Straying by species, life history types, and populations in the Columbia River basin

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Portland, Oregon
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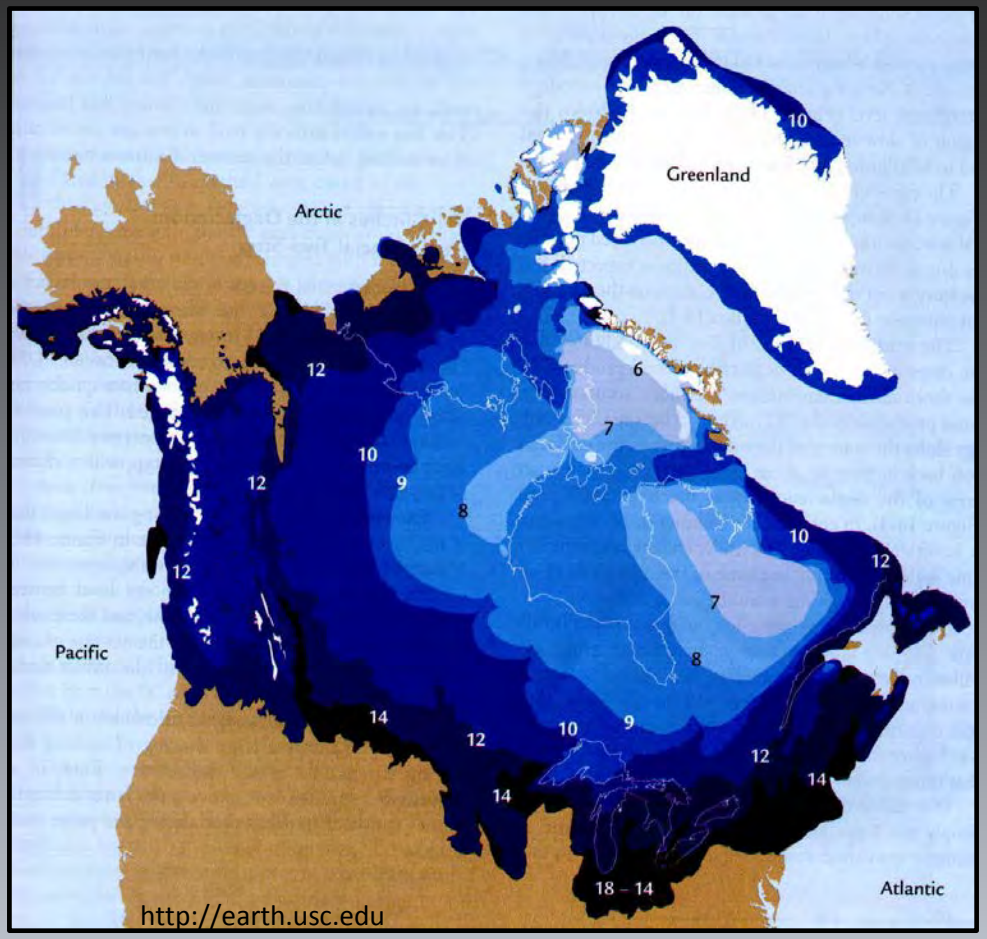
R. Hovel

Benefits of straying



http://earth.usc.edu

R. Krimmel/USGS

Google images

Straying as a conservation concern

Aquaculture escapees

Hatchery-produced strays

The key overarching question…

How have human-caused disturbances affected straying?

Fundamental knowledge gaps, particularly natural variability in the general biological phenomenon, severely impede the ability to understand the potential effects of human-caused disturbances.

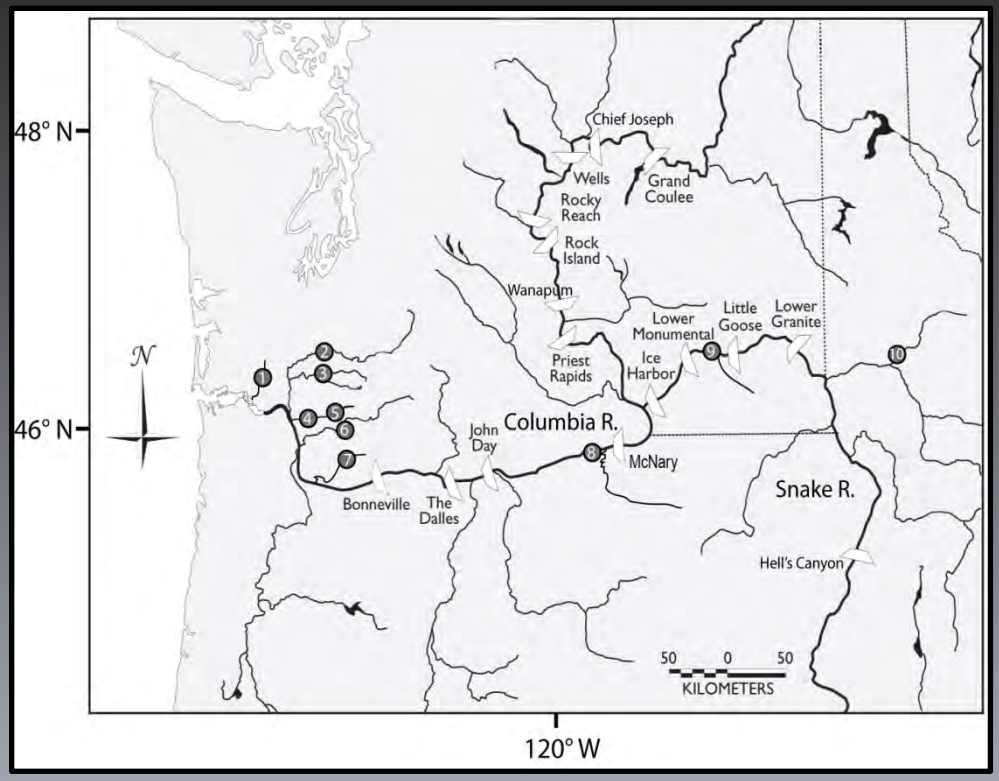
Objective

To use wealth of coded-wire tag recoveries in the Columbia basin to ask:

While all else is equal, do species, life history types, and populations stray at similar or different rates?

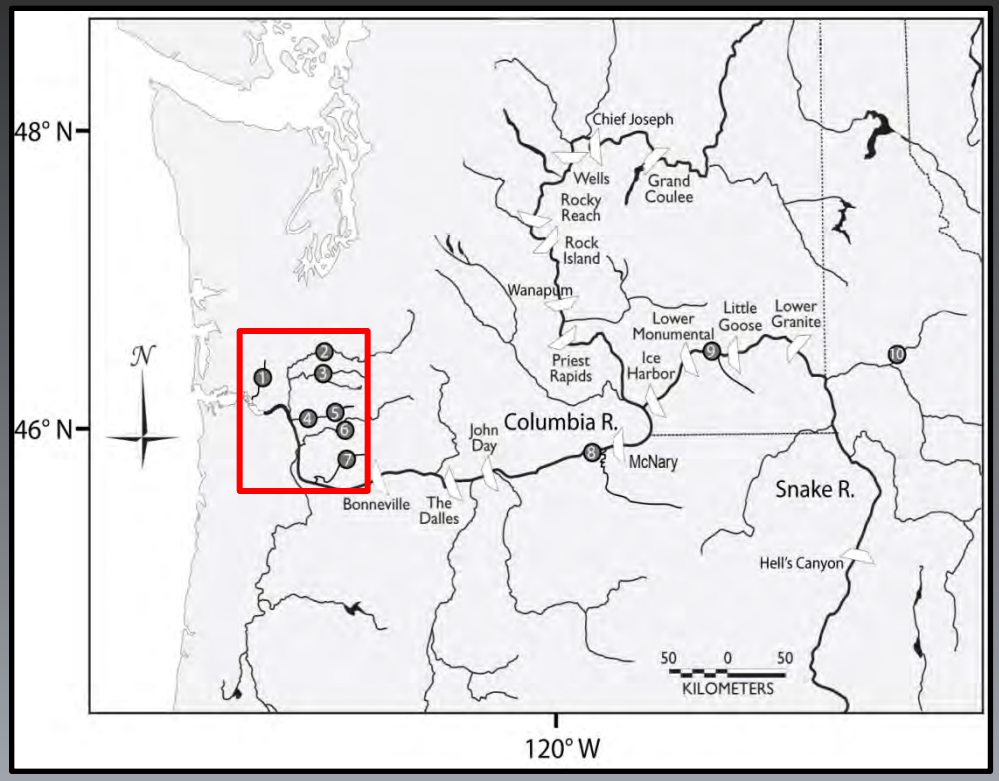
Approach

1. Freshwater recovery and release information from www.rmpc.org
2. Identified 10 hatcheries that produce multiple species and/or life-history forms in multiple years
   - 7 produce Chinook and coho salmon
   - 3 of the above produce stream-type and ocean-type Chinook
   - 3 others produce Chinook and stream-maturing steelhead
3. Rigid data filter applied
   - Paired-releases
   - On site rearing and release
   - 'Local' brood stock
   - Experimental releases removed
4. Definition of stray
5. $100 * \frac{\sum \text{tags recovered as strays}}{\sum \text{all tags recovered}}$
6. Hypothesis testing- GLM, quasi-binomial error (logit link), model selection $QAIC_c$



Results- Chinook vs. coho salmon

1. 186,870 recoveries (62% coho, 8% ocean-type Chinook, 30% stream-type Chinook) of 34, 207,055 tagged releases
2. Grand mean straying:
   - Ocean-type Chinook (15.3%)
   - Stream-type Chinook (4.4 %)
   - Coho salmon (0.52%)
3. Rank pattern consistent in all locations (i.e. ocean-type Chinook > stream-type Chinook > coho salmon)
4. Overwhelming support for effects of species, life history, population, and year of release (next model 163 log-likelihood units worse)
5. Level of straying correlates across the landscape- locations that produce high or low straying do so irrespective of species
6. Straying of Chinook and coho positively correlated within a release year



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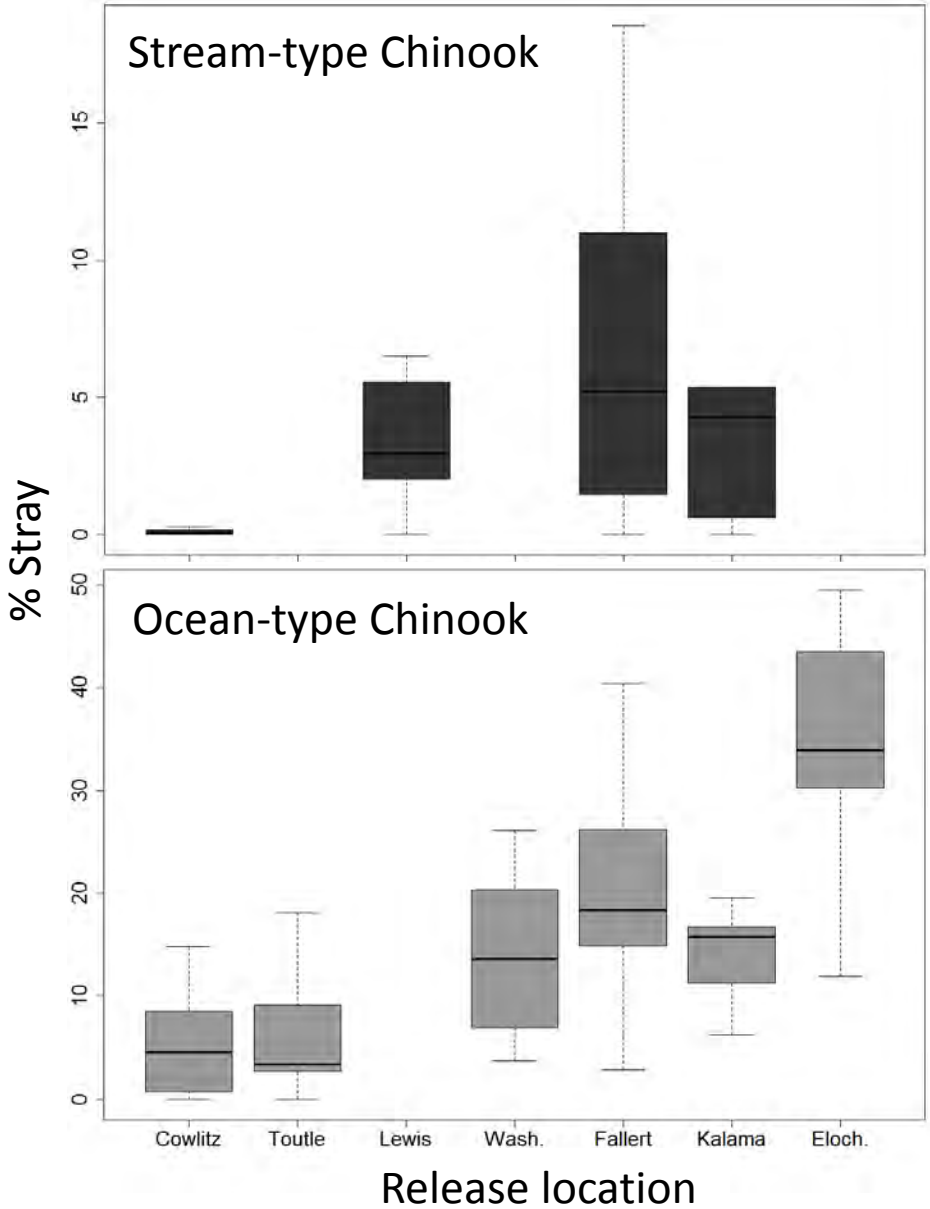
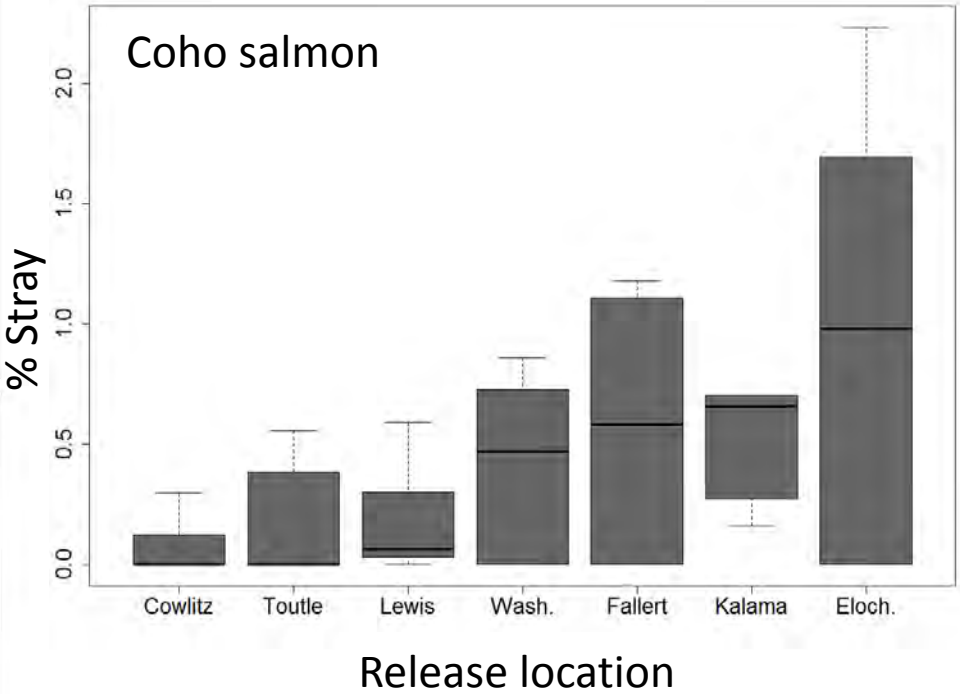
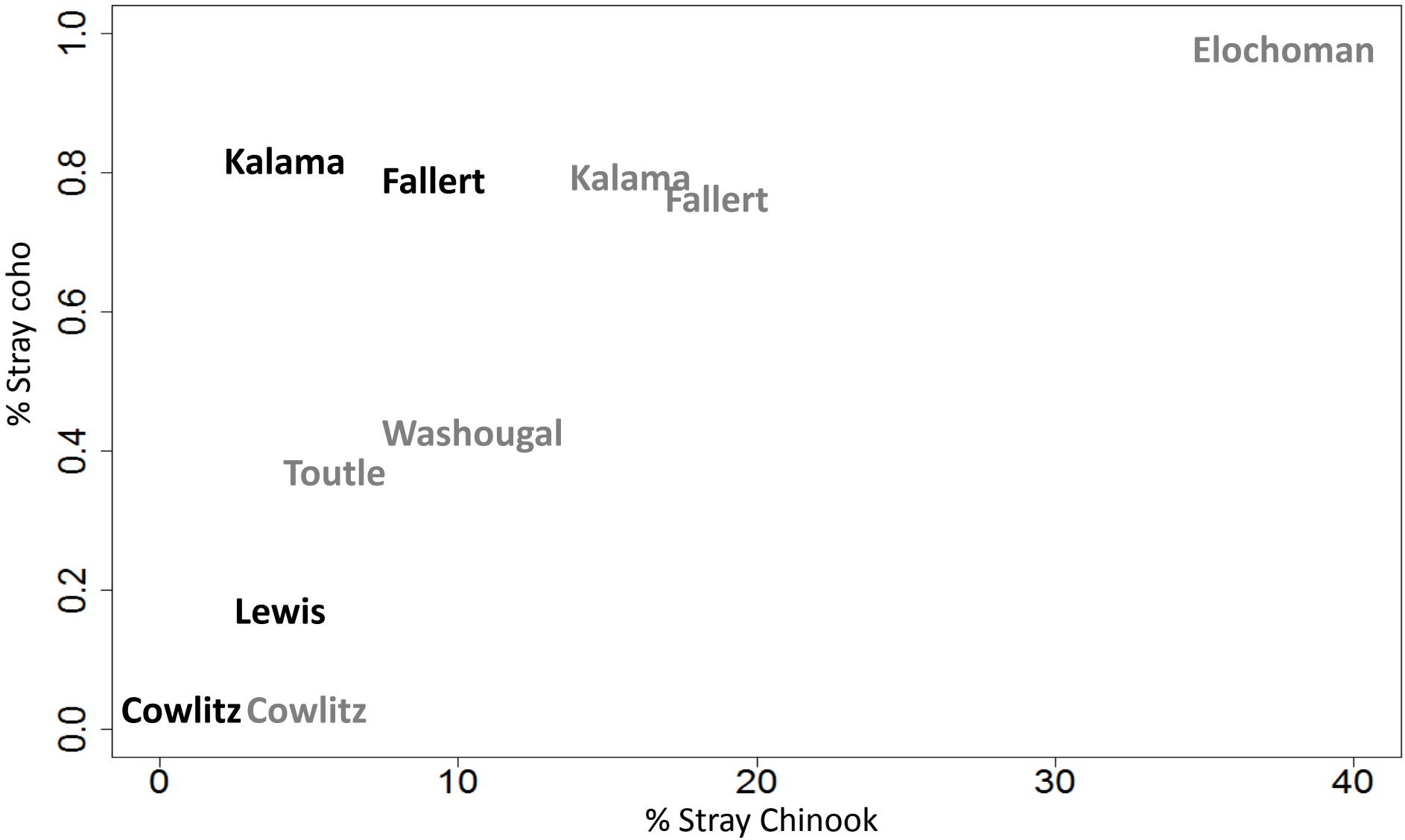


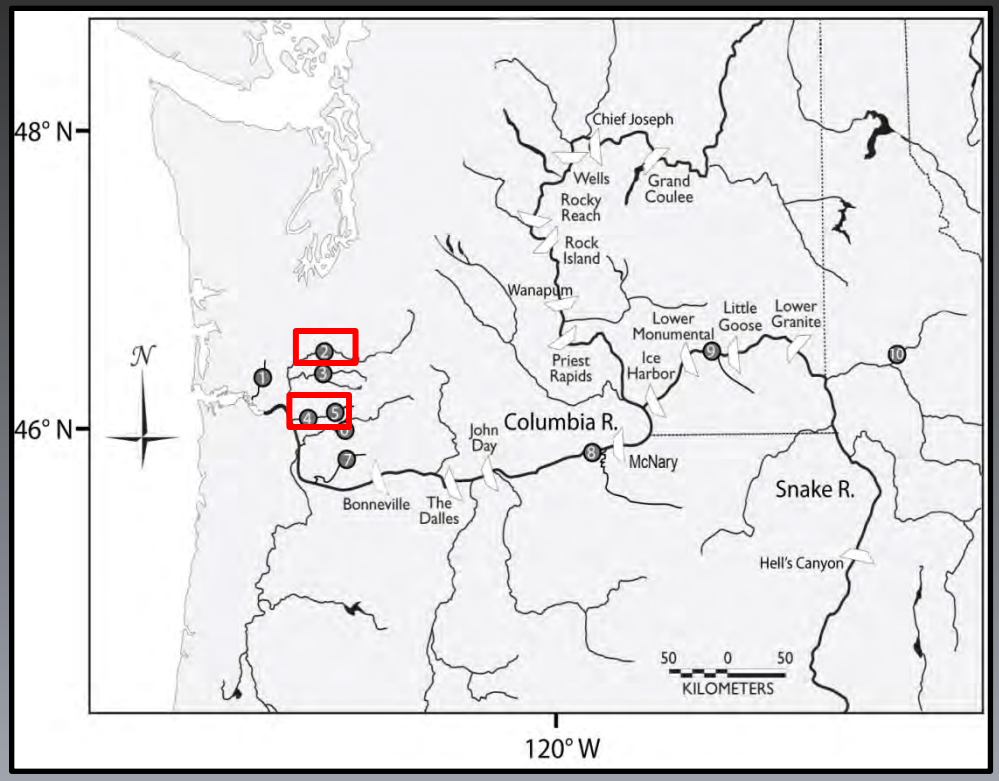


Rate of straying positively correlated across locations

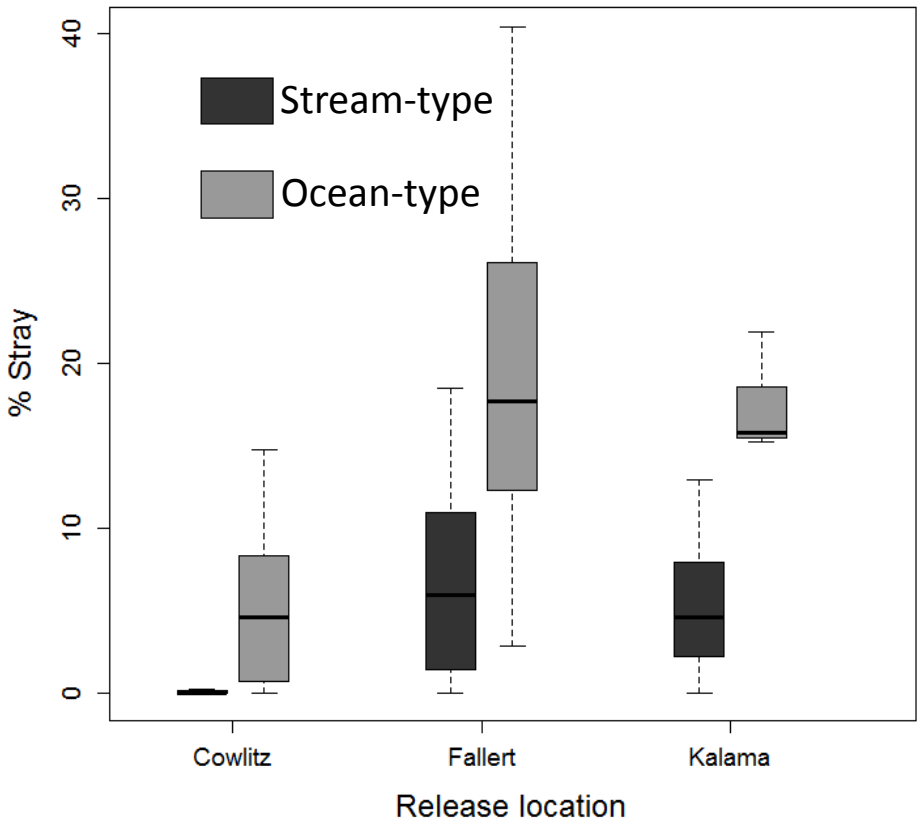


Comparisons between Chinook life history types

1. 42,987 recoveries (18% ocean-type Chinook, 82% stream-type Chinook) of 14,444,385 tagged releases
2. Grand mean straying:
   - Ocean-type Chinook (16.8%)
   - Stream-type Chinook (5.2 %)
3. Rank pattern consistent in all locations (i.e. ocean-type Chinook > stream-type)
4. Strong support for effects of life history & population (Inclusion of year-effect 40 log-likelihood units worse)
5. Level of straying correlates across locations
6. Straying of life history types positively correlated within a release year



Ocean-type Chinook stray at higher rates than stream-type Chinook



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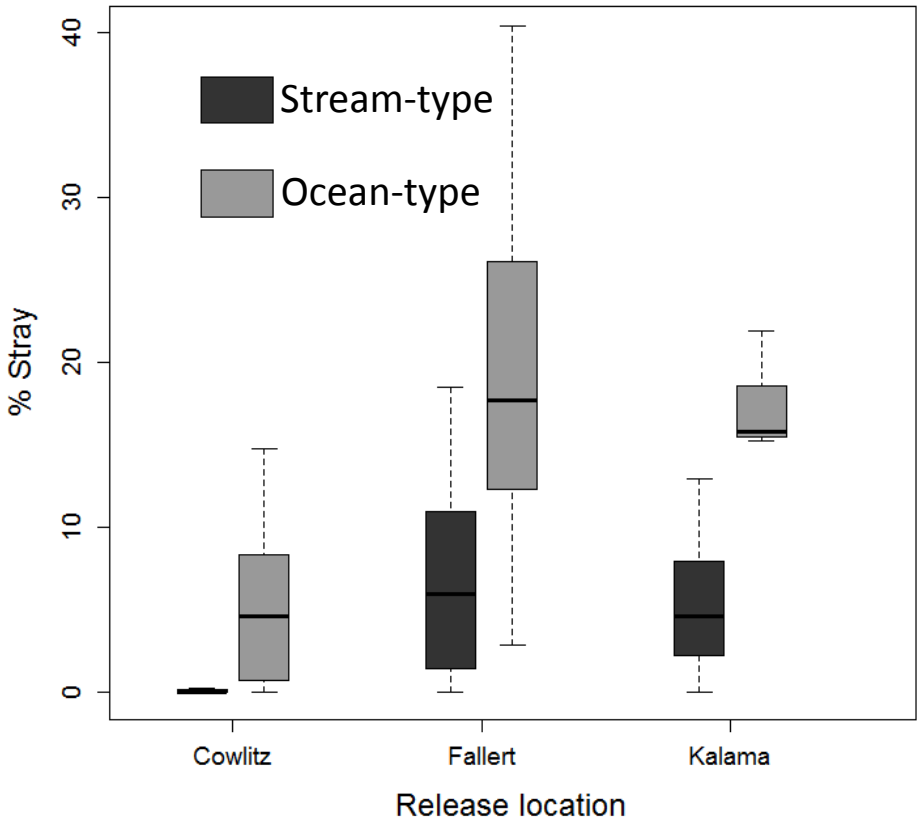
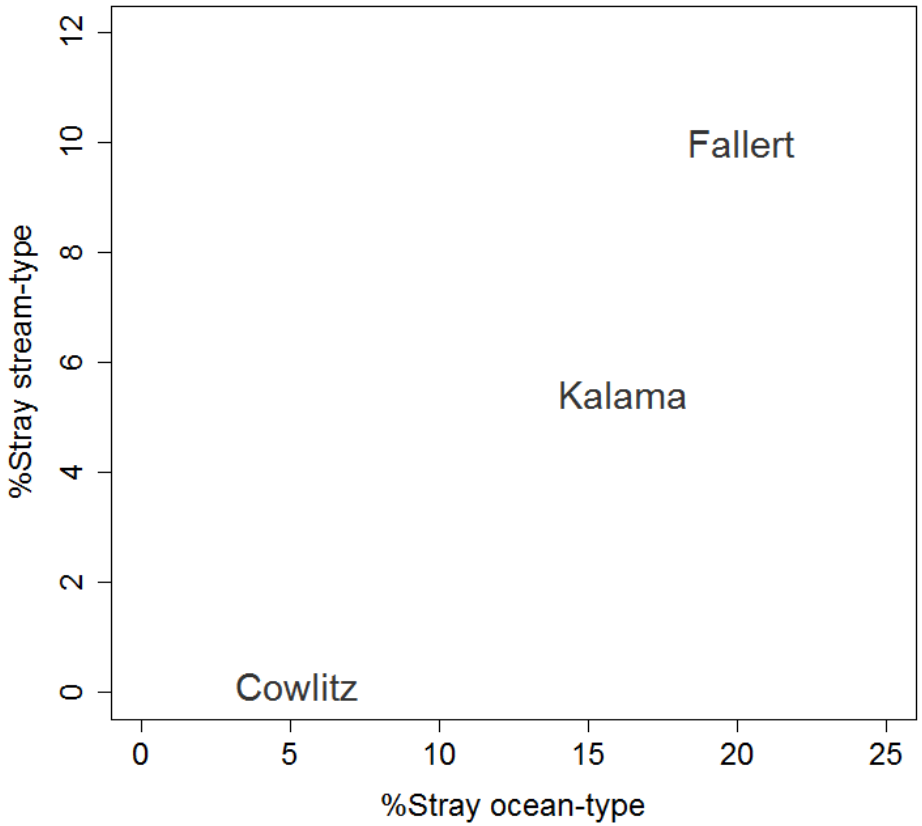
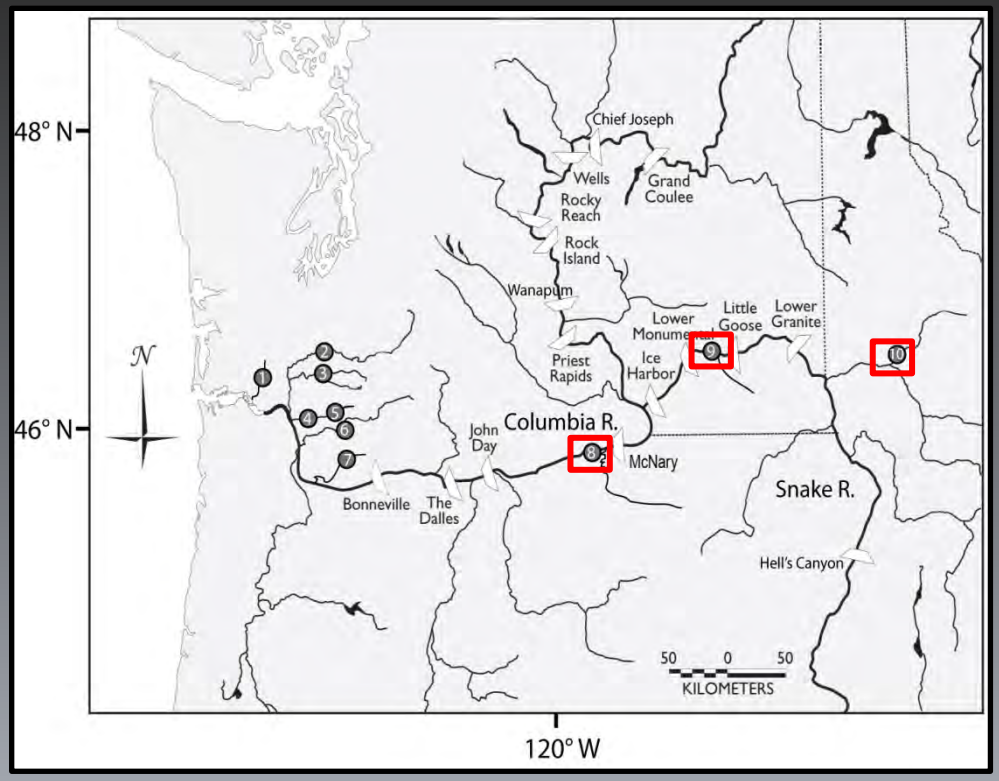




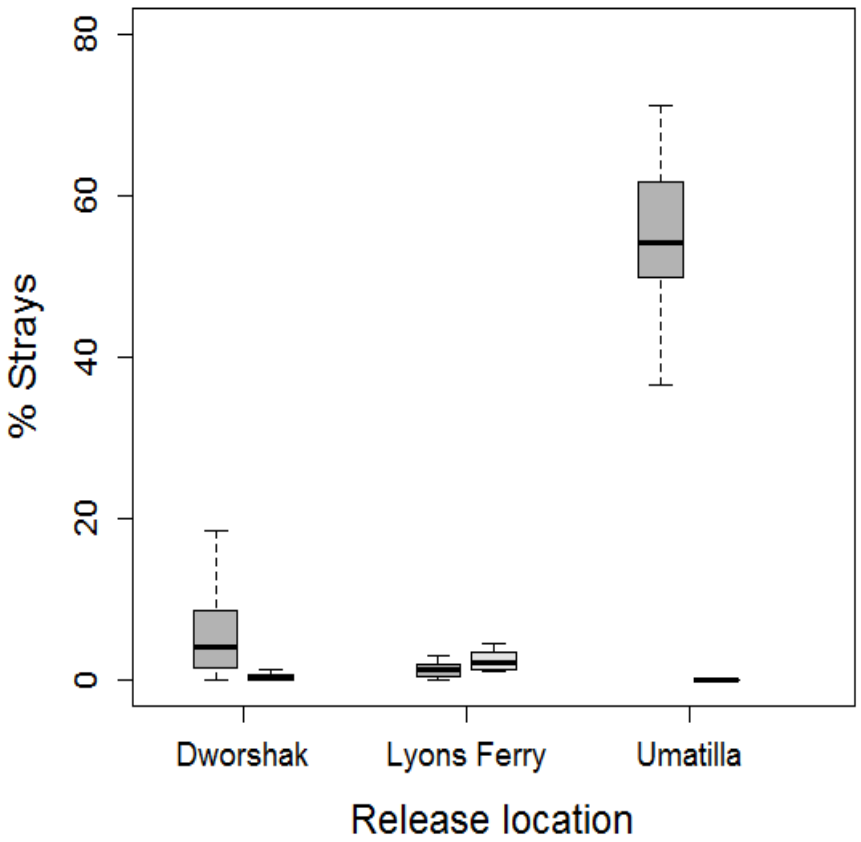
Results- Chinook vs. steelhead

1. 42,260 recoveries (79% Chinook, 21% steelhead) of 15,024,638 tagged releases
2. Grand mean straying:
   - Chinook (15.9%)
     - Umatilla (54.9%)
     - Mean excluding Umatilla (2.8%)
   - Steelhead (1.2 %)
3. 72% Lyons Ferry Chinook (ocean-type lineage) released as yearlings (atypical life history)
   - Stray yearlings (2.3%)
   - Stray sub-yearlings (0.90%)
4. Strong support for effects of species, population, smolt-age of Chinook, year of release (>38 units better then next model)
   - Similar interpretation while excluding Umatilla data



5. No correlation across locations
6. Negative correlation within paired release years (not due to Umatilla data alone)

Results- Chinook vs. steelhead



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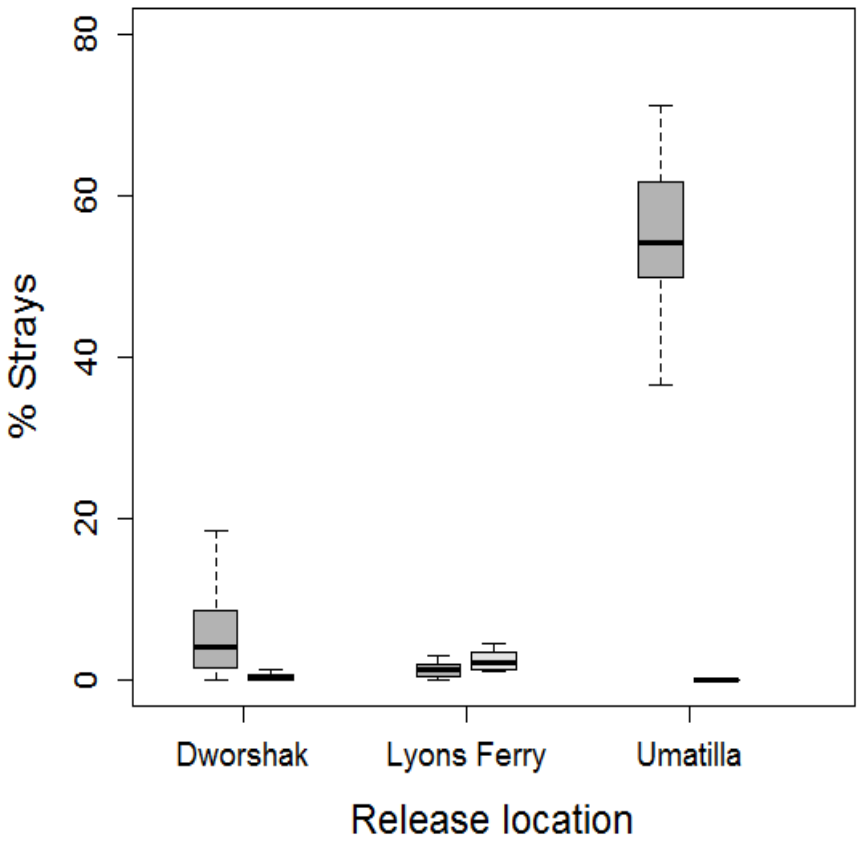
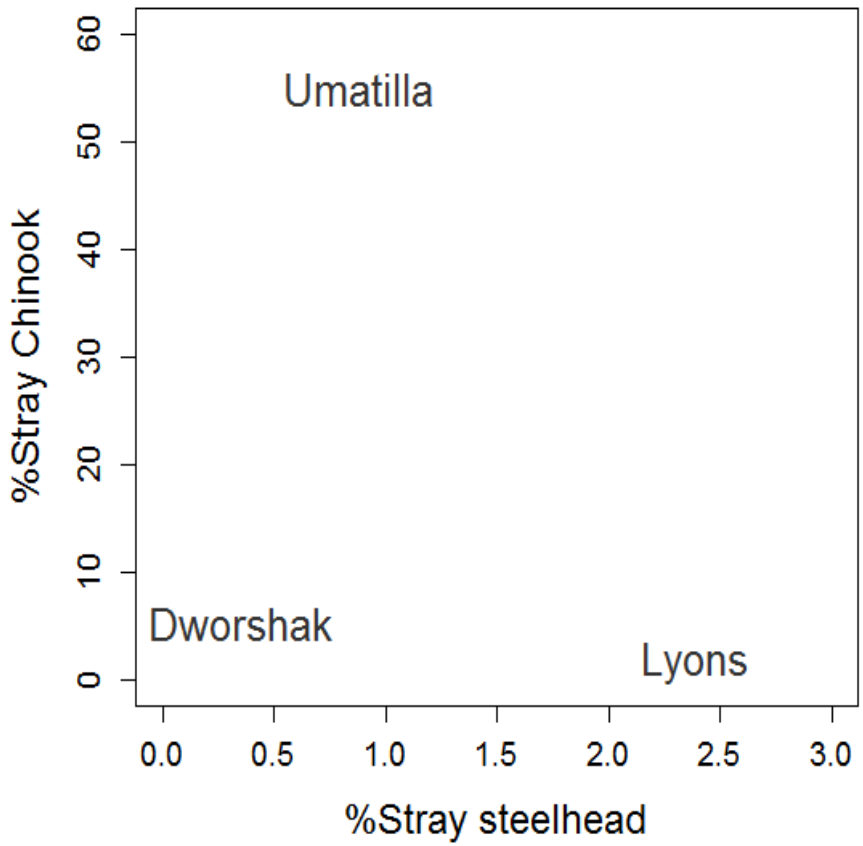
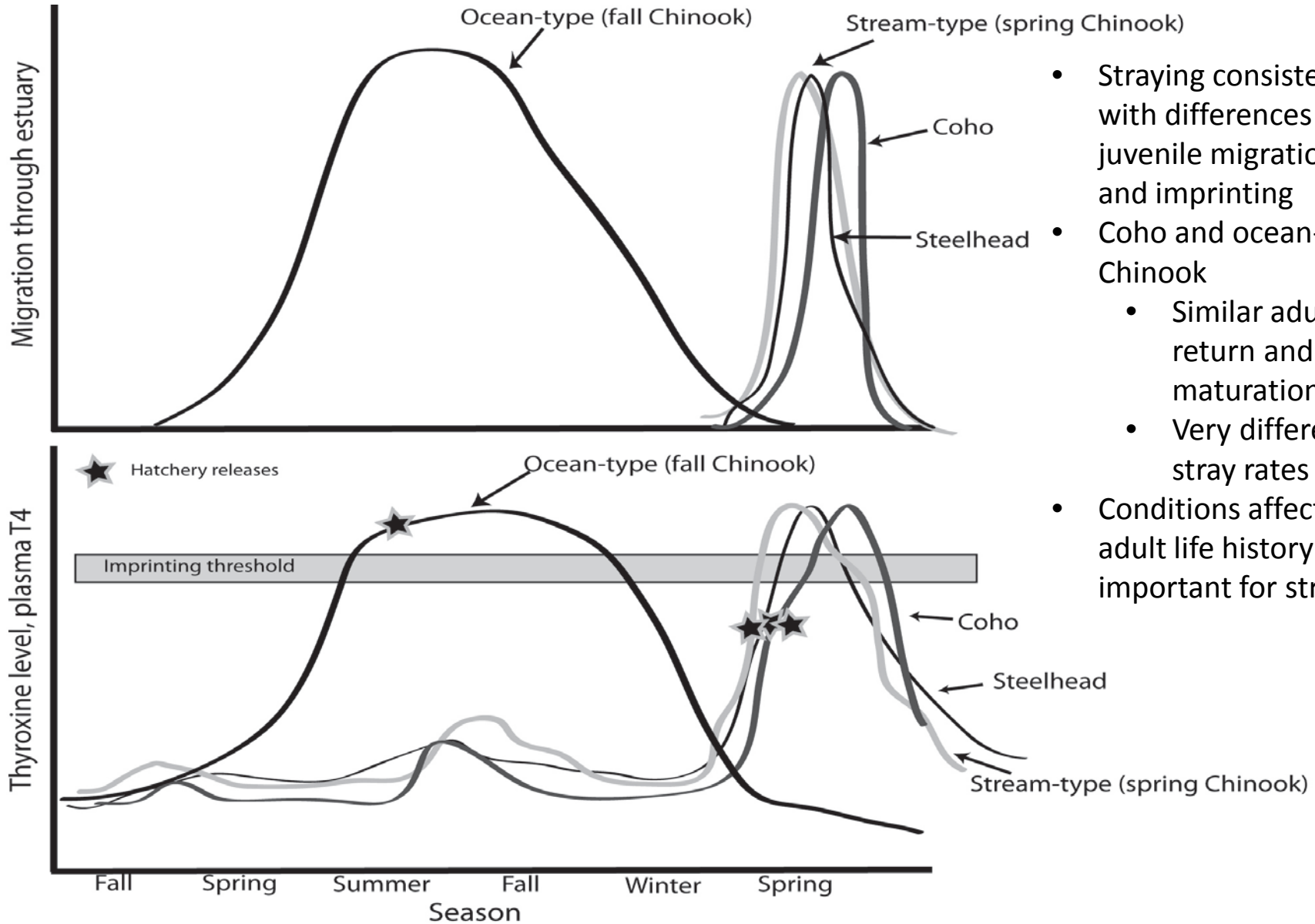




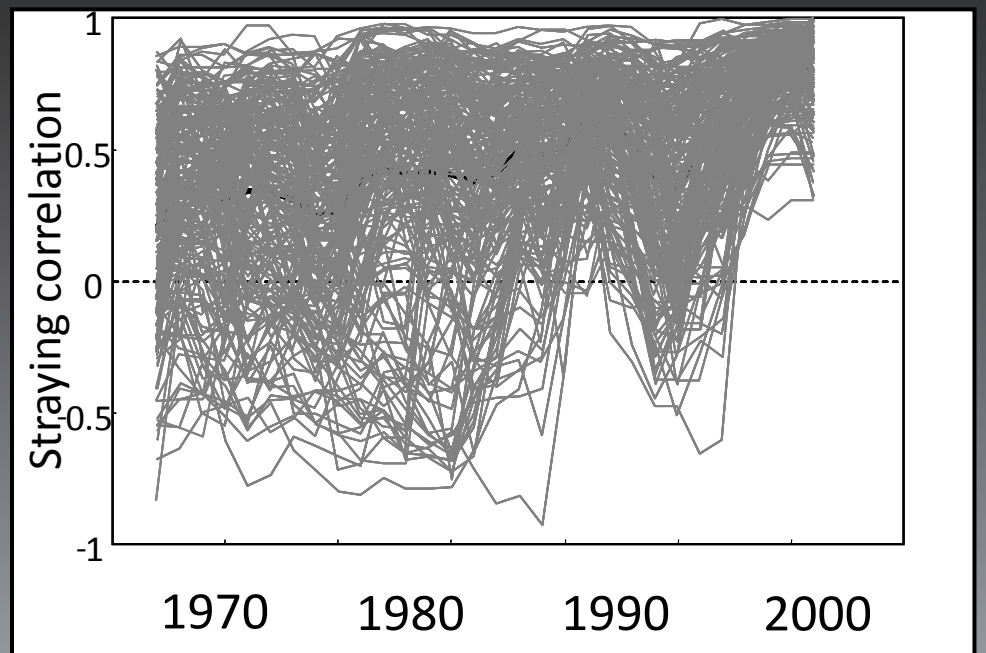
Biological interpretation of findings



- Straying consistent with differences in juvenile migration and imprinting
- Coho and ocean-type Chinook
  - Similar adult return and maturation
  - Very different stray rates
- Conditions affecting adult life history still important for straying

Future directions

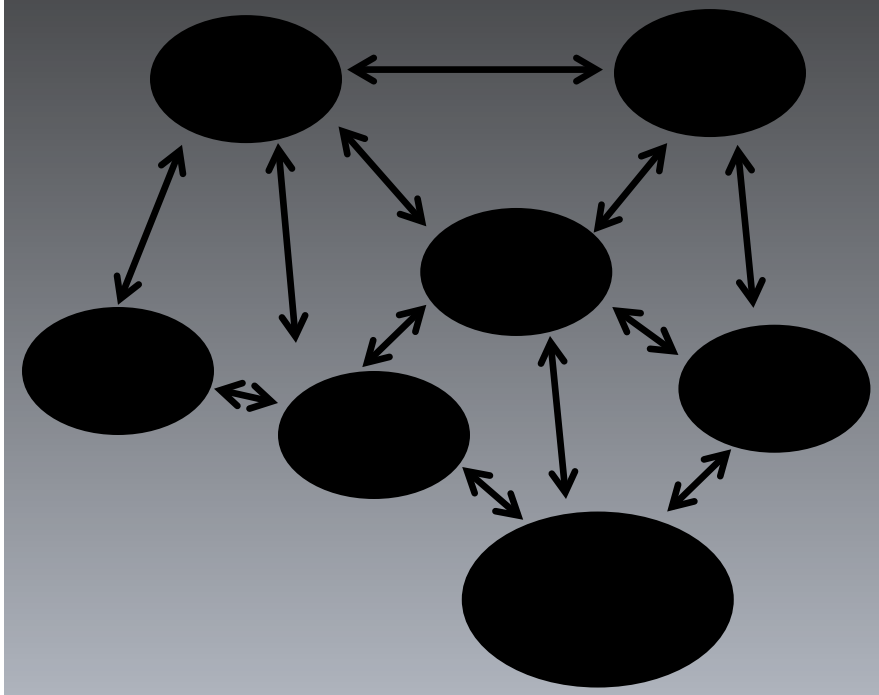
- Reveal causative factors associated with straying
- Straying as time series/portfolios
- Outward to inward looking
- Broaden dataset to more populations
- Straying in wild vs. hatchery-produced fish



Modified from Moore et al. 2010

Key insights and take home message

- Straying differs
  - Among species (coho < steelhead < Chinook)
  - Between life history form (stream-type < ocean-type)
  - Among populations
  - Among years
- Consistent with juvenile life history and patterns of imprinting
- Modification of juvenile life history may come at cost of extra straying
- Failing to include variation may yield results that are very misleading



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