

# Spawner Demographics and Spawning Behavior of Sockeye Salmon Reintroduced into Cle Elum Lake

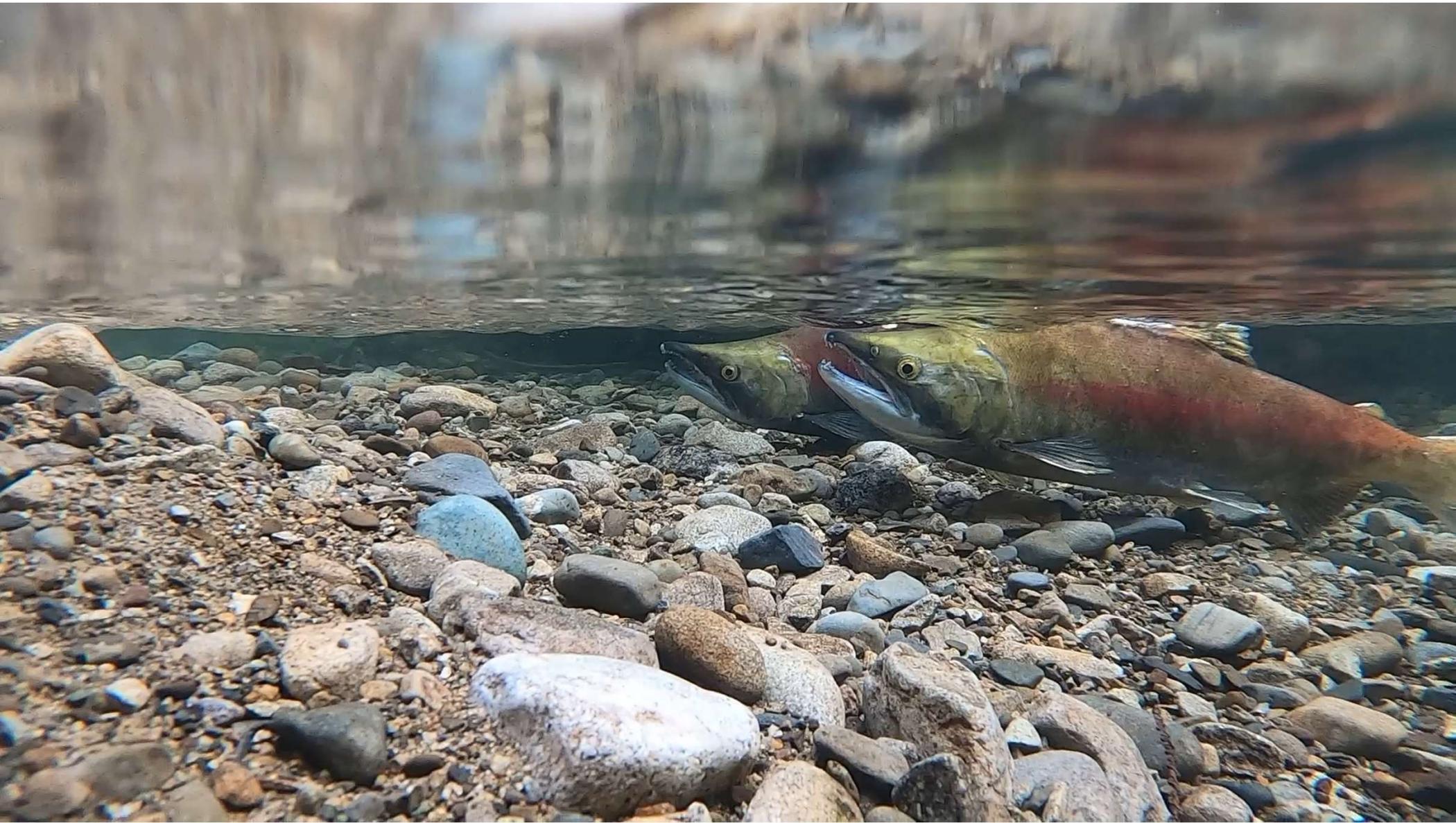


- A. Matala



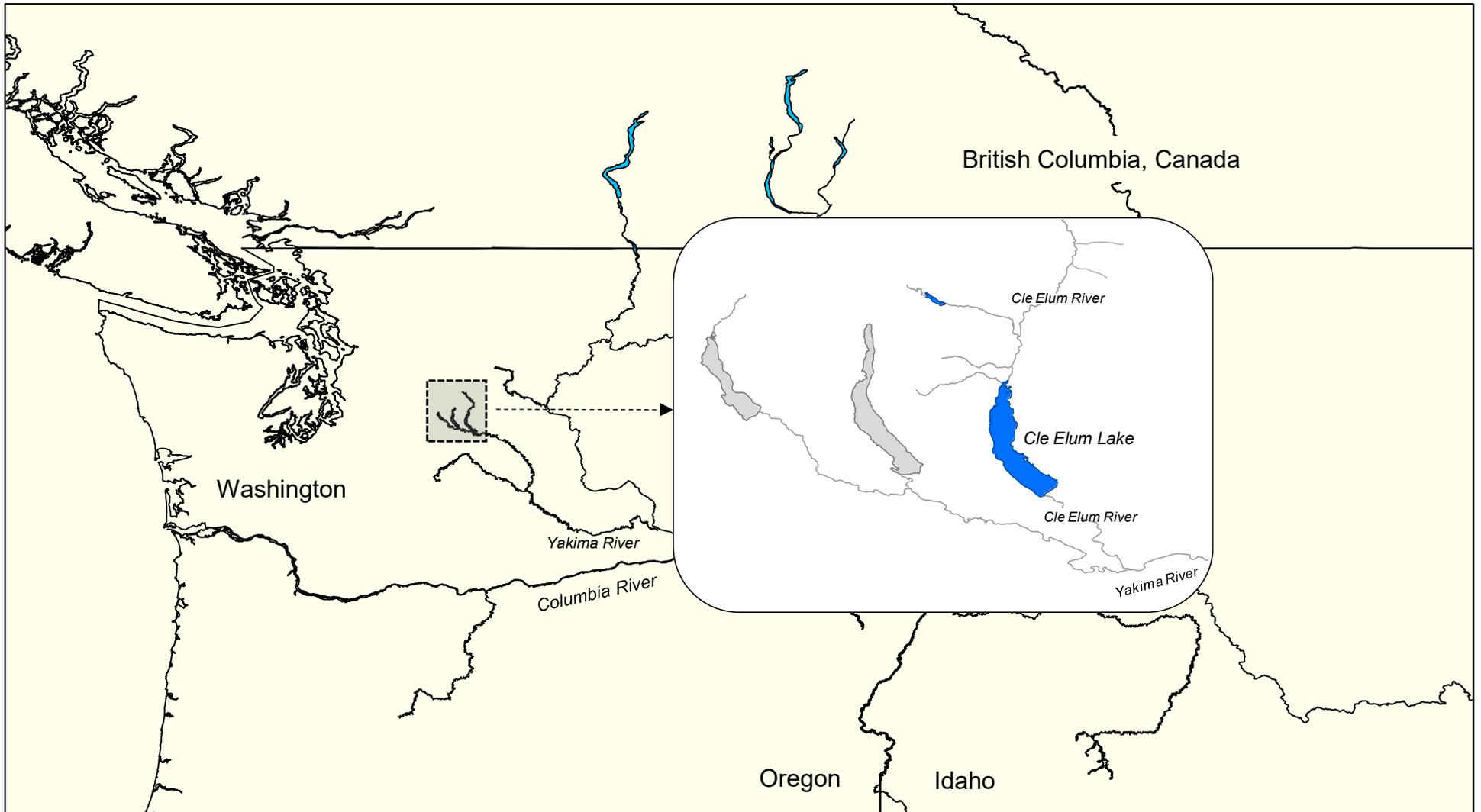
— BUREAU OF —  
RECLAMATION





# The site of reintroduction

- Historical escapement of sockeye among Yakima Basin nursery lake ~200K
- Cle Elum Lake was believed to be the largest producer



# Fate of Sockeye in Cle Elum Lake

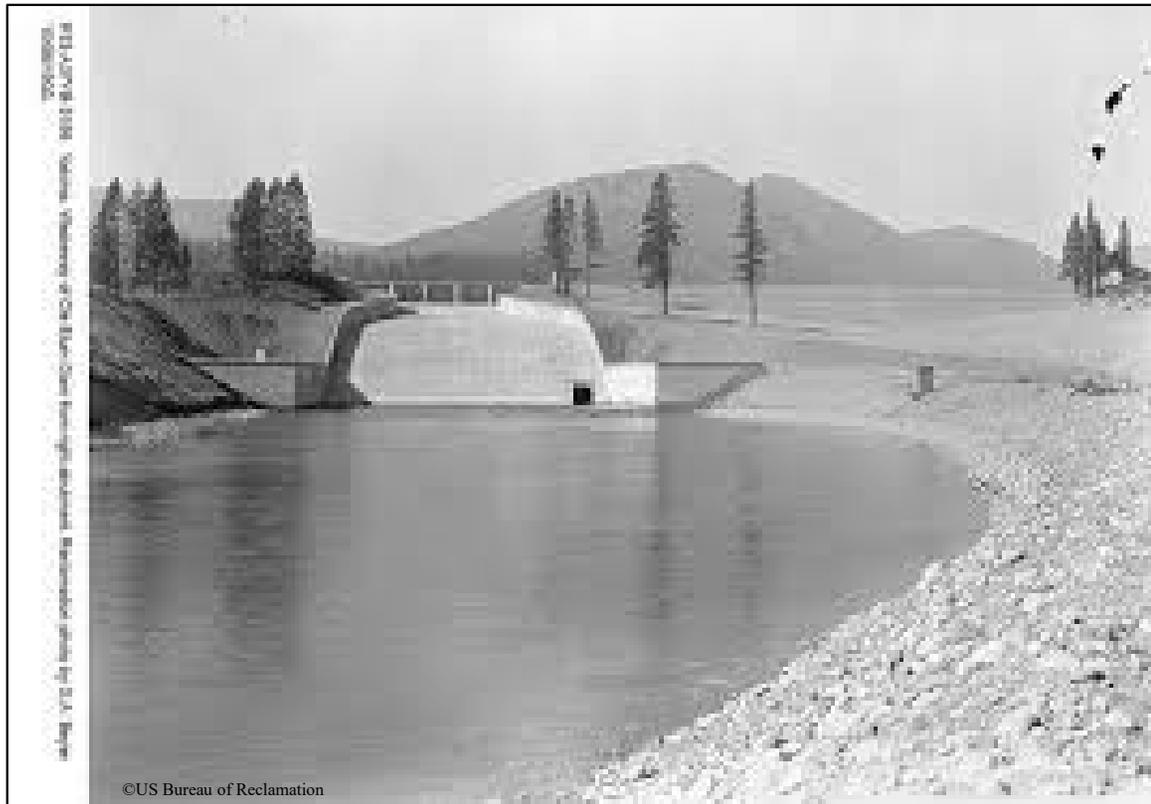
- Timber crib dam built at the outlet of Cle Elum Lake in 1906



- significant obstruction for migrating salmon, leading to “functional” extirpation (>95% decline from historical abundances)

# Fate of Sockeye in Cle Elum Lake

- Cle Elum Dam completed in 1933 – lake becomes a storage reservoir
- no fish passage for migrating salmon - complete extirpation follows



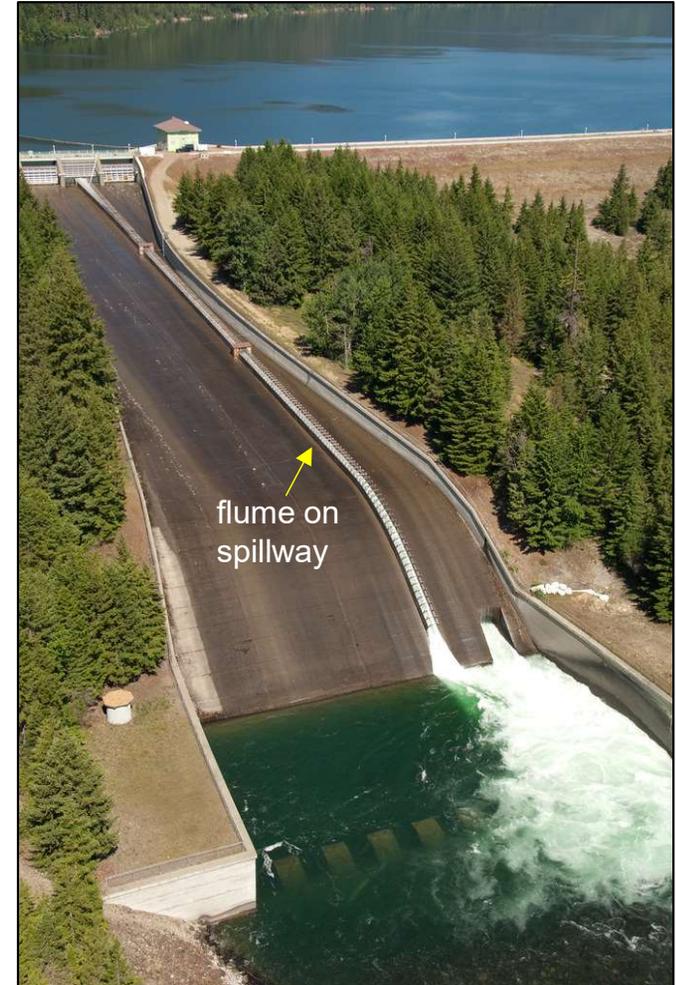
# Bringing Sockeye back after 100 year absence

1987-1993: feasibility studies (NOAA, BOR)

2005: temporary juvenile bypass flume built

2009: translocation of adult sockeye begins

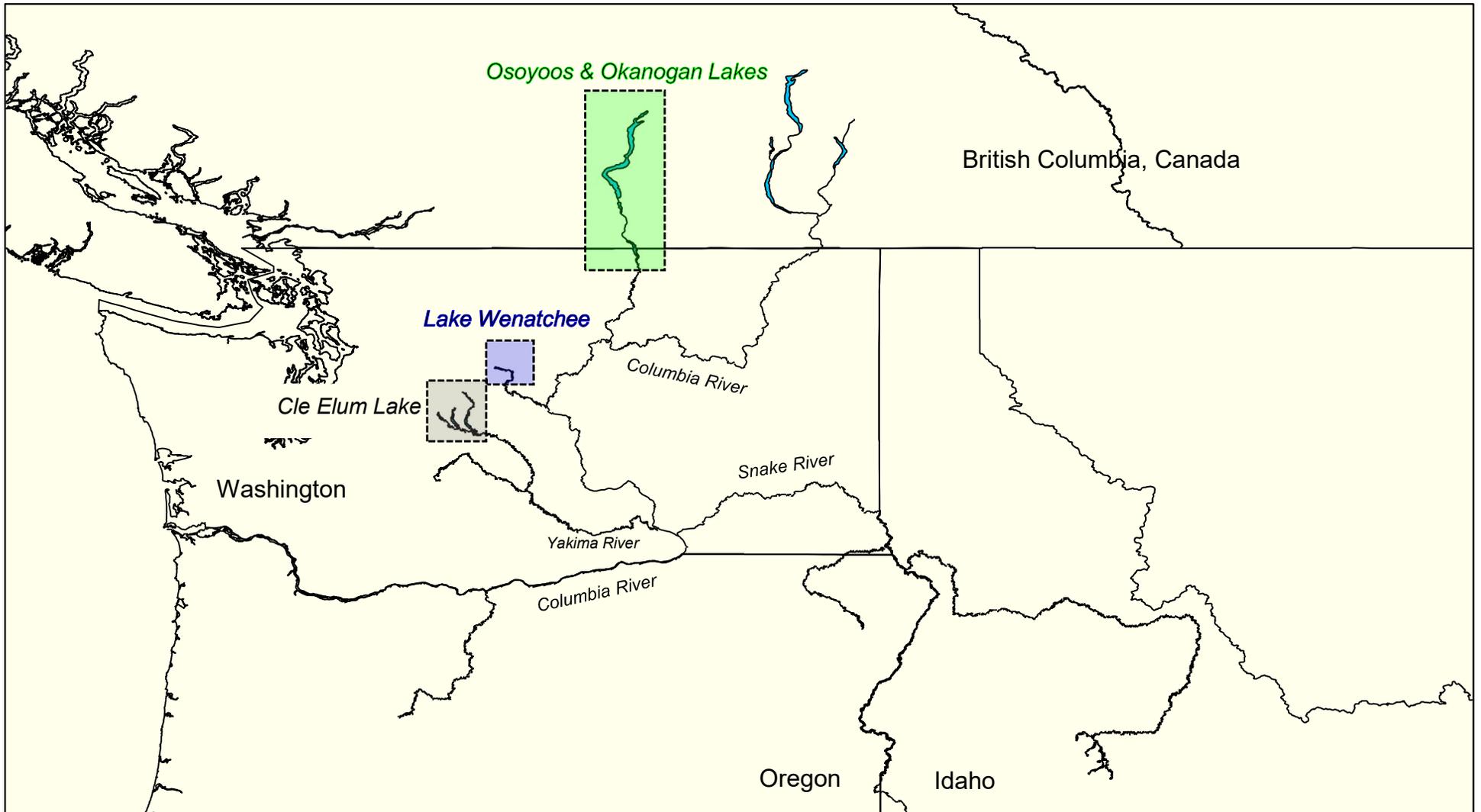
2013: First return of wild sockeye



# Donor stock sources for reintroduction

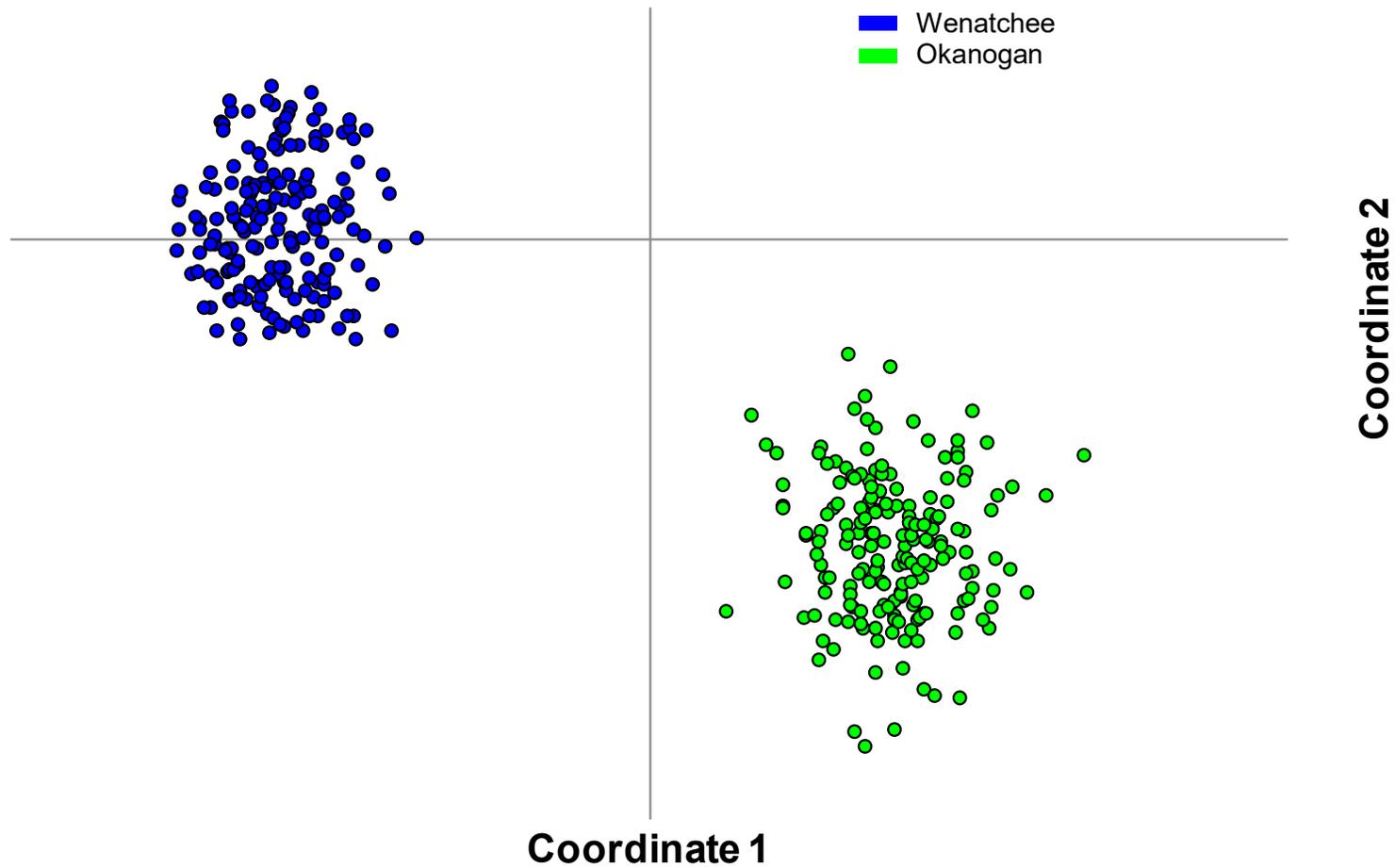
the only two extant populations in the Columbia River

★ stocks will be designated by color throughout



# Characteristics of donor stocks

- Strongly differentiated genetically (PCoA plot based on genotypes)



# Characteristics of donor stocks

## Wenatchee

- adult return age
  - age-4, age-5
- spawn time
  - mid September
- spawning habitat
  - cooler; headwaters
- relative abundance (Columbia escapement)
  - 20-30%



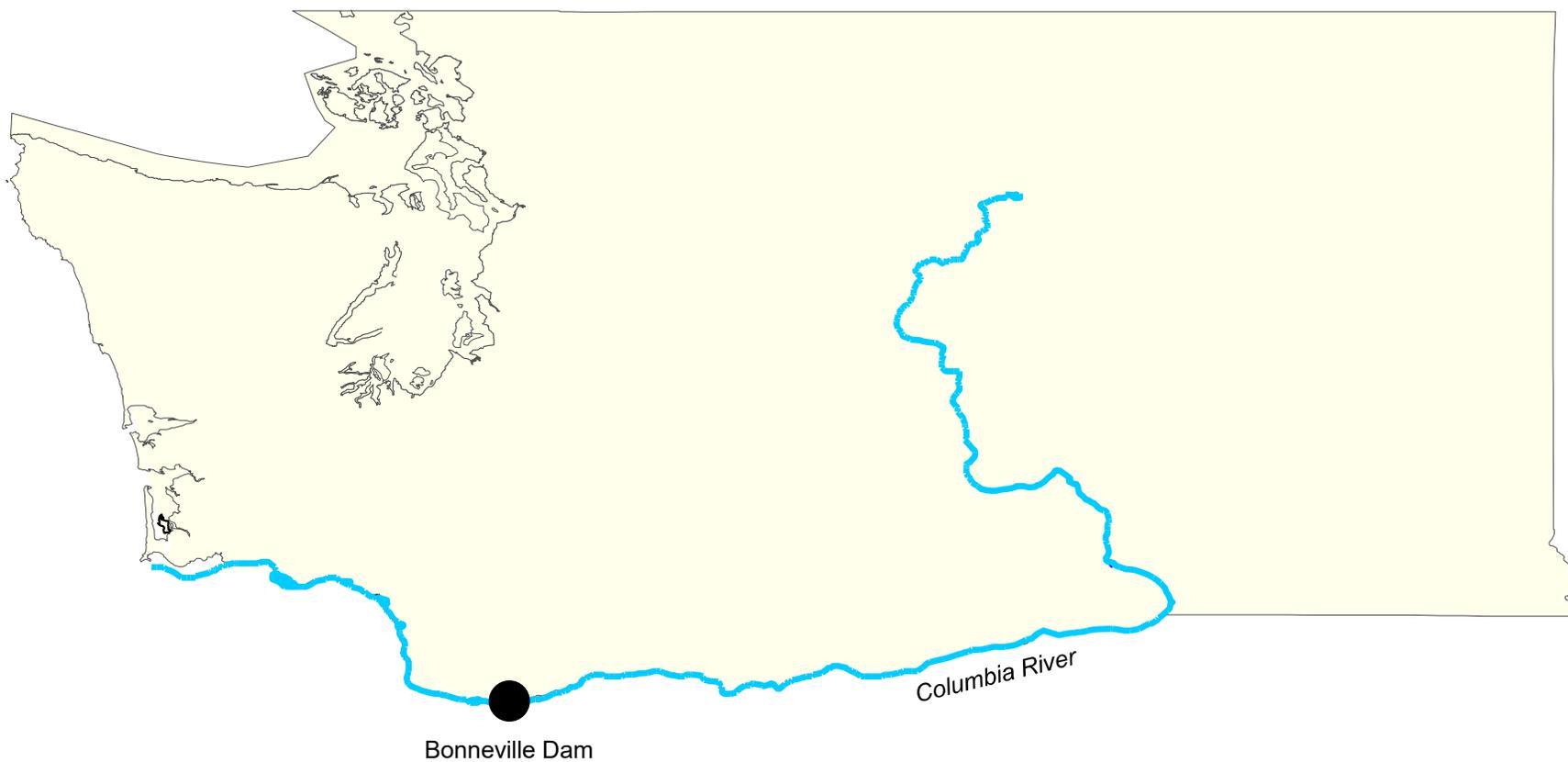
## Osoyoos/Okanogan

- adult return age
  - age-3, age-4, age-5
- spawn time
  - mid October
- spawning habitat
  - warmer, low elevation
- relative abundance (Columbia escapement)
  - 70-80%



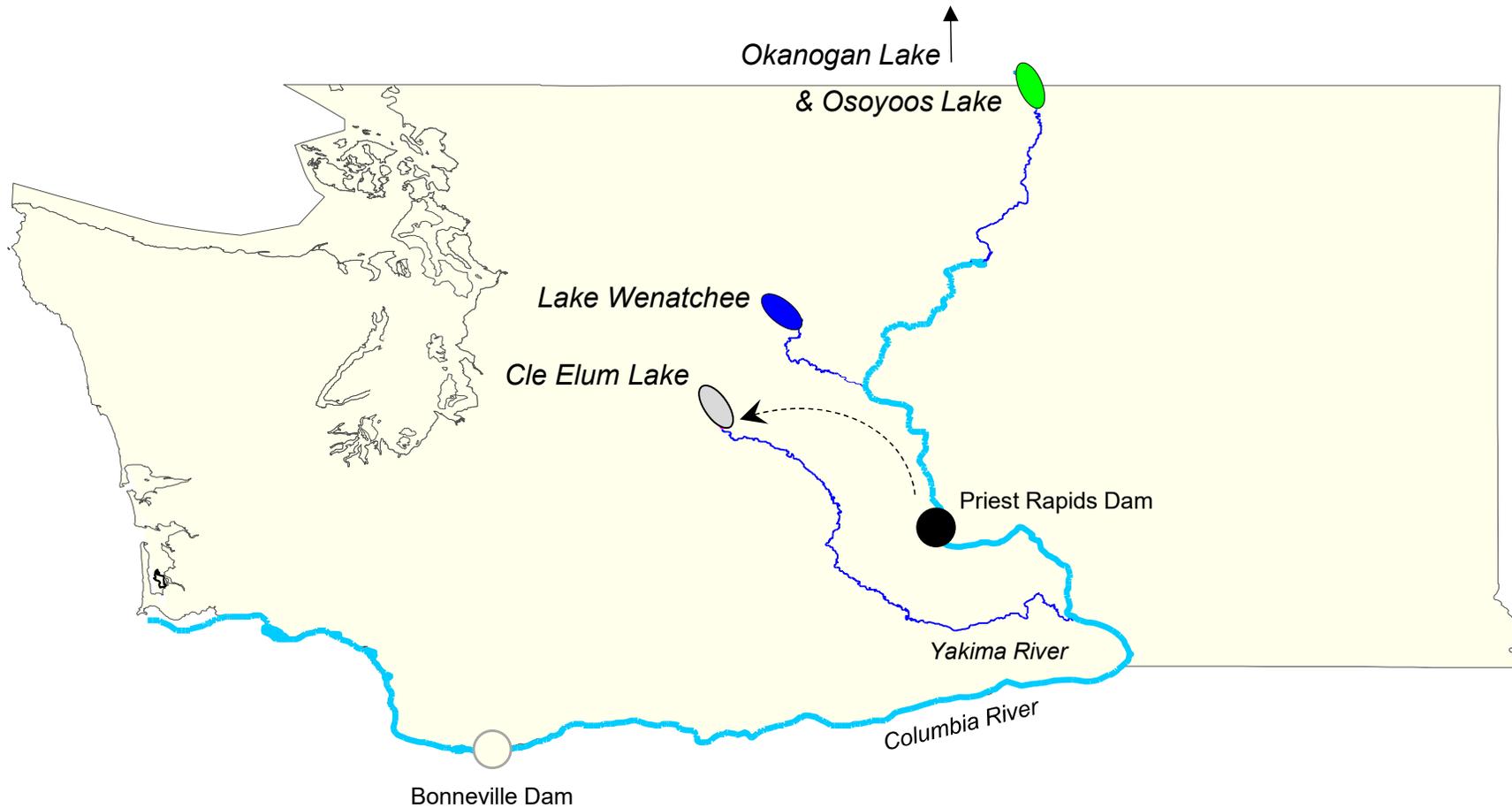
# relevant landmarks

- **Bonneville Dam:** where total Columbia River escapement is estimated



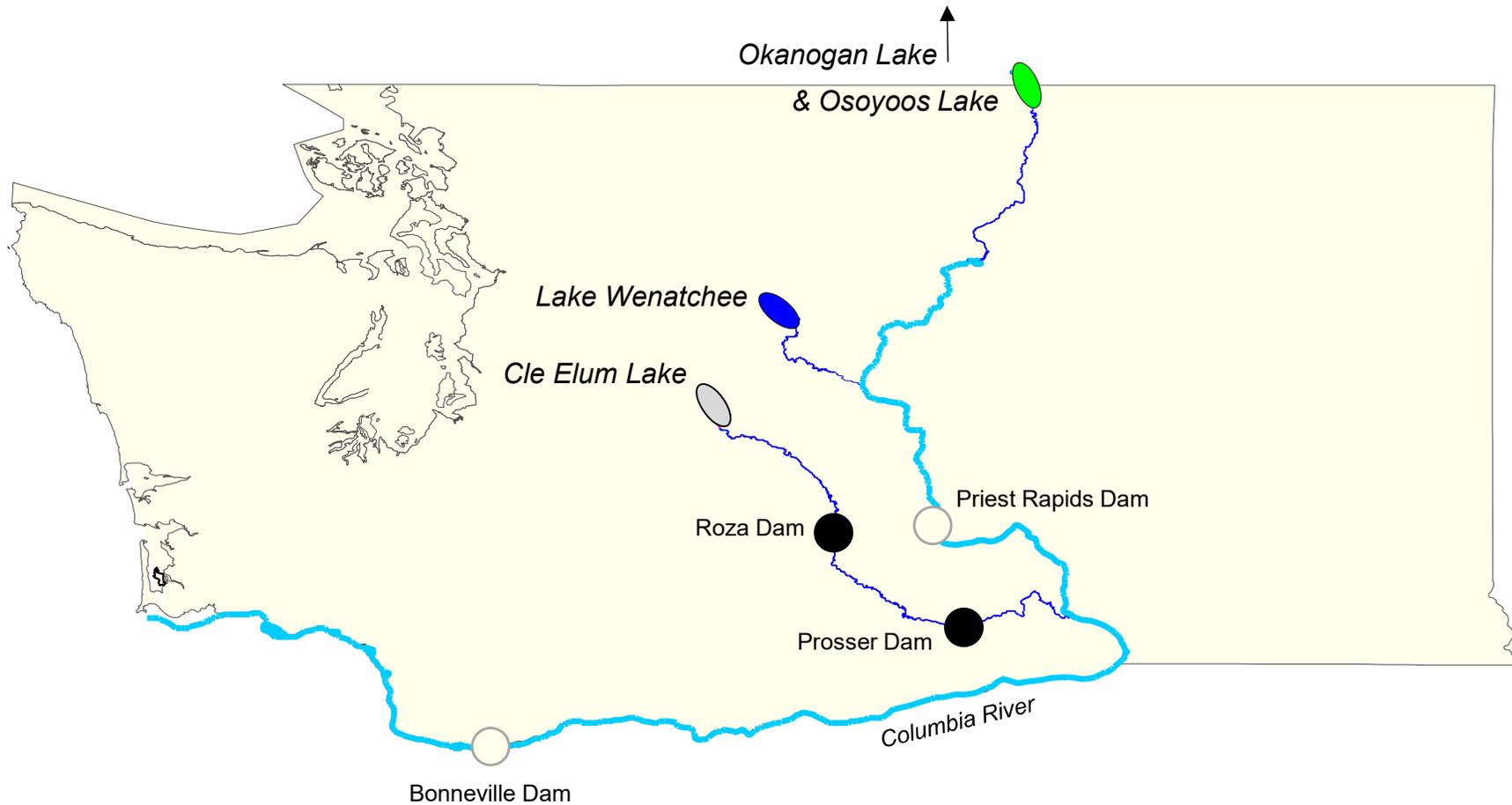
# relevant landmarks

- **Priest Rapids Dam:** fish collected for translocated to Cle Elum Lake (mix of upriver donor stocks – proportions unknown)



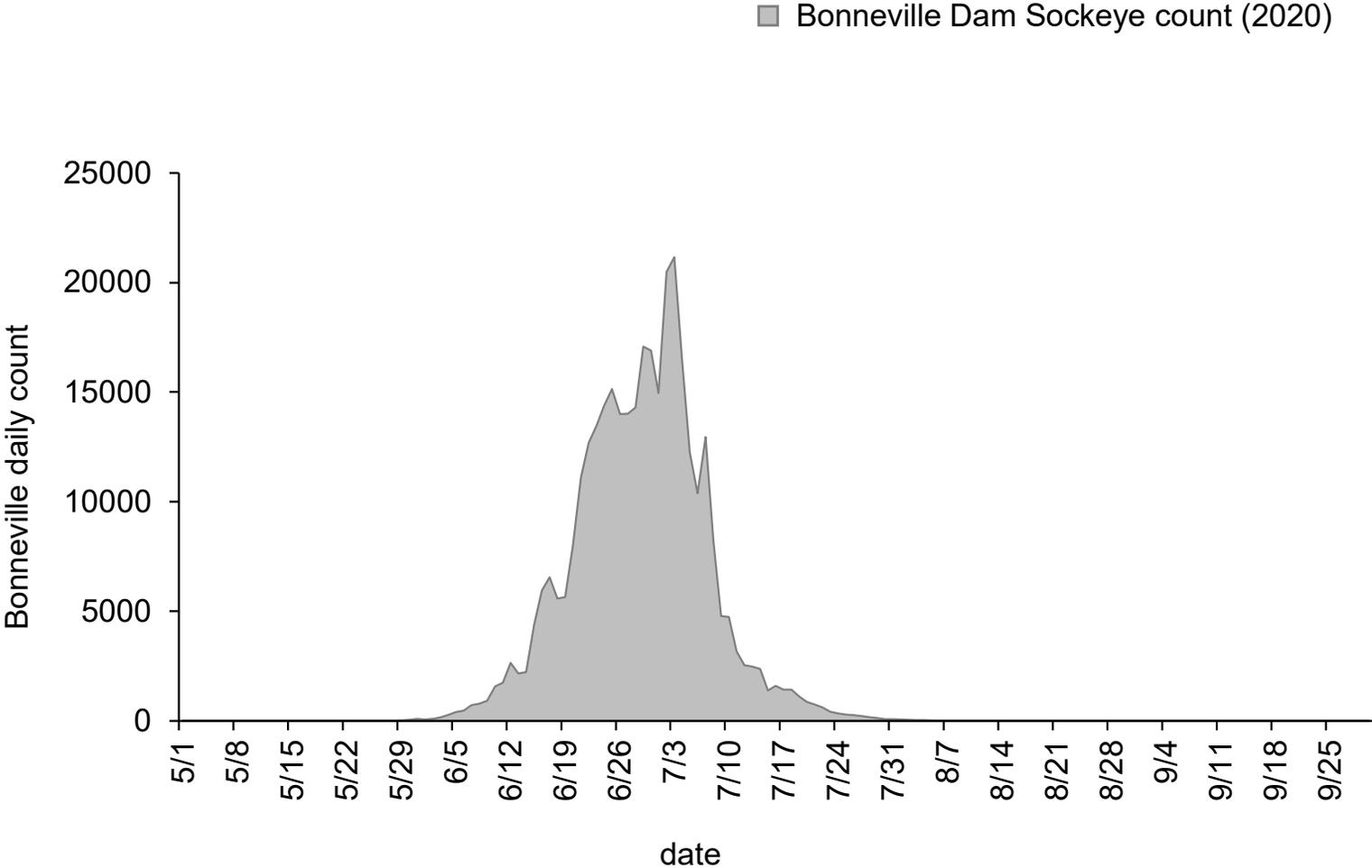
# relevant landmarks

- **Prosser Dam:** Yakima fish count data is collected
- **Roza Dam:** trap & haul site for wild sockeye returning to the Yakima R.



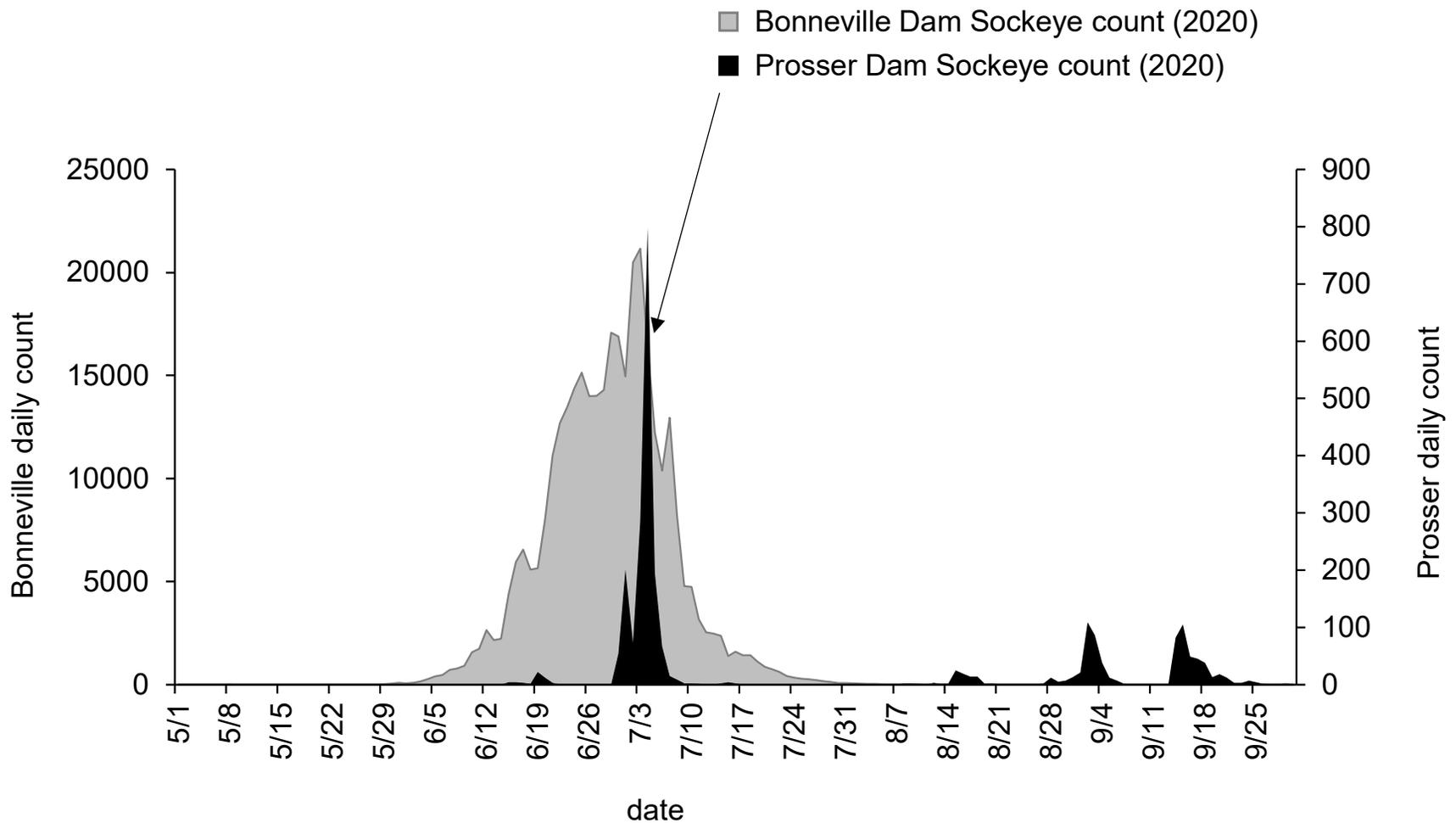
# migration time for return to the Columbia River

- Typical return time is first week in June through last week in July



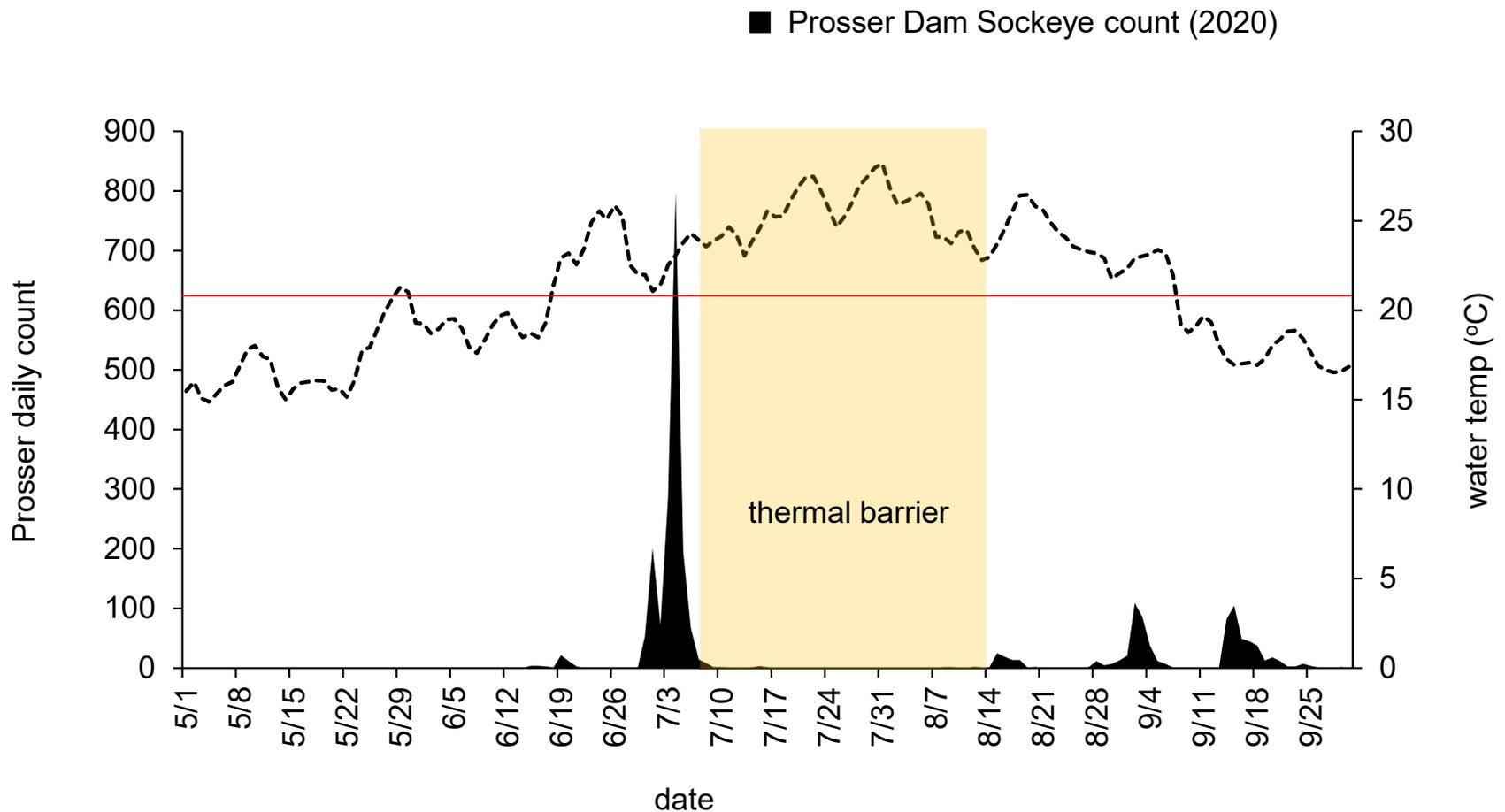
# migration time for return to the Yakima River

- The early return of natural origin fish to the Yakima River follows closely on the heels of the Bonneville return



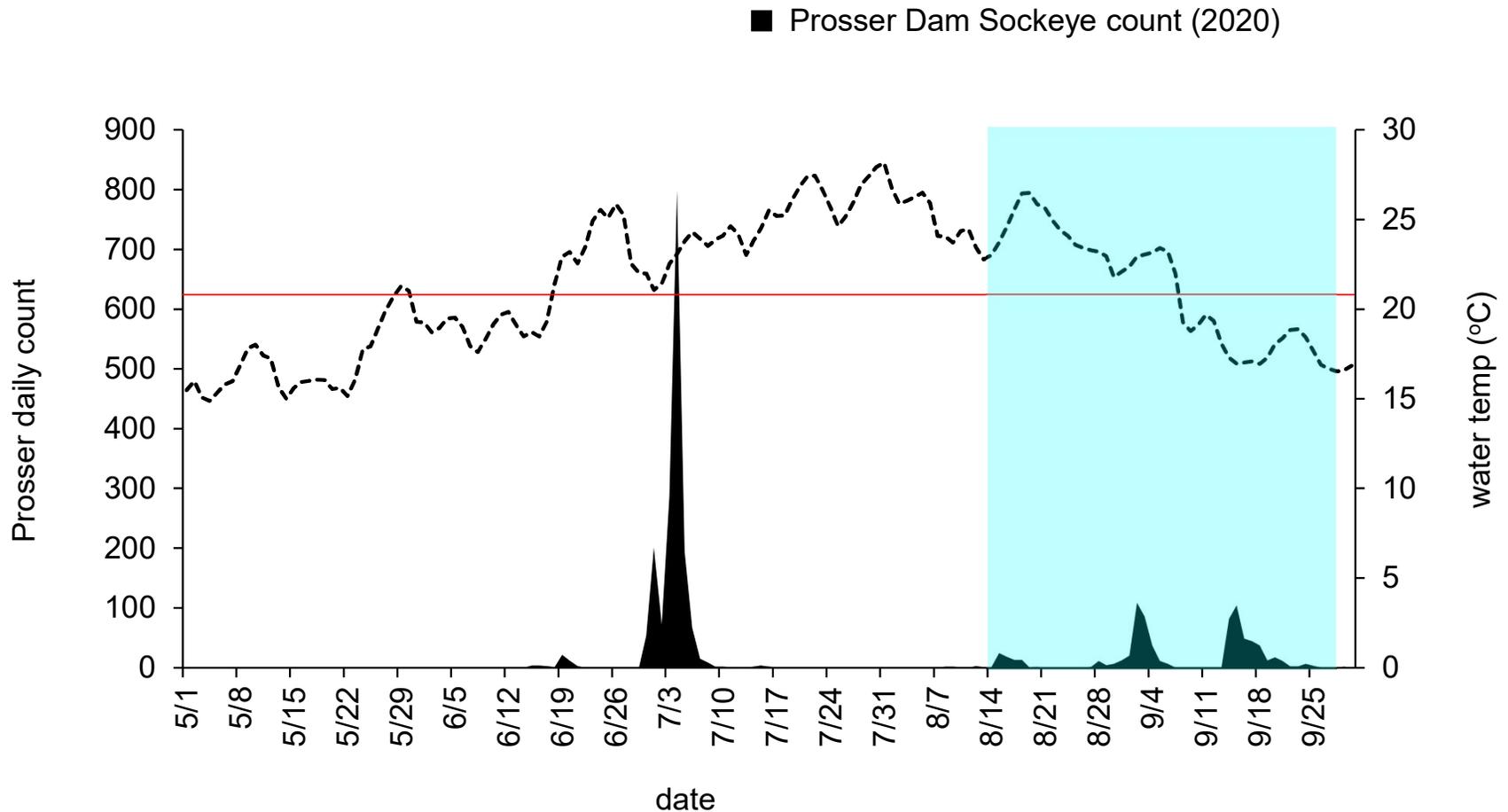
# migration time for return to the Yakima River

- Elevated water temperatures (>21°C) starting in early July deter salmon from entering the Yakima River



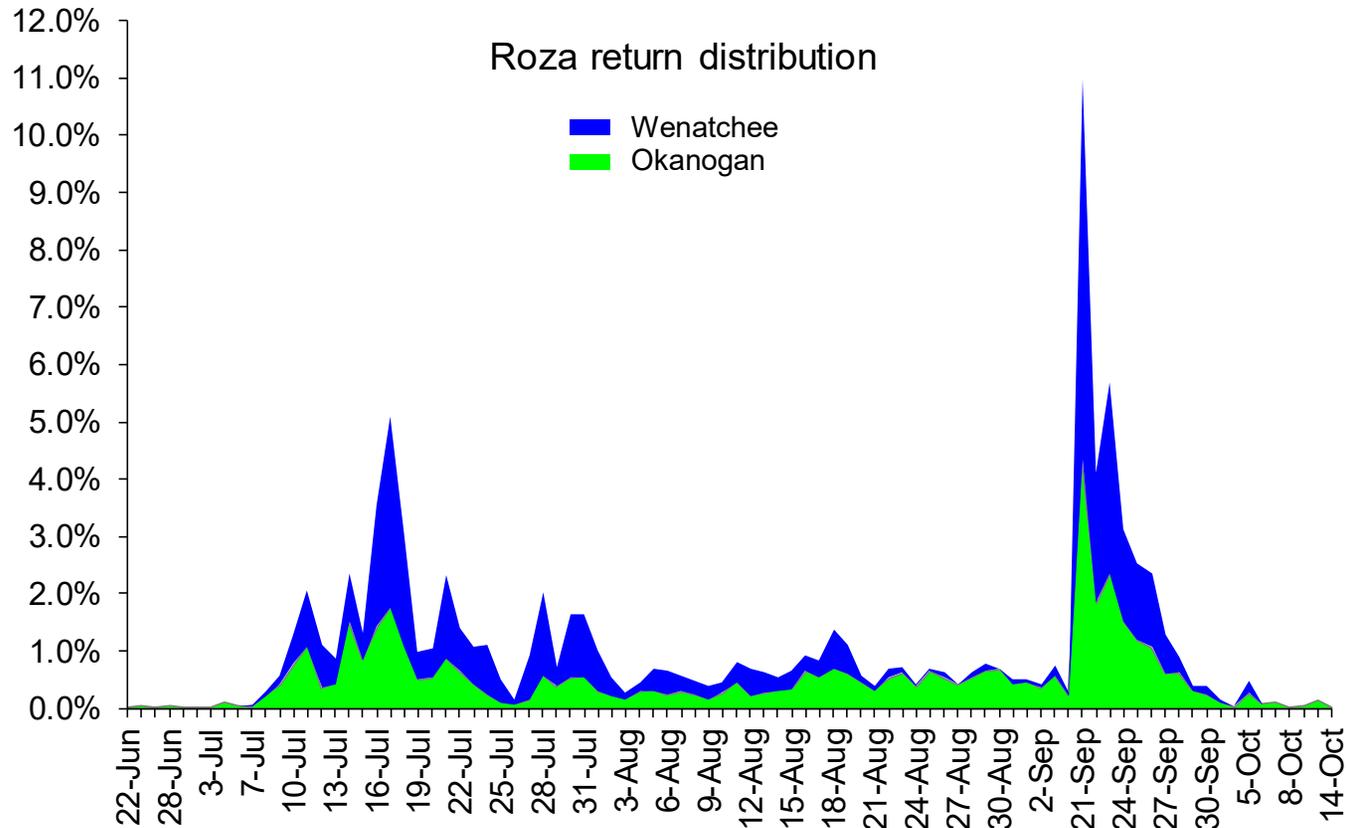
# migration time for return to the Yakima River

- Fish begin migrating up the Yakima River again in late summer as temperatures drop; this phenomenon has occurred each year since 2015



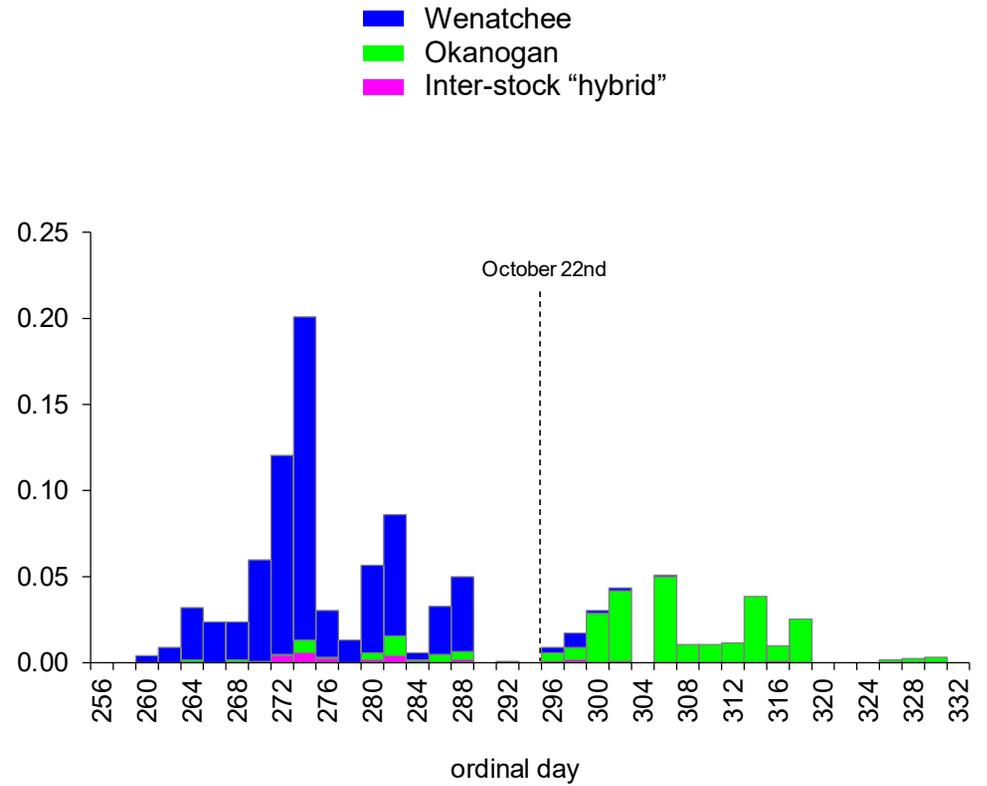
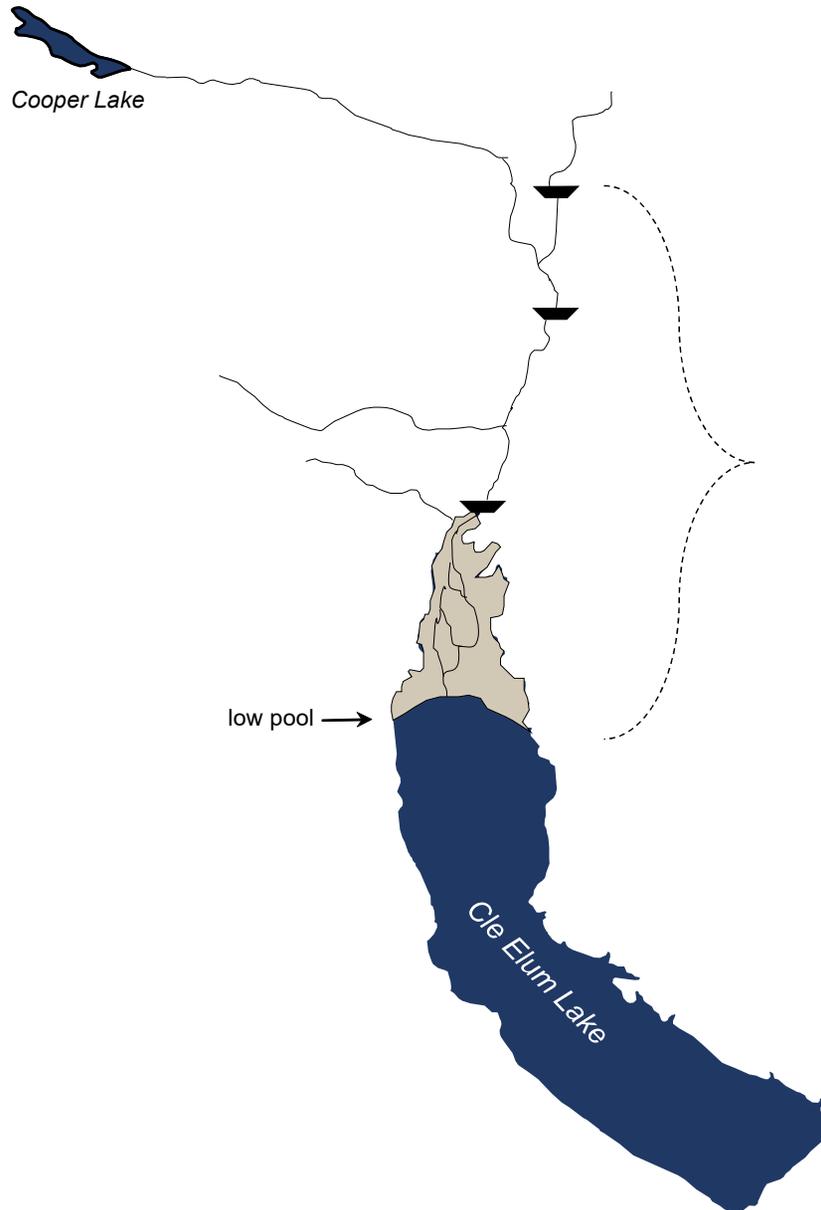
# migration time for return to the Yakima River

- No apparent difference in return time between stocks
- Unclear if one is more impacted by the delay (e.g. straying) which may affect relative abundances

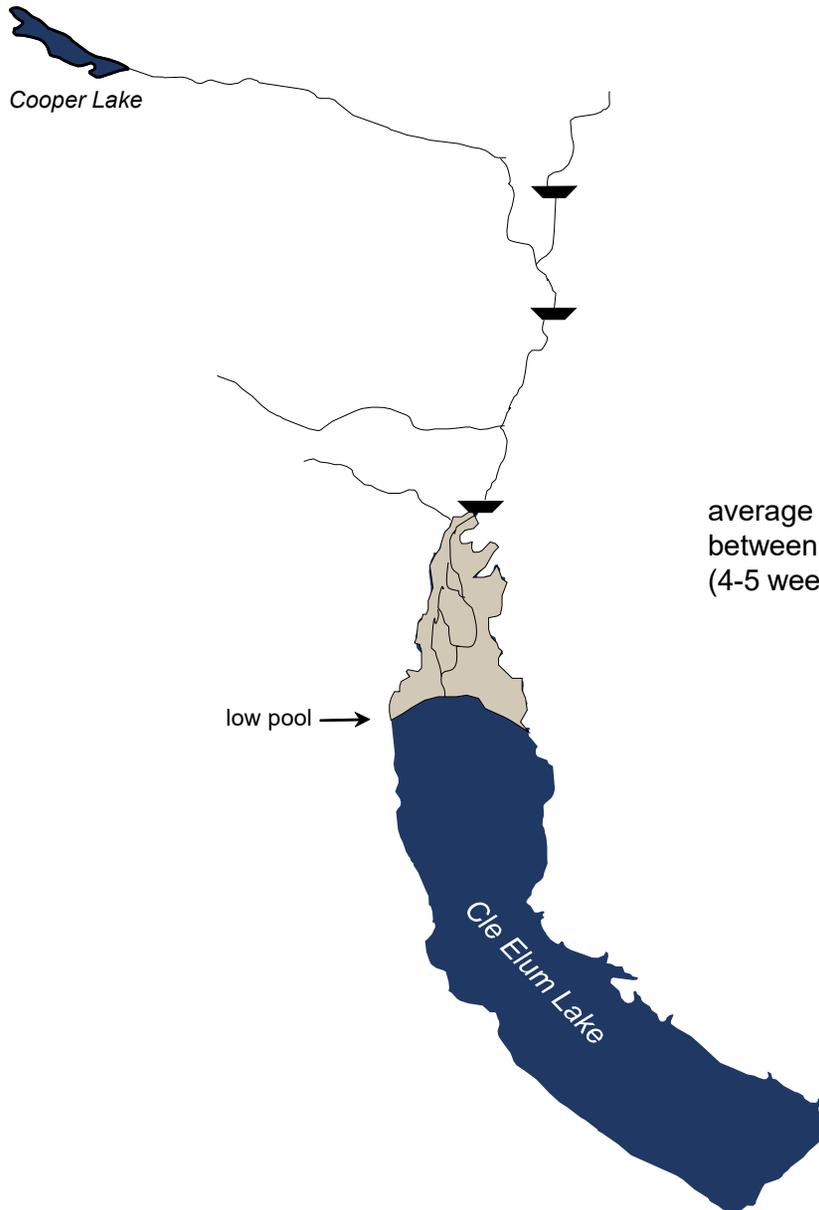


# Spawning Ground Surveys: temporal assortative mating

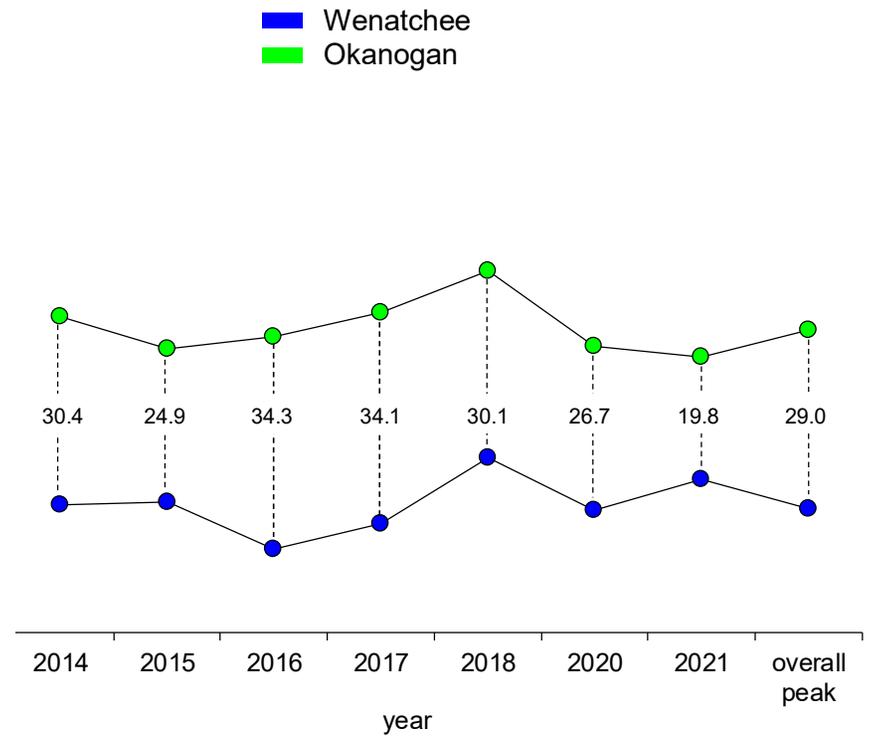
☆ spawn times – trait retained from natal populations



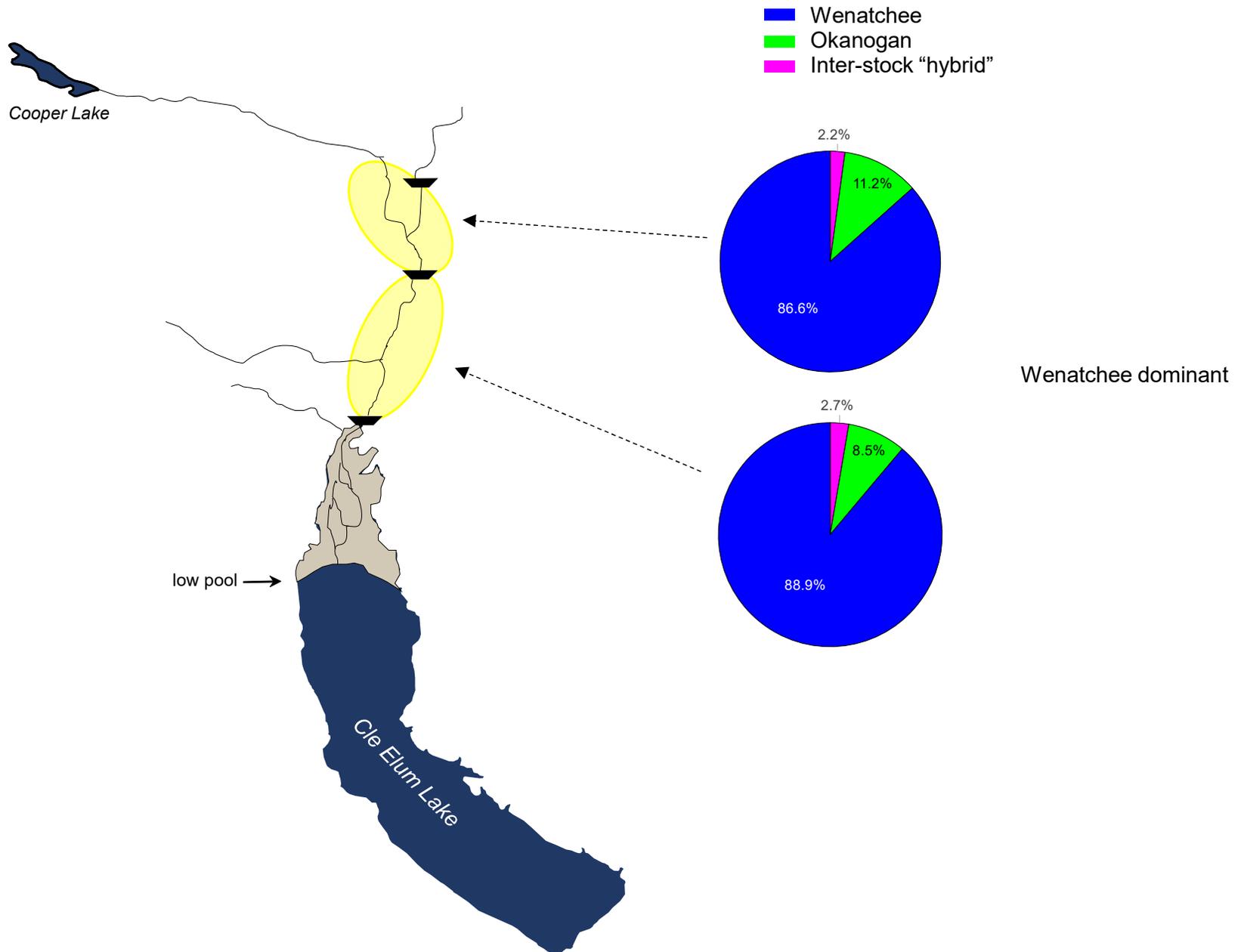
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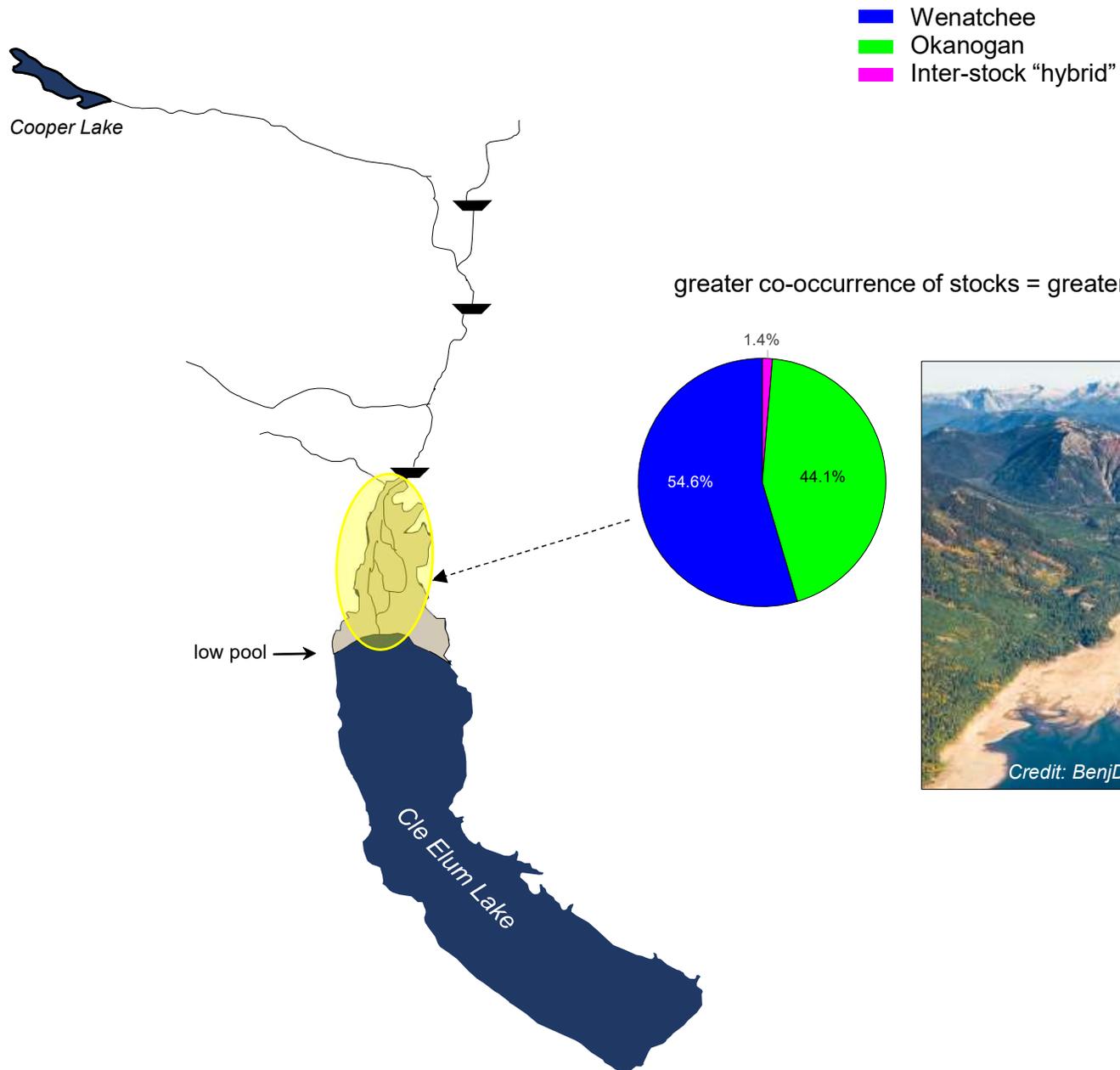
average days  
between recovery  
(4-5 weeks)



# Spawning Ground Surveys: spatial distribution differs



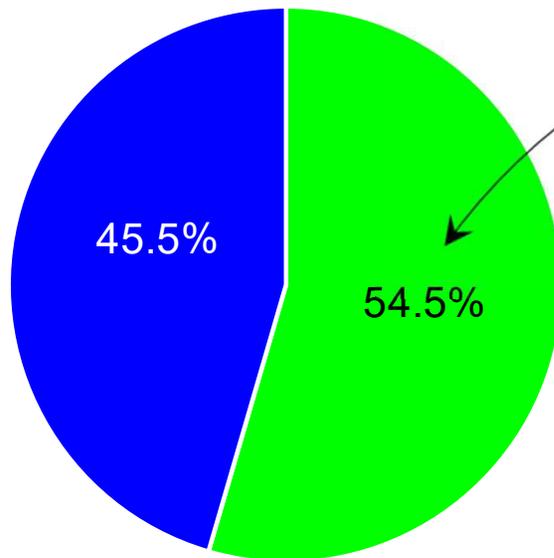
# Spawning Ground Surveys: spatial distribution differs



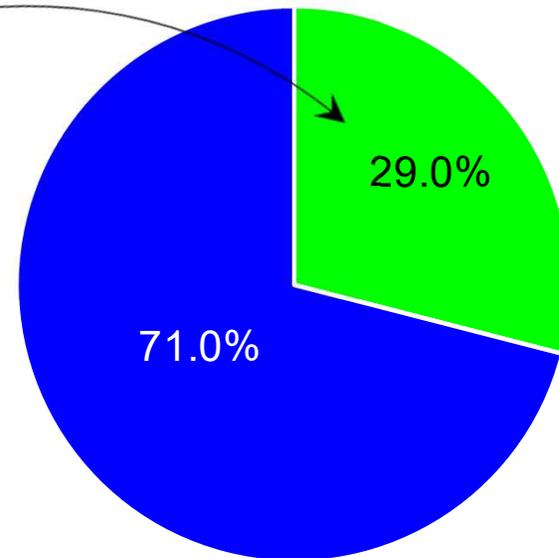
# An accounting problem:

Why so few Osoyoos fish recovered?

average spawner abundance  
(2015-2021)



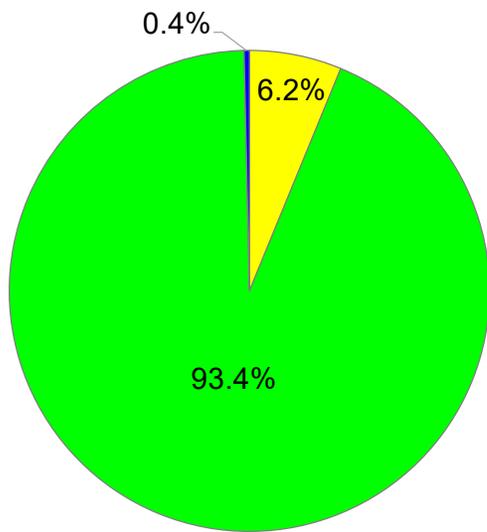
proportion carcass recovery  
(2015-2021)



# Lake Trout removal by gillnet

## Sockeye bycatch

evidence of lake shore spawning  
nearly exclusive to Osoyoos stock

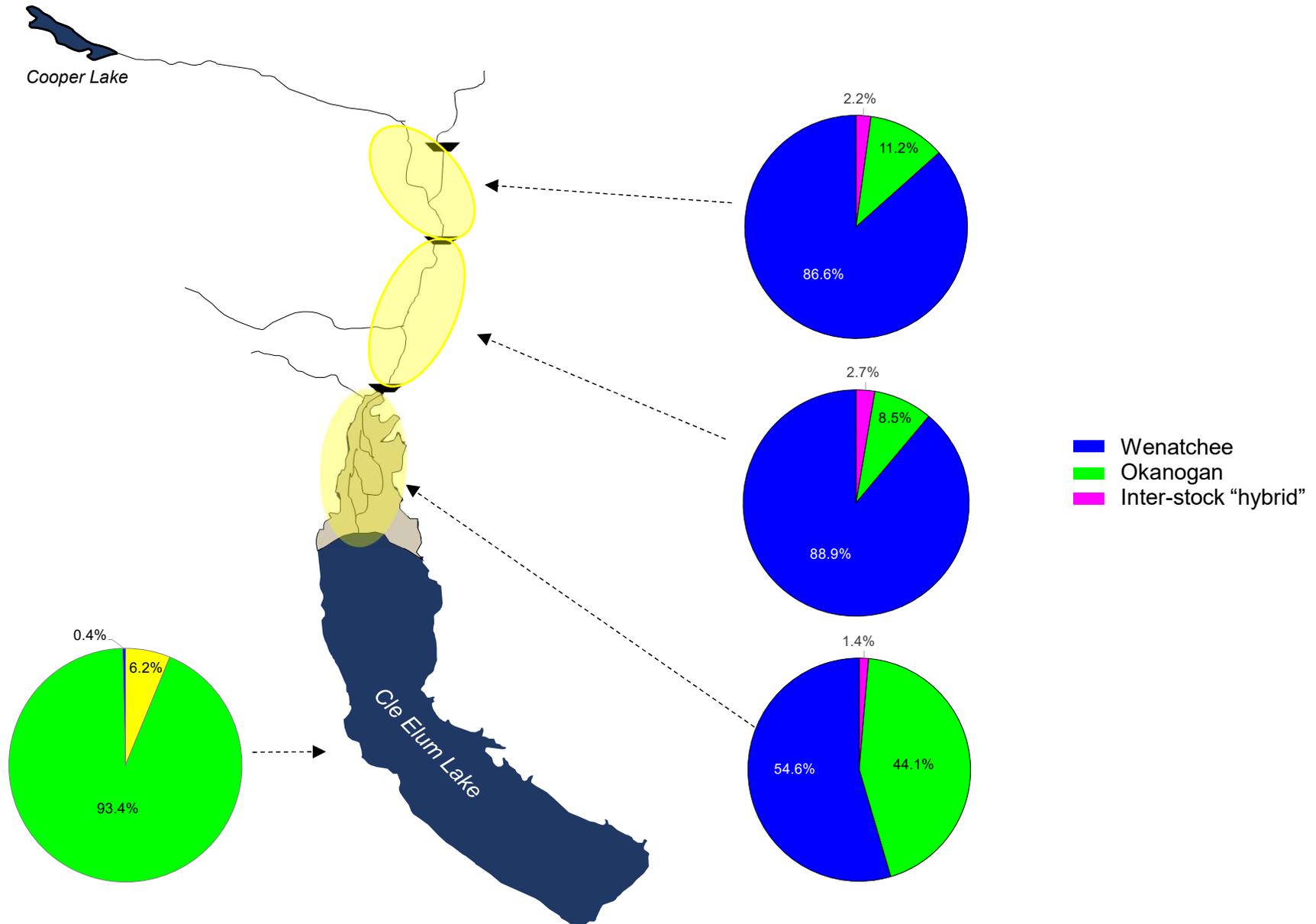


■ Wenatchee  
■ Okanogan  
■ kokanee



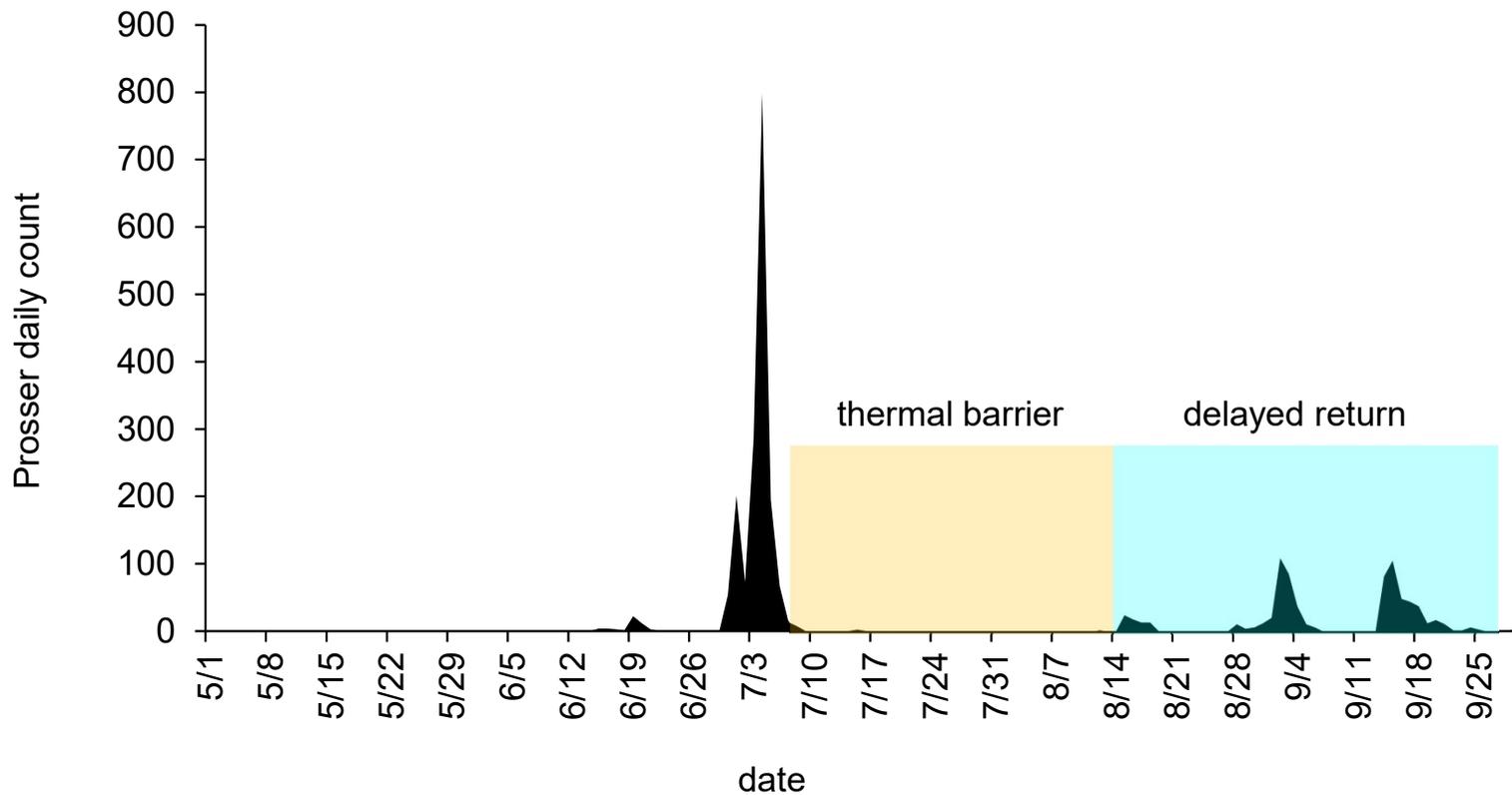
# Spawning Ground Surveys: spatial distribution differs

☆ spawn location – behavior in response to the environment



# Consequences of delayed migration

- Remember this histogram?



# Consequences of delayed migration

- Fish awaiting cooler conditions in the Yakima River deplete their resources while holding at the confluence for an extended period



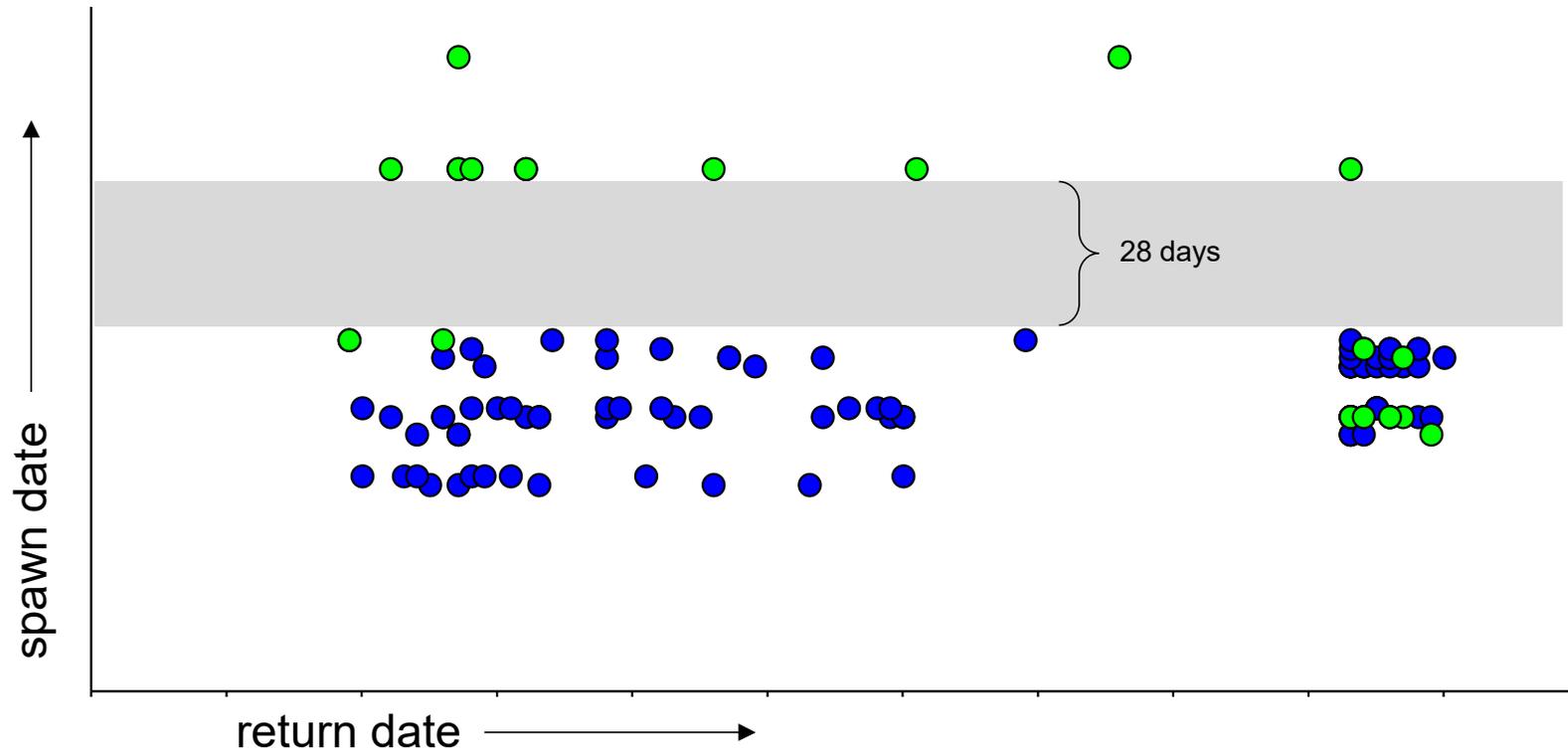
# Consequences of delayed migration

- Fish trapped at Roza in June-July are chrome (“ocean bright”)
- Fish trapped at Roza in late August-September exhibit spawning colors



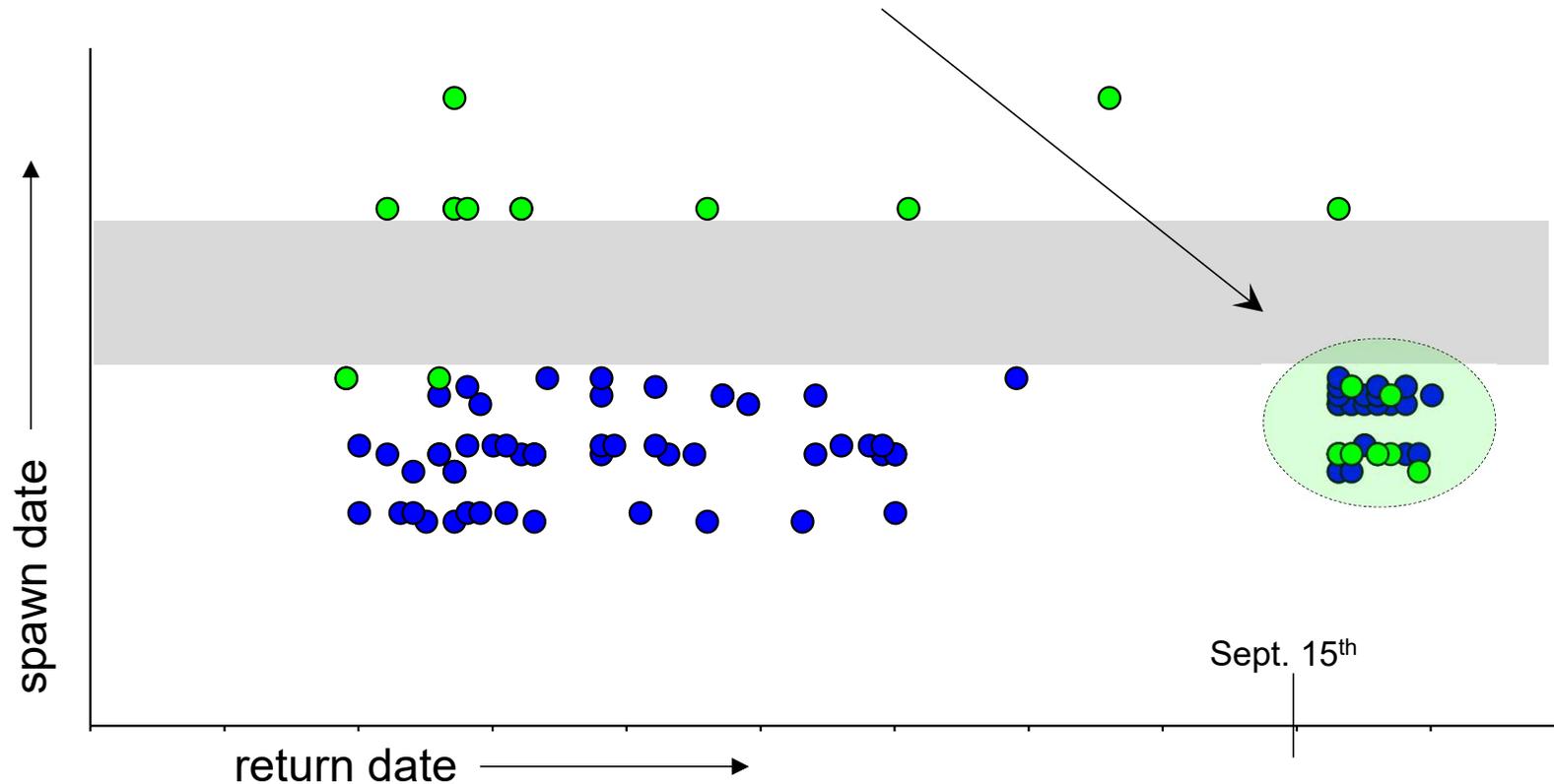
# Consequences of delayed migration

- Recall that spawn time usually differ by ~4-5 weeks



# Consequences of delayed migration

- Exhaustion may cause late arriving Osoyoos fish to spawn early



- may inflate incidence of stock mixing (i.e. interstock “hybrid”)

# Consequences of delayed migration

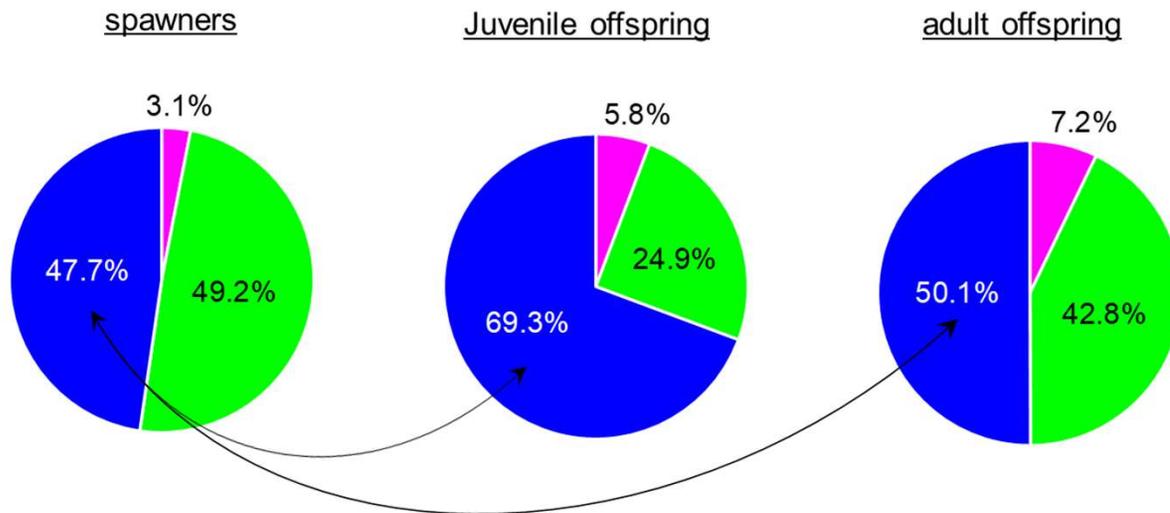
- prespawn mortality & poor egg development
- usually observed early in the survey season;
- linked to fish trapped among the late return

★ Fortunately, trap & haul of most fish occurs by late July



# The payoff: relatively productivity among stocks

- Wenatchee lineage fish appear to be more successful?



- What is the impact on productivity due to:
  - 1) differences in spawning habitat?
  - 2) differences in juvenile rearing environment?
  - 3) differences in fry emergence time?

} egg basket study  
implementation -2022

# That's all (but there's so much more)

Brian Saluskin	- YN	Charlie Strom	- YN	Peter Galbreath	- CRITFC
Kevin Segar	- YN	Simon Goudy	- YN	Hayley Nuetzel	- CRITFC
Andrew Maldonado	- YN	Arnold Barney	- YN	Jeremiah Newell	- CRITFC
Joe Blodgett	- YN	Ted Martin	- YN	Toby Kock	- USGS
Mark Johnston	- YN	Quin James	- YN	Richard Visser	- BOR
Chuck Carl	- YN	Michael Fiander	- YN	Pat Monk	- BOR
				Paul Hoffarth	- WDFW
				Rod O'connor	- GPUD

