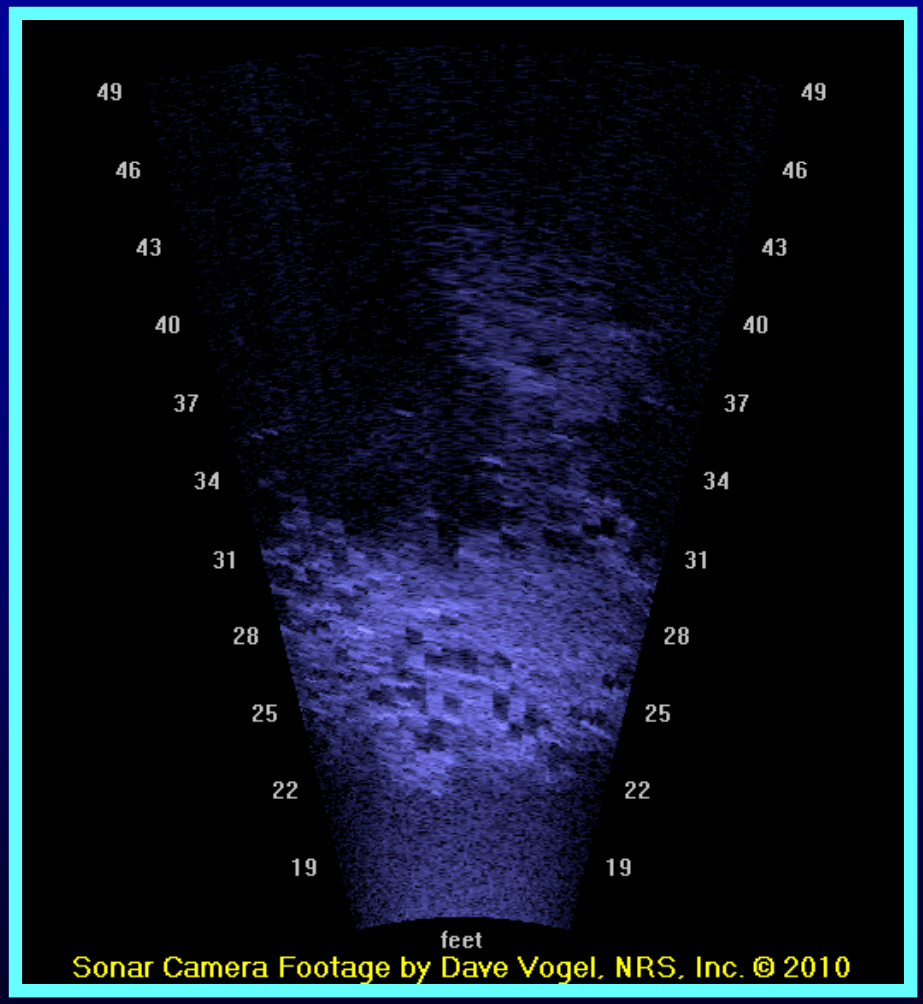
YouTube Footage: NRSIncorporated

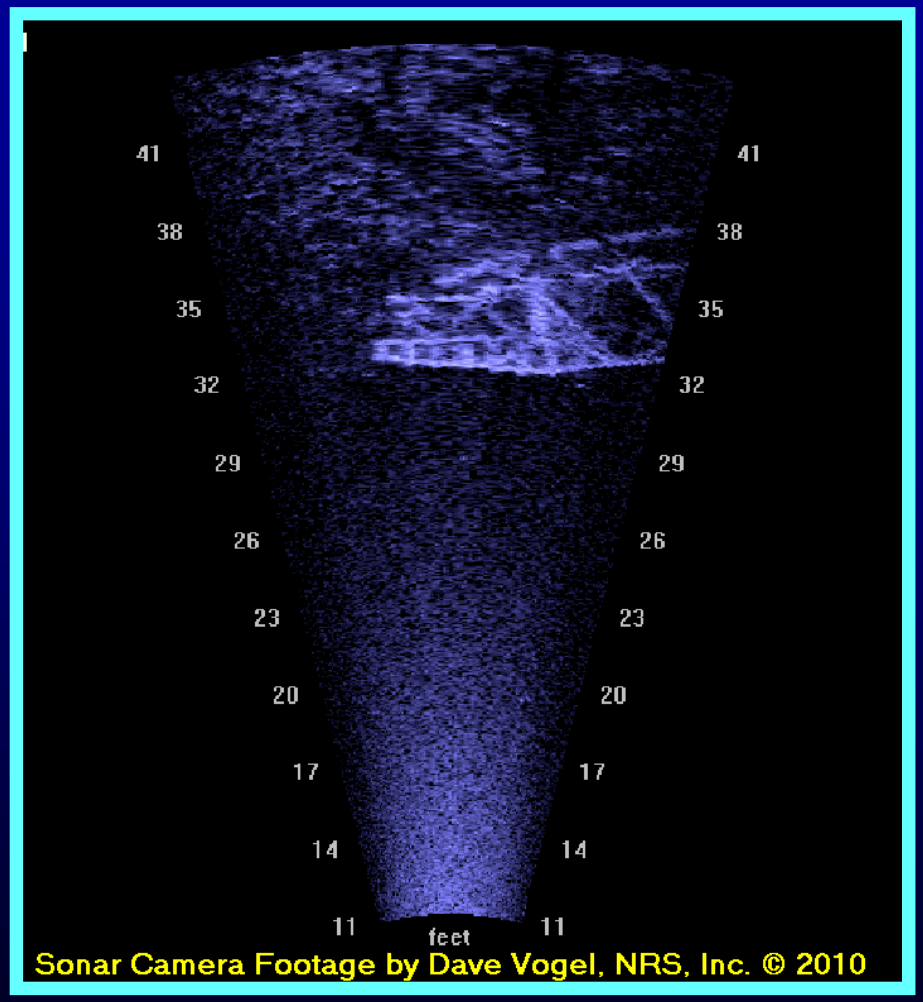
Sonar Camera



Sonar Image

Sonar Footage of Familiar Objects

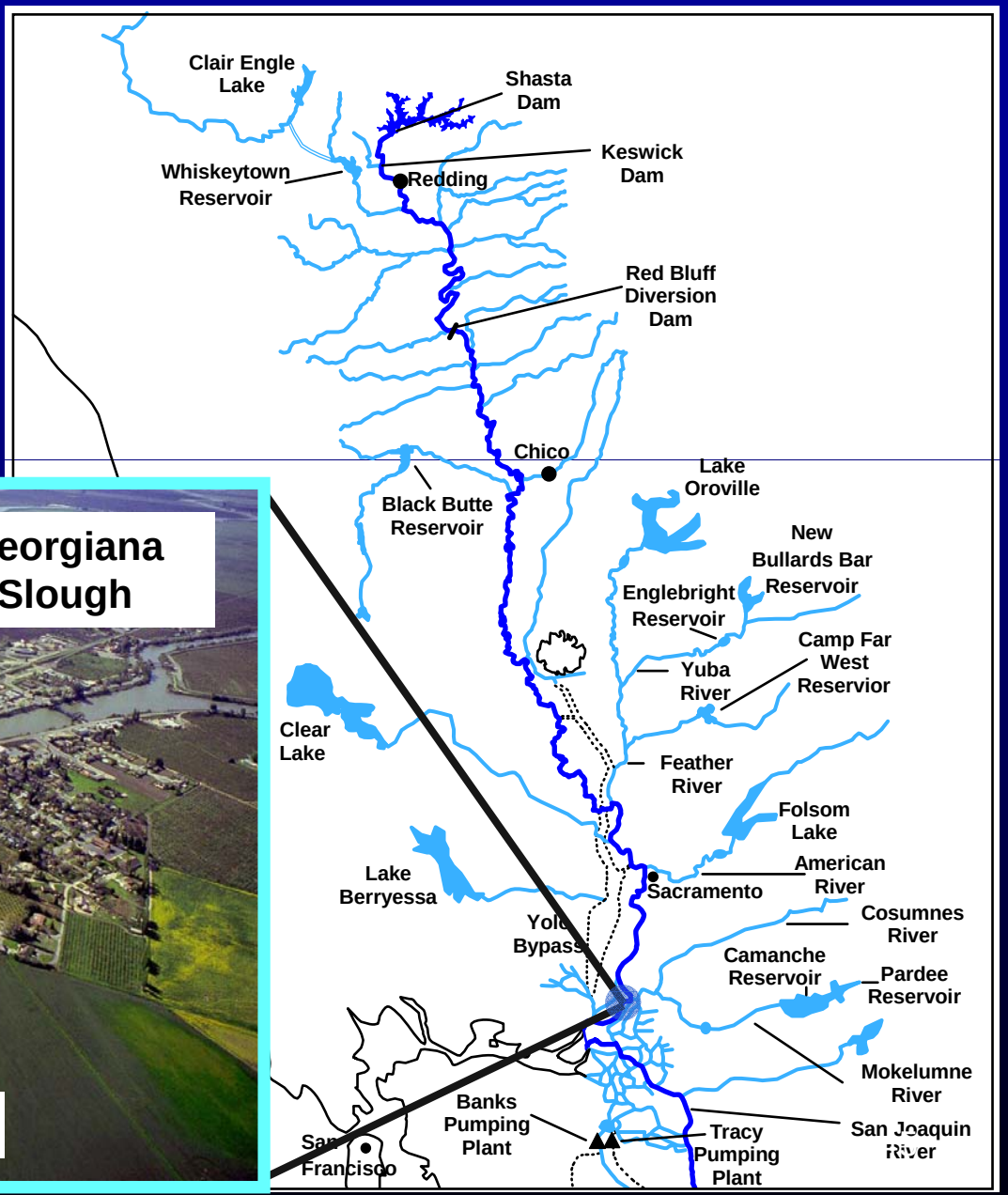




Delta Cross Channel and Georgiana Slough Studies

Delta Cross Channel Gates

North Delta



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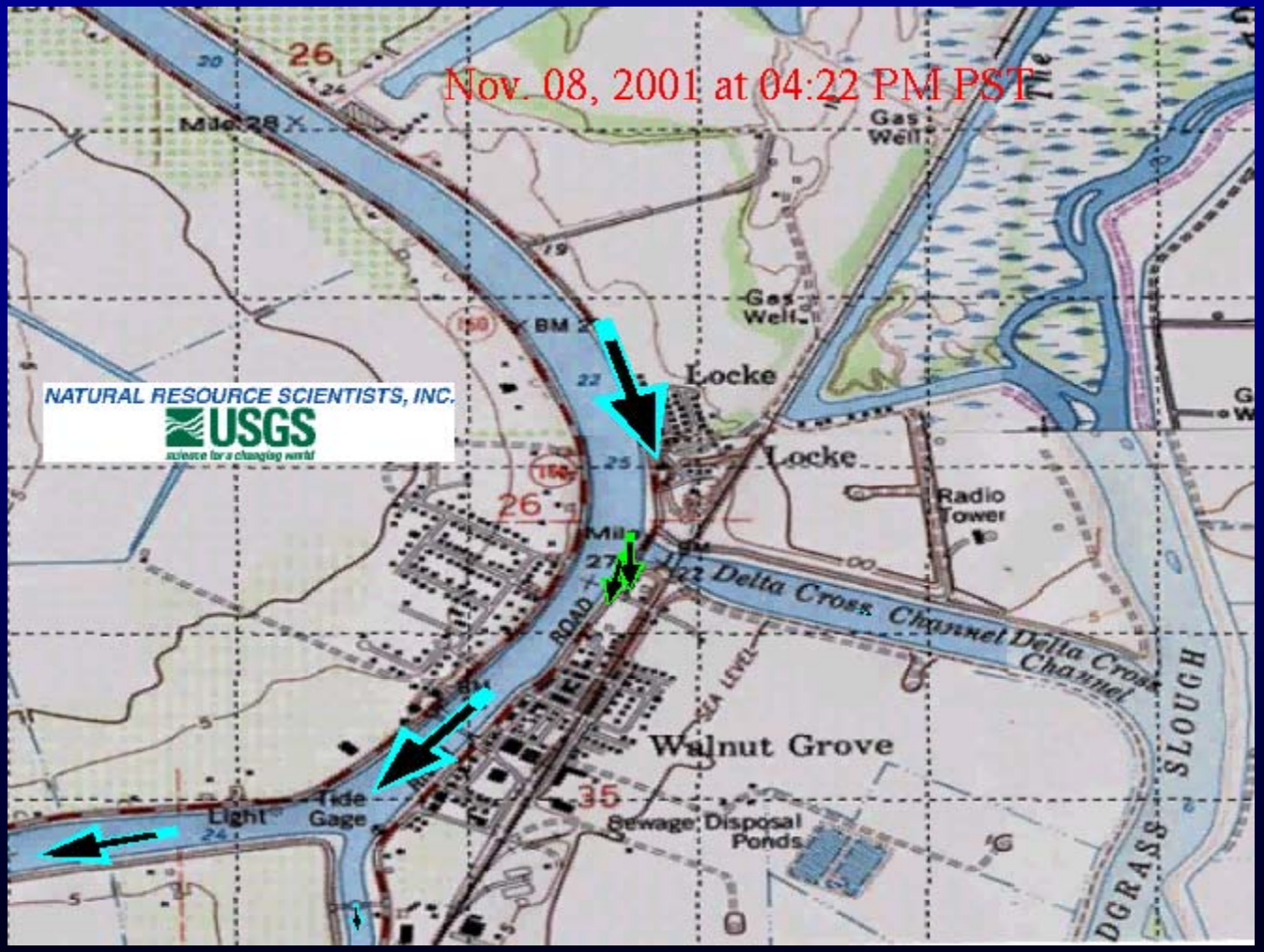
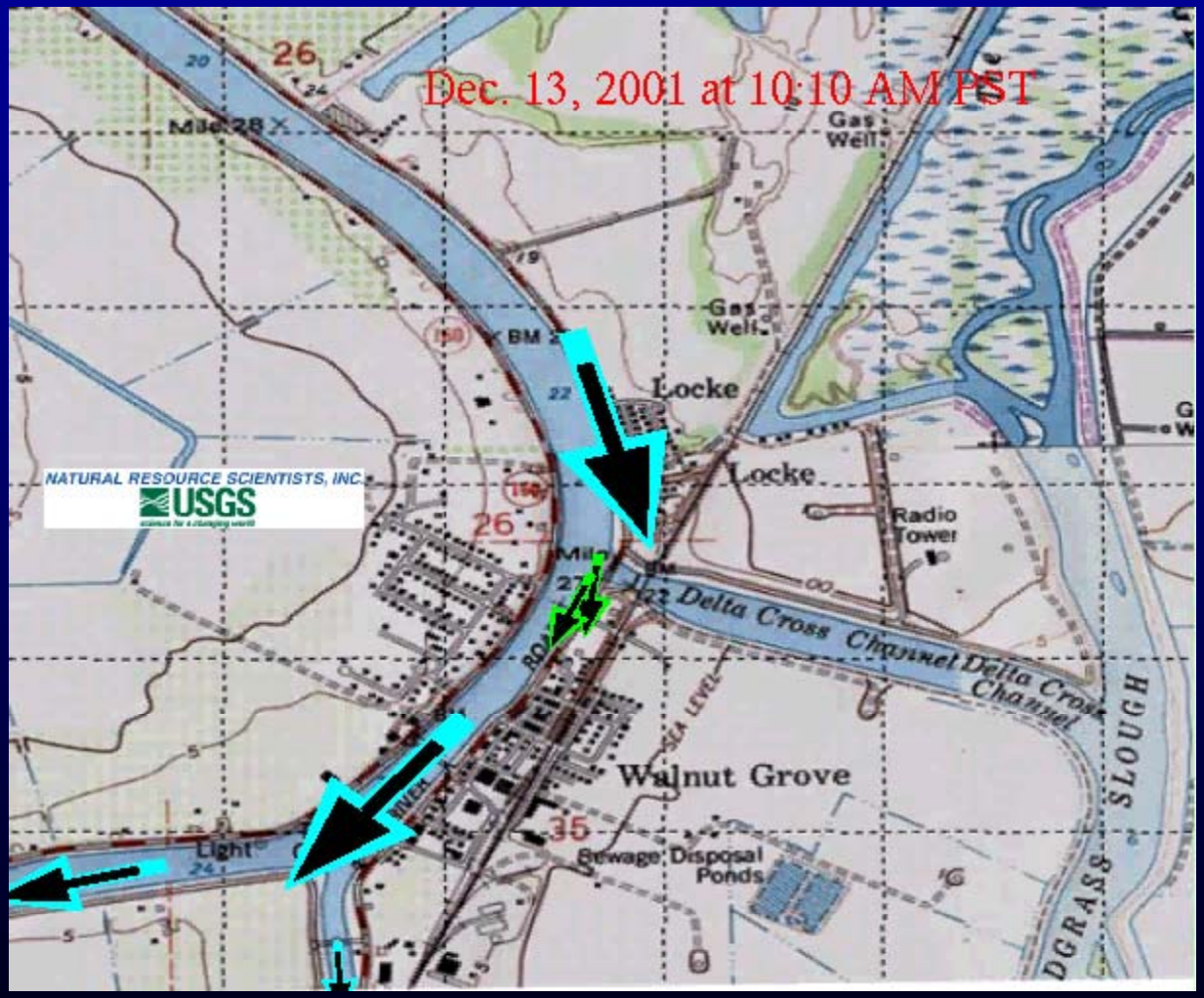
Delta Cross Channel Gates Open
Flood Tide

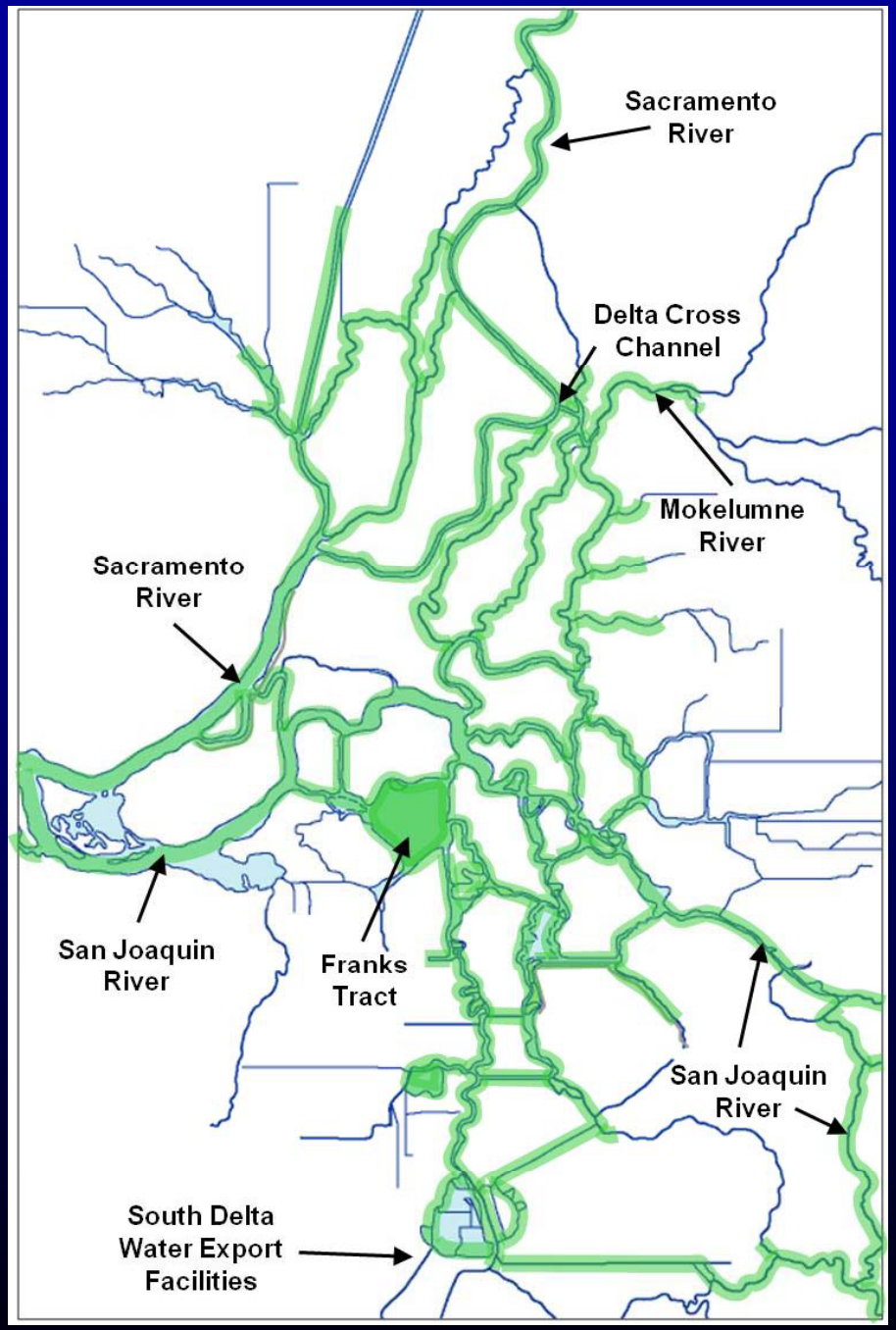
Delta Cross Channel Gates Open
Ebb to Flood Tide Transition



Delta Cross Channel Gates Closed
Ebb to Flood Tide Transition



Salmon Telemetry Studies in the Delta (15 Years)



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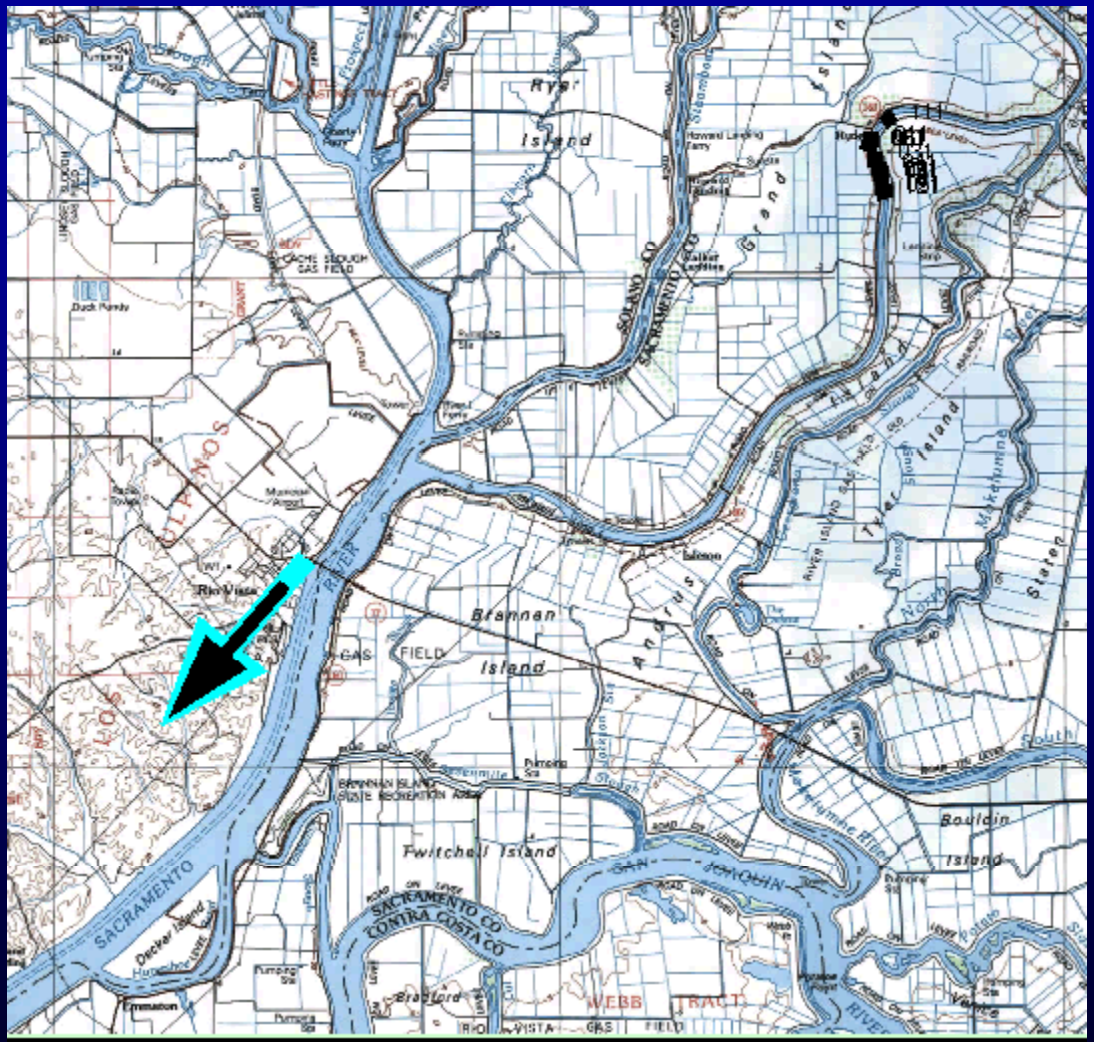
Smolts Move Many Miles Each Day in Correspondence with the Ebb and Flood Tides

USGS Flow Data at Rio Vista



Estimated Fish Positions Based on Interpolation from Known Locations and Fish Behavior

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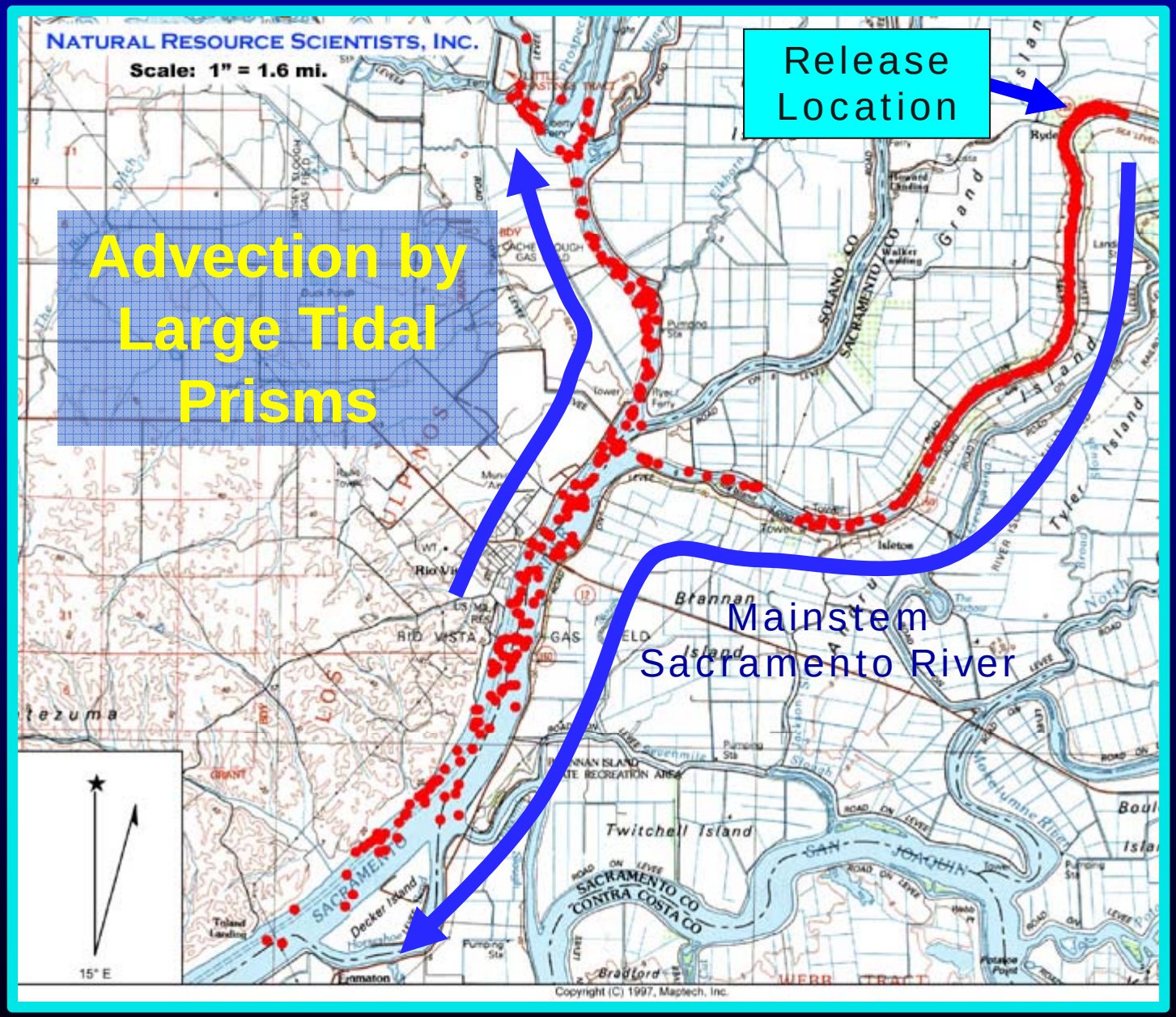
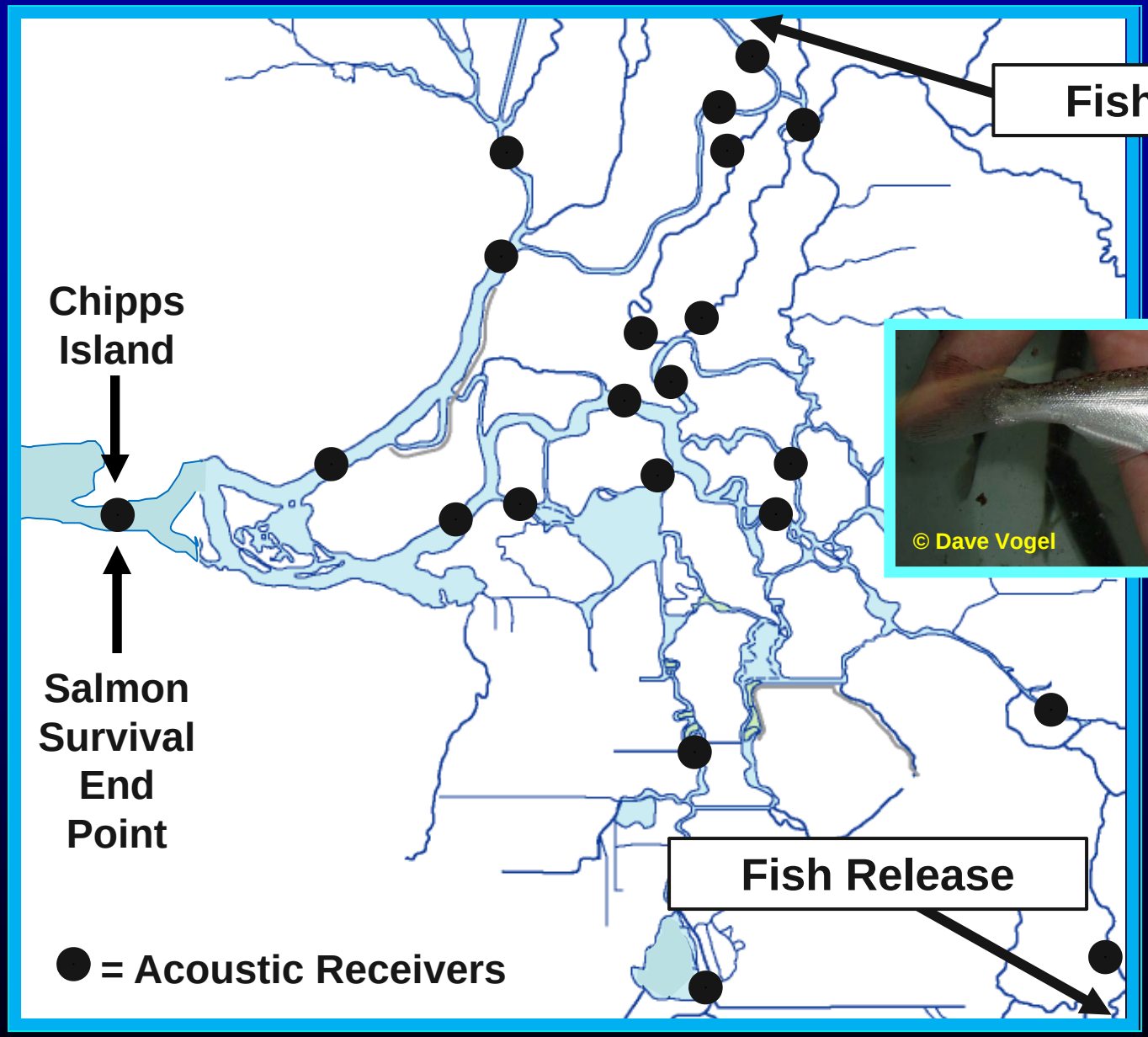
Telemetered Locations of Salmon Smolts



Hypothetical Acoustic Telemetry Array to Estimate Salmon Survival



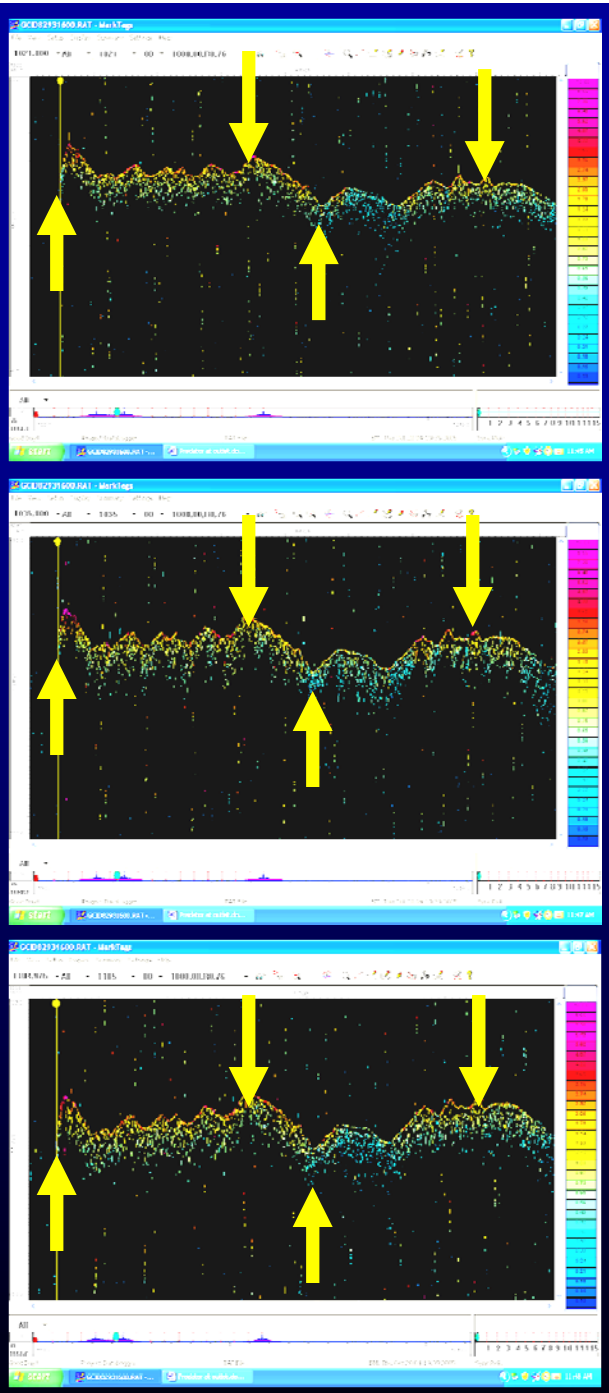
Miniaturized Acoustic Tag (Different Technology)

Natural Resource Scientists, Inc.

Salmon No. 1021

Salmon No. 1035

Salmon No. 1105



Hourly Acoustic Echograms

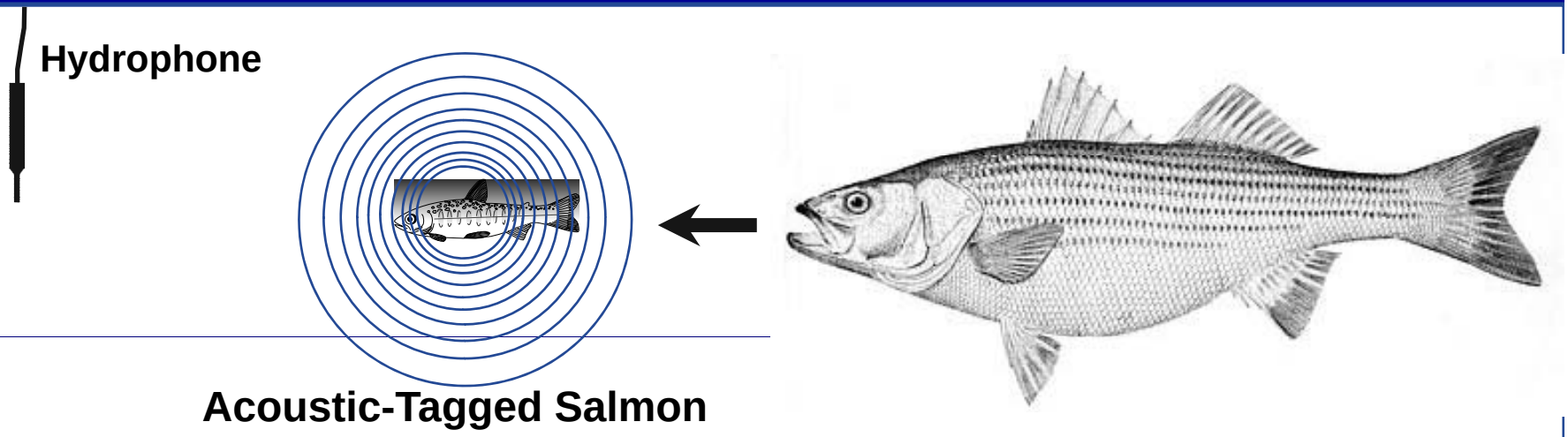
Juvenile Acoustic-Tagged Salmon Released at Different Times and Locations Arrived Downstream at the Same Second

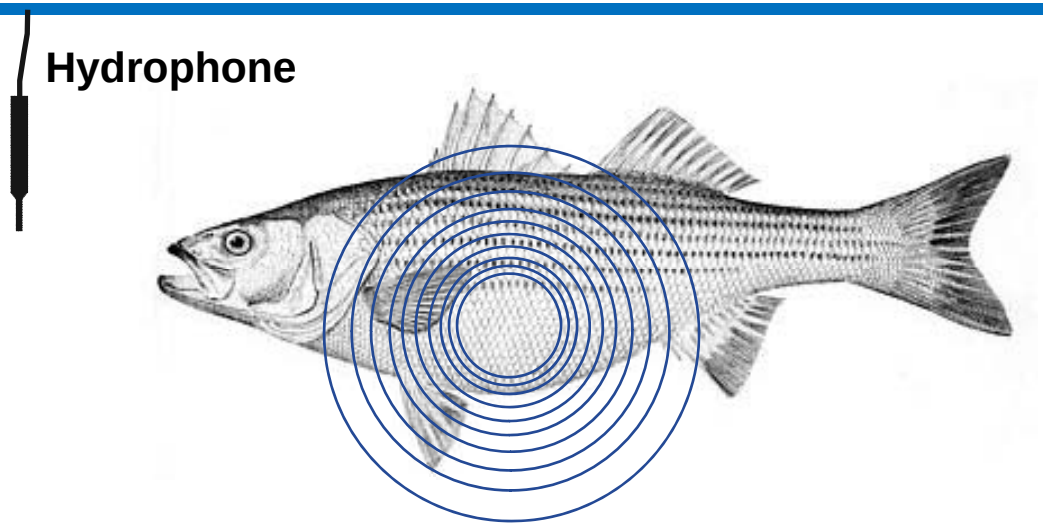
Movement Patterns were Identical for all 3 Transmitters

<u>Conclusion:</u>
<u>3 Salmon Eaten by 1 Predator</u>

Major Problem with Study Design

Striped Bass Predation on Acoustic-Tagged Salmon

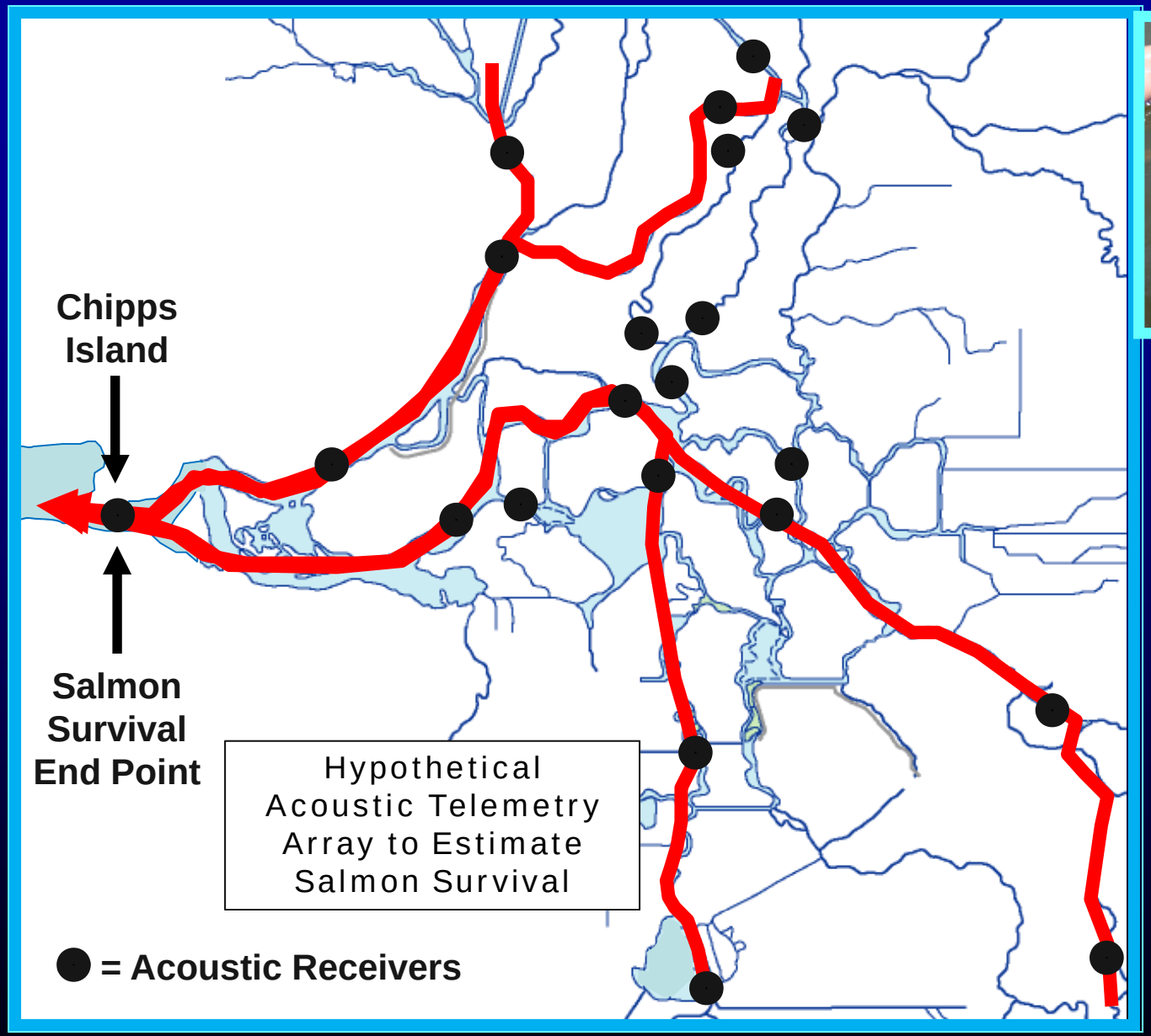




Inability to Determine Live Salmon vs Dead Salmon Inside Striped Bass

Striped Bass Movements in the Delta

(Highly Migratory over Long Distances!)



Acoustic-Tagged Striped Bass

Live Salmon or Dead Salmon Passing Receivers ?

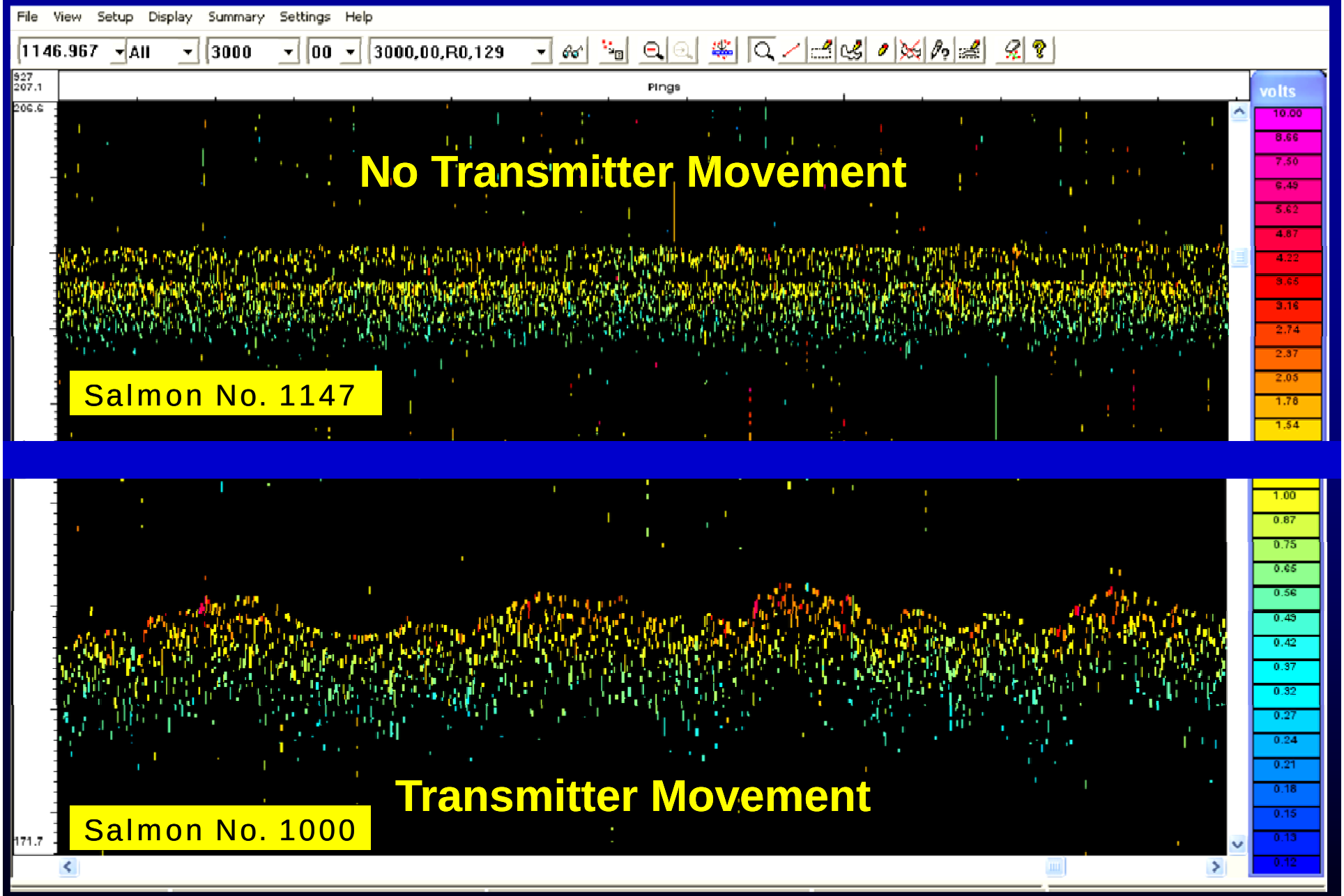
Statistical models failing to account for this predation problem would be in error.

Natural Resource Scientists, Inc.

Ramifications of Striped Bass Predation on Acoustic-Tagged Salmon

Re-analysis changed salmon survival estimates in a lower Sacramento River study from 100% survival to 100% mortality.

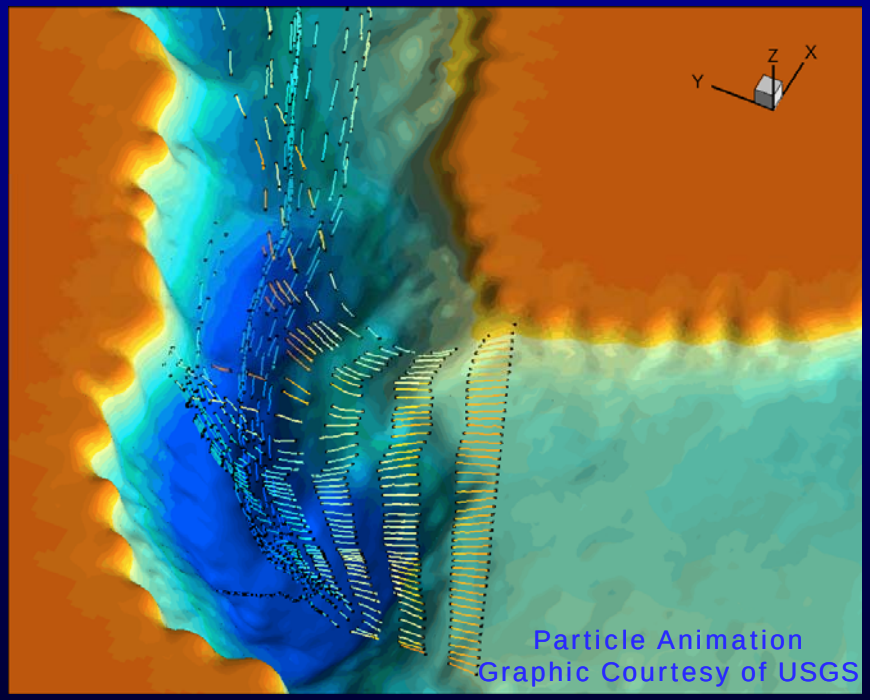
Statistical models failing to account for this predation problem would be in error.

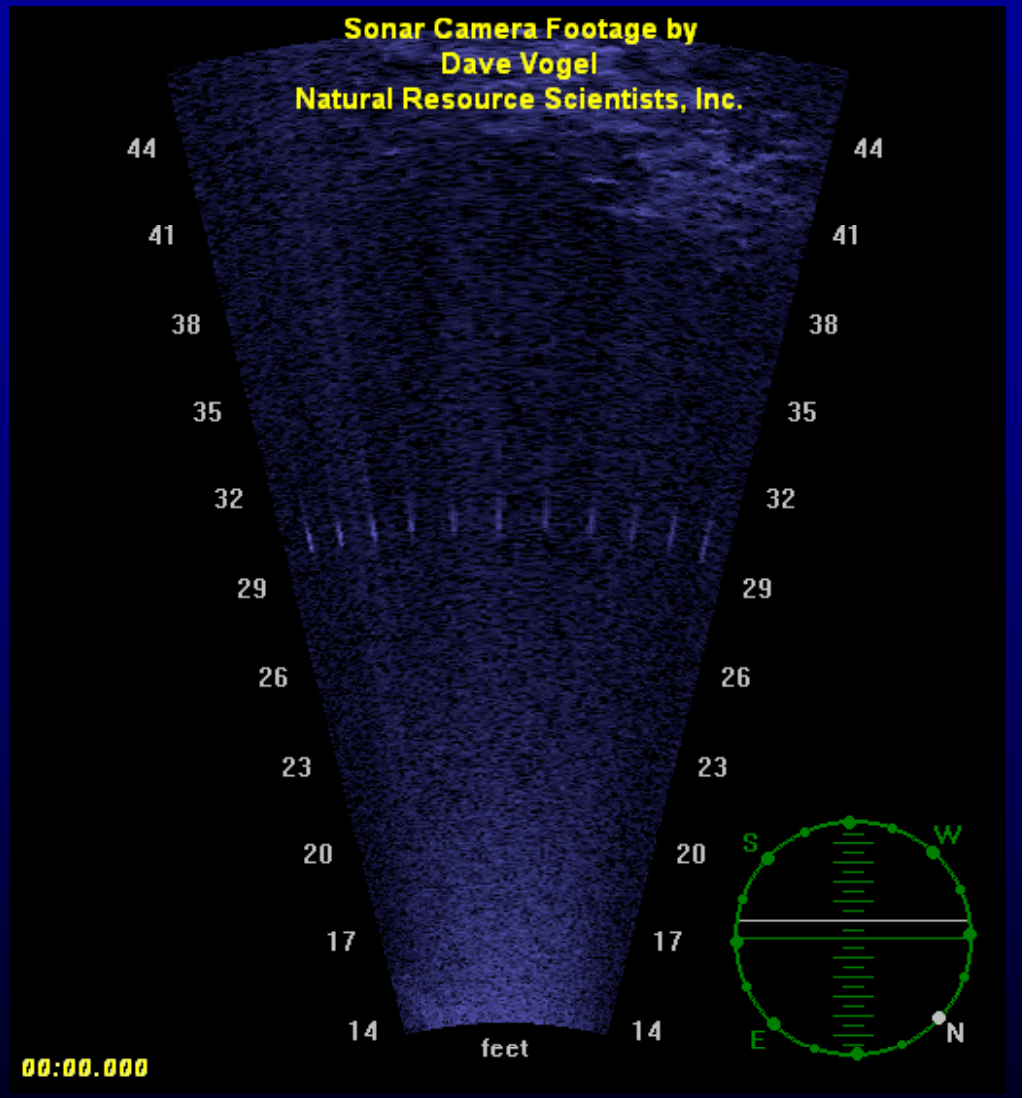

File View Setup Display Summary Settings Help
1146.967 All 3000 00 3000,00,R0,129
Pings
volts
10.00
8.66
7.50
6.49
5.62
4.87
4.22
3.65
3.16
2.74
2.37
2.05
1.78
1.54
No Transmitter Movement
Salmon No. 1147
1.00
0.87
0.75
0.65
0.56
0.49
0.42
0.37
0.32
0.27
0.24
0.21
0.18
0.15
0.13
0.12
Transmitter Movement
Salmon No. 1000

Extremely High Fish Mortality

Motionless Acoustic Transmitters (Dead Salmon)

Scour Holes in the Delta





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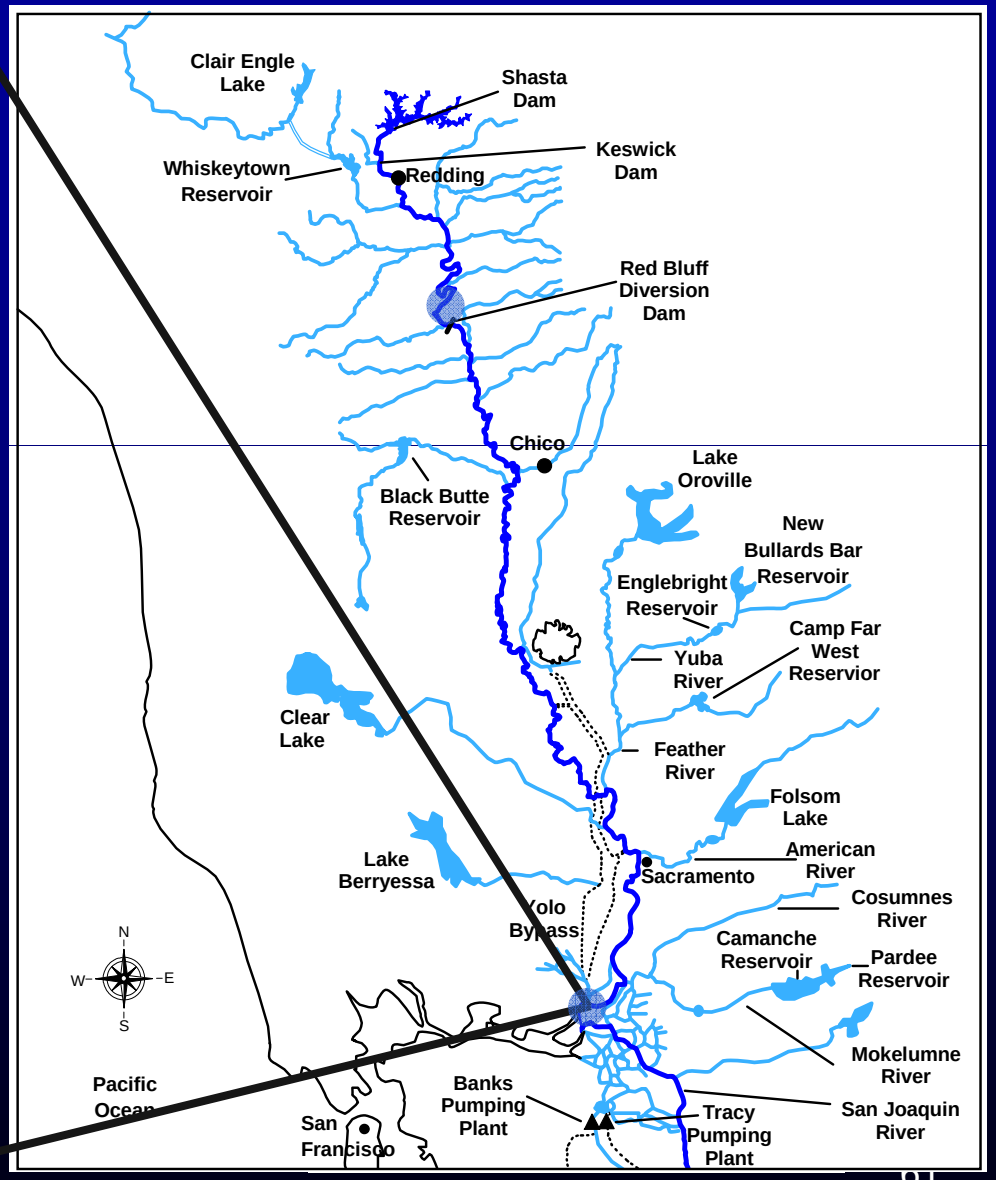
Before Flooding

After Flooding



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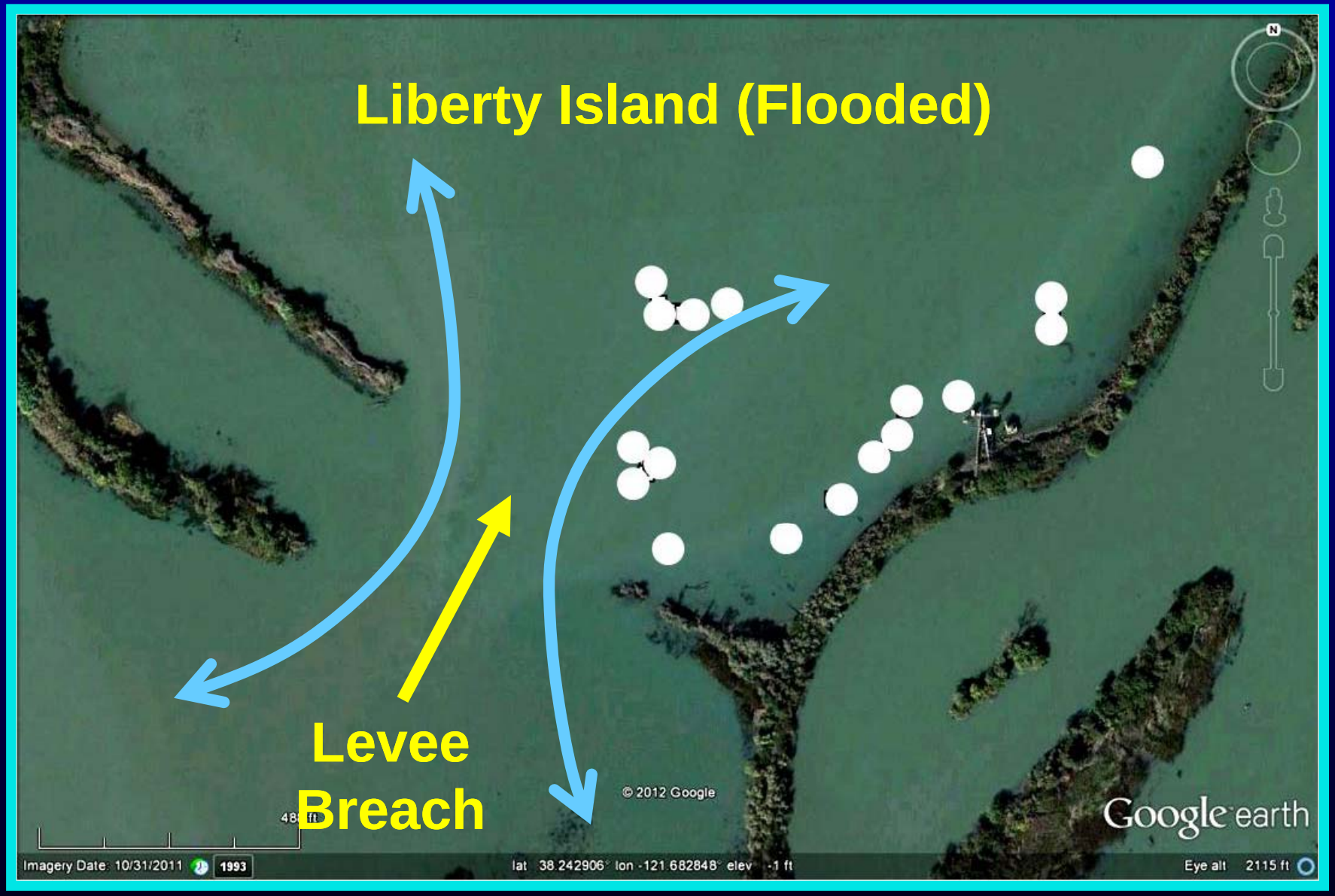
Acoustic-Tagged Adult Striped Bass



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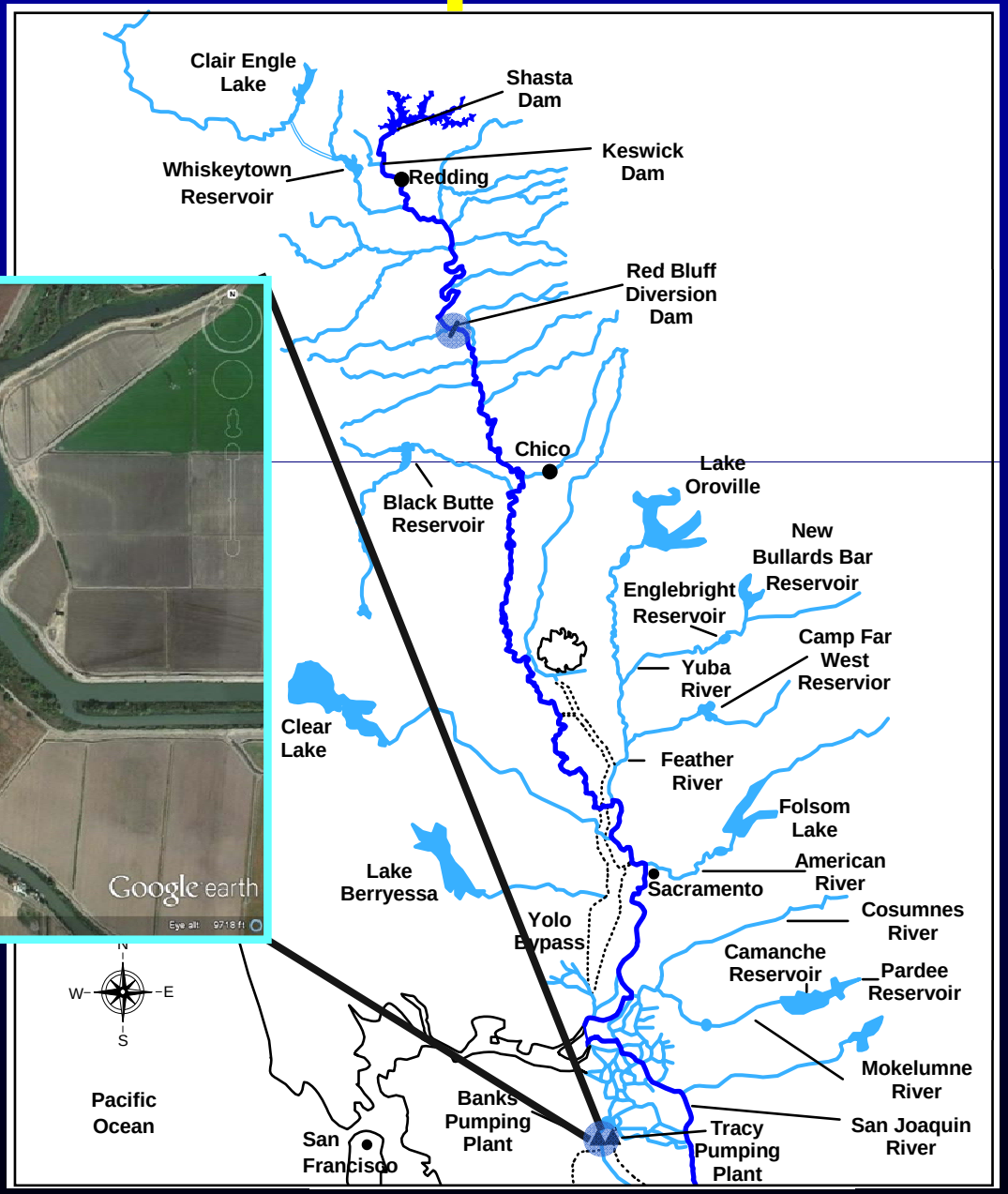
South Delta Water Export Facilities



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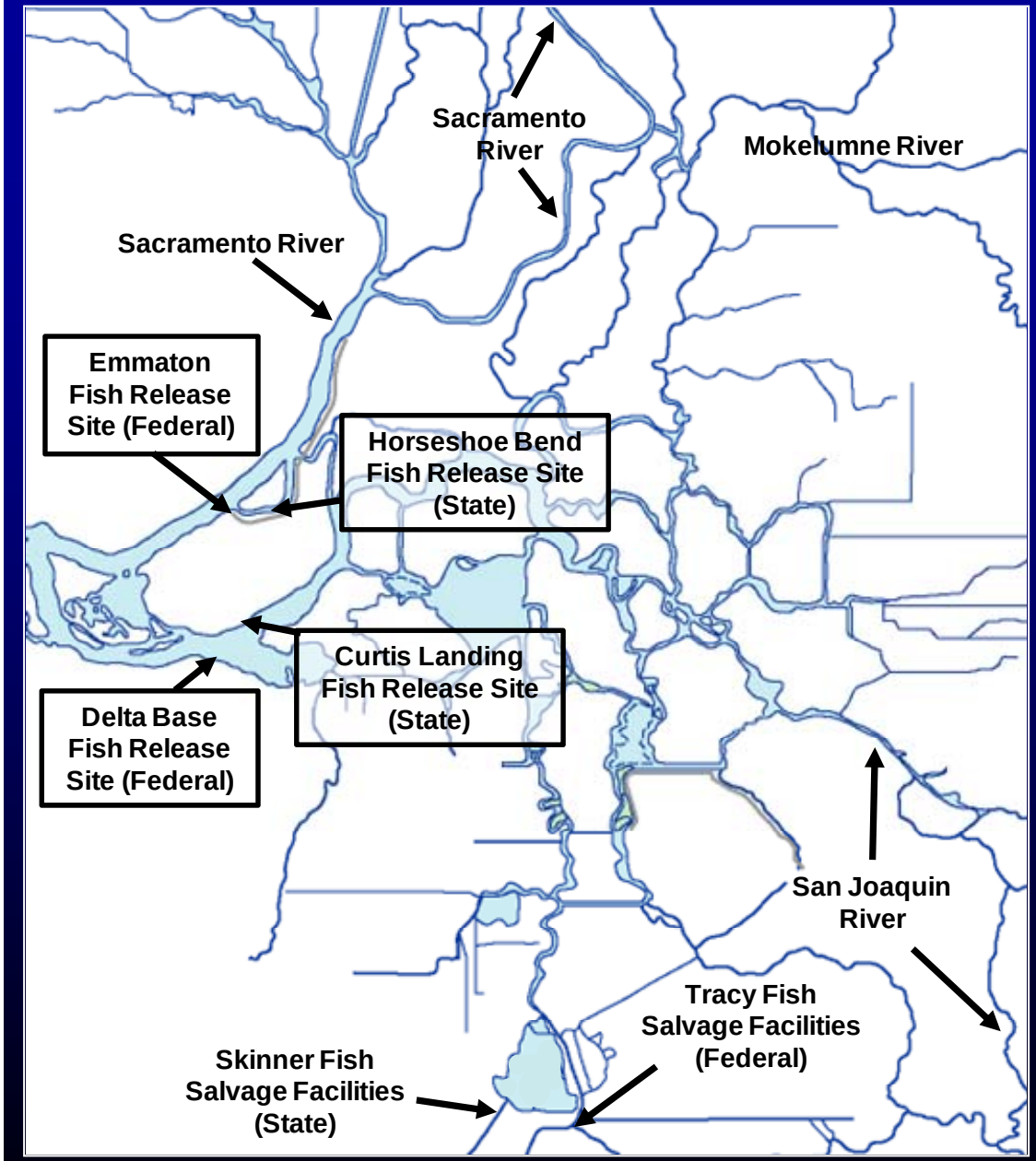

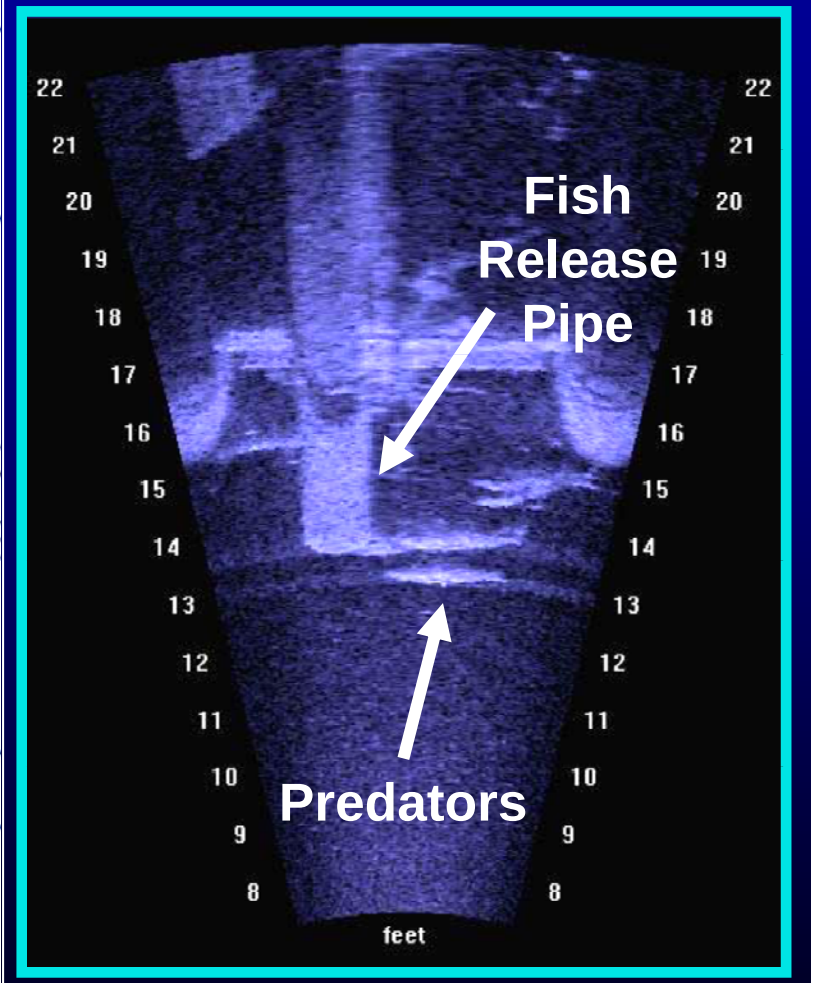

Sonar Camera Image

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Questions ?

Technical report available at: www.norcalwater.org