Sturgeon Health Assessment First Annual Report

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Introduction and Rationale

The aquatic foodweb of the Great Lakes has been contaminated with polychlorinated biphenyls (PCBs) since the mid-20th Century. Although concentrations of PCBs in fish and birds have declined in the past four decades, distinct areas of elevated contamination still exist, including designated Areas of Concern (AOC). Tissue residue concentrations of PCBs in many species exceed levels of concern for human consumption and for fish health. Though management agencies are addressing individual AOCs that contribute PCBs to the lakes, there is no comprehensive regional effort to address fish contamination and the potential consequences of that contamination. Lake sturgeon (*Acipenser fulvescens*) occur throughout all of the Great Lakes and the Saint Lawrence River drainage and is historically one of the most economically important fish in the Great Lakes. Lake sturgeon once supported a commercial fishery, but heavy fishing, altered habitat, and pollution from newly developed land around the lakes has caused it to become very rare. Lake sturgeon is now listed as endangered, threatened, and watch-listed throughout the Great Lakes states, (Bruch and Binkowski, 2001; Bruch et al., 2009; Schmitt-Kline et al., 2009). Though contaminant dynamics and effects have been relatively well investigated in salmonids, much less is known about contaminant thresholds in sturgeon that are associated with adverse effects on development, growth, behavior, and survival.

Therefore, the goal of this study is to understand the sensitivity of lake sturgeon toward PCB and dioxin-like toxicity. Lake sturgeon eggs dosed with PCBs and dioxin under controlled conditions will be used to determine thresholds in tissue that represent unacceptable risk and injury with regard to early life stage survival and important sub-lethal effects. Model chemicals for these tests will be 3,3',4,4',5-pentachlorobiphenyl (PCB 126) and 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Results will be applied to cleanup and restoration decisions and natural resource damage assessments to improve environmental quality for areas of concern throughout the basin. Minimum endpoints that will be evaluated in this project include hatching success, time to peak hatching, time to first feeding, sac fry through post-larval survival, and gross abnormalities to the spine, heart, and yolk sac (edema).

In addition, swimming performance (indicators of cardiac function), and developmentally relevant behaviors such shelter seeking (phototaxis) and feeding will be evaluated in juvenile sturgeon. Swimming performance is critical to survival of juvenile fish, particularly those rapid and coordinated movements required for prey capture and predator avoidance. Exposure to organic and inorganic chemicals has been shown to diminish swimming performance over a range of fish species. Swimming performance reflects the integration of numerous physiological processes (such as cardiac function, respiration, and metabolism) that can be adversely affected by contaminant exposures. Measures of swimming capacity can be useful in understanding the ecological ramifications of changes in these physiological endpoints.

By establishing tissue residue thresholds associated with development, growth, and behavioral impairments, food web models and risk assessments can be applied to derive sediment cleanup concentrations that are protective of this important native species and thresholds for injury to natural resources can be established. This project will fill a data gap needed to ensure that decision makers at Great Lakes Areas of Concern have the information they need to delist beneficial use impairments. Ultimately, this study will improve the effectiveness of Great Lakes cleanup and restoration efforts.

The objective of this project is to determine the effects of PCBs and dioxins in lake sturgeon eggs and the subsequent effect on early life stage development, growth, survival, and behavior. This first annual report describes progress toward refining techniques for rearing lake sturgeon eggs and larvae and evaluating their health and growth. Specific tasks accomplished during the first year included:

- Experimenting with culture techniques and conditions
- Establishing culture timeline
- Collecting anecdotal information and observations on behavior

Methods and Results

Approximately 4000 fertilized lake sturgeon eggs were obtained from Sustainable Sturgeon Culture Center in Fort Frances, Ontario via Genoa National Fish Hatchery on 5/24/11. Eggs arrived at the Columbia Environmental Research Center (CERC) at about 7 days post fertilization. Upon arrival, eggs were examined to determine the percentage viable (66%) and then eggs were maintained at approximately 19^{o} C for rearing (the temperature they were at when they arrived at CERC).

Experiment 1: Determine optimal density of fish in small hatching tubes from egg to start of exogenous feeding

- Methods: Three replicates of either 50, 75, or 100 viable eggs were stocked in small hatching tubes and monitored for mortalities, deformities and growth
- Results: Mortalities and growth were similar amongst all treatments but significant deformities observed in 75 and 100 treatments
- Conclusion: Use 50 eggs per tube density

Figure 1: Small hatching tubes

Experiment 2: Determine timing of yolk plug expulsion and start/end of starvation period

- Methods: Four replicates of 25 eggs cultured in tubes and monitored daily
- Results: See table 1
- Conclusion: End of yolk plug expulsion occurs at approximately 24 dpf

Table 1. 2011 Culture Timeline

Species: Lake Sturgeon

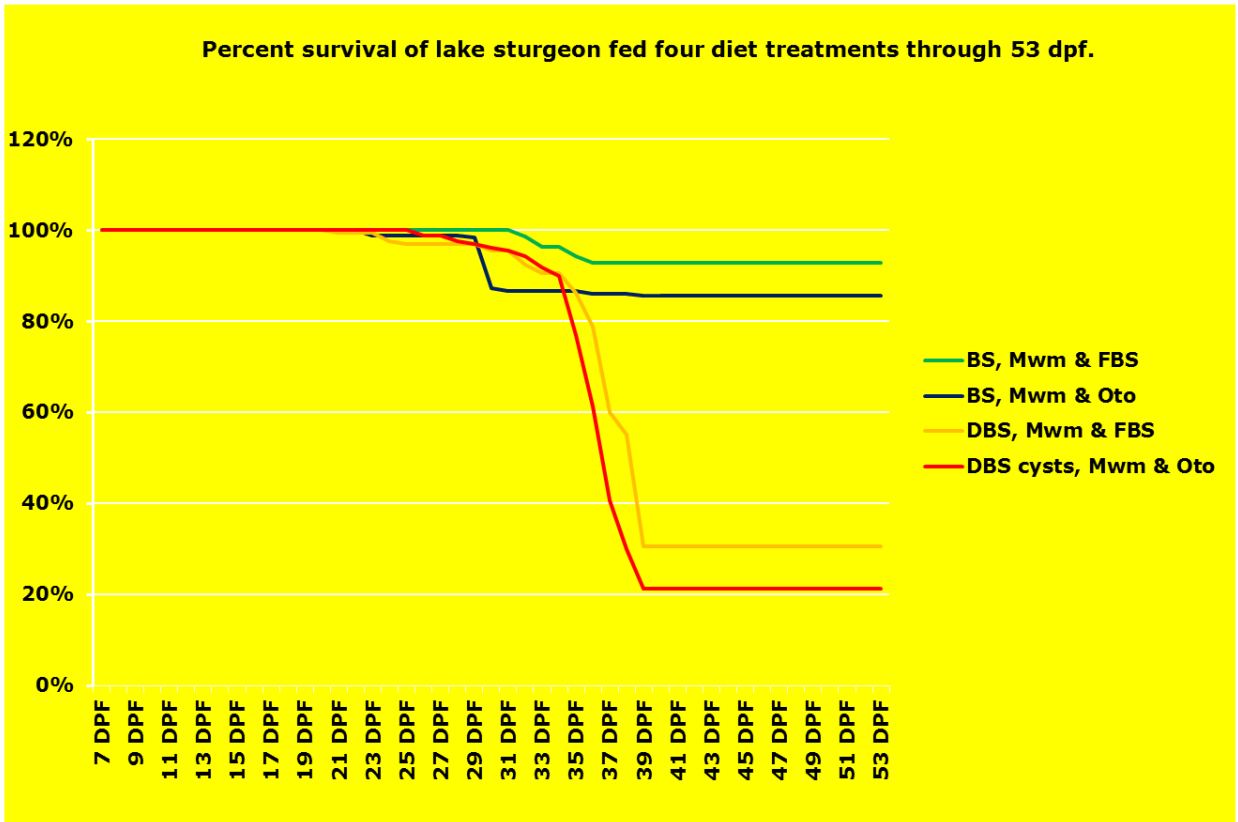
Spawn date:				5/17/2011	
DATE	DAY	DAYS PF	DAYS POST-HATCH	TEMP	STAGE/COMMENTS
5/17/11	Tue	0			Eggs fertilized Ontario Canada
5/20/11	Fri	3			Eggs shipped to Genoa NFH
5/24/11	Tue	7			Eggs received at CERC @ 19.8C
5/25/11	Wed	8		18.5	Start hatch
5/26/11	Thu	9	1	18.3	>50% hatch
5/28/11	Sat	11	3	18.3	End of hatch; 1st sign of pigmented eyes;
6/7/11	Tue	21	13	19.3	start of yolk plug expulsion
6/9/11	Thu	23	15	19.2	>50% yp expulsion

6/10/11	Fri	24	16	19.1	end yp expulsion
6/15/11	Wed	29	21	18.3	Start of starvation
6/23/11	Thu	37	29	19	End of starvation

Experiment 3: Determine optimal food

- Methods:
  - Four diets
    - BS,Mwm & FBS = Live brine shrimp, microworms and frozen brine shrimp
    - BS,Mwm & Oto = Live brine shrimp, microworms and Otohime artificial diet
    - DBS, Mwm & FBS = Decapsulated brine shrimp, microworms and frozen brine shrimp
    - DBS, Mwm & Oto = Decapsulated brine shrimp, microworms and Otohime artificial diet
  - Fish reared in bowls and aquariums
  - Two stocking densities – 30 and 50 fish
  - Drip feeders filled 2x daily, artificial feed fed via automatic feeders 4x day
  - Brine shrimp calculated by number per animal; frozen brine shrimp and artificial feed by body weight
  - observed under microscope daily to determine feeding tendencies
- Results: See figure 1
- Conclusion: Optimal food is a combination of live brine shrimp, microworms and frozen brine shrimp

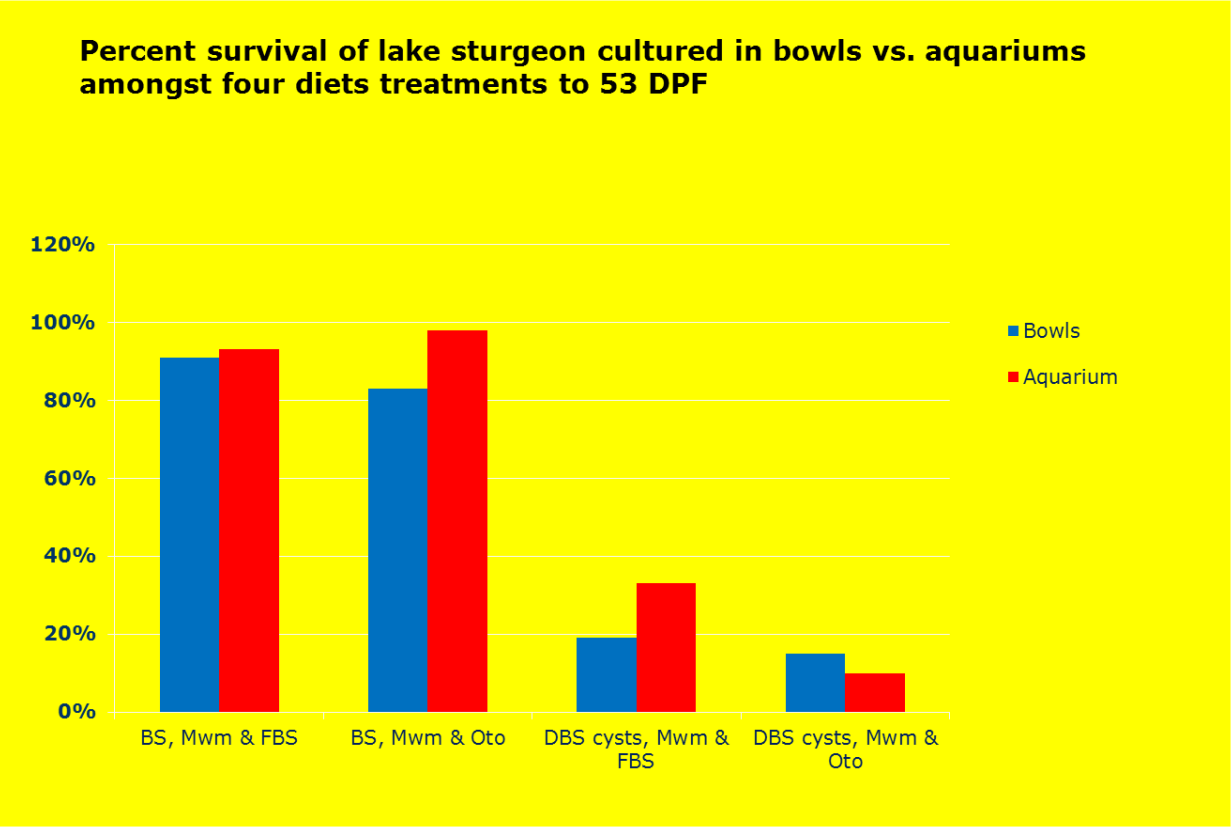
Figure 1:



Experiment 4: Determine if lake sturgeon have better survival in aquariums or bowls

- Methods: Conducted as part of feeding study
- Results: See figure 2
- Conclusion: Culture fish in aquariums

Figure 2:



Experiment 5: Determine optimal stocking density in aquariums or bowls for growout

- Methods: Stock either 30 fish or 50 fish per chamber as part of feeding study
- Results: See figures 3 and 4
- Conclusion: Stock 30 to 40 fish per chamber

Figure 3:

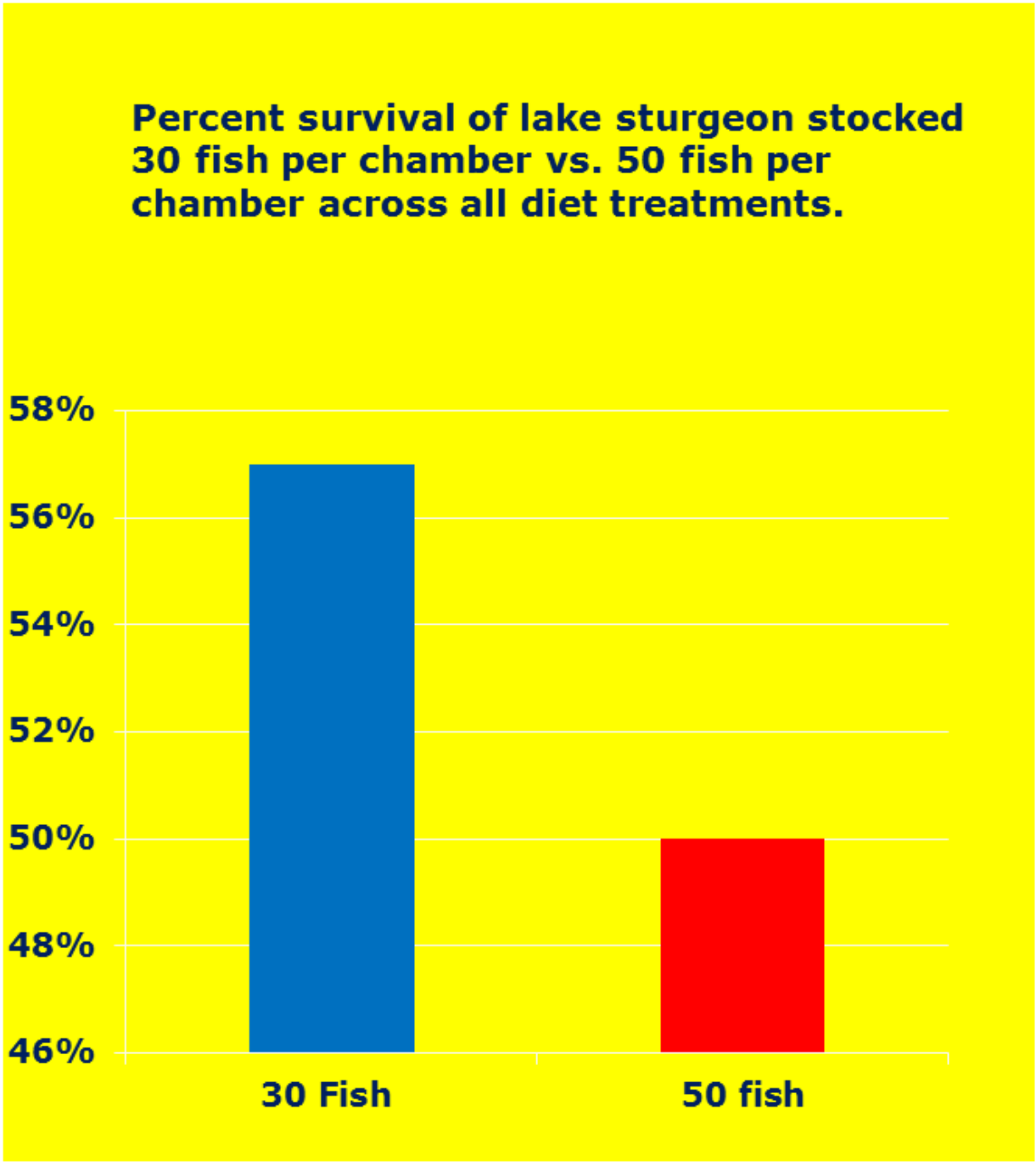
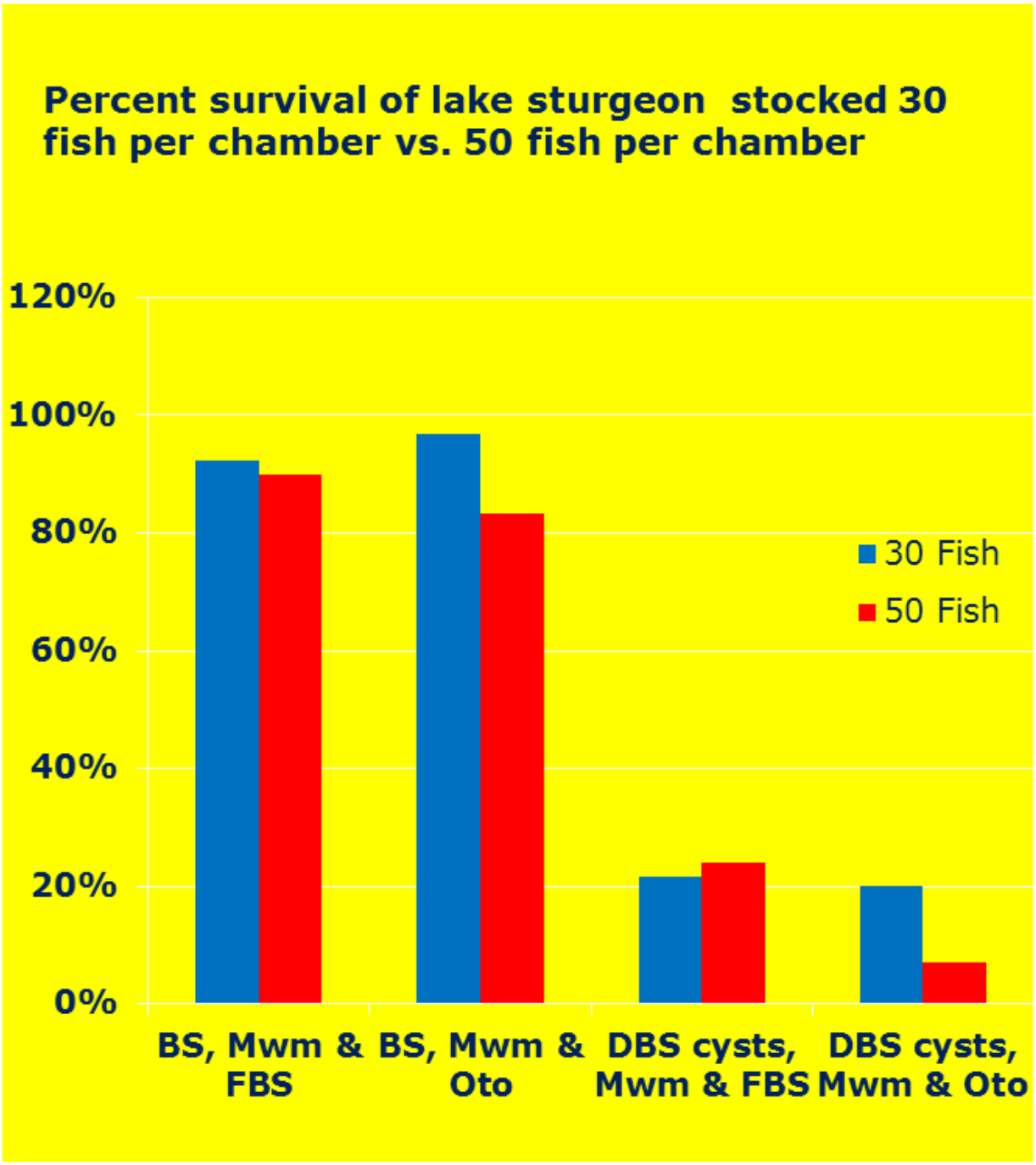


Figure 4:



Additional Observations:
Compared to other sturgeon species cultured at CERC

- Lake sturgeon egg size is larger
- Egg debris is greater at hatch
- Cannibalism is low

- Lake sturgeon are less active
- Lake sturgeon do not transition to artificial food easily

Results of these experiments will be used to finalize the workplan for phase 2 rearing of sturgeon exposed to dioxin and PCBs.

References

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