CAN WE PREDICT PRESPAWNING MORTALITY IN SPRING CHINOOK?

IDENTIFYING INTESTINAL MARKERS FOR ADULT CHINOOK SALMON SENESCENCE

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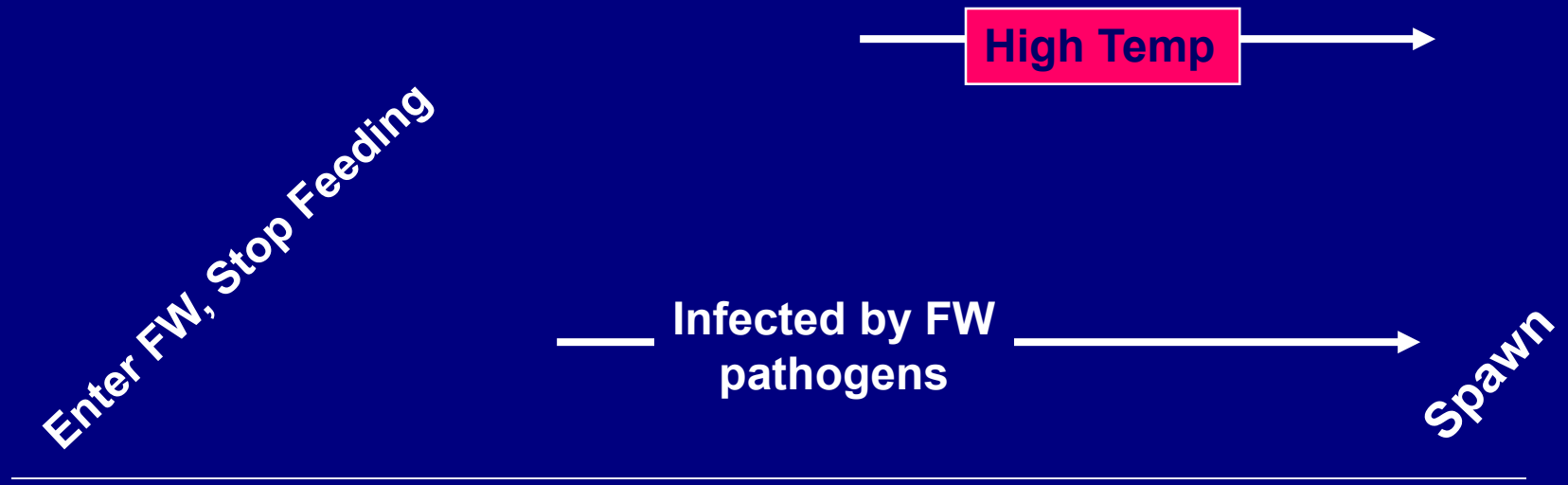
OSU AND USGS

Sequence of Events in Adult Spring Chinook

Cushing Sym = Immunsupp = Infection= Disease = Death

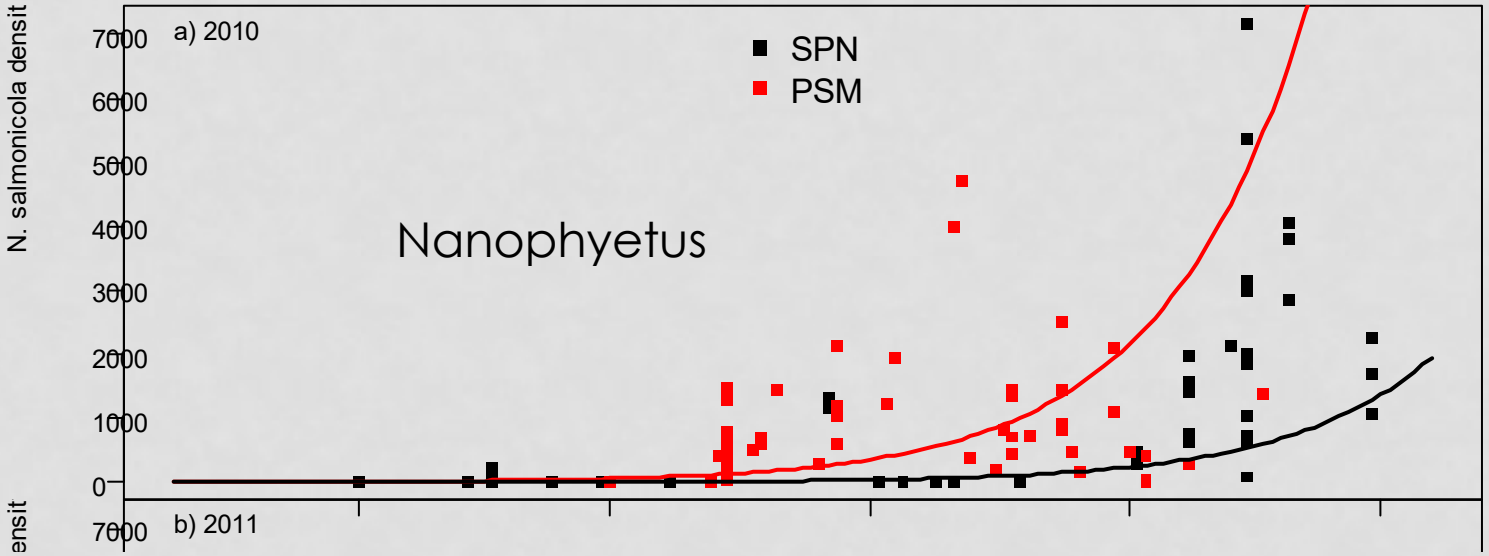


PATHOGEN PROFILES OVER SUMMER UNTIL SPAWNING

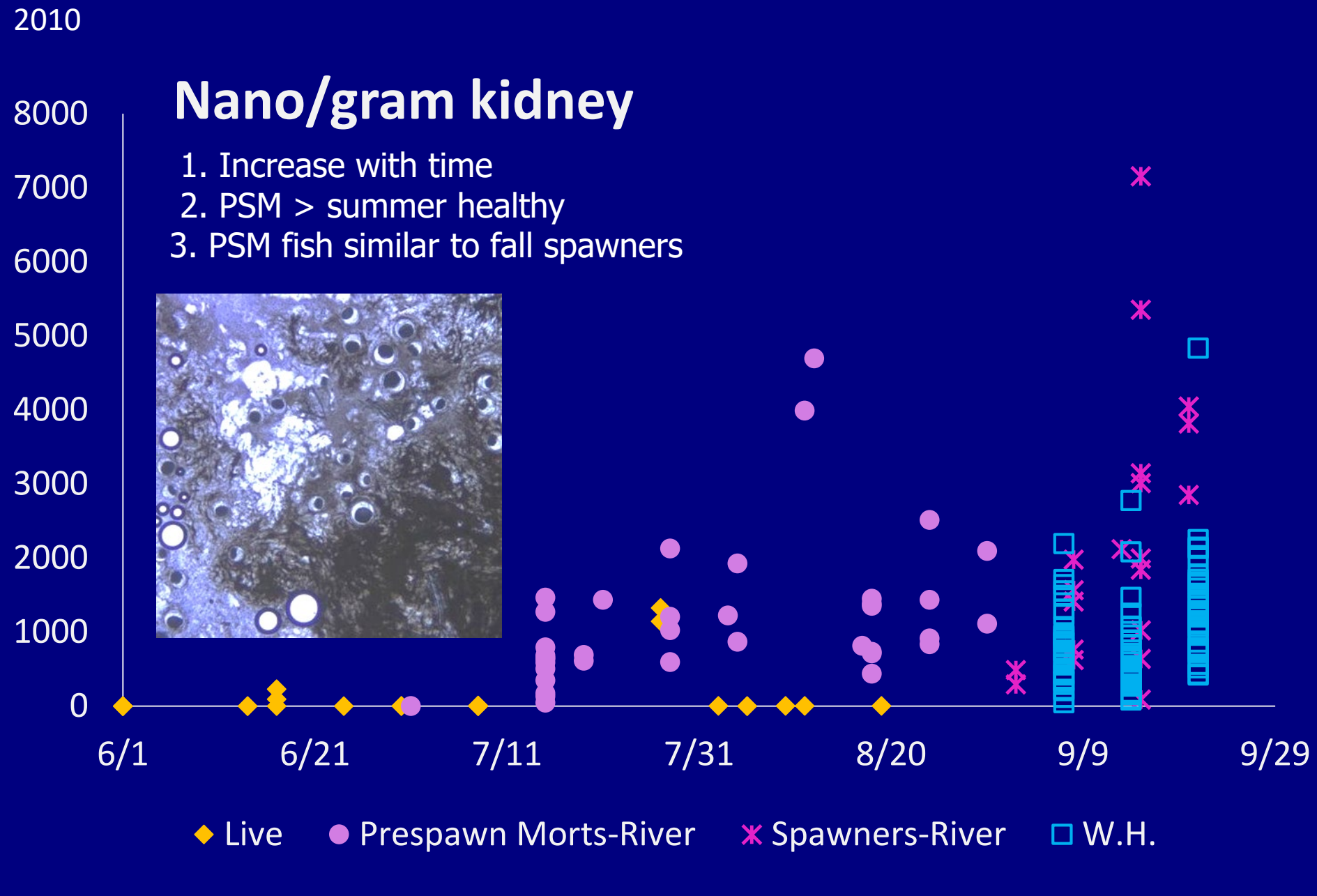
Early fish are clean

Spawned fish lots of pathogens

PSM in July/Aug look like spawned fish

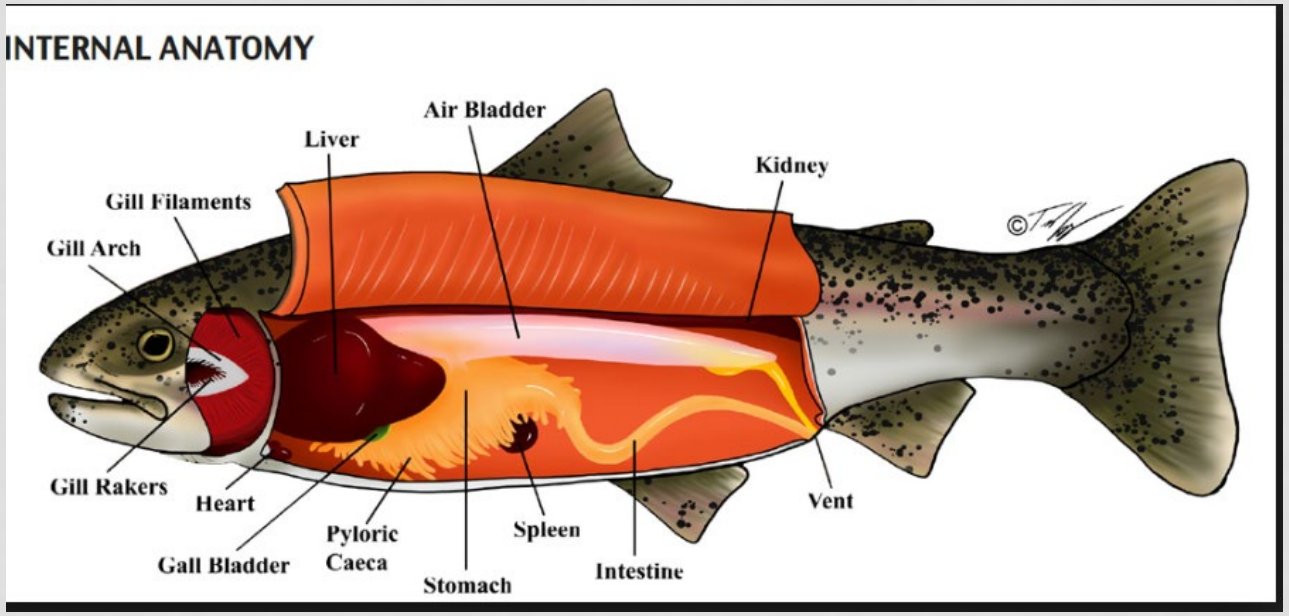


2010: PSM, Healthy, Spawners

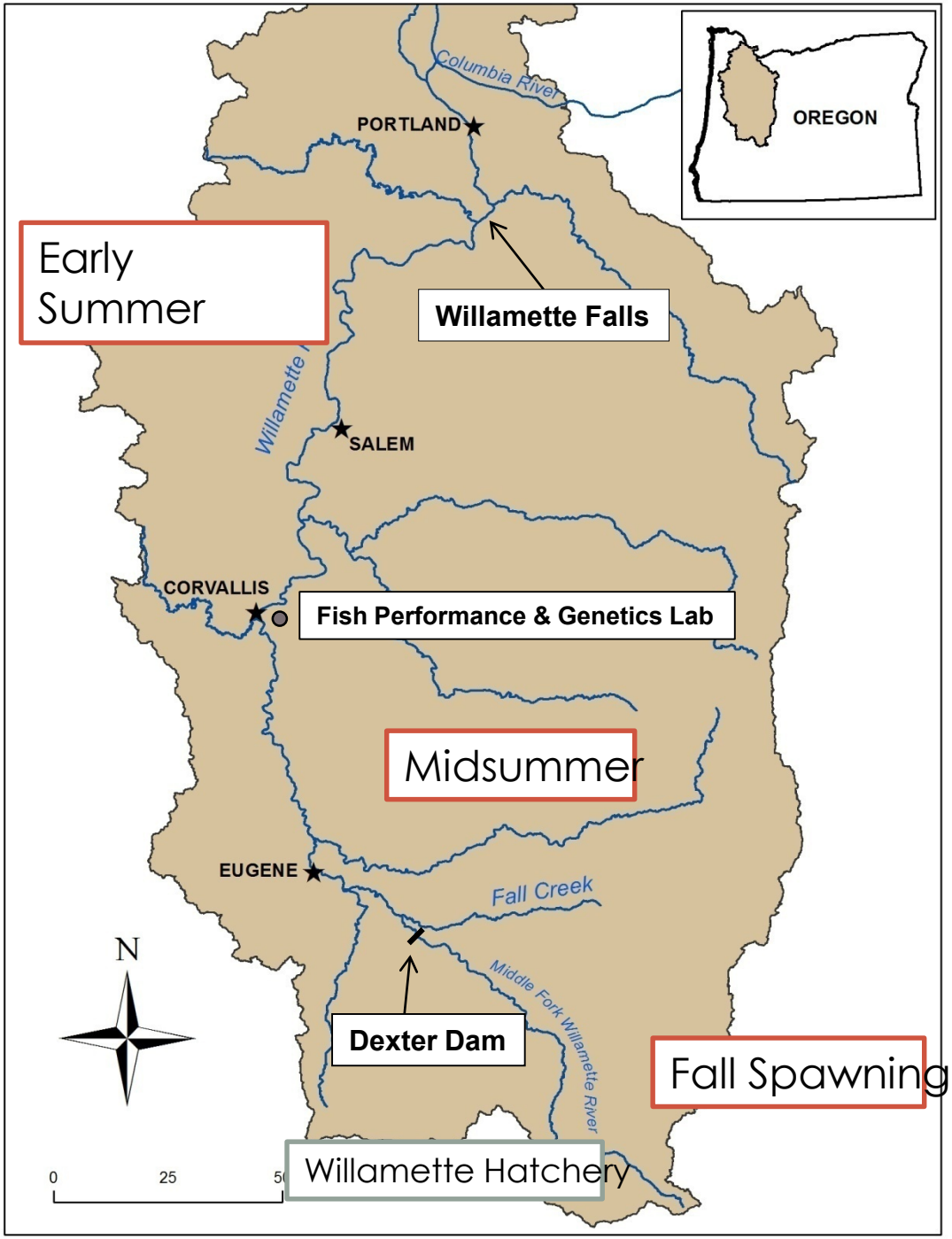


GASTROINTESTINAL PATHOLOGY IN ADULT CHINOOK

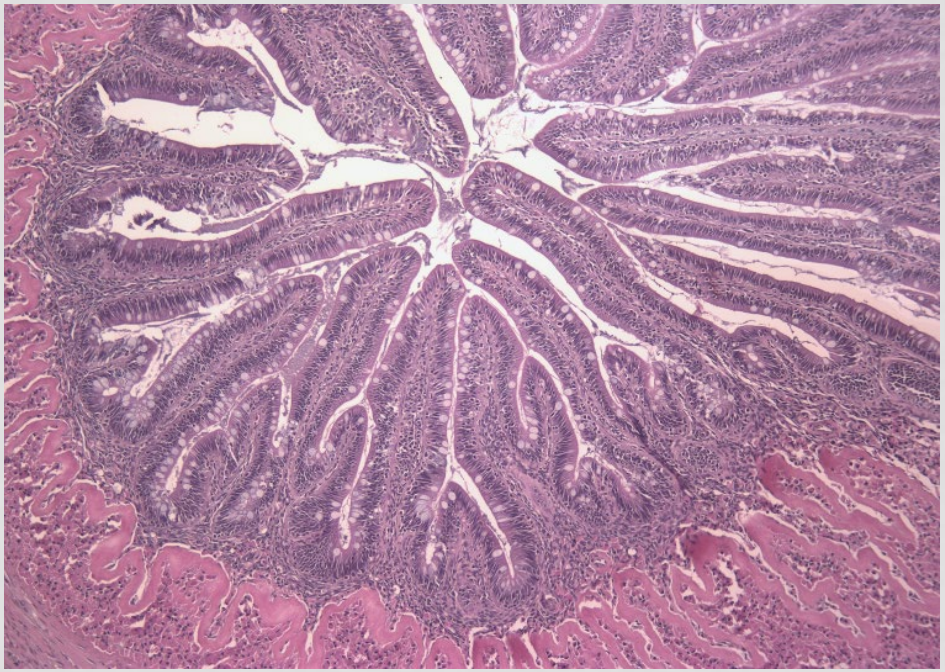
- Adult fish in freshwater do not feed
- Intestine, pyloric caeca & stomach: distinctive pattern of deteriation and inflammation
- …. a hallmark indicator of senescence?



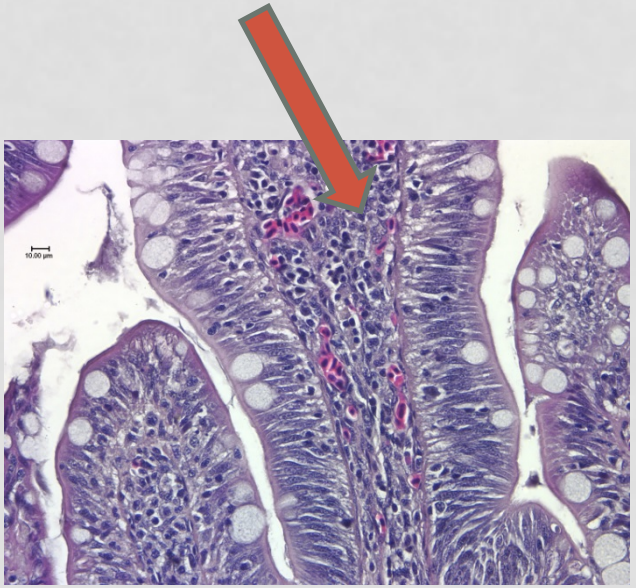
- Archived Gut Histology – 650 fish
- 5 years since 2010
- Willamette Falls
- Dexter and Foster
- PSM and Spawned above Dexter and Foster
- Willamette Hatchery
- OSU (Captured from River)
  - PSM and Spawned



NORMAL: Normal, Prominent Folds and Intact Epithelium

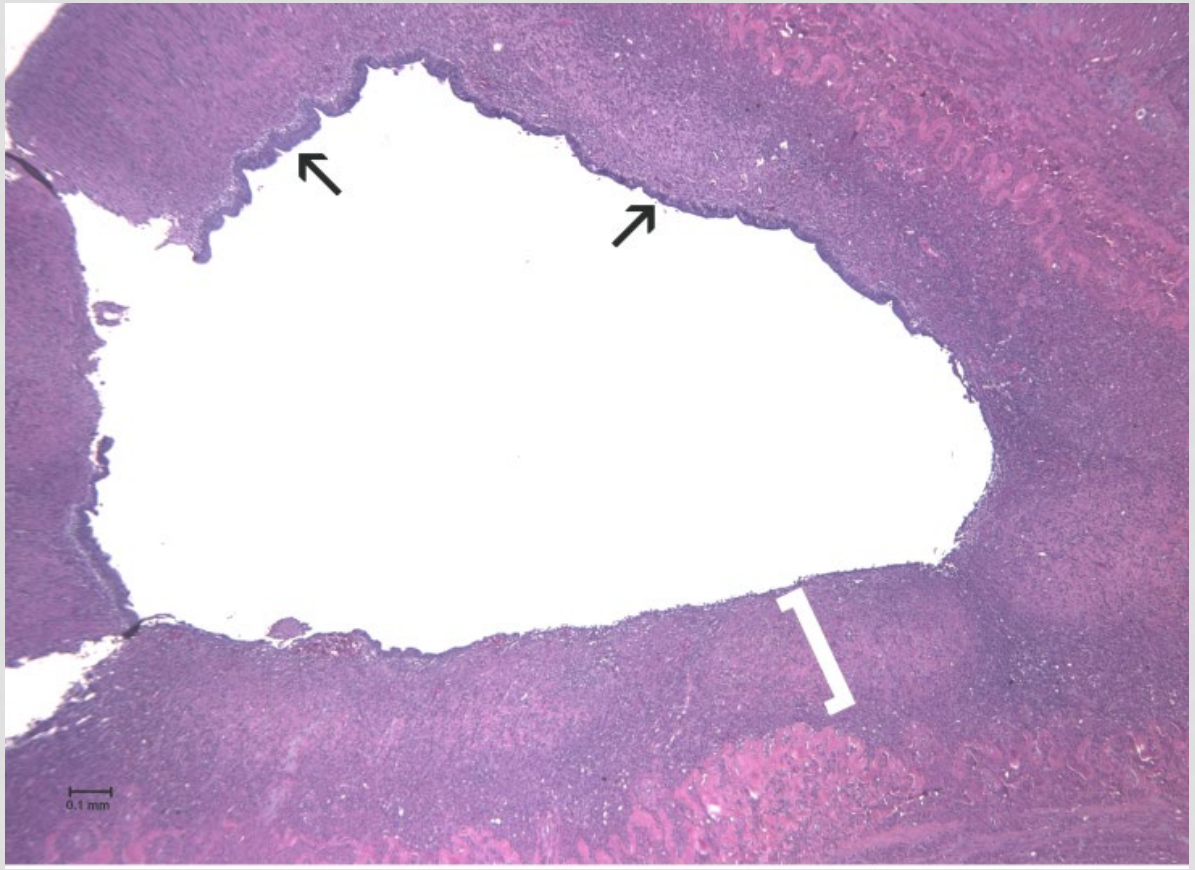


Lamina propria



MIDSUMMER - AUTUMN DETERIORATED/SENESCENT

- No folds, epithelium absent or dysplastic (altered, flattened)
- Severe inflammation in underlying lamina propria.

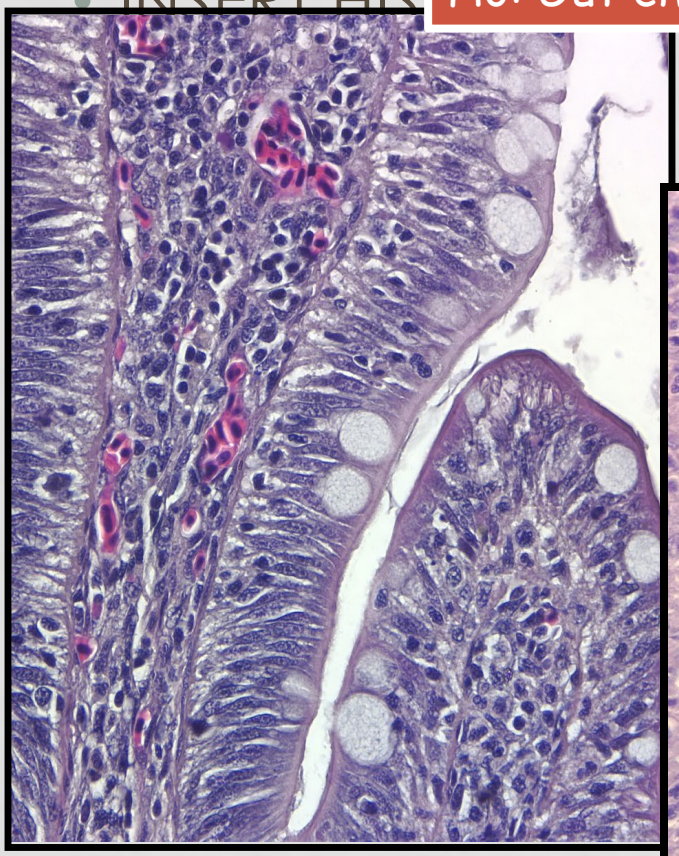


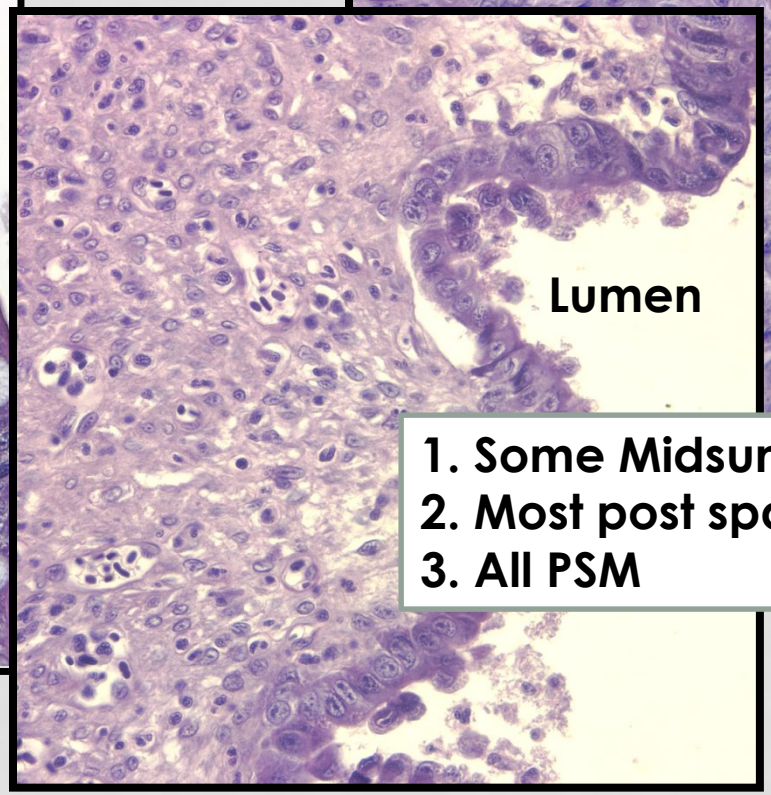
LOSS OF EPITHELIUM

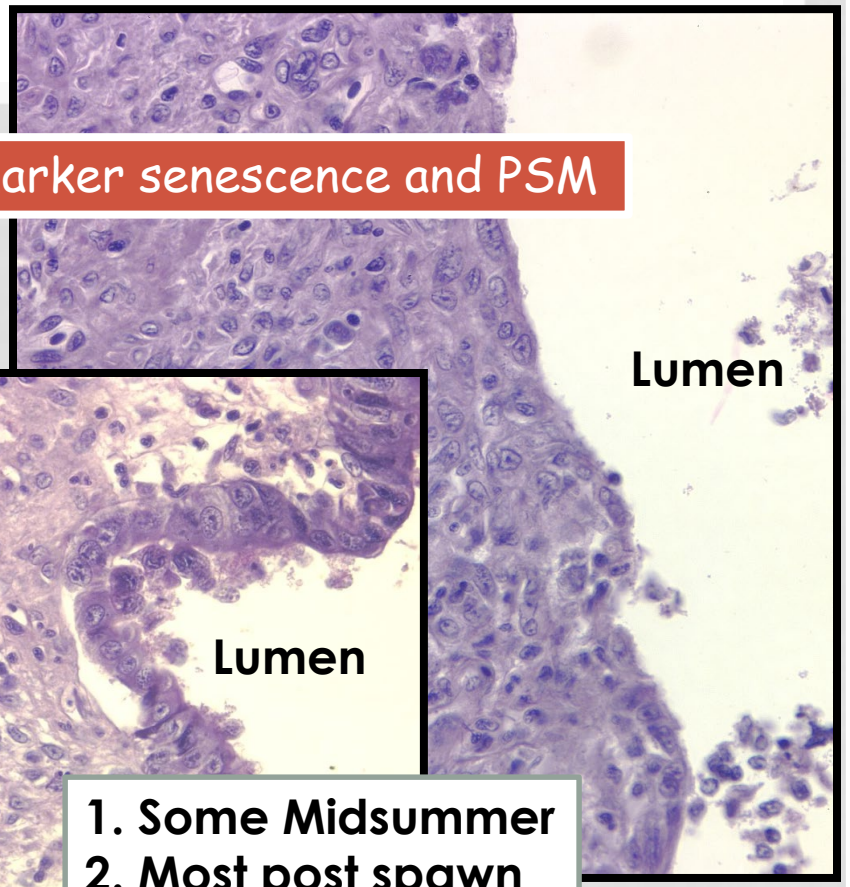
Normal: Early Summer

- INSERT HIS

Ho: Gut changes are a marker senescence and PSM







1. Some Midsummer
2. Most post spawn
3. All PSM

GUT DISEASE

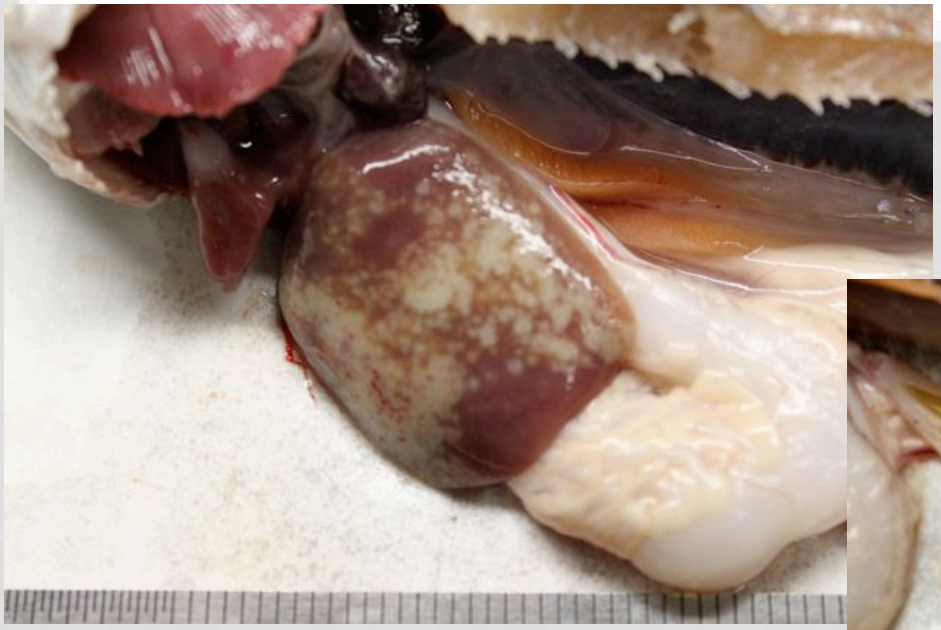
- None Early,
- Some apparently healthy midsummer
- All PSM and Spawned

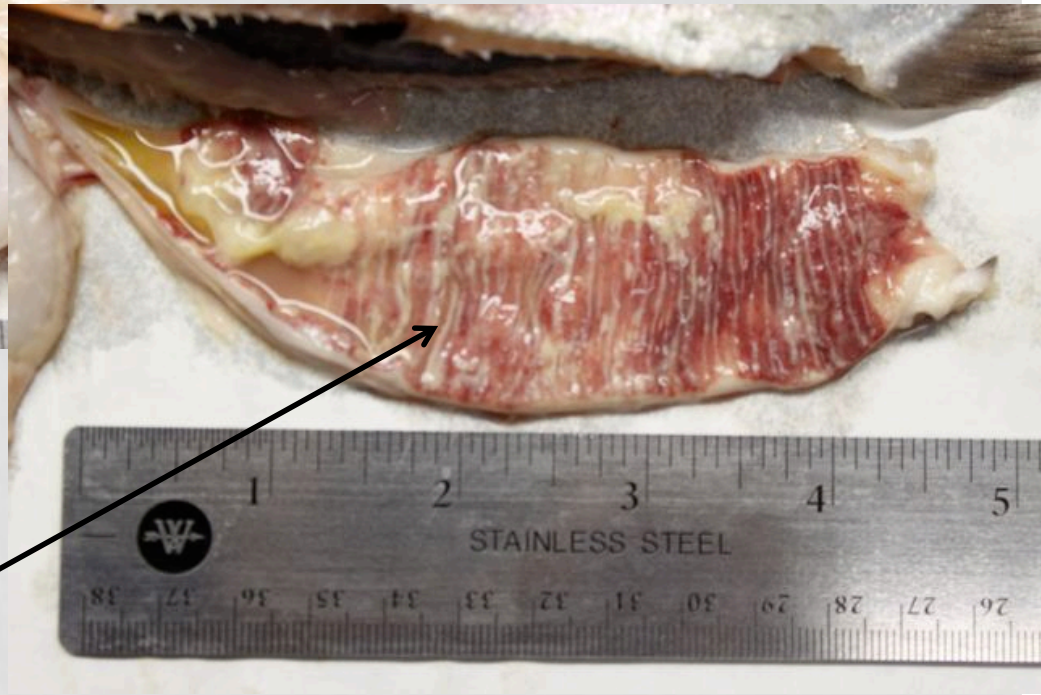
THE HYPOTHESIS:
GUT CHANGES ARE A MARKER SENESCE AND PSM

GUT PATHOGENS

- *Ceratonova shasta* (Myxozoa)
  - Primary site of infection
  - Disease of underyearlings
  - Infects adults after the return to freshwater
- New Microsporidium
  - New "*Enterocytozoon*" species
    - Closely related to *E. bienusi* of humans with AIDs

CERATONOVA SHASTA



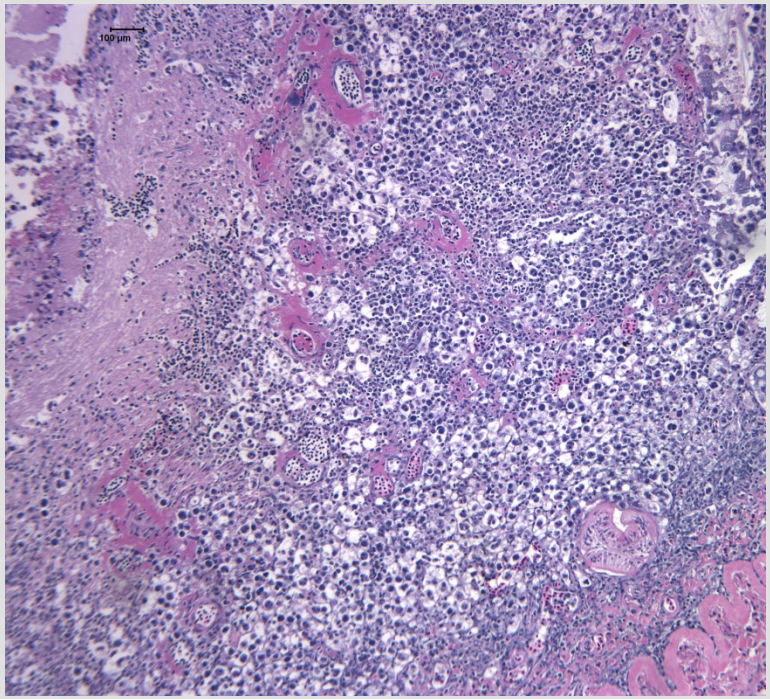


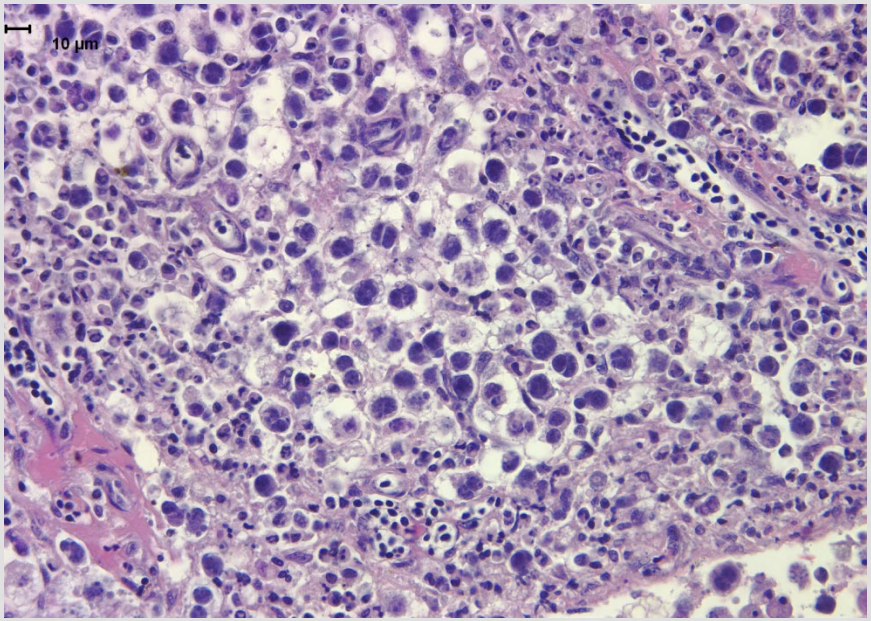
Hemorrhaging in intestine

Bartholomew Lab

+

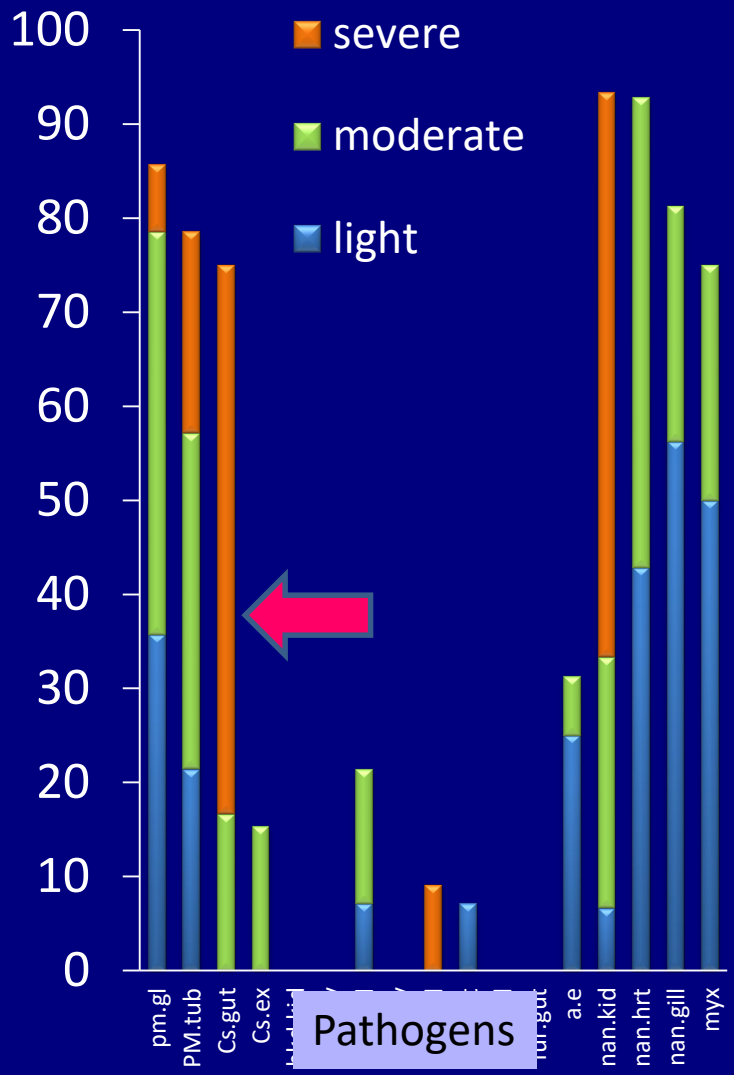
- Adult Chinook
  - Abundant prespore stages, sporulation after death
- Kent et al. 2014 J. Parasitology



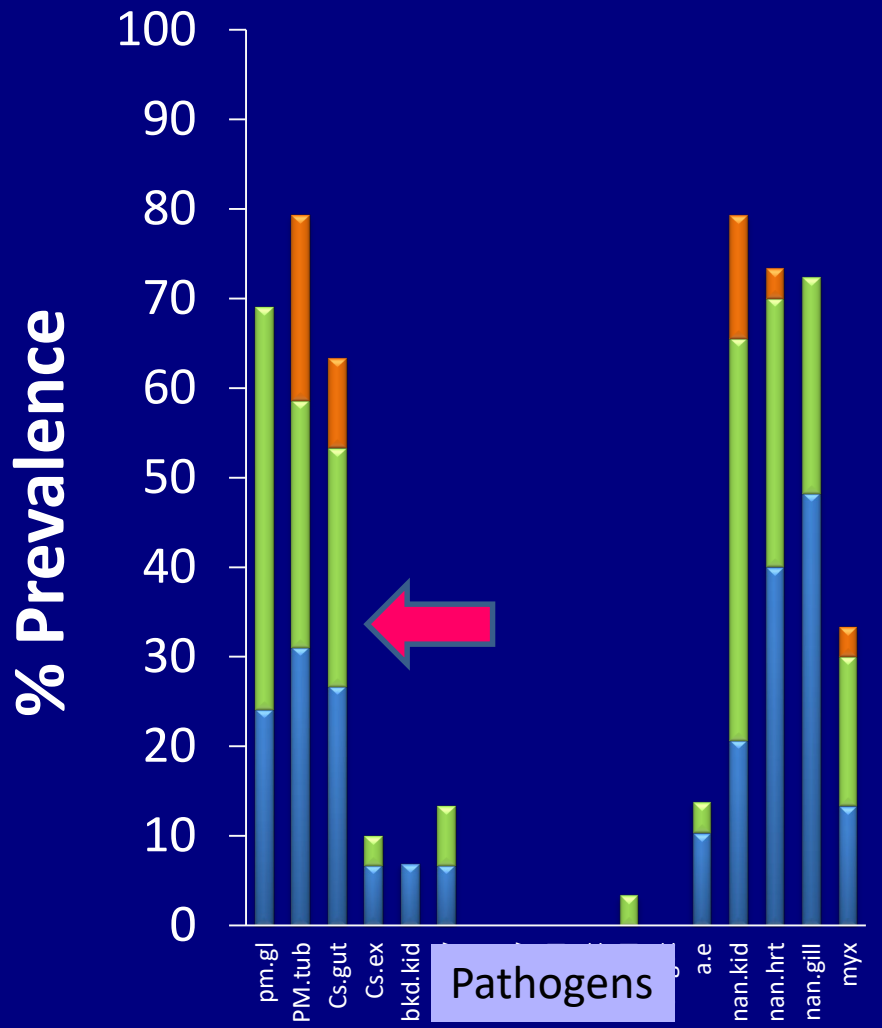


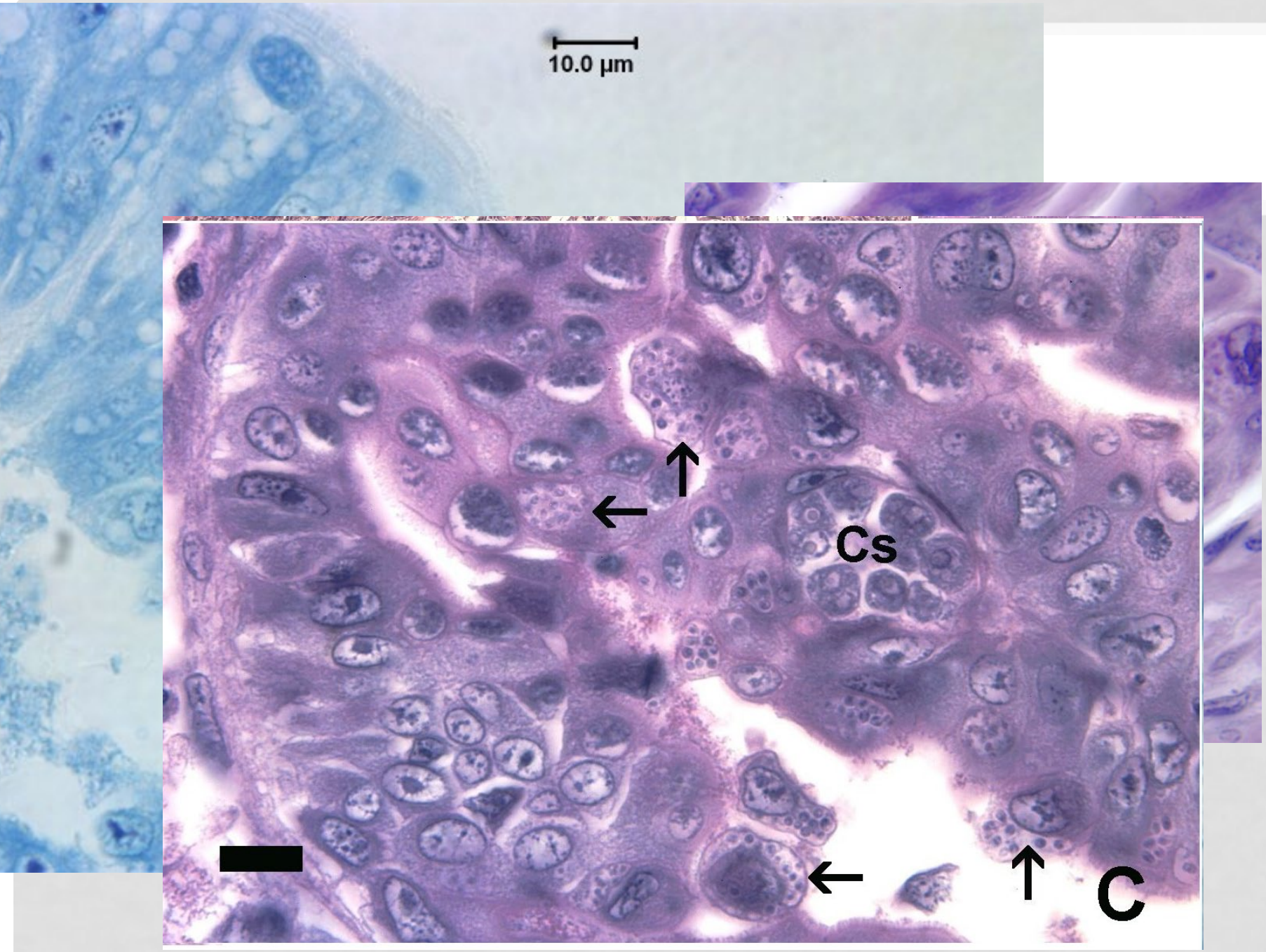
2011 Spawn

River (n = 14)

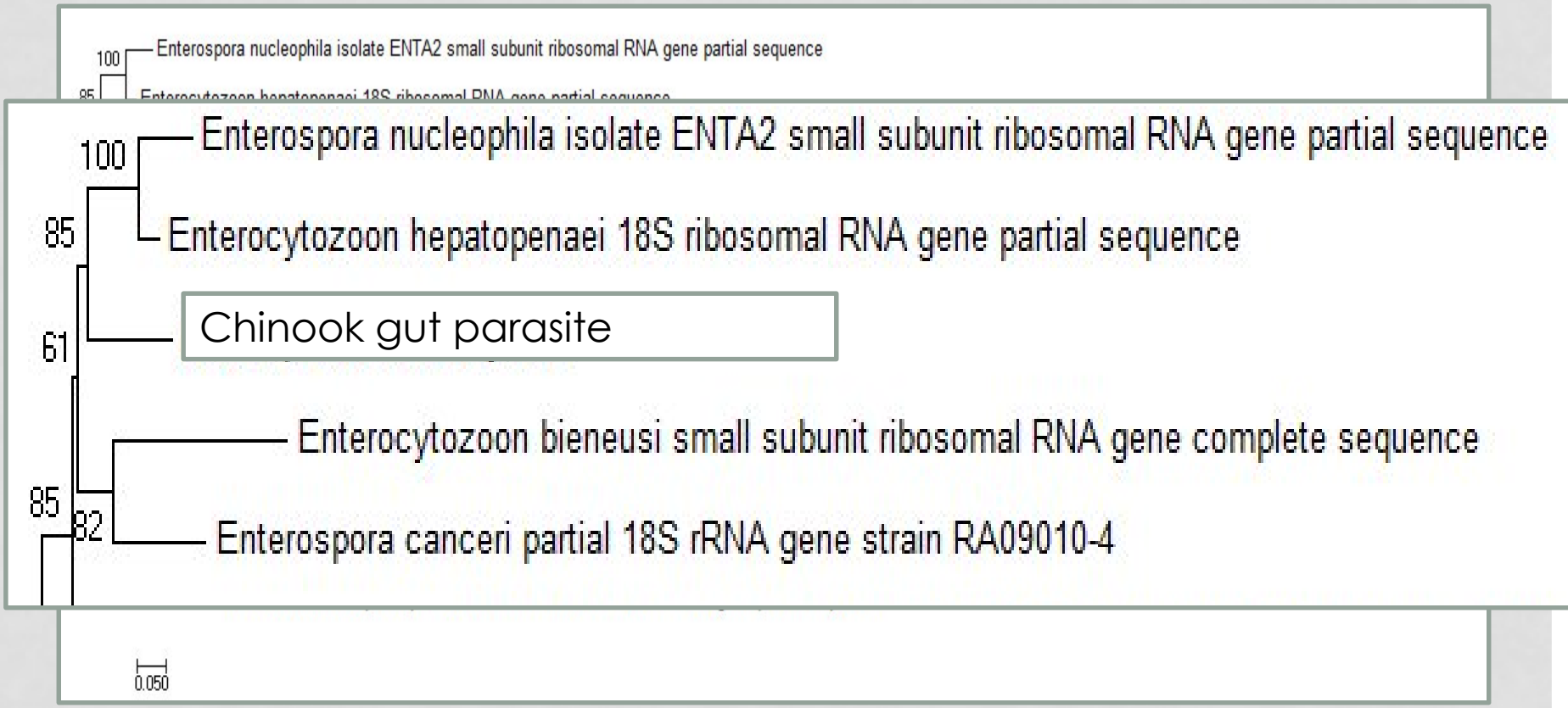


Wil. Hatchery (n=30)



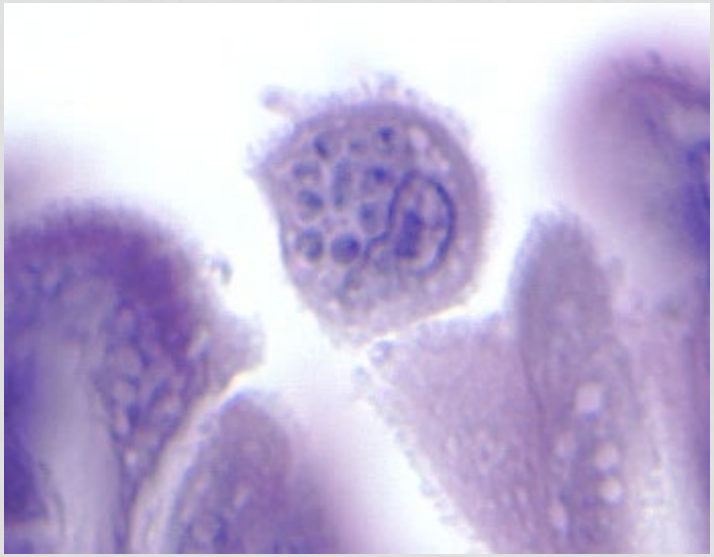

10.0 µm
Cs
C

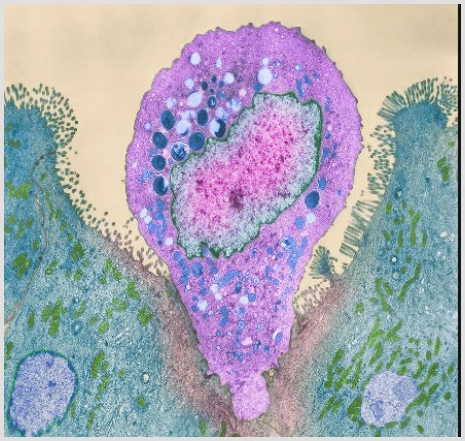
CHINOOK *ENTEROCYTOZOON* (AND *E. BIENEUSI*)



ENTEROCYTOZOON SP. & *E. BIENEUSI*

- *E. bienusi* first described in AIDs patients
- Infects intestinal epithelium, was a major cause of death
- Later found to be more prevalent but not causing disease in healthy humans and other mammals





OK, INTERESTING SCIENCE, BUT HOW DOES IT RELATE TO MANAGEMENT?

1. Lavage/swab of gut - A non-lethal predictor of PSM
2. Varying levels of pre-existing disease leading to "PSM" will cofound transport strategies

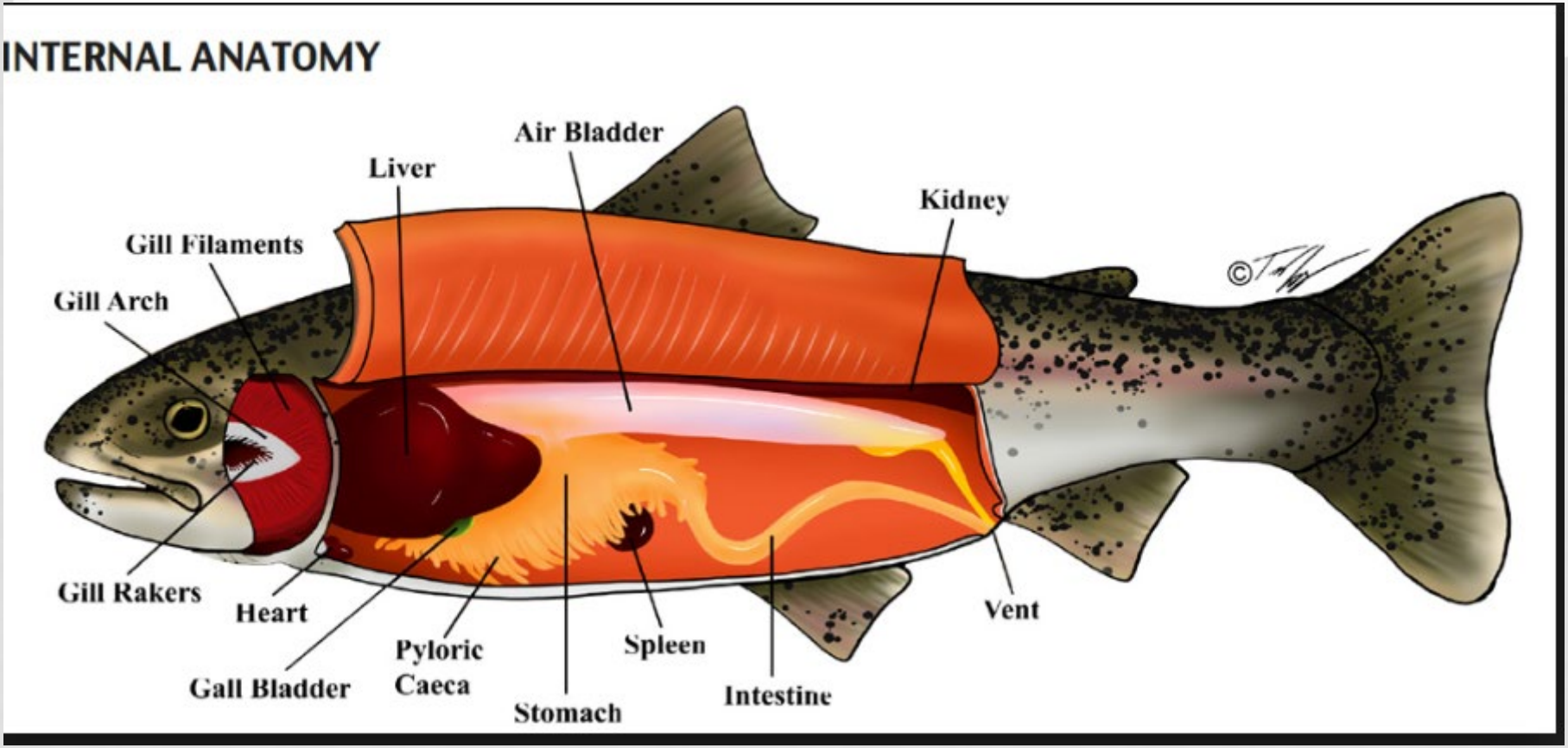
"Non-protocol induced variation"

Trap

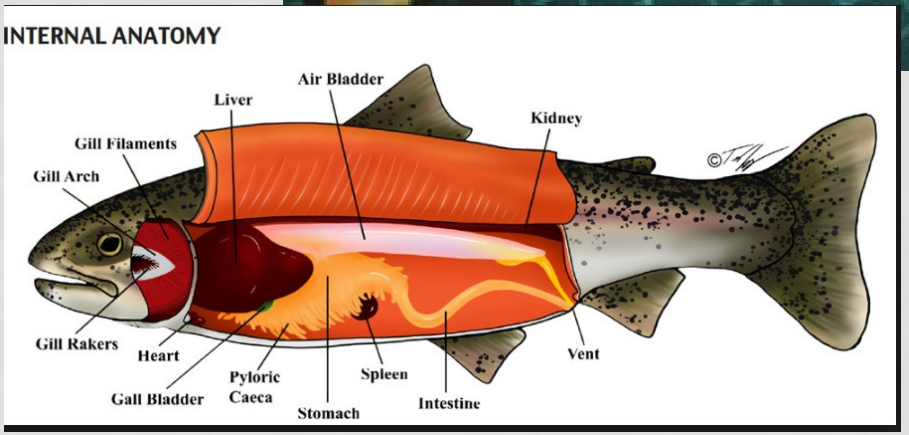
Haul

Outplant

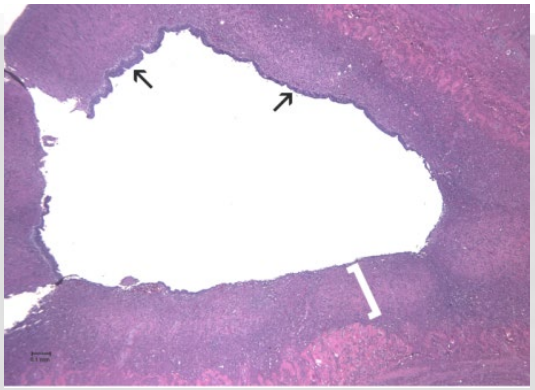
NON-LETHAL SAMPLING OF INTESTINE



NON-LETHAL GUT TESTS
ANAL SWAB OR LAVAGE



POTENTIAL NON-LETHAL ENDPOINTS LINKED TO SENESENCE /PSM PREDICTION



Test with swab/lavage for…

- **Pathogens**
  - A) *Enterocytozoon* sp. by qPCR
  - B) *Ceratonova shasta* by qPCR
  - C) Bacterial Microbiome – start with 16srDNA profiles
  - D) *Aeromonas salmonicida/Furunc - qPCR?*

- **Host Factors Associated with Pathology**
  - Cytokines – e.g., IL1-beta, TNF-alpha, IL-8, and/or IL-10
  - Chemokines, antibodies, etc.
  - Acute Phase Proteins - SAA (serum amyloid A), associated with inflammation and infections
    - 70% similar to mammalian, responds to *A. salmonicida*.

LINKING GUT PROFILES TO PREDICTION OF PSM

- Wild Fish: Tag and Swab/Lavage at Transport
- Then correlate Pathogen/Pathology Profiles with PSM
  - Time of Death, Location, Whole Body Profiles in PSM

- Validation: 1) Hatchery Fish Surrogates at Transport and 2) Spawned fish from Willamette Hatchery

  1) Swab/Lavage

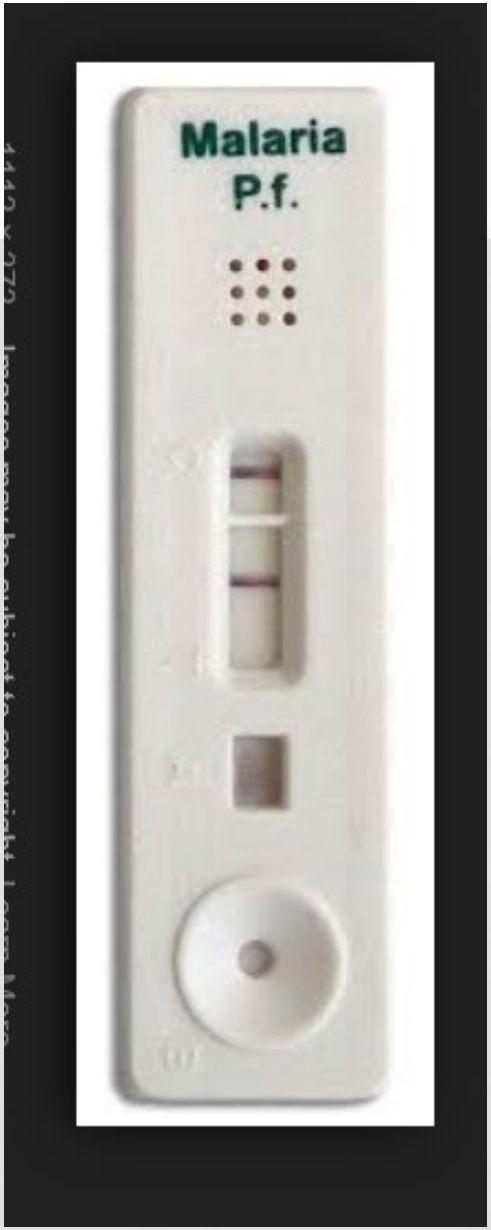
  3) Necropsy, including gut

  4) Compare Swab results with histology of intestine

DOWN THE ROAD

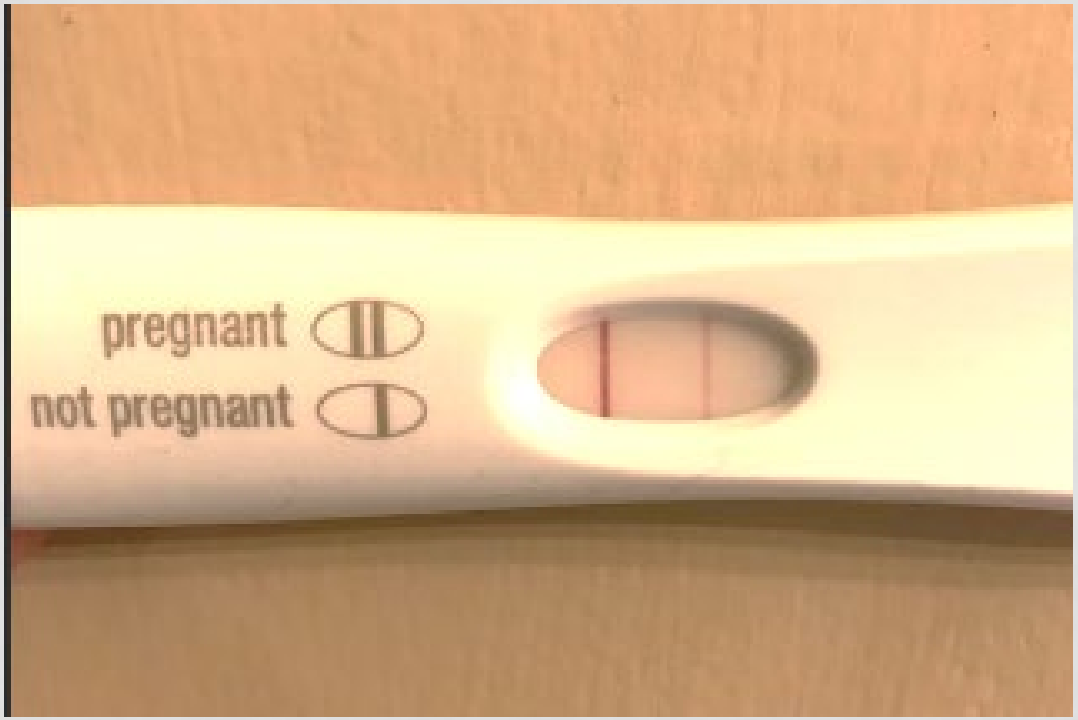
- Rapid, onsite field test?
- Pathogens

Malaria test



DOWN THE ROAD….

- Rapid, onsite field test?
- Host indicators



ACKNOWLEDGMENTS

- US Army Corps of Engineers – Portland
- 2010 – 2014 and 2017