EFFECTS STRESSORS ON SURVIVAL AND DAM PASSAGE OF JUVENILE CHINOOK SALMON: IMPLICATIONS FOR JUVENILE FISH PASSAGE

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USGS science for a changing world

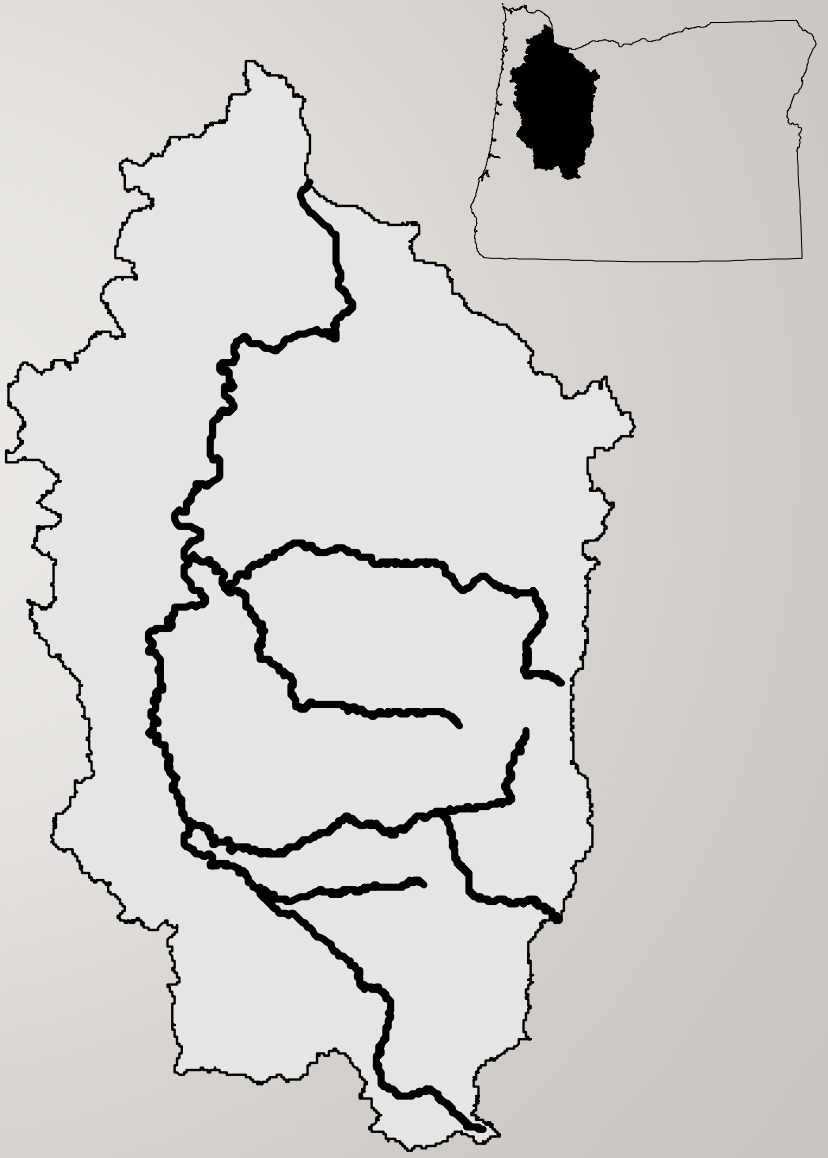
Oregon State University

Oregon Cooperative Fishery Research Unit — Semper Catostomus

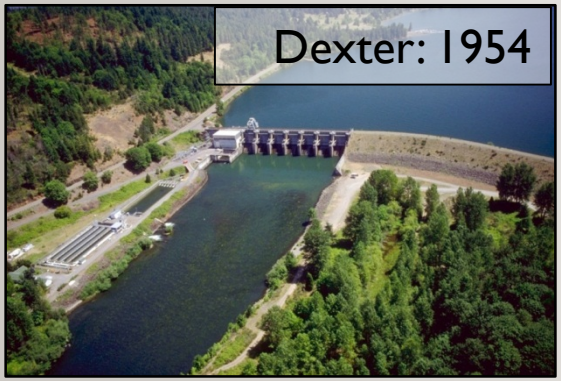
WILLAMETTE BASIN SPRING CHINOOK

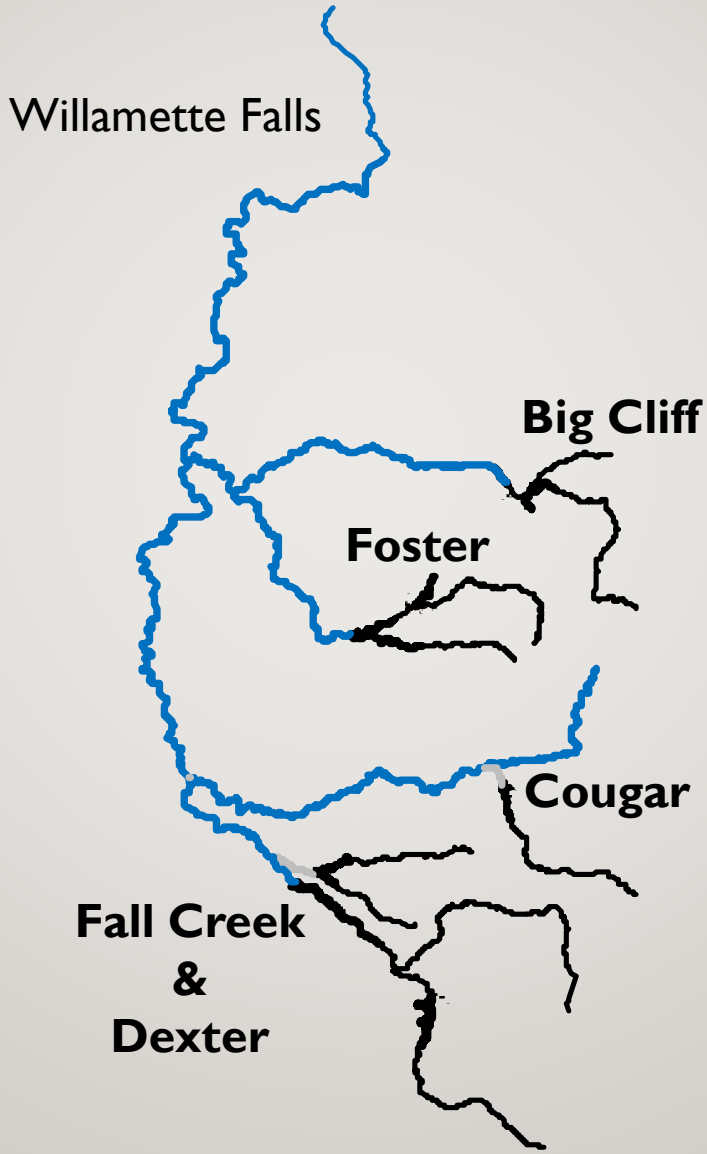
Anadromous species of conservation need

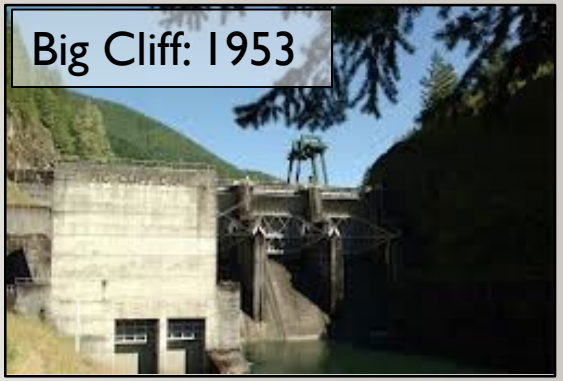
-Threatened status 1999
- Anthropogenic modifications



1950-60s BARRIERS TO ADULT MIGRATION

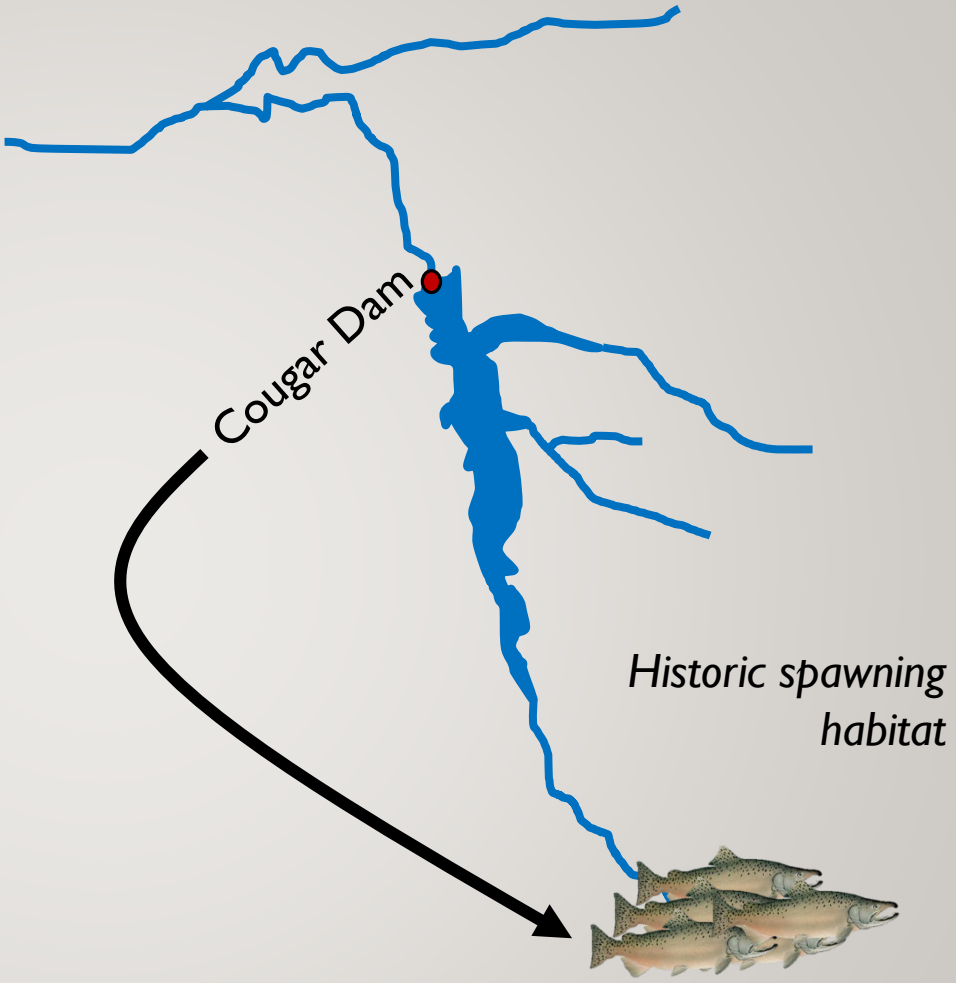






www.nwd-wc.usace.army.mil

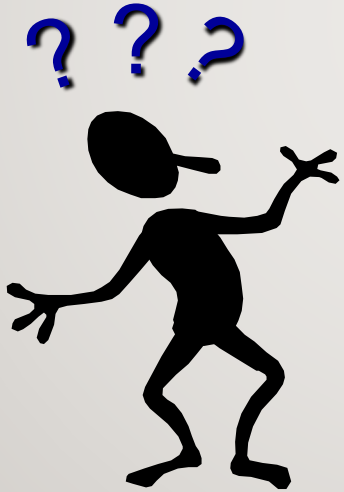
REINTRODUCTION ABOVE DAMS

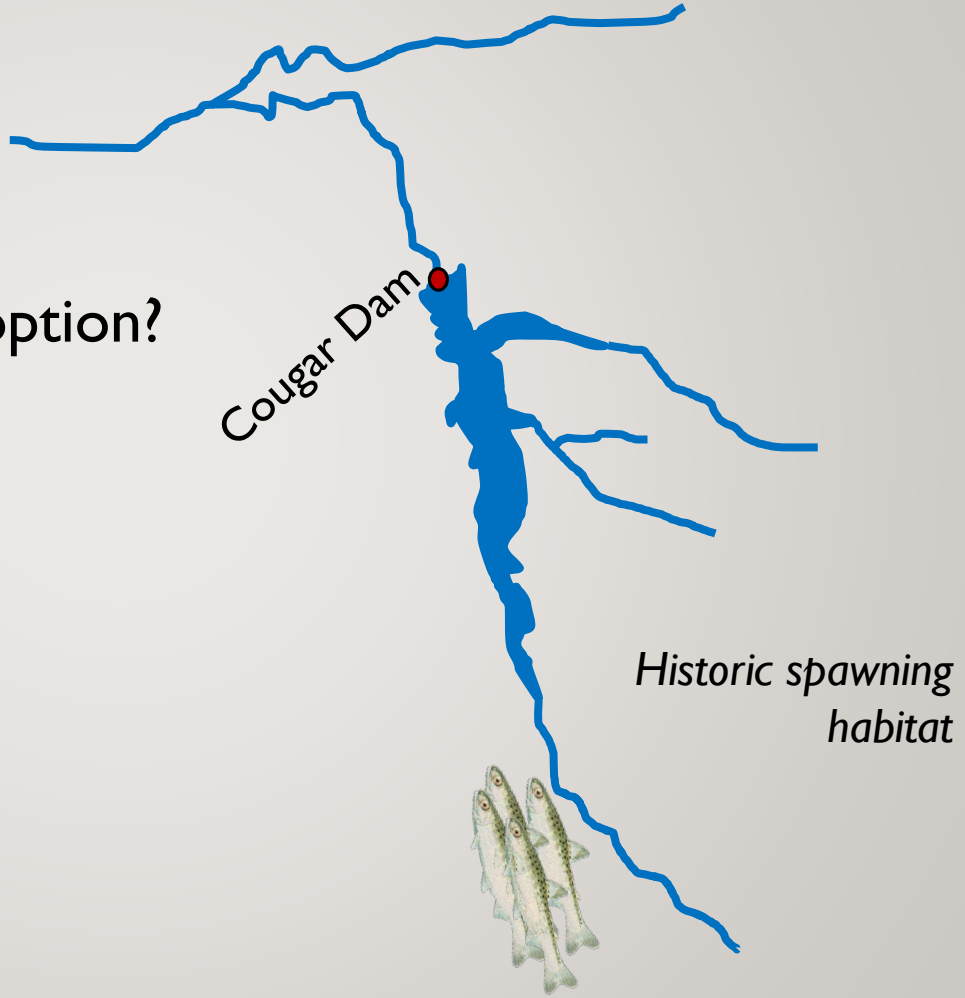


NATURAL PRODUCTION!

But….

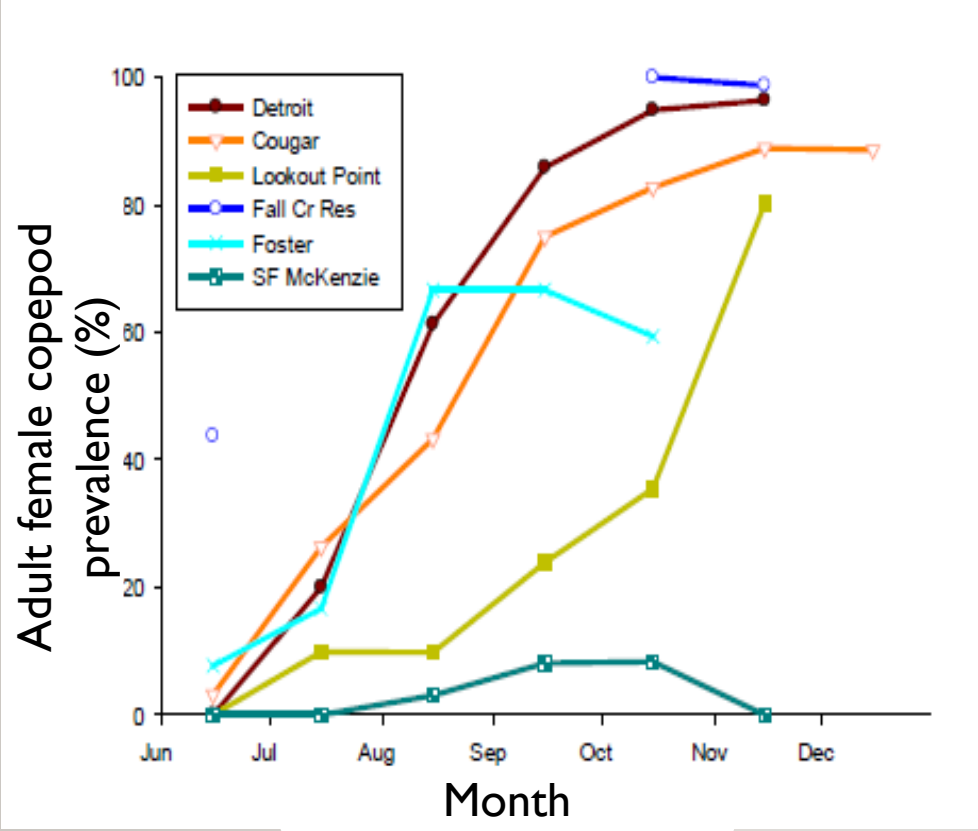
What's the best passage option?





A COMPLICATION!!

Parasitic copepodids



Monzyk et al. 2012

COPEPODS AFFECT FISH PERFORMANCE

"Trap & Haul" with Copepods

- Cougar, natural infection trap & ~ 2-3 hr Haul
  - 34 dead out of 40 in 5 days

- Lab infected, netting & bucket transfer ~20 sec
  - 2 dead out of 40 in 2 days, 0 uninfected dead

- Lab infected, netting & bucket transfer ~20 sec
  - 2 dead out of 63 in 2 days, 0 uninfected dead

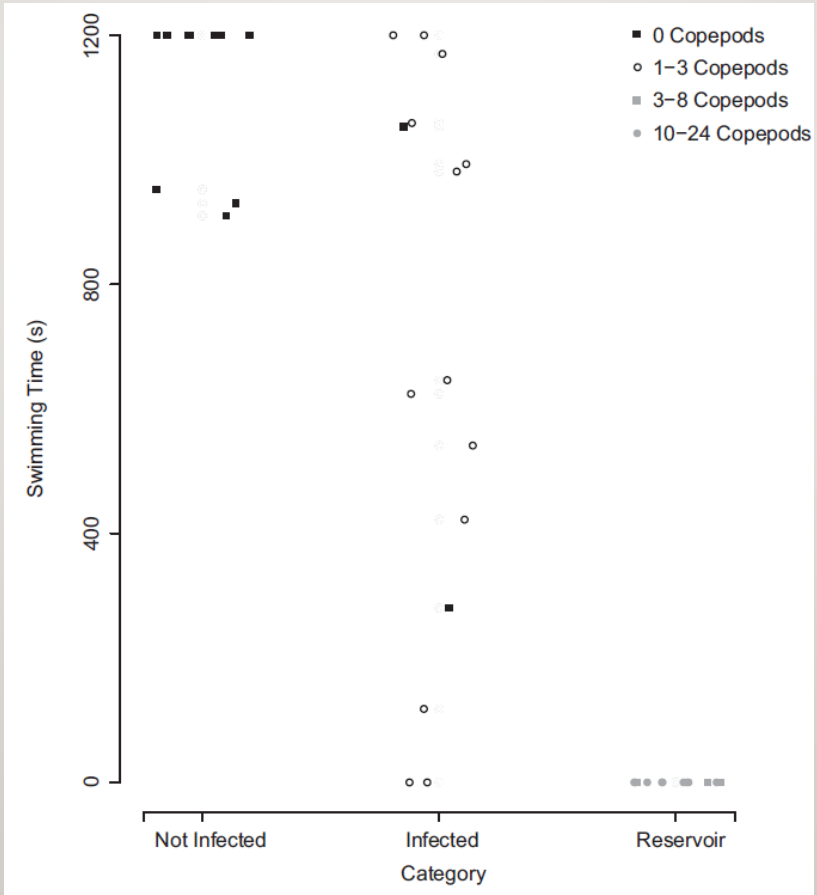
- Lab infected, netting & IP injection ~ 1 min
  - 30 dead out of 30 in 10 days, 0 uninfected dead

Romer &Herron, Kent, Neal et al.

COPEPODS AFFECT FISH PERFORMANCE

Post release performance with Copepods

- Even lightly infected fish have greatly reduced swimming capability



Herron et al. 2018

OBJECTIVES

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

Integrated approach

- Laboratory studies
  - Infection
  - Fish performance
  - Stress
- Field research
  - Spatial temporal distribution
  - Seasonality
  - Dynamics
- Modeling
- Decision Analysis

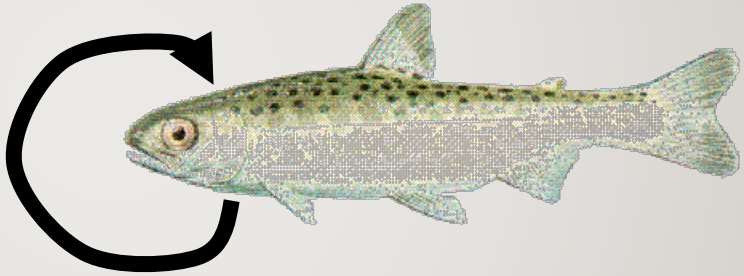
BUT FIRST….

Definitions:

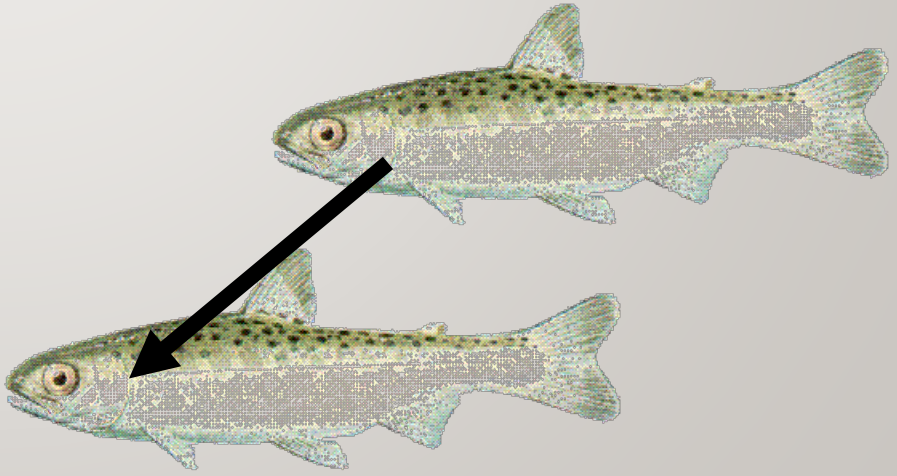
Infection rate (prevalence) = proportion of infected fish

Infection intensity = number copepods per infected fish

Autoinfection



Cross infection



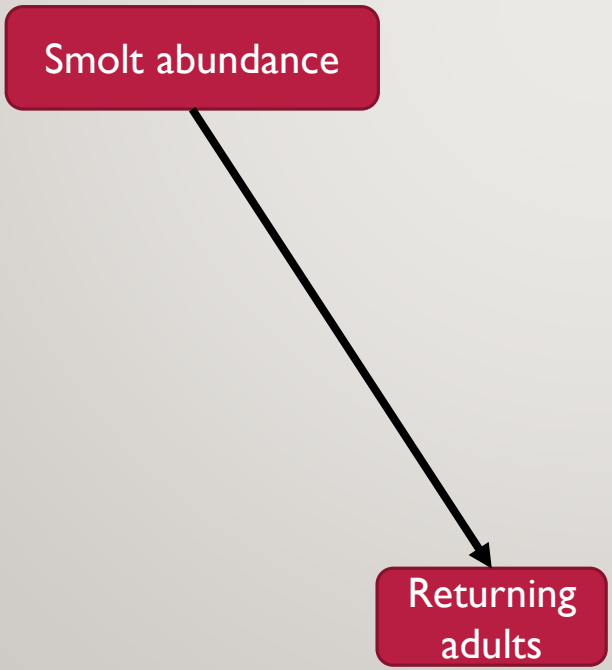
INTEGRATED APPROACH?

Our fundamental objective

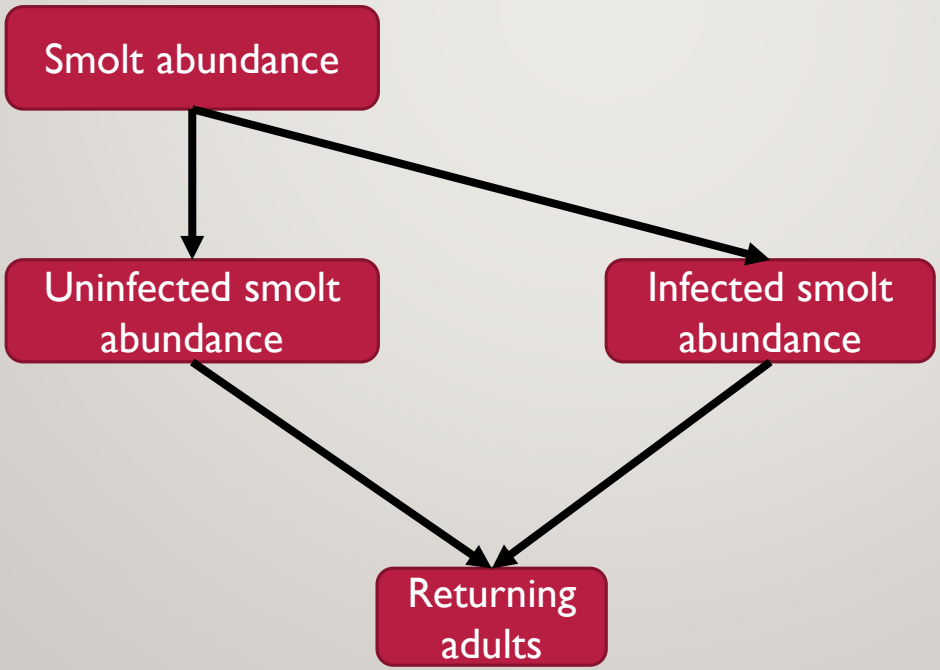
How do we achieve it?

Returning adults

INTEGRATED APPROACH



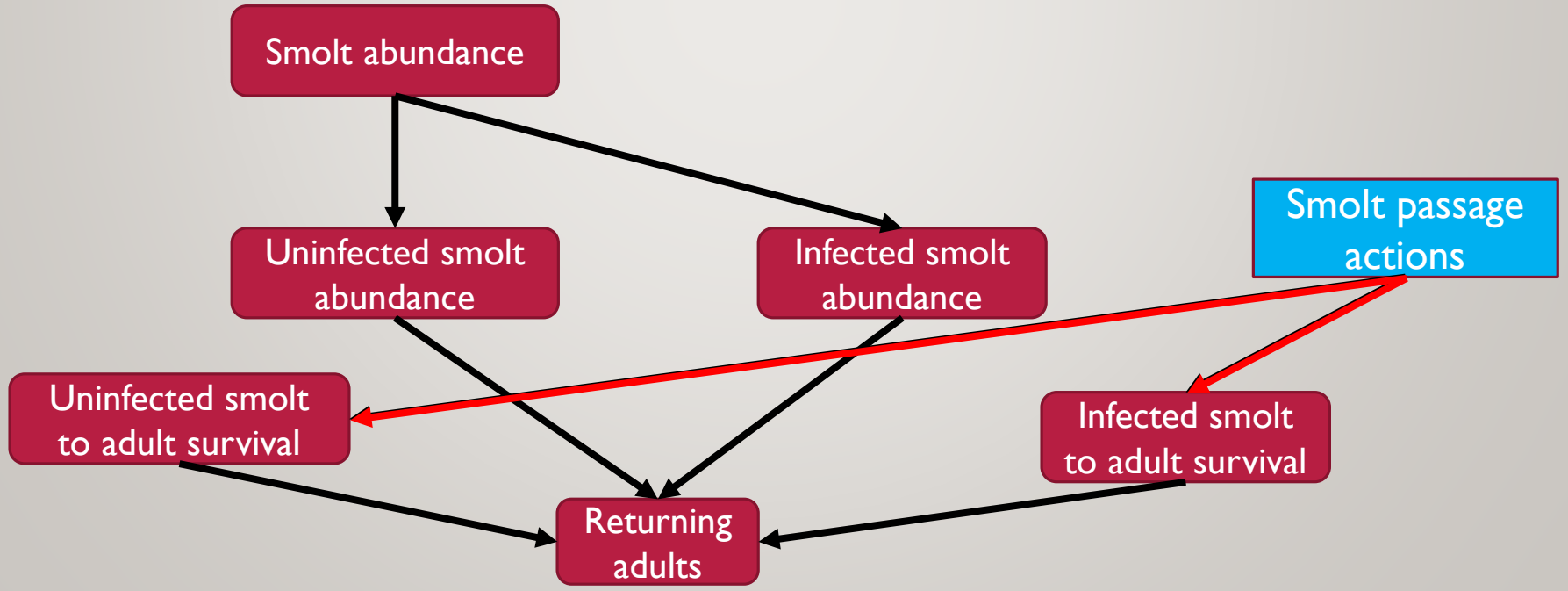
INTEGRATED APPROACH



INTEGRATED APPROACH

What is the best way to pass uninfected and infected juvenile?

Laboratory stress studies
Field evaluations
But… need a reliable supply of infected fish
>>> Infection experiments <<<



INTEGRATED APPROACH

Why are juvenile Chinook so heavily infected?

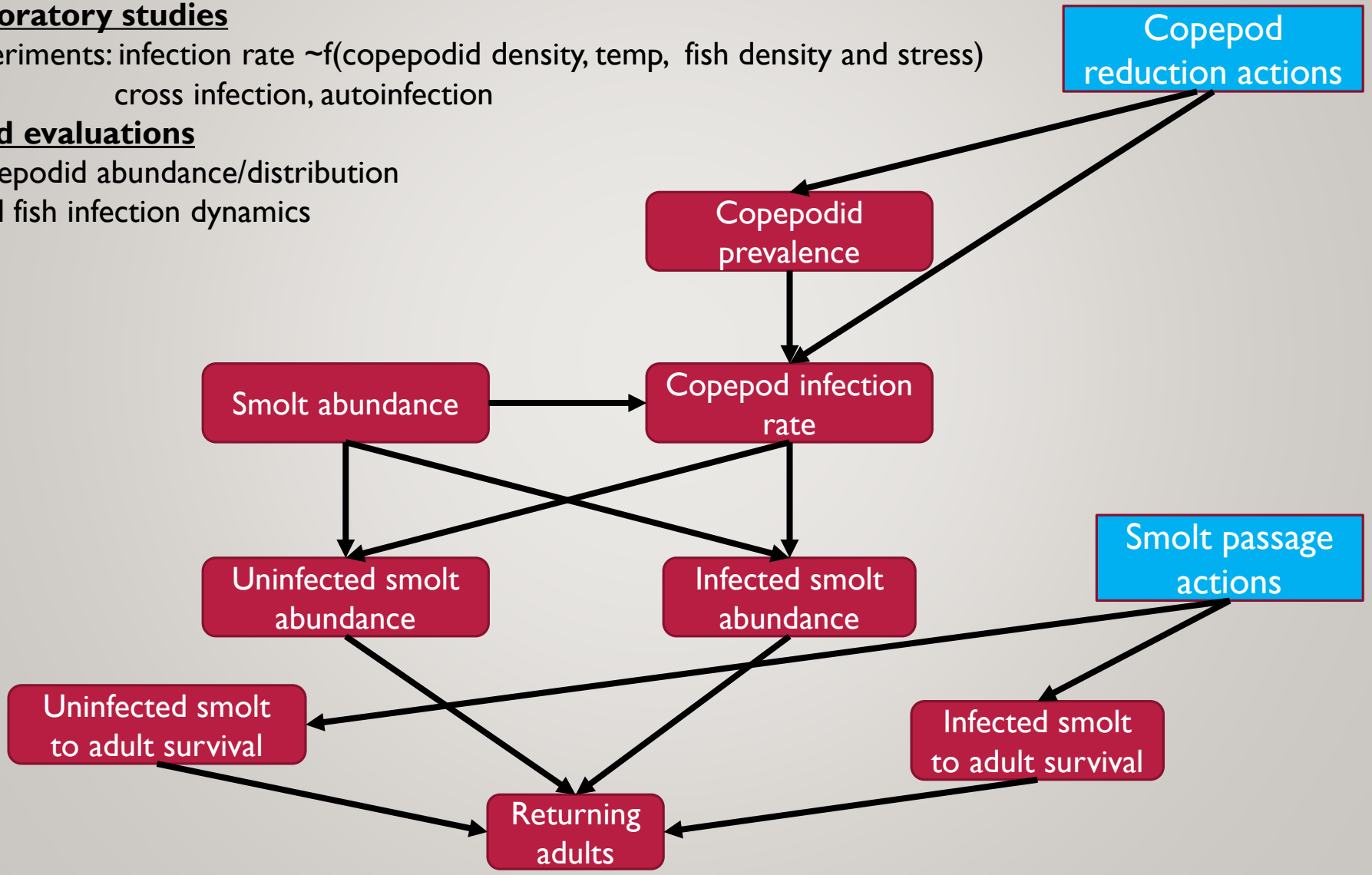
Laboratory studies

Experiments: infection rate ~f(copepodid density, temp, fish density and stress)
cross infection, autoinfection

Field evaluations

Copepodid abundance/distribution

Wild fish infection dynamics



INTEGRATED APPROACH

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Pathogen burden

Copepod reduction actions

Copepodid prevalence

Unknown source of copepods

Smolt abundance

Copepod infection rate

Uninfected smolt abundance

Infected smolt abundance

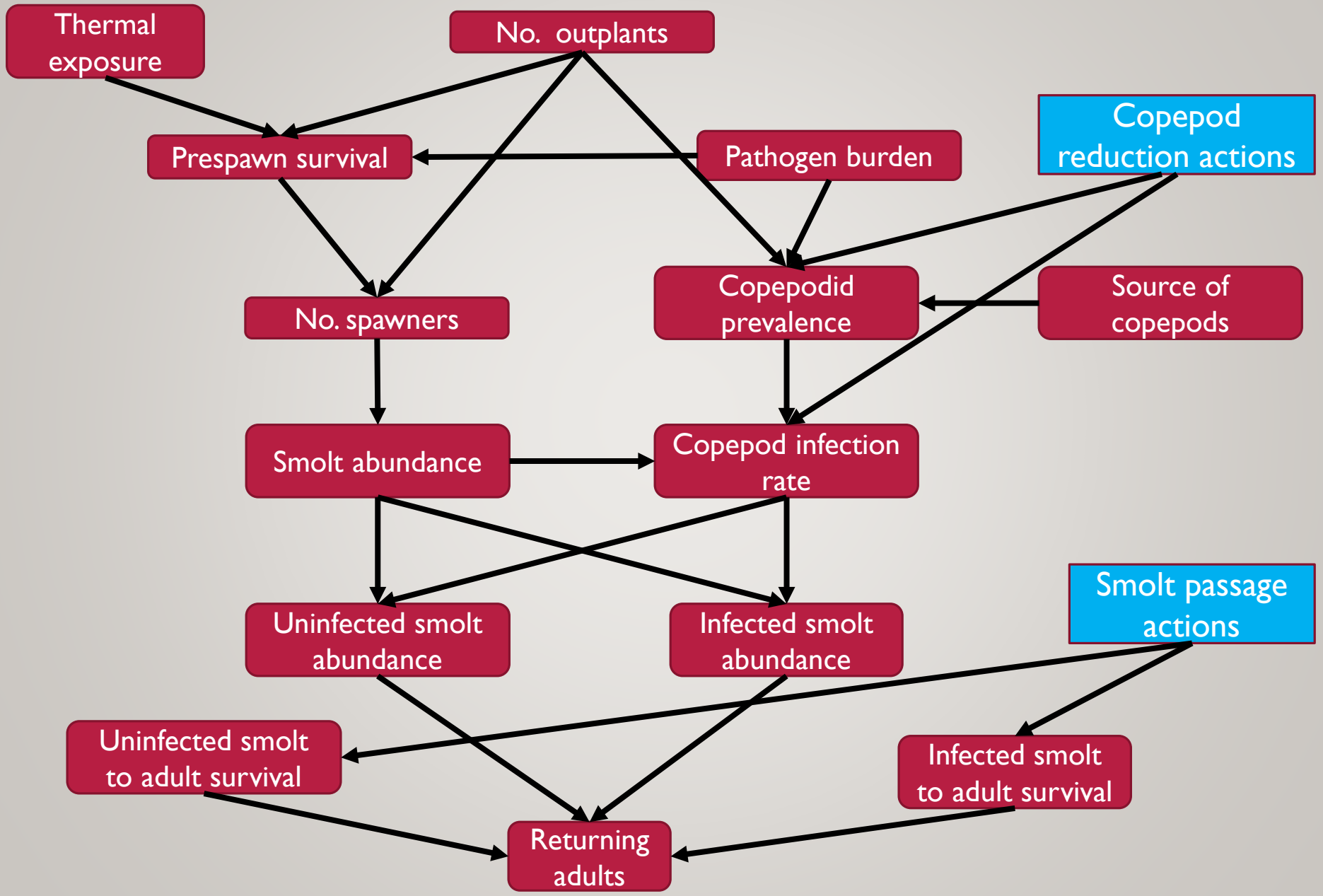
Smolt passage actions

Uninfected smolt to adult survival

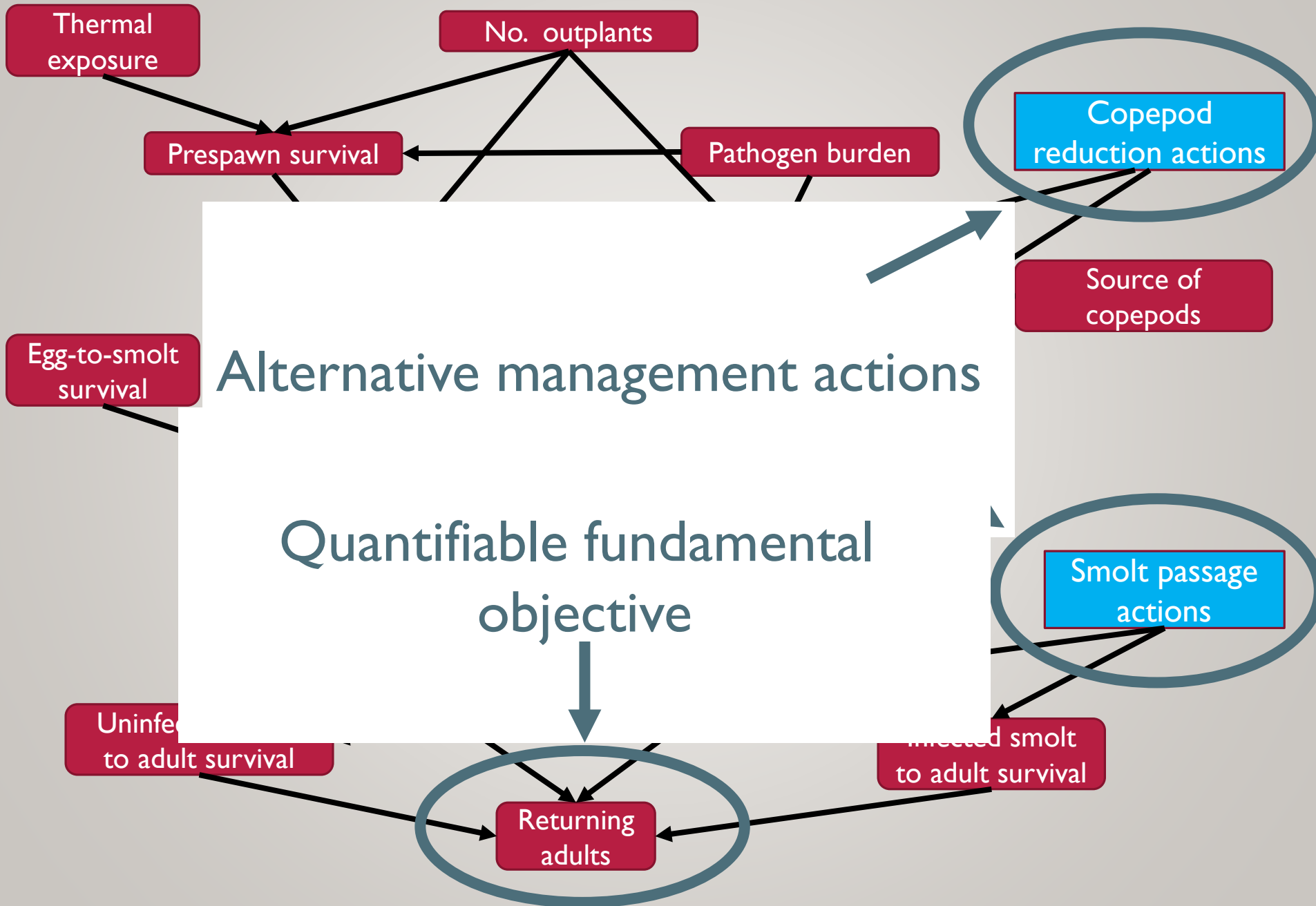
Infected smolt to adult survival

Returning adults

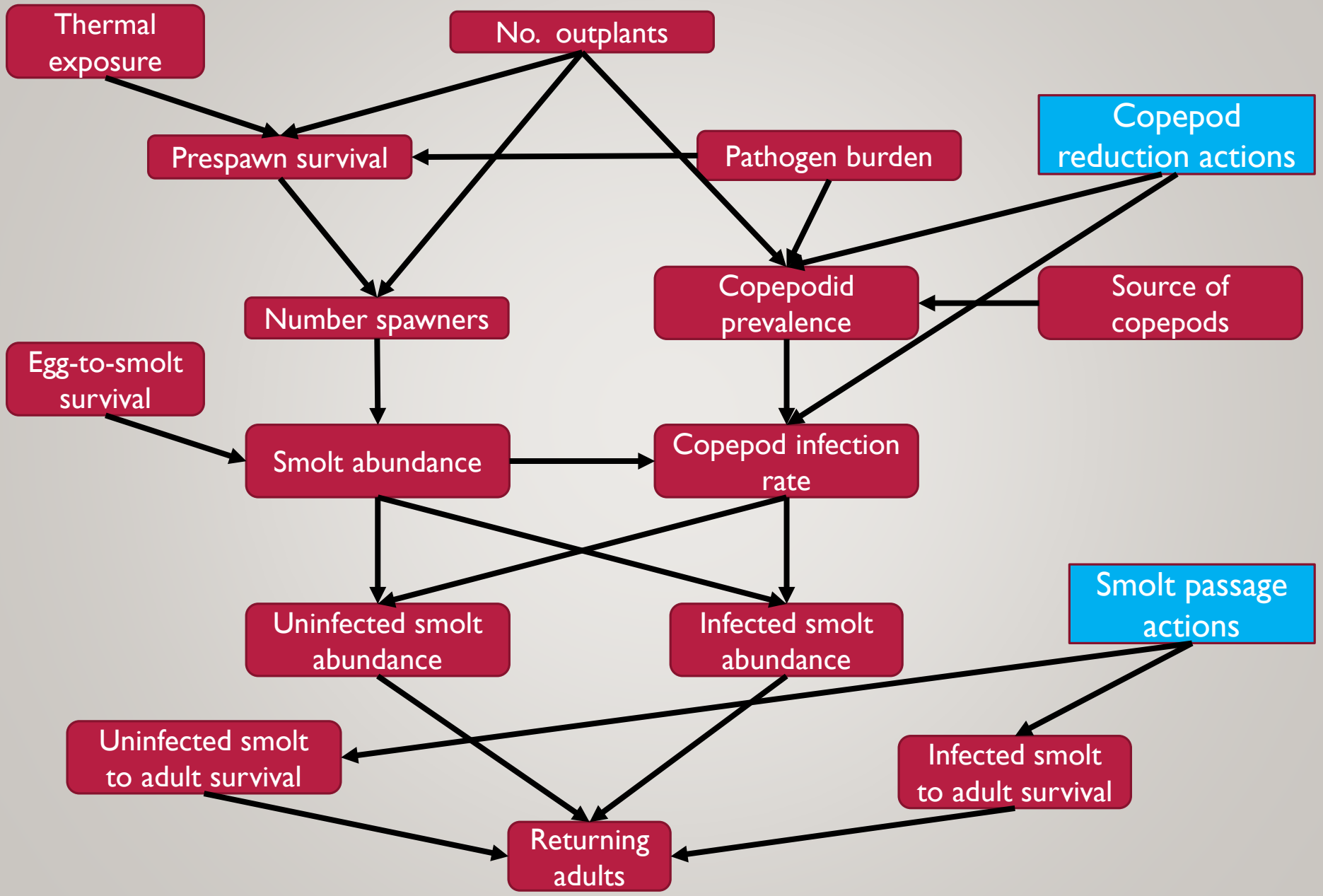
INTEGRATED APPROACH



INTEGRATED APPROACH



BETA DECISION MODEL



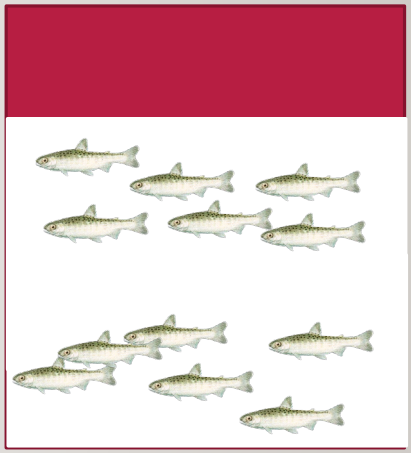
PILOT INFECTION EXPERIMENTS

Two tank sizes- small (2' dia), large (3' dia) x 2 replicates

Copepodid density ~150-300 l

Water temperature- 12-13°C

Surrogate Chinook stocked at 1.6g/L (240 total fish)



20 infection events 16-Nov to 6 Dec

<u>Infection event:</u>

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

ONGOING INFECTION EXPERIMENTS

Working 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

ONGOING 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

Statistical power: main effects > 95%, interactions > 75%

Same infection protocol

Surrogate Chinook stocked at 1.6g/L (equal density)

Last infection dose Feb 4, ends week of March 24

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

Statistical precision: infection rate within 3% true value with 95% confidence

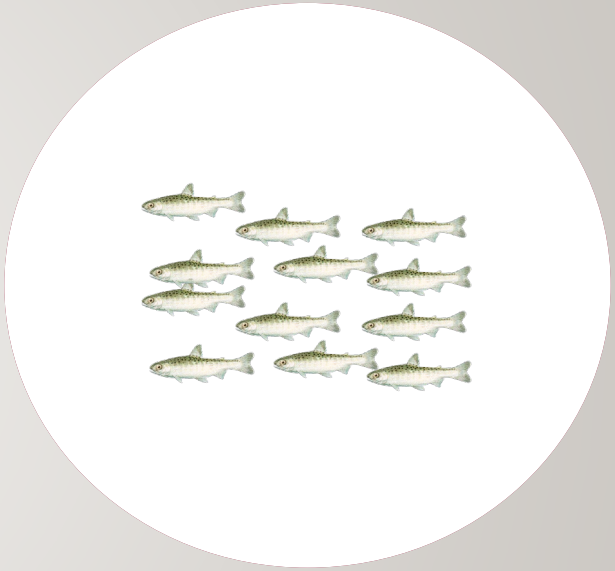
Initiated Feb 14, ends week of April 1

(Preliminary results)

ONGOING STRESS EXPERIMENTS

Replicate level of stress as trap and haul

Large tank 3' dia, 20 fish per tank
Cold 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 3 hr
Release fish from crowding

Sample cortisol at 1 hr, 6 hr, 24h, 2 weeks

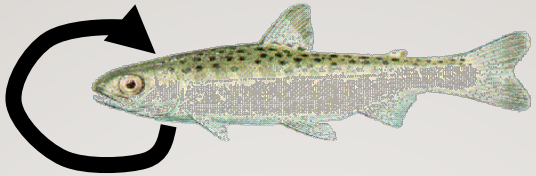
Additional stresses as needed

First test in about 2 weeks

UPCOMING EXPERIMENTS

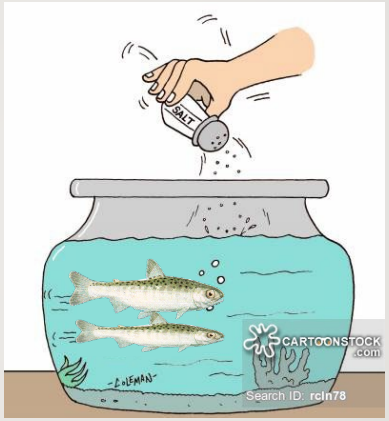
Autoinfection

End of March



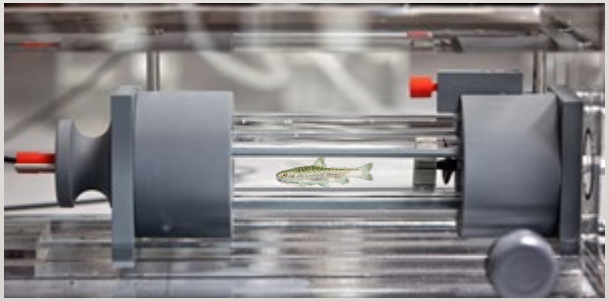
Saltwater challenge

End of March

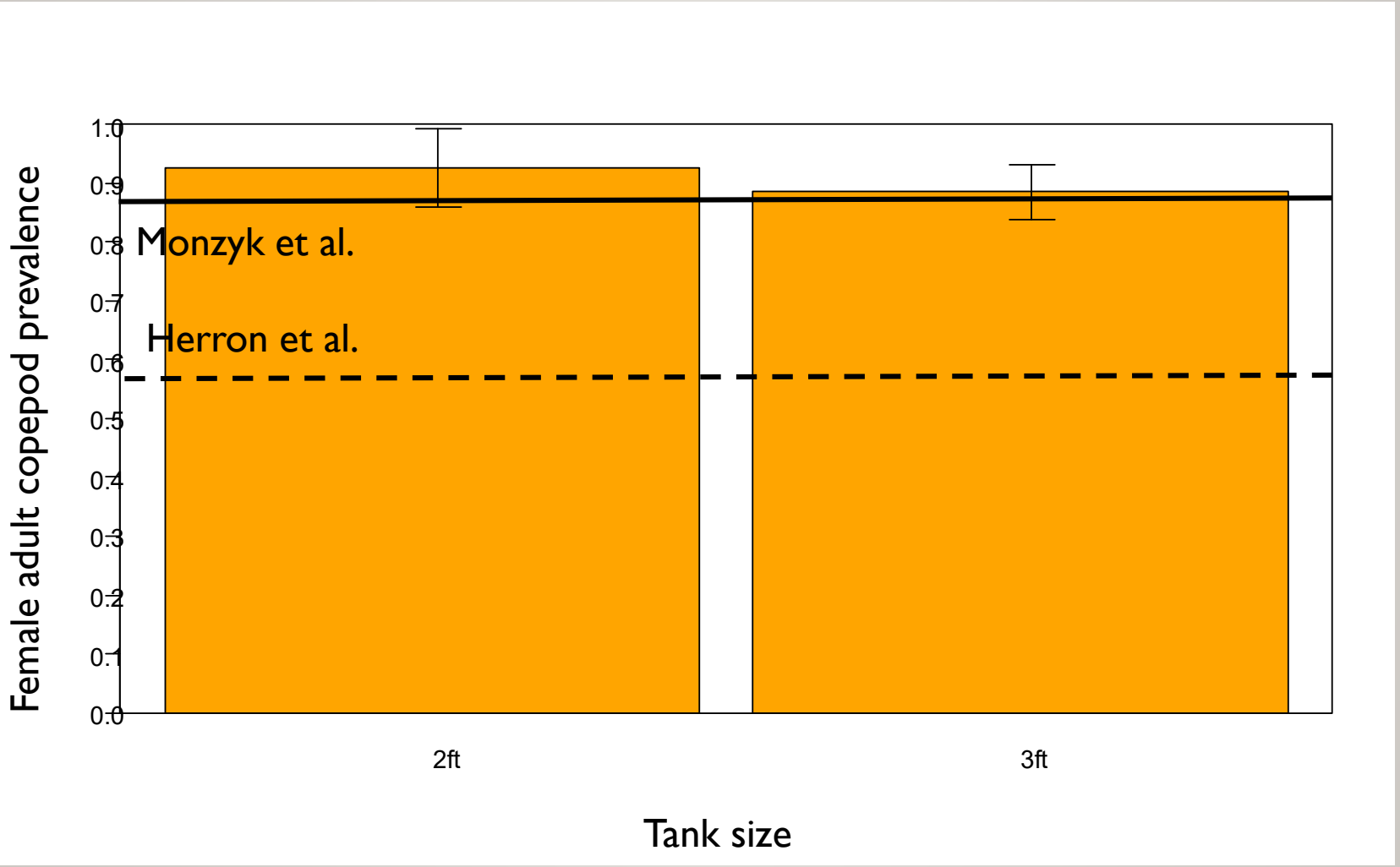


Swimming endurance

April-May

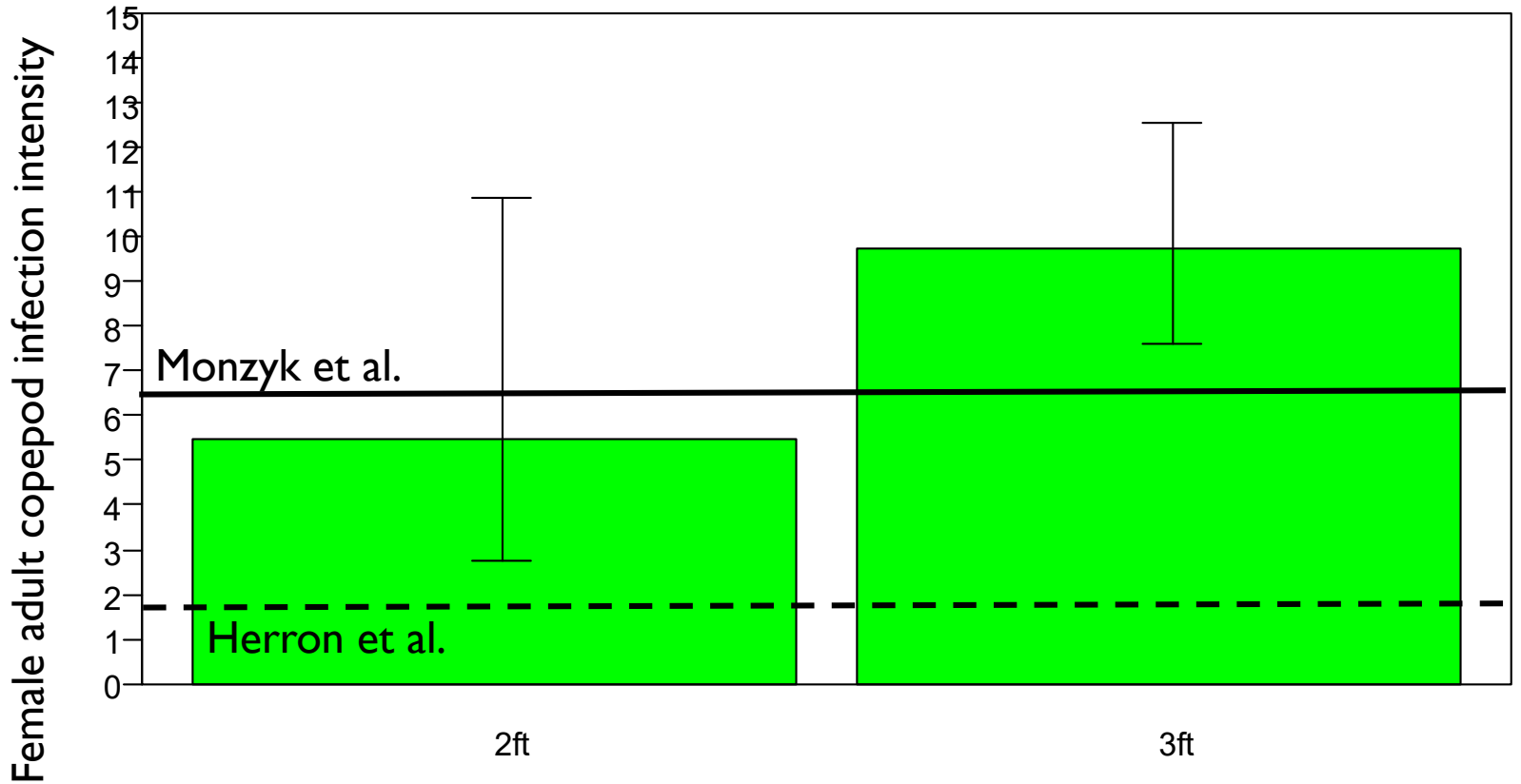


PRELIMINARY RESULTS



Preliminary results subject to revision

PRELIMINARY RESULTS



Preliminary results subject to revision

PRELIMINARY RESULTS

11 mortalities during pilot infection study

Mortalities had 2.87 times more copepods than fish that lived

73% attached to the gills or inside the operculum

Observed presence of pre-adult stages and significant gill damage

Observed evidence of cross or autoinfection in cross infection trials

Observed 2 mortalities transferring infected fish to tanks for stress evaluations, 0 for control fish

Infecting 200 rainbow trout consistent copepod source

Preliminary results subject to revision

CONCLUSIONS

We CAN infect juvenile Chinook salmon

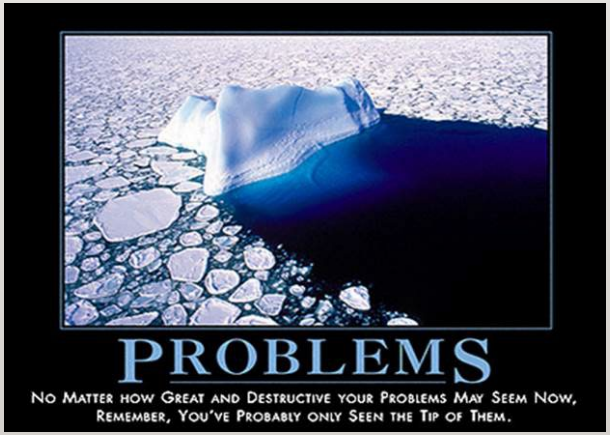
Prevalence and intensity equal to wild

Cross infection successful, large scale evaluations

Preliminary results ongoing studies April

Initiate structured decision making process

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



ACKNOWLEDGEMENTS

Funding: USACE

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