Environmental Windows Research Update: Smallmouth Bass Studies

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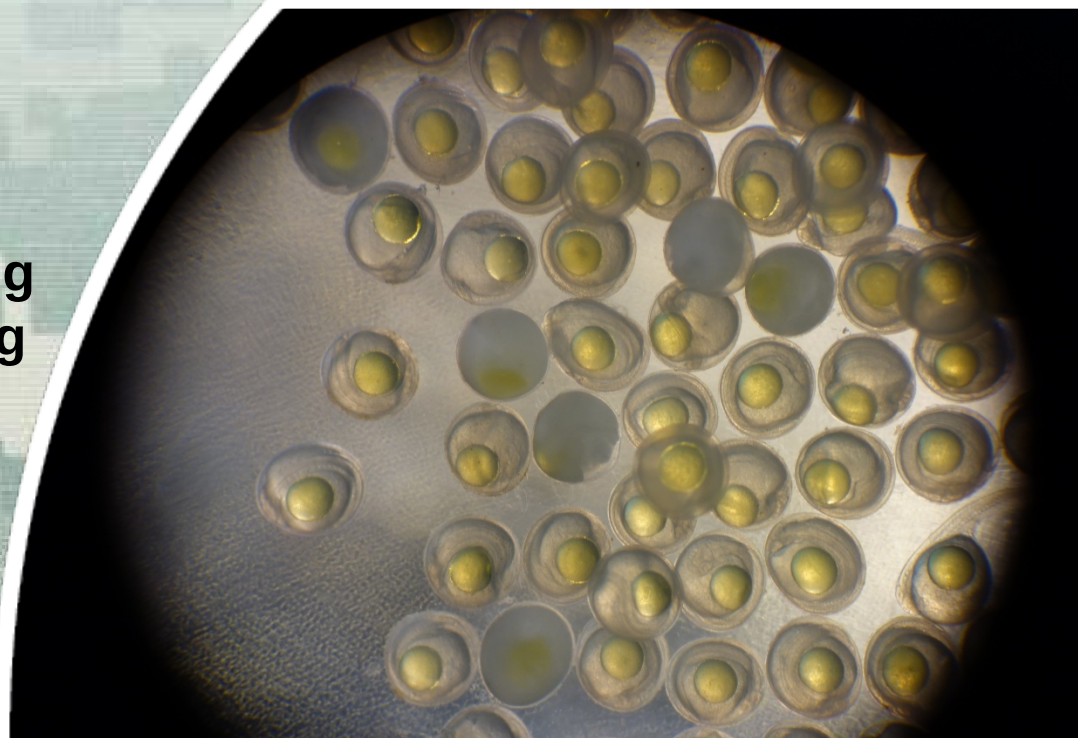

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Dredging Effects on Smallmouth Bass

Problem

- The EW in multiple Great Lakes harbors is restricting dredging operations
- Smallmouth bass spawning along waterway shoals
- Suspended sediment threshold data are lacking for smallmouth bass relevant to dredging
- Effects data are essential for conducting risk assessments and managing dredging risks

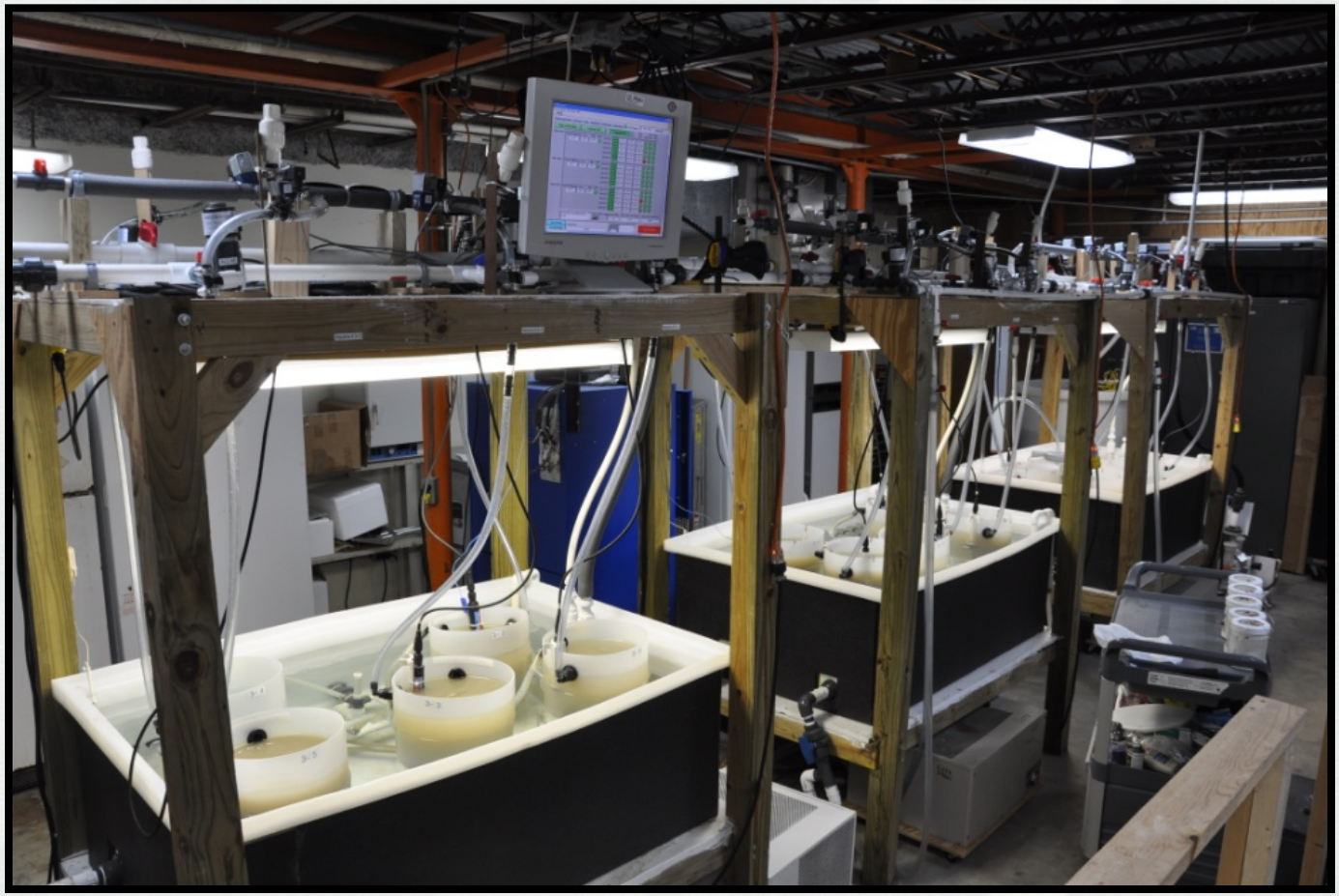
Objective

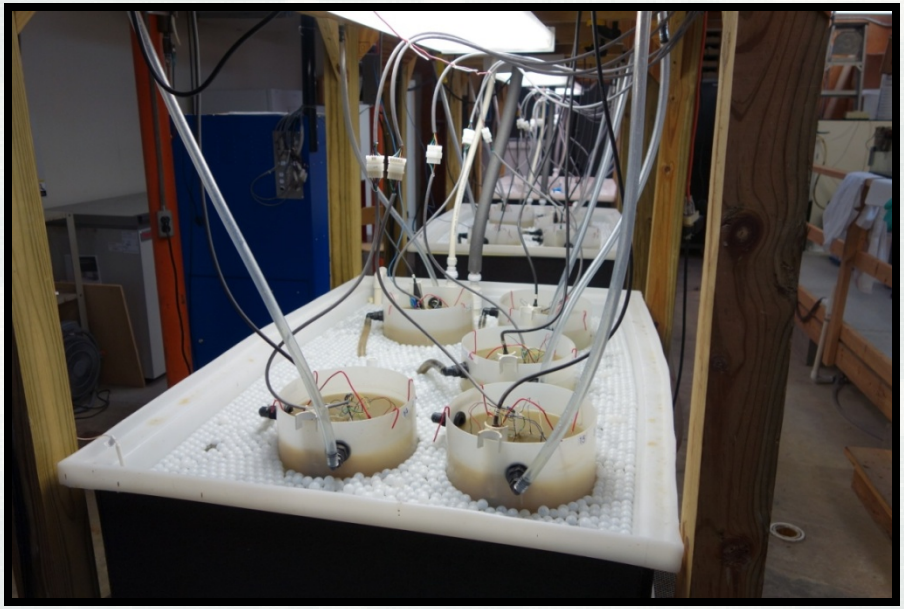
- Develop suspended sediment effects data for smallmouth bass early life stages to reduce uncertainty about adverse dredging impacts

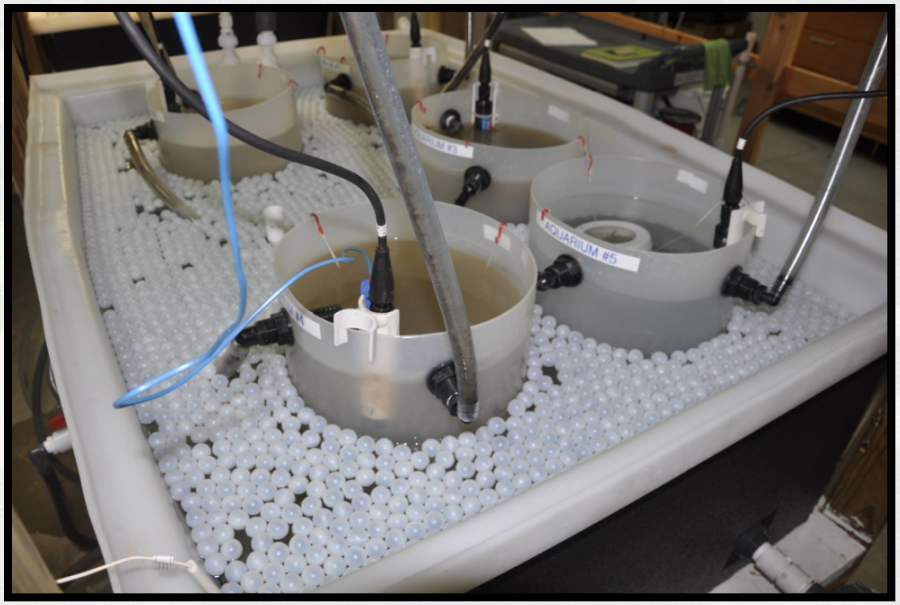
Research Overview

- Smallmouth Bass (*Micropterus dolomieu*)
  - Concern:
    - Turbidity impacts to early life stages in spawning grounds on shoals along waterway margins
  - Sediment collection locations:
    - Lake Michigan – Grand Haven Harbor, MI
    - Lake Erie – Fairport Harbor, OH
  - Fish sources:
    - East Texas
    - Illinois
  - Early life stages:
    - Eggs
    - Swim-up fry

Fish Larvae and Egg Exposure System (FLEES)





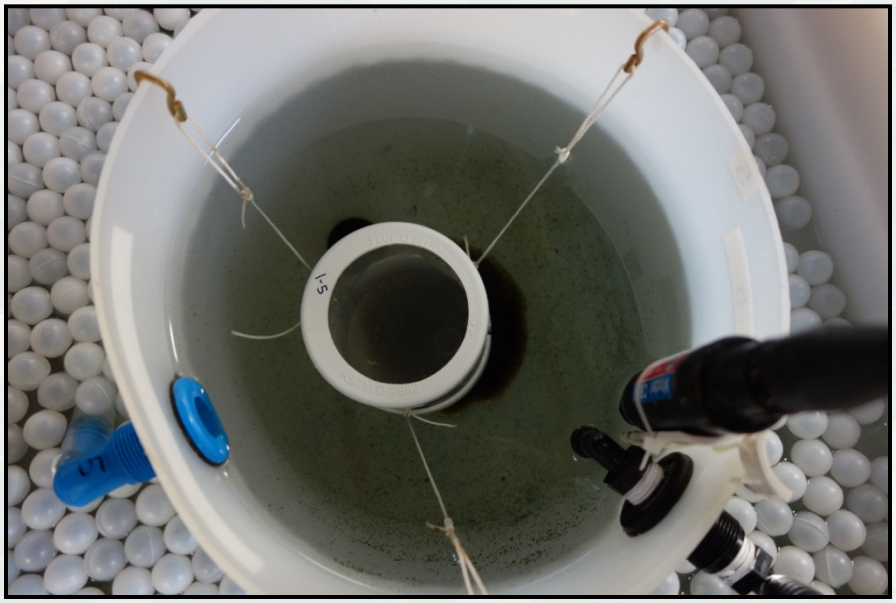


Experimental Design

- Three (3) modules
- Three (3) 500 L water baths
- 15 aquaria
- 20 L polyethylene carboy aquaria
- Modules insulated on sides and water surface to control temperature
- Each aquarium utilizes pump to suspend sediment

Materials and Methods

- Smallmouth Bass
- Experiments: Texas and Illinois eggs (newly spawned) and swim-up fry
- Sediment: Fairport Harbor (Lake Erie); Grand Haven Harbor (Lake Michigan)
- Concentrations: 0, 100, 250, 500 mg/L TSS
- Duration: 3 days (72 h)
- Temp: 16.1 – 18.8°C
- D.O.: 7.2-7.6 mg/L
- Water volume exchange: 1-2; 4-6 (grow-out)



Experimental Endpoints

Eggs→Larvae

- Survival immediately post-hatch

Swim-up fry

- Survival, growth, and swimming performance
- Survival and growth of swim-up fry grown out after exposure

Sediment Characteristics

Parameter	Sediment	
	Grand Haven Harbor	Fairport Harbor
Cation Exchange Capacity, meq/100g	3.8	3.8
Moisture, percent	47.86	42.85
Organic Matter, percent	2.4	2.7
Soil pH	7.9	7.7
Total Organic Carbon, percent	1.69	1.57
Clay, percent	6	20
Silt, percent	20	60
Sand, percent	74	20
Textural Classification	Sandy Loam	Silt Loam

Larval survival after 3-days exposure to suspended sediments as eggs

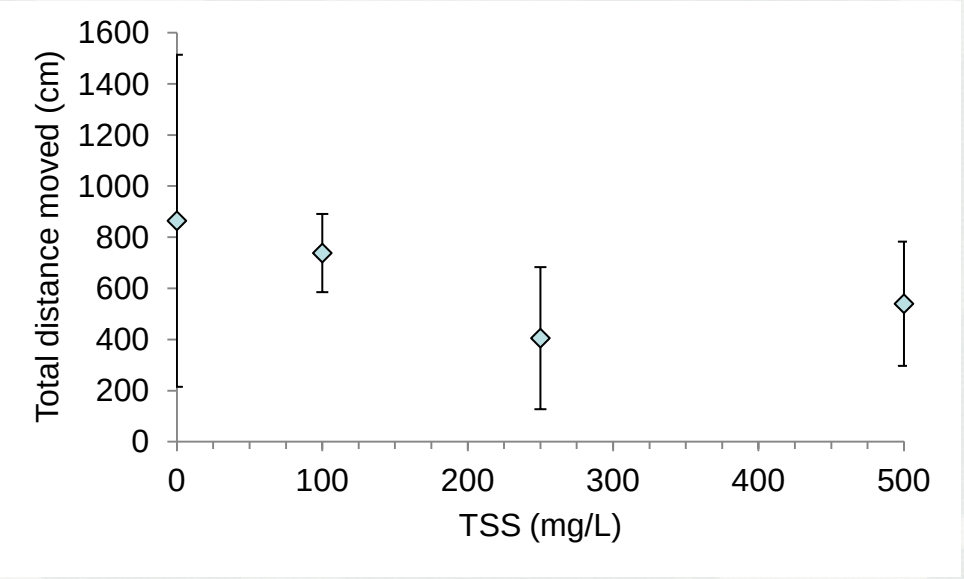
Sediment	Nominal TSS (mg/L)	Measured TSS (mg/L)	N	Post hatch survival (%)	P-value	Significant (Yes/No) 1 tailed	Significant (Yes/No) 2 tailed
Fairport Harbor	0	0 ± 3	3	84 ± 5	--	--	--
	100	100 ± 13	4	60 ± 14*	0.07	Y	N
	250	247 ± 24	4	16 ± 9*	<0.001	Y	Y
	500	547 ± 47	4	26 ± 16*	<0.001	Y	Y
Grand Haven Harbor	0	0 ± 2	3	81 ± 5	--	--	--
	100	111 ± 10	4	9 ± 5*	<0.001	Y	Y
	250	258 ± 9	4	15 ± 10*	<0.001	Y	Y
	500	546 ± 46	4	6 ± 6*	<0.001	Y	Y

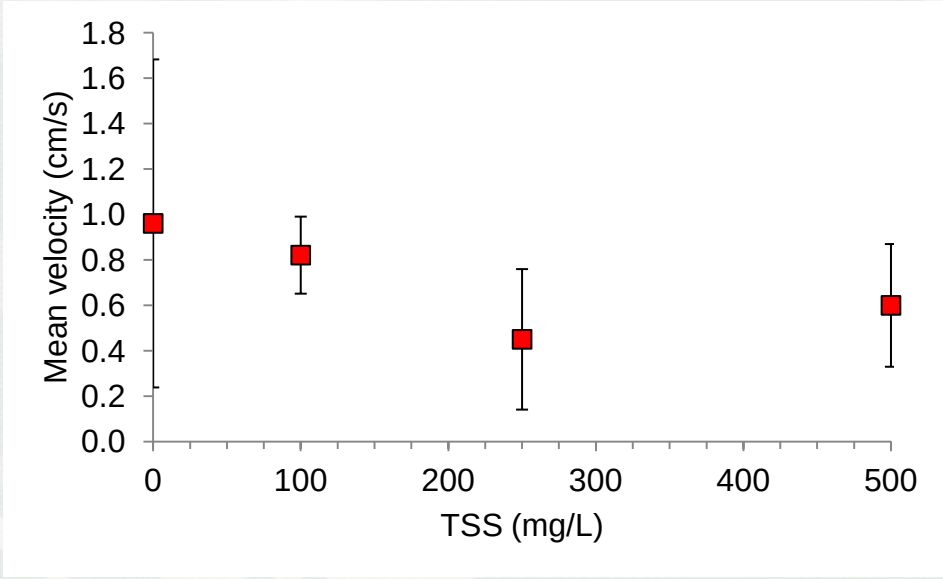
Survival and growth of smallmouth bass fry exposed to suspended sediment for 3 days

Sediment	Measured TSS (mg/L)	Survival (%)	Dry weight (mg)	Total Length (mm)	Standard length (mm)	Swim bladder length (mm)
Fairport Harbor	0 ± 4	99 ± 1	3.0 ± 0.1	11.47 ± 0.13	10.04 ± 0.06	1.53 ± 0.06
	91 ± 11	100 ± 1	3.1 ± 0.2	11.67 ± 0.07	10.03 ± 0.08	1.58 ± 0.02
	221 ± 17	100 ± 0	2.9 ± 0.7	11.16 ± 0.71	9.55 ± 0.58	1.46 ± 0.16
	452 ± 39	90 ± 17	2.2 ± 0.2*	10.97 ± 0.33	9.32 ± 0.27*	1.38 ± 0.13
Grand Haven Harbor	0 ± 3	100 ± 0	2.6 ± 0.2	11.14 ± 0.20	9.74 ± 0.08	1.37 ± 0.08
	110 ± 17	100 ± 0	2.4 ± 0.1	11.24 ± 0.12	9.67 ± 0.12	1.43 ± 0.04
	263 ± 37	100 ± 0	2.0 ± 0.2*	10.85 ± 0.06*	9.30 ± 0.06*	1.32 ± 0.08
	528 ± 40	95 ± 6	1.7 ± 0.0*	10.64 ± 0.12*	9.10 ± 0.09*	1.29 ± 0.05

Swimming Behavior of Texas Fish

No statistical differences relative to the controls were observed for total distance moved (left; p=0.344) and mean velocity (right; p=0.343).





Grow-out survival & growth of smallmouth bass fry reared post exposure

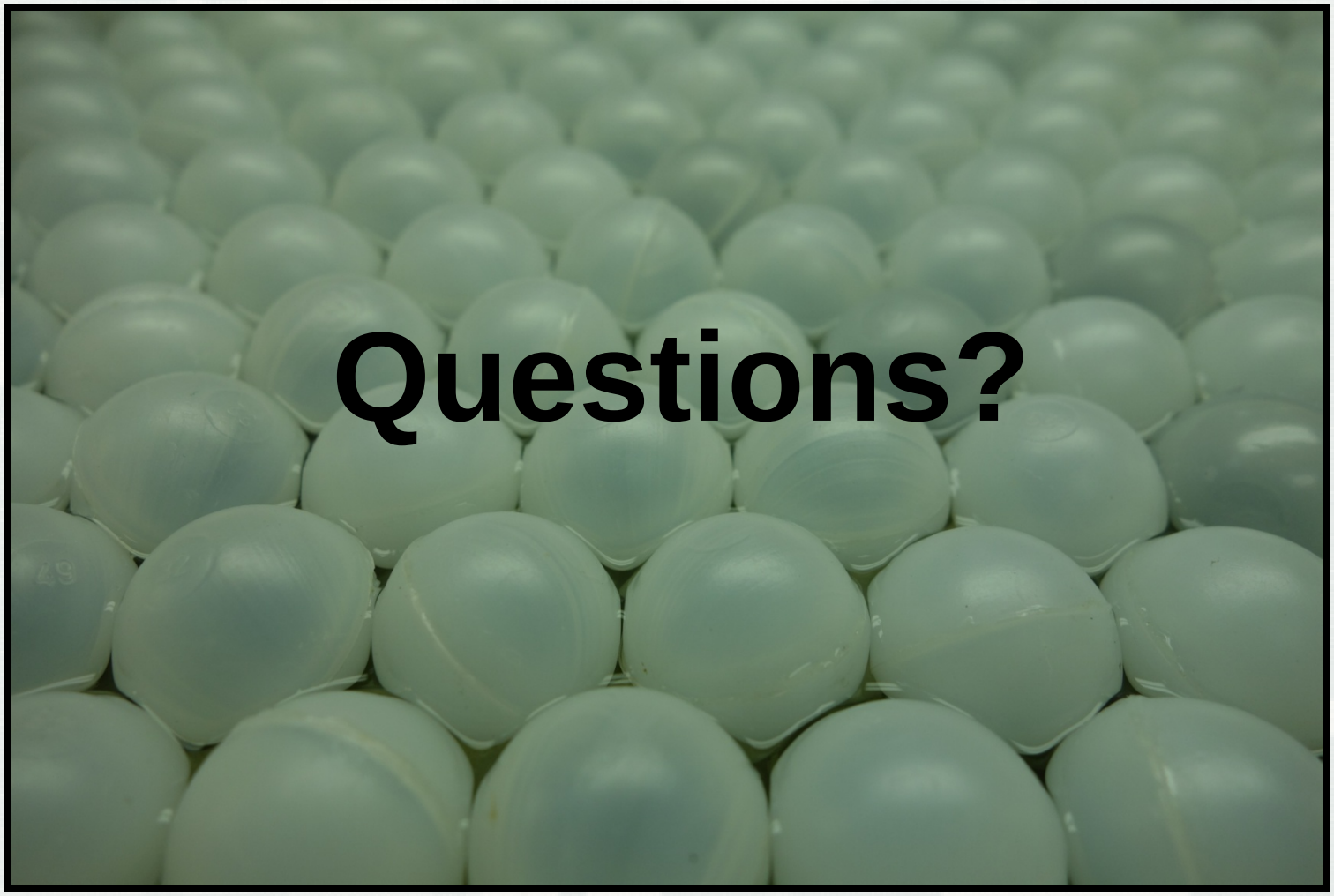
Sediment	Measured TSS (mg/L)	Survival (%)	Dry weight (mg)	Total Length (mm)	Standard length (mm)	SGR (total)
Fairport Harbor (26 days)	0 ± 4	77 ± 15	13.7 ± 2.0	19.87 ± 0.91	16.98 ± 0.47	2.76 ± 0.23
	91 ± 11	58 ± 13	14.0 ± 2.3	20.10 ± 0.77	17.05 ± 0.72	2.77 ± 0.27
	221 ± 17	66 ± 16	13.0 ± 4.4	19.36 ± 1.88	16.27 ± 1.52	2.54 ± 0.50
	452 ± 39	48 ± 11*	12.4 ± 4.0	19.03 ± 1.65	16.04 ± 1.36	2.53 ± 0.64
Grand Haven Harbor (7 days)	0 ± 3	100 ± 0	7.4 ± 0.1	14.58 ± 0.19	12.89 ± 0.06	5.35 ± 0.08
	110 ± 17	100 ± 0	7.1 ± 0.4	14.38 ± 0.27	12.67 ± 0.30	5.14 ± 0.26
	263 ± 37	100 ± 0	5.6 ± 0.6*	13.59 ± 0.31*	11.80 ± 0.28*	4.13 ± 0.48*
	528 ± 40	95 ± 6	5.0 ± 0.6*	13.22 ± 0.22*	11.64 ± 0.21*	3.66 ± 0.47*

Research Findings

- Exposed eggs hatched normally but newly hatched larvae are more vulnerable to the effects of suspended sediment
- Egg experiments indicated reduced survival of larvae when exposed to suspended sediments (≥ 100 mg/L TSS)
- Swim-up fry survival was not reduced (≥ 90%) even at the highest exposure concentration
- Sublethal effects were observed in growth of fish in swim-up fry experiments
  - FPH (silt loam): NOEC=221 mg/L; LOEC=452 mg/L
  - GHH (sandy loam): NOEC=110 mg/L; LOEC=263 mg/L
- Swimming behavior of fry not affected

Research Findings, Cont'd.

- Swim-up fry were found to be more tolerant of high TSS concentrations in the silty (FPH) sediment than the sandy (GHH) sediment
- Sublethal growth effects were observed in fish in grow-out fry experiments
  - FPH (26-d): NOEC=221 mg/L; LOEC=452 mg/L
  - GHH (7-d): NOEC=91 mg/L; LOEC=221 mg/L
- Worst case exposure scenario that can be conservatively extrapolated to the field for protecting the smallmouth bass fishery in Great Lakes harbors
- Publication in JGLR


Questions?