

ECO-PTM Overview

April 16, 2024



Delta Smelt



Longfin Smelt

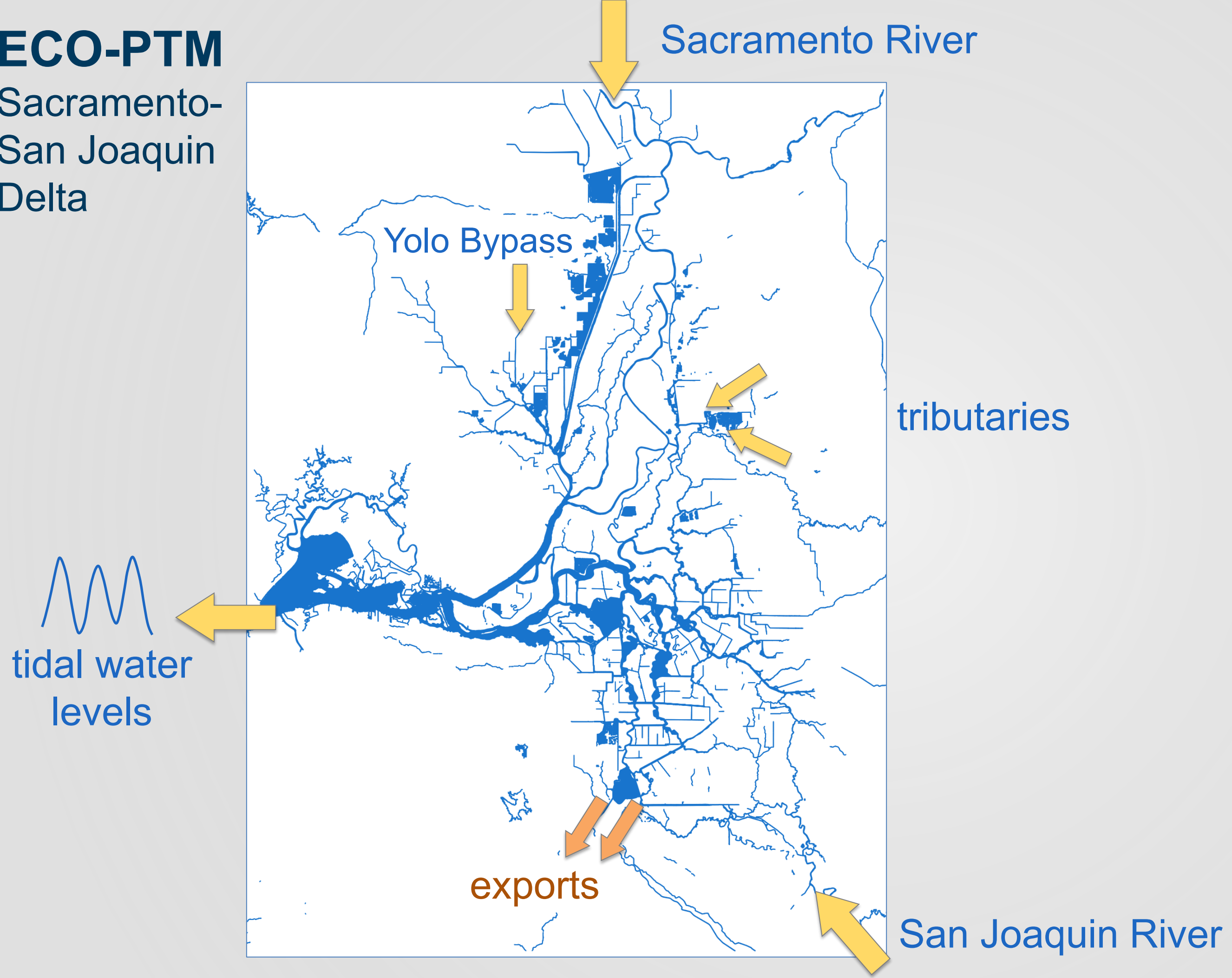


Chinook Salmon

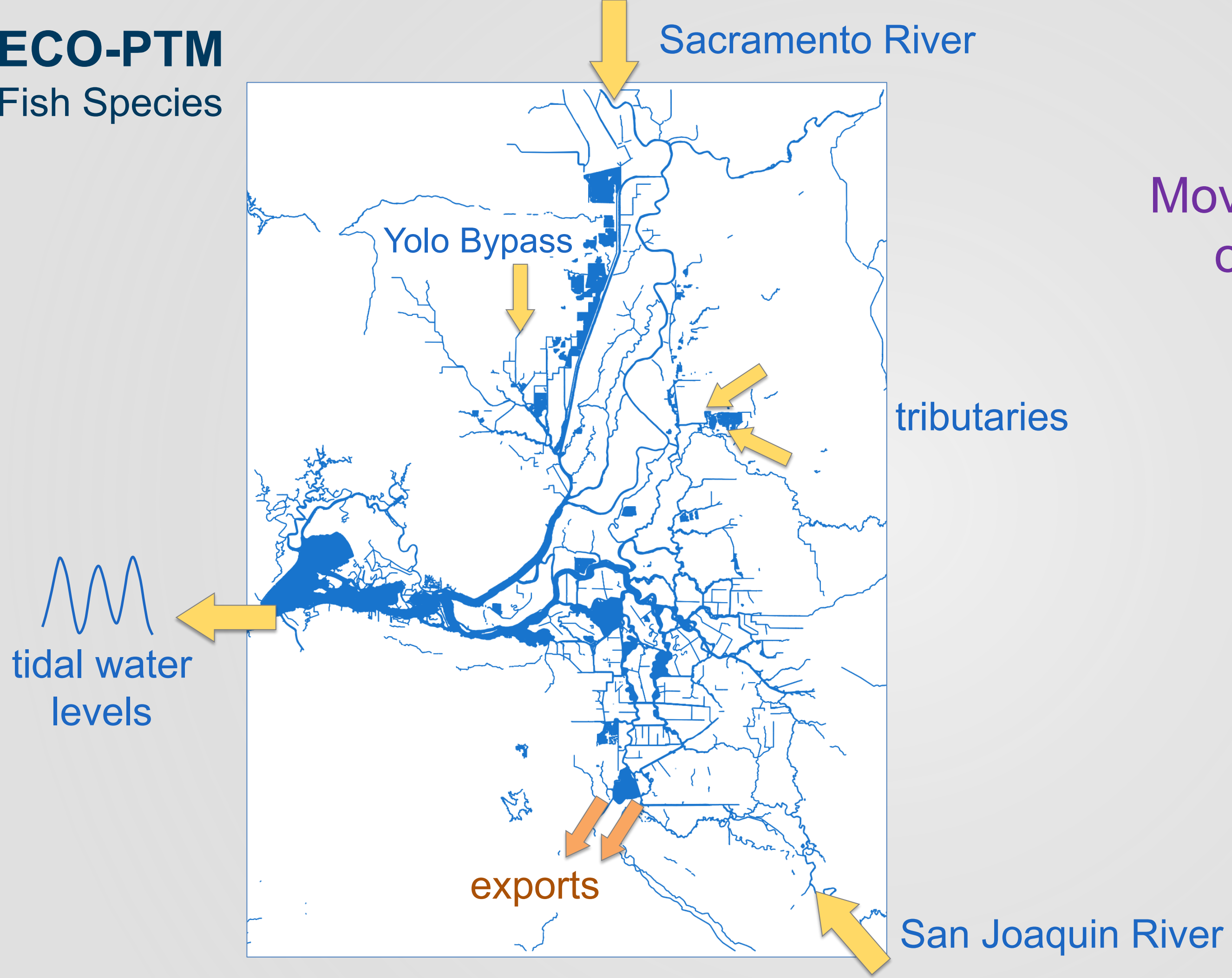
Doug Jackson

QEDα
CONSULTING

ECO-PTM
Sacramento-
San Joaquin
Delta



ECO-PTM
Fish Species



Movement and survival
of listed species?



Chinook salmon



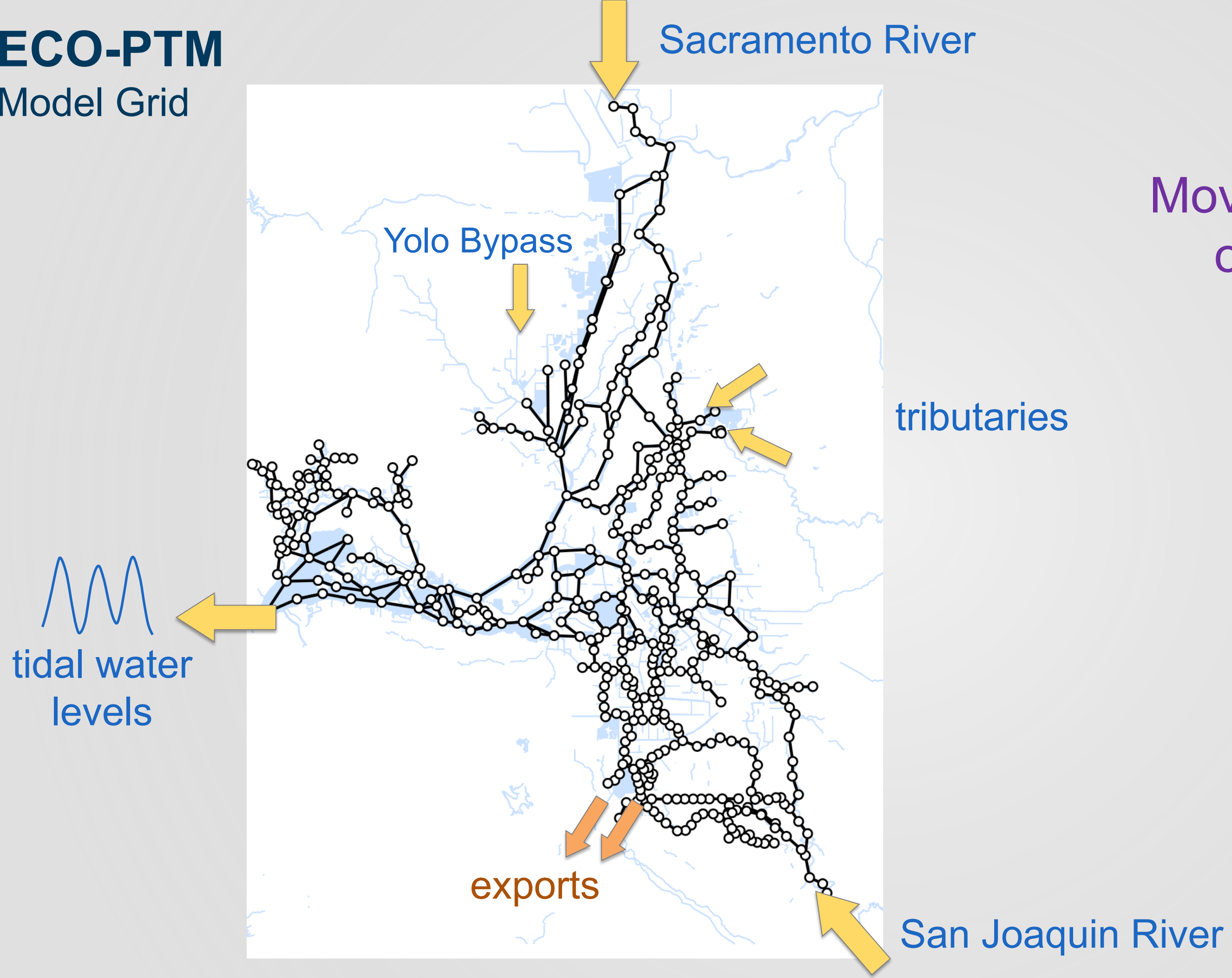
longfin smelt



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?



Chinook salmon



longfin smelt

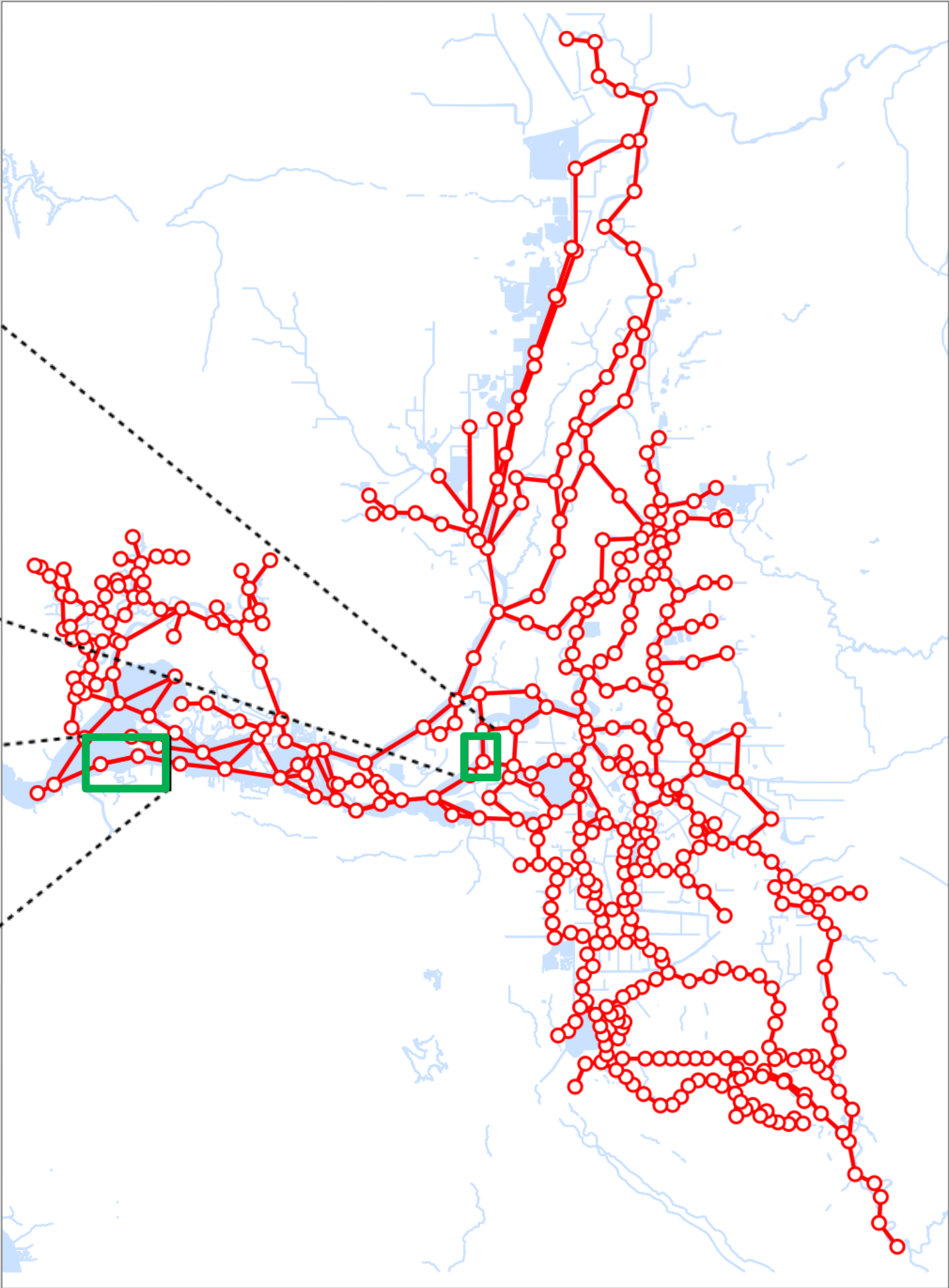
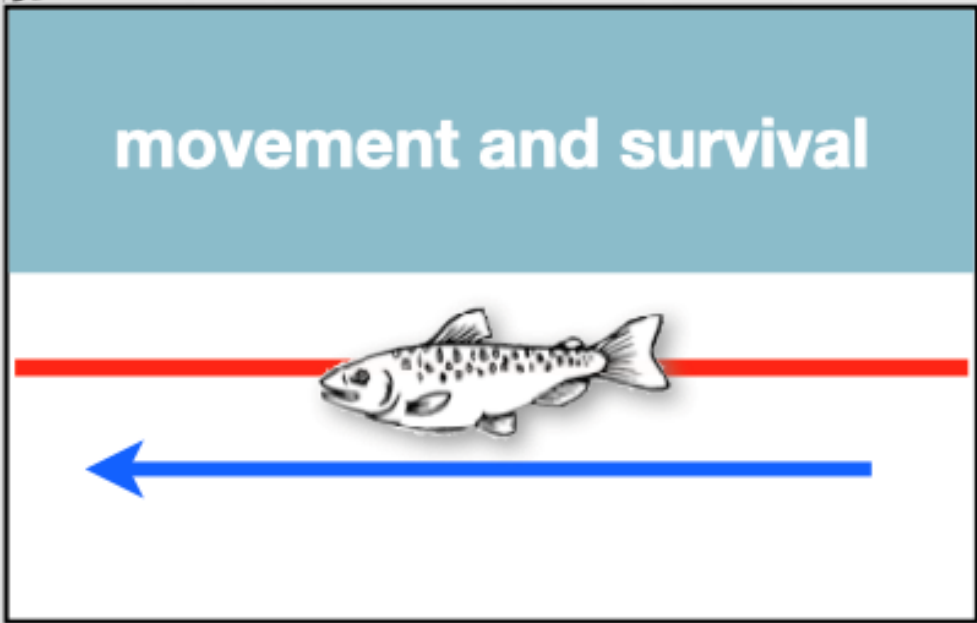
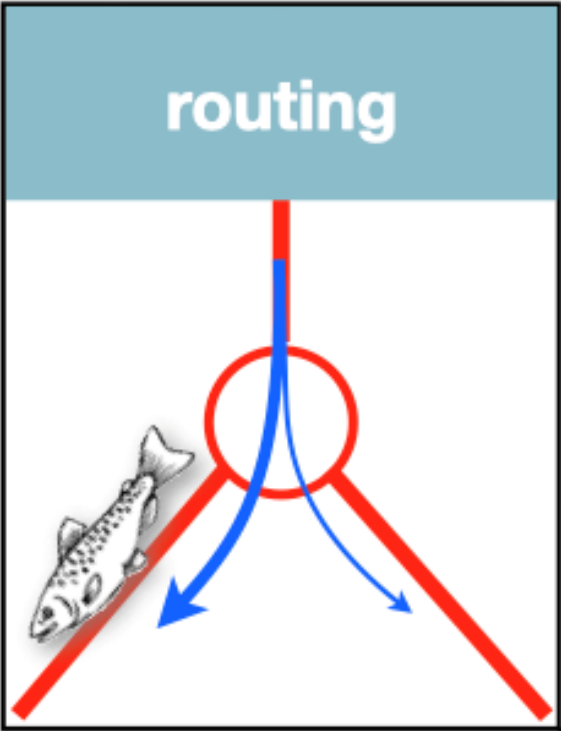


Delta smelt

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

Movement,
Routing, &
Survival

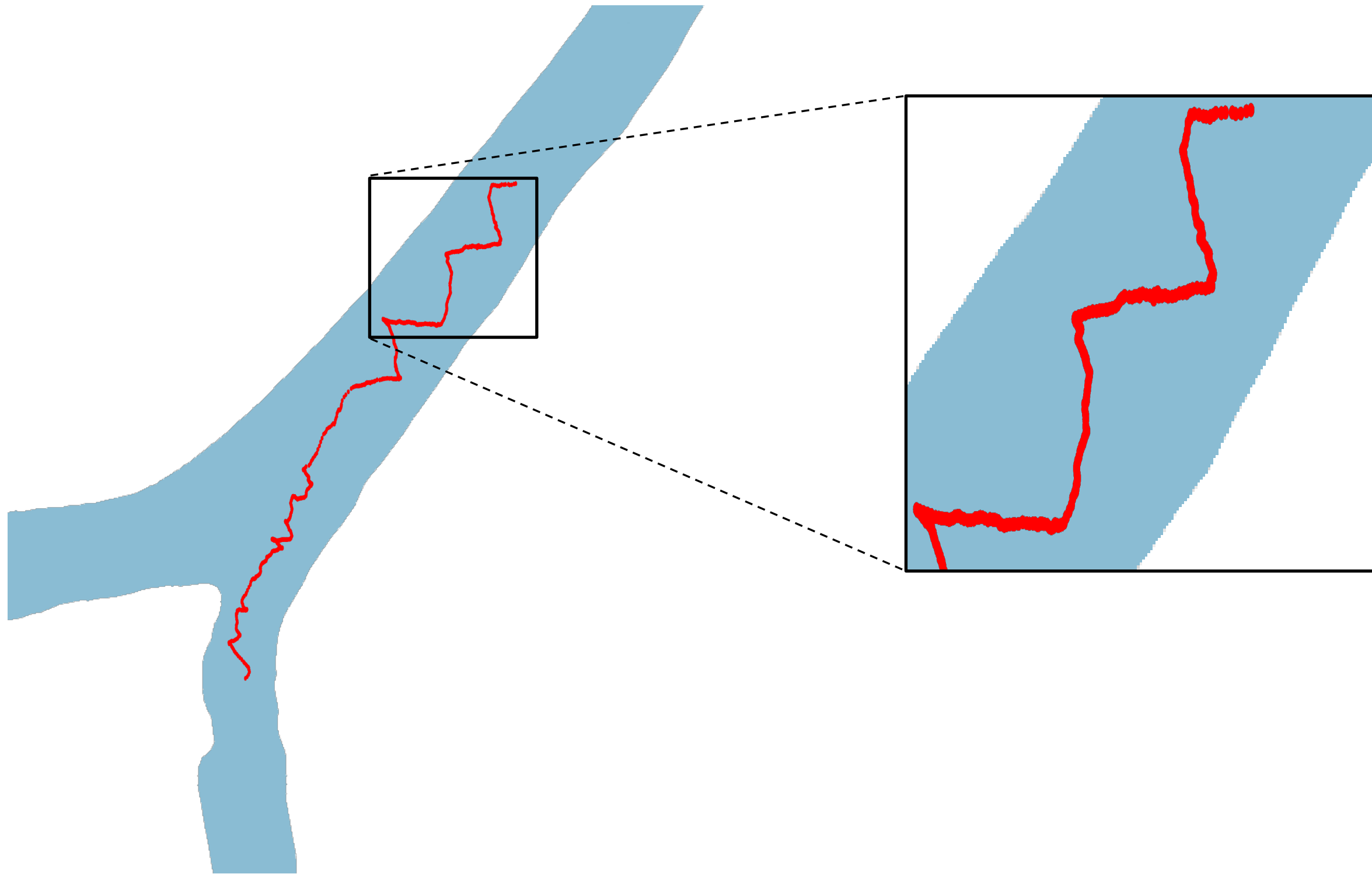


What causes movement?

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 +
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+

behavior:

responses to
hydrodynamic stimuli

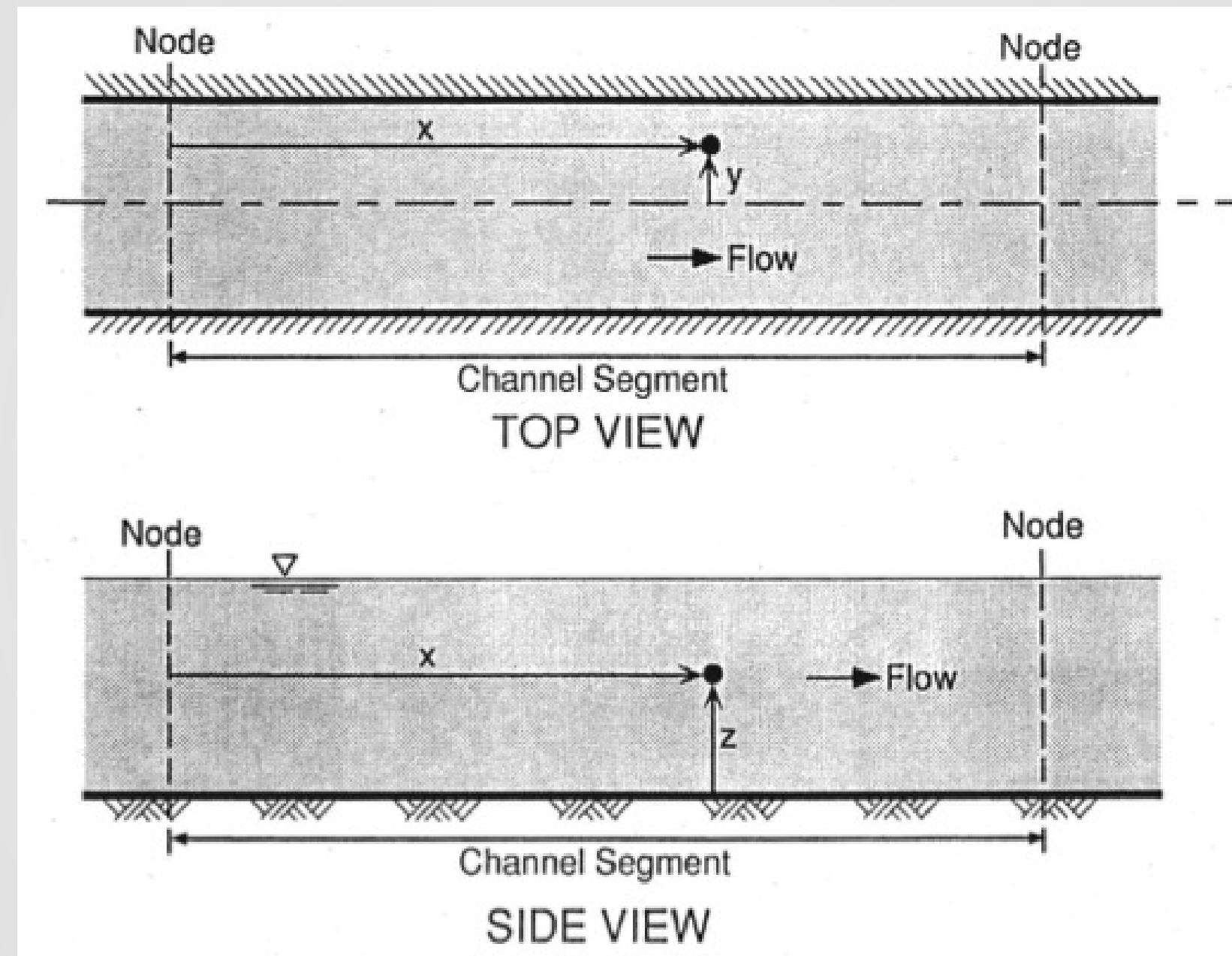
+

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

ECO-PTM

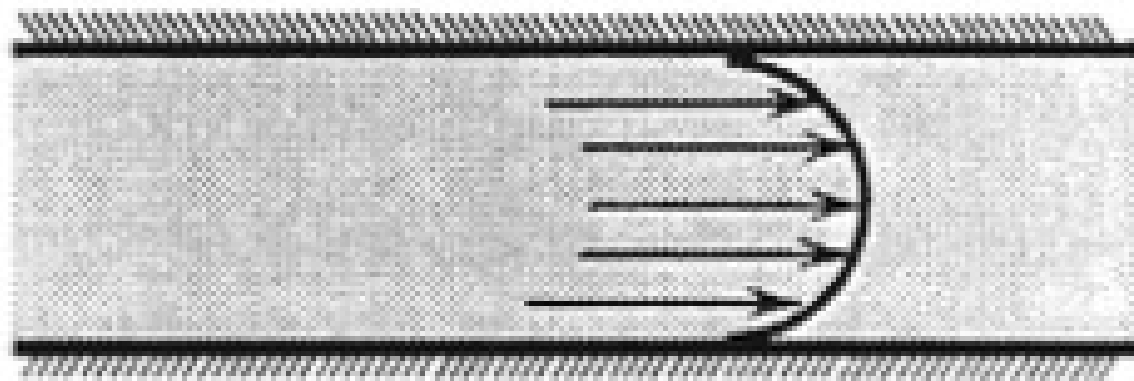
- three modules:
 1. PTM: passive, neutrally buoyant
Delta smelt larvae
 2. PTM + position (surface) orientation
longfin smelt larvae
 3. PTM + salmon behavior and mortality
Chinook salmon smolts

Quasi-3D: channels and nodes

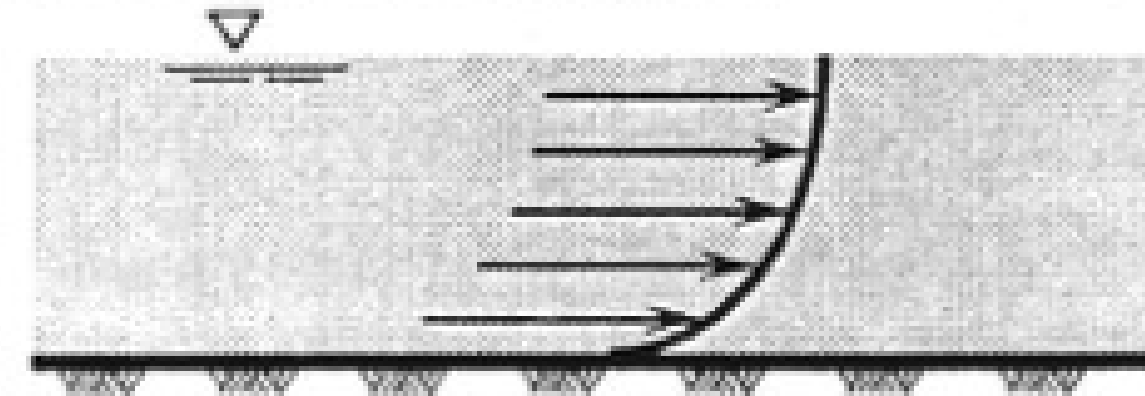


Quasi-3D: velocity profiles

Caused by shear at bottom and sides of channel

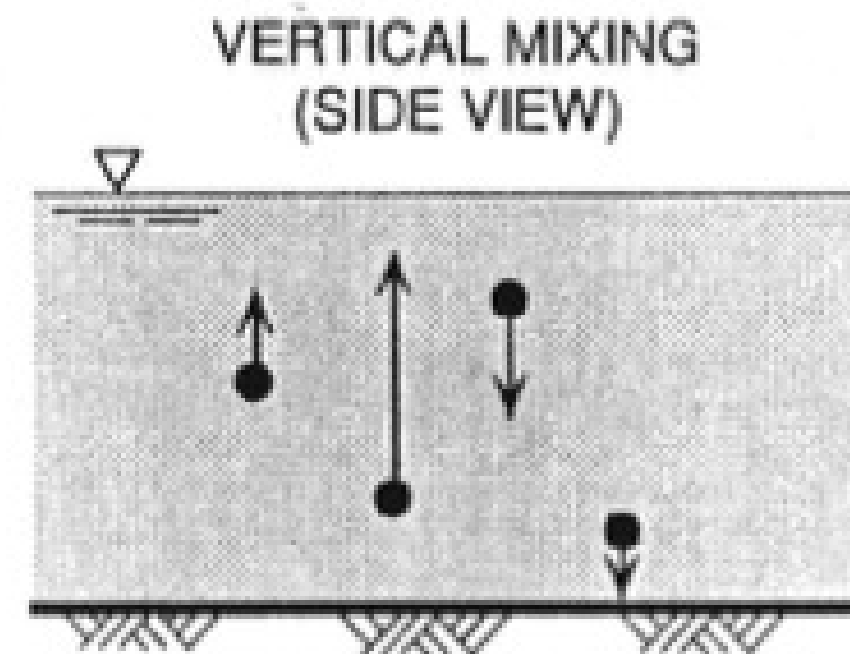
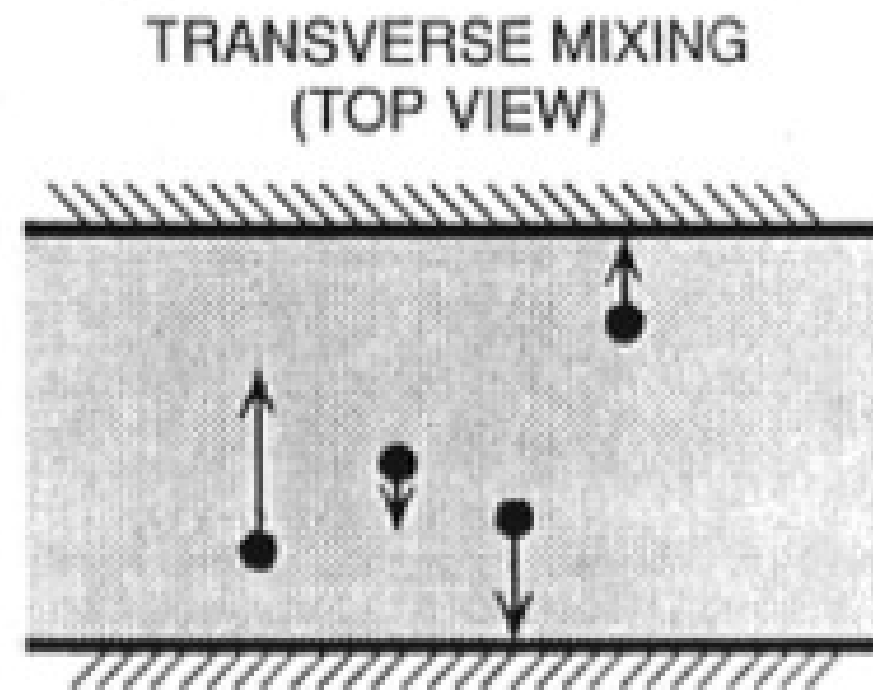


TRANSVERSE VELOCITY PROFILE
(TOP VIEW)

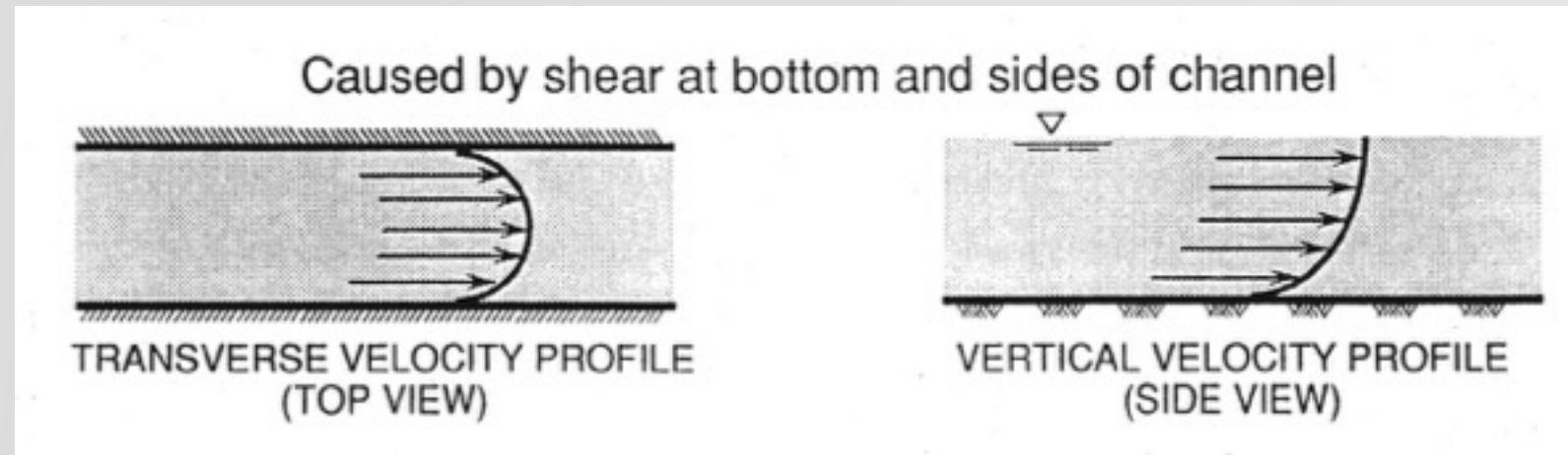


VERTICAL VELOCITY PROFILE
(SIDE VIEW)

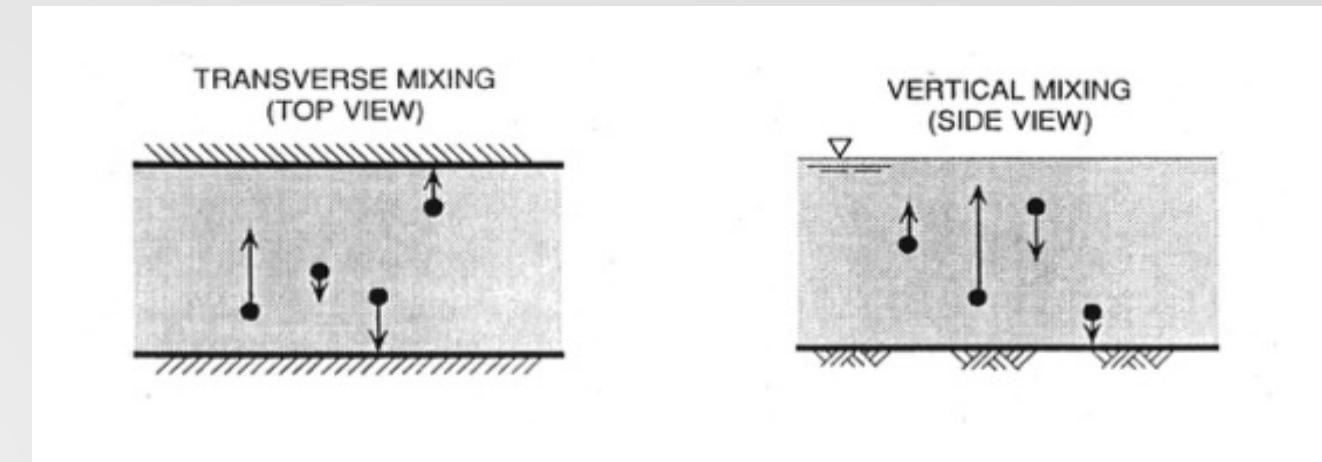
Quasi-3D: mixing



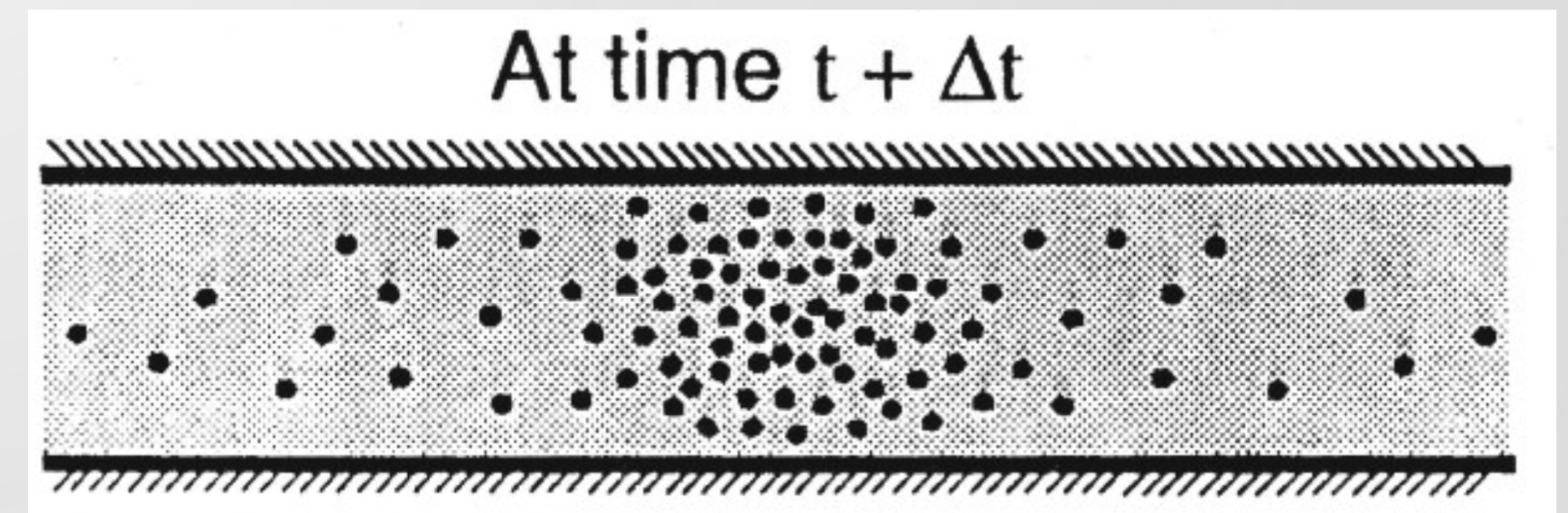
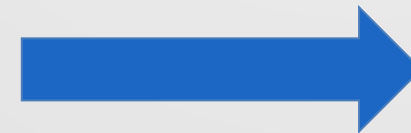
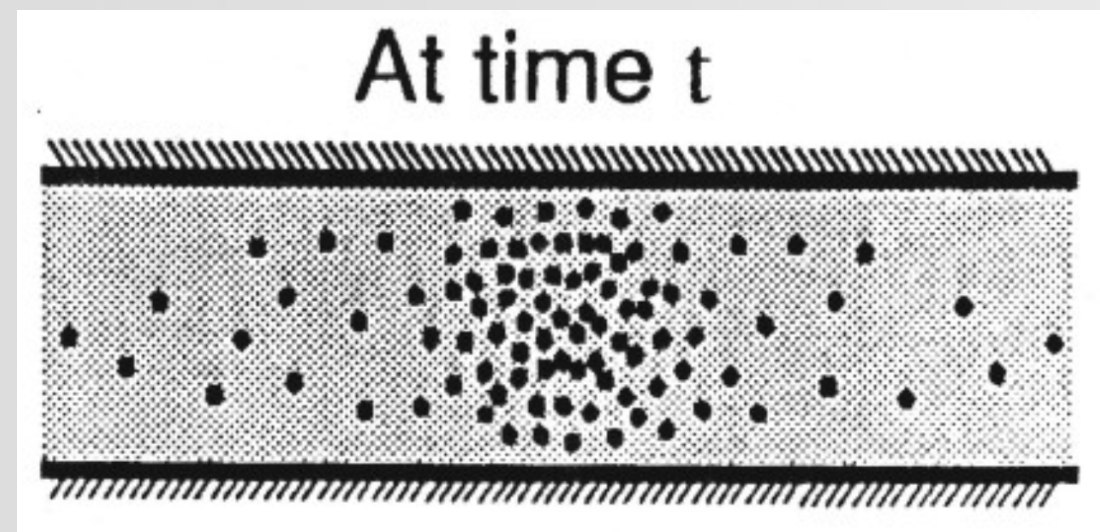
Quasi-3D: dispersion



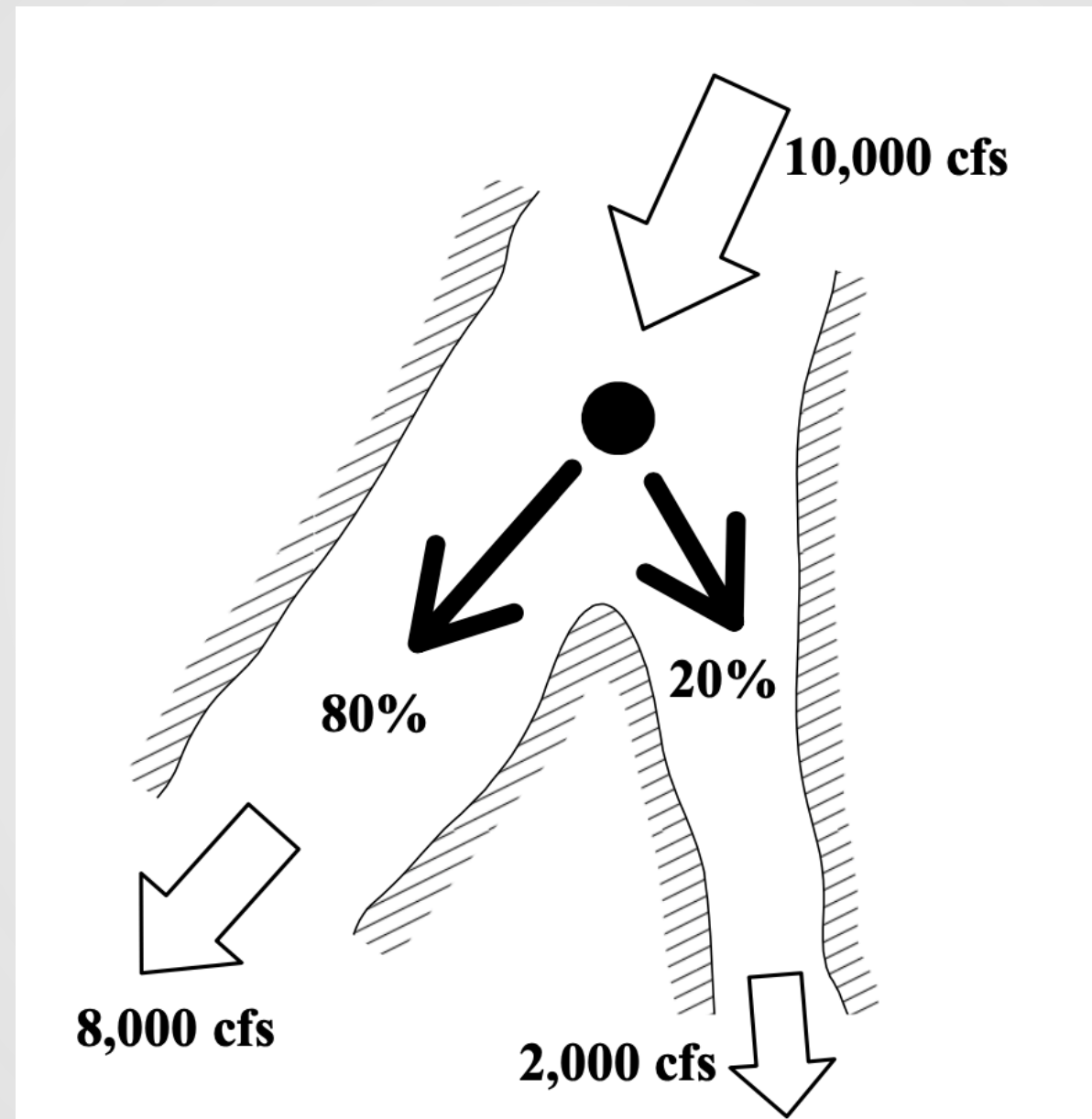
+



= dispersion



Flow-split routing

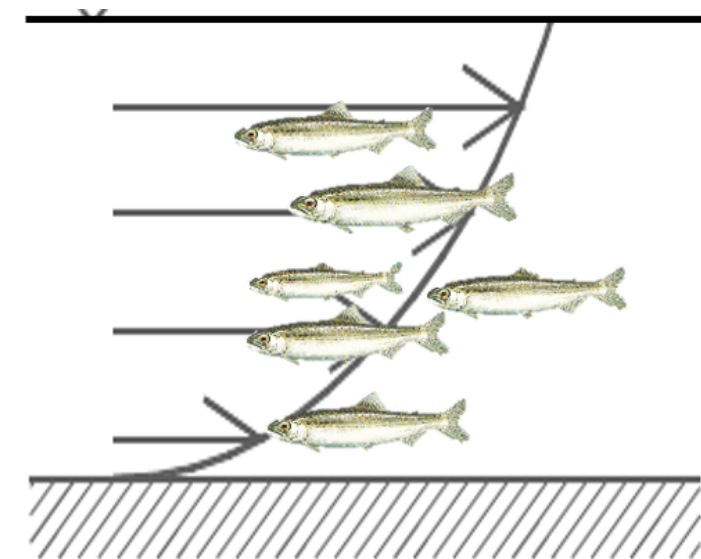
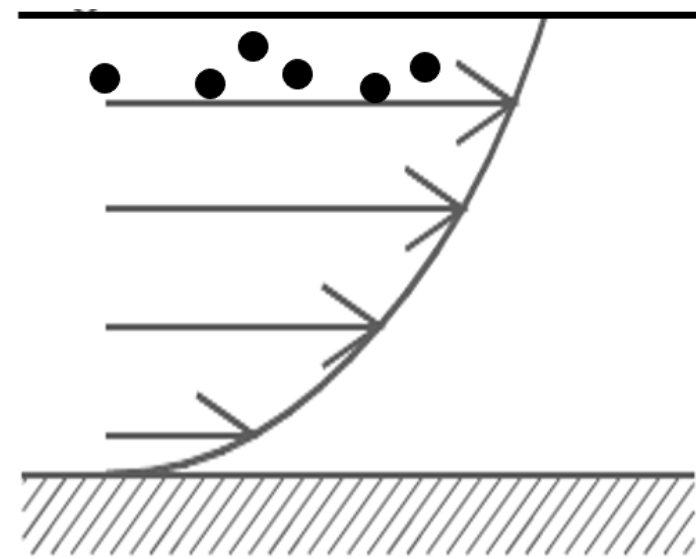
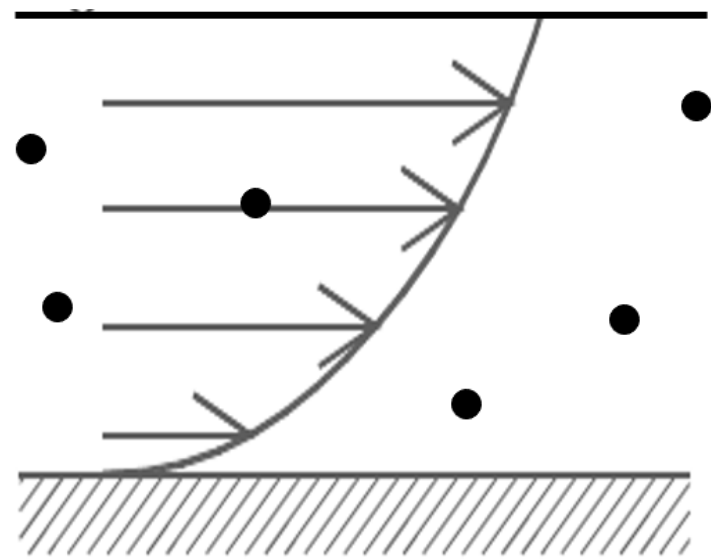


ECO-PTM

neutrally buoyant

surface oriented

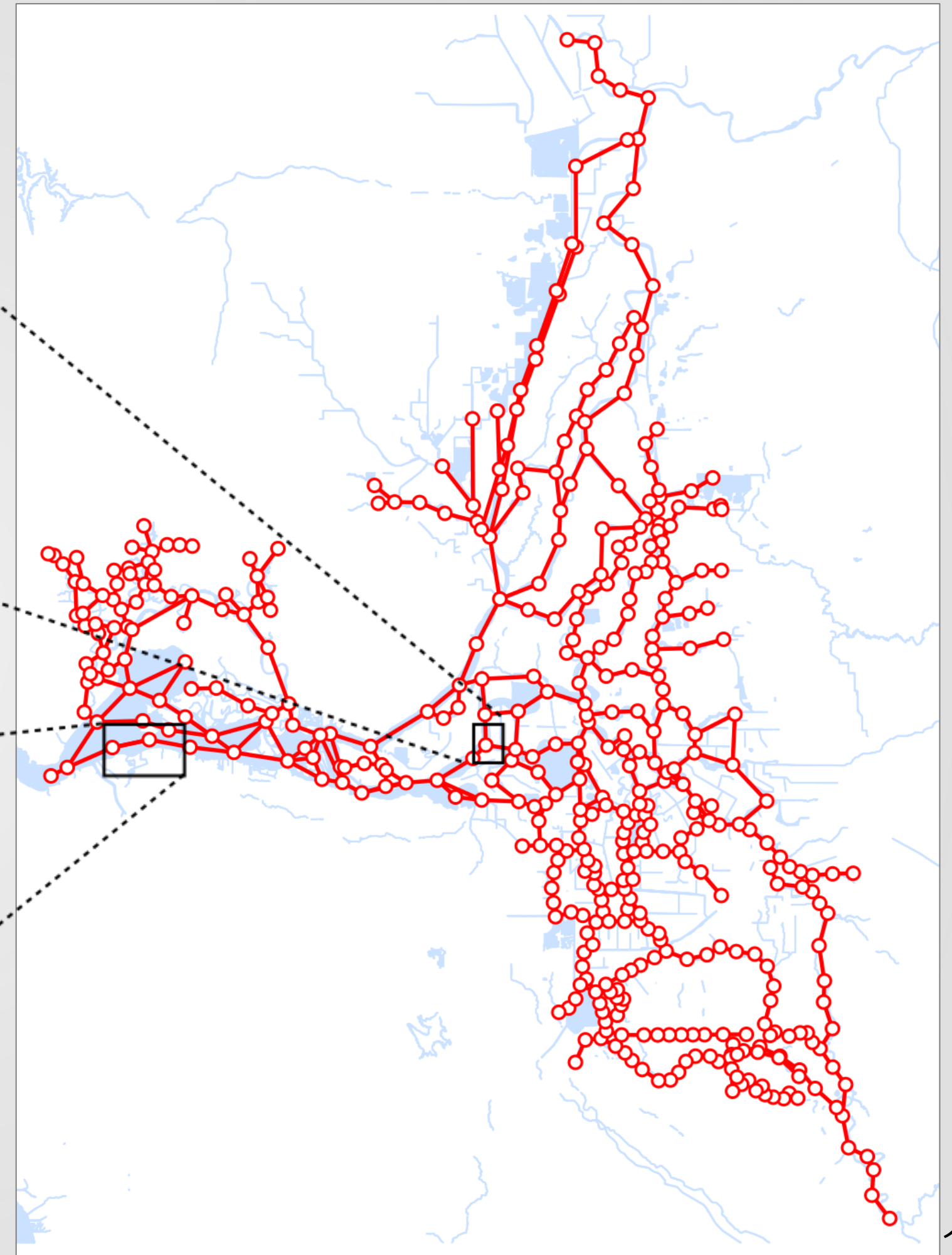
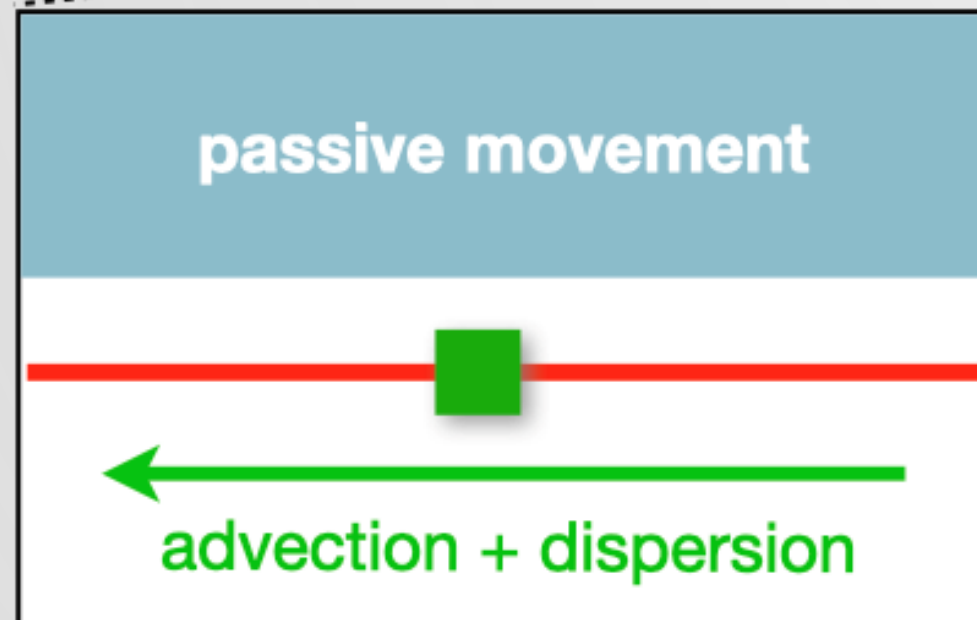
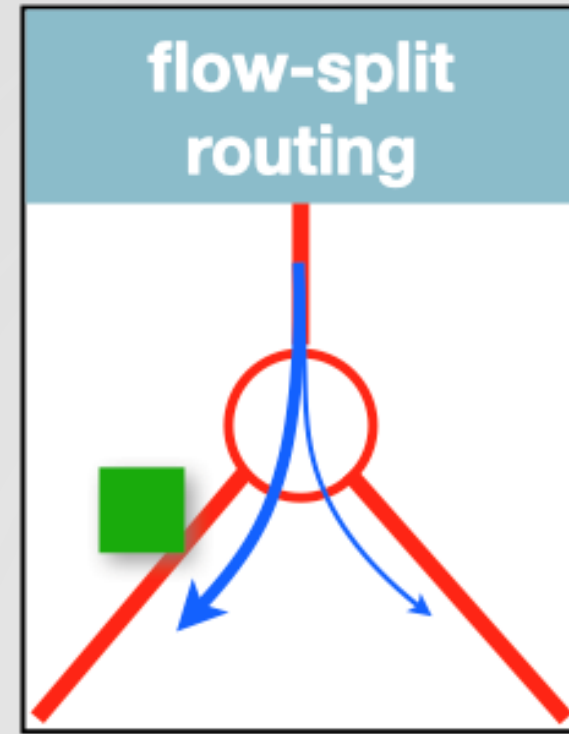
salmon model



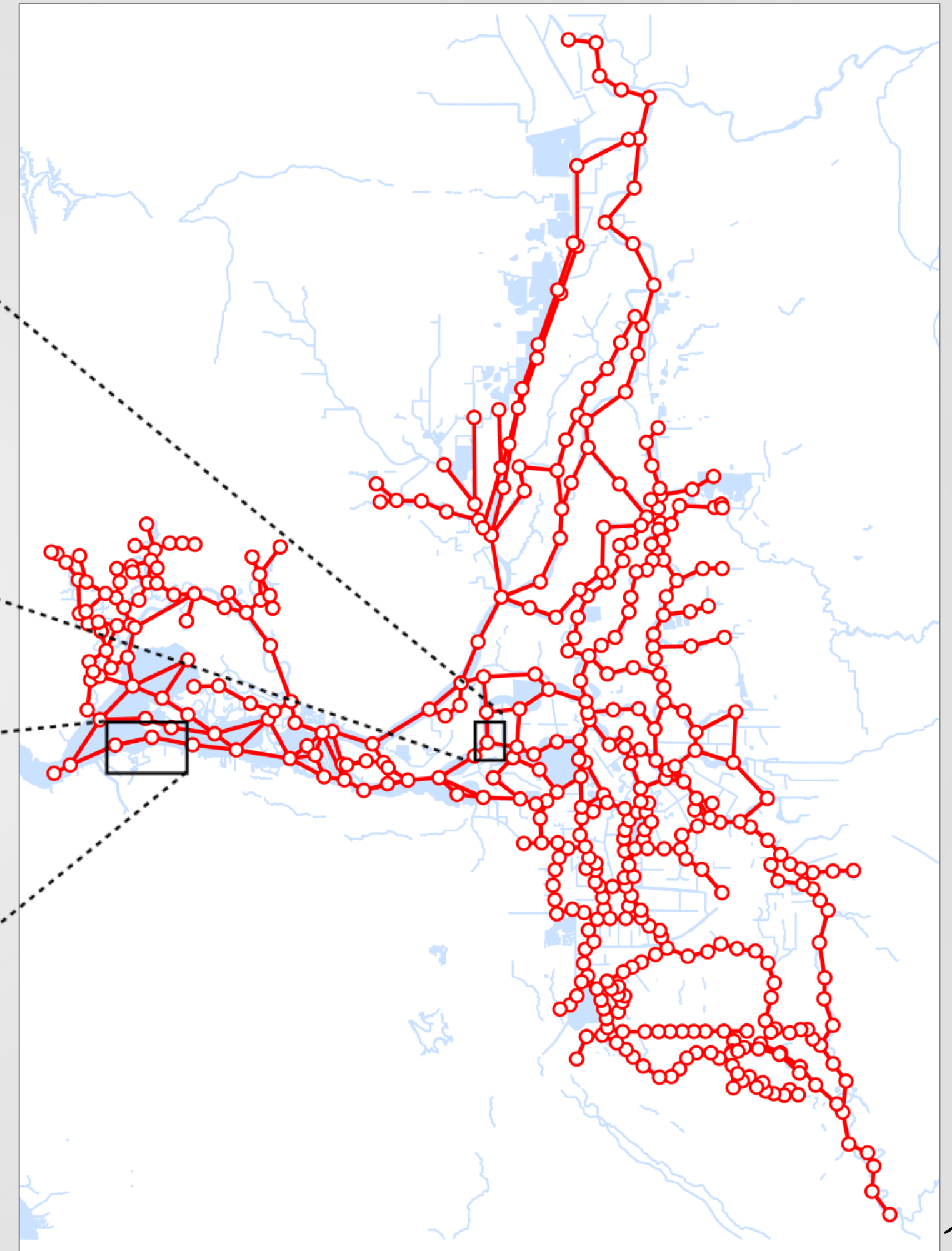
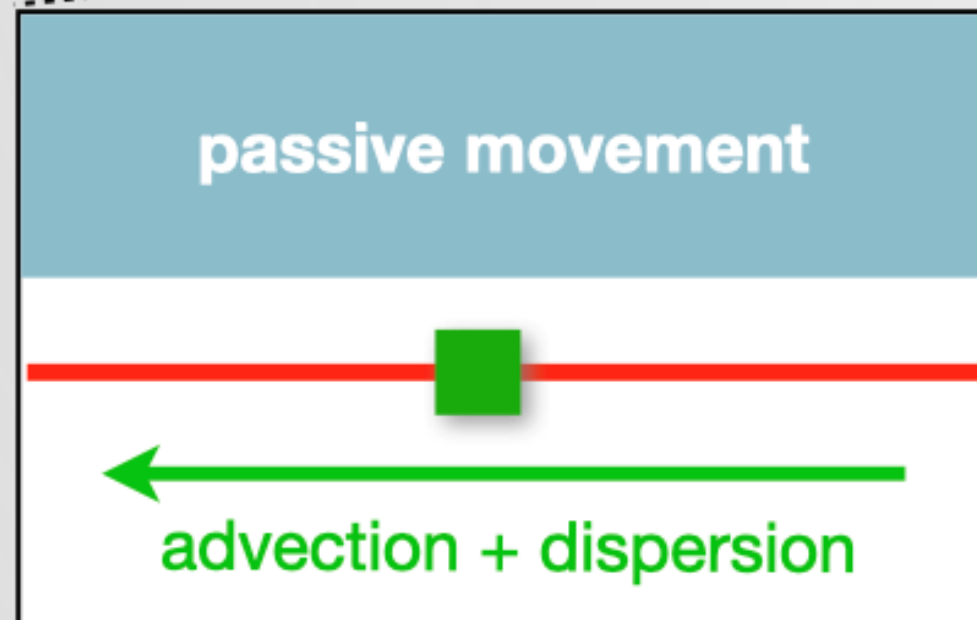
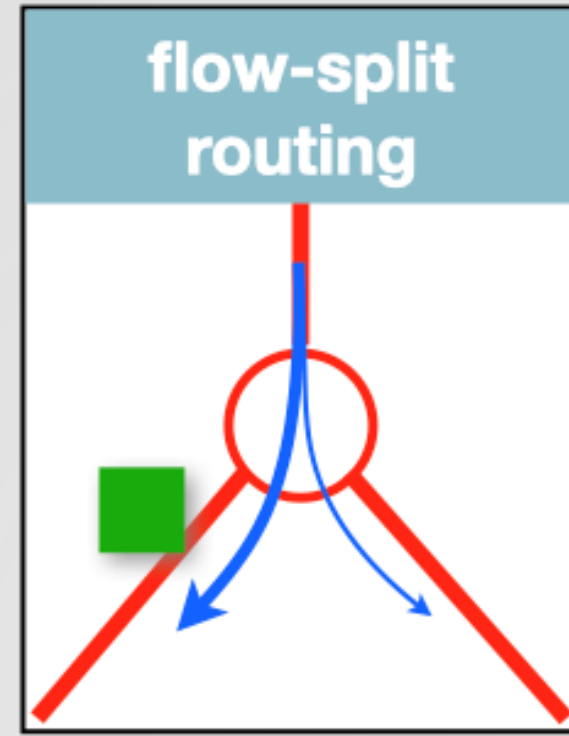
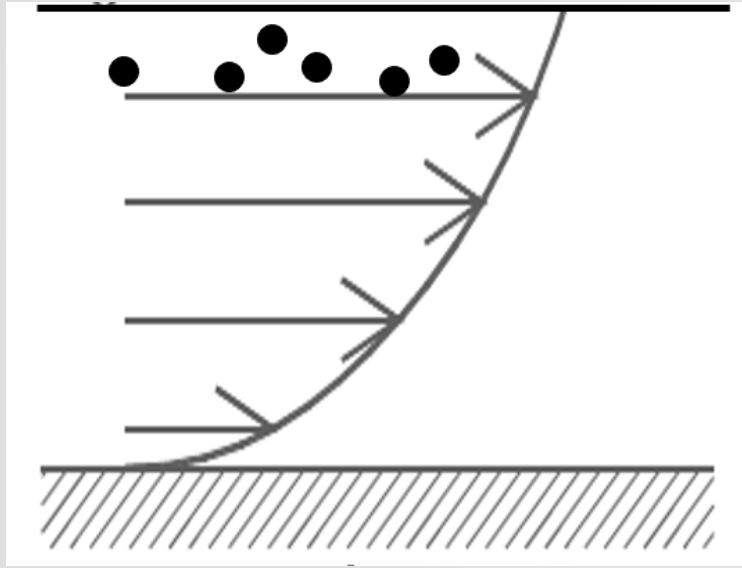
Particle Flux

Fish Survival Rate

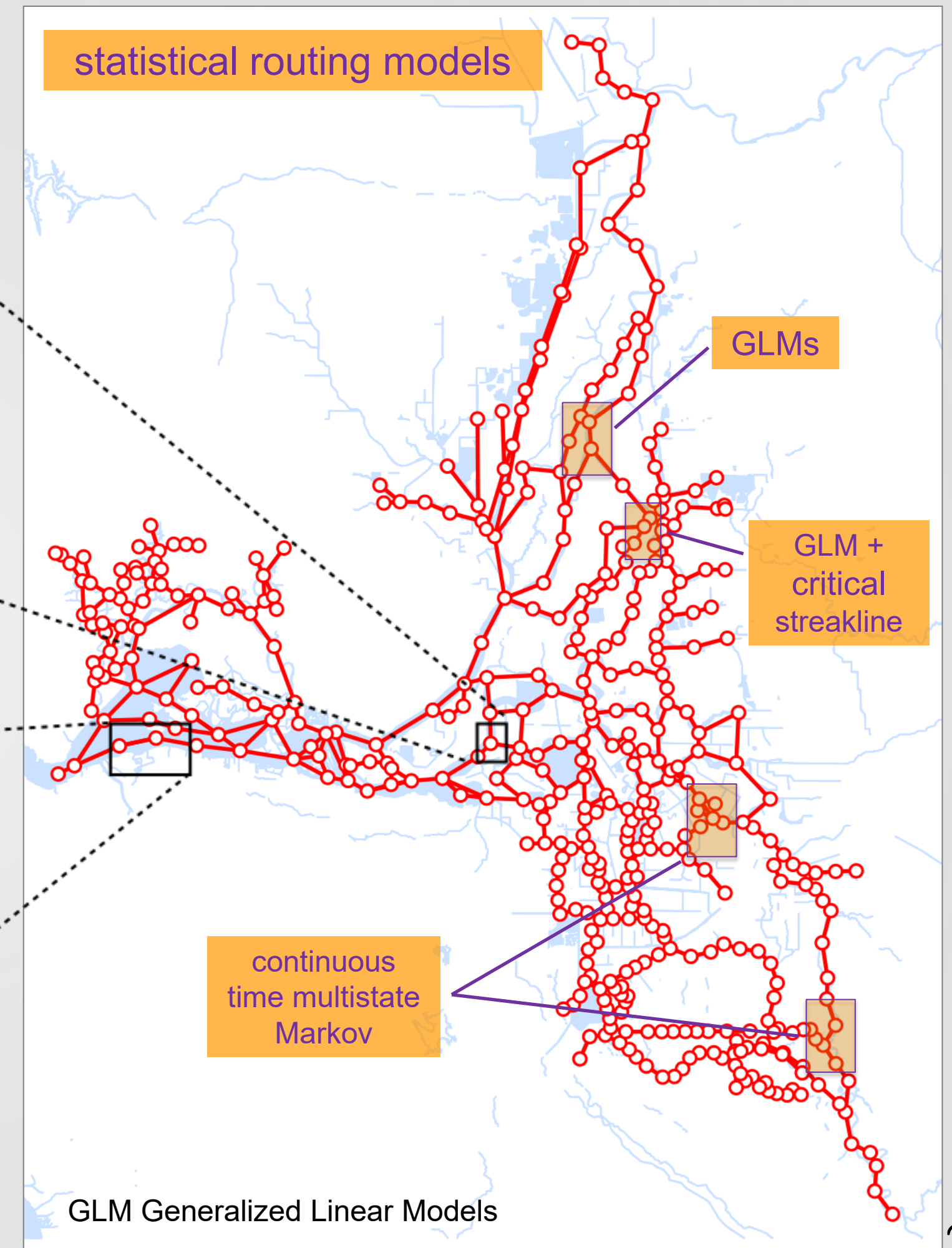
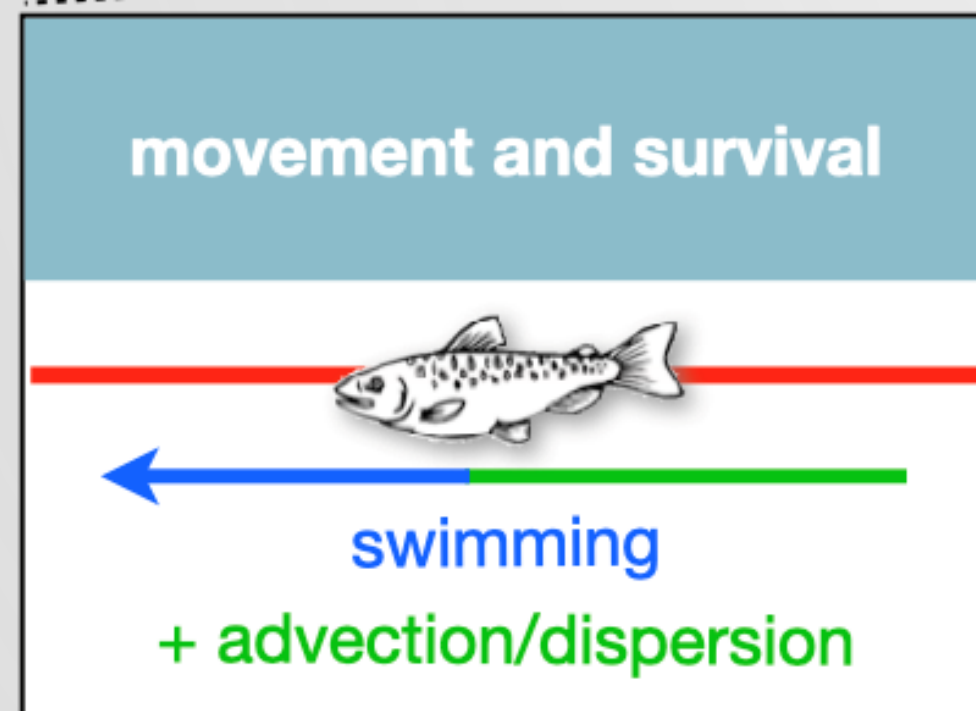
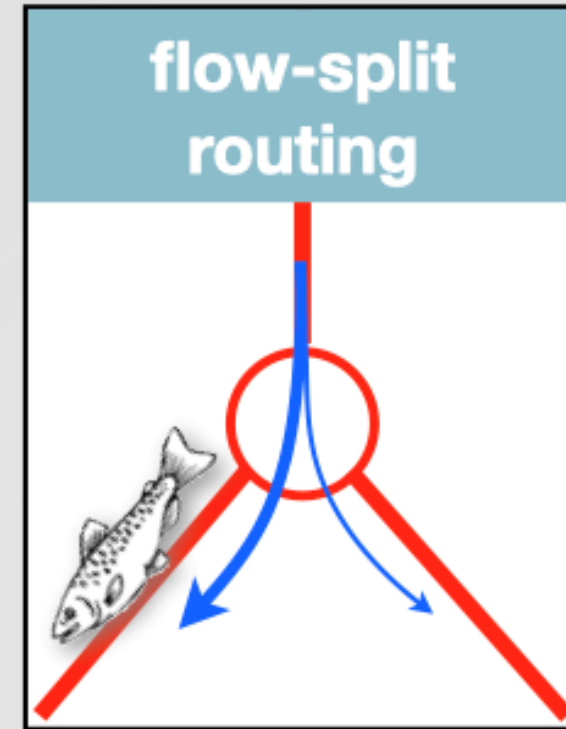
PTM



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

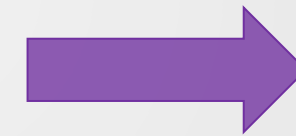
Salmon model

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

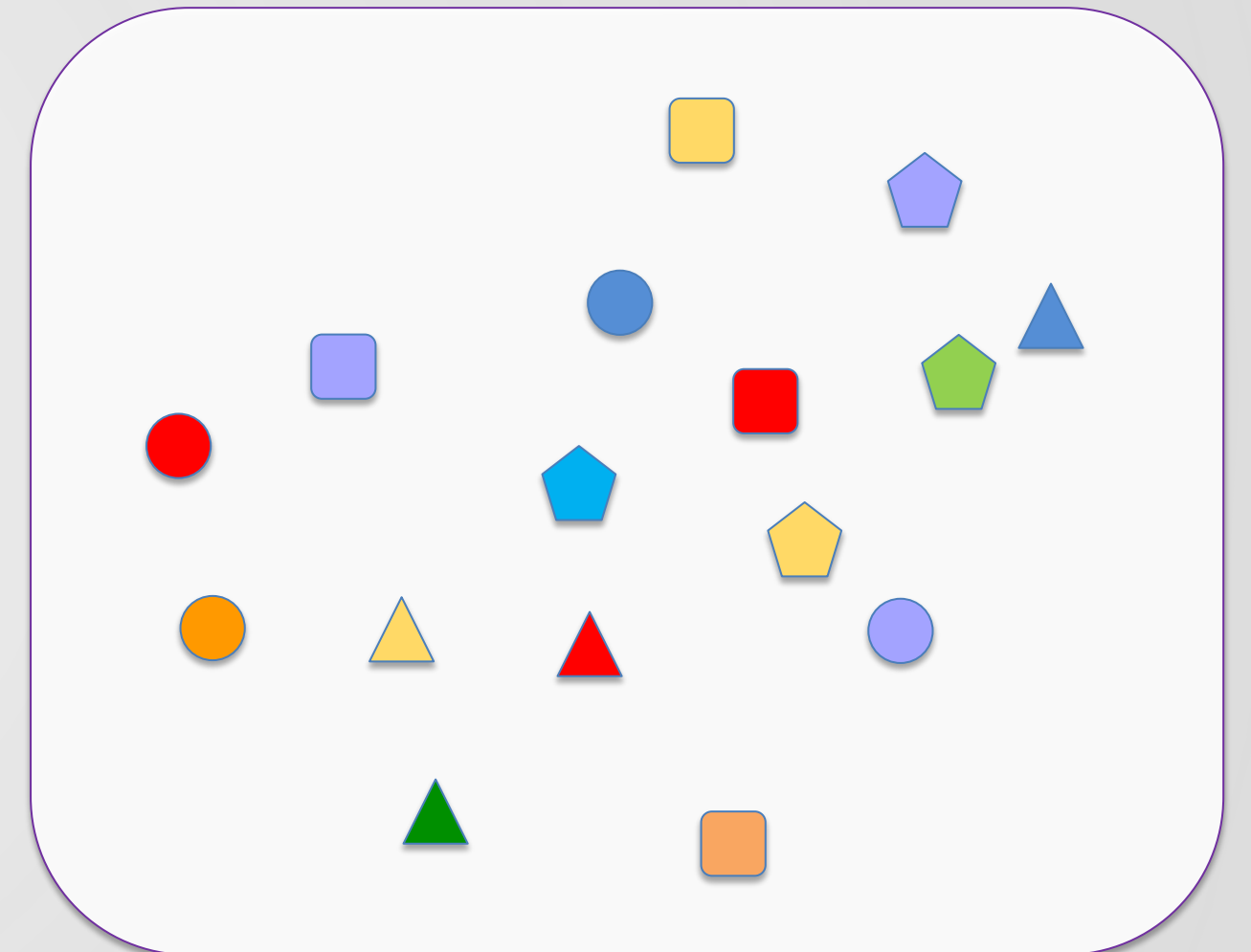
Salmon model

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.

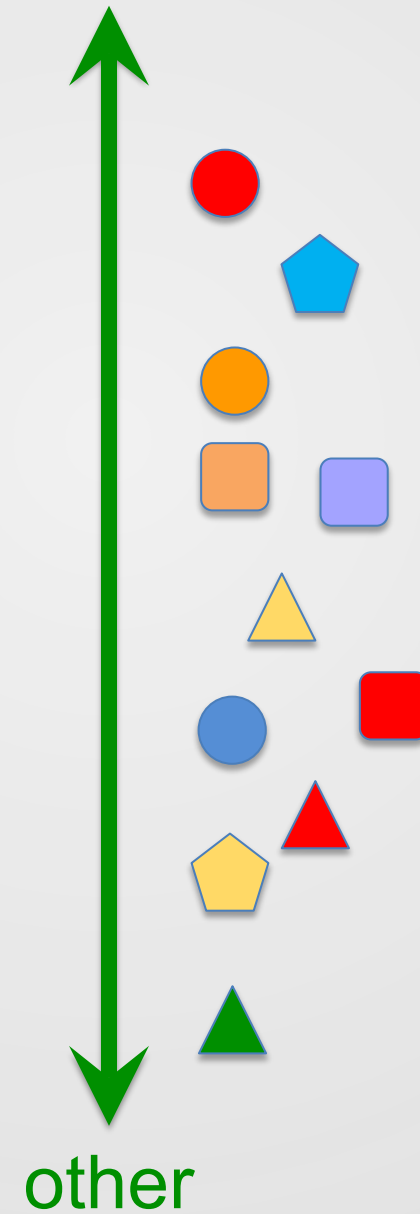


behaviors

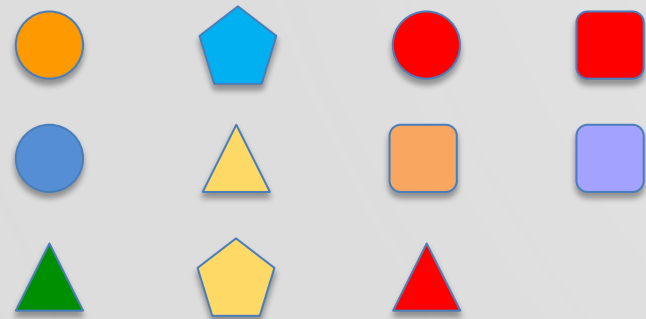


Interpretation of behaviors

responses to
hydrodynamic stimuli

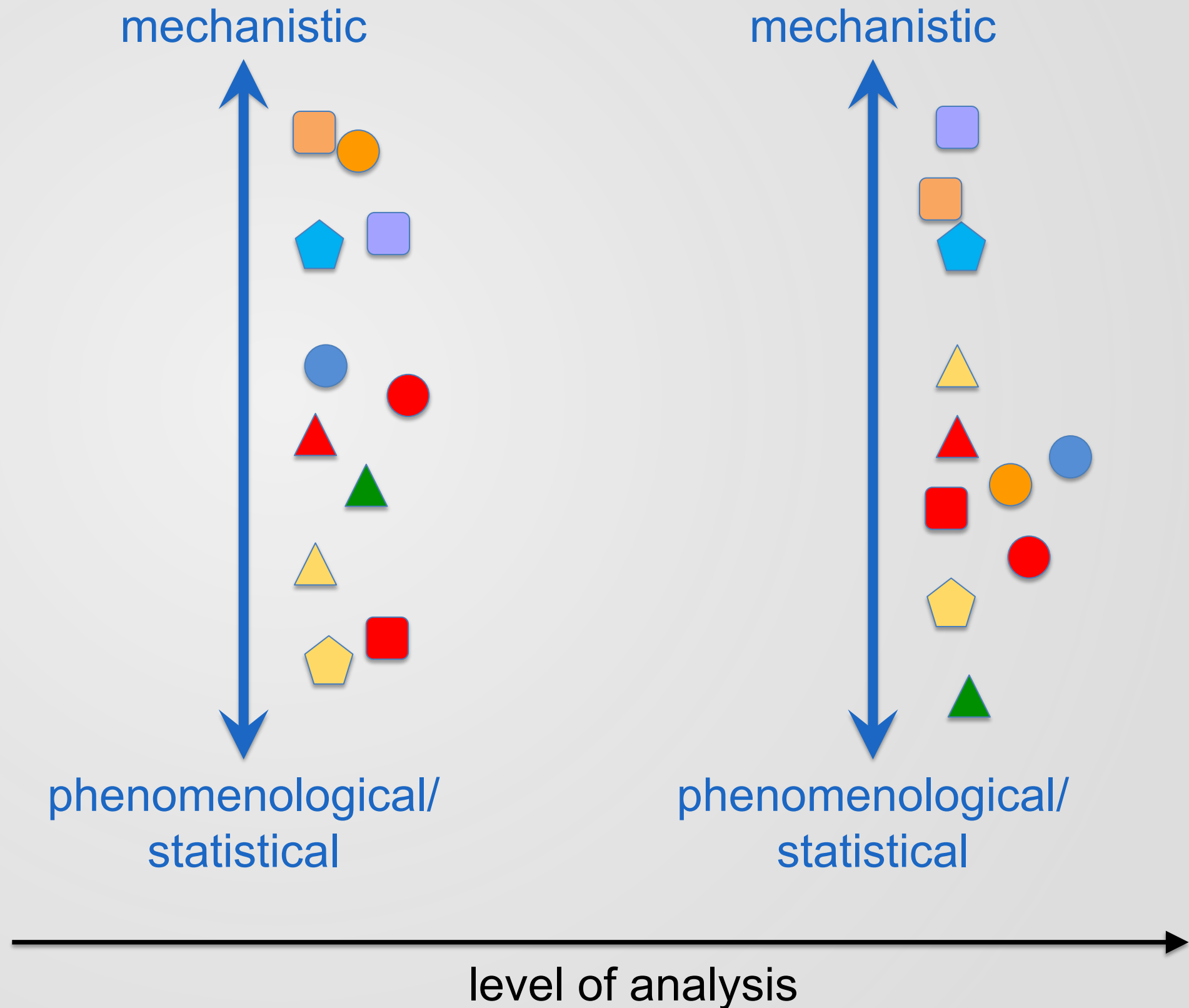
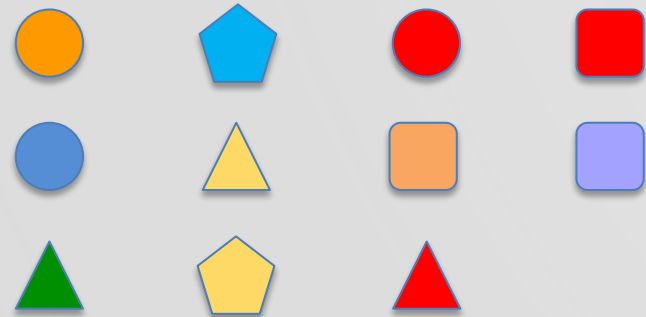


conceptual slide:
hypothetical behaviors



Interpretation of behaviors

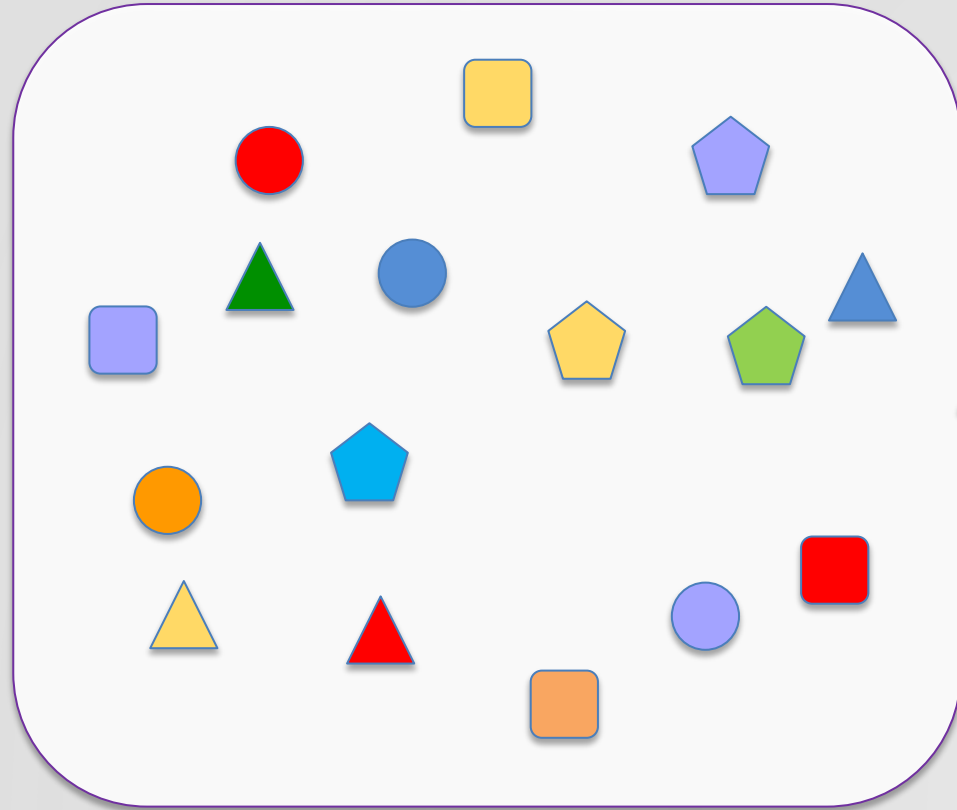
conceptual slide:
hypothetical behaviors



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



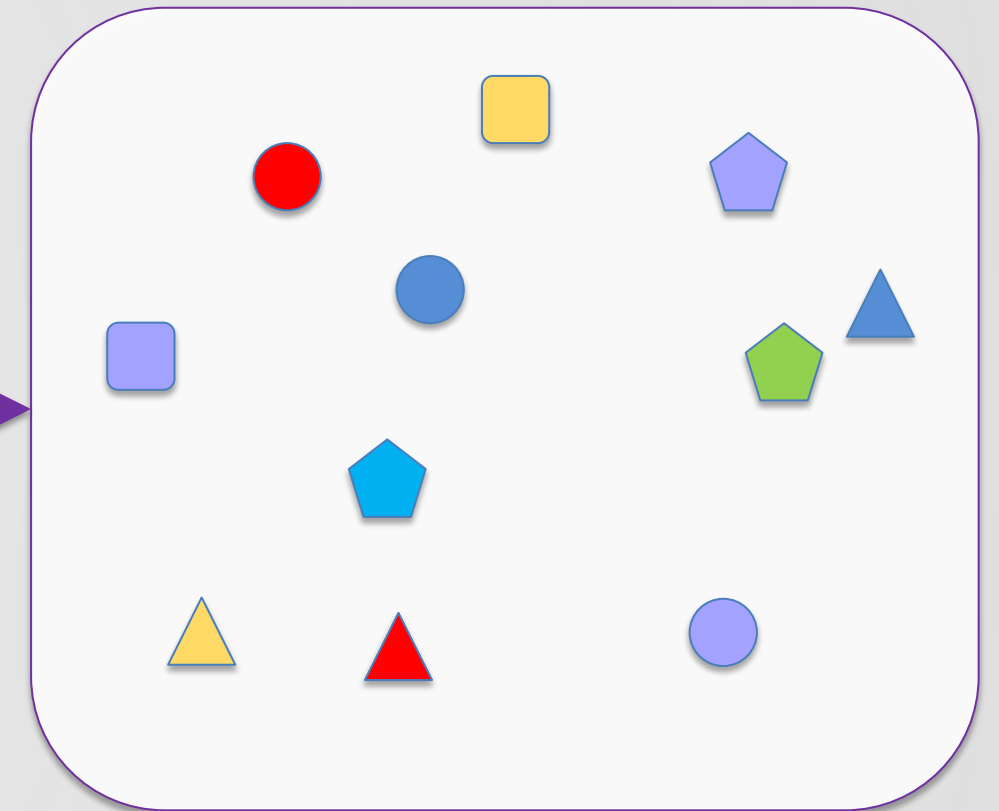
travel times
survival probabilities

acoustic telemetry data

- travel times
- XT parameter values

parameter estimation,
model selection, and
validation

calibrated behaviors



Questions? Please type them into Teams chat

Include slide # if possible



Doug Jackson (doug@qedaconsulting.com)