CALIFORNIA DEPARTMENT OF WATER RESOURCES
UNITED STATES GEOLOGICAL SURVEY

ECO-PTM Overview

April 16, 2024

Delta Smelt

Longfin Smelt

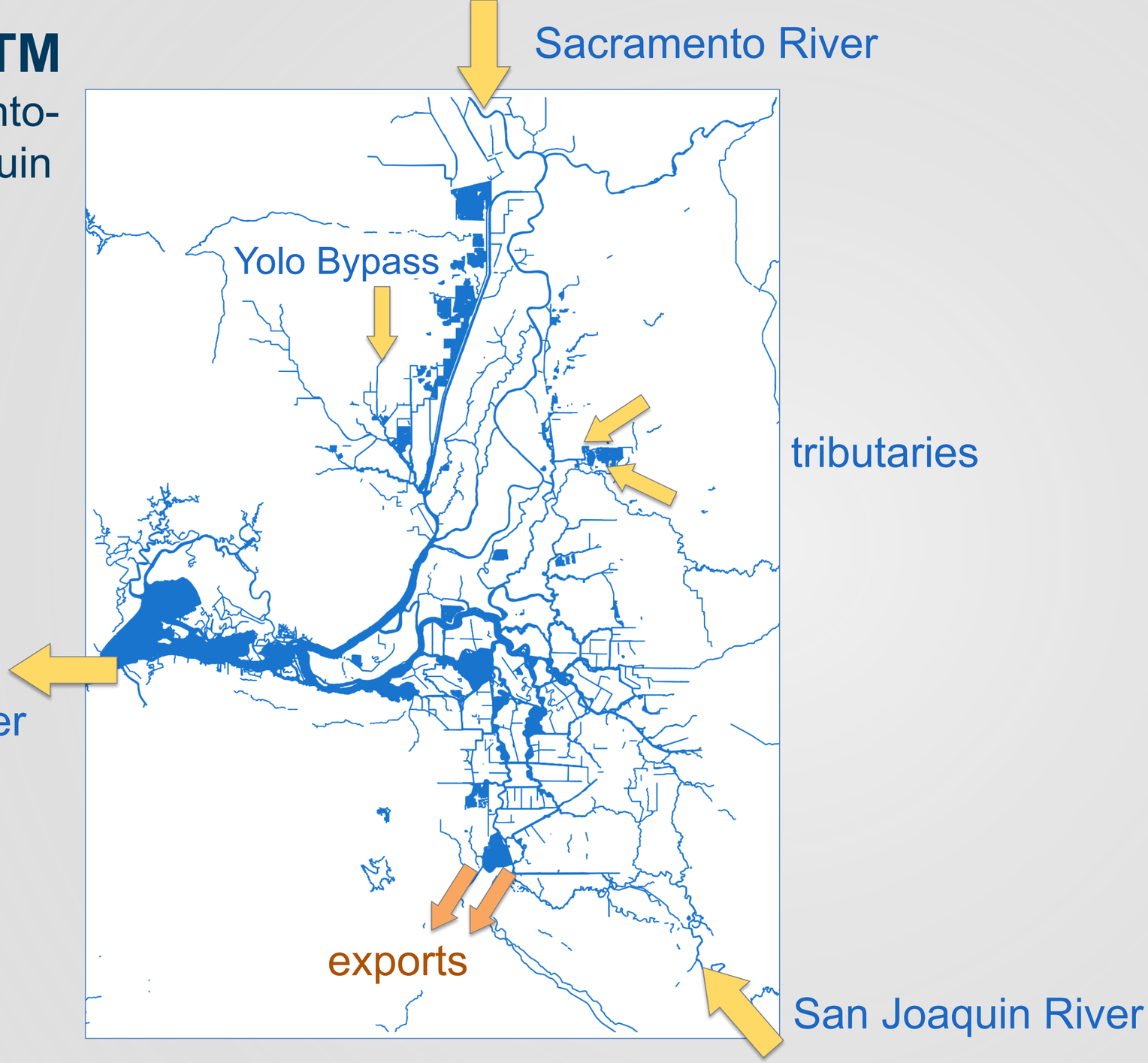
Chinook Salmon

Doug Jackson

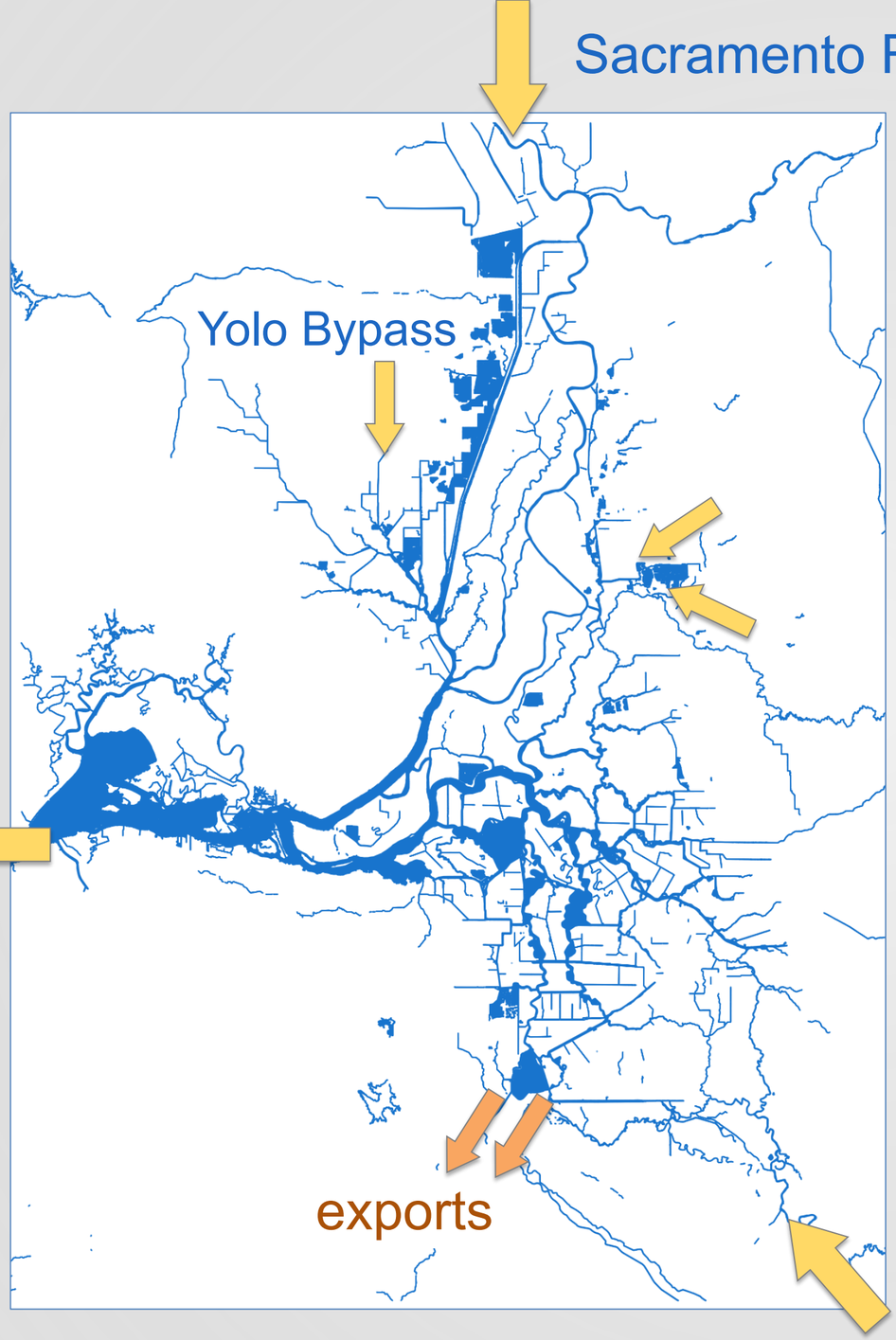
QEDα
CONSULTING

ECO-PTM

Sacramento-San Joaquin Delta

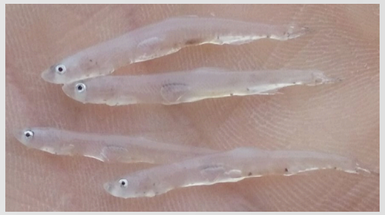


ECO-PTM
Fish Species



Movement and survival of listed species?

Chinook salmon

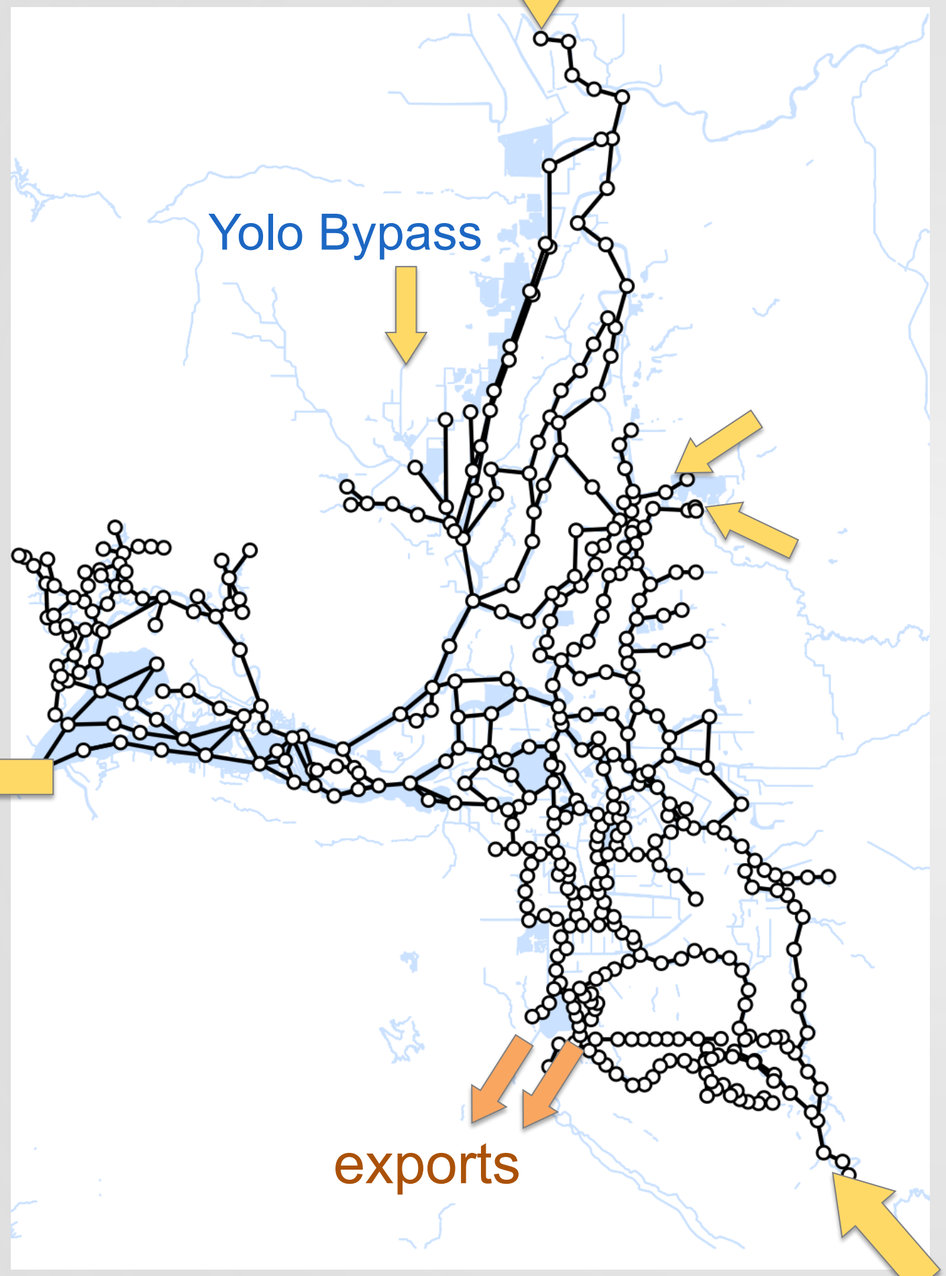


longfin smelt

Delta smelt

longfin smelt: Lewis, Levi S. et al. (2020). Newly discovered spawning and recruitment of threatened Longfin Smelt in restored and underexplored tidal wetlands. 101; Chinook salmon: https://casalmon.org; Delta smelt: https://ecos.fws.gov/docs/species_images/doc4900.jpg

ECO-PTM
Model Grid



Movement and survival of listed species?

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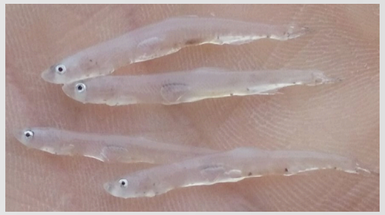

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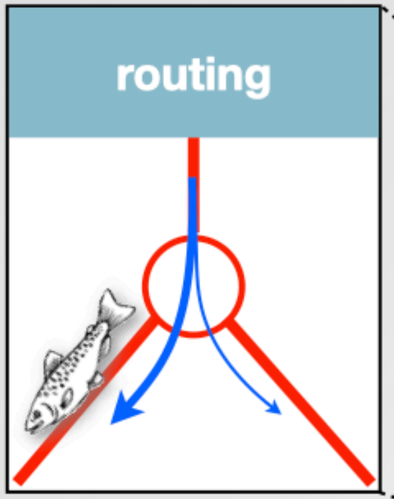
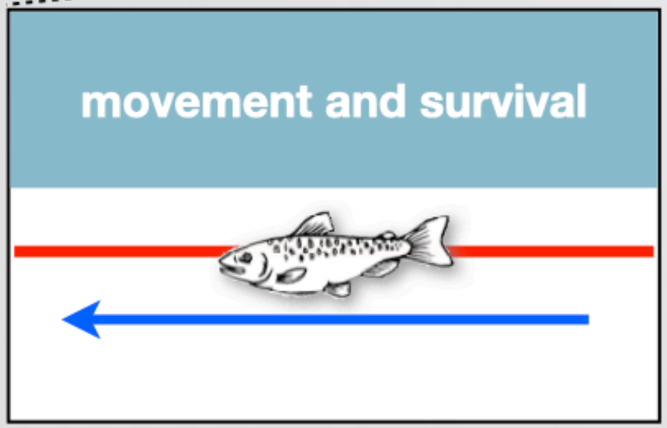
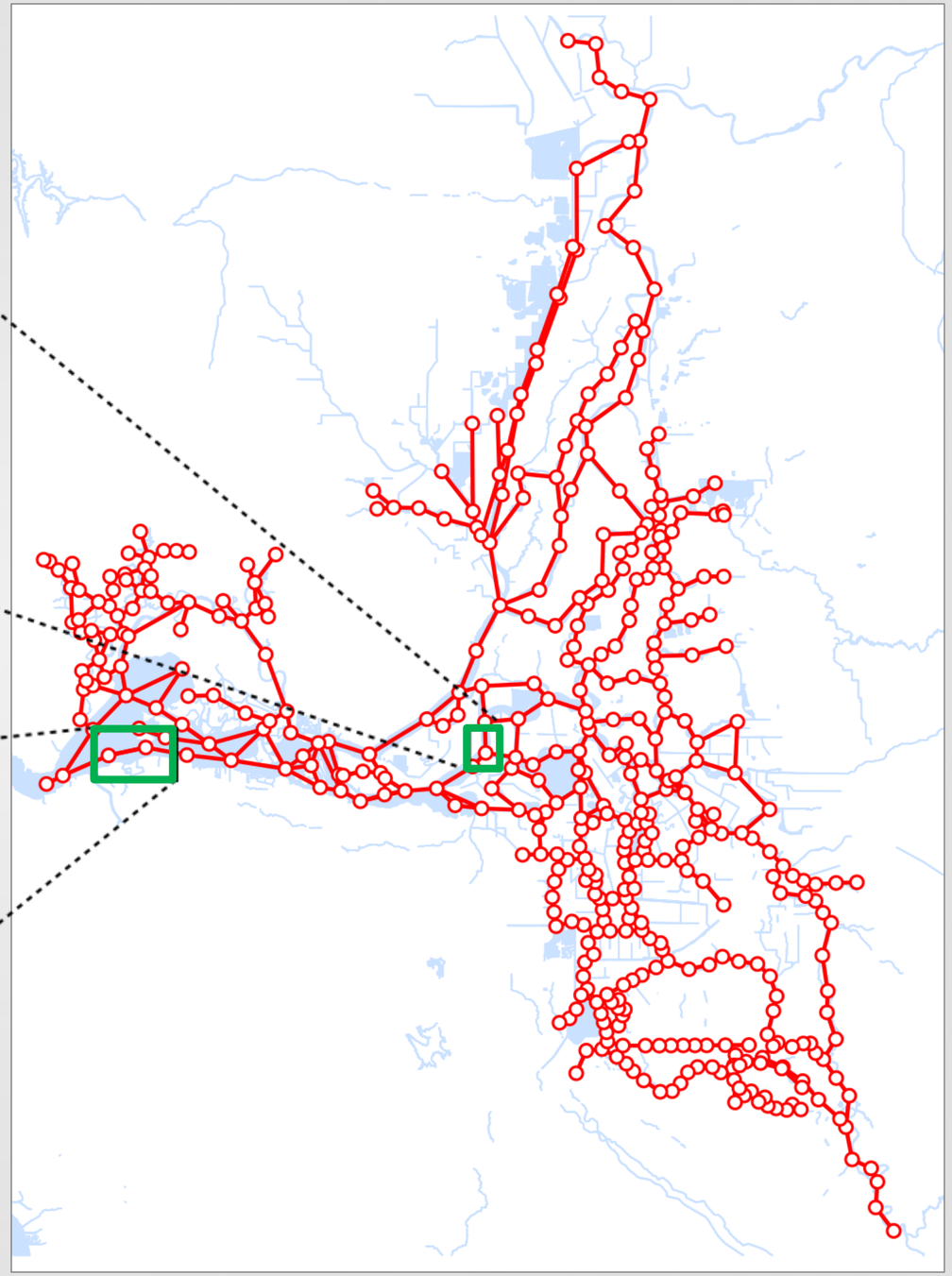
ECO-PTM

Movement, Routing, & Survival





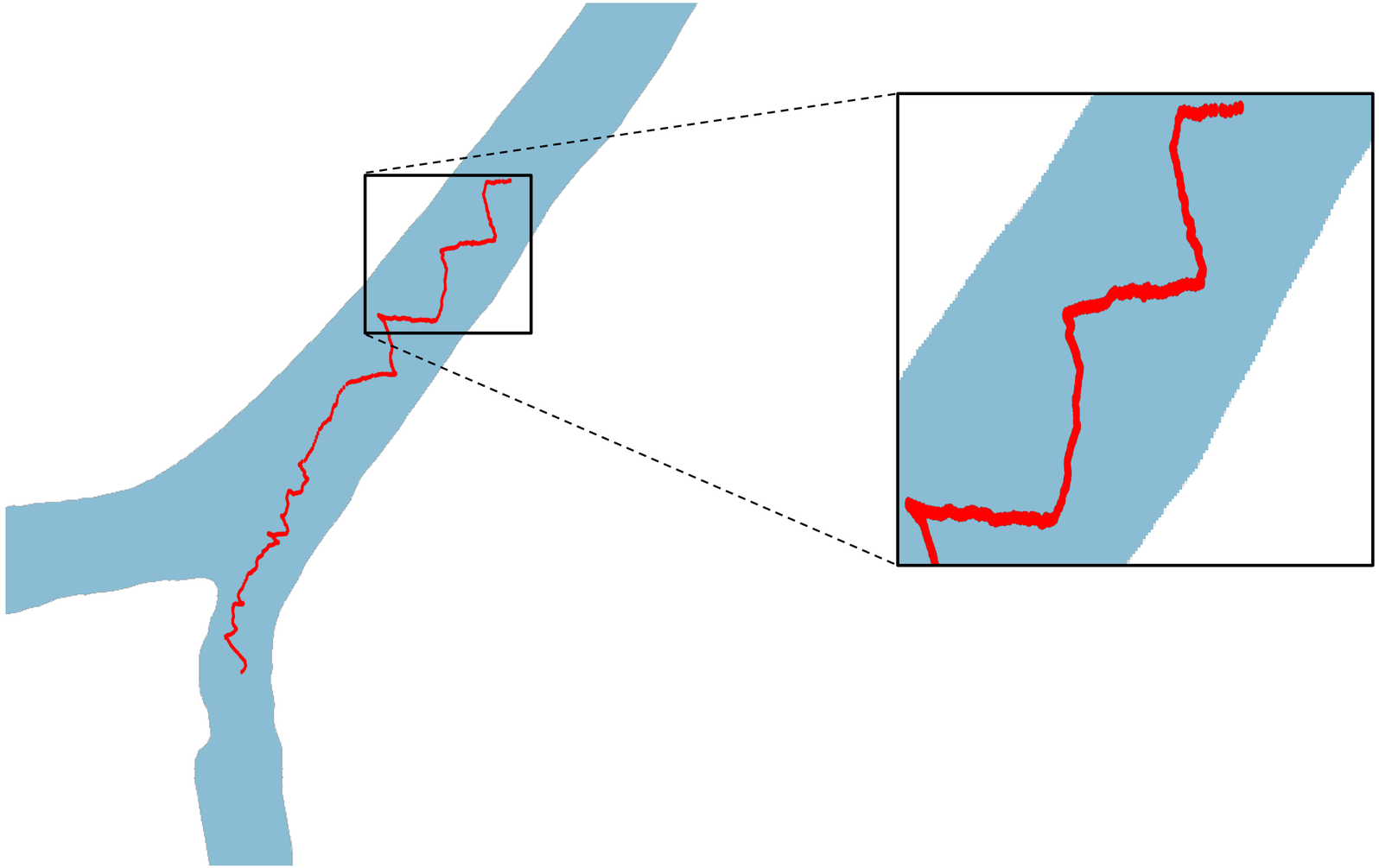


What causes movement?

hydrodynamics:

advection + diffusion + dispersion

How real fish move



2D Acoustic Telemetry Data

What causes movement?

hydrodynamics:

advection + diffusion + dispersion

+

behavior

What causes movement?

hydrodynamics:

advection + diffusion + dispersion

+

behavior:

responses to hydrodynamic stimuli

What causes movement?

hydrodynamics:

advection + diffusion + dispersion

+

behavior:

responses to hydrodynamic stimuli

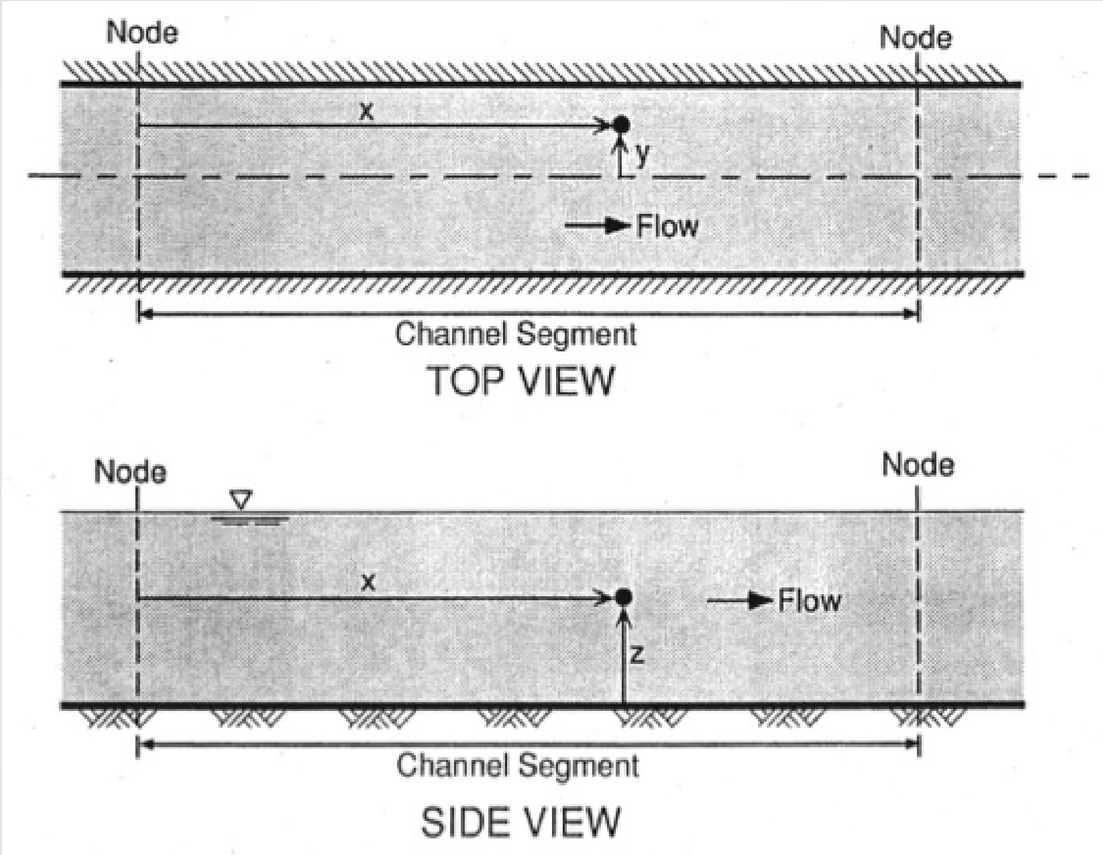
+

chemotaxis; microhabitats; landscape of fear (predators); bioenergetics; phenology; individual variation; etc.

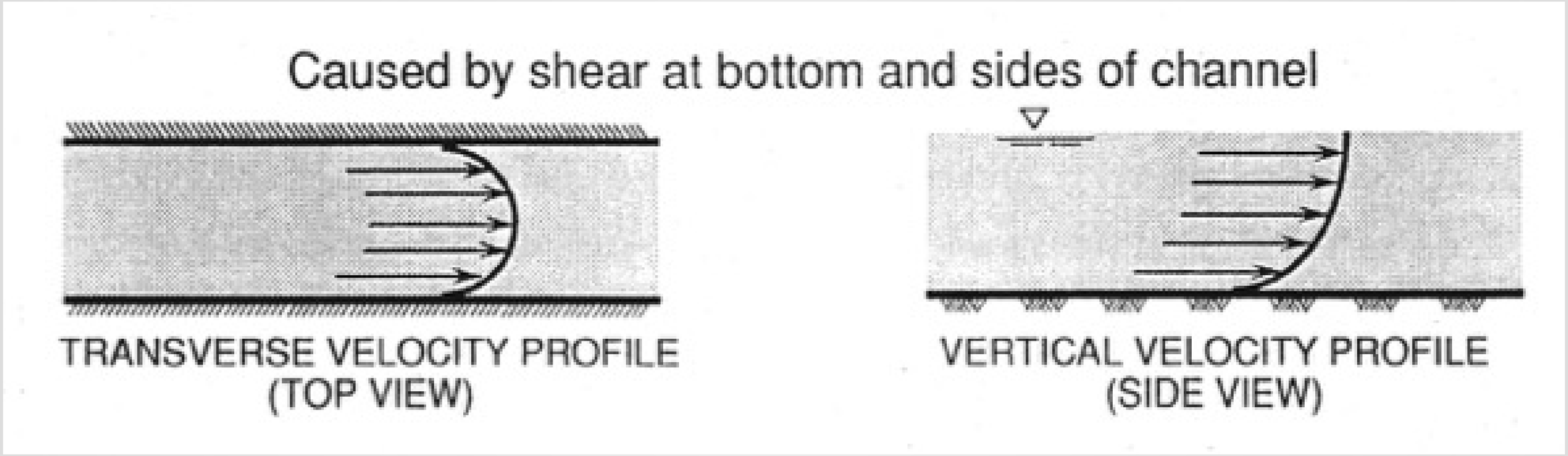
ECO-PTM

- three modules:
  1. PTM: passive, neutrally buoyant
     Delta smelt larvae
  2. PTM + position (surface) orientation
     longfin smelt larvae
  3. PTM + salmon behavior and mortality
     Chinook salmon smolts

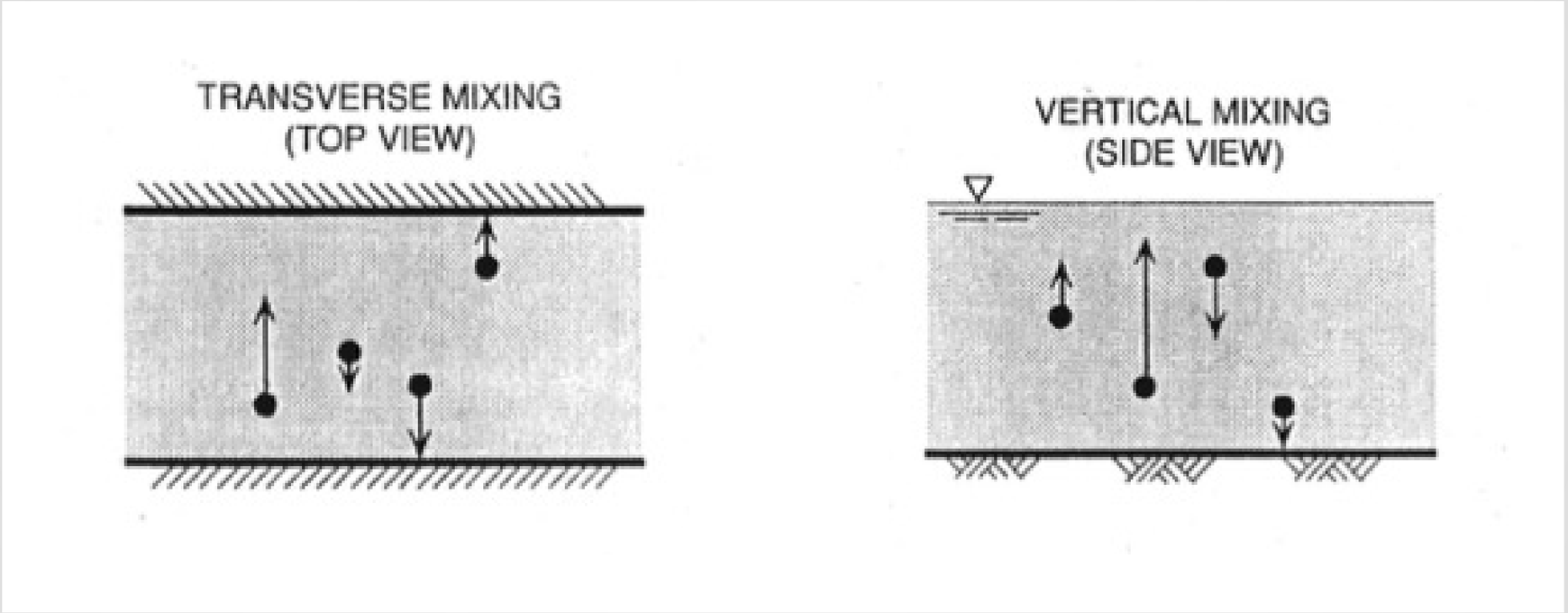
Quasi-3D: channels and nodes



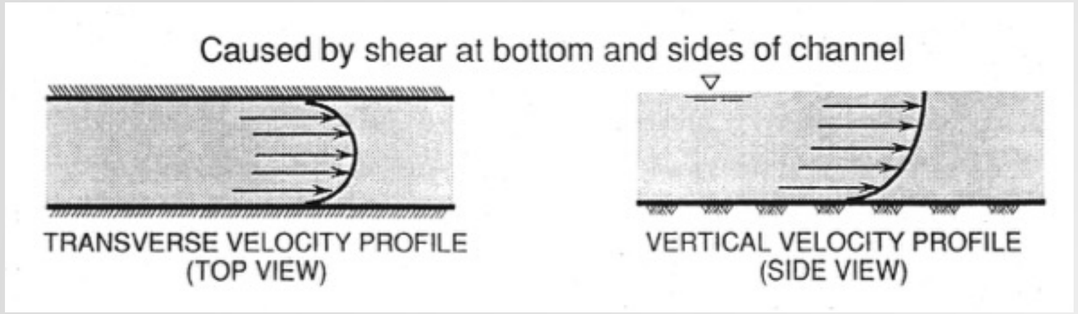
Quasi-3D: velocity profiles



Quasi-3D: mixing



Quasi-3D: dispersion



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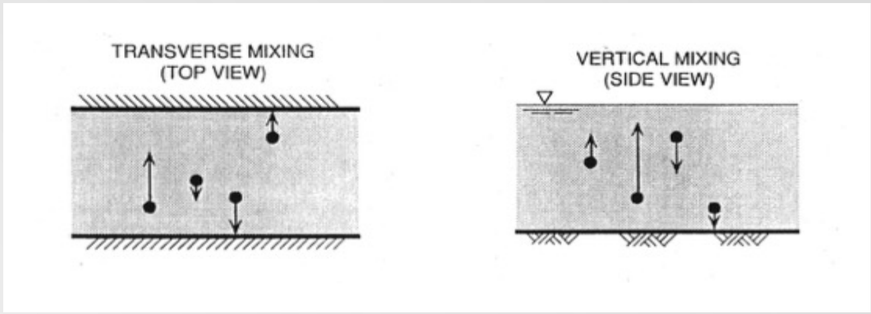
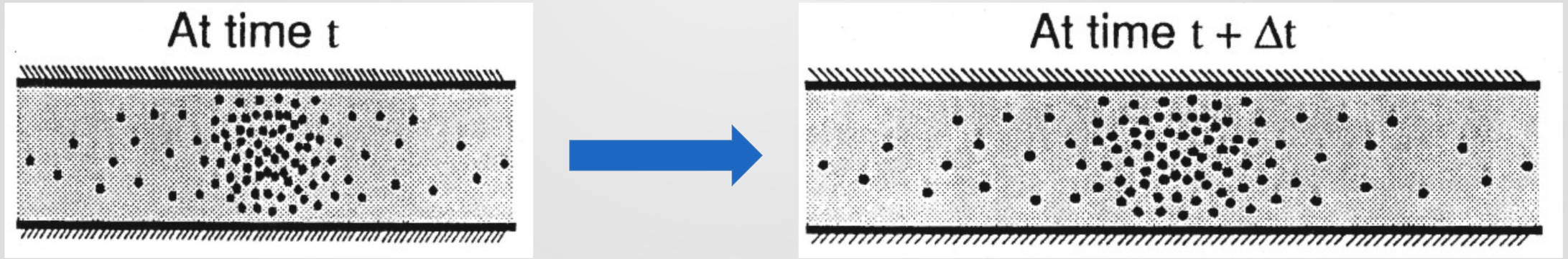
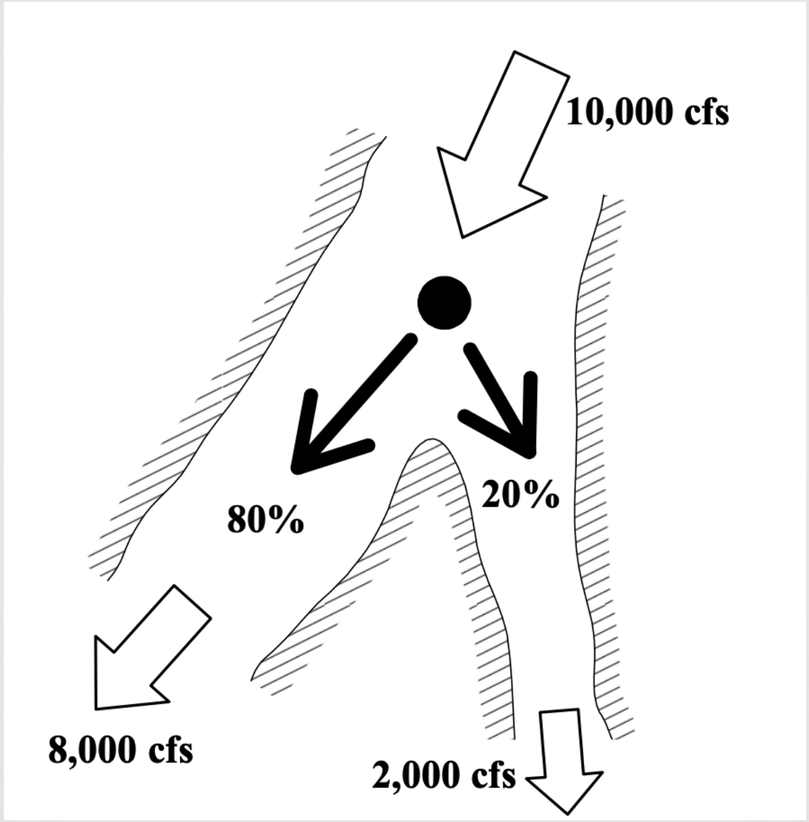


= dispersion

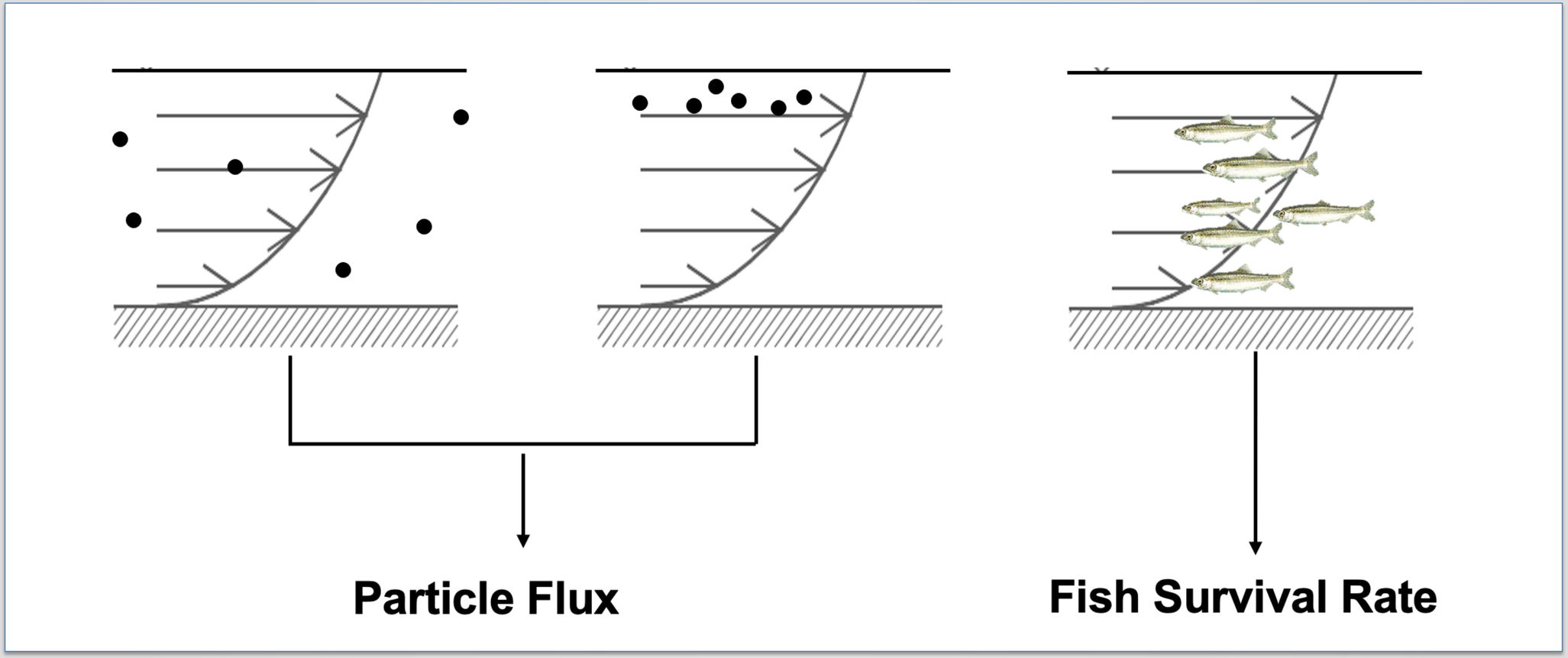


Flow-split routing

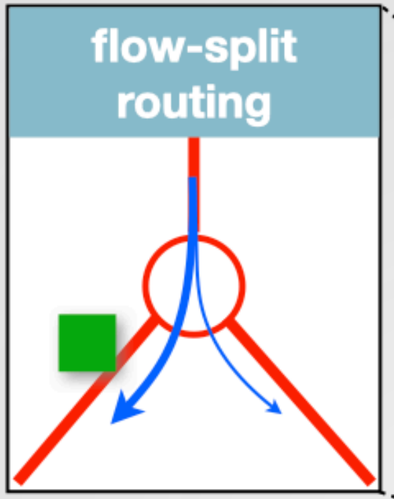


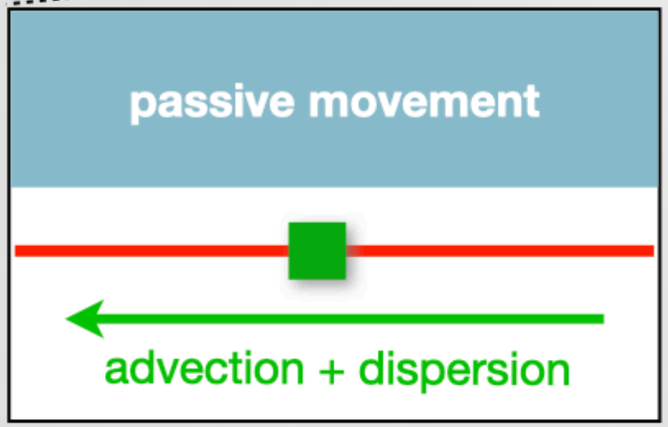
ECO-PTM

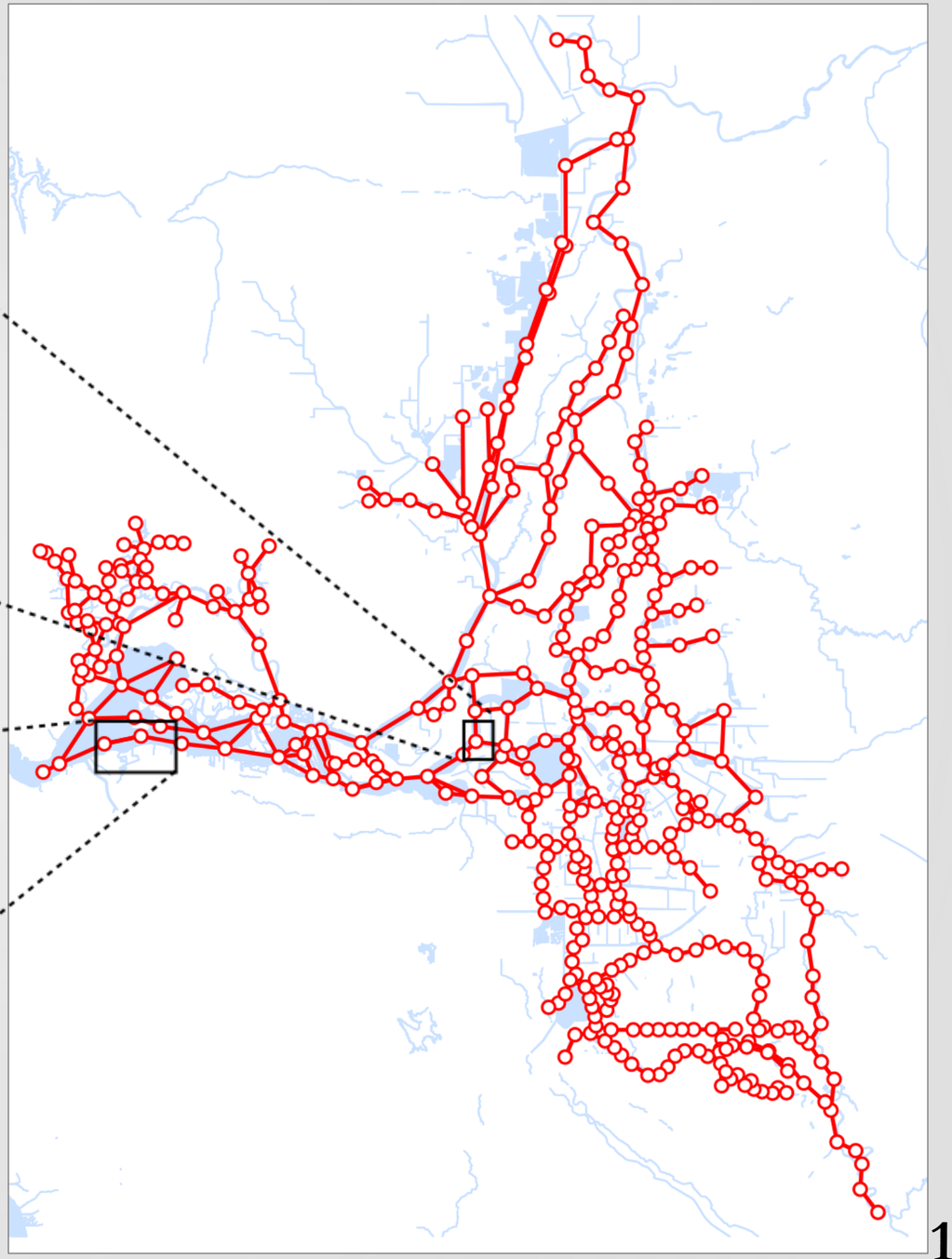
neutrally buoyant surface oriented salmon model



PTM


flow-split
routing

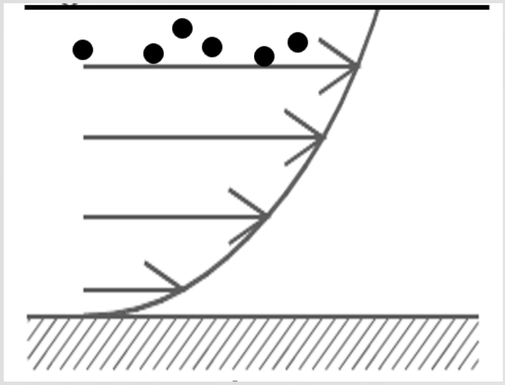

passive movement
advection + dispersion

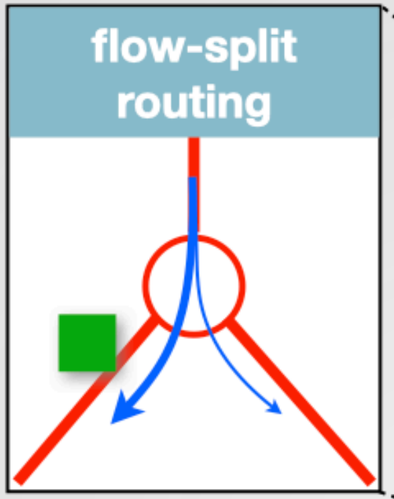


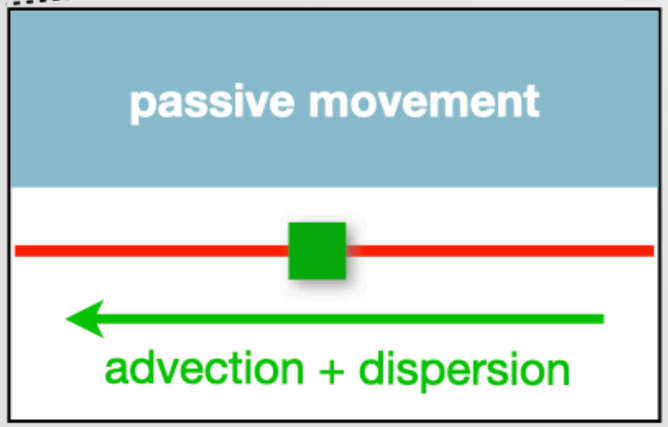
PTM

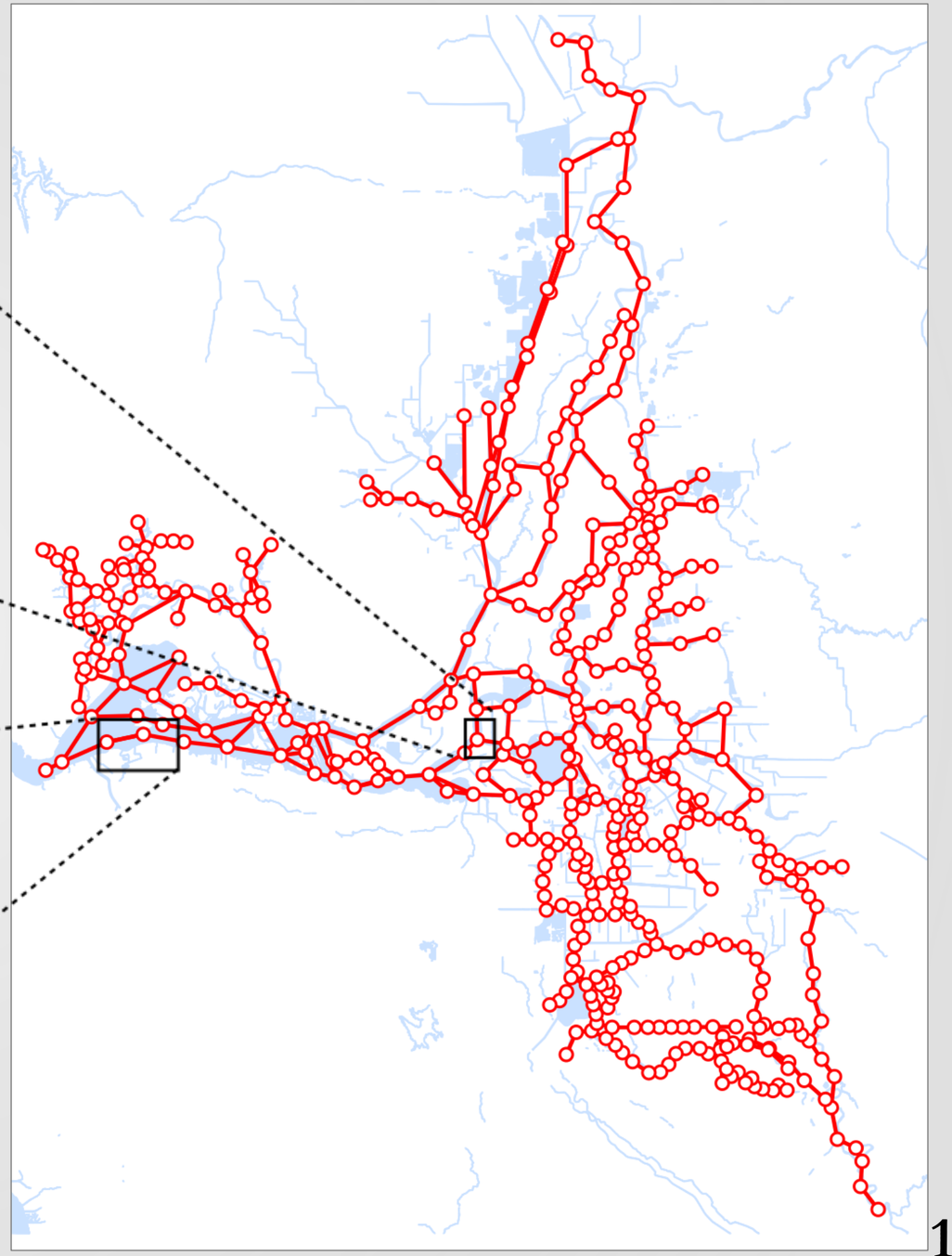
+

surface orientation

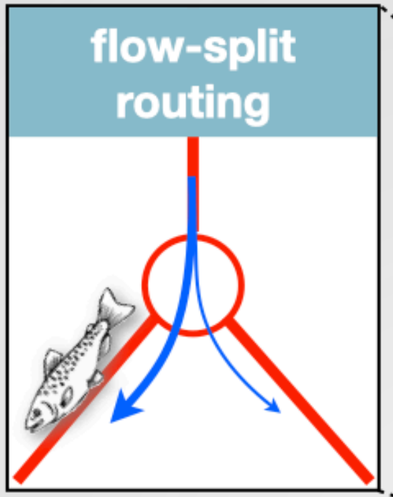


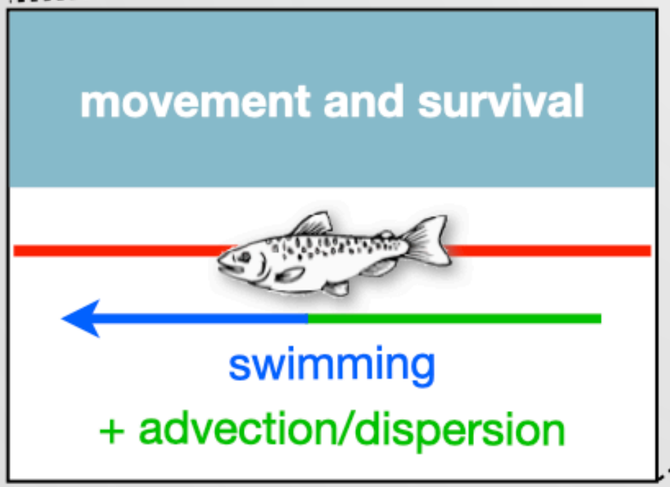


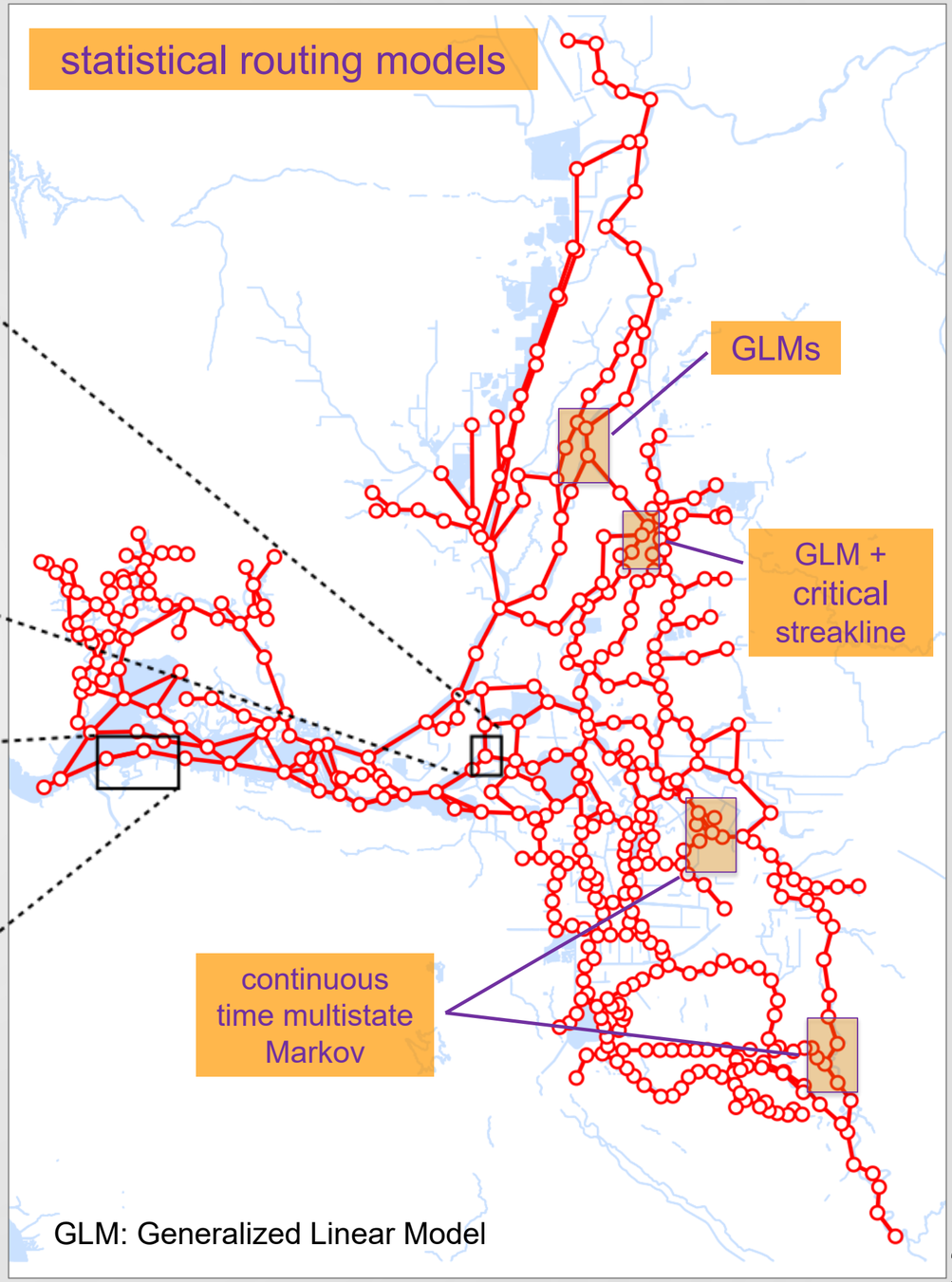




PTM
+
salmon model







Salmon model

- Behaviors
  - stochastic swimming velocity
  - diel holding: hold position during daytime
  - selective tidal stream transport (STST): hold when upstream flow velocity exceeds threshold
  - probabilistic oceanward/landward swimming orientation

Salmon model

- Survival
  - XT mean free-path length model†
  - survival probability = f(x, t)
    - x = travel distance
    - t = travel time
  - parameters
    - λ: mean free-path length, ∼predator density
    - ω: random encounter speed

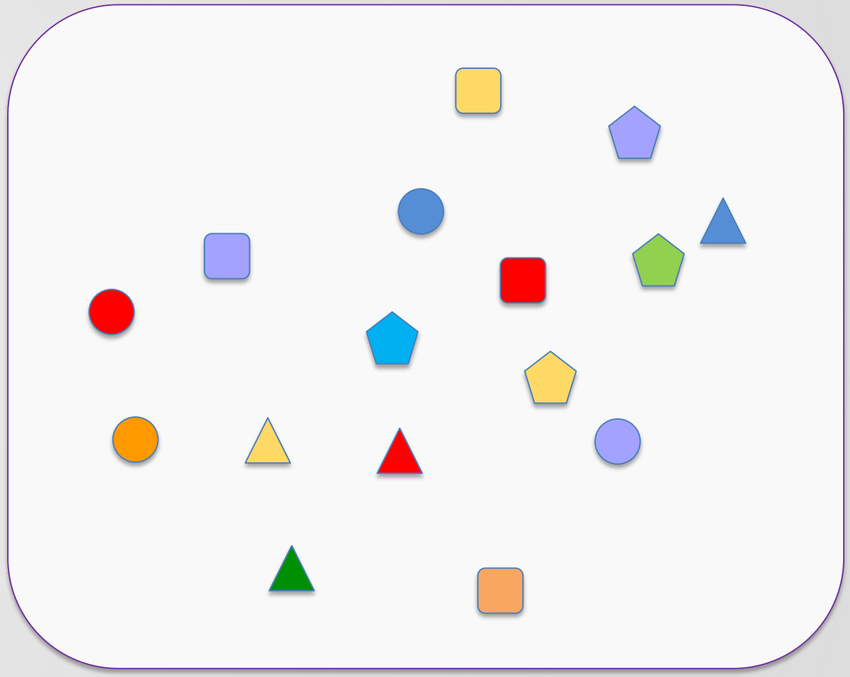
† Anderson, J. J., Gurarie, E., & Zabel, R. W. (2005). Mean free-path length theory of predator–prey interactions: Application to juvenile salmon migration. Ecological Modelling, 186(2), 196-211.

Salmon model

parameters

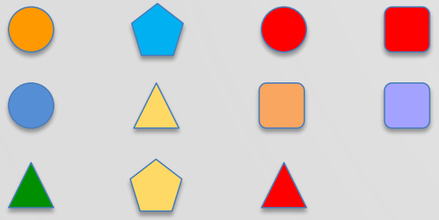
- mean and standard deviation of swimming speed
- probability of daytime holding
- STST flow threshold
- shape of flow relationship governing probability of oceanward/landward orientation
- etc.

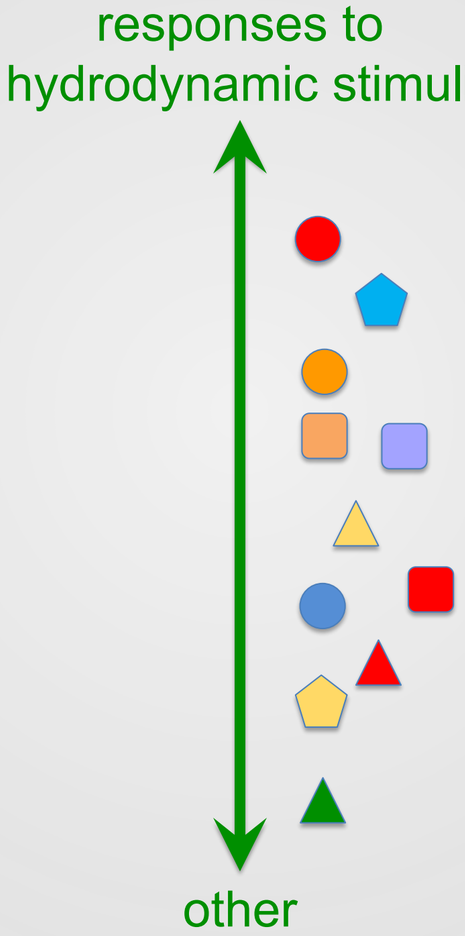
behaviors



Interpretation of behaviors

conceptual slide:
hypothetical behaviors





Interpretation of behaviors

conceptual slide:
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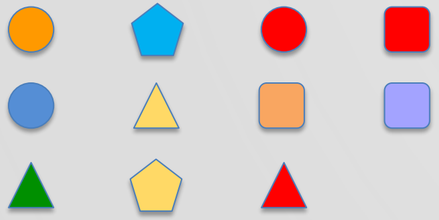
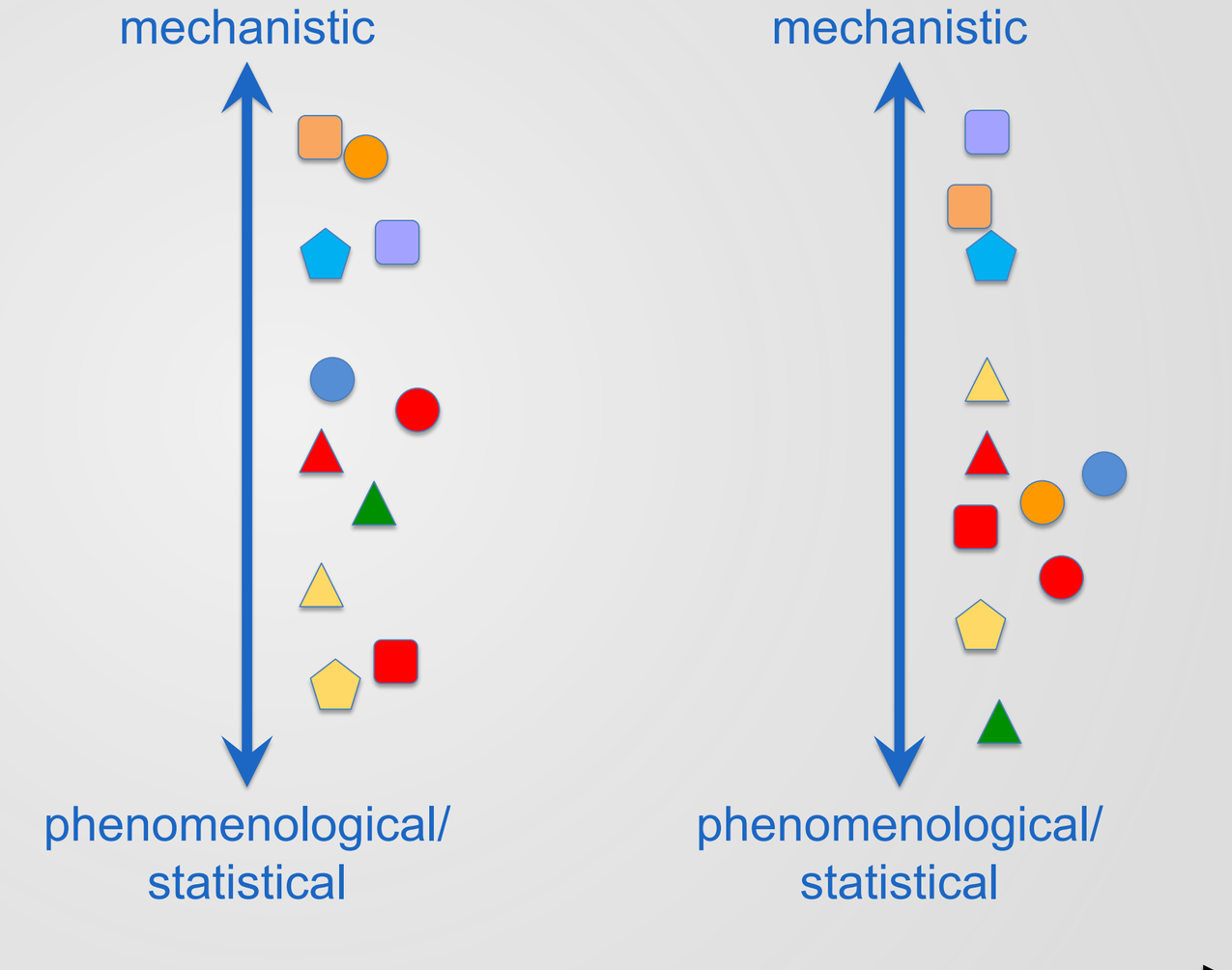
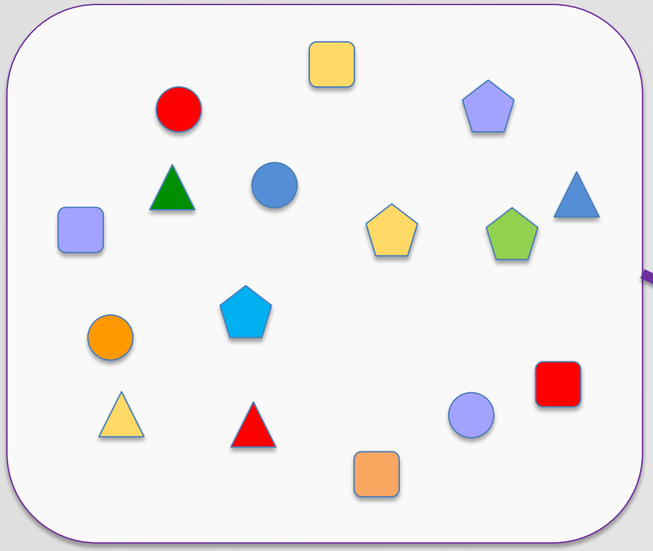




Interpretation of behaviors

- What are the relationships represented in the model?
- What data were used to fit the model?
- Are the model assumptions and data appropriate for the proposed application?

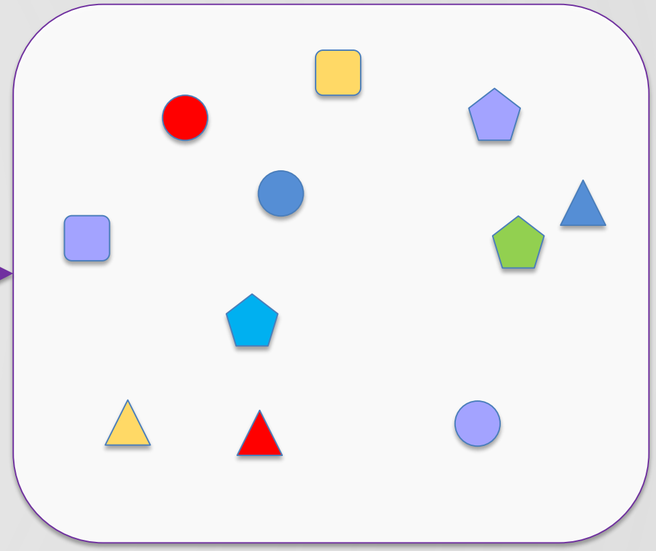
hypothesized behaviors



travel times
survival probabilities

parameter estimation, model selection, and validation

calibrated behaviors



acoustic telemetry data

- travel times
- XT parameter values

Questions? Please type them into Teams chat

Include slide # if possible

Doug Jackson (doug@qedaconsulting.com)