Taylor & Francis
Taylor & Francis Group

Journal of Freshwater Ecology

ISSN: 0270-5060 (Print) 2156-6941 (Online) Journal homepage: http://www.tandfonline.com/loi/tjfe20

Electronic archival tags provide first glimpse of bathythermal habitat use by free-ranging adult lake sturgeon Acipenser fulvescens

Andrew S. Briggs, Darryl W. Hondorp, Henry R. Quinlan, James C. Boase & Lloyd C. Mohr

To cite this article: Andrew S. Briggs, Darryl W. Hondorp, Henry R. Quinlan, James C. Boase & Lloyd C. Mohr (2016) Electronic archival tags provide first glimpse of bathythermal habitat use by free-ranging adult lake sturgeon Acipenser fulvescens, Journal of Freshwater Ecology, 31:3, 477-483, DOI: 10.1080/02705060.2016.1152321

To link to this article: http://dx.doi.org/10.1080/02705060.2016.1152321

JOURNAL OF FRESHWATER ECOLOGY, 2016
VOL. 31, NO. 3, 477–483
http://dx.doi.org/10.1080/02705060.2016.1152321

NOTE

Electronic archival tags provide first glimpse of bathythermal habitat use by free-ranging adult lake sturgeon *Acipenser fulvescens*

Andrew S. Briggs[a], Darryl W. Hondorp[b], Henry R. Quinlan[c], James C. Boase[a] and Lloyd C. Mohr[d]

[a]U.S. Fish and Wildlife Service, Alpena Fish and Wildlife Conservation Office, Waterford, MI 48327, USA; [b]U.S. Geological Survey, Great Lakes Science Center, Ann Arbor, MI 48105, USA; [c]U.S. Fish and Wildlife Service, Ashland Fishery Resources Office, Ashland, WI 54806, USA; [d]Ontario Ministry of Natural Resources and Forestry, Owen Sound, ON N4K 2Z1, Canada

ABSTRACT

Information on lake sturgeon (*Acipenser fulvescens*) depth and thermal habitat use during non-spawning periods is unavailable due to the difficulty of observing lake sturgeon away from shallow water spawning sites. In 2002 and 2003, lake sturgeon captured in commercial trap nets near Sarnia, Ontario were implanted with archival tags and released back into southern Lake Huron. Five of the 40 tagged individuals were recaptured and were at large for 32, 57, 286, 301, and 880 days. Temperatures and depths recorded by archival tags ranged from 0 to 23.5 °C and 0.1 to 42.4 m, respectively. For the three lake sturgeon that were at large for over 200 days, temperatures occupied emulated seasonal fluctuations. Two of these fish occupied deeper waters during winter than summer while the other occupied similar depths during non-spawning periods. This study provides important insight into depth and thermal habitat use of lake sturgeon throughout the calendar year along with exploring the feasibility of using archival tags to obtain important physical habitat attributes during non-spawning periods.

ARTICLE HISTORY
Received 29 September 2015
Accepted 3 January 2016

KEYWORDS
Archival tags; Lake Huron; bathythermal; habitat use; lake sturgeon; *Acipenser fulvescens*

Introduction

Comparatively little effort has been directed towards the enhancement and protection of habitats used by lake sturgeon during non-spawning periods, in part because lake sturgeon are difficult to observe away from shallow water spawning sites and may migrate great distances in search of food or to avoid unfavorable conditions (Auer 1996; Boase et al. 2011). Further, existing data on adult habitat use may be biased because artificial barriers (e.g., dams and hydropower facilities) restrict adult movements in many ecosystems. Given that lake sturgeon spawn only intermittently (intervals between spawning events may be as long as 5–7 years), a more comprehensive understanding of adult habitat use is necessary for managers to evaluate threats to populations stemming from climate change and from human activities such as navigational dredging, dredge spoil dumping, exploitation, and installation of hydrokinetic turbines and offshore wind-power generating stations.

Electronic archival (or data storage) tags are an excellent means for quantifying fish habitat use in large ecosystems such as the Great Lakes. These tags continuously record both the temperature and depth that a fish occupies over the life of the tag and do not require the tagged individual to be

CONTACT Andrew S. Briggs andrew_briggs@fws.gov

continuously re-located or recaptured. Archival tags have been widely used to assess fish habitat use and behavior in both freshwater and marine ecosystems (e.g., Domeier et al. 2005; Bergstedt et al. 2012). The main limitation of currently available archival tags is that data acquisition requires the eventual recovery of the tag.

Fishery managers need better habitat usage data for free-ranging lake sturgeon to facilitate wise resource management decisions. Depth and temperature of habitats occupied by adult lake sturgeon influence both growth and food consumption. In particular, baseline habitat (depth and temperature) data for lake sturgeon during non-spawning periods (when fish are not easily observed) are generally sparse or lacking. Better understanding of bathythermal habitat use by lake sturgeon could help define and protect critical habitat for lake sturgeon, facilitating the design and siting of protected areas or reserves where human activities may be controlled or prohibited. Herein, we assess the feasibility of using electronic archival tags for future studies of lake sturgeon habitat use in the open waters of the Great Lakes based on recovery rates of tagged lake sturgeon. Additionally, we explore the use of archival tags to document seasonal variability in bathythermal habitat use by free-ranging lake sturgeon.

Methods

Lake sturgeon used in this study were captured during spring in commercial trap nets set by Purdy Fisheries, Ltd. of Sarnia, Ontario between Sarnia and Blue Point, Ontario (Figure 1). Lake sturgeon were then transported to an outdoor raceway at Purdy Fisheries, Ltd.

A total of 40 adult (total lengths between 1068 and 1821 mm) lake sturgeon (20 each in 2002 and 2003) were surgically implanted with Lotek LTD-1110 archival tags that record depth and

Figure 1. Map of the study area where lake sturgeon were captured and released (between Sarnia and Blue Point, Ontario) in Lake Huron.

temperature. The LTD-1110 tags were 11 mm in diameter, 40 mm long, and weighed 9 g in air and 4 g in water. The archival tags record temperatures between −5 and 35 °C (0.2 °C resolution) and depths between 0 and 300 m. Maximum tag battery life was three years. Tag delays ranged from 4 to 15 minutes depending on how long the fish was at large (tags deleted data as memory filled so that data were recorded at larger increments).

Archival tags were surgically implanted (at Purdy Fisheries, Ltd.) into the abdomen of each lake sturgeon by making a 2−3 cm incision anterior to the pelvic fin. Tags were sterilized in iodine prior to being inserted. Three absorbable sutures were used to close the incision. To facilitate tag recovery fish were double Floy tagged, one offering a $100 reward and another one with a phone number to call when/if the individual was captured. Sturgeon were held in the outdoor raceway for 10 days prior to being transported to release sites near original point(s) of capture in live wells onboard commercial fishing vessels. Lake sturgeon with tags were later recovered by commercial and recreational anglers.

Data from recovered archival tags were downloaded by the manufacturer. When fish were first released, there was a short time period when fish behavior was abnormal (~8−30 minutes, or 1 or 2 data points). These data were removed from analysis by subjectively viewing the data to determine when depths and temperatures stabilized (similar to Bergstedt et al. 2012). The mean daily temperatures and depths were calculated for each fish. In addition, surface water temperatures collected from an Environment Canada buoy (buoy #45149, http://coastwatch.glerl.noaa.gov/) nearest to the study location in Lake Huron were compared to temperatures occupied by lake sturgeon. However, the surface water temperatures were not collected year-round (the buoys were removed during winter).

Results

A total of five lake sturgeon with archival tags were recaptured (by anglers and commercial nets; recapture rate = 12.5%). Of these five fish, two were male (tag 0054 and 0540), one was female (tag 0582), and gender of the remaining two was unknown (tag 4188 and 4442). Days at large for lake sturgeon IDs 0054, 0540, 0582, 4188, and 4442 were 57, 32, 301, 286, and 880 days, respectively. However, the lake sturgeon with tag 4442 only had data available for 244 days due to the archival tag battery dying.

The range of temperatures occupied by lake sturgeon ranged from 0 to 23.5 °C. Temperatures occupied by tagged lake sturgeon were highest in August and lowest in February and seemed to emulate surface water temperature patterns (Figure 2). Individual temperature histories overlapped,

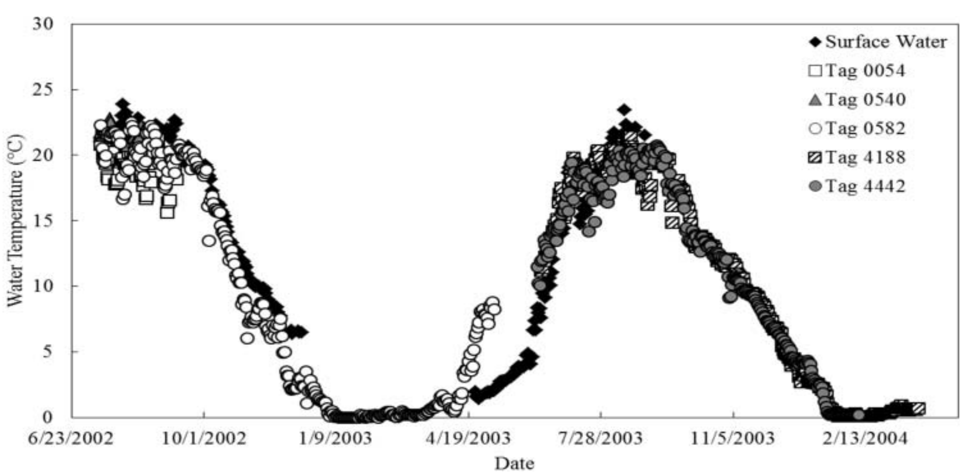

Figure 2. Mean daily temperature (°C) occupied by five lake sturgeon caught and released in Lake Huron and surface water temperatures recorded by an Environment Canada buoy.

suggesting that tagged adult lake sturgeon occupied similar habitats or exhibited preference for the same range of temperatures (Figure 2).

The range of depths occupied by lake sturgeon recorded by the archival tags ranged from 0.1 to 42.4 m with the maximum depths occupied ranging from 25.6 to 42.4 m. Overall mean depth occupied was 16.3 m (± 0.02 standard error). Lake sturgeon occupied deep water more frequently during fall and winter (defined by vernal and autumnal equinoxes) than spring and summer (Figure 3).

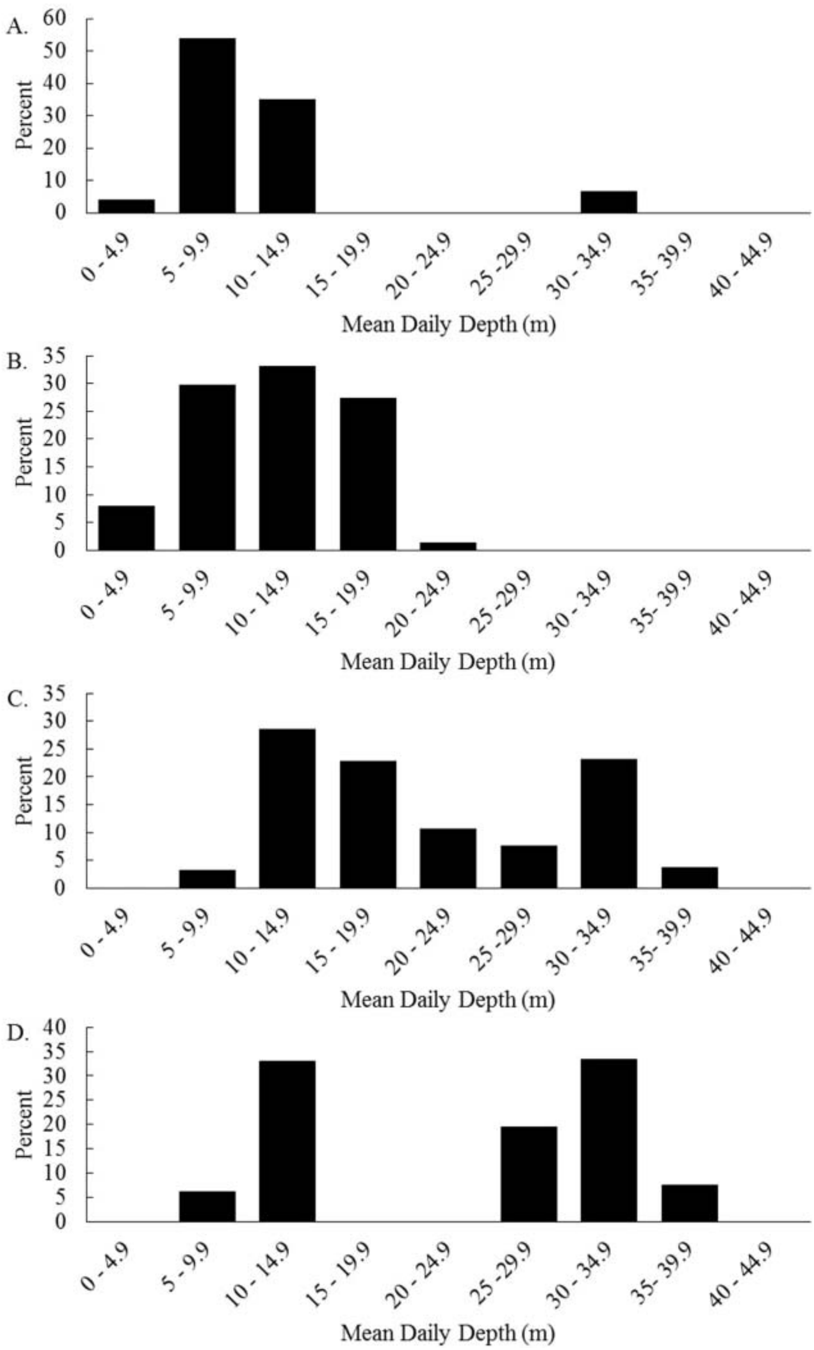

Figure 3. Histograms depicting the percentage of time lake sturgeon occupied various depths in spring (A), summer (B), fall (C), and winter (D).

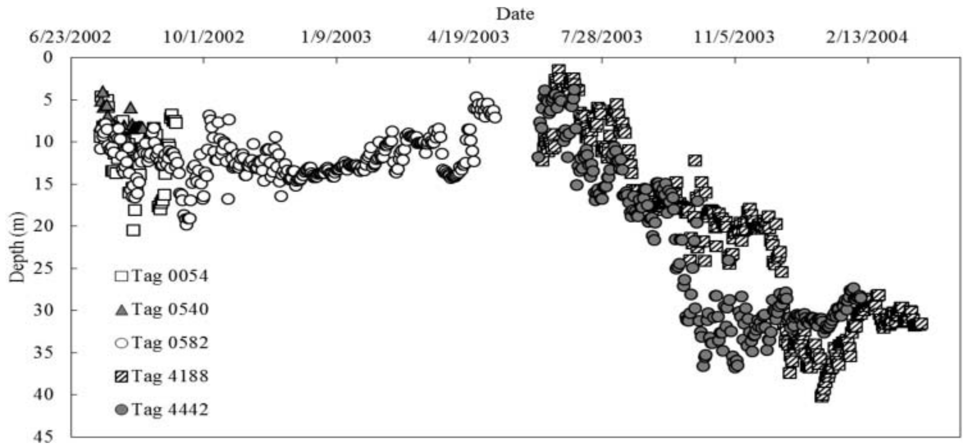

Figure 4. Mean daily depths (m) occupied by five lake sturgeon caught and released in Lake Huron.

Seasonal trends in depth-habitat use varied among the three fish with data records longer than 200 days. All three individuals used a similar range of depth habitat from June through September; thereafter, however, lake sturgeon 4188 and 4442 occupied greater depths than lake sturgeon 0582 (Figure 4). This suggests that tagged lake sturgeon did not use the same overwintering habitats. The mean daily depths occupied by lake sturgeon were deepest during the winter for two lake sturgeon (tags 4188 and 4442) while one lake sturgeon (tag 0582) remained at a relatively consistent depth throughout the life its archival tag (Figure 4).

Discussion

This study was unique from previous work on lake sturgeon habitat use due to the use of archival tags (as opposed to radio or acoustic telemetry). This method proved to be advantageous for observing bathythermal habitat use as compared to telemetry methods previously used (e.g., Boase et al. 2011; Gerig et al. 2011), especially in large ecosystems lacking barriers to sturgeon movement. Logistically, using archival tags reduces the amount of time and manpower needed to actively track the fish. Also, there is no concern associated with the range of receivers and whether a fish can be detected when it is in deep water. Additionally, data are recorded more continuously with the use of archival tags, thereby alleviating the concern of where a fish moves between detections. However, archival tags also have limitations, principally that tagged fish must be recovered at some point in order to retrieve the data. The 35 tagged lake sturgeon never recovered represent a substantial amount of data that could not be obtained, even though tag recovery rate in this study (12.5%) was comparable to recapture rates for other fish species in various environments (e.g., Smithson & Johnston 1999 [8.5%−40%]; West & Stevens 2001 [14.8%−30%]). Likewise, the tags themselves are expensive (about $475 at time of purchase for this study). Finally, as some archival tags do not record animal location, researchers may be unable to classify the type of habitat lake sturgeon are occupying or approximate the distance lake sturgeon traveled. In order to obtain the benefits of both telemetry and archival tags, Howell et al. (2010) utilized both techniques on bull trout (*Salvelinus confluentus*) in Oregon.

Results from this study provide the first unbiased assessment of the depths and temperatures occupied by free-ranging lake sturgeon. Maximum depths occupied by lake sturgeon in this study were greater than those observed in previous studies in other environments (e.g., Boase et al. 2011; Gerig et al. 2011; Damstra & Galarowicz 2013), which likely reflects between-system differences in depth-habitat availability. All five recaptured lake sturgeon occupied depths greater than 24 m and two occupied depths greater than 40 m. Harkness and Dymond (1961) did note lake sturgeon being caught in 42.7 m of water in Lake Beauchene, Quebec; however, the majority were captured in less than 18.3 m of water.

We also noted significant individual variability in depth-habitat use. For the three lake sturgeon that were at large for an extended period of time (tags 0582, 4188, and 4442), two occupied deeper depths during fall and winter than during spring and summer while the other occupied similar depths during summer, fall, and winter. It is possible that the fish that occupied similar depths in summer, fall, and winter (tag 0582) mainly inhabited the St. Clair River whose maximum depth is approximately 24 m. Lake sturgeon occupying deeper waters in fall and winter is contrary to previous studies reporting that lake sturgeon move to deeper water during the summer and prefer depths less than 9 m during cooler months (i.e., Harkness & Dymond 1961; Priegel & Wirth 1974; Hay-Chmielewski 1987). In contrast to depth-habitat use, the water temperatures occupied by lake sturgeon were similar among tagged individuals and appeared to emulate the natural seasonal fluctuation in water temperatures.

This study provided previously unavailable information concerning bathythermal habitat use of free-ranging lake sturgeon during non-spawning periods and exhibited the feasibility of using archival tags in fisheries research in the Great Lakes. A key observation determined from the use of archival tags was that lake sturgeon occupied greater depth than previously thought (especially during winter). Despite relatively low tag recovery rates, the information obtained provides managers with information useful for identifying habitats to protect and restore. Archival tags in this study proved to provide useful data that could not otherwise be gathered, despite the large, open system and low sample size. Future expanded lake sturgeon bathythermal habitat studies using archival tags will likely provide even more data, especially in areas where extensive lake sturgeon surveys are already conducted that will increase recapture probability or if the tags can be combined with telemetry to gain geographic location data.

Acknowledgements

We would like to thank Purdy Fisheries, Ltd. for collecting the lake sturgeon used in this study along with the staff of the Ontario Ministry of Natural Resources, U.S. Fish and Wildlife Service, and U.S. Geological Survey for assisting with this project. Funding was provided by the U.S. Geological Survey – U.S. Fish and Wildlife Service Science Support Partnership. The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government. This article is contribution (2006) of the USGS Great Lakes Science Center.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

U.S. Geological Survey – U.S. Fish and Wildlife Service Science Support Partnership.

References

Auer NA. 1996. Importance of habitat and migration to sturgeons with emphasis on lake sturgeon. Can J Fish Aquat Sci. 53:52–160.

Bergstedt RA, Argyle RL, Krueger CC, Taylor WW. 2012. Bathythermal habitat use by strains of Great Lakes- and Finger Lakes-origin lake trout in Lake Huron after a change in prey fish abundance and comparison. Trans Am Fish Soc. 141:263–274.

Boase JC, Diana JS, Thomas MV, Chiotti JA. 2011. Movements and distribution of adult lake sturgeon from their spawning site in the St. Clair River, Michigan. J Appl Ichthyol. 27:58–65.

Damstra RA, Galarowicz TL. 2013. Summer habitat use by lake sturgeon in Manistee Lake, Michigan. Trans Am Fish Soc. 142:931–941.

Domeier ML, Kiefer D, Nasby-Lucas N, Wagschal A, O'Brien F. 2005. Tracking Pacific bluefin tuna (*Thunnus thynnus orientalis*) in the northeastern Pacific with an automated algorithm that estimates latitude by matching sea-surface-temperature data from satellites with temperature data from tags on fish. Fish Bull. 103:292–306.

Gerig B, Moerke A, Greil R, Koproski S. 2011. Movement patterns and habitat characteristics of lake sturgeon (*Acipenser fulvescens*) in the St. Marys River, Michigan, 2007-2008. J Great Lakes Res. 37:54–60.

Harkness WJK, Dymond JR. 1961. The lake sturgeon. Toronto: Ontario Department of Lands and Forests, Fish and Wildlife Branch.

Hay-Chmielewski EM. 1987. Habitat preference and movement patterns of the lake sturgeon (*Acipenser fulvescens*) in Black Lake, Michigan. Ann Arbor (MI): Michigan Department of Natural Resources. (Fisheries Research Report 1949).

Howell PJ, Dunham JB, Sankovich PM. 2010. Relationships between water temperatures and upstream migration, cold water refuge use, and spawning of adult bull trout from the Lostine River, Oregon, USA. Ecol Freshw Fish. 19:96–106.

Priegel GR, Wirth TL. 1974. The lake sturgeon: its life history, ecology, and management. Madison (WI): Wisconsin Department of Natural Resources Publication 4-3600 (74).

Smithson EB, Johnston CE. 1999. Movement patterns of stream fishes in a Ouachita Highlands stream: an examination of the restricted movement paradigm. Trans Am Fish Soc. 128:847–853.

West GJ, Stevens JD. 2001. Archival tagging of school shark, *Galeorhinus galeus*, in Australia: initial results. Env Biol Fish. 60:283–298.