

Spatial and Temporal Dynamics of Spawning between Native Westslope Cutthroat Trout, Introduced Rainbow Trout, and their Hybrids, with Implications for Hybridization and Loss of Adaptation

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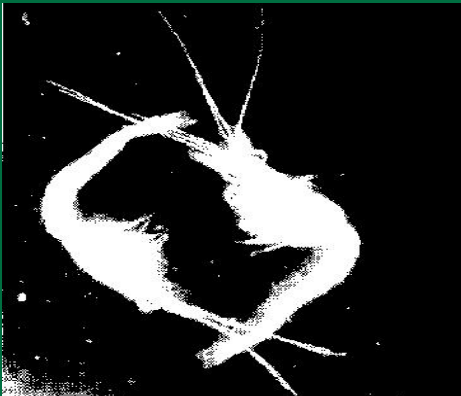


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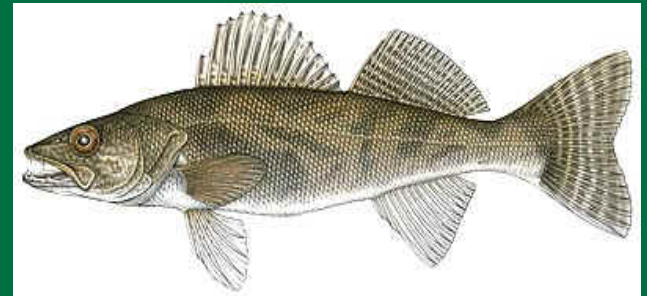
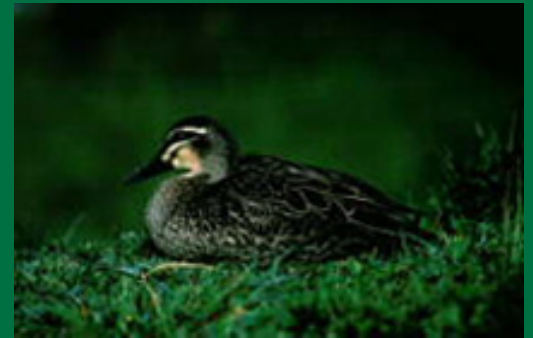


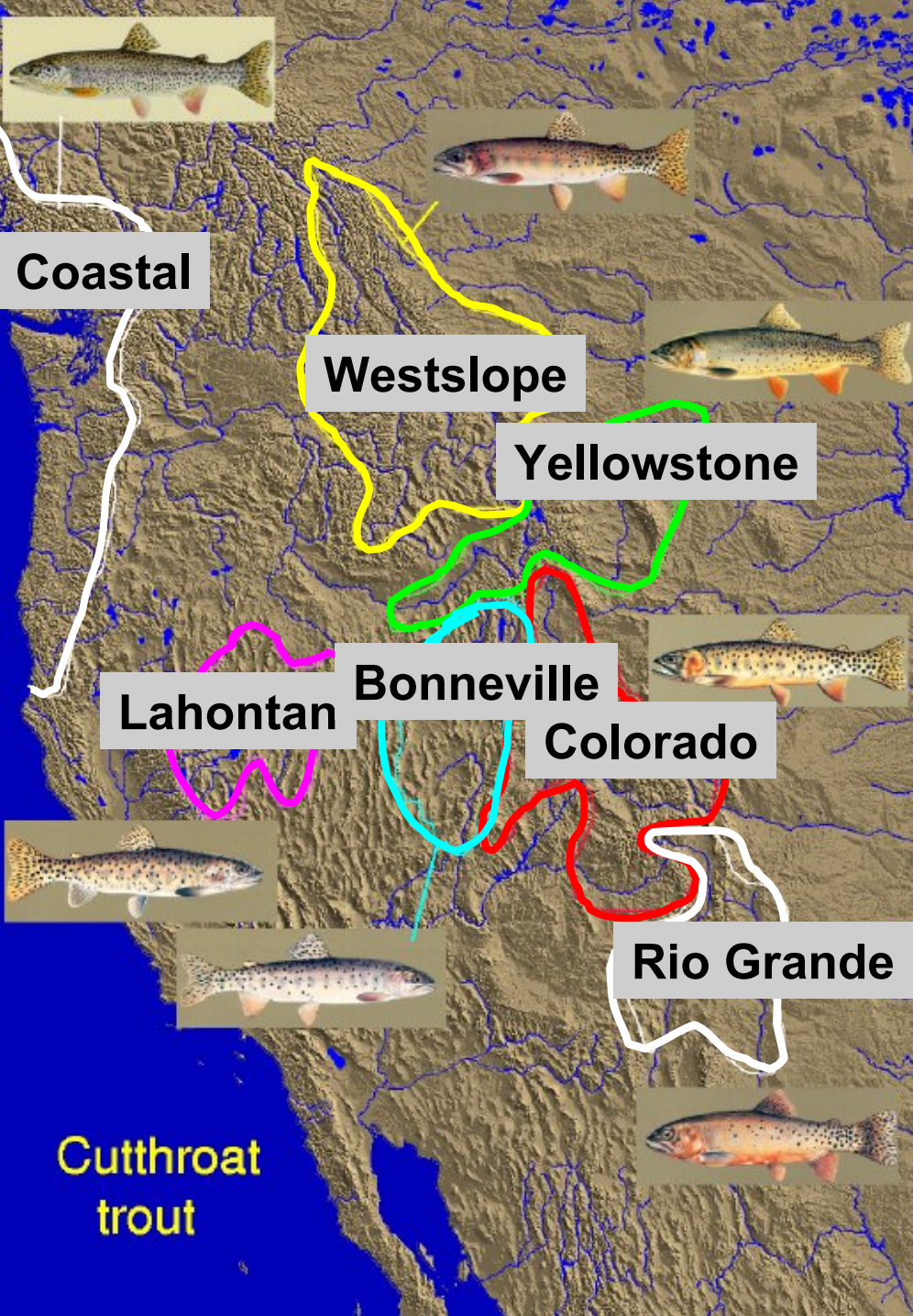
Introductions of Exotic Species



Hybridization

- Loss of locally adapted gene complexes and ecological adaptations in native populations
- Threatens the persistence of many rare and endangered species





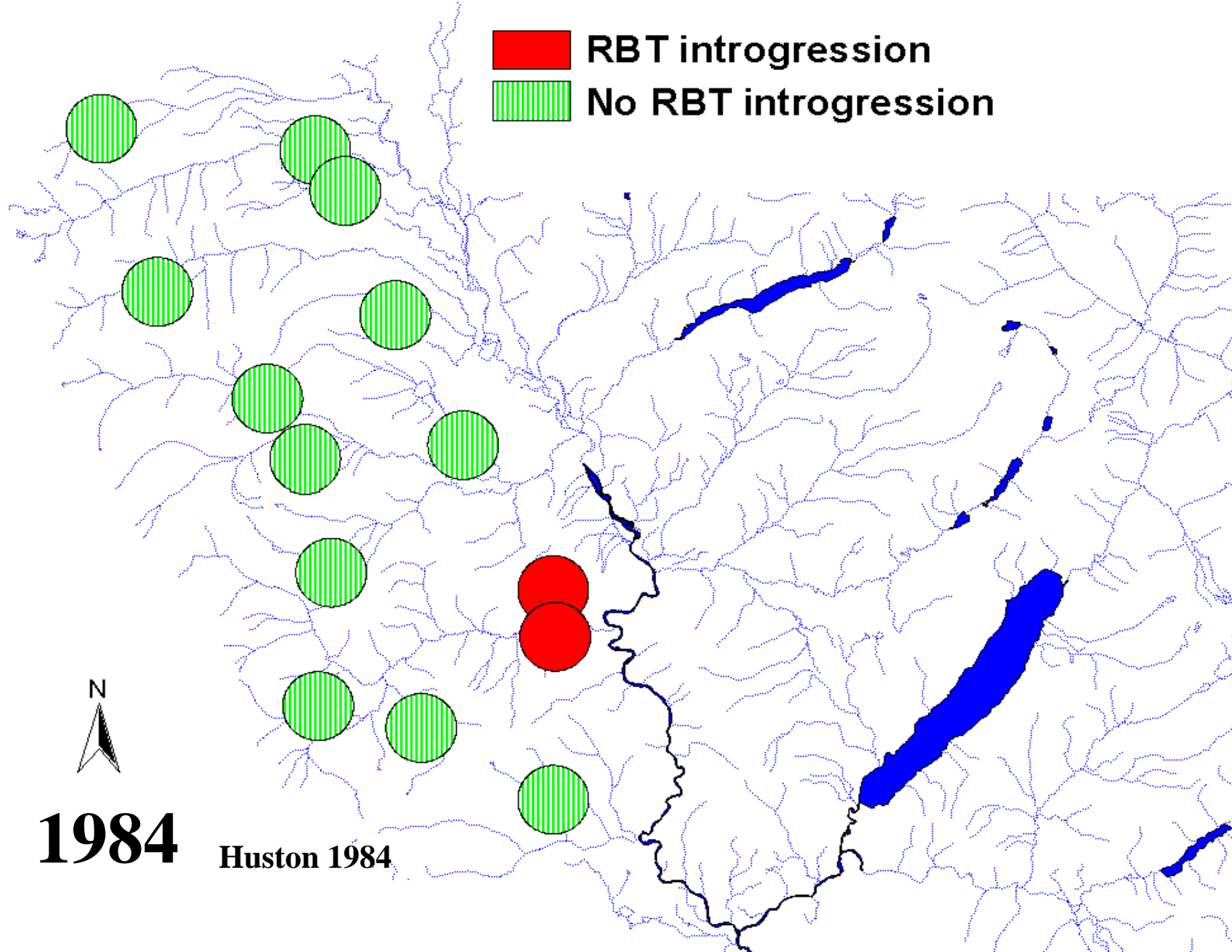
Cutthroat trout

- 14 subspecies
- Historic distribution includes Pacific NW, Great Basin, Rocky Mountains, Southwest

Westslope cutthroat trout




- One of four major subspecies
- Distribution includes the Columbia, Fraser, Missouri, and Hudson Bay drainages of the US and Canada

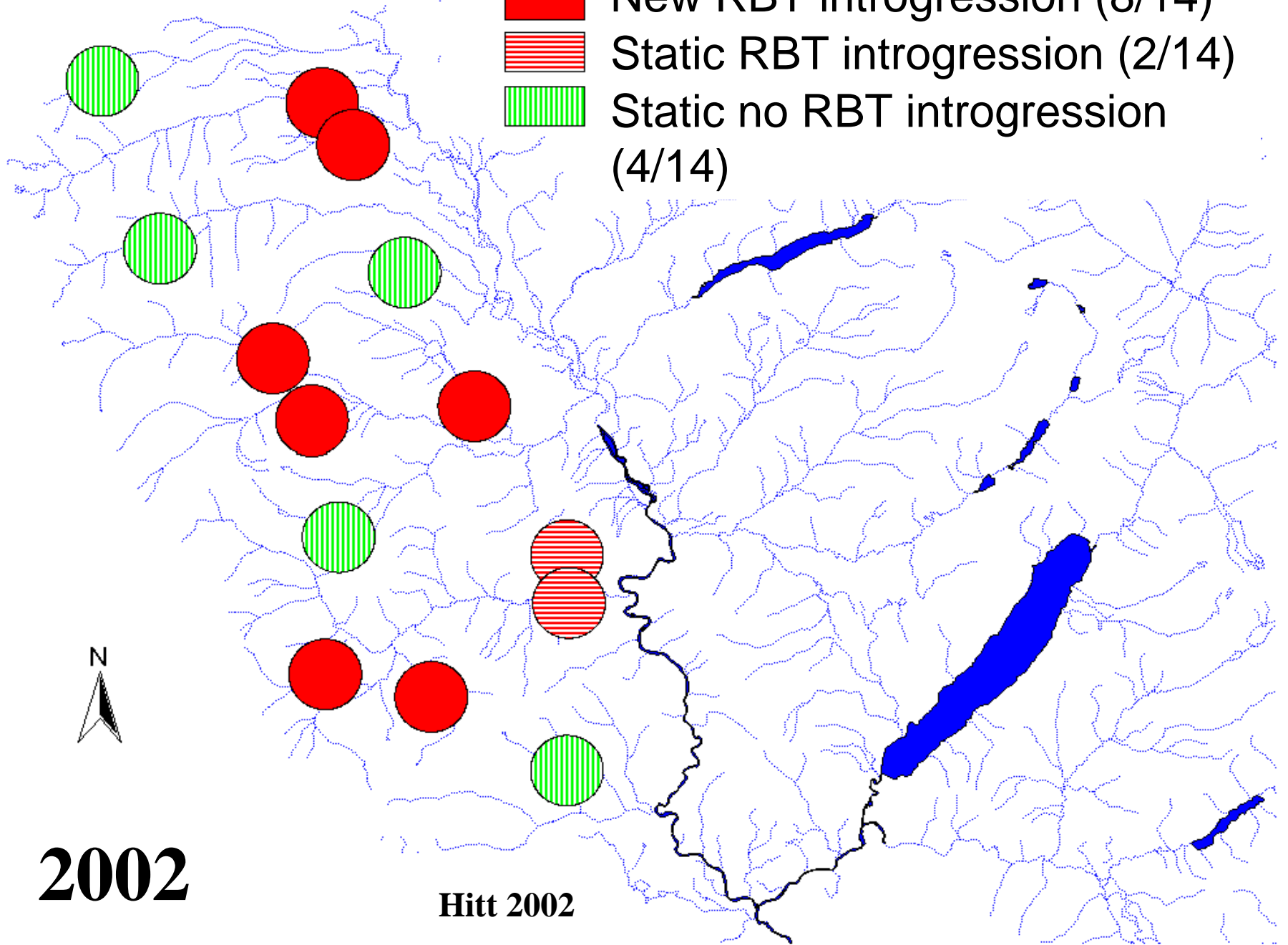
Red square RBT introgression
Green hatched square No RBT introgression



1984

Huston 1984

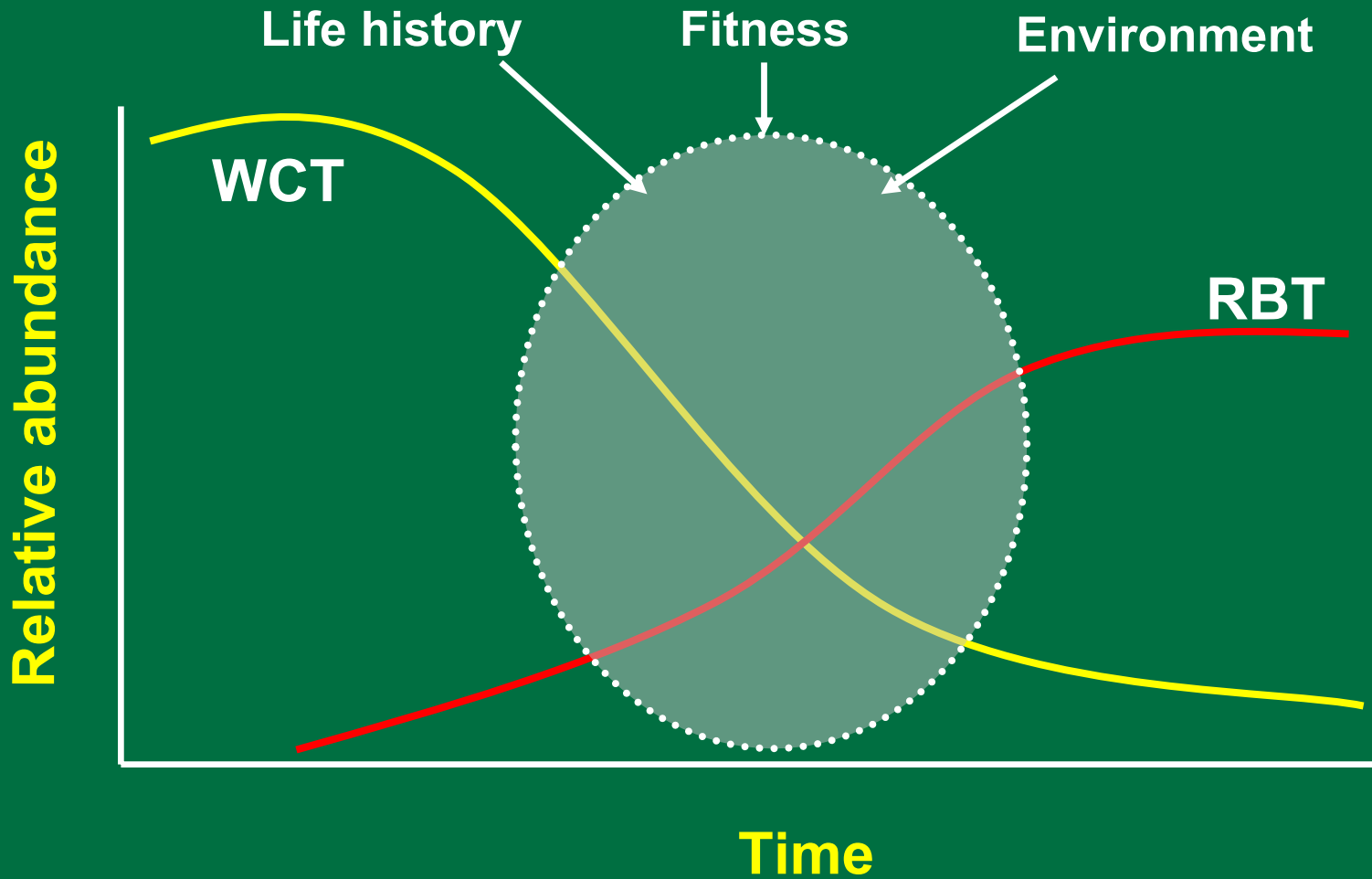
-  New RBT introgression (8/14)
-  Static RBT introgression (2/14)
-  Static no RBT introgression (4/14)



2002

Hitt 2002

What factors influence successful invasion of hybrids?

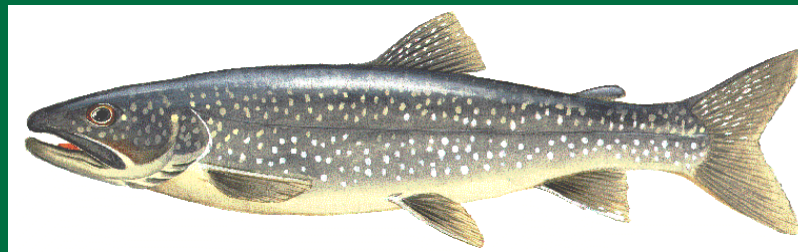
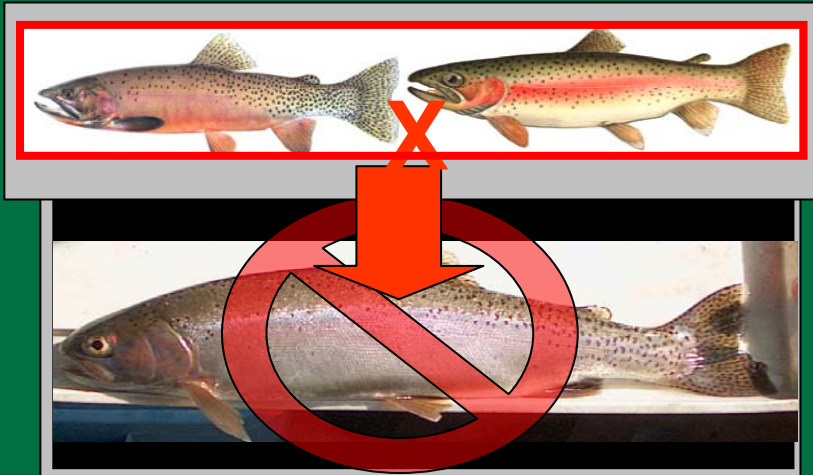
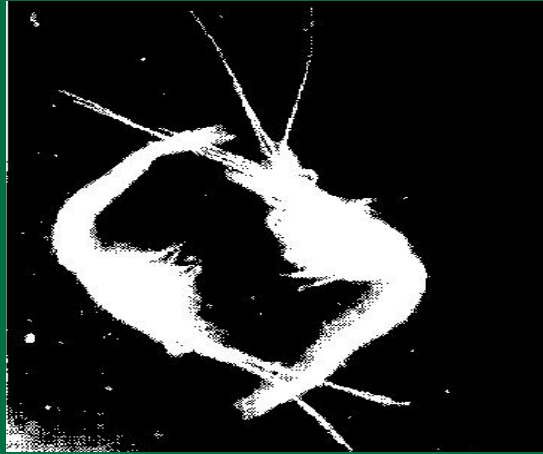


Upper Flathead River Drainage

A native species stronghold



Population Declines



Columbia Falls ●

Kalispell ●

Upper Flathead River System



Objectives

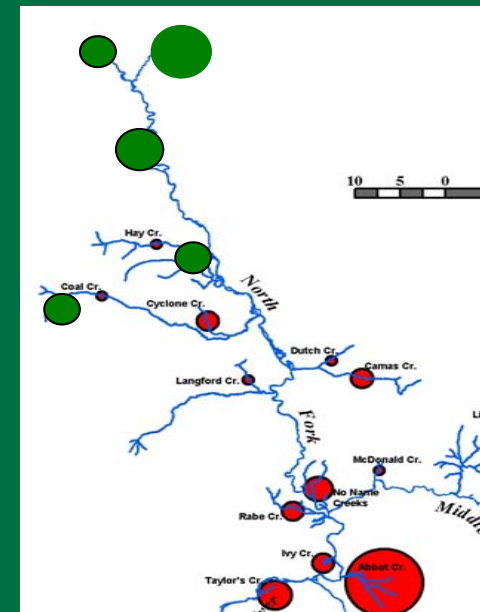
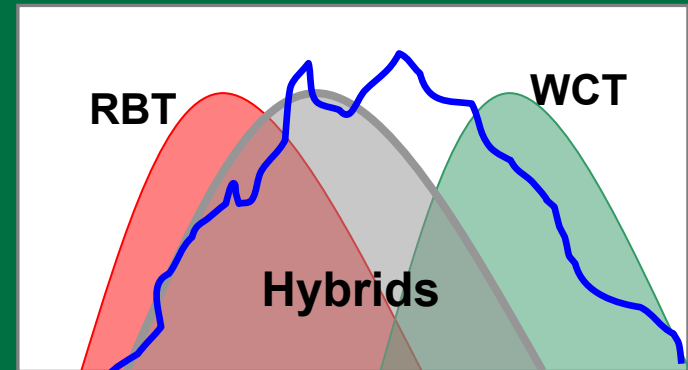
- 1. Identify RBT and hybrid source populations in the upper Flathead River system;
- 2. Compare the timing, location and movements of spawning by RBT, WCT, and their hybrids; and
- 3. Describe the patterns of spatial and temporal overlap among parental taxa and hybrid types.

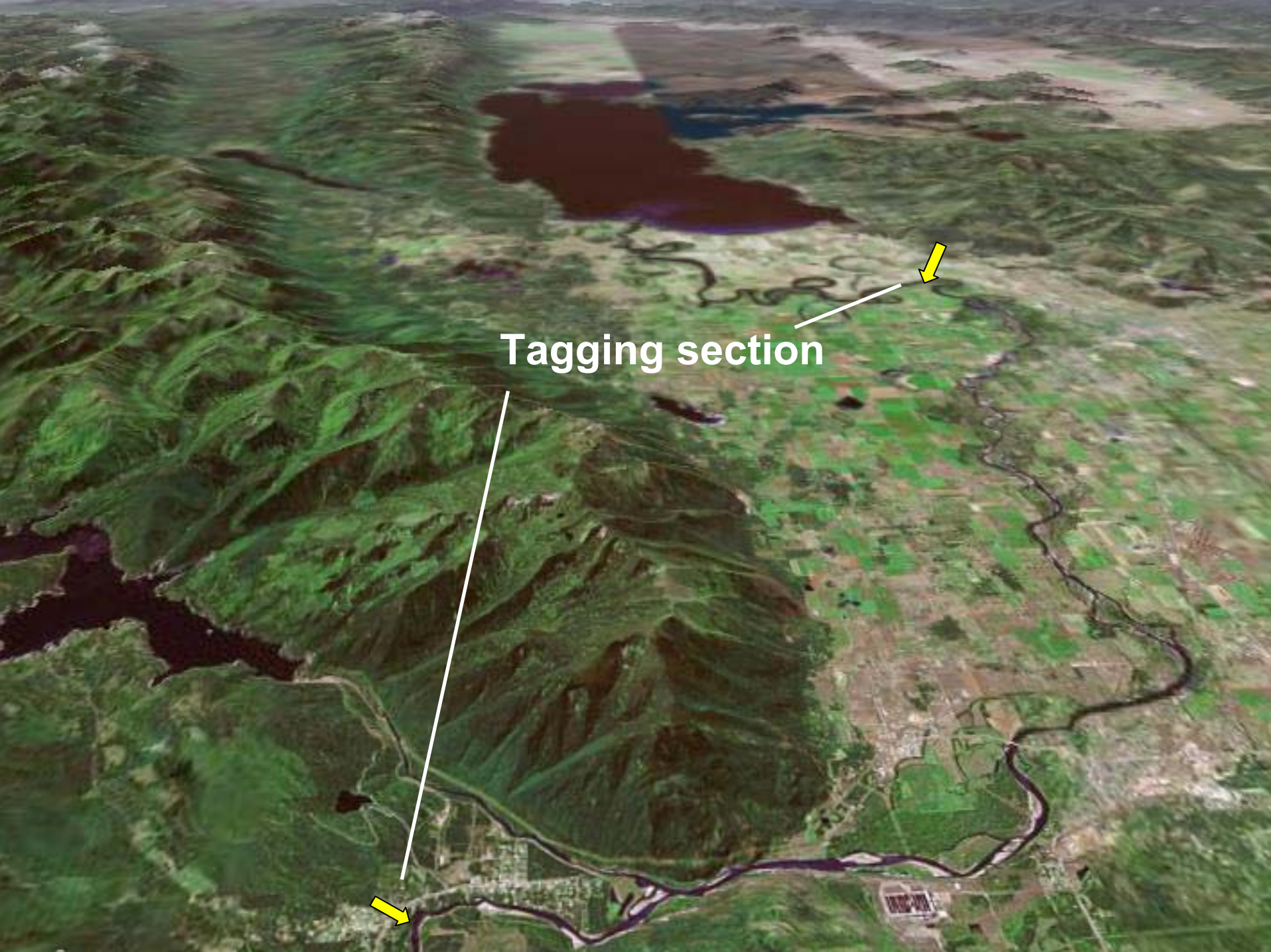
Objective: Compare spawning dynamics

H_{o_1} : There are no differences in the timing and location of spawning among WCT, RBT and hybrid trout.

Predictions:

- Hybrid and RBT spawn during increasing and peak flows; WCT during peak and declining flows; Hybrids have a longer spawning period
- Hybrid and RBT spawn in tributaries lower in the drainage as compared to WCT





Tagging section

Telemetry Methods



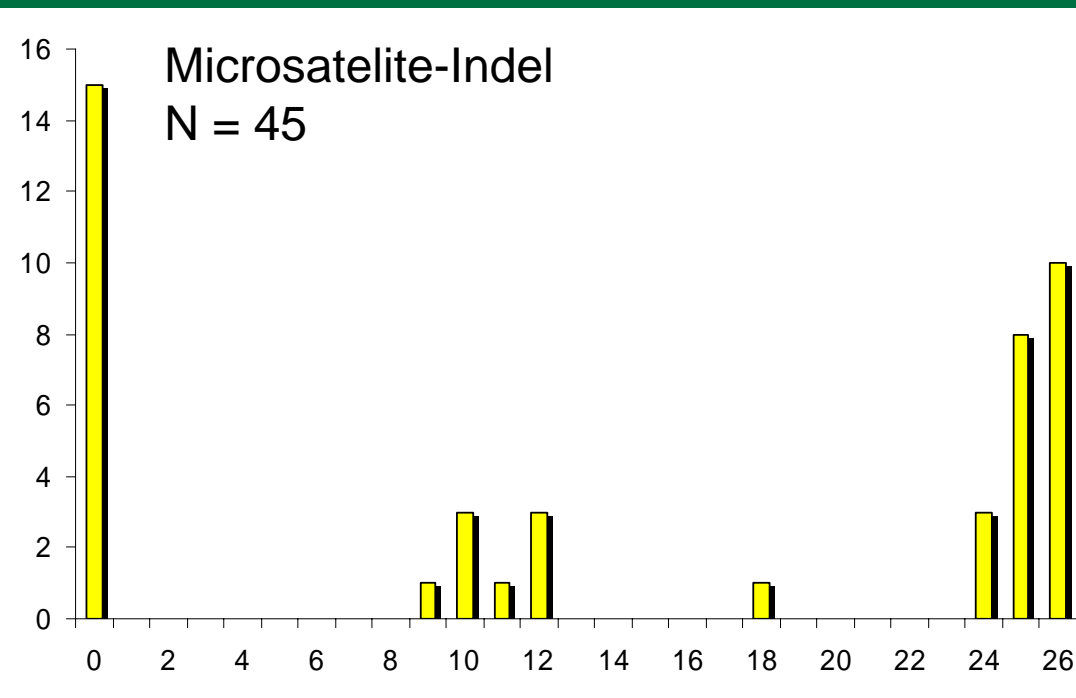
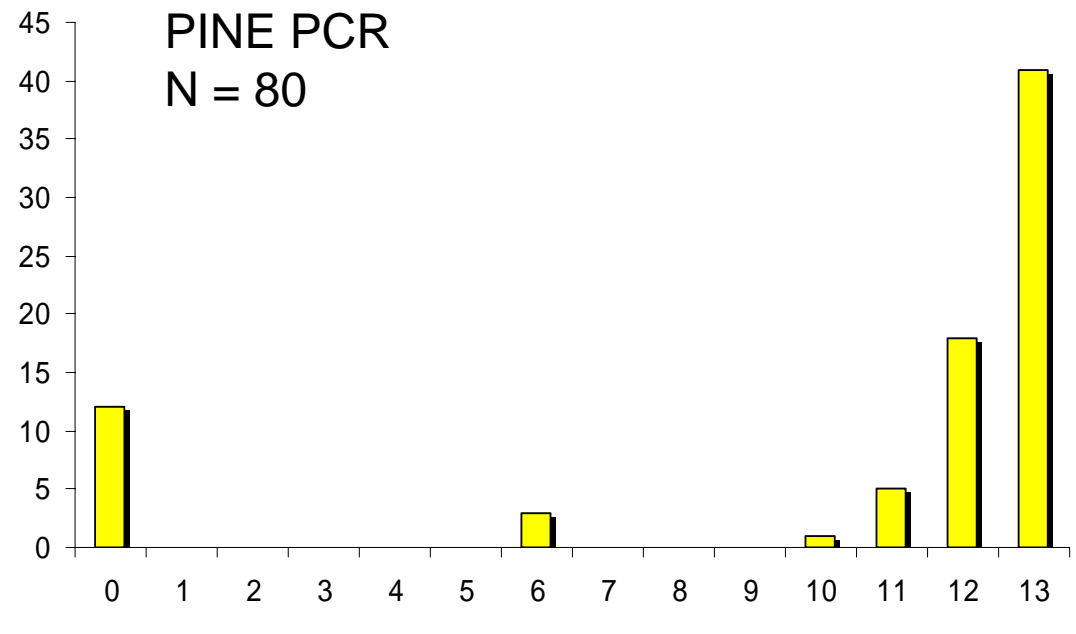
Timing and location of spawning

Spawning and movement variables:

- Beginning migration date
- Beginning migration temperature (°C)
- Beginning migration flow (m³/s)
- Spawning date
- Spawning temperature
- Spawning flow
- Migration period (d)
- Migration distance (km)



Number of fish



Hybrid Index

Genetic analyses



2000-2007

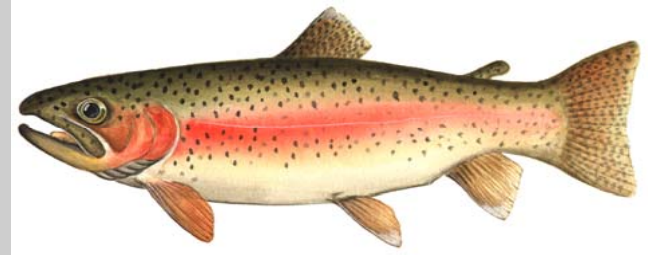
- 27 WCT
- 11 WCT-hybrids
- 36 RBT-hybrids
- 51 RBT

N = 125 fish

Statistical Analyses

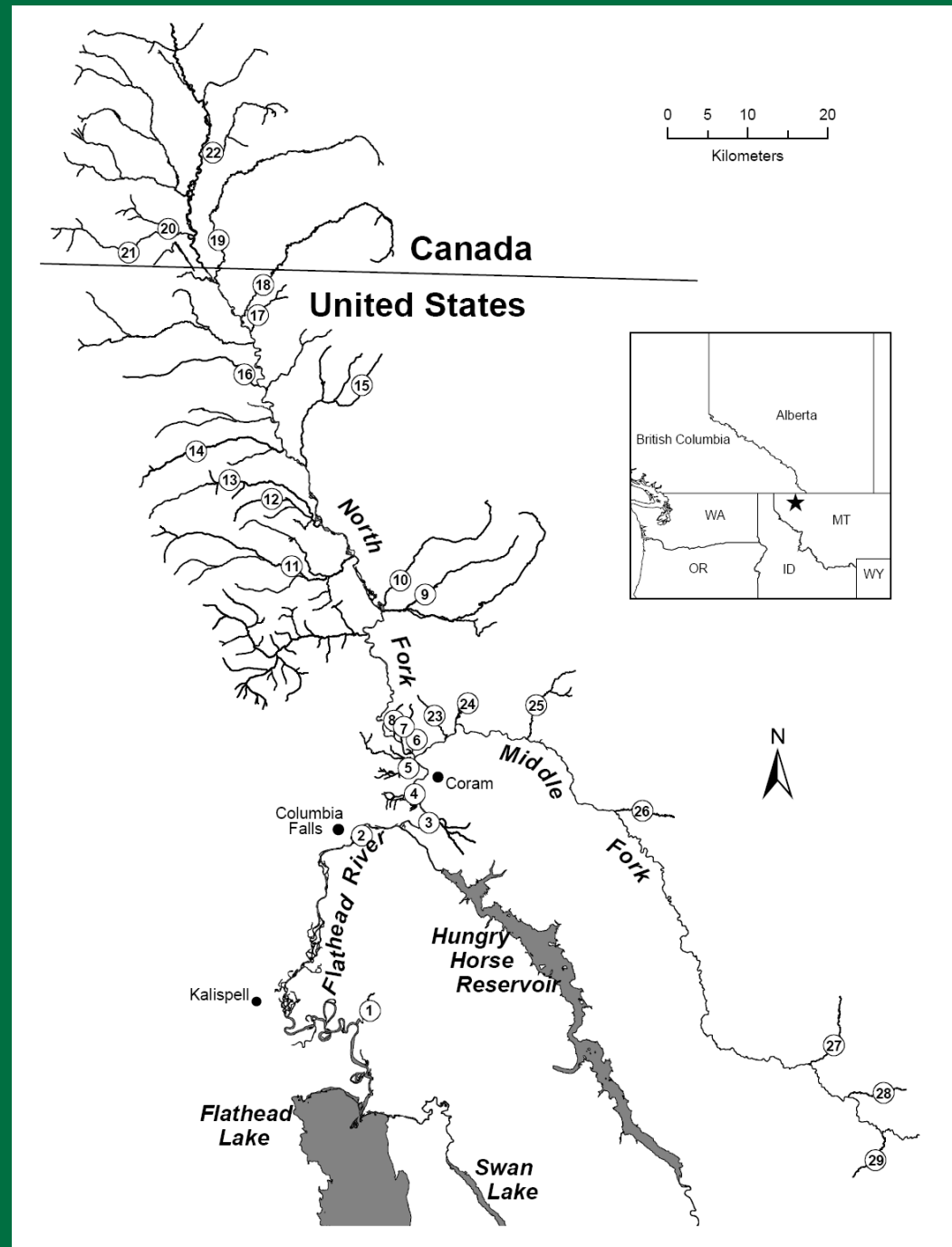
- MANOVA (genotype, sex, and year with interaction terms)
- MANOVA (genotype)
- Tukey's tests for post-hoc comparisons
- $P < 0.05$ alpha level

Genotype



Results

- 29 spawning tributaries were used
- 98% moved upstream
- No evidence of mainstem or side-channel spawning



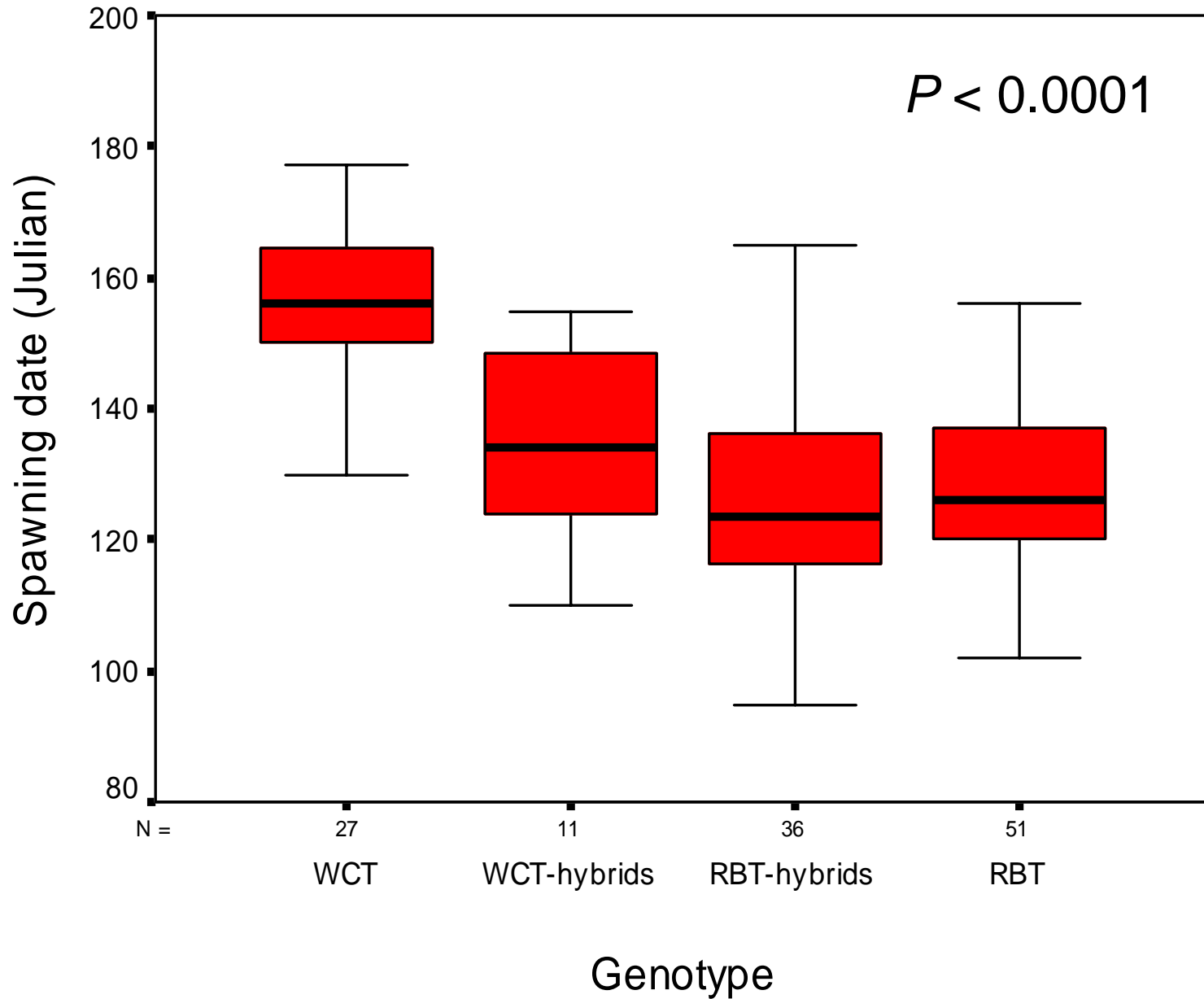
Results

- MANOVA (genotype, year, sex, interactions)
- No differences due to sex and interaction terms
- RBT and RBT-hybrids spawned significantly later and at higher flows in 2002, likely due to a protracted and higher spring runoff

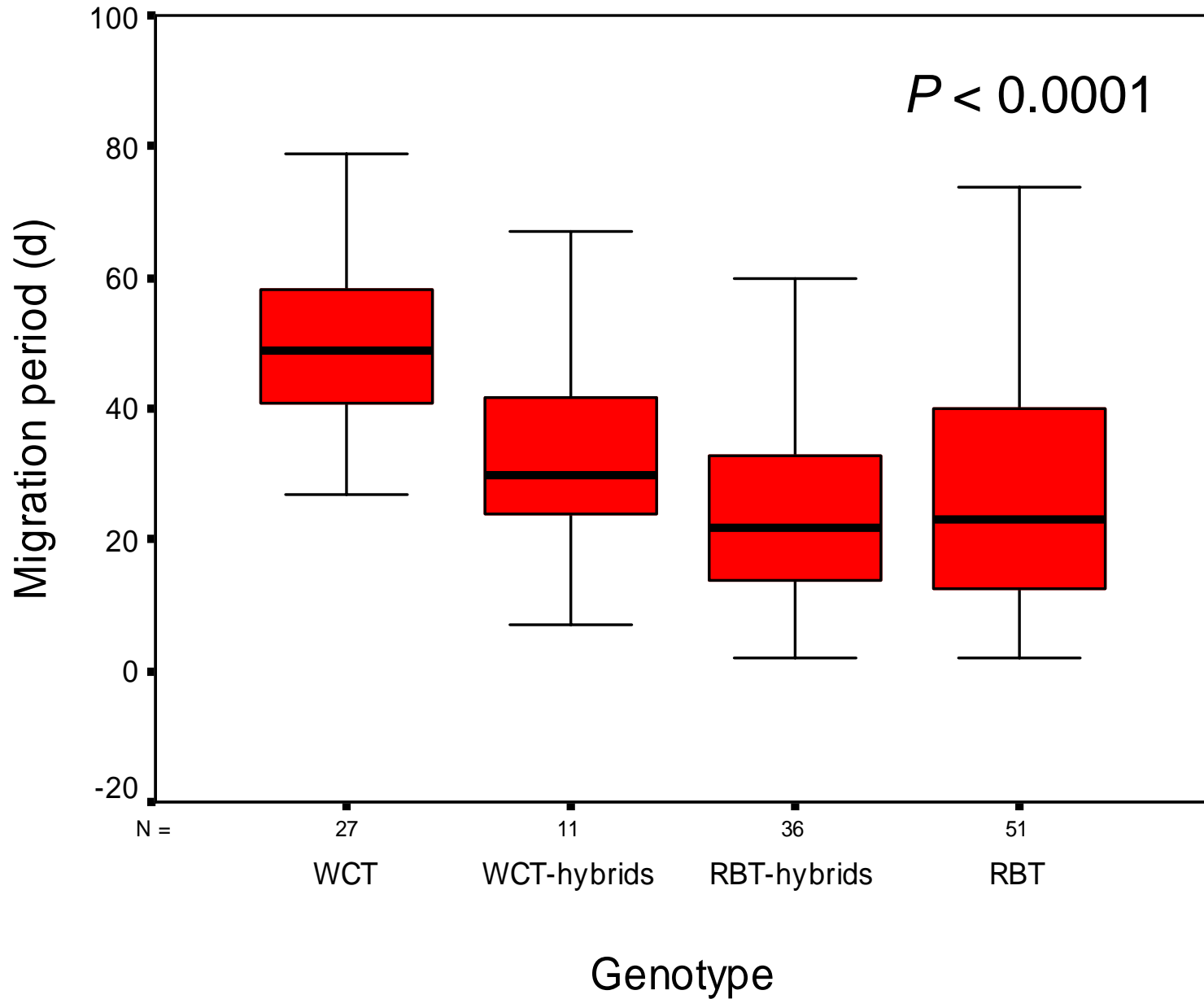
- MANOVA (genotype): Wilks' $\lambda = 0.164$, $F = 13.804$, $P < 0.0001$

- Significant differences for five of the eight spawning and movement variables

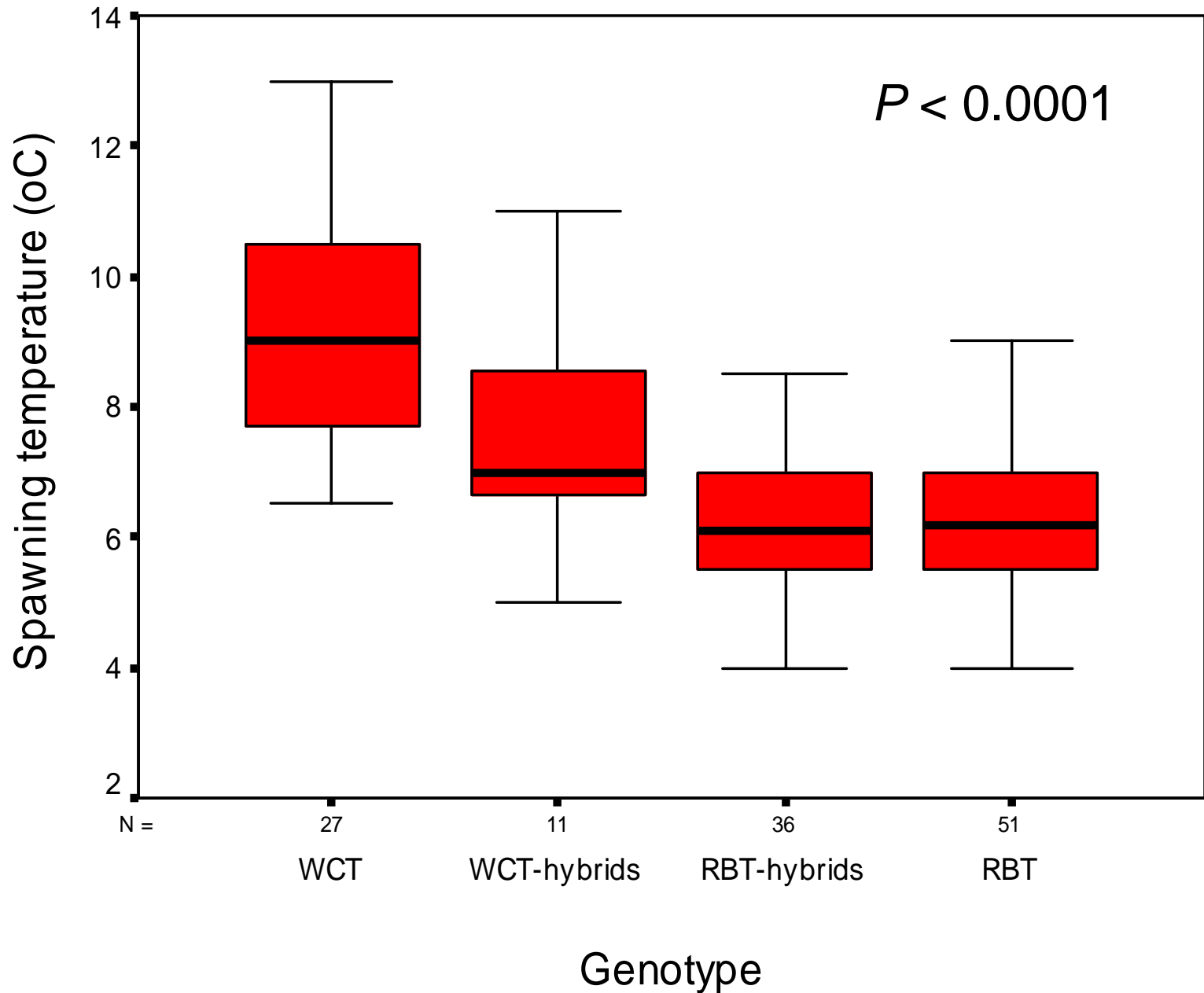
Spawning Date



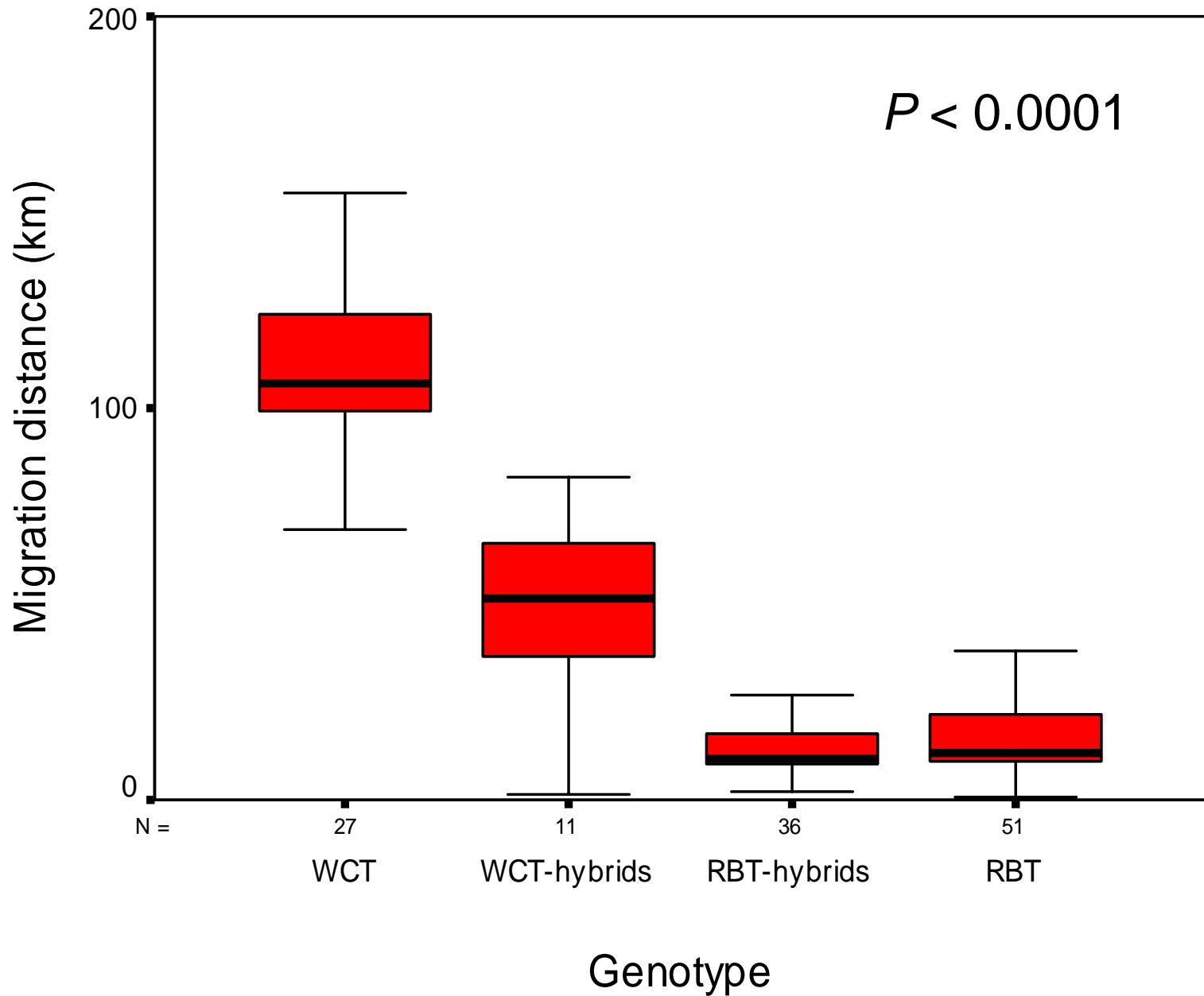
Migration period



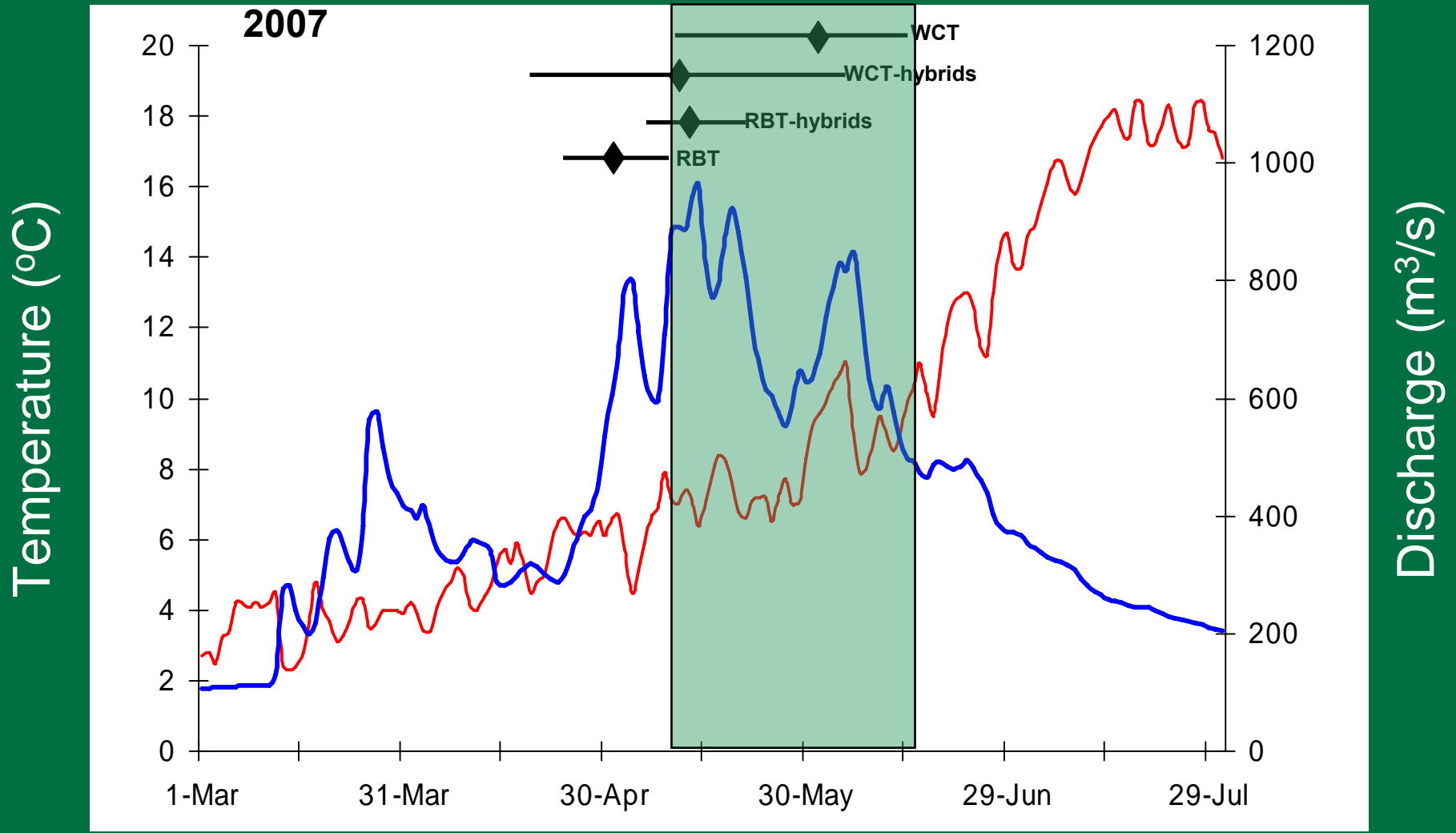
Spawning temperature



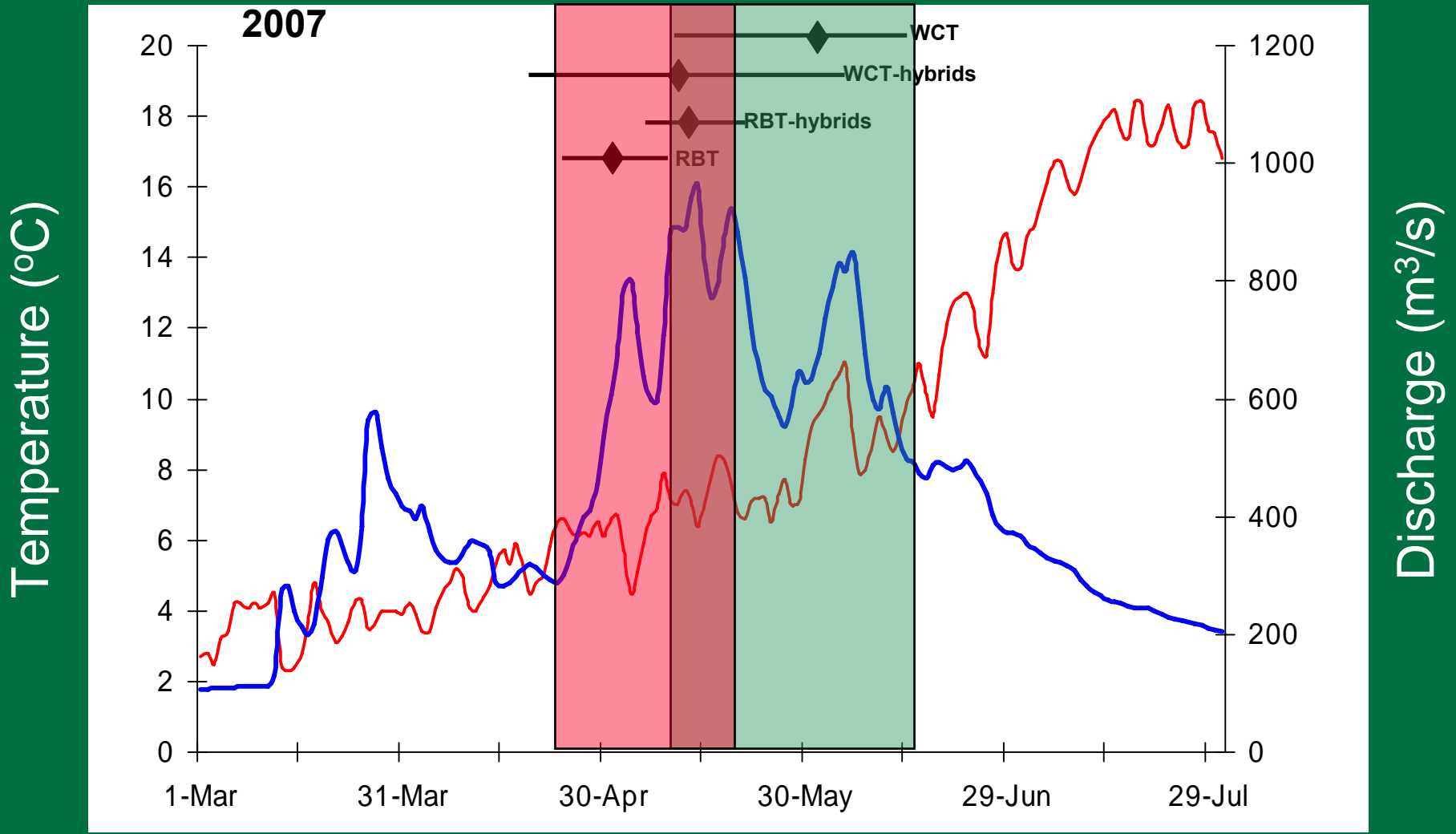
Migration distance



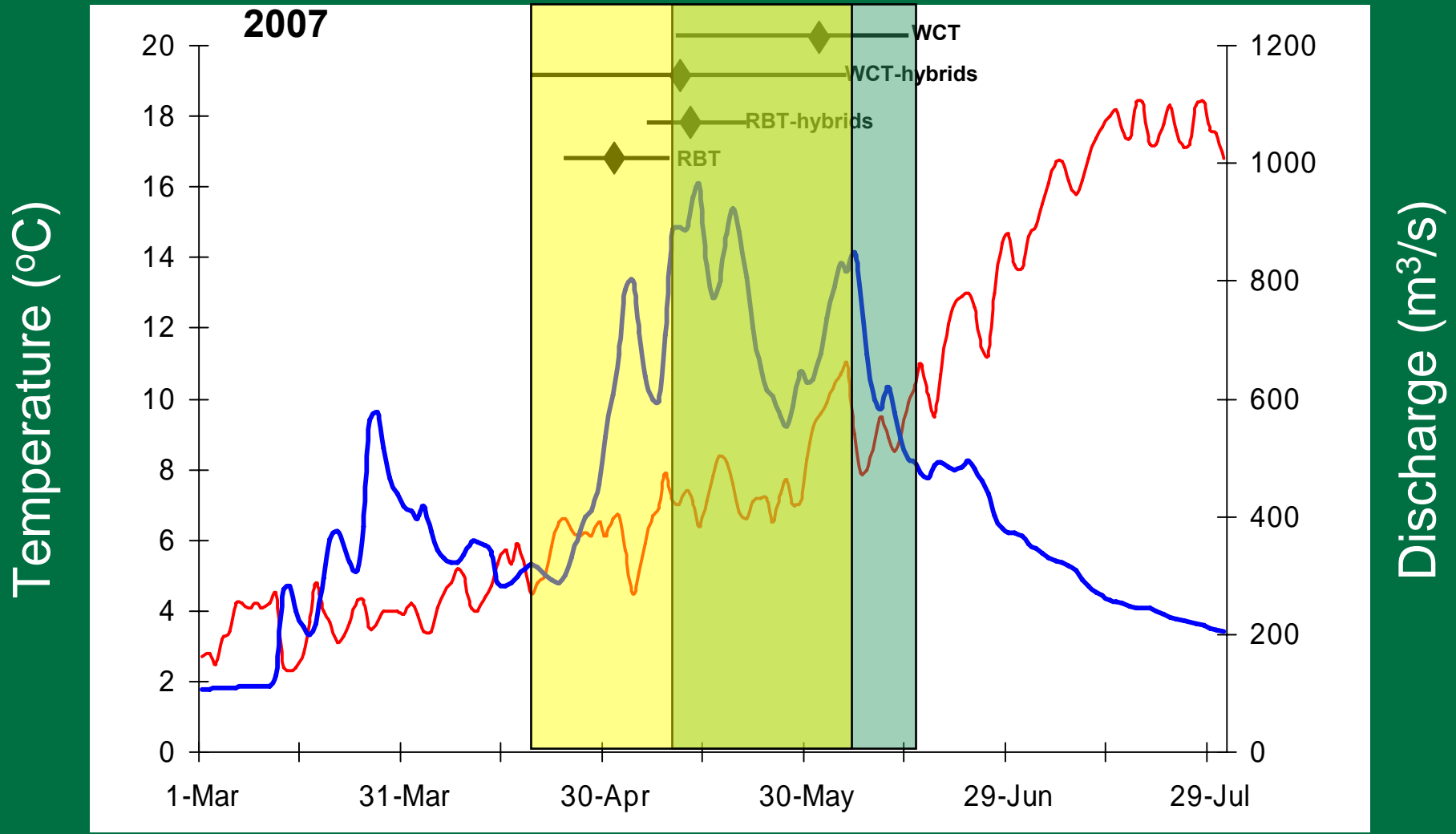
Timing of Spawning



Timing of Spawning

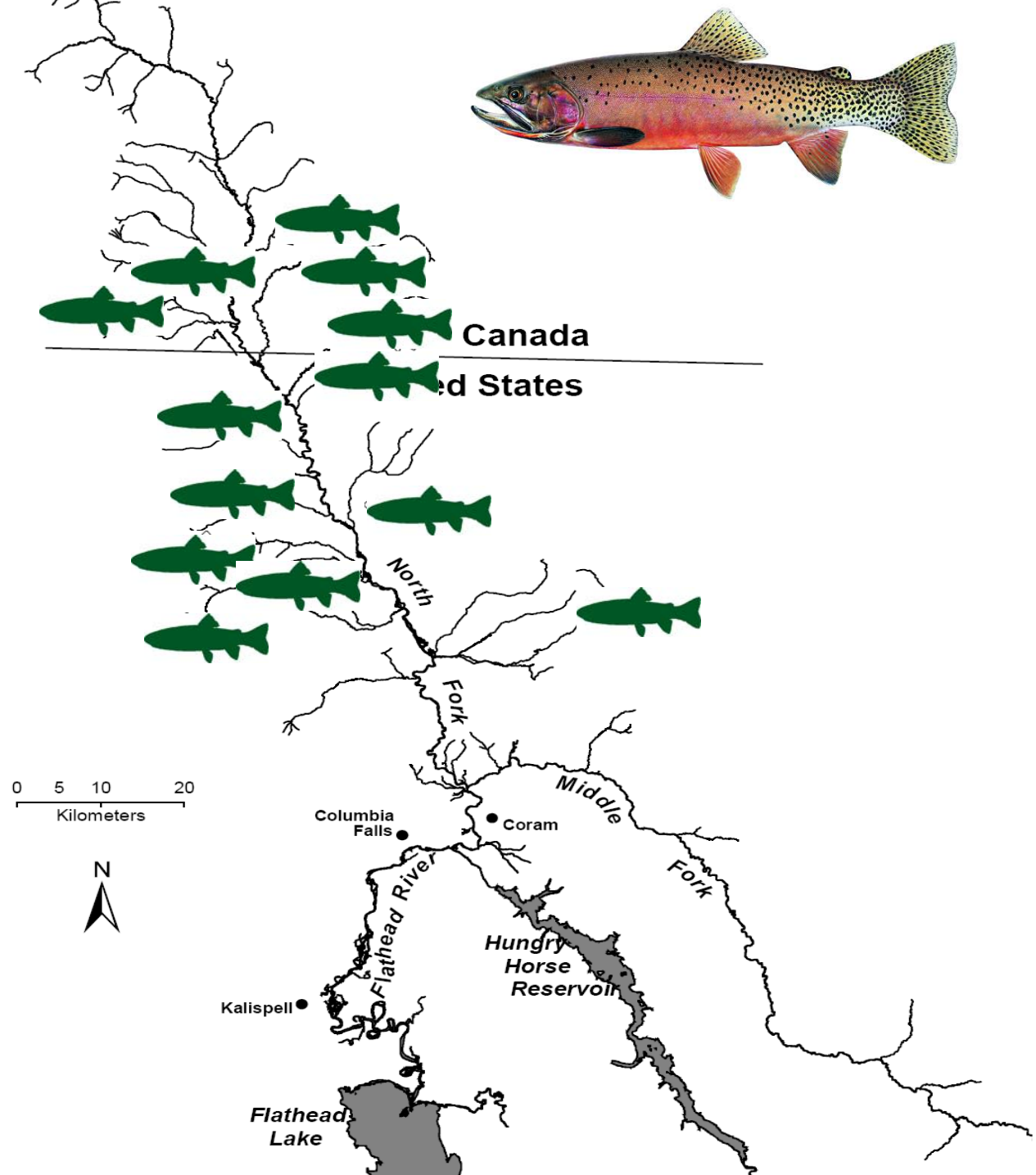


Timing of Spawning

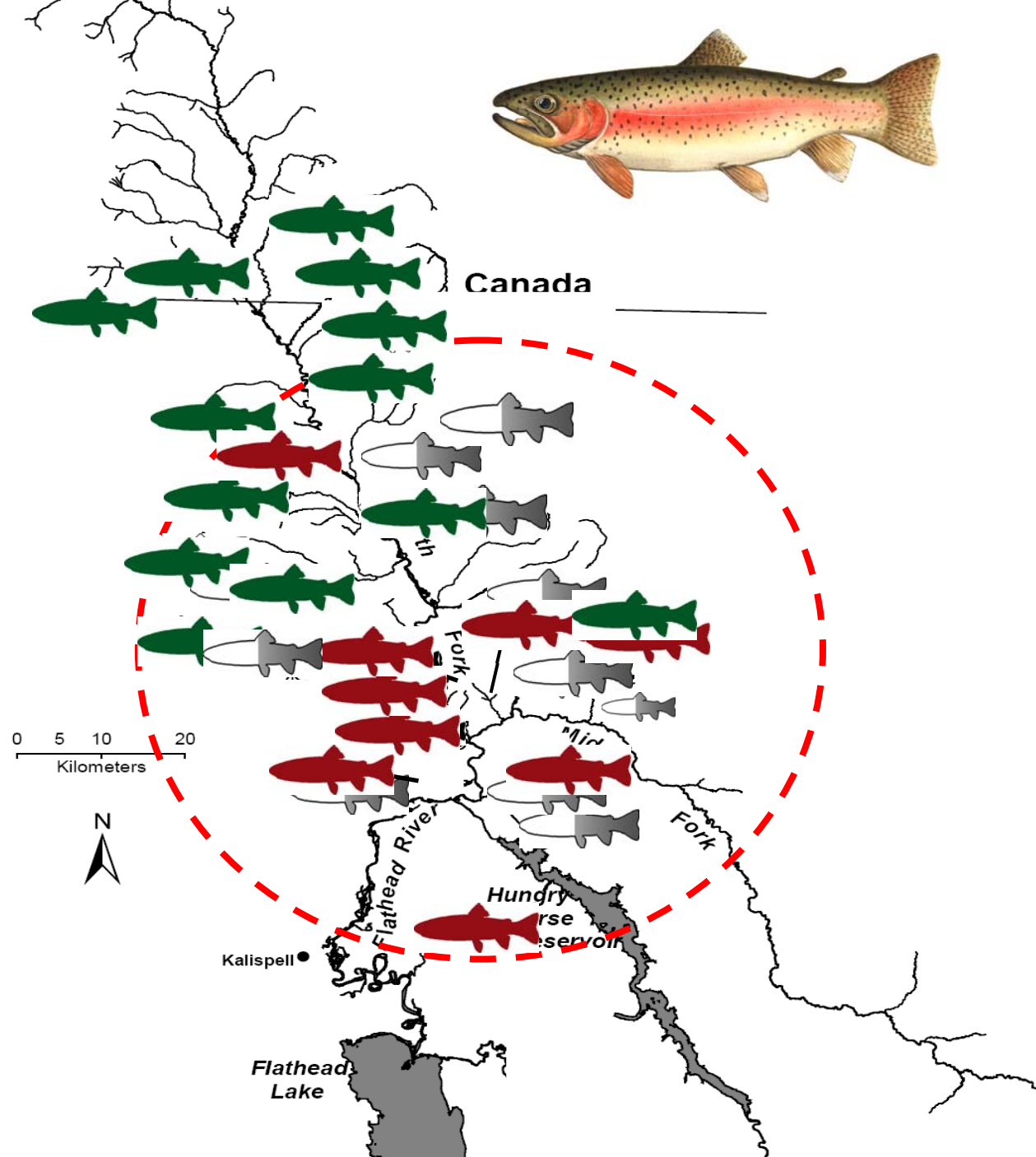


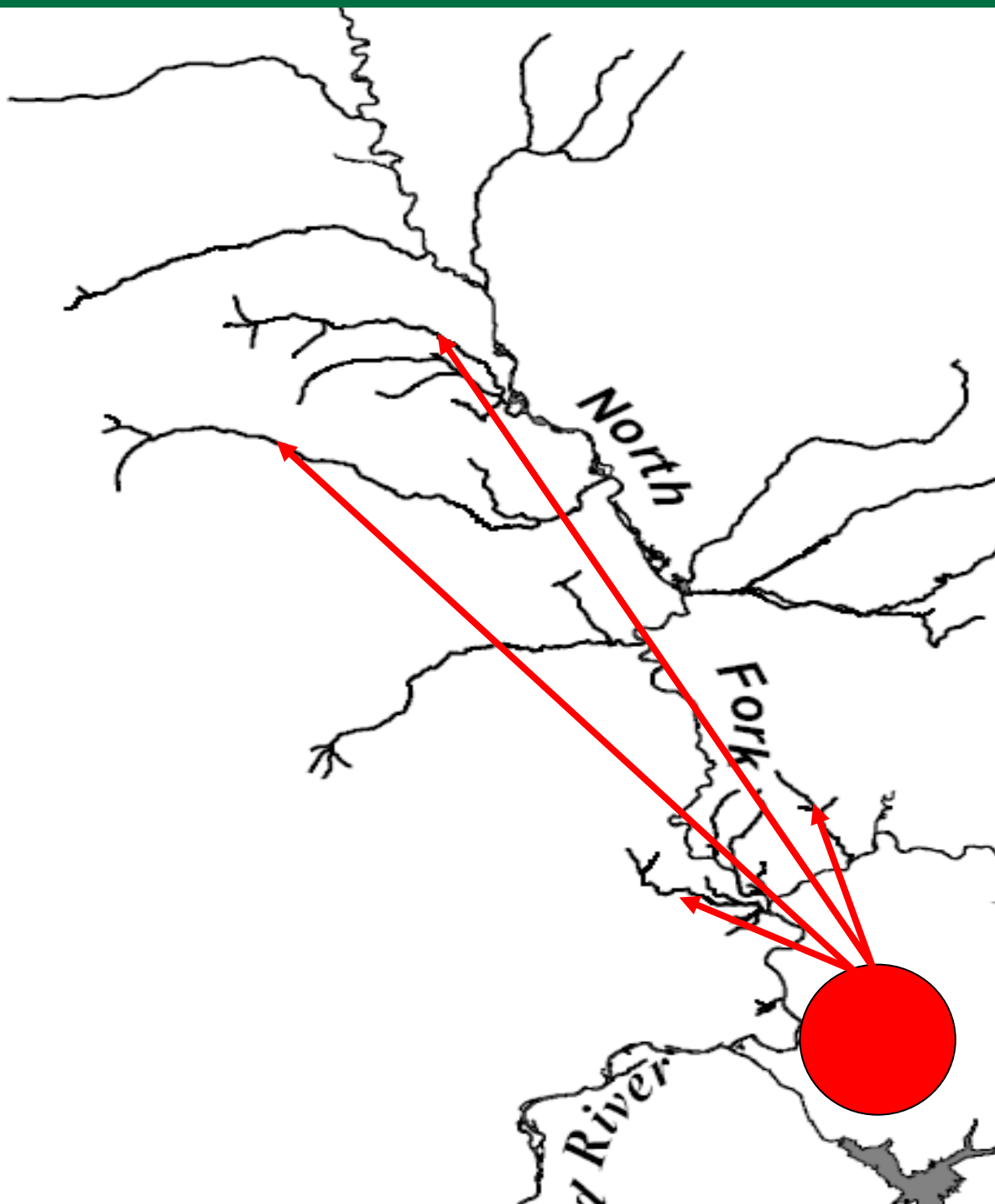
WCT

- Spawned in the middle to upper portions of the drainage



RBT and Hybrids





2 F₁ hybrids

2 RBT

Likely
produced by
migration
from Abbot
Creek

(Boyer et al. 2008)

Conclusions

- **Spatial and temporal overlap is occurring in the lower drainage, but streams in the middle and upper drainage still provide reproductive segregation**

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- **Introgression erodes discrete spawning behavior of migratory WCT**
- **Genomic extinction is imminent if hybrid populations with high amounts of RBT admixture are not reduced or eliminated.**

