Synopsis of Klamath River Salmon Disease Issues

J. Scott Foott* USFWS) and Jerri L Bartholomew (OSU)

Funding Agencies and Research Partners:
Oregon State University, Bureau of Reclamation
USFWS, NMFS
Karuk, Yurok and Hoopa Tribes
OR Department of Fish and Wildlife
CA Dept of Fish and Game

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
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 *Rs salmoninarum* 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

myxospore

polychaete

actinospore

salmonid

J Bartholomew
Myxosporean parasites:
Ceratomyxa shasta and
Parvicapsula minibicornis

Anemia
Weak swimming = “food”
Normal intestine

*Cshasta* trophozoite

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
First Cs infection in April, > 10°C

Wet winter
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 Scott R

Overlap high Ms & adult myxospore input

J Bartholomew
S Hallett
2008 H2O Actinospore counts

Water Samples Collected during Sentinel exposures

- May 12-16 exposure
- June 16-20 exposure

- >10 spore/L
- >100 spore/L by May

KKB  KBC  KSV  KOR
## Iron Gate Hatchery Smolts

### Previous studies

<table>
<thead>
<tr>
<th>Year</th>
<th>Ceratomyxa</th>
<th>Parvicapsula</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>43% (81/186)</td>
<td>78% (23/29)</td>
</tr>
<tr>
<td>2002</td>
<td>60% (3/5)</td>
<td>100% (5/5)</td>
</tr>
<tr>
<td>2006</td>
<td>51% (35/69)</td>
<td>90% (62/69)</td>
</tr>
<tr>
<td>2007</td>
<td>68% (70/103)</td>
<td>83% (69/83)</td>
</tr>
</tbody>
</table>

Parvicapsula: 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
IGH = Shasta R. = Salmon R. ≤ 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

Bar chart showing the distribution of genotypes across different locations:
- Williamson
- Keno
- Klamathon
- Beaver Creek
- Seiad Valley
- Orleans
- Young's Bar

Locations are grouped as follows:
- Rainbow
- Chinook
- Coho
**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