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# Field Evaluation of Neutrally Buoyant External Transmitter

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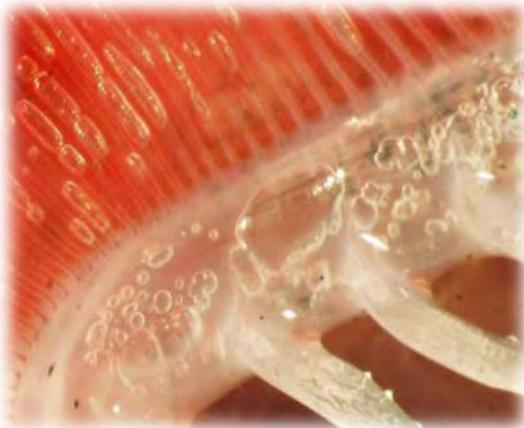
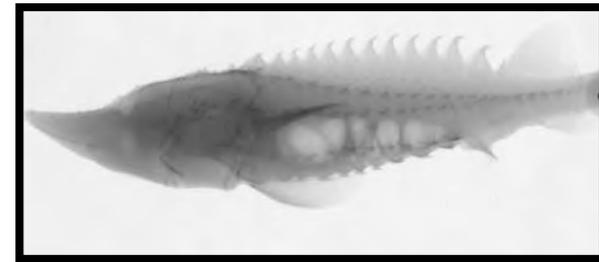
# Barotrauma due to Rapid Decompression



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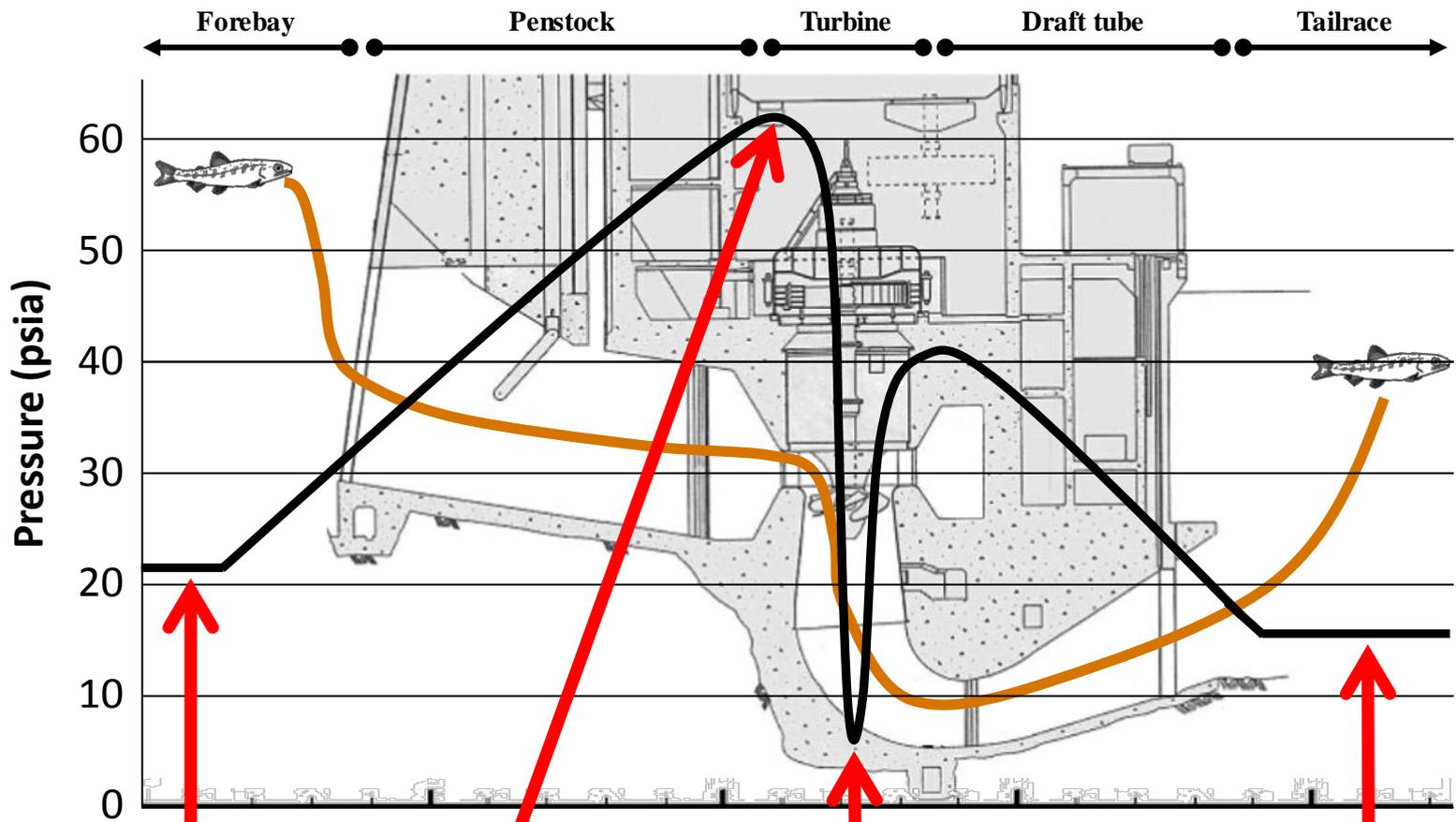
- ▶ Rapid decompression can cause barotrauma in fish
  - Turbine passage
  - Spill / especially deep spill
- ▶ Gas within fish (primarily swim bladder) follows Boyle's Law
  - Volume of gas inversely proportional to pressure
  - When pressure is cut by  $\frac{1}{2}$  the volume doubles
- ▶ Ratio of pressure change is critical
  - Acclimation pressure / exposure pressure (nadir)
  - Leads to expansion and rupture of swim bladder
  - A key cause of barotrauma





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**Pressure profile**

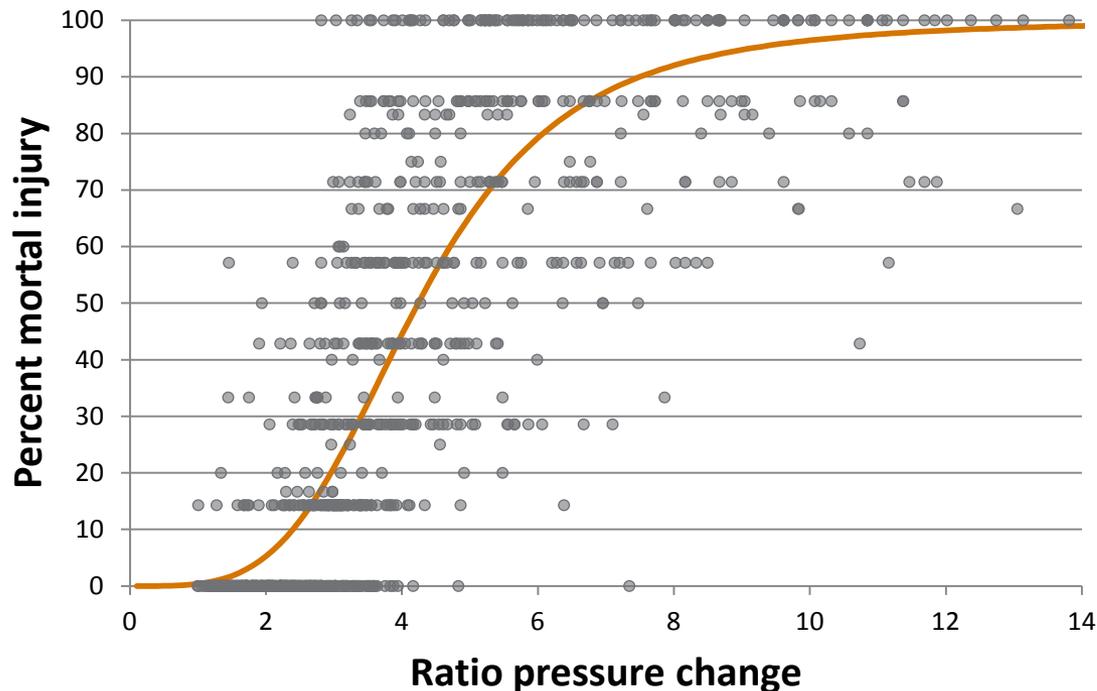
**Path of fish**



# Barotrauma due to Rapid Decompression

## ► Relationship between mortality / injury and pressure change

■ Brown et al. 2012 Transactions of the American Fisheries Society

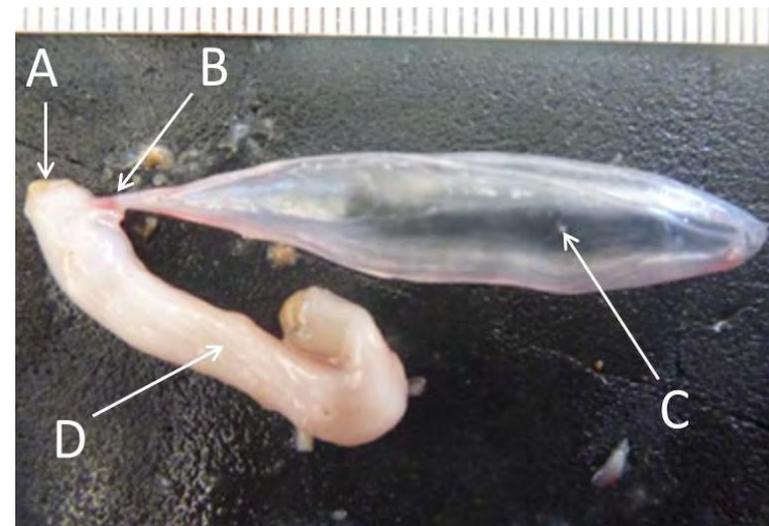


## Example of ratio pressure change

Surface pressure to half of surface pressure

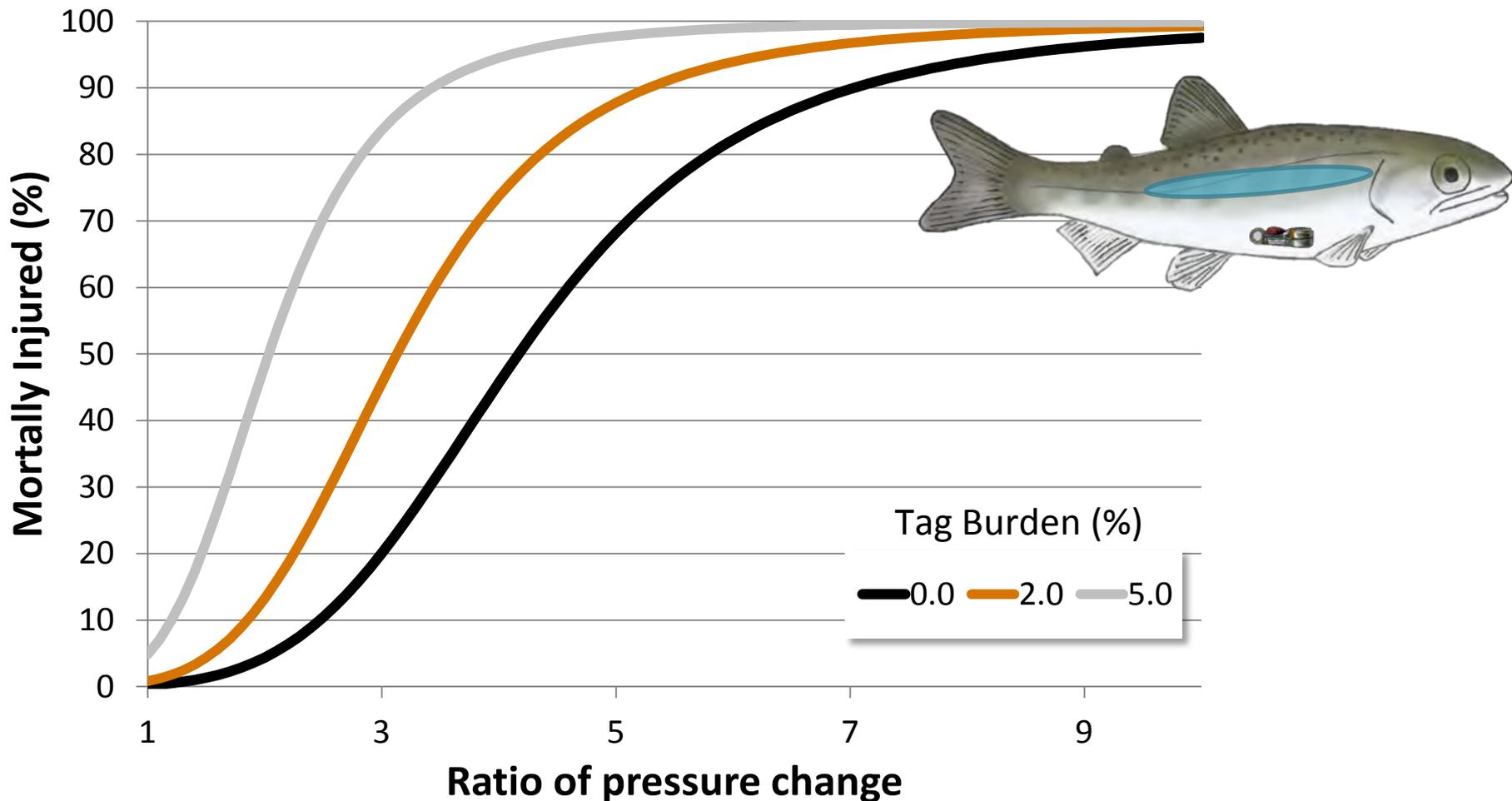
$15 / 7.5 \text{ psia} = \text{RPC } 2$

Swim bladder 2 times bigger



# Turbine Passage Tag Bias

## Why the External Neutrally Buoyant (External<sup>NB</sup>) tag was developed



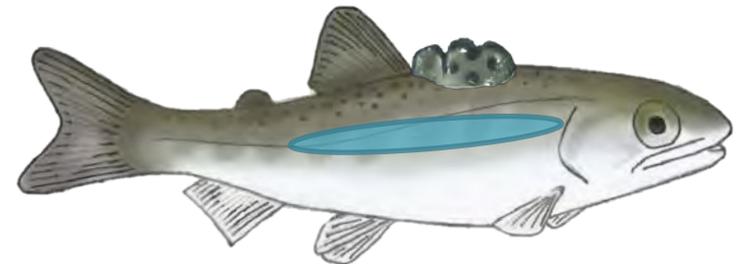
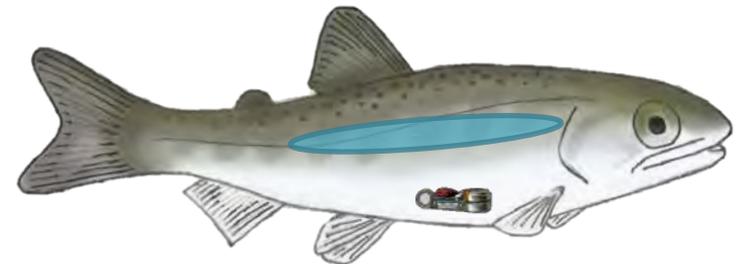
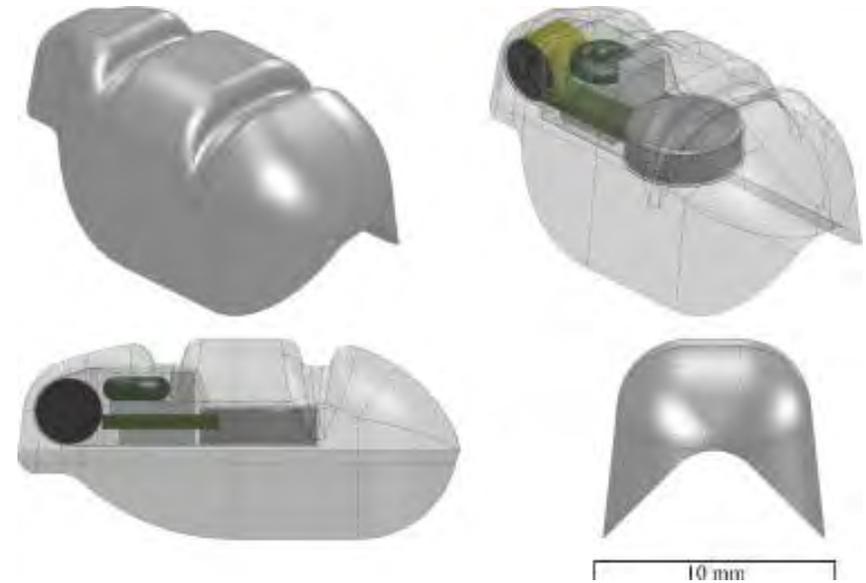
# External Neutrally Buoyant (External<sup>NB</sup>) Tag



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- ▶ Designed for short term study
  - <1 week
  - Passage route survival
    - Not system or reservoir survival
  - Not a JSATS replacement
- ▶ Modified JSATS tag
- ▶ Neutrally buoyant
  - 0% tag burden in water
- ▶ No space in body cavity
- ▶ No swim bladder increase
- ▶ Laboratory tested
  - Tag retention, growth, and survival  
*Deng et al. 2011, Fisheries Research*
  - Swimming performance  
*Janak et al. 2012, Transactions of the AFS*
  - Predation  
*Janak et al. 2012, Transactions of the AFS*
  - Shear  
*Deng et al. 2011, Fisheries Research*
  - Simulated turbine passage (STP)  
*Brown et al. 2012, J. Renewable Sustainable Energy*

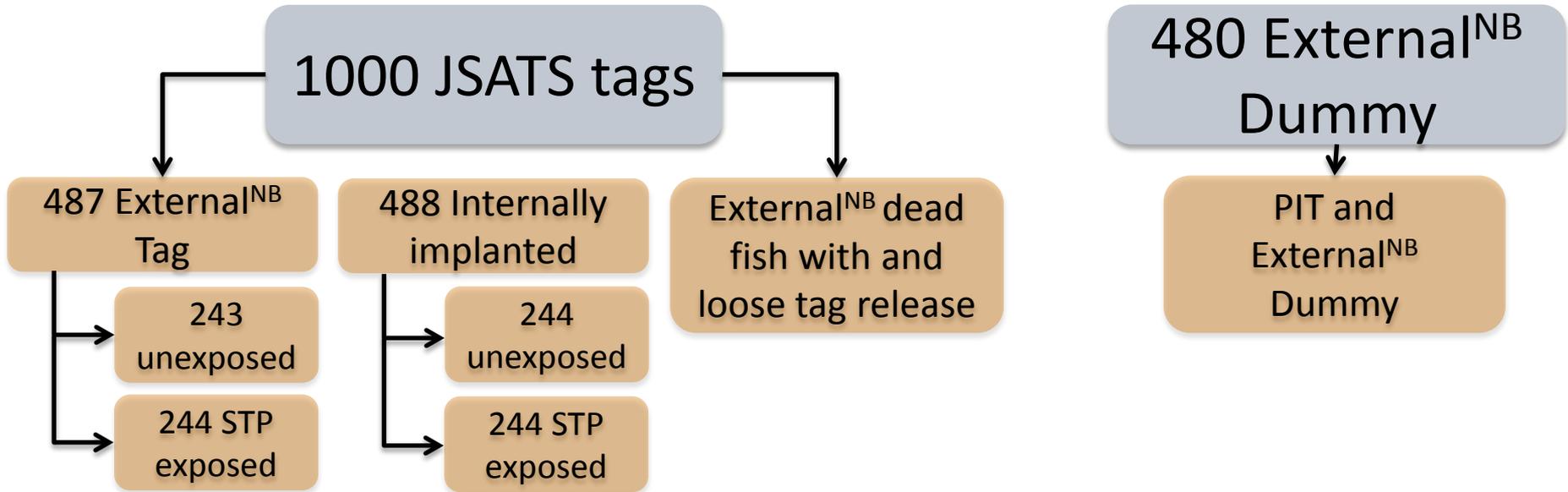


# Project Goals

- ▶ Determine effectiveness of External<sup>NB</sup> tag
  - Examine survival and travel times
    - Ice Harbor to mouth of the Snake River
  - Examine tag retention
    - Ice Harbor to McNary Dam
  - Great concern of increased predation
    - Test in high predation area
    - Between Ice Harbor Dam and Snake River mouth

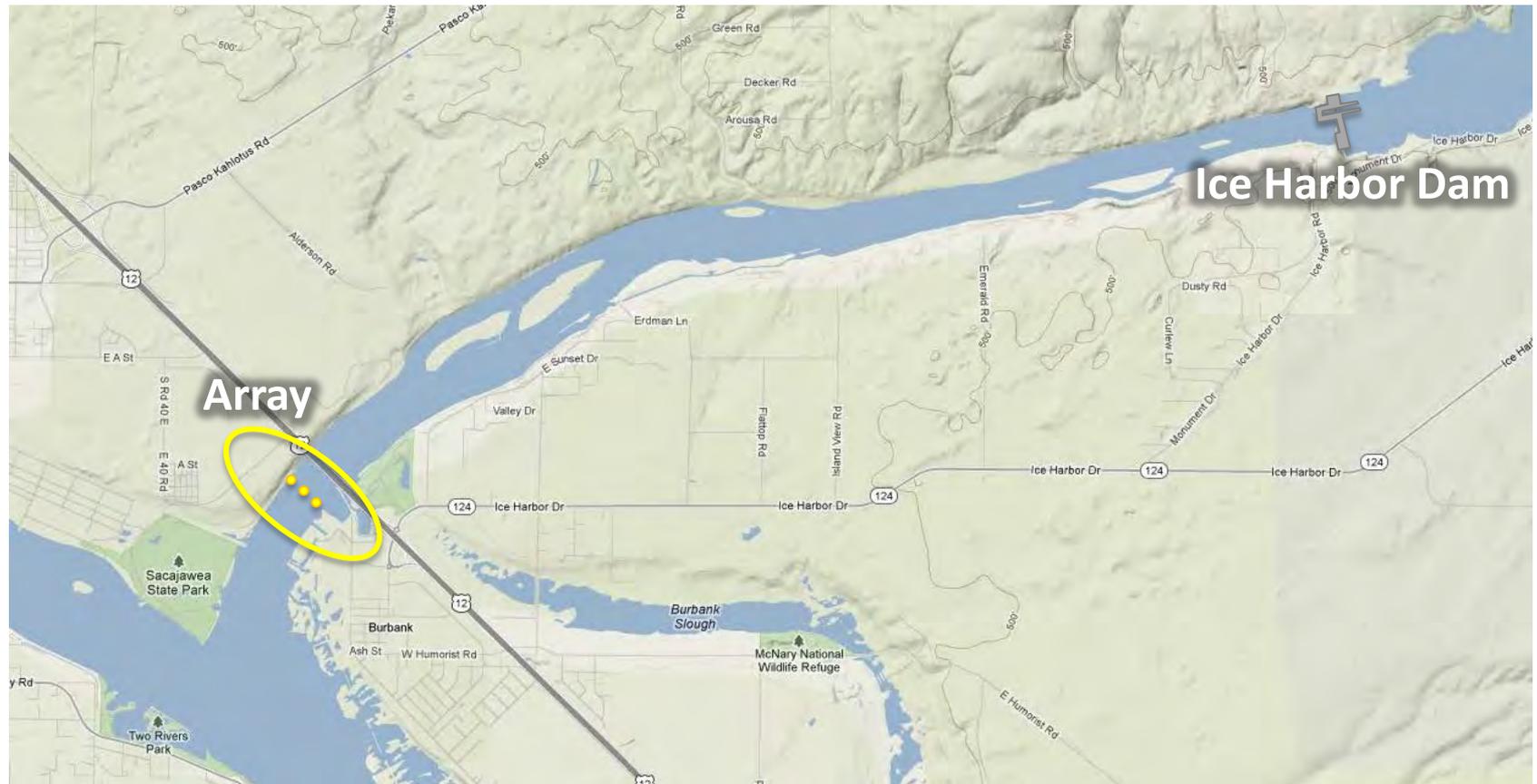
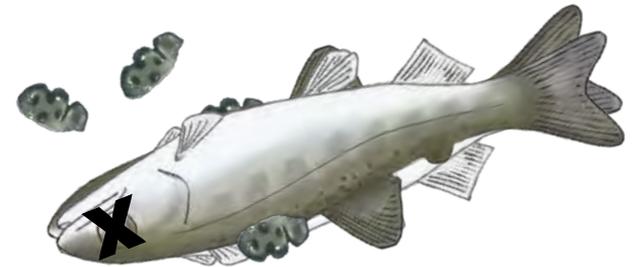


# Study Design



# Tag & Dead Fish Release

- ▶ Ensure lost tags and dead fish are not detected as live fish
- ▶ Ice Harbor dam to Snake River mouth (12 km)



# Dummy Tag Release

- ▶ Pit tagged & Dummy External<sup>NB</sup>
  - Separation-by-code
  - Collected at McNary

- ▶ Released in Ice Harbor forebay
  - 2 Groups of 240 fish



# Surgeries

## ▶ Subyearling source

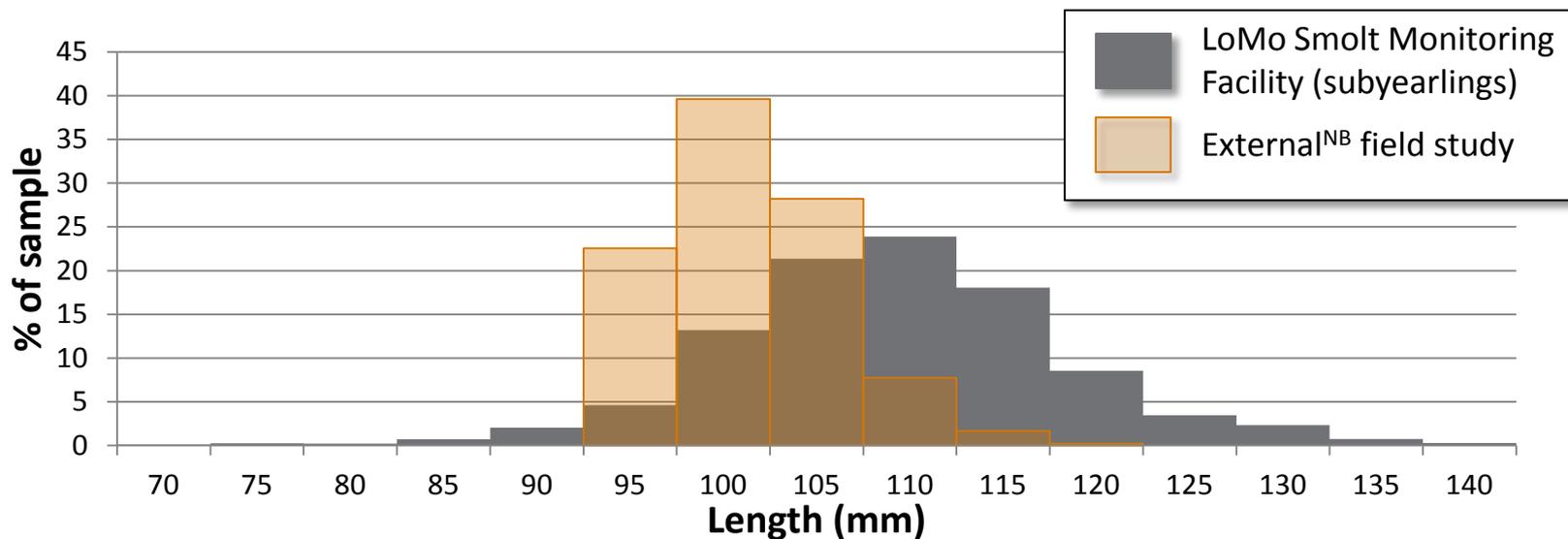
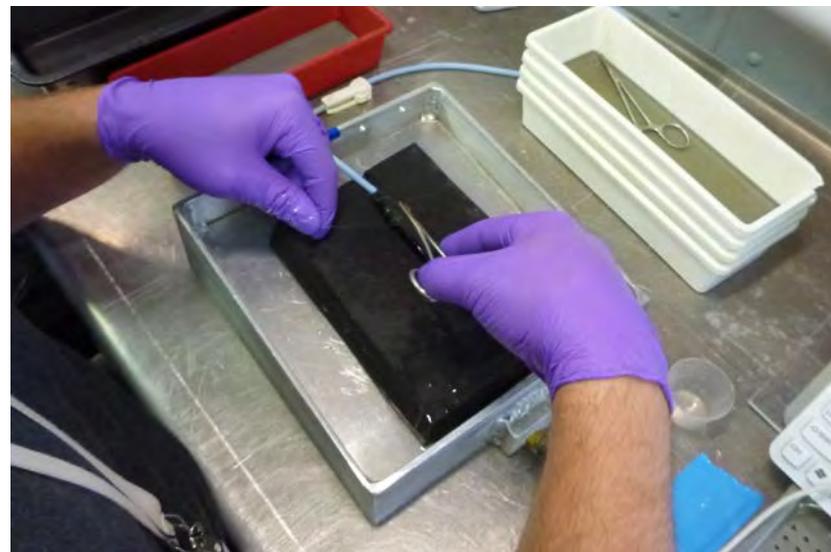
- Lyons Ferry Hatchery
- Permit for in-river fish not granted
- Size range = 95-122 mm

## ▶ Surgery location

- Lower Monumental Dam

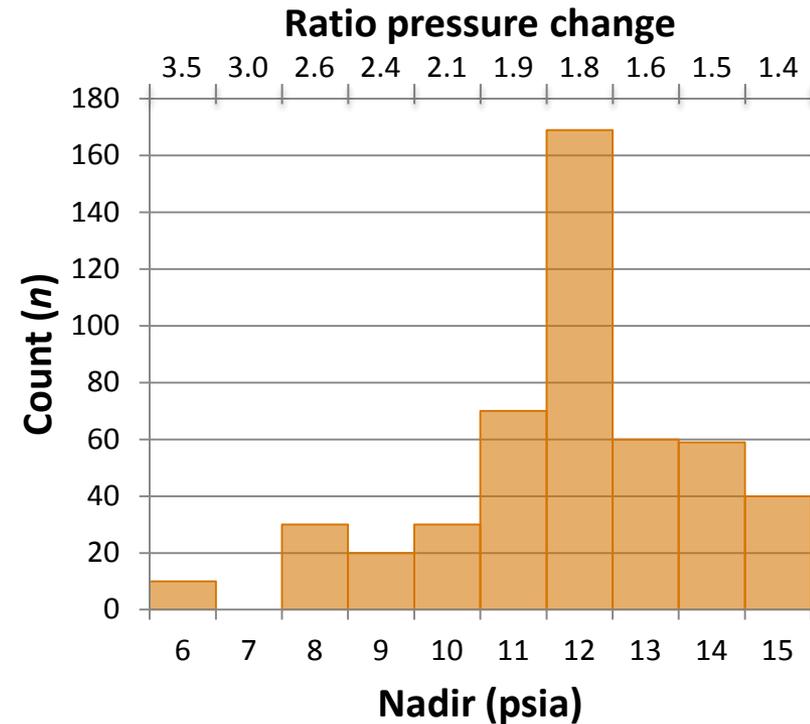
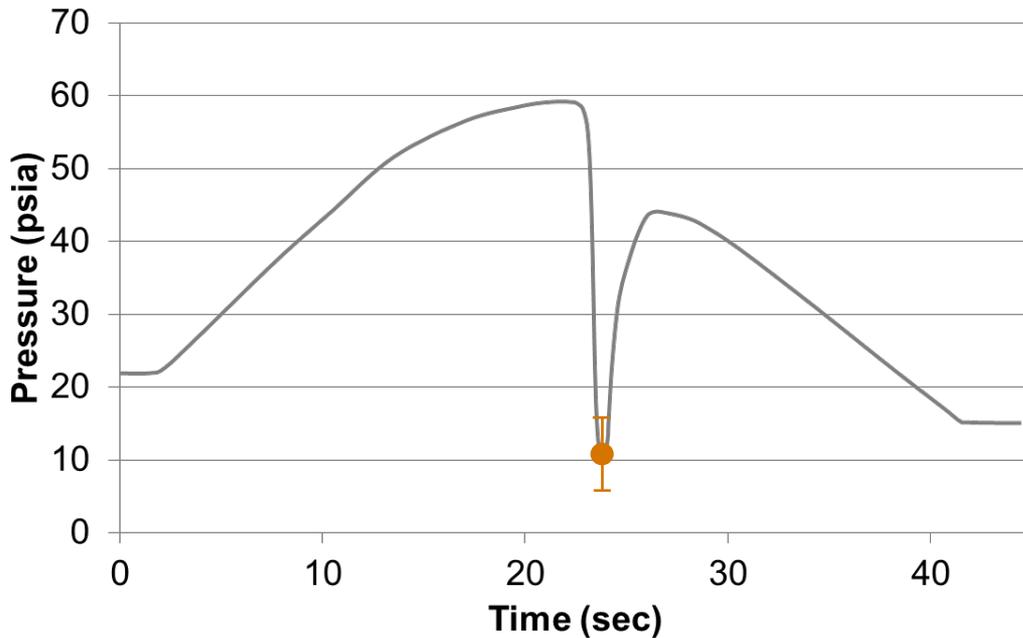
## ▶ Post surgery transport

- Trucked to Ice Harbor Dam



# STP Exposed Fish

- ▶ 10 fish per chamber
  - 5 External<sup>NB</sup> tag
  - 5 Internal AT
- ▶ 49 Trials
- ▶ Acclimated to 15' depth equivalent



# Fish release location

- ▶ Released in Ice Harbor Tailrace
  - Turbine upwell
- ▶ 13 Release groups
  - 80 fish per group





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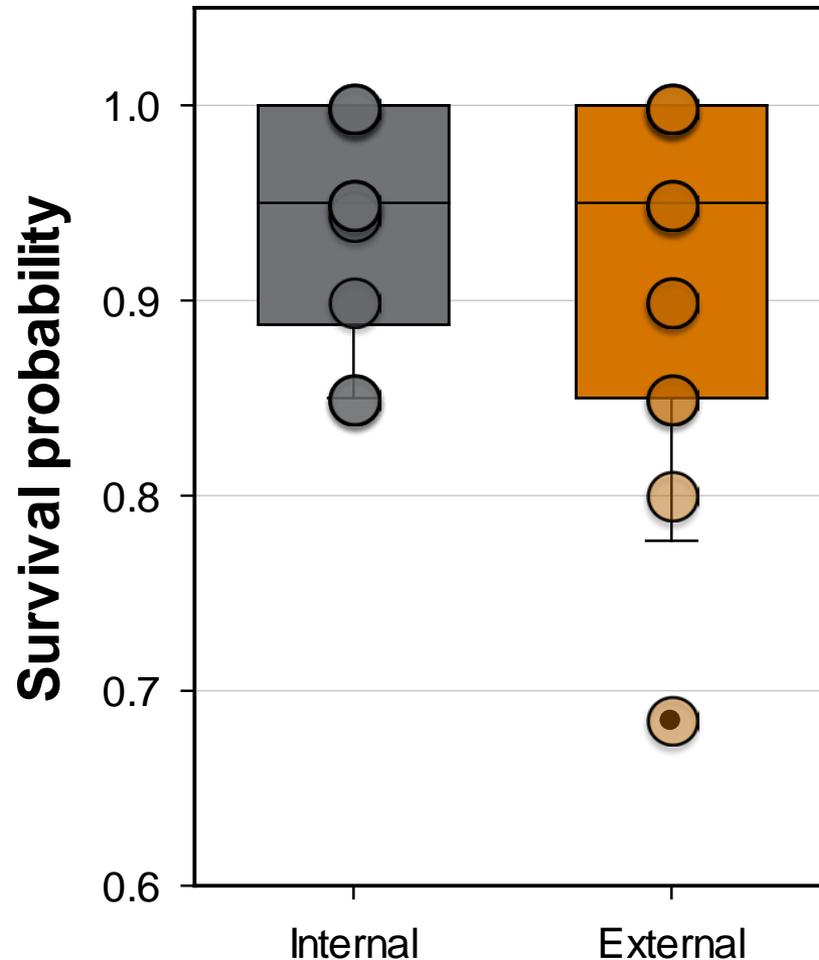
# Preliminary results

# Ice Harbor to Snake River Mouth (12 km)

## Survival

- ▶ No significant difference between treatment groups

### Unexposed



50% data in box  
80% in whiskers

# Ice Harbor to Snake River Mouth (12 km)

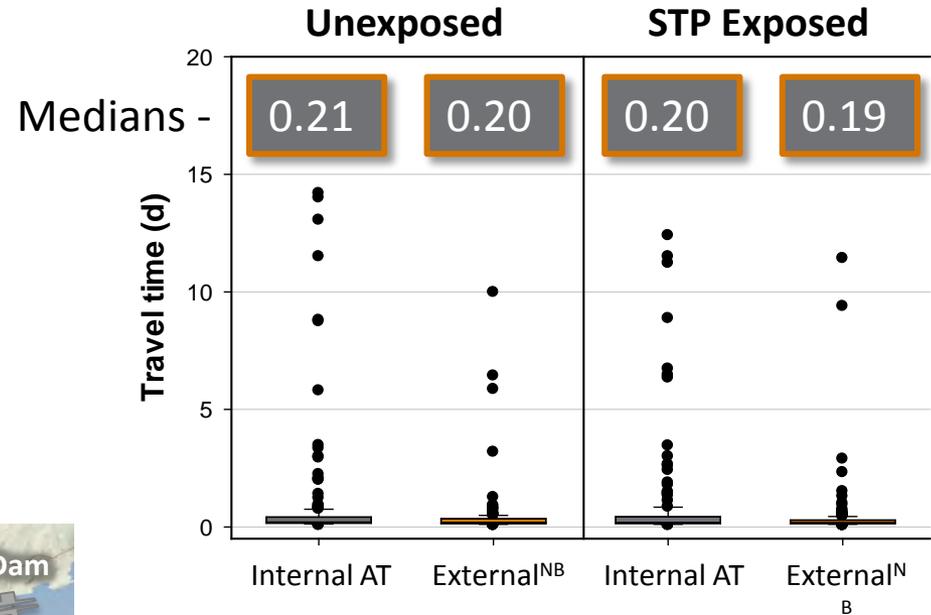
## Travel time



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- ▶ Significant difference between groups
  - Internally tagged fish travel slightly slower
  - Not likely biologically significant
- ▶ Majority of fish traveled <1 day



# Ice Harbor to Snake River Mouth (12 km)

## Conclusion



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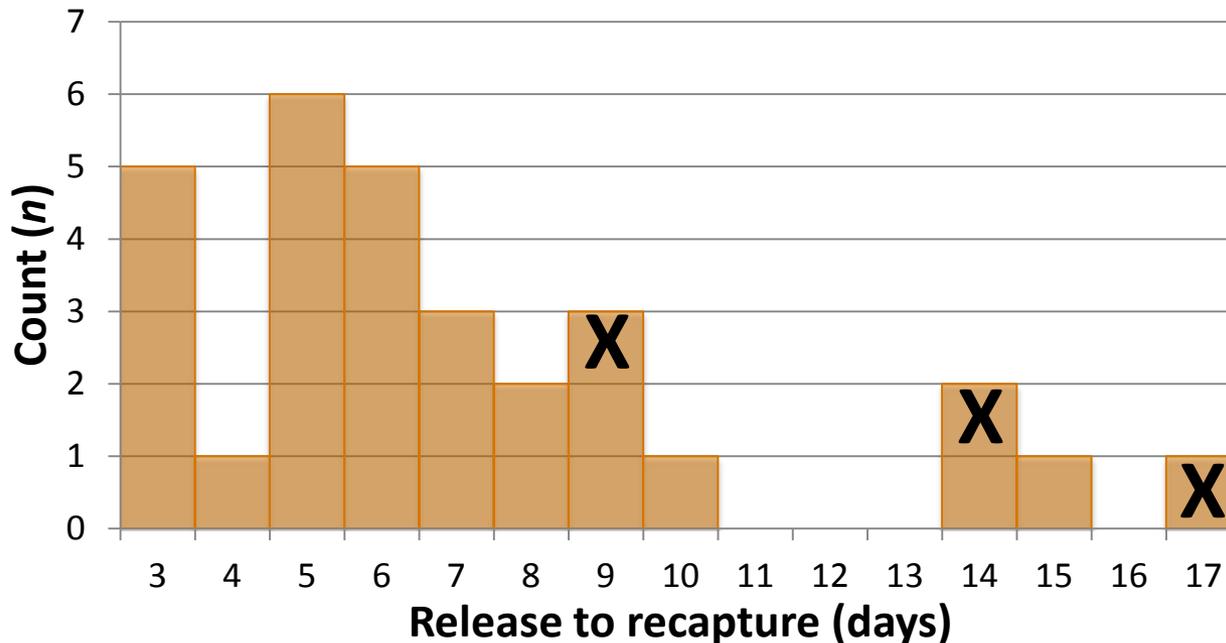
- ▶ High predation area
  - No significant difference in survival
- ▶ Good for estimating turbine survival in short reaches
- ▶ No difference among pressure exposed fish



# Tag Retention to McNary

## Dummy External<sup>NB</sup> and PIT: Ice Harbor to McNary (65km)

- ▶ 30 (6.3%) of the 480 recaptured
  - ▶ Recovered 3-17 days after release (median 6 days)
- ▶ 3 (10%) were missing External<sup>NB</sup> tags
  - Recovered 9, 14, and 17 days after release
  - 2 tags found in tank



Losses in  
lab study  
on day 13

MPS  
median  
~2 days

# When to Use External<sup>NB</sup> Tag

Internal fish had an average tag burden 3.07

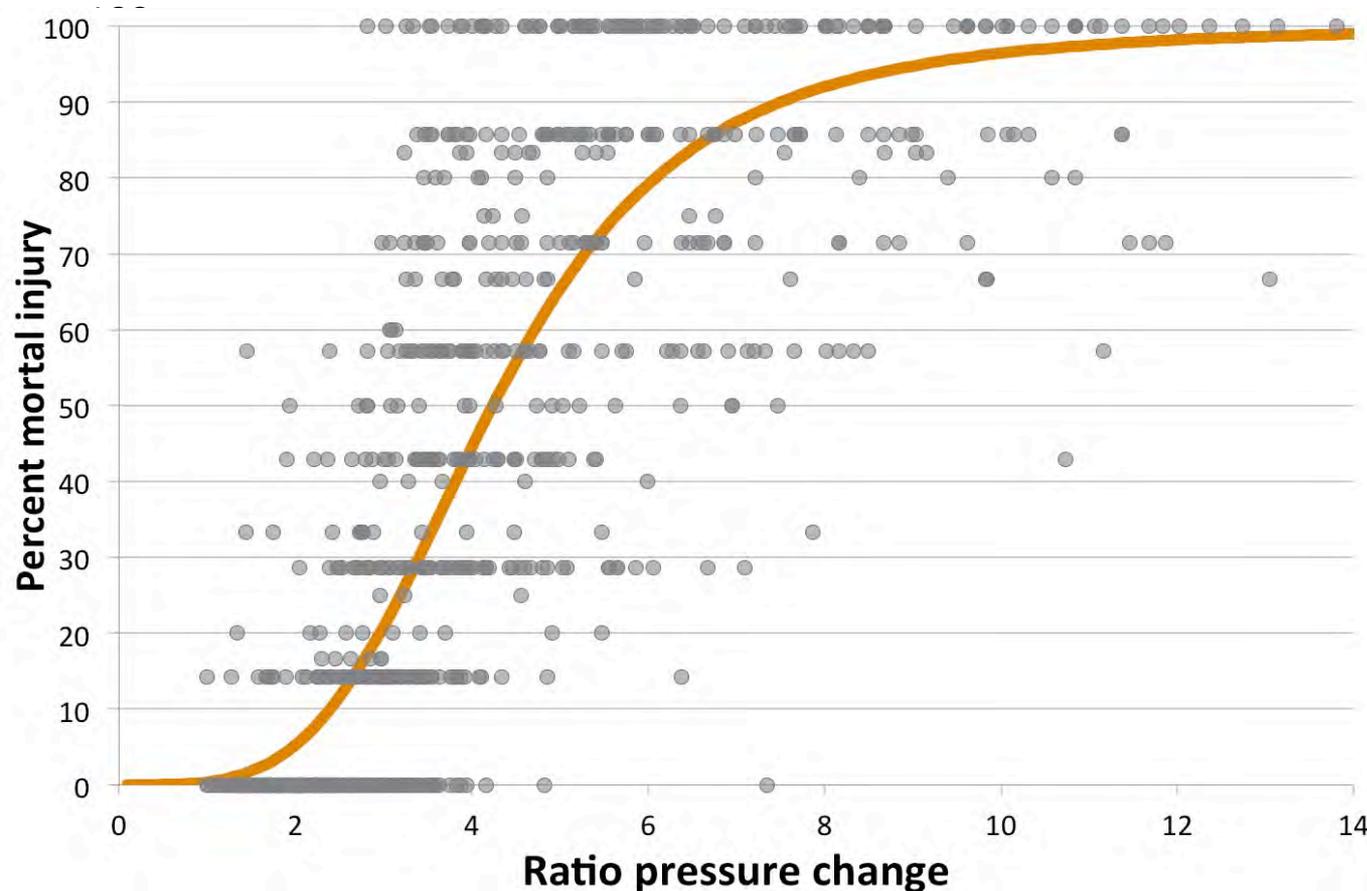
This study:  
Median RPC = 1.88  
~10-15% more likely to have mortal injury

Likely need higher sample sizes to see a difference

Ratio pressure change of 3.3 has greatest bias

External<sup>NB</sup> most effective at highest probable bias

3.3 ratio pressure change example:  
21 psia (~15ft depth)  
to 7 psia



# Conclusion

- ▶ No short term survival diff. in high predation area
  - Ice Harbor to Snake River mouth
- ▶ Results influenced by hatchery source fish
- ▶ Tag loss in >9d
- ▶ External<sup>NB</sup> tag suitable for short term turbine survival research
  - Not suitable for studies where retention is required over 10 days

# Looking Forward

- ▶ Replacement of turbines at Ice Harbor Dam
- ▶ After replacement compare new to existing turbines
  - Conduct SensorFish tests
  - Conduct survival estimates
  - Pressures likely much lower through older turbines
    - Makes use of External<sup>NB</sup> tags more critical



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