Using physiological tools to forecast male life-history types to aid in management of hatchery and wild *Oncorhynchus mykiss*

Don Larsen and Penny Swanson

NOAA Fisheries

Mollie Middleton and Jon Dickey

UW, School of Aquatic and Fishery Sciences

Ryan Gerstenberger and Chris Brun

Confederated Tribes of the Warm Springs Reservation

Photo courtesy IDFG

Research approach adapted from….

- 2:50 – 3:10 pm **BREAK**
- 3:10 – 5:10 pm
- **Session Three – 20 Minute Presentations Hatchery Issues – Chair: Russ Bellmer, CDFW**
- 3:10 – Insights into Oregon anglers: How angler opinions can help fisheries management – Kevin Goodson, ODFW
- **3:30 – Evaluating survival and residualism of hatchery steelhead during the transition to locally sourced broodstock and two year old smolt production at the Winthrop National Fish Hatchery – Chris Tartara, NOAA NWFSC**
- 3:50 – Elucidation of reproductive traits in California steelhead using intergenerational genetic tagging – Carlos Garza, NOAA SWFSC
- 4:10 – Recommendations of the California Hatchery Scientific Review Group for California's Steelhead Programs – Michael Lacy, CDFW
- 4:30 – Increased size at release of hatchery steelhead decreases tendency of Trinity River Steelhead to exhibit the half-pounder life history – David G. Hankin, Humboldt State Univ
- 4:50 – Panel discussion – Moderator: Russ Bellmer, CDFW

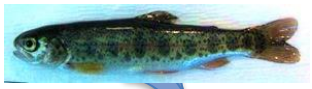
Steelhead, Oncorhynchus mykiss, life history

Maturation & spawning

Embryo

Anadromous Steelhead

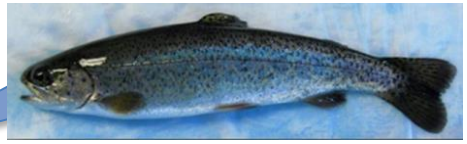
Parr



Ocean (1–3 years)

Estuary/early marine (2 weeks)

Smolt (age 1 -3)

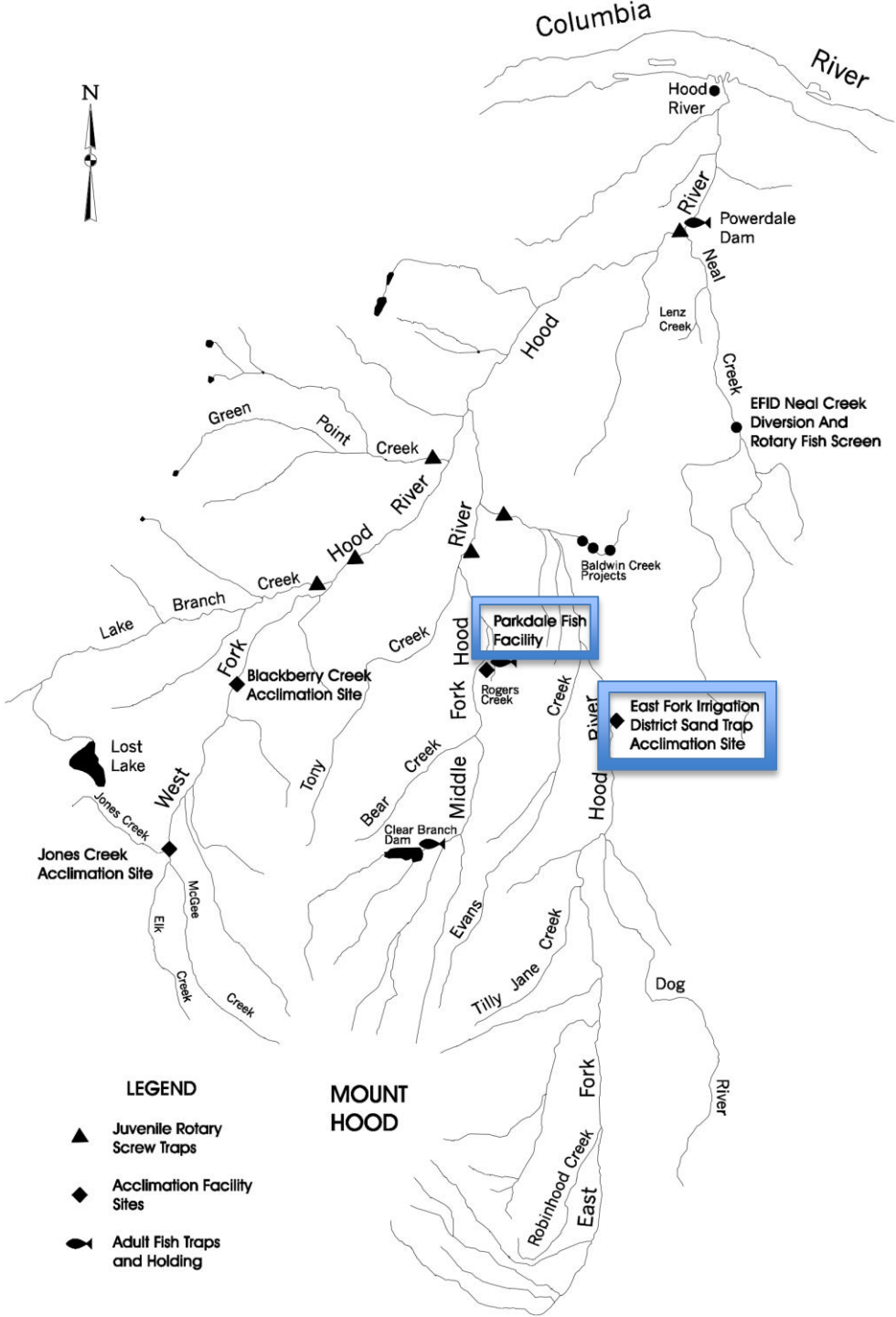


Resident Rainbow Trout

Maturation in fresh water

Hood River Basin, Oregon

Co-managers from the Confederated Tribes of the Warm Springs Reservation (CTWSR) and ODFW release ~50K Hood R. winter run steelhead annually from the Parkdale Fish Facility and East Fork Sand Trap combined.



Independent Scientific Review Panel (ISRP) 2008-2010 Review of Revised Hood River Production Master Plan

ISRP Review Summary

Residualism by Hatchery Steelhead

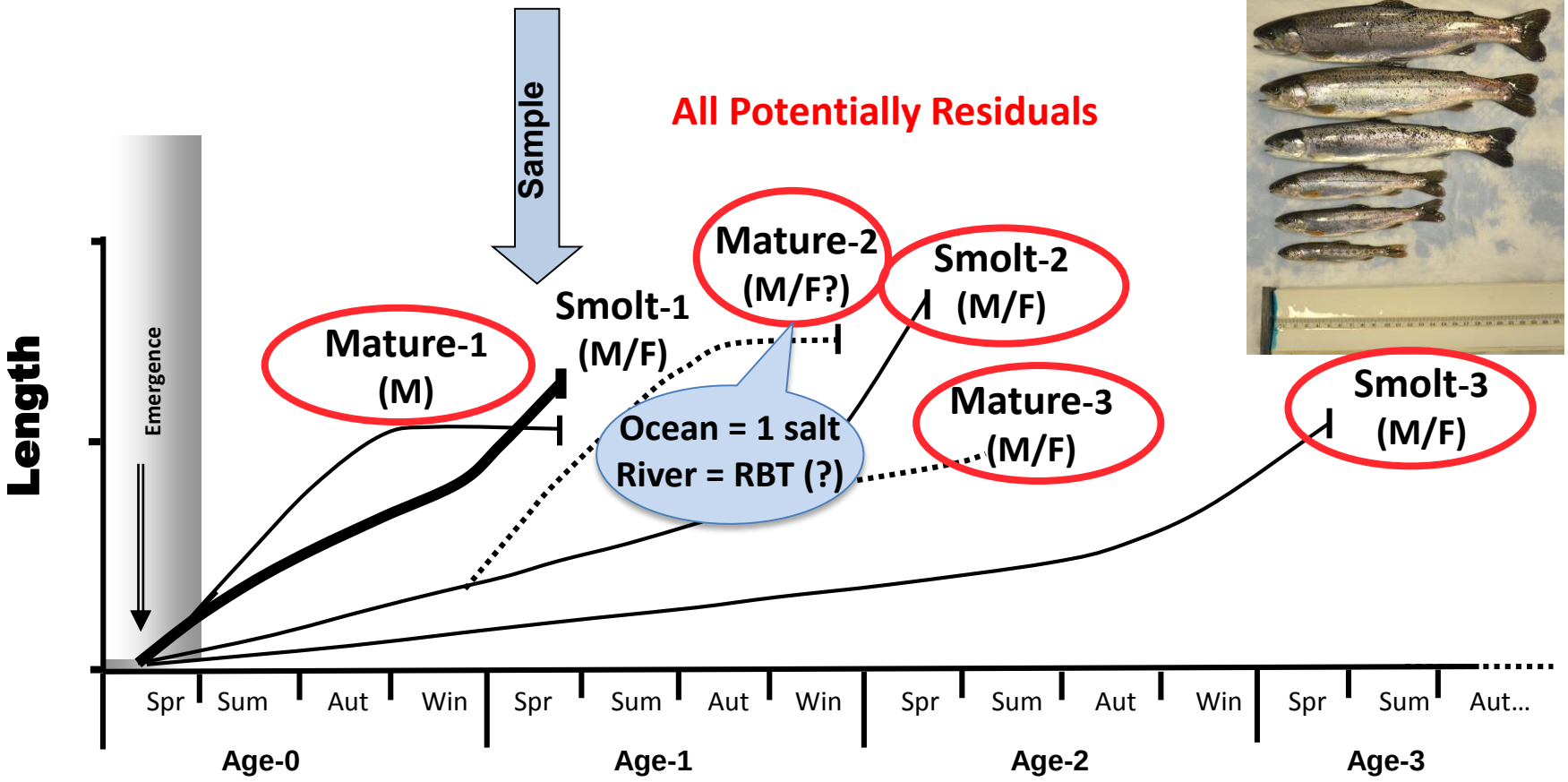
"……..reviews recommended that the project sponsors **develop M&E protocols to assess the extent to which the residualism of hatchery steelhead is resulting in the displacement of wild fish** from Hood River habitat…… These yearling residuals may compete with and displace wild underyearling parr….may contribute little or nothing to subsequent smolt yields, while a few likely mature precociously and spawn with wild fish, thus decreasing fitness of wild spawners….contributing toward hybrid swarms with cutthroat trout……..

A good starting point …….estimate the number of residuals the hatchery is producing…….or try to "forecast" life-history types.

Why do steelhead residualize?

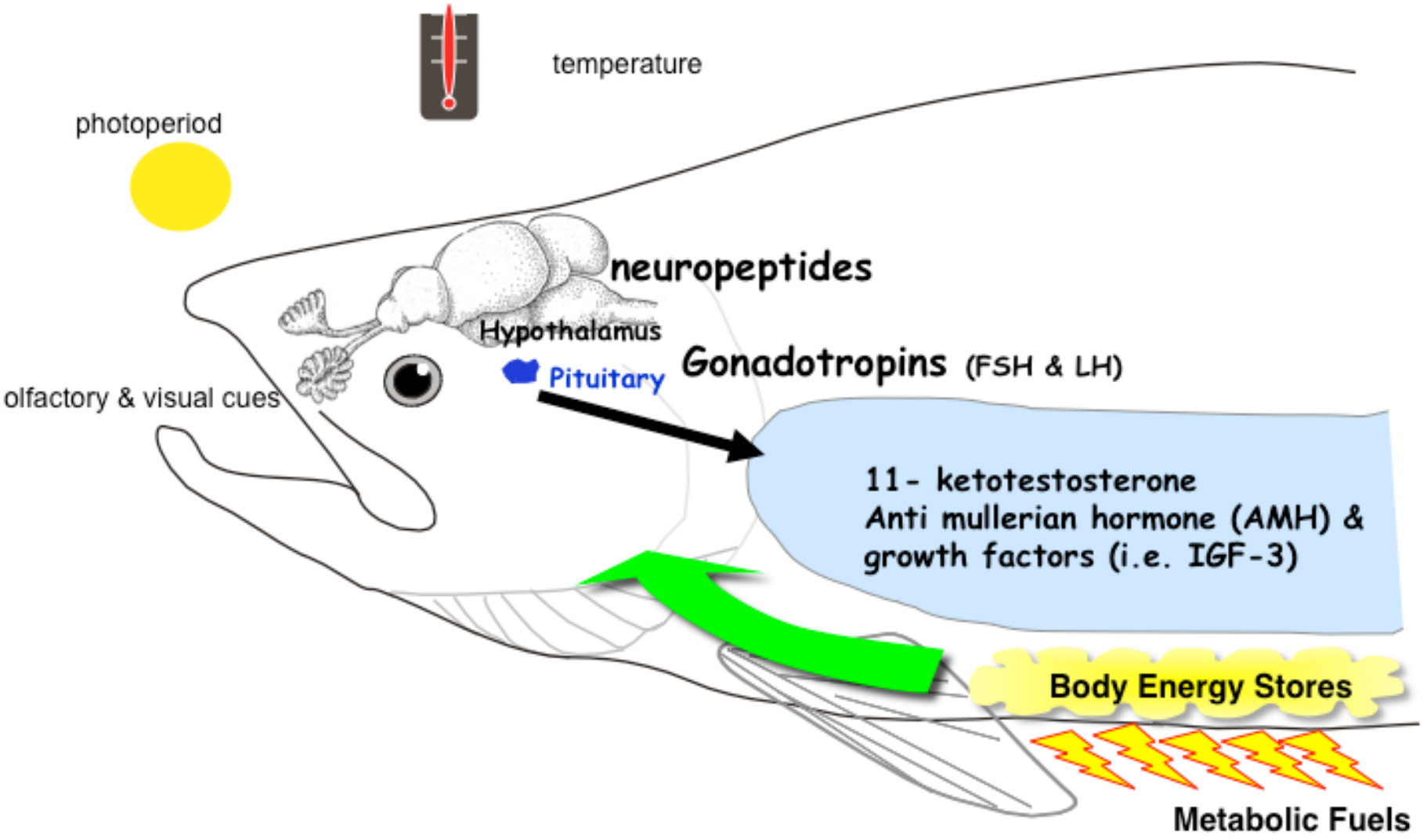
- Too small to smolt – notable in S1 programs
- Fast early growth leads to early male maturation
- I'm actually a rainbow trout despite the life-style may parents chose

What are the possible life-history options for Hood River Winter run steelhead?

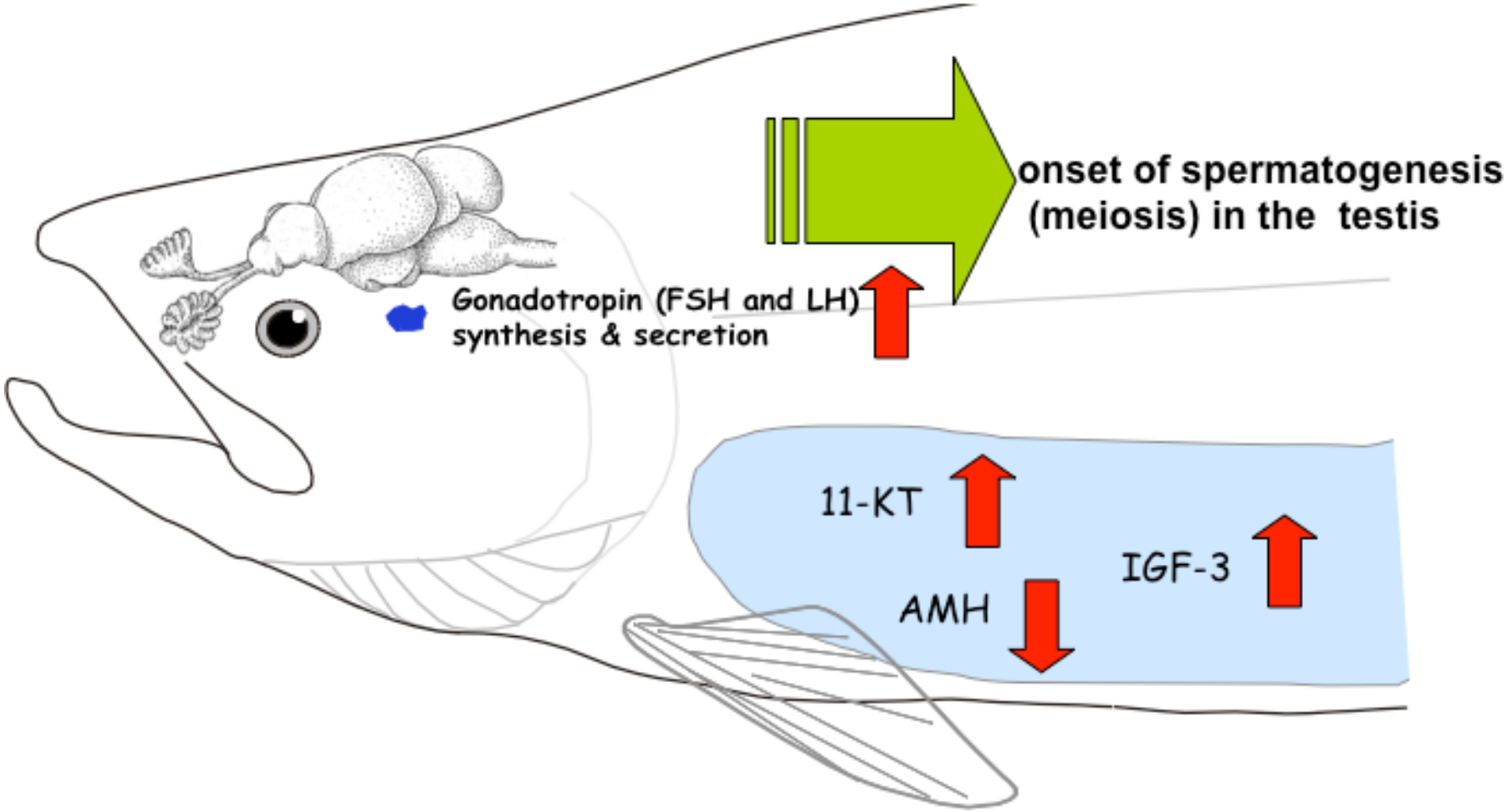


Adapted from Berejikian et al. 20ll

Reproductive Endocrine Axis



Onset of Puberty in Salmon



Methods

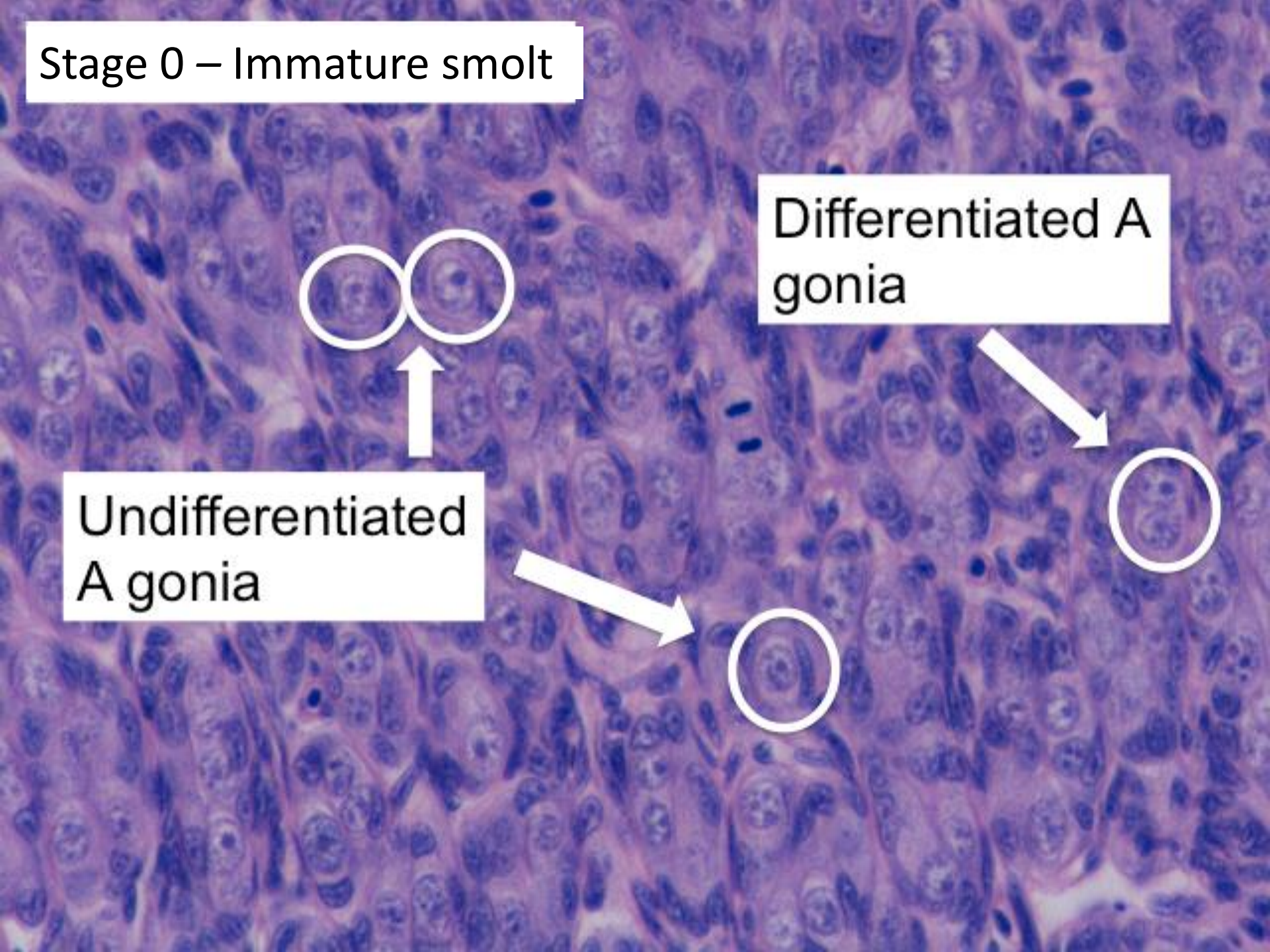
- Collect 300 Hood River Winter steelhead at Parkdale Facility in May 2012 and 2013 just prior to release
- Measure length, weight, sex, gonad weight for GSI, visual sexual development state, visual smolt state
- Collect
  - Gill tissue from males and females
  - Plasma from all males
  - Pituitary glands from all males
  - Testes from all males

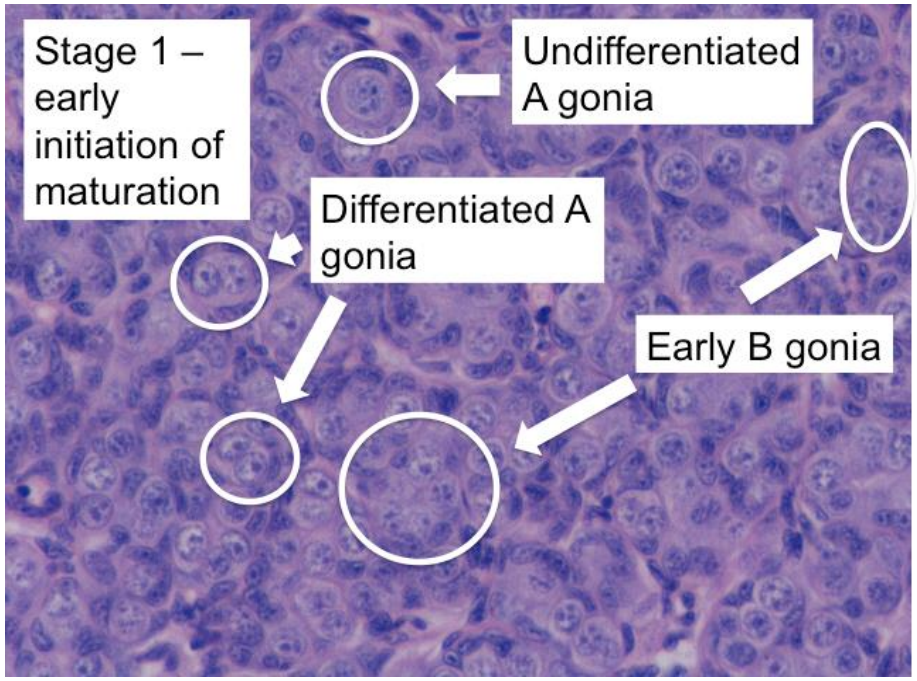
Physiological tools to determine life-history

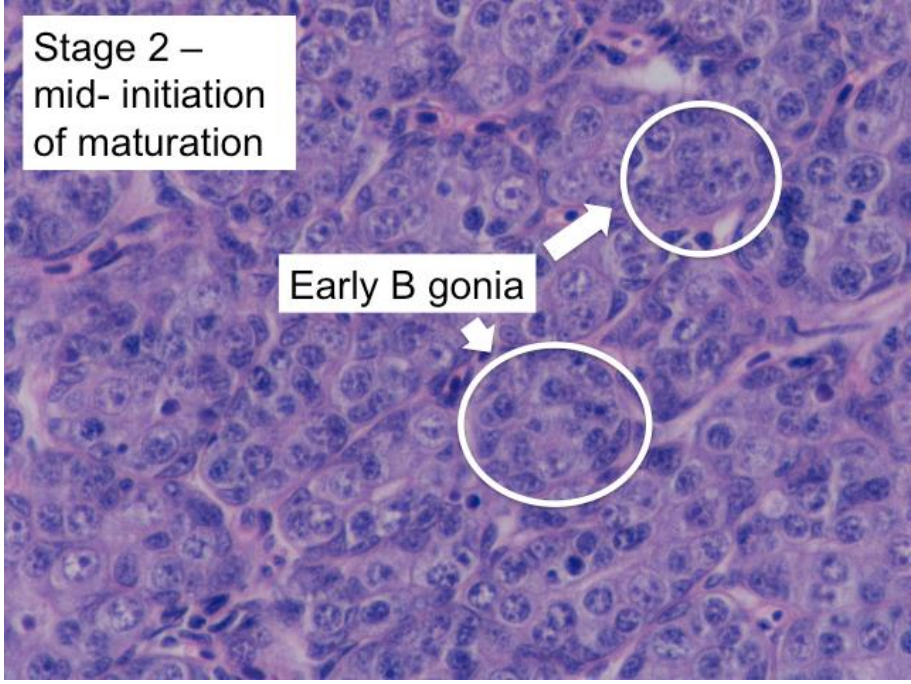
- Sex of the fish
- Testes histology – characterize cell types
- Male GSI
- Male Plasma 11-KT levels
- Pituitary mRNA transcript for FSH and LH in males
- Testes mRNA for AMH and IGF-3 (BY 2012) in males
- Male and female Gill Na+/K+-ATPase levels
- Male and female External appearance – parr marks or silvering
  - 1 = parr, 2 = transitional, 3 = smolt

Results

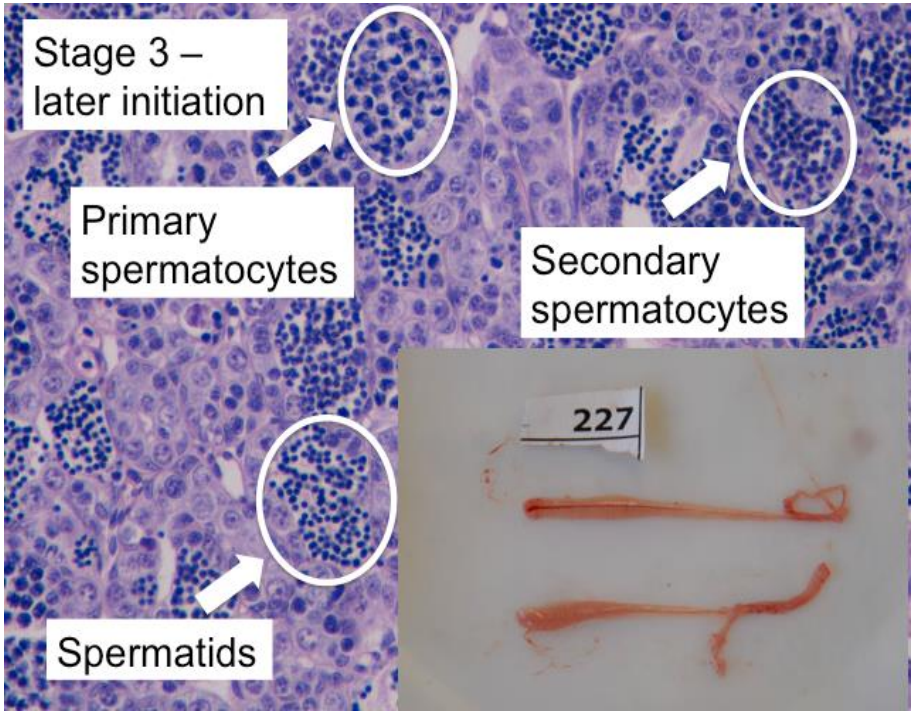
- Sex - 154 females, 146 males (51:49) – BY 2011
  - 165 females, 135 males (55:45) – BY 2012
- There were only 4 immature parr (smolt index = 1) in 2011 (all female) and 0 in 2012.
- All other females were immature smolts
- Smolts were the most common life-history in both years
- In males maturation initiates before clear increases in GSI
- Histology was best method for examining male maturation and we recognized 6 different life-history stages (or types) in both brood years
- Other parameters were required to support the histological results
- This approach could be used for surveying wild stocks as well.


Stage 0 – Immature smolt
Differentiated A gonia
Undifferentiated A gonia





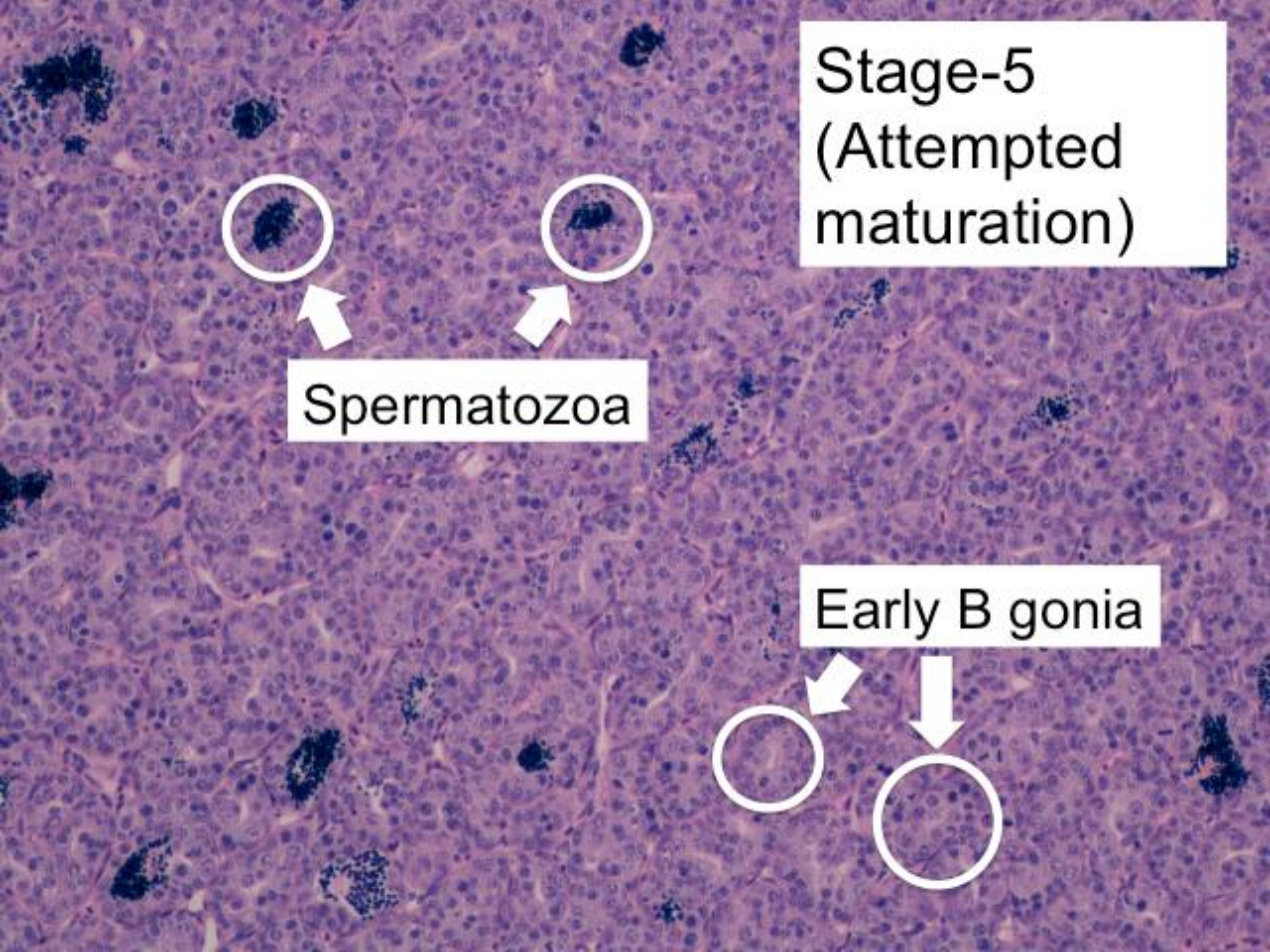
Stage-1, 2, and 3 male fish are all at varying stages of initiating maturation for next spring



Stage-4
(Precocious Parr
or M -1)

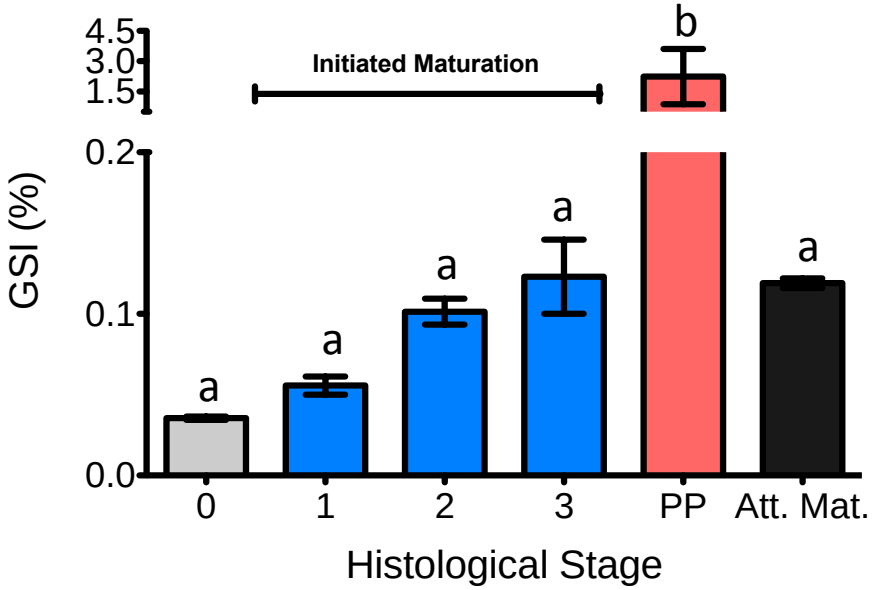
Channel of milt

Spermatozoa

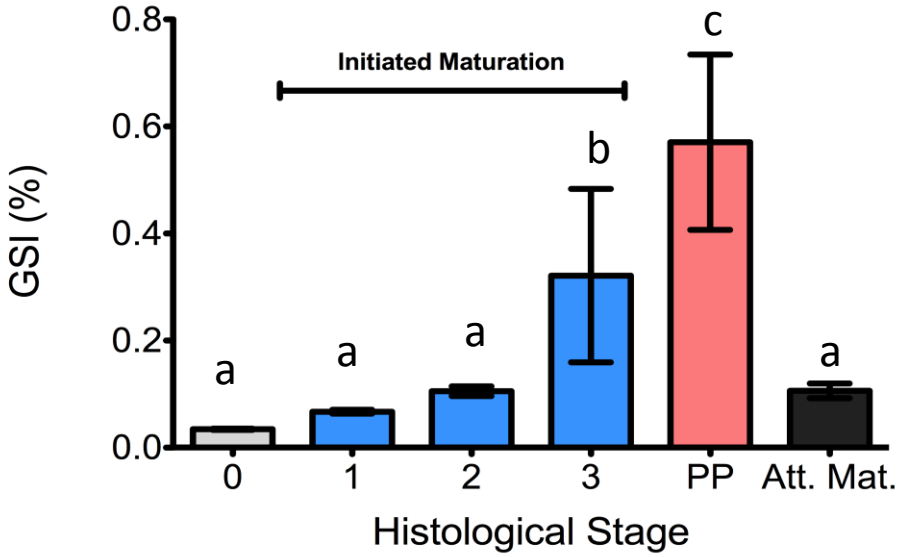

Stage-5
(Attempted
maturation)
Spermatozoa
Early B gonia

GSI is low in smolts and increases with maturation

BY 2011

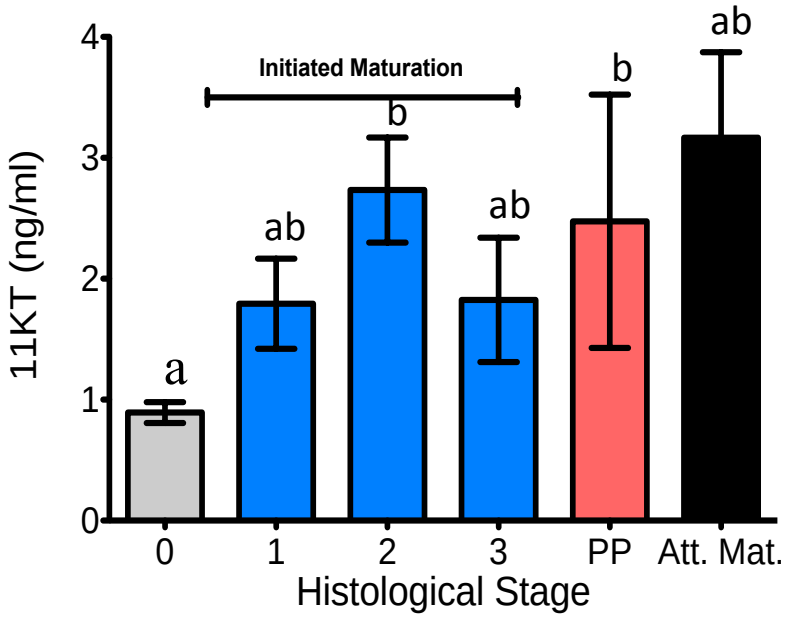


BY 2012

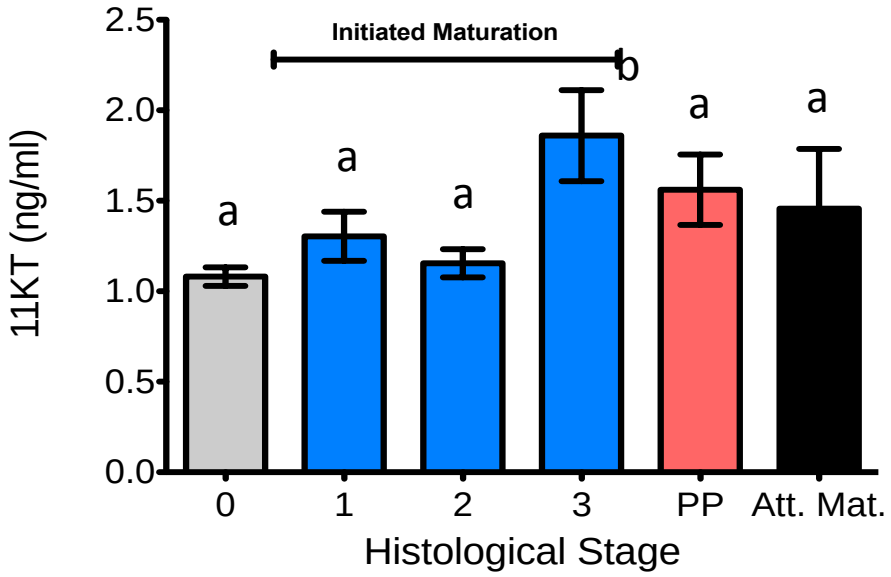


Plasma 11-KT is low in smolts and increases with maturation

BY 2011

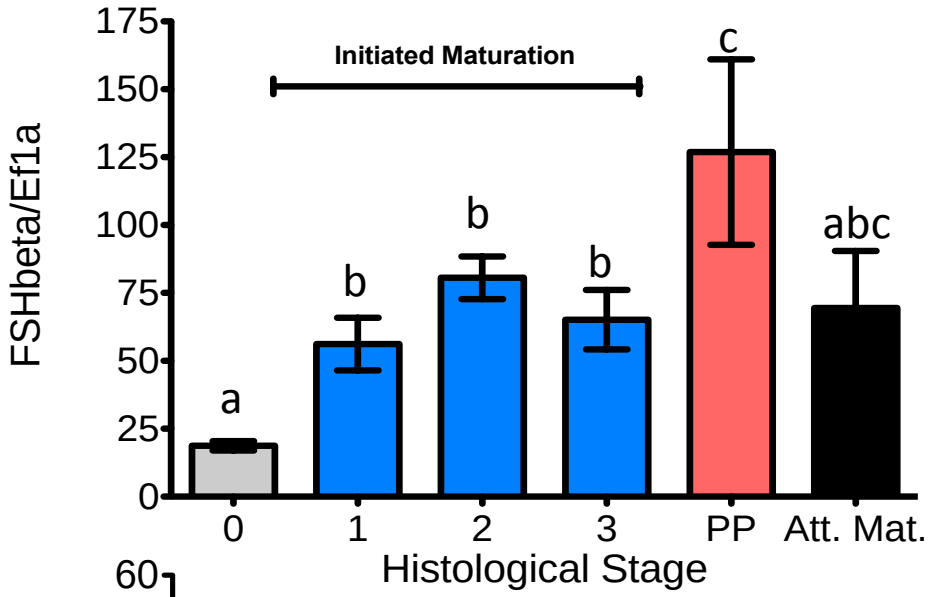


BY 2012

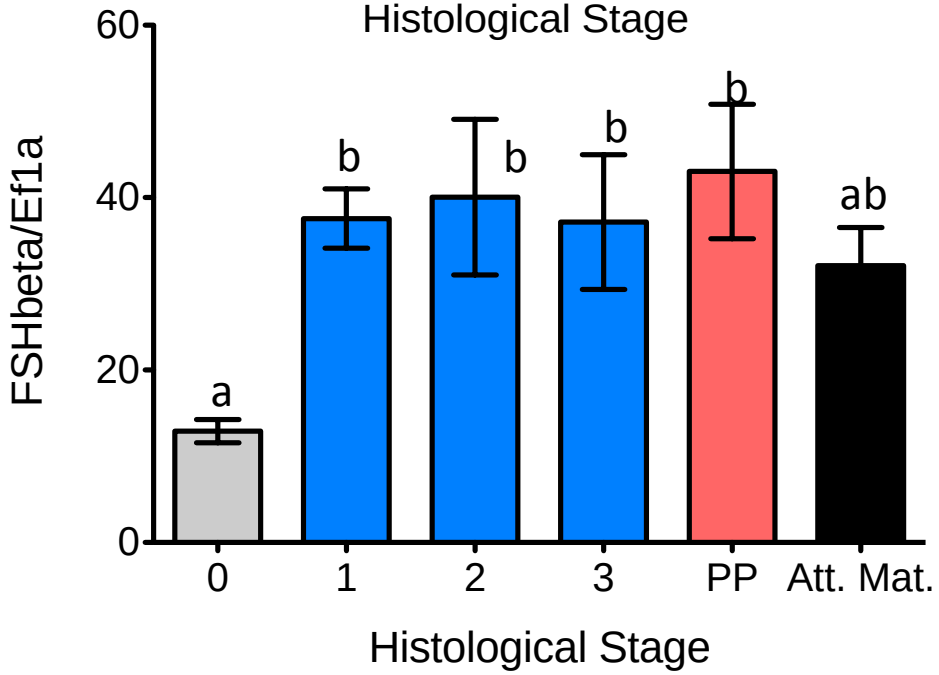


Pituitary FSH mRNA is low in smolts and increases with maturation

BY 2011

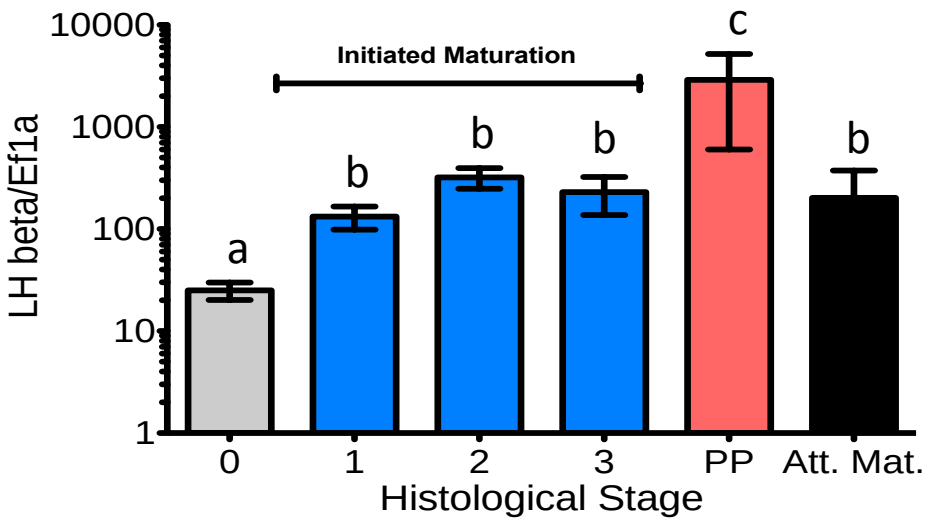


BY 2012

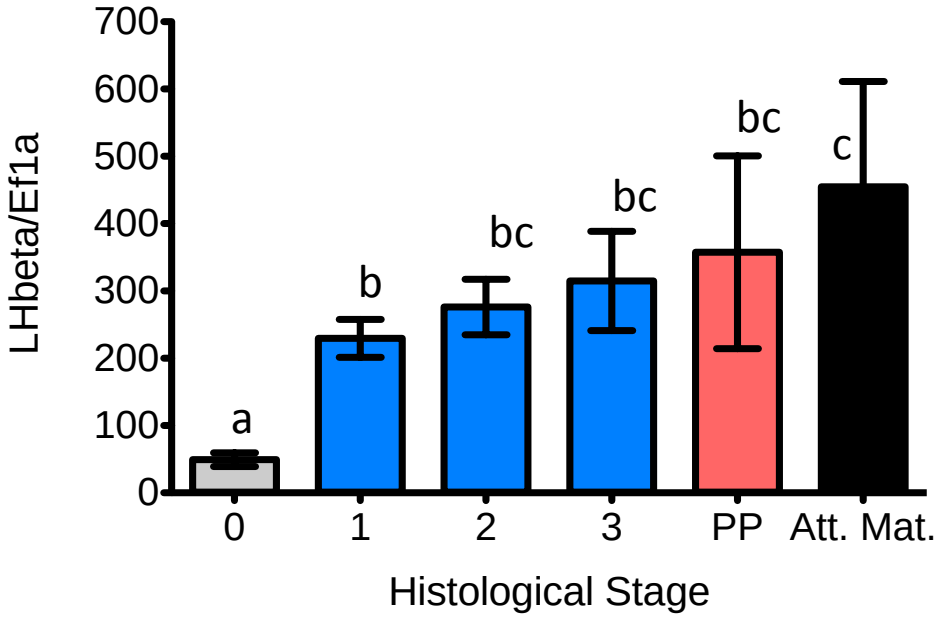


Pituitary LH mRNA is low in smolts and increases with maturation

BY 2011

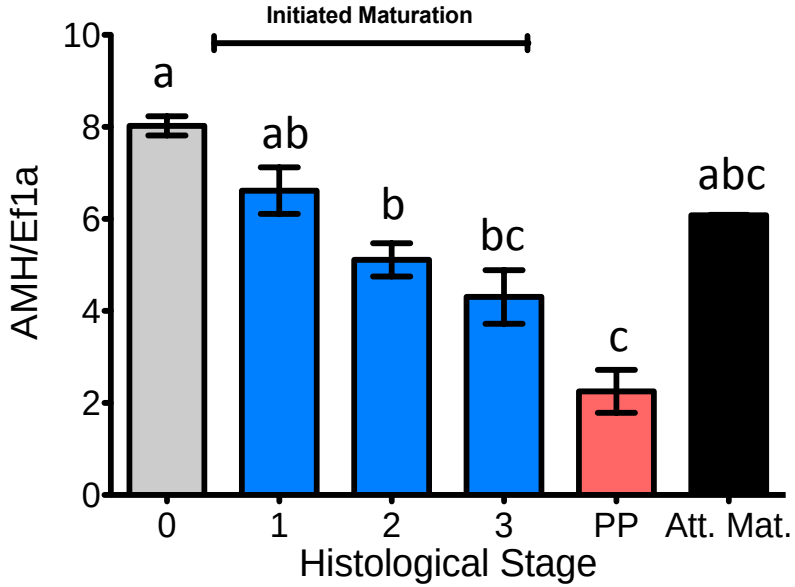


BY 2012



Testicular AMH mRNA is high in smolts and decreases with maturation

BY 2011

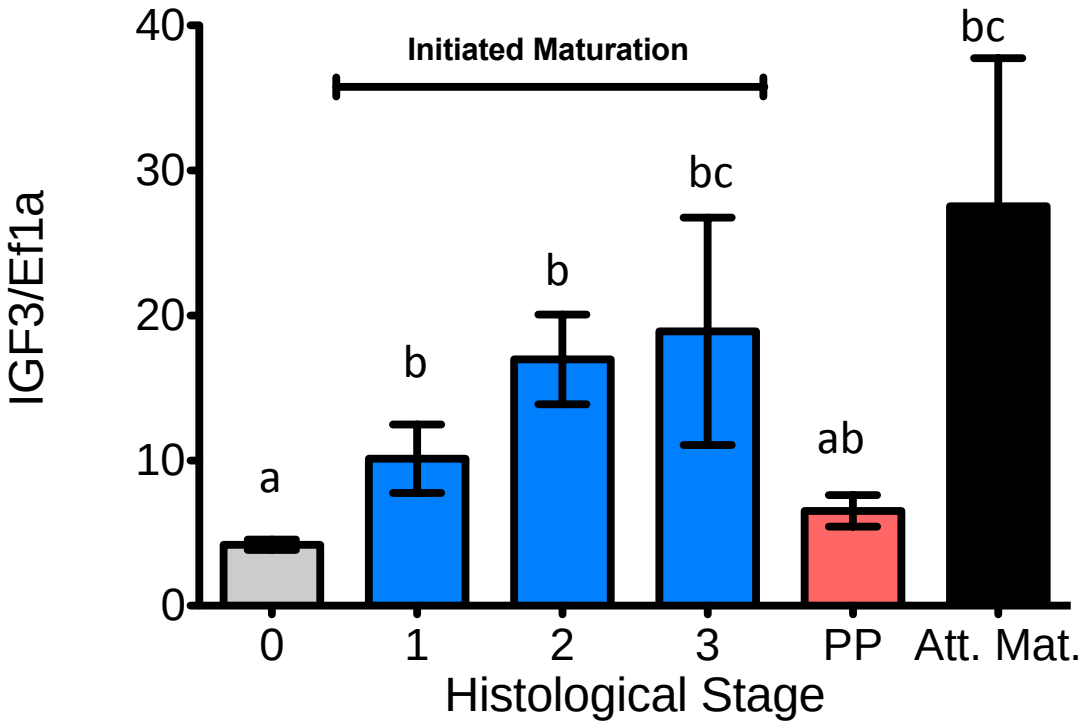


BY 2012

Not measured due to Gov't Furlough

Testicular IGF3 mRNA is low in smolts and increases with maturation

BY 2011



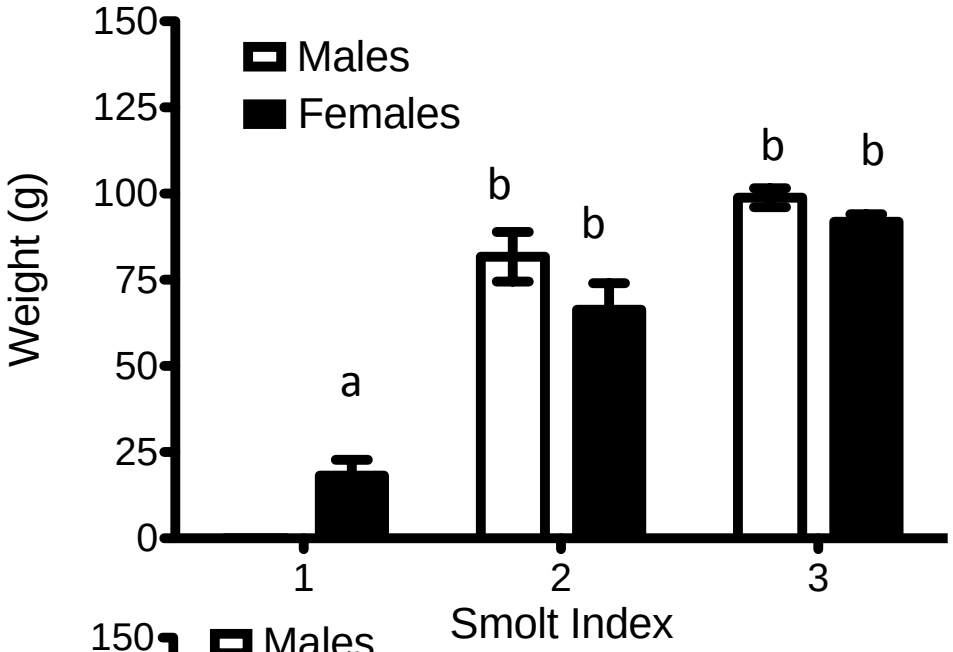
BY 2012

Not measured

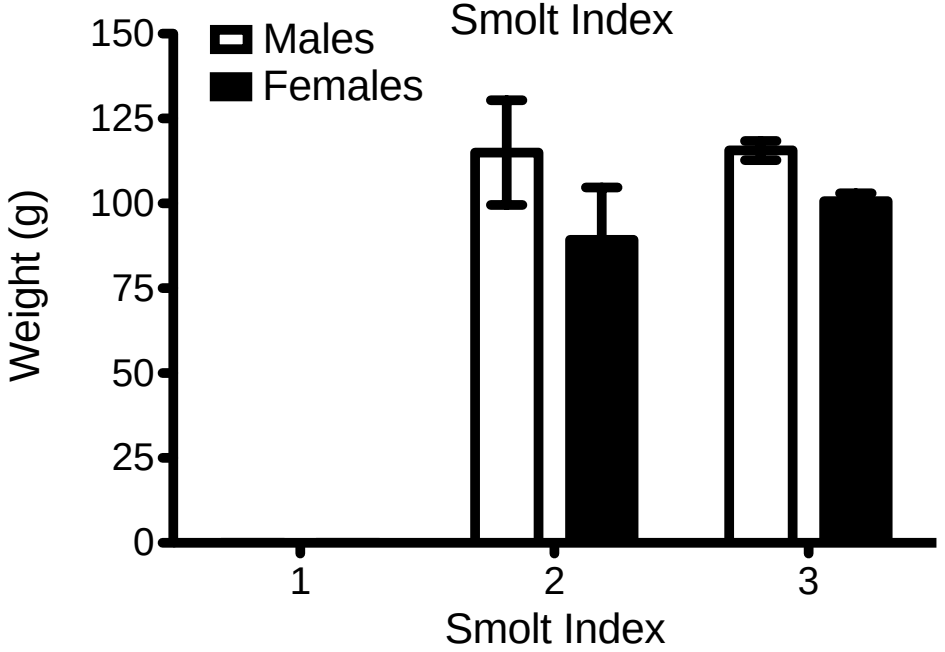
Smolt data

Smolt Index *by* Size *by* Sex

BY 2011

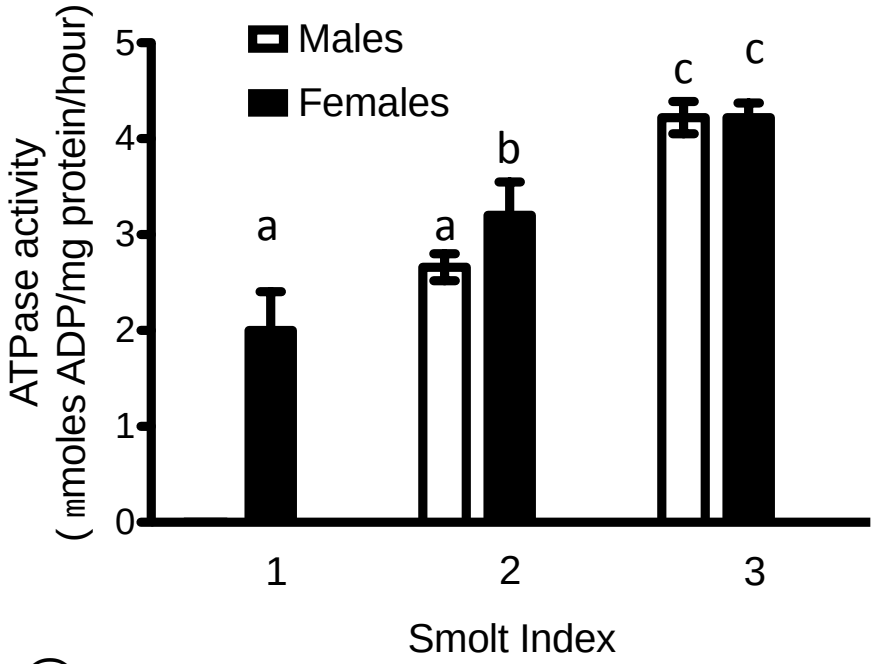


BY 2012

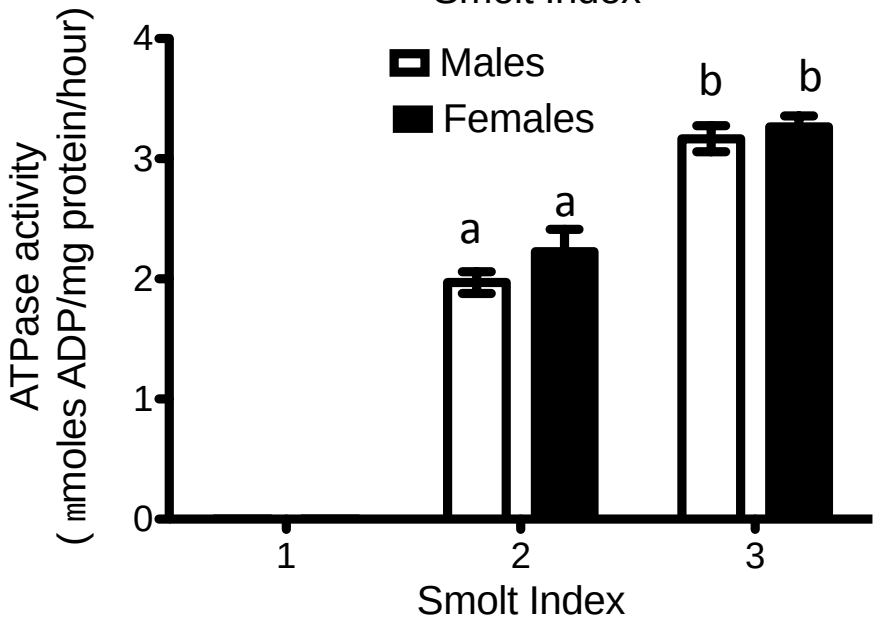


Gill ATPase increased with higher smolt index

BY 2011

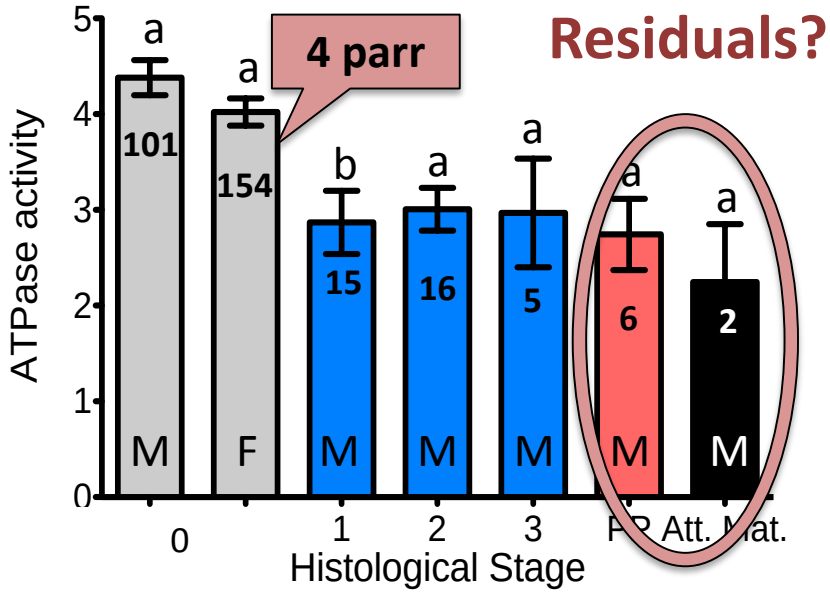


BY 2012

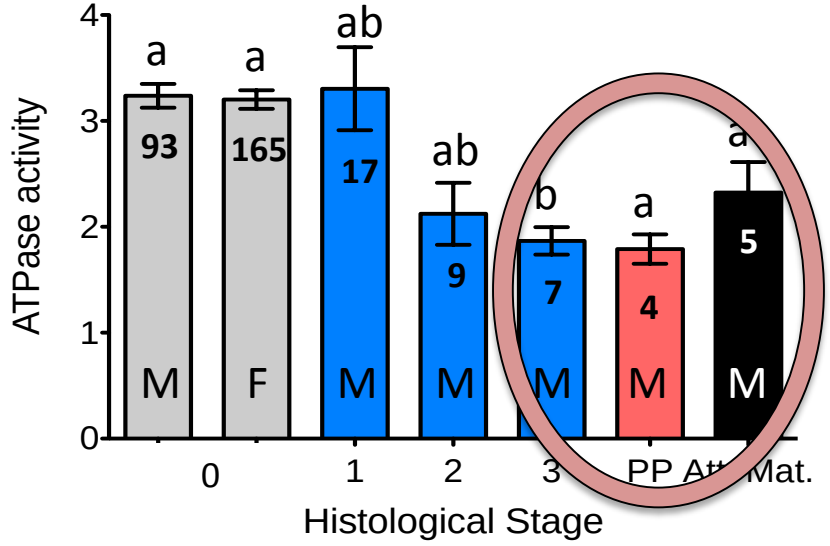


Now combine smolting / sex / maturation to categorize each fish

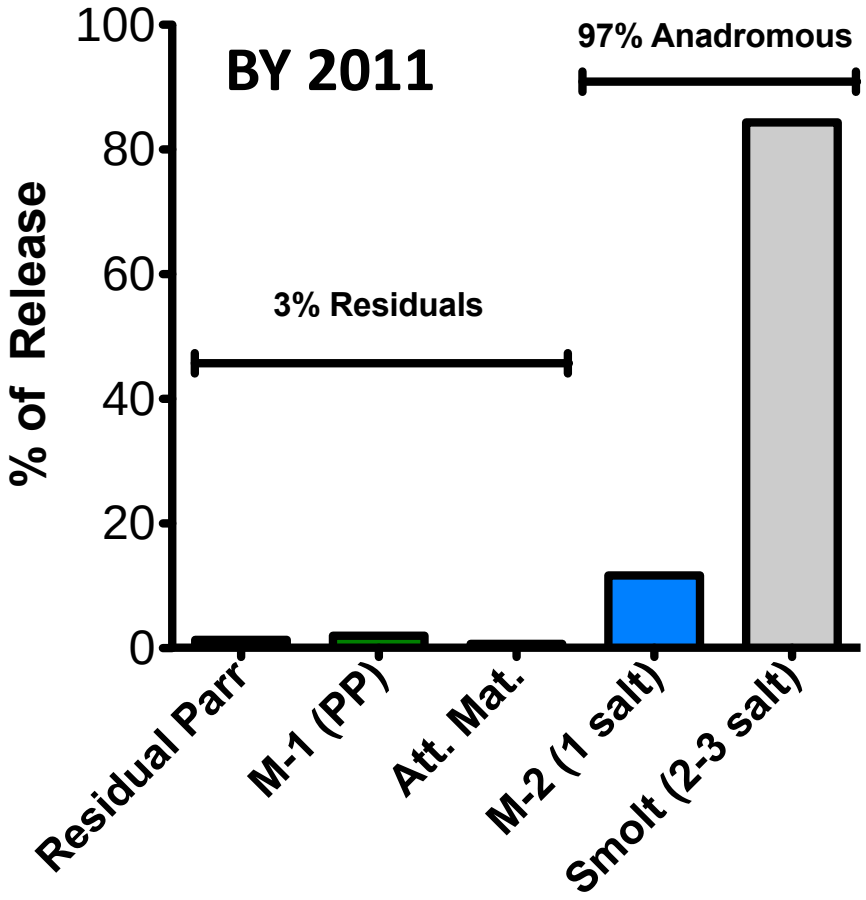
BY 2011

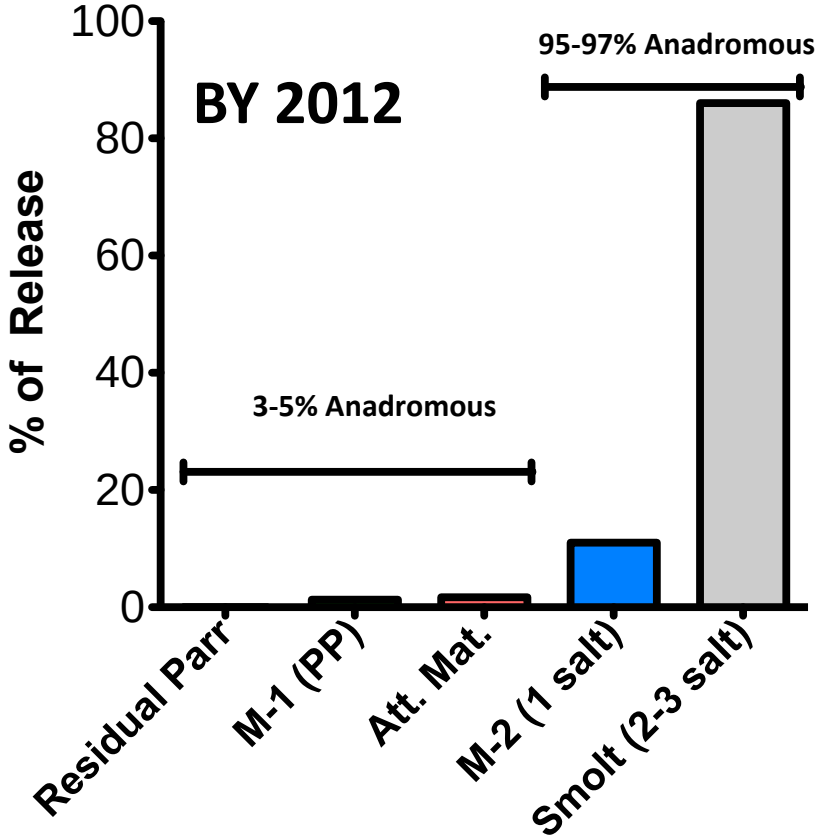


BY 2012



BY 2011 and 2012 Hood River winter run Steelhead life-history forecast





Conclusions

- We have demonstrated the efficacy of using physiological indices from a single time point to forecast steelhead life-history types
- Residualism estimate was 3% in BY 2011, ~5% in BY 2012 = about 1,500-2,500 per 50,000 fish (is this low?)
- Attempted maturation appears to be a real phenotype
- M-2 (a.k.a. 1 Salts if smolting) ~ 11-12% in both years = 5,500 per 50K.
- Challenging question – do any of the M-2's stay in FW (RBT)?
- Repeat in BY 2013 fish

Acknowledgements

- Louisa Harding (UW), Lindsay Brewer (CTWSR) – sampling Parkdale Fish Facility management and staff
- Graham Young (UW)
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