

WRITTEN IN BONE: Reconstructing Life Histories of Fish Using Hormones and Stable Isotopes Stored in Incrementally Grown Structures



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Context

Seasonal Field Surveys

- Abundance and Demography
- Size or Age of maturity, Reproductive Capacity
- Physiological status

Survey Data are Limited

– A brief “snapshot” in time of species biology and ecology

Stable Isotopes, Elements, & Compounds stored in annual growth increments of hard parts to reconstruct age-specific changes in life history

Temperature (Movement) – [$\delta^{18}\text{O}_2$], Sr:Ca, Ba:Ca

Movements – ^{87}Sr : ^{86}Sr , Sr:Ca, [$\delta^{34}\text{S}$]

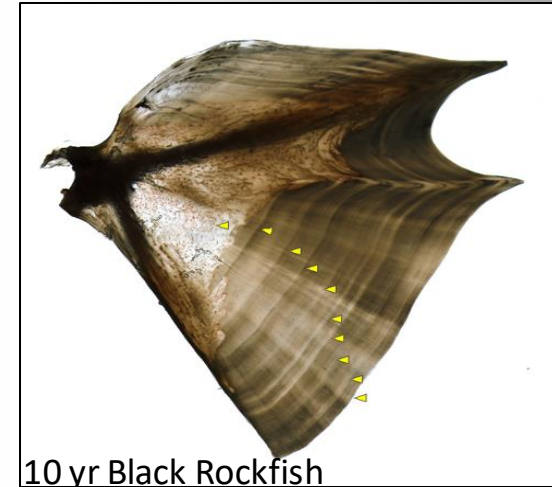
Trophic Ecology (Diet, Trophic Level) – [$\delta^{13}\text{C}$], [$\delta^{15}\text{N}$]

Physiology

- Reproduction – [Estradiol, Progesterone, Estrogen]
- Stress/Health Status – [Cortisol]



Rockfish larvae. Credit Vancouver Aquarium



10 yr Black Rockfish



The Players and Structures

Bluefin Tuna (*Thunnus orientalis*)



Epipelagic, migratory
15 – 26 yrs

Mature @ 5 yrs

Chinook Salmon (*O. tshawytscha*)



Anadromous, Migratory
3 – 7 yrs

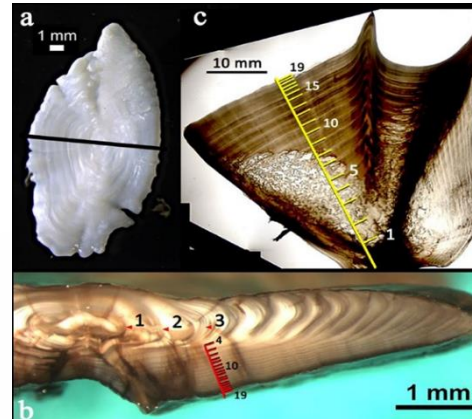
Mature @ 3 – 7 yrs

Yelloweye Rockfish (*Sebastes ruberrimus*)



Benthic (91 – 180m)
+100 yrs

Mature @ 18 - 22 yrs

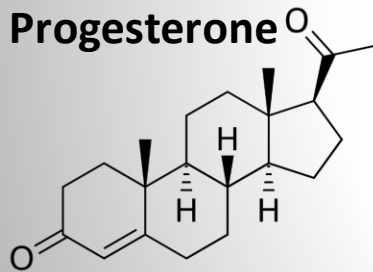
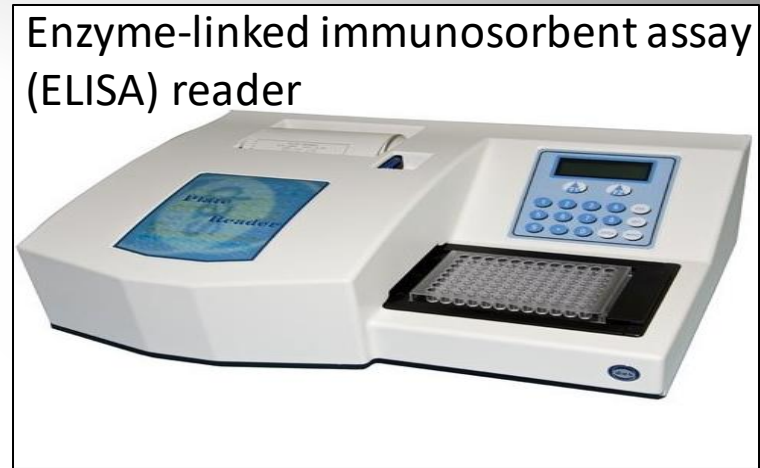
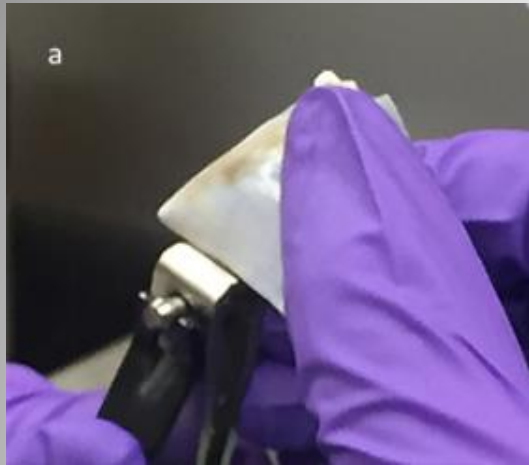


Otolith Age = Opercular Age = Centra Age

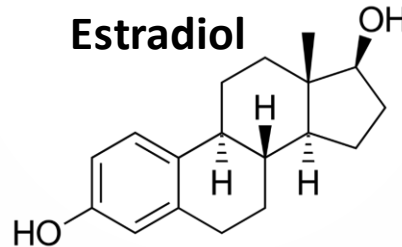
Except for Chinook

The Hormones

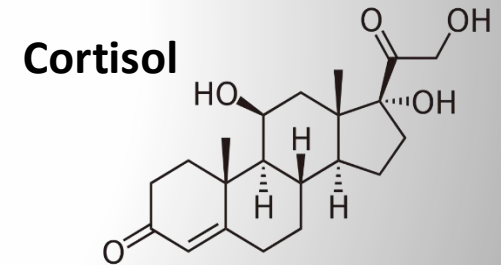
Hormones extracted from annual growth increments (Chinook @ 1mm)



- Regulates gamete maturation
- Reproductive behavior



- Directs gamete formation
- 2nd Sex Characteristics



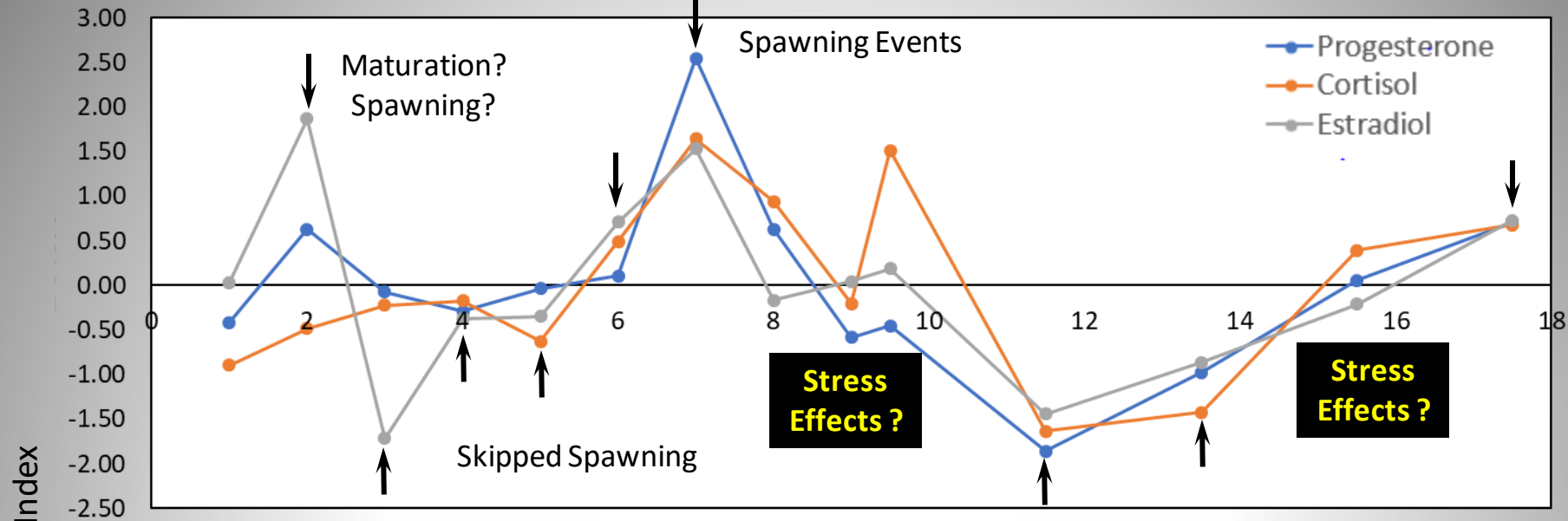
- Stress
- Enhance/suppress endocrine function (reproduction)

Lifetime Hormone Profile

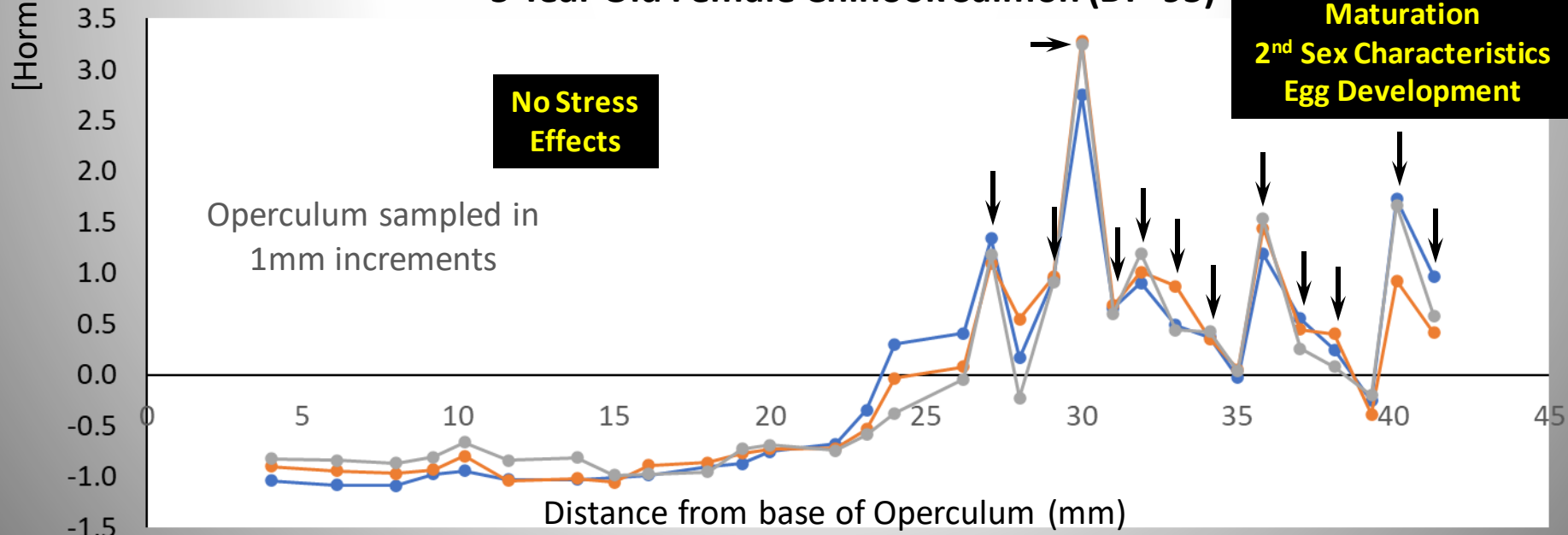
- Age of Maturity
- Reproductive Frequency
- Senescence
- Stress

STABLE ISOTOPES: Yelloweye
Elemental Analyzer-Isotope Ratio
Mass Spectrometer (EA-IRMS)

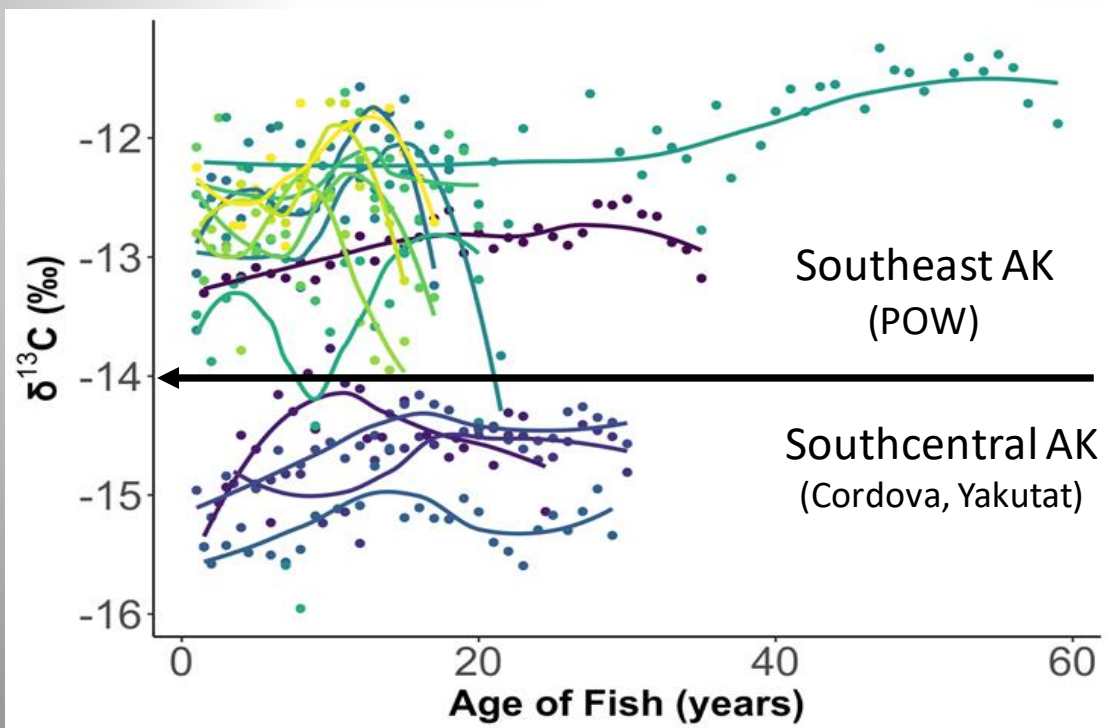
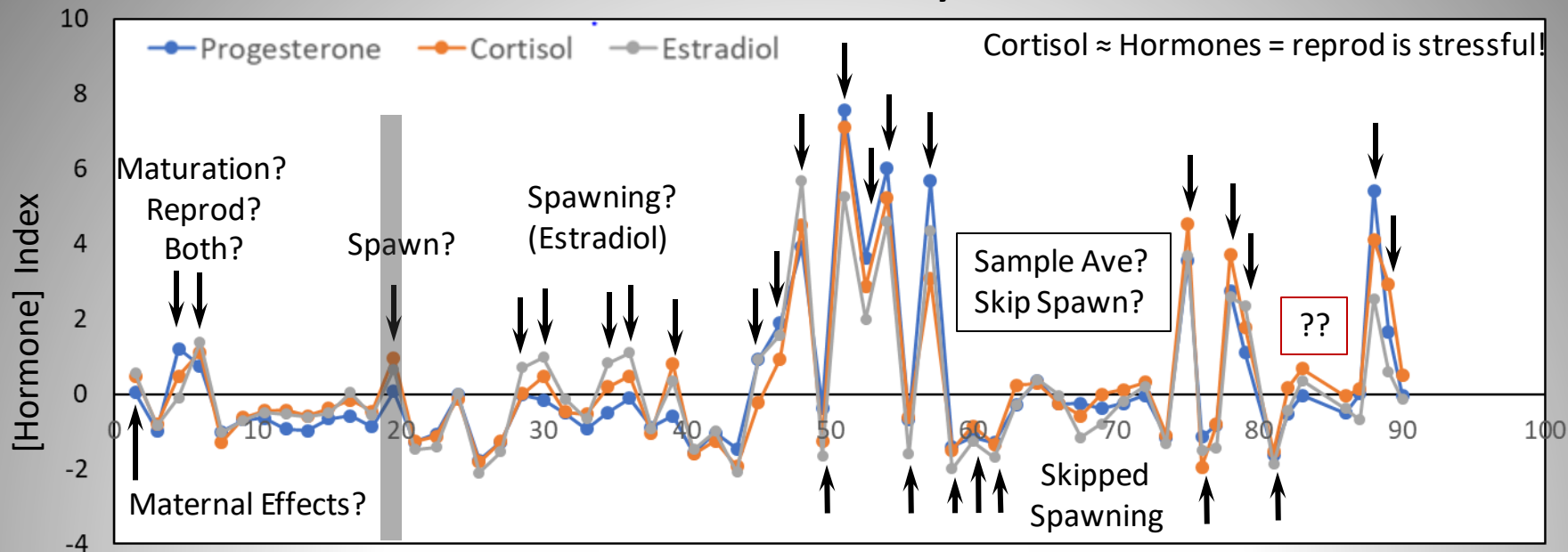
18 Year Old Female Pacific Bluefin Tuna



5 Year Old Female Chinook Salmon (BY '95)



90 Yr Old Female Yelloweye Rockfish



Stable Isotopes
 $\delta^{15}\text{N}$, $\delta^{34}\text{S}$, and $\delta^{18}\text{O}$

Trace Metals
 Cu, Zn, Se, Cd, Hg, Pb

Applications



- Reconstruct age-specific life history events and environmental conditions.
- Assess management assumptions regarding reproductive life history
- Assess effects of environmental change on health (stress), reproductive potential, ecology.
- Historical / Temporal Context



Questions, Problems, Solutions . . .



- Logistical Issues
- Sample Mass
- Developmental Conditions

- ***Are inferences made from lifetime patterns in hormone concentrations real?***
 - Are statistically significant peaks and valleys biologically significant?

Biological Validation

Compare maturity status (via gonad development) and blood hormone levels to those recovered from hard parts to inform interpretation of hormone profiles.

- ***Sampling Issues – Averaging among adjacent annuli***
 - As age increases, annual growth increments get smaller
 - Samples from old fish can represent more than a year

