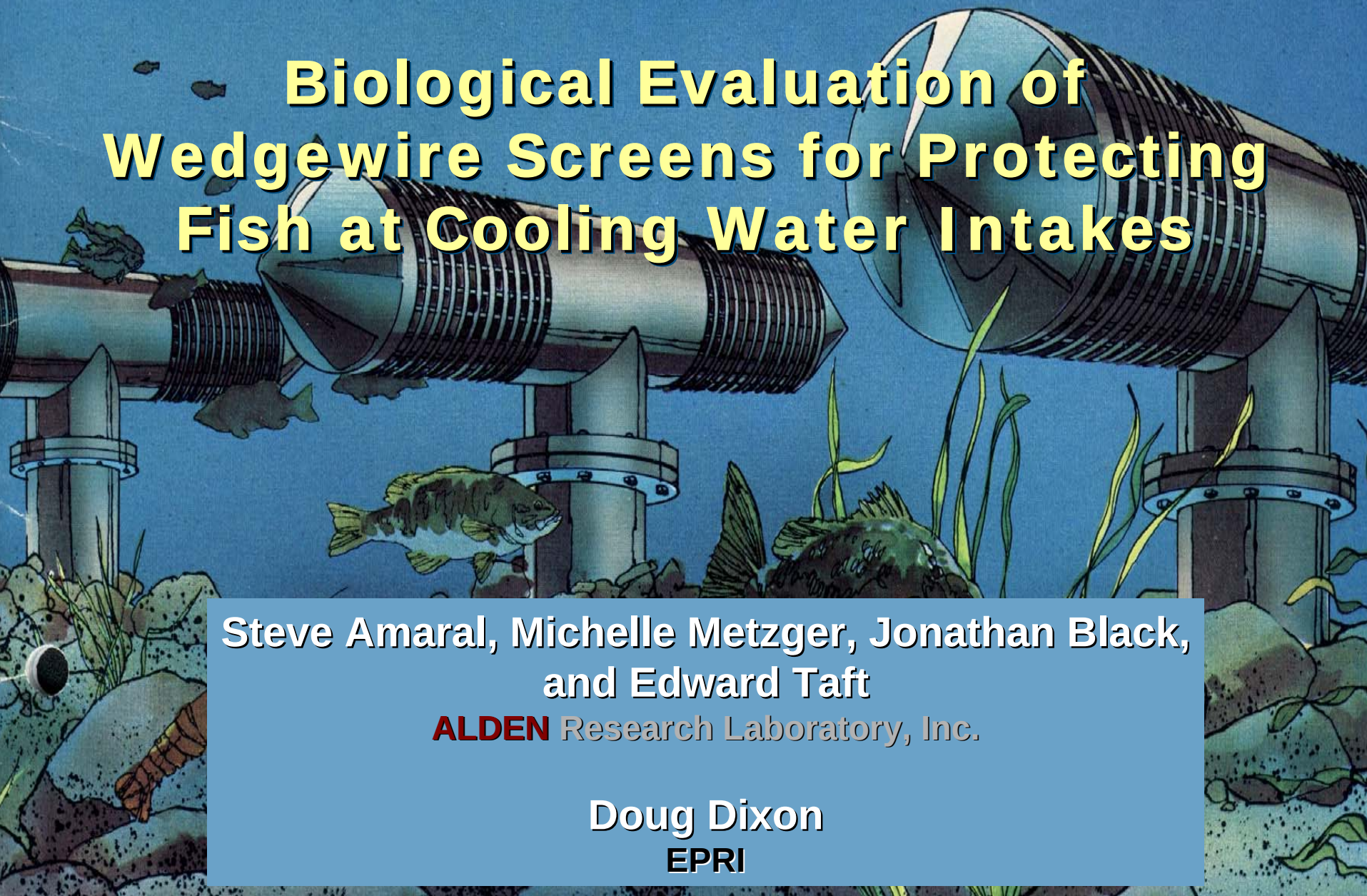
A Symposium on Cooling Water Intake Technologies To Protect Aquatic Organisms

Biological Evaluation of Wedgewire Screens for Protecting Fish at Cooling Water Intakes



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Biological Evaluation *Objectives*

Determine the relative influence of the following parameters on entrainment and impingement rates of selected species and life stages:

- Slot size
- Through-slot velocity
- Approach channel velocity

METHODS

Test Conditions

Screen Orientation	Slot Size (mm)	Slot Velocity (m/s)	Channel Velocity (m/s)
0°	0.5	0.15	0.08
90°	1.0	0.30	0.15
	2.0		0.30

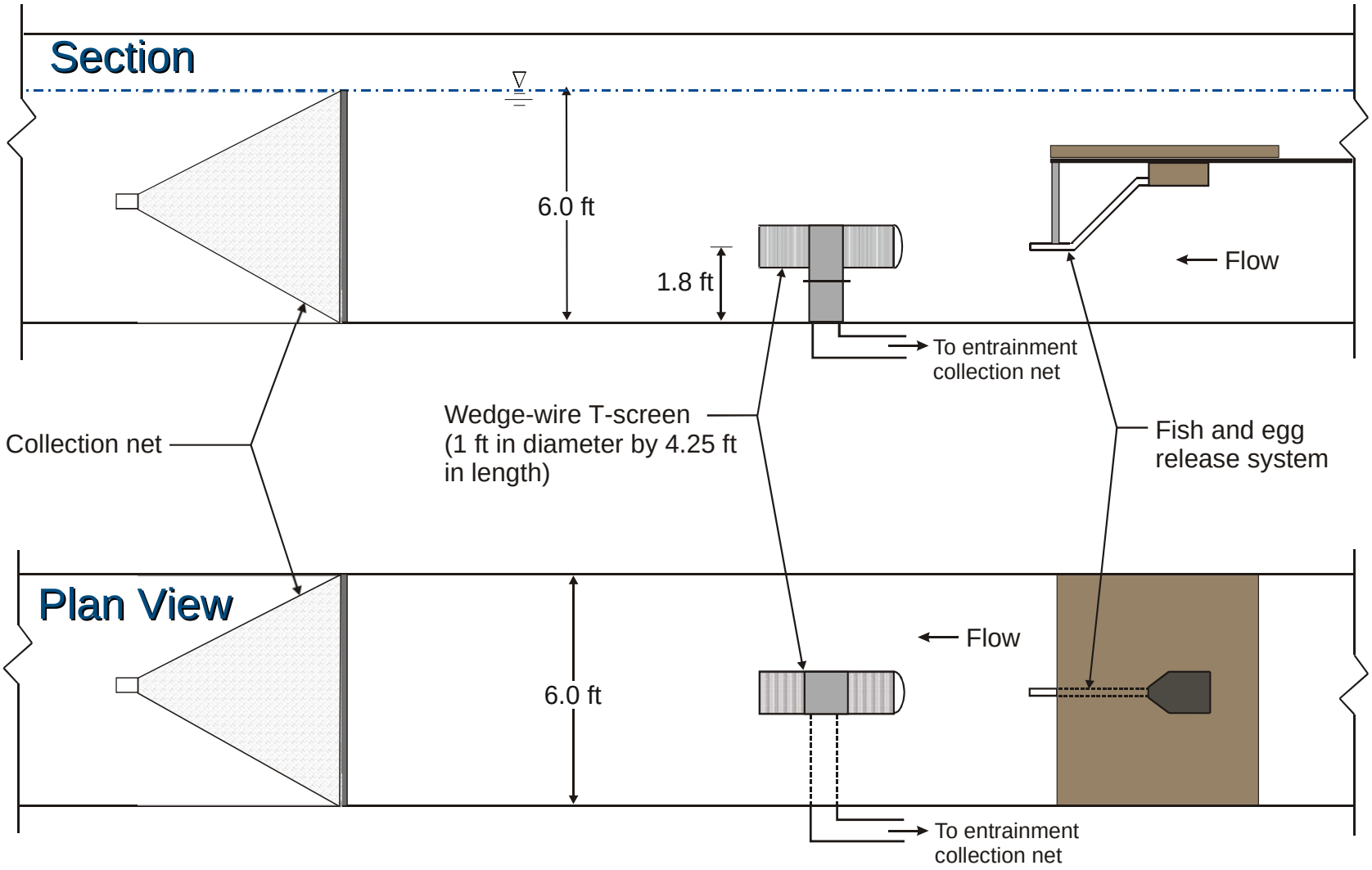
METHODS

Test Fish

	SPECIES	EGG DIA	LARVAL LENGTH
	striped bass (*Morone saxatilis)*	4.5	4.3 - 8.8
	winter flounder (*Pleuronectes americanus)*	--	5.0 - 7.9
	yellow perch (*Perca flavescens)*	--	6.3 - 7.3
	common carp (*Cyprinus carpio)*	--	6.4
	white sucker (*Catostomus commersoni)*	3.2	13.9
	bluegill (*Lepomis macrochirus)*	--	19.0
	alewife (*Alosa pseudoharengus)*	0.7	--
	rainbow smelt (*Osmerus mordax*)	--	6.2

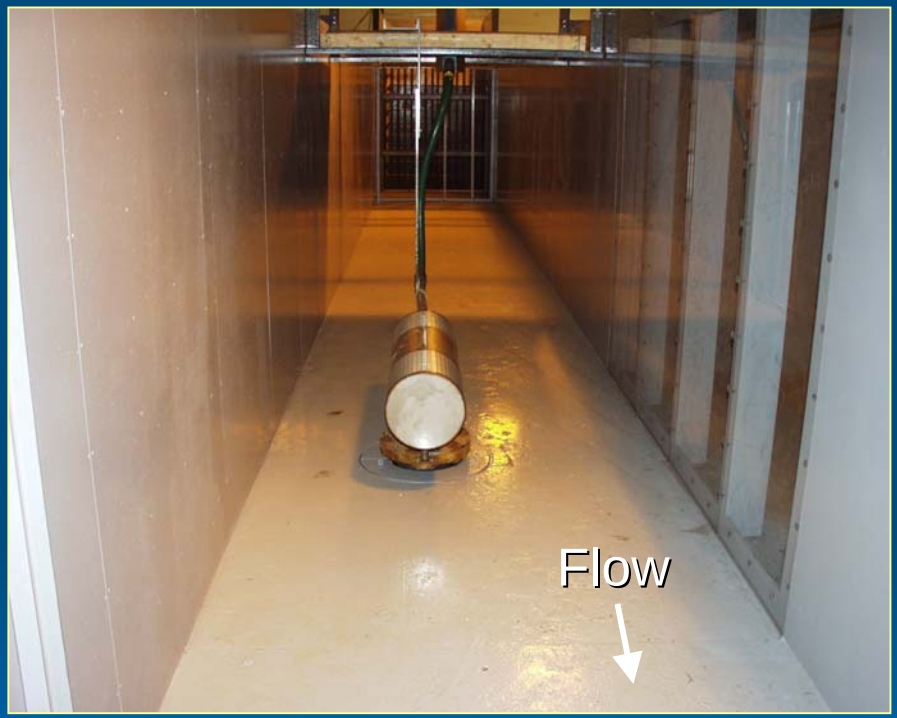
METHODS

Test Facility Design



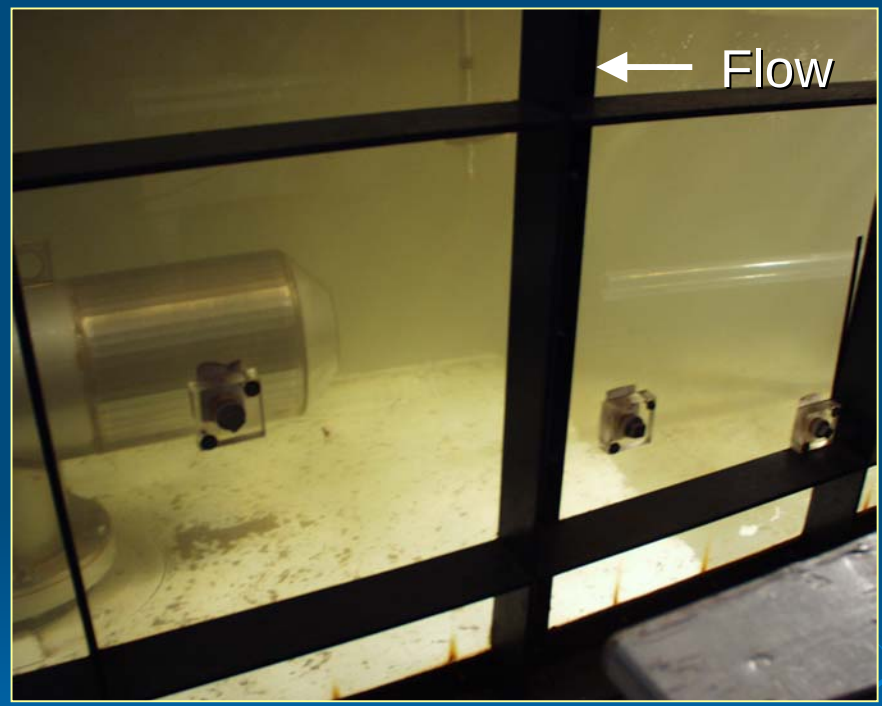
METHODS

Test Facility Design



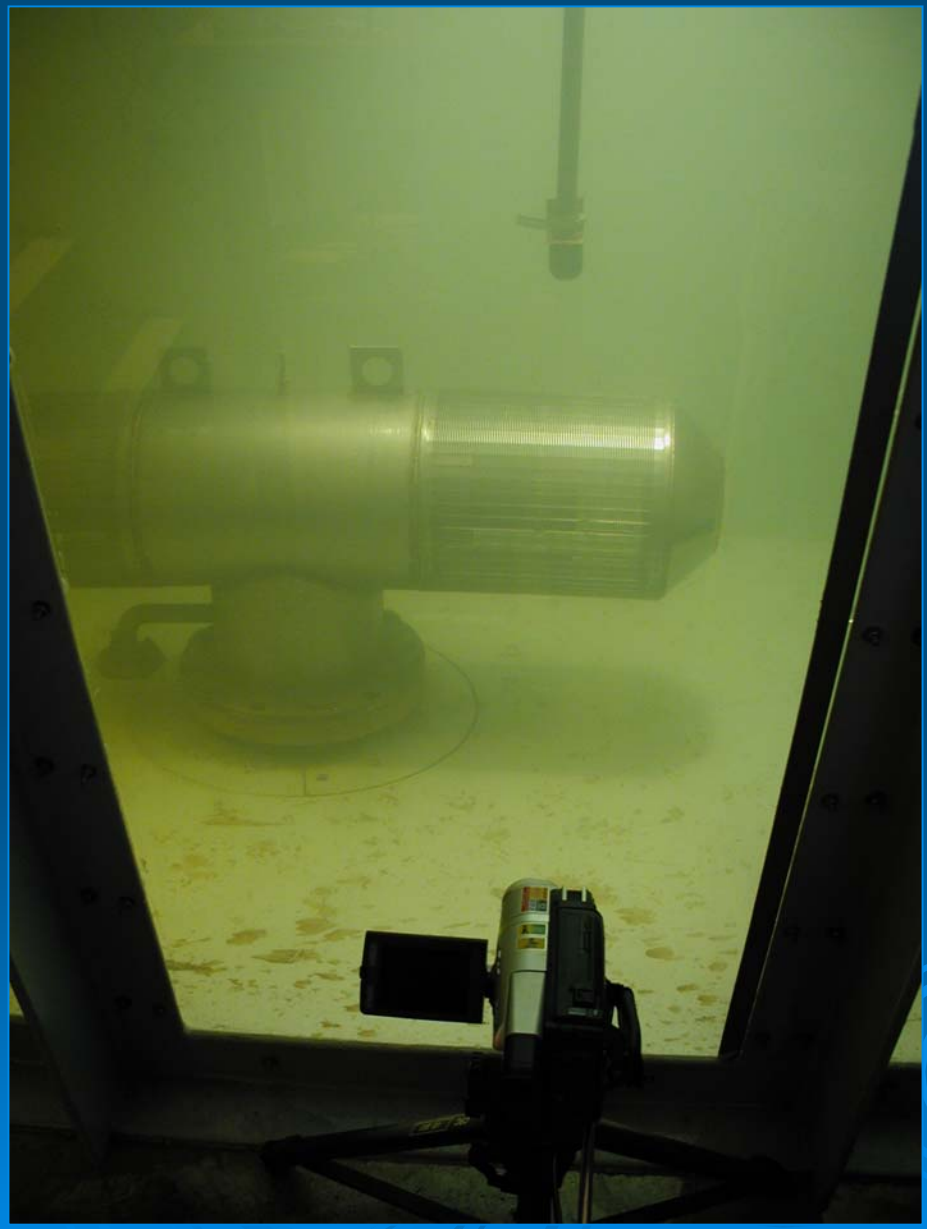
METHODS

Fish Release



Entrainment Collection Tank and Net

METHODS *Video Observations*



METHODS *Experimental Design*

For each set of test conditions (i.e., slot size, slot velocity, approach velocity, species):

- Conduct 3-5 trials
- Release 50 to 100 organisms per trial
- Estimate number entrained
- Estimate number impinged

METHODS *Entrainment/Impingement*

$$\%\ \text{Fish Lost to Impingement/Entrainment} = \left(\frac{E_{adj} + I}{R} \right) \times 100$$

METHODS

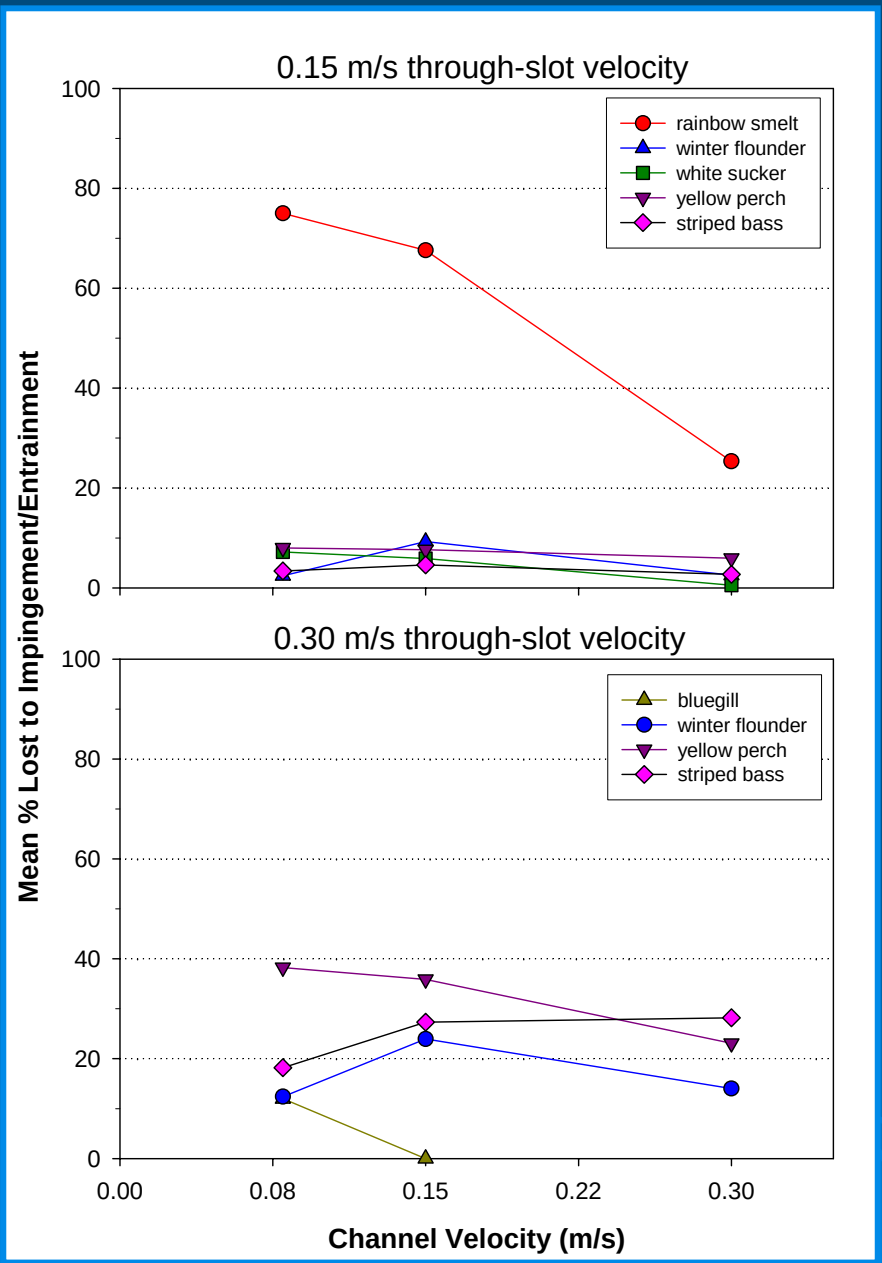
Data Analysis

- Analyze entrainment and impingement data for statistical differences among test conditions (slot width, slot velocity, channel velocity, species)
- Explore potential interactions among the test conditions
- For larval data, examine fish length as a covariate

RESULTS

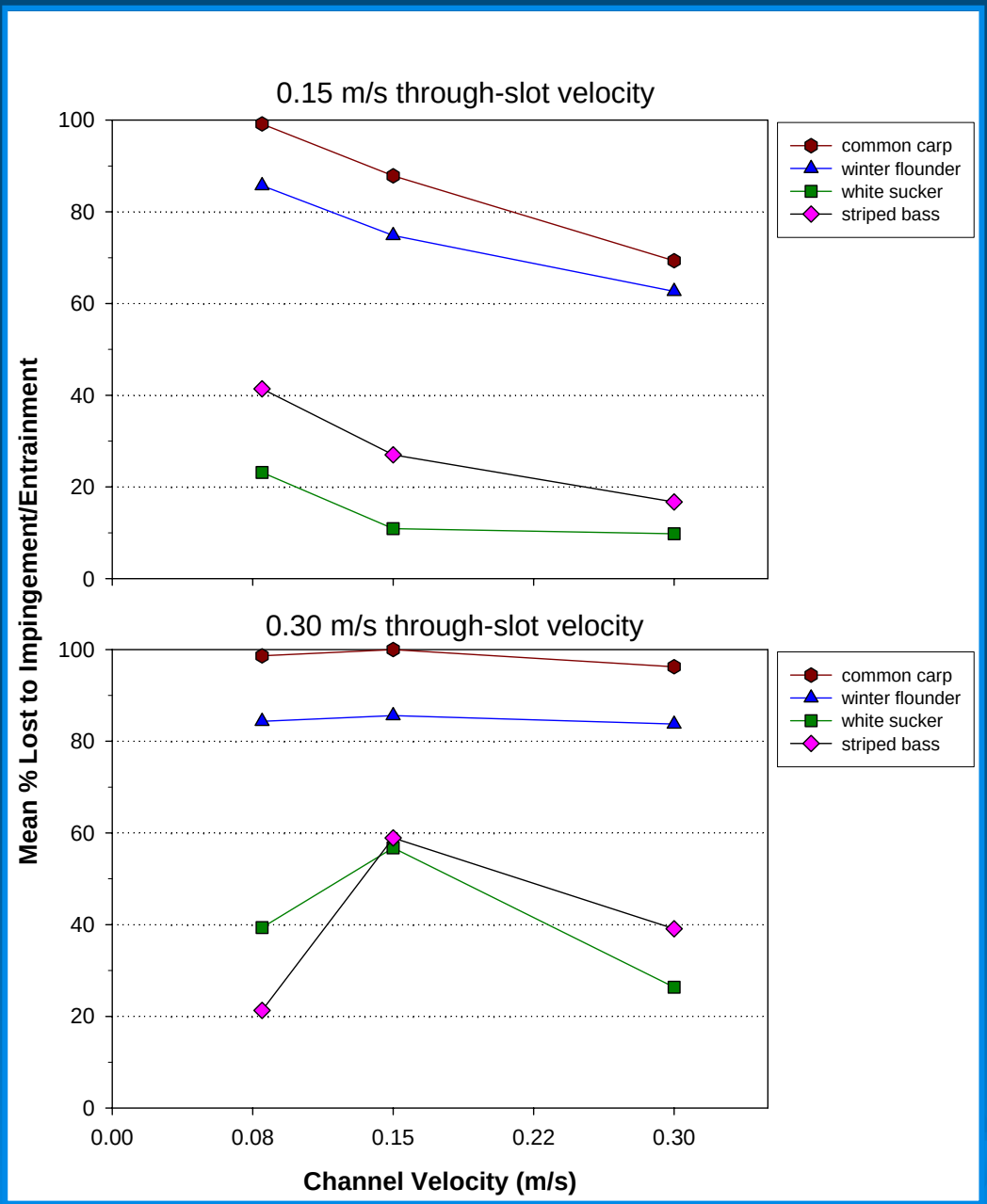
- Percent of organisms lost to entrainment and impingement by slot size
- Relationship between length/diameter and entrainment and impingement
- Effect of channel/slot velocity ratio on percent of organisms lost to entrainment and impingement

RESULTS



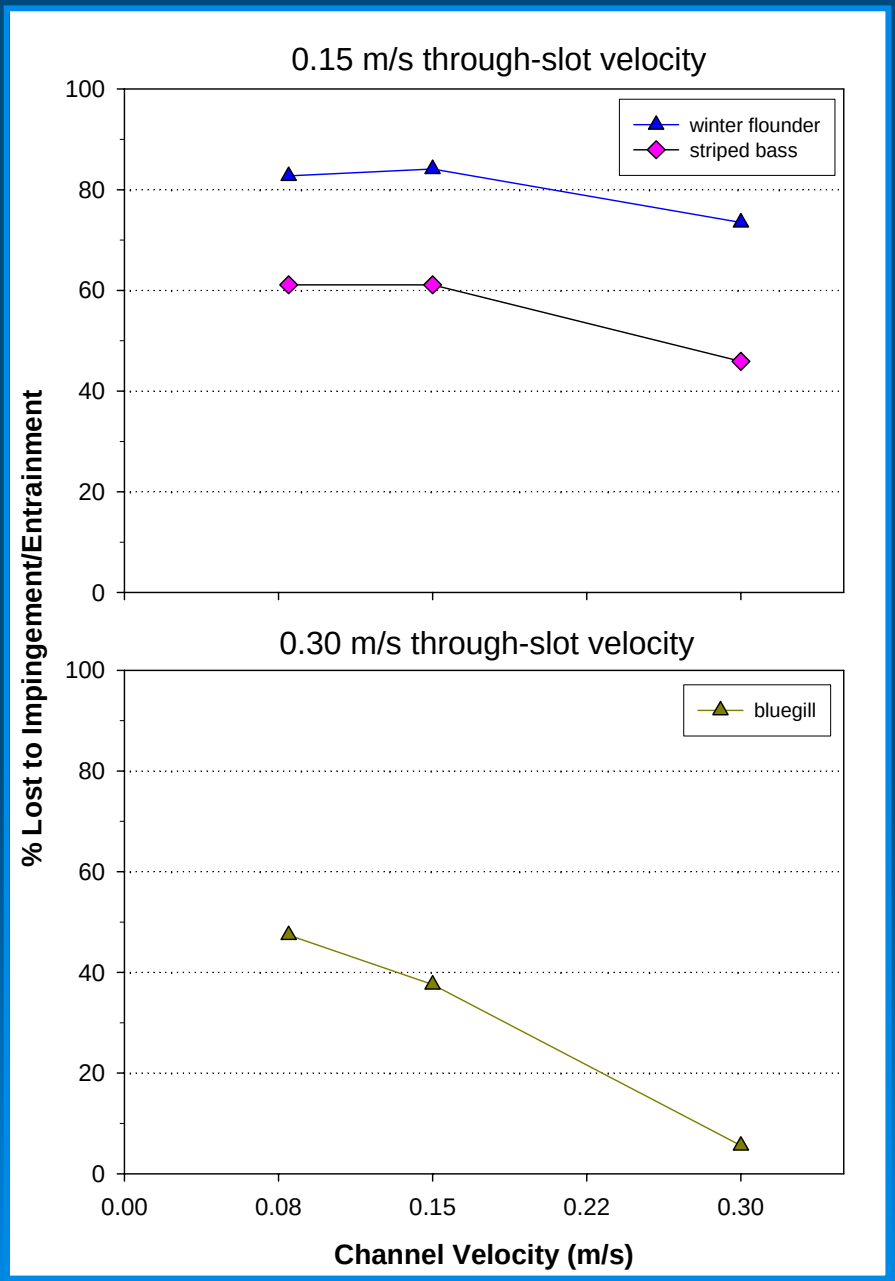
0.5-mm slot screen
Fish Larvae

RESULTS



1-mm slot screen
Fish Larvae

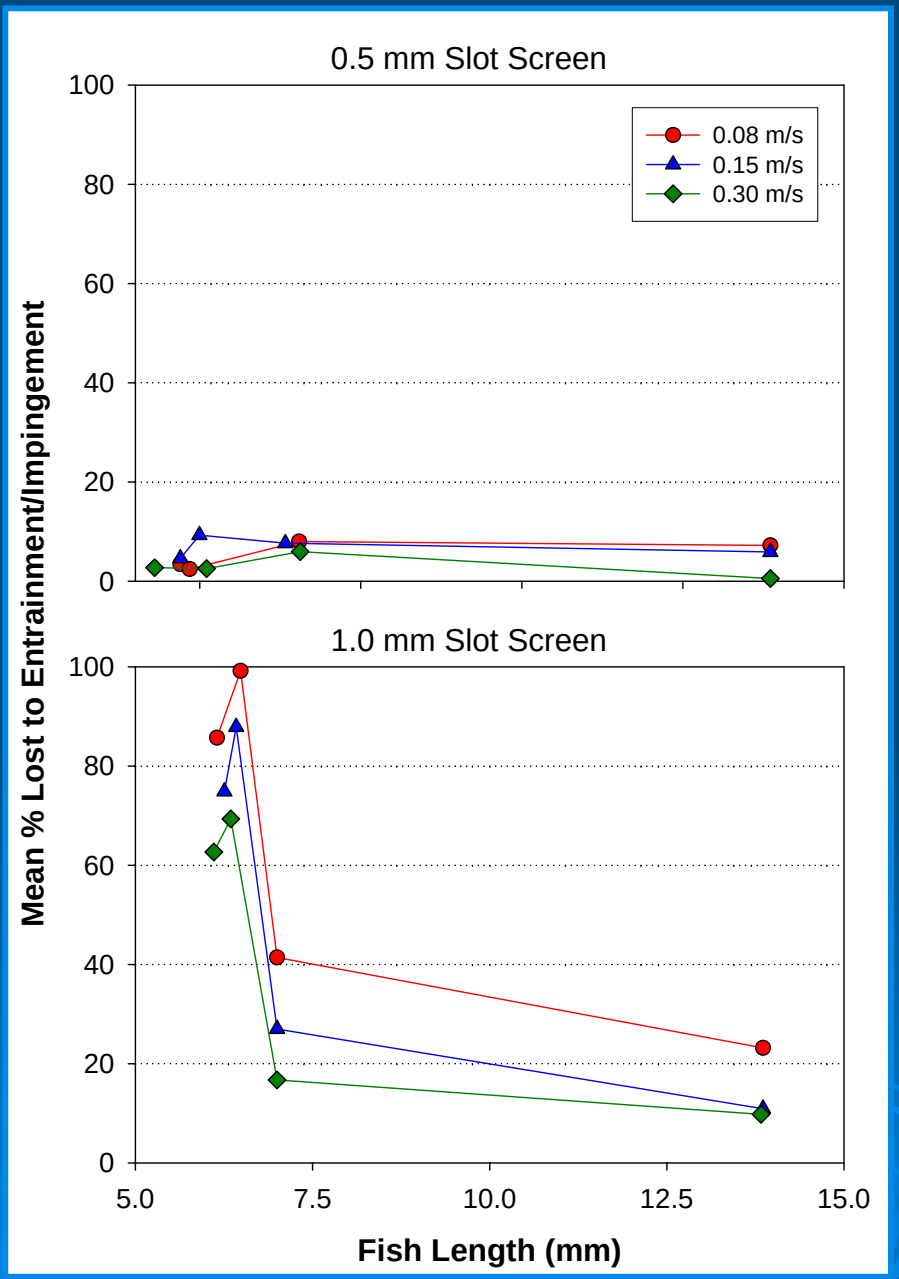
RESULTS



2-mm slot screen
Fish Larvae

RESULTS

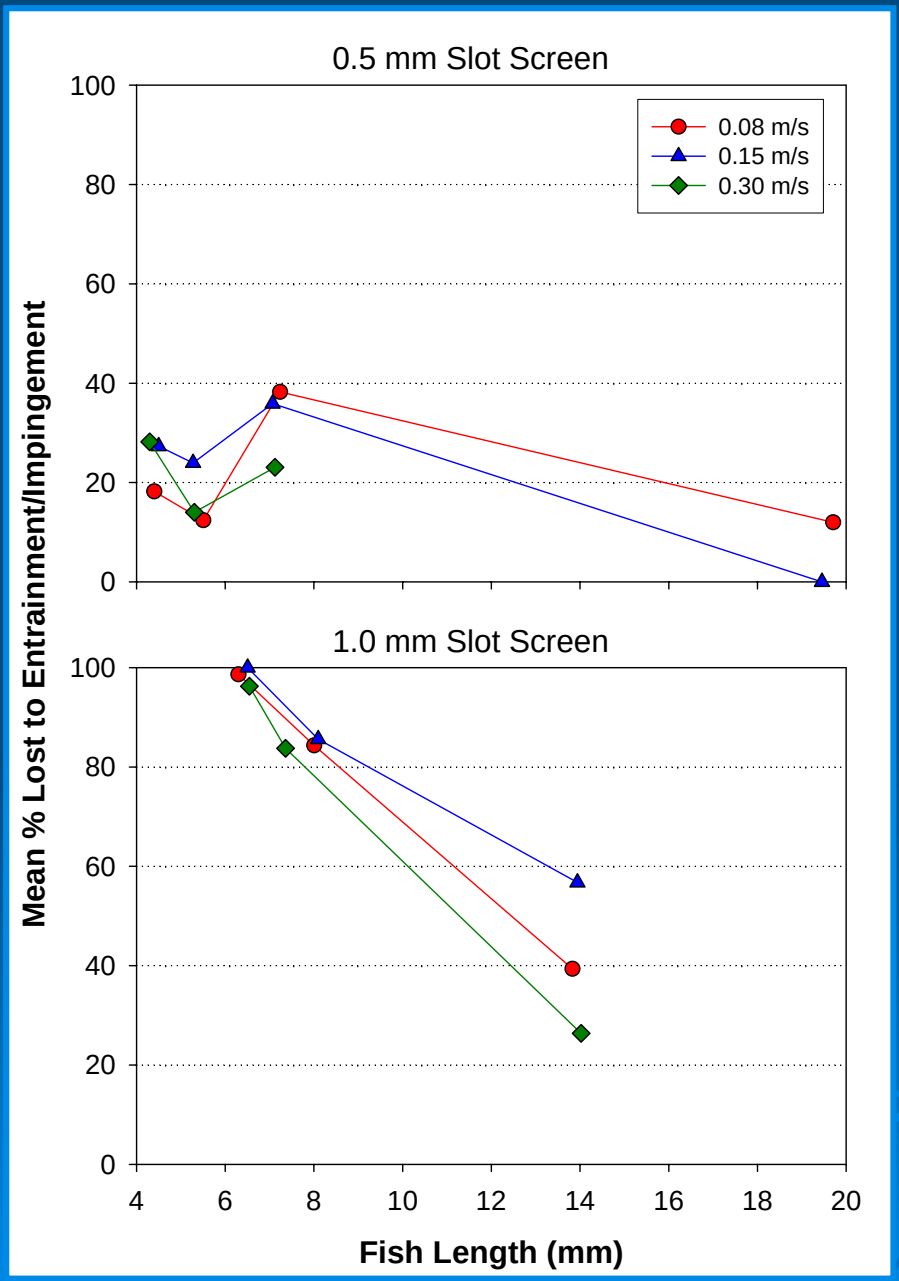
Fish Length



0.15 m/s through-slot velocity
Fish larvae

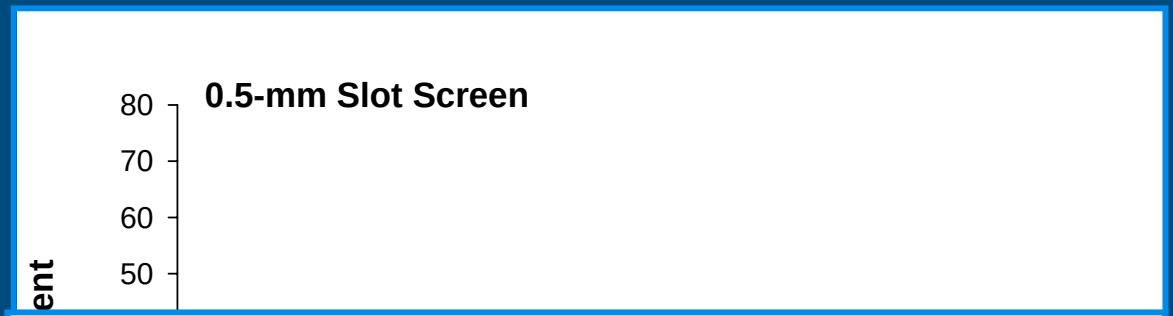
RESULTS

Fish Length

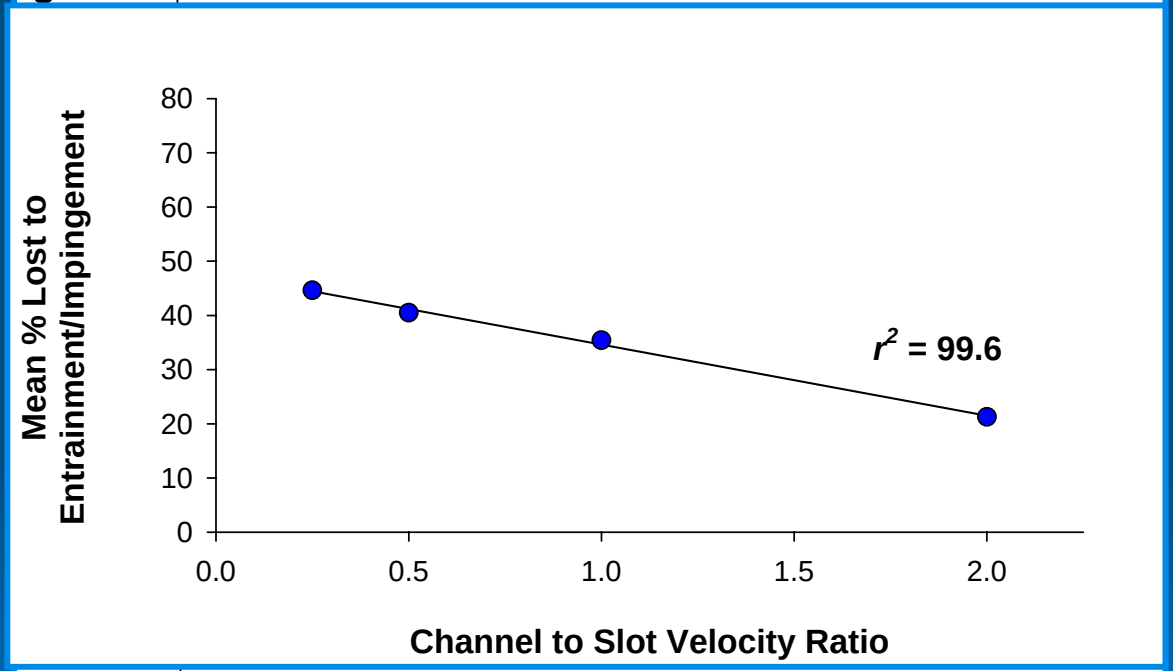


0.30 m/s through-slot velocity
Fish Larvae

RESULTS *Channel/Slot Velocity Ratio*

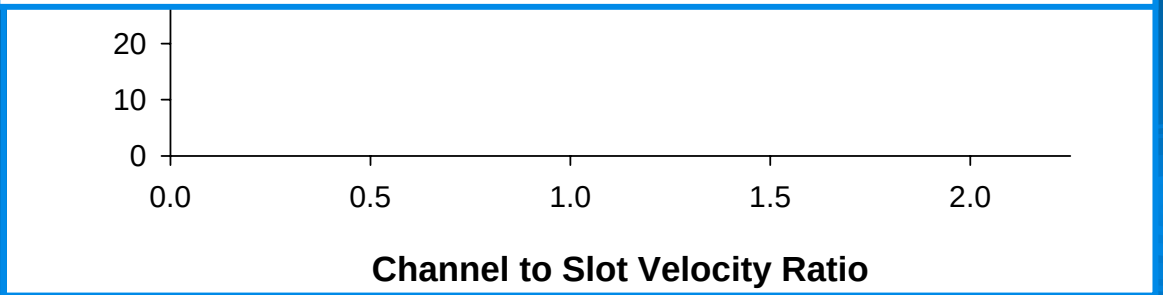


Fish Larvae

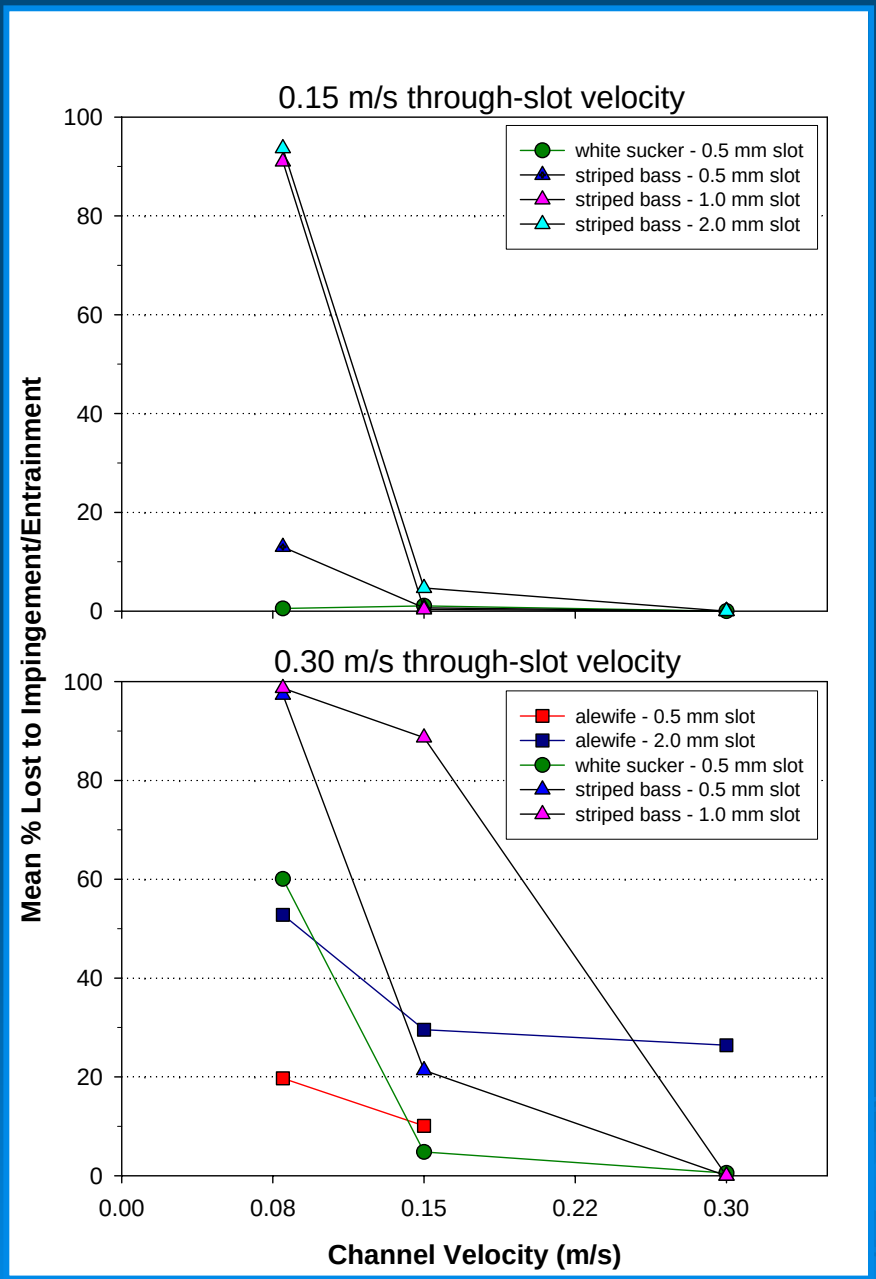


Fish Larvae

All screens combined



RESULTS

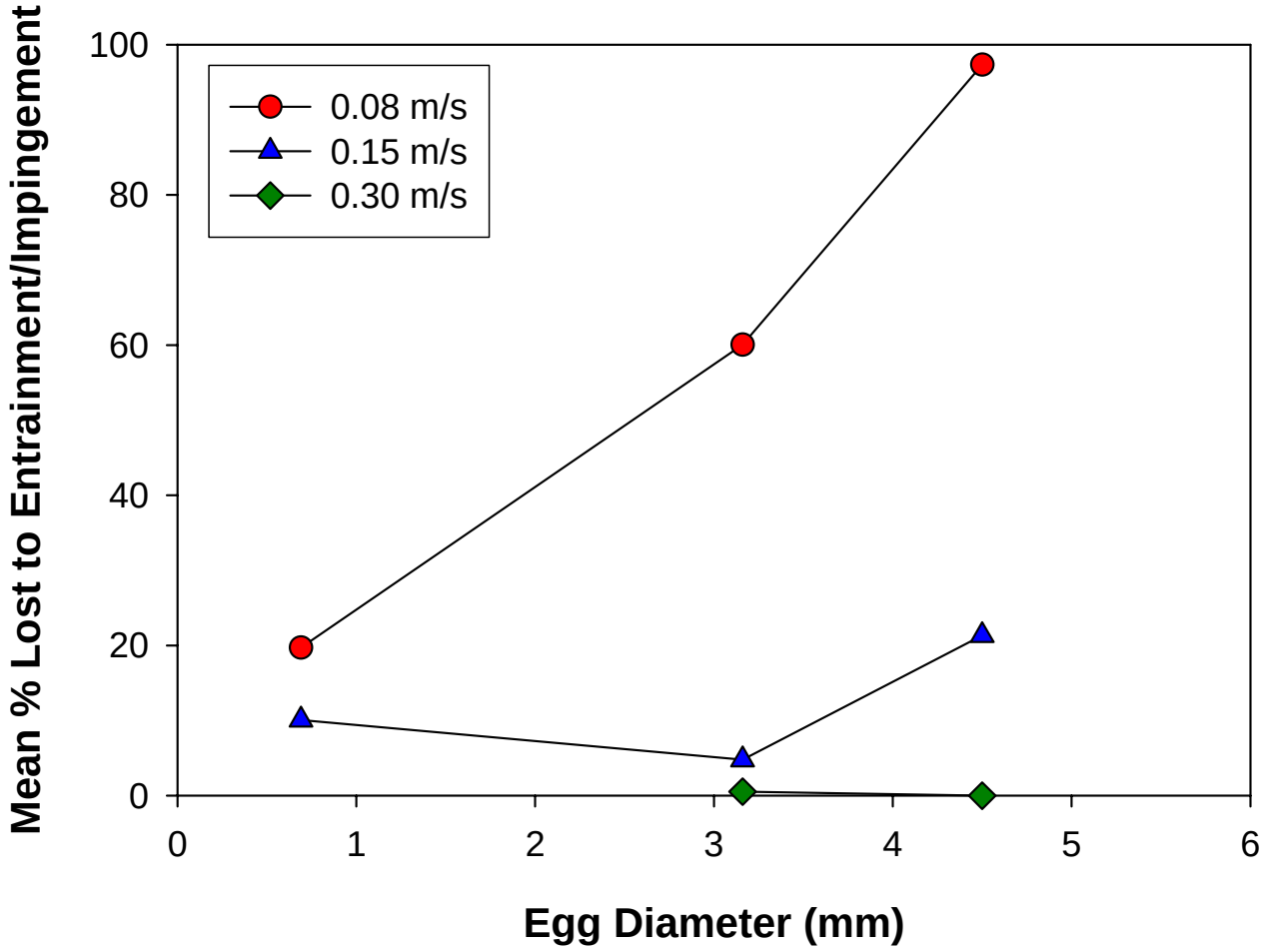


Fish Eggs

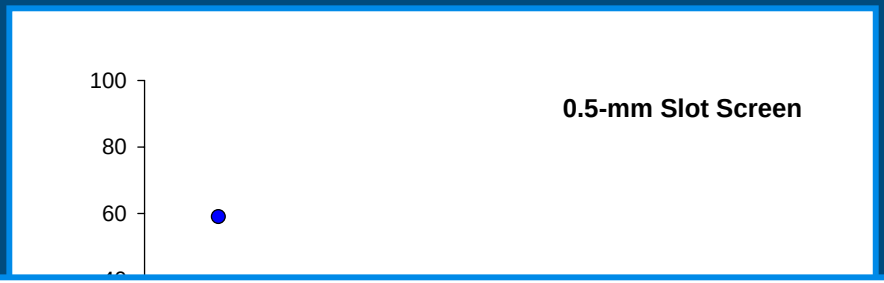
RESULTS

Egg Diameter

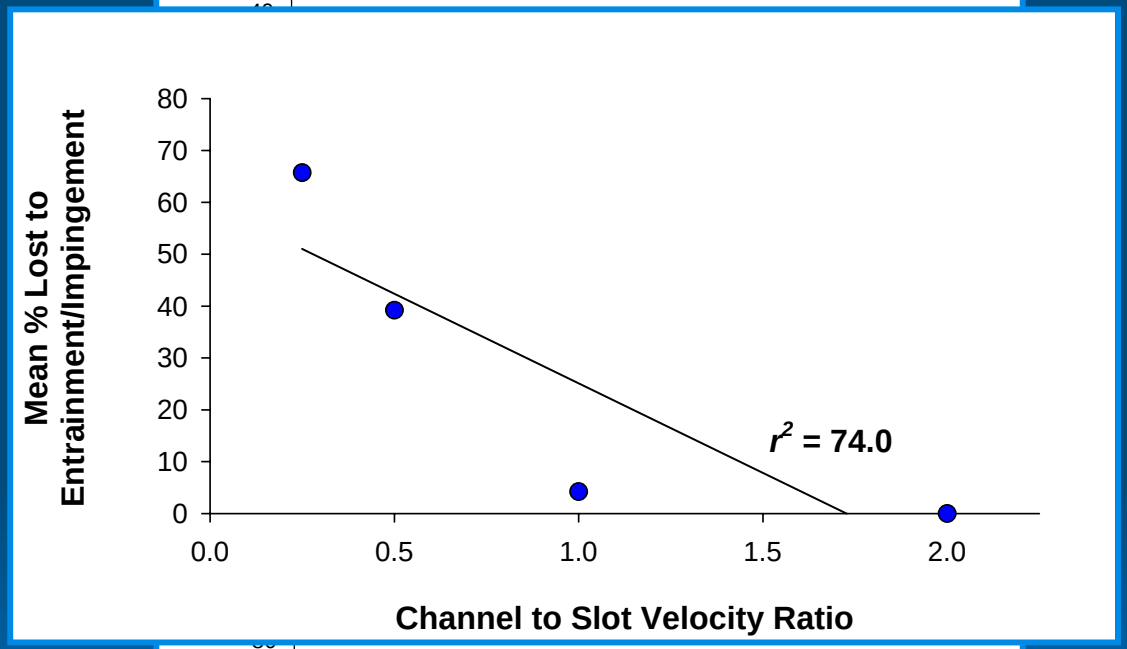
0.5 mm slot with 0.30 m/s through-slot velocity
Fish Eggs



RESULTS *Channel/Slot Velocity Ratio*

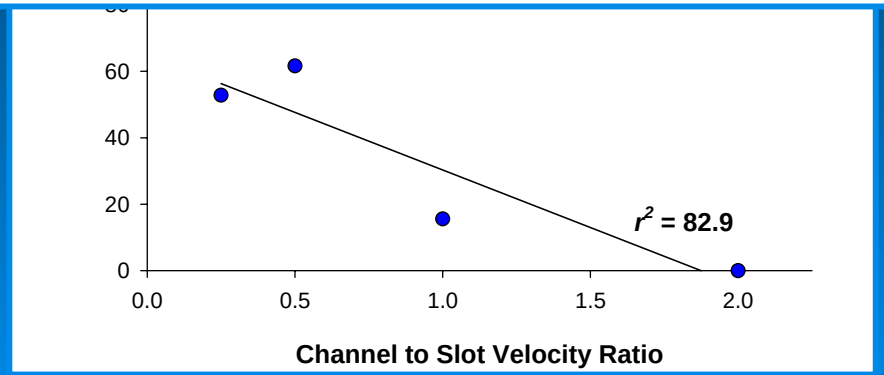


Fish Eggs



Fish Eggs

All screens combined

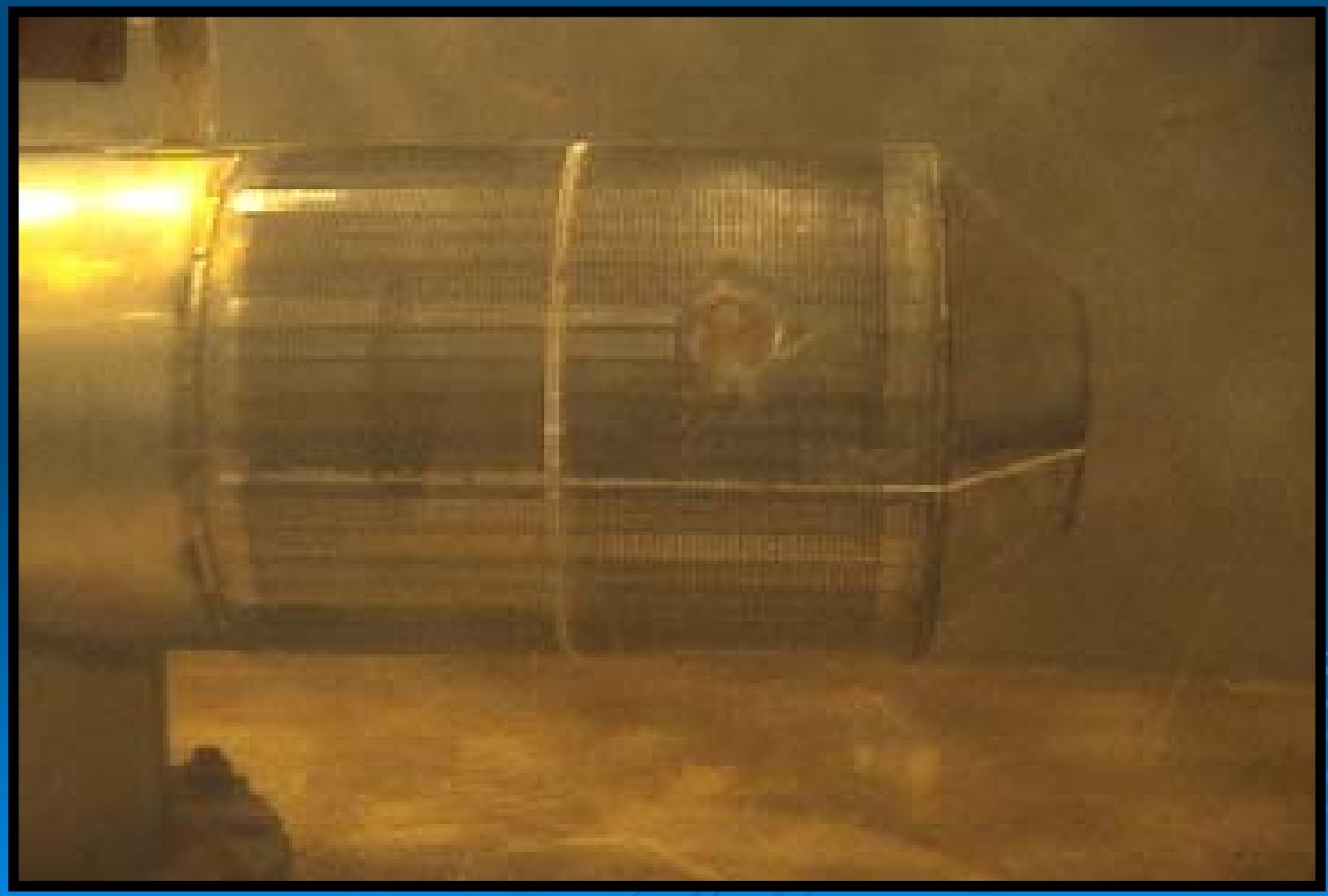


VIDEO OBSERVATIONS

Slot Width:	2.0 mm
Through-slot Velocity:	0.5 ft/s
Channel Velocity (ft/s):	0.25 ft/s

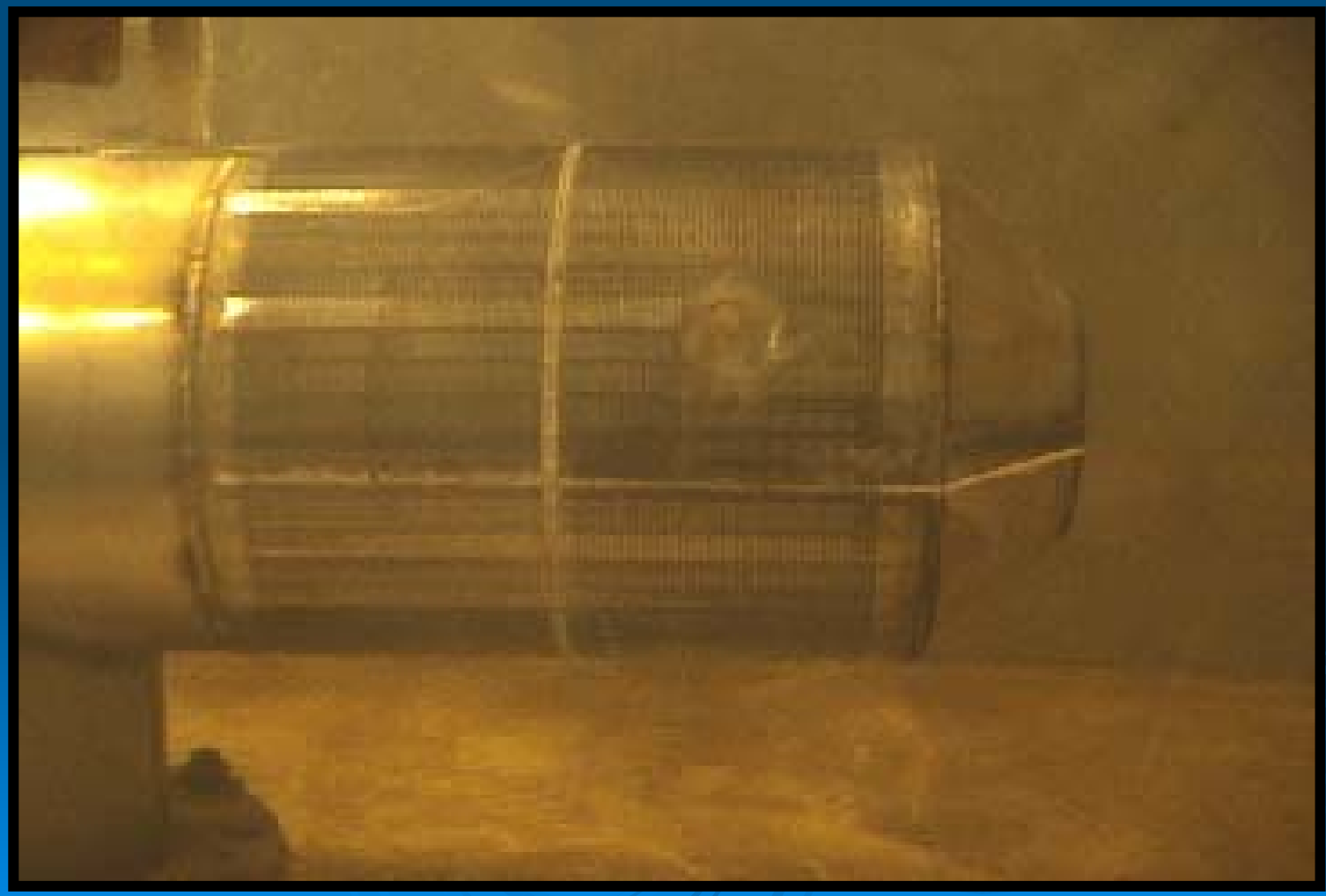
VIDEO OBSERVATIONS

Slot Width:	2.0 mm
Through-slot Velocity:	0.5 ft/s
Channel Velocity (ft/s):	0.5 ft/s



VIDEO OBSERVATIONS

Slot Width:	**2.0 mm**
Through-slot Velocity:	**0.5 ft/s**
Channel Velocity (ft/s):	**1.0 ft/s**



Conclusions

- Impingement decreased with increases in slot size
- Entrainment increased with increases in slot size
- Entrainment and impingement increased with increases in through-slot velocity
- Entrainment and impingement decreased with increases channel velocity
- For each species evaluated, larval length generally did not influence entrainment and impingement rates, most likely due to the narrow size ranges that were tested
- Among species, larval entrainment and impingement rates generally decreased with increasing fish length
- Percent of eggs lost to entrainment and impingement increased with diameter at the lower channel velocities
- The ratio of channel velocity to slot velocity was negatively correlated with entrainment/impingement rates

Conclusions

General Effectiveness of Wedgewire Screens

- Entrainment and impingement rates less than 10% can be achieved for eggs and larvae depending on organism size, screen design, and local hydraulics

Considerations in Assessing Wedgewire Screen Effectiveness

- The relative importance of each variable is dynamic
- More information is needed to fully understand the interactions among all variables that influence entrainment and impingement
- Effects of debris loading are unknown
- Entrainment and impingement rates will be lower when all organisms that are within the biological zone of influence are considered
- Conclusions from the laboratory study must be verified in the field