Journal of Great Lakes Research xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Journal of Great Lakes Research

journal homepage: www.elsevier.com/locate/jglr

Consistent individual differences in sea lamprey (*Petromyzon marinus*) behaviour: Implications for control via trapping

Adrienne R. McLean *, Robert L. McLaughlin

Department of Integrative Biology, University of Guelph, 50 Stone Road East, ON N1G 2W1, Canada

ARTICLE INFO

Article history:
Received 24 October 2017
Accepted 27 February 2018
Available online xxxx

Associate Editor: Nicholas Johnson

Keywords:
Boldness
Exploration
Invasive species
Personality
Sea lamprey
Trapping

ABSTRACT

We tested if consistent individual differences (CIDs) in the behaviour of sea lamprey (*Petromyzon marinus*) from the Laurentian Great Lakes could influence their vulnerability to trapping. The sea lamprey is invasive in the Upper Laurentian Great Lakes and the target of a binational control program. Trapping could be used for control if trapping efficiency is unbiased and effective. Our test involved comparing the behaviour of sea lamprey collected in the field from a trap (n = 42) at a barrier and electrofished (n = 9) downstream of the barrier. We quantified each individual's latency to exit an enclosure (a measure of exploration), proportion of time spent moving (a measure of general activity), and change in activity in response to a putative predator cue (a measure of boldness). CIDs were detected for each behaviour measured (intraclass correlations: 0.3–0.5). CIDs in behaviour also differed between trapped individuals and those collected downstream using electrofishing, irrespective of size, sex, and maturity status. Trapped individuals decreased their activity in response to a putative predator cue, while individuals collected using electrofishing increased their activity in response to the cue. Trapped individuals also tended to spend a greater proportion of time moving than individuals sampled downstream of the trap. However, the two samples of lamprey did not differ significantly in time taken to exit an enclosure. The behavioural differences between sea lamprey sampled from a trap and those sampled downstream of the trap suggest that CIDs in behaviour can influence an individual's vulnerability to trapping.

© 2018 International Association for Great Lakes Research. Published by Elsevier B.V. All rights reserved.

Introduction

Concepts developed in the field of animal behaviour are important for the conservation and management of fish and wildlife (Berger-Tal et al., 2016; Merrick and Koprowski, 2017). Individuals from populations of wild animals can differ markedly and consistently in behaviour, beyond that expected due to differences in age, sex, or body size (Réale et al., 2007). In fishes, consistent individual differences in behaviour (CIDs) have been observed in measures of five behavioural domains, each representing a continuum: bold-shy (boldness), exploration-avoidance (exploration), active-inactive (activity), aggressive-submissive (aggression), and social-asocial (sociability) (Conrad et al., 2011). CIDs in behaviour measured from one of these domains can also be correlated with behaviour measured from another domain (behavioural syndromes; Sih et al., 2004). Further, there have been theoretical arguments, and initial empirical studies from a range of taxa, relating CIDs in behaviour to key ecological processes, such as habitat selection, space use, dispersal, migration (e.g., Fraser et al., 2001; Cote et al., 2010), predator-prey interactions (e.g., Harris et al., 2010; Belgrad and Griffen, 2016), and mate finding (e.g., Godin and Dugatkin, 1996; Wilson et al., 2010) which can all be important to managing invasive and pest species (Merrick and Koprowski, 2017).

We tested the hypothesis that CIDs in the behaviour of sea lamprey (*Petromyzon marinus*) from the Laurentian Great Lakes could influence their vulnerability to trapping. Sea lamprey provide an exceptional opportunity to assess the importance of CIDs in a fishery management context of broad ecological and economic significance. The sea lamprey is an invasive, parasitic fish that feeds on blood and tissue from large host fishes. Sea lamprey invaded the Upper Laurentian Great Lakes following construction on the Welland Canal in the 1920s (Christie and Goddard, 2003). Once resident in the upper lakes, dramatic increases in the abundances of sea lamprey were followed by collapses in populations of large host fishes, such as lake trout (*Salvelinus namaycush*), walleye (*Stizostedion vitreum*), and lake whitefish (*Coregonus clupeaformis*) (Smith and Tibbles, 1980), and by changes in the lakes' food webs (Eshenroder and Burnham-Curtis, 1999). These changes led to the founding of the Great Lakes Fishery Commission, a binational agency created by Canada and the United States, that was charged with coordinating a program for eradication, or at least control, of sea lamprey in the Great Lakes (Smith and Tibbles, 1980).

Trapping adult sea lamprey could become a valuable form of control if the proportions of adults migrating upstream into spawning

* Corresponding author at: Department of Psychology, Neuroscience & Behaviour, McMaster University, 1280 Main Street West, Hamilton, ON L8S 4K1, Canada.
E-mail address: mcleaa7@mcmaster.ca (A.R. McLean).

https://doi.org/10.1016/j.jglr.2018.03.002
0380-1330/© 2018 International Association for Great Lakes Research. Published by Elsevier B.V. All rights reserved.

Please cite this article as: McLean, A.R., McLaughlin, R.L., Consistent individual differences in sea lamprey (*Petromyzon marinus*) behaviour: Implications for control via trapping, J. Great Lakes Res. (2018), https://doi.org/10.1016/j.jglr.2018.03.002

ARTICLE IN PRESS

tributaries that are removed by trapping (trapping efficiency) can be increased (McLaughlin et al., 2007). Trapping is currently used to quantify the abundances of adult sea lamprey, but there is interest in improving it for control purposes because it removes maturing fish before they reproduce (Great Lakes Fishery Commission Vision Statement, 2011). The two main methods of sea lamprey control are low-head migration barriers placed in tributaries to deny migrating adult lamprey access to spawning habitat and periodic applications of chemical lampricides in tributaries where larval lamprey occur. Trapping for control would be highly valuable for large rivers, where shipping and boating activity make barriers impractical and where river size can make lampricide treatments challenging, expensive, and less successful relative to smaller rivers. Highly successful trapping could potentially reduce the need for barriers and chemical treatments, and alleviate concerns about the effects of barriers and chemicals on native species (McLaughlin et al., 2007). However, the efficiency of trapping across the Great Lakes basin is relatively low, 23 to 79% of the lamprey run in a tributary (McLaughlin et al., 2007). Recent field studies combining passive integrated transponder and acoustic tags have shown that trapping efficiency is low, because many sea lamprey do not encounter traps, or enter traps upon encounter, but few escape once trapped (Bravener and McLaughlin, 2013; Dawson et al., 2017; McLean et al., 2015; Rous et al., 2017).

CIDs in behaviour could provide an explanation for the lower than desired trapping efficiency if current trap designs only sample a portion of the behavioural types within a population. Simulation studies further show that personality-based trapping can negatively bias estimates of migratory run size and positively bias estimates of trapping efficiency by 10–60% (McLaughlin et al., 2016). CIDs in behaviour have been related to vulnerability to trapping in fishes (Wilson et al., 1993), lizards (Carter et al., 2012), birds (Garamszegi et al., 2009), and mammals (Boon et al., 2008; Boyer et al., 2010). One of the earliest studies of CIDs in behaviour compared individual pumpkinseed sunfish (*Lepomis gibbosus*) captured in traps with those captured by seining (Wilson et al., 1993). Trapped individuals were more willing to take risks (bolder) than individuals captured by seining. Examples where CIDs in behaviour were related to differences in habitat selection, space use, and dispersal further suggest that CIDs in behaviour could influence encounter with and entrance into traps, and trapping efficiency (Chapman et al., 2011; Duckworth and Badyaev, 2007).

We tested whether CIDs in behaviour were related to trapping of sea lamprey by completing two steps in Réale et al.'s (2007) framework for assessing the ecological significance of CIDs in behaviour. First, we tested if sea lamprey exhibit CIDs in three behaviours expected to influence an individual's vulnerability to trapping: (i) willingness to exit an enclosure into a novel environment (a measure of exploration), (ii) willingness to move about a simple environment free of social and predator cues (a measure of baseline activity), and (iii) change in activity in response to phenylethylamine hydrochloride (PEA HCl), a chemical cue found in the urine of many mammalian carnivores (Ferrero et al., 2011) that elicited a putative predator avoidance response (a measure of boldness) in laboratory experiments with sea lamprey (Imre et al., 2014; but see Di Rocco et al., 2016). We also tested if the behaviours were correlated, which would provide evidence of a behavioural syndrome (Sih et al., 2004). Second, we tested if individuals captured in traps differed in these behaviours compared to individuals captured at large in the stream (untrapped individuals). To structure our investigation, we predicted that trapped individuals would (i) take less time to exit an enclosure into a novel environment than individuals captured at large because sea lamprey do not home (Bergstedt and Seelye, 1995), so the tributary is a novel location and the trap a novel object, and response to novelty could influence encounter with and entrance into a trap; (ii) exhibit higher activity than individuals captured at large because higher activity would increase the probability of finding and entering a trap (Gerritsen and Strickler, 1977; Koopman, 1980); and (iii) increase activity upon exposure to a putative predator cue, if increased activity increases the probability of finding and entering a refuge (potentially a trap) (Hume et al., 2015).

Methods and materials

Sea lamprey collection and care

Maturing sea lamprey were collected from Duffins Creek in Ajax, ON (Fig. 1) on 4, 9, 18, and 27 May 2013. These dates coincided with one collection early in the spawning migration, two near peak migration, and one late in the migration. Duffins Creek was selected as our study site because there is (i) a large annual run of sea lamprey, (ii) a trap integrated with an in-stream barrier from which we could sample trapped lamprey, (iii) a significant portion of migrating lamprey that remain untrapped each year (the proportion of untrapped individuals was estimated to be 32% in 2013) and have been observed spawning downstream of the barrier, and (iv) creek sections downstream of the trap are wadeable, facilitating the sampling of adult sea lamprey.

On each sample day, sea lamprey were collected from the trap at the low-head migration barrier and from creek sections downstream of the trap. Traps are commonly located at dams to exploit the sea lamprey's attraction to flow (Smith and Tibbles, 1980). The trap had funnel openings designed to direct lampreys to entrances and into the trap. The trap was also designed to force attractant water flow from its openings to encourage lampreys to swim to and enter the trap. The trap was normally emptied daily by contractors hired by Fisheries and Oceans Canada. In the morning of each sample day, sea lamprey trapped during the previous night (trapped sample) were removed from the trap and held downstream in a 189.3 L perforated tub from approximately 1100 to 1800 h. During this time, sea lamprey occurring in the 1.5 km section downstream of the trap (the at large sample) were collected using back-pack electrofishing. A two-person crew moving from downstream to upstream electrofished habitat features sea lamprey are known to be associated with, using 275 V (30 Hz, 12% duty cycle) for three pulses with a Smith-Root LR24 back-pack electrofishing unit. Sea lamprey displaced by the electric current were netted. If no lamprey appeared after the three pulses, a second electroshock sweep of that location was performed after a five-minute pause. Captured lamprey were immediately placed in a 189.3 L perforated tub until 1800 h, when lamprey collection ended for the day. Once the downstream section had been electrofished, the trapped sample of sea lamprey was briefly electroshocked (3 times averaging 5 s each) at 275 V in their perforated holding tub. This was done to standardize the electroshocking experience of all individuals sampled in case the exposure to electricity had any lasting influence on individual behaviour.

Once sampling for the day was complete, the two groups of sea lamprey were placed in separate, labelled, aerated coolers and transported to Hagen Aqualab at the University of Guelph (ON). Upon arrival, one group was selected randomly for internal tagging with passive integrative transponder (PIT) tags. That group was tagged in the evening and placed in an 800-L holding tank at 8 °C. The other group was placed in the same 800-L holding tank overnight and tagged the following morning. The tagging allowed us to identify individuals from each group. Tagging of the two groups was staggered across days because of the time required to complete the tagging and concern about prolonging the stress of transportation and tagging on the lamprey.

The PIT tagging protocol involved eight steps. First, an individual was netted from the appropriate aerated cooler (or from the holding tank the next day) and placed in an aerated bath of 50 mg/L MS222 until it achieved partial loss of equilibrium, demonstrated by arrested movement and attachment to the side of the bath container. Second, the lamprey was sexed and total length was measured to the nearest mm using a measuring board. Third, the lamprey was transferred to a moist foam pad ventral side up for surgery. Fourth, the area around the incision (ventral, midline) site was disinfected with Povidone iodine solution (5 g L^{-1}) and rinsed with a sterile saline solution (9 g L^{-1}). Fifth, a

Please cite this article as: McLean, A.R., McLaughlin, R.L., Consistent individual differences in sea lamprey (*Petromyzon marinus*) behaviour: Implications for control via trapping, J. Great Lakes Res. (2018), https://doi.org/10.1016/j.jglr.2018.03.002

Download English Version:

https://daneshyari.com/en/article/8849113

Download Persian Version:

https://daneshyari.com/article/8849113

Daneshyari.com