WASHINGTON STATE
Academy of Sciences
10TH ANNUAL MEETING & SYMPOSIUM
CLIMATE CHANGE IN WASHINGTON STATE
Research Questions Critical to Preparing for the Future

# The Impact of Climate Change on the Diseases of Fish

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# The Impact of Climate Change on Diseases of Fish

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# What Do We Know About Fish Diseases and Pathogens?

- Most fish pathogens were discovered in captive animals
- Stress can greatly increase mortality or disease
- Features of the host, the pathogen and the environment determine disease outcome
- Temperature is the most important environmental factor affecting the severity of disease in fish
- There is a global increase in emerging diseases of fish

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# Why are Some Fish Diseases and Pathogens "Emerging"?

- Better diagnostic assays
- Surveys of new species or geographic areas
- Global growth of aquaculture
- Movement by fish trade, anglers, ballast water, etc.
- Natural movements of vectors, reservoirs and carriers
- Application of biotic stressors to ecosystems
  - Spread of non-native species, loss of habitat, changes in forage base
- Changes in the physical environment
  - Water quality, flows, contaminants, temperature

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# Effect of Water Temperature on Coho Salmon Infected with *Flavobacterium columnare*

| Temperature (°C) | 4 | 7 | 9 | 12 | 15 | 18 | 21 | 24 |
|---|---|---|---|---|---|---|---|---|
| Control (% Dead) | 1 | 0 | 0 | 1 | 3 | 4 | 1 | 1 |
| Infected (% Dead) | 0 | 0 | 0 | 4 | 51 | 99 | 100 | 100 |

Holt et al. 1975

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# Effect of Water Temperature on Rock Seabream Infected with *Red Seabream Iridovirus*

| Temperature (°C) | 13 | 18 | 21 | 25 |
|---|---|---|---|---|
| Control (% Dead) | 0 | n.d. | n.d. | 0 |
| Infected (% Dead) | 0 | 100 | 100 | 100 |

Jun et al. 2009

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# Klamath River Fish Kills

- Major loss of returning adult Chinook, coho and steelhead in 2002 (est. 35,000+ fish died)
- Large run of fish (partially supplemented)
- 50-year low flows and high temperatures due to drought
- Significant water use conflicts
- Fish held in pools (low flows and temperature blocks)
- Death from columnaris and icthyophthiriasis
- Subsequent closure of coastal salmon fishery

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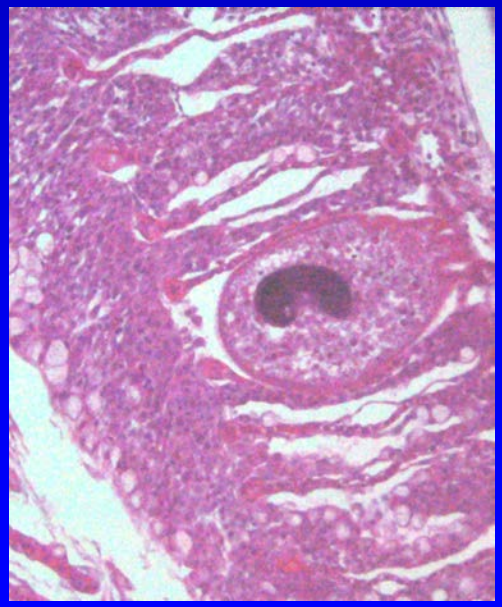

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# Columbia River Fish Kills

- Catastrophic loss of returning adult sockeye in 2015
- Large run of fish decimated by disease during migration
- Very low flows and very high temperatures early in run
- Fish held in pools between mid-Columbia dams due to flow and temperature blocks
- Death from columnaris and fungus
- Large sturgeon also affected
- Loss of more than 90% of some Snake River stocks

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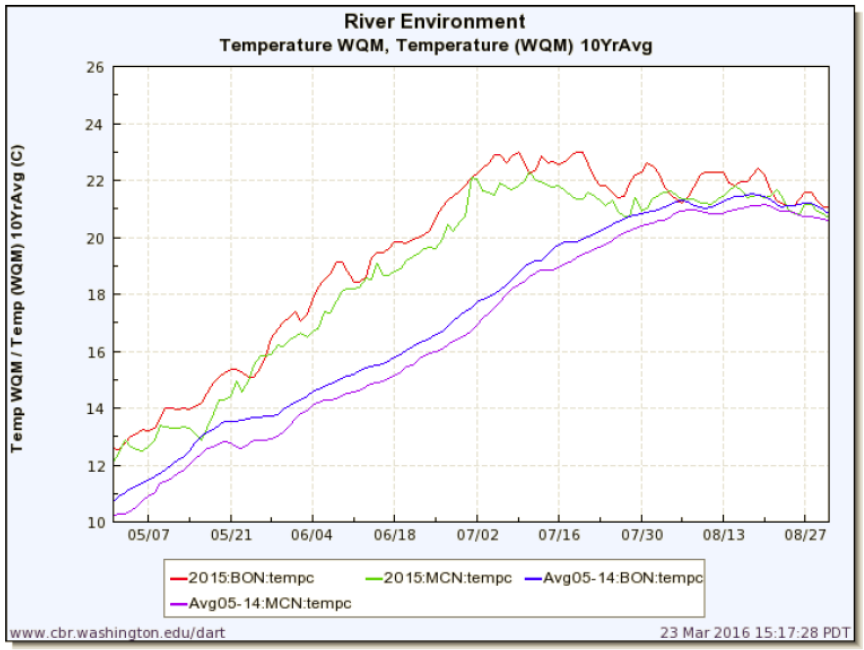


**Figure 2.** Columbia River temperature at Bonneville Dam and McNary Dam (forebays) in 2015 relative to the prior 10-year average.

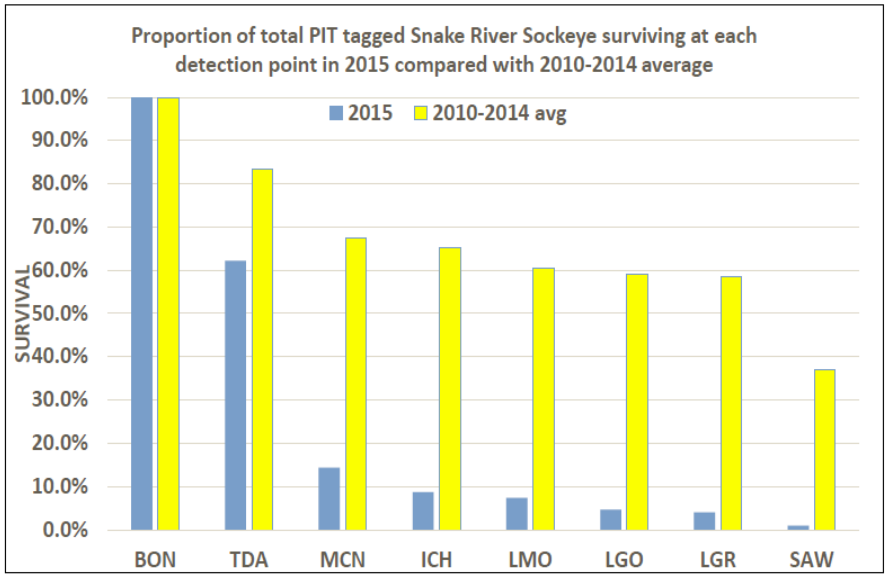


**Figure 12.** Proportion of total PIT-tagged Snake River sockeye salmon detected at Bonneville Dam that survived to each subsequent detection point (The Dalles, McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams and the Sawtooth Hatchery weir) in 2015 compared to average for 2010-2014. Source: PTAGIS data


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# Ichthyophoniasis in Yukon River Chinook Salmon

- First noted in the subsistence fishery in mid-1980s
- Returning adult Chinook infected – especially heart
- Steady increase in severity as fish move upriver
- Evidence of pre-spawning mortality
- Laboratory demonstration on the effects of temperature
  - Shorter mean-day-to-death
  - Loss of swimming stamina

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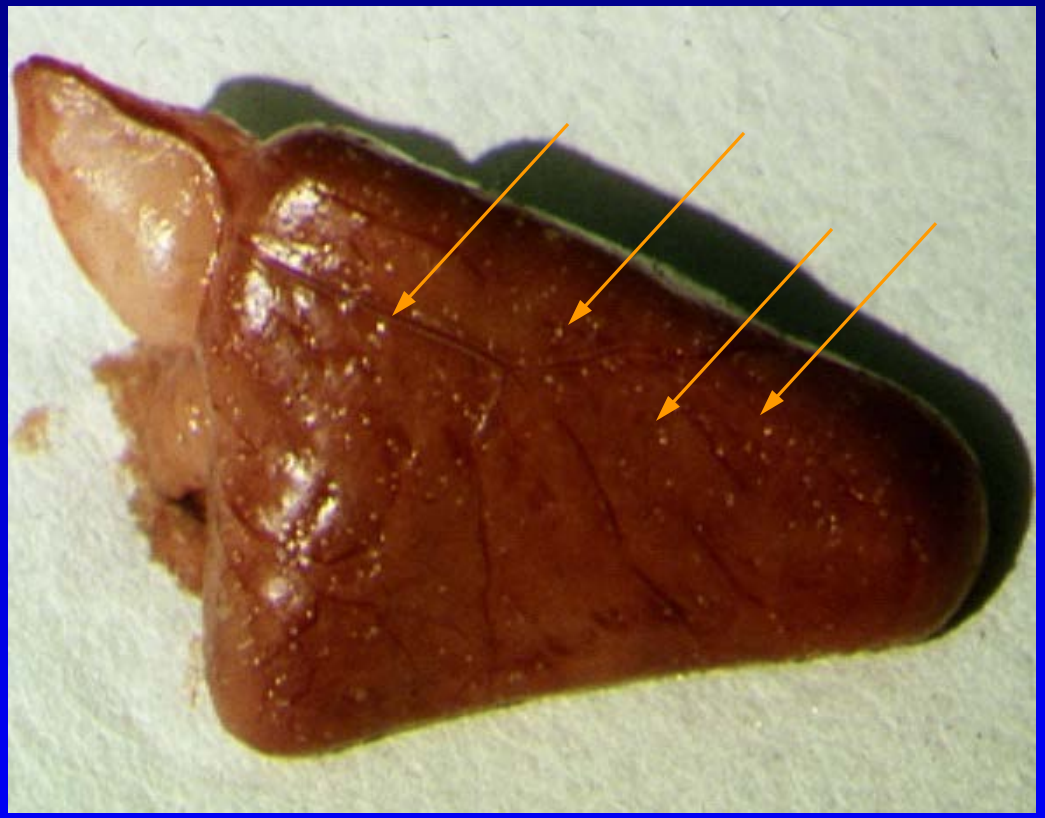
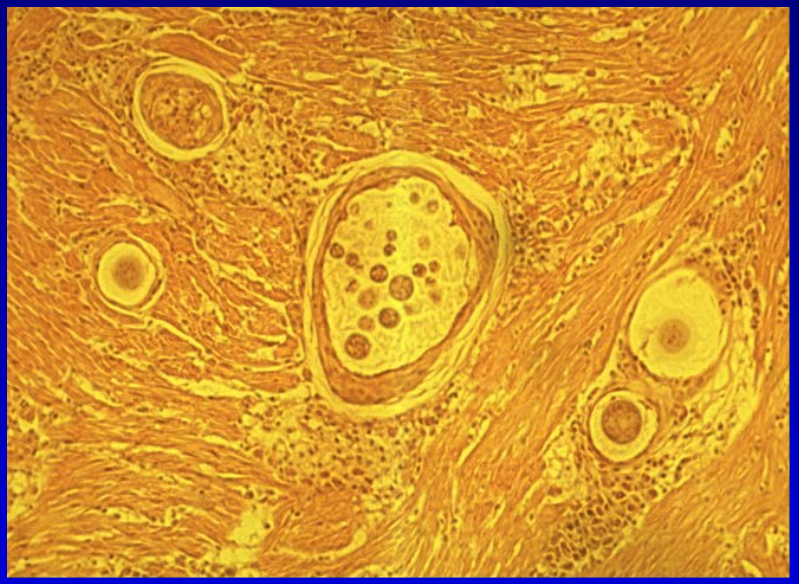
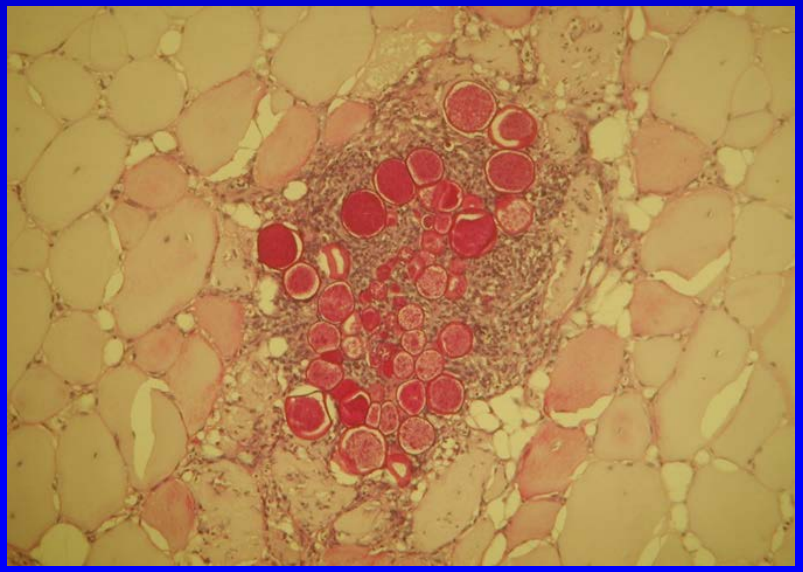
# Gross Lesions in Heart of Adult Chinook Salmon







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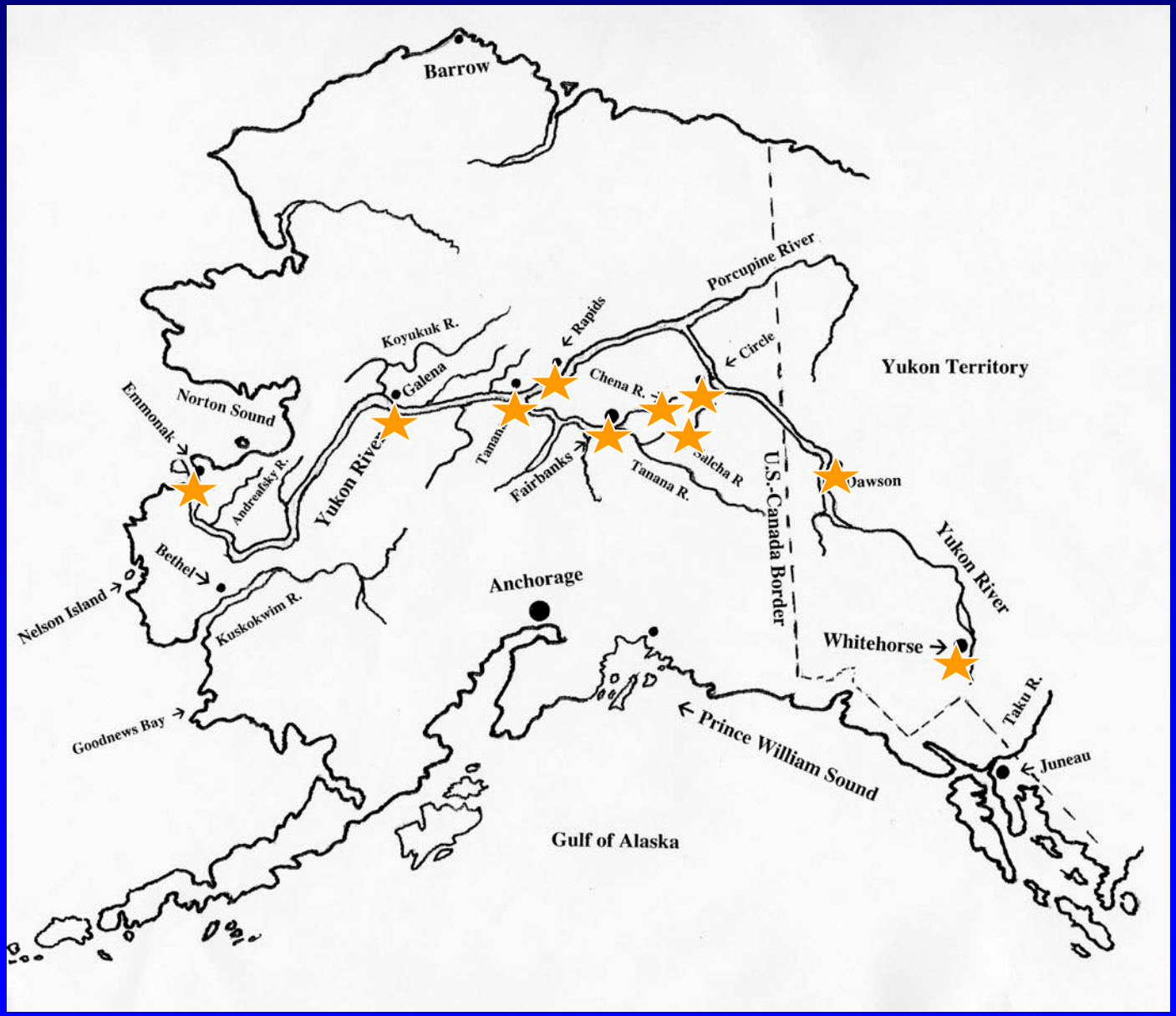
# Adult Chinook Sampling Sites on the Yukon River

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# Gross and Sub-clinical Infection Prevalence in Adult Chinook Salmon at Sites Along Yukon River


Kocan et al. 2004

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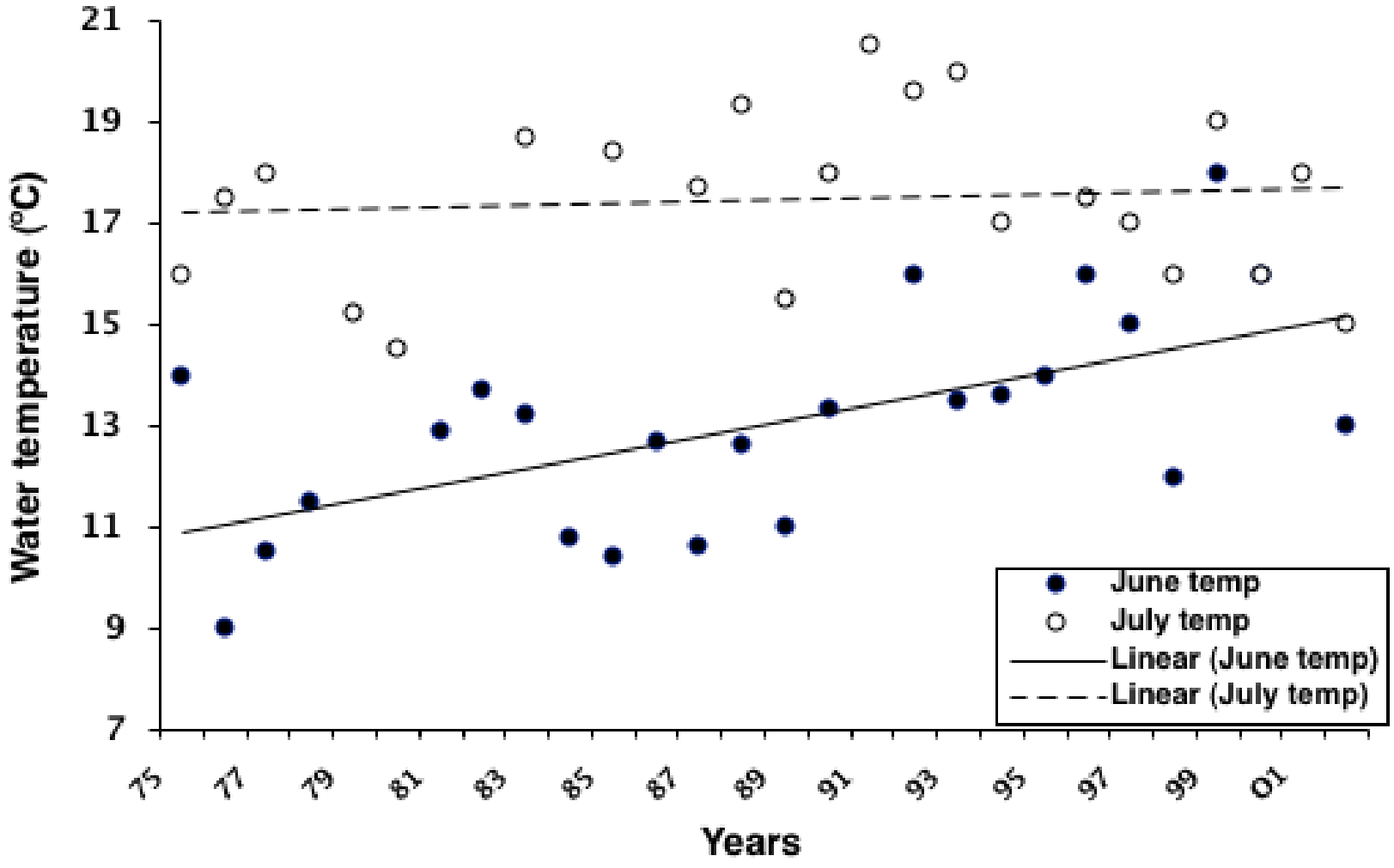
# Historic Yukon River Temperatures

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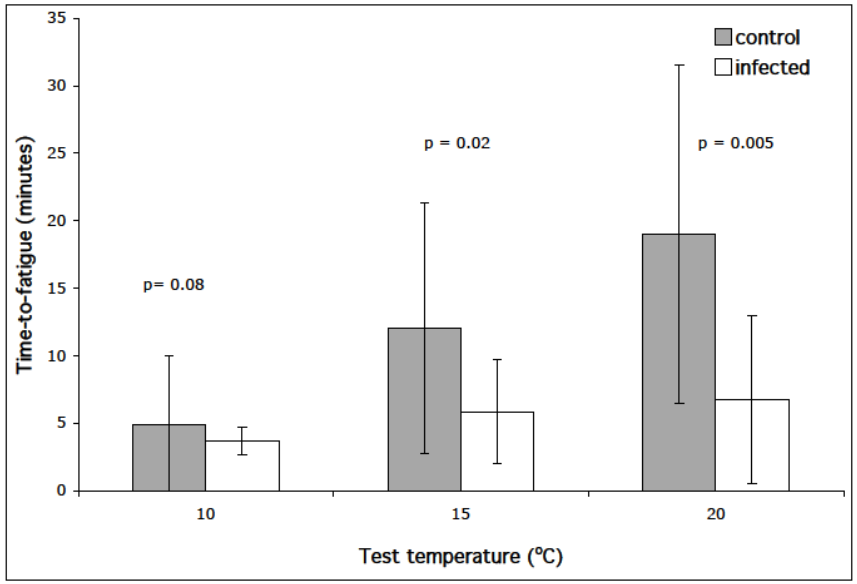
# Time to Death and Swimming Stamina of Ichthyophonus-infected Rainbow Trout at Three Temperatures

## Mean-day-to-death

| | Infected | Control |
|---|---|---|
| 10° C | 21.6 | 0 |
| 15° C | 13.4 | 0 |
| 20° C | 10.7 | 0 |

## Time-to-fatigue




Kocan et al. 2009

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# How Will Climate Change Affect Diseases of Fish?

- Change growth rate of pathogens
- Change host immune response to disease
- Change distribution of vectors, carriers and reservoirs
- Change density or distribution of susceptible species
- Change types or strains of pathogens present
- Change diets that affect host resistance or alter exposure
- Change physical habitat in ways that cause stress or affect disease ecology (water flows, water quality)

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# What Can the Washington State Academy of Sciences Do?

- Assist in outreach efforts to make the public aware of future impacts of climate change on fish and other aquatic organisms
- Provide technical assistance and advice to State and local policy-makers dealing with climate impacts
- Encourage regional, multi-agency and multi-state approaches for watershed management to include anticipated effects of climate change on fish and other aquatic species
- Facilitate studies to better define impacts of climate change and to evaluate mitigation strategies to ensure fish health

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# Thank You!


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