Science and Information Branch

Aquatic Science Unit Update
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Depth selectivity of juvenile lake sturgeon in the Ottawa River based on broad-scale monitoring

Lake sturgeon (*Acipenser fulvescens*) have been described as a shallow water species with depth preferences of 4–9 metres (m) (Wilson and McKinley 2004) although they have been sampled in depths of 43 m (Scott and Crossman 1973). Holtgren and Auer (2004) suggested that there was depth segregation by size of sturgeon with smaller fish selecting greater depths but still generally located in depths less than 10 m. Based on a habitat suitability model, juvenile foraging depth was deemed to be most suitable between 4–8 m and not suitable in depths greater than 14 m (Threader et al. 1998).

Broad-scale monitoring (BsM) has recently been implemented across Ontario including the Ottawa River. The protocol uses depth stratified, random small mesh and large mesh gillnets net sets (Sandstrom et al. 2008). Lake sturgeon, specifically juveniles (i.e., <1150 millimetres (mm) total length), are vulnerable to the gear used in BsM. This provided an excellent opportunity to examine depth selectivity of juvenile lake sturgeon within the Ottawa River. More specifically, the BsM protocol was used to determine if there was an effect of depth on:
i) the probability of capturing a lake sturgeon;
ii) number of lake sturgeon captured (i.e., catch-per-unit-effort [CUE]); and
iii) size of the sturgeon sampled.
In addition, the effect of gear type (e.g., large mesh/small mesh) and reach on the probability of capturing a lake sturgeon was assessed.

Methods

The BsM protocol was employed on Upper Allumette Lake, Lower Allumette Lake and Lac Coulonge of the Ottawa River in 2008 (Figure 1). These reaches are unimpounded, contiguous, and support the most robust sturgeon population within the Ottawa River (Haxton and Findlay 2008). A Bayesian approach (i.e., statistical method) was used to analyze the data using Markov chain Monte Carlo (MCMC; 2 chains, 10 000 iterations with 1 000 iteration burn-in). Logistic regression was used to determine the probability of capturing a sturgeon in a gillnet based on depth strata (1–3 m; 3–6 m; 6–12 m; 12–20 m; 20–35 m; 35–50 m; and 50–75 m), gillnet mesh size (small: 13–38 mm; large: 38–127 mm), and river reach (Upper Allumette Lake,

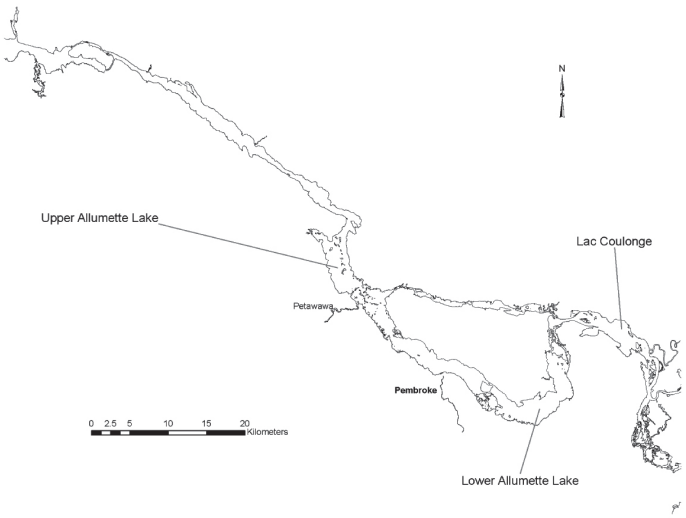

Figure 1. Location of study reaches within the Ottawa River.

Lower Allumette Lake and Lac Coulonge). Poisson regression was used to determine if there was an effect of depth on the number of sturgeon caught. Finally, a generalized linear model (GLM) was used to determine if there was a depth effect on the size of sturgeon captured.

Results

A total of 109 nets, 62 large mesh nets and 47 small mesh nets were set throughout the three reaches capturing 118 lake sturgeon ranging from 240 to 950 mm fork length (large mesh 240–950 mm; small mesh 245–810 mm).The probability of capturing a lake sturgeon was significantly greater in the large mesh gillnets than small mesh gillnets (Table 1). The probability of capturing a lake sturgeon was significantly greater in Lac Coulonge than Upper Allumette Lake but not Lower Allumette Lake. The probability (*P*) of capturing a lake sturgeon was greatest in depth stratum 12–20 m whereas it was lowest in depth stratum 35–50 m (Tables 1 and 2).

Table 1. MCMC output from logistic regression. Depth stratum 1–3m, large mesh gillnet and Lac Coulonge were references (i.e., β= 0) for their respective categories. Inclusion of 0 within the 95% credible intervals (CI) suggests a non-significant effect.

Variable	Mean	2.5% CI	97.5% CI
reference (β0)	-0.2475	-1.662	1.104
3- 6 m	1.067	-0.3523	2.527
6-12 m	1.122	-0.306	2.622
12–20 m	1.718	0.113	3.281*
20-35 m	0.9355	-1.062	2.937
35 –50 m	-25.88	-72.55	-0.8825*
50-75 m	0.6623	-3.183	3.68
small mesh nets	-1.05	-2.043	-0.111
Lower Allumette	-1.579	-3.331	0.0137
Upper Allumette	-1.395	-2.395	-0.3819*
* denotes significance at *P*=0.05			

Table 2. Probability of capturing at least one lake sturgeon in a net at each depth strata.

Depth stratum	*P*	2.5% CI	97.5% CI
1 – 3 m (β0)	0.165	0.053	0.367
3 – 6 m	0.38	0.041	0.888
6 – 12 m	0.395	0.045	0.895
12 – 20 m	0.527	0.206	0.841
20 – 35 m	0.441	0.1156	0.833
35 – 50 m	<0.001		
50 – 75 m	0.269	0.012	0.87

Similar results were observed for the number of lake sturgeon captured (CUE). Lake sturgeon CUE was significantly greater in depth stratum 12–20 m and significantly lower in depth stratum 35–50 m (Table 3).

Table 3. MCMC output from Poisson regression. Depth stratum 1–3 m was established as the reference.

Depth stratum	mean	2.5% CI	97.5% CI
1 – 3 m (β0)	-0.478	-1.037	0.014
3- 6 m	-0.108	-0.849	0.643
6 -12 m	0.326	-0.331	1.023
12 – 20 m	1.474	0.9505	2.094
20 – 35 m	0.724	-0.066	1.5
35 – 50 m	-26.5	-72.3	-2.467
50 – 75 m	0.301	-1.202	1.498

Lake sturgeon were significantly smaller in the 1–3 m depth stratum than all other depth strata with the exception of the 50–75 m stratum (Table 4). No lake sturgeon were sampled in depth stratum 35–50 m therefore the relationship was deemed insignificant. Lake sturgeon were significantly larger in Upper Allumette Lake in comparison to Lac Coulonge (Table 4) whereas there was no significant difference in the body size of fish caught in Lower Allumette Lake and Lac Coulonge.

Table 4. MCMC output from GLM of mean fork length at different depth strata and river reaches. Depth stratum 1–3 m and Lac Coulonge are references for their respective categories.

Variable	mean	2.5% CI	97.5% CI
reference (β0)	392.2	345.3	432.0
3- 6 m	52.81	1.204	104.6
6-12 m	48.23	0.0298	96.5
12–20 m	100.2	57.85	142.8
20-35 m	52.31	1.269	102.7
35 –50 m	0.5135	-60.45	62.42
50-75 m	45.61	-14.01	105.8
Lower Allumette	33.63	-25.24	91.82
Upper Allumette	121.6	70.61	170.4
Note- to interpret this table, the reference (β0) provides the base data. Values (i.e., mean) for each variable are added to reference (e.g., true mean at 12–20 m would equal 492.4). This applies to all tables in this update.			

Summary

It was evident from these analyses that there is a preference (i.e., higher probability of capture and CUE) towards the depth stratum 12–20 m although lake sturgeon were sampled in most other depth strata in the Ottawa River. All lake sturgeon within this study were less than 950 mm and therefore would be considered juveniles (Haxton 2008). The depth stratum selected was greater than predicted by both Threader et al. (1998) and Holtgren and Auer (2004). A depth effect on the size of lake sturgeon sampled as suggested by Holtgren and Auer (2004) was not evident although smaller lake sturgeon were sampled in the 1–3 m depth stratum. The main limitation of this study was not including the potential covariates (e.g., velocity, temperature, or substrate) that may influence and explain depth selectivity.

There was a gradient in size of sturgeon from upstream reaches to downstream reaches with smaller sturgeon generally caught downstream (i.e., Lac Coulonge). In addition, the probability of capturing a lake sturgeon using the BsM protocol was greater in Lac Coulonge than Upper Allumette Lake. This may reflect the importance of contiguous, unimpounded reaches in a regulated river and suggests that size segregation is a function of life history traits and nursery habitat needs (i.e., Lac Coulonge could potentially be a very important nursery area for juvenile lake sturgeon within these reaches and that they eventually disperse upstream as they grow).

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