Development of New Information to Inform Fish Passage Decisions at the Yale and Merwin Hydro Projects on the Lewis River

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Photo by R. Al-Chokhachy, USGS

Outline

1. Project objectives

2. Task-by-task description of methods and preliminary results

3. Future modeling efforts target overarching questions

Scope of Work: project tasks

1. Review information regarding fish transport into Lake Merwin and Yale Lake
2. Habitat assessment of tributaries to Yale Lake and Lake Merwin
3. Assessment of adult potential for spawning success
4. Assess juvenile production potential and emigration success
5. Evaluation of Lake Merwin predator impacts
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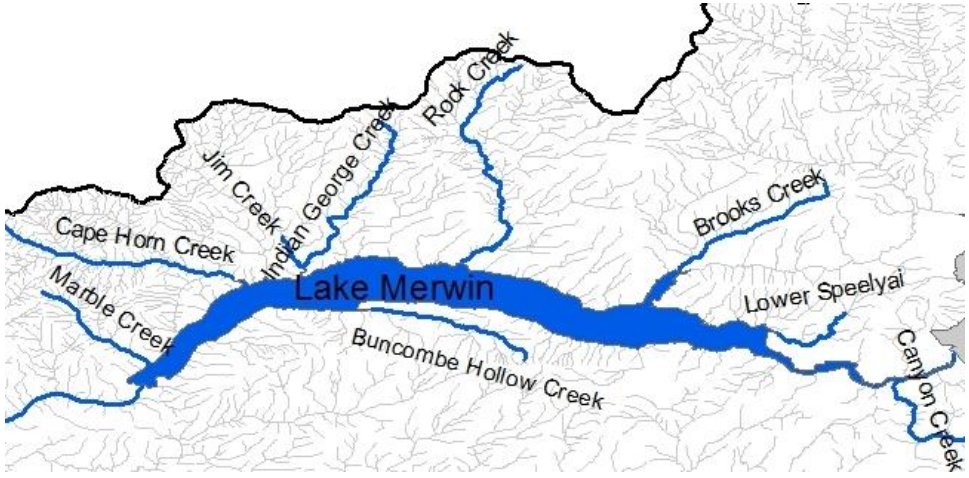
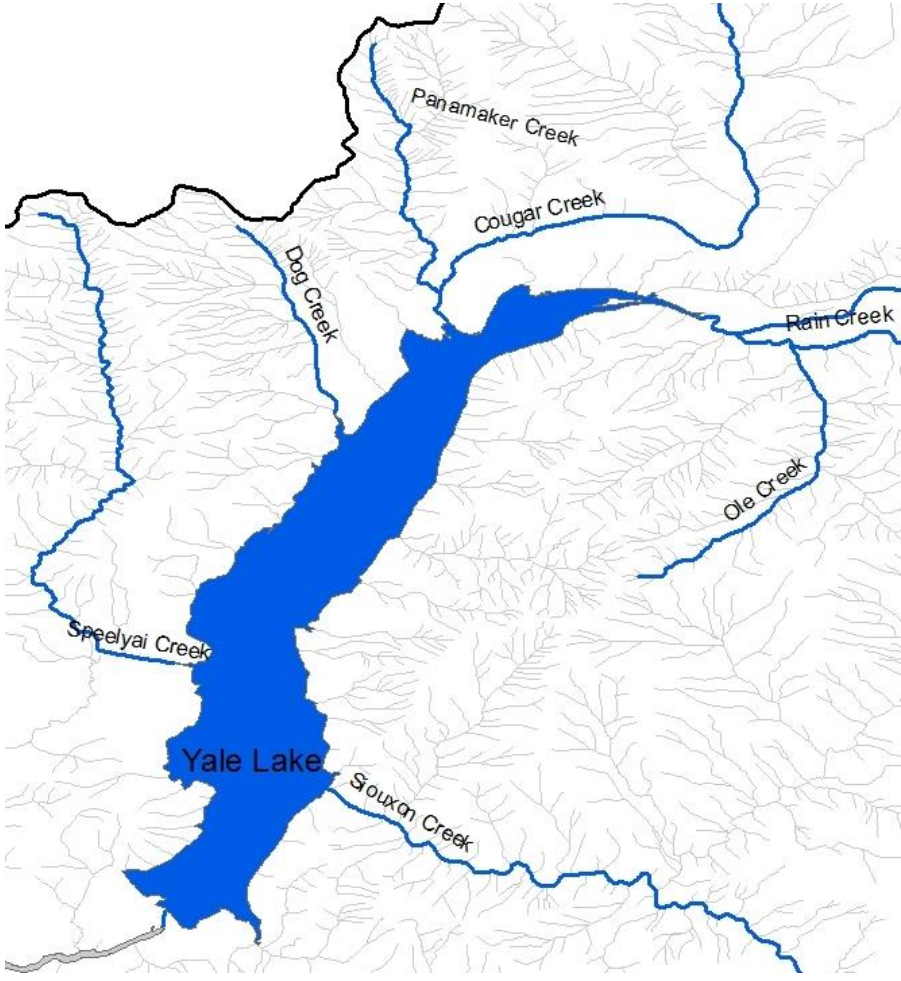
Task 2: Habitat assessment of tributaries to Yale Lake and Lake Merwin





- Study tributaries

Task 2: Habitat assessment of tributaries to Yale Lake and Lake Merwin

- **Objectives and methods**
  1. Quantify the extent of habitat within the tributaries
  2. Quantify flow and thermal regimes in tributaries
  3. Assess tributary habitat and riparian conditions
  4. Rerun EDT model with quantitative field-bases measures of habitat

Task 2: Habitat assessment of tributaries to Yale Lake and Lake Merwin

2. Quantify flow and thermal regimes in tributaries
   - Methods:
     - Install pressure transducers at top and bottom of tributaries
     - Quantify stage-discharge relationships

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Task 2: Habitat assessment of tributaries to Yale Lake and Lake Merwin

3. (and 4) Assess tributary habitat and riparian conditions
    - Methods:
        - Utilize existing habitat protocols within the PNW (CHaMP)
        - Continuous habitat surveys
            - Given site-site variability in reach-based assessments

Channel unit attributes

- Habitat attributes
  - Bankfull width, wetted width, depth
  - Substrate
  - Channel units
  - Large woody debris
  - Gradient
  - Riparian condition
- All georeferenced

- Collected specifically for parameterizing EDT model

Task 2: Habitat assessment

	Stream	Length (km)
Lake Merwin	Brooks Creek/B1	4.1
	Buncombe Hollow Creek	1.1
	Cape Horn Creek	0.5
	Indian George Creek	1.5
	Jim Creek	0.5
	Lower Speelyai	0.3
	Rock Creek	0.2
Total		**8.2**
Yale Lake	Cougar Creek	3.9
	Dog Creek	0.3
	North Siouxon Creek	0.7
	Ole Creek	1.7
	Panamaker Creek	0.4
	Siouxon Creek	6.1
	Speelyai Creek	6.0
	Swift Bypass Channel	6.5
	W. Fork Speelyai Creek	1.3
	W. Tributary Speelyai Creek	1.1
Total		**28.0**

Task 2: Habitat assessment of tributaries to Yale Lake and Lake Merwin

5. Rerun EDT model
   - Empirical habitat data used to rerun EDT models
   - Kevin Malone et al. DJ Warren

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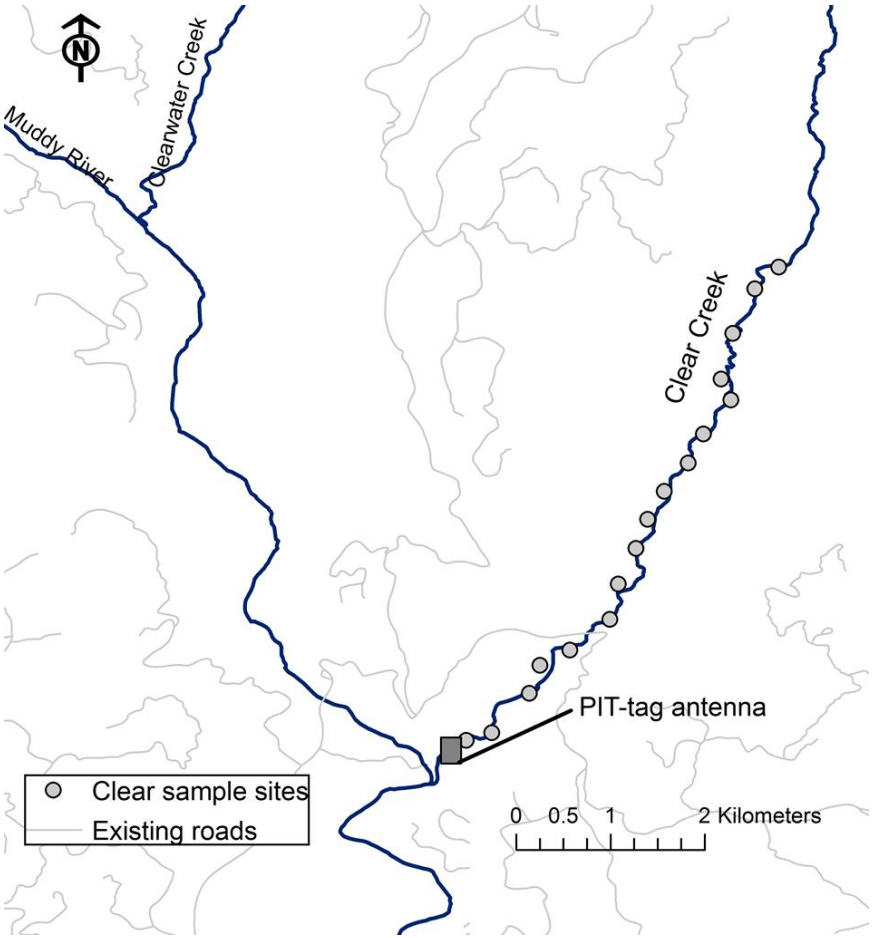
Task 4: Assess juvenile production potential and emigration success

- **Objectives and methods**
  1. Determine emigration timing into Swift Reservoir
  2. Quantify behavioral relationships with streamflow, temperature, and interannual differences
  3. Understand factors influencing tributary growth
  4. Quantify travel times and survival to collection facility
  5. Evaluate behavior near collection sites

Task 4: Methods-stream habitat

- Determine emigration and factors influencing emigration timing into Swift Reservoir
  - 2013 installed a Biomark, full duplex PIT-tag antenna with level reader and temperature logger in Clear Creek

Task 4: Methods-stream habitat



- Determine emigration timing into Swift Reservoir
  - **Wild Coho**
  - 20 reaches per year-5 km of habitat
    - Marking fish with 12 mm PIT-tag
      - 2013 = 357 fish
      - 2014 = 883 fish

Task 4: Methods-stream habitat

- Determine emigration timing into Swift Reservoir
  - Wild Coho
  - **Releases PIT-tagged acclimation Chinook**
    - Acclimation ponds
  - Migration timing

Year	Species	Clear Creek	Crab Creek	Muddy River
2013	Chinook	1,750	750	1,750
	Coho			2,000
2014	Chinook	7,576[1]		
2015	Chinook	3,400	3,300	3,300

Task 4: Methods-stream habitat

- Understand factors influencing tributary growth of wild Coho

Task 4: Methods-stream habitat

- Understand factors influencing tributary growth of wild Coho
  - Early summer and fall sampling
  - Macroinvertebrate production
  - Thermal and hydrologic regimes
    - Temperature and streamflow loggers
  - Tributaries
    - Clear Creek, Drift Creek, P3

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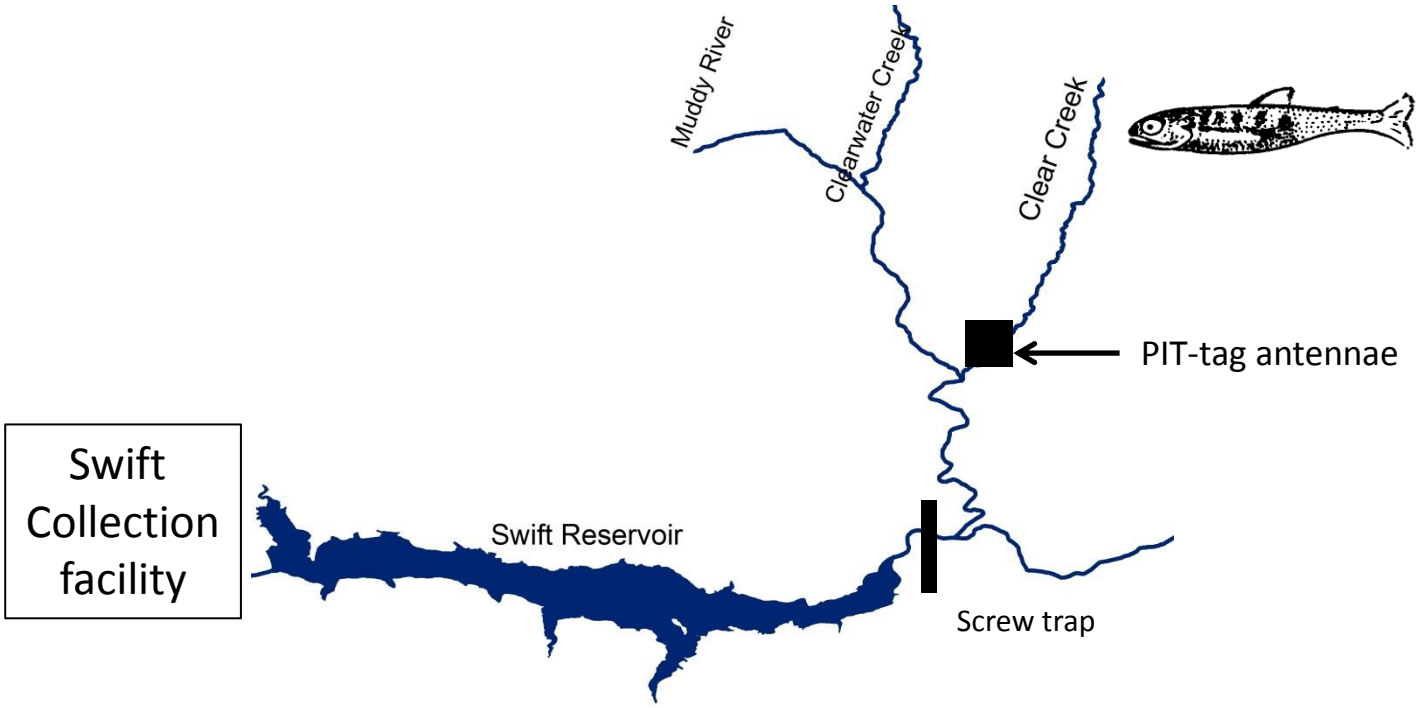
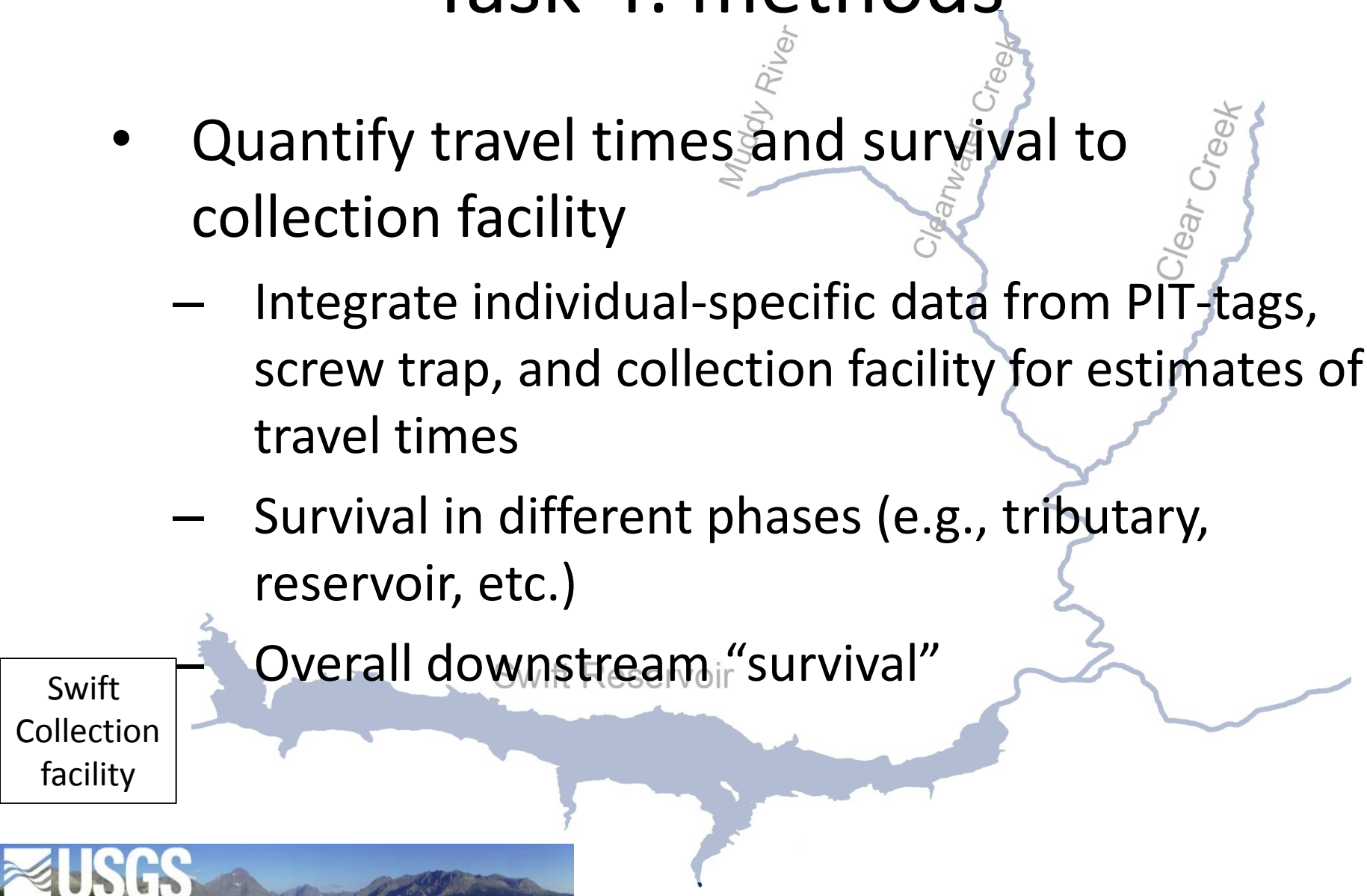
Task 4: methods

- Quantify travel times and survival to collection facility



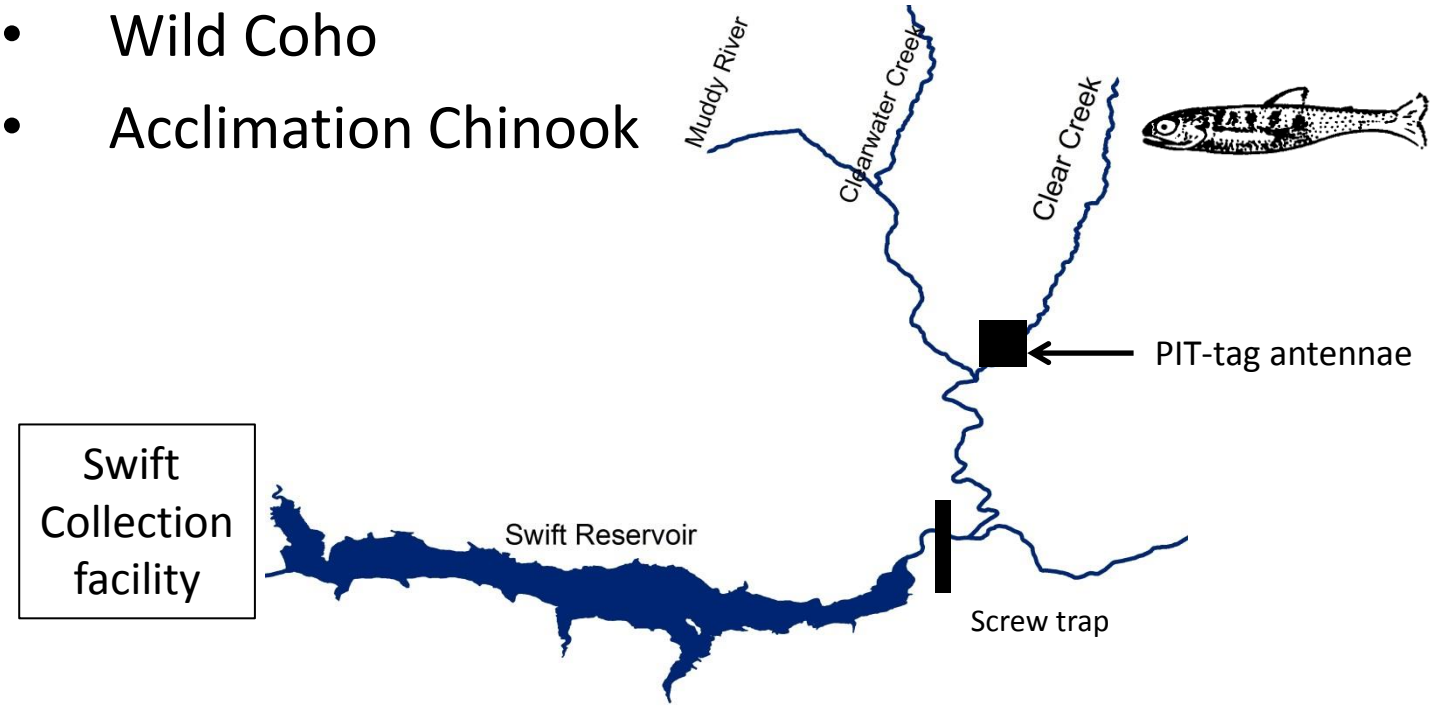
Task 4: methods

- Quantify travel times and survival to collection facility
  - Integrate individual-specific data from PIT-tags, screw trap, and collection facility for estimates of travel times
  - Survival in different phases (e.g., tributary, reservoir, etc.)
  - Overall downstream "survival"



Task 4: methods streams

- Quantify travel times and survival to collection facility
  - Wild Coho
  - Acclimation Chinook



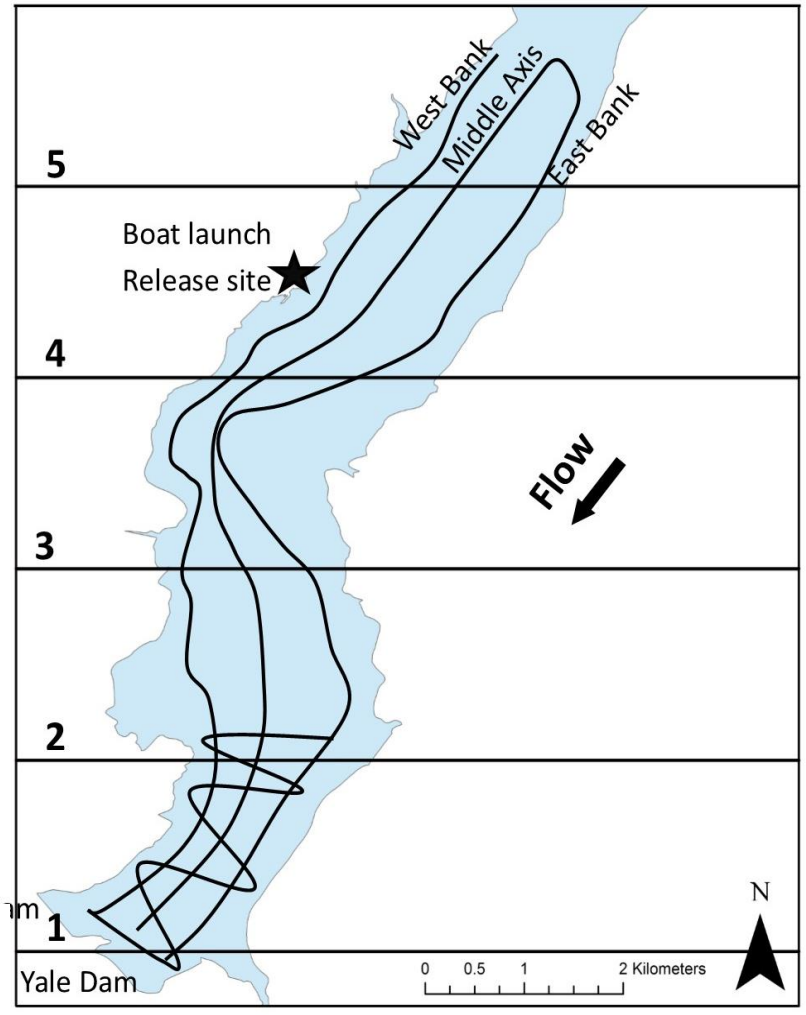
Task 4: methods **reservoir**

- Evaluate travel behavior and near potential collection facilities
  - Yale Lake
  - Compliment PIT-tag data and previous radiotelemetry data for assessments of variability of travel times
  - Habitat use near dam~potential collection facility

Task 4: methods **reservoir**

- Evaluate travel behavior and near potential collection facilities
  - 2014 test release of 5,000 Coho smolts
    - April 8th at Yale Park

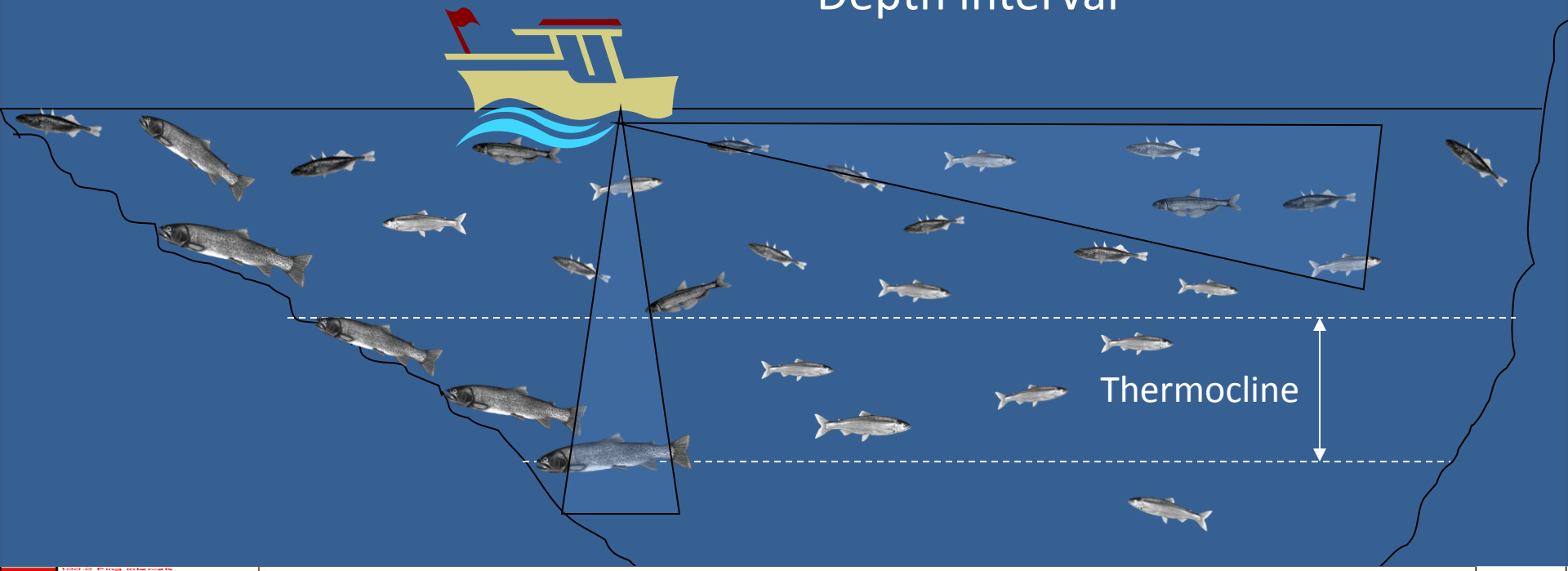
Task 4: methods **reservoir**

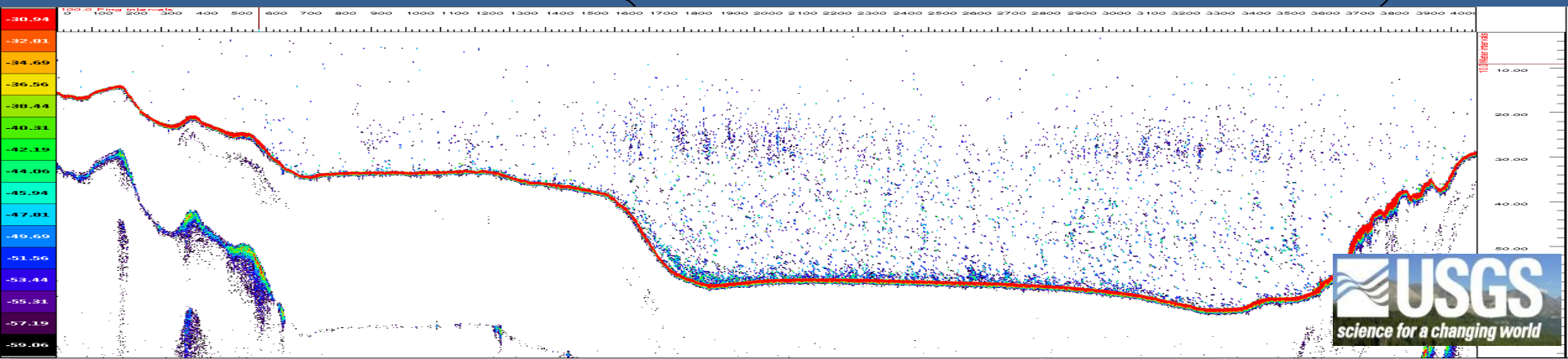


- Evaluate travel behavior and near potential collection facilities
  - 2014 (5,000 Coho smolts)
  - Hydroacoustic surveys (UW)
    - Pre-release
    - Day of release
      - Near Yale Park to identify targets
    - Post-release

Task 4: Hydroacoustic surveys

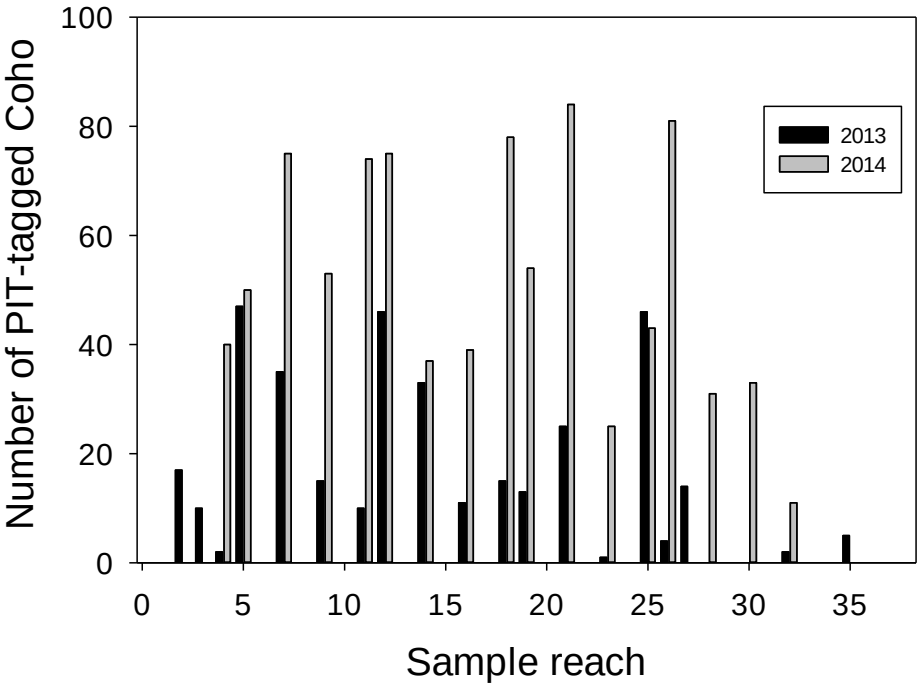
- Quantify Coho density and abundance
  - Depth interval





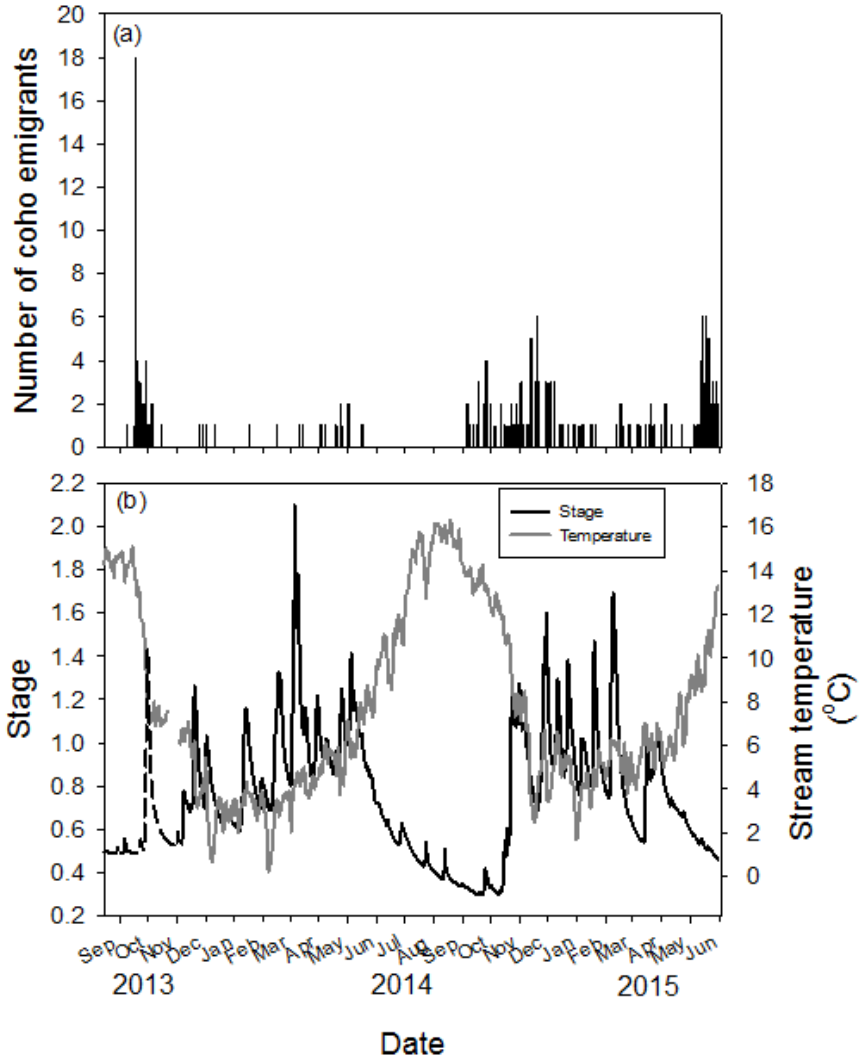
Task 4: Results

Task 4: Results-Coho



- Distribution of wild Coho sampled in Clear Creek

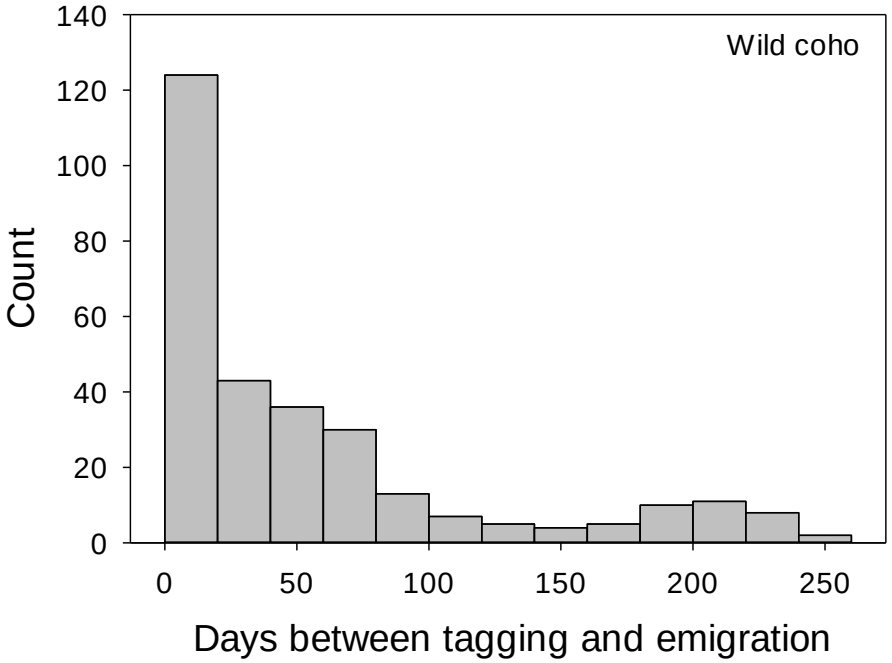
Task 4: Results-Coho



Emigration timing varied considerably across years

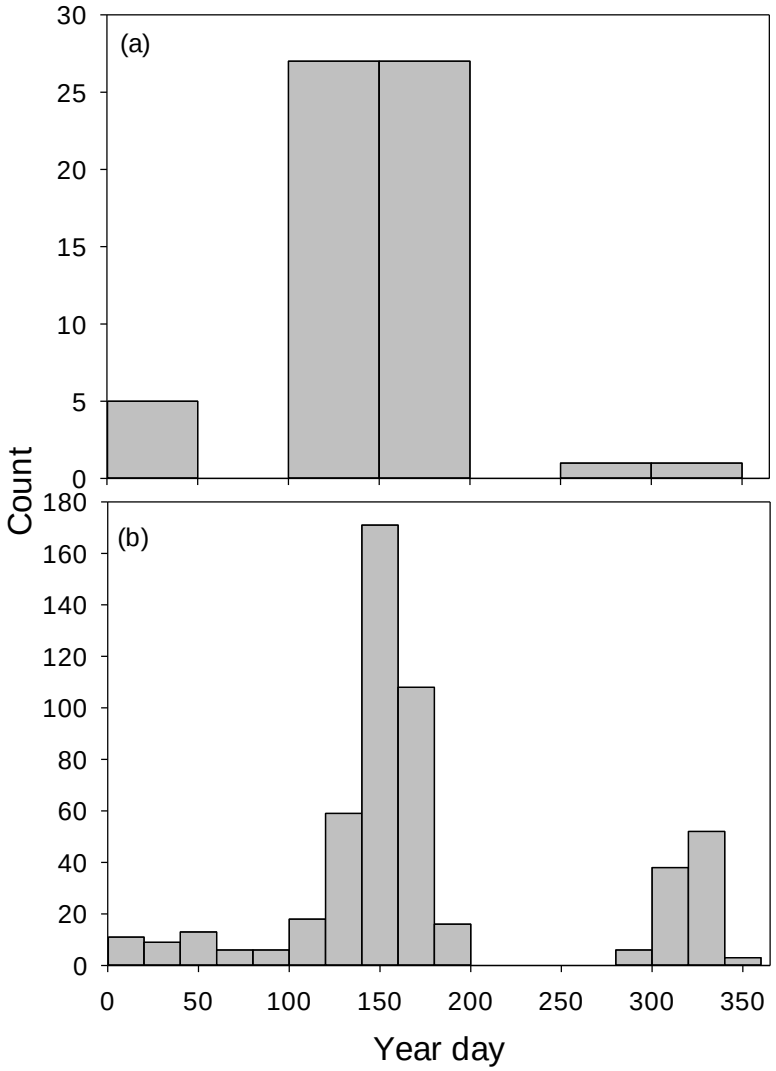
- 2013-high flow event
- 2014-mixed results
  - Association with high flow events similar to Pess et al. (2011)
  - Influence of low-flow-
    - More time in reservoir?

Task 4: Results-Coho



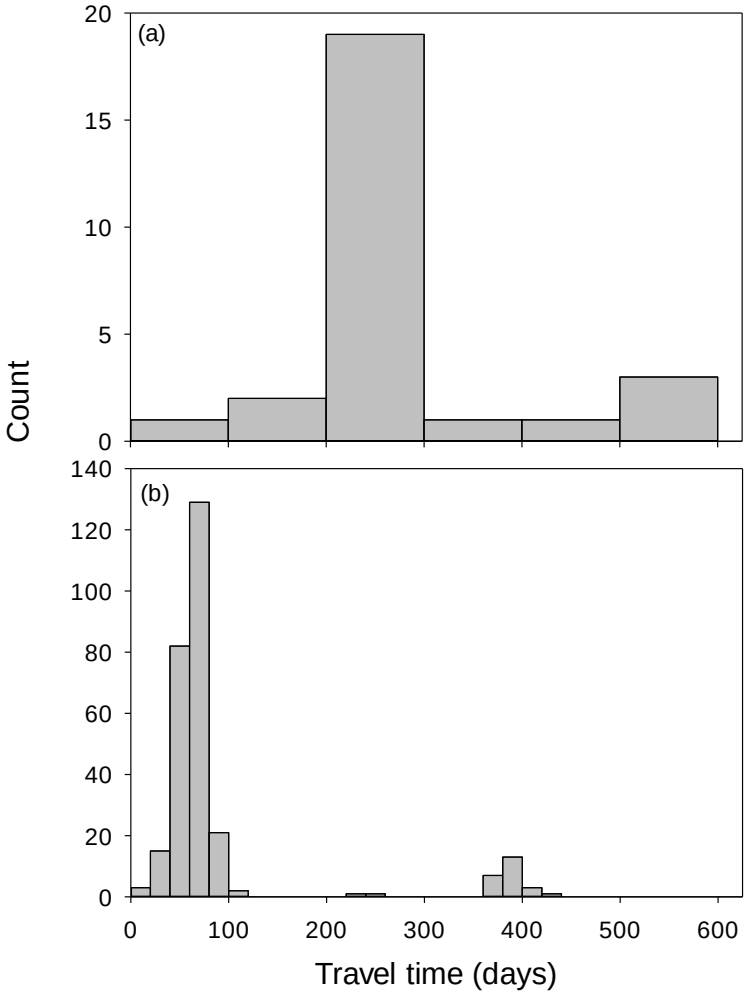
- Emigration timing
  - Tagging = Late August and early September
  - Early fall and late spring
  - Bimodal is consistent with Pess et al. (2011)

Task 4: Results-Coho



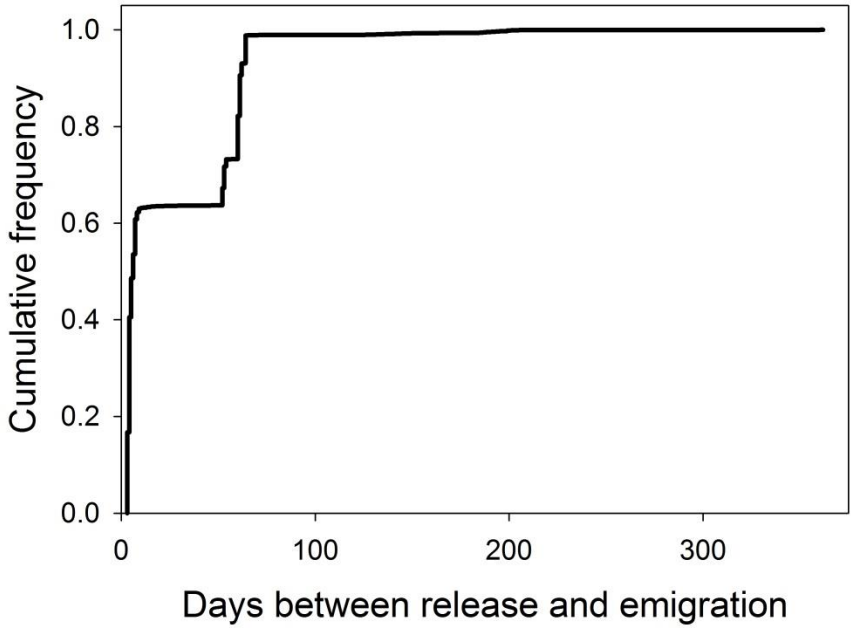
- Timing to collector
  - Similar for wild and hatchery Coho
  - May

Task 4: Results-Coho



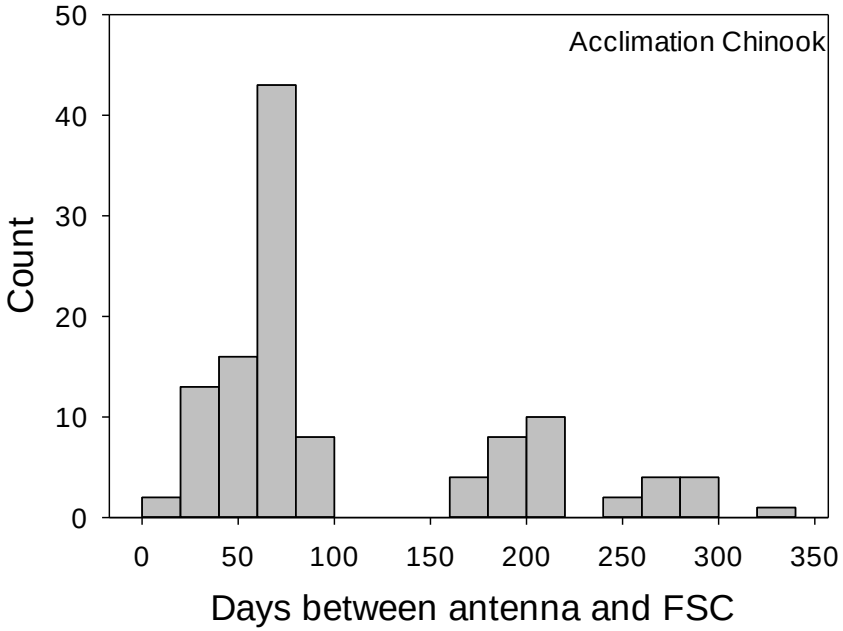
- Total time from marking to the FSC
  - Wild Coho (top)
    - 7-8 months
    - After emigration from Clear Creek
      - Median = 121 days in Swift
      - Range = 27 – 347 days
  - Different results from test release of Coho (2013)

Task 4: Results-Chinook



- Acclimation Chinook in Clear Creek
  - Direct and acclimation pond releases (2014 – 2015)
  - ~60% emigrate within a week
  - 98% within 60 days

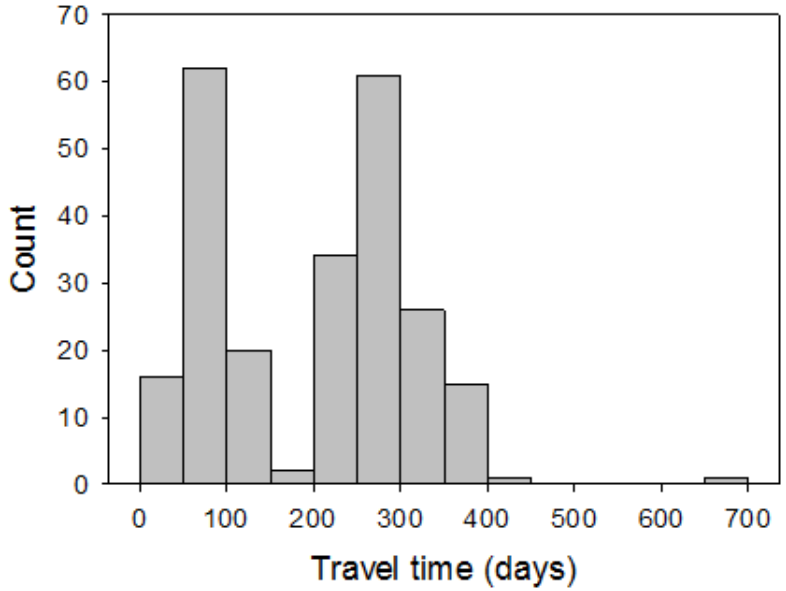
Task 4: Results

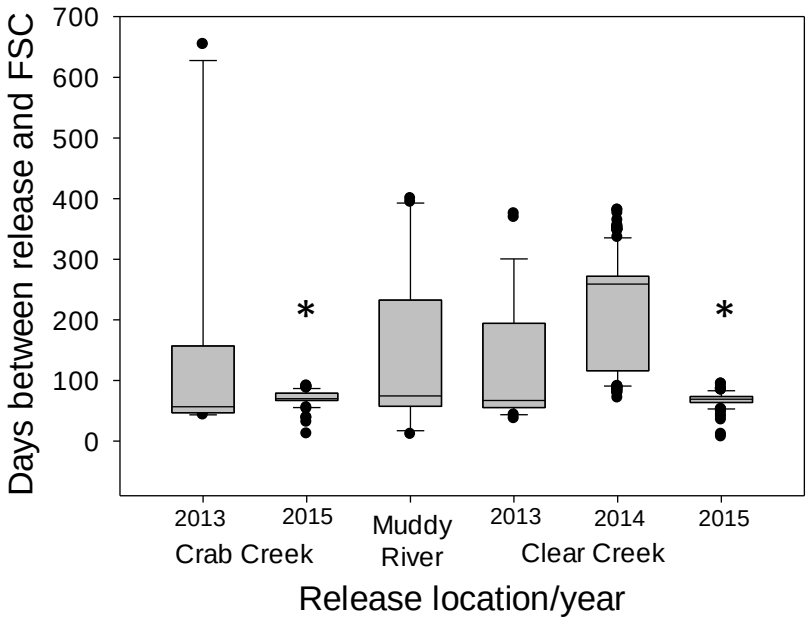


Acclimation Chinook (Clear Creek) time in Swift after passing antenna

- Median days = 69
- Range = 5 – 320 days

Task 4: Results





- All acclimation Chinook
  - From release
    - Crab Creek, Muddy River, Clear Creek
    - Bimodal
  - Apparent differences across sites and years

Task 4: Results

- **Fish reaching the FSC in Swift Reservoir**
- As May 31, 2015 focusing specifically on PIT-tagged fish:
  - Coho
    - 14% of hatchery Coho (2013) were collected at the FSC
    - 8% of 2013 wild fish tagged in Clear Creek
    - 5% of 2013 and 2014 fish combined (early estimate*)
  - Acclimation Chinook
    - 1.4% (2013)
    - 2% (2014)
    - 1.7% (2015)*

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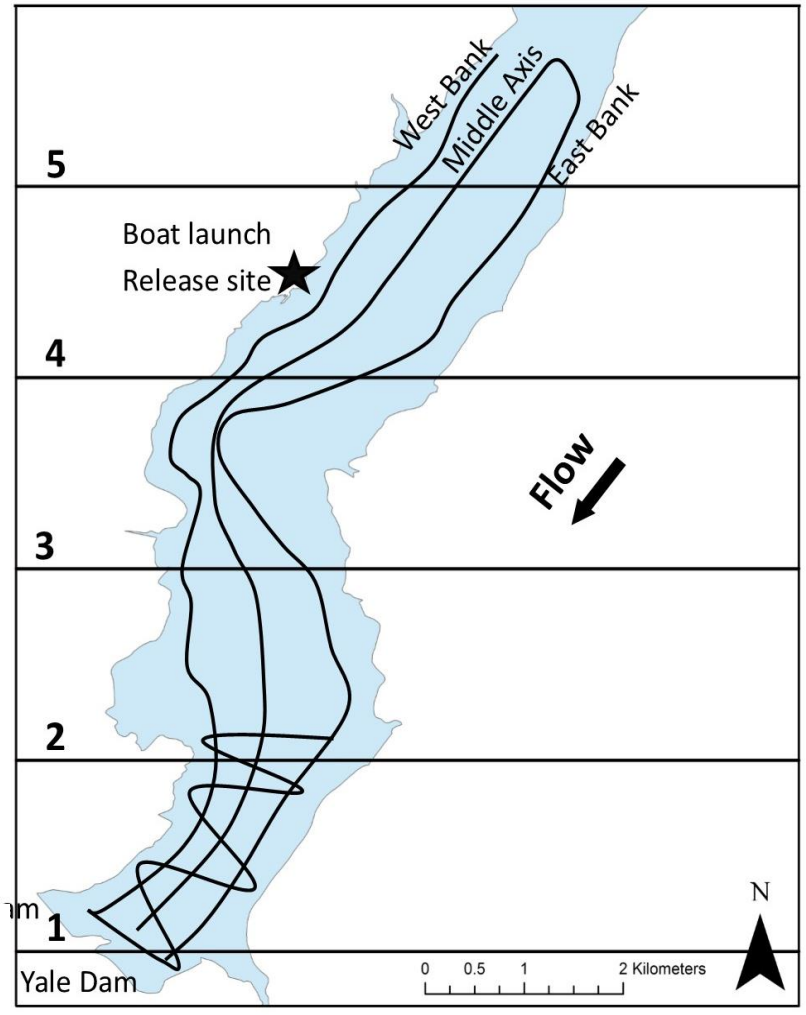
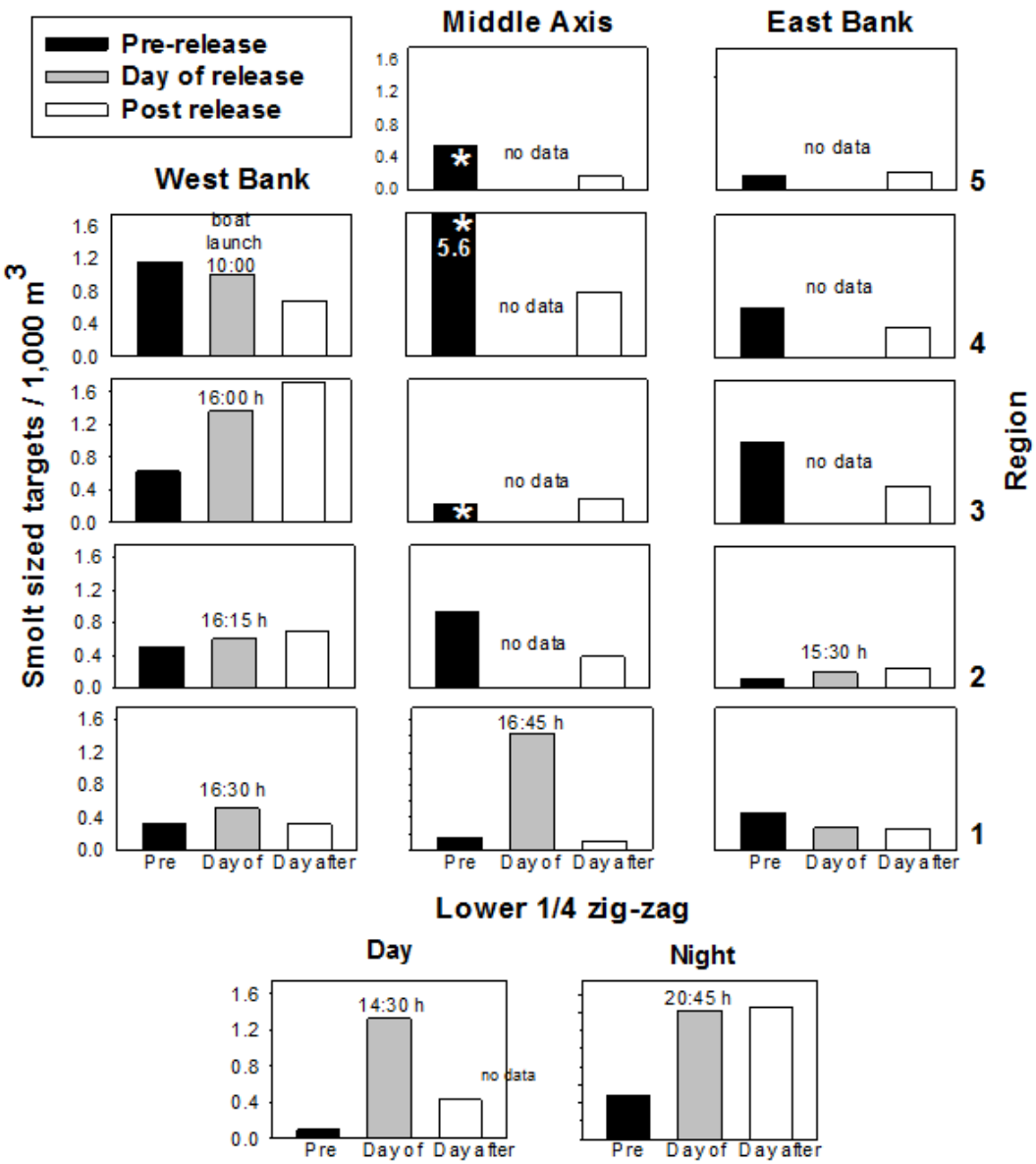
Task 4: methods **reservoir**



- Hydroacoustic survey
  - Pre-release
  - Day of release
  - Post-release
- Zones
- Paths

Task 4: Reservoir Results



- Hydroacoustic results
  - Smolts relatively rapidly move downstream to collector
    - Progress downstream
  - Use of upper water column
    - Side-looker data

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Task 4: Summary

- Emigration success
  - In-river survival not yet computed, but expected to be high
  - Residence time in Swift Reservoir from PIT-tagged data for Coho = ~4 months, Spring Chinook = > 2 months
  - Test release data suggest relatively rapid migrations
    - Radiotelemetry data
      - 5.2 km/day travel rate
    - Hydroacoustics, Yale
      - Yale Park – Dam = ~7 km
  - Together results suggest difficulties of fish “finding” collector

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Task 5: Evaluation of Lake Merwin predator impacts

Objectives and methods

1. Estimate abundance and size structure of predators
2. Quantify predator-prey interactions and evaluate if predation will be a limiting factor for anadromous populations
3. Quantify spatial and temporal distributions of predators, which may provide information for potential control efforts, if needed

Task 5: Evaluation of Lake Merwin predator impacts: methods

- Estimate abundance and size structure of predators
  - Northern Pikeminnow
  - Seasonal sampling
    - Gill nets
      - Variety of gill net sizes
      - Mesh sizes 2.5 – 15.2 cm stretch
      - Perpendicular to shore
      - 24-hour sets

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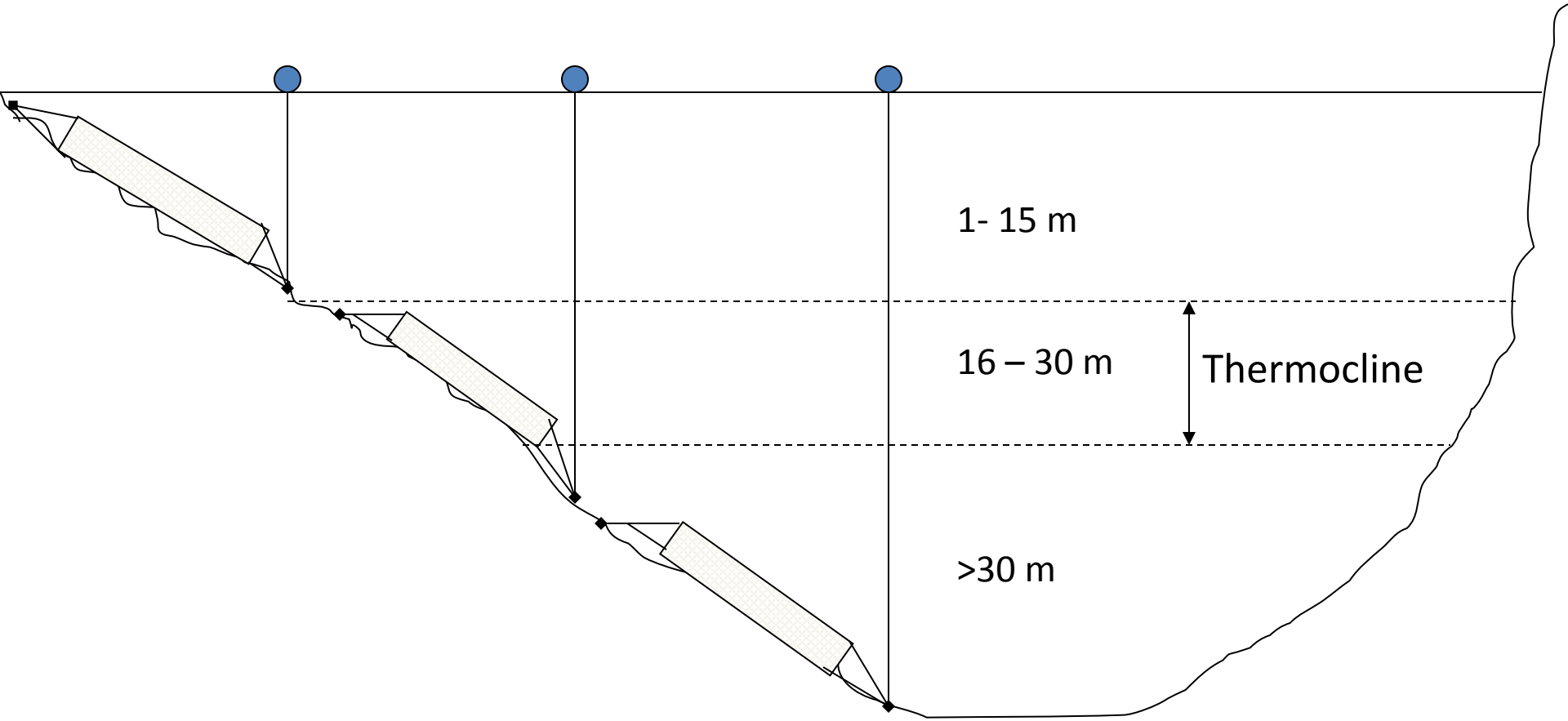
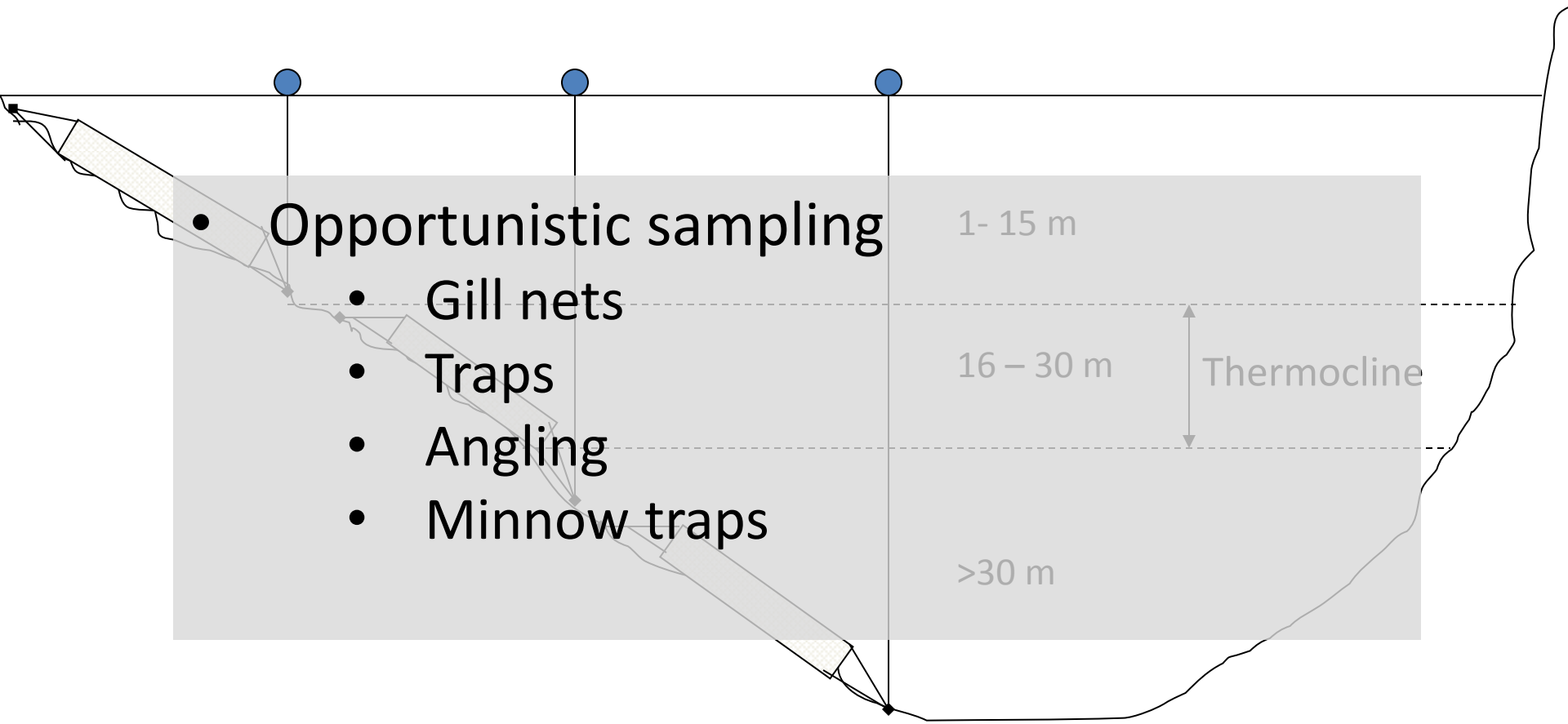
Task 5: Evaluation of Lake Merwin predator impacts: methods



Depth-Stratified Sinking Gill Nets in Littoral and Slope Zones

Task 5: Evaluation of Lake Merwin predator impacts: methods



- Opportunistic sampling
  - Gill nets
  - Traps
  - Angling
  - Minnow traps

Task 5: Evaluation of Lake Merwin predator impacts: methods

- Estimate abundance and size structure of predators
    - Gill netting
        - Mark-recapture study to estimate abundance (2013 – 2014)
            - External floy tags
            - Chapman estimator

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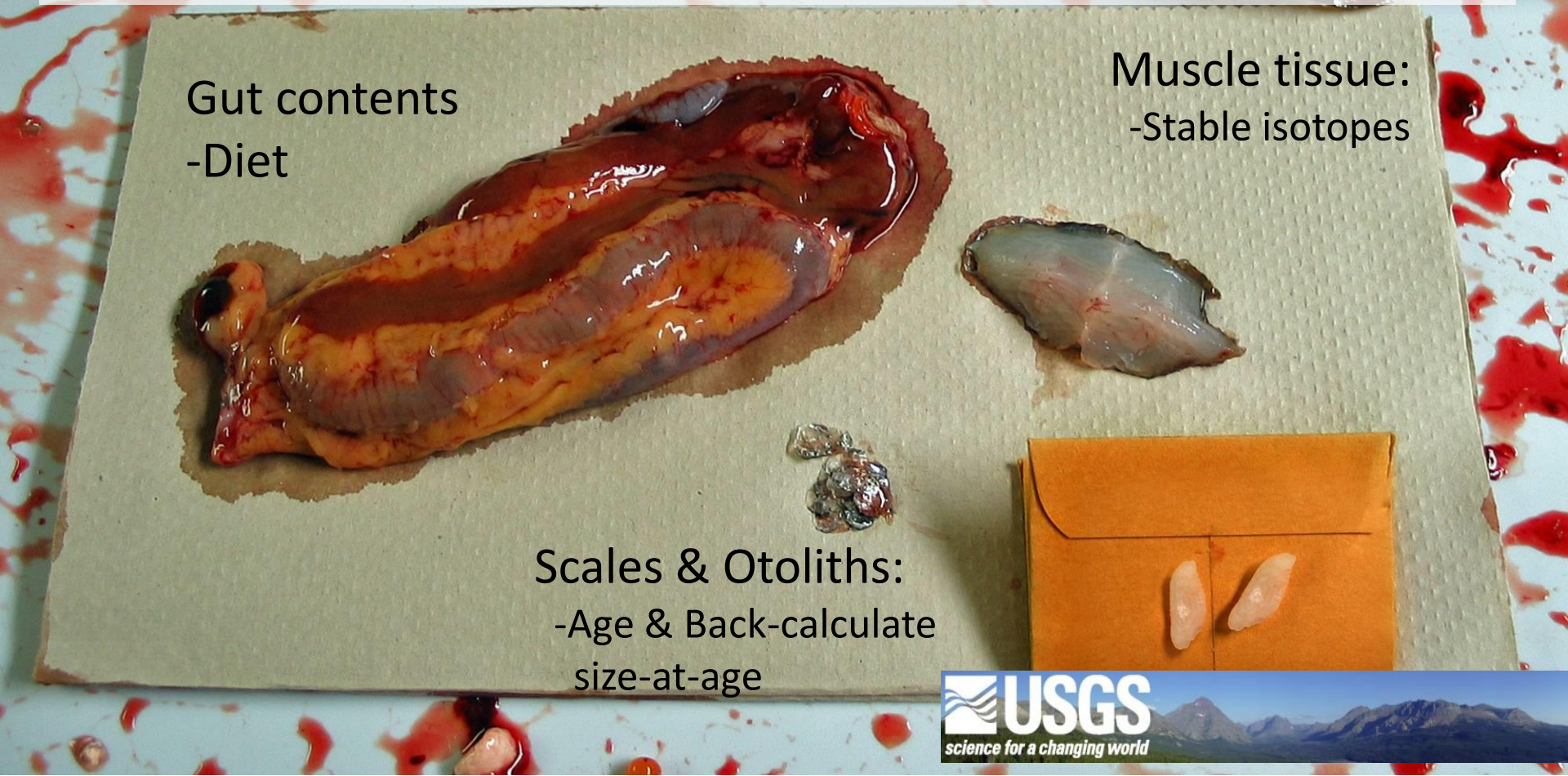
Task 5: Biological and diet data

- Biological data
  - Size, age, growth, diet, energetic, trophic & reproductive status



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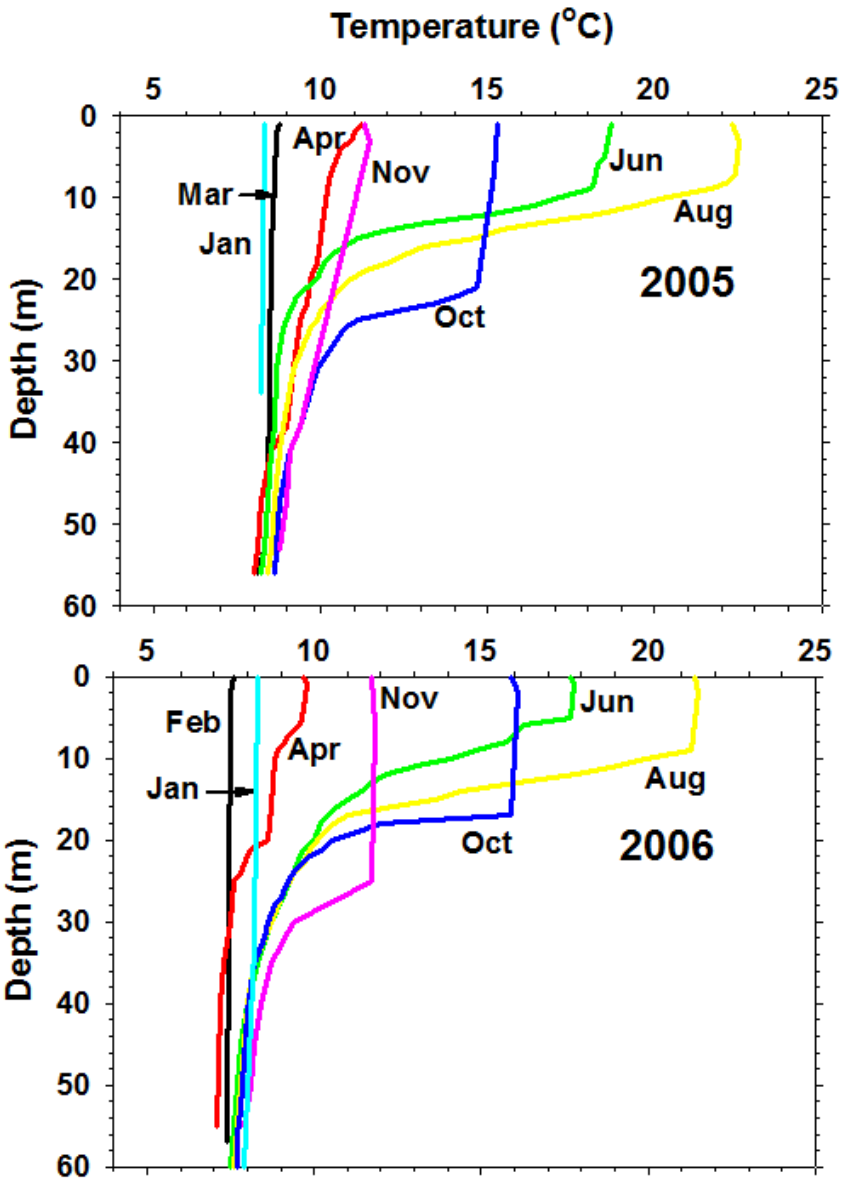
Task 5: Thermal Environment

- Limnological and thermal data collected



Task 5: Lake Merwin predation potential

Temporal Diet Composition

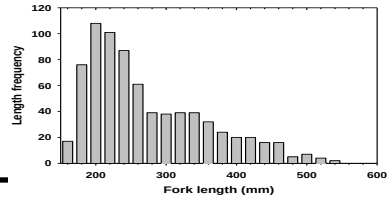
Consumer Growth

Predator Energy Density

Thermal Experience

Prey Energy Density

Bioenergetics Model



Consumer Size Structure & Abundance

Consumption Estimate

Population Consumption

Biomass of Exploitable prey

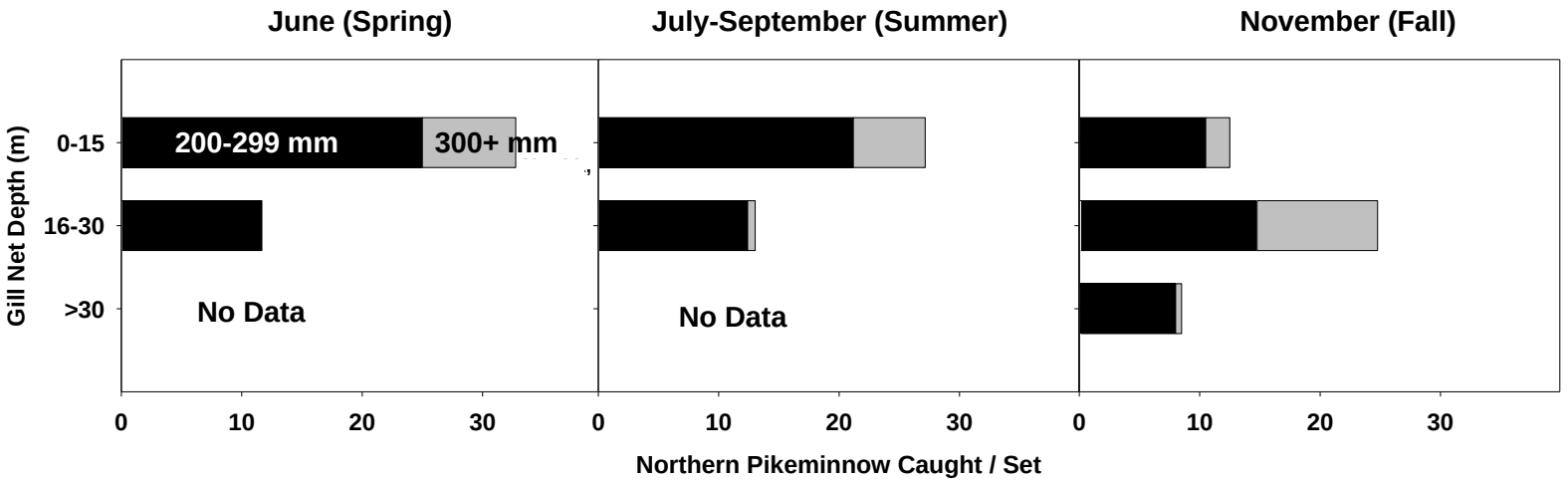
Consumption as % of Prey Biomass or Production

Task 5: Results

Task 5: Results

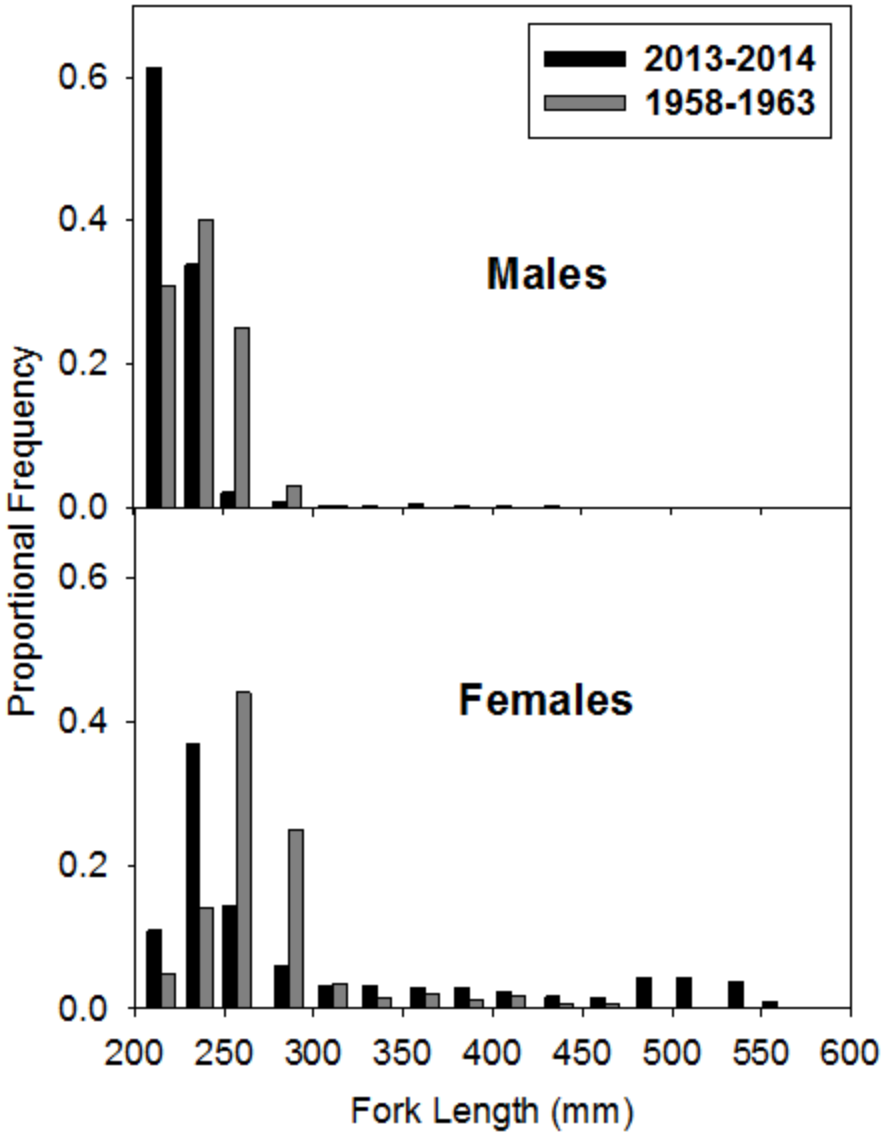
- Abundance
  - Northern Pikeminnow
    - Tagged > 2,000 fish
    - Abundance > 200 mm = 314,000 (95% CI 175,000 – 583,000)
    - Abundance >300 mm = 5,200 (95% CI = 2,200-13,900)
  - Preliminary estimate of >300 mm NPM
    - Low
    - Bias correction, gear
    - Spatial variability in sampling

Task 5: Results

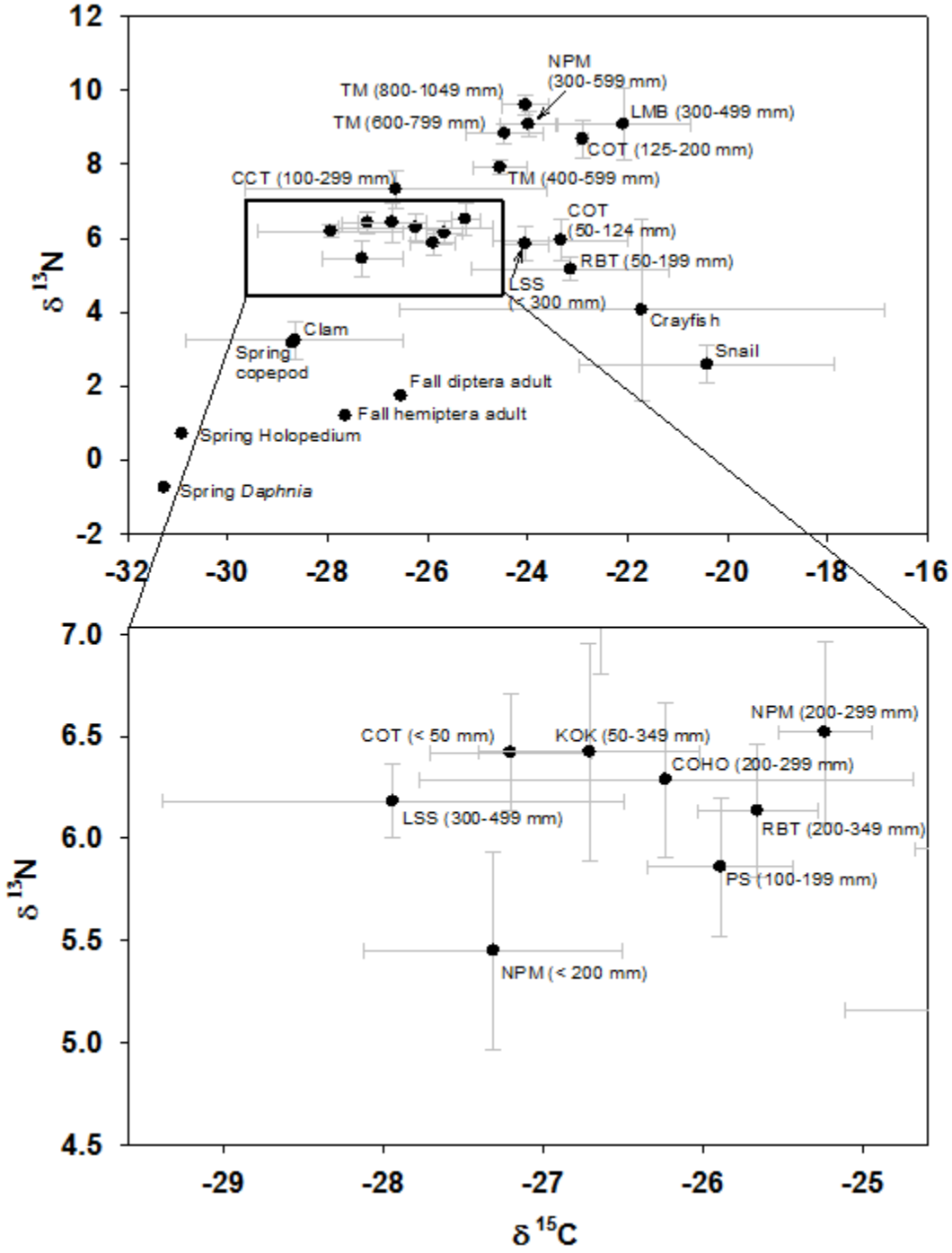


- Distribution
  - Majority of NPM in upper 15 m during stratification
  - High predation potential during all seasons, but particularly during spring/summer

Task 5: Results

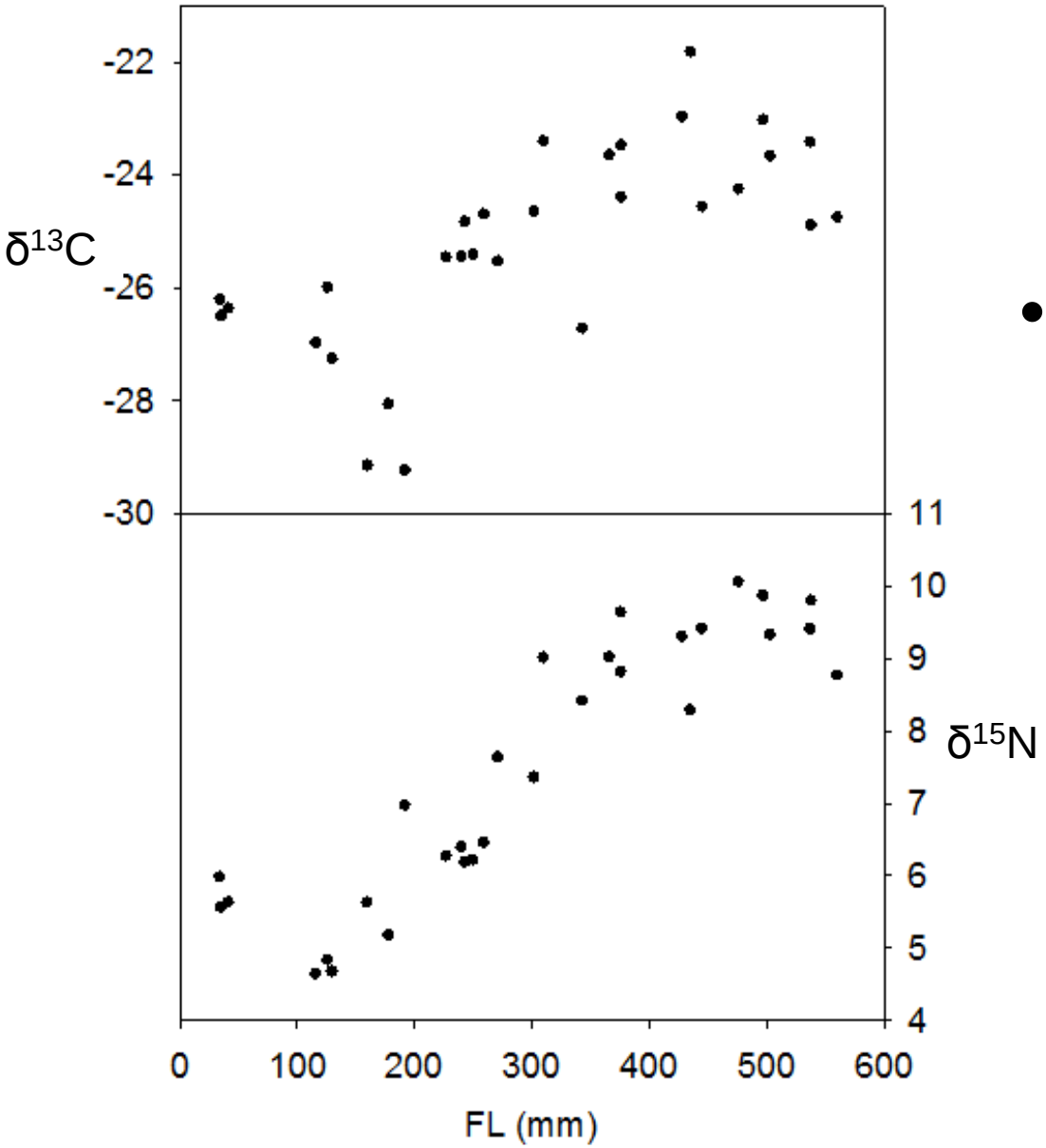


- Size distribution
  - Northern Pikeminnow
- Tiger Muskie controls
  - Fewer >250mm fish
  - Artifact of matching up comparison



Task 5: Results

- Stable isotope data
  - Substantial differences in trophic level and forage
    - NPM
      - >300 mm
      - <300mm
    - Tiger Muskie



Task 5: Results

- NPM length-isotope
  - Strong relationships with size
    - Forage base
    - Trophic structure

Task 5: Results

- Bioenergetics simulations
  - In progress
    - Estimate potential consumption of salmonids
    - Cannibalism
    - Tiger Muskie-controls

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Next steps

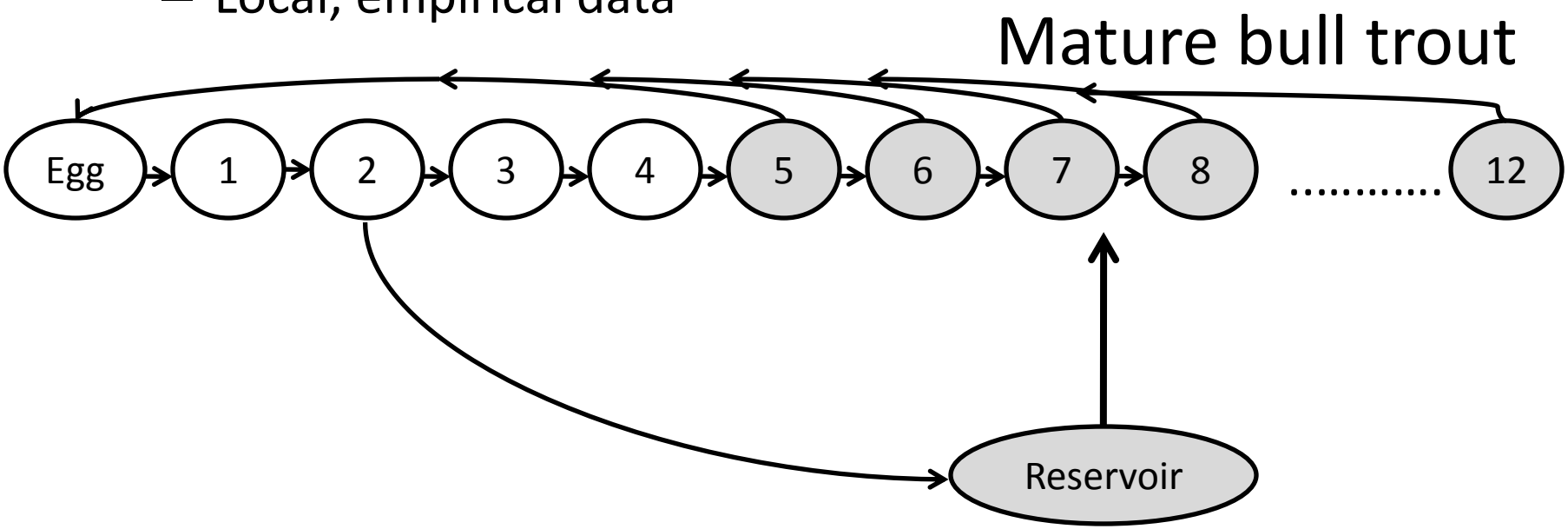
- Finalize fieldwork-related to emigration, instream survival, final isotope data collection, lab work

Next steps

- Finalize fieldwork-related to emigration, instream survival, final isotope data collection, lab work
- Integrate field data from Task 6 to model potential effects of Coho on existing bull trout populations
  - Yale, Swift

Individual-based model

- Small population in Swift/Yale
  - Enables tracking of individuals
  - Averages for small populations not applicable (e.g., matrix models)
  - Local, empirical data



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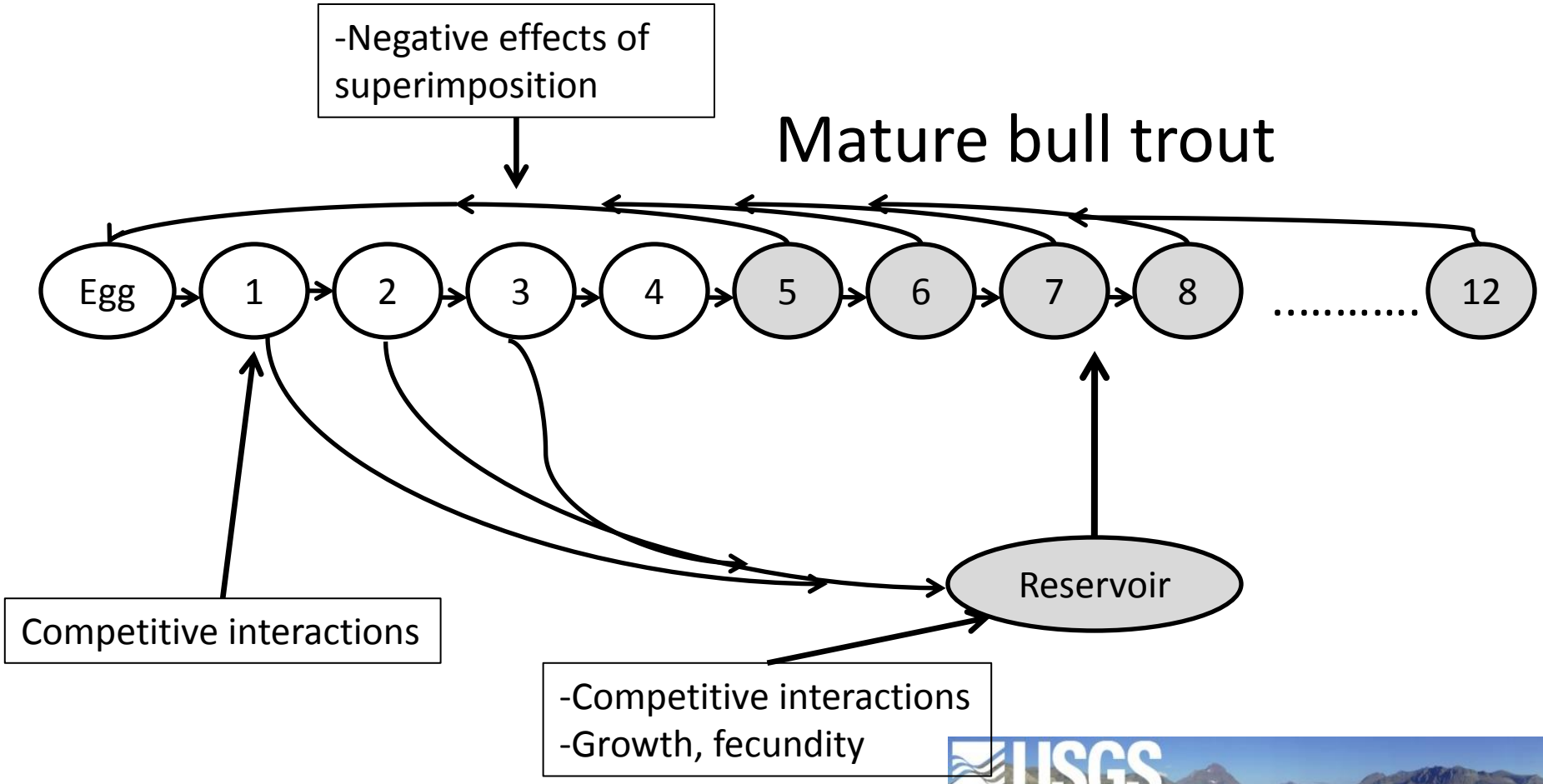
Individual-based model

- Small population in Swift/Yale



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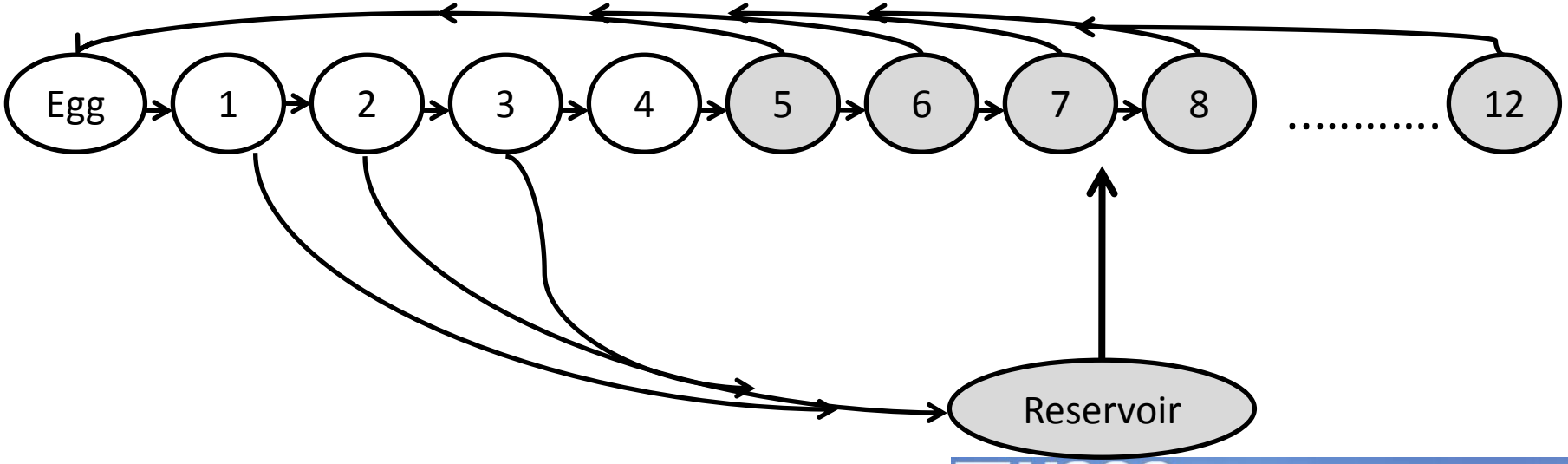
Individual-based model

- Small population in Swift/Yale
  - Empirical estimates of growth, life-history, etc.
- Likely risk to populations



Al-Chokhachy et al. 2015 Transactions of the American Fisheries Society

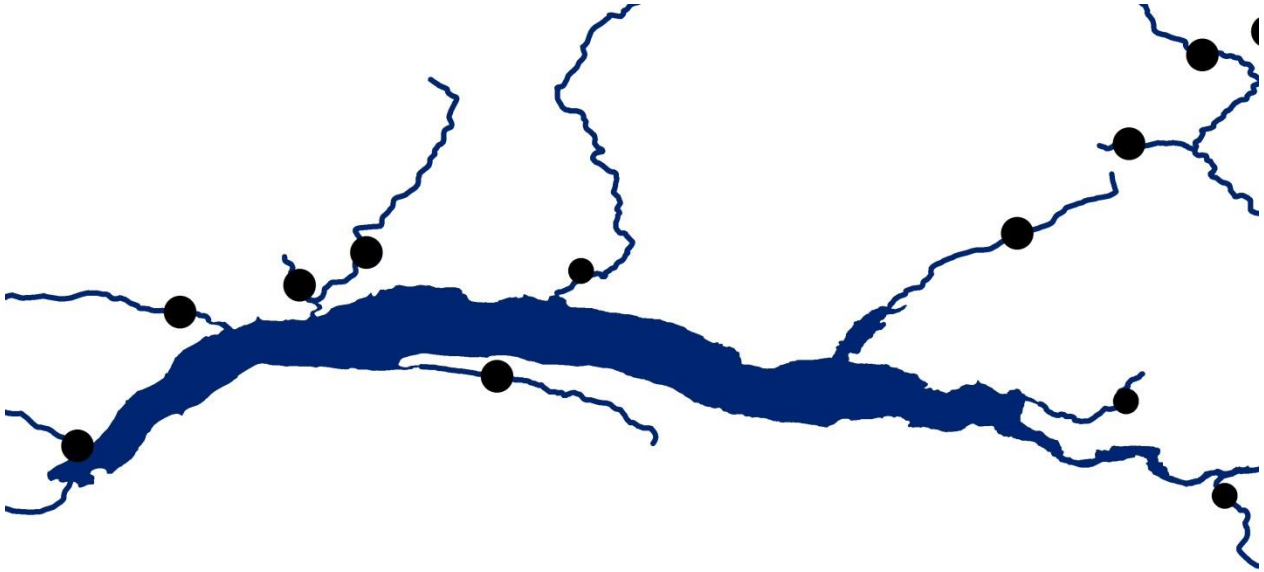
USGS science for a changing world

Next steps

- Finalize fieldwork-related to emigration, instream survival, final isotope data collection, lab work
- Integrate field data from Task 6 to model potential effects of Coho on existing bull trout populations
- Assess feasibility of reintroductions in Yale and Merwin

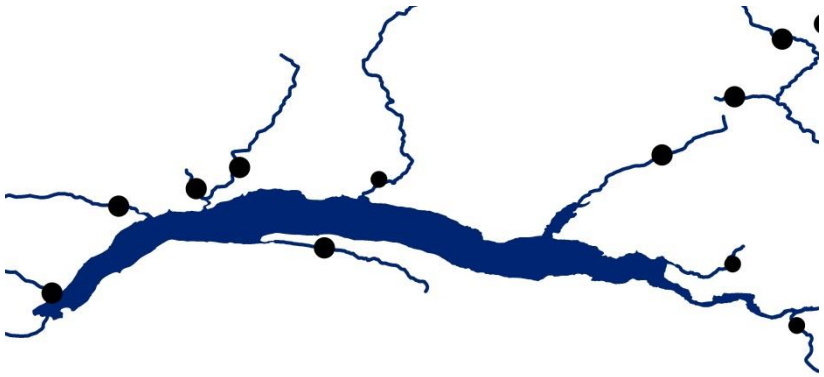
Reintroduction feasibility

- Integrate results different field components
- Modeling framework



Reintroduction feasibility

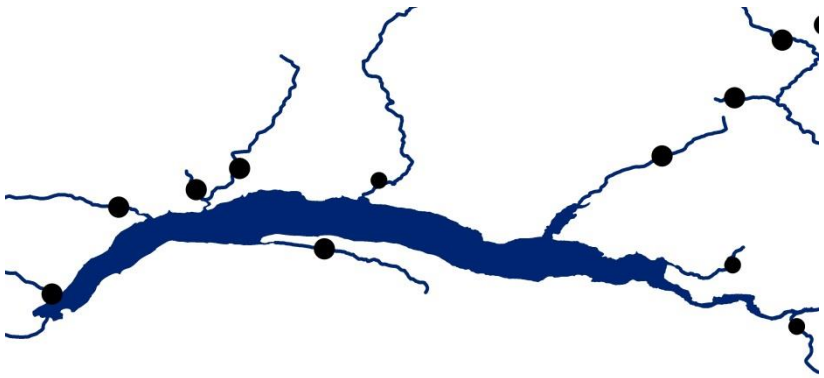
- Modeling framework



Juvenile production

Reintroduction feasibility

- Integrate different field components

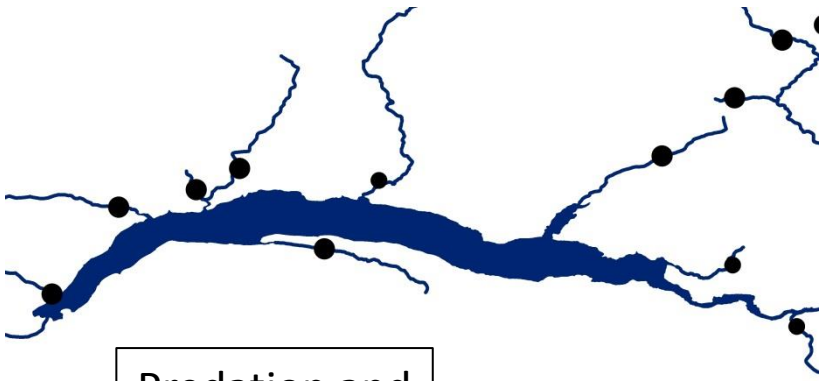


Juvenile production

Travel times and reservoir rearing

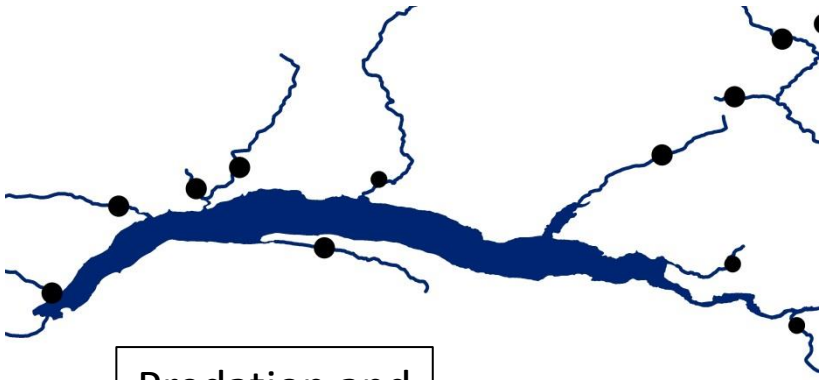
Reintroduction feasibility

- Integrate different field components



Reintroduction feasibility

- Integrate different field components



Juvenile production

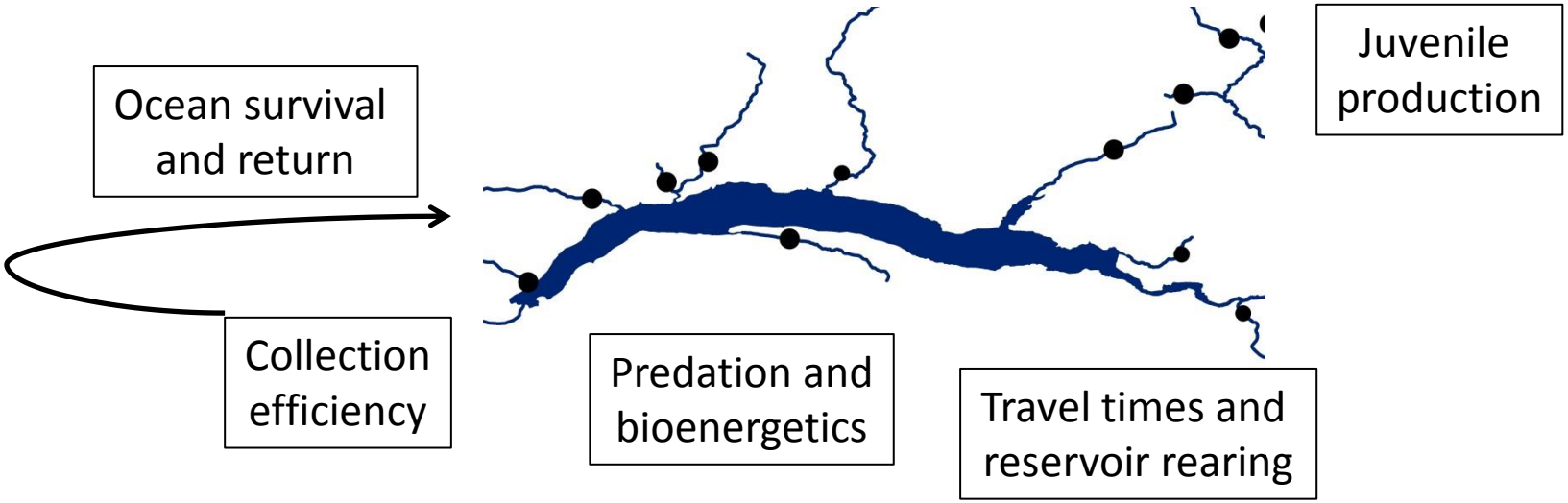
Collection efficiency

Predation and bioenergetics

Travel times and reservoir rearing

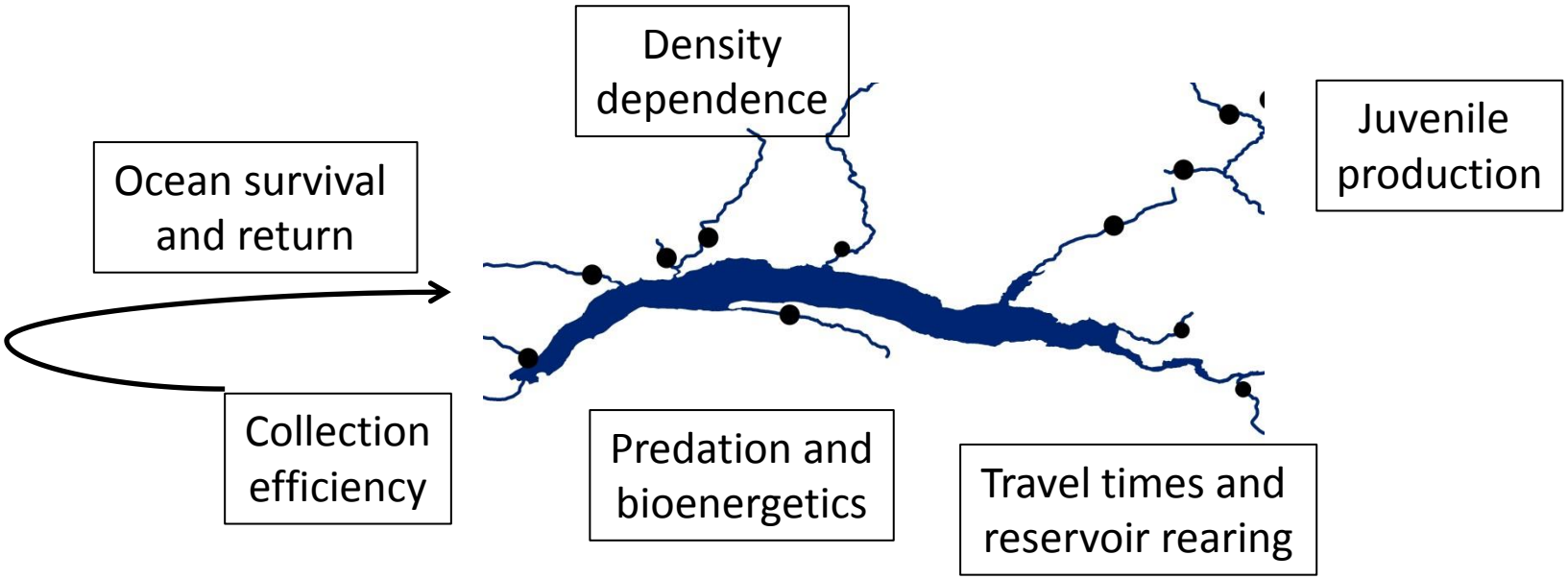
Reintroduction feasibility

- Integrate different field components



Reintroduction feasibility

- Integrate different field components



Questions