ECO-PTM Training – Sacramento Delta Juvenile Salmon Junction Routing, Movement, and Survival

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U.S. Geological Survey

ECO-PTM training session, April 16, 2024

ECO-PTM

- Current version of CADWR enhanced particle tracking model
  - Uses DSM2 historical simulation hydrology
- ECO-PTM adds ‘swimming behaviors’ to original PTM’s neutrally-buoyant particles
- Particle routing at key junctions governed by statistical sub-model
- Particles ‘die’ probabilistically according to XT model

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Modeling Salmon Migration

- Which way?
  - What is the route migration probability for important junctions? (Migration route model)
- How long?
  - What is the travel time distribution for migrating juvenile salmon? (Travel time model)
- Who's left?
  - What is mortality for migrating juvenile salmon in each reach within the Delta? (Survival model)

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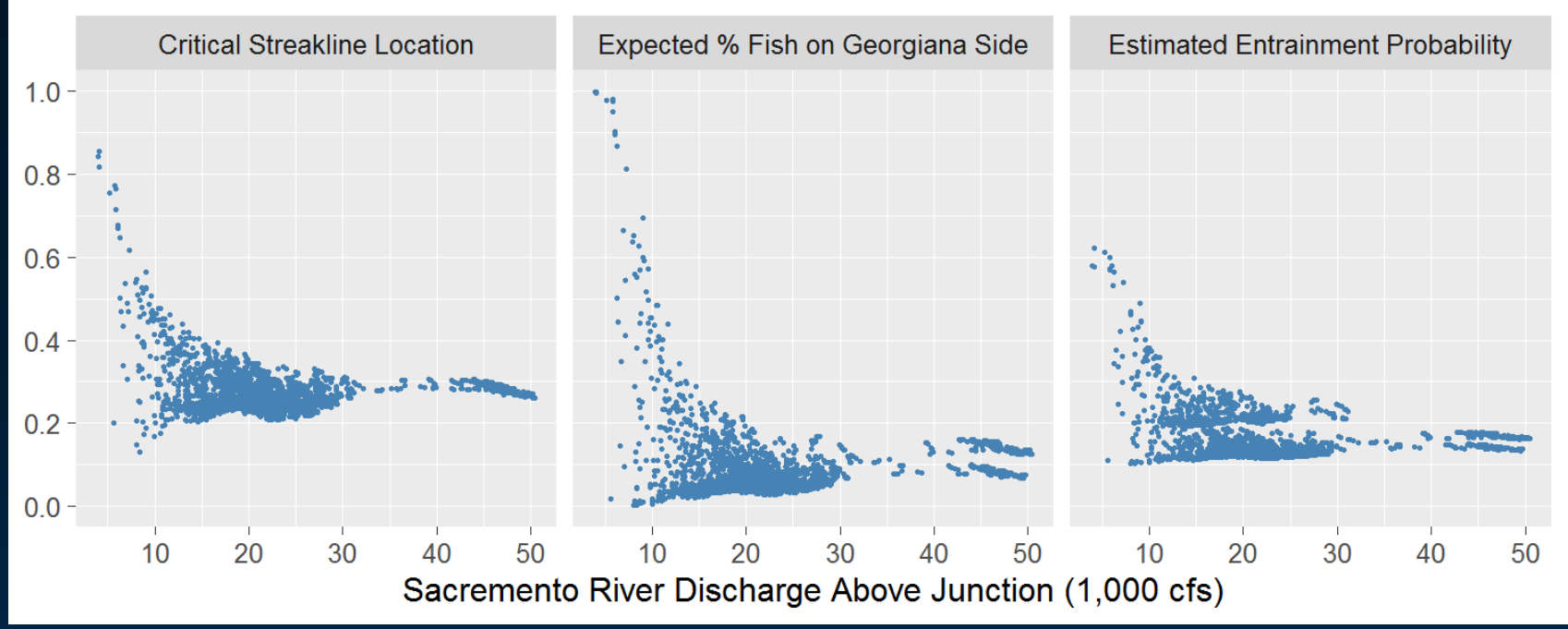
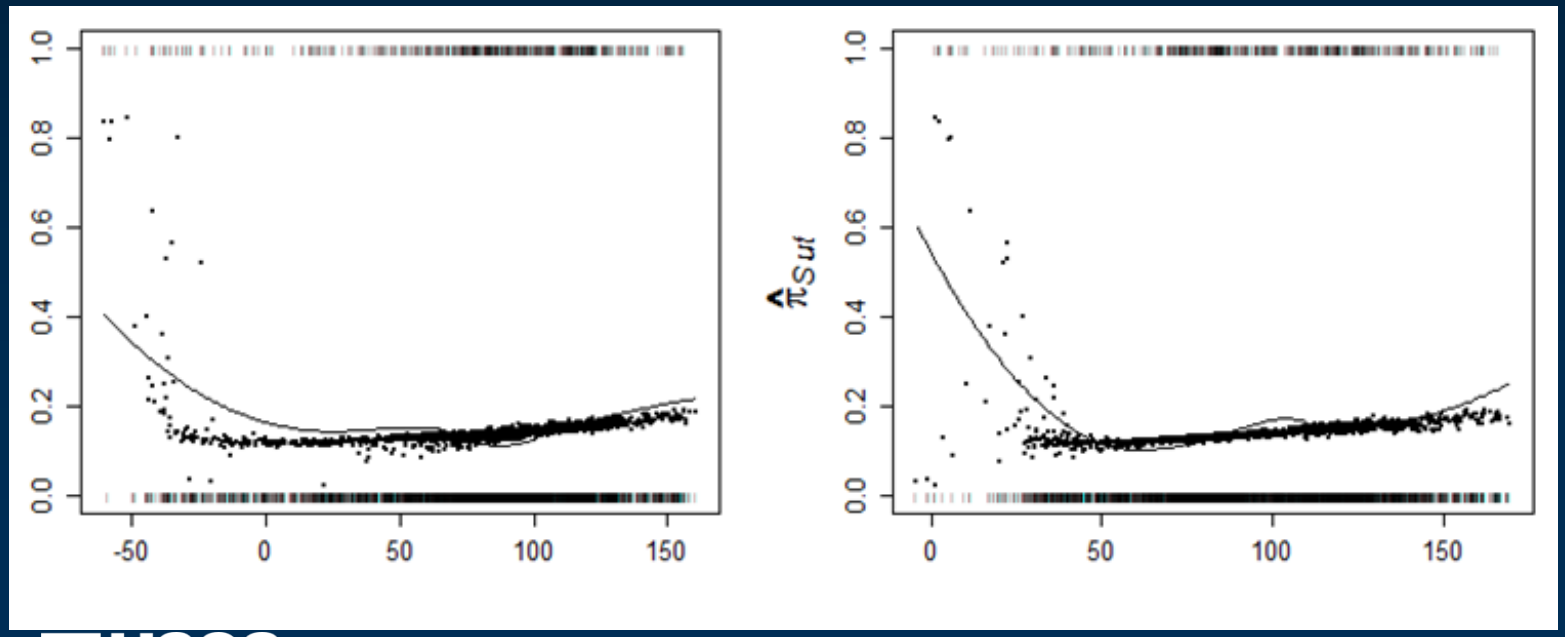
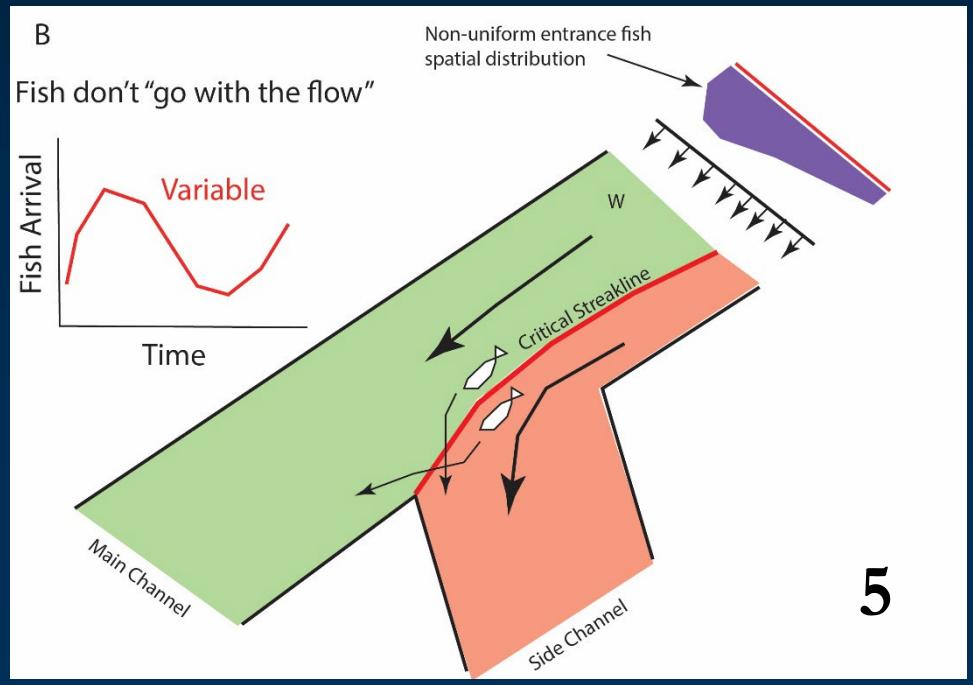
- We need a model to predict entrainment because it isn't always proportional to flow







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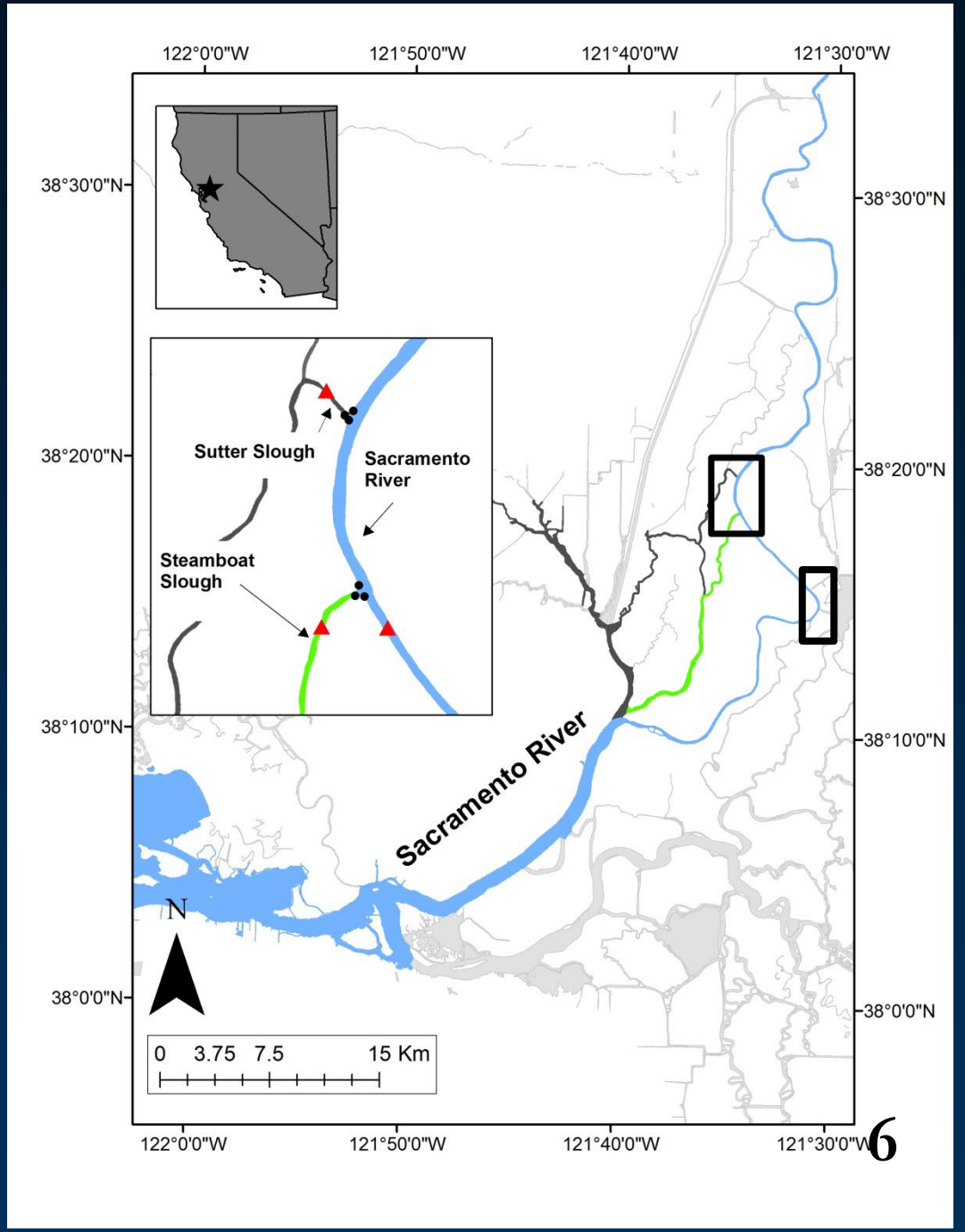
- 2 junctions, 3 models
  - Georgiana Slough has separate models for high and low flows
- All use acoustic tagged late-fall Chinook
- Data collected between 2006 and 2014
- Many agencies
  - DWR, USGS, USFWS, NMFS
- Acoustic tag sample sizes
  - 714 fish – Georgiana Slough and DCC routing
  - 3,418 fish – Sutter and Steamboat routing



Environ Biol Fish (2022) 105:2065–2082
https://doi.org/10.1007/s10641-022-01273-1

Quantifying the effects of tides, river flow, and barriers on movements of Chinook Salmon smolts at junctions in the Sacramento – San Joaquin River Delta using multistate models

Michael J. Dodrill · Russell W. Perry · Adam C. Pope · Xiaochun Wang

SAN FRANCISCO ESTUARY & WATERSHED SCIENCE

Sponsored by the Delta Science Program and the UC Davis John Muir Institute of the Environment

Combining Models of the Critical Streakline and the Cross-Sectional Distribution of Juvenile Salmon to Predict Fish Routing at River Junctions

2020 | Hance, Dalton J.; Perry, Russell W.; Burau, Jon R.; Blake, Aaron; Stumpner, Paul; Wang, Xiaochung; Pope, Adam

SAN FRANCISCO ESTUARY & WATERSHED SCIENCE

Sponsored by the Delta Science Program and the UC Davis John Muir Institute of the Environment

Effects of Tidally Varying River Flow on Entrainment of Juvenile Salmon into Sutter and Steamboat Sloughs

2021 | Romine, Jason G.; Perry, Russell W.; Stumpner, Paul R.; Blake, Aaron R.; Burau, John R.

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ECO-PTM behavioral parameters

- Movement velocity beyond advection
  - Each particle has a mean velocity (μ) drawn from a normal distribution (standard deviation σ_p)
  - A particle's velocity each timestep is drawn from another normal distribution around that mean (σ_t)
- Holding and orientation behaviors
  - Probability of holding during daylight hours (p_{diel})
  - Selective tidal stream transport (STST, f_{ST})
  - Probability of mis-assessing downstream direction (logistic function with intercept C_0)

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Model comparison allows parameter selection

- 'Base' model allows for swimming velocity and diel holding behavior
  - μ, σ_p, σ_t, p_{diel}
  - μ and p_{diel} can vary by tidal region
  - If p_{diel} near 0, would be evidence against it
- 3 additional models allow for either STST, mis-assess direction, or both
  - f_{ST} and C_0
  - Model fit to data determines ECO-PTM behaviors

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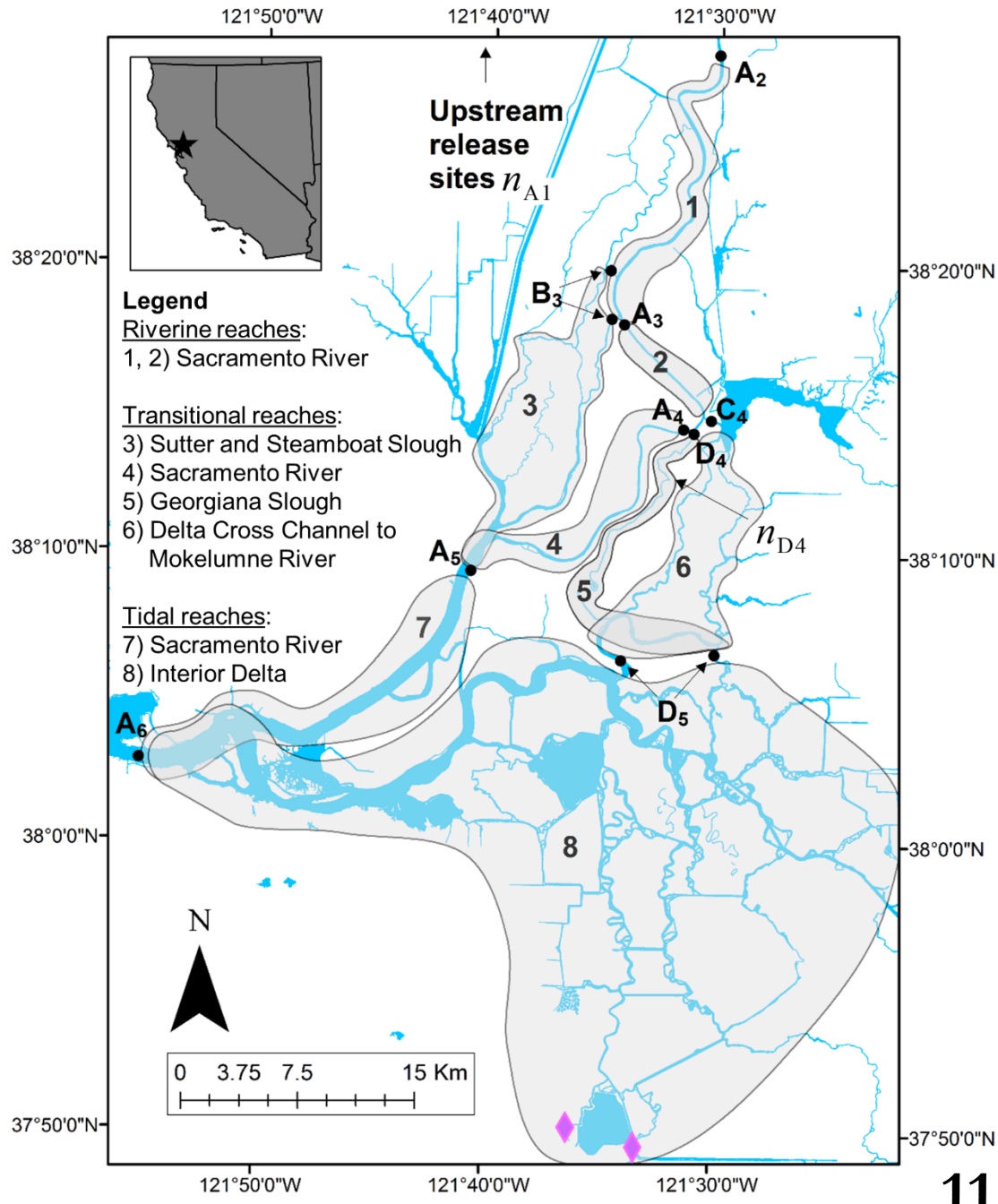
Acoustic Telemetry Data for Travel Time Analysis

- Acoustic Telemetry: USFWS (Delta Action 8) & CADWR Salmon Studies
- Late-fall run Chinook
- 2,170 Acoustic tagged fish
- 5 Years (2007–2011)
- Migrated December to February
- Travel times,
  % detected at night



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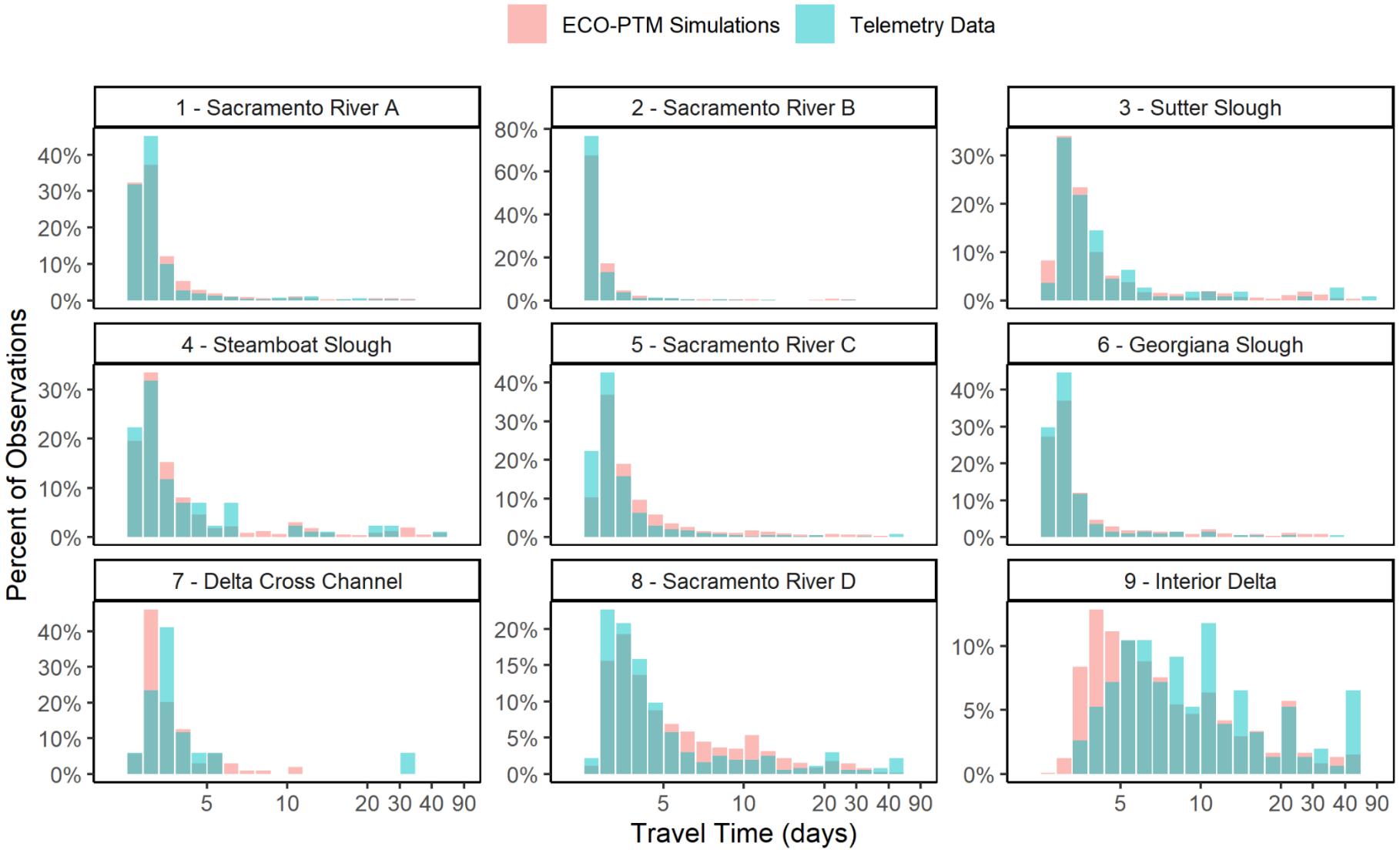
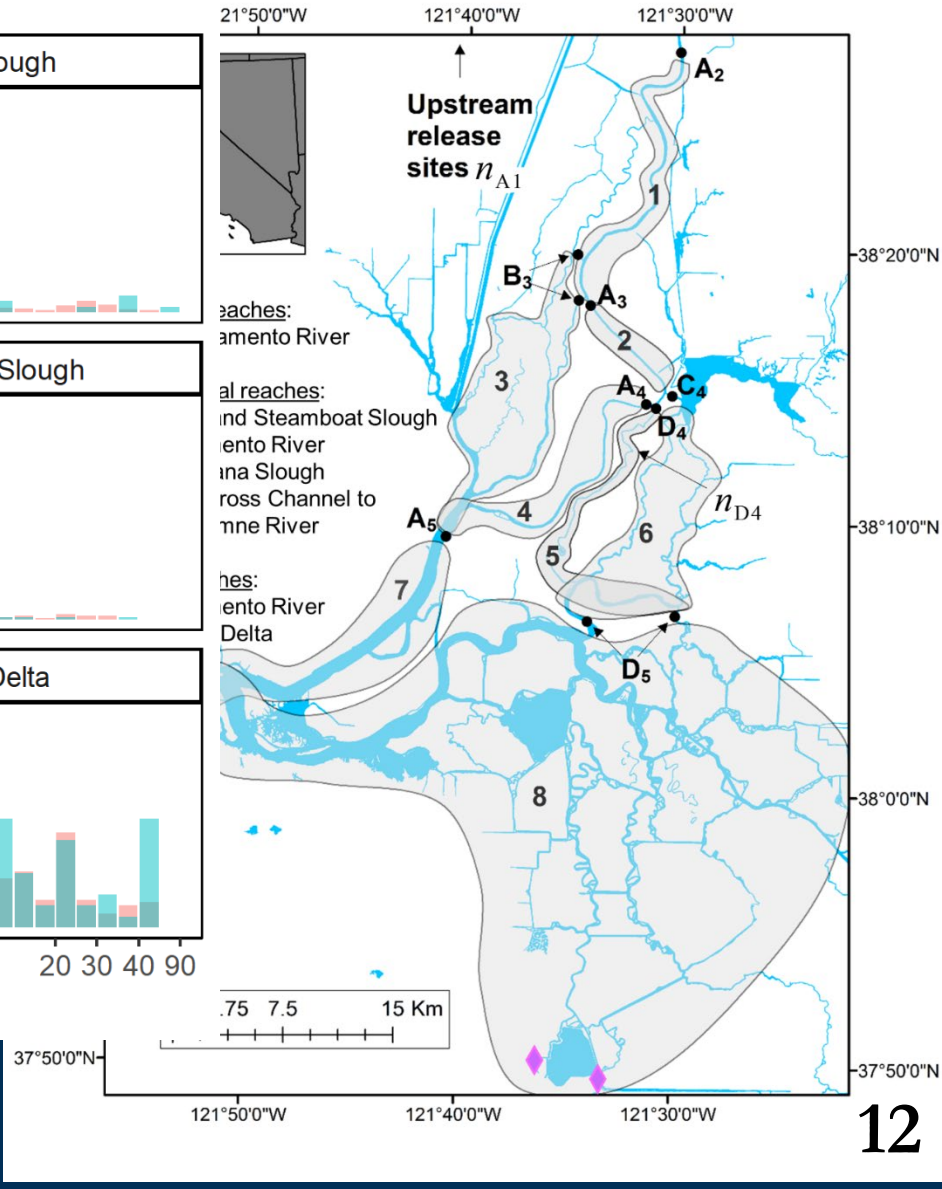
Calibration: Travel Time





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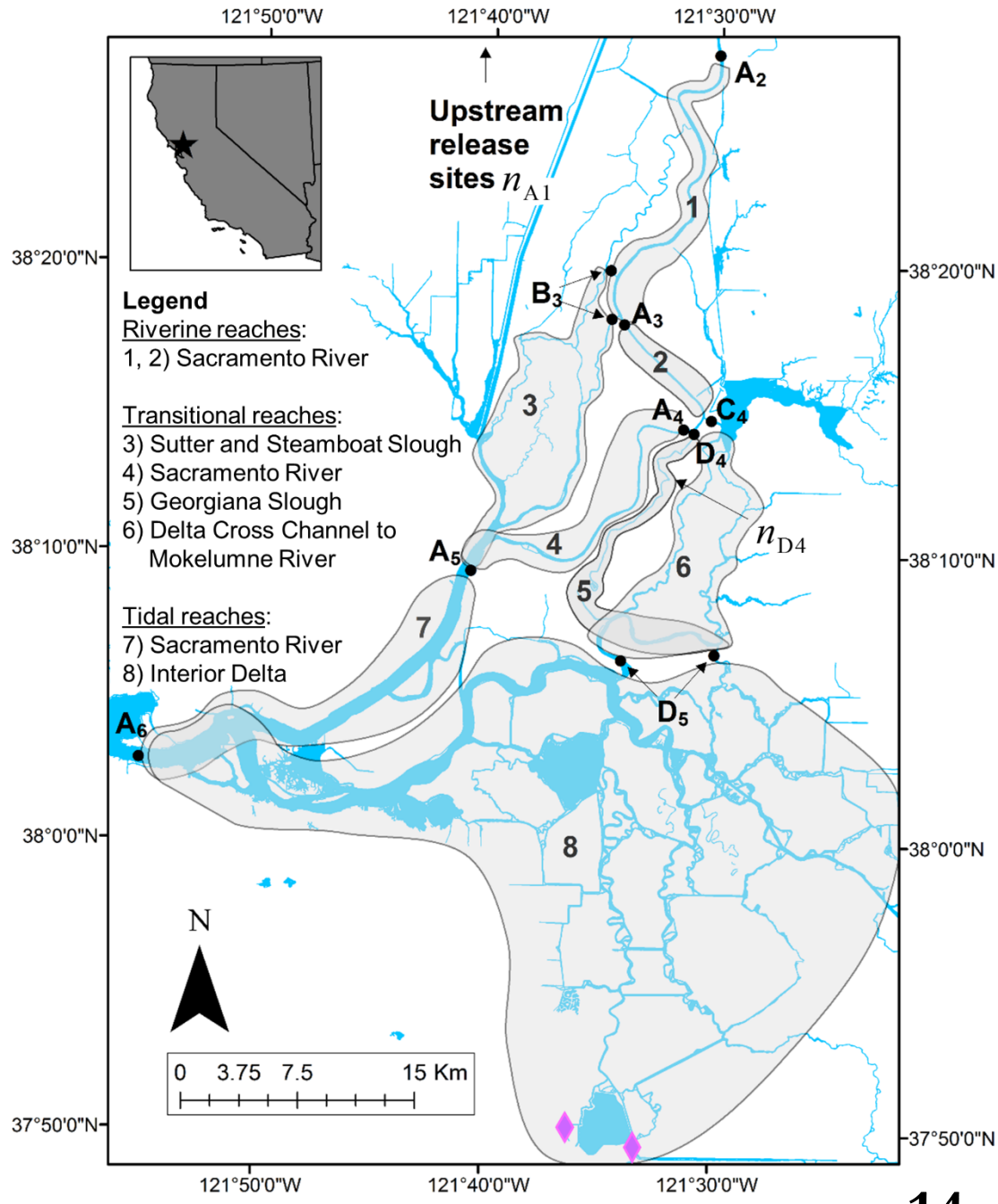

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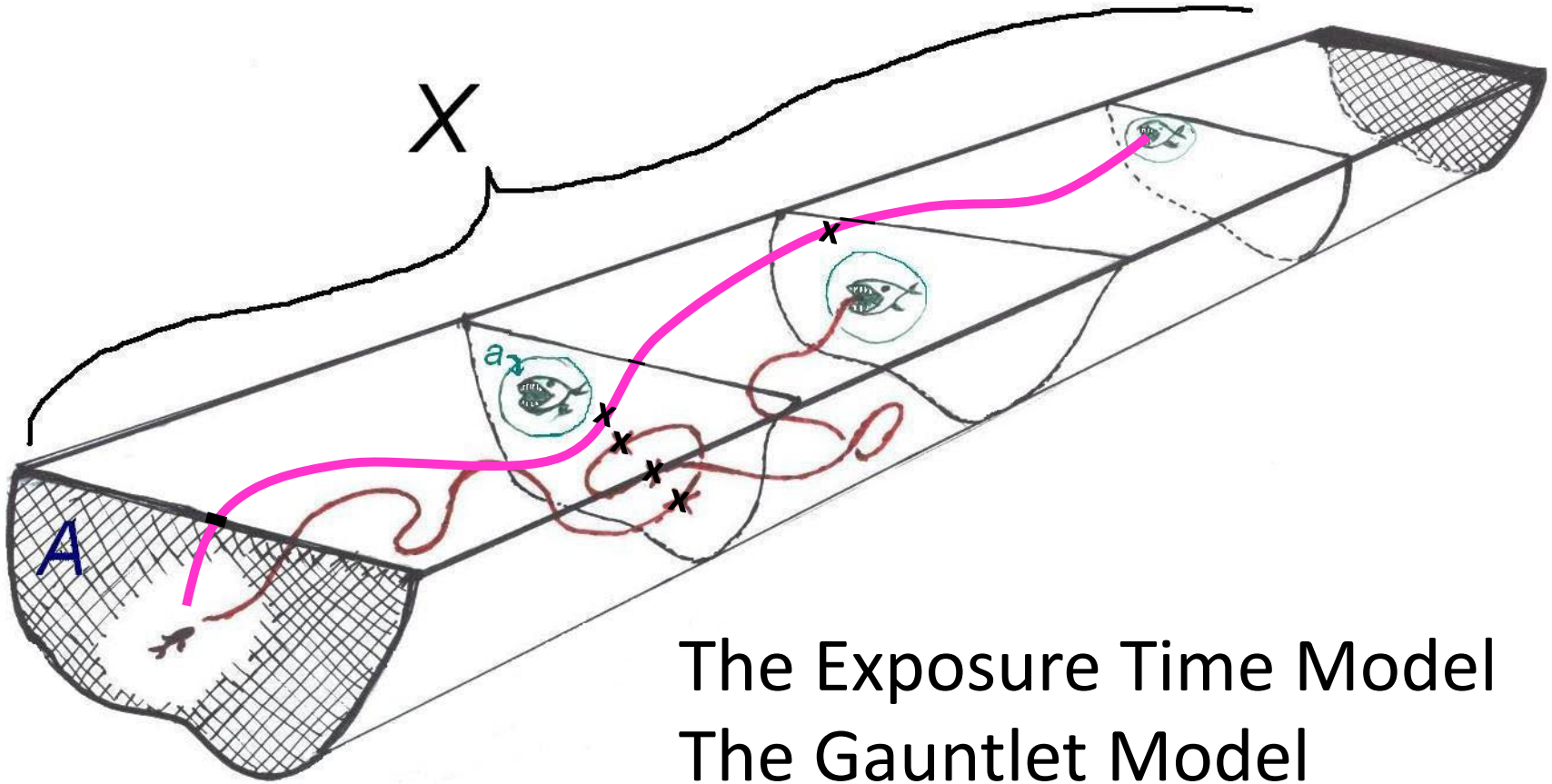
XT survival model (Anderson et al. 2005)

$$S = \exp\left(-\frac{1}{\lambda}\sqrt{x^2 + \omega^2 t^2}\right)$$



The Exposure Time Model
The Gauntlet Model

XT model cartoon: E. Gurarie 2008

XT Parameter Estimation

- Based on Perry et al. 2018 CJFAS
- Bayesian mark-recapture framework
  - Simultaneously estimate travel time and XT survival parameters
  - Replace logit function on survival with XT equation

1886

NRC Research Press

ARTICLE

Flow-mediated effects on travel time, routing, and survival of juvenile Chinook salmon in a spatially complex, tidally forced river delta

Russell W. Perry, Adam C. Pope, Jason G. Romine, Patricia L. Brandes, Jon R. Burau, Aaron R. Blake, Arnold J. Ammann, and Cyril J. Michel

Can. J. Fish. Aquat. Sci. **75**: 1886–1901 (2018) dx.doi.org/10.1139/cjfas-2017-0310

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Questions? Please type them into Teams chat

Include slide # if possible

Adam Pope (apope@usgs.gov)

Go to next slide to start the break timer