Factors influencing survival and consecutive rematuration in steelhead kelts

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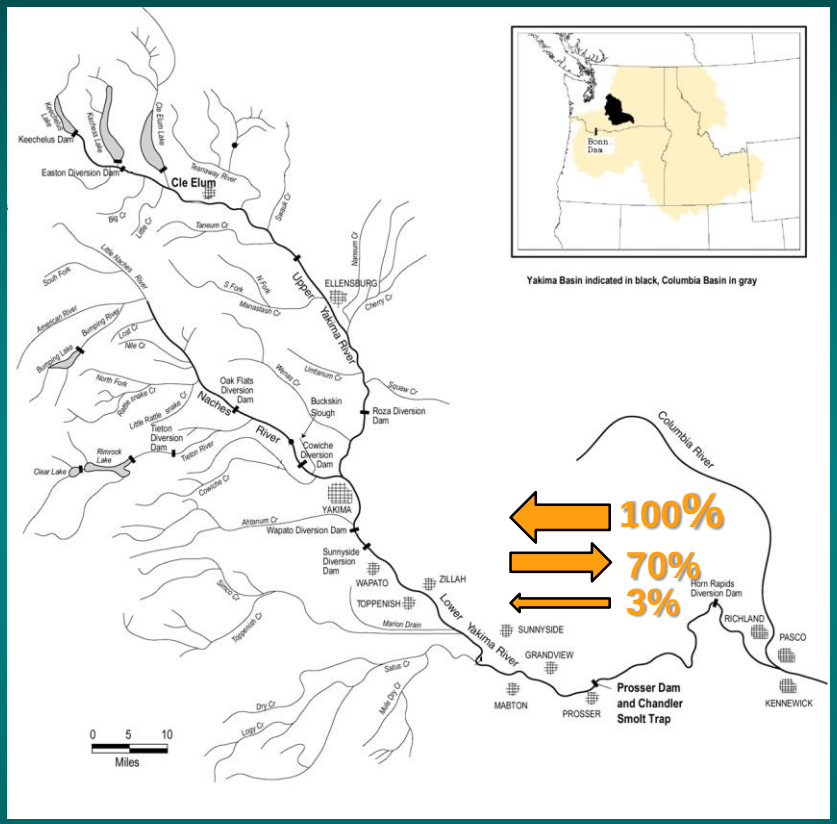
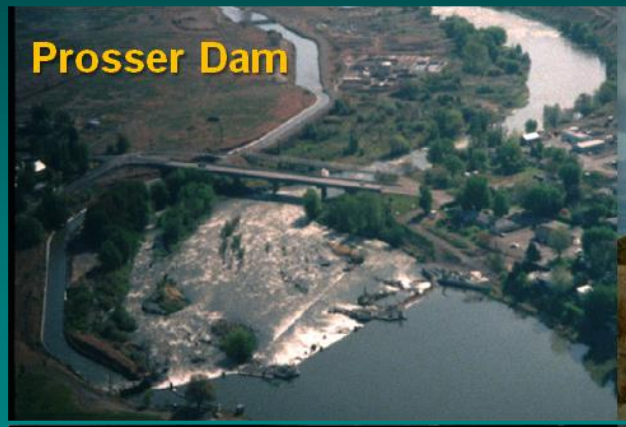
Kelt reconditioning is a restoration strategy that takes advantage of the repeat spawning life history of steelhead.



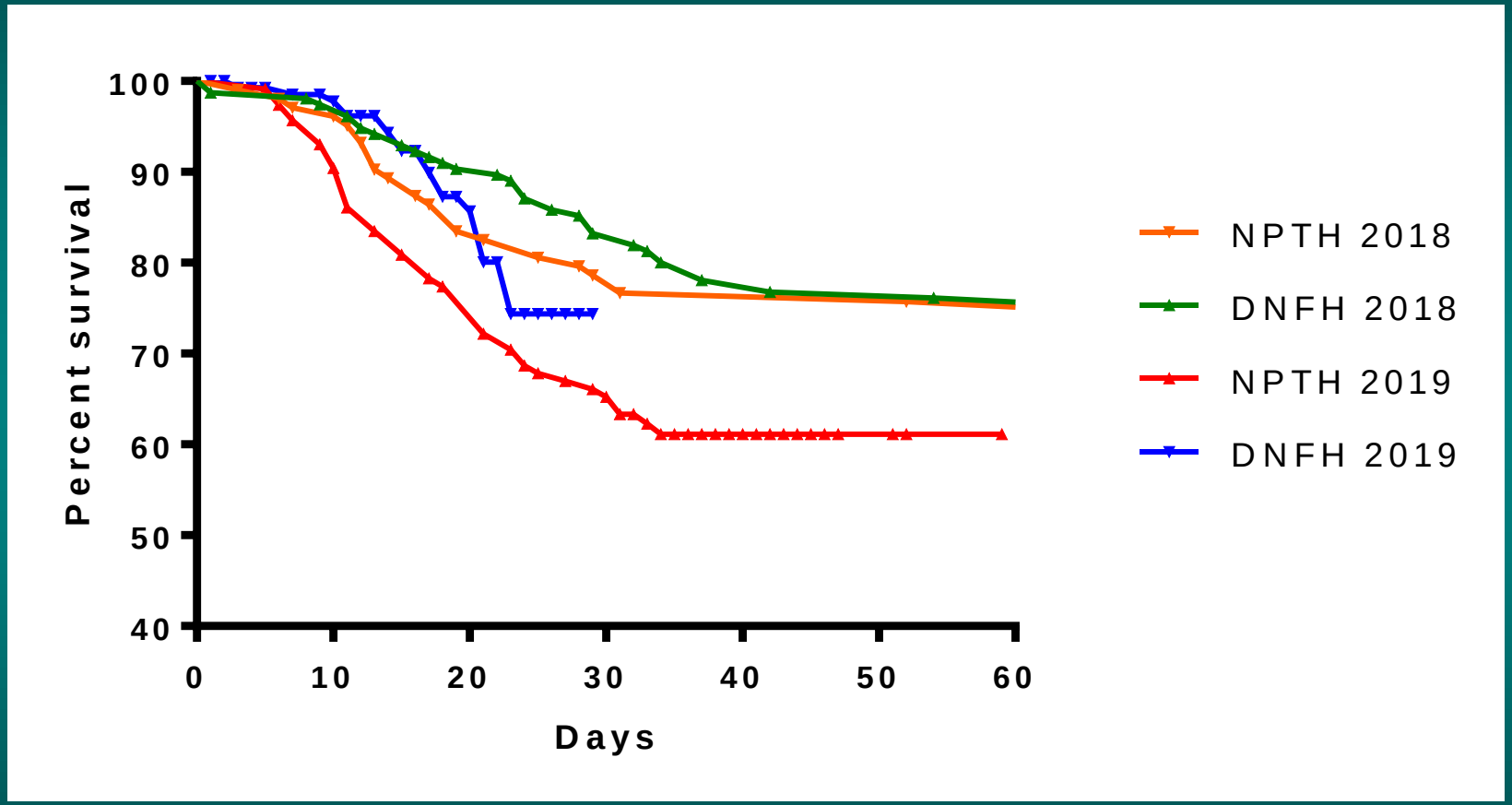


Intake Reconditioning Release

Feb Mar Apr May Jun Jul Aug Sep Oct Nov

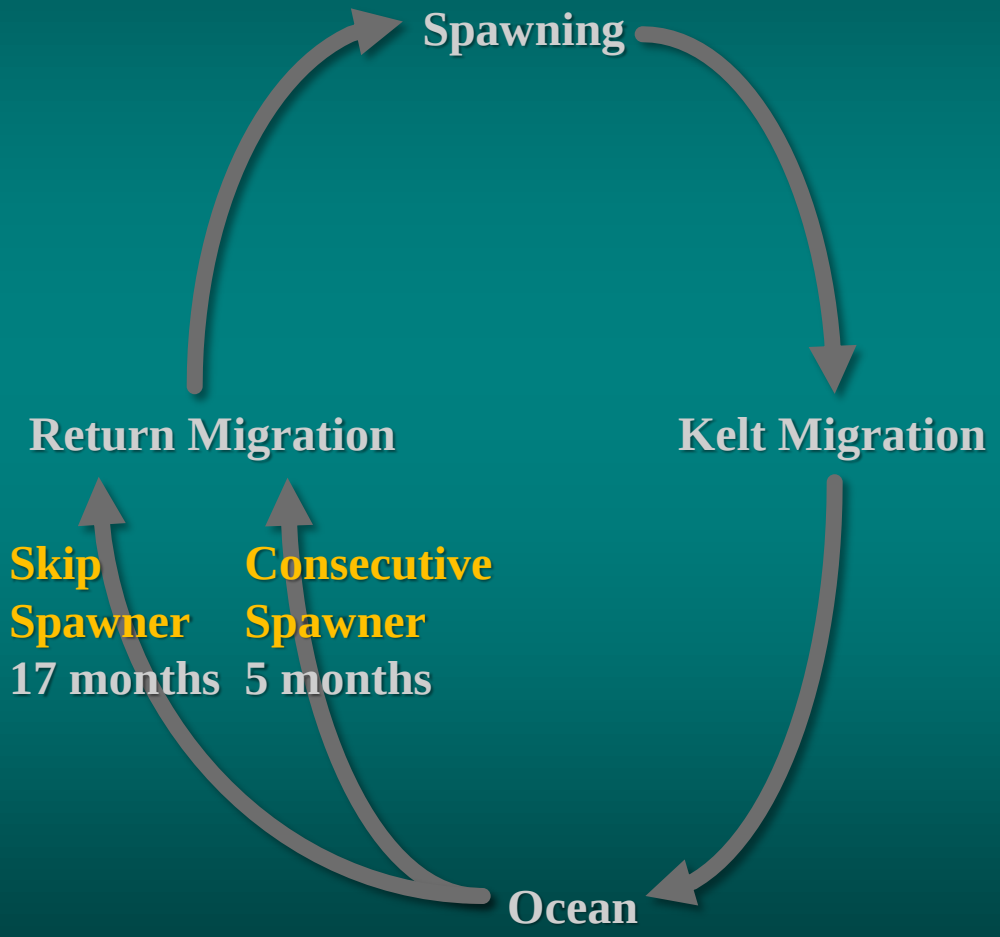
Kelt reconditioning is being implemented at several locations in the Columbia River Basin.

Most mortality in wild kelt reconditioning occurs during the month after collection.



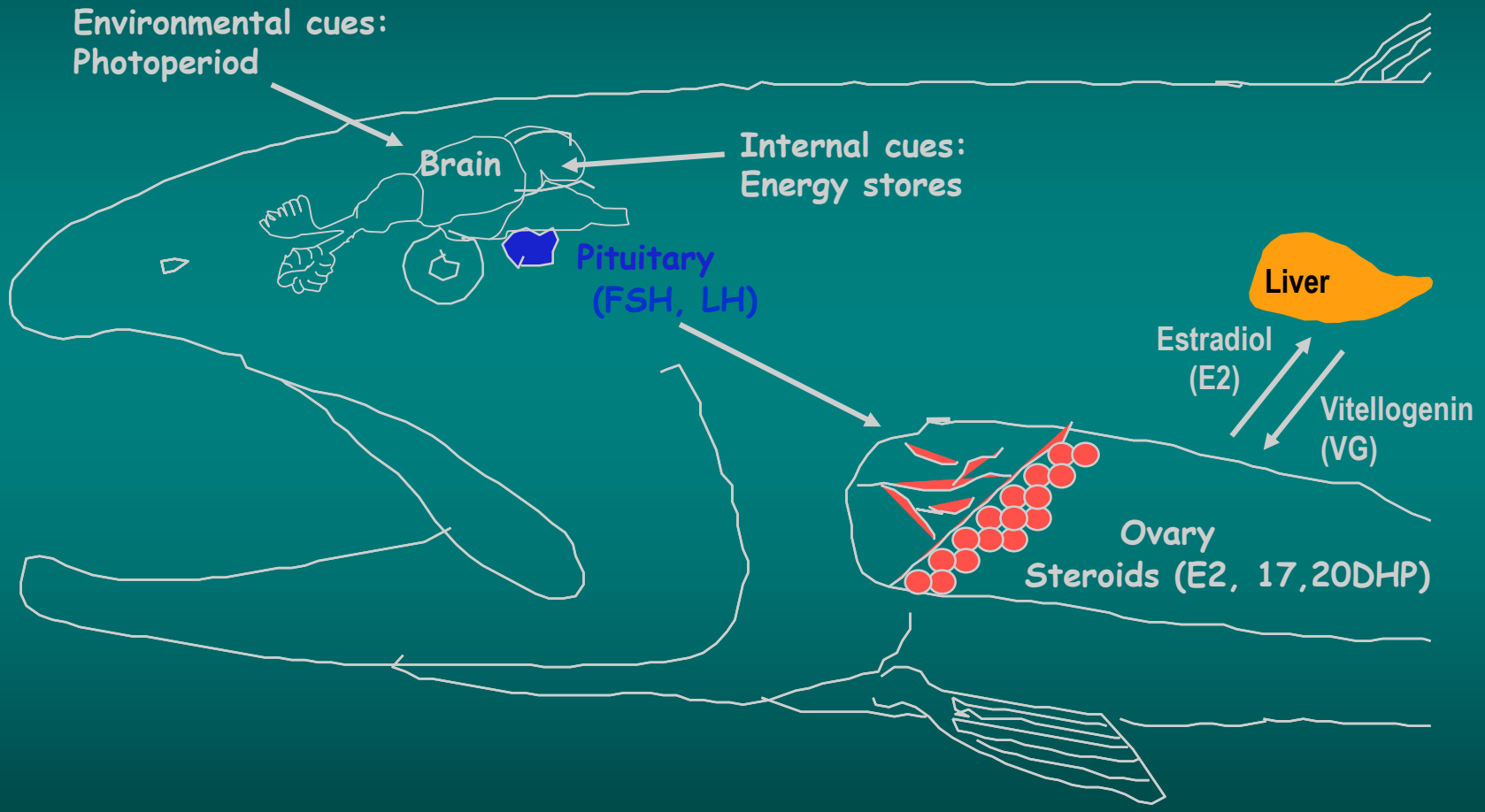
Similar with Yakima River fish.

Repeat spawning female steelhead can spawn as consecutive or skip spawners, both in the wild and in reconditioned fish.

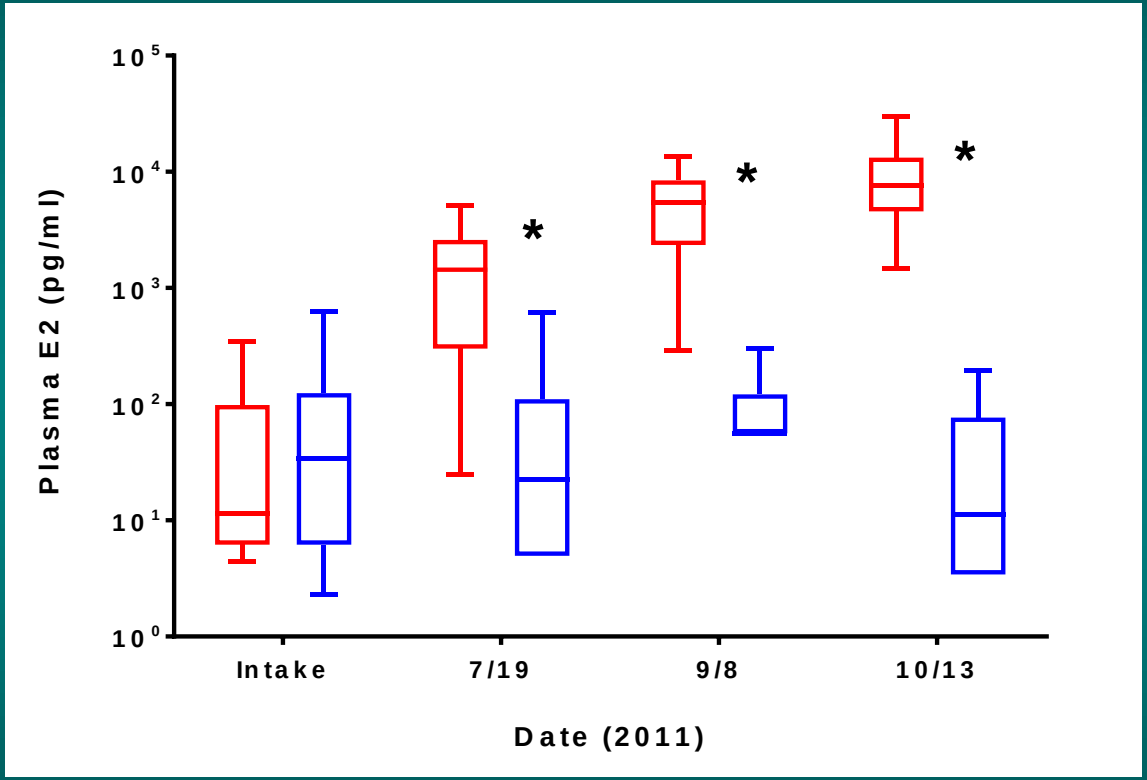


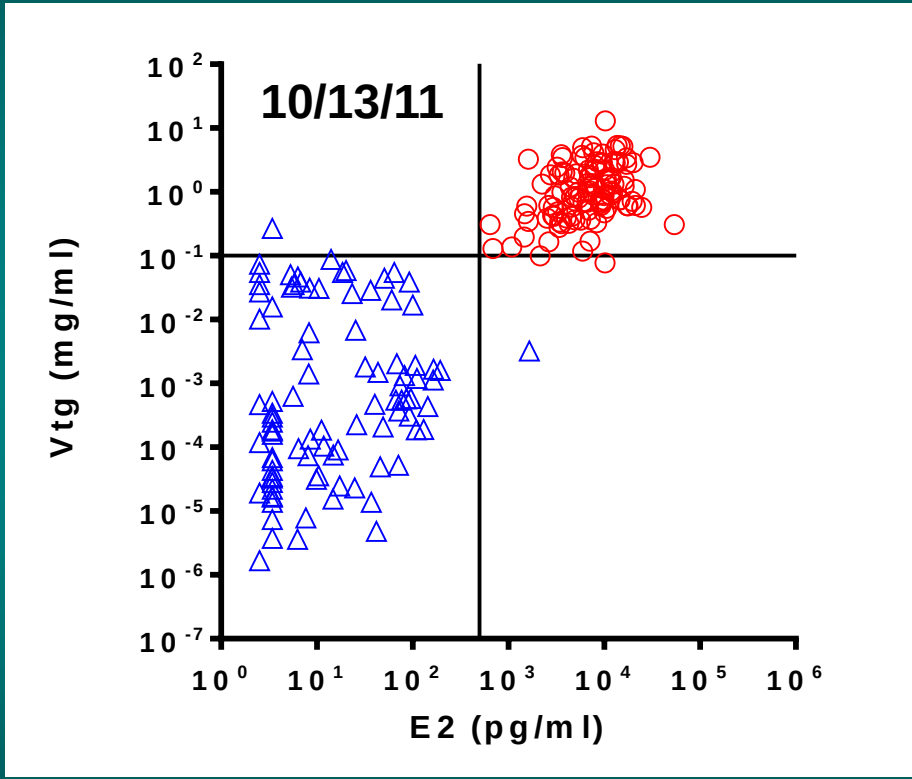
Keefer et al., 2008, *CJFAS*. Pierce et al., 2017 *CJFAS*.

The Reproductive Endocrine Axis regulates reproductive maturation in female salmonids.



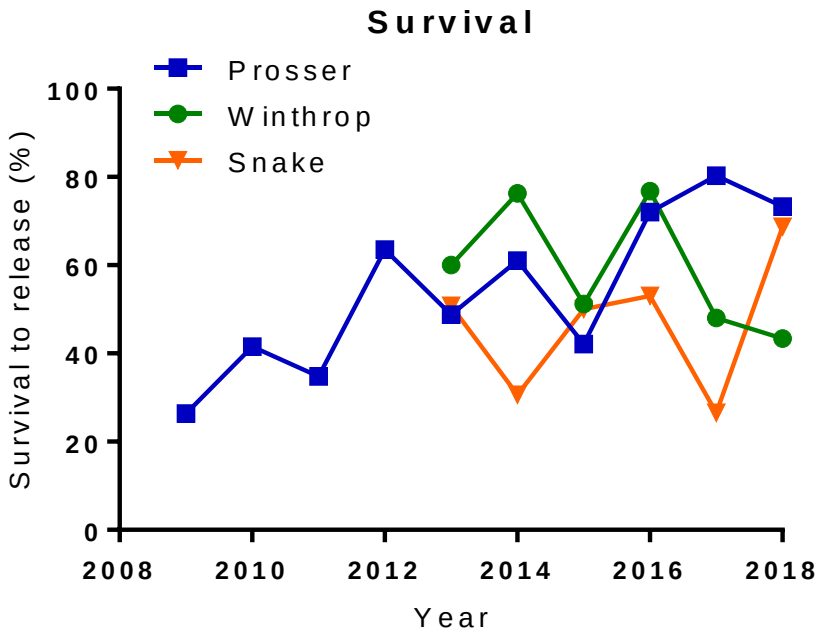
Consecutive and skip spawners can be identified by blood estradiol or vitellogenin level before release.

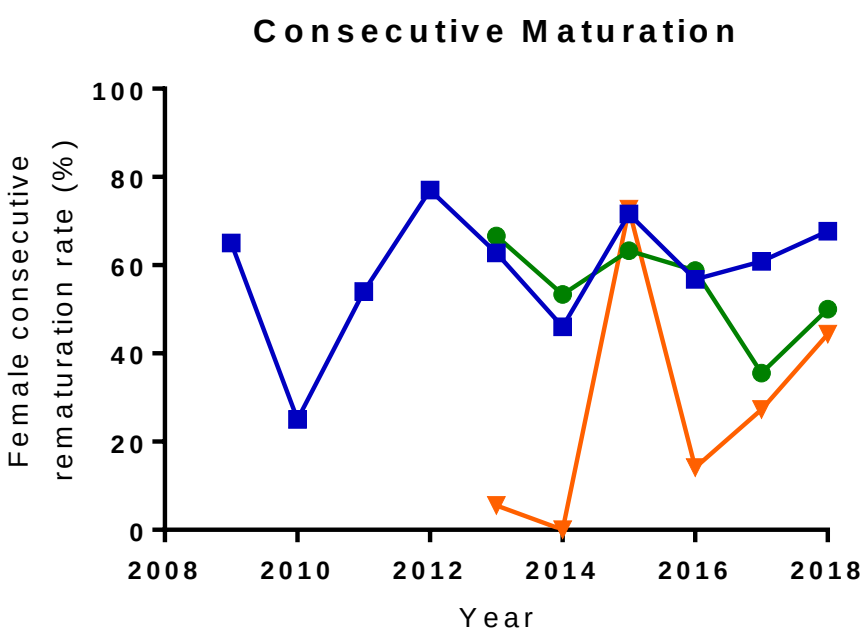




Pierce et al., 2017, *CJFAS*.

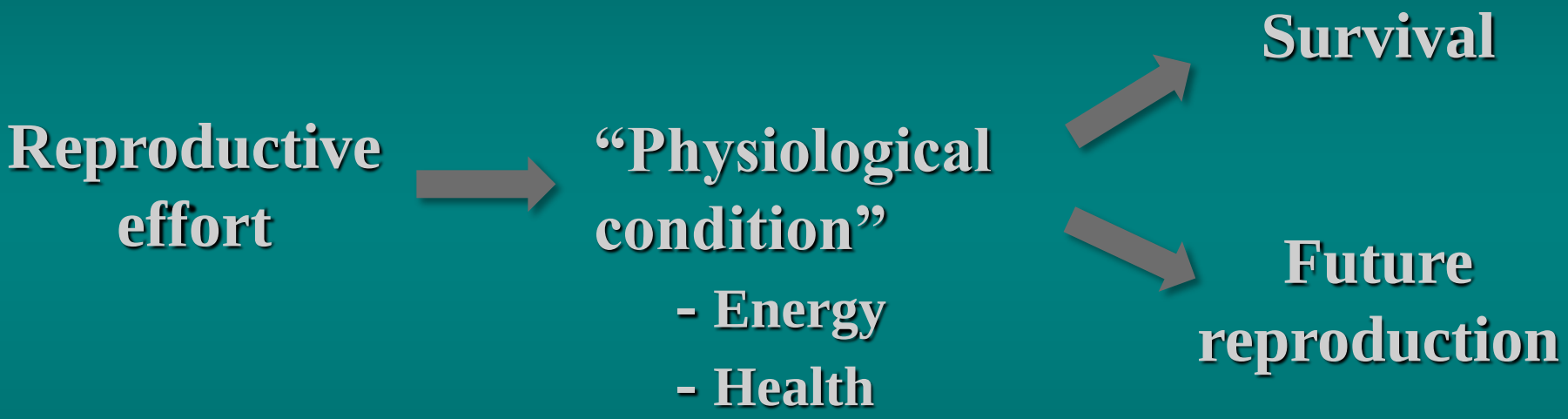
Survival and consecutive maturation rates vary in Columbia River Basin steelhead kelt reconditioning projects.





D. Hatch et al., Kelt Reconditioning and Reproductive Success Evaluation Research 1/1/2018-12/31/2018, Bonneville Power Administration Annual Report.

Life history theory predicts that there may be tradeoffs between reproductive effort, physiological condition, and future survival and reproduction.



e.g. Stearns 1992; Christie et al., 2018, *PNAS*, Hood River steelhead.

We used a hatchery kelt model to investigate the development of consecutive and skip spawning, reproductive performance, and predictors of survival and consecutive maturation in female steelhead kelts.

DNFH hatchery steelhead

Air spawning

Total egg mass
Egg size
Fecundity

Blood sampling

Estradiol (E2)
Triglycerides
Osmolality

Reconditioning tanks

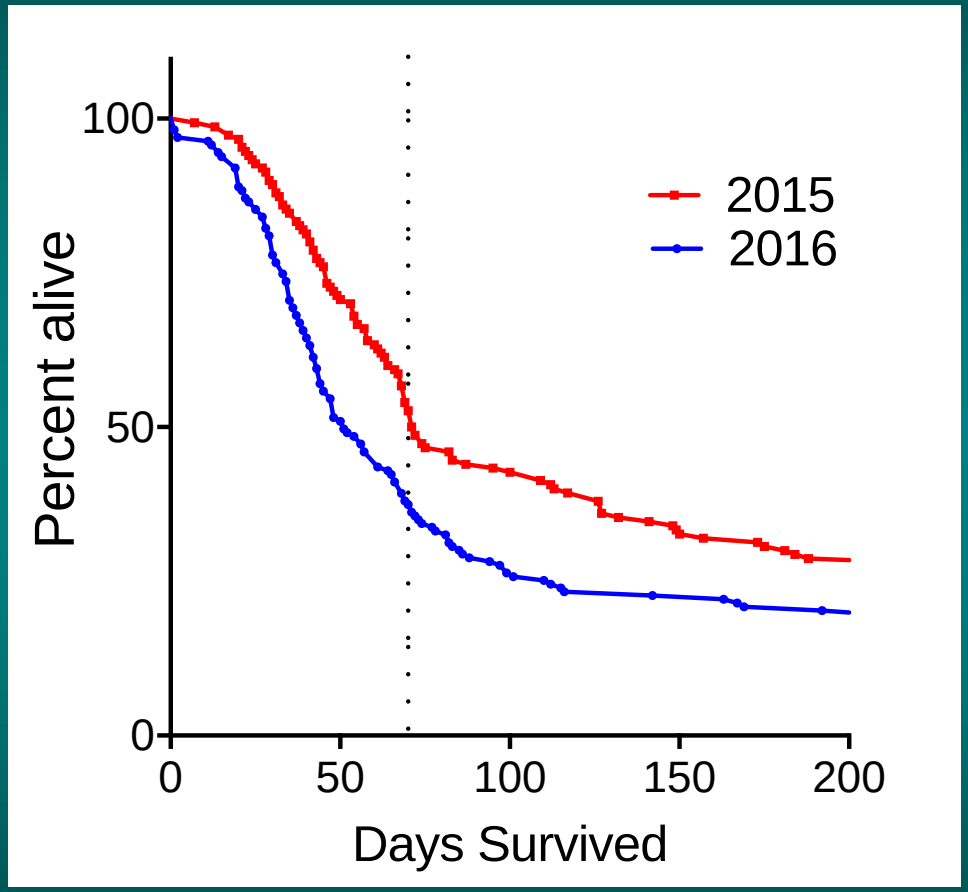
Parasite load

 # Copepods

Fatmeter

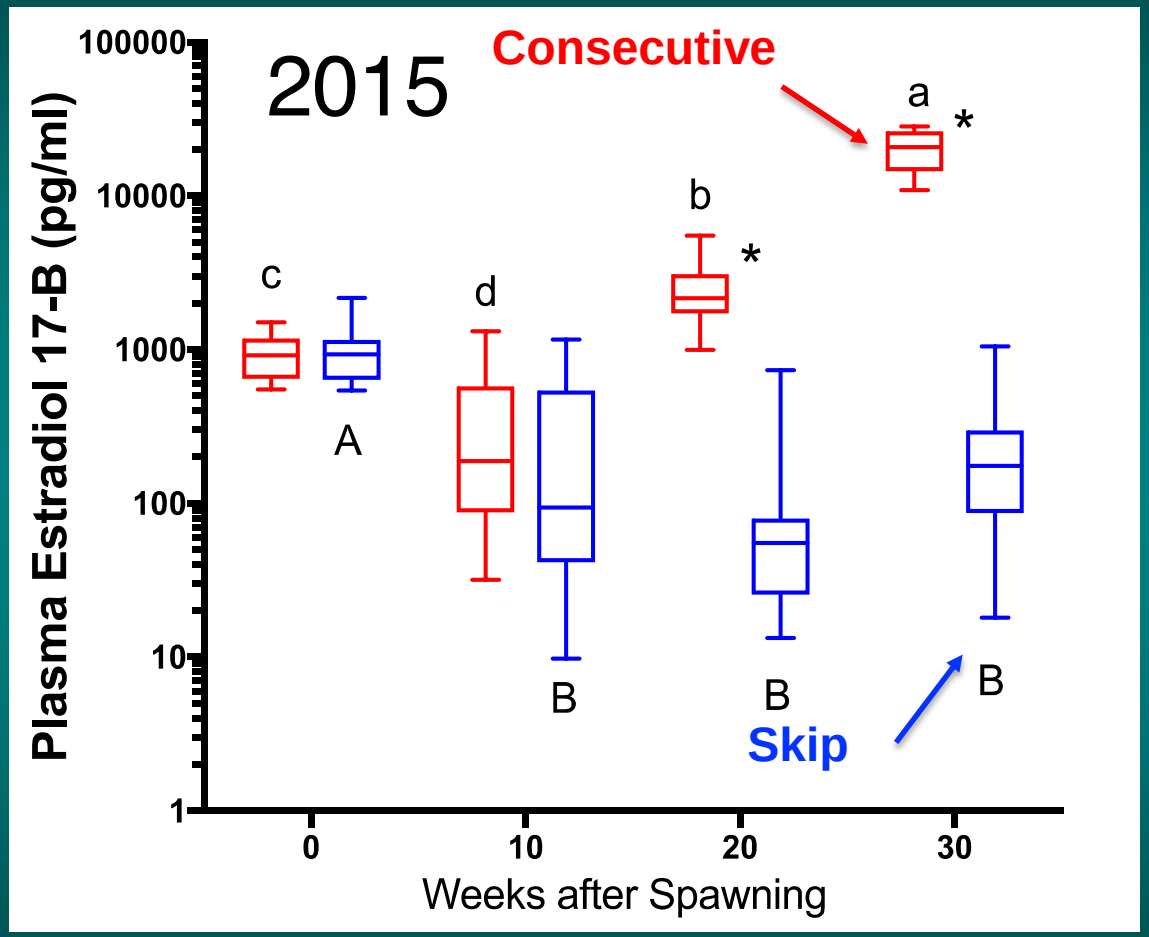
Muscle lipid

Most mortality in DNFH kelts occurred during the 70 days after spawning.



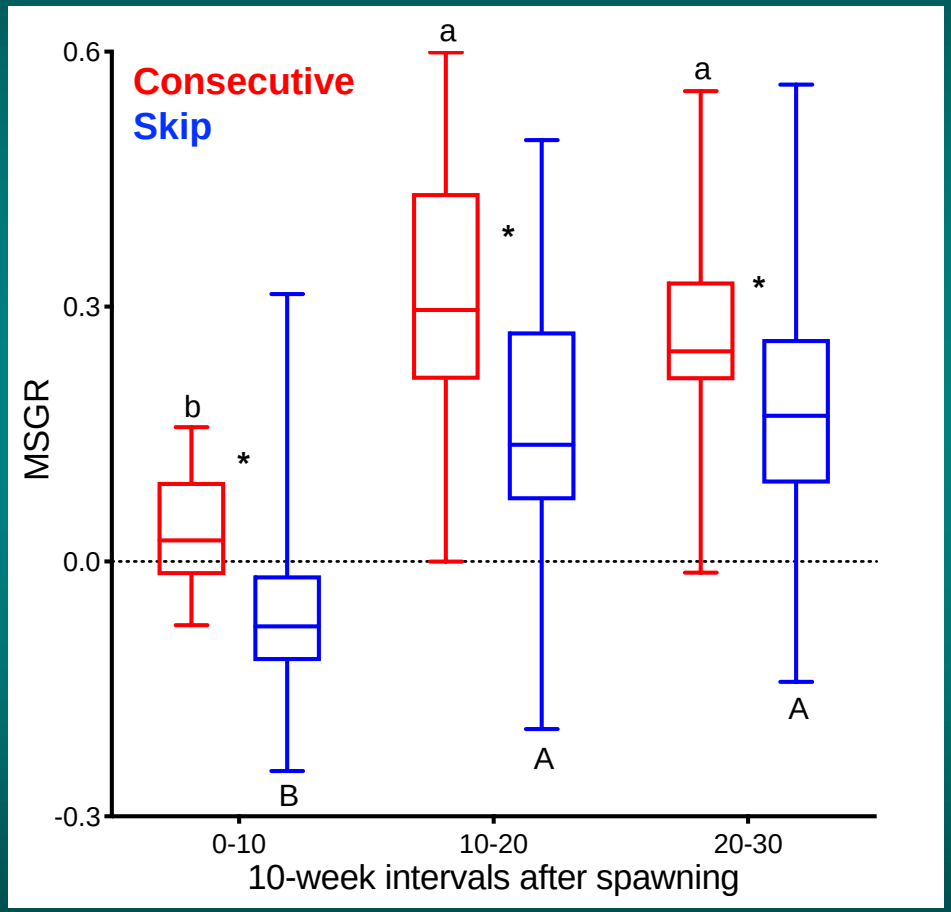
Jenkins et al., in review.

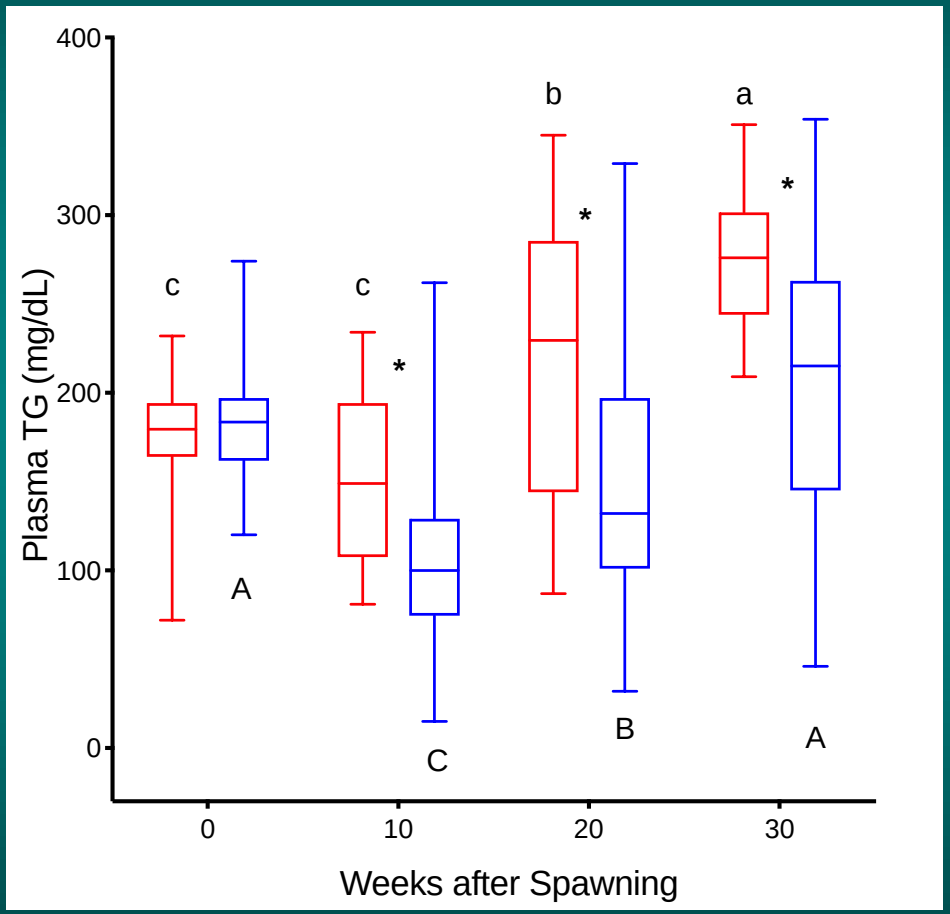
Estradiol diverged between consecutive and skip spawners between 10 and 20 weeks after maiden spawning



Jenkins et al., in press, *Conservation Physiology.*

Consecutive spawners displayed greater growth and circulating triglyceride (TG) levels over the first 10 weeks after spawning.

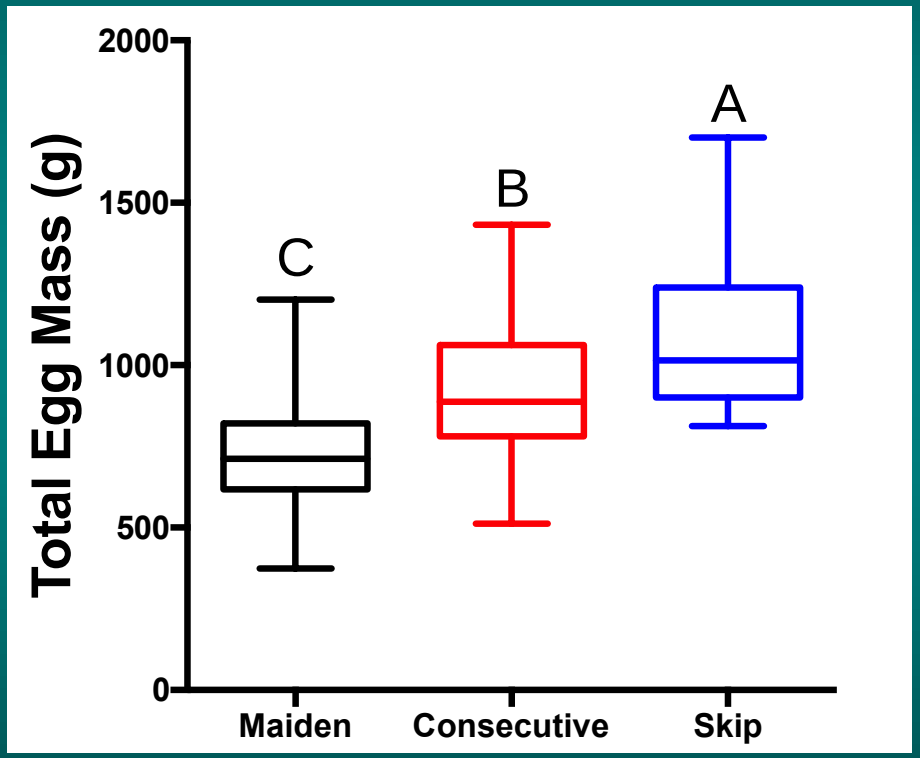




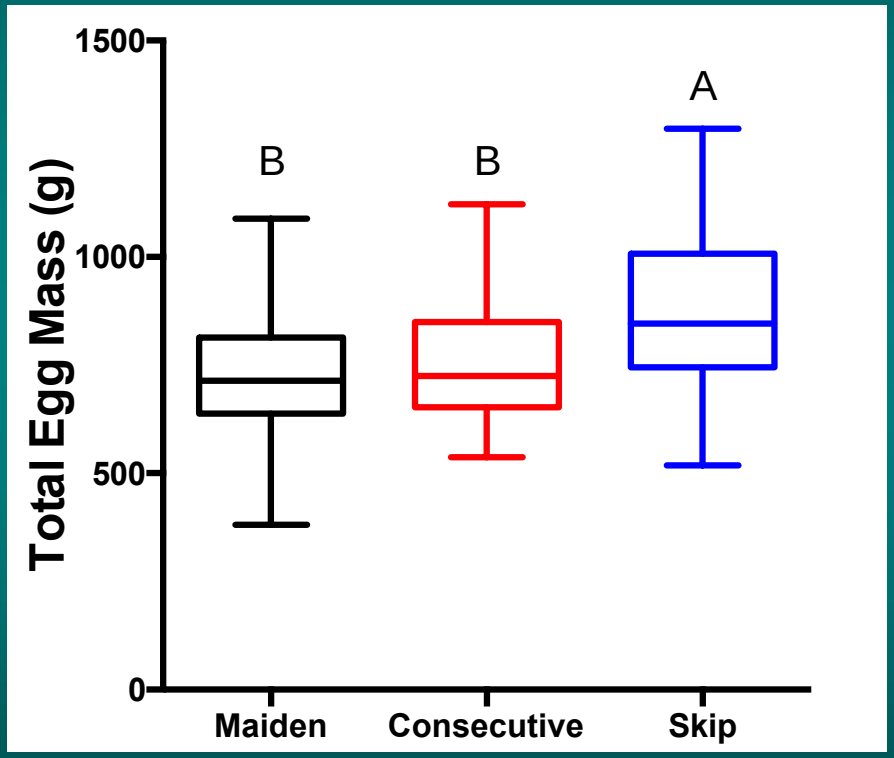
Jenkins et al., in press, *Conservation Physiology.*

Repeat spawners had greater total egg mass (TEM) than maidens. After size standardization, skip spawners had greater TEM, a measure of reproductive effort.

Absolute

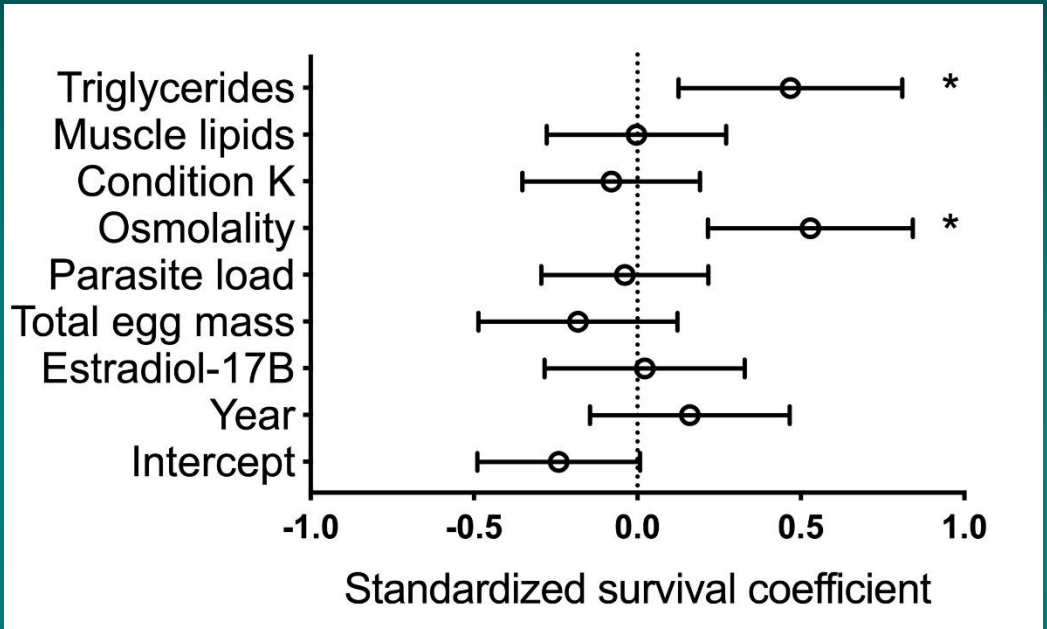


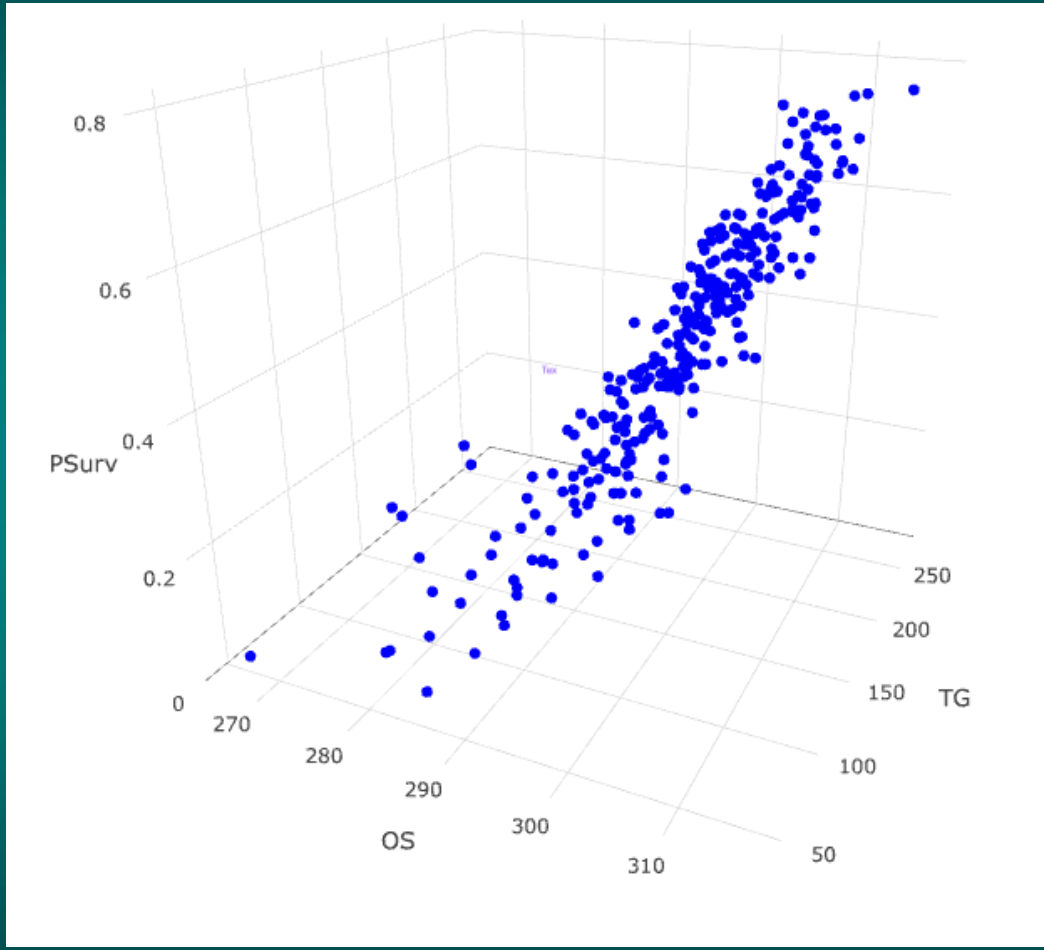
Standardized



Jenkins et al., 2018 *TAFS*. Individual fish TEM was standardized to the average mass of a maiden spawner using the maiden spawner mass versus TEM regression.

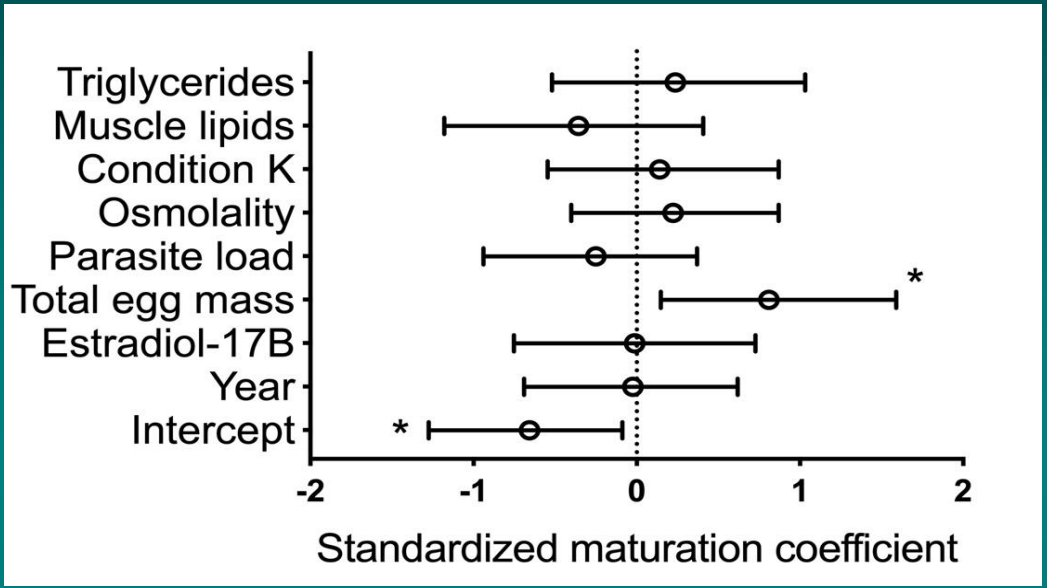
Plasma osmolality and triglyceride level at maiden spawning predicted survival to 10 weeks post-spawning. Standardized TEM did not.

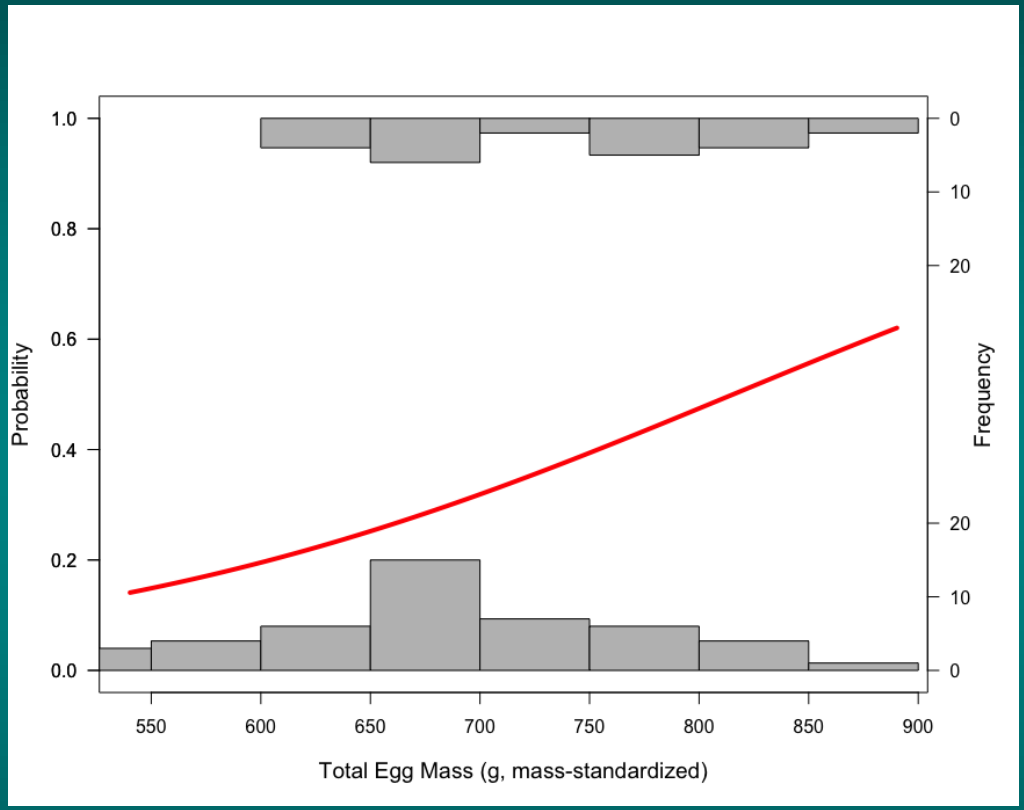




Jenkins et al., in review. Multiple logistic regression on standardized predictor variables. Final logistic regression model: $p < 0.0001$.

Maiden spawning total egg mass was positively related to consecutive rematuration.





Jenkins et al., in review. Multiple logistic regression on standardized predictor variables. Final logistic regression model: p = 0.0437.

Conclusions

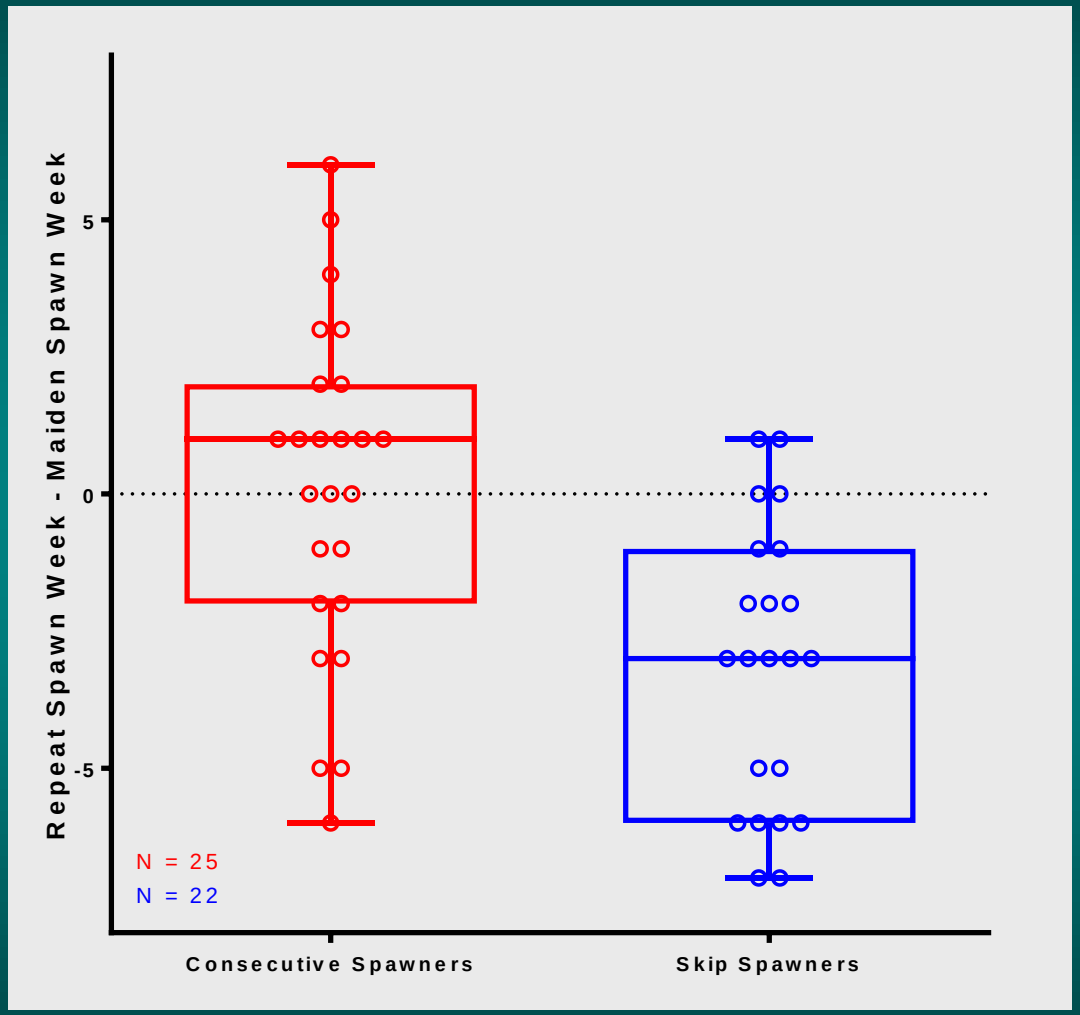
Physiological differences were found between consecutive and skip spawners within 10 weeks after spawning.

Absolute reproductive effort increased with spawning interval whereas size-standardized reproductive effort was greater in skip spawners.

We did not find support for a tradeoff between maiden reproductive effort and survival or consecutive rematuration.

The ability to access stored energy and maintain salt and water balance predicted survival.

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.*, 2018, TAFS. One sample t-test versus 0, Consecutive Spawners P=0.85; Skip Spawners P<0.0001.