Georgiana
Slough
GRAND ISLAND
STEAMBOAT
RIVER
ISLAND
GRAND
ISLAND
WEST THORN
New Hope Landing

2012 Georgiana Slough
Non-Physical Barrier Performance Evaluation

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Project Collaborators/ Acknowledgements

Introduction and Background

- Juvenile Chinook salmon experience greater mortality when migrating into Georgiana Slough than in the Sacramento River (Perry 2010)
- Movement and/or diversion of these fish into the interior and south Delta increases the likelihood of losses (Brandes and McLain 2001; Perry 2010; NMFS 2009)
- NMFS BO RPA:
  - Action IV.1.3 Consider Engineering Solutions to Further Reduce Diversion of Emigrating Juvenile Salmonids to the Interior and Southern Delta, and Reduce Exposure to CVP and SWP Export Facilities

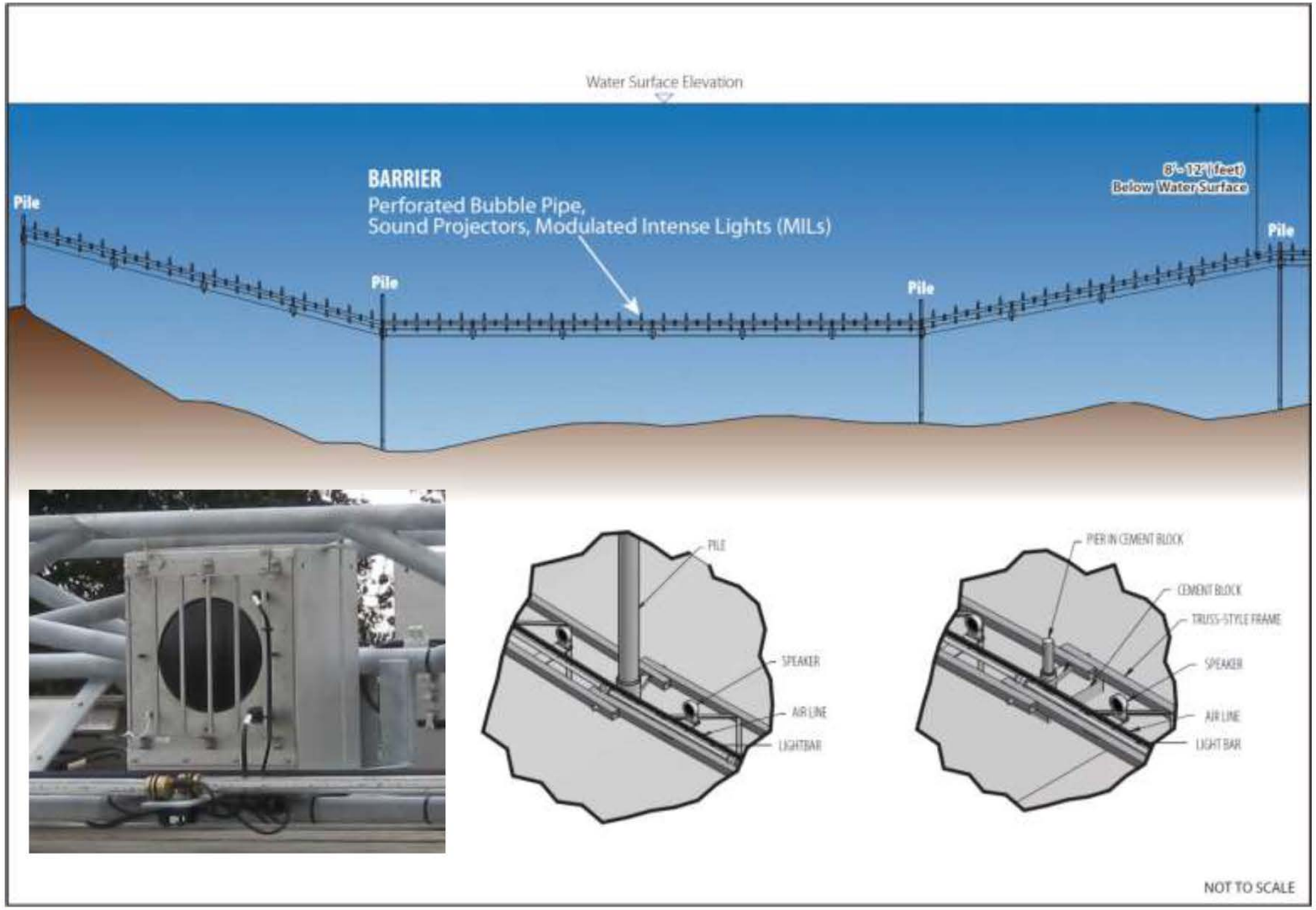
Study Purpose and Objectives

- Purpose:
  - Test the effectiveness of a non-physical barrier in preventing outmigrating juvenile Chinook salmon from entering Georgiana Slough
- Objectives:
  - Estimate the effectiveness of the barrier
  - Determine relative contribution of various factors influencing barrier effectiveness
    - water velocity, ambient light (day/night), cross stream fish position in the Sacramento River
  - Observe the behavior, movements, and response of predatory fish near the barrier

Fish Guidance Technology

- Non-Physical Barrier Utilizing Bio-Acoustic Fish Fence™(BAFF) Technology
- BAFF combines three stimuli:
  - sound
  - high-intensity modulated light
  - bubble curtain
- Advantages include:
  - Tune sound frequencies for specific species of fish
  - Minimal impact on boat traffic
  - Minimal hydraulic impact

Non-Physical Barrier (BAFF)

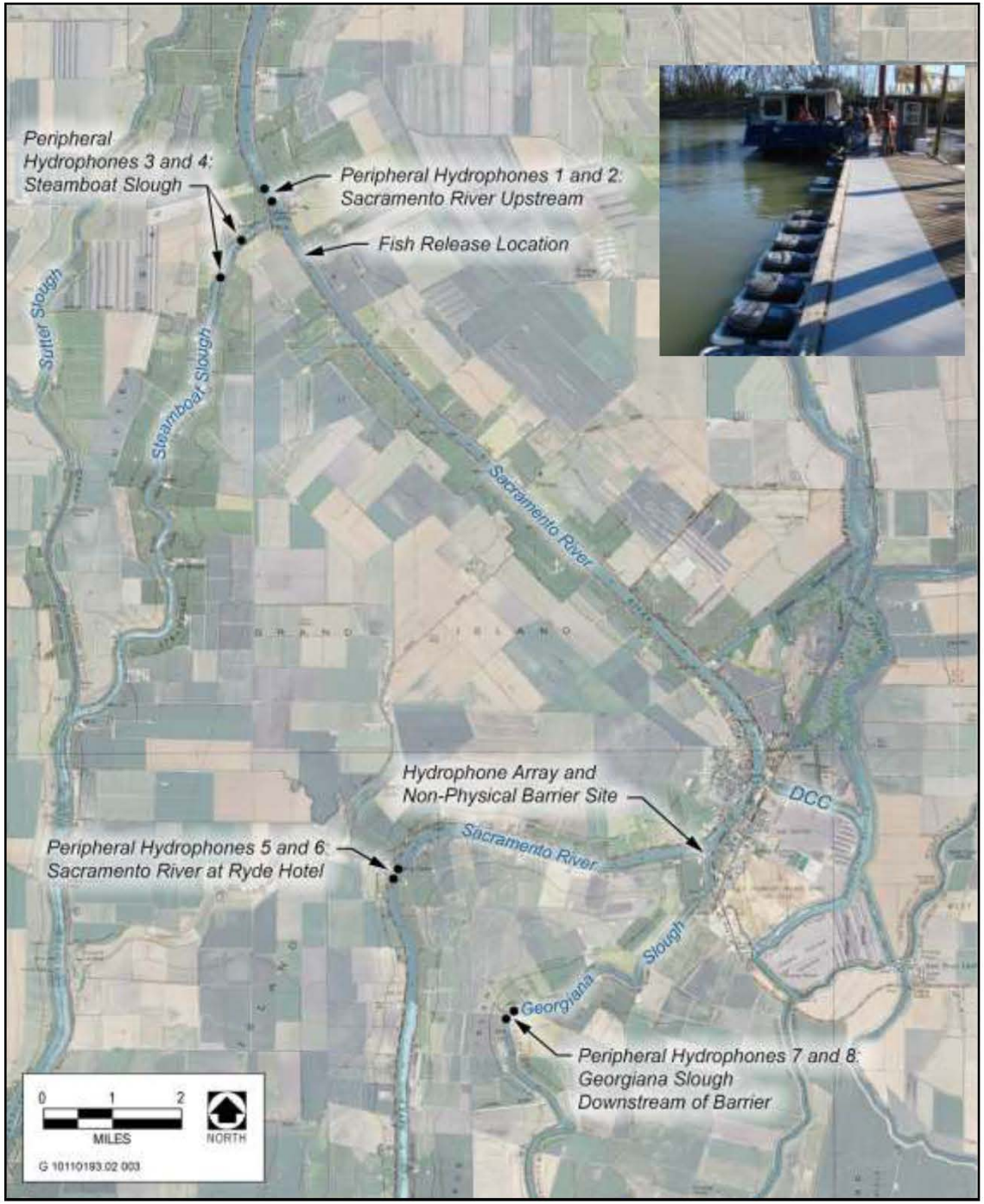


Non-Physical Barrier (BAFF)

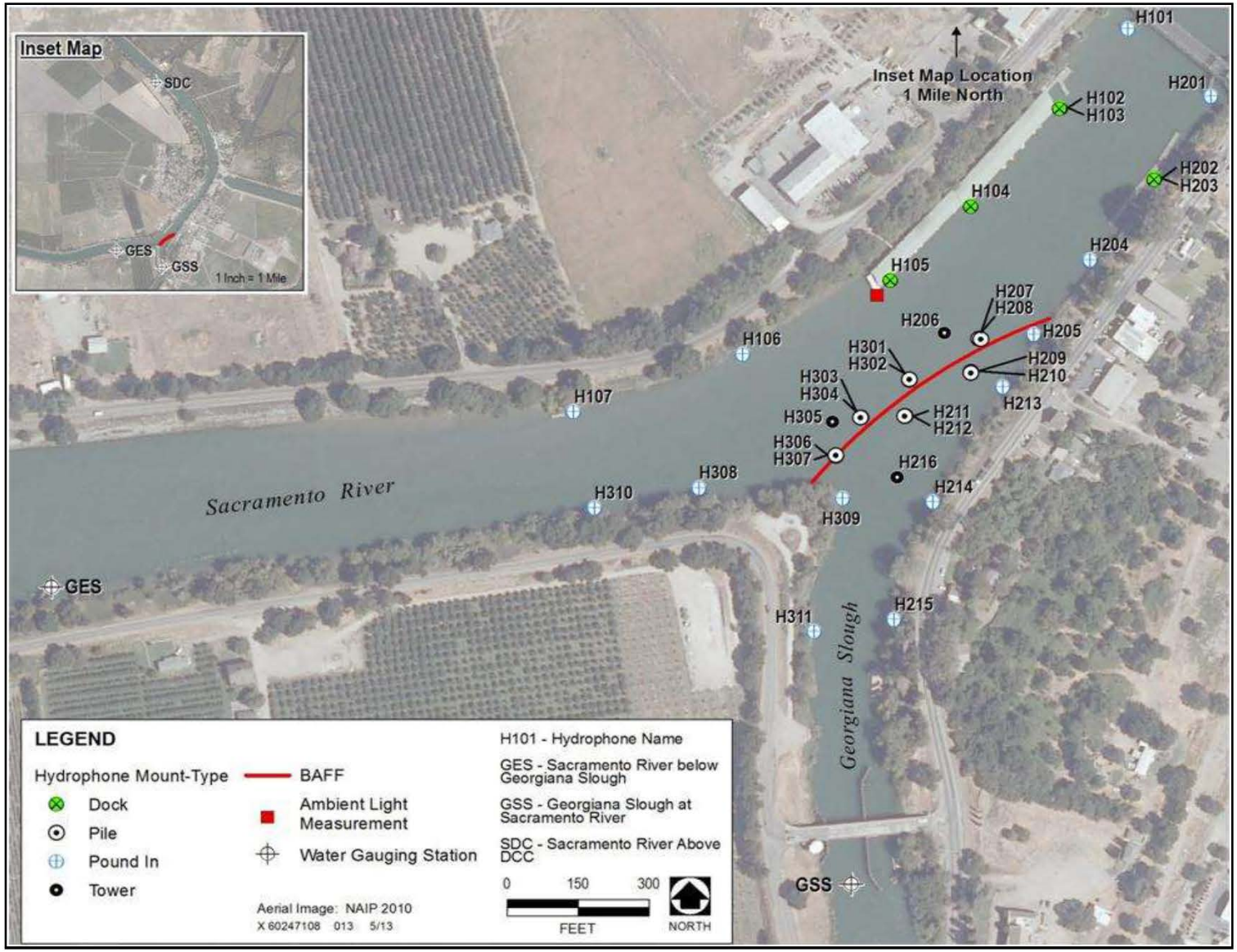
BAFF Operations at Night

Primary Study Components

- BAFF in blocked On and Off modes (25 hour)
- 1,501 Chinook salmon & 299 steelhead
- Released March 6, 2012 to April 29, 2012
- Releases made ~8.9 kilometers upstream of the BAFF
- Tagged salmonids monitored via array (2D & 3D) and nodes (detection)
- 50 predatory fish also tagged and monitored
- Hydrologic and other conditions monitored
  - Discharge: 30,000 cfs peak (10,000 to 20,000 cfs)


Peripheral
Hydrophones 3 and 4:
Steamboat Slough
Peripheral Hydrophones 1 and 2:
Sacramento River Upstream
Fish Release Location
Sutter Slough
Steamboat Slough
Sacramento River
Hydrophone Array and
Non-Physical Barrier Site
DCC
Peripheral Hydrophones 5 and 6:
Sacramento River at Ryde Hotel
Sacramento River
Georgiana
Slough
Peripheral Hydrophones 7 and 8:
Georgiana Slough
Downstream of Barrier
0
1
2
MILES
NORTH
G 10110193.02 003

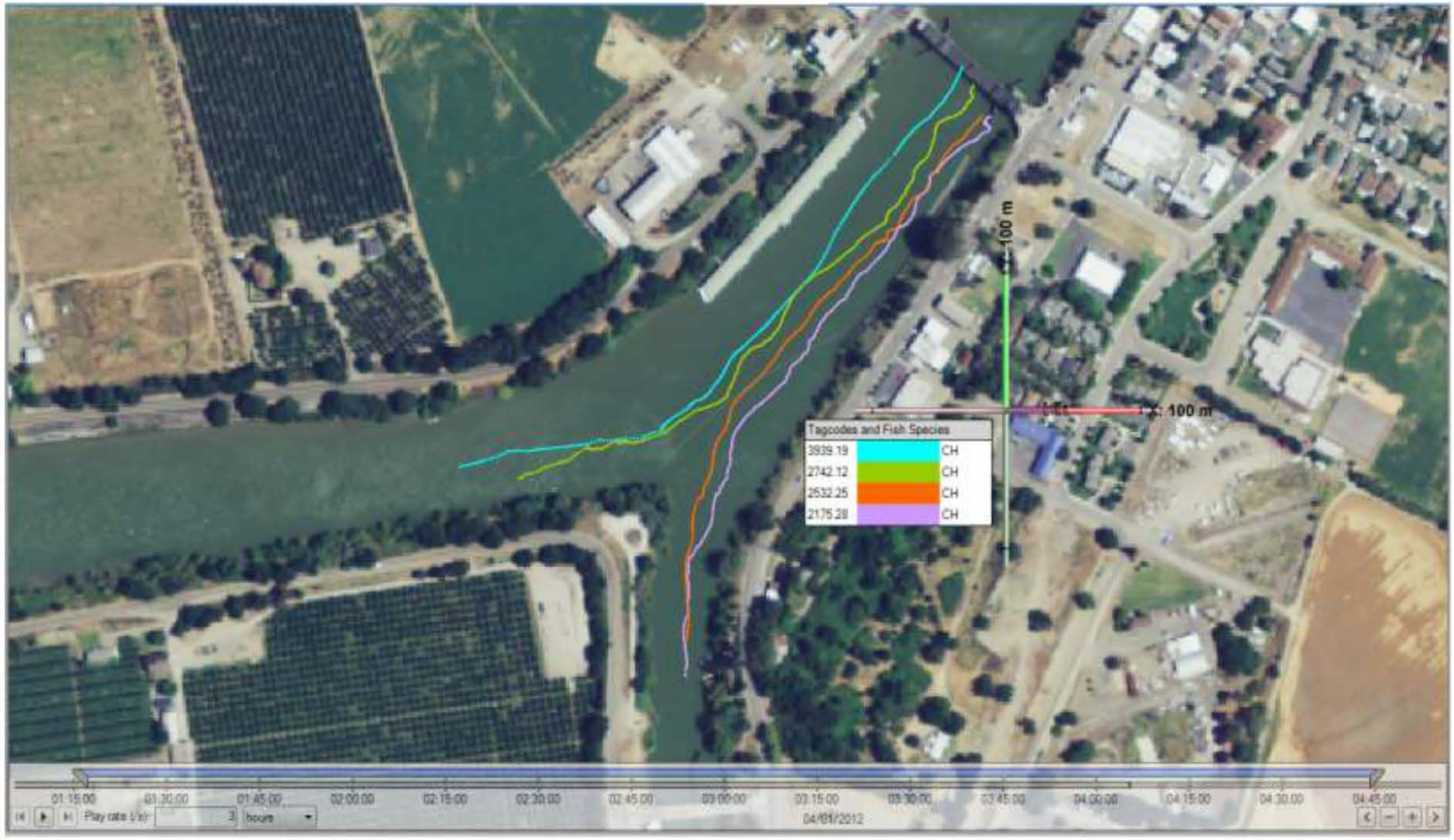
Hydrophone Array and other Data Collection Instrument Locations



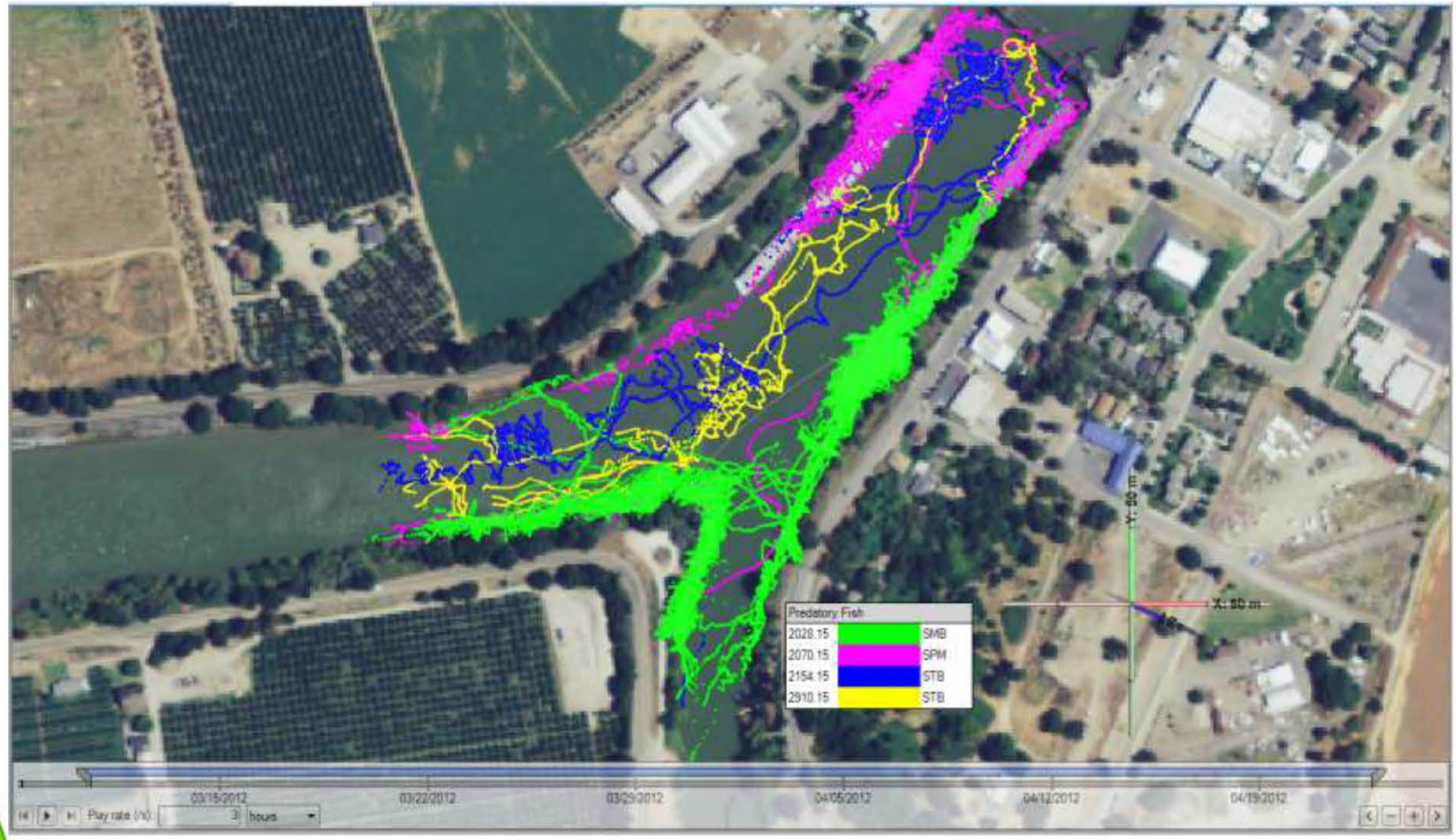
Approach to Analysis

- Fish detections and tracking
- Study evaluation metrics
  - Barrier efficiencies
  - Route entrainment probabilities
  - GLM of tagged fish fates
  - Critical streakline analysis
  - Predatory fish and predation
  - Reach-specific survival probabilities

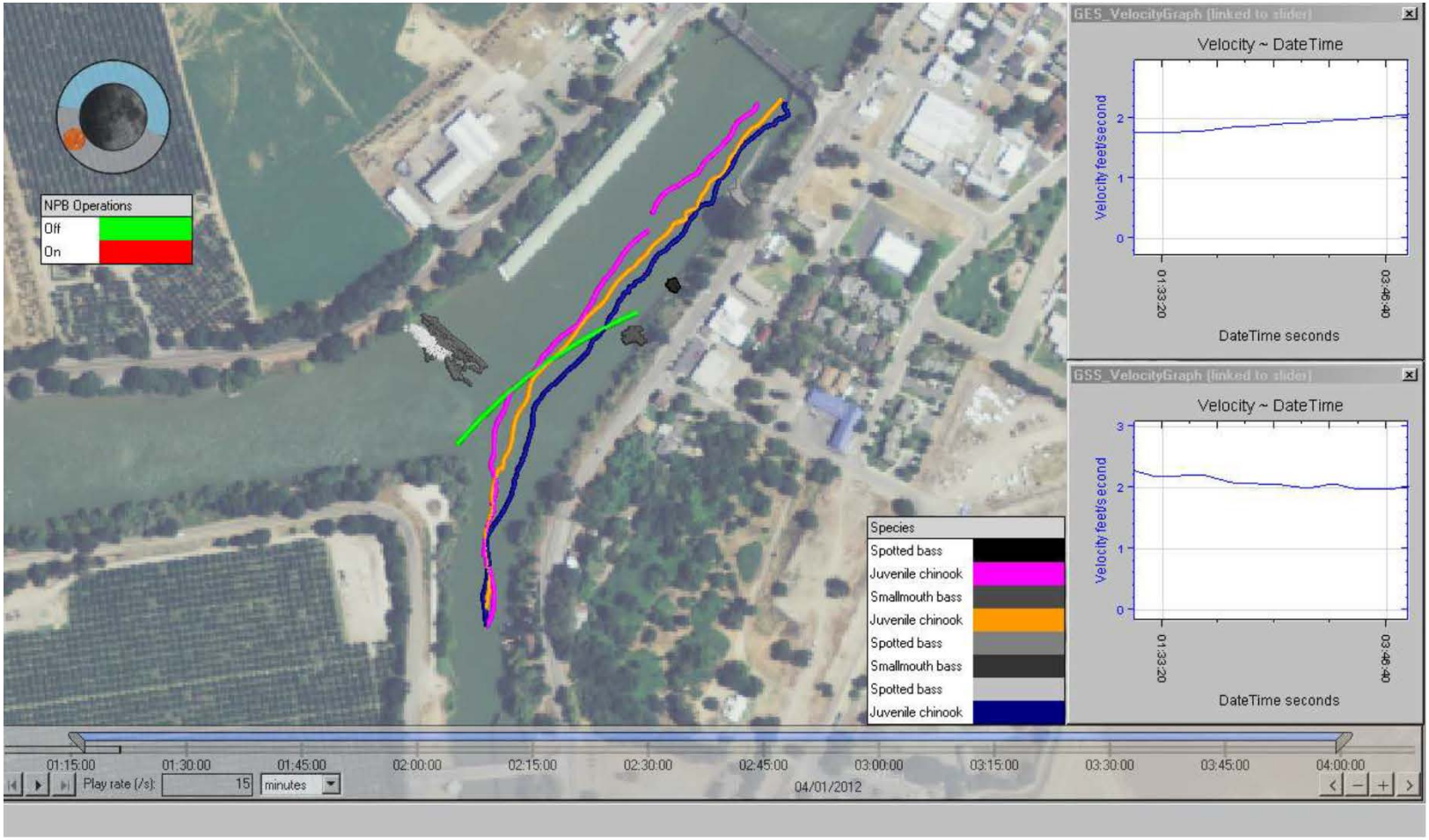
Representative 2D Fish Tracks (smolts)



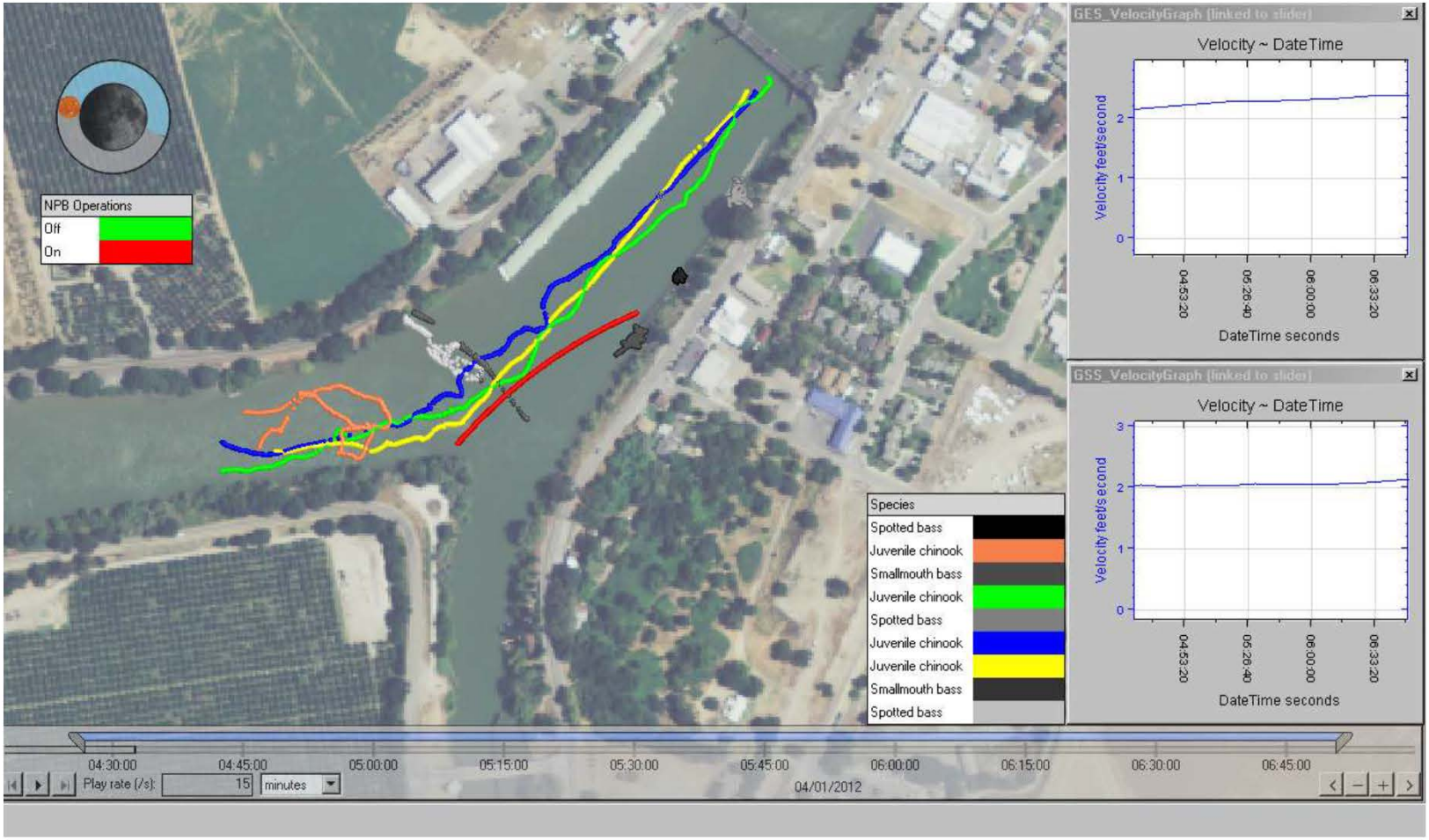
Representative 2D Fish Tracks (predators)



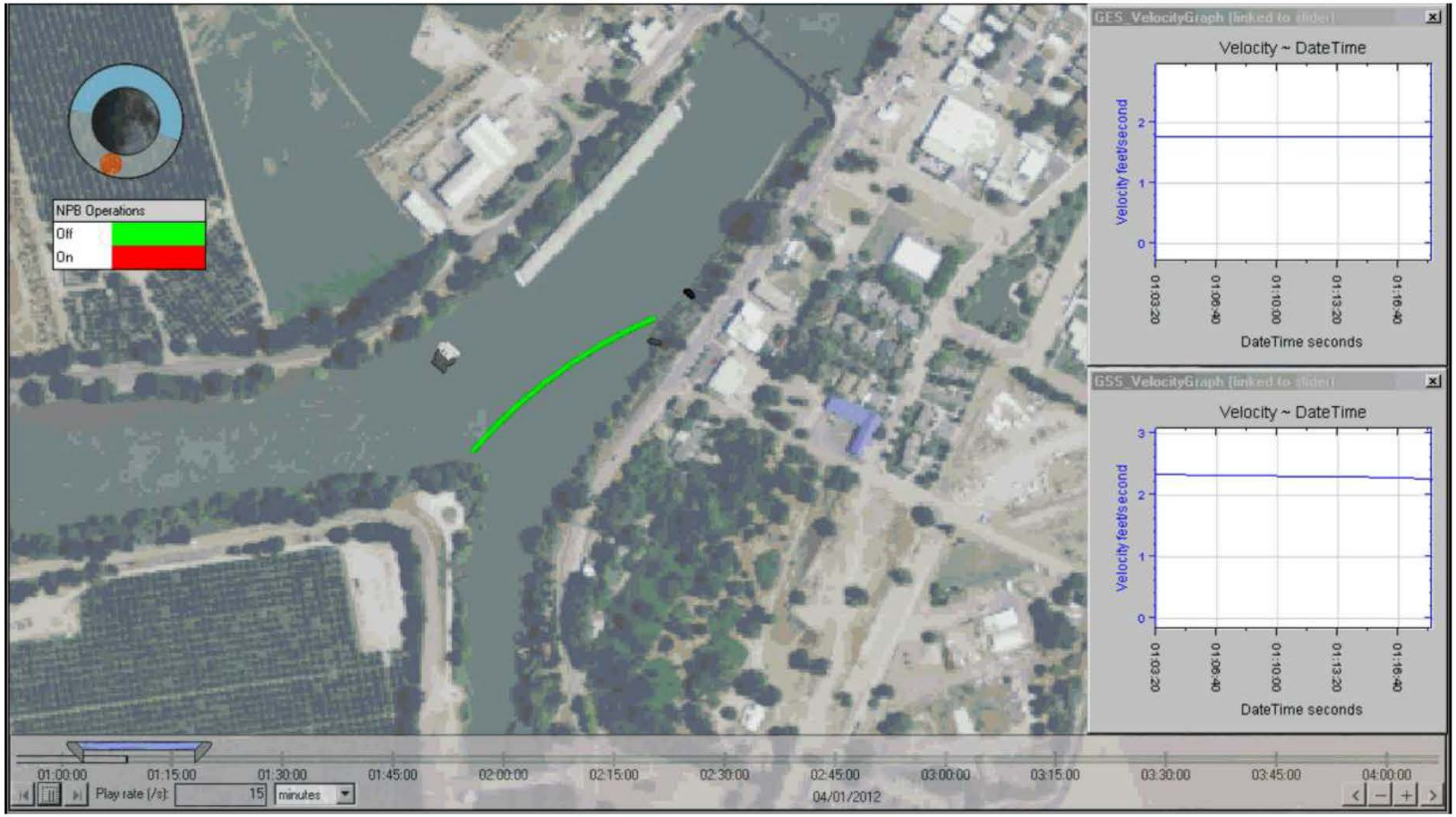
April 1, 2012 (BAFF Off)



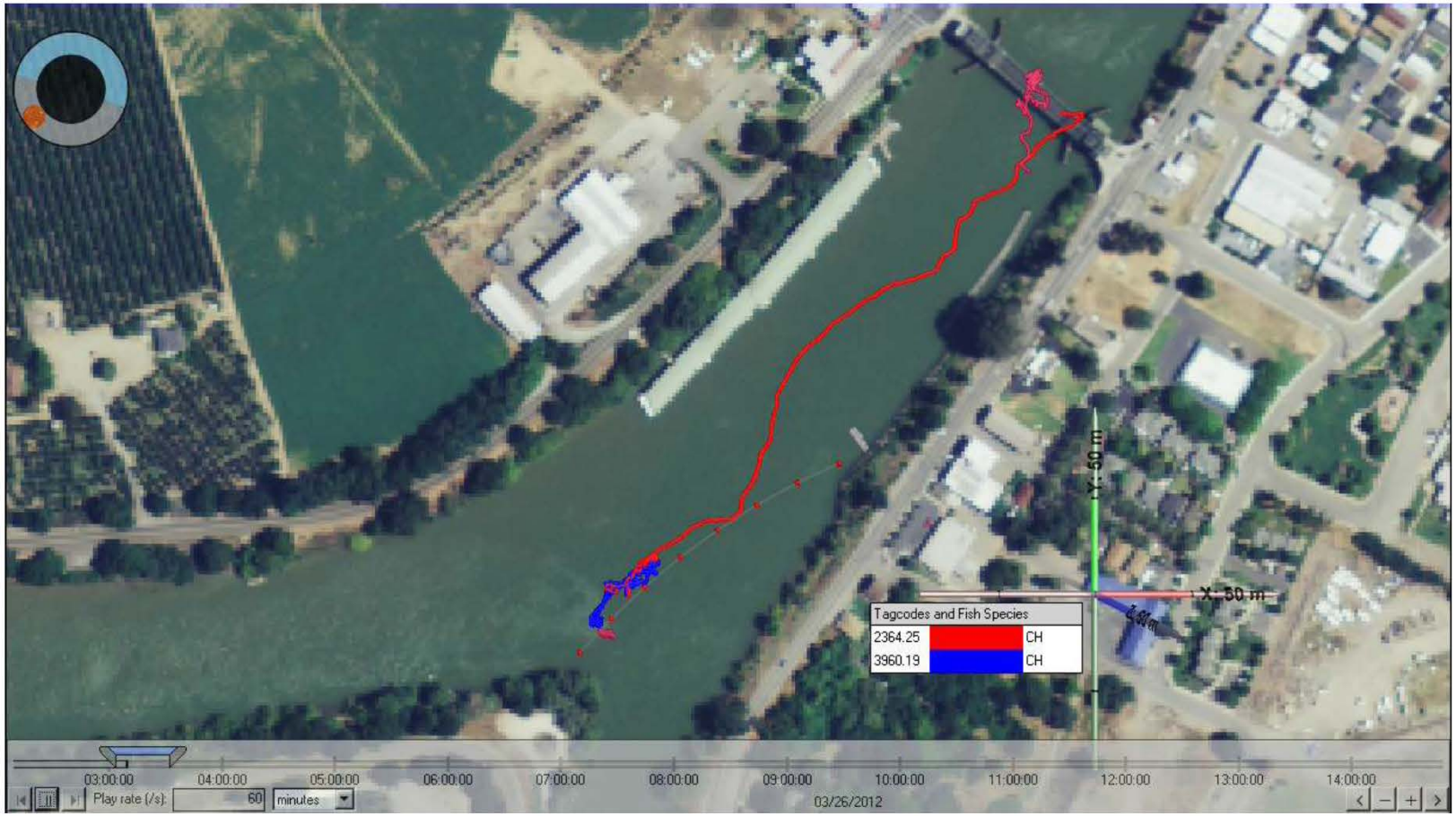
April 1, 2012 (BAFF On)



April 1, 2012 (BAFF Off and On)



One fish, two fish, red fish, blue fish, poo fish…



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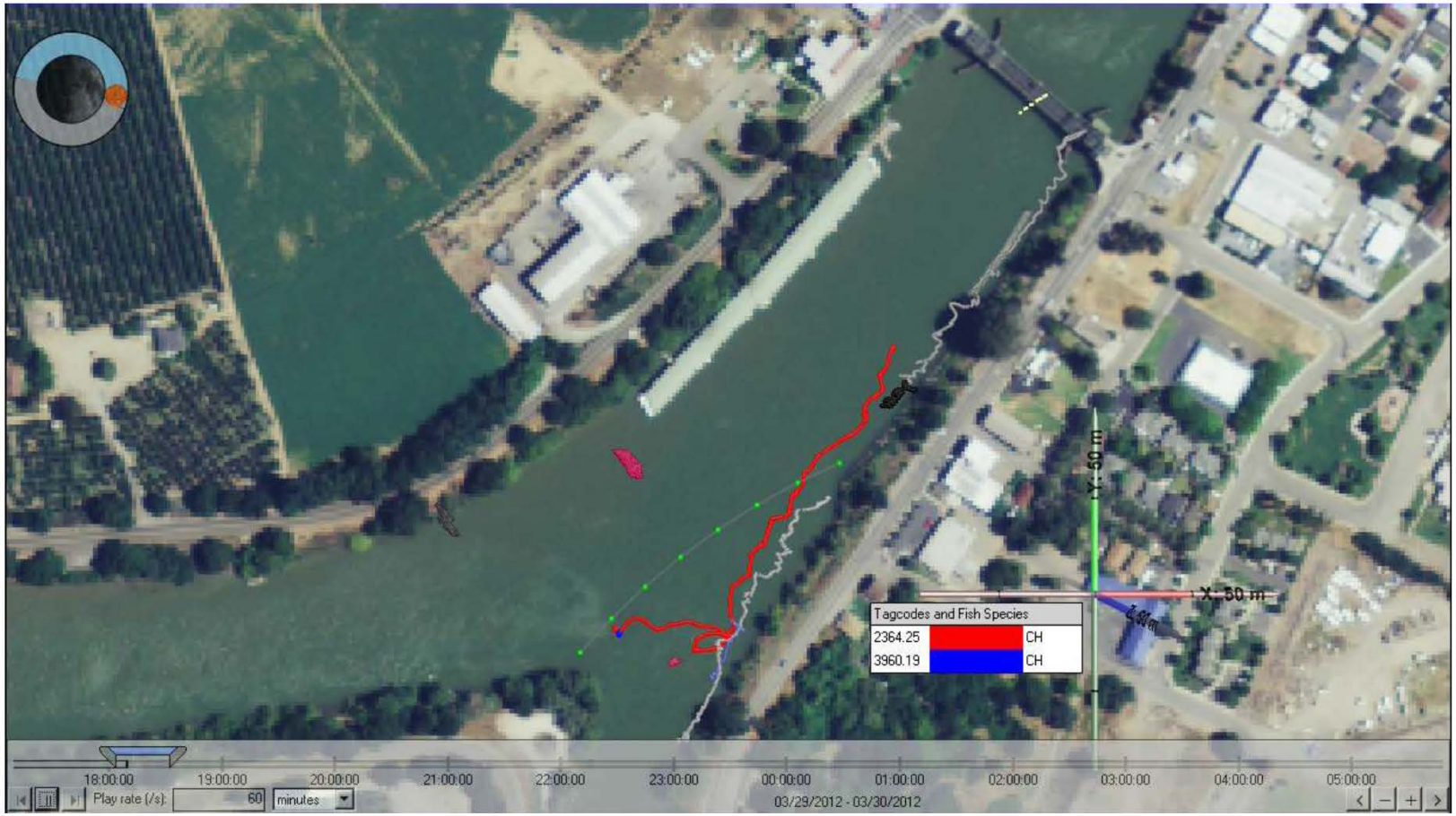

One fish, two fish, red fish, blue fish, poo fish…

Results – Barrier Efficiencies

- Chinook salmon

Comparison of Deterrence, Protection, and Overall Efficiencies for BAFF On versus BAFF Off				
Comparison Metrics	**BAFF On Mean**	**BAFF Off Mean**	**Percentage Point Change in Efficiency**	**P-value**
Deterrence	**0.561**	**0.409**	**15.2**	**<0.0001**
Protection	0.890	0.746	14.4	<0.0001
Overall	**0.897**	**0.752**	**14.5**	**<0.0001**

Table 3.2-3

- Steelhead
  - Similar efficiencies for BAFF On versus BAFF Off; however, sample size not powered for statistical analysis

Results

- BAFF Deterrence (D) Contribution to Overall Efficiency Under High and Low Velocity

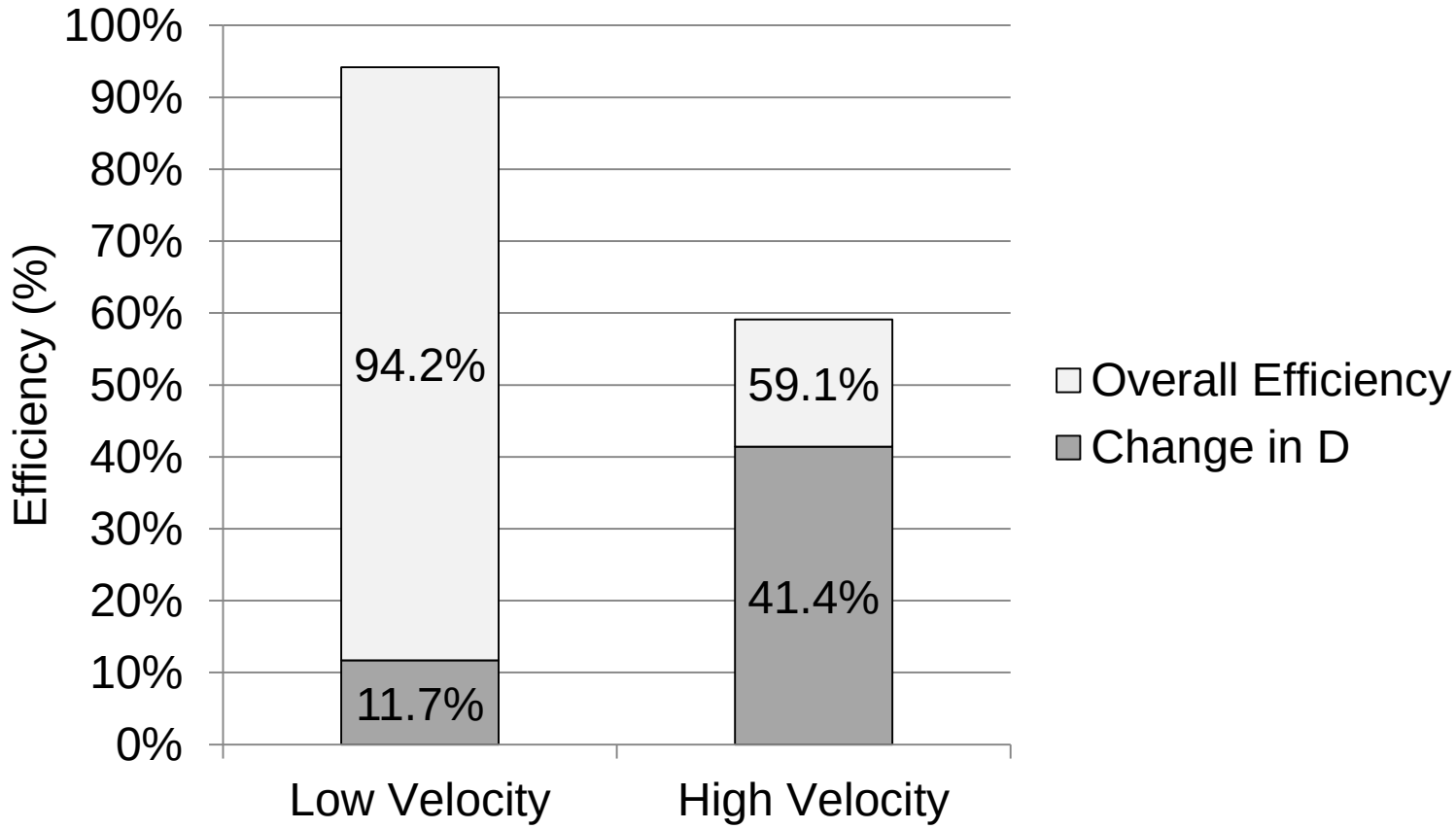

Figure 3.2-4

Results

- Predation
  - Estimated predation of tagged salmonids in the array during BAFF operations:
    - 6.3% (total array)
    - 2.3% (within 80m of BAFF)
    - <1% (within 5m of BAFF)

Discussion and Conclusions

- BAFF performance as measured by differences in — barrier efficiencies were statistically significant and demonstrated a fish behavioral response to the BAFF
  - BAFF efficiency results varied most notably as a function of river velocity
- BAFF reduced entrainment into Georgiana Slough from 24.8% (BAFF Off) to 10.3% (BAFF On) — > 50% reduction
  - Entrainment varied most notably with cross stream fish position and velocity
- Not sufficient evidence to suggest predator behavior was related to BAFF

Recommendations and Future Directions

- Review and evaluate other technologies in deterring juvenile salmon from entering Georgiana Slough
- Assess effect on technologies on through-Delta survival

- 2014 Floating Fish Guidance Structure Study

Questions

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