National Marine Fisheries Service Biological Opinion

Dave Vogel
Natural Resource Scientists, Inc.
September 7, 2011 - Sacramento CA

Sacramento River Basin Native Anadromous Fish

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

Sacramento River Basin Native Anadromous Fish

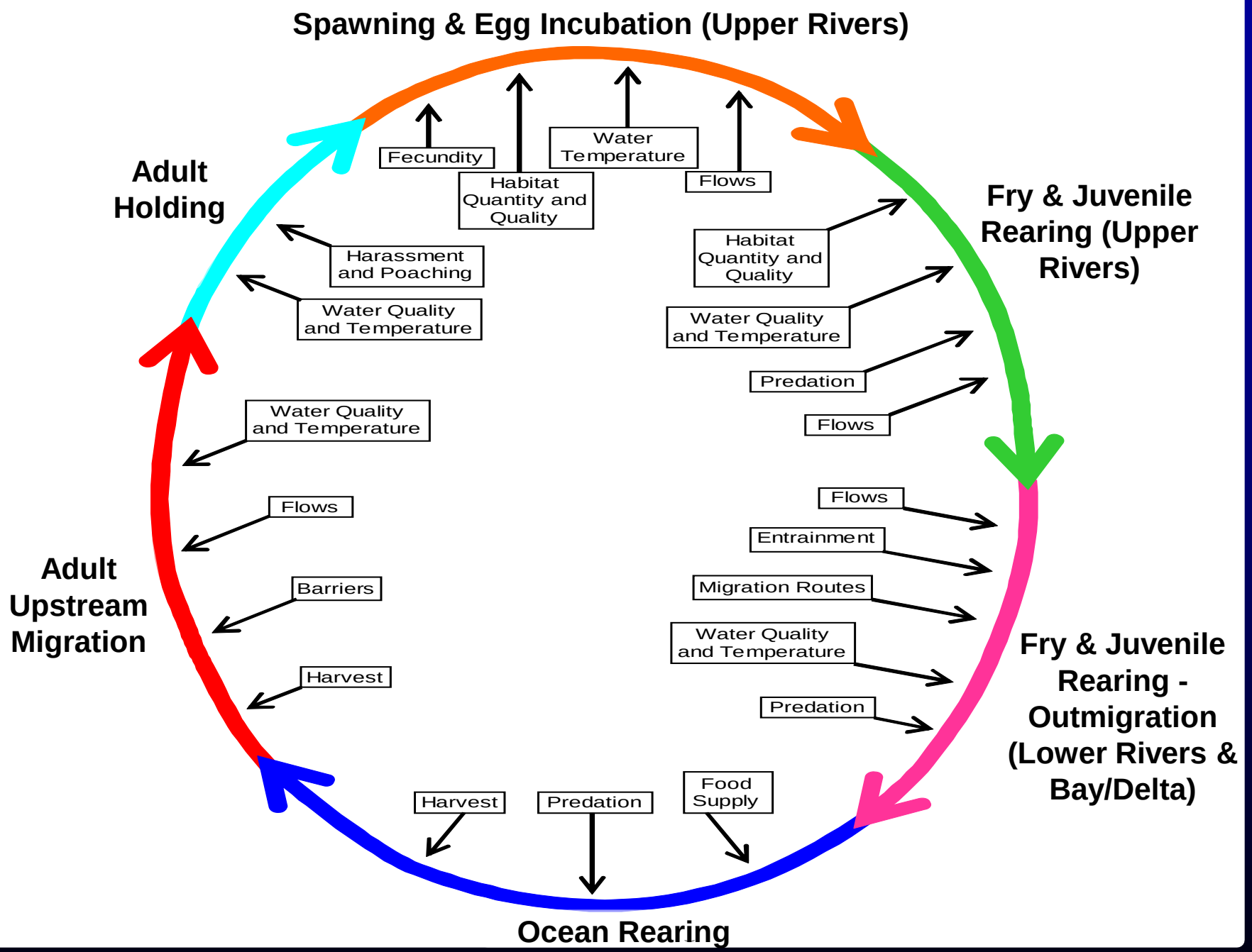
Green Sturgeon (Threatened)

White Sturgeon (Not Listed)

Findings of the Biological Opinion

CVP OCAP would jeopardize:

- Winter-Run Chinook Salmon
- Spring-Run Chinook Salmon
- Steelhead Trout
- Green Sturgeon
- Killer Whales


Spawning & Egg Incubation (Upper Rivers)
Fecundity
Habitat Quantity and Quality
Water Temperature
Flows
Fry & Juvenile Rearing (Upper Rivers)
Habitat Quantity and Quality
Water Quality and Temperature
Predation
Flows
Fry & Juvenile Rearing - Outmigration (Lower Rivers & Bay/Delta)
Flows
Entrainment
Migration Routes
Water Quality and Temperature
Predation
Ocean Rearing
Harvest
Predation
Food Supply
Adult Upstream Migration
Water Quality and Temperature
Flows
Barriers
Harvest
Adult Holding
Harassment and Poaching
Water Quality and Temperature

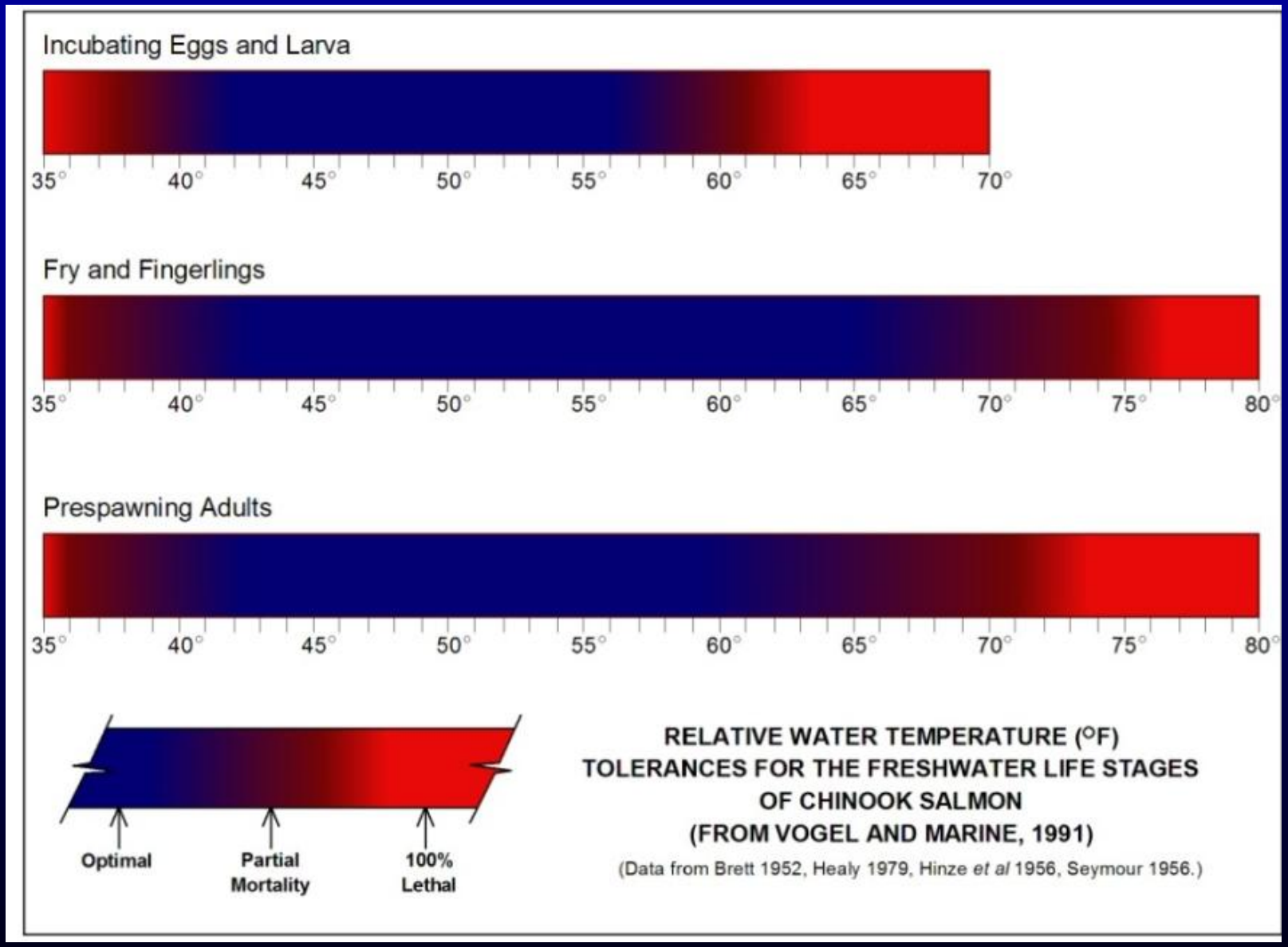
Upstream Migration

Holding

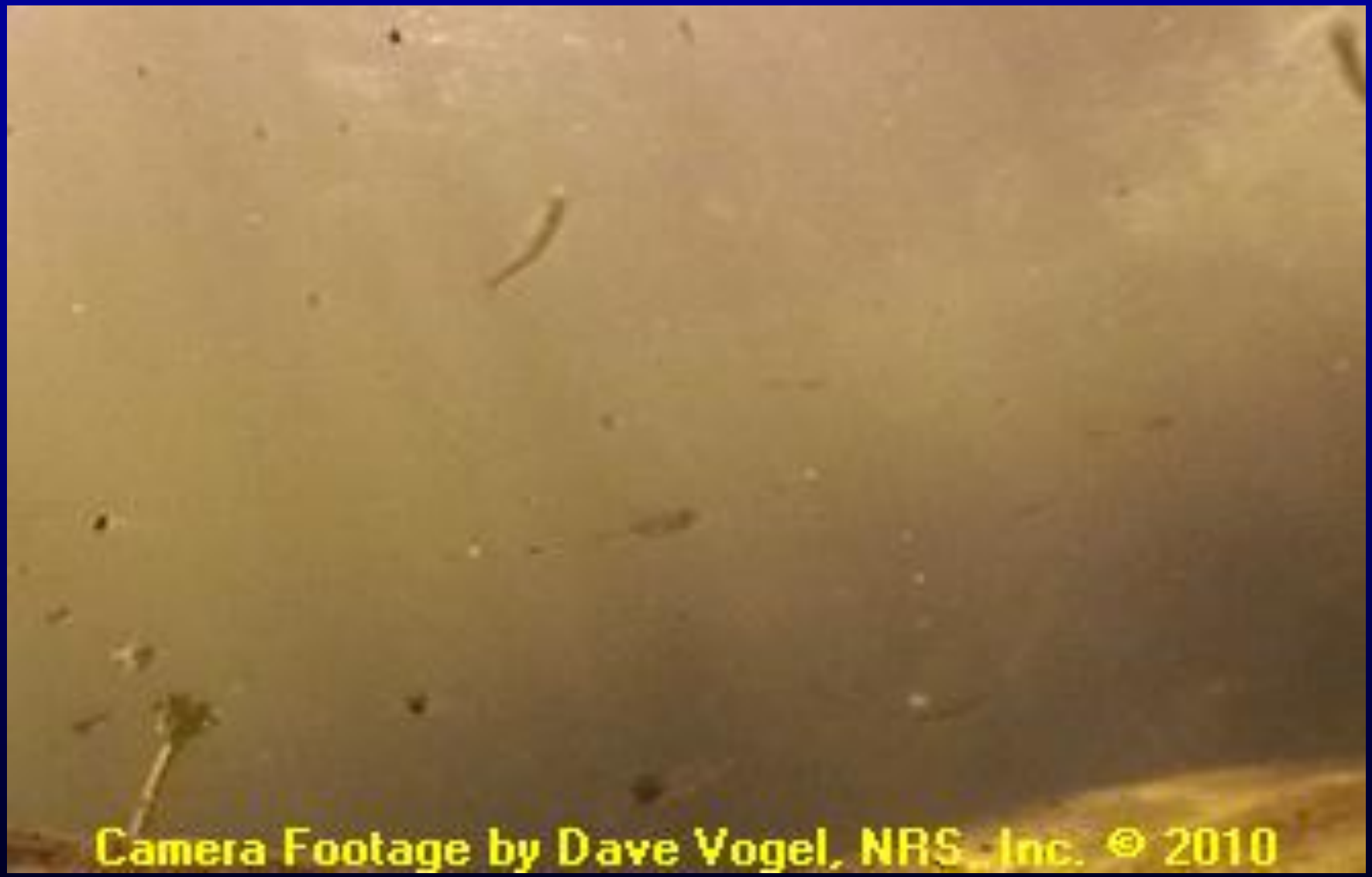
Spawning Habitat

Egg Incubation

Temperature Tolerances of Chinook Salmon



Juvenile Rearing and Outmigration



Upriver RPAs (not all-inclusive)

Clear Creek

- Flows
- Spawning Gravels
- Water Temperature Control

Battle Creek

- Large-Scale Watershed Restoration

Sacramento River

- Flows
- Water Temperature Control
- Carryover Storage Levels
- Red Bluff Diversion Dam Gates Out
- Re-introduction Studies above Dams

Upriver RPAs (cont.)

American River

- Flows
- Water Temperature Control
- Hatchery Genetics Studies
- Re-Introduction Studies above Dams

Stanislaus River

- Flows
- Water Temperature Control
- Spawning Gravel Additions
- Re-introduction Studies above Dams

RPAs (cont.)

North Delta

- Yolo Bypass Rearing Studies/Projects
- Freemont Weir Upstream Passage
- Liberty Island/Lower Cache Slough Rearing

Delta RPAs (cont.)

Delta

– Delta Cross Channel Closures

– Georgiana Slough Entrainment Reduction

– Real-Time Monitoring of Salmon Outmigration

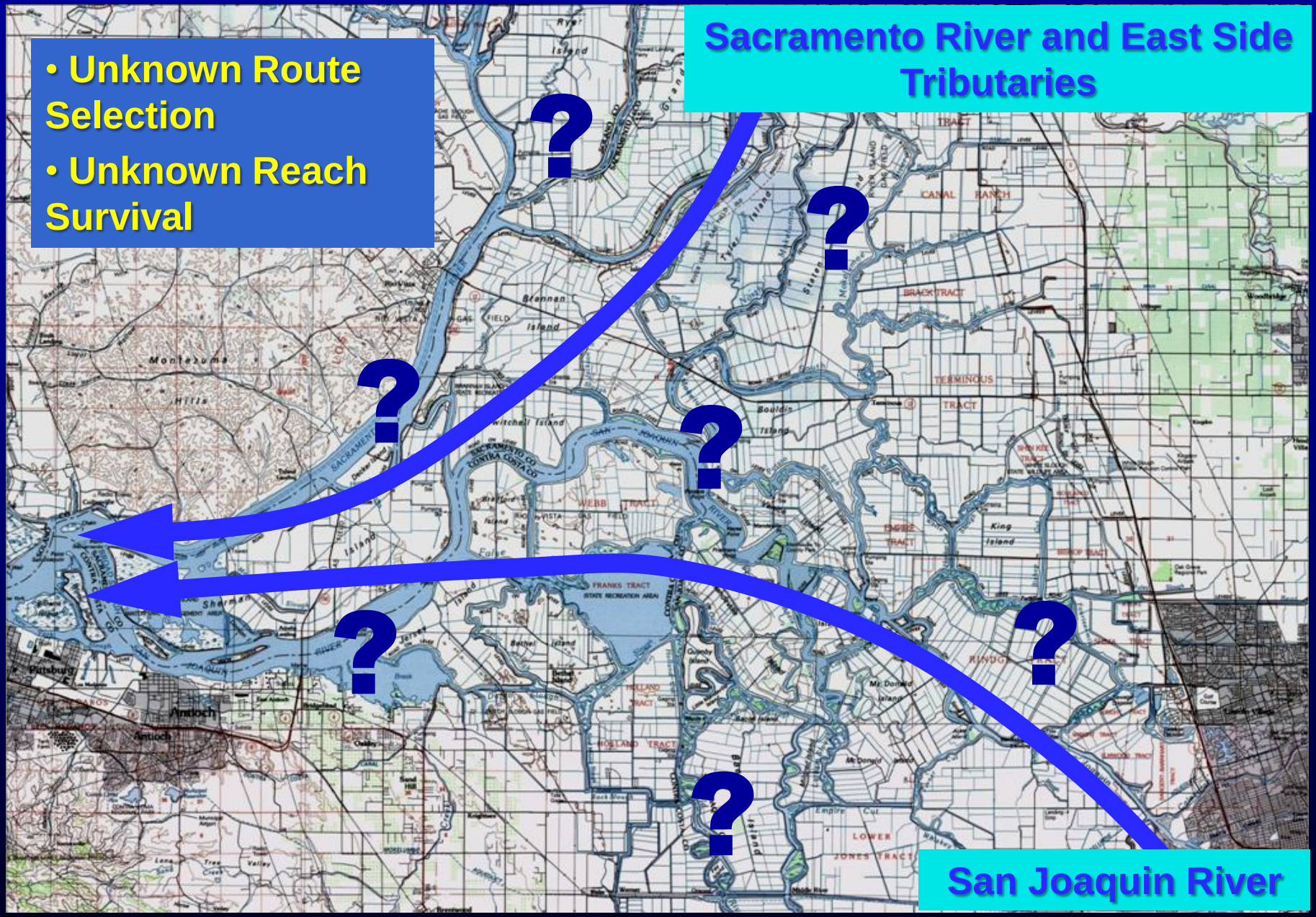
– San Joaquin Flows/S. Delta Exports

– Old/Middle River Flow Management

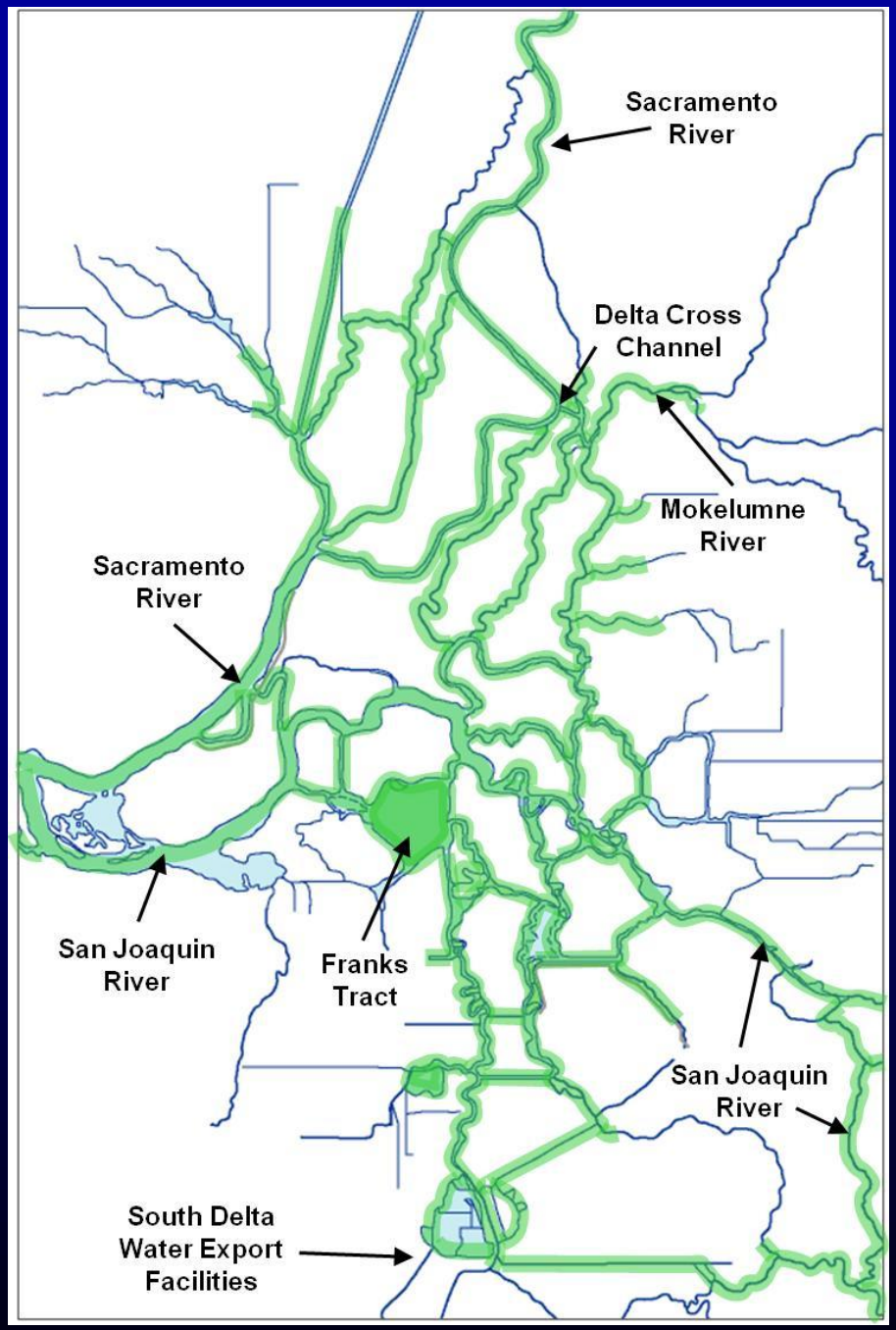
– S. Delta Exports Reductions Tied to Real-Time Monitoring of Salmon Outmigration

– S. Delta Export Fish Salvage Improvements

– 6-Year Acoustic-Tag Experiments

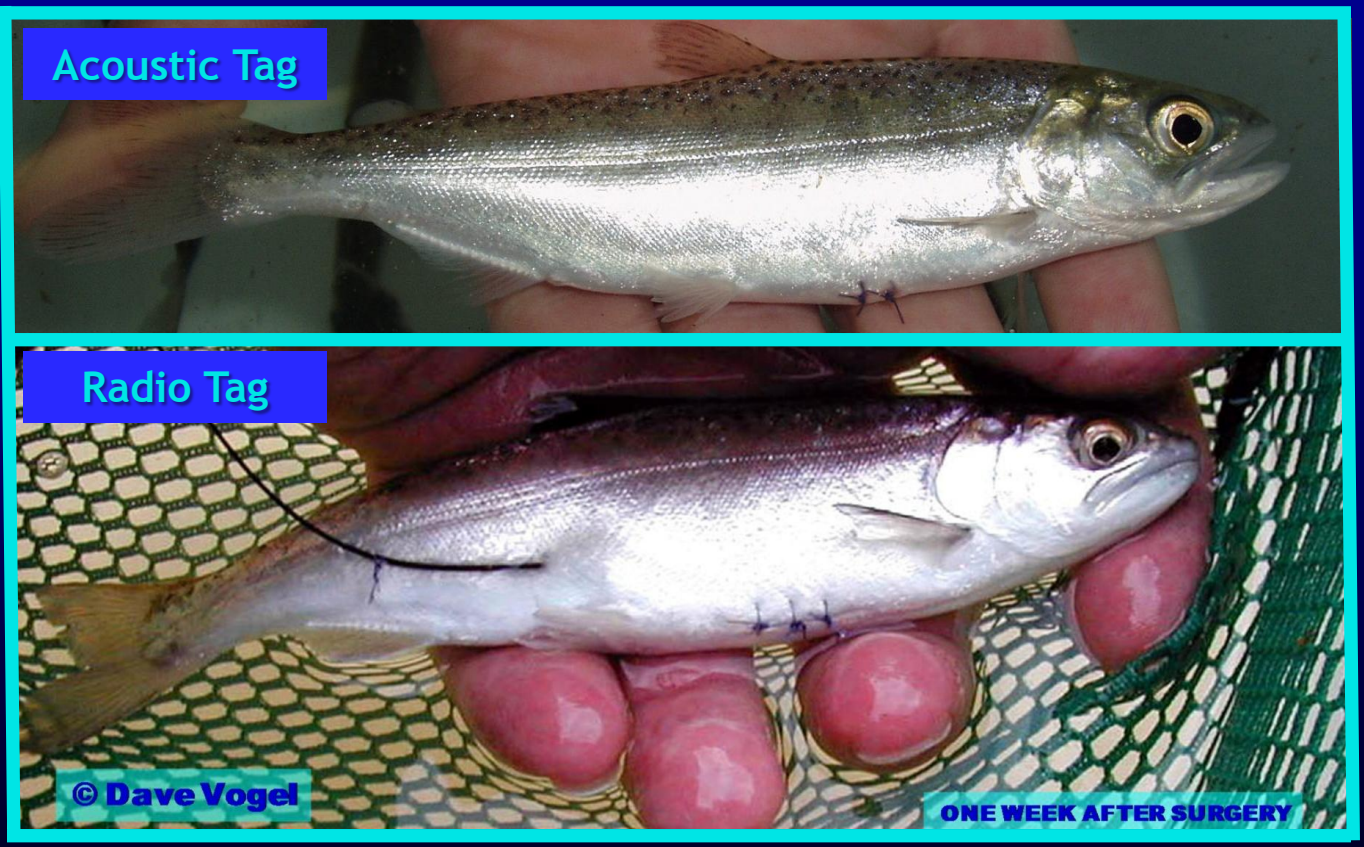


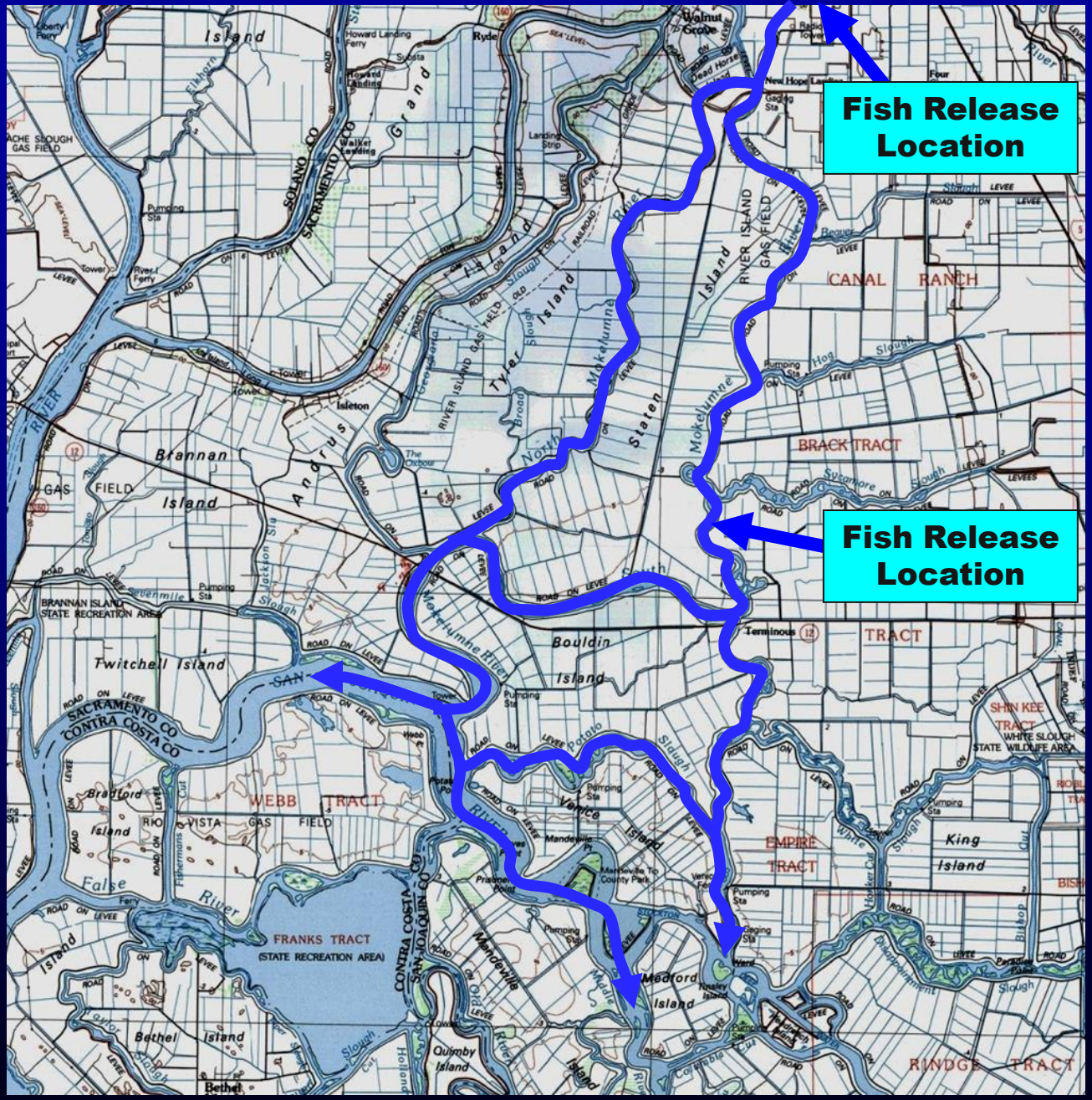
Where and Why do Juvenile Salmon Die in the Delta?



Salmon Telemetry Studies in the Delta (1996 – 2010)

Juvenile Salmon Telemetry Studies in the Delta





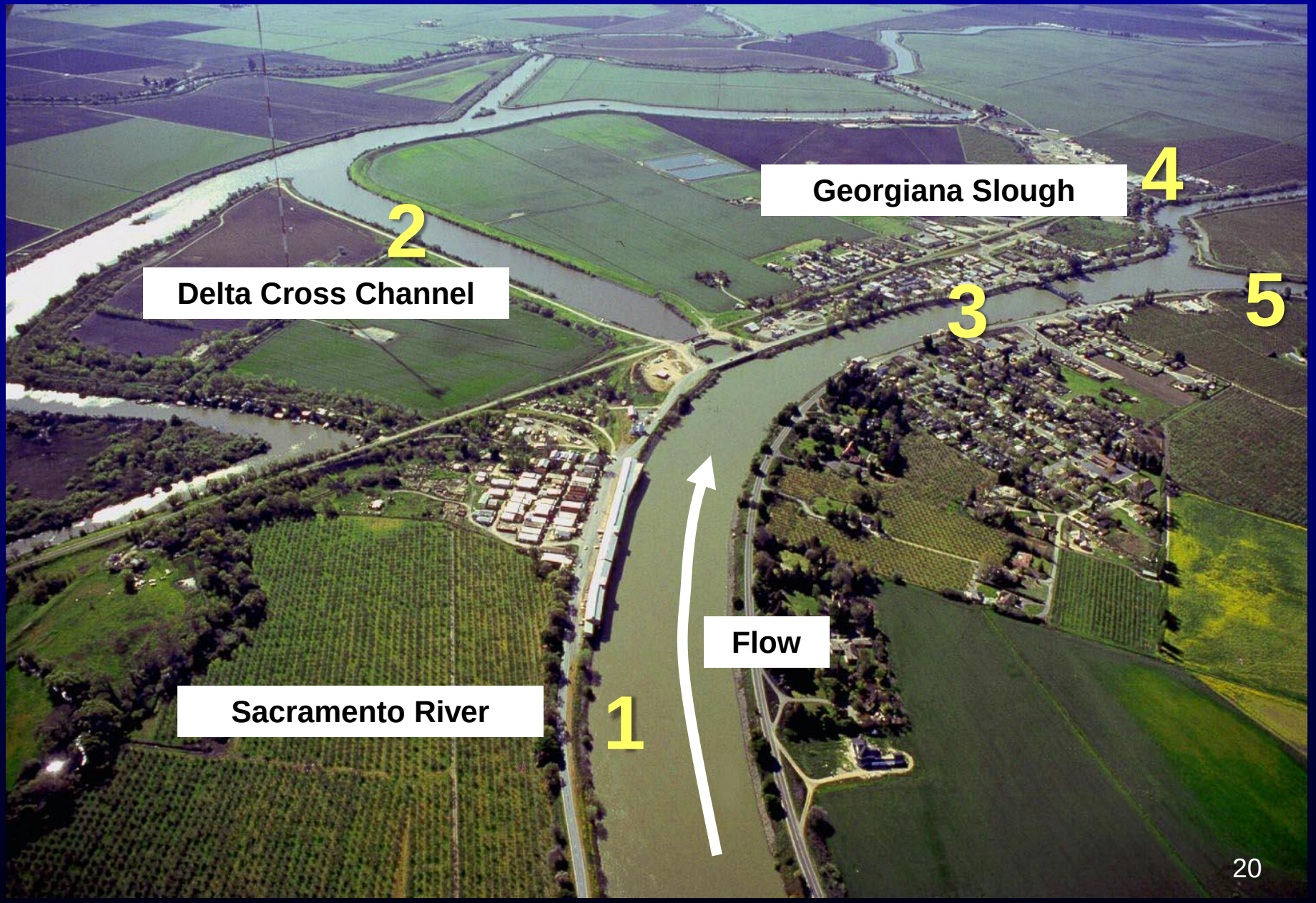
Early Findings

- No schooling
- Movements with tides
- Side channels unused
- Mid-channel migration
- Flow split / route selection
- Evidence of predation

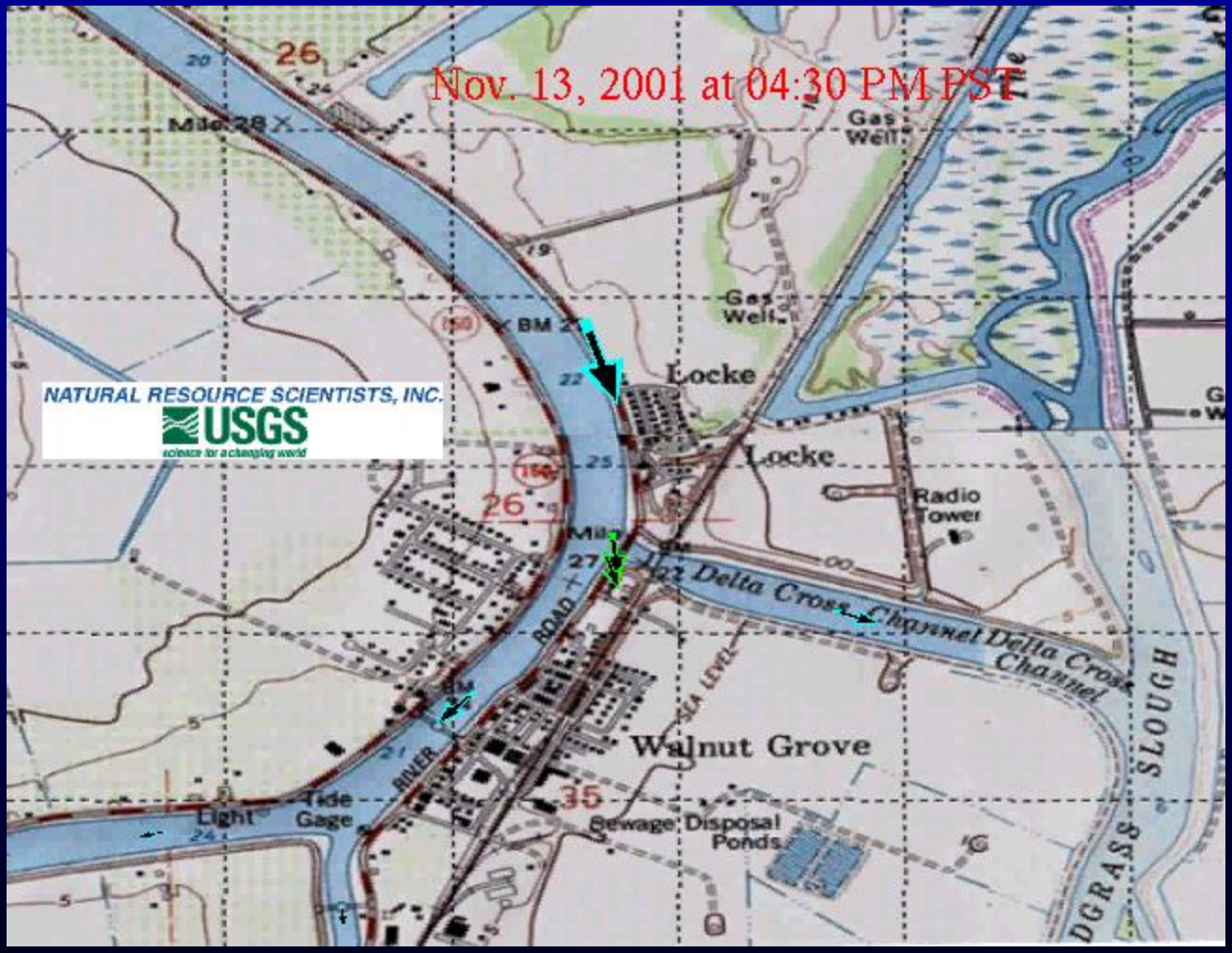
Lower Mokelumne Studies (1990s)

Delta Cross Channel Studies

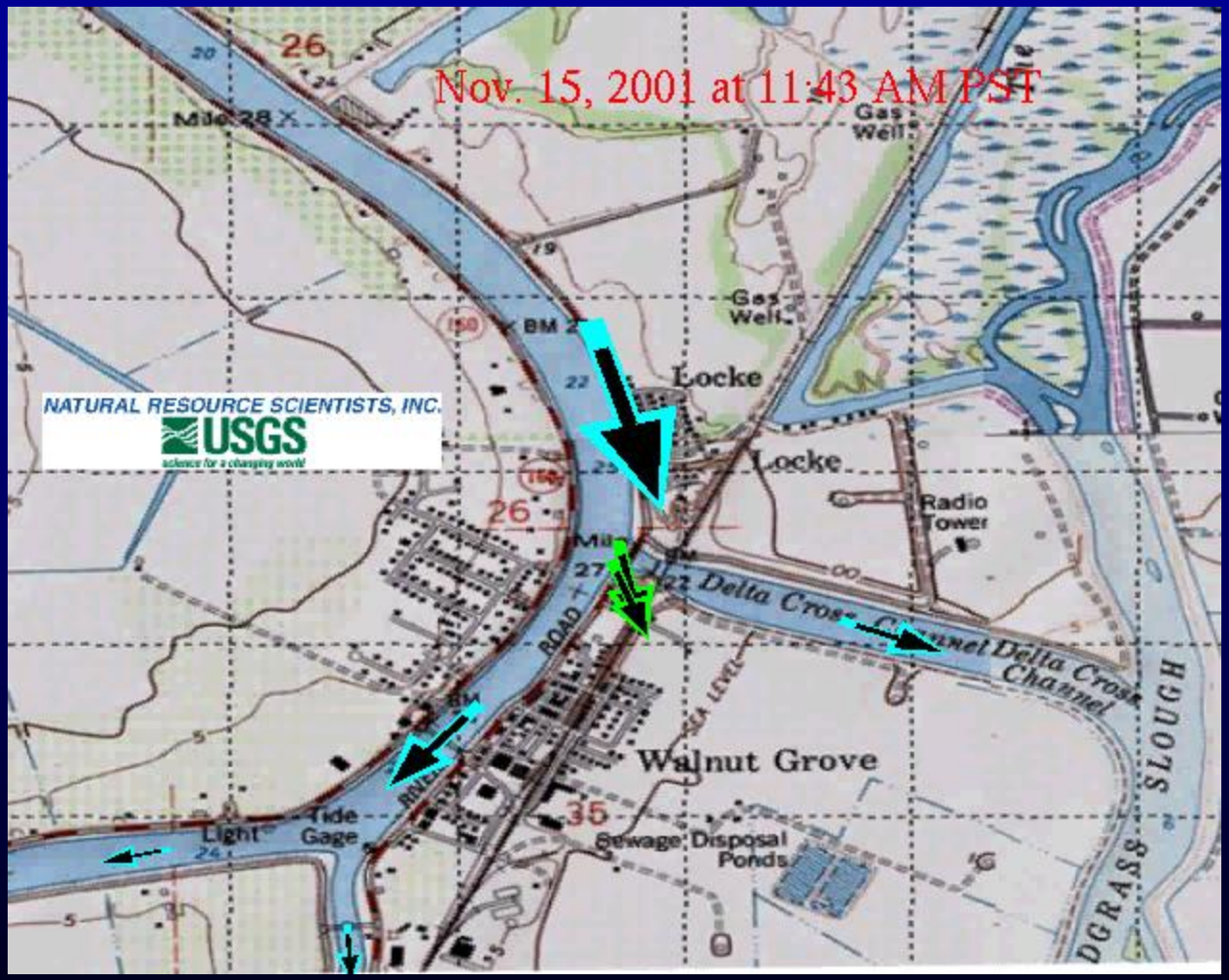
Delta Cross Channel Studies



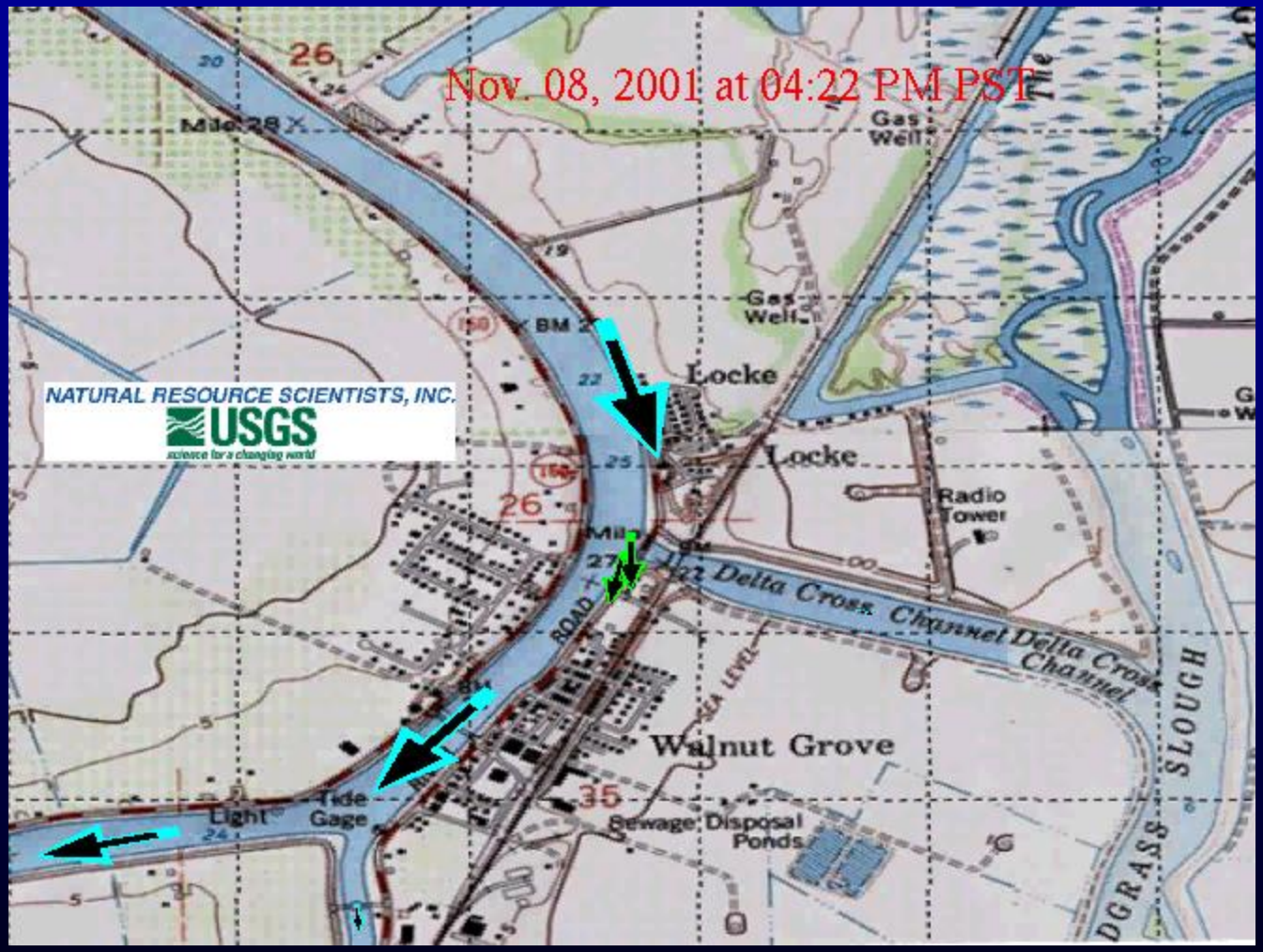
Delta Cross Channel Gates Open
Strong Ebb Tide



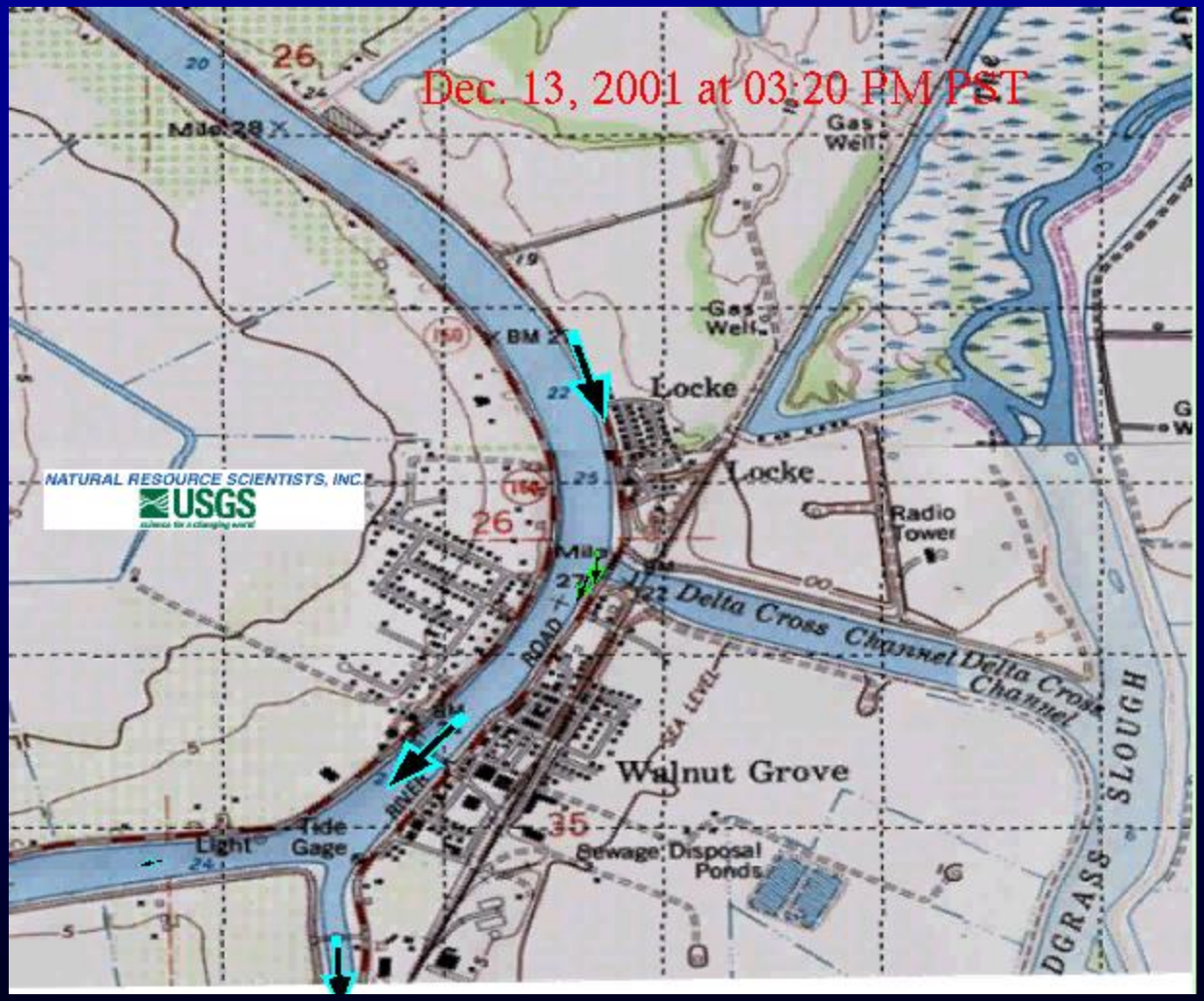
Delta Cross Channel Gates
Flood Tide



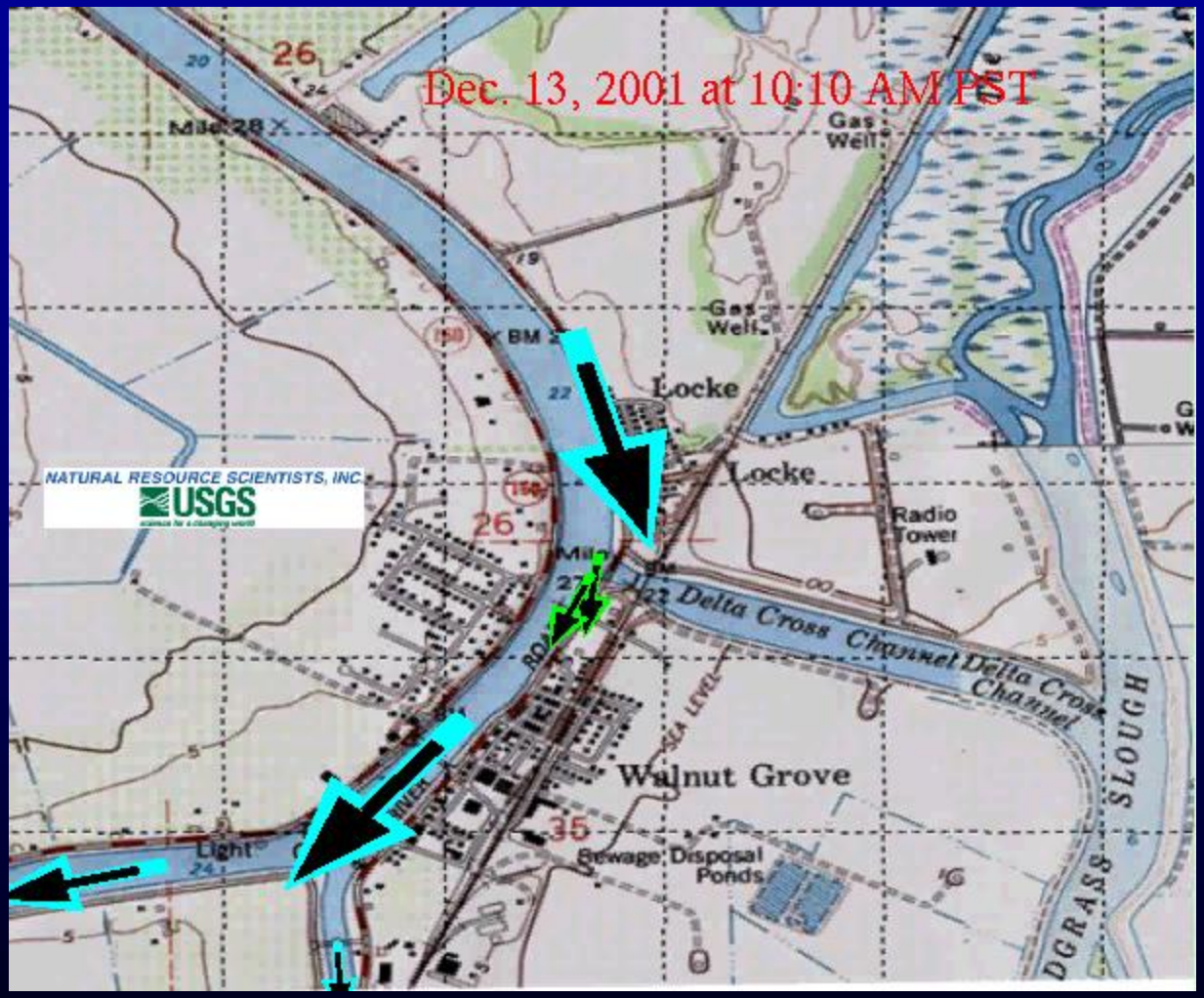
Delta Cross Channel Gates Open
Ebb to Flood Tide Transition



Delta Cross Channel Gates Closed
Ebb Tide



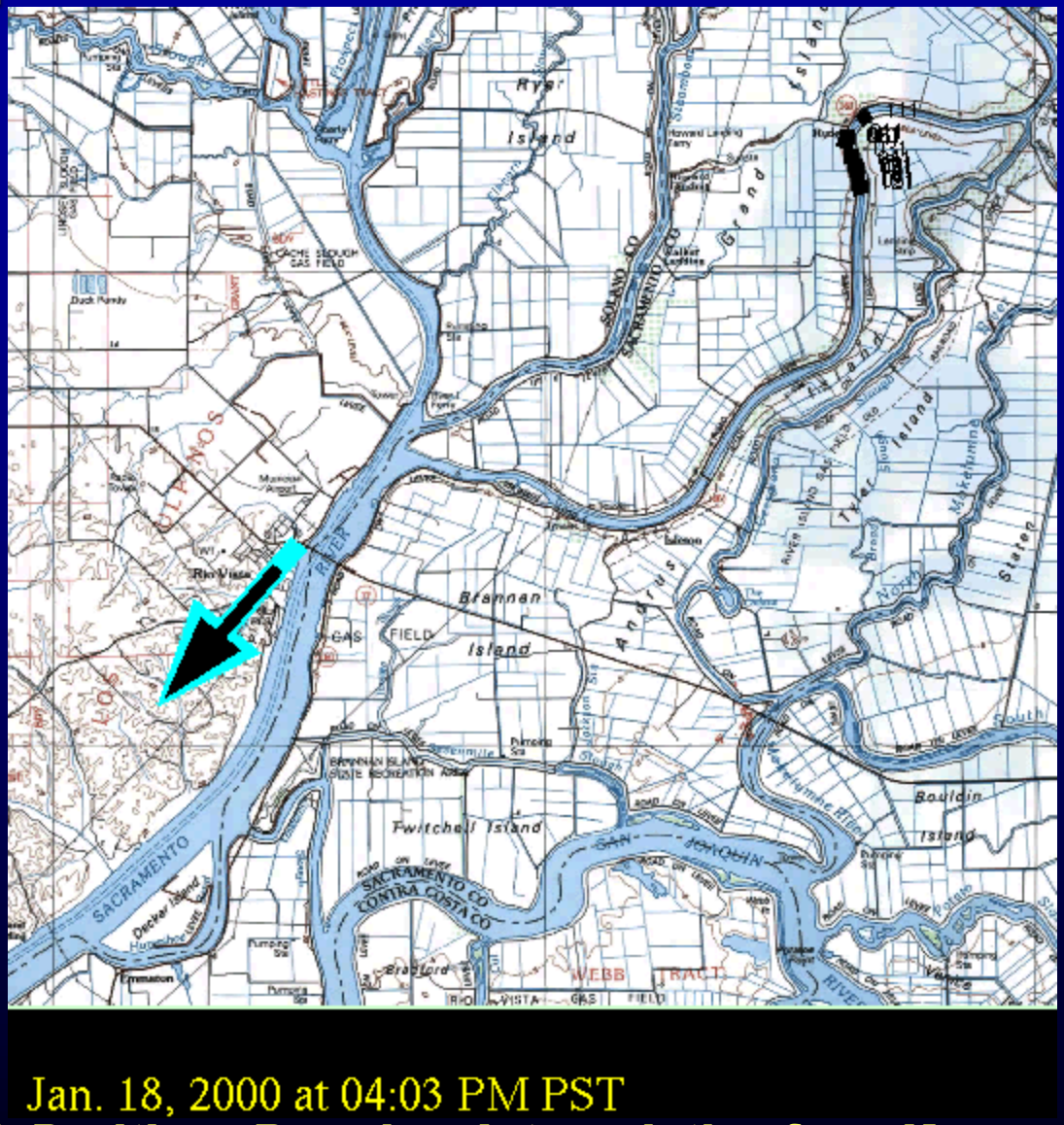
Delta Cross Channel Gates Closed
Ebb to Flood Tide Transition



Radio Telemetry Studies

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

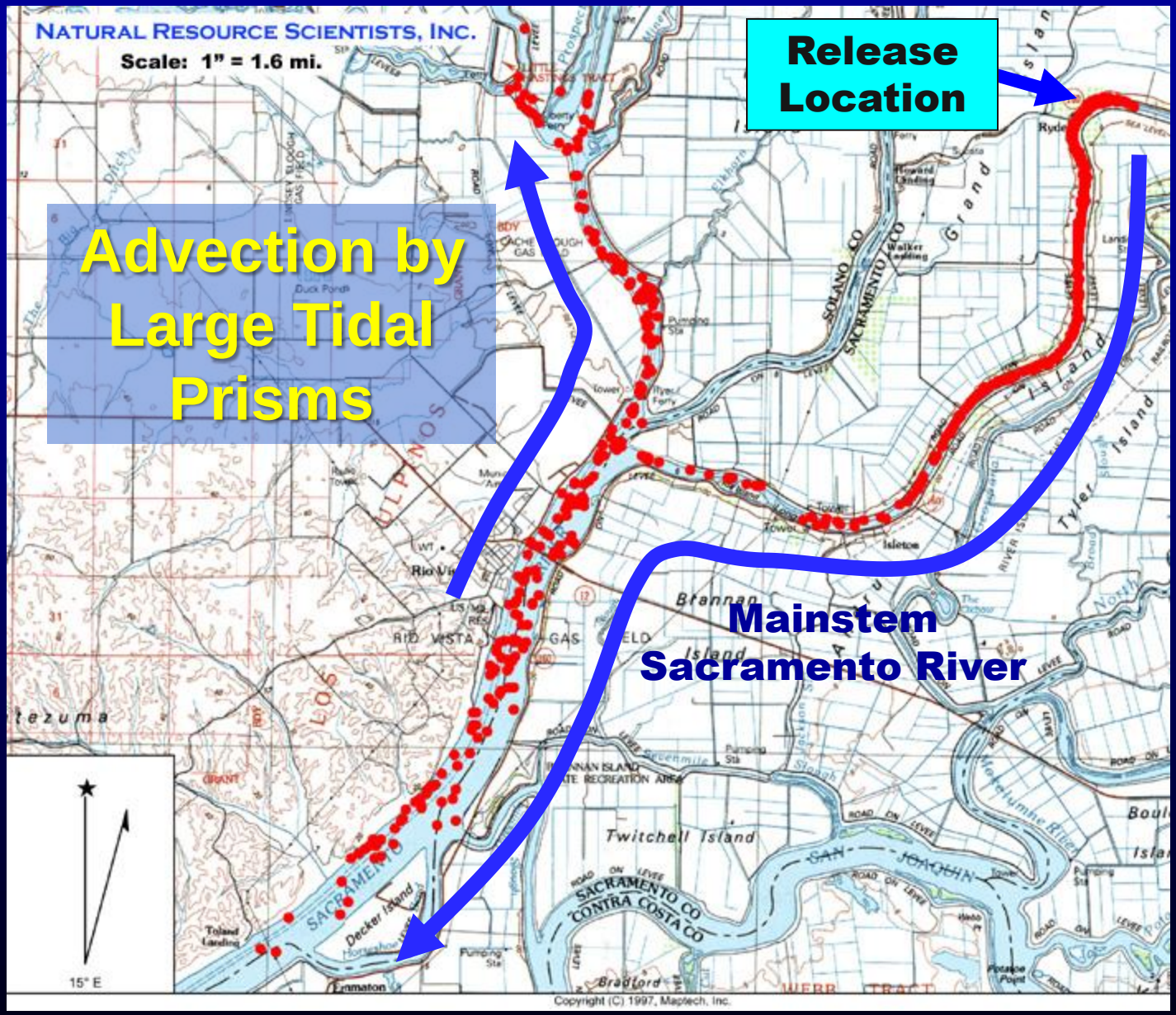
USGS Flow Data at Rio Vista



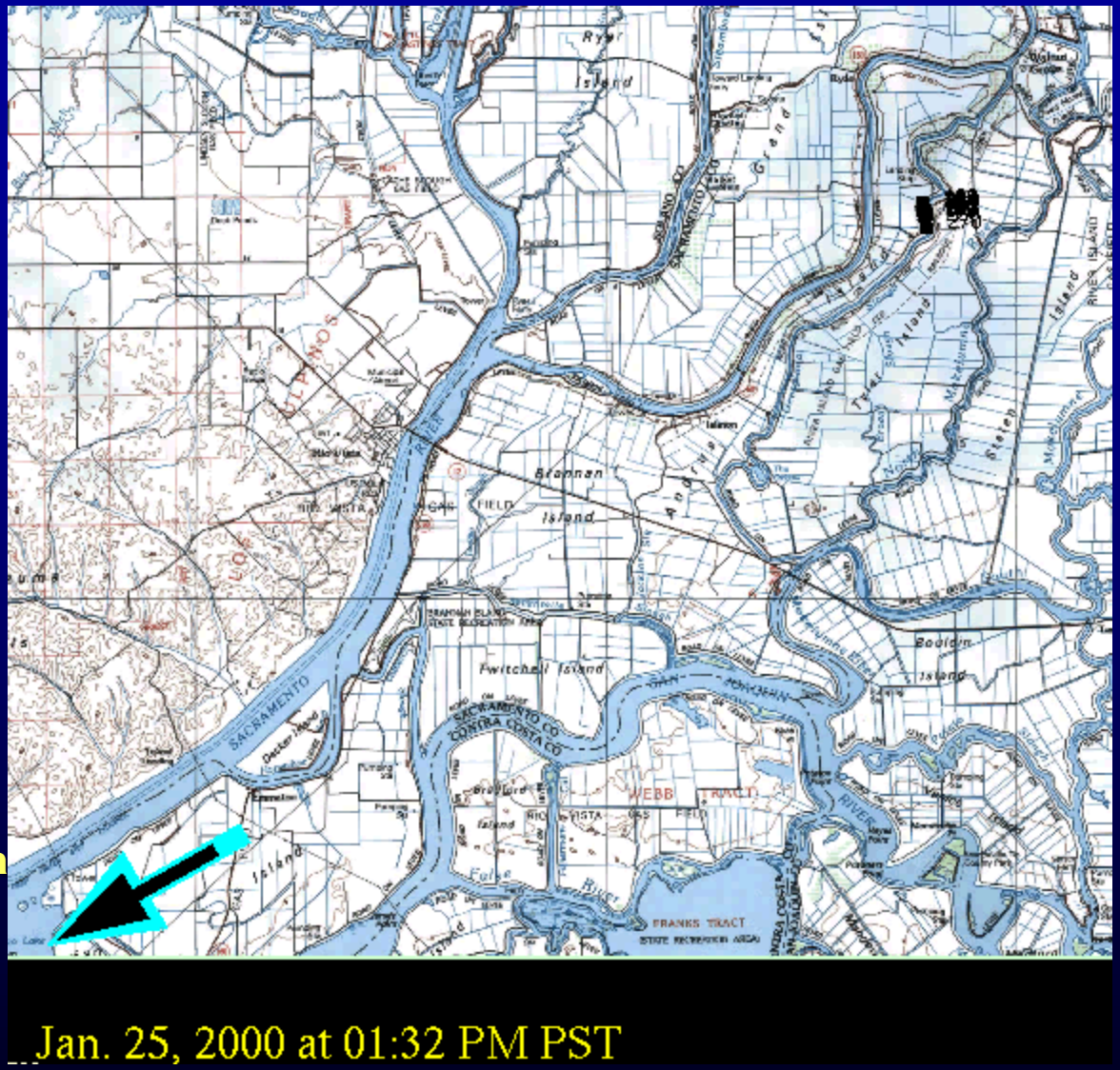
Estimated Fish Positions Based on Interpolation from Known Locations and Fish Behavior

Natural Resource Scientists, Inc.

Telemetered Locations of ~100 Smolts



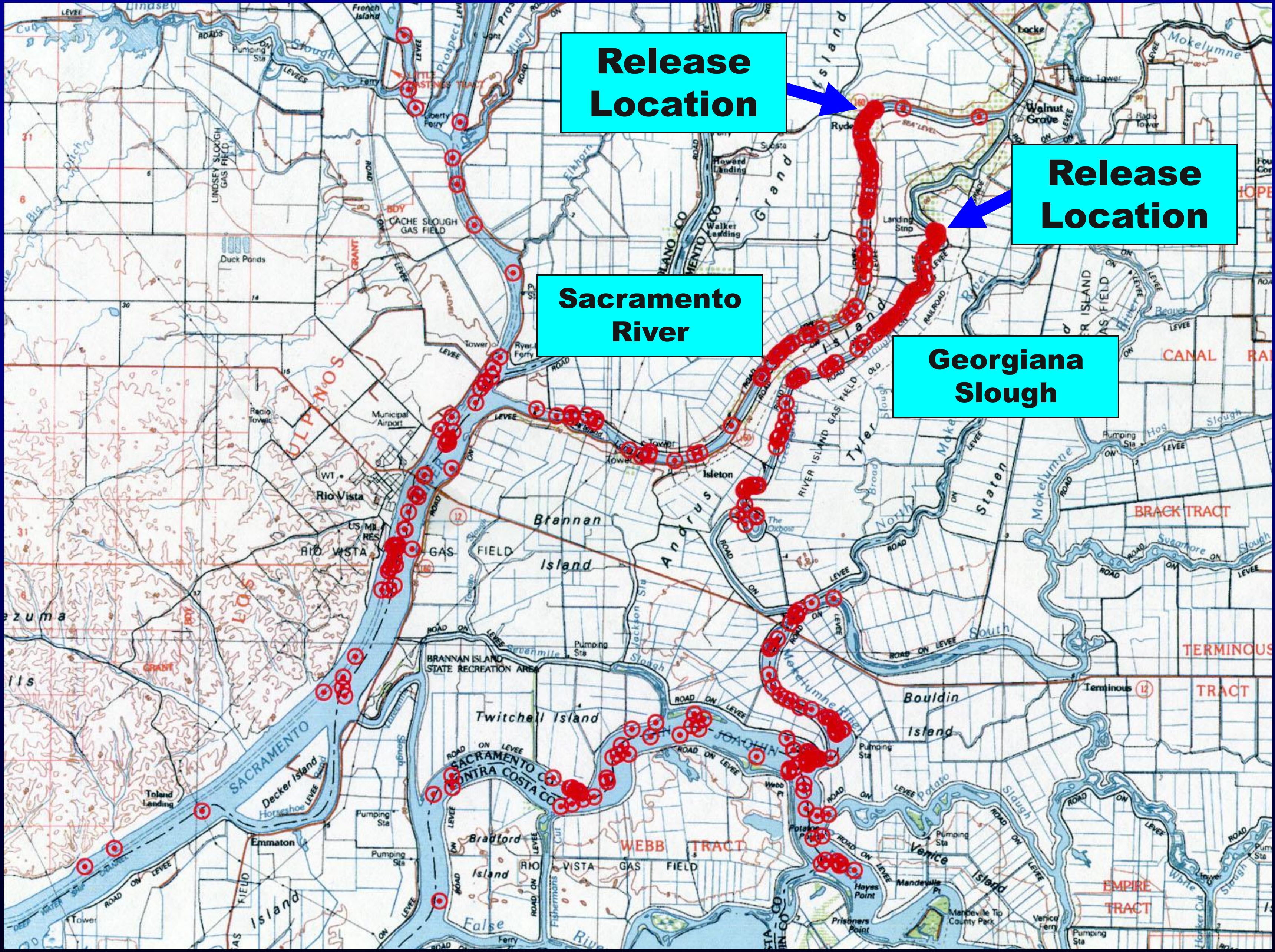
Georgiana Slough Fish Release



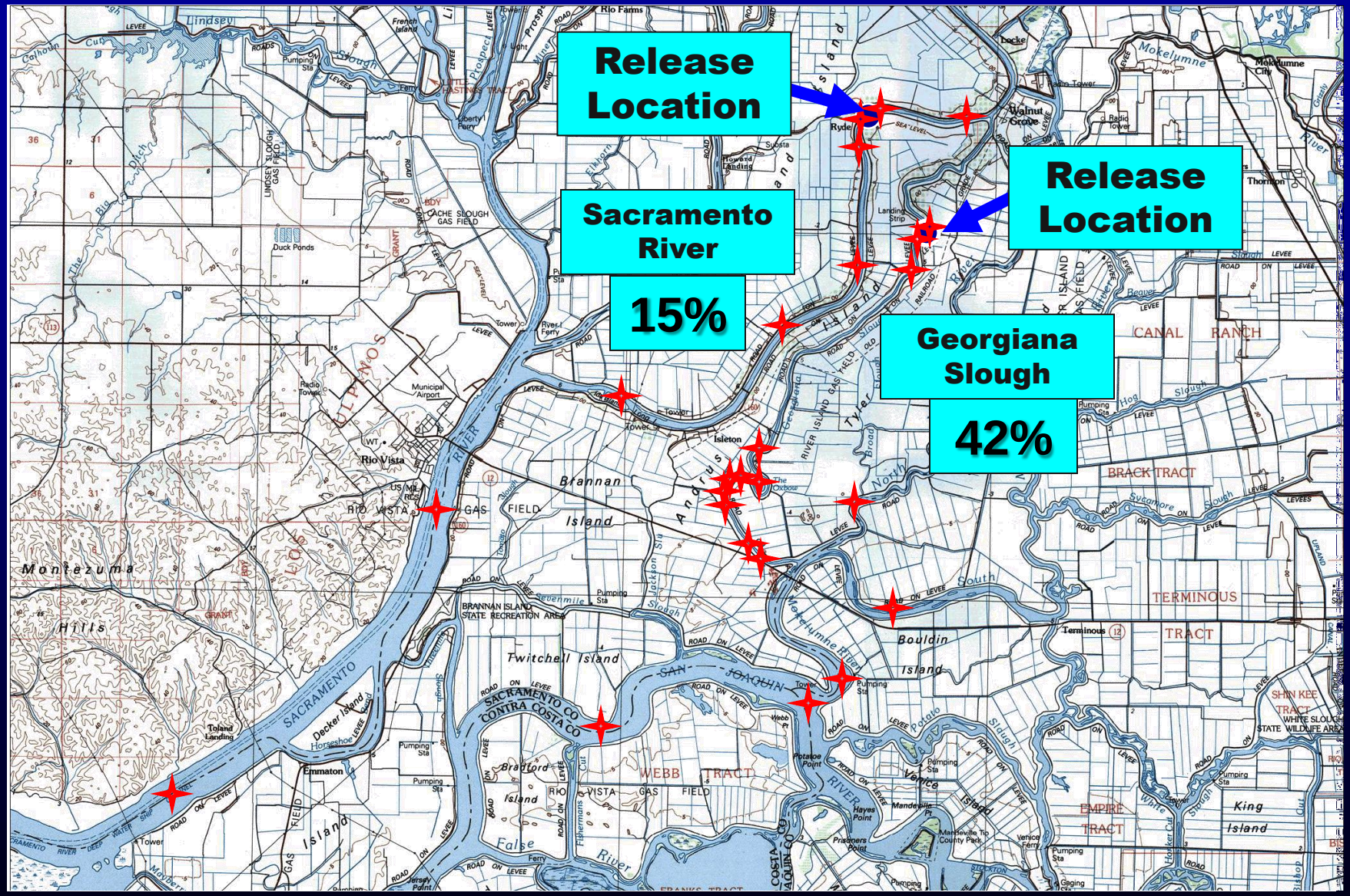
USGS Flow Data at Jersey Point

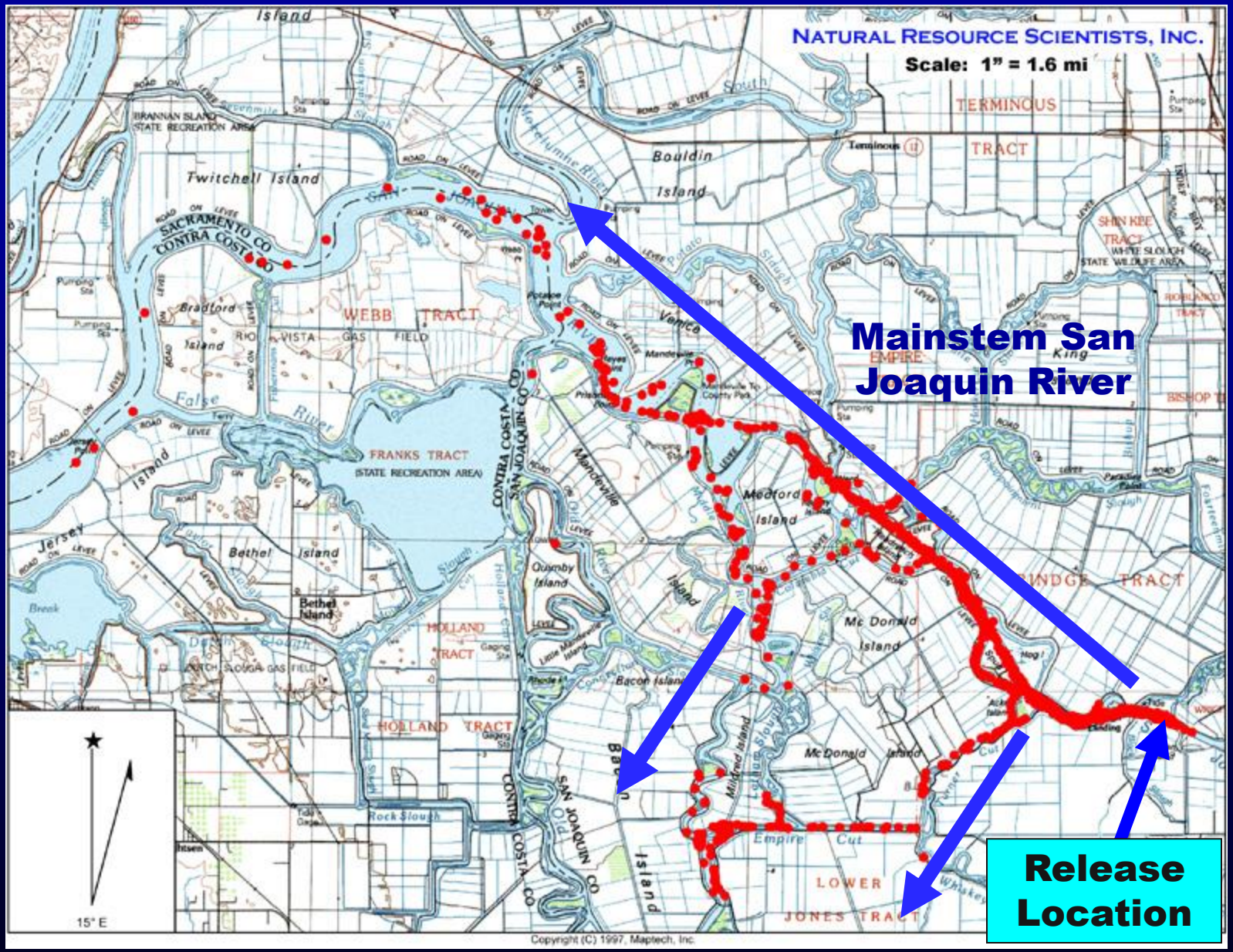
Estimated Fish Positions Based on Interpolation from Known Locations and Fish Behavior

Natural Resource Scientists, Inc.


Release Location
Release Location
Sacramento River
Georgiana Slough

Predation on Smolts in Some Delta Regions is Consistently Higher than Other Areas





Telemetered Locations of ~100 Smolts

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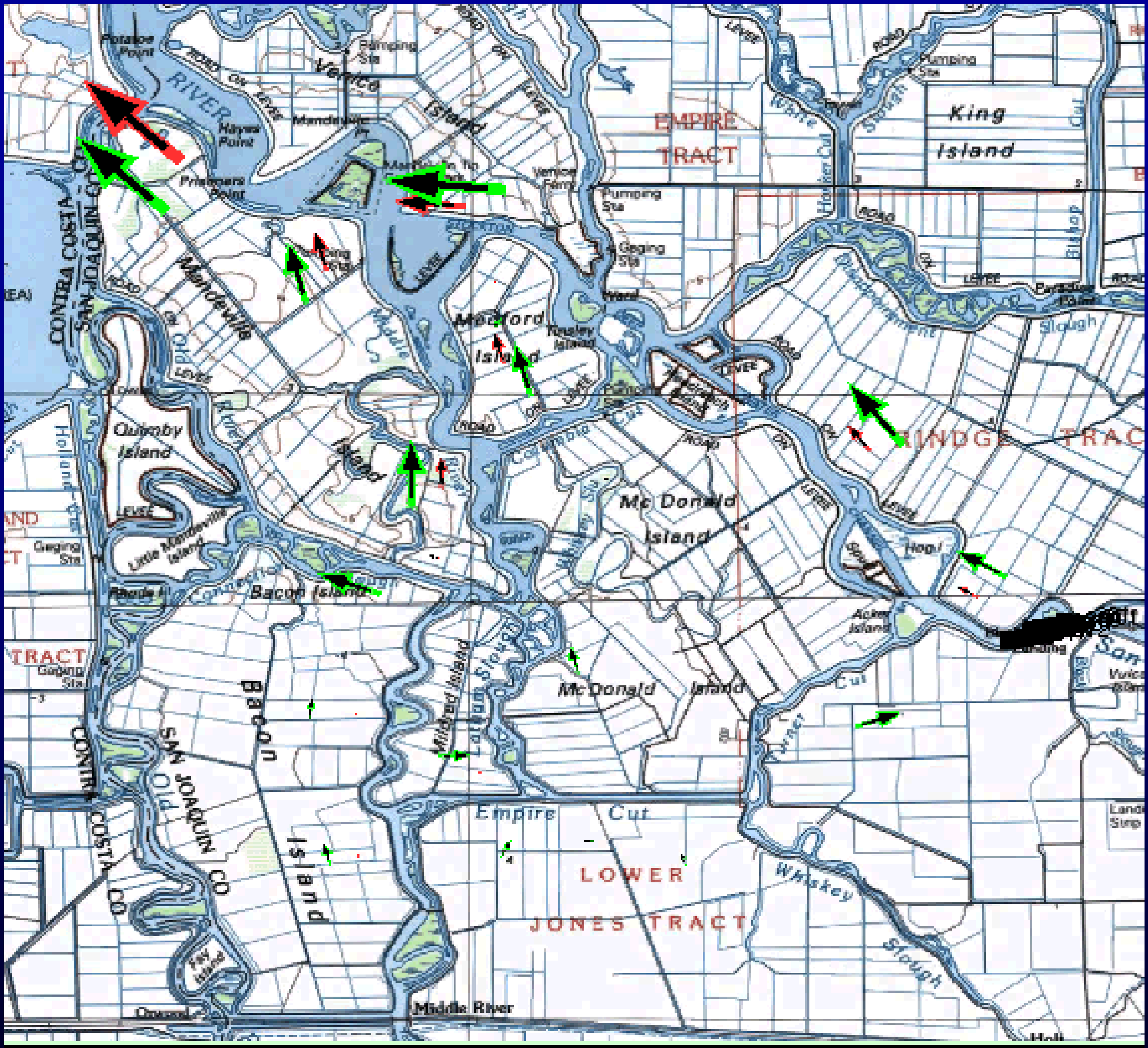
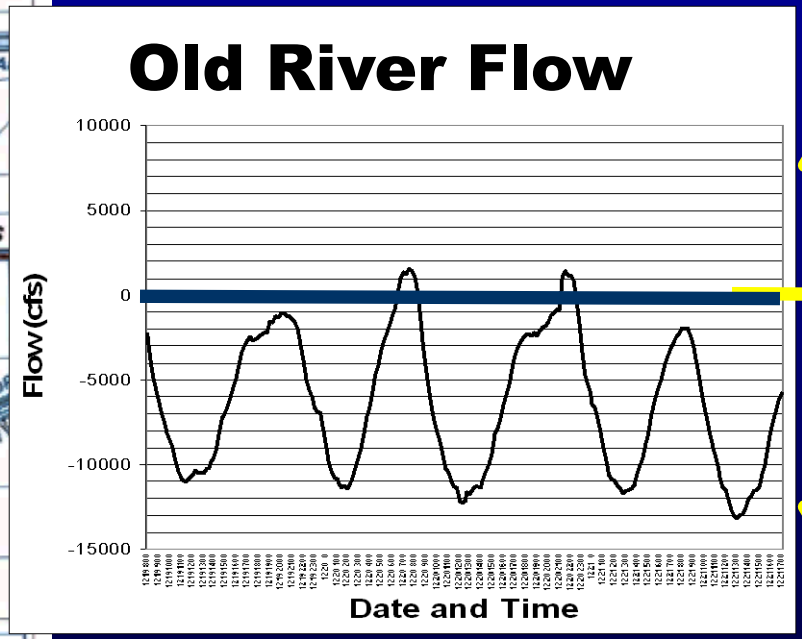


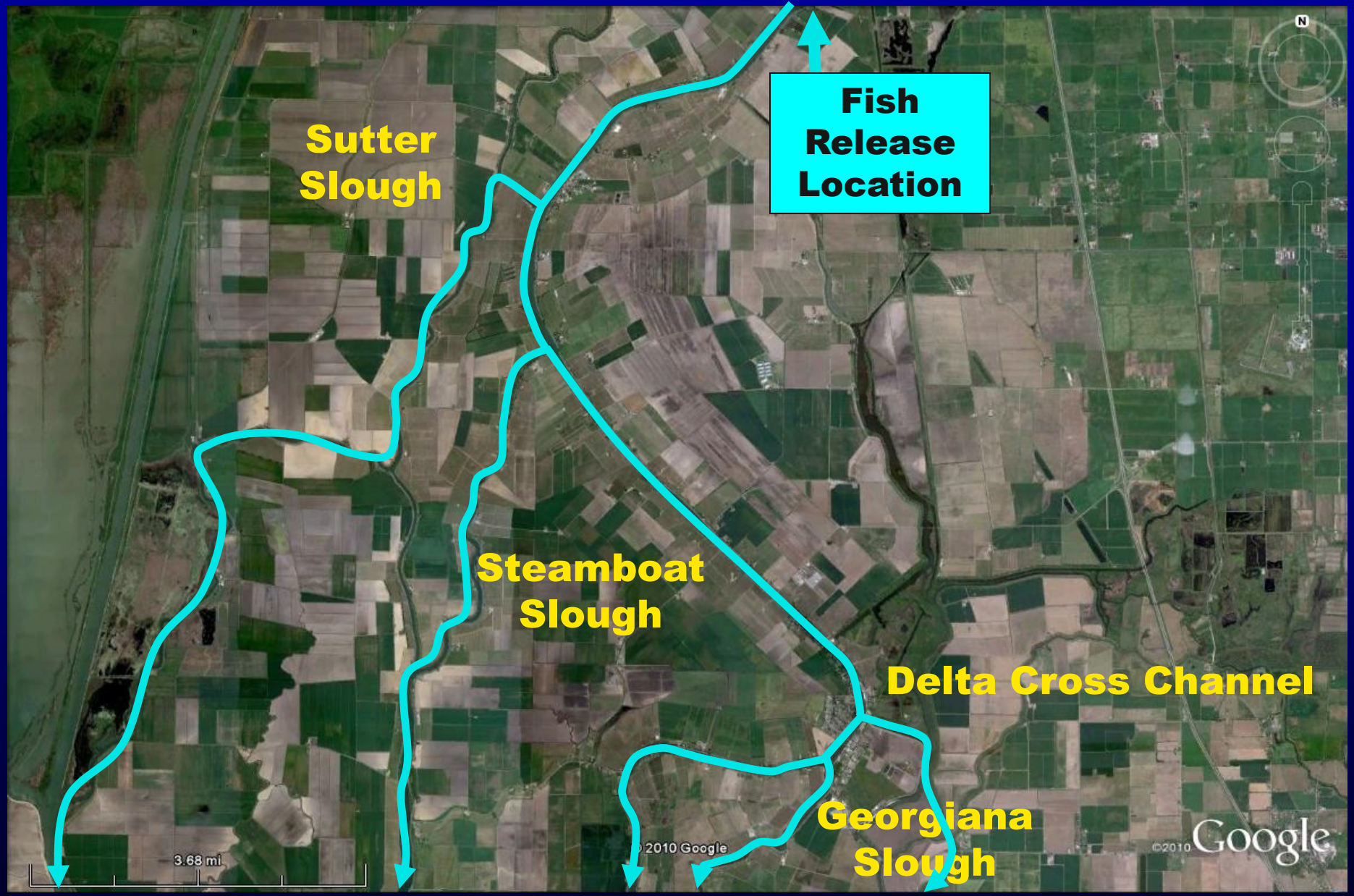
Apr. 10, 2002 at 07:42 AM PST

South Delta Studies



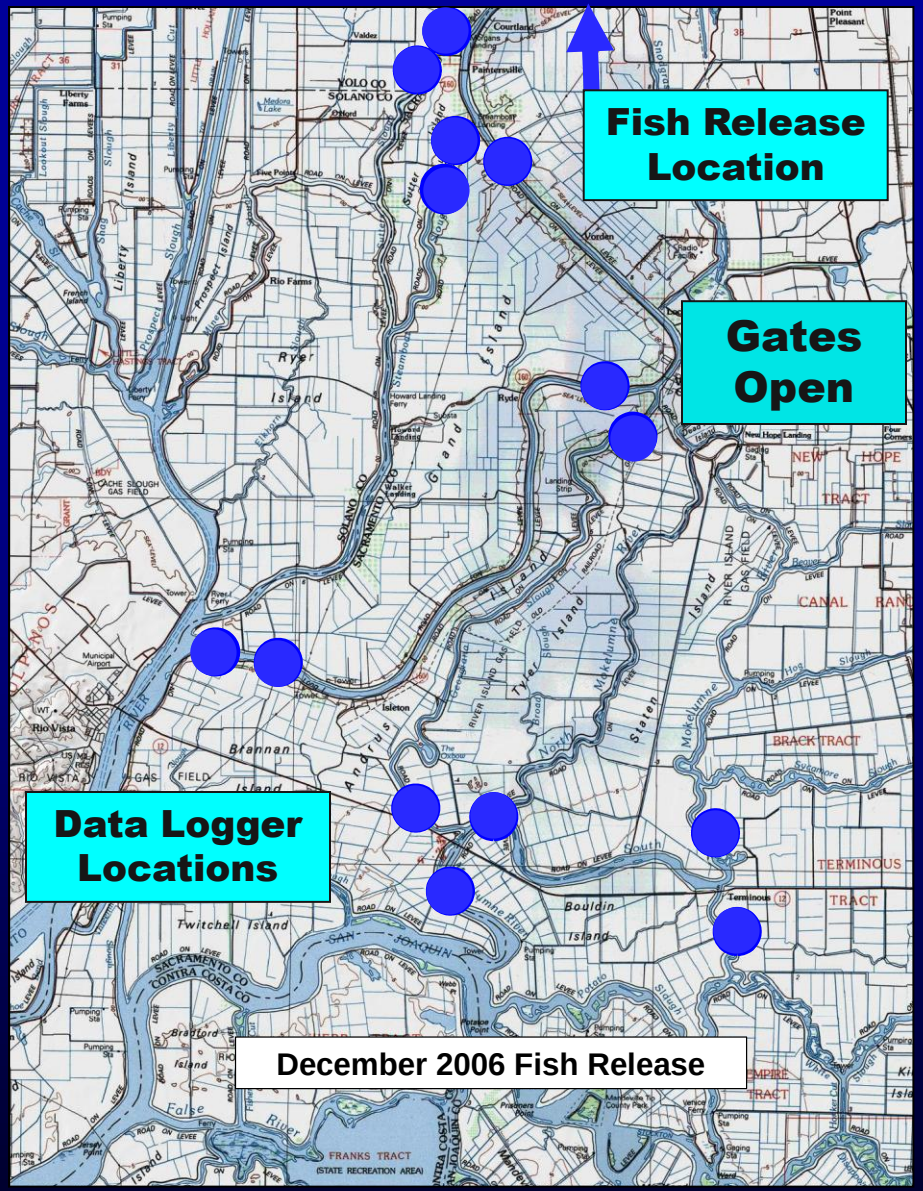
Radio-Telemetry Findings

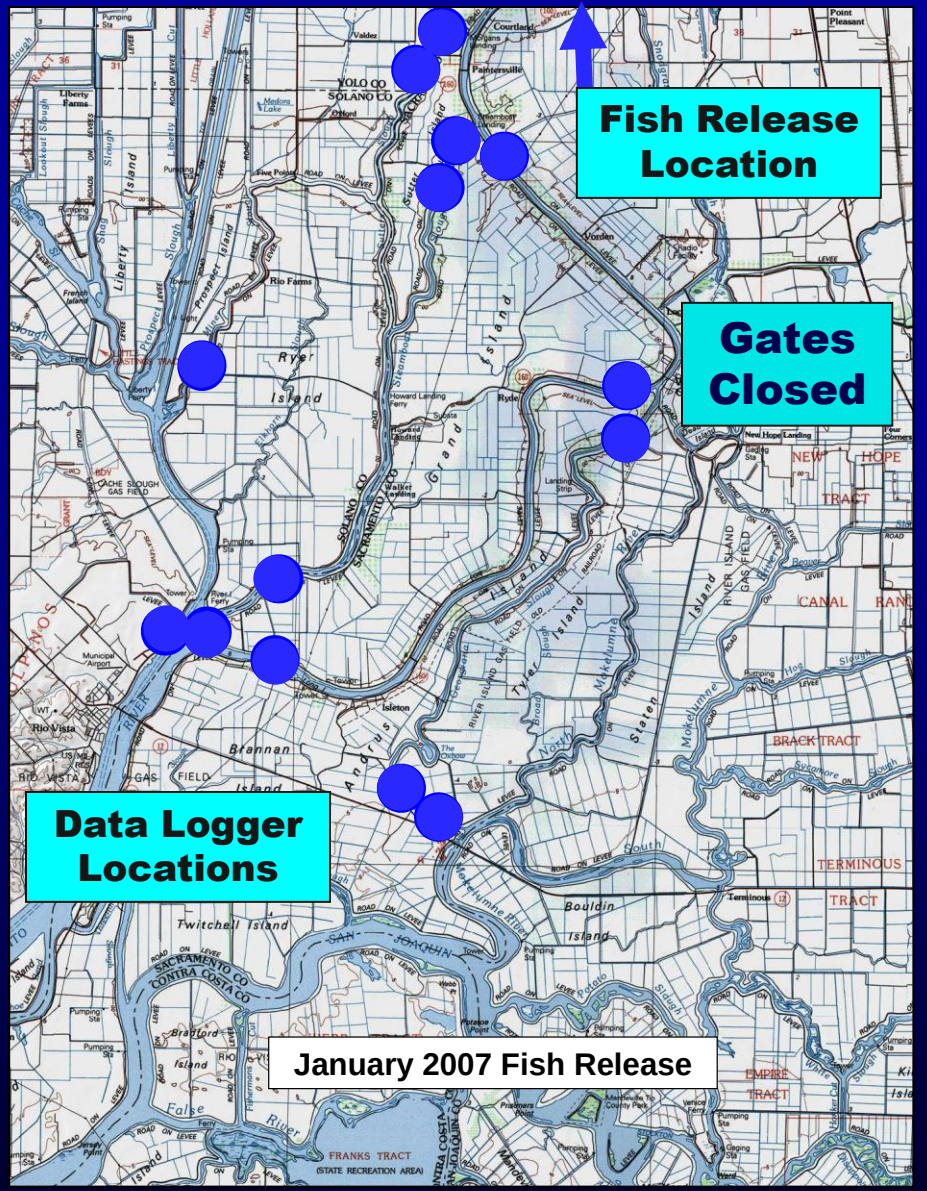
- Fish did not move as a "school"
- Fish movements showed strong correspondence with flood and ebb tides
- Fish movements against the flow was rare
- Net fish movement was more rapid in some Delta regions compared to others
- Some regions had higher predation rates
- Fish generally migrated near mid channel
- Localized hydrodynamic conditions at flow splits affected migration routes
- Delta regions with large tidal prisms greatly affected smolt movements
- Fish usually moved slower than ambient water velocities



North Delta Acoustic Telemetry Studies
Fish Route Selection and Survival

Natural Resource Scientists, Inc.





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Fish Route Selection and Survival

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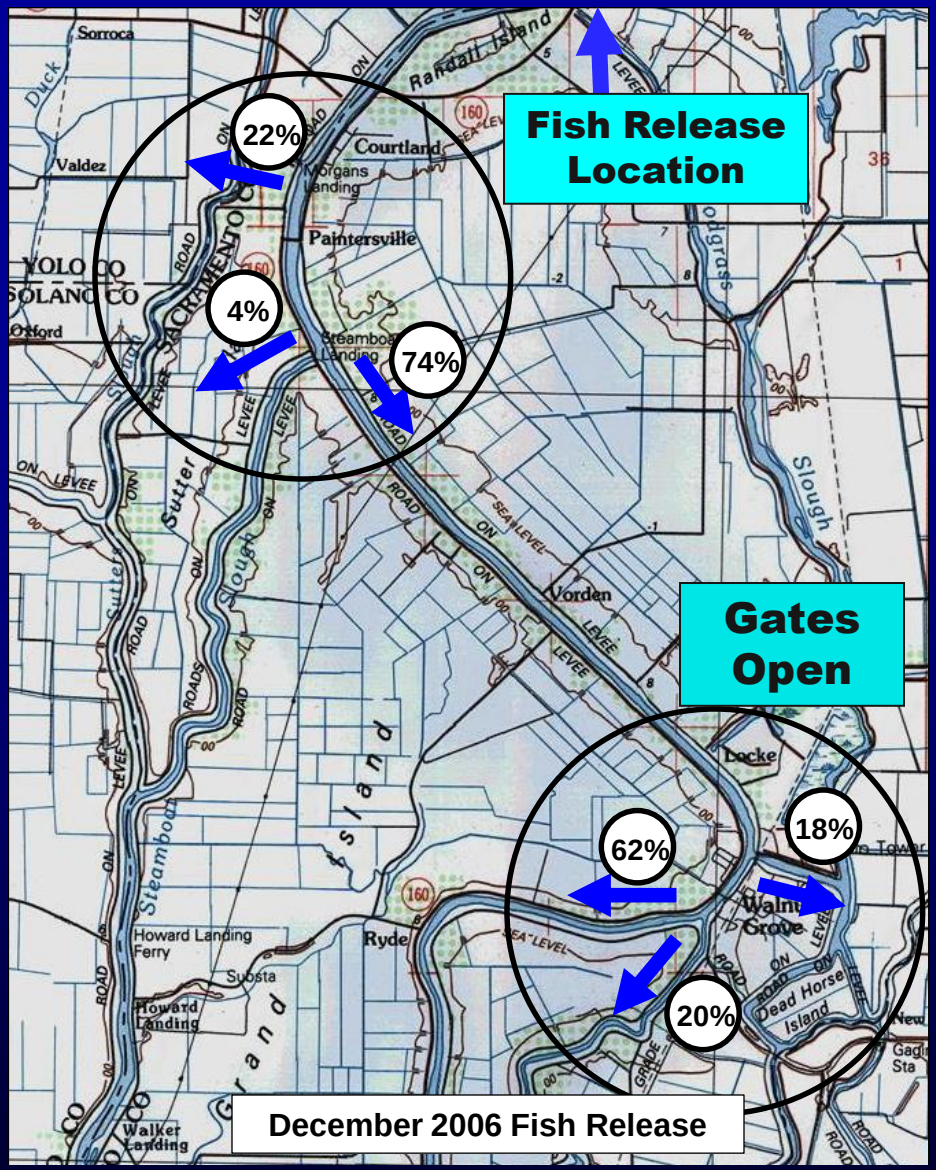
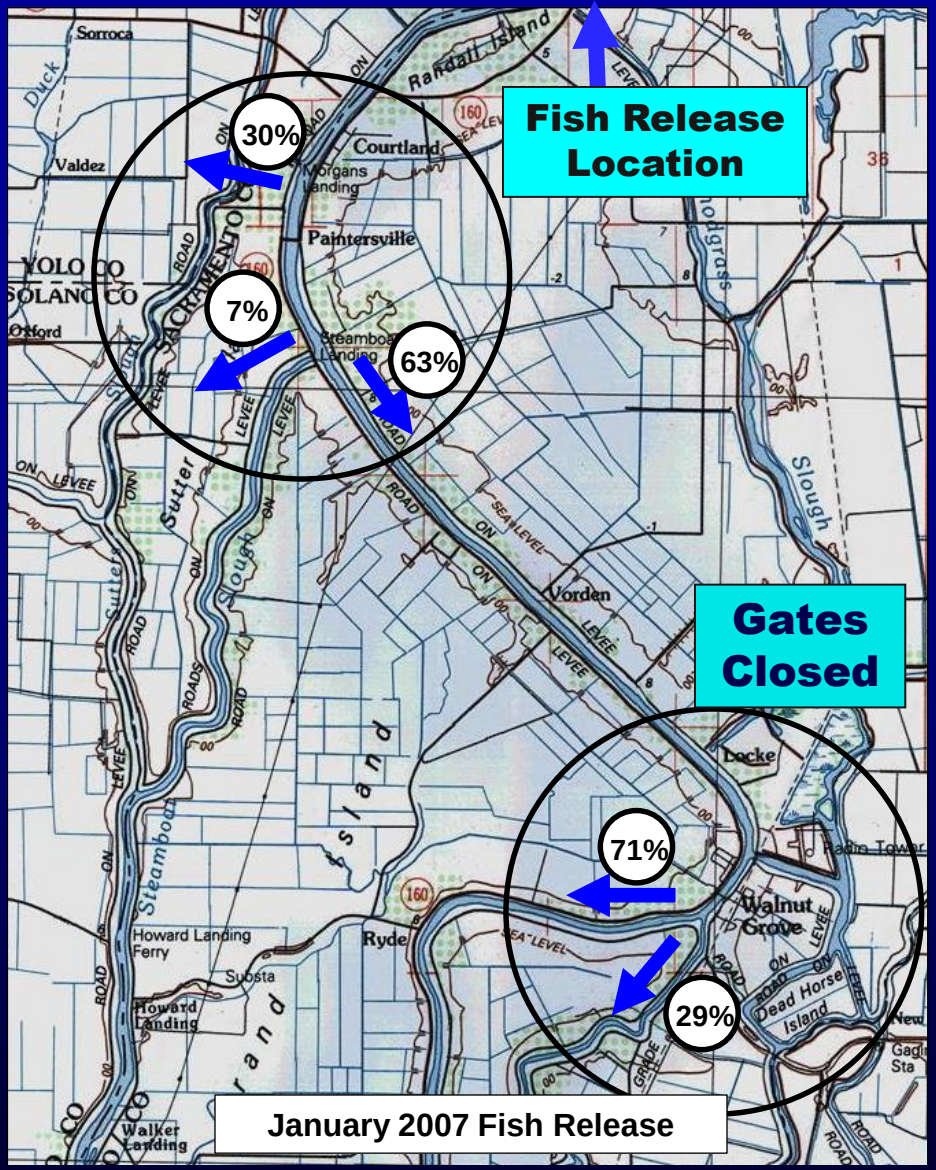


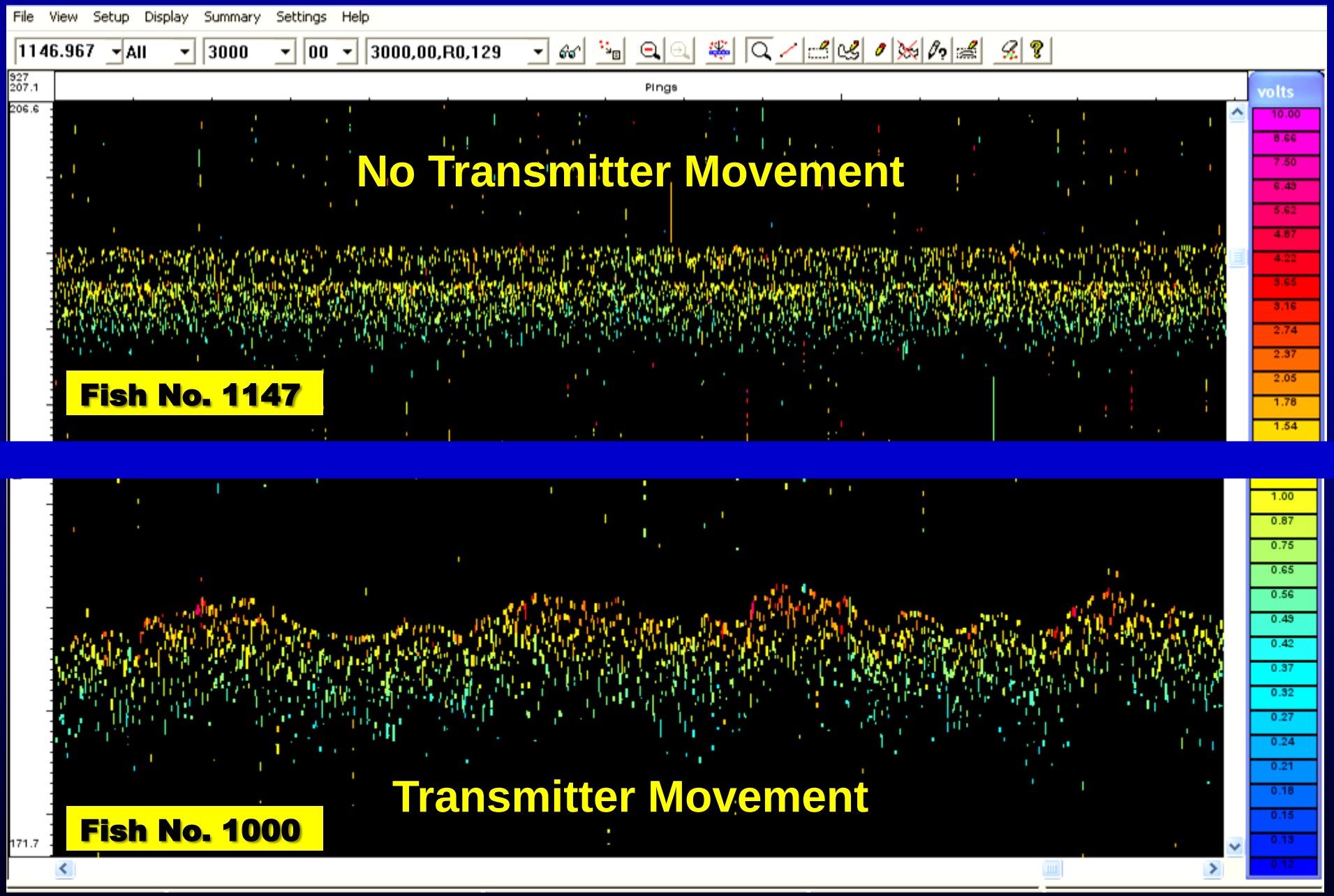


North Delta Acoustic Telemetry Studies
Fish Route Selection and Survival

Natural Resource Scientists, Inc.

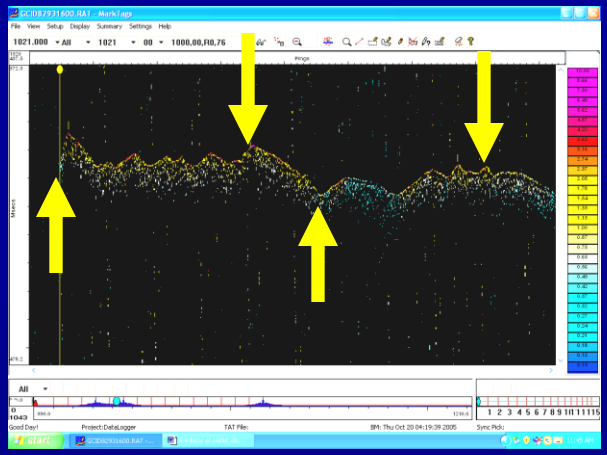
Predators on Salmonids

Pikeminnow | Striped Bass | Largemouth Bass

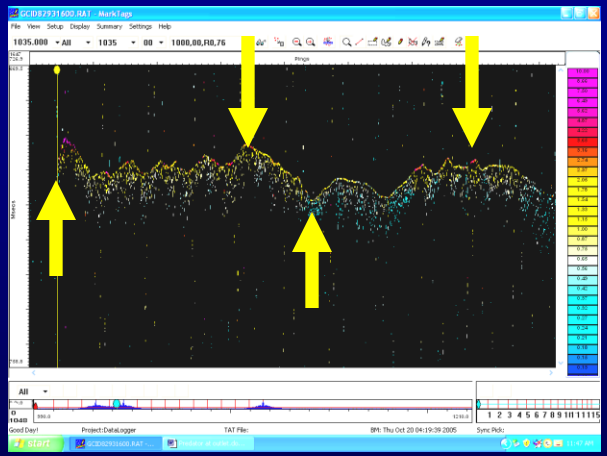

File View Setup Display Summary Settings Help
1146.967 All 3000 00 3000,00,R0,129
927
207.1
206.6
Pings
volts
10.00
8.66
7.50
6.49
5.62
4.87
4.22
3.65
3.16
2.74
2.37
2.05
1.78
1.54
No Transmitter Movement
Fish No. 1147
1.00
0.87
0.75
0.65
0.56
0.49
0.42
0.37
0.32
0.27
0.24
0.21
0.18
0.15
0.13
0.12
171.7
Transmitter Movement
Fish No. 1000

Extremely High Fish Mortality

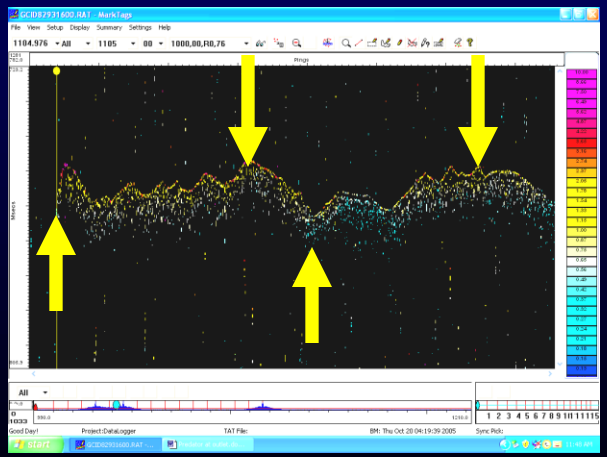
Fish No. 1021



Fish No. 1035



Fish No. 1105



Movement patterns were identical for all 3 transmitters

Detection of Predation

Predation analyses changed salmon survival estimates in a lower Sacramento River study from 100% survival to 100% mortality.

Striped Bass Predation on Acoustic-Tagged Salmon

Scour Holes in the Delta

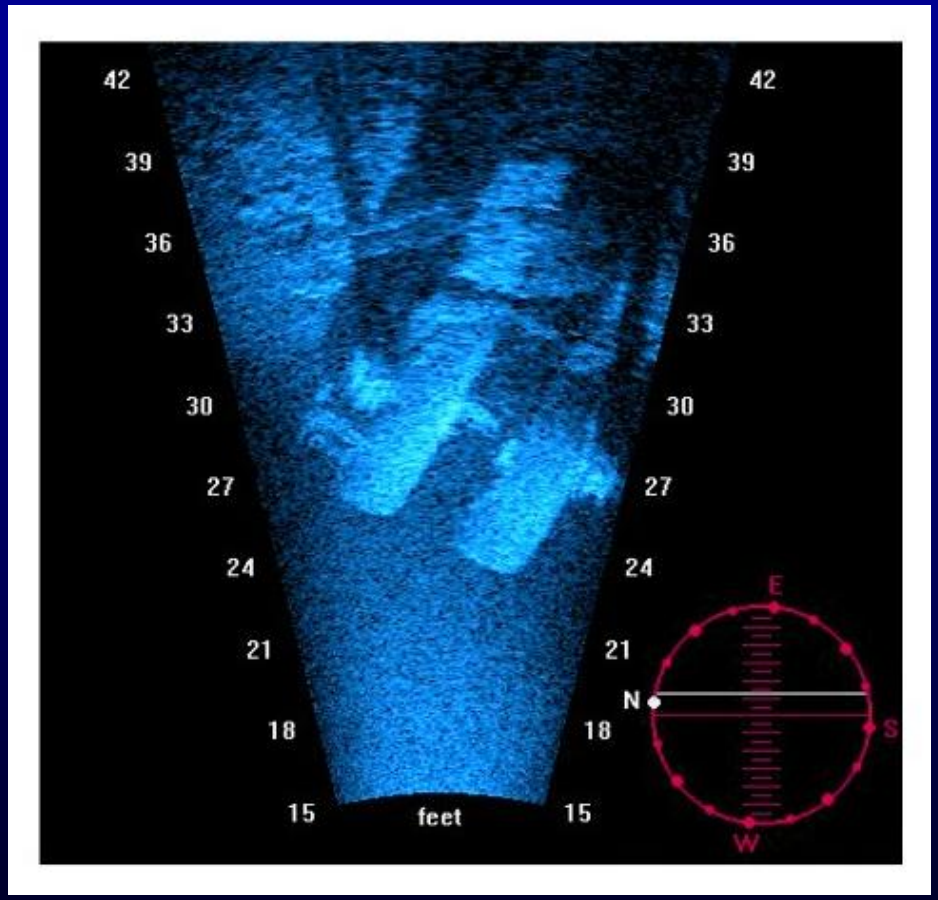
"Hot Spots"


Liberty Island
(Flooded)
Miner
Slough
Sacramento Deep
Water Ship Channel
© 2010 Google
Google
Imagery Date: Apr 7, 2010


5059
6919
6802
6480
5436
5371
5140
5619
384 ft
Image © 2010 DigitalGlobe
©2009 Google

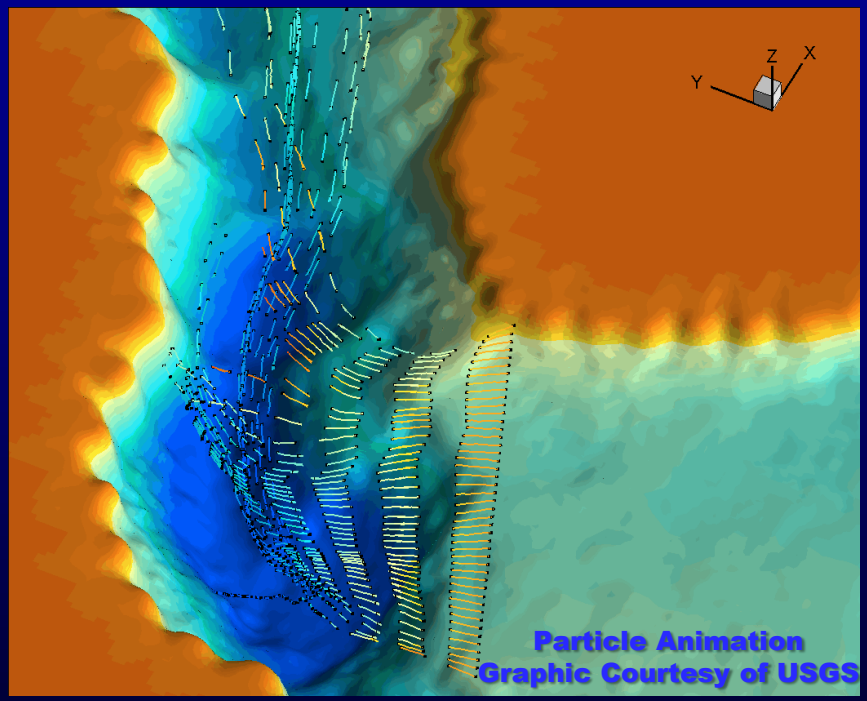
Dual-Frequency Identification Sonar Surveys

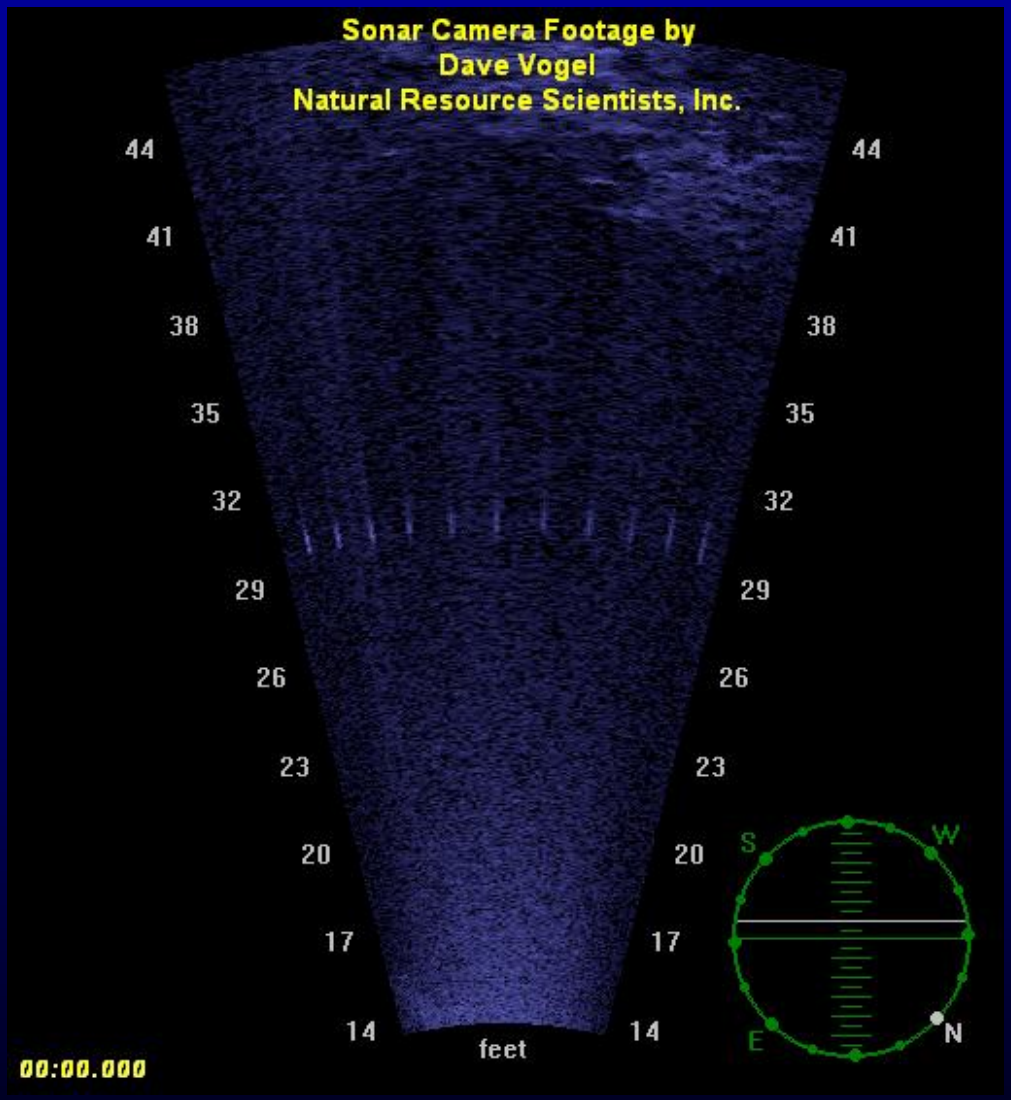
Sonar Camera



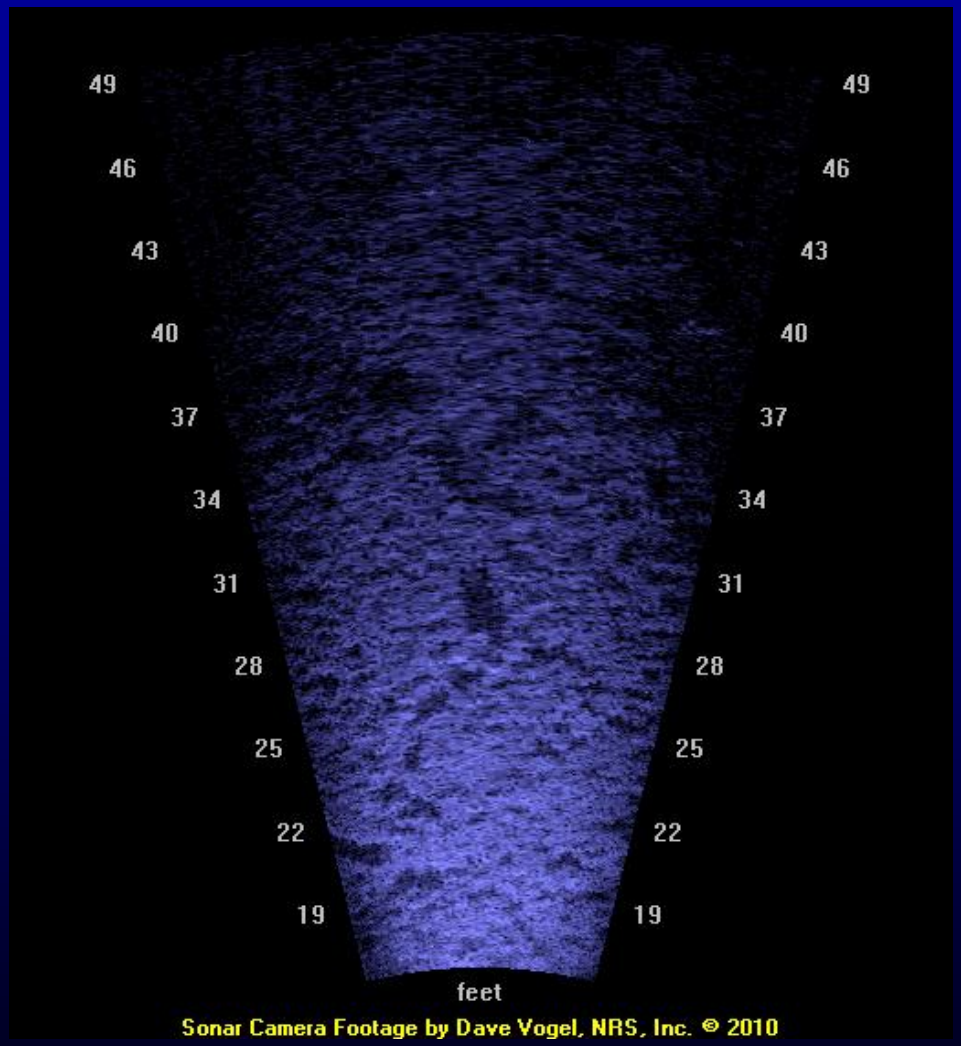
Sonar Image

Scour Holes in the Delta

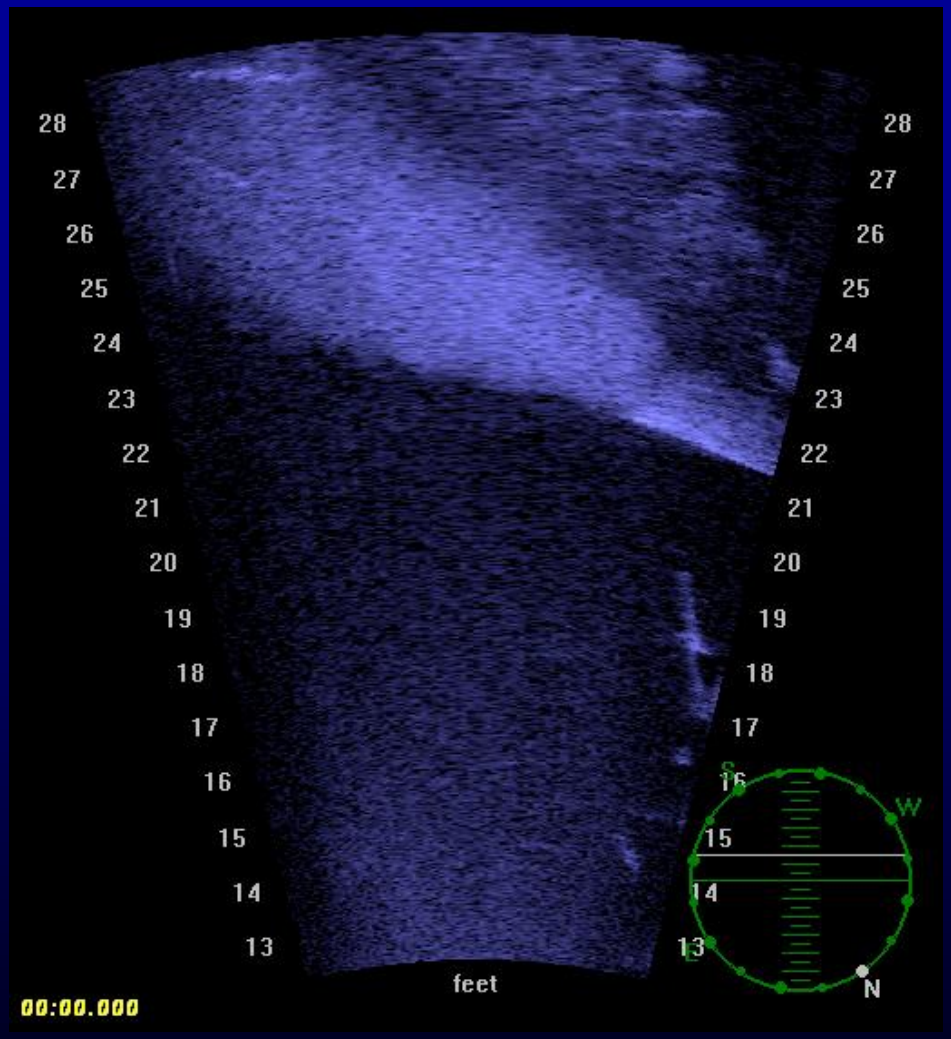




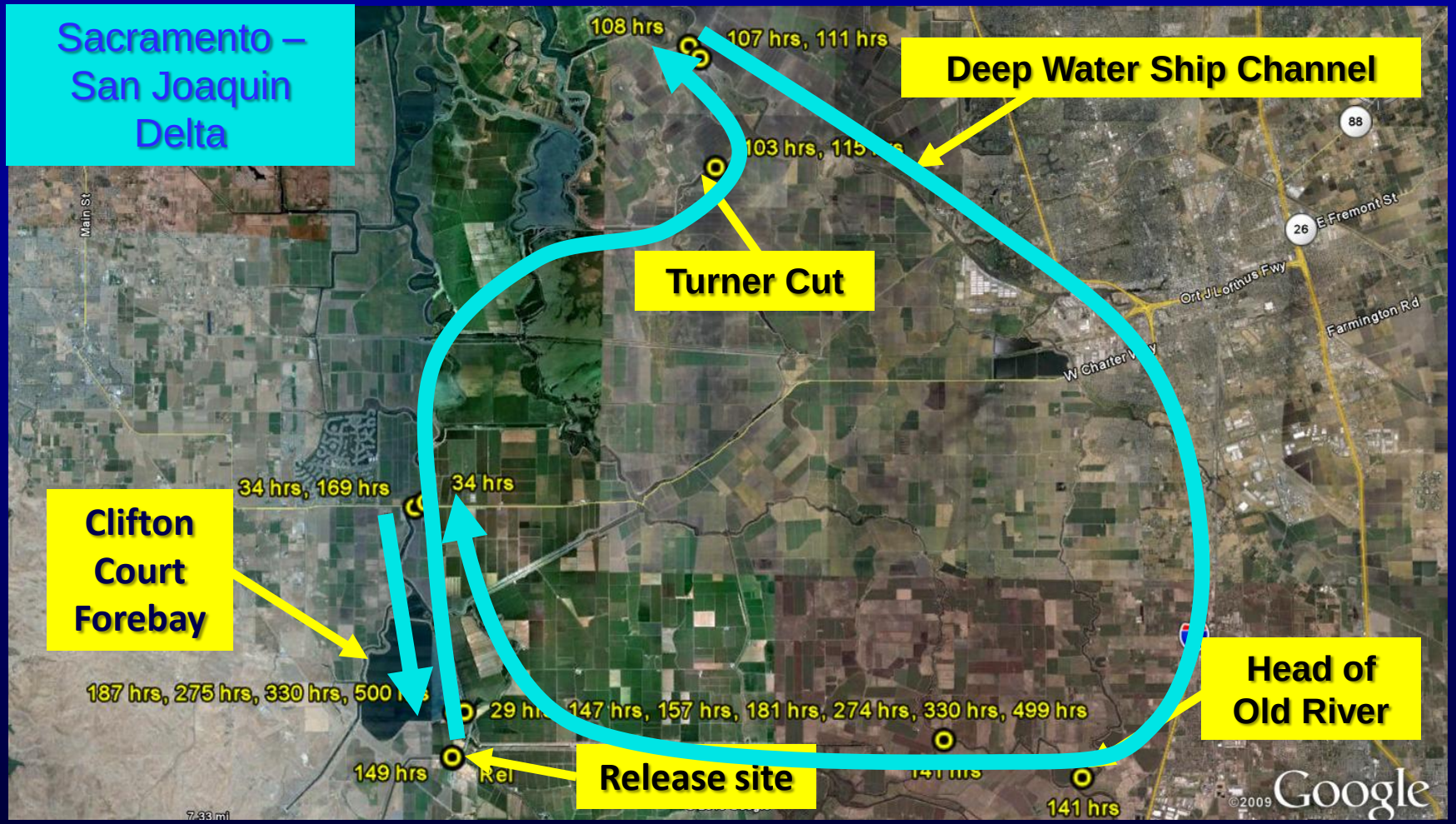
Striped Bass Near Ag Intake



Striped Bass Near Ag Drain

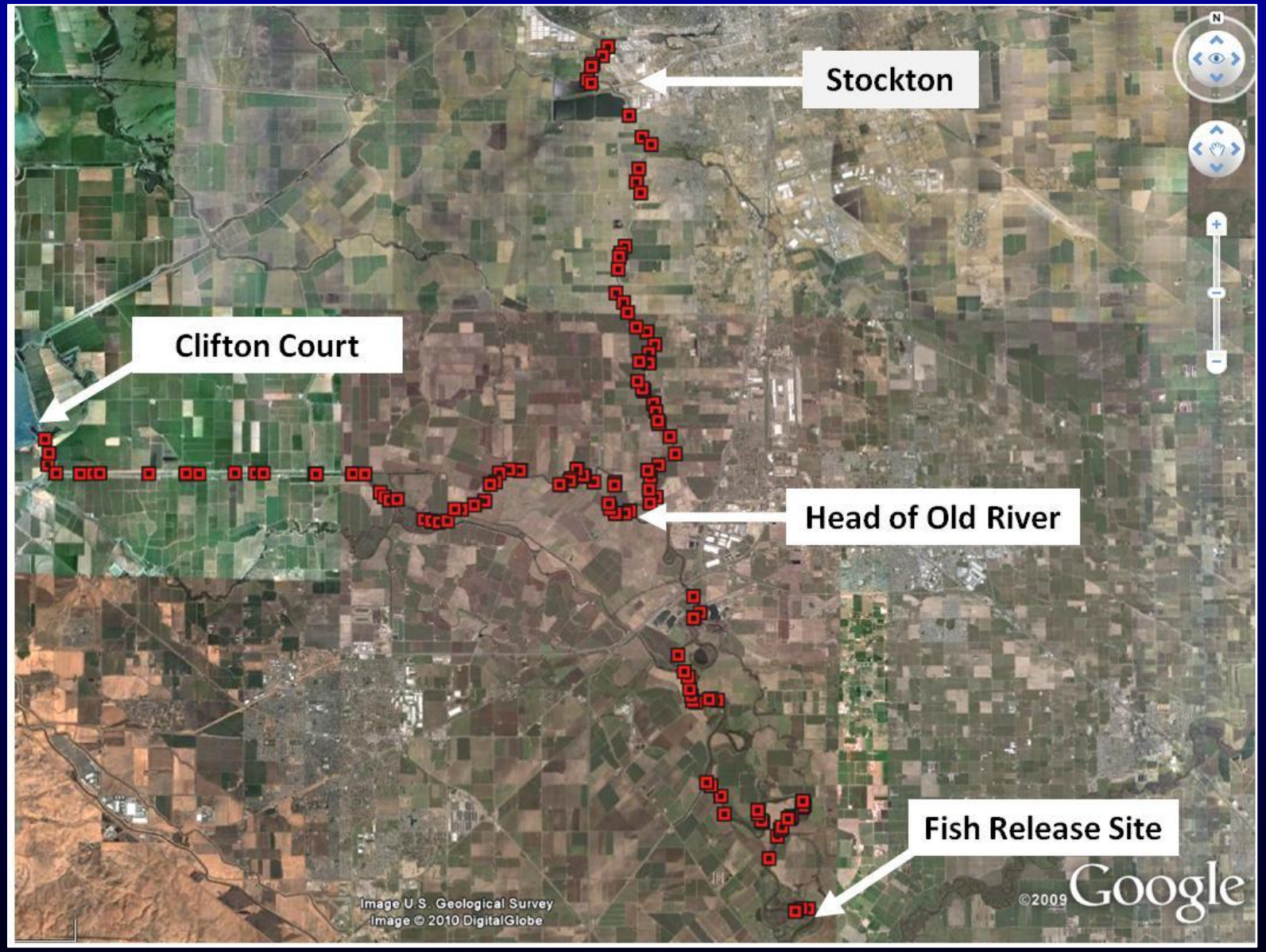


Integration with Acoustic – Tagged Predatory Fish Behavior



Striped Bass Movements in the South and Central Delta

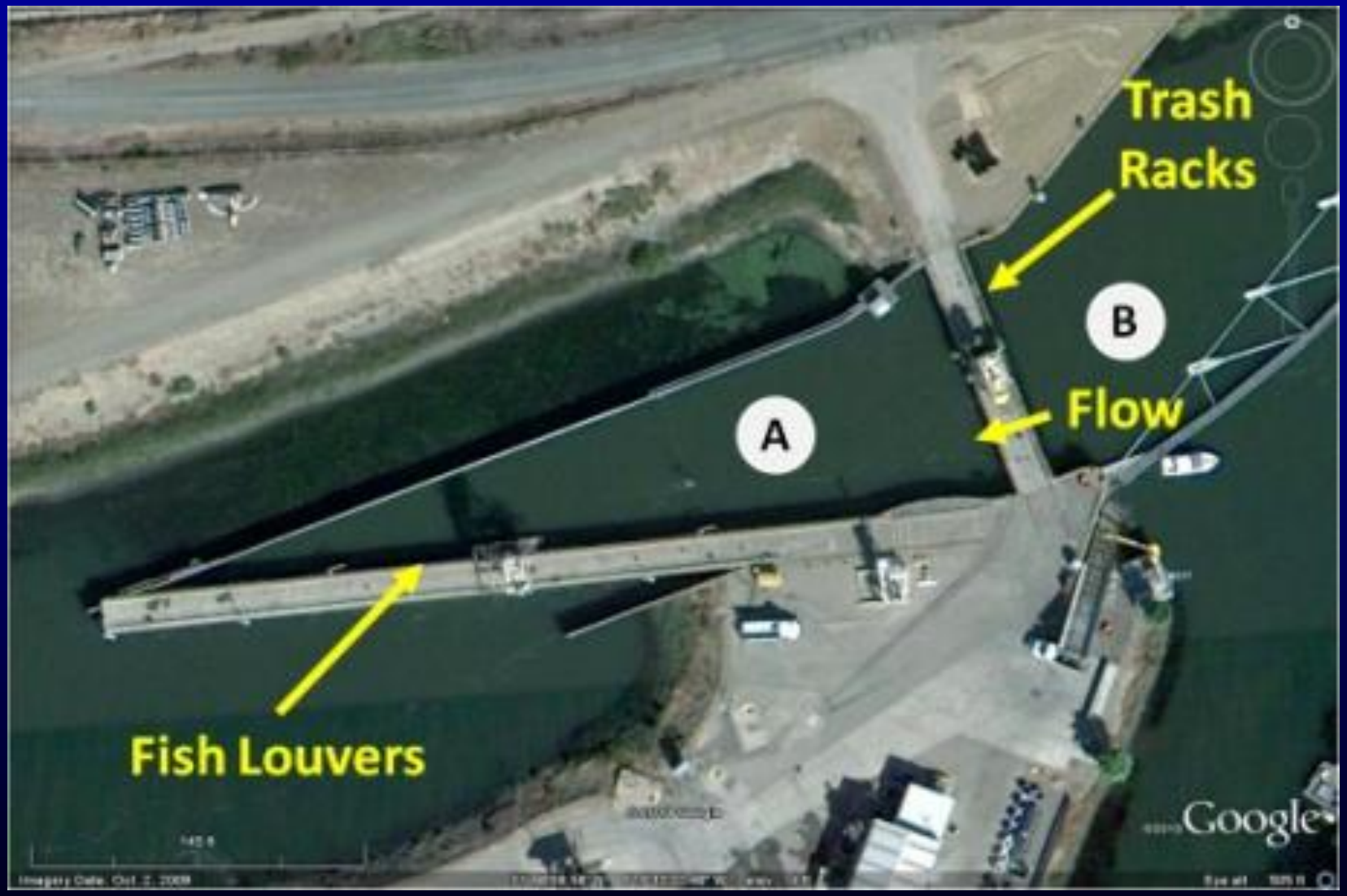
Tag # 4208.07


Stockton
Clifton Court
Head of Old River
Fish Release Site
Image U.S. Geological Survey
Image © 2010 DigitalGlobe
©2009 Google


Clifton Court Forebay
Extremely High Fish Mortality
Tracy Fish Facilities
© 2010 Google
©2010 Google
37°49'22.87" N 121°33'24.99" W elev -2 ft
Eye alt 8368 ft

Clifton Court

Tracy Fish Facilities



Questions ?

Technical Report Available at: www.norcalwater.org