Reducing Disease Risks Caused by Pathogens Associated with Columbia River Hatcheries

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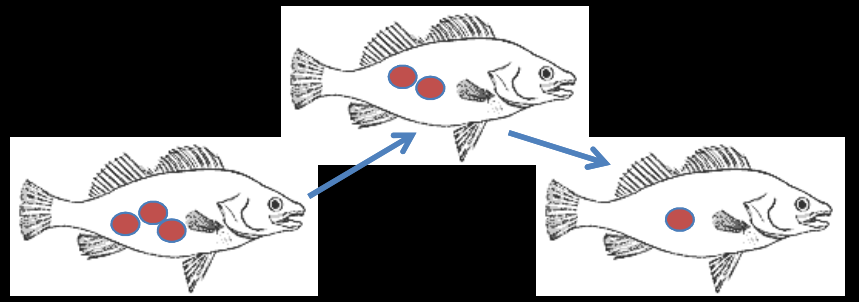
Pathogen Transmission and Hatchery Risk:

Mode of transmission

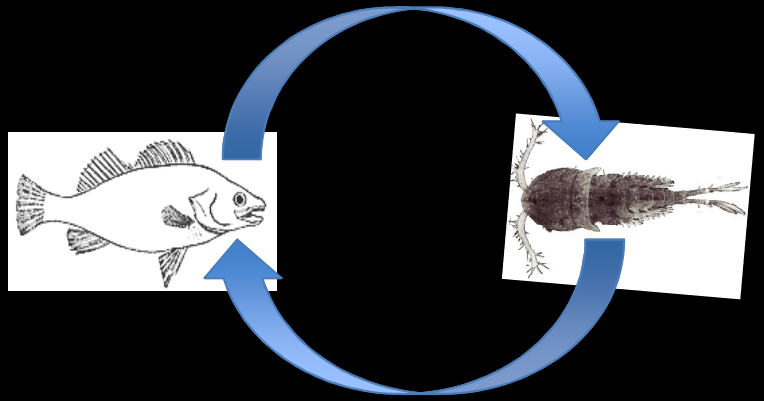
– Horizontal (fish to fish)

- Most bacteria, viruses



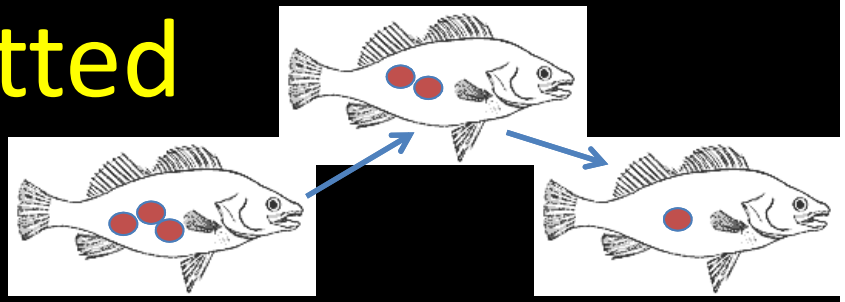
- Indirect

- Parasites with complex lifecycles



Require different approaches to control and have unique risks

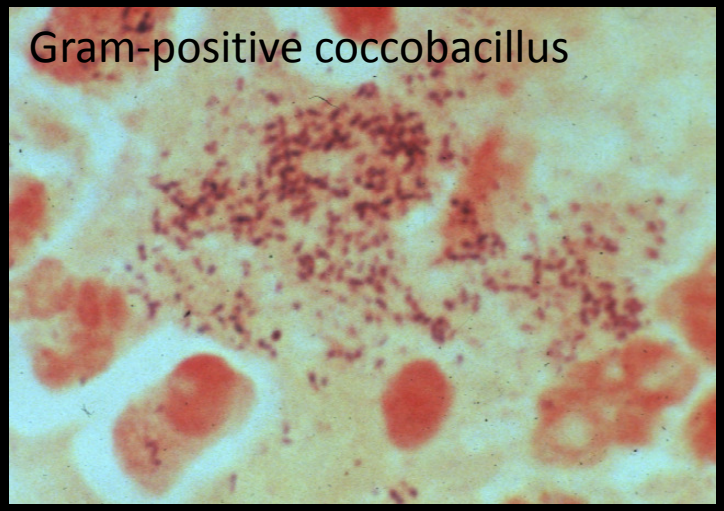
Horizontally transmitted pathogens

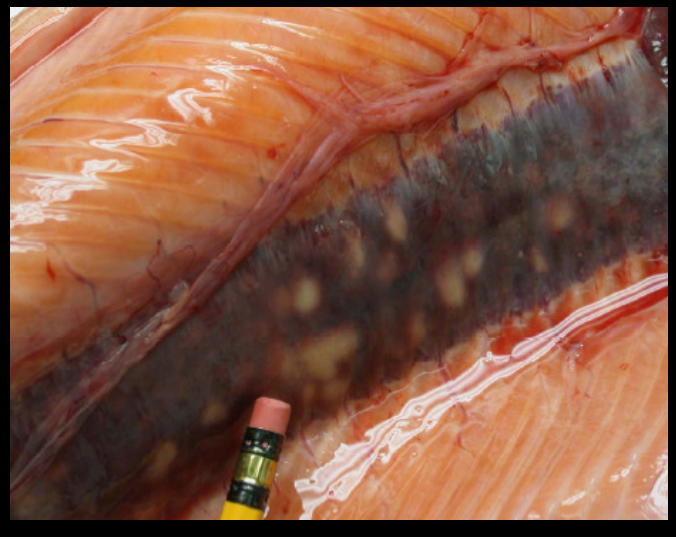


- Although there is good evidence that wild fish above hatcheries results in disease transmission to hatchery fish, there are few documented examples of transmission from hatchery to wild fish
- Reasons:
  - Endemic pathogens are already present in wild populations and any additional impacts as a result of hatchery fish are difficult to monitor
  - Transmission relies on high fish densities or frequent contact with an infectious source

Renibacterium salmoninarum
Bacterial Kidney Disease

- Disease transmission
  - Horizontal – contact with contaminated water, via skin abrasions, by ingestion
  - Vertical*- inside egg
- Disease chronic
- Obligate pathogen





Renibacterium salmoninarum transmission from hatchery to wild fish

- Present in both wild and hatchery fish
- Disease stress mediated, high risk periods include migration and transition to salt water
- Transmission likely to occur with crowding and when fish present have high levels of Rs
- High risk practices include barging, although actual transmission has been difficult to document

IHNV transmission from hatchery to wild fish

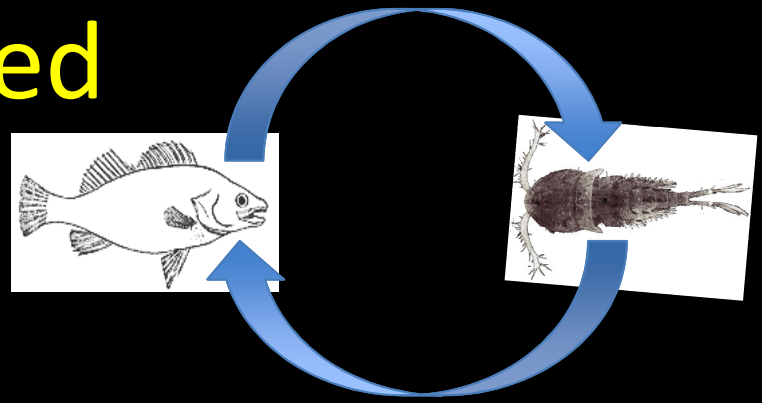
- Laboratory study by Foott et al. (2006) demonstrated
  - cohabitation of infected hatchery smolts with natural fish did not result in transmission
  - Environmentally relevant exposure doses did not result in high mortality

Treatment	*1:1*	*1:10*	*1: 20*
5 min			
Cohabitated + stress	0 / 8	0 / 8	0 / 8
Cohabitated	0 / 8	0 / 8	0 / 8
Caged	0 / 6	0 / 8	0 / 8
24 h			
Cohabitated + stress	0 / 4	0 / 5	0 / 4
Cohabitated	0 / 4	0 / 5	0 / 3
Caged	0 / 4	0 / 4	0 / 8
No exposure control	0 / 1	0 / 34	0 / 17
Injected hatchery fish	16 / 16	80 / 80[a]	98 / 98[a]

a. Two-fish pool samples.

Conclusion: Transmission of IHNV from infected hatchery fish to wild fish is low risk

Indirectly transmitted pathogens



- Transmission dependent on alternate host densities
- Interactions between these parasites, hatcheries and natural populations are often complex and the risks variable

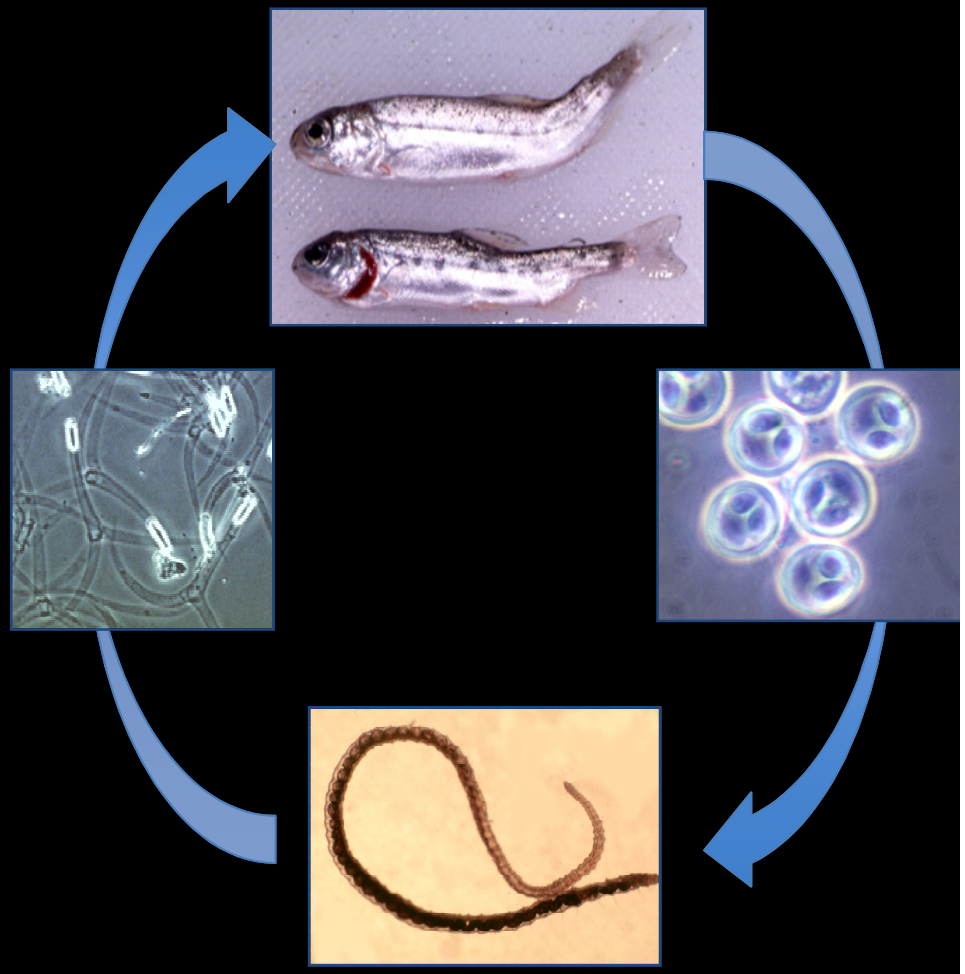
Case Study
Introduction of
Myxobolus cerebralis

Disease: whirling disease

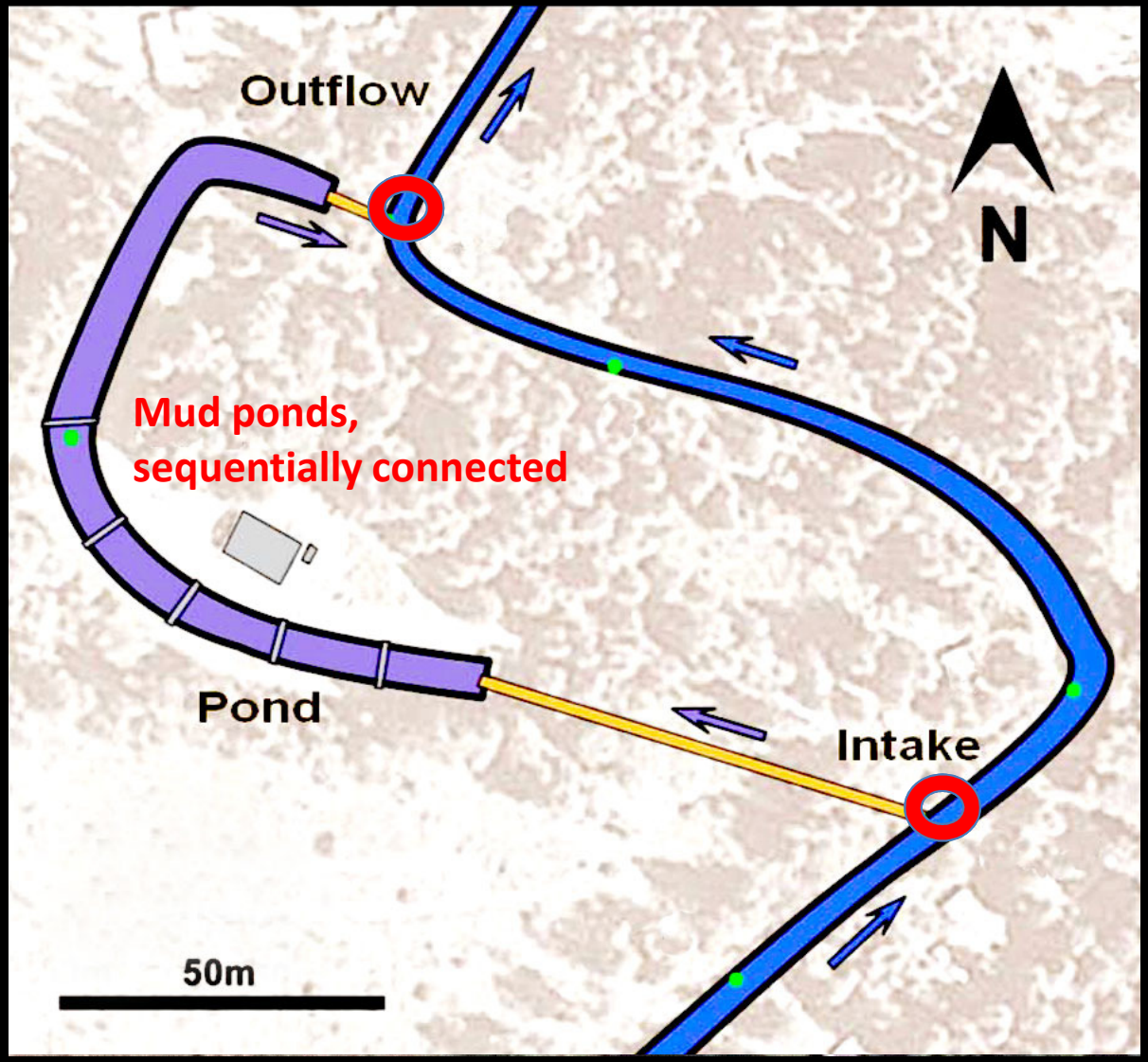
Parasite introduced, now considered endemic in upper Columbia River basin

Transmission: indirect

- 2 spore stages
- invertebrate host *Tubifex tubifex*



Detection Scenario



- Hatchery imported eyed eggs
  - Hatched on well water
  - Reared on creek water
- Routine inspection Nov 2001
  - 64% juvenile RBT positive for *M. cerebralis*
  - *No clinical signs*

Assessment

- Parasite likely introduced by stray steelhead
- Open water supply gave parasite access to hatchery
- Hatchery provided conditions for parasite replication
- Worm host not present at high densities in the stream, thus conditions unsuitable for parasite to establish in wild

Actions and Outcomes

- Closure of hatchery outflow to protect wild fish
- Parasite not detected in sentinel fish below the hatchery after closure

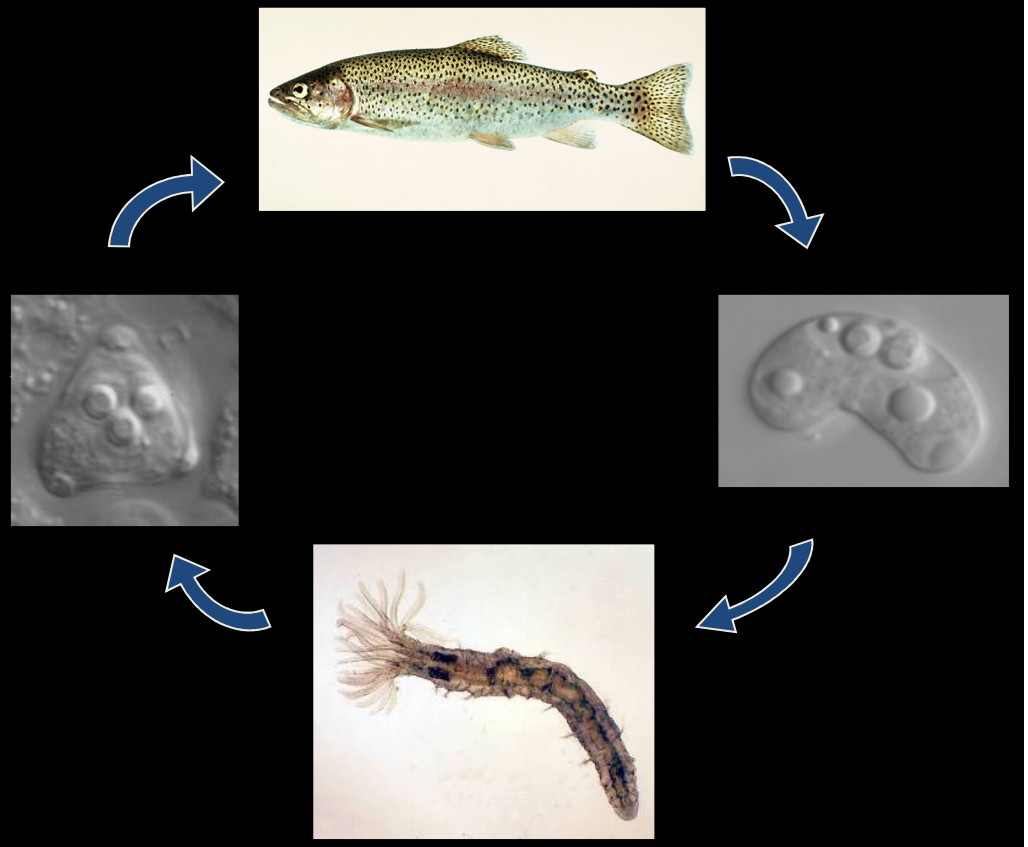
Case Study
Amplification of
Ceratomyxa shasta

Disease: Ceratomyxosis

Parasite endemic

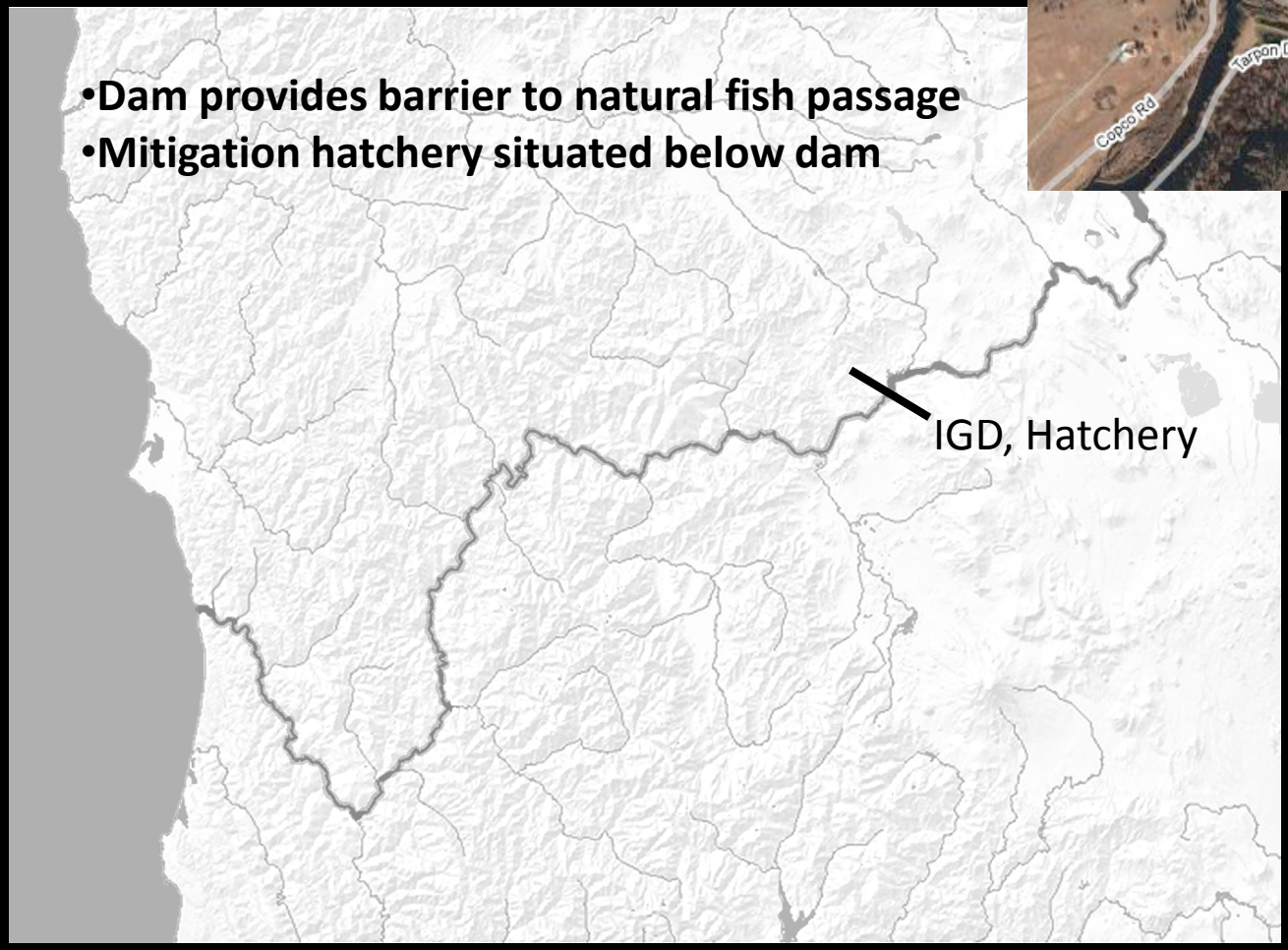
Transmission: indirect

- 2 spore stages
- invertebrate host
  - *Manayunkia speciosa*



Scenario: Klamath River Iron Gate Dam/Hatchery

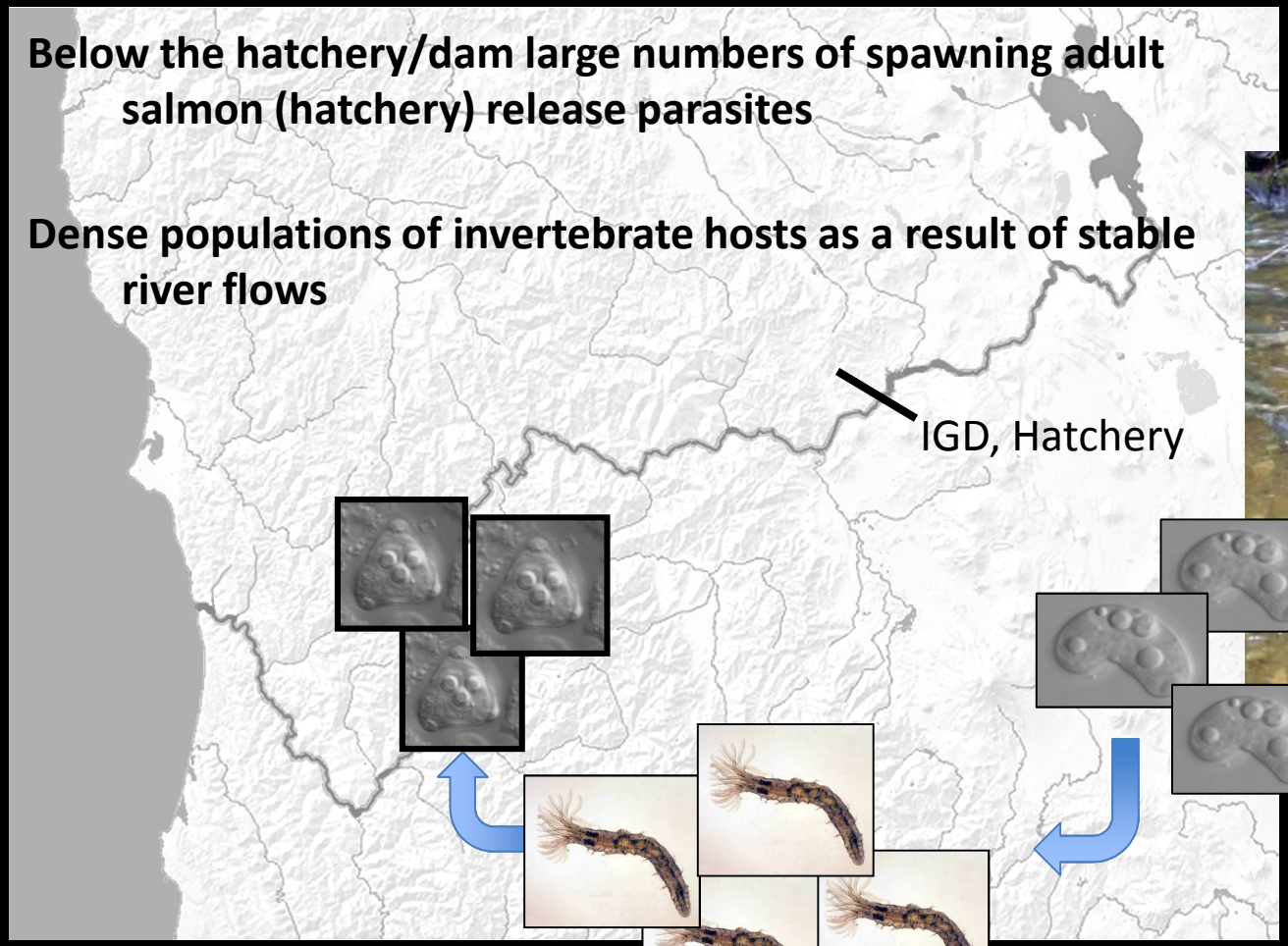
- **Dam provides barrier to natural fish passage**
- **Mitigation hatchery situated below dam**



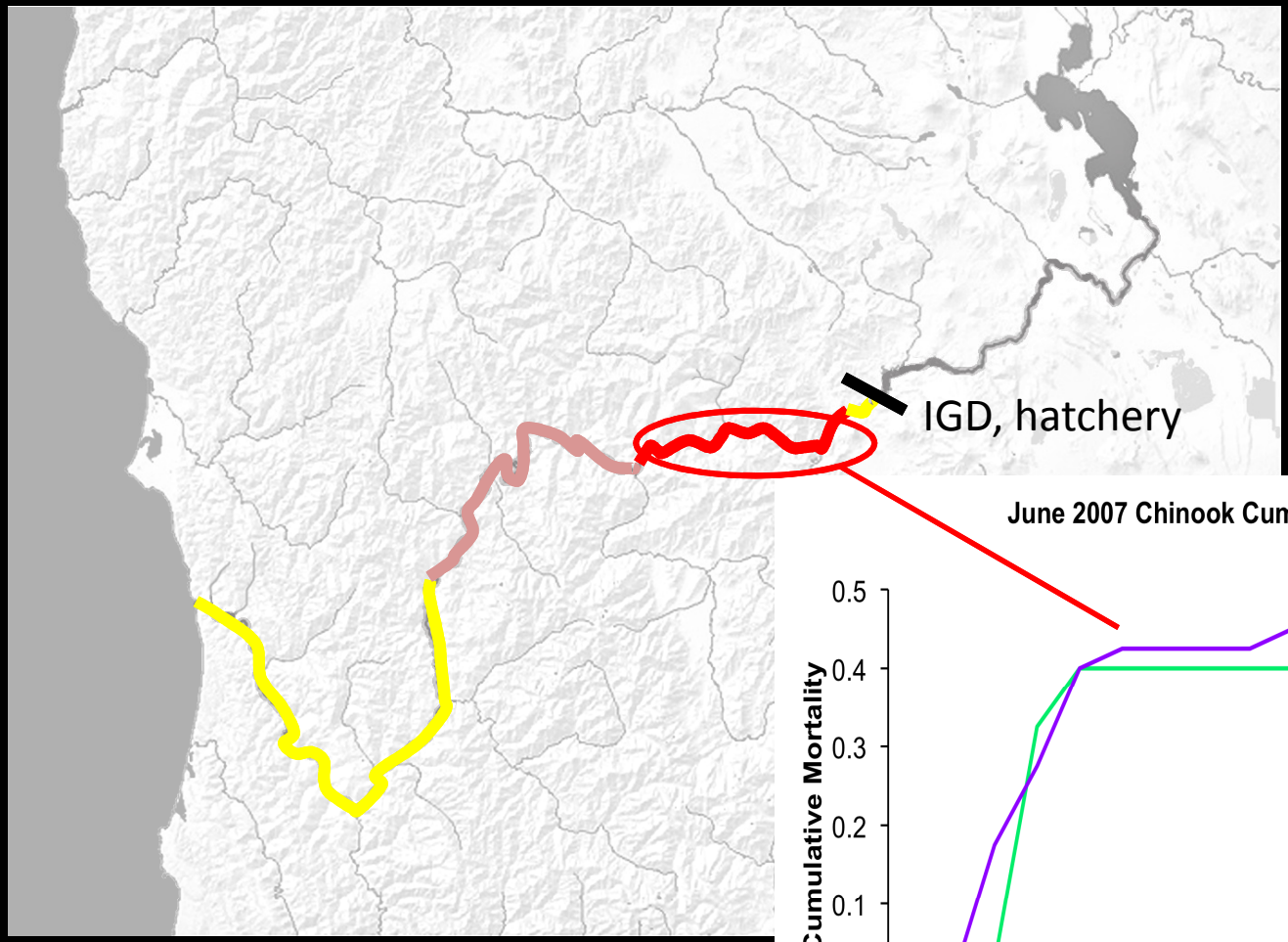
Assessing the Risk:

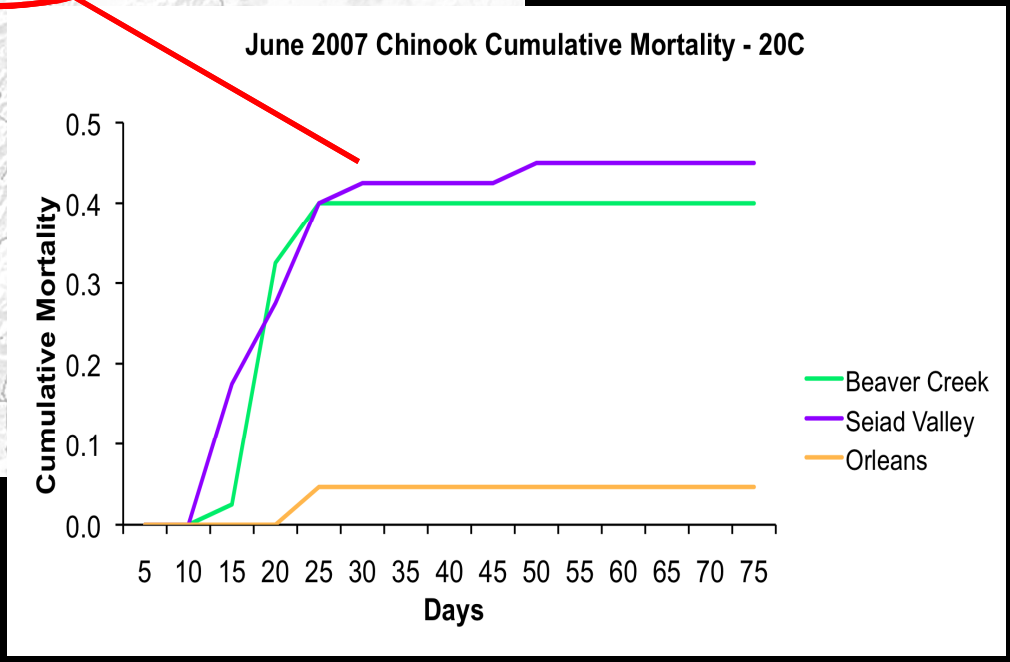
Below the hatchery/dam large numbers of spawning adult salmon (hatchery) release parasites

Dense populations of invertebrate hosts as a result of stable river flows



Result: Amplification of parasite





Assessment

- Co-location of hatchery and dam increases the number of adult salmon spawning in this area
- Conditions in the river are favorable for parasite establishment
- Amplification of the parasite results in disease effects on out migrating juvenile fish

Potential Actions

- Fish passage above dam
  - passage on the Cowlitz resulted in increased disease problems in the salmon hatchery

Reducing Disease Risks From Hatcheries: Things we already do

Disease monitoring

- Increased disease monitoring prior to release
  - Prevent release of diseased fish

- Prohibit release of any fish from a facility with a history of a pathogen into areas where the pathogen has not previously been detected

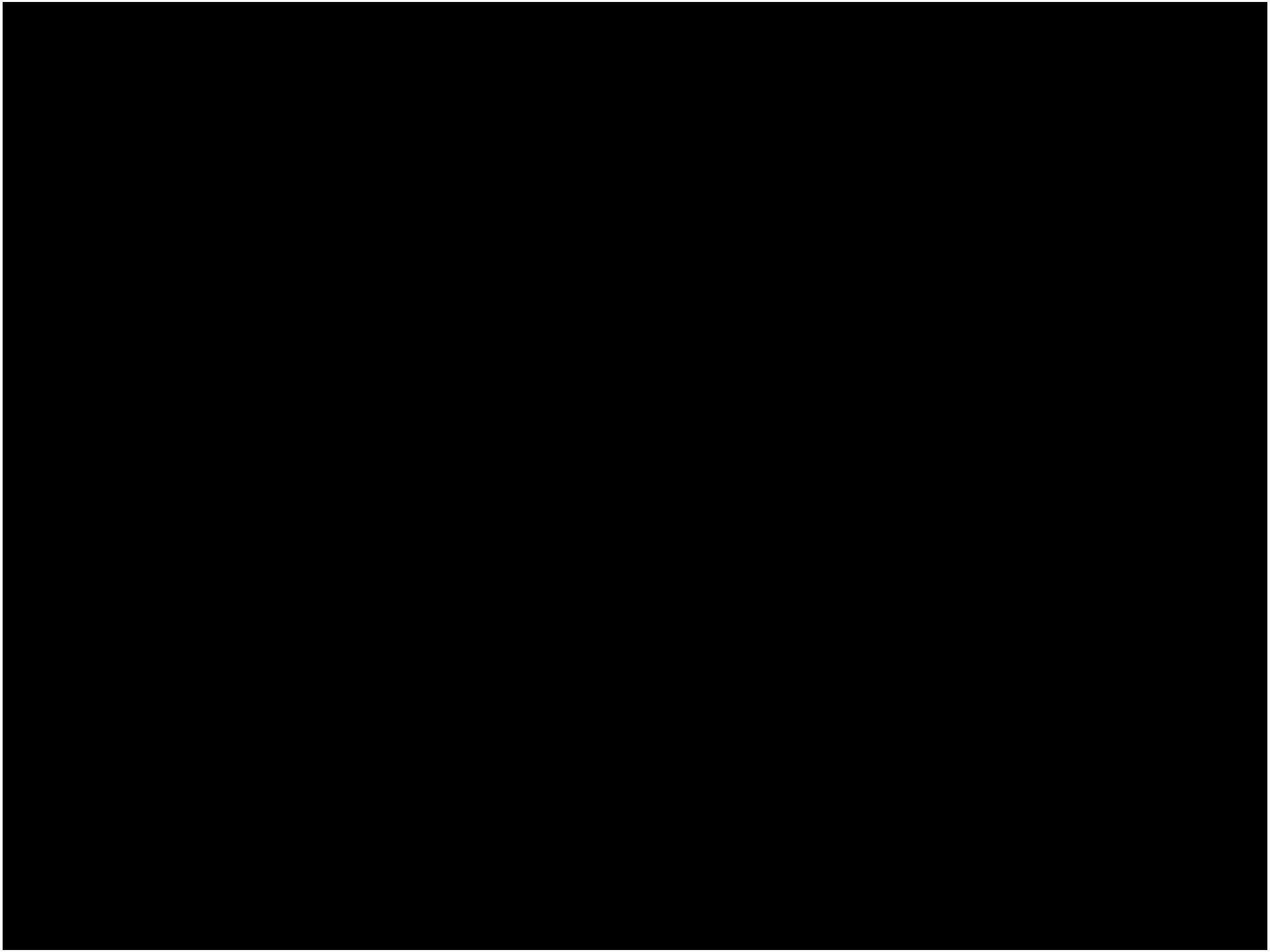
- Monitor adult fish for vertically transmitted pathogens
  - Identify progeny that should be isolated or culled

Reducing Disease Risks From Hatcheries: Strategies to minimize wild : hatchery interactions

- Release larger fish
  - Higher resistance to pathogens
  - Likely to migrate faster
- Time releases
  - To miss high pathogen prevalence periods in the river
  - To minimize contact with wild fish

What are we missing?

- Data and methods for evaluating disease transmission between hatchery and wild fish
- Better understanding of disease ecology in the wild
  - How could release strategies (timing, location) affect disease ecology
- Improved methods for detecting pathogens in effluent and environmental samples
- Better laboratory models for studying transmission of pathogens under conditions relevant to hatchery: wild fish interactions
- Real data on effects of disease outside hatcheries and long-term effects on survival
  - Freshwater, estuary, ocean



Reducing Disease Risks From Hatcheries: Areas for consideration

Outflow Management

- Monitor settling ponds and outflow for pathogens
- Treatment of discharge
  - Filtration, UV, ozone, sand filtration, wastewater systems

Craig Brook Natnl Fish Hatchery

Pathogens and Hatcheries
What are the risks?

- Introduction of pathogens into the hatchery
  - Incoming water supply unprotected and contains fish
  - Transfers of fish from other locations

- Amplification of pathogens within the hatchery

- Release of pathogens from hatcheries
  - Directly through effluent
  - Released infected fish interacting with wild fish

- Spread between watersheds
  - Stocking, natural migration or straying

- Amplification of pathogens outside hatchery
  - High numbers of adult salmon returning to hatchery

Types of Pathogens

- Endemic pathogens –occur naturally in native fish
  - E.g. *Renibacterium salmoninarum,* IHNV, *Ceratomyxa shasta*
- Emerging pathogens –not historically reported
  - Environmental disturbances or anthropogenic activities may cause emergence
  - E.g. VHSV
- Exotic pathogens –originate outside the region
  - E.g. *Myxobolus cerebralis*

Reducing Disease Risks From Hatcheries: Things we already know

Facility location

- High quality CLEAN water with good flow
- Avoid sites below anadromous fish spawning locations

Materials and Design

- Construction using concrete or non-porous materials
- Separate areas for different life stages with separate water supplies

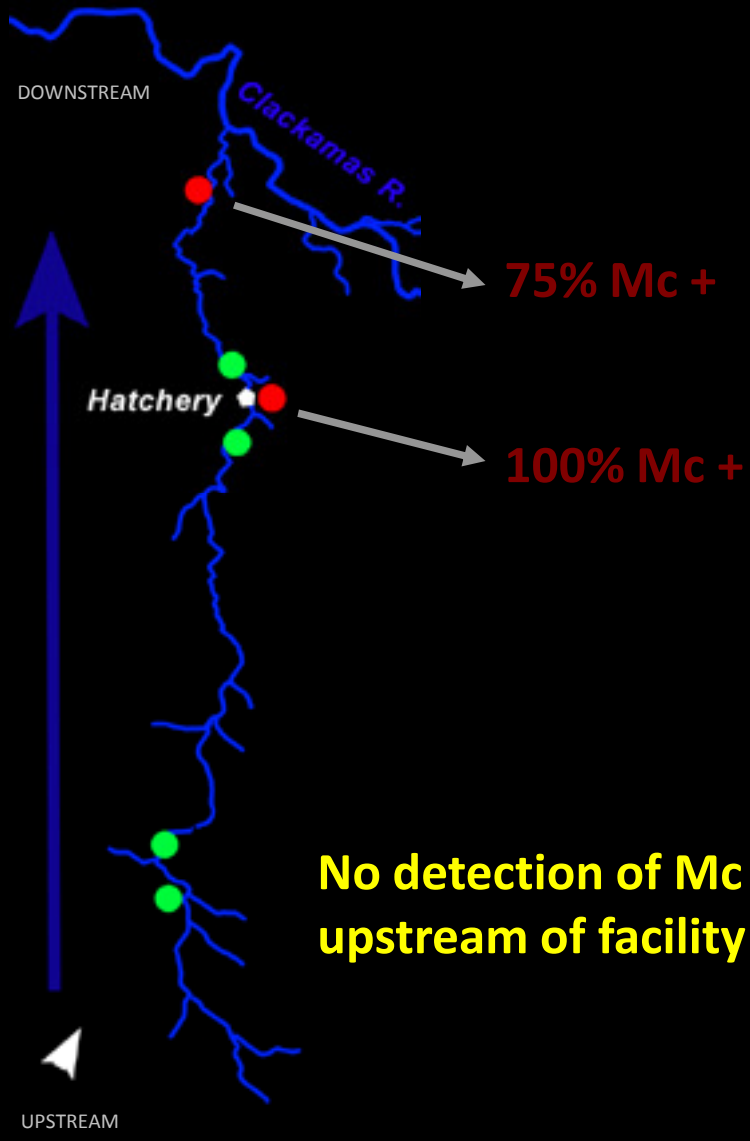
Good husbandry

- Regular fish health inspections

Cleanliness and biosecurity

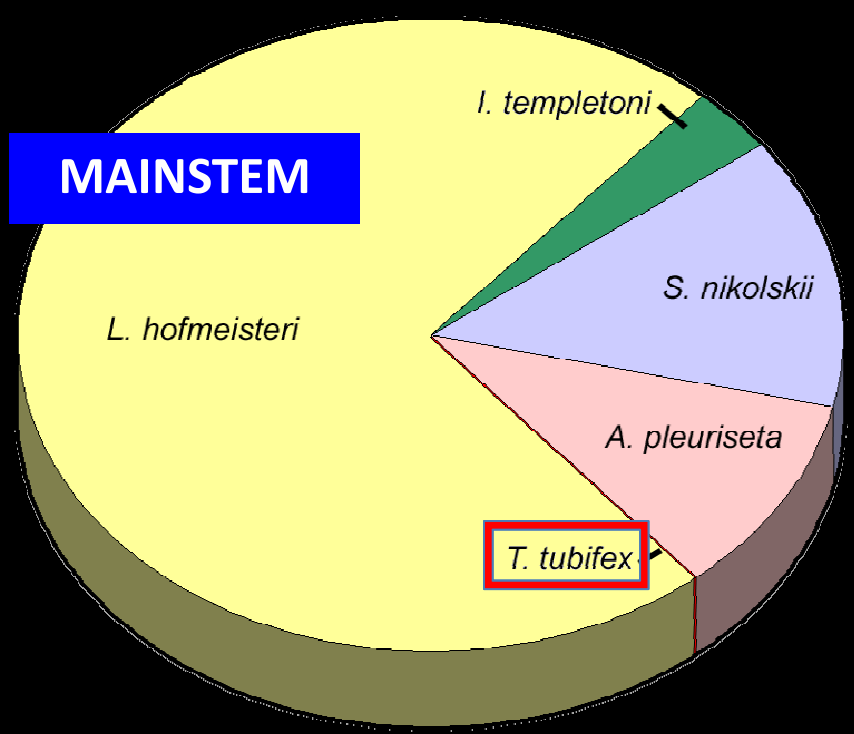
- Use nets that minimize physical injury
- Foot-baths & disinfection baths
- Separation of equipment

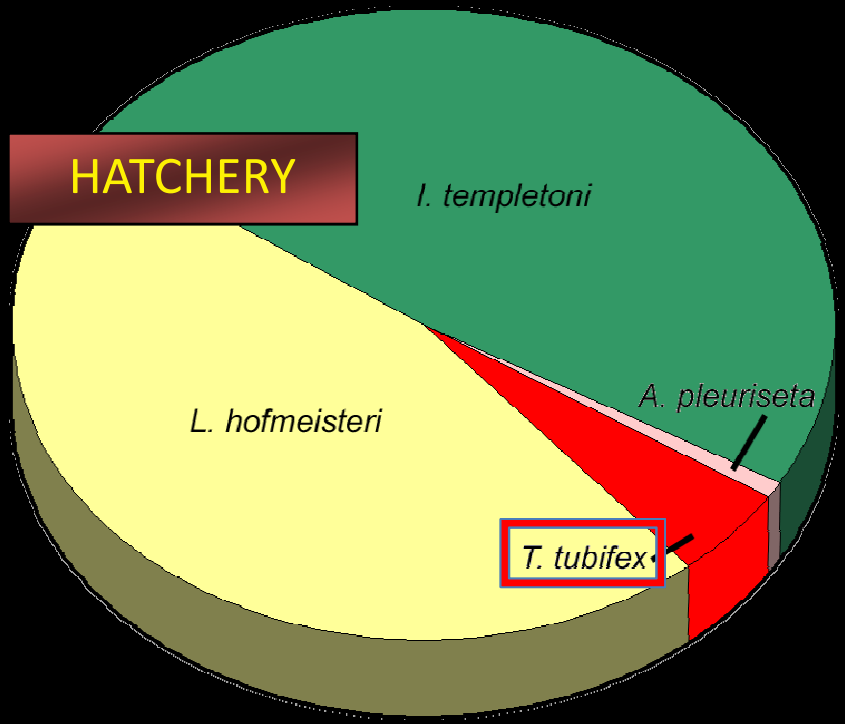
Assessing the risk: extent of spread



Survey using sentinel fish and molecular detection methods

Assessing the risk: distribution of invertebrate hosts





Invertebrate host at low prevalence in stream compared to hatchery