

Migration Behavior of Spawning Adult Lake Sturgeon in the Black River, MI

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Introduction

- Male and female fish use different reproductive strategies including timing and duration of migration (Henson and Warner 1997).
- There are an estimated 1,090 adult lake sturgeon in Black Lake, MI (Baker, unpublished).
- Of this population, 697 individuals have been tagged with Oregon RFID PIT tags.
- Every year roughly 250 adult lake sturgeon are captured migrating up the Upper Black River to spawn (Figure 1).
- Increasing water temperature and declining discharge are associated with timing of river entry and when lake sturgeon arrive on the spawning areas (Forsythe et al. 2012).

Objective

- To understand biotic and abiotic factors associated with upstream travel time, during spawning migration.

Hypotheses and Predictions

- Upstream travel time will vary as a function of biotic and abiotic factors including
 - a) Body size (fork length).
 - b) The number of sturgeon in the river the day before spawning.
 - c) Temperature.
 - d) Discharge.
 - e) Standardized spawning day.



Figure 1. The Black River and the locations of the RFID PIT tag arrays.



Figure 2. One of the RFID PIT tags implanted in the sturgeon.



Figure 3. RFID PIT tag array deployed in the river.

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Methods

- During the spring spawning period adults were tagged with Oregon RFID PIT tags (shown in Figure 2) at the base of the left pectoral fin.
- RFID PIT tag antenna arrays (Figure 3) were upstream immediately below the spawning site and at the mouth of the river.
- Recorded data included individual tag ID, date, and time of day when the adult passed each antenna array.
- The duration (hours) of migration between the river mouth and the spawning site was used as a measure of upstream travel time.
- Fork length and number of fish in river were recorded during adult surveys during the spawning season.
- Discharge and river temperature were collected by an Onset data logger placed between the spawning site and the river mouth.
- Standardized spawning day was found by dividing the day the individual was in the river by the total number of days there were spawning adults present.

Results

- The average upstream travel time was 19 hours.
- The average upstream travel time was 20 hours for males and 16 for females (Table 1).
- Table 2 shows the only variables with significant association to upstream travel time were discharge and standardized spawning day.
- The peak period adults entered the river was between 10 PM and 5 AM (Figure 4).
- Upstream travel time was slightly negatively associated to temperature (Figure 5) and fork length (Figure 6)
- Upstream travel time had no significant association with number of sturgeon in the river.
- Standardized spawning day was positively correlated to upstream travel time for females and negatively for males (Figure 7).
- Discharge was positively correlated to upstream travel time for males and negatively for females (Figure 8).

*Data used from regression analysis of temperature and discharge was from only 2015.

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Biotic and Abiotic Variables	♀ Mean (Range)	♂ Mean (Range)
Upstream Travel Time (hr)	15.9 (9.2 to 38.8)	19.7 (7.4 to 67.8)
Fork Length (cm)	164.9 (150 to 180)	138.8 (101 to 169)
Number of Sturgeon in River	28.9 (0 to 60)	29.0 (0 to 60)
Number of Females in River	9.7 (0 to 23)	9.2 (0 to 23)
Number of Males in River	18.5 (0 to 41)	19.2 (0 to 46)
Temperature (°C)*	16.1 (14.8 to 18.3)	16.0 (14.3 to 18.7)
Discharge (m³/sec)*	7.4 (5.9 to 9.6)	7.2 (5.93 to 10.7)
Standardized Spawning Day	0.28 (0.07 to 1)	0.24 (0.02 to 0.98)

Table 1. The mean and range for each variable used separated by sex.

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Males	Slope	R ²	p-value	Sample Size
Fork Length	-0.010	<0.001	0.876	191
Number of Fish in the River	-0.043	0.006	0.287	191
Number of Females in the River	-0.006	<0.001	0.962	191
Number of Males in the River	-0.115	0.012	0.137	191
Temperature (°C)	-1.782	0.023	0.145	95
Discharge (m ³ /sec)	-2.249	0.042	0.051	95
Standardized Spawning Day	-12.818	0.031	0.014	191
Females	Slope	R ²	p-value	Sample Size
Fork Length	-0.187	0.04	0.361	23
Number of Fish in the River	-0.060	0.012	0.620	23
Number of Females in the River	-0.019	<0.001	0.922	23
Number of Males in the River	-0.089	0.024	0.484	23
Temperature (°C)	-4.123	0.221	0.568	15
Discharge (m ³ /sec)	3.855	0.288	0.039	15
Standardized Spawning Day	7.471	0.05	0.306	23

Table 2. The results of statistical analyses comparing the various factors to upstream travel time.

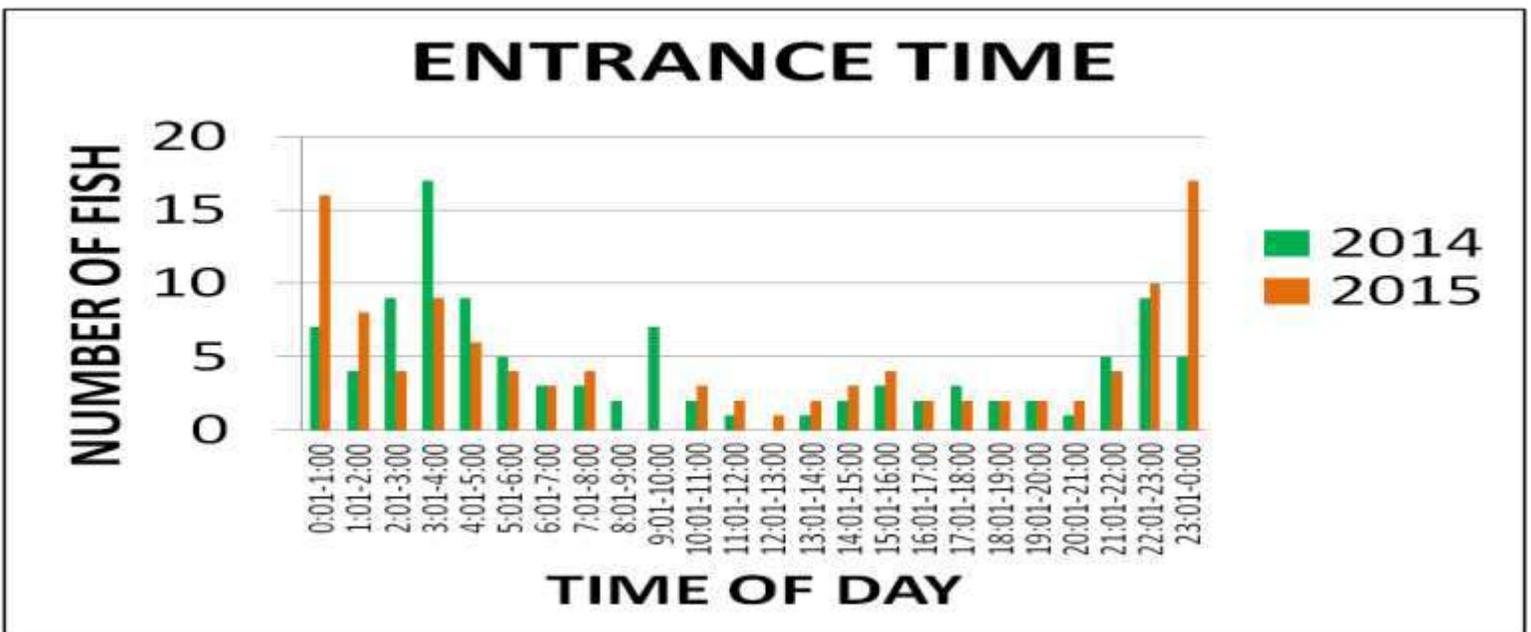


Figure 4. The time of day when adult lake sturgeon entered the mouth of the Upper Black River during the 2014 and 2015 spawning seasons.

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TEMPERATURE VS UPSTREAM TRAVEL

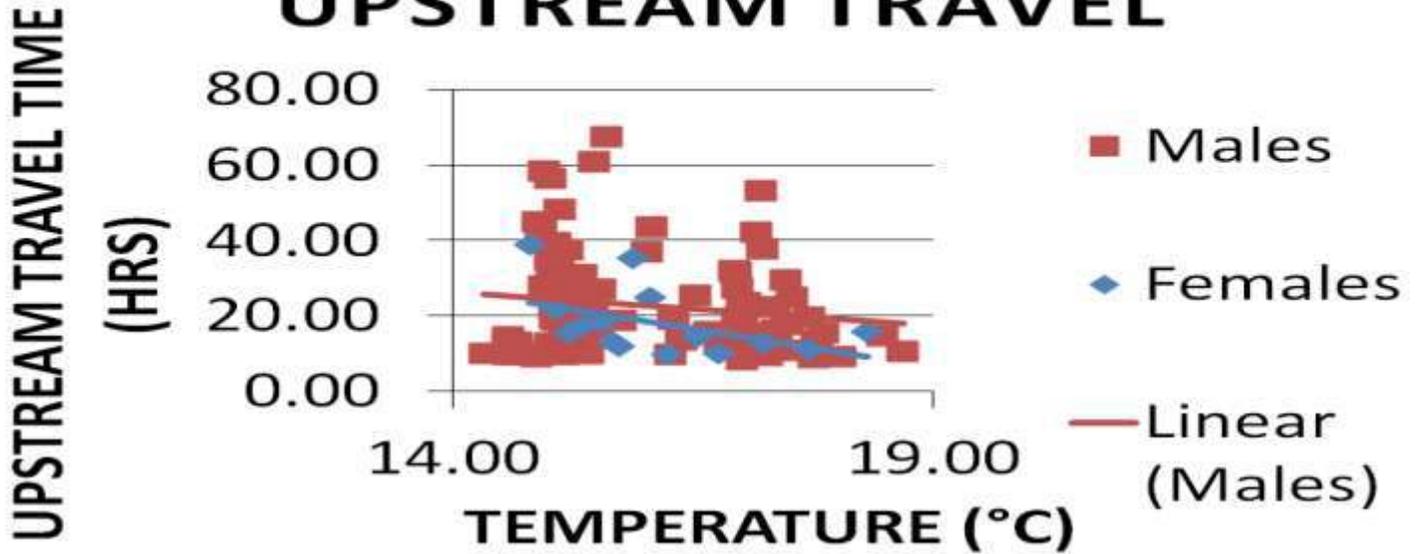


Figure 5. Change in water temperature as the adult sturgeon move upstream to spawn compared to the upstream travel time.

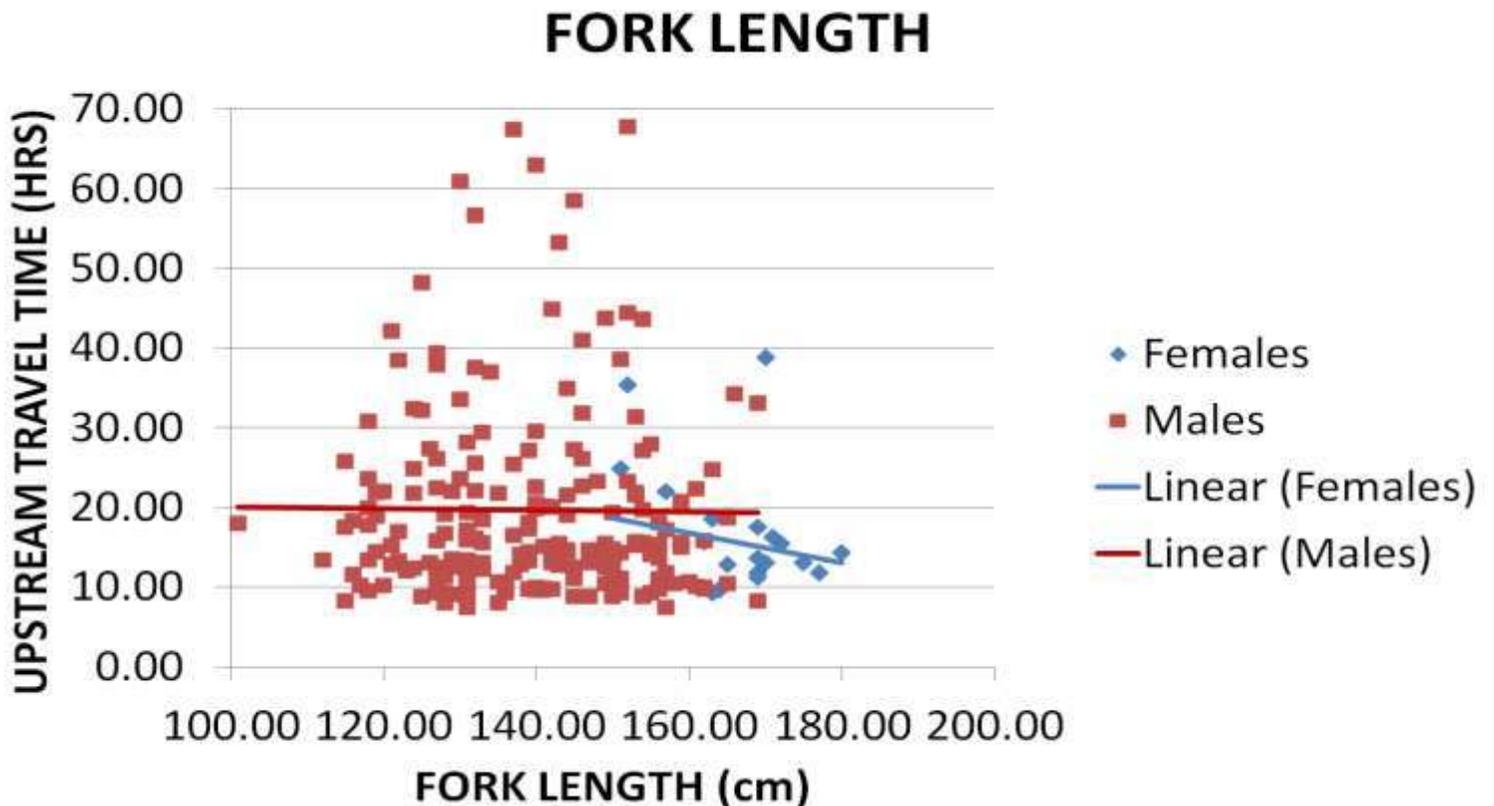


Figure 6. Fork length as a function of variation in adult lake sturgeon upstream travel time.

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STANDARDIZED SPAWNING DAY

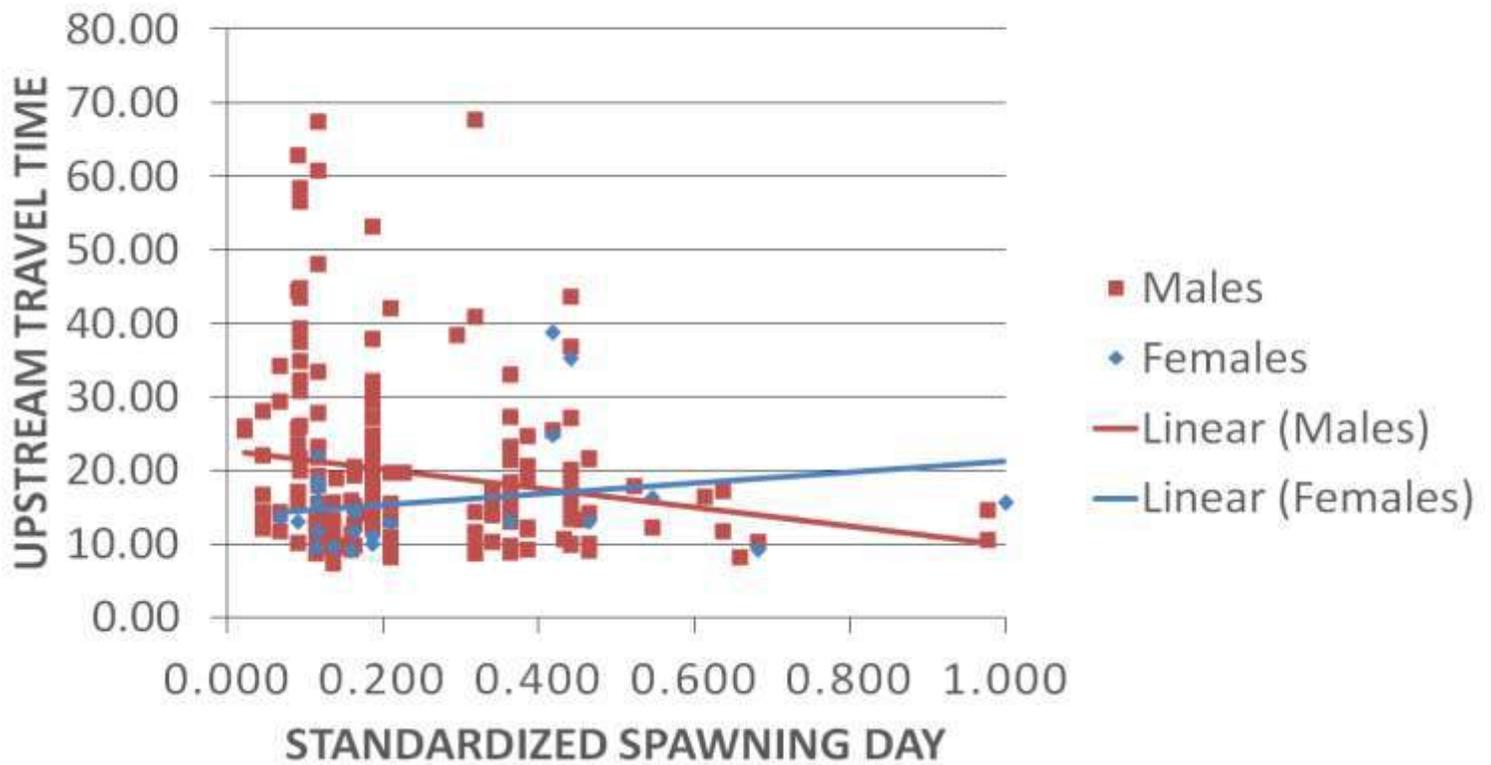


Figure 7. Variation in upstream travel time as a function of standardized spawning day.

DISCHARGE VS UPSTREAM TRAVEL TIME

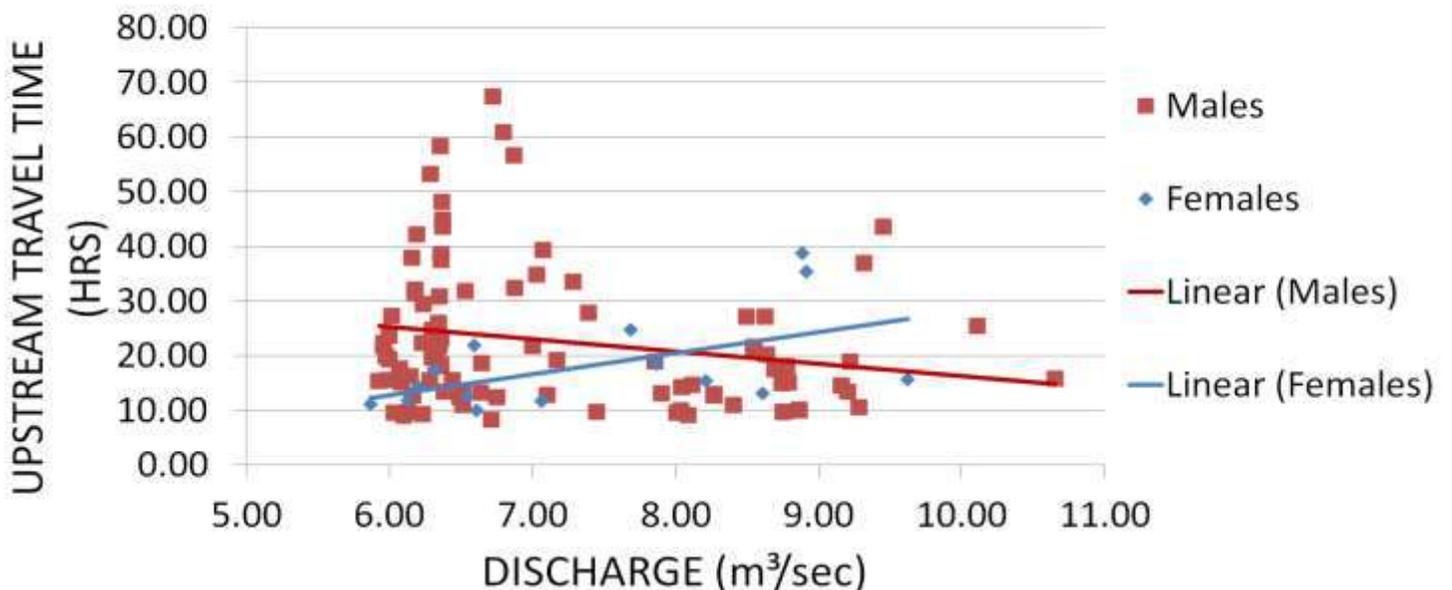


Figure 8. Variation in upstream travel time of adult lake sturgeon as a function of discharge in the Upper Black River during migration.

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Discussion and Conclusions

- Most biotic and abiotic factors measured in this study had no significant association with upstream travel time.
- Upstream travel time was negatively related to fork length, but the relationship was not significant for either sex.
- The number of fish in the river before entry had no effect on the upstream travel, suggesting there is no association between pheromones and the duration of upstream travel.
- Upstream travel time slightly decreased during periods of warmer water possibly due to the increased metabolic rate (Bolluck 1955).
- Upstream travel time was longer for females during periods of higher discharge, which may be attributed to greater effort needed to travel against a stronger current.
- Upstream travel time for males was shorter during periods of higher discharge, potentially due to the stronger discharge signaling a cue to the males that the spawning season is peaking.
- Upstream travel time was likely associated with standardized spawning day because discharge, temperature, and lunar cues were all affected by what day the sturgeon spawned.
- Further studies are underway to quantify associations between male reproductive success with male migratory behavior (Figure 9 and 10).



Figure 9. The left photo shows an adult male sturgeon migrating up river.

Figure 10. The right photo shows larval drift nets being placed in the river to quantify reproductive success.

References

- Henson, S. A. and R. R. Warner. 1997. Annual Review of Ecological Systematics. 28:571-92
- Forsythe, P.S., K.T. Scribner, J.A. Crossman, A. Ragavendran, C. Davis, E.A. Baker, and K.K. Smith. 2012. Journal of Fish Biology. 81: 35-53.
- Bolluck, T. H. 1955. Biological Reviews. 30: 3: 311-342

Acknowledgements

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