



Synopsis of Klamath River Salmon Disease Issues

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The findings and conclusions in this presentation have not been formally disseminated by the USFWS and should not be construed to represent any agency determination or policy.

September 2002 Columnaris & Ich epizootic

>35,000 CHK, COHO, STT died

Low flows, thermal block, congregation

Juvenile salmon disease largely unseen



Photo Mike Belchik

1991 – 2002

CA-NV FHC + cooperators

- Pathogen surveys in Trinity, Klamath, estuary = broad scope, variable collection
 - TR – generally healthy smolts
 - *Nanophyetus* infection, columnaris > 21C,
 - KR – *Cshasta*, KD myxosp., columnaris
 - Low *Rsalmoninarum* adult and juveniles
 - KR Disease mortality observed in 1995 - Cs

Health issues

- #1 **Ceratomyxosis** in juvenile Chinook during spring and summer
 - Dual infections with *Parvicapsula minibicornis*
- #2 **Columnaris** (*Flavobacterium columnare*),
 - MDT > 20 C in both juvenile and adult
 - Congregation in thermal refugia



Ceratomyxa shasta Life cycle

Parvicapsula
similar LC



polychaete



myxospore



actinospore



salmonid

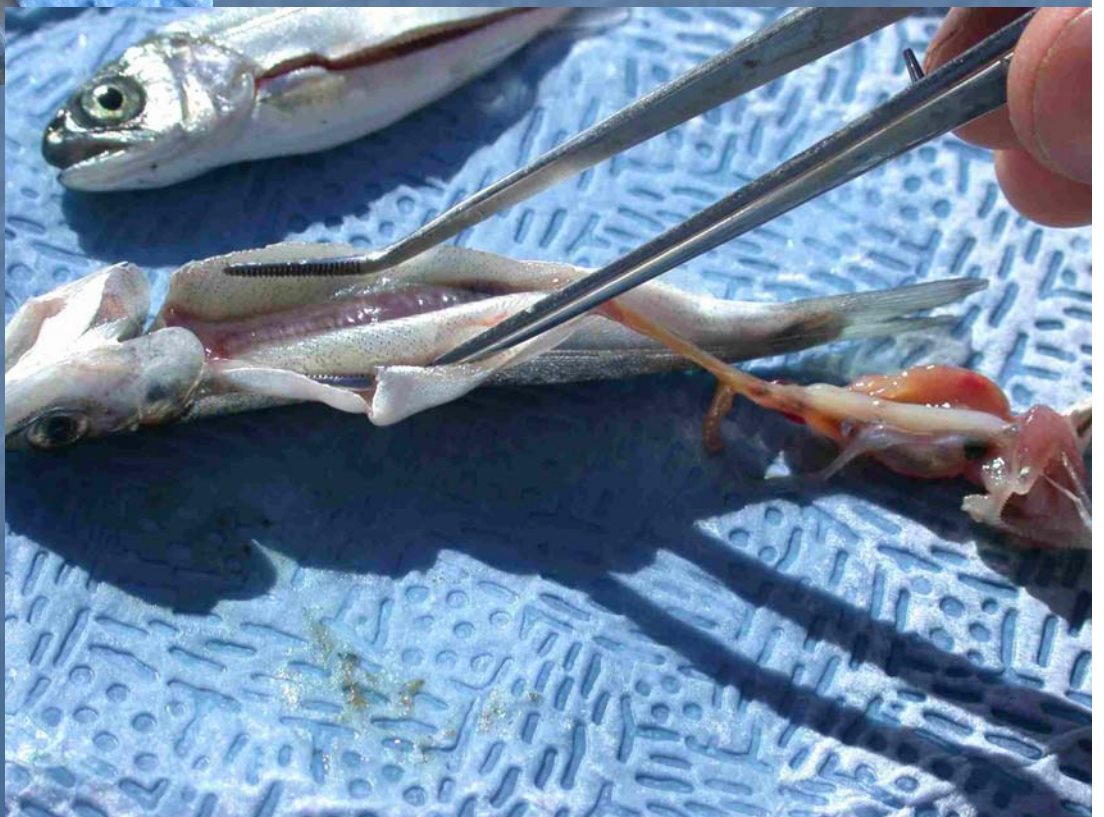
J Bartholomew



Myxosporean parasites:
Ceratomyxa shasta and
Parvicapsula minibicornis

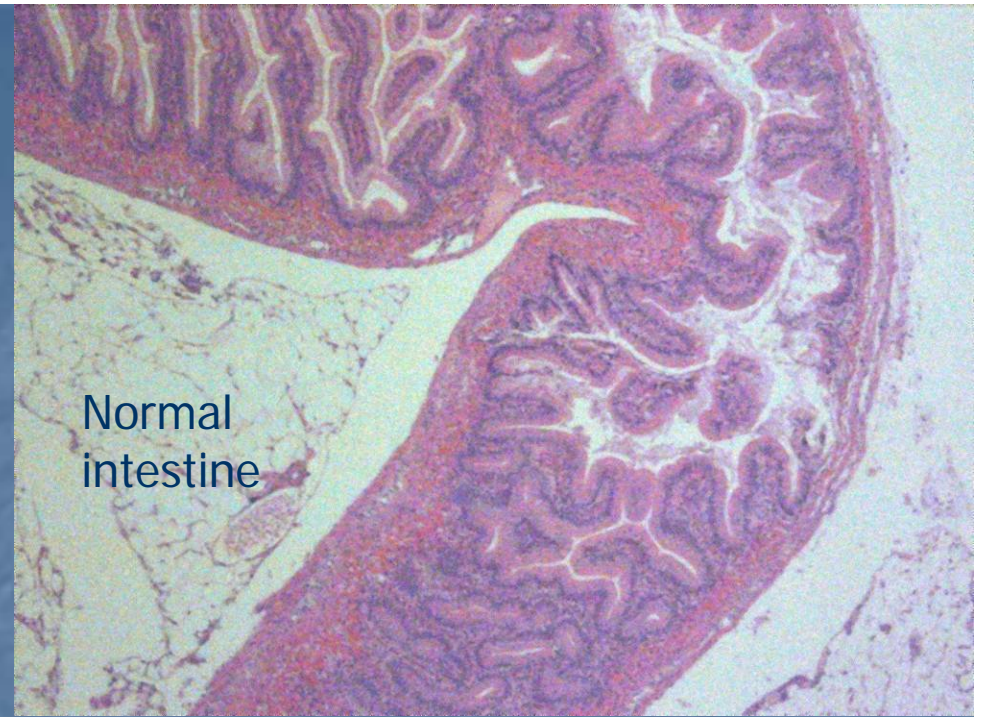
Anemia

Weak swimming = "food"

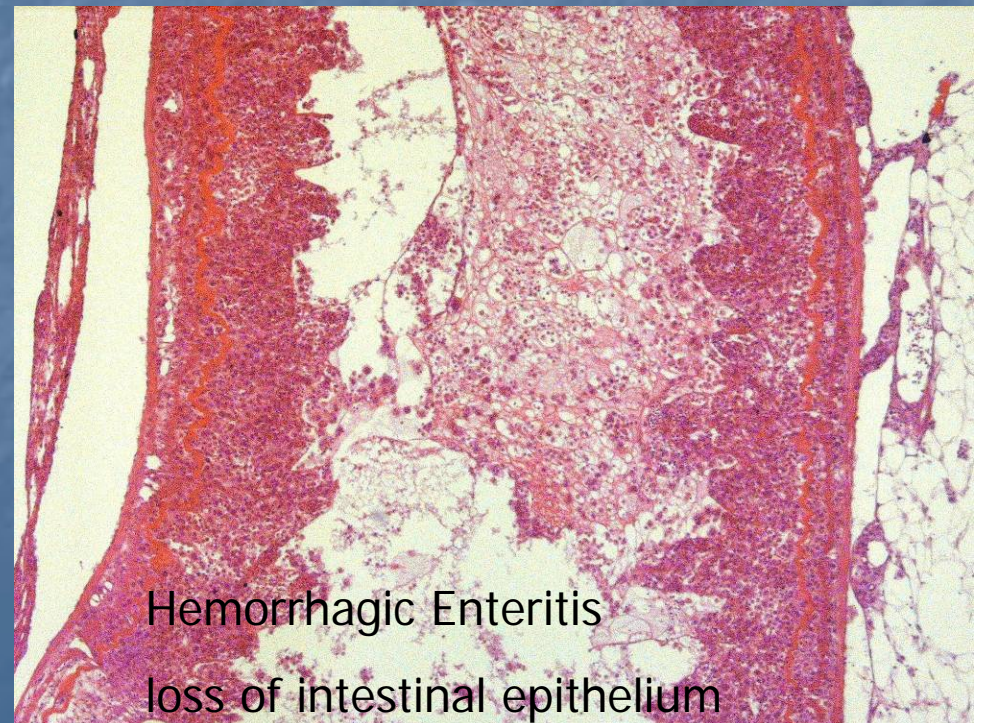




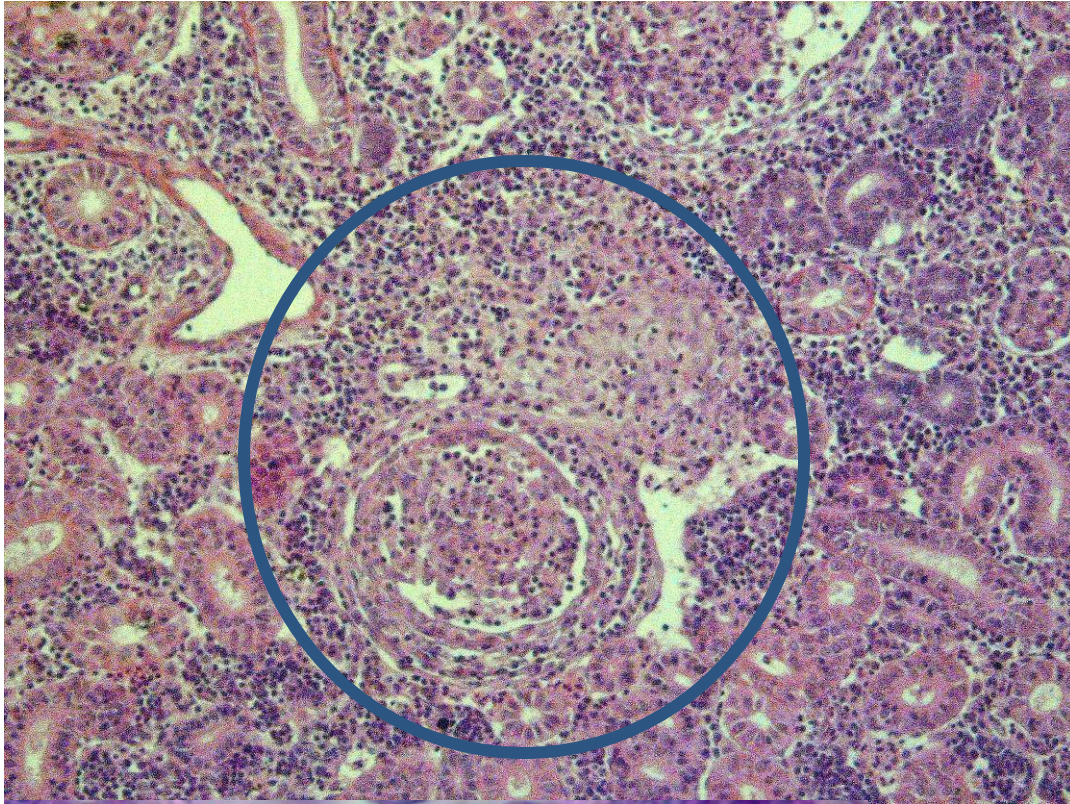
Cshasta trophozoite



Normal
intestine



Hemorrhagic Enteritis
loss of intestinal epithelium

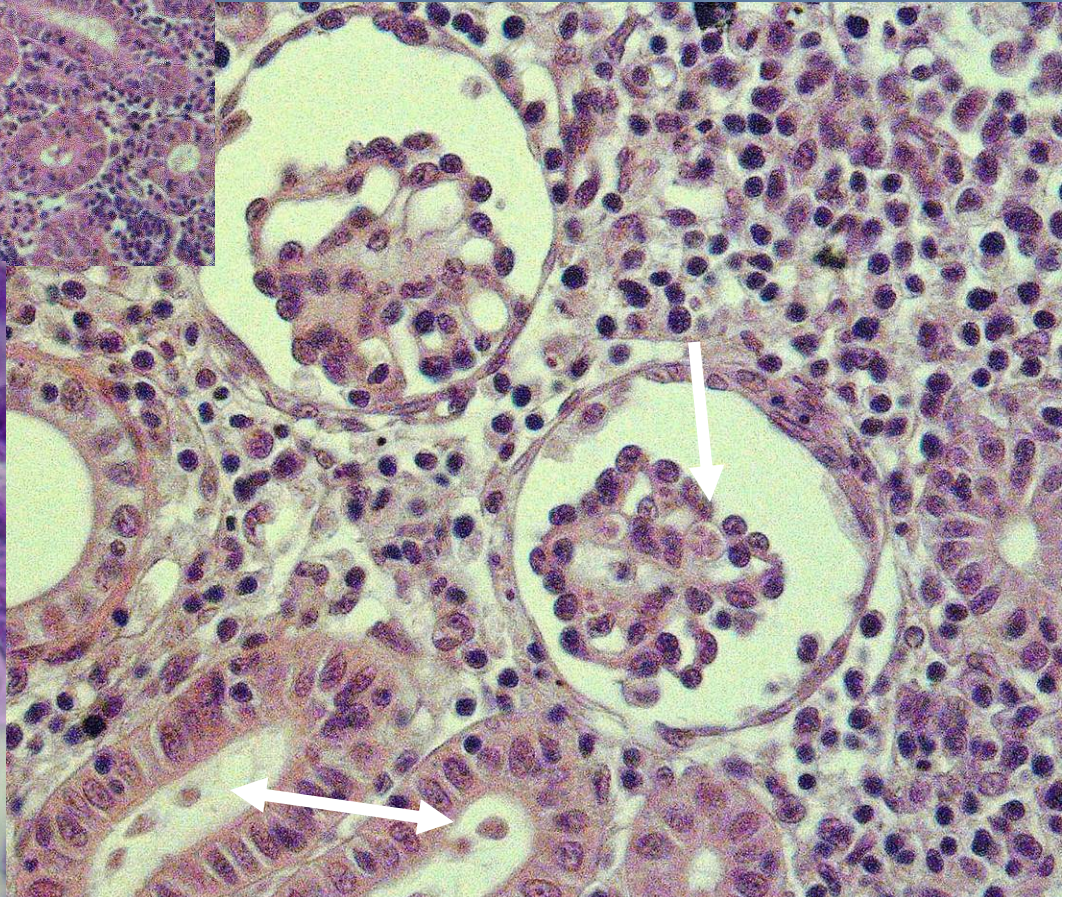
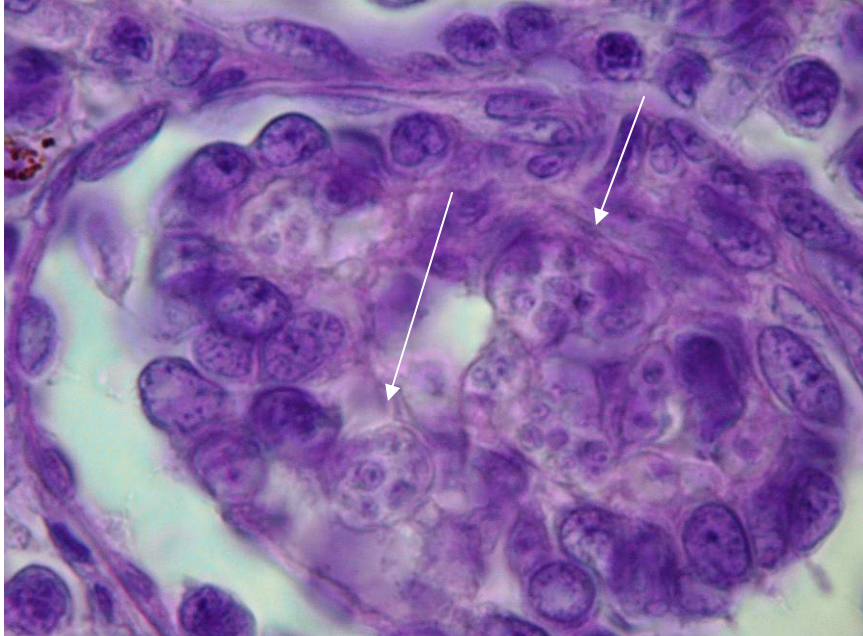


Pm and Chinook:

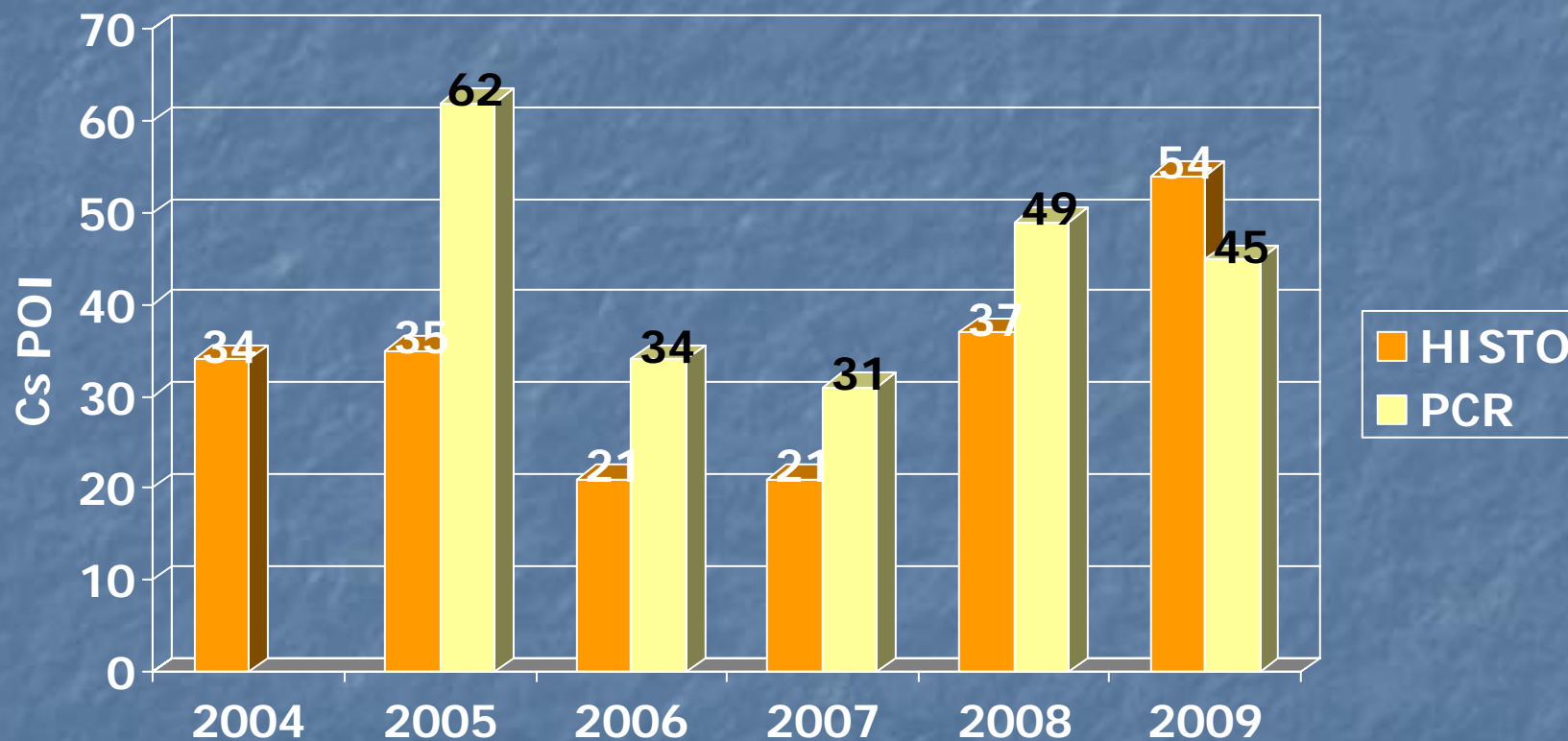
Glomerulonephritis

Impaired nephron function &
hemopoiesis

Can recover from infection



C. shasta incidence of infection May- July IGD- TR, Juv. Chinook



Pm 58 – 92% DUAL INFECTIONS

Wet winter

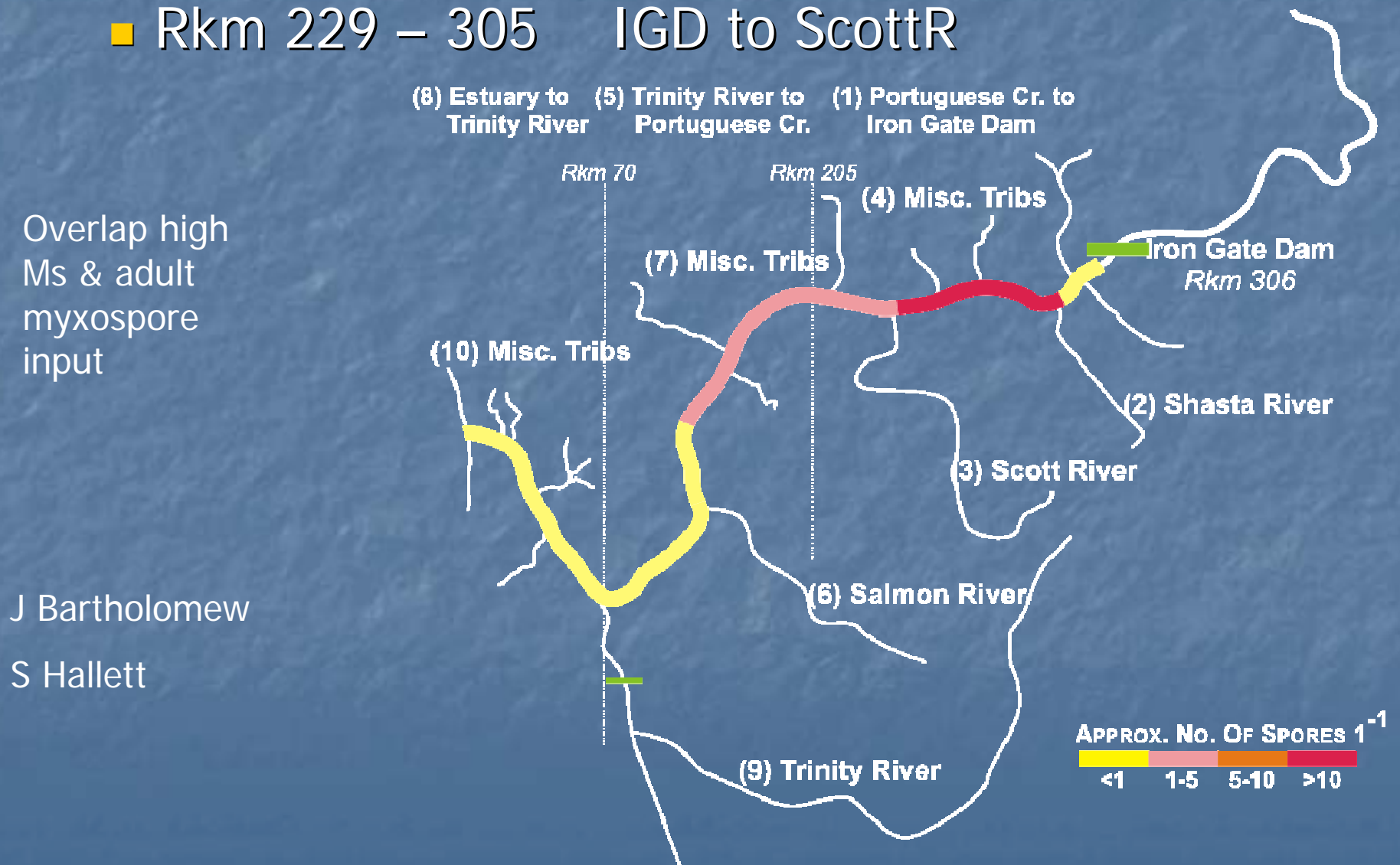
First Cs infection in April, > 10C

Cshasta & Klamath Coho

- Lower mortality than Chinook in 72h sentinel challenges but > 50%
 - 1+ smolts – lower risk due to migration timing
 - Before late April – low actinospore levels
 - May08 7d challenge = 85% Cs mortality
 - 2006 – 2008 surveys, **3- 48%** Cs in 0+ coho
 - 72h Sentinel 2008 - >90% clinical ceratomyxosis
-
- Steelhead & Redband Trout – infected but rarely diseased

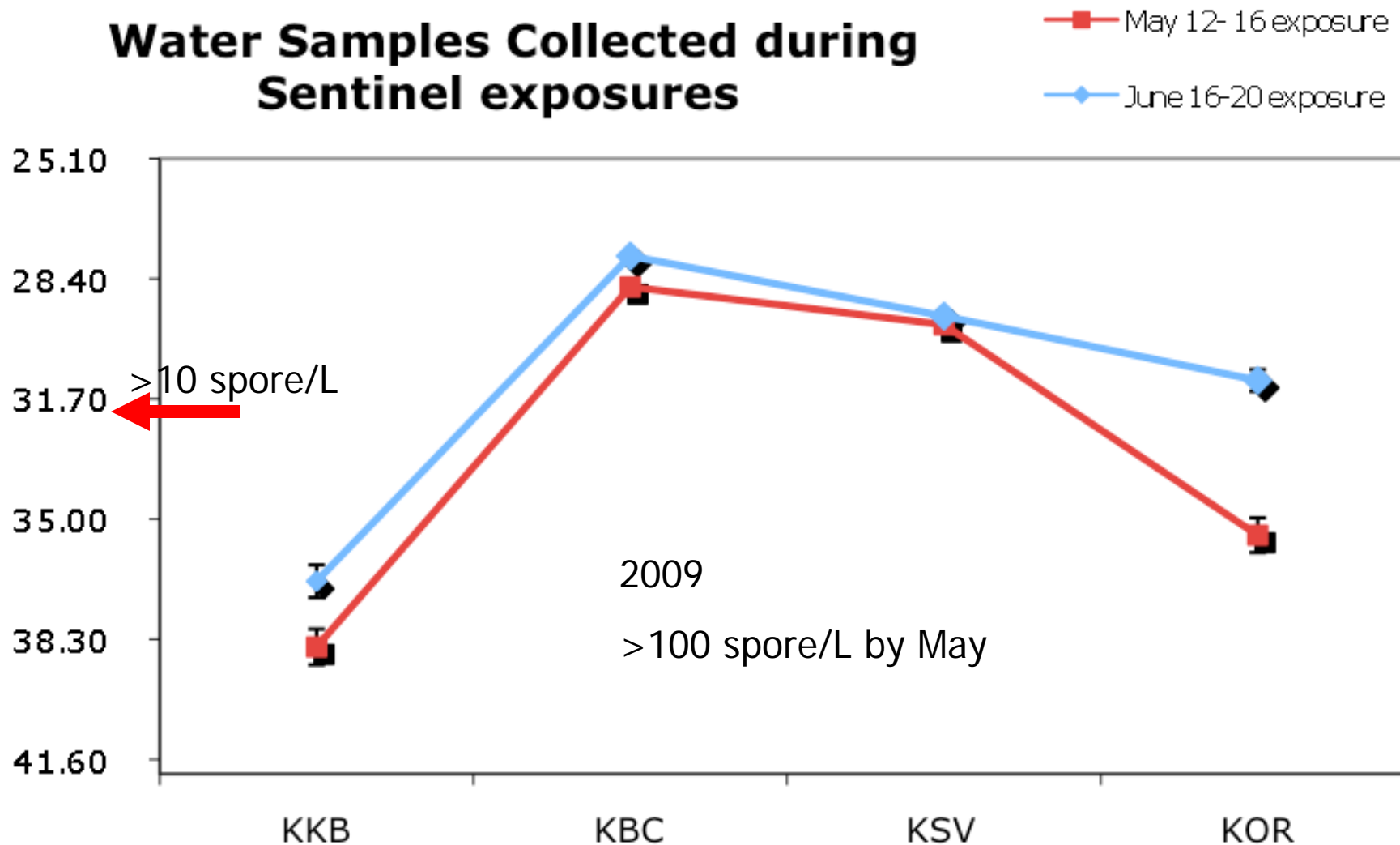
Probability of lethal Myxosporean infection

- "HOT" zone = **where** a fish enters KR
- Rkm 229 – 305 IGD to ScottR



2008 H2O Actinospore counts

Water Samples Collected during Sentinel exposures



Iron Gate Hatchery Smolts

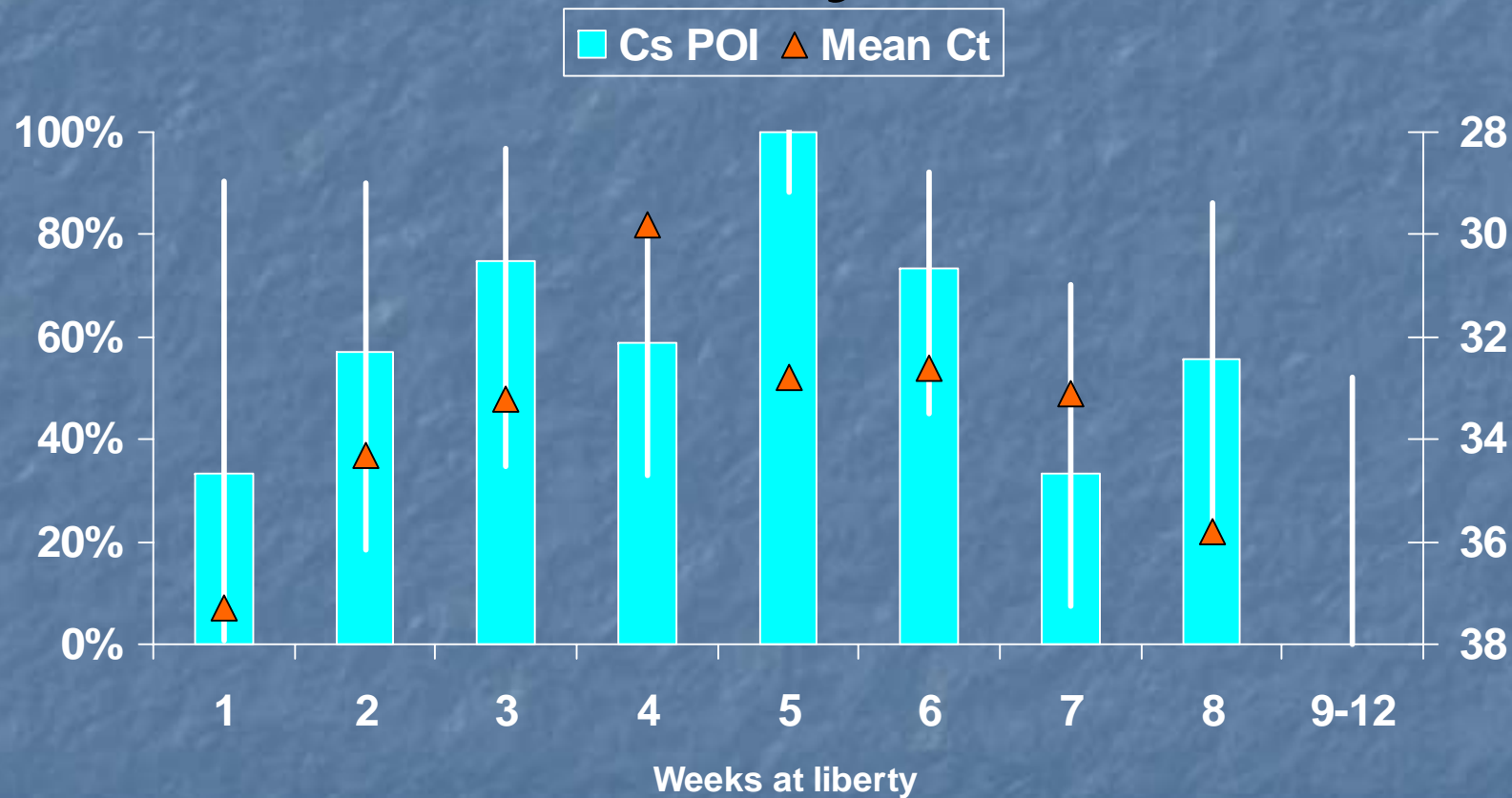
Previous studies

Year	<i>Ceratomyxa</i>	<i>Parvicapsula</i>
1995 Histology	43% (81/186)	78% (23/29)
2002 Histology	60% (3/5)	100% (5/5)
2006 QPCR	51% (35/69)	90% (62/69)
2007 QPCR	68% (70/103)	83% (69/83)

Surrogate for Shasta R. and mainstem naturals

Recaptured IGH smolts (2008)

Ceratomyxa shasta



Detect in 7d, 3wk peak, estuary "luck fish" in August 27 – 68%POI

TRH CWT 1- 14% Cs POI , enter below hot zone

Infection data = *What does it mean?*

Does incidence data portray disease loss of "Klamath smolts"?

Infection is not equal to disease , unknown history of unmarked fish in survey

Lab data to link field observation

1. 3d sentinel studies - >80% mortality
3-24h exposures = > 20-50% mortality
2. dead and dying smolts in traps
3. Kinsman 2008 - >82% mort May & June collections, initial PCR screen underestimates final POI

Bottomline – migrate / rear in Hot zone
results in high disease mortality

Dual infections

Synergism

- High Pm infection = dual infections of Cs and Pm
- 2007 data
 - IGH cwt: 89% (51/57)
 - TRH cwt: 76% (34/45)
 - Coho: 92% (12/13)

Other studies

- Stock susceptibility
- Effect of migration
- Cs genotyping
- Cs Myxospore surveys

2006 Chinook Stock Susceptibility

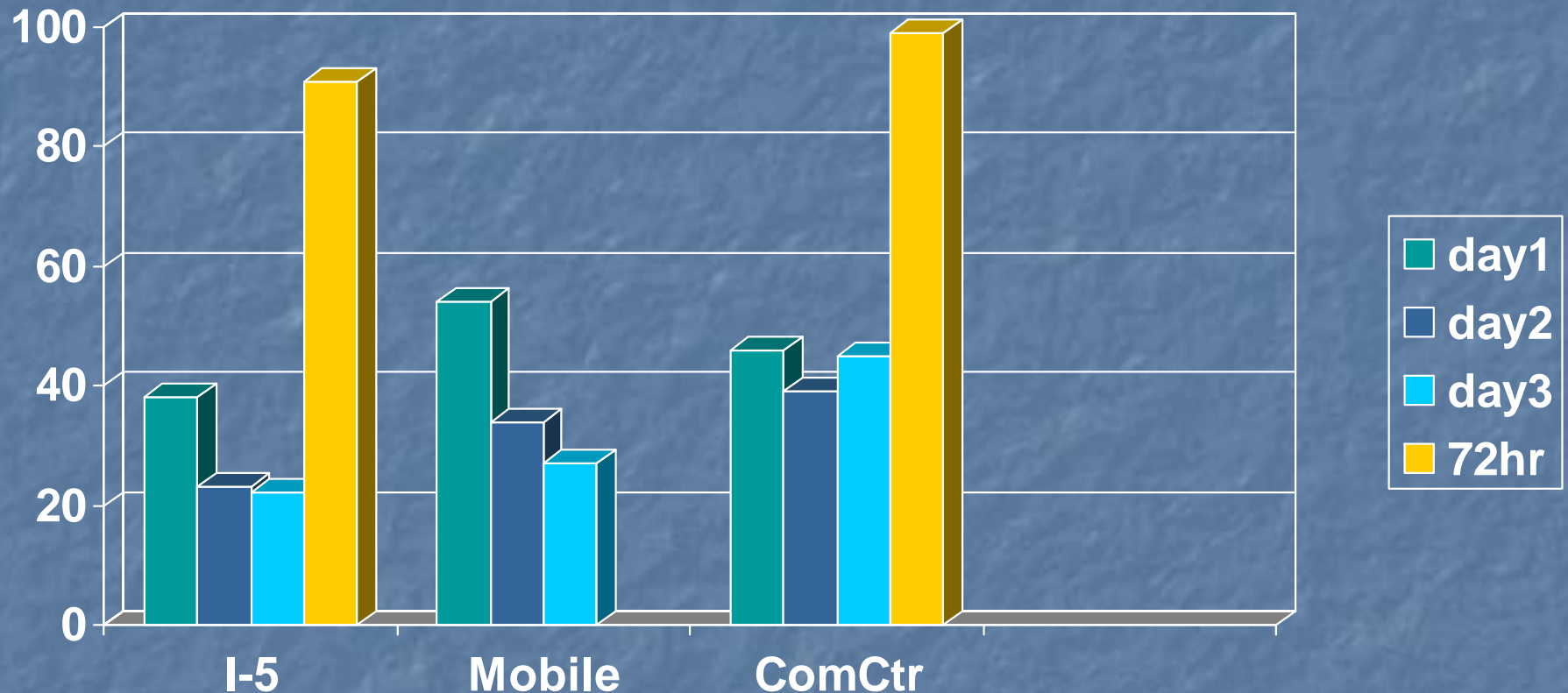
- IGH = Shasta R. = Salmon R. \leq TRH
- IGH coho slower disease progression than Chinook

All control groups were negative for Cs.

Mobile Cage June 2009

Cumulative Mortality

2008 Radiotag results – question on migration



Day1=8-10h, Day2 =7-9h, Day3=6-8h
similar spore load >10/L

Bottomline:

Moving = still

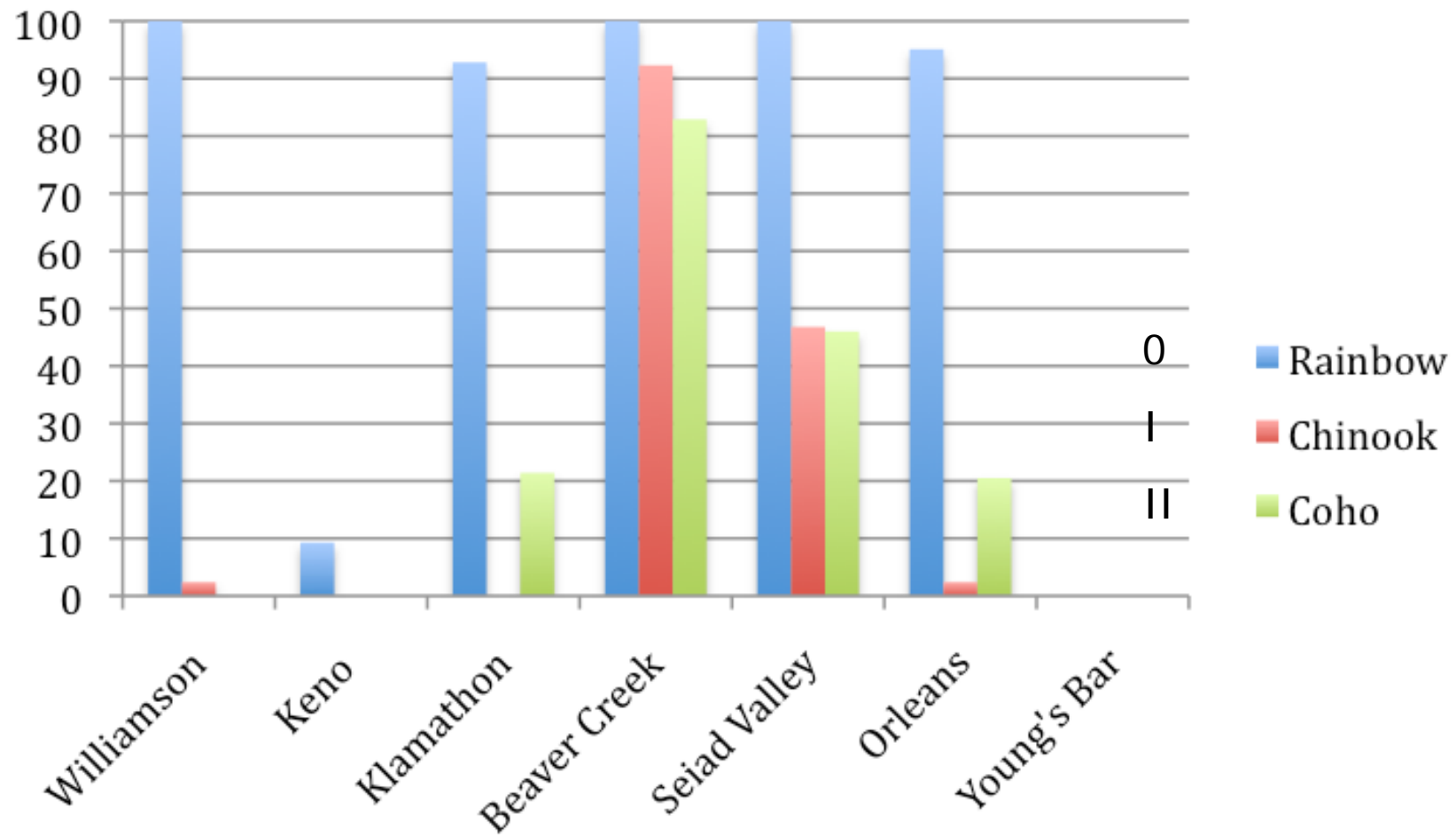
>6h 30-50% mort

CS Genotypes

S. Atkinson, OSU

- Examine variable region (ITS-1) ss rRNA
 - 3 types 0, I, II
- Type 0 = Steelhead / redband (WR down)
 - Little disease observed – **exception Blue hole Aug09**
- Type I = chinook (below IGD)
- Type II = coho (WR down)
- Mix of types found in water & fish tissues

2008 OSU data genotype spatial



Cshasta myxospores- Chinook YTF, Ryan Slezak (HSU)

- Estuary-below TR confluence
 - 2007 0 / 154 (25%PCR+)
- IGH FCS spawners
 - 2006 1 / 60 (60%PCR+)
 - 2007 6 / 166
 - Coho 14/ 35 (40%)
 - STT/RBT 3/ 14 (21%) NOV-JAN *low temp / genetics?*
- FCS Carcasses (Bogus, Shasta, Mainstem)
 - 2007 22 / 64 (34%)
 - 2008 (Bogus) 30 / 100 (30%)
 - 3000 to 15M spores/gut
- Juveniles – can produce myxospores if they survive over 20 days at summer temperatures
 - Assume infected juveniles myxospore source in lower reaches



Current research

OSU-Tribes-HSU-Agencies

- Myxospore input – feasibility of carcass removal
- Survey of polychaete density, infection, biology, microhabitats
- Temperature effects on smolt immune system
 - Federal earmark funds, PacifiCorp funds, USBR, Sea Grant, others



J Strange YTFP