GREAT LAKES FISHERY COMMISSION

Project Completion Report[1]

# Radio telemetry investigations of the upstream migratory behaviour of sea lampreys, including sterilized males

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# Radio telemetry investigations of the upstream migratory behaviour of sea lampreys, including sterilized males

Completion Report to the Great Lakes Fishery Commission

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## Overview

The release of sterile male lampreys and construction of in-stream barriers to migrating adult sea lampreys are two of the technologies that, with the periodic application of lampricides, can be applied to suppress the abundance of sea lamprey populations in the Great Lakes. The contribution of these alternative control measures to sea lamprey management will be affected by the success of the introduced sterile males in mating with the indigenous spawning population, by the response of the in-stream adult population to barriers and by the vulnerability of the adult population during migration to current and emerging trapping or capture options. Therefore, to estimate emigration and the upstream rate of travel, to determine distribution and destination in a potential spawning stream and to describe the refugia used during migration and prior to spawning we relocated sea lampreys with attached radio transmitters released in three tributaries to Lake Superior. Also, to determine the interaction of non-indigenous sterilized male sea lampreys with other spawning lampreys and the fidelity among animals and to a nest, we continuously followed sea lampreys with radio transmitters and observed spawning at a subset of nests during spawning in the Carp River, another tributary to Lake Superior.

Between 1993 and 1996, we followed 75 non-indigenous sterile male, 52 indigenous male, 17 indigenous sterile male (captured in the Bad River, sterilized and then returned to the Bad River) and 5 indigenous female sea lampreys equipped with radio transmitters and released in the Wolf (1994, 1995), Pancake (1993, 1994, 1995) and Bad (1995, 1996) rivers. We used a portable receiver with a directional antenna as we walked, canoed or used an aircraft to determine the location of these lampreys in the portion of the watershed accessible to them.

For all years and all tributaries, 25% of sea lampreys released with radio transmitters emigrated from the stream in which they were released. Emigration was variable among streams and was highest in the Wolf River (51% of those that emigrated), intermediate in the Pancake River (38%) and lowest in the Bad River (10%). Emigration also was variable among years and was highest in 1995 in both the Wolf and Pancake rivers. There was no significant difference in the proportion of indigenous male and non-indigenous sterile male sea lampreys that emigrated from the three streams. Emigration of sea lampreys from streams occurred in May, June and July and seemed to occur more frequently during a freshet or in the 1-2 days following a freshet. We suggest that the ease of access to upstream reaches (a stream with an impediment close to the estuary will have higher emigration rates) and freshets during the period of upstream migration will affect fidelity of sea lampreys to a potential spawning stream.

Some sea lampreys (8 of 149) with radio transmitters remained in the tributary but made no upstream progress, some (5 of 149) went downstream from their release location but most (64%) went upstream by making unidirectional progress (40% of total released) or by migrating upstream, retreating and then moving upstream again. Sea lampreys travelled upstream faster in the Bad River, 0.68 km day$^{-1}$, than in the Pancake (0.25 km day$^{-1}$) or the Wolf (0.25 km day$^{-1}$) rivers. Non-indigenous sterile male sea lampreys moved upstream at a slightly greater daily rate in the Bad River in 1995 and 1996, in the Pancake River in 1993 and 1995 but not in 1994 and in the Wolf River in 1995 but not in 1994. However, the difference in daily upstream movement rates was significantly different (analysis of variance F=5.38, $P_{.05}$) only between movement by indigenous male and non-indigenous sterile male sea lampreys released in the Bad River in 1995. Consequently, we assume that there was no significant difference in daily upstream travel rates of indigenous male, indigenous sterile male (Bad River only) and non-indigenous sterile male sea lampreys within the three tributaries.

In the Wolf River, most of the upstream movement occurred prior to mid-June but in the Pancake and Bad rivers some sea lampreys continued moving upstream until mid-July. Downstream movement rarely occurred in any tributary after late June. Non-indigenous sterile male lampreys traveled farther upstream than indigenous males with radio transmitters in the Bad River in both years and in the Pancake and Wolf rivers in 1995. However, the distance travelled upstream was significantly different (analysis of variance F=5.29, $P_{.05}$) only between indigenous male and indigenous sterile male lampreys in the Bad River in 1996. We suspect that, overall, although differences may exist among animals of different sex or handling histories, the variability is not biologically significant. We used $\chi^2$ contingency tables to test whether there was any significant difference in the overall incidence of emigration, no movement, upstream progress only, upstream combined with downstream progress by indigenous male and non-indigenous sterile male sea lampreys within a tributary and found no significant difference. Therefore, we conclude that origin and the sterilization process does not affect the general patterns of upstream migration by sea lampreys in a stream.

Few sea lampreys passed continuously recording receivers installed in the Pancake and Bad rivers in the early morning, 0500 to 0800 h, or in mid-afternoon, 1300 to 1600 h. Conversely, the period of greatest upstream movement was between 2200 and 0300 h. When not actively moving upstream, sea lampreys were found in brush piles, under overhanging banks, under boulders and in general, in locations where light levels were significantly reduced (analysis of variance F= 3952, sig. $P_{.05}$ between sea lamprey location and a mid-stream reference) and, perhaps, water velocity was lower. Sea lampreys were most commonly found within the tangled brush and log piles that occur in bends of these northern streams. There was no significant difference in the habitat in which indigenous male and non-indigenous sterile male sea lampreys were found and no significant difference among the tributaries. Native New Zealanders capture lampreys (*Geotria australis*) from refugia and attachment sufaces (McDowall 1993 and others); however, these habitats and structures may be limited in New Zealand streams. The diversity in refugia and their common occurrence in at least these Lake Superior streams indicates that interception during travel (some form of trapping) may offer more opportunities for reducing adult abundance of sea lampreys than concentrating adults (through creating refugia) to enhance capture or removal of adults.

Of the sea lampreys released with transmitters in the Wolf River, only 61 and 45% of the animals progressed far enough upstream such that they may have encountered the low-head barrier and its trap. The capture rates for the barrier, therefore, were 15% (2 captured, 21 released, 13 vulnerable) and 45% (4 captured, 20 released, 9 vulnerable) of the vulnerable adult population in 1994 and 1995, respectively. Further, because emigration occurred and some sea lampreys did not progress upstream to areas where nests were found, not all adults in potential spawning streams may spawn. Assuming that sea lampreys located within 10 m of areas where nests occur may spawn, leads us to suggest that about 35% of the animals released with transmitters in two tributaries might reproduce. In the Wolf and Pancake rivers (smaller tributaries where nest assessment was recent and occurred during the study period) respectively, we suggest that 44 and 28% of the sea lampreys with transmitters may have spawned.

Approximately 4X more nests were found in late June and early July in the Carp River in 1996 and 1997 and none of the sea lamprey with radio transmitters that were continuously observed during this period was seen actively spawning in 1997, although three spawned in 1996. In both years, sea lampreys with radio transmitters that were continuously followed spent 75-100% of their time in refugia, undercover. In 1996, 3 sea lampreys (2 non-indigenous male and 1 non-indigenous sterile male) left refugia, visited 2-6 different nests, were observed with a non-indigenous female at nests but eggs were seen being deposited during only one pairing for each male.

We repeatedly checked 7 nests in 1996 and 4 nests in 1997 in the Carp River for the presence of sea lampreys. In 1996, on 57 occasions (47% of the times that we inspected the nests) we saw single non-indigenous male or sterile male and 14 mating pairs of sea lampreys on the 7 nests. In 1997, we saw 10 males or sterile males on the 4 nests and saw 10 pairs of mating non-indigenous sterile male and female sea lampreys. The same individual may have made repeated visits (a visible mark differentiated male, sterilized male and female lampreys) to our subsample of nests but scars, wounds, and different colours of individuals and the movement of sea lampreys with transmitters among these and other nests, indicates that we probably observed a number of different individuals.

The process of capturing sea lampreys in Lake Huron, sterilizing males at a central facility, then introducing sterile males into a stream did not alter emigration rates, daily upstream movement rates and the habitat selected during upstream migration and prior to spawning from that of indigenous male sea lamprey populations. However, the instinctive drive of sea lampreys to move upstream and their fidelity to a potential spawning stream is, in our view, modest. Also, we suggest that differences in watershed size, in the distance between the estuary and an upstream impediment to passage and in freshet occurrence likely caused the observed differences in emigration and travel rates reported in the literature and determined by this study. We concur with Hanson and Manion's (1980) conclusion that sterilization of male sea lampreys with bisazir had no detectable effect on their nest building and spawning behaviour and did not alter their mating competitiveness with other male sea lampreys. Any increase in emigration induced by freshets and differences in fidelity to a potential spawning stream, however, will affect the number of sea lampreys that actually spawn. As well, not all sea lampreys near areas where nests were constructed in the Carp River were observed mating and this, too, will affect the reproductive success of the in-stream population of sea lampreys. Because nests were used by >1 pair of sea lampreys and because pairing between a male and female was not sustained, assessment of the reduction in progeny by introducing non-indigenous sterile male sea lampreys into spawning populations will be more informative through sampling at the stream level after larval lamprey become vulnerable to sampling.