

Jun 25th, 3:10 PM - 3:30 PM

Concurrent Sessions B: Columbia River Passage - Hydroturbine Passage Related Barotrauma Research in the Columbia River Basin: How Far Have We Come?

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Presenter Information

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Hydroturbine passage related barotrauma research in the Columbia River Basin: How far have we come?

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Barotrauma due to Rapid Decompression

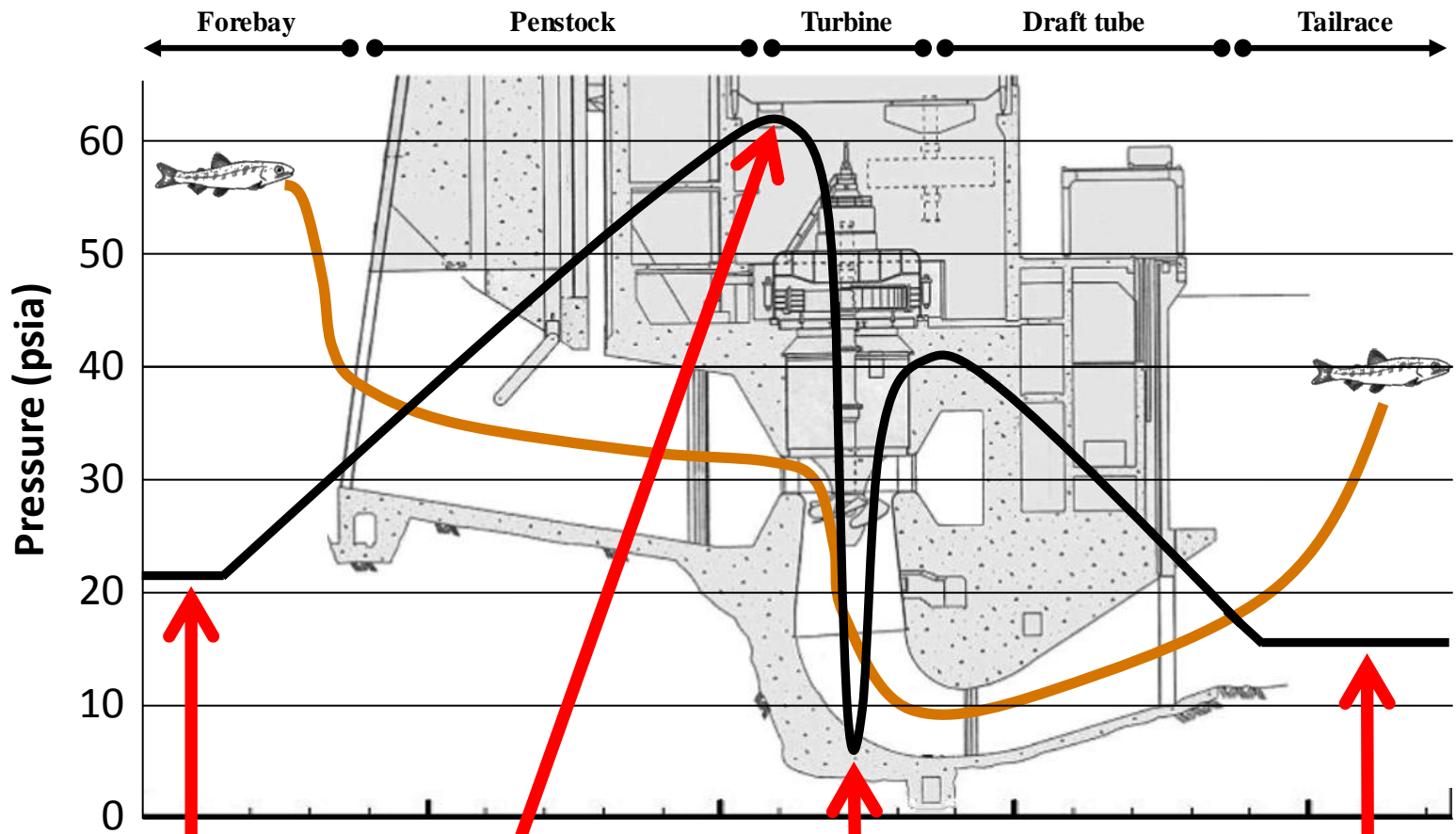
- ▶ Rapid decompression can cause barotrauma in fish
 - Turbine passage
 - Spill / especially deep spill
- ▶ Gas within fish (primarily swim bladder) follows Boyle's Law
 - Volume of gas inversely proportional to pressure
 - When pressure is cut by $\frac{1}{2}$ the volume doubles
- ▶ Ratio of pressure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





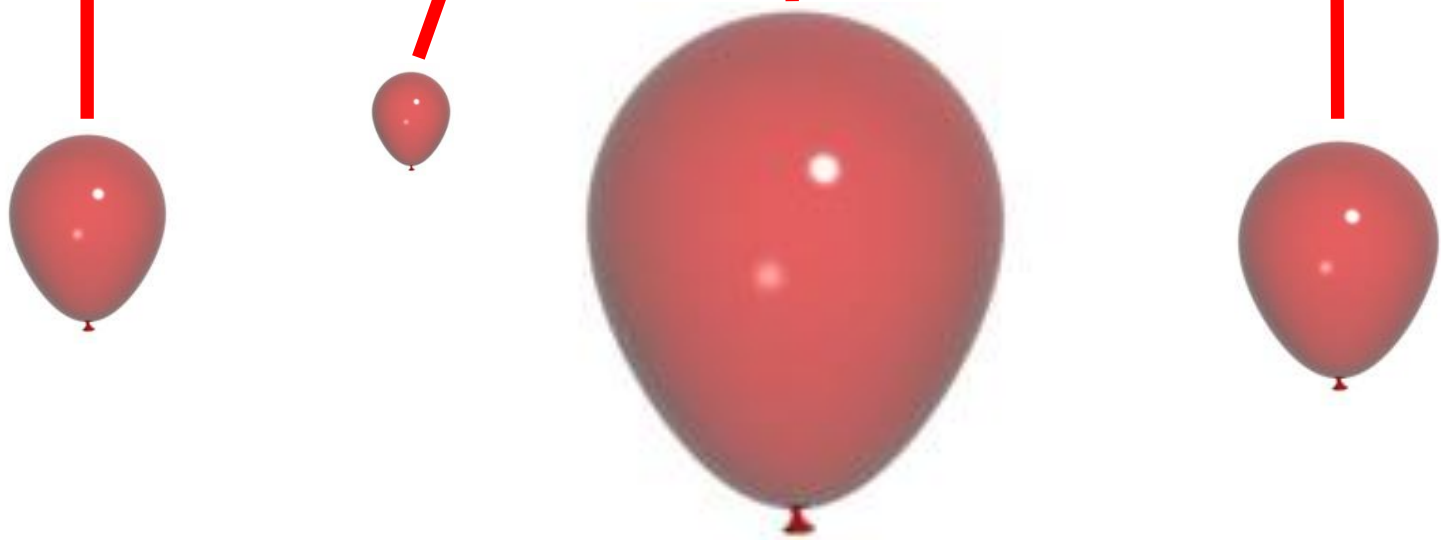
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Spike data

Path of fish



Laboratory Pressure Simulation

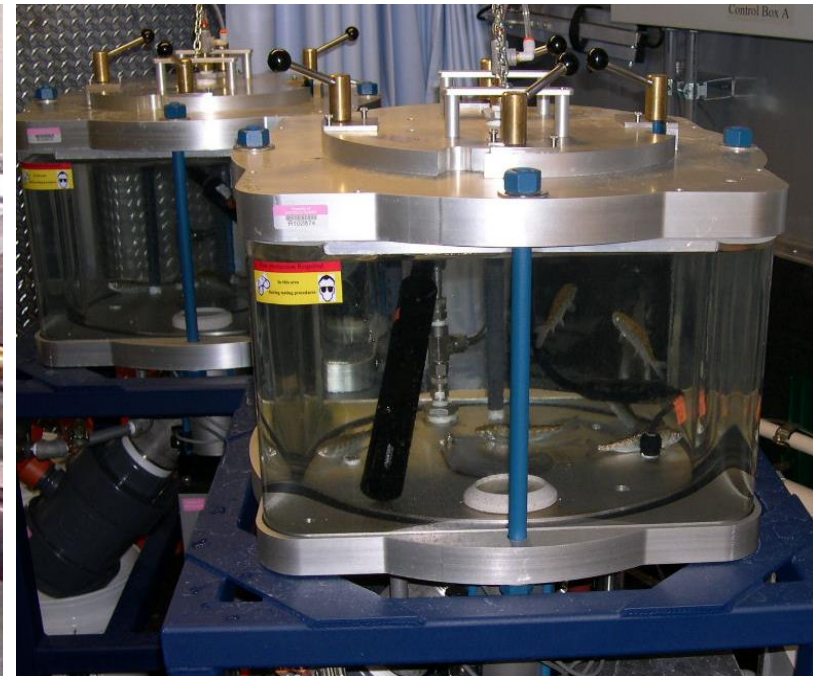
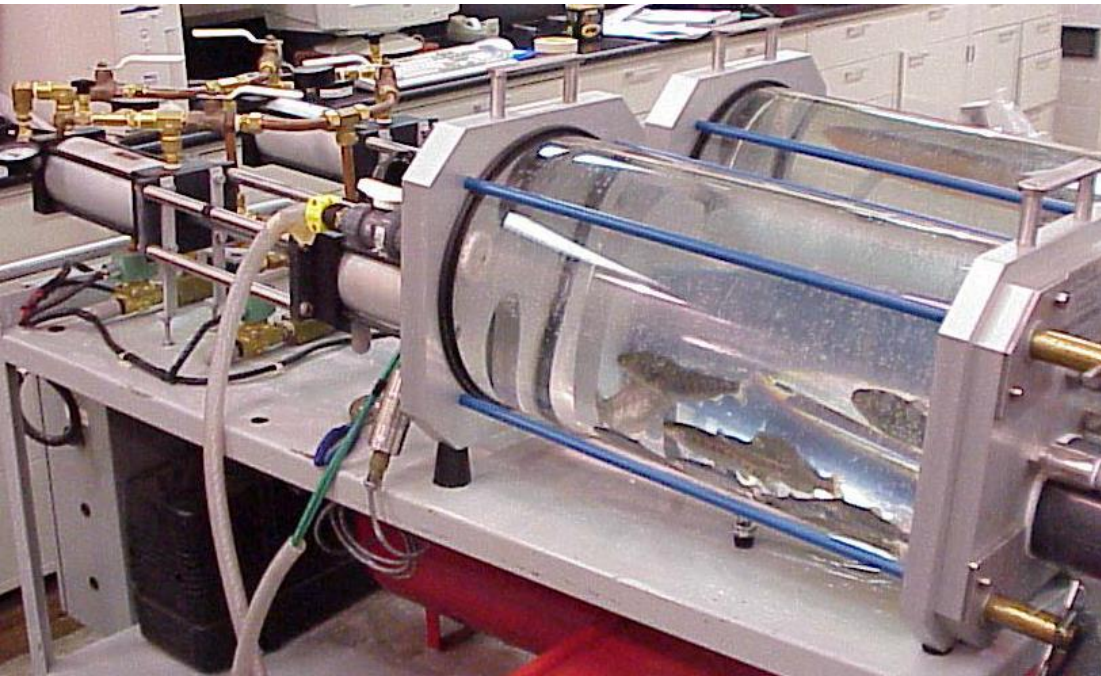
Lab studies starting in 1999

- ▶ Rainbow trout
- ▶ Chinook salmon
- ▶ Smallmouth bass
- ▶ Bluegill
- ▶ White sturgeon

Mobile Aquatic Barotrauma Lab

Lab studies starting in 2006

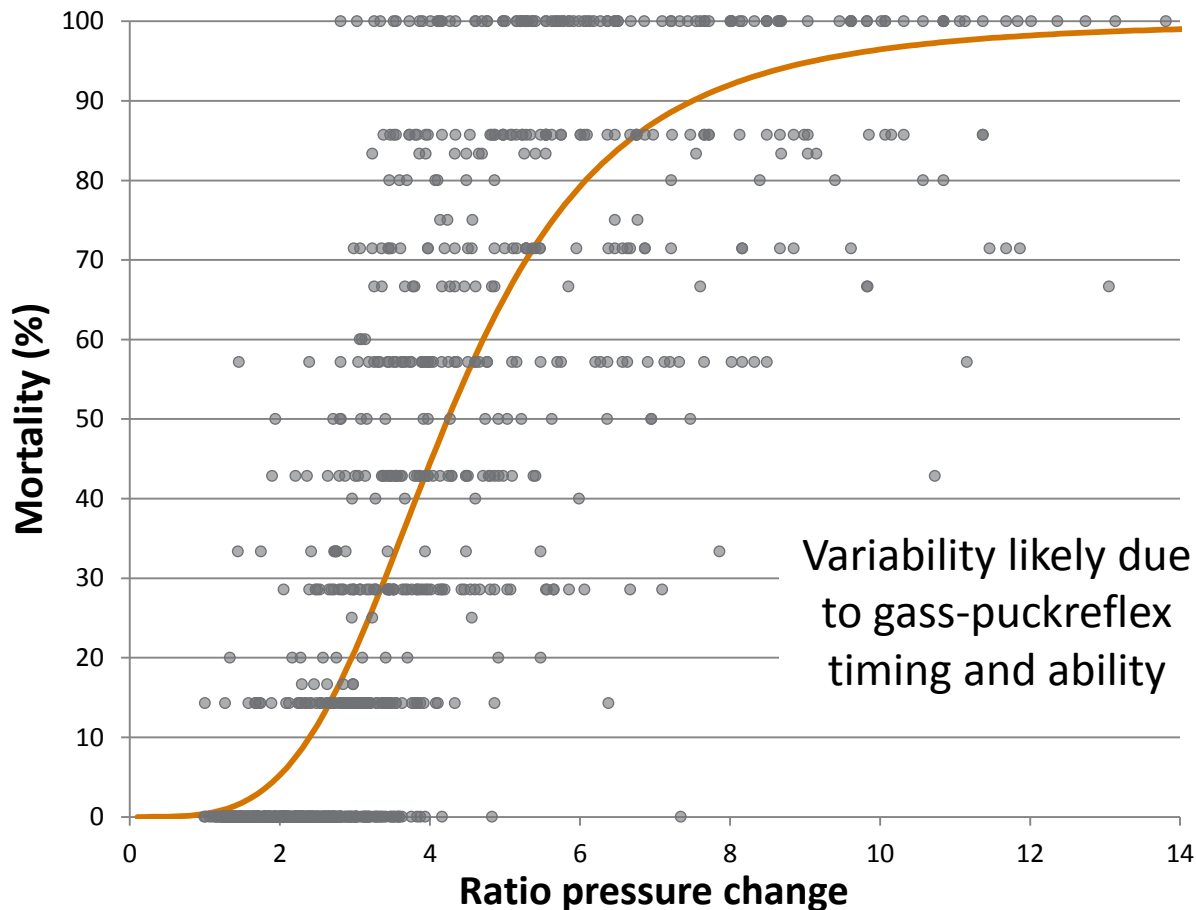
- ▶ Chinook salmon
- ▶ Steelhead
- ▶ Pacific and brook lamprey
- ▶ Barbs (Southeast Asia)
- ▶ Tetras (South America)



Estimating Mortality/Injury

► Relationship between mortality/injury and pressure change for juvenile Chinook salmon

Brown et al. 2012 Transactions of the American Fisheries Society



Example of ratio pressure

Used for the development of new hydroturbines to be installed in the Snake and Columbia river basins

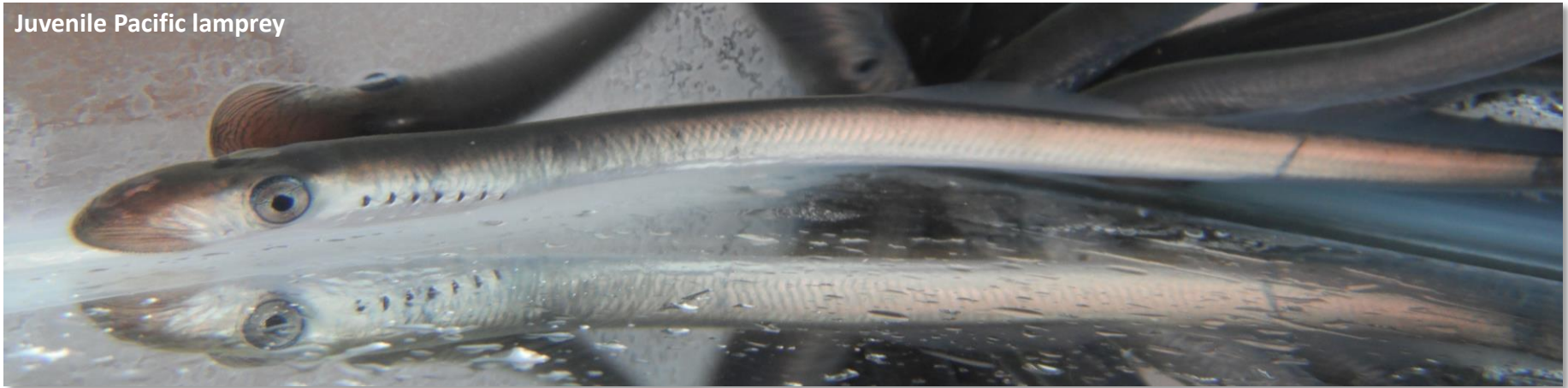
Swim bladder 2 times bigger



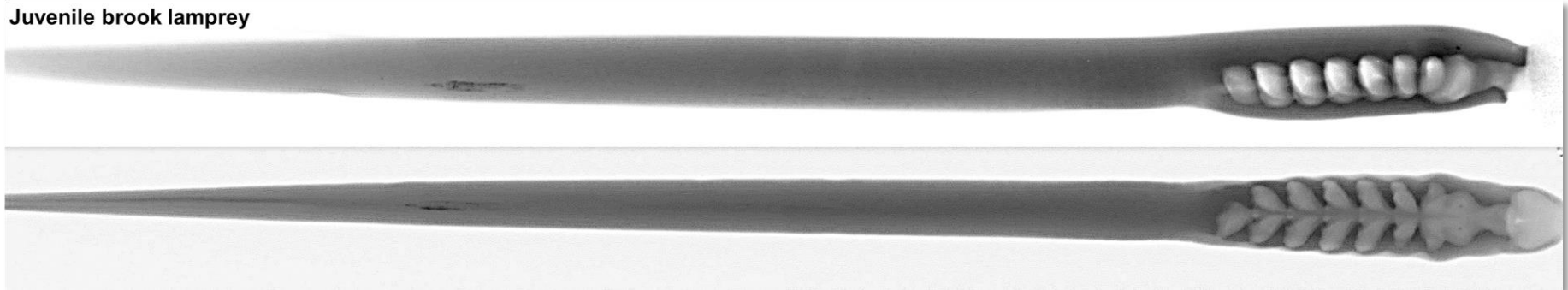
Lamprey

No barotrauma observed in brook and Pacific lamprey exposed to rapid and sustained decompression known to cause ~100% mortality in juvenile Chinook salmon

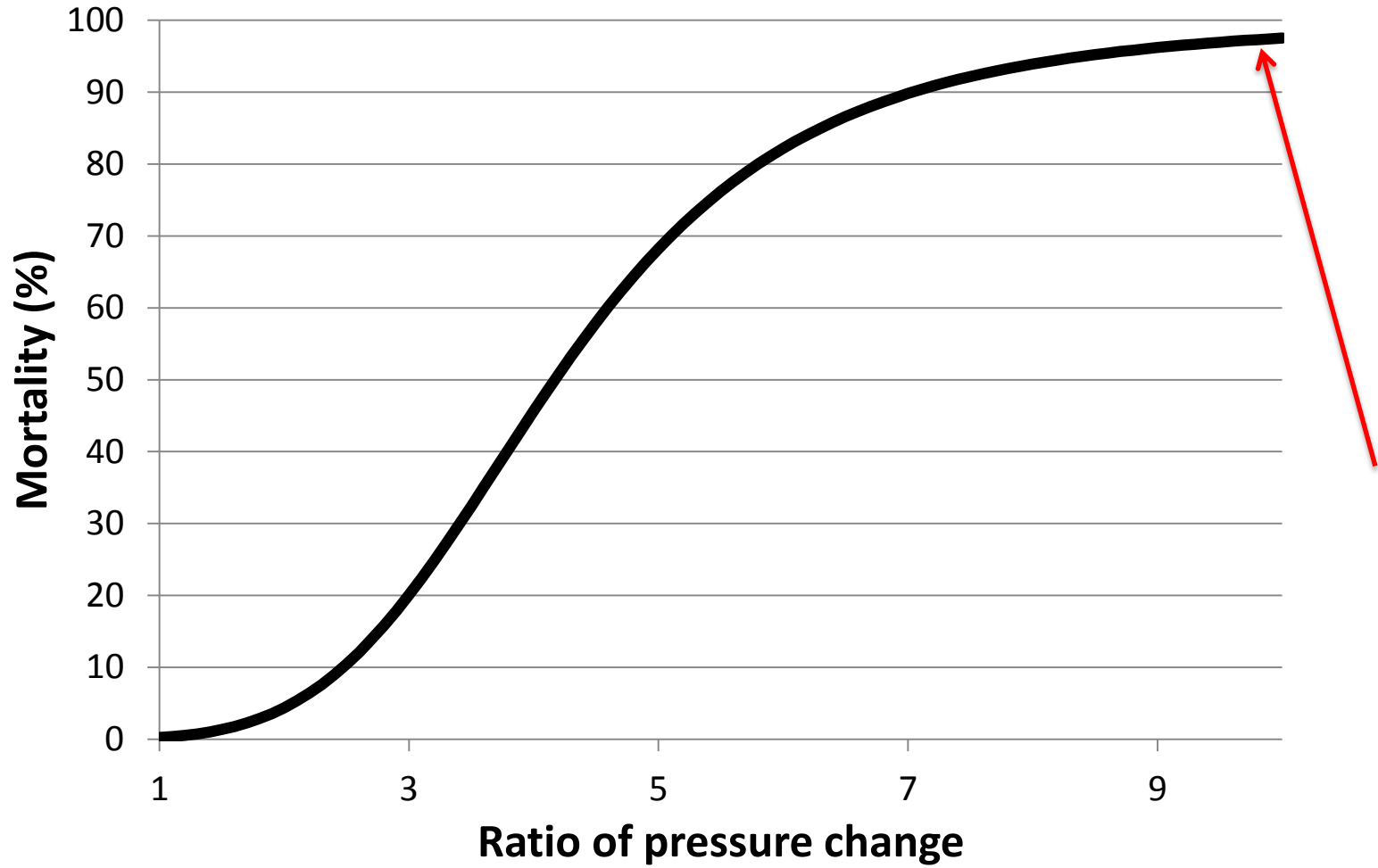
Juvenile Pacific lamprey



Juvenile brook lamprey



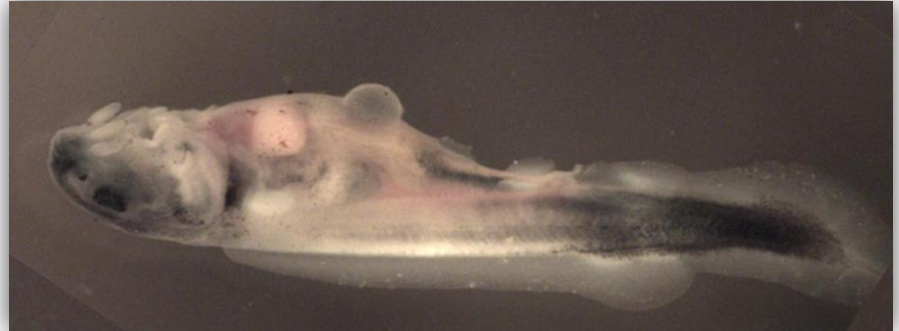
Lamprey



Barotrauma in White Sturgeon

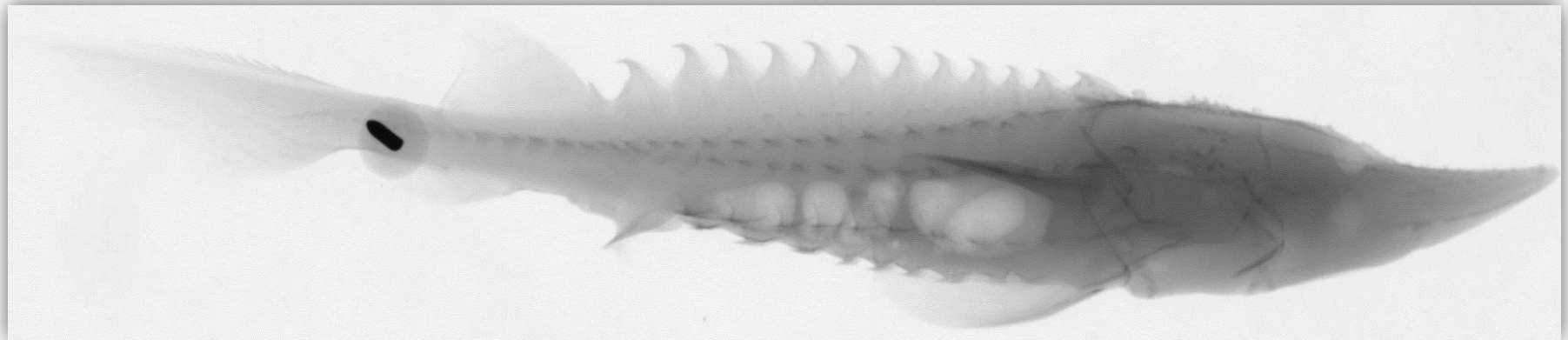
Due to metabolism

- ▶ Short period after first feeding
- ▶ Gas found in intestine of unexposed fish may cause injury

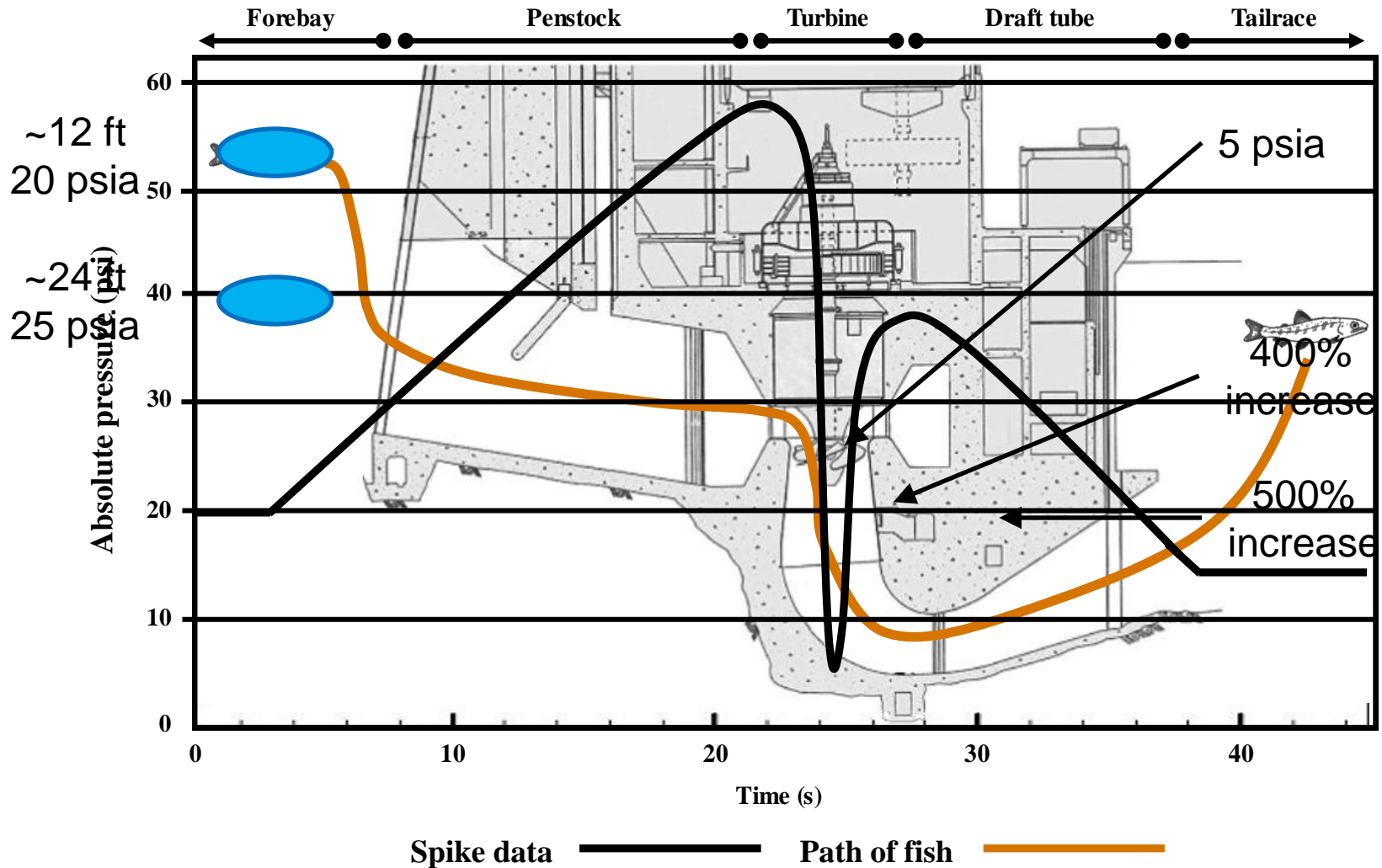


Due to swim bladder

- ▶ After inflation

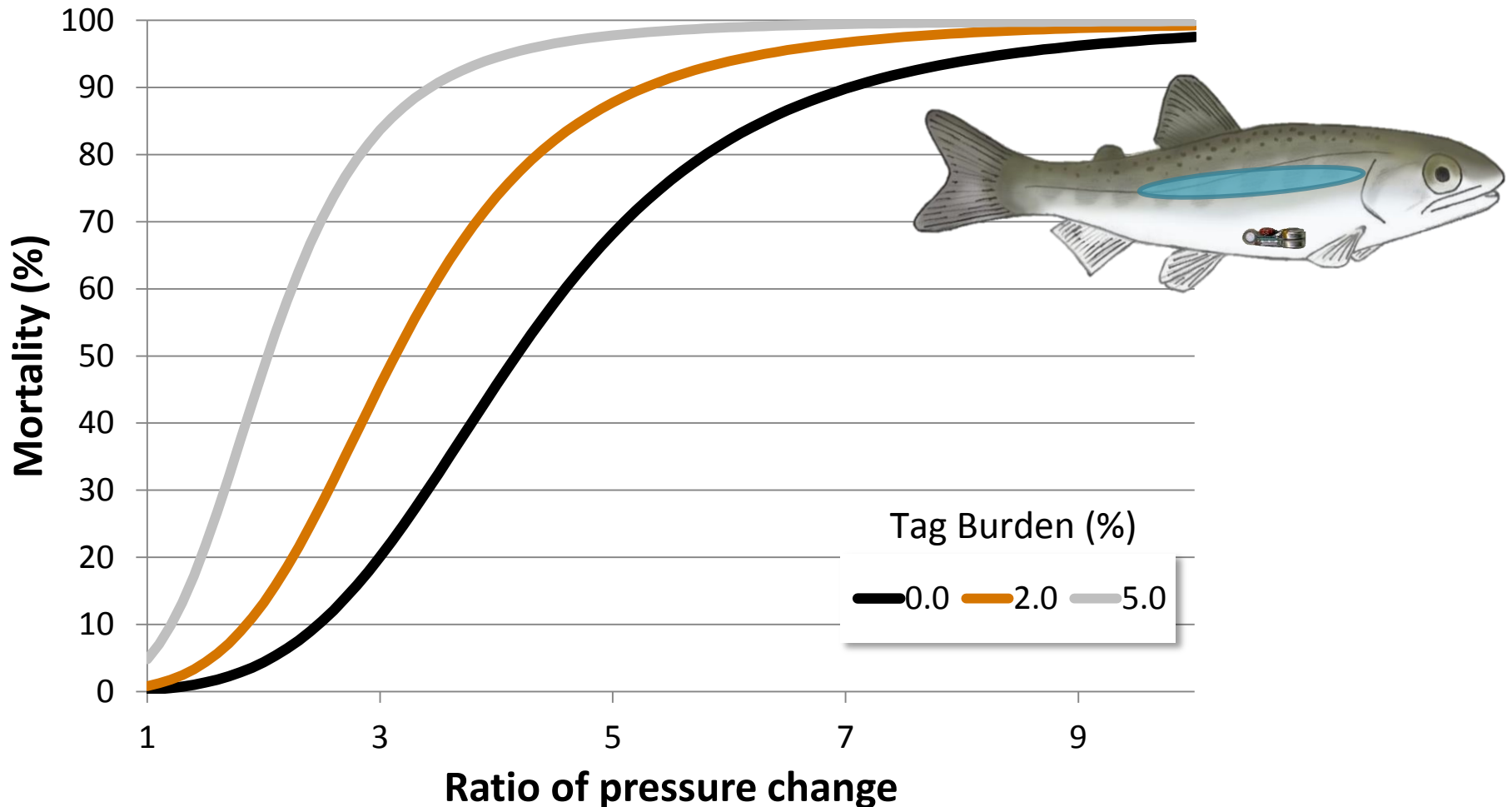


Acclimation Depth

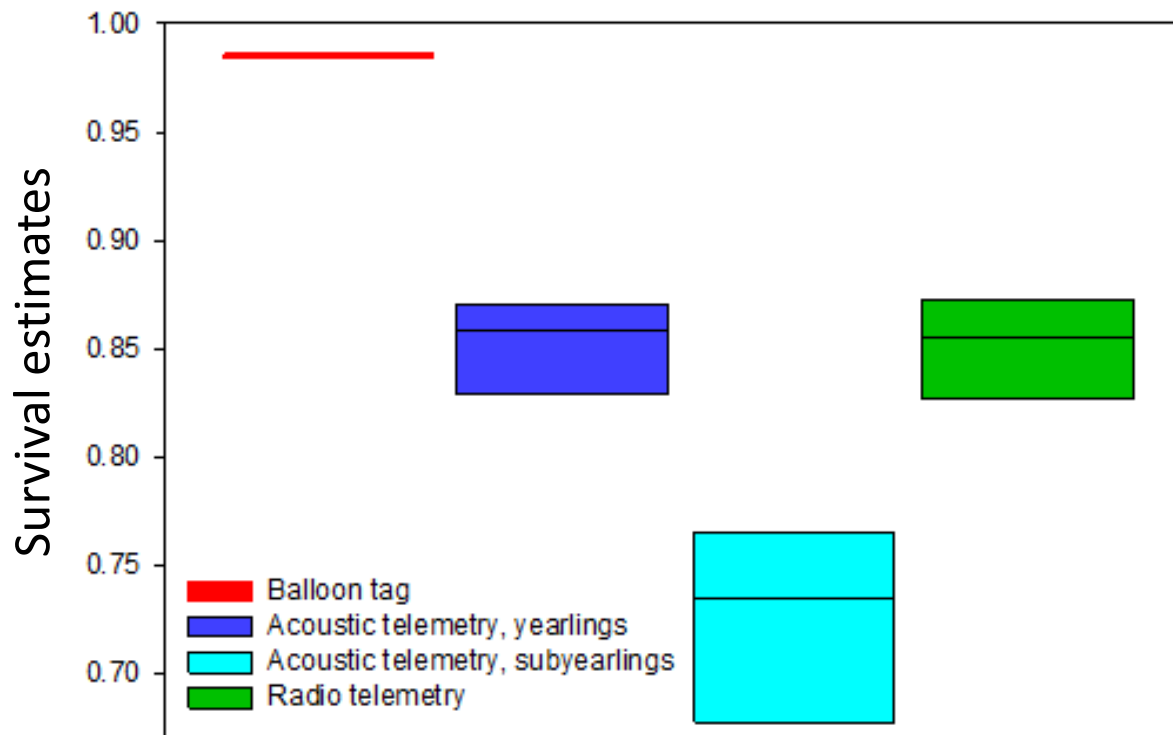


Tag Presence Bias

Tag presence increase mortality of turbine passed fish



Turbine Survival at McNary Dam



Likely causes of survival differences

- ▶ Acclimation
- ▶ Tag presence
- ▶ Delayed mortality
- ▶ Indirect mortality

Balloon tag

(Normandeau et al. 1999)

Median survival 0.98

Mean size 154 mm

3 turbine passage scenarios



Acoustic telemetry

Yearlings

(Adams et al. 2011; Evans et al. 2012)

Median survival 0.85

5 years; 2 studies

Subyearlings

(Adams et al. 2011)

Median survival 0.74

5 years

Radio telemetry

(Absolon et al. 2003; Adams et al. 2011)

Median survival 0.86

2 spill treatments; 2 years

Includes bypass system

Future Direction

- ▶ Examine differences in susceptibility to barotrauma for other species
 - Physoclistous fishes (closed swim bladder)

- ▶ Apply laboratory findings to better understand biases associated with field studies
 - Reconcile differences in survival estimates among different techniques

- ▶ Prepare for increased electricity demands
 - Development in new hydropower projects
 - Retrofitting of existing dam structures

Acknowledgments

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