Willamette Copepod Research Program: Infection experiments and impacts on juvenile Chinook salmon

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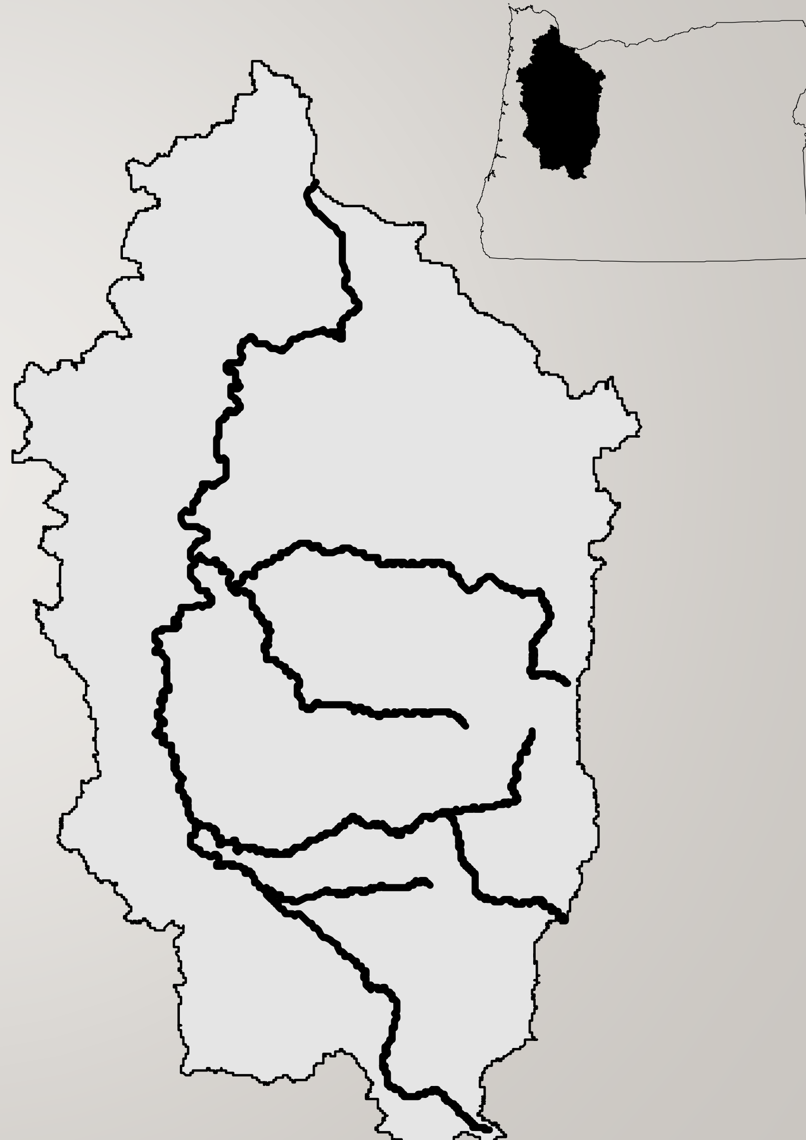
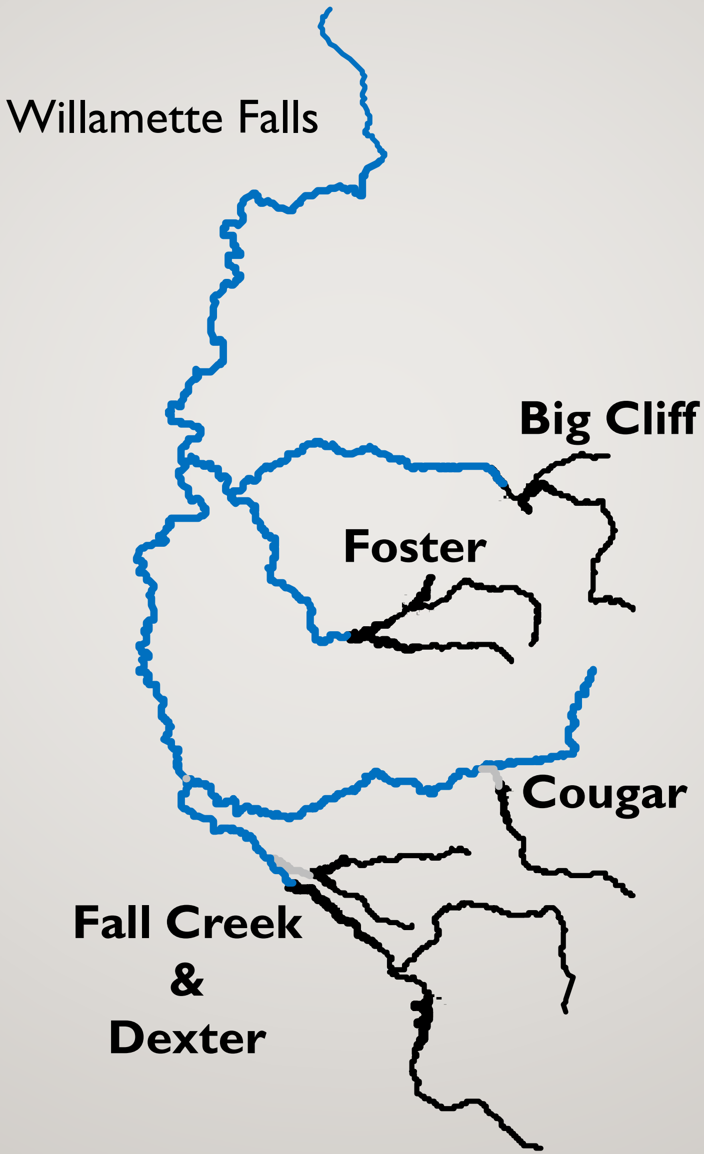
WILLAMETTE BASIN SPRING CHINOOK

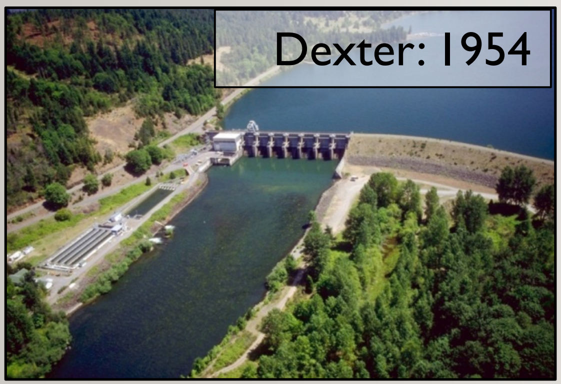
Anadromous species of conservation need

-Threatened status 1999
- Anthropogenic modifications

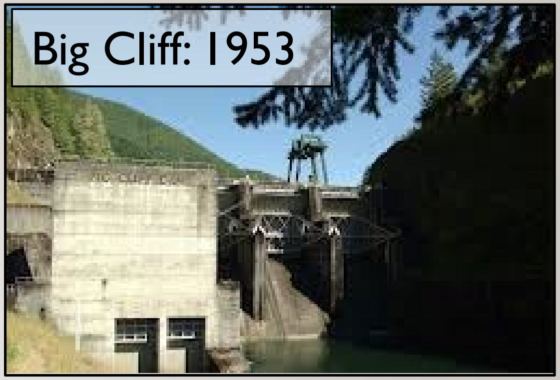


1950-60s BARRIERS TO ADULT MIGRATION




Dexter: 1954


Fall Creek: 1966

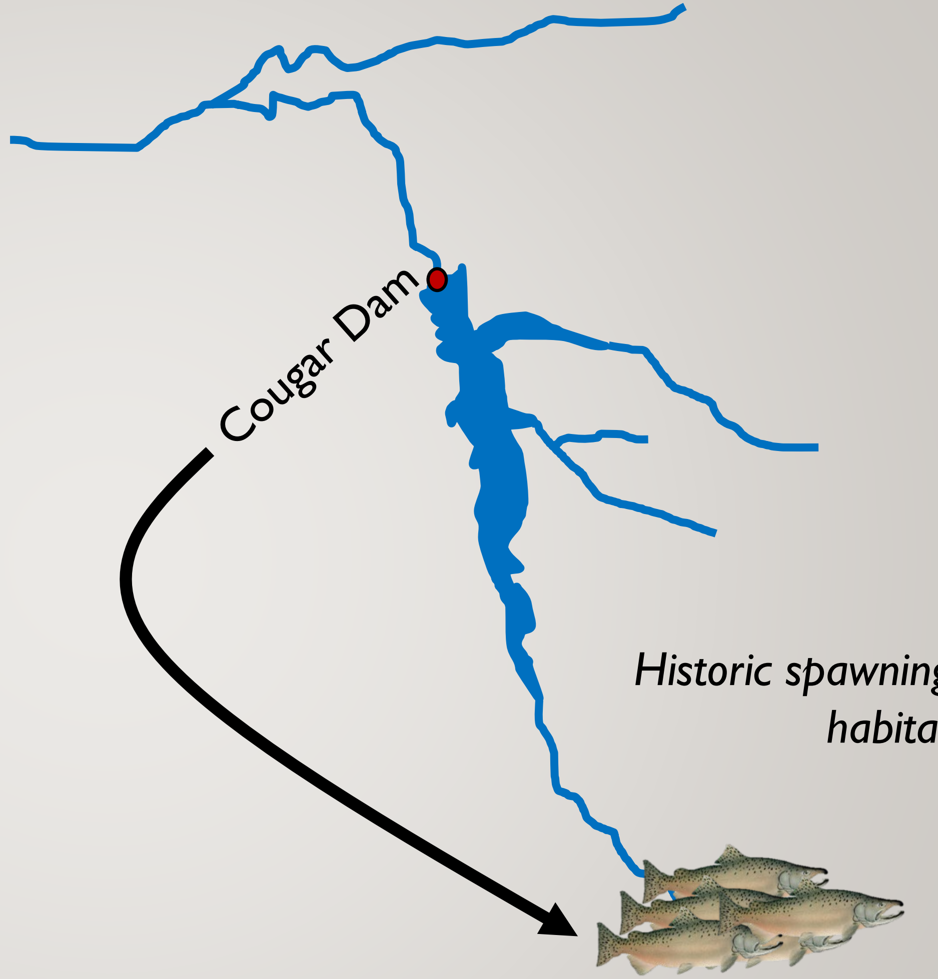

Big Cliff: 1953


Foster: 1968


Cougar: 1963

www.nwd-wc.usace.army.mil

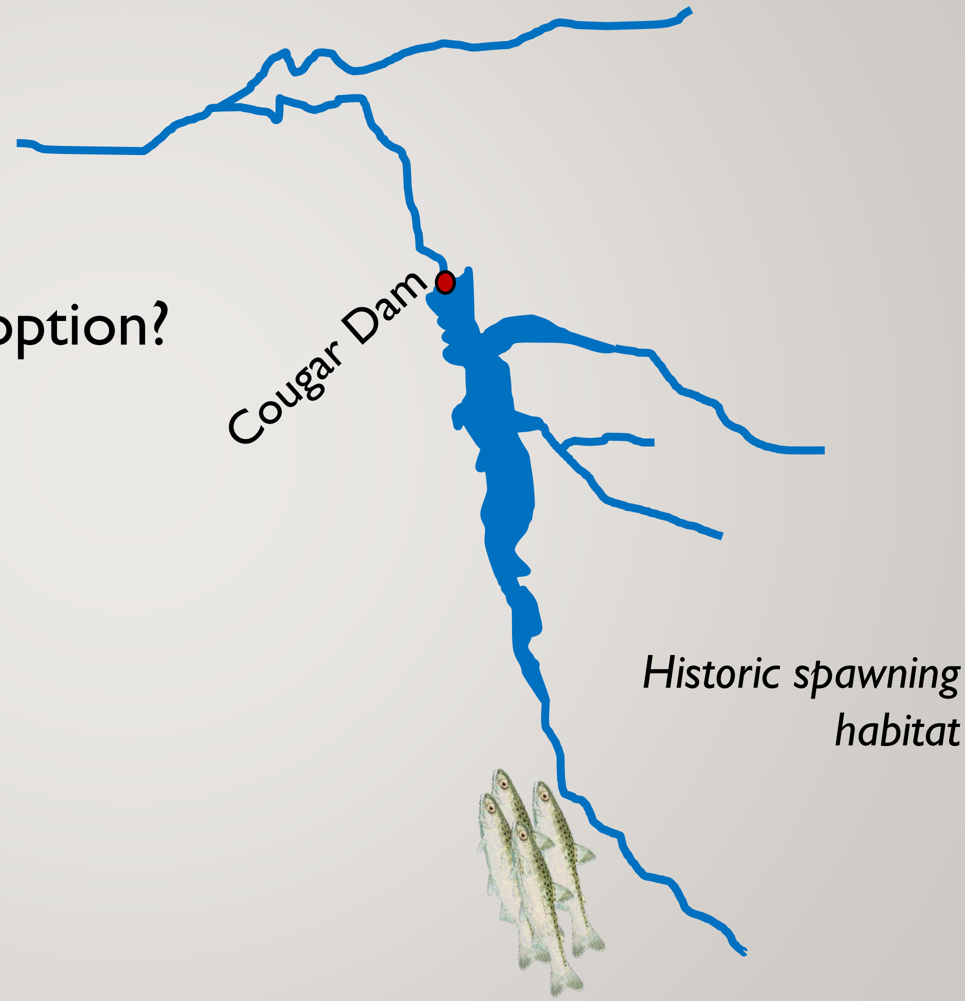
REINTRODUCTION ABOVE DAMS



NATURAL PRODUCTION!

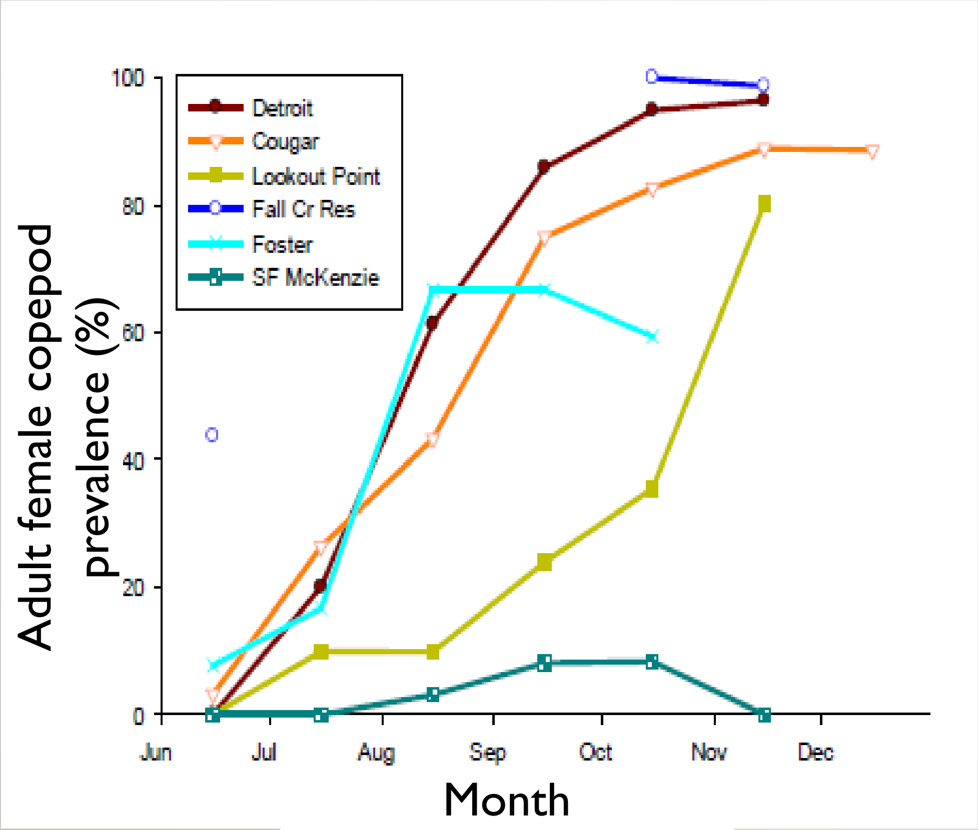
But….

What's the best passage option?



A COMPLICATION!!

Parasitic copepodids



Monzyk et al. 2012

OBJECTIVES

Ultimate goal: *safe and effective downstream juvenile Chinook passage (salmon recovery)*

Integrated approach

- Laboratory studies (experiments)
  - Infection
  - Stress
  - Osmoregulation
- Field research (Chrissy)
  - Spatial temporal distribution
  - Seasonality
  - Dynamics

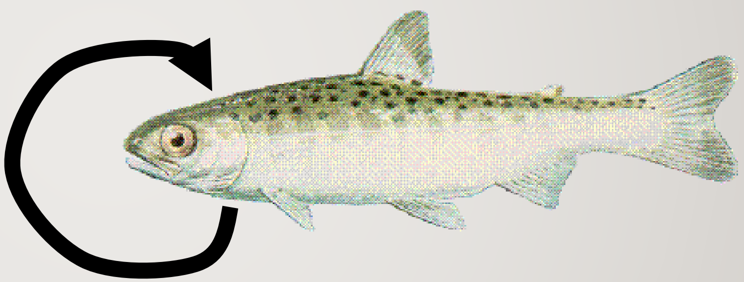
BUT FIRST….

Definitions:

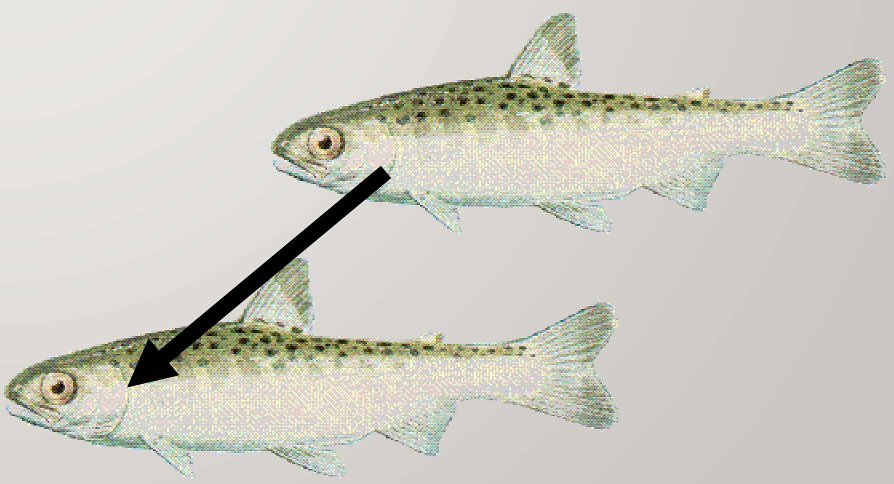
Infection rate (prevalence) = proportion of infected fish

Infection intensity = number copepods per infected fish

Autoinfection



Cross infection



INFECTION EXPERIMENTS

Hypotheses

1. Infection rate increases with increased stress
2. Infection rate and intensity increases with copepodid density
3. Infection rate increases with increased water temperature
4. Very high copepod infection intensities largely due to autoinfection
5. Very high copepod infection prevalence largely due to cross-infection

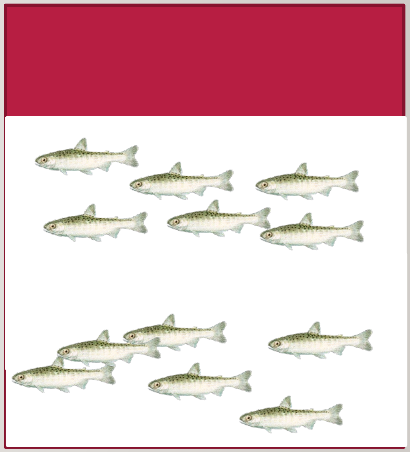
INFECTION EXPERIMENTS

Treatments

Tank size (stress)- small (2’ dia), large (3’ dia)

Copepodid density- low (35-75 l), high (150-300 l)

Water temperature- cold (12-13°C), warm (15-16°C)



Fully factorial design 3^2 = 8 trmts, 2 replicate tanks

Infection event:

- Lowered tank water
- Introduced copepodids
- Let stand 1 hr
- Raised water level

INFECTION EXPERIMENTS

Cross infection

Large tanks- 3' dia

Cold water temperature- 12-13°C,

10 infected and 10 uninfected (ad clipped) surrogate fish

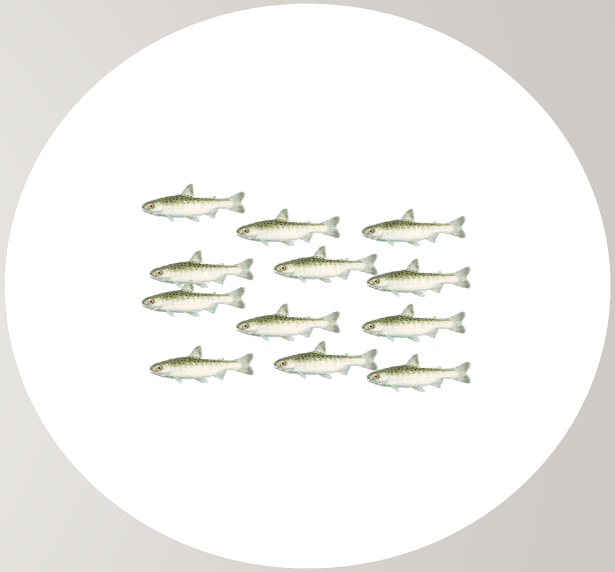
Hold fish minimum 6 weeks (complete copepod life cycle)

6 replicate tanks, 3 treatment x 3 control

STRESS EXPERIMENTS

Replicate level of stress as trap and haul

Large tank 3' dia, 20 fish per tank
Cool water temperature 12-13°C
20 fish per tank
3 replicates control (uninfected) and infected ea



Initial experimental stressor- low level stressor
Crowd fish into center of tank
Hold 1 hr
Release fish from crowding

Second experimental stressor- low level stressor
Empty tank and expose fish to air (30 sec)
Raise water 6 cm, leave 1-h
Return normal water level

Sample cortisol at 1 hr, 3 hr, 9 hr

SALTWATER CHALLENGE

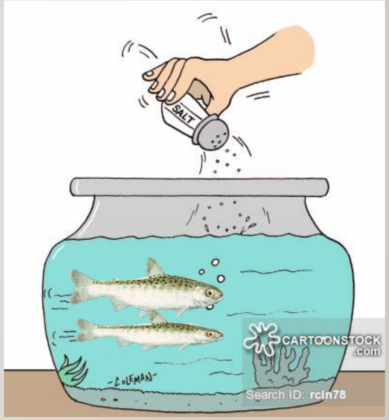
Evaluate osmoregulation ability

Fish from pilot study, experimental infection, control

15 fish randomly selected per group,

Placed in aerated saltwater (34 ppt)

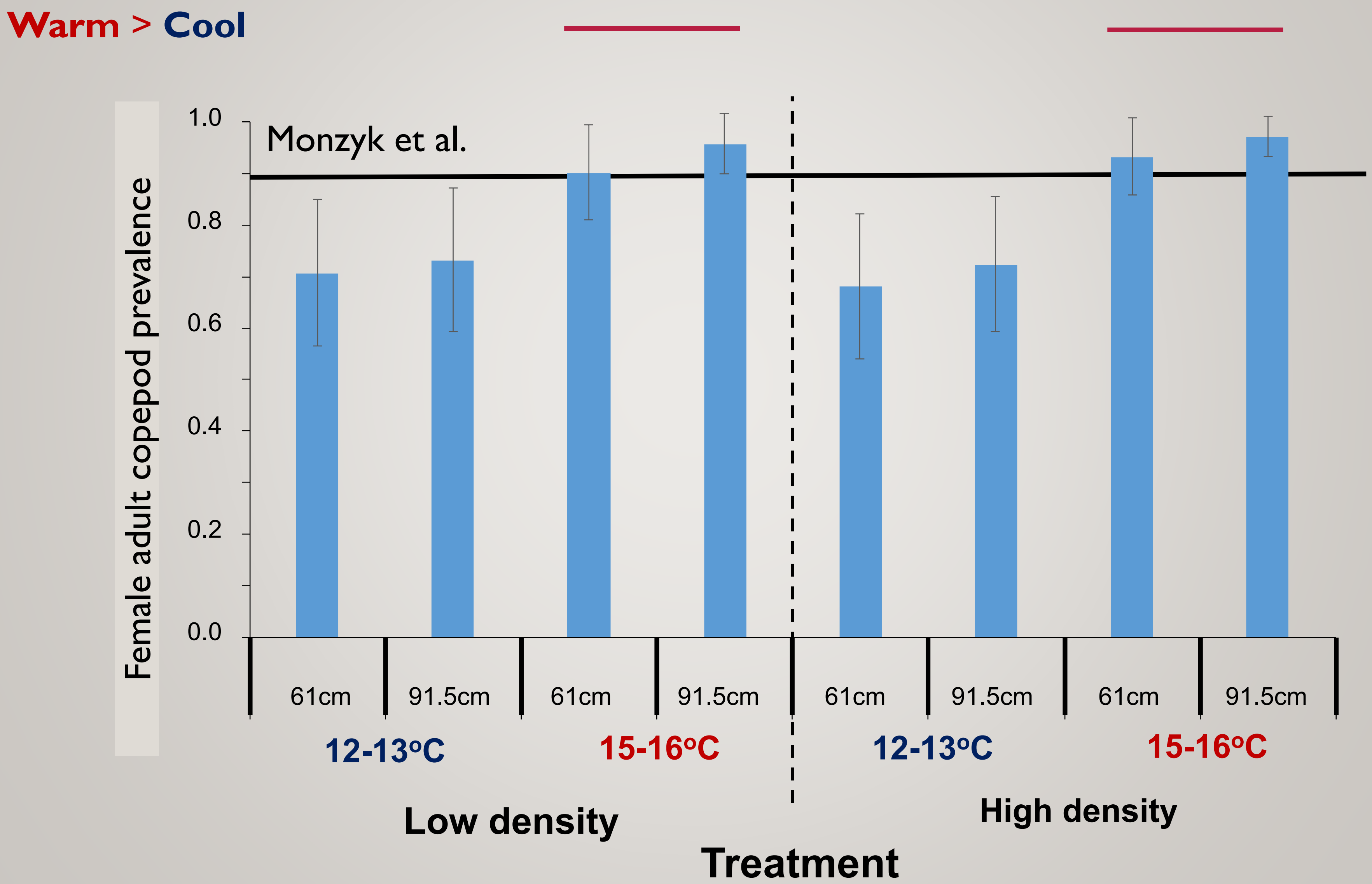
3 replicates control (uninfected) and infected ea



Hold fish 24hr

Sample blood

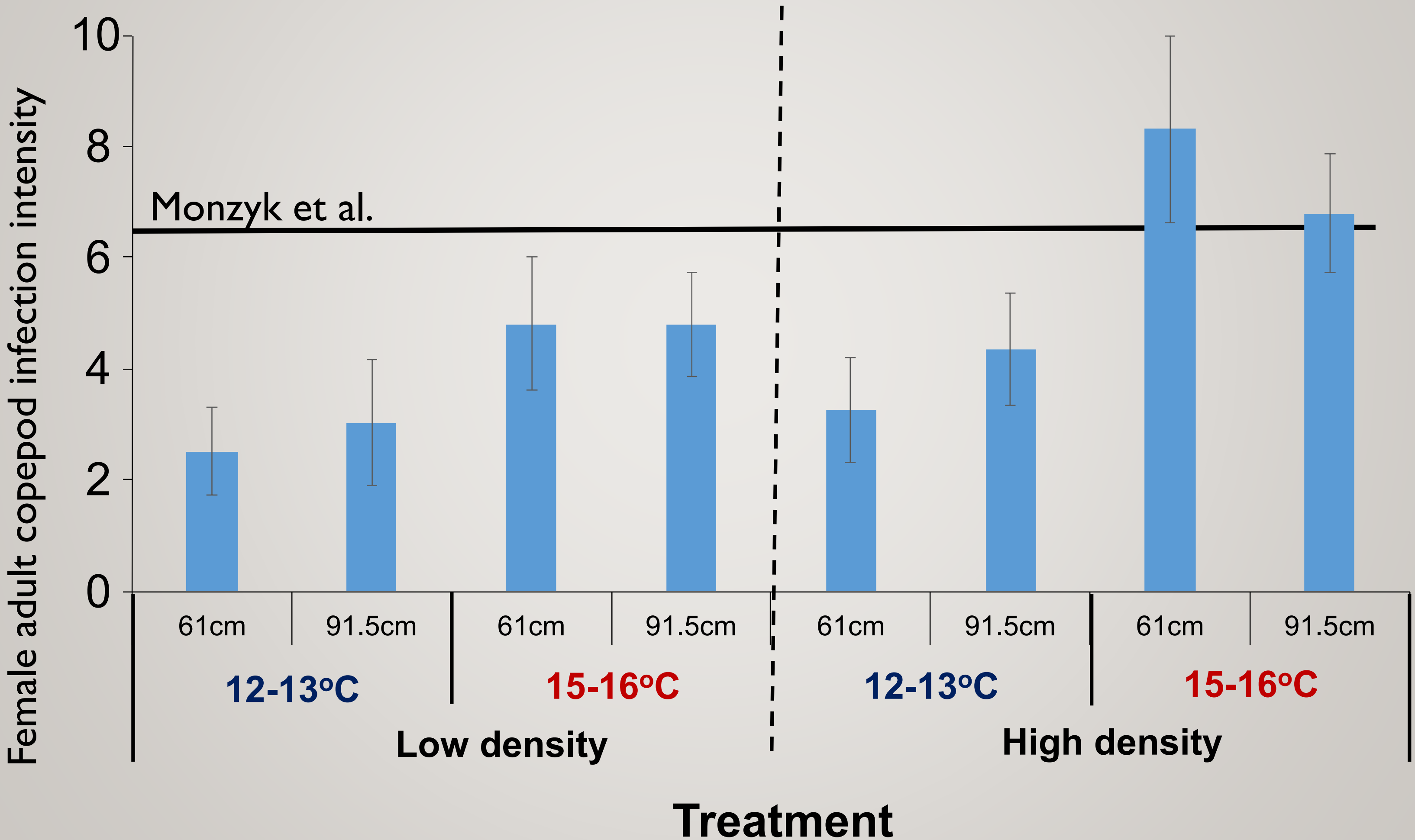
PRELIMINARY RESULTS: INFECTION EXPERIMENTS



Preliminary results subject to revision

PRELIMINARY RESULTS

Copepodid density
Temperature
Tank size
Tank size x temperature



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PRELIMINARY RESULTS: INFECTION EXPERIMENTS

83 (20%) mortalities during infection experiments

Mortalities 1.1 times more likely with each adult female copepodid 2.1 times with each juvenile stage attached

High copepodid treatment fish 4.87 times more likely to die

Warm water treatment fish 3.8 time more likely to die

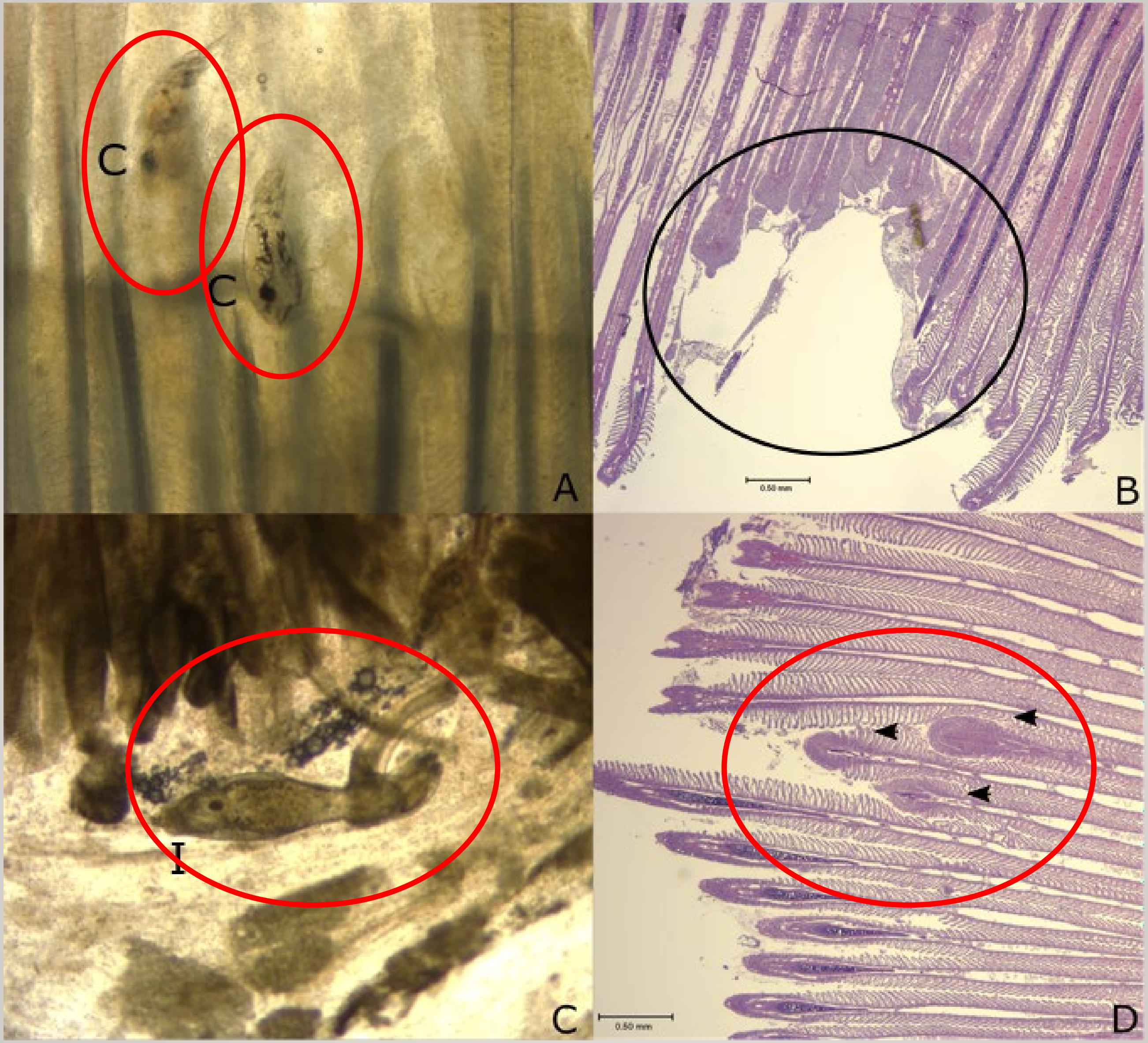
76% attached to the gills or inside the operculum

Most gill damage associated with pre-adult stages

Preliminary results subject to revision

Juvenile stage

Damage from juvenile stage



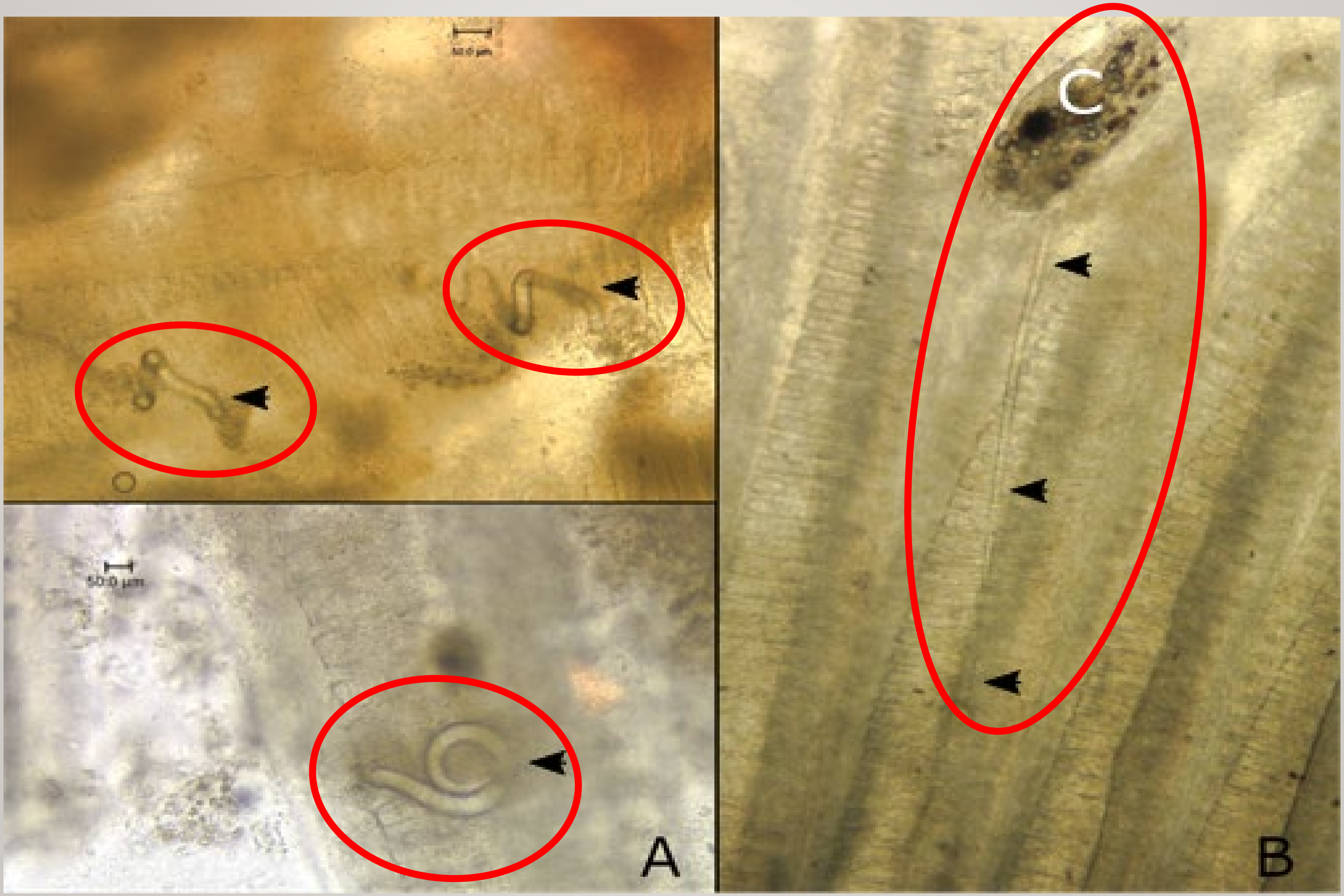
Immature adult stage

Regeneration

Preliminary results subject to revision

DO ALL JUVENILES BECOME ADULTS?

Filaments, no juveniles | Juvenile attached by filament



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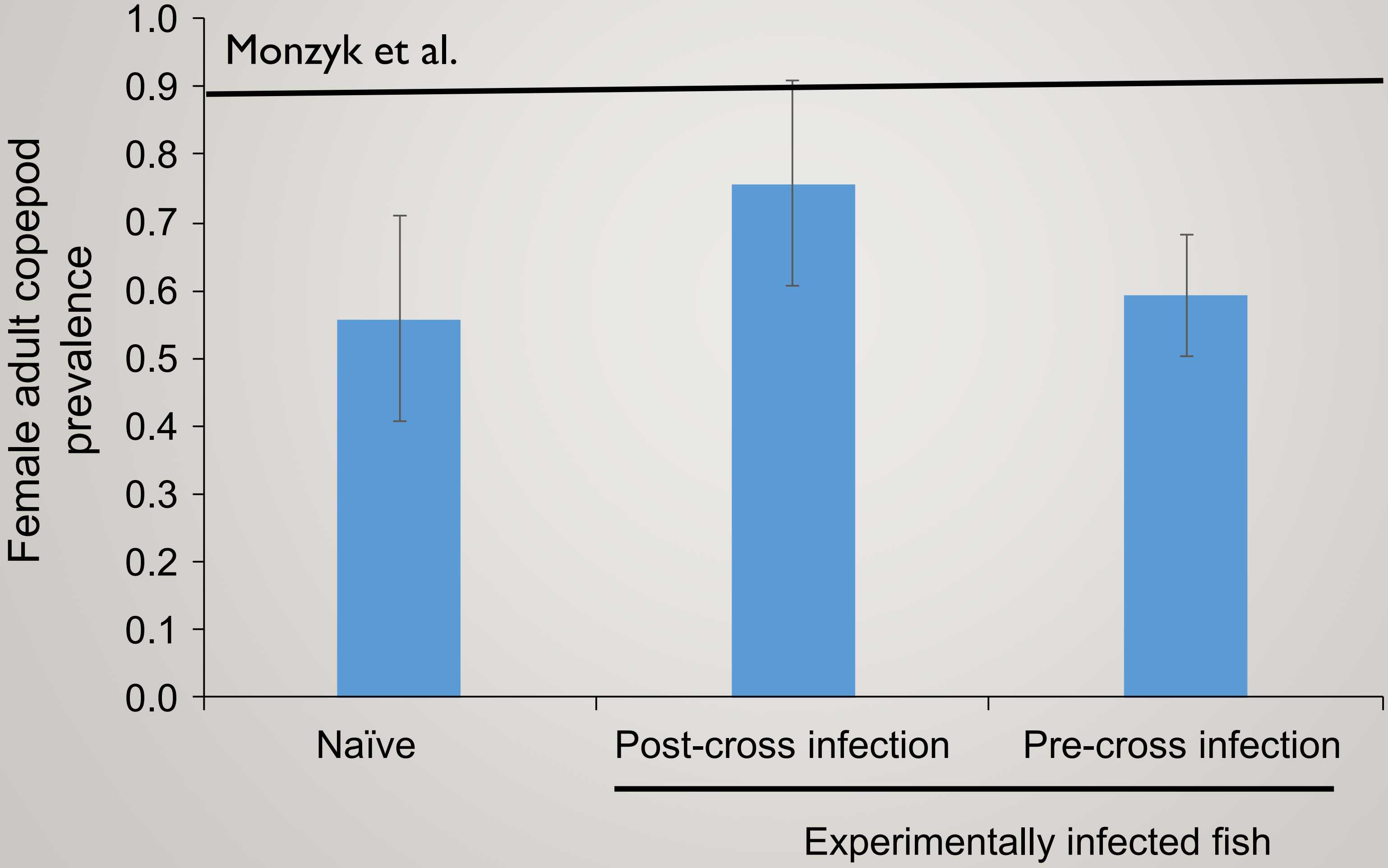
PRELIMINARY RESULTS: CROSS INFECTION EXPERIMENTS



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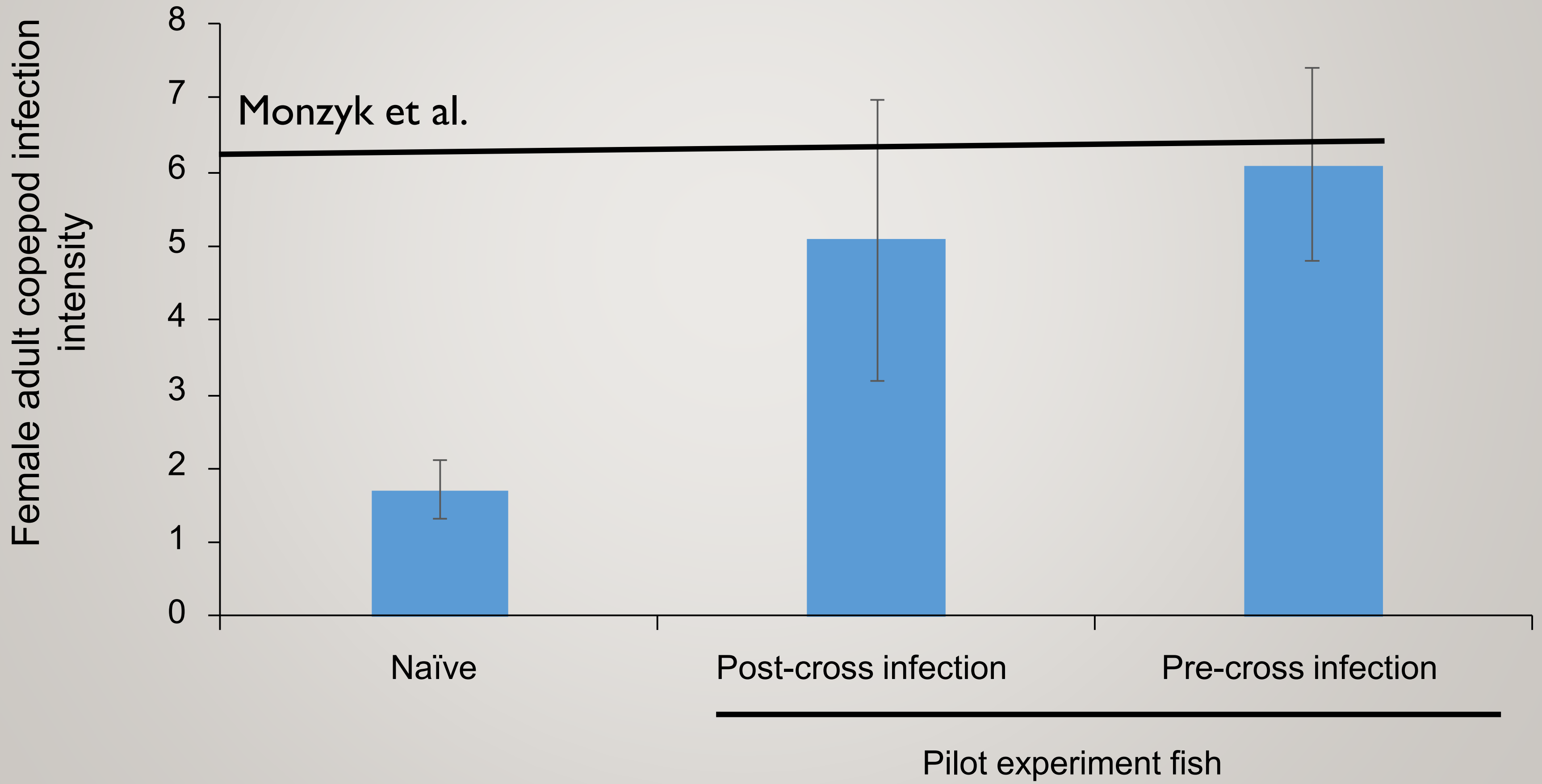

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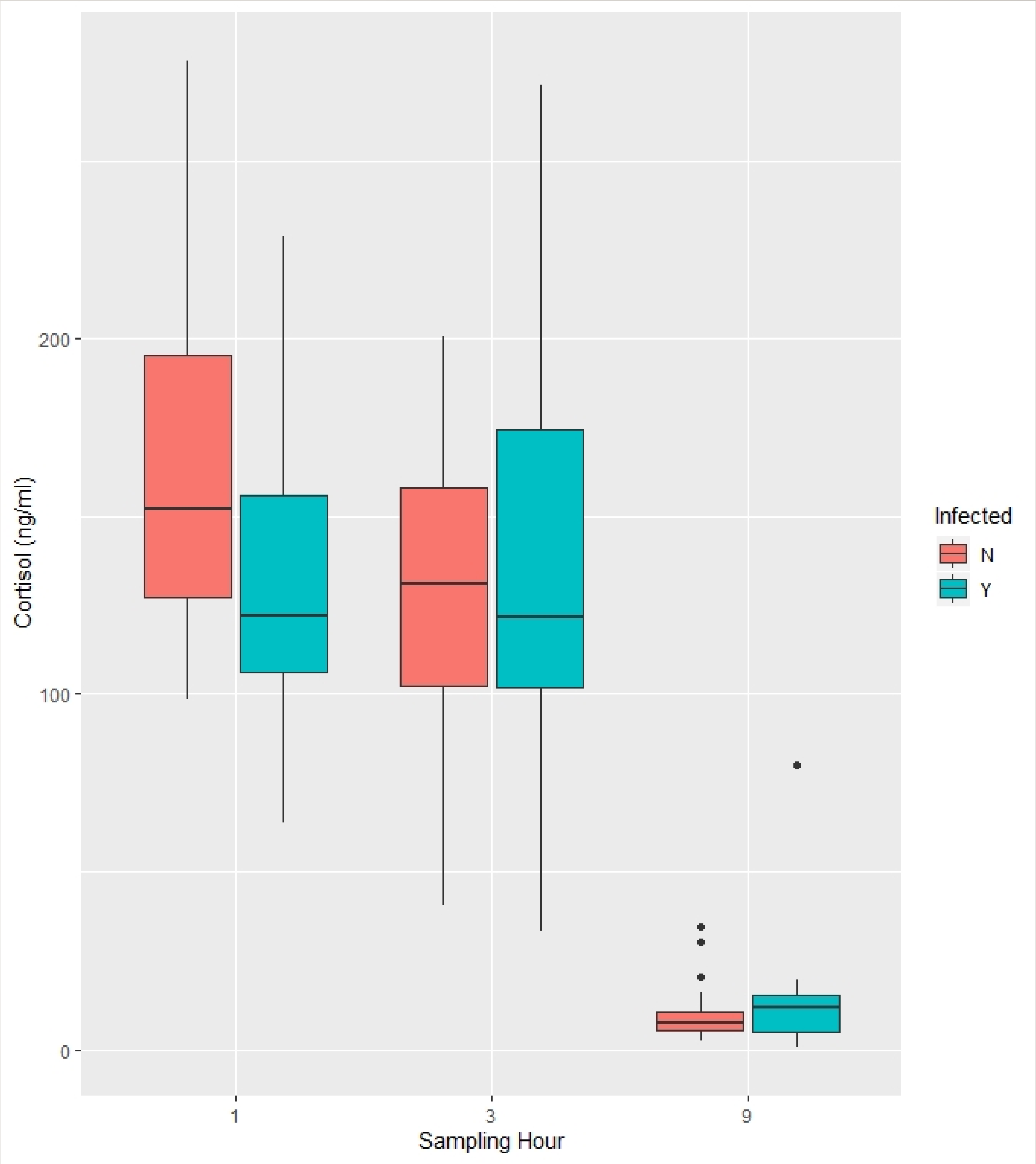
PRELIMINARY RESULTS: STRESS EXPERIMENT

Significant differences

3 & 6 hr > 9hr

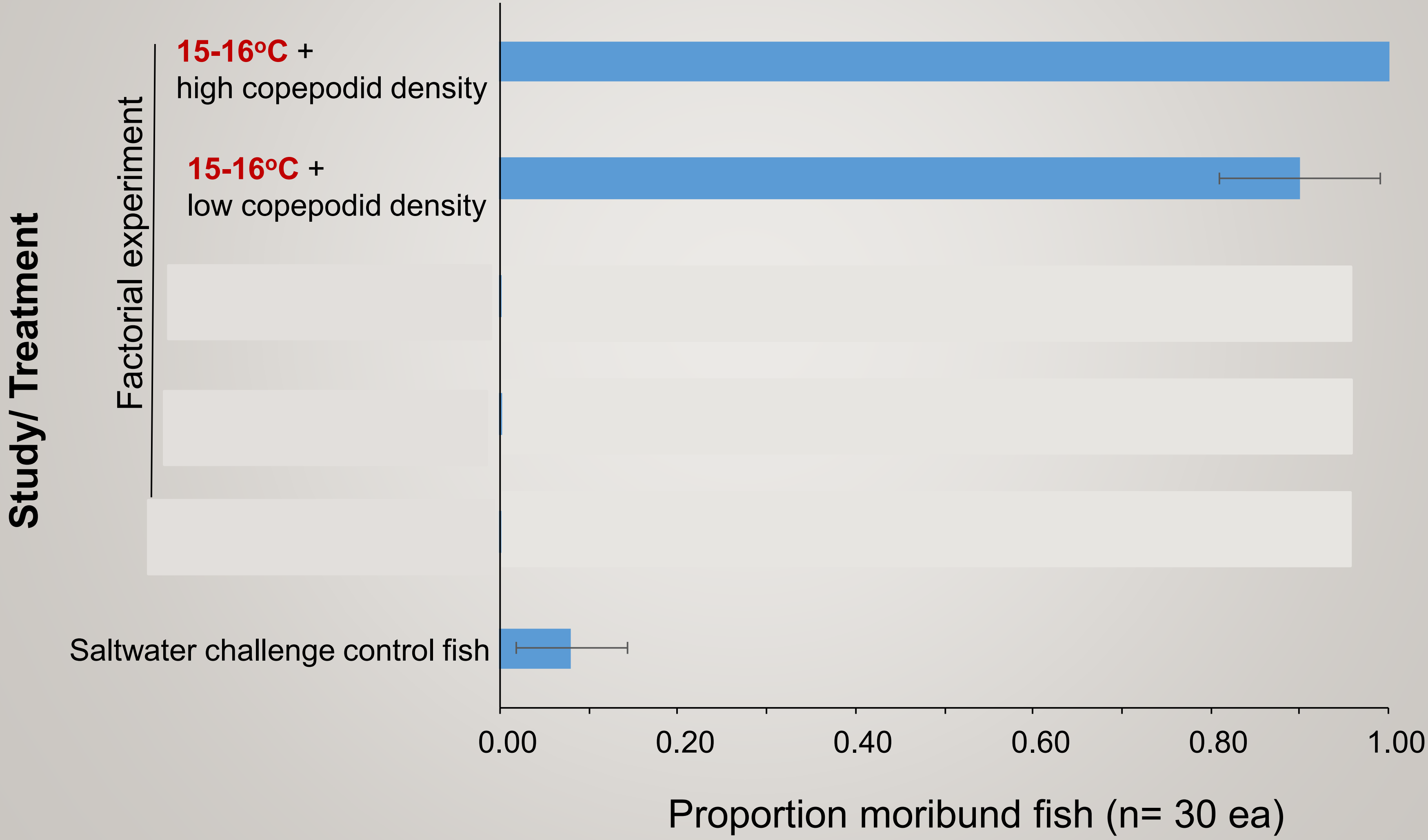
Increased with length



Preliminary results subject to revision

PRELIMINARY RESULTS: SALTWATER CHALLENGE

Substantial mortality



Preliminary results subject to revision

CONCLUSIONS

Infect juvenile Chinook salmon at wild levels

Water temperature and copepodid density key drivers

Cross infection successful, but intensity low

Juvenile stages cause most gill damage

Infection intensity of adult female copepods are a poor indicator of the damage

Stress test inconclusive

Osmoregulation affected by infection, but possible healing

Key unknown: infection dynamics in wild populations

Preliminary results subject to revision

ACKNOWLEDGEMENTS

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ODFW

USACE

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