Analysis of straying rates and behaviors of Snake and Columbia River salmon and steelhead

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Overall Objective

Conduct analysis of existing coded wire (CWT) and PIT tag data to identify factors associated with straying by Columbia River salmonids, with emphasis on “baseline” rates of straying, and straying associated with transport.

Specific Objectives

- **For any given site (river, hatchery), do stray rates differ between species/life history types?**
- **For any given species/life history, do stray rates differ between different populations of the same species?**
- **Do stray rates of different populations differ between years?**
- **Do environmental factors influence *straying out* (i.e., not going to the natal site) and *straying in* (i.e., entering a given non-natal river)?**
- **Do salmon *transported by barge* stray more than "run of the river" fish, and are any effects dam- or site-specific?**

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CWT Key Findings

Straying rates differed among species (i.e., Chinook, coho, steelhead), life-history types (i.e., stream vs. ocean-type), and populations of salmon in the Columbia River basin. Populations within a species may vary by an order of magnitude in their straying rates.

Westley, Quinn, Dittman 2012. Rates of straying by hatchery-produced Pacific salmon (*Oncorhynchus spp.*) and steelhead (*Oncorhynchus mykiss*) differ among species, life history types, and populations. Can. J. Fish. Aquat. Sci. 70:735–746.

The straying rates of different hatchery stocks of Columbia River basin Chinook salmon respond independently to alternative biotic and abiotic conditions. Thus predicting straying rates requires population specific estimates of response to changing conditions.

Westley, Dittman, Ward, Quinn, *In review*. Climate, density-dependence, and human factors influence dispersal plasticity in populations of a migratory fish. Ecology

We identified three types of straying patterns among sites: distinguishable (low straying out, low straying in), unattractive (high straying out, low straying in), and attractive (low straying in, high straying out). Temperature and distance upstream were primary determinants of site attractiveness for strays in the Columbia Basin. Westley, Bond, Quinn, Dittman in prep.

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- Steelhead and Spring Chinook demonstrate increased straying with juvenile barge transport. (Reviewed in Keefer and Caudill 2014 Rev. Fish Biol. Fisheries)

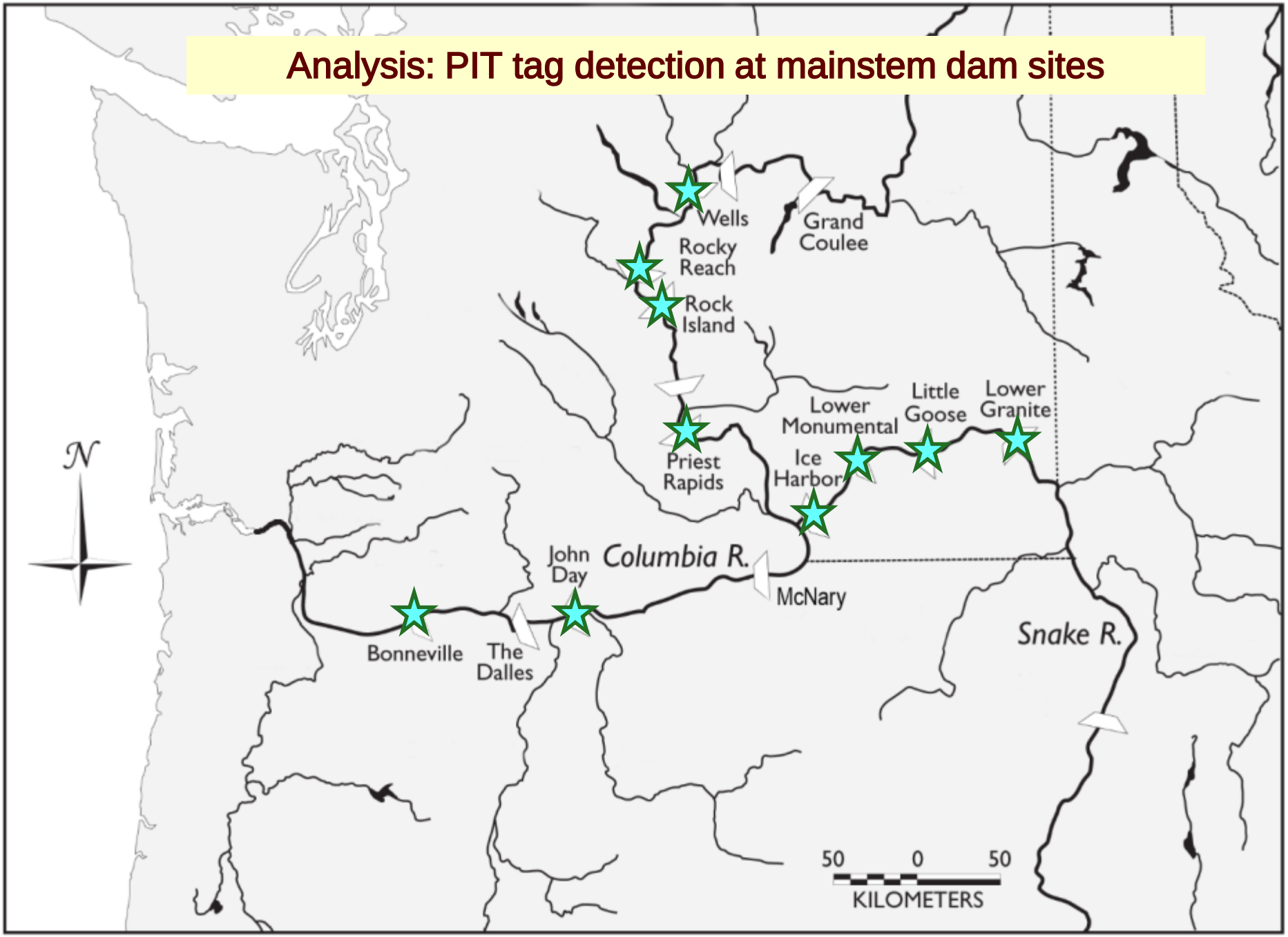
- Fall Chinook salmon produced in the Snake River basin
  - -2000-2011 tag years/through 2013 return year
  - -3,844,593 fish tagged
  - -1,993,162 detected (most only as smolts)

- PITpro (CBR) to identify transported fish and remove some errors

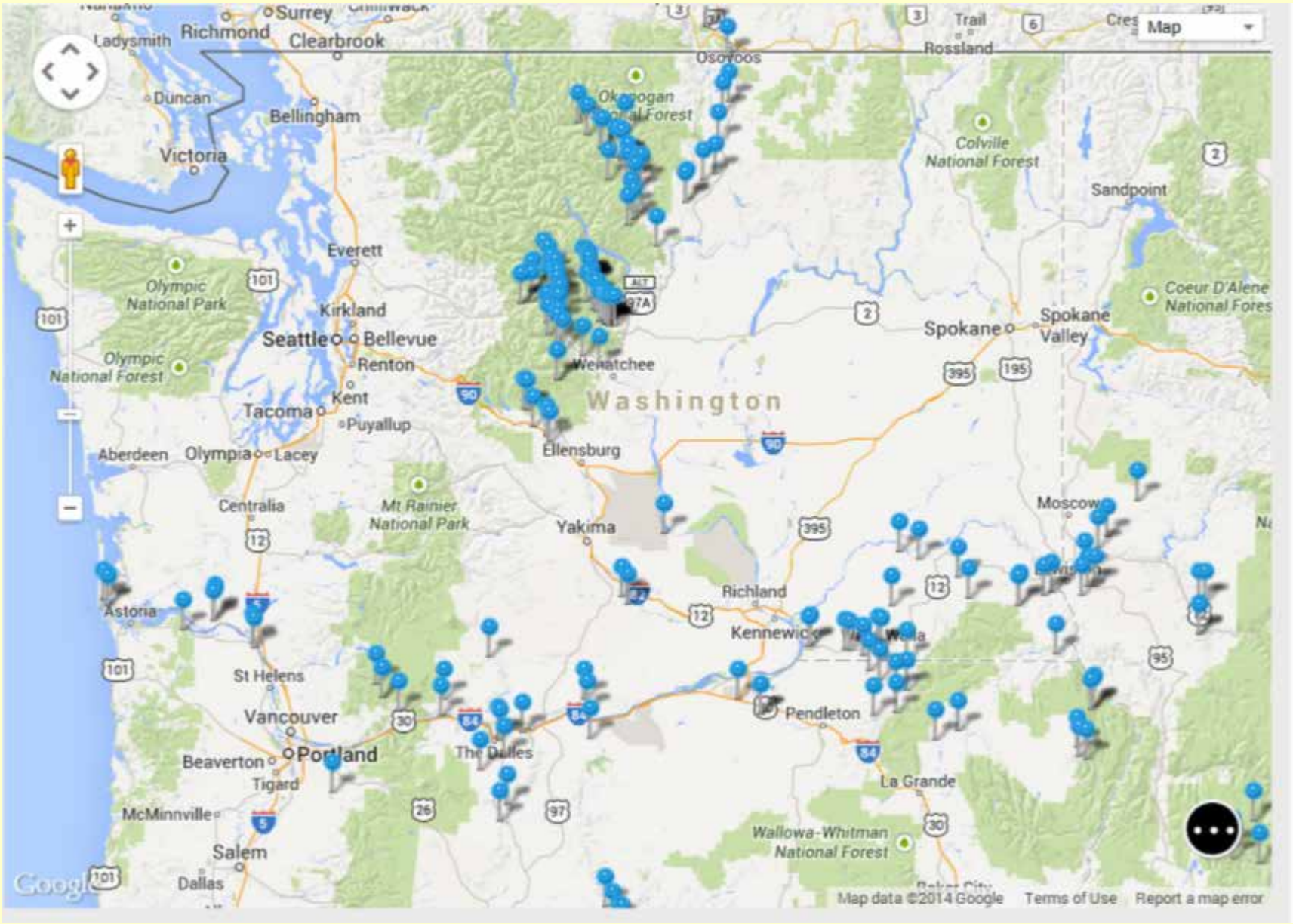
- Keep only individuals:
  - -Detected migrating upriver as adults
  - -Known rearing location (LYFE, NPTH, etc.)

- 24,797 individuals included

Analysis: PIT tag detection at mainstem dam sites

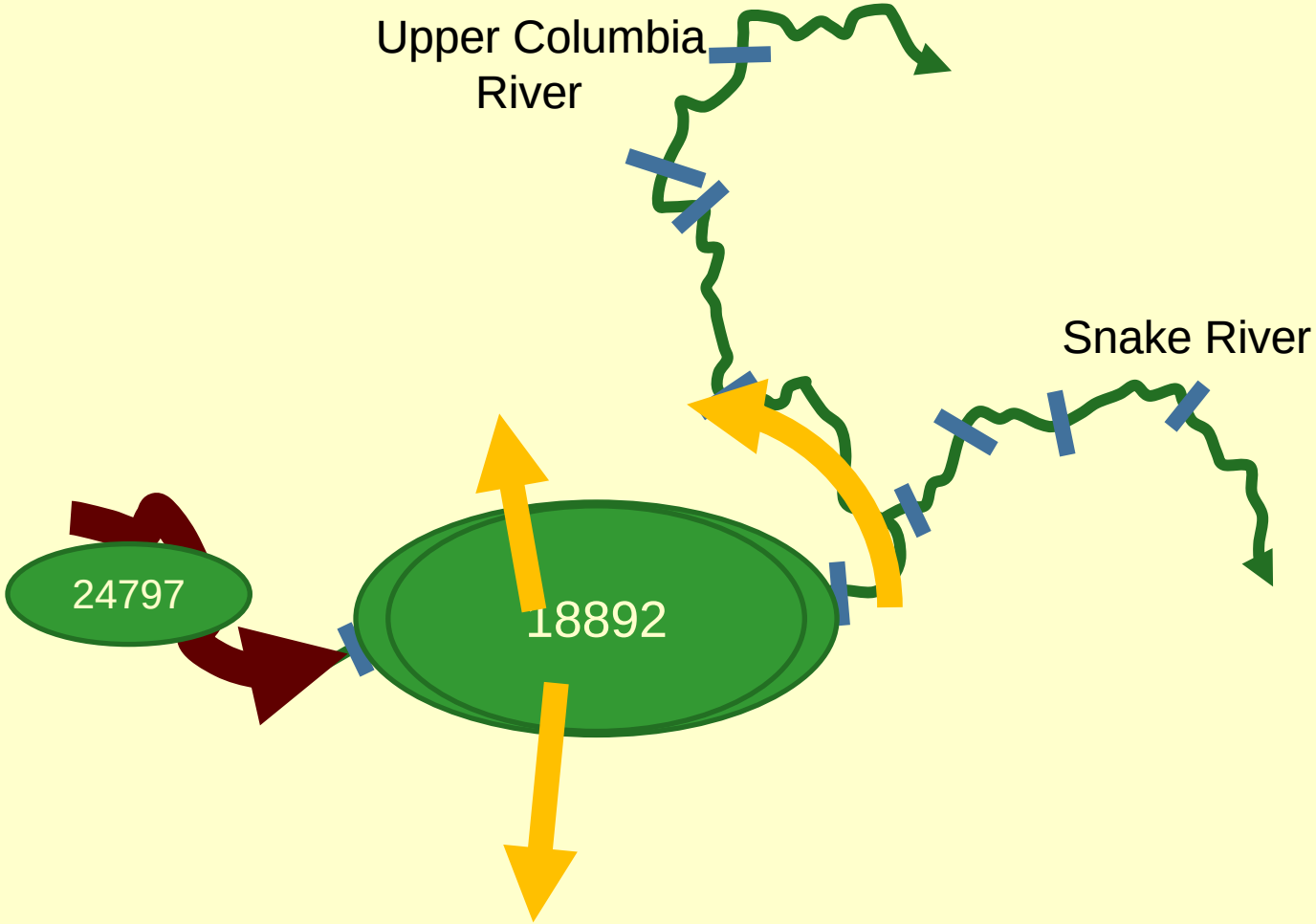


PIT tag interrogation sites



First, we looked at overall patterns of migration and entry into non-natal rivers, before comparing transported to run of the river fish.

Analysis of *straying* by Snake River Chinook salmon



Type I: Straying or “dipping in” to tributaries prior to reaching the Snake confluence

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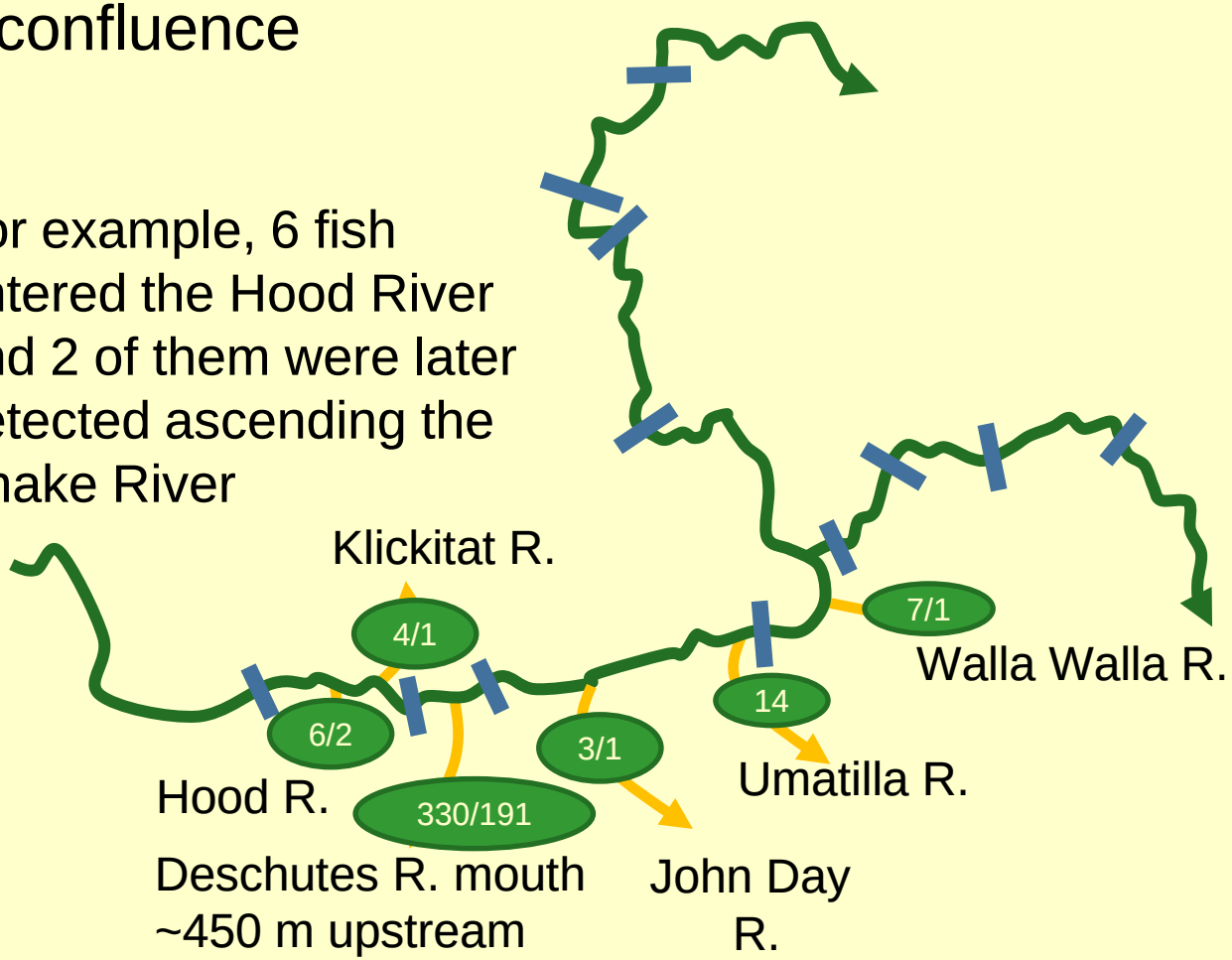
For example, 6 fish entered the Hood River and 2 of them were later detected ascending the Snake River



Type II: Straying past the Snake River into middle and upper Columbia River

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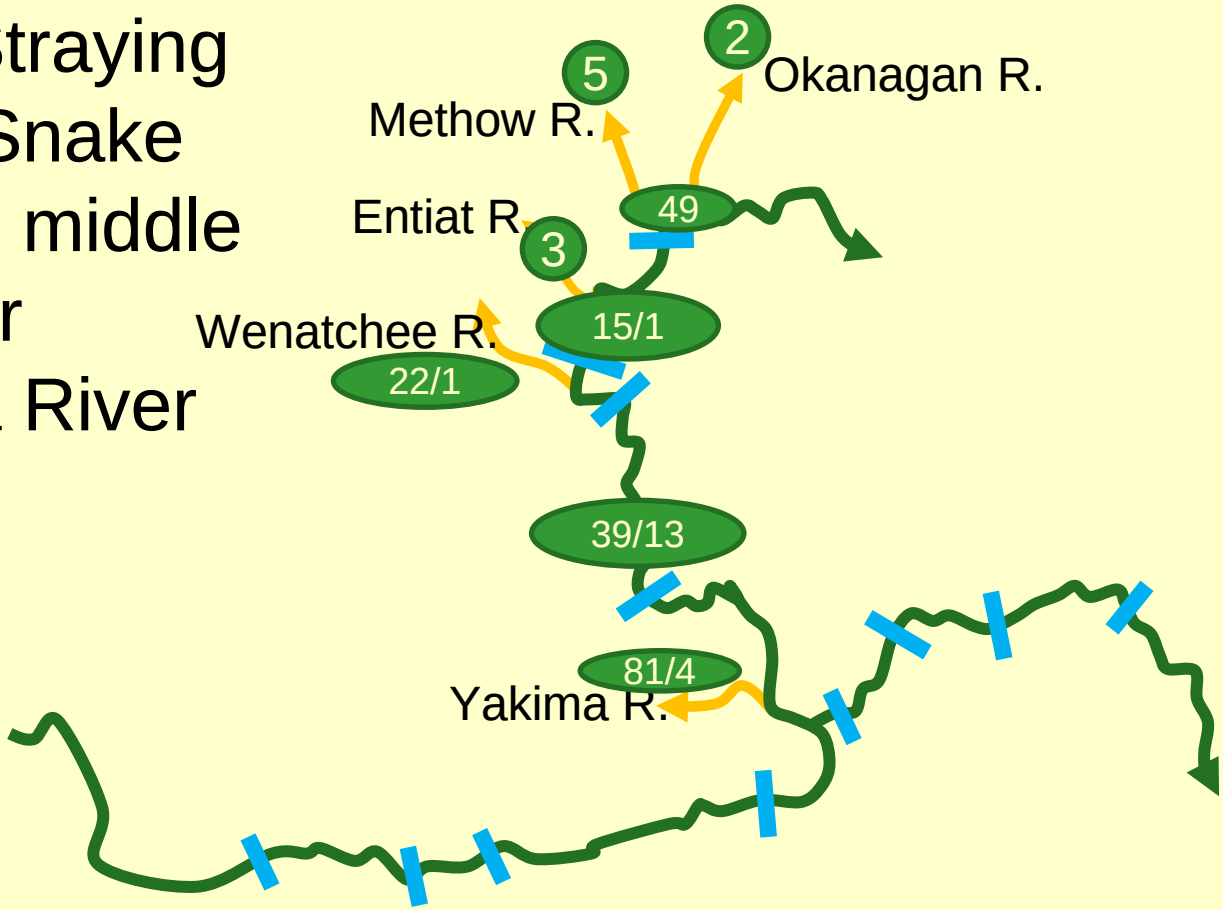
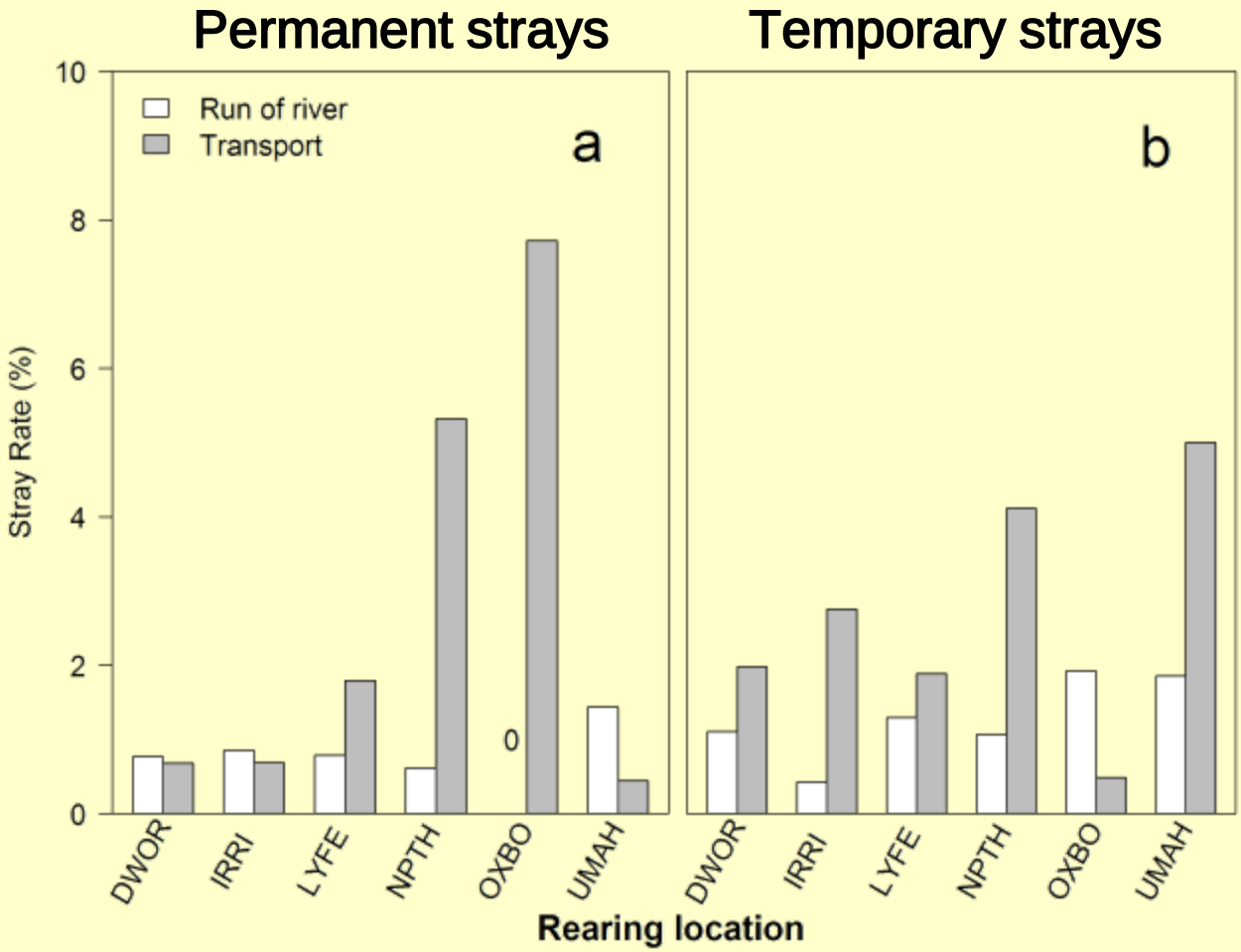


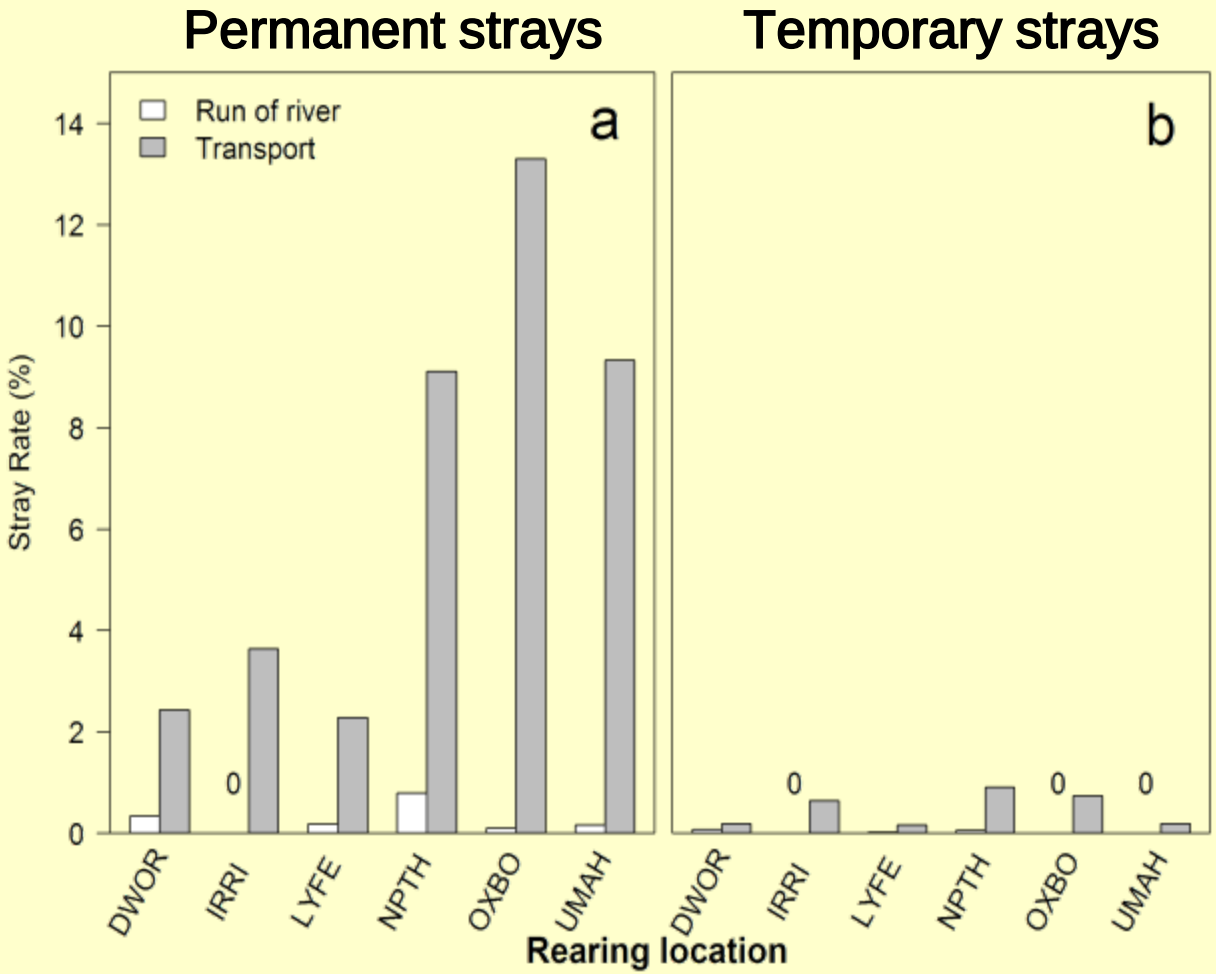
215 total detected above confluence

Fish detected entering tributaries of the Columbia River *below* the confluence with the Snake River



Many temporary strays entered non-natal tribs but later ascended the Snake River.

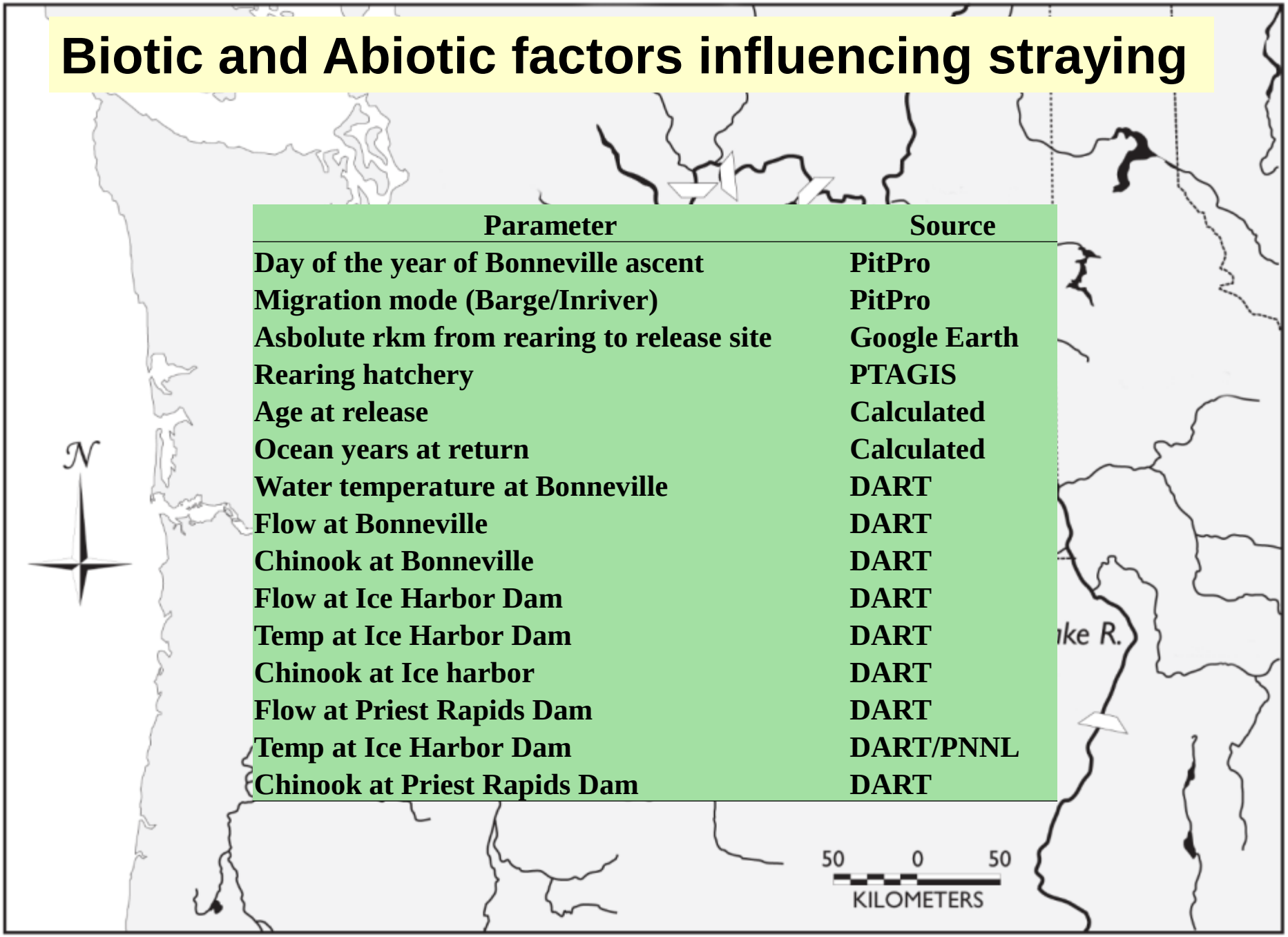
Fish detected entering tributaries of the Columbia River *above* the confluence with the Snake River



Very few temporary strays – those turning from the Snake River do not later find it.

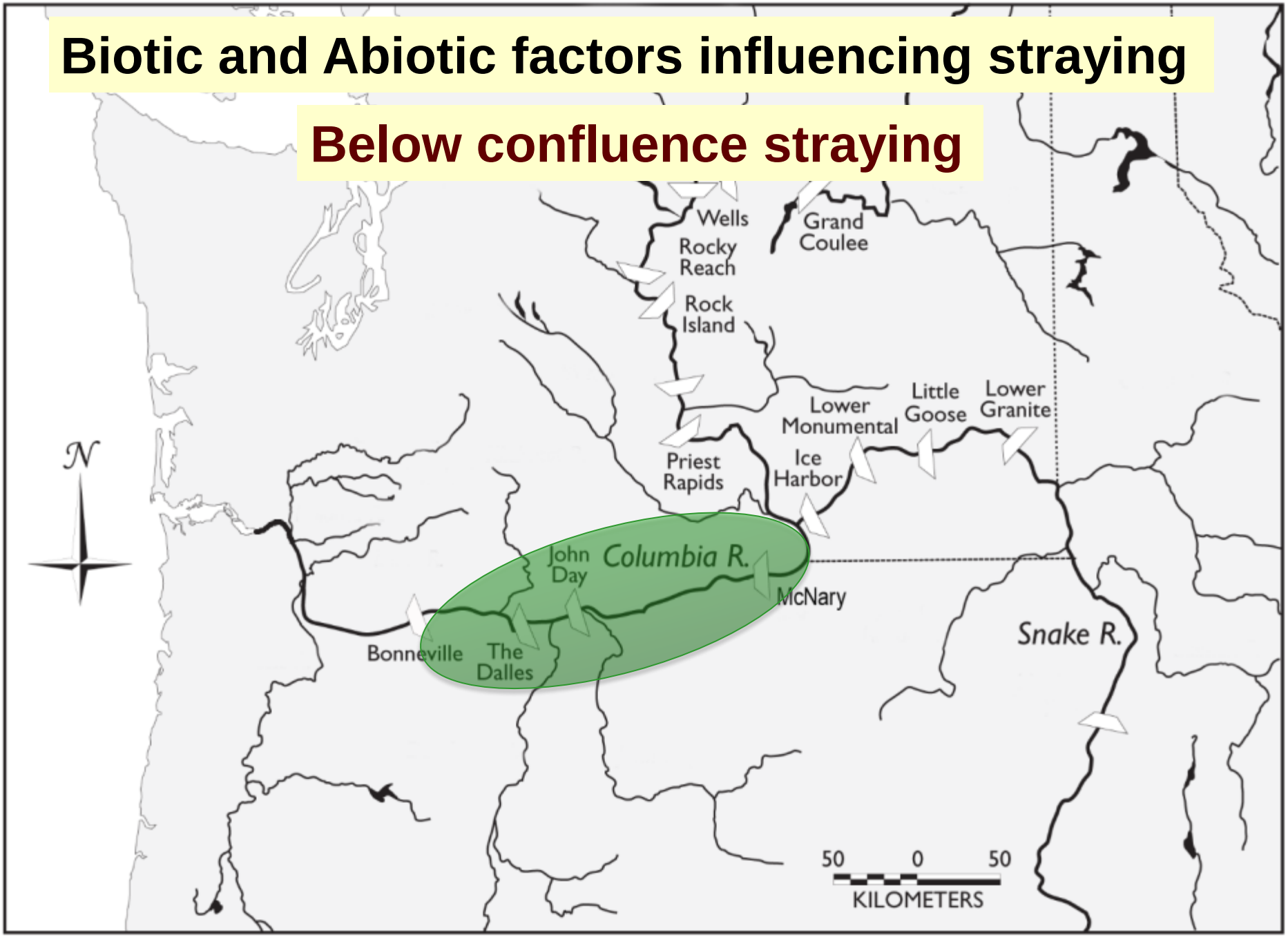
Biotic and Abiotic factors influencing straying

Parameter	Source
Day of the year of Bonneville ascent	PitPro
Migration mode (Barge/Inriver)	PitPro
Asbolute rkm from rearing to release site	Google Earth
Rearing hatchery	PTAGIS
Age at release	Calculated
Ocean years at return	Calculated
Water temperature at Bonneville	DART
Flow at Bonneville	DART
Chinook at Bonneville	DART
Flow at Ice Harbor Dam	DART
Temp at Ice Harbor Dam	DART
Chinook at Ice harbor	DART
Flow at Priest Rapids Dam	DART
Temp at Ice Harbor Dam	DART/PNNL
Chinook at Priest Rapids Dam	DART



Biotic and Abiotic factors influencing straying

Below confluence straying



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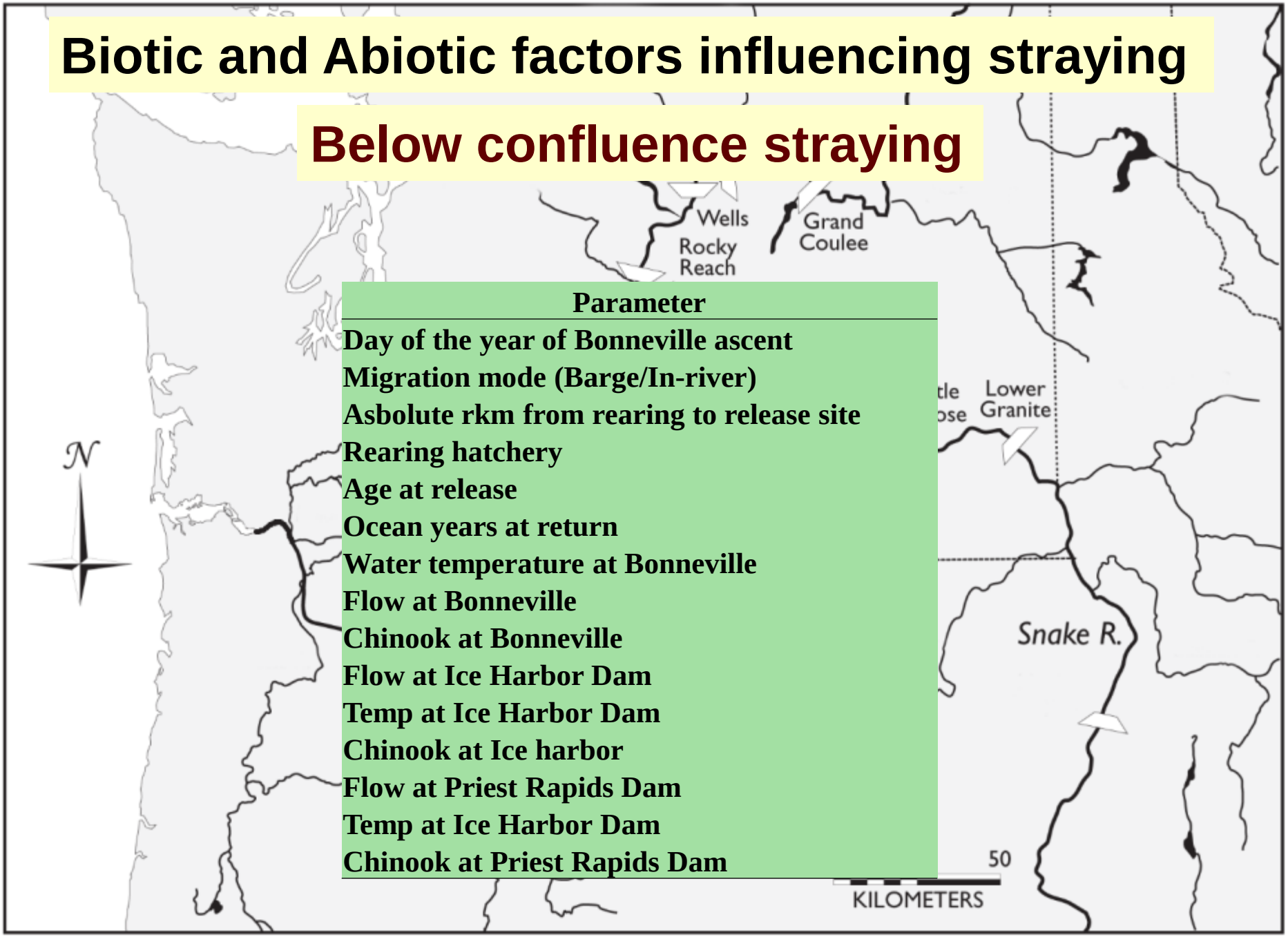

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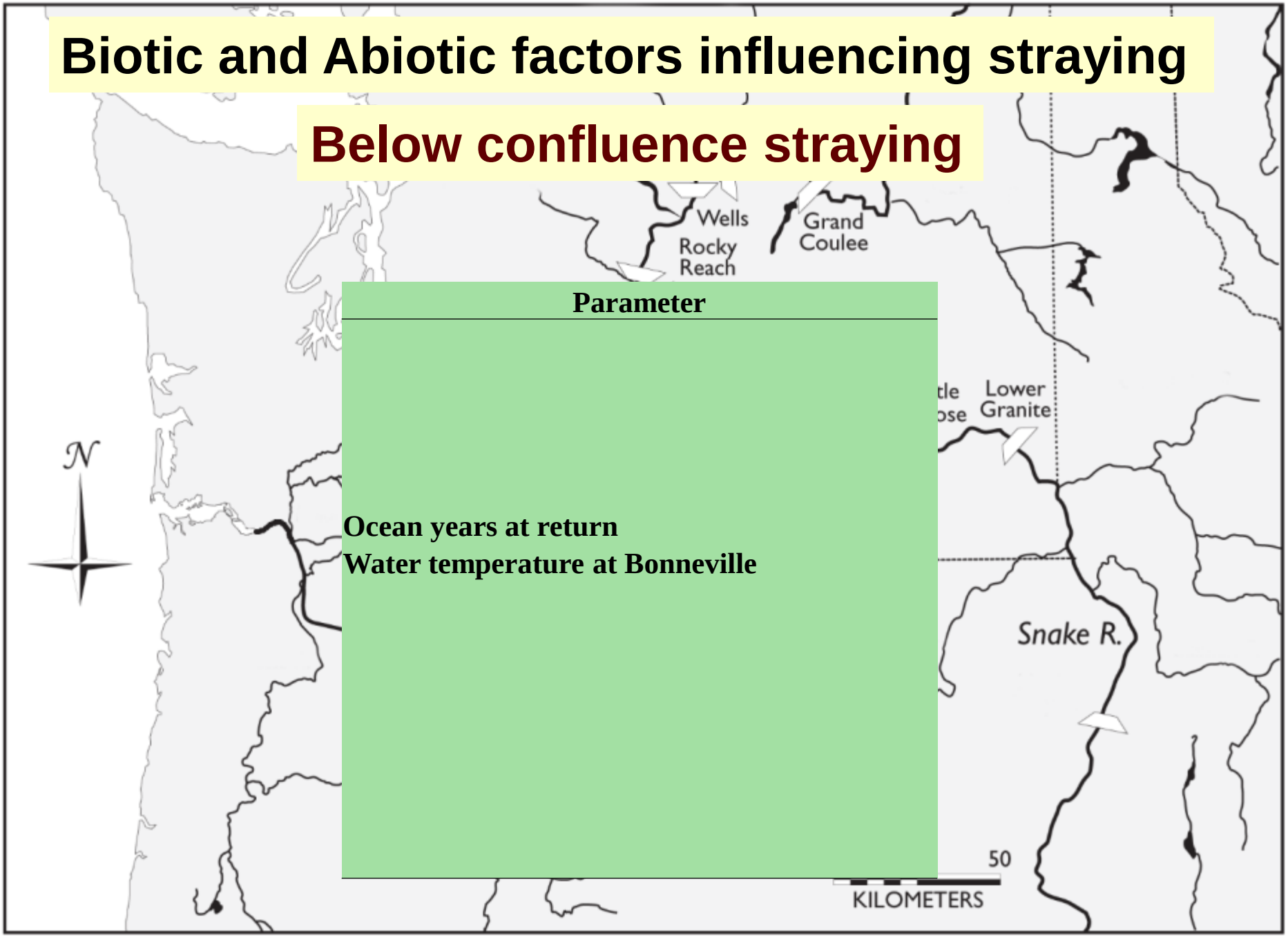

Parameter
Ocean years at return Water temperature at Bonneville

Biotic and Abiotic factors influencing straying

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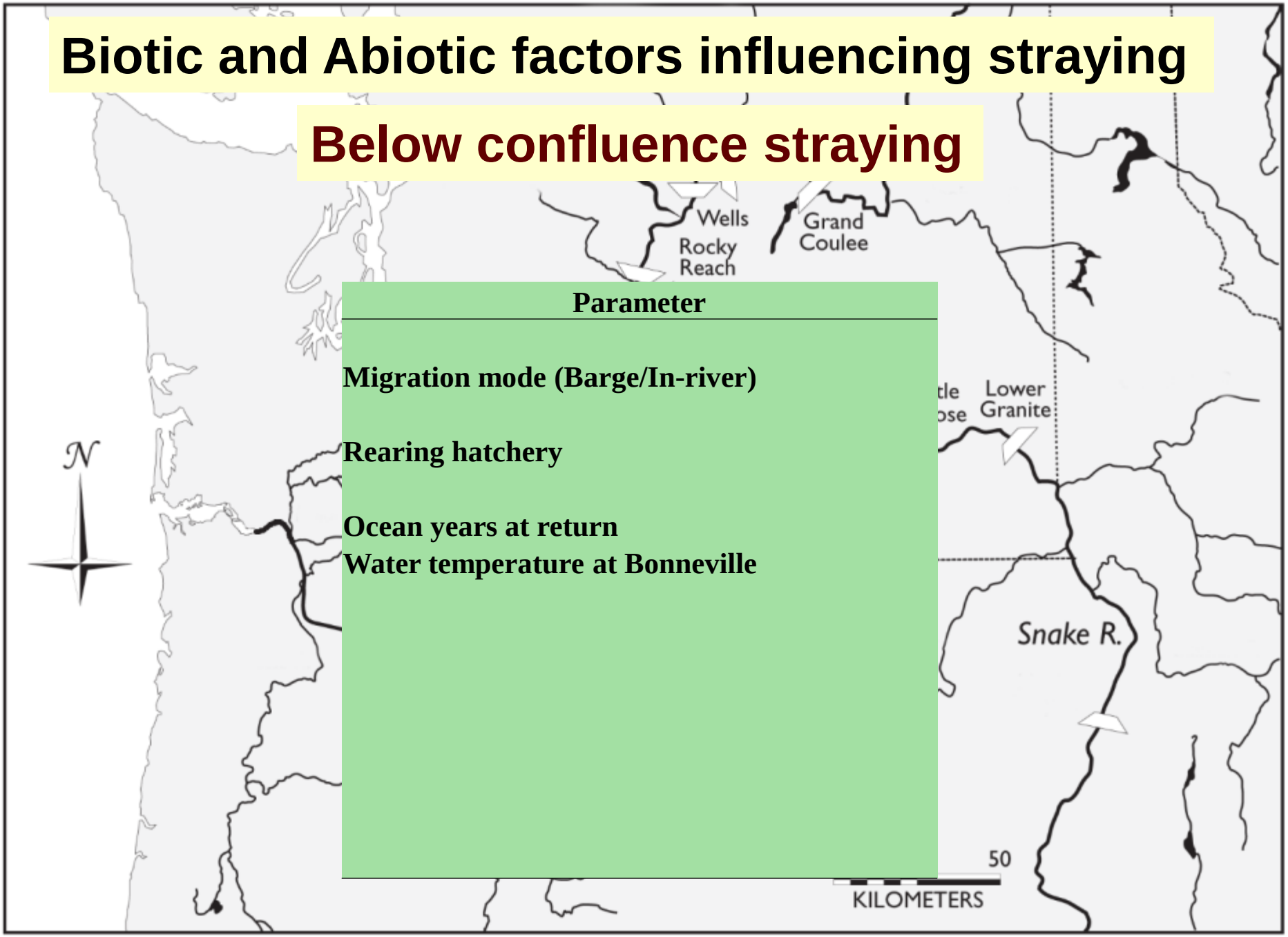

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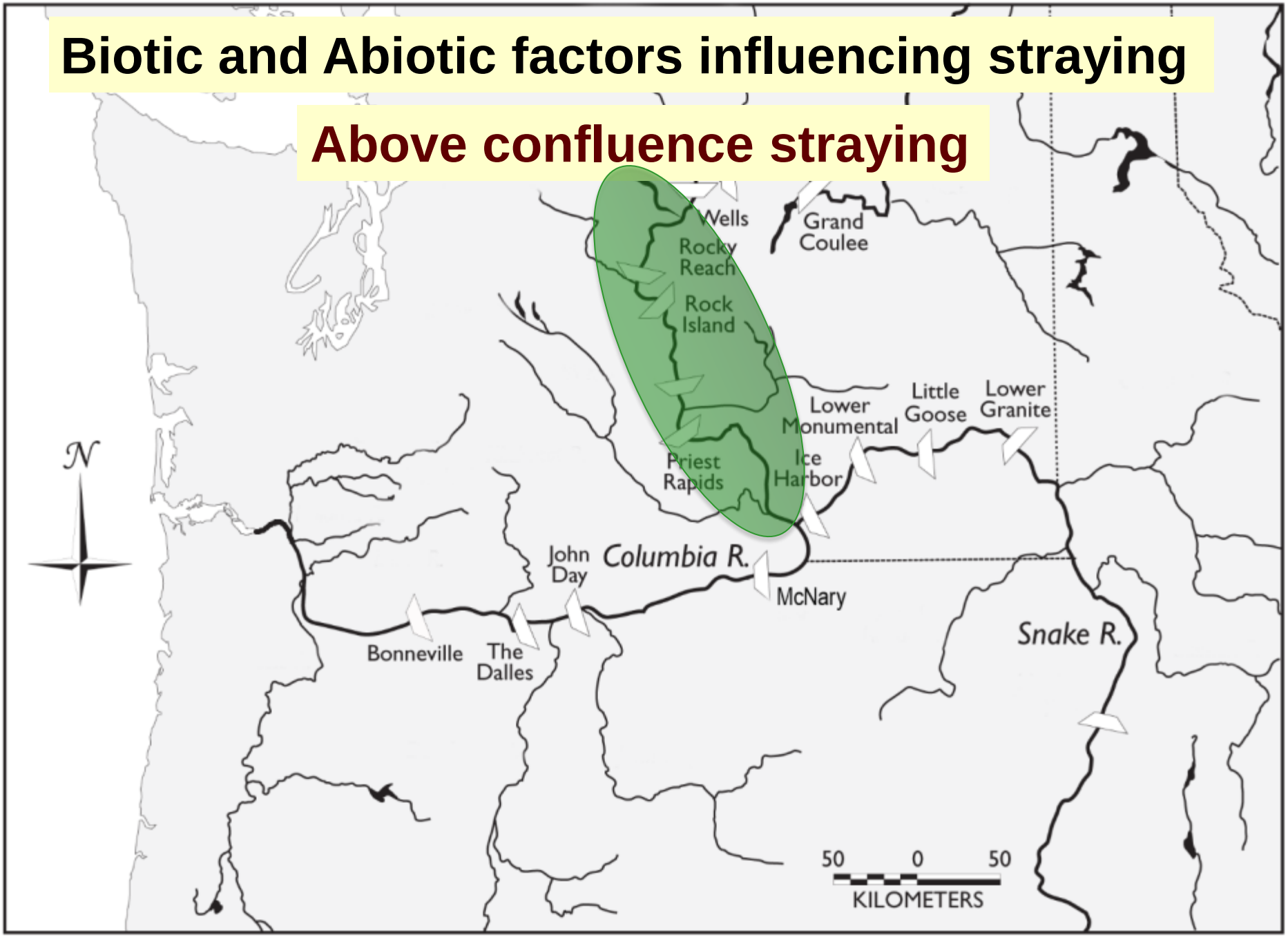

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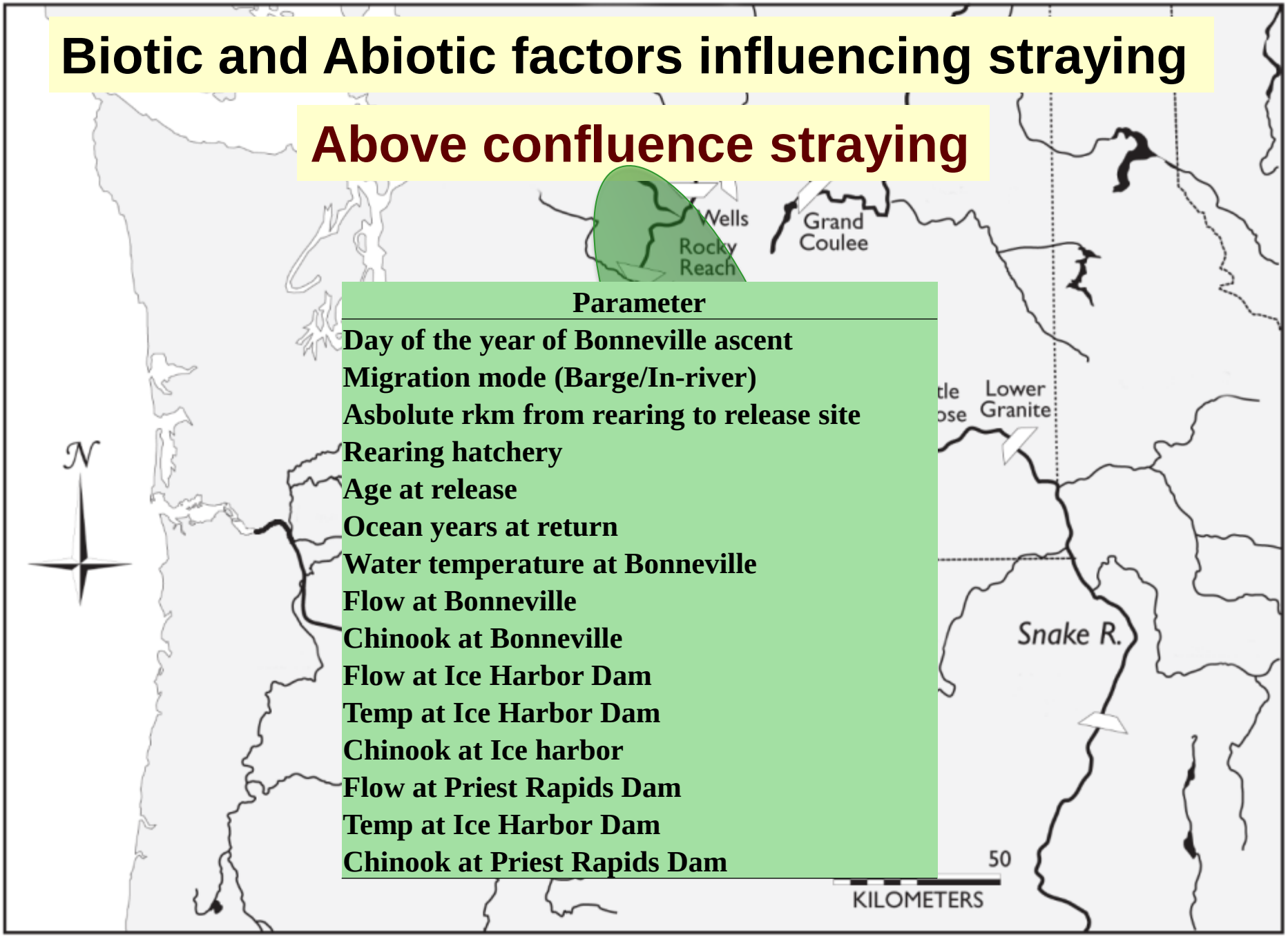

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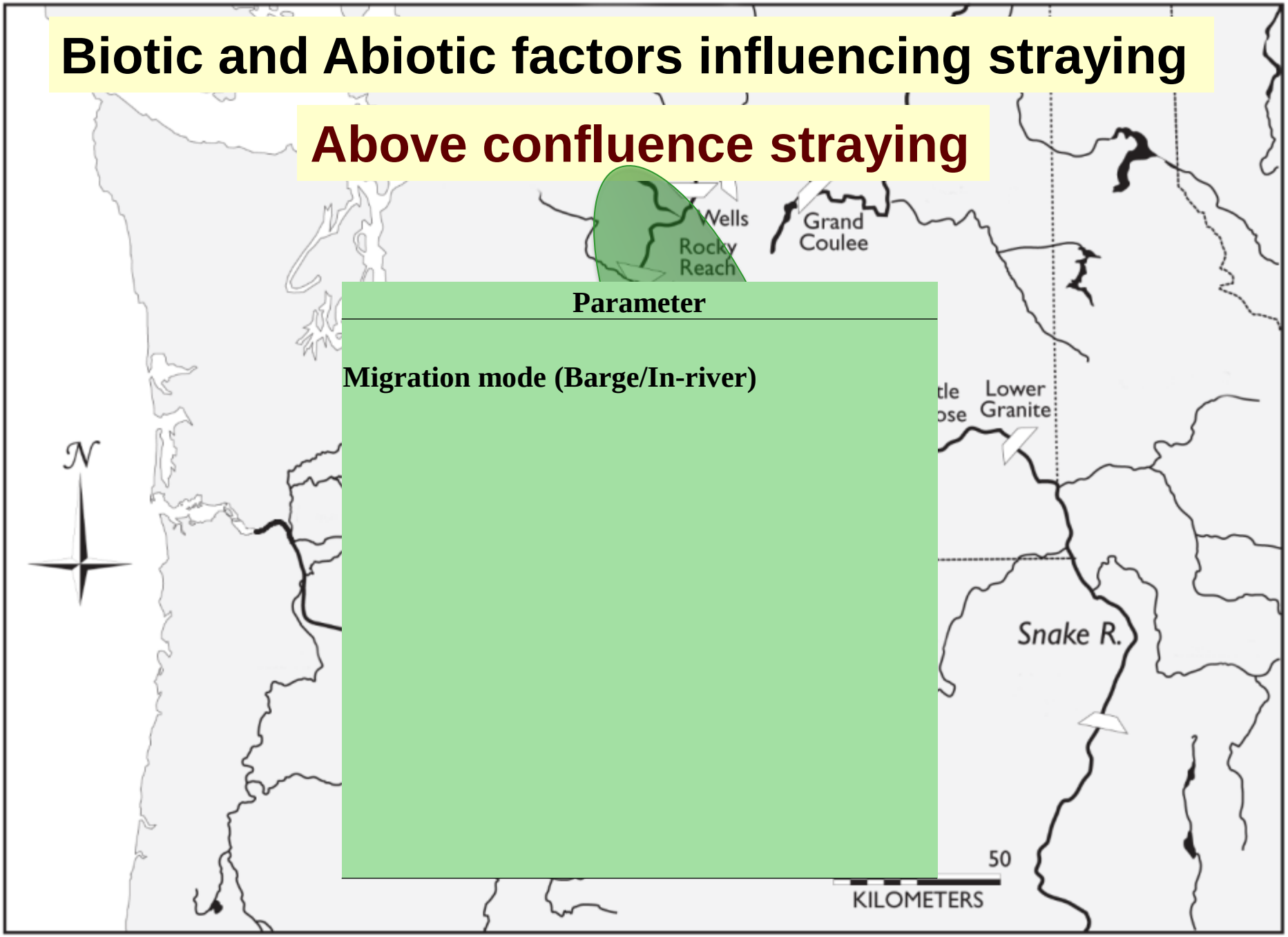

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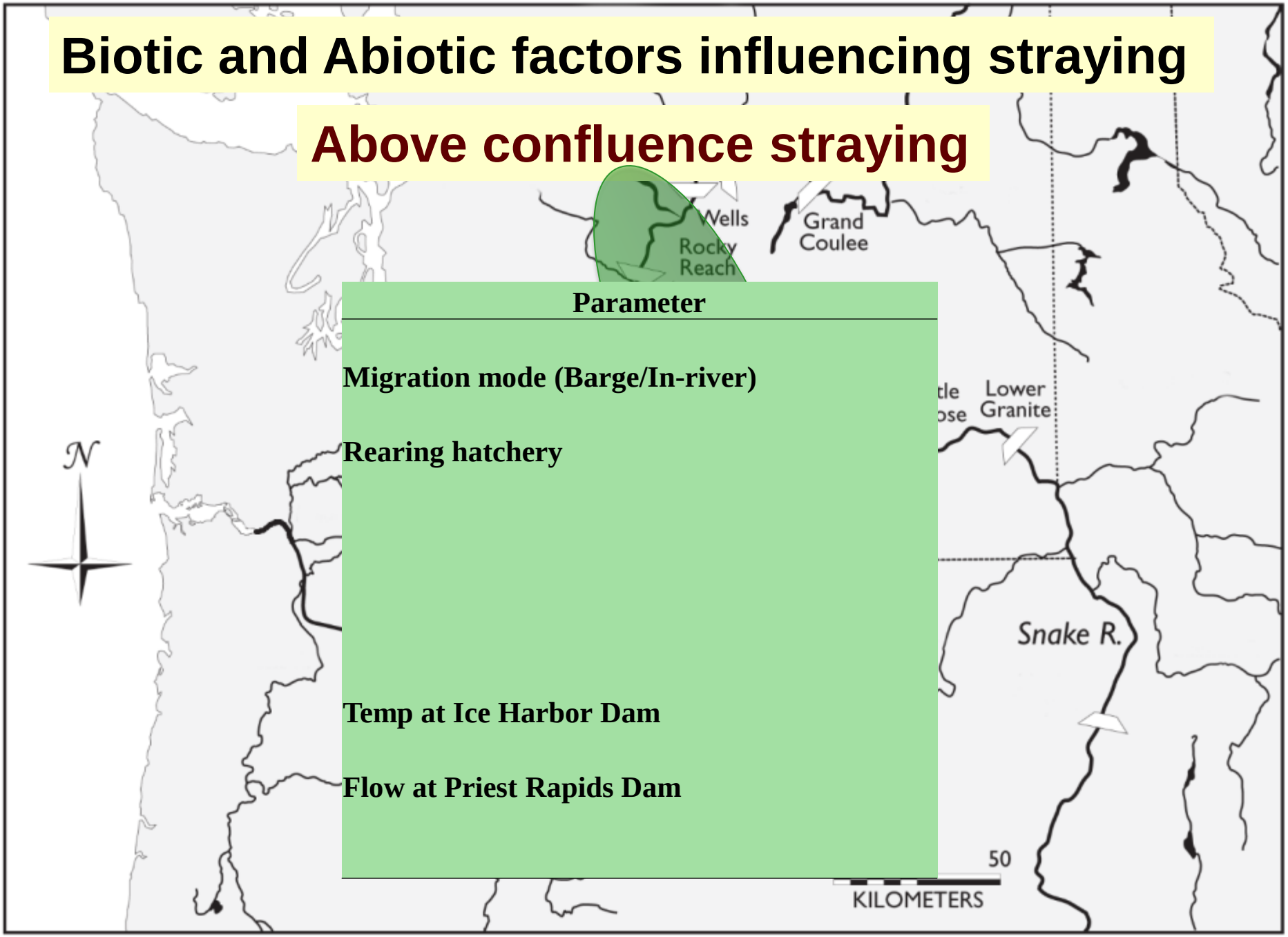

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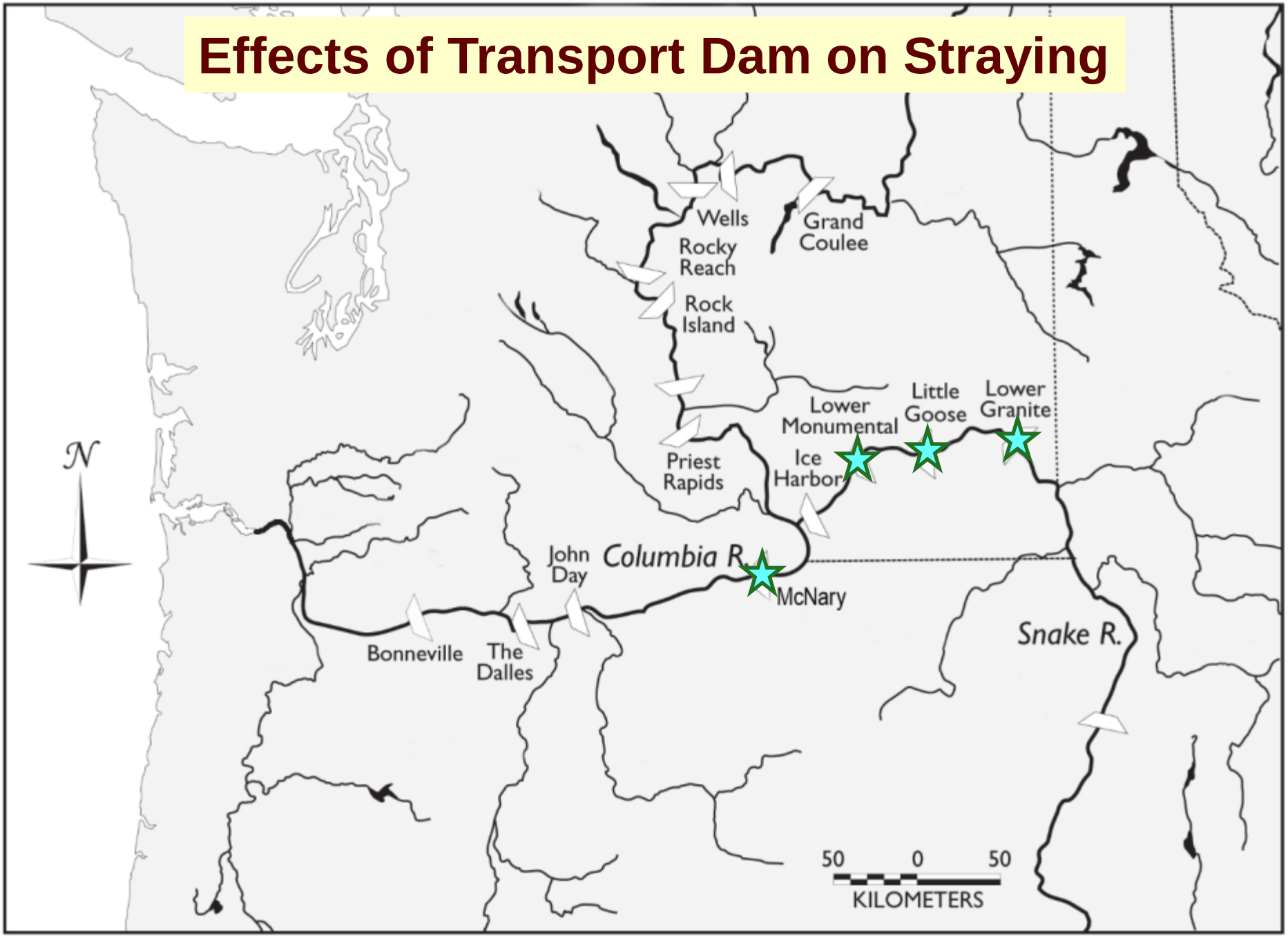
Migration mode (Barge/In-river)
Rearing hatchery
Temp at Ice Harbor Dam
Flow at Priest Rapids Dam

Effects of Transport Dam on Straying



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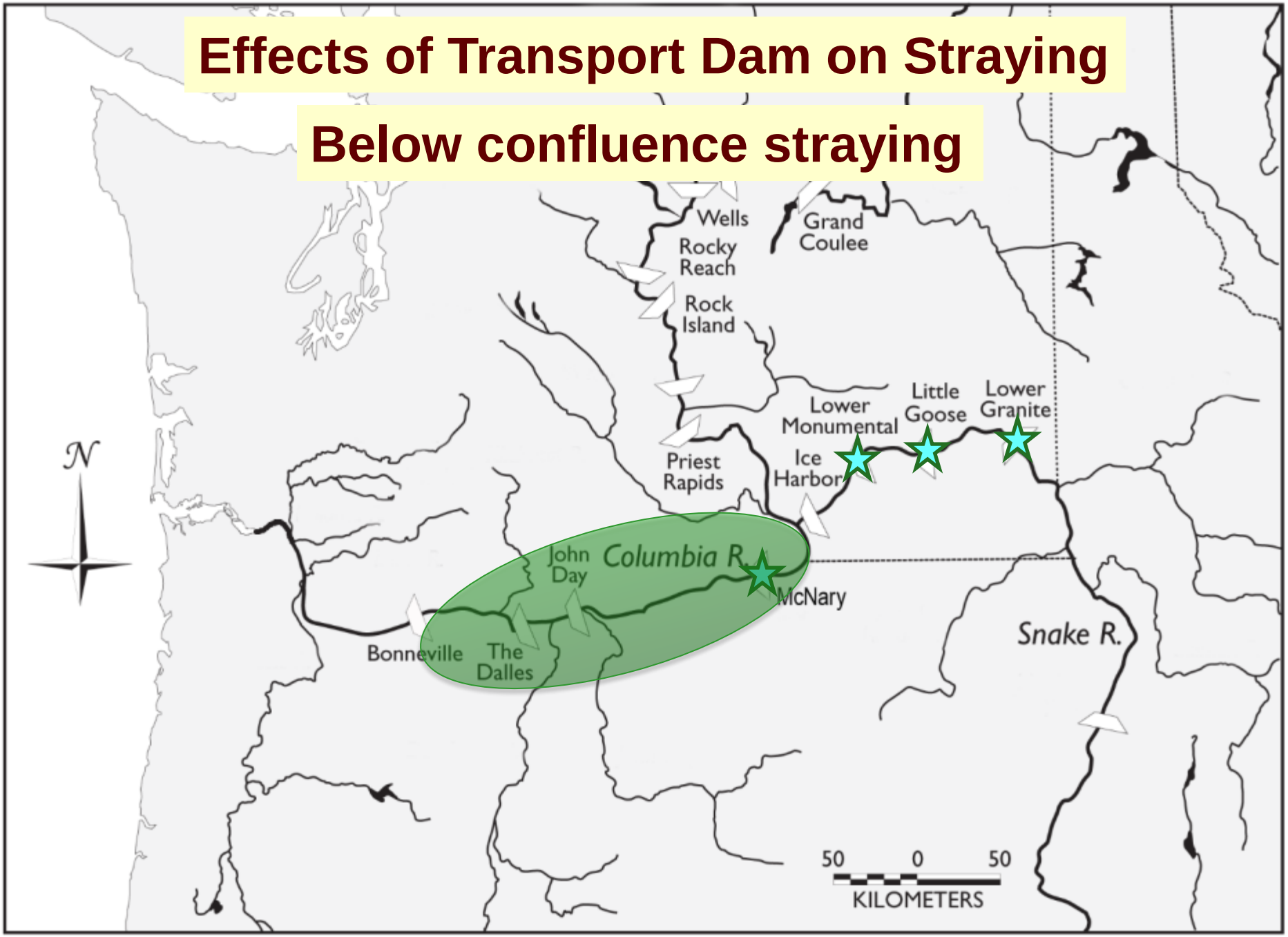
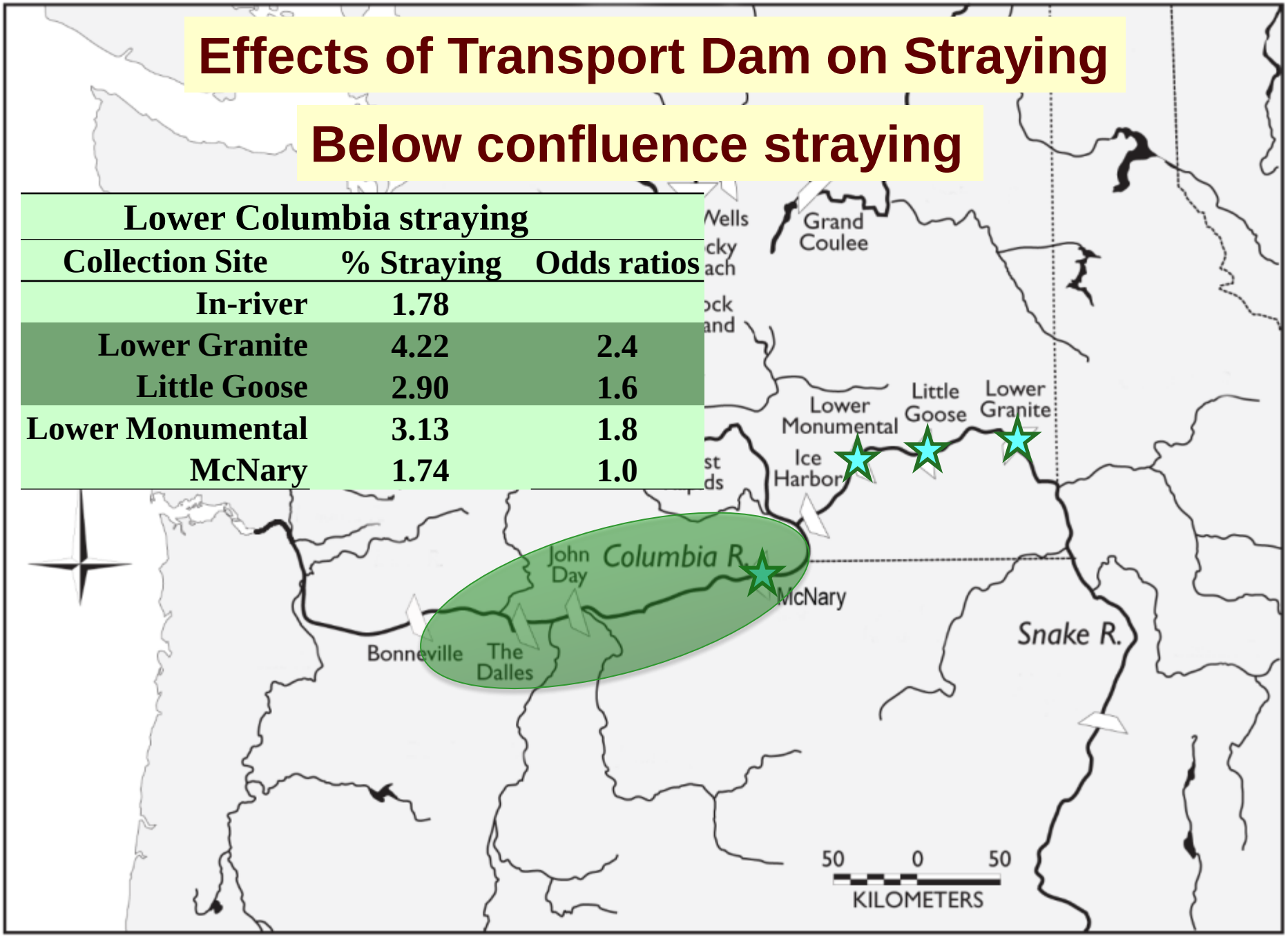


Effects of Transport Dam on Straying

Below confluence straying

Lower Columbia straying		
Collection Site	% Straying	Odds ratios
In-river	1.78	
Lower Granite	4.22	2.4
Little Goose	2.90	1.6
Lower Monumental	3.13	1.8
McNary	1.74	1.0



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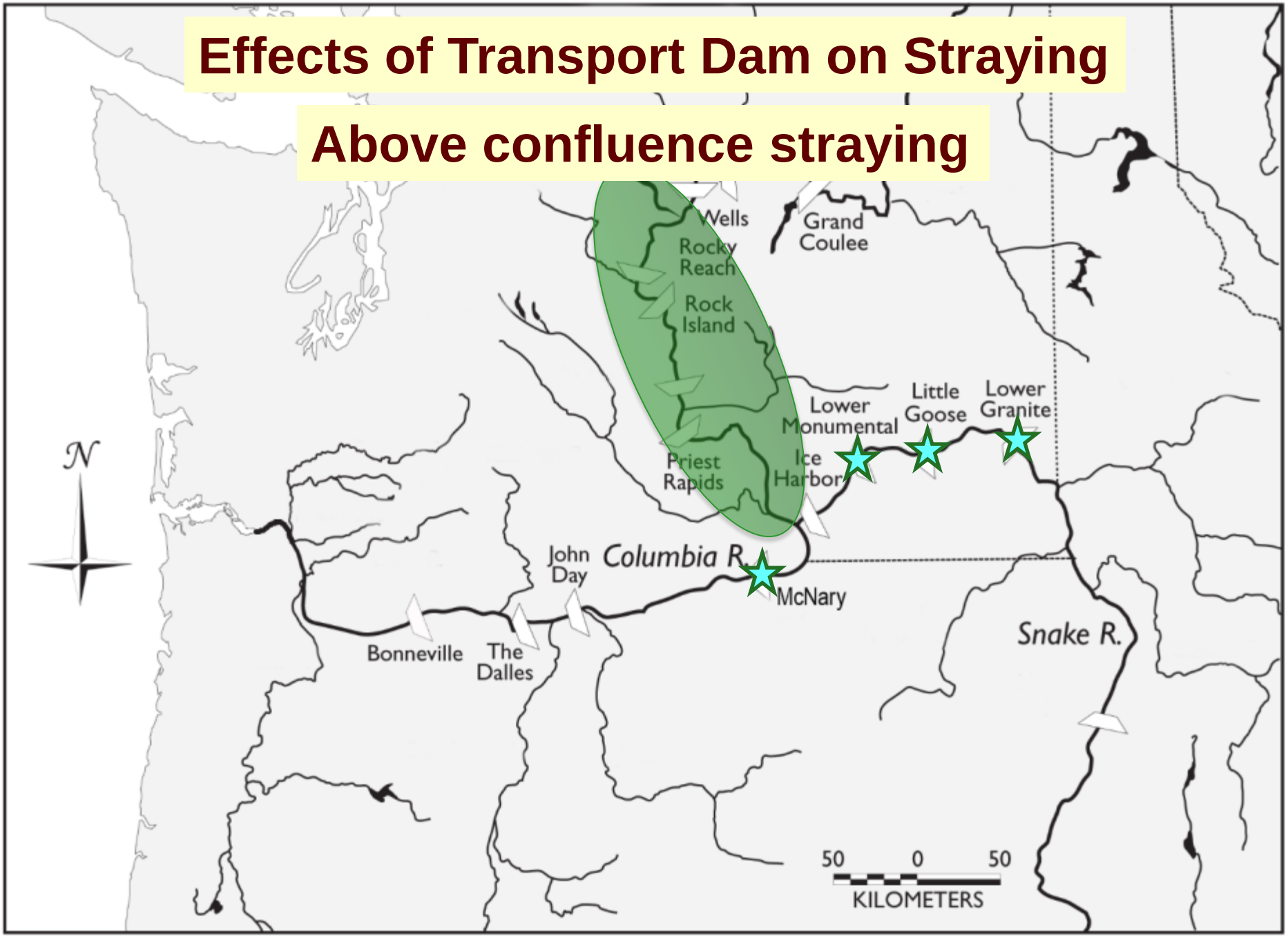

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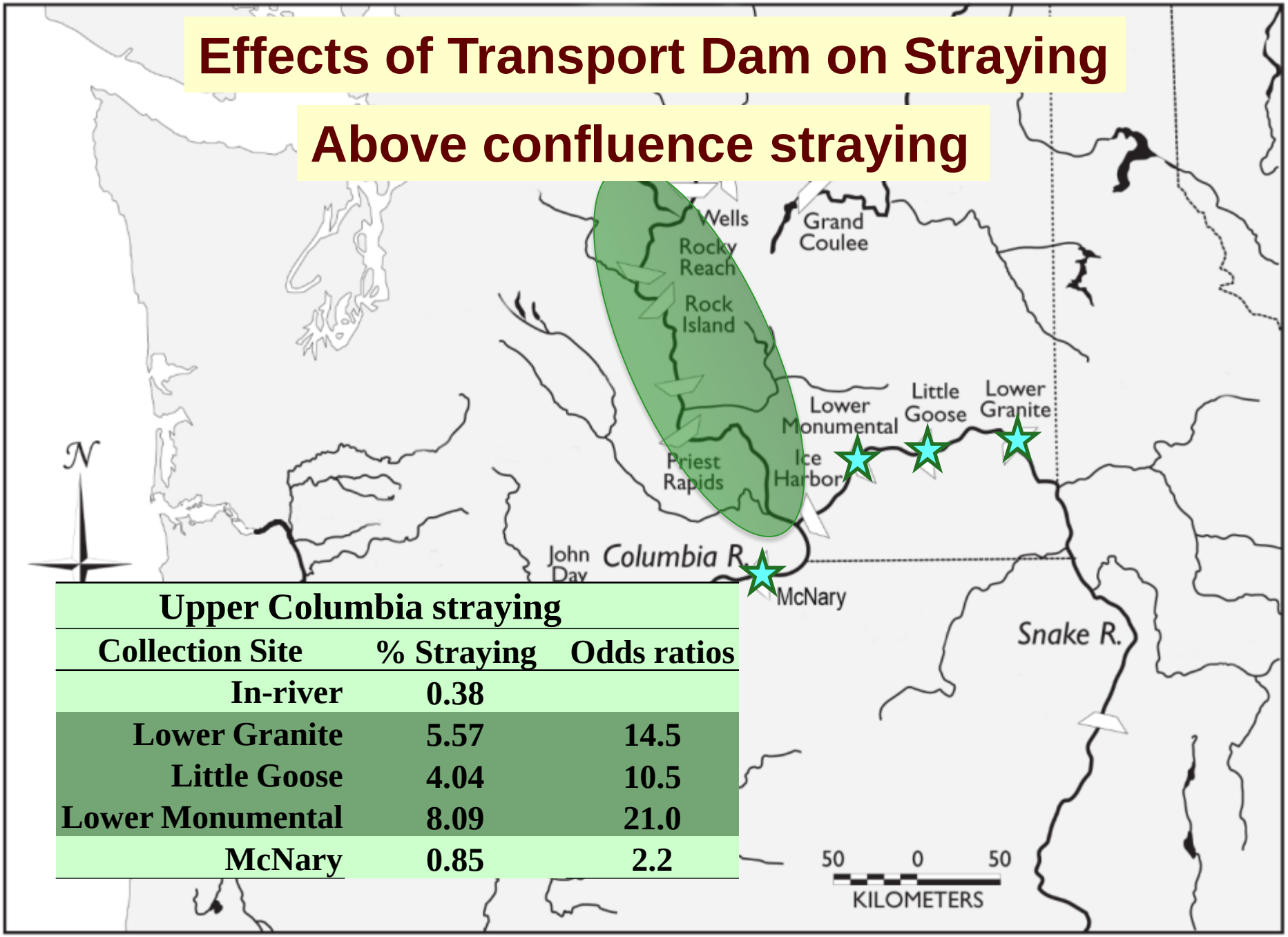


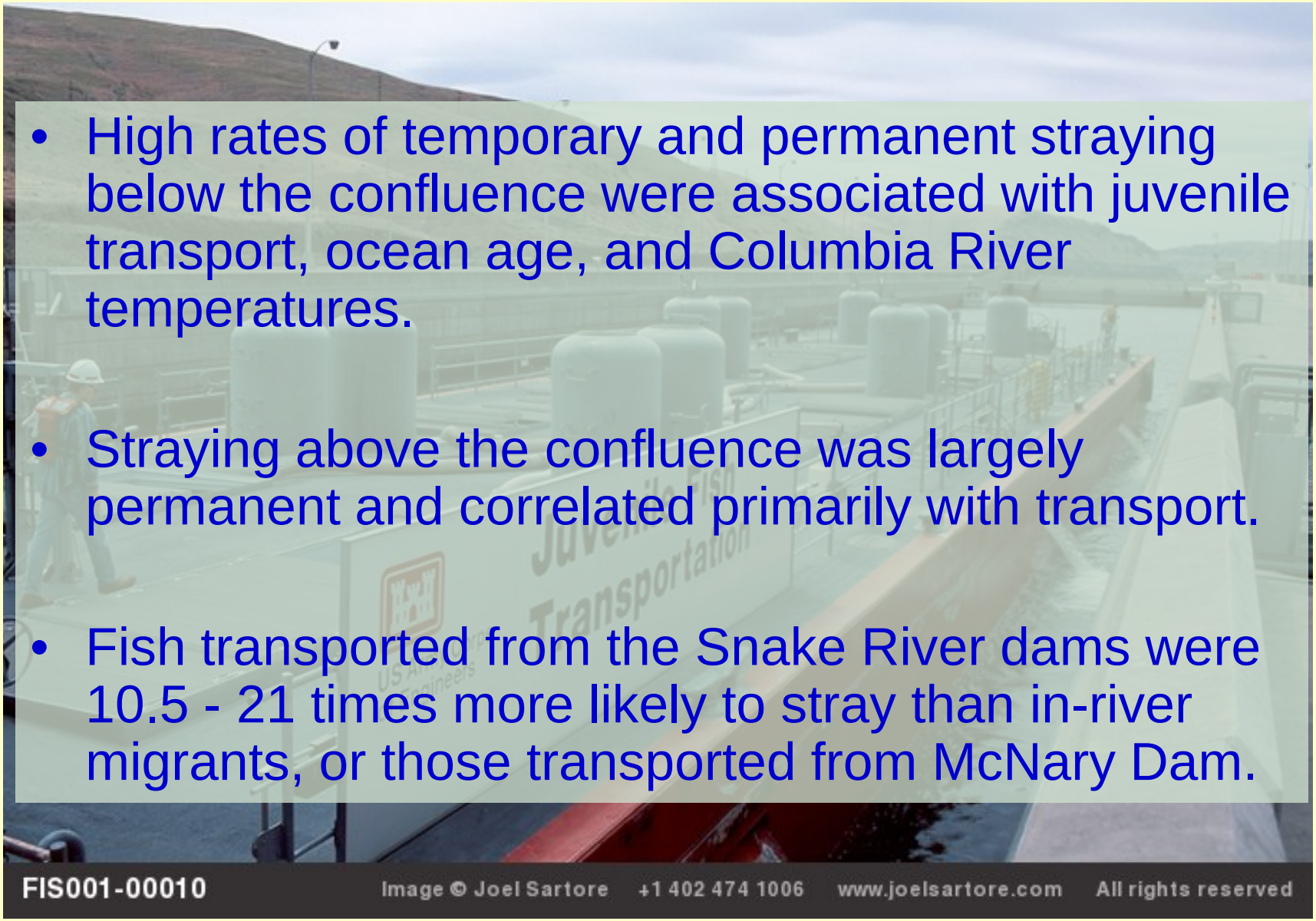
Upper Columbia straying		
Collection Site	% Straying	Odds ratios
In-river	0.38	
Lower Granite	5.57	14.5
Little Goose	4.04	10.5
Lower Monumental	8.09	21.0
McNary	0.85	2.2

Conclusions

- High rates of temporary and permanent straying below the confluence were associated with juvenile transport, ocean age, and Columbia River temperatures.

- Straying above the confluence was largely permanent and correlated primarily with transport.

- Fish transported from the Snake River dams were 10.5 - 21 times more likely to stray than in-river migrants, or those transported from McNary Dam.

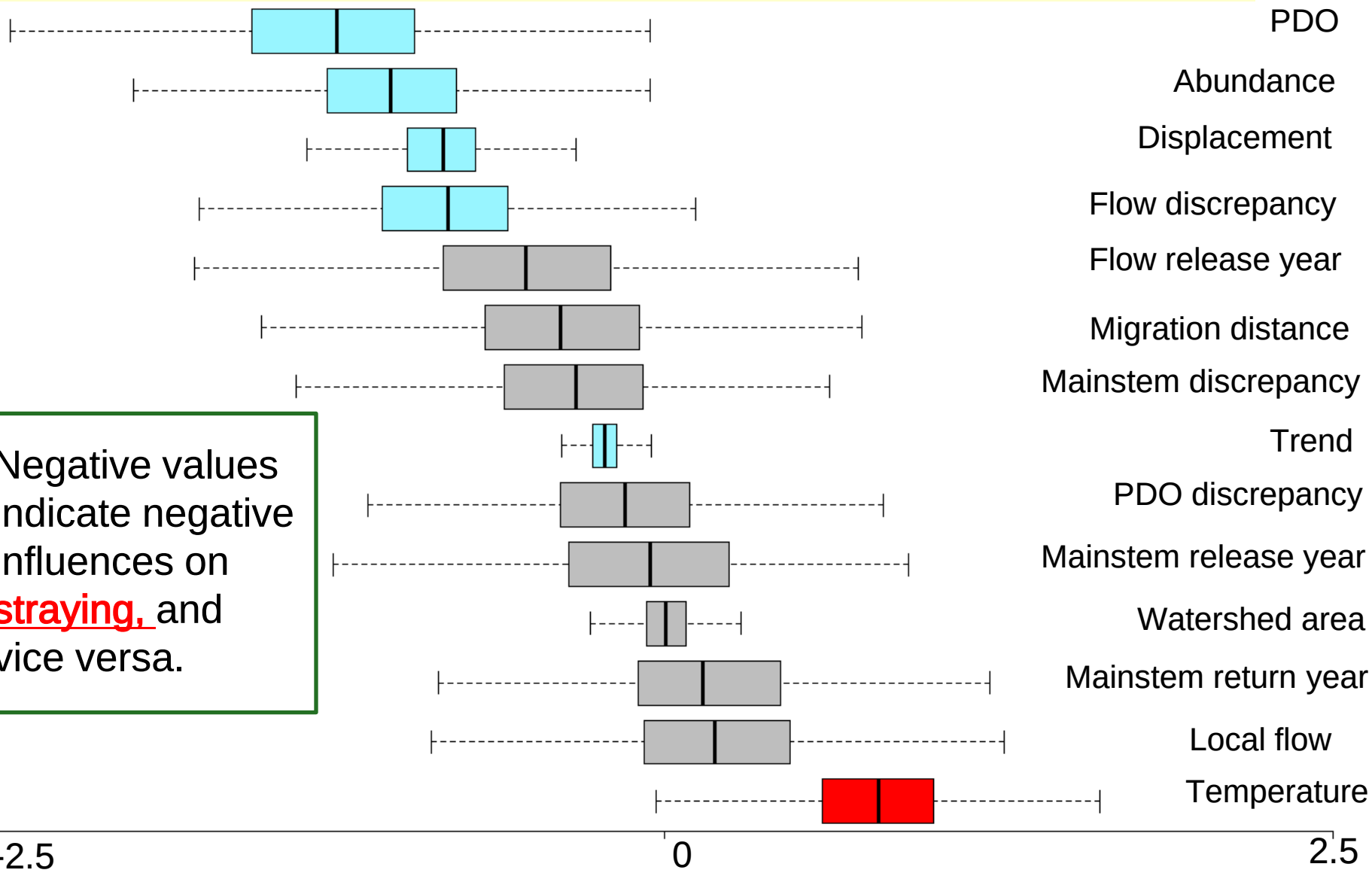


Conclusions

- Increasing numbers of tributary PIT tag interrogation sites offers great potential for further straying studies.

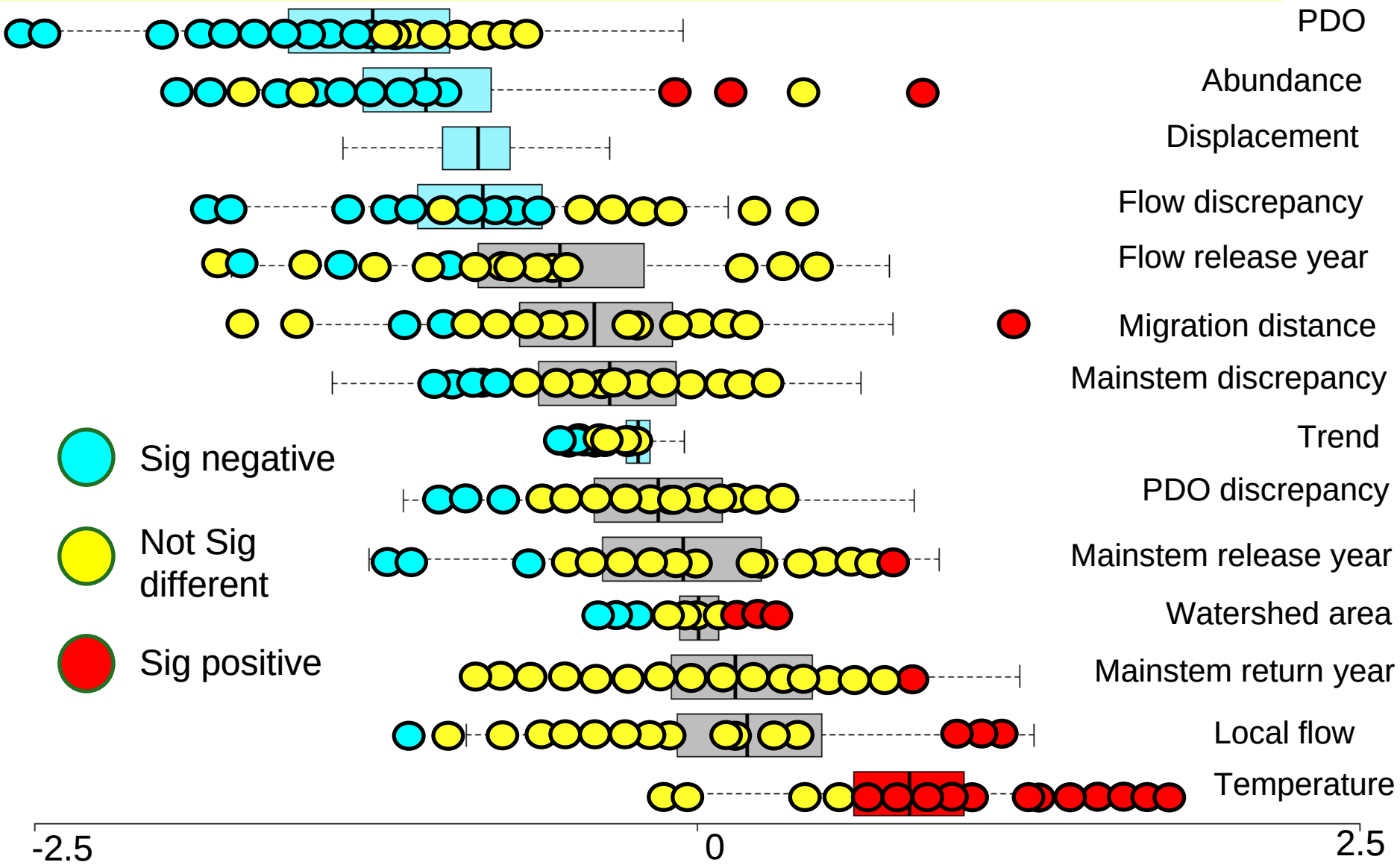
- Potential to improve homing fidelity with alternate barge protocols

Net influences on overall straying rates



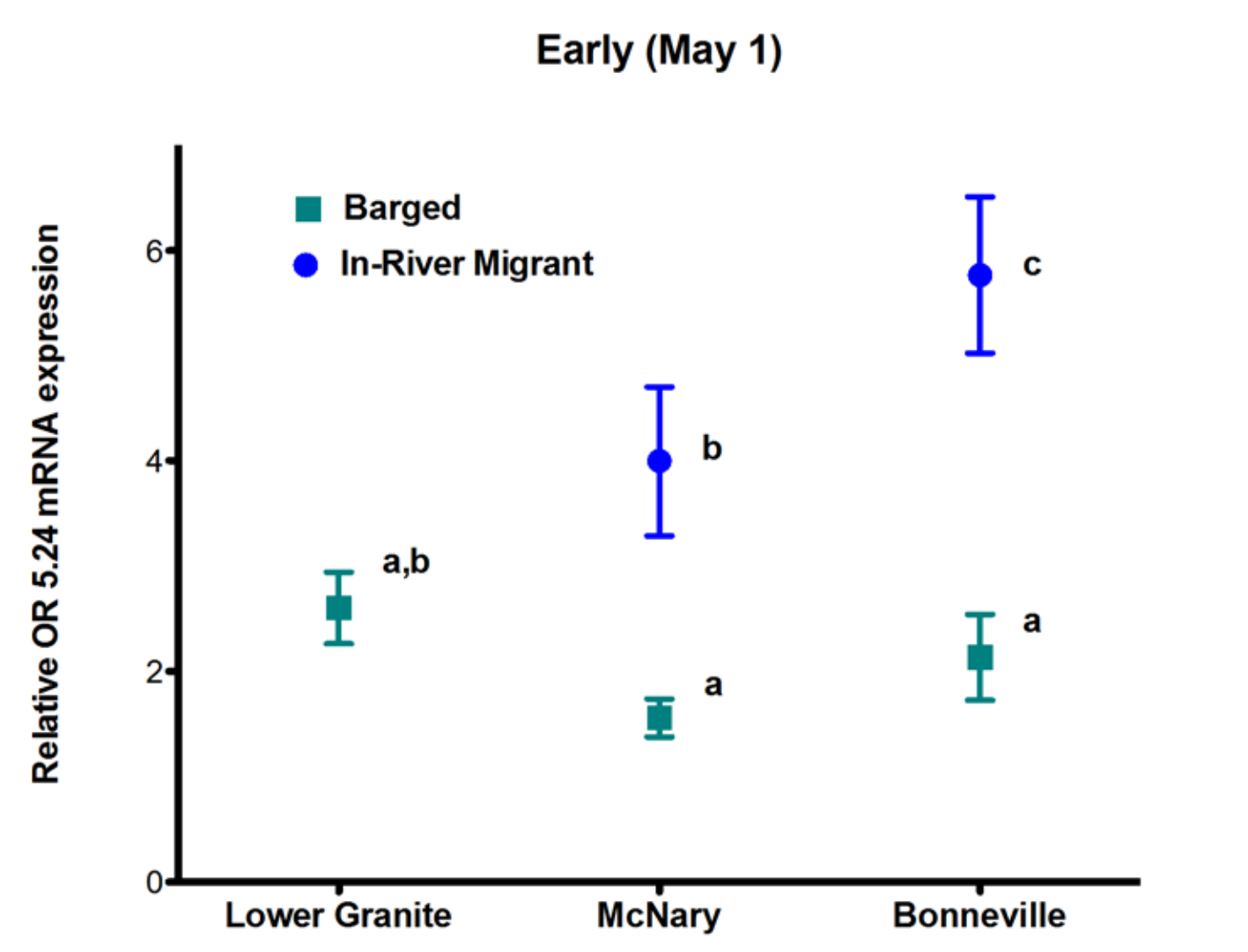
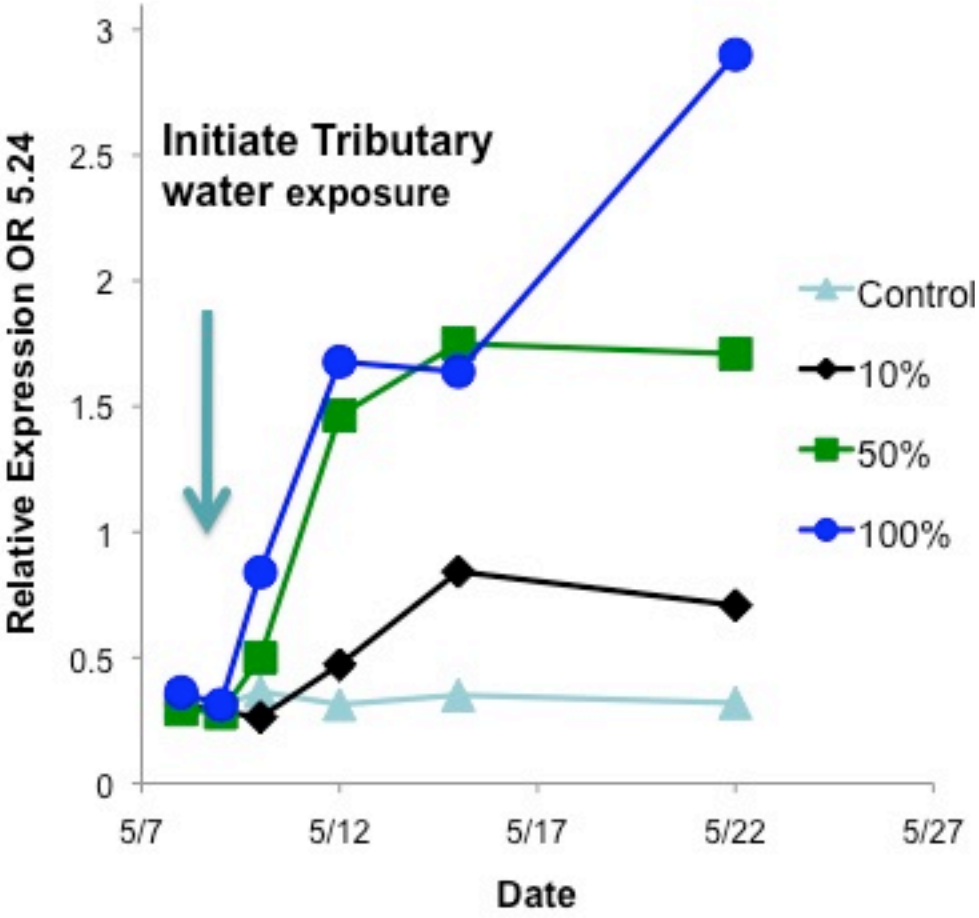
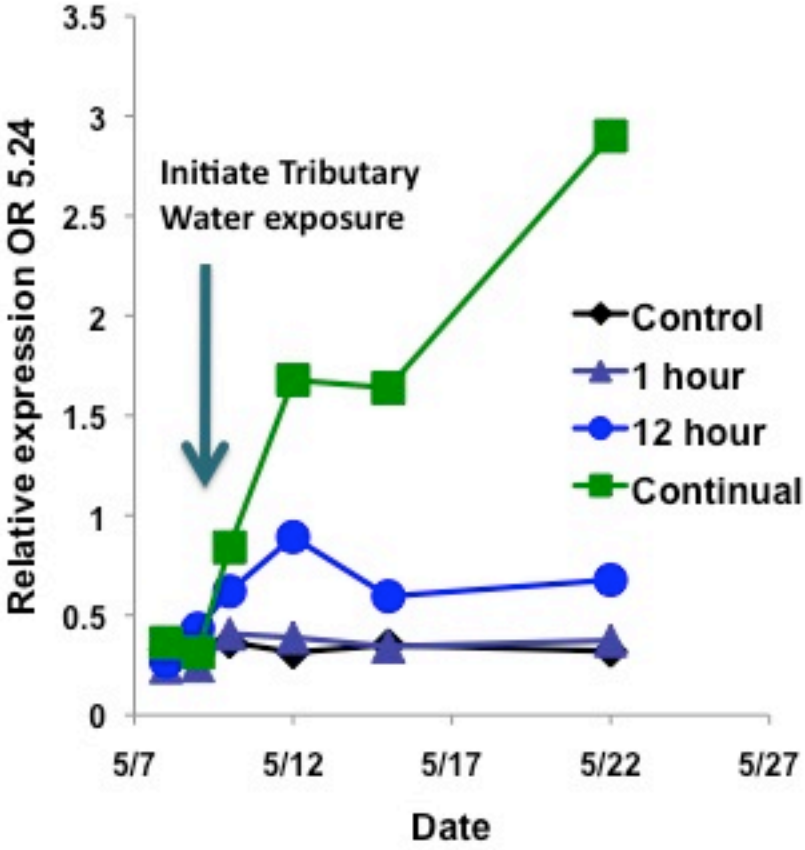
Negative values indicate negative influences on straying, and vice versa.

Populations respond differently in straying



Differences between Barged and In-river Steelhead

Odorant Receptor Expression



Objective 2. Assess importance of tributary experience and exposure period