Columbia River Basin Steelhead Kelt Reconditioning Physiology Research

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Thanks to YN Fisheries, NPT Fisheries, USFWS Dworshak National Fish Hatchery, WDFW, IDFG, and many others.

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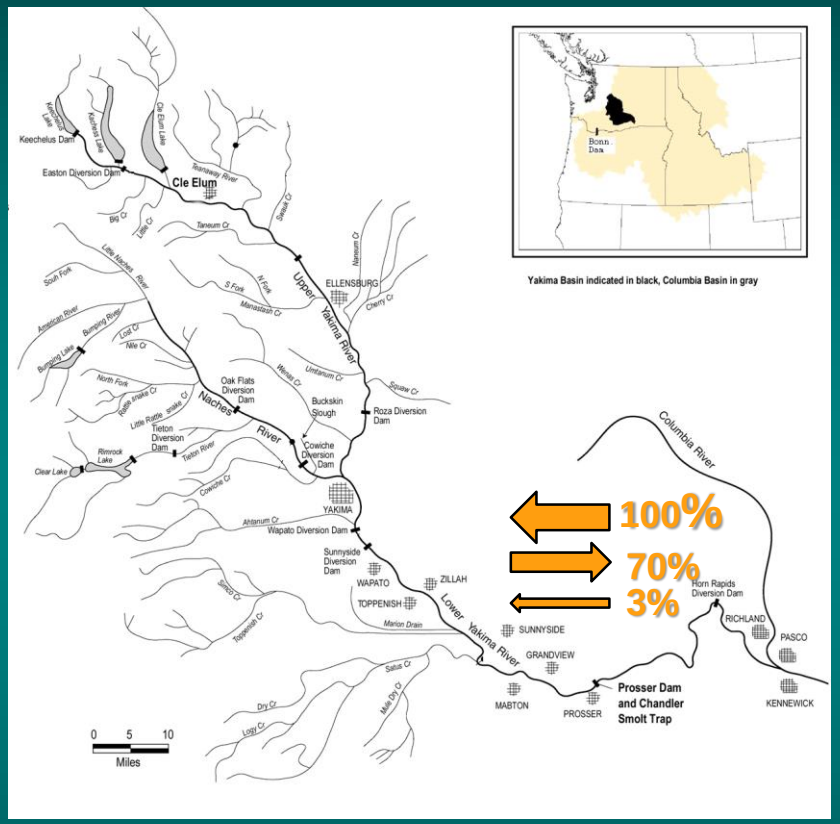
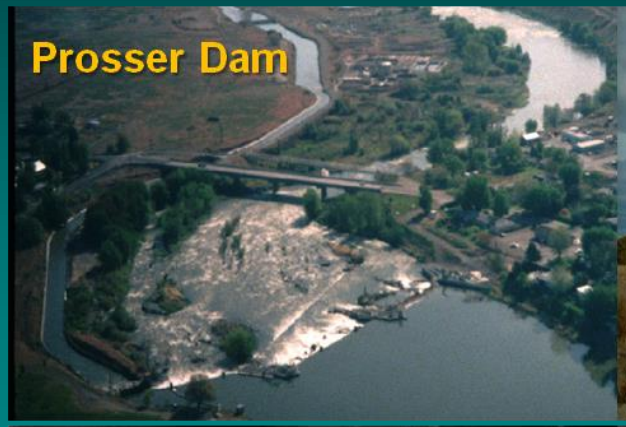
Kelt reconditioning is a restoration strategy that takes advantage of the repeat spawning life history of steelhead.





Intake Reconditioning Release

Feb Mar Apr May Jun Jul Aug Sep Oct Nov

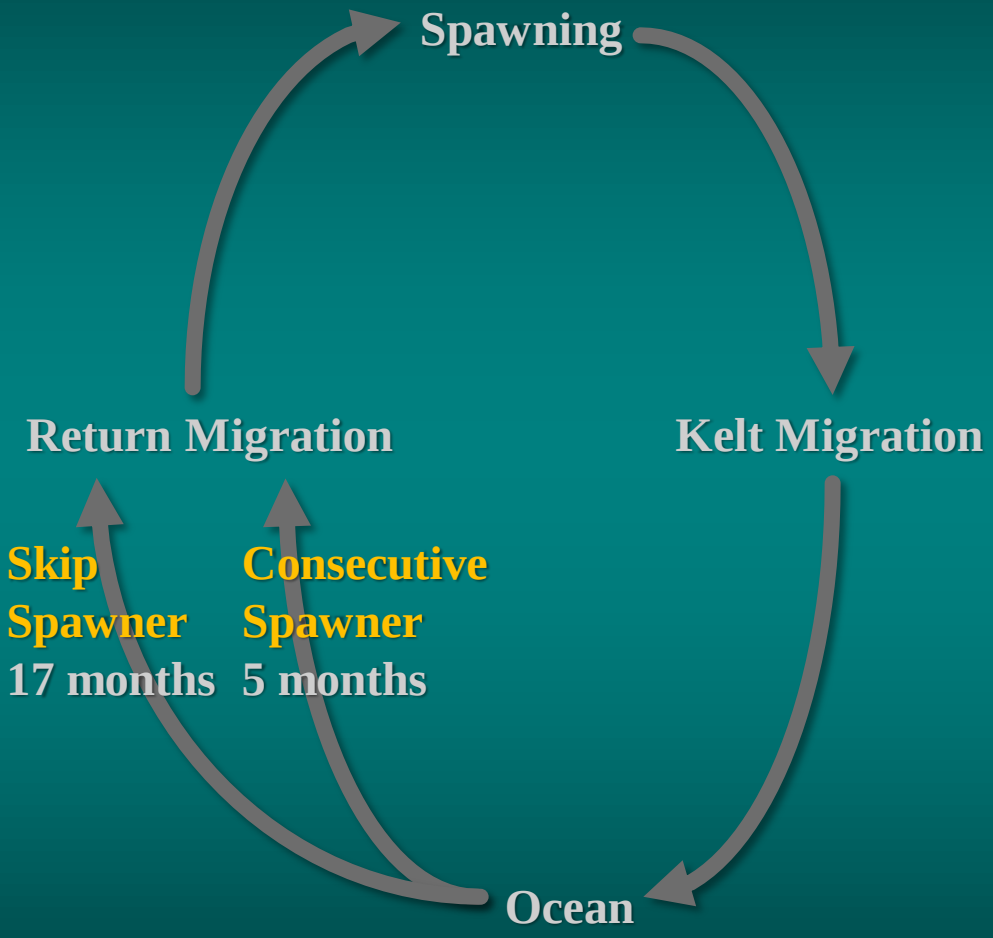
Kelt reconditioning is being implemented at several locations in the Columbia River Basin.

Questions:

What determines survival in kelt reconditioning?

How does does survival vary between locations and over time?

Natural repeat spawning female steelhead have two major post-spawning life histories.



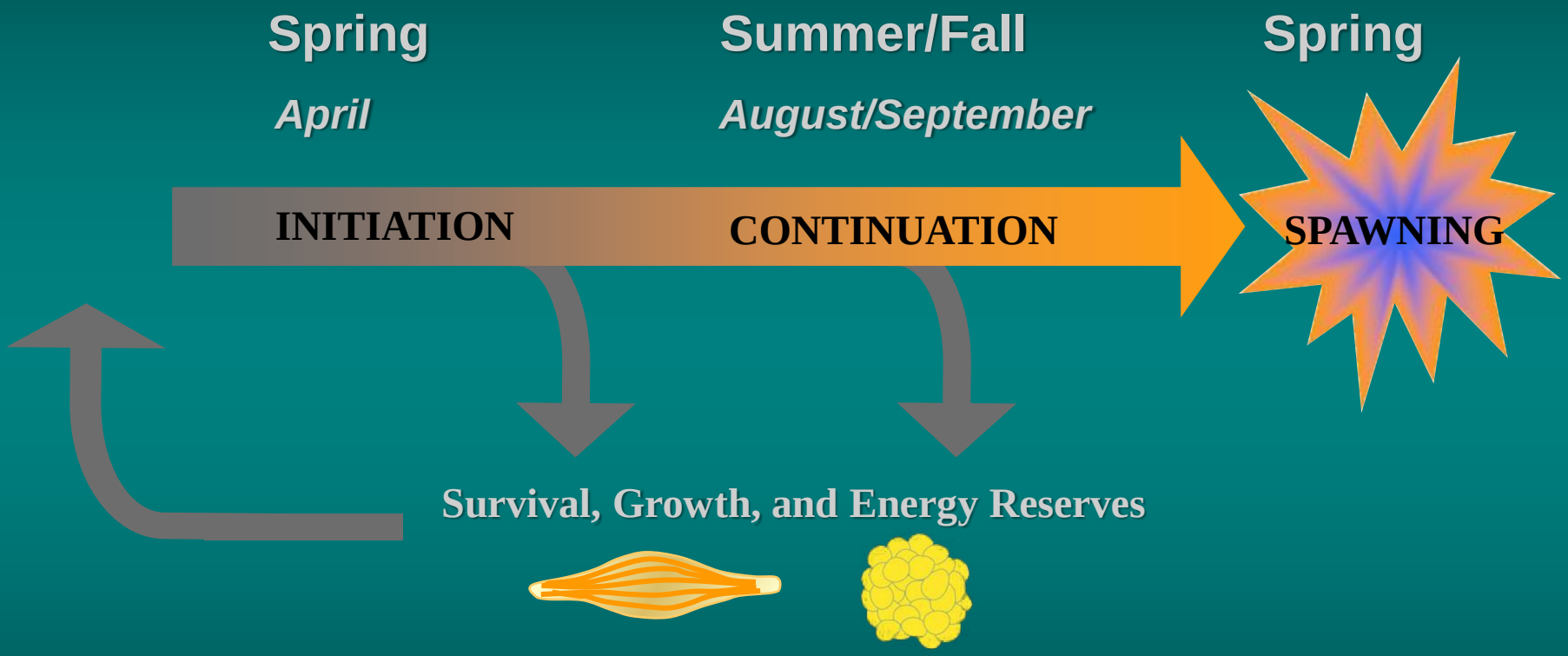
Skip spawning is common in seasonally breeding iteroparous fishes, and is driven by energetics (Rideout 2005).

Skip spawning rates increase from 50% in the mid-Columbia to 70% at Lower Granite (Keefer 2008).

Fecundity and egg size are greater in skip spawning than consecutive spawning Atlantic salmon (Reid & Chaput 2012).

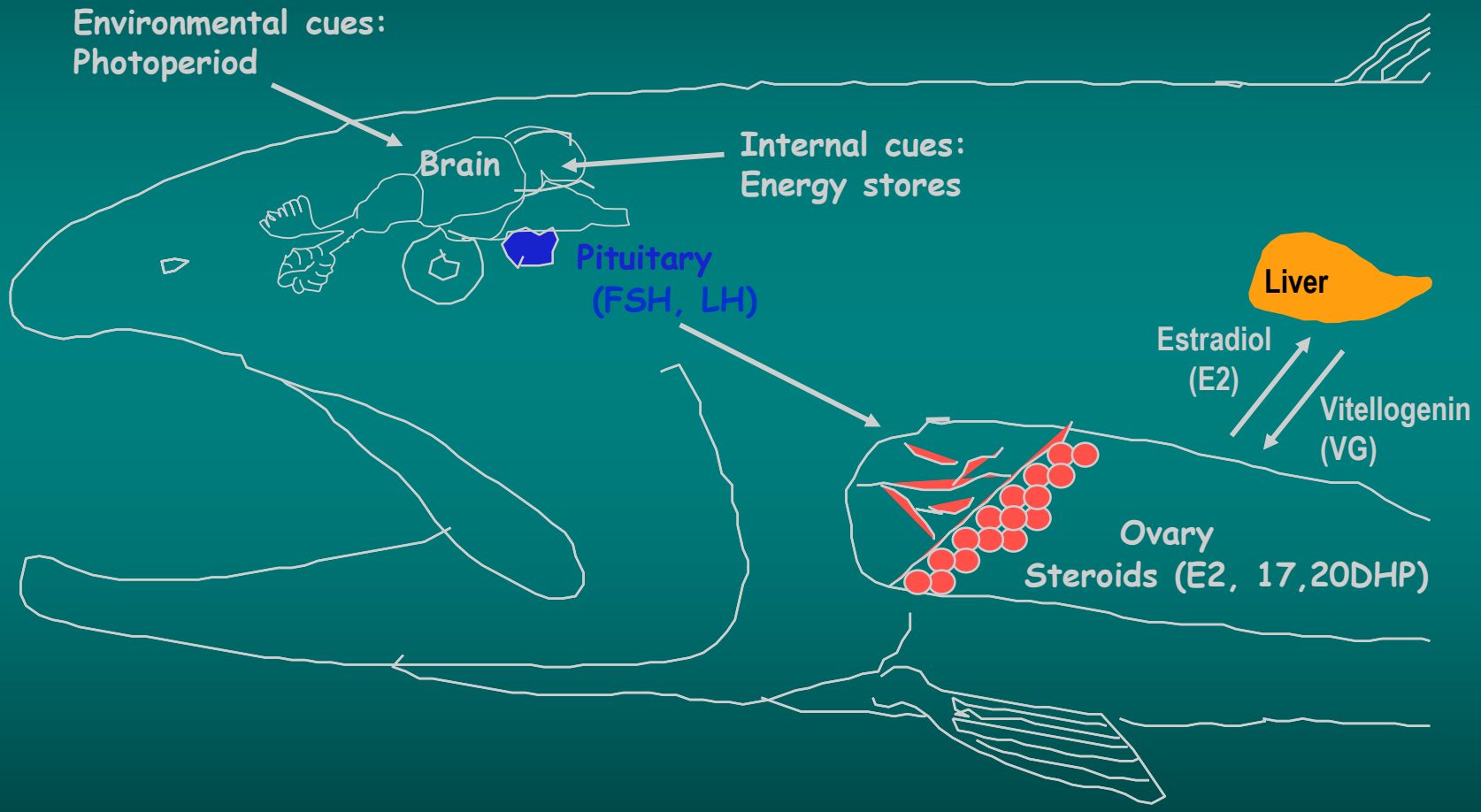
Questions:
Are these life histories found in captive reconditioning? What is the effect on reproductive performance?

In salmonids, maturation is initiated during a critical period about 1 year before spawning.

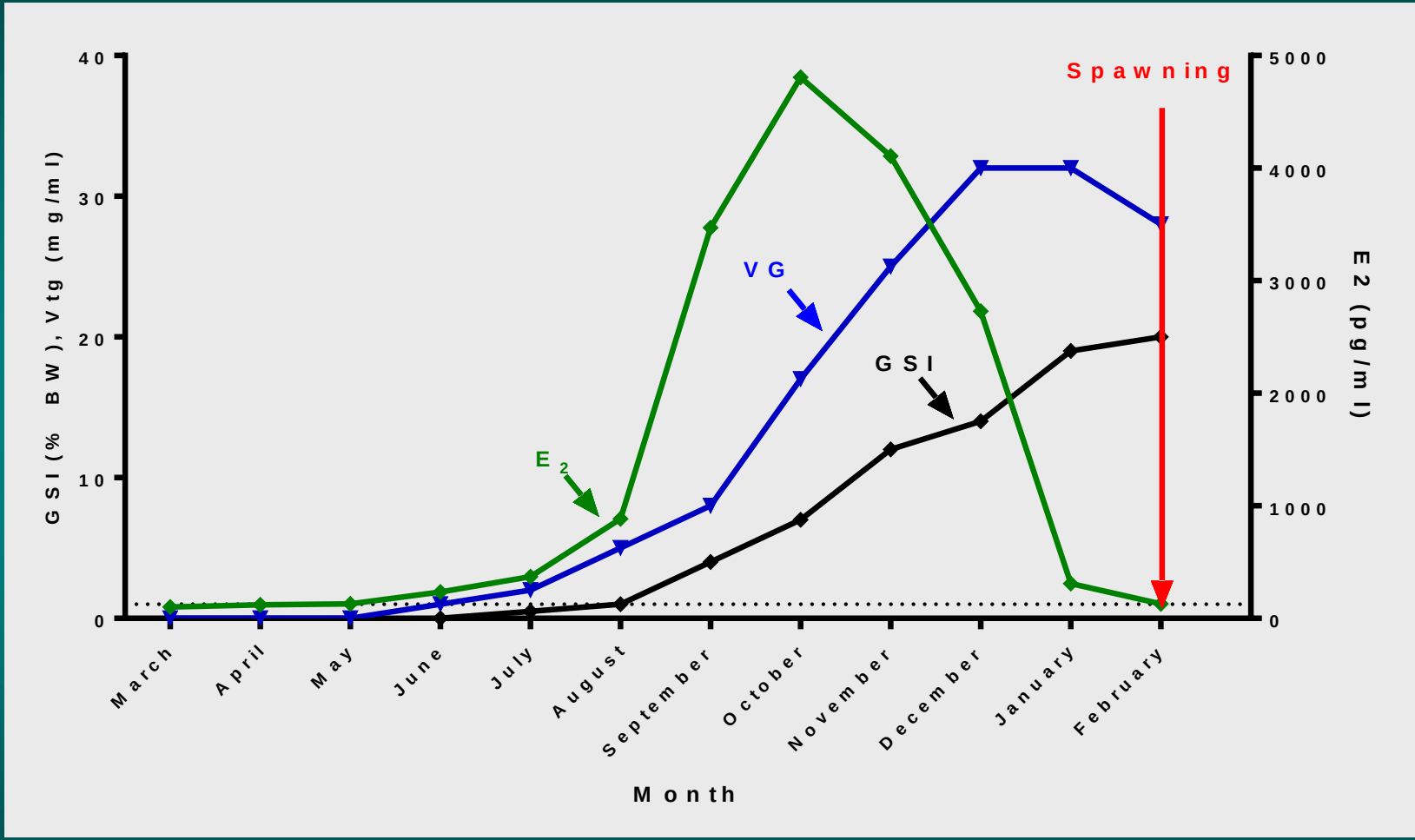


Questions: When is rematuration determined in steelhead kelts? What are the inputs to the decision?

The Reproductive Endocrine Axis regulates reproductive maturation in female salmonids.



In rainbow trout, E2, VG, and Gonadosomatic Index increase beginning 6-9 months before spawning.



Sources: Bromage, Whitehead & Breton 1982 Gen Comp Endocrinol; Whitehead, Bromage & Breton 1983 Gen Comp Endocrinol; Tyler, Sumpter & Witthames 1990 Biol Reprod; Prat, Sumpter & Tyler1996 Biol Reprod

Objectives

Assess survival in kelt reconditioning projects and factors influencing survival.

Determine whether the consecutive and skip spawning life histories are found in kelts reconditioned in captivity.

Investigate when reproductive decisions are made in kelts.

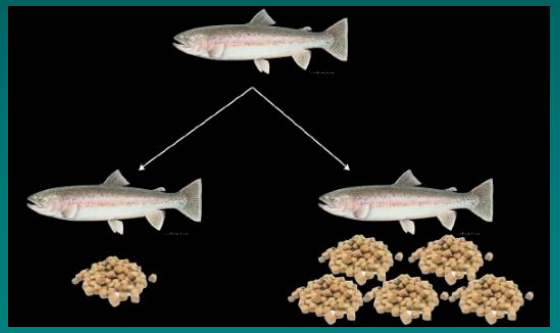
Assess reproductive performance in reconditioned kelts.

Methods

Wild steelhead kelts

DNFH hatchery steelhead model

Post-spawning rainbow trout model

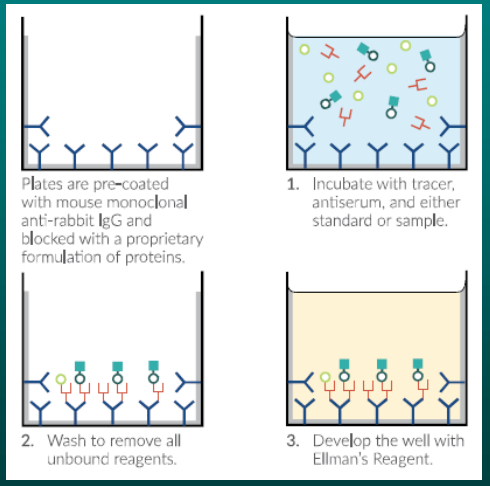


Air spawning

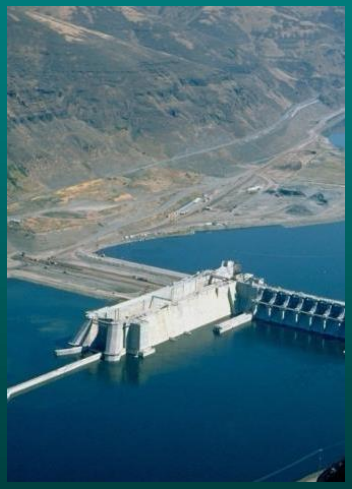
Egg metrics

Blood sampling

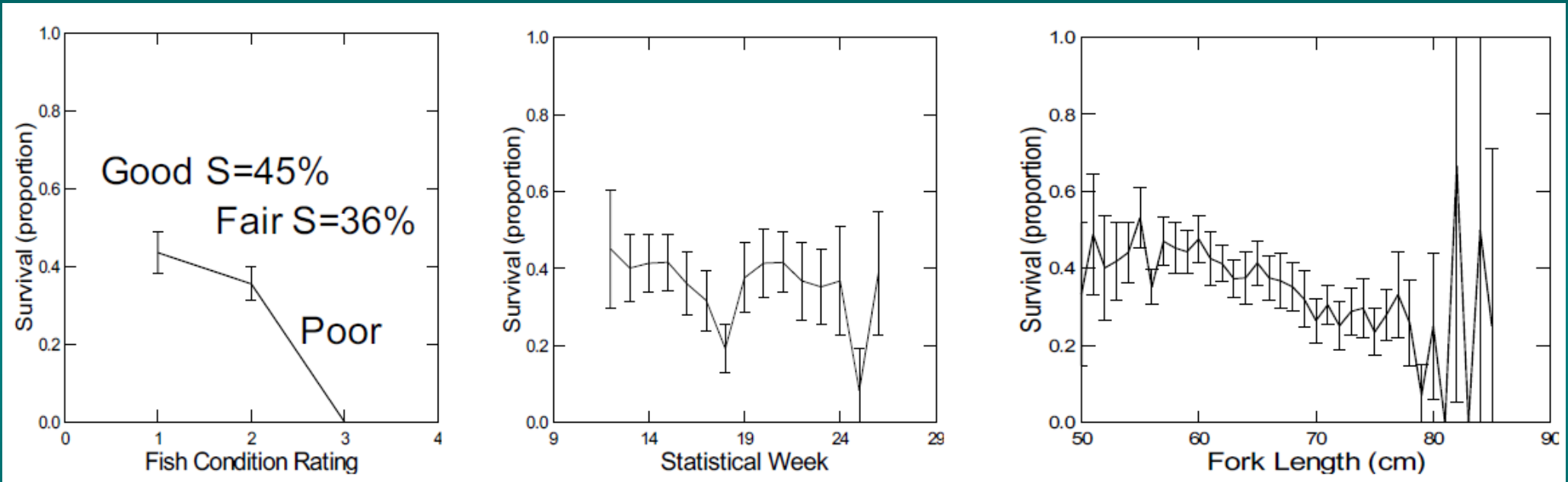
Plasma hormone assay



PIT tag detection

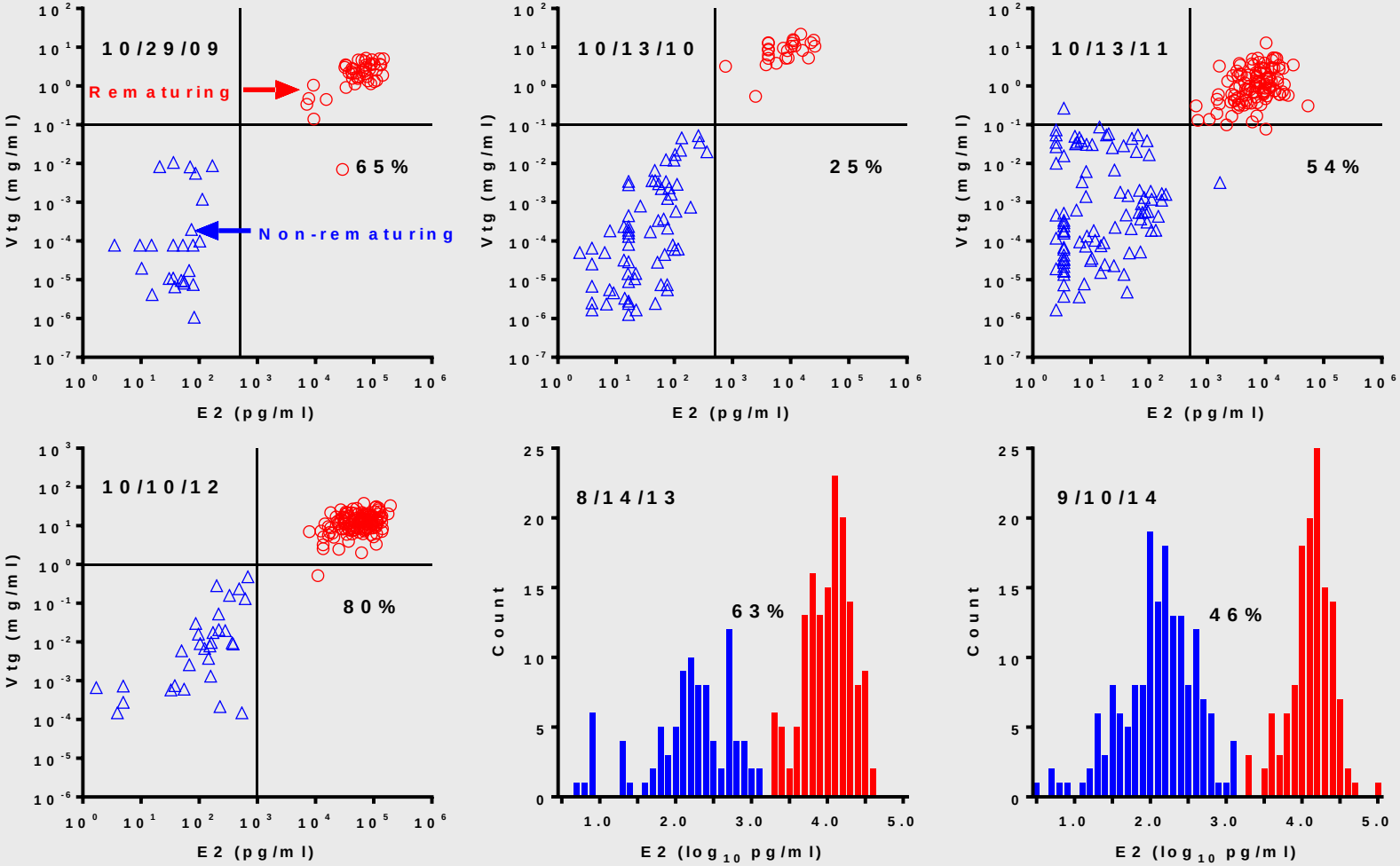


In Yakima River kelts, survival was related to fish condition, collection date, and fork length.



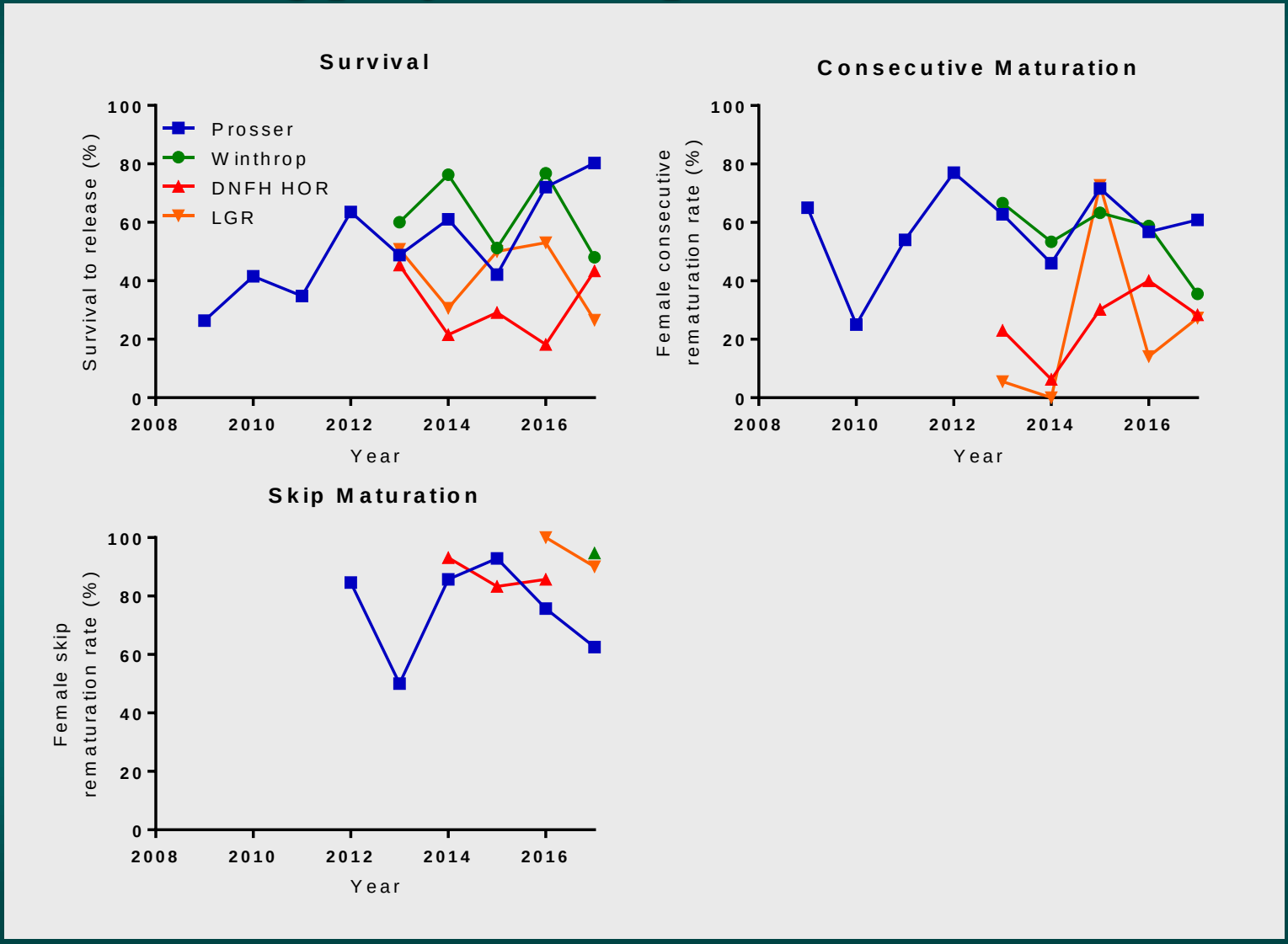
D. Hatch et al., 2013, *North American Journal of Fisheries Management*.

Consecutive and skip spawning life histories are found in reconditioned Yakima River kelts. Fish can be screened by blood hormone level before release.



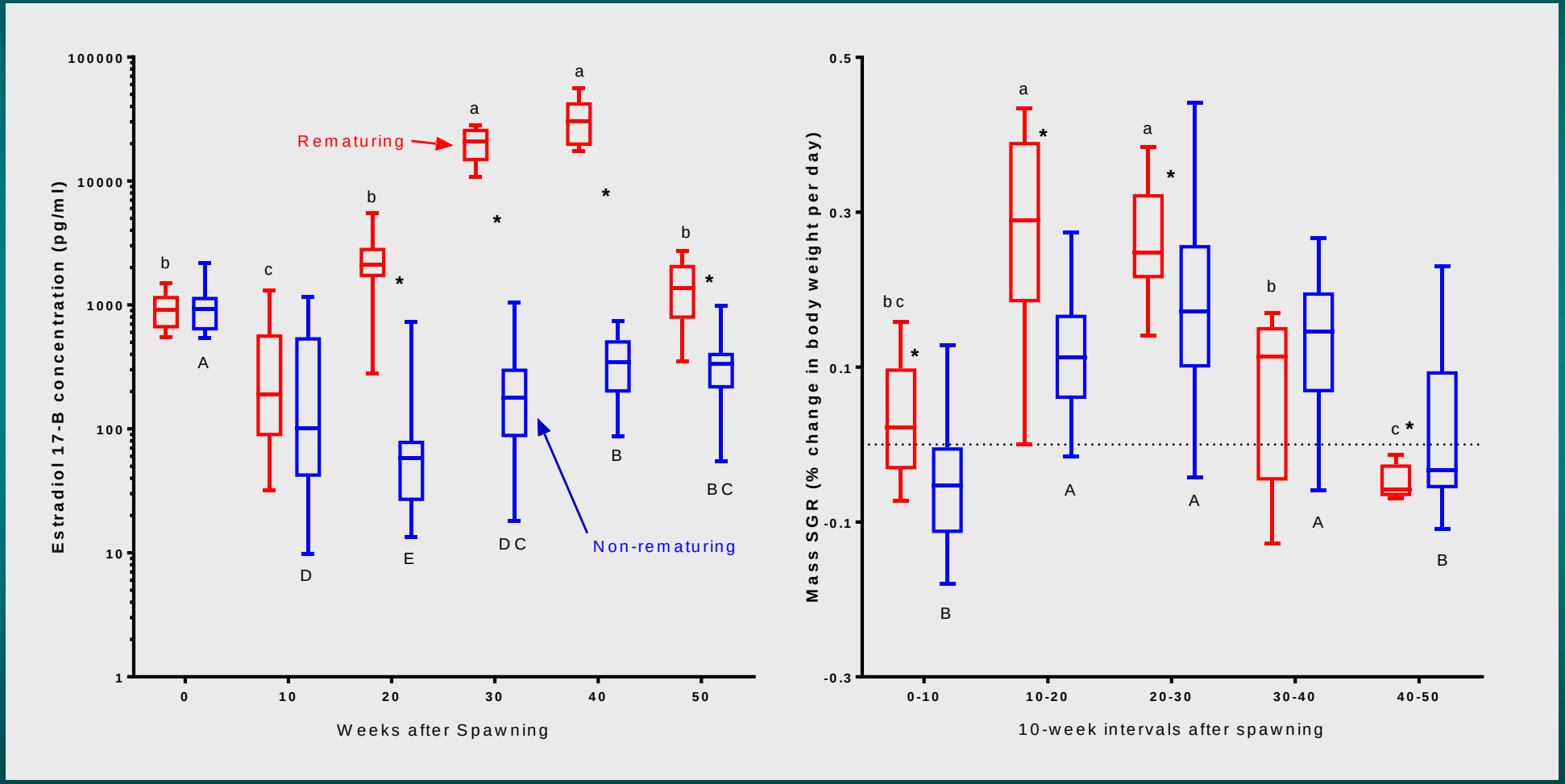
A. Pierce et al., 2017, *Canadian Journal of Fisheries and Aquatic Sciences*.

Survival and consecutive maturation rates vary in CRB kelt reconditioning projects. Skip maturation rates are high.



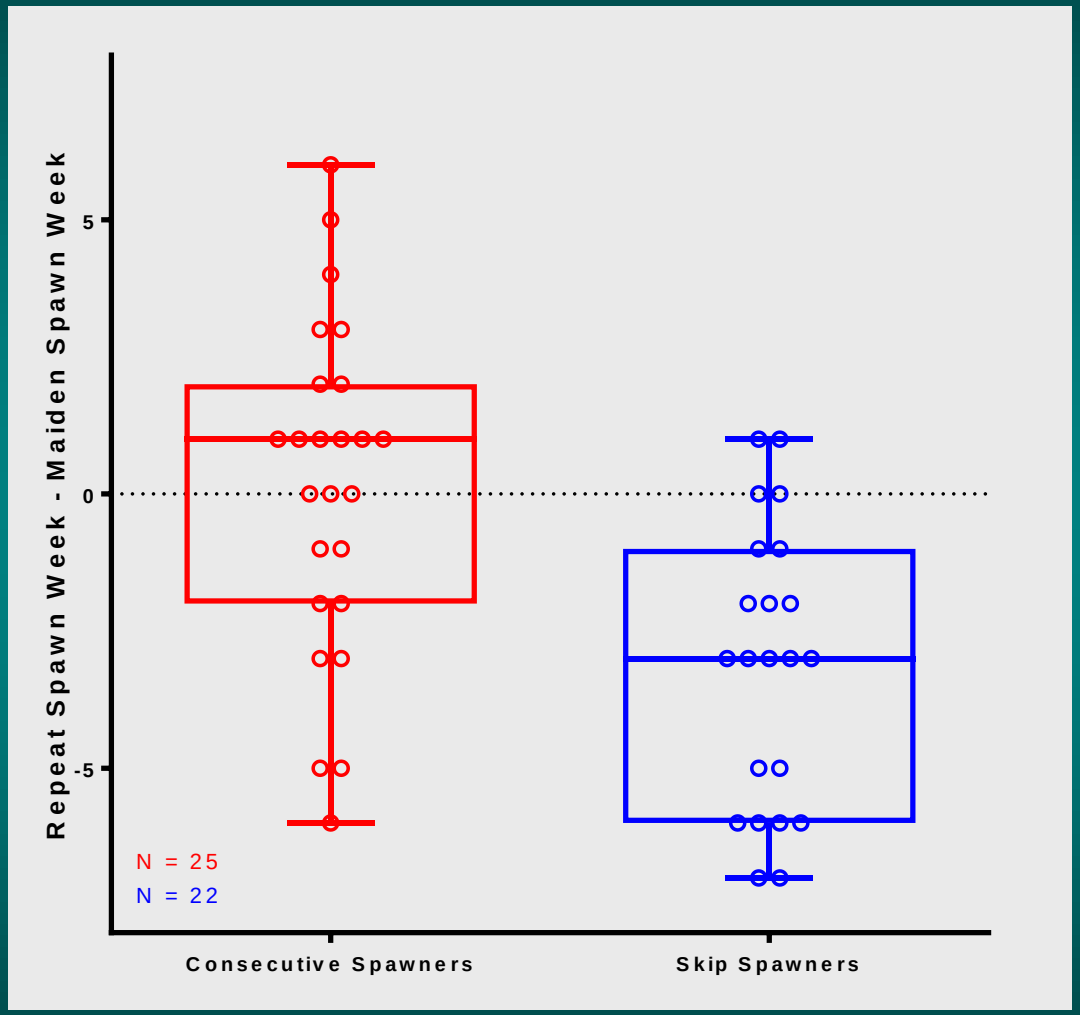
D. Hatch et al., Kelt Reconditioning and Reproductive Success Evaluation Research 1/1/2017-12/31/2017, Bonneville Power Administration Annual Report.

Plasma estradiol diverged at 20 weeks after spawning in air-spawned DNFH kelts. Growth diverged over the first 10 weeks after spawning.



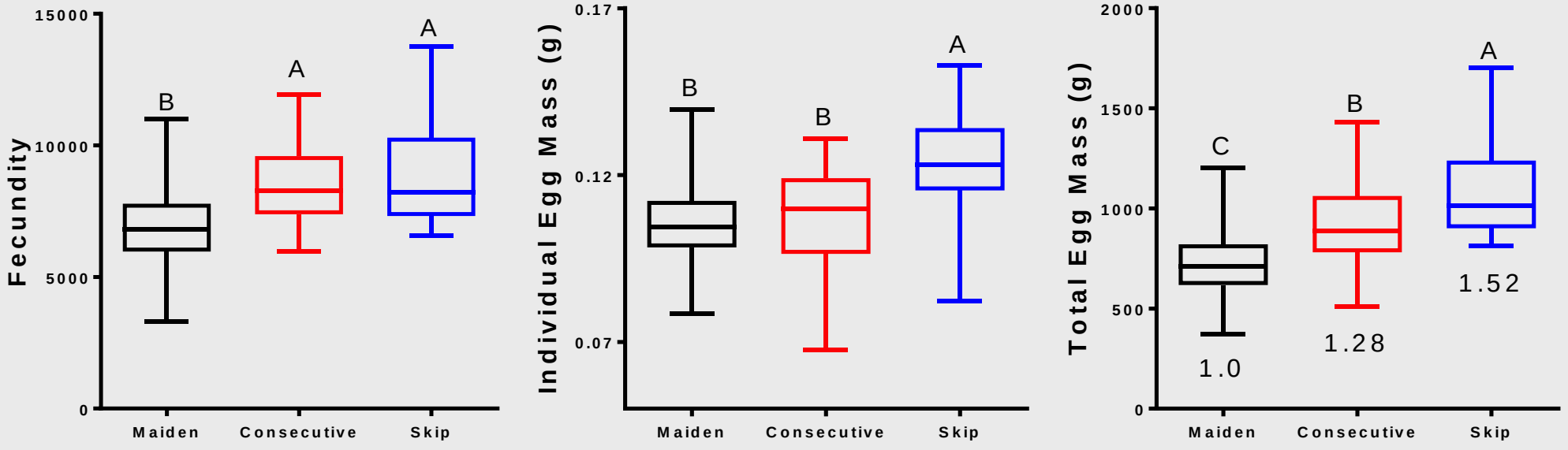
L. Jenkins *et al.*, in preparation. Asterisks indicate significant differences between rematuring and non-rematuring fish; letters indicate differences over time. 2015 spawn year.

Spawn timing was not shifted in consecutive spawning DNFH kelts. Skip spawners spawned 3 weeks earlier than their maiden spawn date.



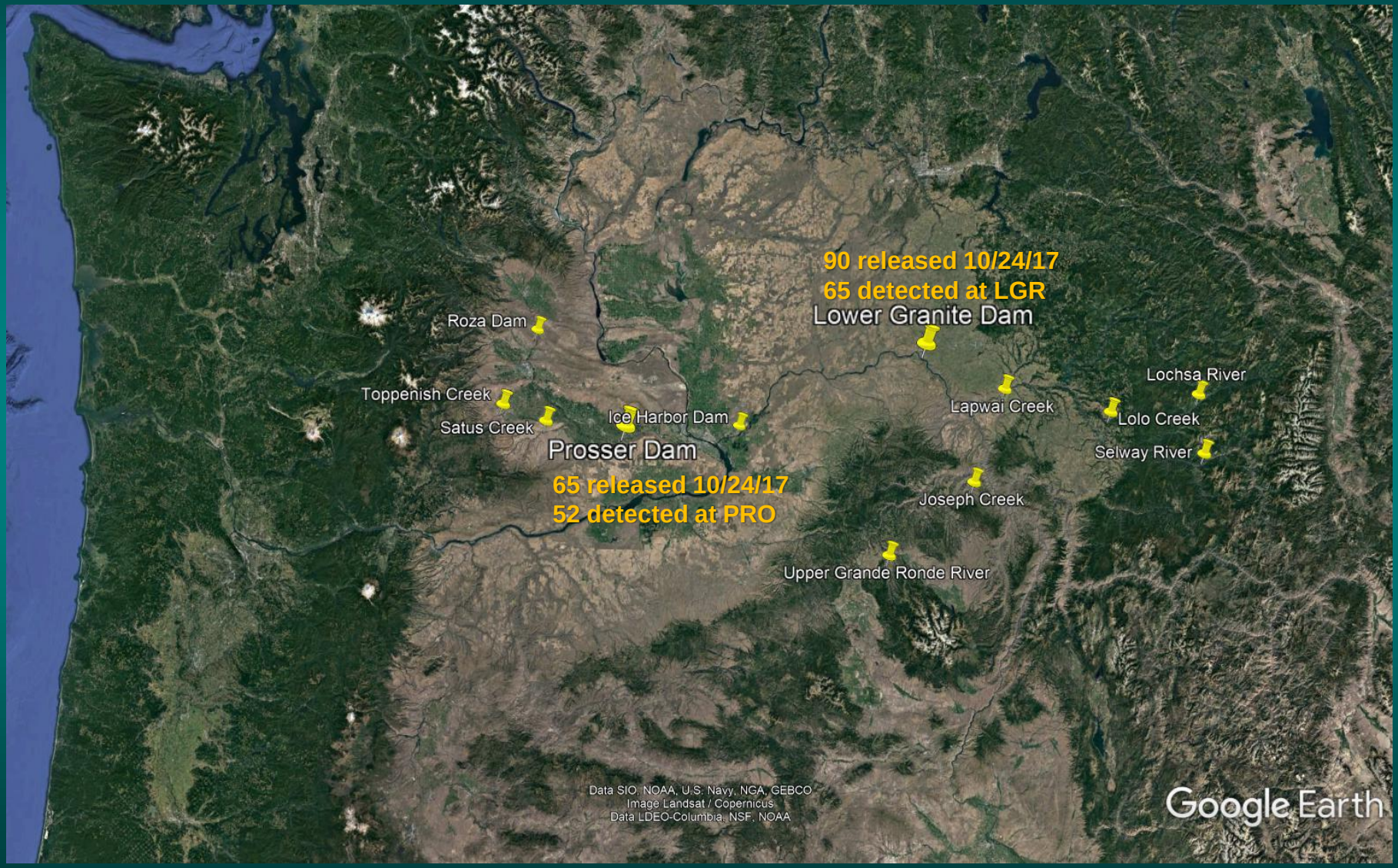
L. Jenkins *et al.*, submitted. One sample t-test versus 0, Consecutive Spawners $P=0.85$; Skip Spawners $P<0.0001$.

Fecundity increased from maiden to consecutive to skip spawners. Egg size increased strongly in skip spawners.



L. Jenkins *et al.*, submitted. Letters indicate significant differences between groups (GLM followed by independent contrasts).

Rematuring reconditioned female kelts released in the fall of 2017 are moving into spawning tributaries now.



Conclusions

Reconditioned kelts express the consecutive and skip spawning life histories.

Fish can be screened for maturation status before release.

Survival and consecutive maturation rates near 60% can be expected, at least for Yakima and Upper Columbia kelts.

Reproductive performance increases in reconditioned kelts versus maiden spawners.

Reconditioned kelts are spawning throughout the Columbia River Basin.

Additional ongoing research not covered

Reproductive success in the wild and in a spawning channel (J. Stephenson, R. Branstetter).

Genetic stock identification of kelts (A. Matala et al., 2016, ICES J. Marine Sci).

Models of benefit of kelt reconditioning (J. Trammel et al., 2016, NAJFM; R. Lessard).

Homing of kelts (D. Hatch).

Energy reserves in kelts versus maidens (A. Pierce, L. Jenkins, M. Abrahamse).