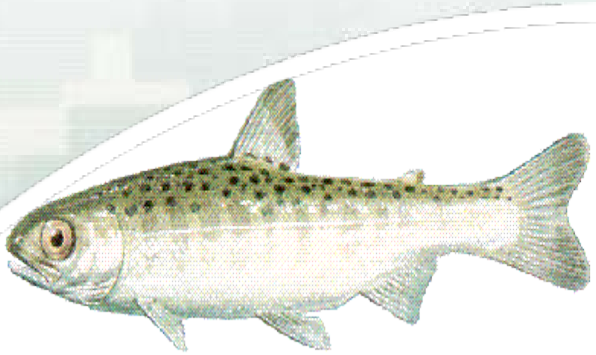
# Forecasting Fish Response to Habitat Features in Developing Riparian Project Design Alternatives



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**5 August 2011**

**National Conference on Ecosystem Restoration – Baltimore**

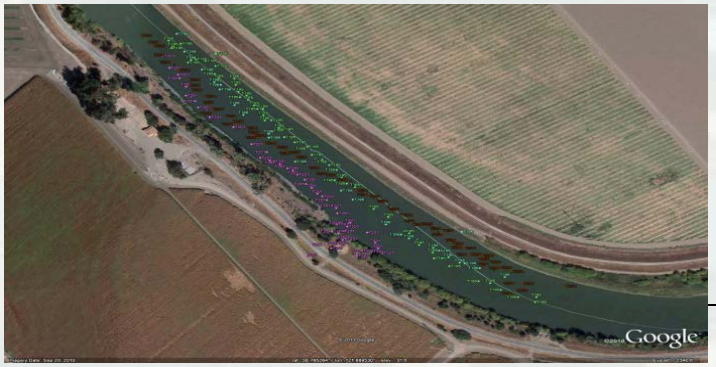
# Overview

## The Project

**Sacramento River Bank Protection Project (SRBPP)**

## The Problem

**Repair Erosion While Restoring Fish Habitat**

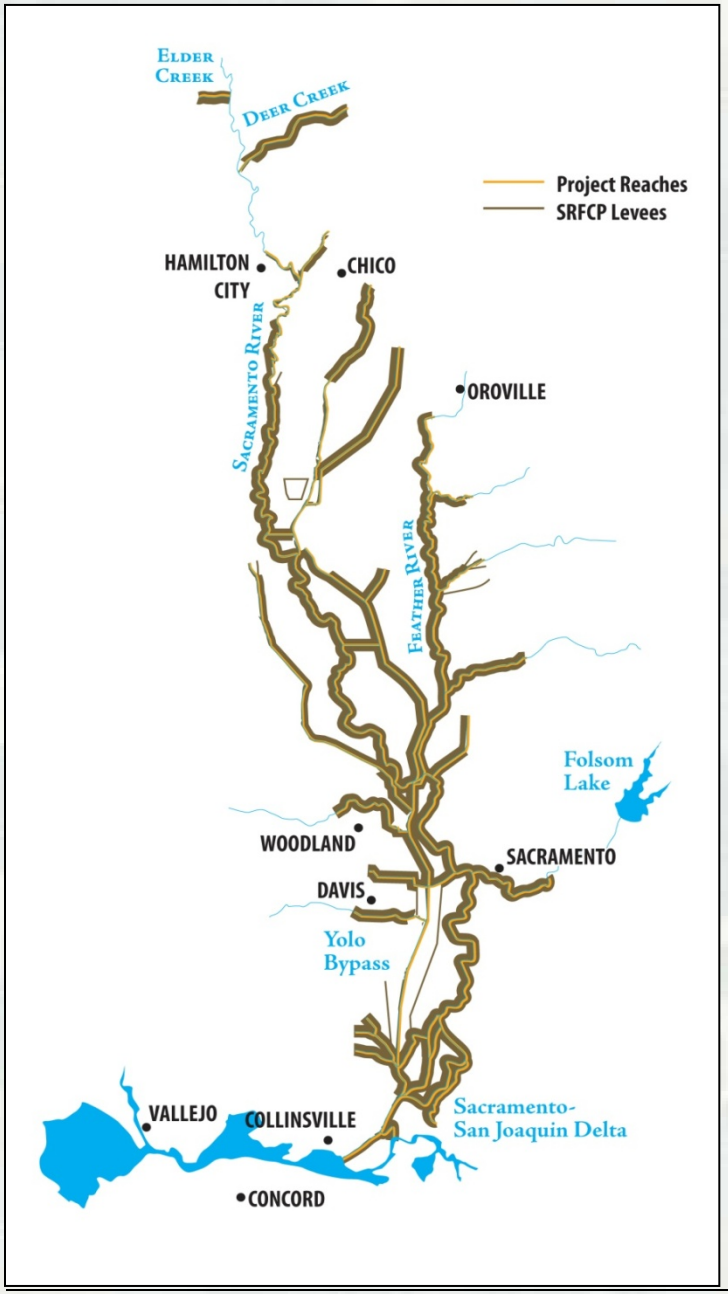



## The Tools

**Modeling, Monitoring and 2D Fish Tracking**

# Sacramento River Bank Protection Project (SRBPP) was authorized by the Flood Control Act of 1960 to protect existing levees from erosion.

- Original Authorization
  - 440,000 linear feet
  - No mitigation
- Reauthorization – 1974
  - 405,000 linear feet
  - Mitigation authorized




- SRBPP covers 1000 miles of levees
- Sacramento River from river mile 0 to 194 + tributaries
- 840k linear ft. of bank protection
- 80k additional linear ft. authorized

# 2001 – NMFS/FWS issued draft JEOPARDY Biological Opinions (listed fish species)

- Winter-Run Chinook Salmon

- Spring-Run Chinook Salmon
- Central Valley Steelhead

- Green Sturgeon

- Delta Smelt

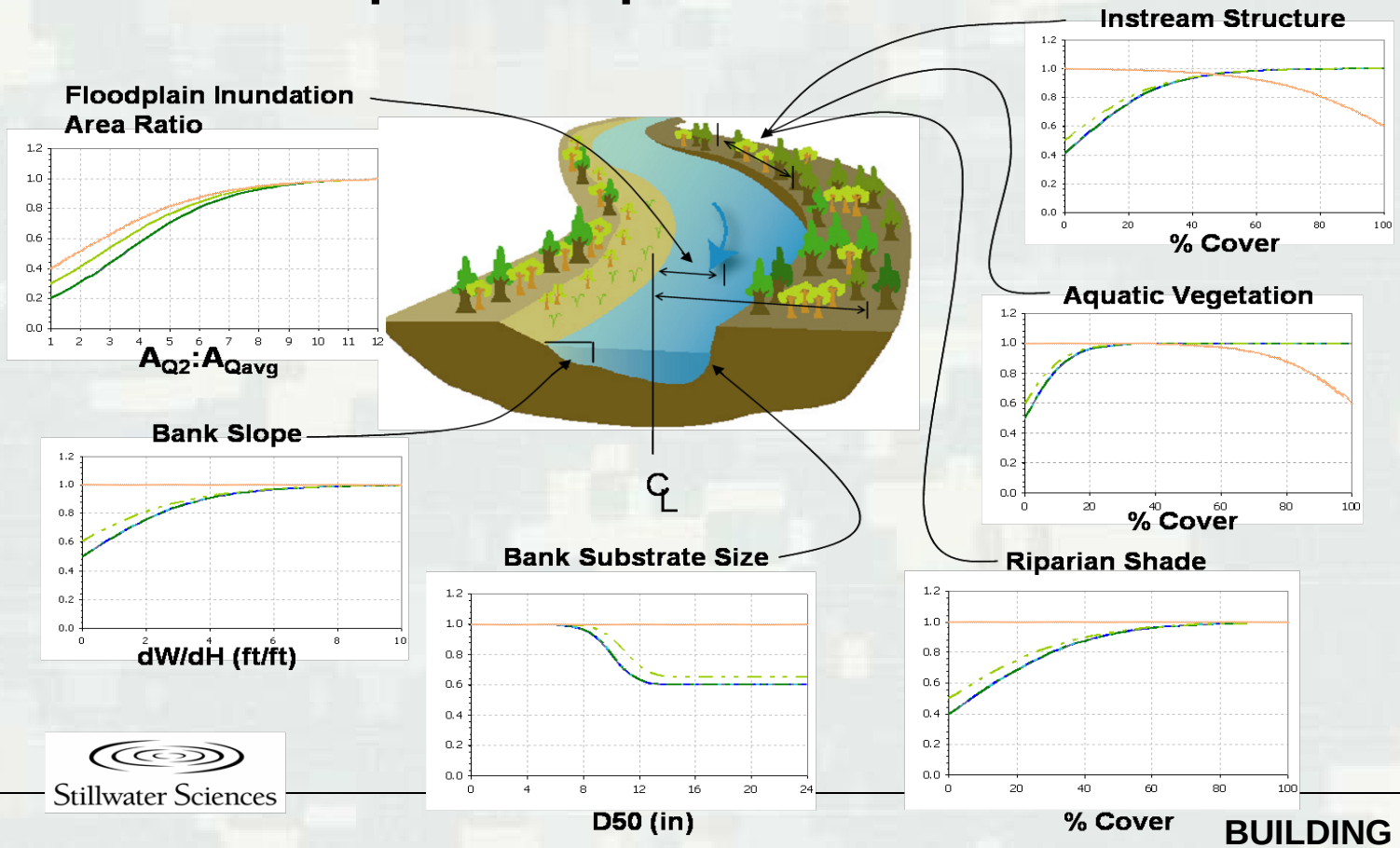
# 2004-Present – Bank protection designs incorporate habitat features to address impacts to habitat function and values for listed fish species (On-site mitigation)

Instream Woody Material

Floodplain Bench

# The SAM model was developed with state and federal resource agencies to evaluate responses of focus fish species to habitat features affected by bank repairs over time (t = 0, 1, 5, 15, 25, and 50 years)

## SAM Conceptual Response Models

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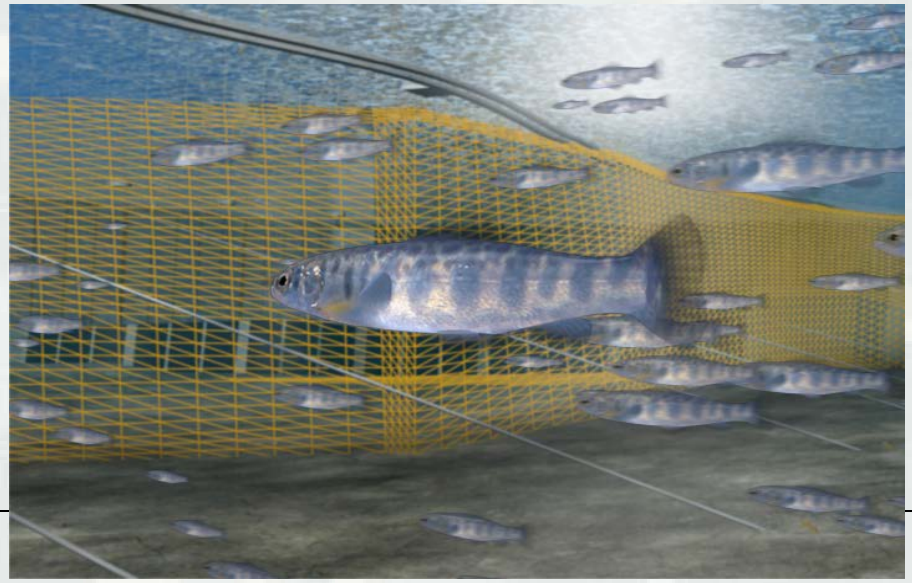
# Long-Term Aquatic Monitoring Plan

- Developed plan 2007
- Includes vegetation, IWM, trapping, electro-fishing and acoustic tagging

- ERDC – ELAM modeling studies feeding into long-term SAM refinement and cumulative analysis
- Bathymetry data
- Pilot 2-D acoustic tagging in 2010
- Expanded 2-D acoustic tagging in 2011

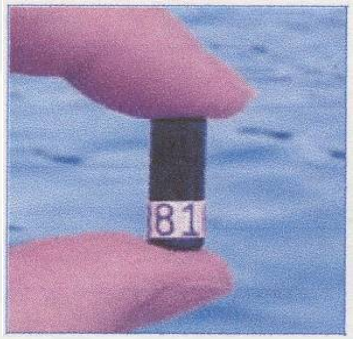
# Eulerian-Lagrangian-Agent Method (ELAM)

- ELAM analyzes the movement behavior of animals in complex environments
- Applied to the movement of aquatic species using a numerical surrogate with hydraulic and/or water quality modeling



# 2-D ACOUSTIC TAGGING

- Need for better tracking of fish through target areas relative to habitat features
- Need to compare response to constructed features vs. natural
- Results used to calibrate ELAM
- ELAM can then be used to predict fish response and refine the SAM indices



# 2-D Study Site
# Sacramento RM-85.6

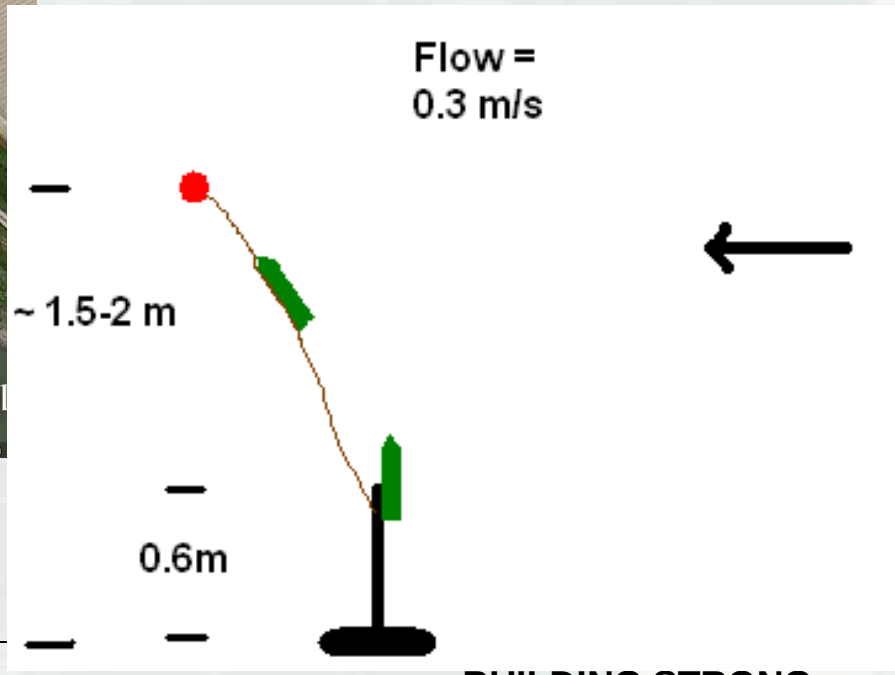
# Bathymetry

- USGS characterized the riverbed, levees, and flow in the Sacramento River
- Acoustic Doppler Current Profiler (*ADCP*)
- Sidescan sonar
- Movie

# Range Test

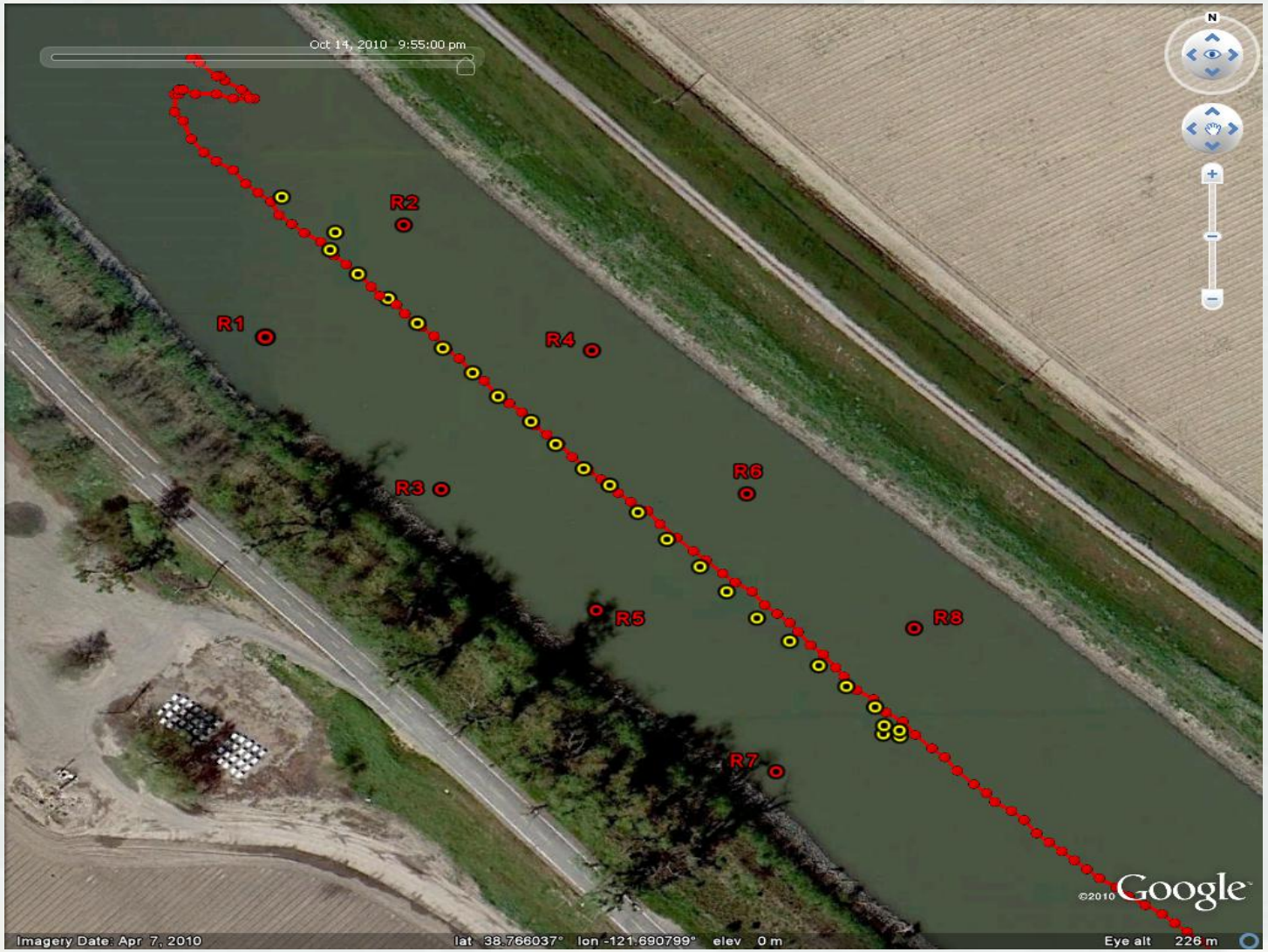
## Range Test Design

## Test Mooring Design



# 2-D Tracking Test

# 2-D Tracking Test with GPS Overlay



# Acoustic Equipment

**VEMCO-VR2W Receivers**
- 180 khz
- 69 khz

**Bryte Yard Custom Mount System**

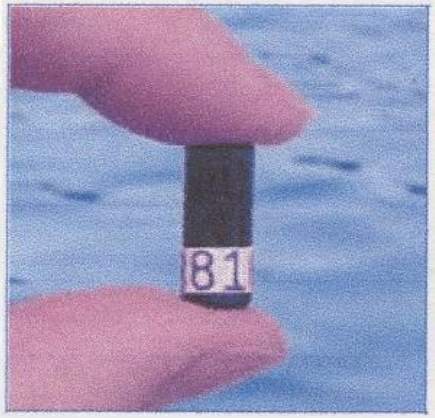
**VEMCO V6 Fish Tags**
- 180 khz

# Fish Tagging

**Late Fall-run Chinook Size Range**

**Length: 100 – 190 mm FL**

**Weight: 11.5 – 70.9 g**




**Two Release Events**

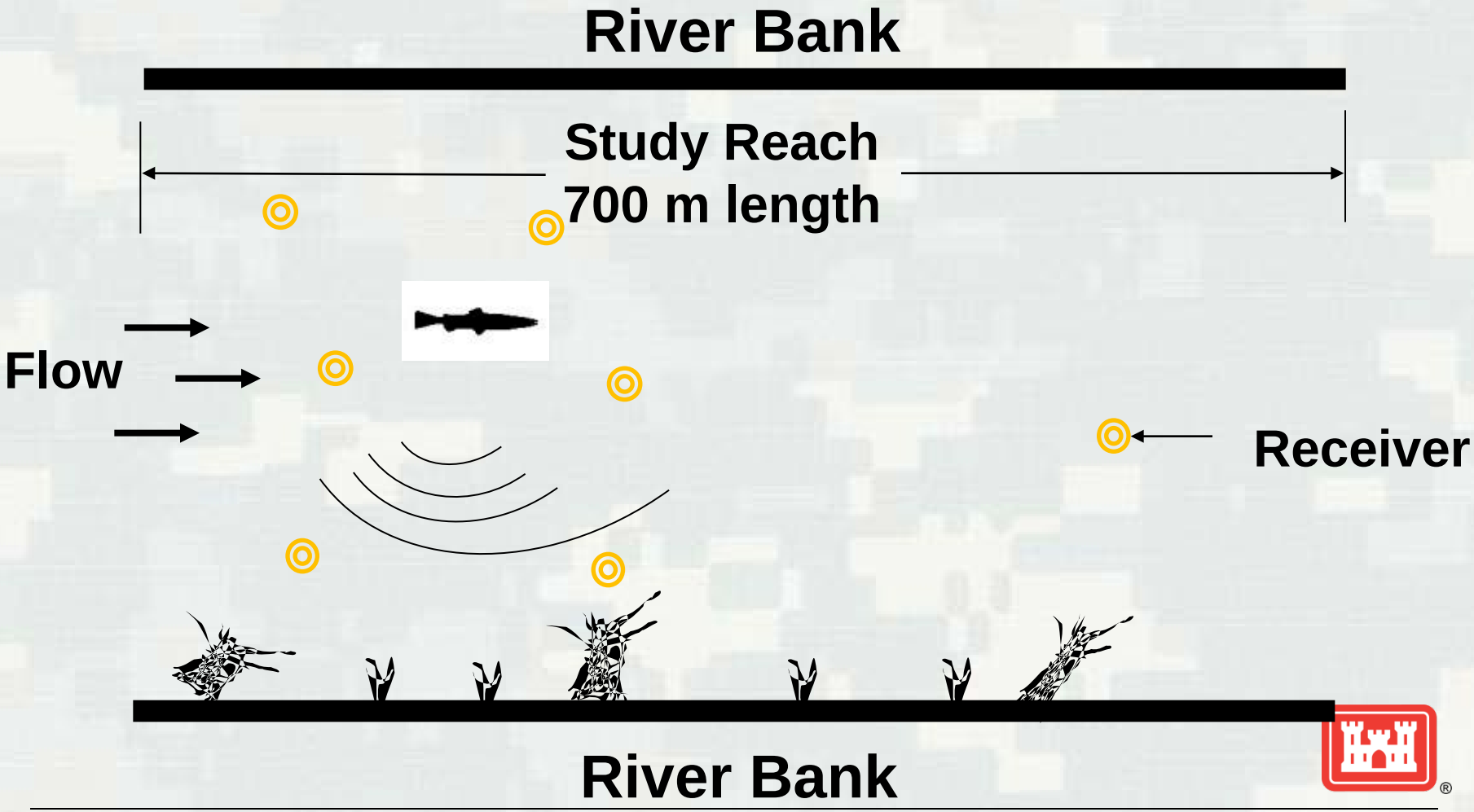
**126 on January 13, 2011**

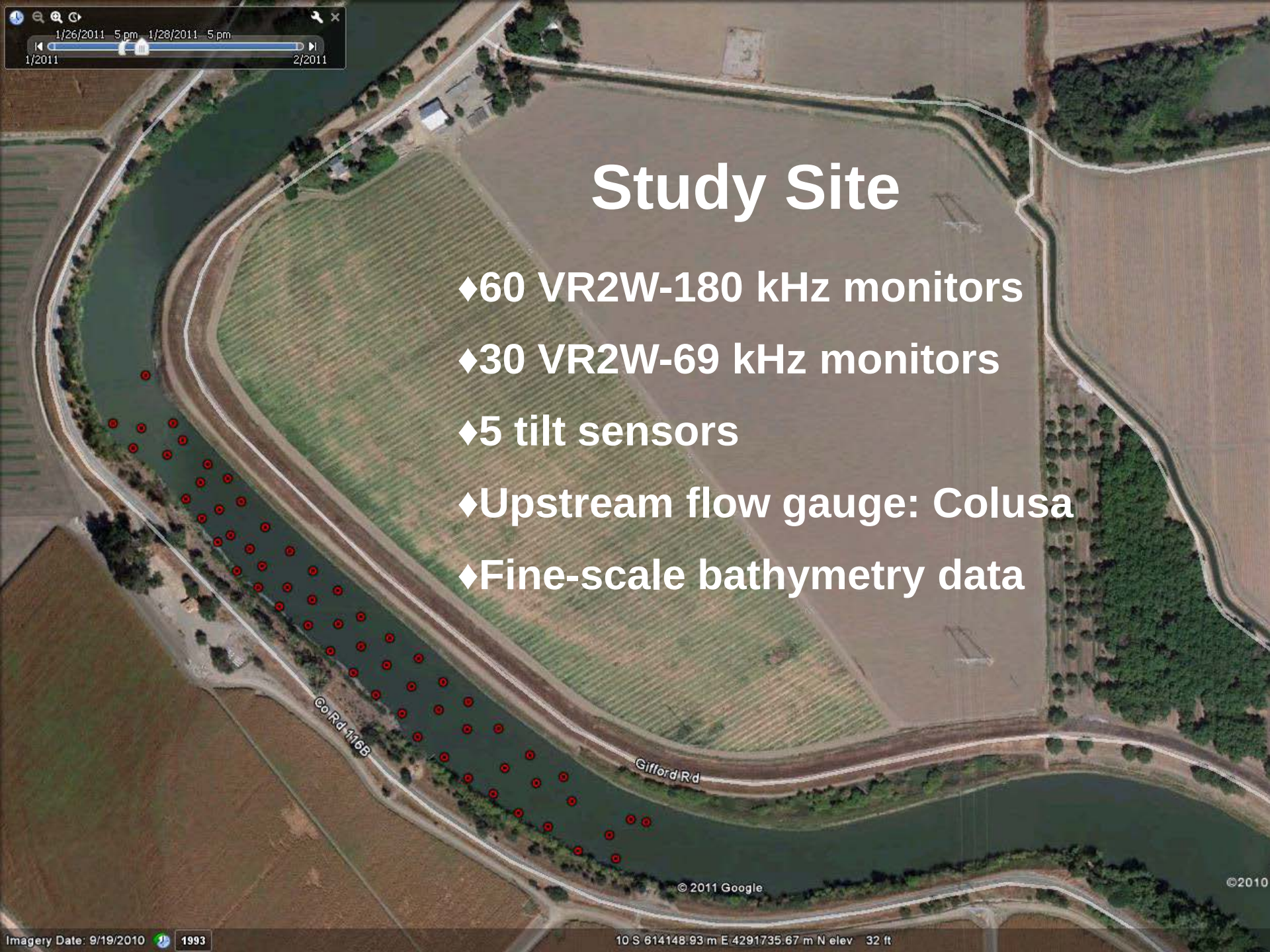
**124 on February 25, 2011**

# Proposed setup with 50 VR2Ws

# High Flows

# Conceptual diagram of study site setup






# Study Site

- ♦60 VR2W-180 kHz monitors
- ♦30 VR2W-69 kHz monitors
- ♦5 tilt sensors
- ♦Upstream flow gauge: Colusa
- ♦Fine-scale bathymetry data

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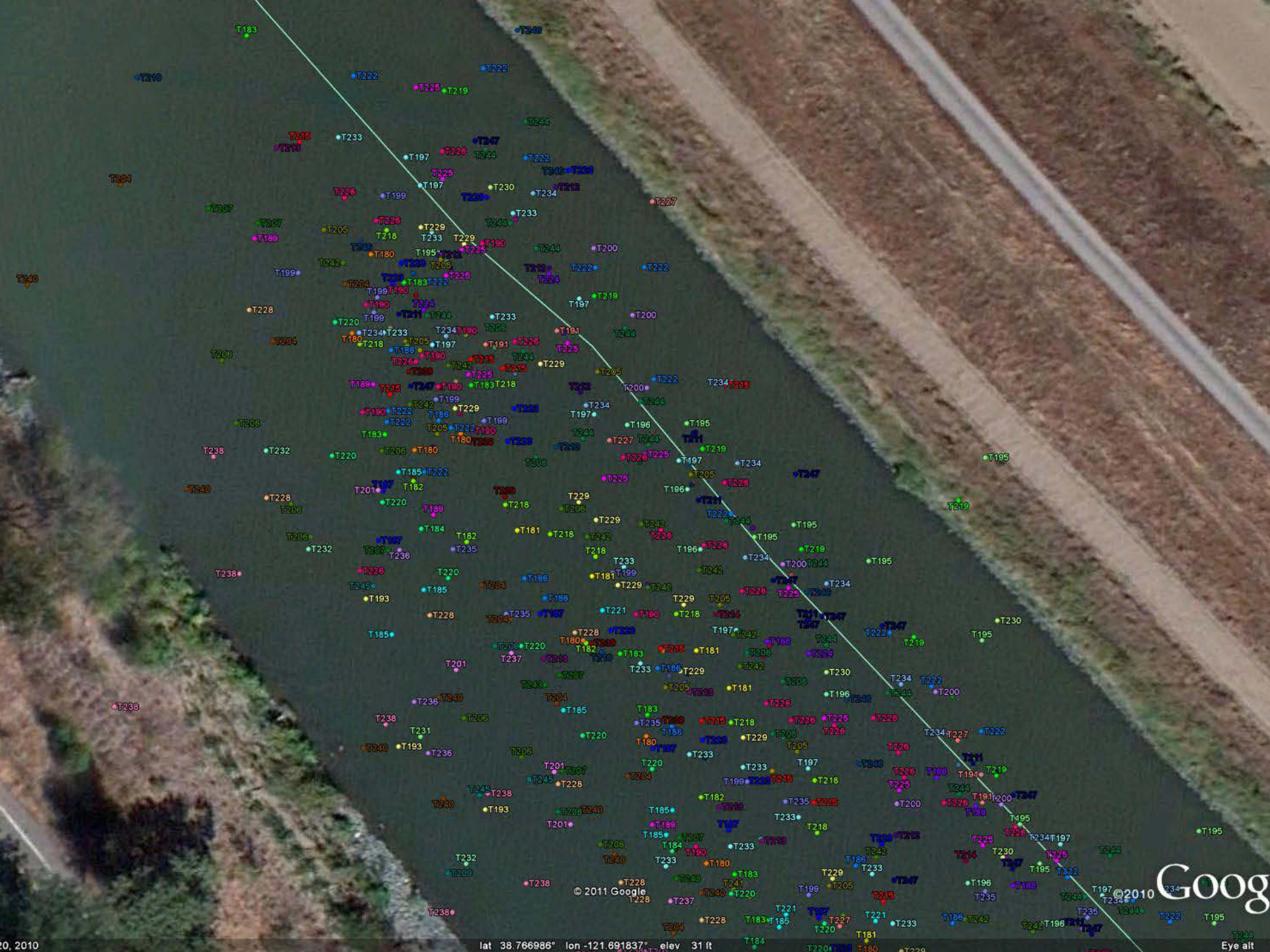
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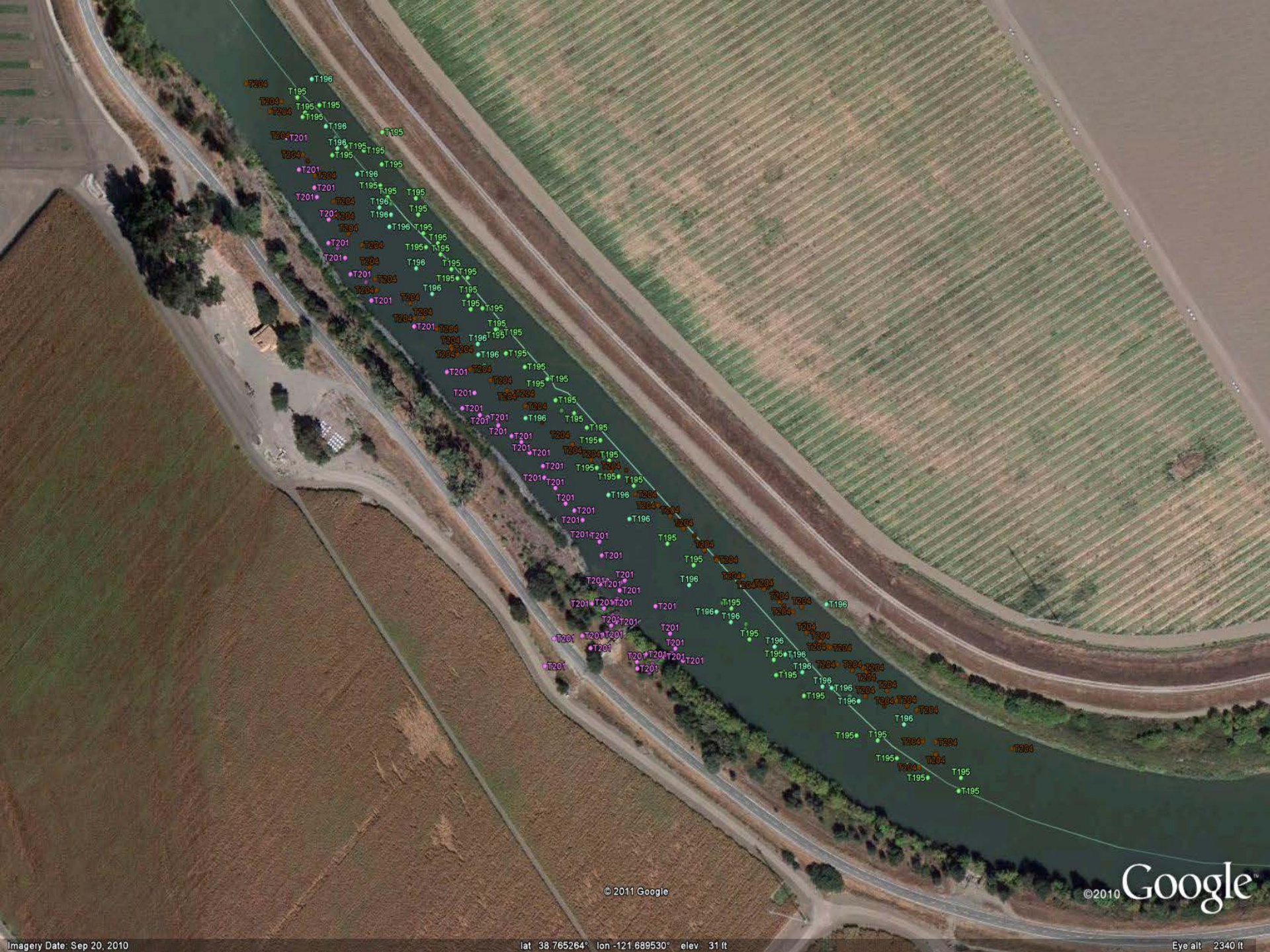
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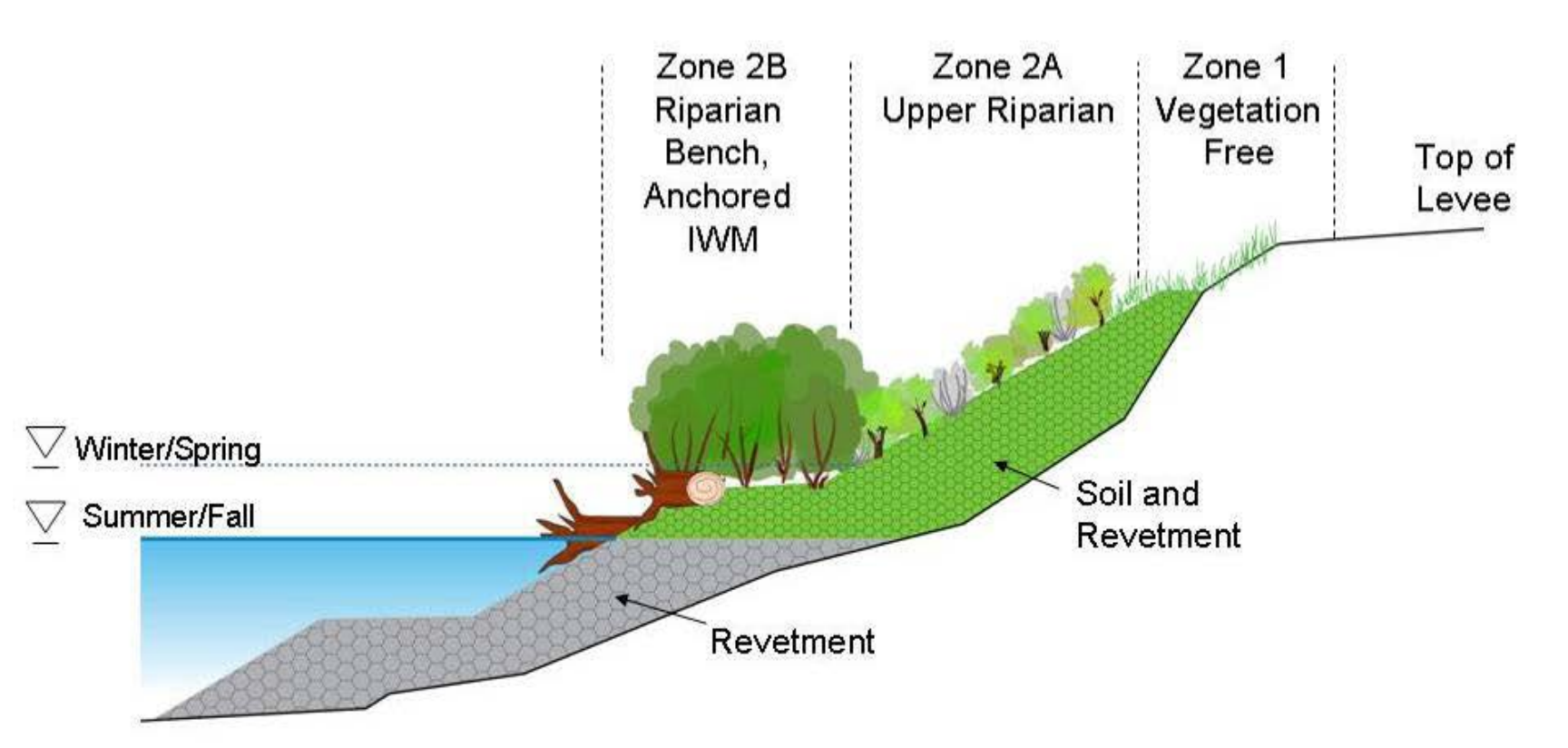
# Multiple Species

## Sturgeon

## Steelhead

## Smallmouth

# The Goal:
# Improve Erosion Repair Designs



# Next Steps

- Expand tracking efforts at several locations
- Tag smaller fish
- Time fish release when repair sites are inundated
- Predator-prey dynamics
- Test water quality
- Additional species (sturgeon, Delta smelt)

# Acknowledgments


- CA Department of Water Resources
- U.S. Army Corps of Engineers
- SRBPP Interagency Working Group (NMFS, USFWS, CDFG)
- Stillwater Sciences
- Environ International
- VEMCO