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# Assessment of Information Required for the Identification of Critical Habitat for Northern Madtom (*Noturus stigmosus*), Spotted Gar (*Lepisosteus oculatus*), Lake Chubsucker (*Erimyzon sucetta*) and Pugnose Shiner (*Notropis anogenus*) in Canada

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**Foreword**

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

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## ABSTRACT

Canada's *Species at Risk Act* (SARA) requires the development of recovery strategies for species listed as Endangered or Threatened under the Act (SARA, Schedule 1). As mandated by SARA, recovery strategies must include a description of critical habitat to the extent possible based on the best available information. When sufficient data are lacking, a schedule of studies may be included that, when completed, would allow critical habitat to be identified. Critical habitat is defined under Section 2 of SARA as, "the habitat necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species". Once designated, SARA provides provisions to protect critical habitat of these species.

Fisheries and Oceans Canada (DFO) Science has been asked to provide a review of the information required for the identification of critical habitat. Species-specific descriptions of critical habitat have been proposed by recovery teams for four species at risk (Northern Madtom, *Noturus stigmosus*; Spotted Gar, *Lepisosteus oculatus*; Lake Chubsucker, *Erimyzon sucetta*; Pugnose Shiner, *Notropis anogenus*). Science advice on a population-by-population basis is requested for each of the four species across their Canadian range, taking into consideration the limited data available for each population. The science advice should include a conceptual framework for identifying information required for the identification of critical habitat for freshwater fishes and, thus, provide general guidance that may be adapted for broader usage.

**Évaluation de l'information requise pour la désignation de l'habitat essentiel du chat-fou du nord (*Noturus stigmosus*), du lépisosté tacheté (*Lepisosteus oculatus*), du sucet de lac (*Erimyzon sucetta*) et du méné camus (*Notropis anogenus*) au Canada**

## RÉSUMÉ

La *Loi sur les espèces en péril* (LEP) du Canada exige que soient établis des programmes de rétablissement pour toutes les espèces inscrites sur la liste des espèces menacées ou en voie de disparition selon la *Loi* (LEP, annexe 1). Conformément à la LEP, les programmes de rétablissement doivent comprendre une description de l'habitat essentiel fondée, dans la mesure du possible, sur la meilleure information disponible. Lorsque l'on manque de données, il est possible d'inclure un calendrier d'études qui, une fois terminées, devraient permettre la désignation de l'habitat essentiel. Selon la définition de l'article 2 de la LEP, l'habitat essentiel est en fait « l'habitat nécessaire à la survie ou au rétablissement d'une espèce sauvage inscrite, qui est désigné comme tel dans un programme de rétablissement ou un plan d'action élaboré à l'égard de l'espèce ». Après la désignation, la LEP prévoit des dispositions pour protéger l'habitat essentiel de ces espèces.

Le Secteur des sciences de Pêches et Océans Canada (MPO) a été chargé de fournir un examen de l'information requise pour la désignation de l'habitat essentiel. Des descriptions de l'habitat essentiel propres aux espèces ont été proposées par les équipes de rétablissement pour les quatre espèces en péril (chat-fou du nord [*Noturus stigmosus*], lépisosté tacheté [*Lepisosteus oculatus*], sucet de lac [*Erimyzon sucetta*] et méné camus [*Notropis anogenus*]). Des avis scientifiques pour chaque population sont nécessaires pour chacune des quatre espèces dans toute leur aire de répartition canadienne, en tenant compte de la faible quantité de données qui sont disponibles au sujet des populations. Les avis scientifiques devraient inclure un cadre conceptuel pour indiquer les renseignements nécessaires à la désignation de l'habitat essentiel en ce qui concerne les poissons d'eau douce et ainsi fournir une orientation générale pouvant être adaptée à un usage élargi.

# INTRODUCTION

Canada's *Species at Risk Act* (SARA) requires the development of recovery strategies for species listed as Endangered or Threatened under the Act (SARA, Schedule 1). As mandated by SARA, recovery strategies must include a description of critical habitat to the extent possible based on the best available information. When sufficient data are lacking, a schedule of studies may be included that, when completed, would allow critical habitat to be identified. Critical habitat is defined under Section 2 of SARA as, "the habitat necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species". Once designated, SARA provides provisions to protect critical habitat of these species.

Recovery strategies have been developed for four species of fishes (Northern Madtom, *Noturus stigmosus*; Spotted Gar, *Lepisosteus oculatus*; Lake Chubsucker, *Erimyzon sucetta*; Pugnose Shiner, *Notropis anogenus*) (Table 1). Science advice on the information required for the identification of potential critical habitat for these species is required for consideration, and possible integration, into their respective recovery strategies. Existing descriptions of critical habitat for some species and populations have been proposed by the recovery team, and need to be considered in range-wide recommendations for identifying critical habitat for the four fishes. Science advice on a population-by-population basis is requested for each of the four fishes across their Canadian range, taking into consideration the limited data available for each population. The science advice should include a conceptual framework for identifying information required for the identification of critical habitat for freshwater fishes and, thus, provide general guidance that may be adapted for broader usage.

This document was prepared for the Canadian Science Advisory Secretariat regional advisory process peer-review meeting "Assessment of Information Required for the Identification of Critical Habitat for Four Species at Risk" held on May 29th, 2008 in Burlington, Ontario. Proceedings that document the activities and key discussions of the meeting are also available (DFO 2009). The delineation of critical habitat has continued to evolve since that meeting and this document is being published to provide historical context on the development of methods to identify critical habitat.

*Table 1. Endangered and Threatened species with recovery strategies.*

| Common Name | Scientific Name | COSEWIC Status[1] (date assessed) |
|---|---|---|
| Pugnose Shiner | *Notropis anogenus* | THR (2013)* |
| Northern Madtom | *Noturus stigmosus* | END (2012)* |
| Lake Chubsucker | *Erimyzon sucetta* | END (2008)* |
| Spotted Gar | *Lepisosteus oculatus* | THR (2005)* |

* Schedule 1, SARA

# METHODS

Rosenfeld and Hatfield (2006) identified the key information needed for identifying critical habitat as basic organism life history, recovery targets, habitat availability and habitat-abundance relationships.

## BASIC LIFE HISTORY

Basic life history information by life-stage for the four species was compiled from the literature. This information included the known habitat requirements for the following life-stages:

1) Spawn to hatch;
2) Young-of-the-year;
3) Juvenile; and,
4) Adult.

## RECOVERY TARGETS

Clearly defined recovery targets are integral to the identification of critical habitat (Rosenfeld and Hatfield 2006). To identify limiting habitat, habitat quantity must be linked to a recovery target. Recovery targets were derived from existing recovery strategies and by estimating minimum viable population size (MVP). Recovery strategies typically had qualitative targets related to no further decline in number of populations and in abundance within each population. We also estimated a quantitative, demographically sustainable recovery target based on the concept of MVP. This quantitative target was determined using the allometry between maximum population growth rate and MVP developed by Reed et al. (2003). MVP was defined as the adult population size required for a 99% probability of persistence over 40 generations (Table 2; see Vélez-Espino and Koops 2010 for details).

*Table 2. Minimum viable population size for Northern Madtom, Spotted Gar, Lake Chubsucker and Pugnose Shiner. From Vélez-Espino and Koops (2010).*

| Species | MVP (# of individuals) |
|---|---|
| Northern Madtom | 1777 |
| Spotted Gar | 1545 |
| Lake Chubsucker | 1545 |
| Pugnose Shiner | 1850 |

## HABITAT AVAILABILITY

The spatial extent of the populations of, and the habitat associated with, these four species in Canada is poorly known.

### Species distribution data

To identify potential critical habitat within a spatial context for a species, the distribution of the species, including each of its populations, must be known.

Estimating population ranges

Our knowledge of the ranges of each population of the four species varies widely from the record of the species at a single locality to records at multiple localities presumed to be within the range of a single population. To identify potential critical habitat within a spatial context, the range of a population must be known or predicted if not known. We used five general methods to predict the range of each population. Some methods were simply spatial in nature (e.g., convex polygon); whereas, others were linked to biological attributes (e.g., MVP, home range).

*Minimum Area for Population Viability (MAPV)*

Vélez-Espino and Koops (2010) defined the minimum area for population viability (MAPV) as the amount of exclusive and suitable habitat necessary to maintain a demographically sustainable recovery target based on MVP. They estimated MAPV using two approaches:

(1) predictive equations developed for freshwater fishes relating area per individual (API) to adult length, and

(2) an allometric relationship between adult weight and density for aquatic organisms.

Vélez-Espino and Koops (2010) used two predictive equations of API ($m^2$) based on body size and developed for freshwater fishes (Randall et al. 1995; Minns 2003) to determine MAPV in rivers and lakes. The use of separate equations for rivers and lakes is necessary because API (Randall et al. 1995; Minns 2003) and home range (Minns 1995) are both significantly larger in lake environments. This metric of required habitat (henceforth named $MAPV_1$) was calculated as the product of MVP and adult API. Vélez-Espino and Koops (2010) used the allometric equation for density-body weight in aquatic species obtained by Cyr et al. (1997) to estimate a second metric of required habitat, $MAPV_2$. MAPV values were represented spatially by buffering occurrence points by the areas calculated for $MAPV_1$ and $MAPV_2$. In lakes and very large rivers (e.g., Detroit River), wetted areas around the points were simply buffered by the MAPV values (see Figure 1 for example). In rivers, the MAPV values were divided by the mean width of the river at the occurrence point and the resulting value was the buffer length around the occurrence point.

*Minimum area for the conservation of aquatic habitats*

In cases where MAPV values are extremely small and are of no conservation value, the use of a guideline to define the minimum area or threshold for the conservation of aquatic habitats (MACAH) could be used (Vélez-Espino and Koops 2010). This was the case for the Pugnose Shiner, which had very small MAPV values (1107 $m^2$ in rivers; 2220 $m^2$ in lakes). As a result, Vélez-Espino and Koops (2010) developed a metric of MACAH that combines home range and MVP, without assuming that home ranges are independent and exclusive; MACAH values were calculated as 7123 $m^2$ for rivers and 12 932 $m^2$ for lakes. As with MAPV, MACAH was represented spatially by buffering points by the calculated area (Figure 2).

*Home range*

Estimates of MAPV based on API might underestimate required habitat in species displaying large home ranges (Vélez-Espino and Koops 2010). Although estimates of home range cannot be translated directly into MAPV without knowing the degree of overlap among individual home ranges, it is informative to explore the relationship between MAPV and home range as the home range size of an individual in a population would set the minimum population range size. A positive relationship between body size and home range has been demonstrated for fishes (McAllister et al. 1986). To determine home range size for individual fishes, Vélez-Espino and Koops (2010) applied the allometry between body size (L; mm) and home range ($HR_M$; $m^2$) developed by Minns (1995) to minimum and maximum values of adult size and incorporating habitat type (lake, river). Woolnough et al. (unpubl. data) determined that both body size of a fish and size and shape of the waterbody in which it is found influences home range size. Therefore, home range size ($HR_W$; $m^2$) taking this into consideration was calculated separately for each waterbody in which populations of each of the four species were found. As with MAPV,

$HR_M$ and $HR_W$ were represented spatially by buffering occurrence points by the calculated areas.

*Ecological classification*

Various ecological classification (EC) systems have been developed as management and modeling tools. Examples of EC systems in Ontario that relate to aquatic systems include Ecological Land Classification (ELC) and the Aquatic Landscape Inventory System (ALIS). ALIS is used to define stream segments based on a number of unique characteristics, found only within valley segments. To determine estimated range for riverine populations, river reaches were buffered by the entire length of ecological class (using ALIS) within which species occurrence points were present. Estimated population ranges were identified as the reach of river that includes all contiguous ALIS segments from the uppermost stream segment with the species present to the lowermost stream segment with the species present. This was done as the ecological class represents a homogeneous landscape based on variables important to aquatic biota; therefore, if a population has been found in one part of the ecological class, there is no reason to believe that it would not be found in other spatially contiguous areas of the same class (see Figure 3 for example).

*Area of occupancy - convex polygon*

Population range could be simply estimated by measuring the wetted area in a minimally convex polygon around the occurrence points (see Figure 4 for example). However, this method only works for populations with three or more occurrence points, and may not represent population range well in waterbodies with complex shapes.

*Area of occupancy - population range envelope*

Another simple method for estimating population range is to develop an envelope (i.e., projected rectangle) around the occurrence points based on the minimum and maximum latitude and longitude values (see Figure 5 for example). In this study, population range was estimated as the wetted area within an envelope that was defined by values 10% less and greater, respectively, than the minimum and maximum latitude and longitude values of all occurrence points for the population.

*Area of occupancy – whole waterbody*

In some cases, the occurrence points for a population may be spread widely throughout a waterbody. Given such a pattern, it may not be unreasonable to assume that the population range encompasses the whole waterbody (see Figure 6 for example).

## HABITAT-ABUNDANCE RELATIONSHIPS

Rosenfeld and Hatfield (2006, p. 687) indicated that, “designation of critical habitat requires quantitative relationships between habitat and abundance, because these relationships are needed to establish the amount of habitat required to achieve a population recovery target” (Figure 7a, b). As aquatic habitat layers are not available for the locations of the four species, we roughly assessed if there was enough habitat to support the recovery target of each population by comparing the area of the estimated population range to waterbody size.

## ENVIRONMENTAL DATA

To incorporate habitat quantity into the identification of critical habitat and, subsequently map critical habitat spatially, the distribution of important habitat variables must be known or predicted. However, aquatic habitat layers are not generally available for areas of southern Ontario where aquatic species at risk are present. Furthermore, as many waterbodies (particularly streams) are dynamic systems, the spatial distribution of habitat within them may change over time (Rosenfeld and Hatfield 2006).

# SPECIES-SPECIFIC ACCOUNTS

## NORTHERN MADTOM (*Noturus stigmosus*)

### Background

In Canada, the Northern Madtom is known only from Lake St. Clair, and the Detroit, St. Clair, Sydenham and Thames rivers (Figure 8). The first recorded occurrence of the Northern Madtom in Canada was a single specimen that was trawled from Lake St. Clair near the mouth of the Detroit River in 1963 (Trautman 1981). Although it was not recorded from Canada until 1963, it is likely that the Northern Madtom has always been present but went undetected due to its cryptic nature and because it is found in areas that are difficult to sample as a result of accessibility issues and inhospitable habitat conditions. As of 2008, fewer than 100 specimens had been collected in Canada, and many of the records were obtained incidental to other surveys (i.e., the species was not targeted).

### Functional habitat needs (by life-stage)

Spawn to hatch

There is very little published information on the spawning habitat requirements of Northern Madtom in Canada. Spawning likely occurs at night in mid- to late summer in Ontario (Goodchild 1993); MacInnis (1998) observed males guarding eggs on 17 July 1996, gravid females and recently spawned eggs on 24 July 1996, and gravid females on 13 August 1996, suggesting that the reproductive period may be at least one month. The water temperature during this time was 23°C (MacInnis 1998). Northern Madtom is a cavity spawner and nests are typically found in small depressions under rocks, logs, and anthropogenic material such as milk bottles, cans, and boxes (Etnier and Starnes 1993, Goodchild 1993, MacInnis 1998, Holm and Mandrak 1998). Northern Madtom nests in Lake St. Clair observed by MacInnis (1998) were found on substrates of sand and/or cobble and surrounded by heavy growths of aquatic vegetation, mainly stonewort (*Chara* sp.), wild celery (*Vallisenaria americana*) and *Cladophora* sp. Water depths ranged from 1.5-1.8 m (MacInnis 1998). Male Northern Madtom provide sole parental care of eggs and newly hatched larvae. Eggs hatch within 5-10 days (MacInnis 1998).

Young-of-the-year

There is almost no information published on the habitat requirements of young-of-the-year (YOY) Northern Madtom. Larvae were observed in nests on 13 August 1996, by MacInnis (1998) still being guarded by the male Northern Madtom. It is possible that YOY require the presence of aquatic macrophytes for shelter as MacInnis (1998) observed YOY specimens taking shelter in the surrounding macrophytes when nests were removed. The YOY of a related species, the Brindled Madtom (*Noturus miurus*), are typically found in shallow waters (0-2 m) of marshes and tributaries over substrates of sand, mud, and silt, with aquatic vegetation (Goodyear et al. 1982; Lane et al. 1996b). Similarly, the YOY of another related species, the Tadpole Madtom (*Noturus gyrinus*), are usually present in protected nearshore areas, including marshes, in shallow water (0-2 m) over substrates of sand, mud and silt, with aquatic vegetation (Goodyear et al. 1982; Lane et al. 1996b).

Juveniles (age 1 until sexual maturity [age 2-3 years])

Literature describing juvenile Northern Madtom habitat, or juvenile habitat requirements of related species, is lacking; however, a juvenile specimen was collected from the same site as an adult specimen in the Thames River (Holm and Mandrak 1998), suggesting that adult and juvenile habitat requirements could be the same or similar.

Adult

Adult Northern Madtom are found in large creeks and rivers and, sometimes, in lakes. The species has been associated with clear to turbid waters, moderate to swift currents, and substrates of sand, gravel and rocks, occasionally with detritus, silt, debris and fallen logs. It is also occasionally associated with large macrophytes, such as *Chara* spp. (Holm and Mandrak 2001). Although the species is somewhat tolerant of turbidity, it is believed to avoid extremely silty situations (Trautman 1981). The Northern Madtom has been sampled at depths ranging from less than 1 m to 7 m, where it was either seined or trawled during the day and/or night. Two specimens were collected in the Thames River (Secchi depth < 0.2 m) over a substrate consisting of sand, gravel and rubble, and devoid of silt or clay (Holm and Mandrak 2001). Other abiotic characteristics of the site included a moderate current, maximum depth of 1.2 m, water temperature of 23-26°C, conductivity of 666 µS and a pH of 7.9 (Holm and Mandrak 2001).

Nothing further is known regarding the environmental requirements (e.g., optimal temperatures) of adult Northern Madtom. No information is available concerning possible overwintering areas, or possible differences in habitat requirements for males and females.

**Estimating population range**

All known populations of Northern Madtom in Canada have been summarized in Table 3; also included is the method used to estimate population range for each population. Three locations are believed to support single populations with the exception of Lake St. Clair, which was considered to support three populations. A more detailed description of estimated population range for each location follows.

*Table 3. Locations of known Northern Madtom populations in Canada and most conservative method used to estimate the range of each population. A summary of the results for all methods by population is provided in Appendix 1.*

| Location (# of populations) | Method | Area of Estimated Population Range ($m^2$) |
|---|---|---|
| Detroit River (1) | AO (population range envelope) | |
| Lake St. Clair (3) | $HR_W$ | 31 805 930<br>(35 839 865;<br>35 912 562;<br>31 804 596) |
| St. Clair River (1) | $MAPV_2$ | 50 771 (51 405) |
| Thames River (1) | EC (ALIS) | 3 218 385 |

Detroit River

The Northern Madtom records in the Detroit River were considered to be part of one population. Estimated population range in the Detroit River (Figure 9) was determined based on an area of occupancy (AO) approach (Table 3, Appendix 1), as this approach provided the most precautionary value.

Lake St. Clair

Estimated population range for the Northern Madtom in Lake St. Clair (Figure 10) was determined based on the $HR_W$ approach (Table 3, Appendix 1), as this approach produced the largest area. Three records exist for the Northern Madtom in Lake St. Clair, one just south of Walpole Island and two located along the southern shore. The three records of Northern

Madtom in Lake St. Clair were considered representative of individual populations as there are physical barriers that likely prevent migration, and hence gene flow, between populations, and each point was buffered using a home range estimate based on waterbody size and fish body size (see Appendix 1 and Methods section). Due to the effect of the large waterbody size of Lake St. Clair on the methods used ($HR_W$) the area of estimated population range required approached 36 $km^2$ at these sites.

St. Clair River

Estimated population range for the Northern Madtom in the St. Clair River (Figure 10) was determined using the $MAPV_2$ approach (Table 3, Appendix 1). Only a single record exists for the St. Clair River (from 2003) and this point was buffered with an approximate area of 50 771 $m^2$.

Thames River

Estimated population range for the Northern Madtom in the Thames River (Figure 3) was determined based on an EC approach (ALIS segments; Table 3, Appendix 1). ~60 km stretch of the lower river downstream of the City of London has been proposed as the estimated population range. The identified reach of river includes all contiguous segments of the main branch from the uppermost stream segment with the species present to the lowermost stream segment with the species present.

Summary

All habitats that meet the functional habitat requirements for each life-stage of the Northern Madtom within the identified areas required to support MVPs at known locations (Figures 1, 3, 9, 10), could be considered potential critical habitat. The protection and maintenance of these habitats would support the long-term recovery goal of sustaining and enhancing viable populations of Northern Madtom in the Erie-Huron corridor (Detroit and St. Clair River and Lake St. Clair) and the Thames River. If the species is found to be extant within the Sydenham River (or the re-establishment of a population within this watershed is planned), additional areas may be considered for potential critical habitat at a later date. Additional studies recommended for refining information required to identify critical habitat for the Northern Madtom are summarized below.

## SPOTTED GAR (*Lepisosteus oculatus*)

### Background

The current range of Spotted Gar in Canada includes the coastal wetlands of Lake Erie (Point Pelee National Park, Rondeau Bay and Long Point Bay), and East Lake (an embayment off Lake Ontario and south of Sandbanks Provincial Park; Figure 11). The presence of Spotted Gar in East Lake was confirmed when a single specimen was collected in May 2007 by a commercial fisherman. In 1963, a single specimen was caught in Lake St. Clair, 4 km west of the mouth of the Thames River. This population (if anomalous record is representative of historic population) is presumed to be extirpated based on recent sampling of suitable habitats in this area (COSEWIC 2005). Until 2004, fewer than 55 specimens had been collected in Canada (COSEWIC 2005); however, in 2007, 210 specimens were captured at Rondeau Bay, including 39 individuals from one net (B. Glass, University of Windsor, unpubl. data).

### Functional habitat needs (by life-stage)

Spawn to hatch

Spotted Gar spawn in May and June, when water temperatures range from 21-26°C, in quiet, shallow, areas with abundant aquatic vegetation, such as marshes and flooded riparian areas

(Goodyear et al. 1982; Snedden et al. 1999; Cudmore-Vokey and Minns 2002). In Oklahoma, Spotted Gar were found primarily in association with *Polygonum* sp., *Potamogeton* sp., *Myriophyllum* sp. and *Justicia* sp. (Tyler and Granger 1984). Water depths at spawning sites are typically 1 m or less. The adhesive, demersal eggs adhere to aquatic vegetation and debris in gelatinous masses (Scott and Crossman 1998), and hatch in six to eight days (Goodyear et al. 1982; Cudmore-Vokey and Minns 2002). Nothing further is known regarding the functional habitat requirements of spawning Spotted Gar.

Young-of-the-year

YOY Spotted Gar have an adhesive organ on their snout (Simon and Wallus 1989) by which they remain hanging on submerged vegetation and other objects for 9-10 days. YOY remain at the spawning site until the yolk-sac is absorbed (approximately 17 mm total length or greater), at which point they disperse and begin feeding (Simon and Wallus 1989), remaining in shallow (0.6-0.9 m) littoral zones over substrates of mud, silt, sand and vegetation (Goodyear et al. 1982). No information on overwintering habitats is available. Nothing further is known concerning the functional habitat requirements of YOY Spotted Gar.

Juvenile (age 1 until sexual maturity [age 2-3 males; 3-4 females])

There is no information available concerning the habitat requirements of juvenile Spotted Gar; however, the habitat requirements of YOY and adult Spotted Gar are similar and it is likely that the requirements of juveniles are the same or similar to these.

Adult

Adult Spotted Gar inhabit clear, quiet, well-vegetated backwaters, and bays of lakes and rivers. Water depths are typically shallow (0-5 m) and aquatic vegetation is abundant (Parker and McKee 1984; Lane et al. 1996a; Snedden et al. 1999; Cudmore-Vokey and Minns 2002). Aquatic vegetation associated with the Spotted Gar includes spatterdock (*Nuphar* sp.), cattails (*Typha* sp.), *Anacharus* sp., knotweed (*Polygonum* sp.), pondweed (*Potamogeton* sp.), milfoil (*Myriophyllum* sp.) and water-willow (J*usticia* sp.; Parker and McKee 1984; COSEWIC 2005). Dense vegetation gives necessary camouflage and reduces visibility to potential prey (Coen et al. 1981). As the Spotted Gar is an ambush predator, dense vegetation is critical for its foraging behaviour. Submerged logs and fallen trees also provide cover (Snedden et al. 1999). Preferred substrates are silt, clay and sand (Lane et al. 1996a). Secchi disk readings in one study ranged from 0.3 m to over 3.0 m, and dissolved oxygen levels ranged from 9-11 mg/L at water temperatures of 15-17°C (in September; Parker and McKee 1984). The preferred water temperature for the Spotted Gar is 16°C (Coker et al. 2001). Diel and seasonal movement of the Spotted Gar has been studied in Louisiana by Snedden et al. (1999). Greatest movement occurred as water temperatures and levels rose during the spring. Distinct home ranges were established in the spring, typically in inundated floodplains, which provided suitable spawning and nursery habitat. Small home ranges were usually established during the summer, fall and winter (median 6.6 hectares). However, approximately one third of the Spotted Gar tracked, established significantly larger home ranges (median 265 hectares), that were usually considerable distances from initial captures sites. These new home ranges consisted of seasonally inundated floodplain habitats and heavily vegetated marshes with little or no flow. Except in the spring, Spotted Gar are more active at night, which is thought to coincide with their feeding period. Overwintering habitat requirements for this species are unknown. Differences in habitat requirements for males and females have not been reported.

**Estimating population range**

All known populations of Spotted Gar in Canada have been summarized in Table 4; also included is the method used to estimate population range for each population. Each location is believed to support a single population with the exception of Point Pelee National Park, where the number of populations is unknown as the connectivity between habitats is unknown. A more detailed description of estimated population range for each location follows.

*Table 4. Locations of known Spotted Gar populations in Canada and most conservative method used to estimate the range of each population. A summary of the results for all methods by population is provided in Appendix 1.*

| **Location (# of populations)** | **Method** | **Area of Estimated Population Range ($m^2$)** |
|---|---|---|
| Point Pelee National Park (?) | AO (whole waterbody) | 2 202 264 |
| Rondeau Bay (1) | AO (whole waterbody) | 35 581 756 |
| Long Point Bay (1) | AO or $MAPV_1$ | |
| East Lake (1) | $MAPV_1$ | 3 566 787 (3 567 326) |

Point Pelee National Park

The following has been taken from Vlasman and Staton (2007): The four extant populations of the Spotted Gar in Canada are found in disjunct locations with very limited occupancy. While limited sampling has been conducted for most populations, the ponds within Point Pelee National Park were rigorously sampled by Surette (2006) over a two-year period, providing an extensive dataset for this population (Figure 12). Using these data, Parks Canada Agency has identified potential critical habitat for the Spotted Gar, based on an area of occupancy approach (Figure 13), as the open water2 and shallow water3 Ecological Land Classification (ELC) community classes and the majority of the Wild Rice Mineral Shallow Marsh ELC Vegetation Type (Lee et al. 1998; Dougan & Associates 2007) within:

1) Harrison Pond;
2) Lake Pond;
3) Redhead Pond;
4) East Cranberry Pond; and,
5) West Cranberry Pond.

These are the locations within the Park where records of Spotted Gar have recently been documented. Nineteen records were collected during 605 sampling events across all Park ponds in 2002 and 2003 (Surrette 2006). Nine records were collected in 2005 (Razavi 2006) during a study of Big (Lake) and Sanctuary Ponds to determine the current quality of the Point Pelee National Park marshes. Visual observations, with photographic documentation, were made in 2007 in Theissen Channel, which is broadly connected to Harrison Pond. No other records of Spotted Gar are known to exist within the boundaries of Point Pelee National Park.

Parks Canada Agency excluded anthropogenic features from this definition. In particular, Thiessen Channel, connecting Harrison Pond to Lake Pond, and a short extension of it through the Wild Rice Mineral Shallow Marsh ELC Vegetation Type (Dougan & Associates 2007) into Lake Pond, is excluded from the potential critical habitat definition. This route has been highly managed (modified and maintained) since at least 1922 to allow for watercraft passage from the western boundary of the marsh into Lake Pond and the connecting ponds (Battin and Nelson

1978). How Spotted Gar use the habitat within these areas and whether their use may be attributed to the management practices in place is currently unclear.

Rondeau Bay

Recent tracking and capture location data for the Spotted Gar in Rondeau Bay indicate that the species has been found throughout most of the bay (W. Glass, University of Windsor, unpubl. data). Therefore, it was determined that the entire Bay should be recommended as the estimated population range (Figure 6).

Long Point Bay

Evaluation not completed for, or presented at, meeting.

East Lake

The method that provided the largest area for estimated population range in East Lake (Figure 14) was the $MAPV_1$ approach (Table 4, Appendix 1). A single record exists in this lake (from 2007). The capture location was buffered with an area of approximately 3 500 000 $m^2$.

Summary

All habitats that meet the functional habitat requirements for each life-stage of the Spotted Gar within the identified areas required to support MVPs at known locations (Figures 6, 12, 13, 14), could be considered potential critical habitat. The protection and maintenance of these habitats would support the long-term recovery goal of ensuring viable populations persist within the three coastal wetlands of Lake Erie, and East Lake. Additional studies recommended for refining information required to identify critical habitat for the Spotted Gar are summarized below.

## LAKE CHUBSUCKER (*Erimyzon sucetta*)

### Background

In Canada, the Lake Chubsucker is only known to occur in southwestern Ontario. It has been found in the Old Ausable Channel (OAC; Lake Huron drainage), Lake St. Clair (Mitchell's Bay, St. Clair National Wildlife Area [NWA] and Walpole Island), Thames River (Jeanette's Creek), Lake Erie (Point Pelee, Rondeau Bay, Long Point Bay, Big Creek NWA), several tributaries of Big Creek and the Niagara River (Tea Creek and Lyons Creek; Figure 15). Canadian collections have not been made in a standardized manner, nor have there been specific studies on population size, making it difficult to assess population sizes and trends. Populations are believed to be stable in the OAC, Point Pelee National Park and Long Point Bay. The species had not been recorded in Rondeau Bay since 1963, until 2005, when just a single individual was found, despite considerable search effort in 2004 and 2005. Further surveys are required to verify the status of populations from Jeanette's Creek, Tea Creek, Big Creek tributaries and Mitchell's Bay.

## Recovery goal and population and distribution objectives

The draft recovery strategy for the Lake Chubsucker (Vlasman and Staton 2007) states:

"*The long-term recovery goal (greater than 20 years) is to maintain existing distributions and densities of the Lake Chubsucker and restore viable populations to formerly occupied wetland habitats*."

Population and distribution objectives – "*Over the next five year period, maintain current densities and abundance of known extant populations in the Old Ausable Channel, Lake St. Clair (Walpole Island and St. Clair NWA), Lake Erie (Point Pelee, Rondeau Bay, Long Point Bay) and the upper Niagara River (Lyons Creek). More quantifiable objectives relating to individual populations are not possible at this time, but will be developed once the necessary sampling and studies have been completed.*"

## Functional habitat needs (by life-stage)

### Spawn to hatch

In Ontario, the Lake Chubsucker probably spawns between late April and June (Mandrak and Crossman 1996), at which time adults migrate to shallow waters of bays, lower reaches of tributaries, ponds or marshes, where eggs are laid over submerged vegetation, filamentous algae or grass stubble (Goodyear et al. 1982; Becker 1983; Mandrak and Crossman 1996; Scott and Crossman 1998; COSEWIC 2008). Scott and Crossman (1998) report spawning over gravel substrates in quiet streams with the male cleaning an area for a nest. Spawning usually occurs at depths of 0-2 m (Lane et al. 1996c), and water temperatures of approximately 22.5-29.5°C (Becker 1983). Adhesive eggs are broadcast and stick to substrate or aquatic vegetation; no parental care is given (Coker et al. 2001). The eggs hatch at water temperatures between 22-29°C (COSEWIC 2008).

### Young-of-the-year

YOY Lake Chubsucker prefer habitat containing heavy aquatic vegetation (emergent and submergent) such as marshes and lagoons, over substrates of silt, sand and clay, and water depths of 0-2 m (Goodyear et al. 1982; Becker 1983; Lane et al. 1996b). Leslie and Timmins (1997) report YOY Lake Chubsucker from vegetated drainage ditches with water temperatures ranging from 24-28°C. Specimens were also found in January in a roadside ditch that was intermittently connected to the St. Clair River; YOY Lake Chubsucker were located in 10 cm of water under a layer of leaves (Leslie and Timmins 1997). Nothing further is known regarding the functional habitat requirements for YOY Lake Chubsucker.

### Juveniles (age 1 until sexual maturity [age 2-3 years])

There is limited literature available that discusses the functional habitat requirements of juvenile Lake Chubsucker. Leslie and Timmins (1997) report age 1+ individuals from marshes in Long Point Bay associated with aquatic vegetation such as hairgrass (*Eleocharis* sp.), sedges (*Carex* sp.), cattails (*Typha* sp.) and pondweed (*Potamogeton* sp.). Further data regarding specific environmental requirements of juvenile Lake Chubsucker are unavailable. However, relationships can be inferred by examining other phases of the life-cycle. Habitat requirements of adult and YOY Lake Chubsucker are very similar (i.e., quiet areas with abundant aquatic vegetation over substrates of sand, silt, gravel and organic debris at depths of 0-2 m); therefore, it is probable that the functional habitat requirements of juvenile Lake Chubsucker are comparable.

Adult

Adult Lake Chubsucker are typically found in stagnant bays and channels, ponds, swamps, bayous, drainage ditches, oxbows, sloughs, floodplain lakes, marshes and wetlands (Trautman 1981; Becker 1983; Mandrak and Crossman 1994, 1996; COSEWIC 2008). The species requires quiet waters with low turbidity and abundant aquatic macrophytes, and substrates of gravel, sand, silt, clay and organic debris (Trautman 1981; Becker 1983; Mandrak and Crossman 1994, 1996; COSEWIC 2008). Water depth and temperature ranges from 0-2 m (Lane et al. 1996a) and 28-34°C (Coker et al. 2001), respectively. No further information is available concerning the functional habitat requirements of adult Lake Chubsucker. Information regarding possible seasonal movements (e.g., overwintering) is generally lacking, other than the short migrations made to marshes during spawning season. Aside from the short migrations to spawning habitat, the Lake Chubsucker's ability to migrate seems limited (Leslie and Timmins 1997). Differences in habitat requirements for males and females have not been reported.

**Estimating population range**

All known populations of Lake Chubsucker in Canada have been summarized in Table 5; also included is the method used to determine estimated population range for each population. Each location is believed to support a single population, with the possible exception of the Old Ausable Channel (believed to have two populations), and Point Pelee National Park and Big Creek tributaries, which have an unknown number of populations as physical barriers may prevent migration, and hence gene flow, throughout these areas. A detailed description of estimated population range for each location follows.

*Table 5. Locations of known Lake Chubsucker populations in Canada and most conservative method used to estimate the range of each population. A summary of the results for all methods by population is provided in Appendix 1.*

| Location (# of populations) | Method | Area of Estimated Population Range ($m^2$) |
|---|---|---|
| Point Pelee National Park (?) | AO (whole waterbody) | 331 157 |
| Rondeau Bay (1) | AO or $MAPV_2$ | |
| Long Point (Inner Bay) (1) | AO or $MAPV_2$ | |
| Long Point (Ponds at Tip) (1) | AO or $MAPV_2$ | |
| Old Ausable Channel (2) | AO (whole waterbody) | 370 765 (Upper)<br>239 005 (Lower) |
| Lake St. Clair (1) | AO or $MAPV_2$ | |
| Walpole Island (1) | AO or $MAPV_2$ | |
| Lake St. Clair NWA (1) | AO or $MAPV_2$ | |
| Big Creek NWA (1) | AO or $MAPV_2$ | |
| Lyons Creek (1) | AO or EC | |
| L Lake (1) | AO (whole waterbody) | 63 118 |
| Big Creek tributaries (?) | $MAPV_2$ or EC | |

Point Pelee National Park

The remaining populations of Lake Chubsucker in Canada are limited to six disjunct locations with very limited occupancy. While limited sampling has been conducted for most populations, the ponds within Point Pelee National Park have been rigorously sampled by Surette (2006) over a recent two year period, providing an extensive dataset for this population (Figure 16). Using these data, proposed critical habitat for the Lake Chubsucker is partially defined based on an area of occupancy approach (Figure 17), as the following:

- Open and aquatic areas of Girardin Pond; and,
- Open and aquatic areas of Redhead Pond.

These ponds are the locations within the Park where records of Lake Chubsucker were most recently documented by Surette (2006). This estimated population range is based on 25 records, collected during 605 sampling events between 2002 and 2003 across all Park ponds, with all captures occurring in 2003. No other records of the Lake Chubsucker have been documented within Point Pelee National Park within the last 20 years. Lake Pond is excluded from this definition, as the records for this pond (Wyett and Dutcher 1967; Wyett and Dutcher 1968; Wyett and Dutcher 1969; Ward 1973) are 35 or more years old and extensive sampling of this pond by Surette (2006) failed to locate the Lake Chubsucker. Anthropogenic features are also excluded from this definition.

Rondeau Bay

Evaluation not completed for, or presented at, meeting.

Long Point (inner bay)

Evaluation not completed for, or presented at, meeting.

Long Point (ponds at tip)

Evaluation not completed for, or presented at, meeting.

Old Ausable Channel

Estimated population range in the OAC (Figure 18) was determined using an AO approach (Table 5, Appendices 1 and 2). A detailed spatial analysis linking species occurrence to habitat conditions within a portion of the OAC has been completed by the Ausable River Recovery Team and is included in Appendix 2. Given that the species has been detected in all three regions of the channel (North, South and Central) and that the habitat throughout the channel is largely homogeneous, it is recommended that the entire channel be considered the estimated population range (possibly representing two populations separated by a low head dam within Pinery Provincial Park). Estimated population range was calculated for the upper channel (Northern and Central regions), and for the lower channel (Southern Region and the mouth). Although estimated population range was determined using an AO approach, the $MAPV_2$ method actually produced the most precautionary value. However, the area of the upper and lower channel (separately and combined), is less than the area estimated using the $MAPV_2$ approach (Appendix 1), suggesting that there may be insufficient habitat available for the long-term persistence of the Lake Chubsucker within the OAC.

Lake St. Clair

Evaluation not completed for, or presented at, meeting.

Walpole Island

Evaluation not completed for, or presented at, meeting.

Lake St. Clair NWA

Evaluation not completed for, or presented at, meeting.

Big Creek NWA

Evaluation not completed for, or presented at, meeting.

Lyons Creek

Evaluation not completed for, or presented at, meeting.

L Lake

Based on the number and distribution of recent records throughout L Lake, it is recommended that the entire lake be considered the estimated population range (Figure 19). However, this AO approach did not produce the most precautionary value for estimated population range; this was obtained using the $MAPV_2$ approach. Given that the precautionary value for estimated population range is larger than the available area in L Lake, it is possible that there is insufficient habitat available for the long-term persistence of the Lake Chubsucker.

Big Creek tributaries

Evaluation not completed for, or presented at, meeting.

Summary

All habitats that meet the functional habitat requirements for each life-stage of the Lake Chubsucker within the identified areas required to support MVPs at known locations (Figures 16-19), could be considered potential critical habitat. The protection and maintenance of these habitats would (in part) support the long-term recovery goal of maintaining existing distributions and densities of the Lake Chubsucker. Additional studies recommended for refining information required to identify critical habitat for the Lake Chubsucker are summarized below.

**Additional studies**

Additional studies to assist in identifying/refining critical habitat for the Lake Chubsucker have been recommended by the recovery team and are listed in Table 6 (Vlasman and Staton 2007). These activities are not exhaustive but outline the range and scope of actions necessary to obtain the best description of critical habitat possible. The process of investigating the actions outlined in Table 8 is likely to uncover further knowledge gaps that will require further attention.

*Table 6. Schedule of studies required to refine the information required to identify potential critical habitat for the Lake Chubsucker. Taken from Vlasman and Staton (2007).*

| Description of Activity | Approximate Time Frame[1] |
|---|---|
| Extensive review of known life history and ecological needs. Identification of associated habitat features with the expressed consideration that each population/ subpopulation must have access to all such habitats of adequate quality to remain viable. | 2007 - |
| Assist the ARRT in designating critical habitat within the OAC; designation to be published within the finalized Ausable River Recovery Strategy. | 2007 - 2008 |
| Conduct background population and habitat surveys/ monitoring to confirm:<br>presence, extent and demographics of extant populations<br>extent and quality of suitable habitat (both occupied and non-occupied) | 2007-2010 |
| Map current and historically occupied areas, as well as areas that are suitable but uninhabited. Highlight areas of former occurrence that are restorable. | 2007 - |

| Description of Activity | Approximate Time Frame[1] |
|---|---|
| Assess existing habitat conditions (e.g. water quality and quantity, flow, substrate, vegetation, etc.) within the historic range of the Lake Chubsucker at all known sites. Compare current conditions to species' requirements to identify circumstances/ factors that led to habitat unsuitability/ deterioration at some sites. This exercise will reinforce the importance of a suite of habitat features that are critical to the species. | 2009-2011 |
| Assess degree of connectivity of habitat patches/ populations of the Lake Chubsucker through physical surveys and genetic analyses. | 2009-2012 |
| Based on information gathered, review population and distribution goals (i.e. survival vs. recovery) | 2012 |
| Determine amount and configuration of critical habitat required to achieve goal if adequate information exists. Validate model. | 2012 |

[1] Timeframes are subject to change in response to demands on resources and/ or personnel, and as new priorities arise.

## PUGNOSE SHINER (*Notropis anogenus*)

### Background

In Canada, the Pugnose Shiner has a limited distribution and is found in four main regions of Ontario; the southern drainage of Lake Huron, Lake Erie, Lake St. Clair, and the St. Lawrence River (Figure 20). The species was known historically from Lake Erie (Long Point Bay, Point Pelee and Rondeau Bay) and the St. Lawrence (Gananoque). Recent collections have confirmed that the species is extant in the St. Lawrence River (between Eastview and Mallorytown Landing); Long Point Bay (Lake Erie; Lake St. Clair; and, the OAC and the Teeswater River (Saugeen watershed, Lake Huron drainage; Figure 20). Pugnose Shiner has been only rarely sampled from historical and new locations within Canada.

### Functional habitat needs (by life-stage)

Spawn to hatch

The Pugnose Shiner spawns in densely vegetated waters, no deeper than 2 m, with sand/silt and sometimes gravel substrates (Lane et al. 1996c). The species is a lithophil – a non-guarding open substrate spawner – eggs are broadcast over vegetation and substrate (Leslie and Timmins 2002). In Ontario, the Pugnose Shiner likely spawns in early to mid-June, at water temperatures of 21-29°C (Holm and Mandrak 2002) and when aquatic macrophytes are developed. The species was observed to only move into shallow depths once beds of submergent vegetation appeared at or near the time of spawning (Becker 1983). Newly hatched embryos are highly photophobic and aquatic vegetation is essential to provide shelter from the light (Leslie and Timmins 2002).

Young-of-the-year

YOY Pugnose Shiner require shallow (0-2 m), heavily vegetated habitats, with substrates of sand and silt (Lane et al. 1996b). Larval Pugnose Shiner collected from Mitchell's Bay (St. Clair River delta) and Long Point Bay were found almost exclusively in 1-2 m of water in areas with dense aquatic vegetation; dominant macrophytes included stonewort (*Chara* sp.), Eurasian watermilfoil (*Myriophyllum spicatum*), wild celery (*Vallisineria americana*), pondweed (*Potamogetan* sp.) and naiad (*Najas* sp.; Leslie and Timmins 2002).

Juveniles (age 1 until sexual maturity [age 1 year])

Literature which deals specifically with juvenile Pugnose Shiner functional habitat requirements is lacking; however, relationships can be inferred by examining other phases of the life-cycle. The habitat requirements for both YOY and adult Pugnose Shiner are very similar (i.e., clear, quiet, shallow waters that are heavily vegetated). Therefore, it is probable that juvenile Pugnose Shiner functional habitat requirements are comparable.

Adult

The functional habitat requirements of the adult Pugnose Shiner are similar to those of the YOY. Adults are typically found in slow-moving, clear, waters of streams, large lakes and embayments with low gradients and abundant rooted vegetation (Carlson 1997; ARRT 2006). Records of Pugnose Shiner have also been obtained from sheltered inshore ponds, stagnant channels and protected bays adjacent to large waterbodies (Parker et al. 1987). Substrates that are associated with this species include sand, mud, organic detritus, clay and marl, although, detritus is considered ideal for this species (Parker et al. 1985; NatureServe 2007). The Pugnose Shiner is typically collected at shallow depths in less than 3 m of water (Holm and Mandrak 2002), but such sampling often occurs in warmer months and this species is believed to move to deeper waters in cool months (Becker 1983). Although it has been suggested that the Pugnose Shiner prefers areas with low turbidity (Trautman 1981; Scott and Crossman 1998; Holm and Mandrak 2002), specimens have been captured in areas with higher turbidity levels (e.g., Secchi depths of 0.3 m in Rondeau Bay; Parker et al. 1987). The species has occasionally been collected from shallow, turbid, waters devoid of vegetation (Leslie and Timmins 2002). Both emergent and submergent aquatic macrophytes characterize the areas where Pugnose Shiner is typically found, especially stonewort (*Chara vularis*; Becker 1983). Other types of aquatic vegetation that the species is often associated with include filamentous algae (especially *Spirogyra*), wild celery (*Vallisneria americana*), naiad (*Najas flexilis*), pondweeds (*Potamogeton* spp.), Eurasian watermilfoil and the waterweed (*Elodea* spp.), as well as emergent vegetation such as cattails, bulrushes and sedges (Becker 1983; Holm and Mandrak 2002; Leslie and Timmins 2002).

**Estimating population range**

All known populations of Pugnose Shiner in Canada have been summarized in Table 7 as well as the method used to determine estimated population range for each population. Each location is believed to have a single population with the exception of the OAC (believed to have two populations) and the Teeswater River and St. Lawrence River, which have an unknown number of populations. A more detailed narrative for each location follows the table.

*Table 7. Locations of known Pugnose Shiner populations in Canada and most conservative method used to estimate the range of each population. A summary of the results for all methods by population is provided in Appendix 1.*

| Location (# of locations) | Method | Area of Estimated Population Range ($m^2$) |
|---|---|---|
| Old Ausable Channel (2) | AO (whole waterbody) | 370 765; 239 005 |
| Teeswater River (?) | EC or MACAH | |
| Cargill Mill Pond (Teeswater River) (1) | MACAH | 12 932 (12 892) |
| Long Point (Inner Bay) (1) | AO or MACAH | |

| Location (# of locations) | Method | Area of Estimated Population Range ($m^2$) |
|---|---|---|
| Lake St. Clair (1) | AO or MACAH | |
| Walpole Island (1) | AO or MACAH | |
| Whitebread Drain (1) | EC or MACAH | |
| Little Bear Creek (1) | EC or MACAH | |
| Detroit River (1) | $HR_W$ | 8350 |
| St. Lawrence River (?) | AO (population range envelope) | 152 739 976 |

### Old Ausable Channel

Refer to Lake Chubsucker section and Appendix 2 (PCH figures should be identical for the 2 species).

### Teeswater River

Evaluation not completed for, or presented at, meeting.

### Cargill Mill Pond (Teeswater River)

Estimated population range for the Pugnose Shiner in Cargill Mill Pond (Figure 2) was determined using the MACAH approach (Table 7, Appendix 1). The single point in the pond was buffered using an area of approximately 12 932 $m^2$. A single record for Pugnose Shiner immediately downstream of the mill pond dam is not believed to be representative of a separate population (and was therefore not considered in the analysis).

### Long Point (Inner Bay)

Evaluation not completed for, or presented at, meeting.

### Lake St. Clair

Evaluation not completed for, or presented at, meeting.

### Walpole Island

Evaluation not completed for, or presented at, meeting.

### Whitebread Drain

Evaluation not completed for, or presented at, meeting.

### Little Bear Creek

Evaluation not completed for, or presented at, meeting.

### Detroit River

Estimated population range in the Detroit River was determined using the $HR_W$ approach. A single record exists for the Detroit River, at the mouth of the River Canard; this location was buffered using an area of approximately 8350 $m^2$ (Table 9, Appendix 1).

St. Lawrence River

Pugnose Shiner estimated population range in the St. Lawrence River (Figure 5) was determined using an AO (population range envelope) approach (Table 9, Appendix 1). A stretch of the river (Canadian side only) between Eastview and just east of Mallorytown Landing is recommended as estimated population range.

Summary

All habitats that meet the functional habitat requirements for each life-stage of the Pugnose Shiner within the identified areas required to support MVPs at known locations (Figures 2, 5), could be considered potential critical habitat. The protection and maintenance of these habitats would (in part) support the long-term recovery goal of maintaining existing populations. Additional studies recommended for refining information required to identify critical habitat for the Pugnose Shiner are summarized below.

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Wyett and Dutcher. 1968. Point Pelee National Park records.

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# FIGURES

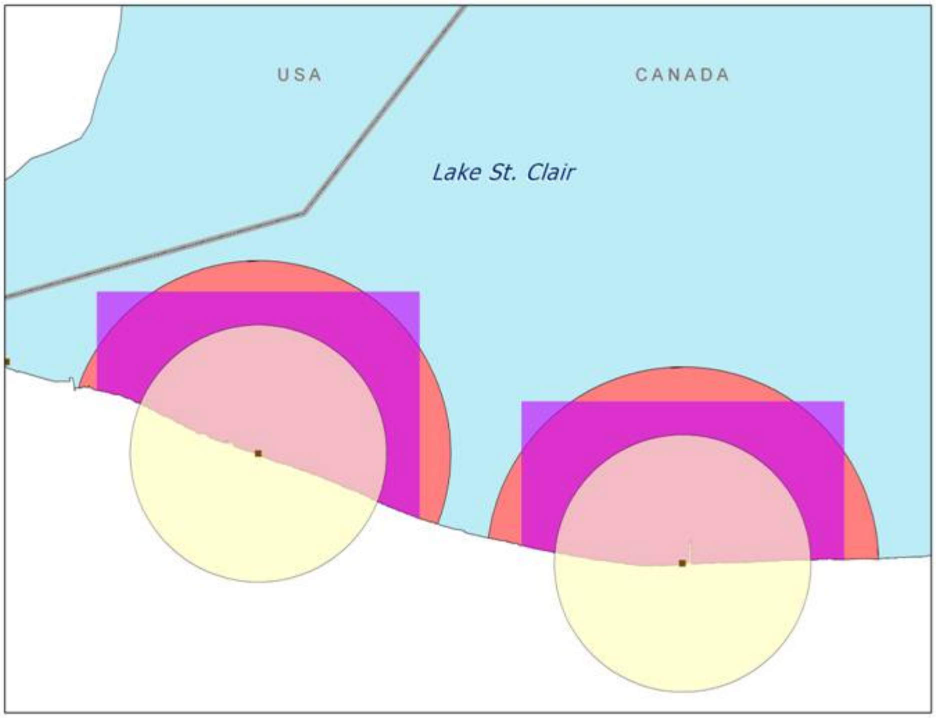



*Figure 1. Northern Madtom occurrence points in Lake St. Clair buffered by calculated MAPV values.*

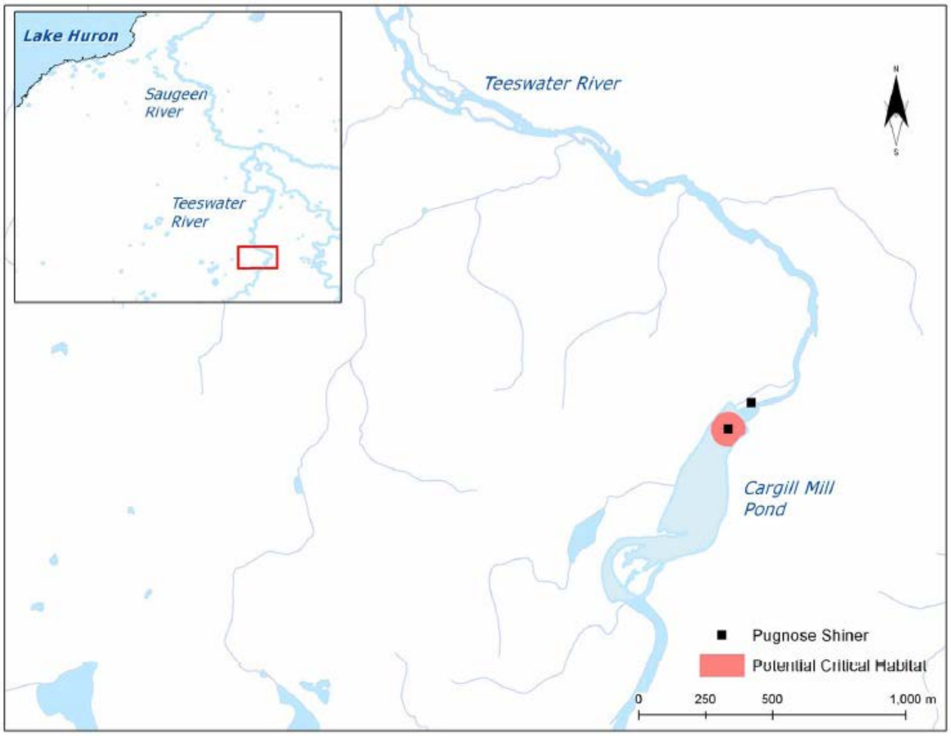



*Figure 2. Pugnose Shiner – estimated population range in Cargill Mill Pond (Teeswater River; MACAH).*

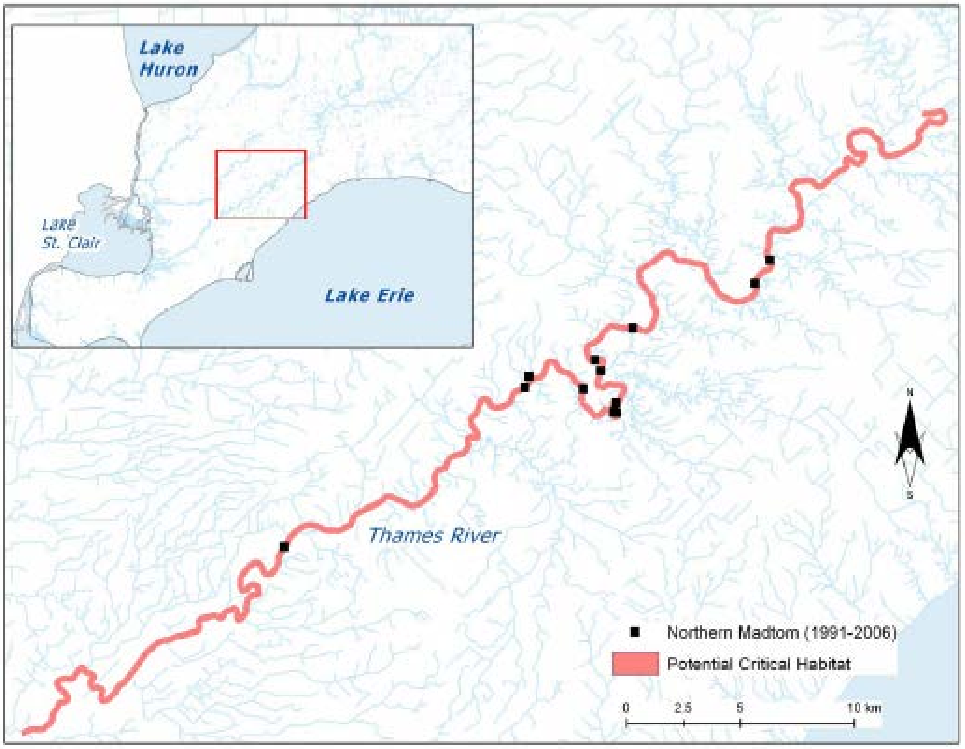



*Figure 3. Northern Madtom points of occurrence in the Thames River, including critical habitat delineated by using an ecological classification approach.*

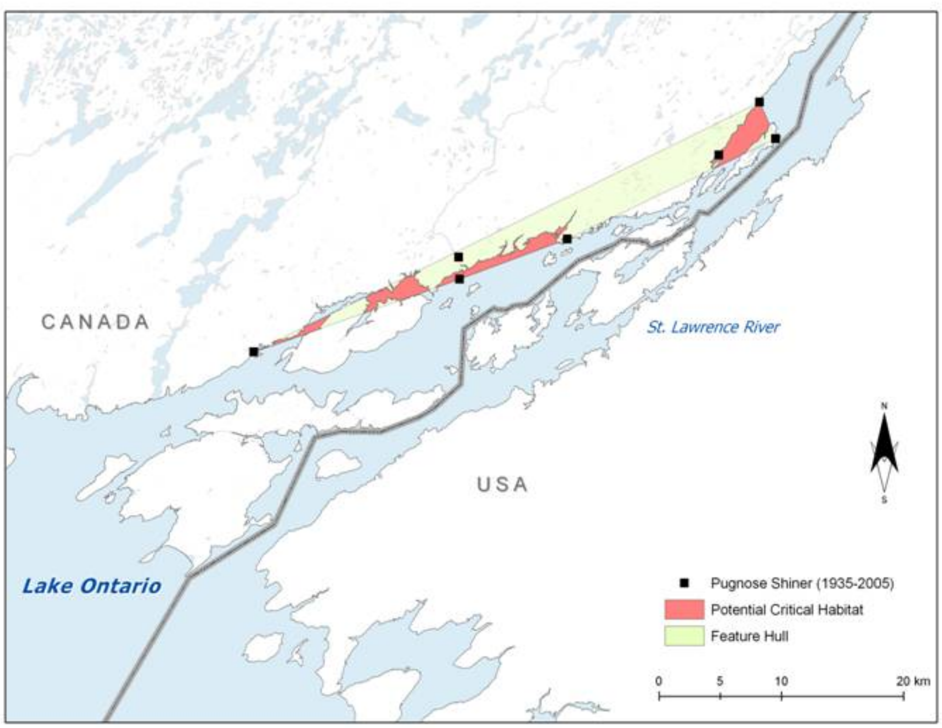



*Figure 4. Pugnose Shiner points of occurrence in the St. Lawrence River, including critical habitat delineated by using an area of occupancy with convex hull polygon approach.*

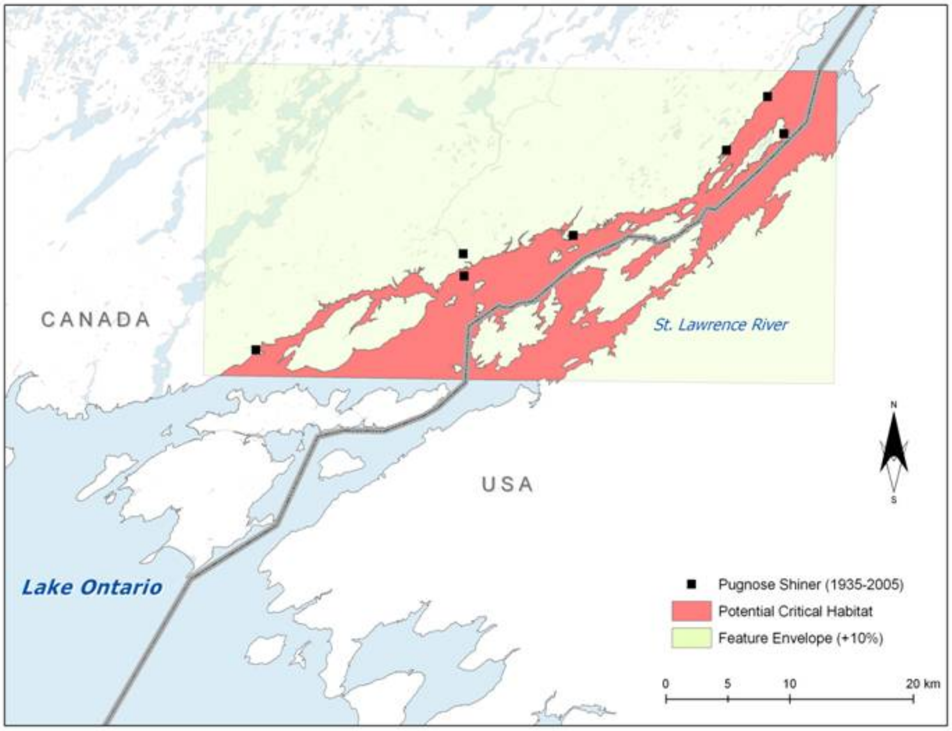



*Figure 5. Pugnose Shiner points of occurrence in the St. Lawrence River, including critical habitat delineated by using an area of occupancy with a population range envelope.*

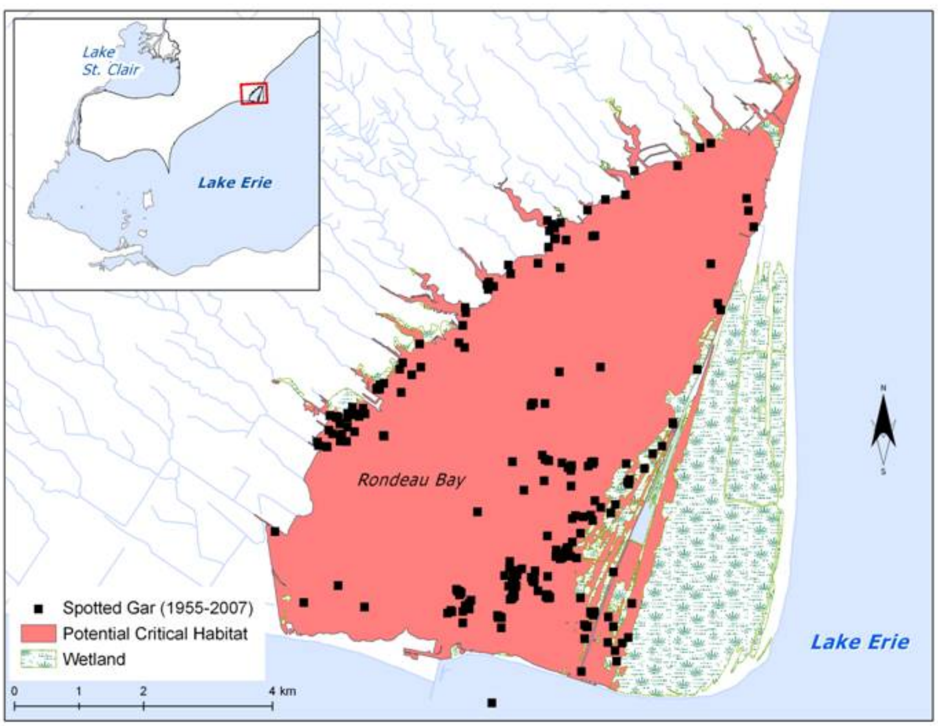



*Figure 6. Spotted Gar points of occurrence in Rondeau Bay, including critical habitat delineated by using an area of occupancy and a whole waterbody approach.*

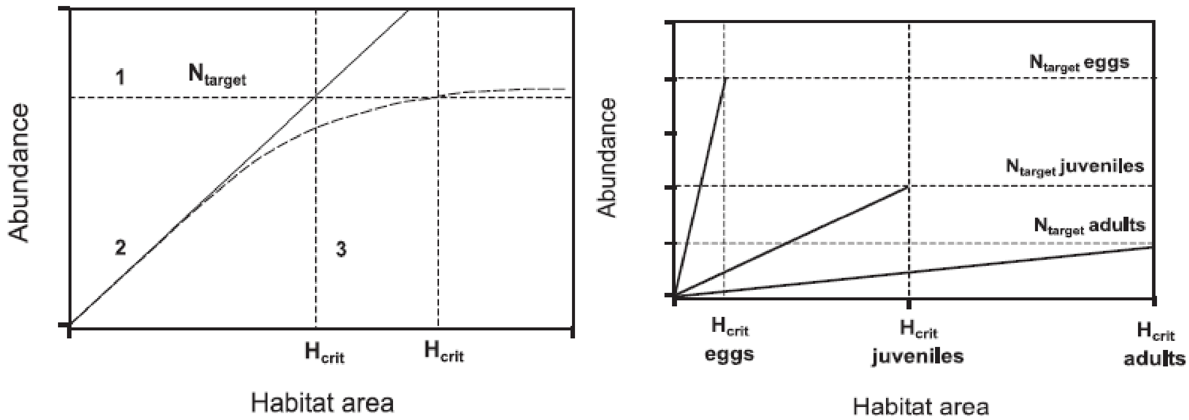



*Figure 7 (a) Methods proposed by Rosenfeld and Hatfield (2006) to be used when defining critical habitat, and (b) a variation of these methods to account for multiple life history stages. See Rosenfeld and Hatfield (2006) for a full description of methods used.*

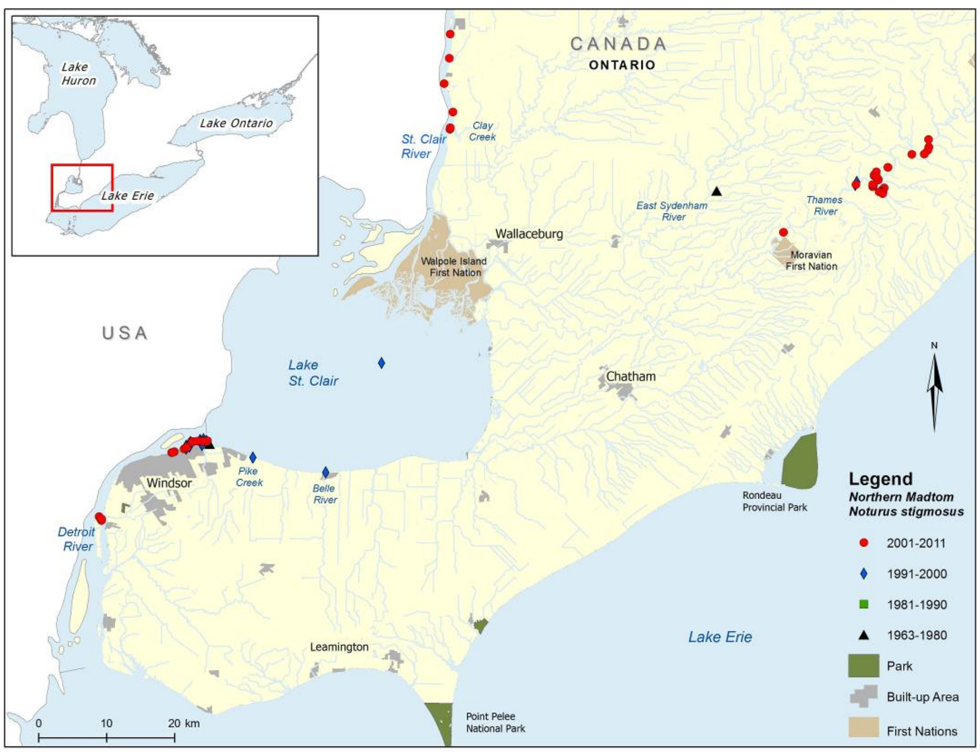



*Figure 8. Distribution of Northern Madtom in Canada.*

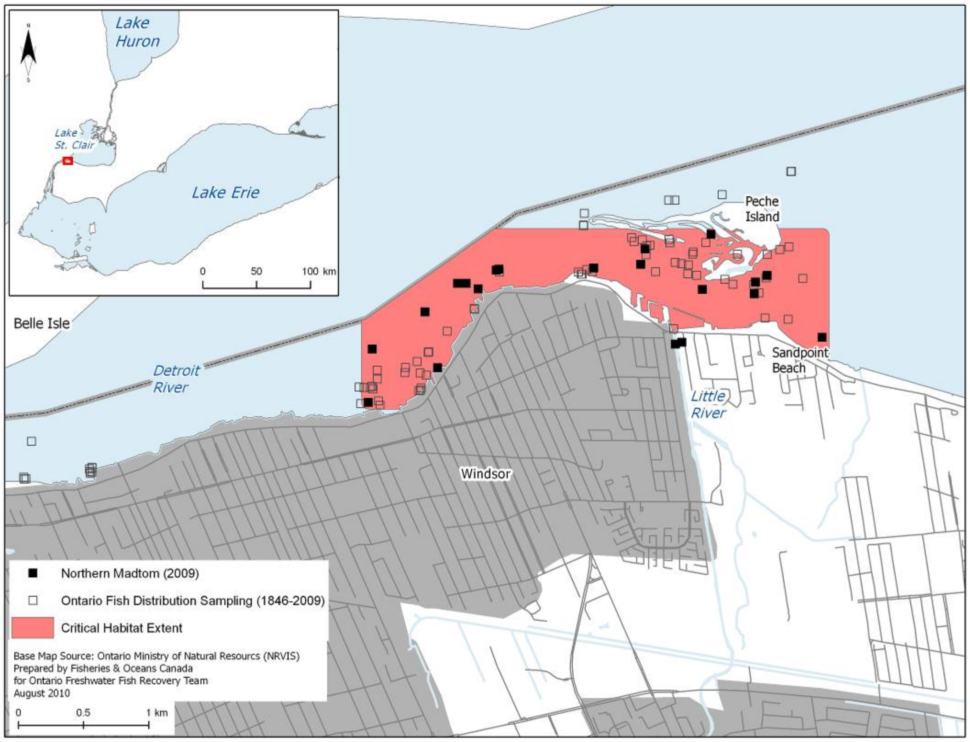



*Figure 9. Estimated population range of Northern Madtom in the Detroit River.*

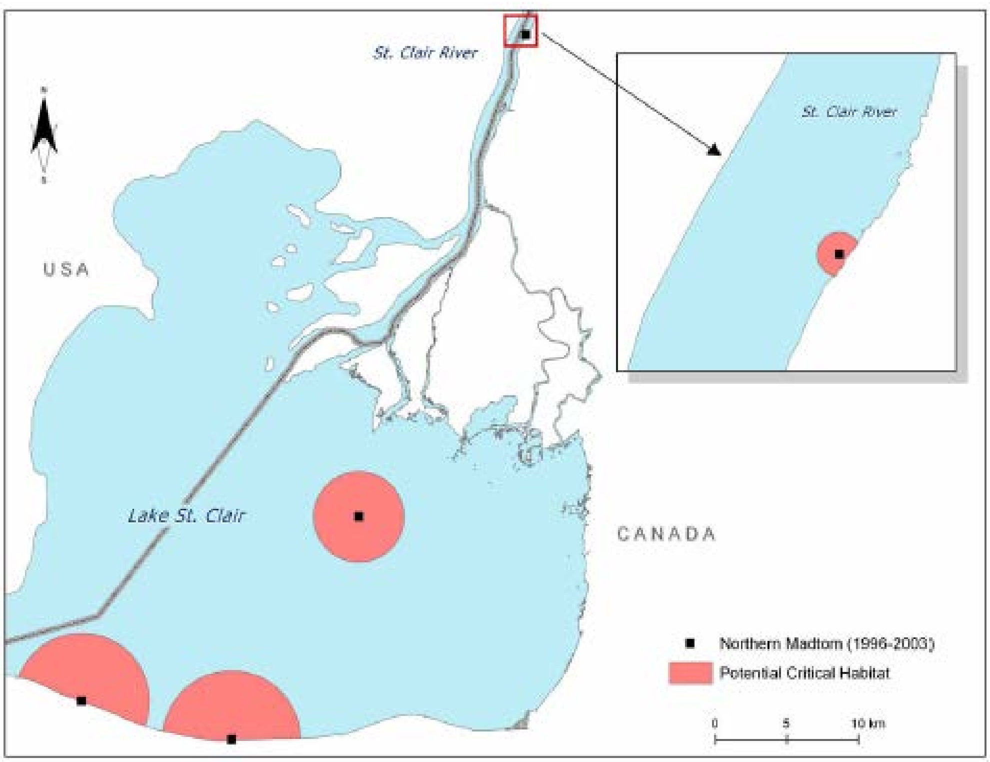



*Figure 10. Estimated population range for Northern Madtom in Lake St. Clair and the St. Clair River (Home Rangew).*

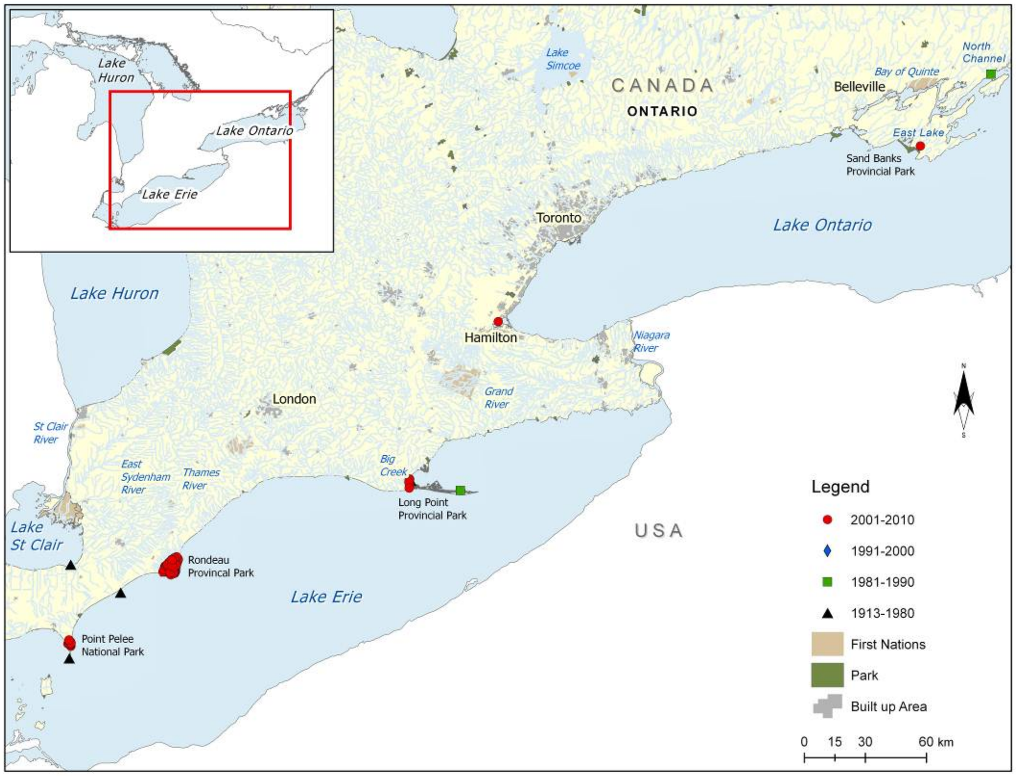



*Figure 11. Distribution of Spotted Gar in Canada.*

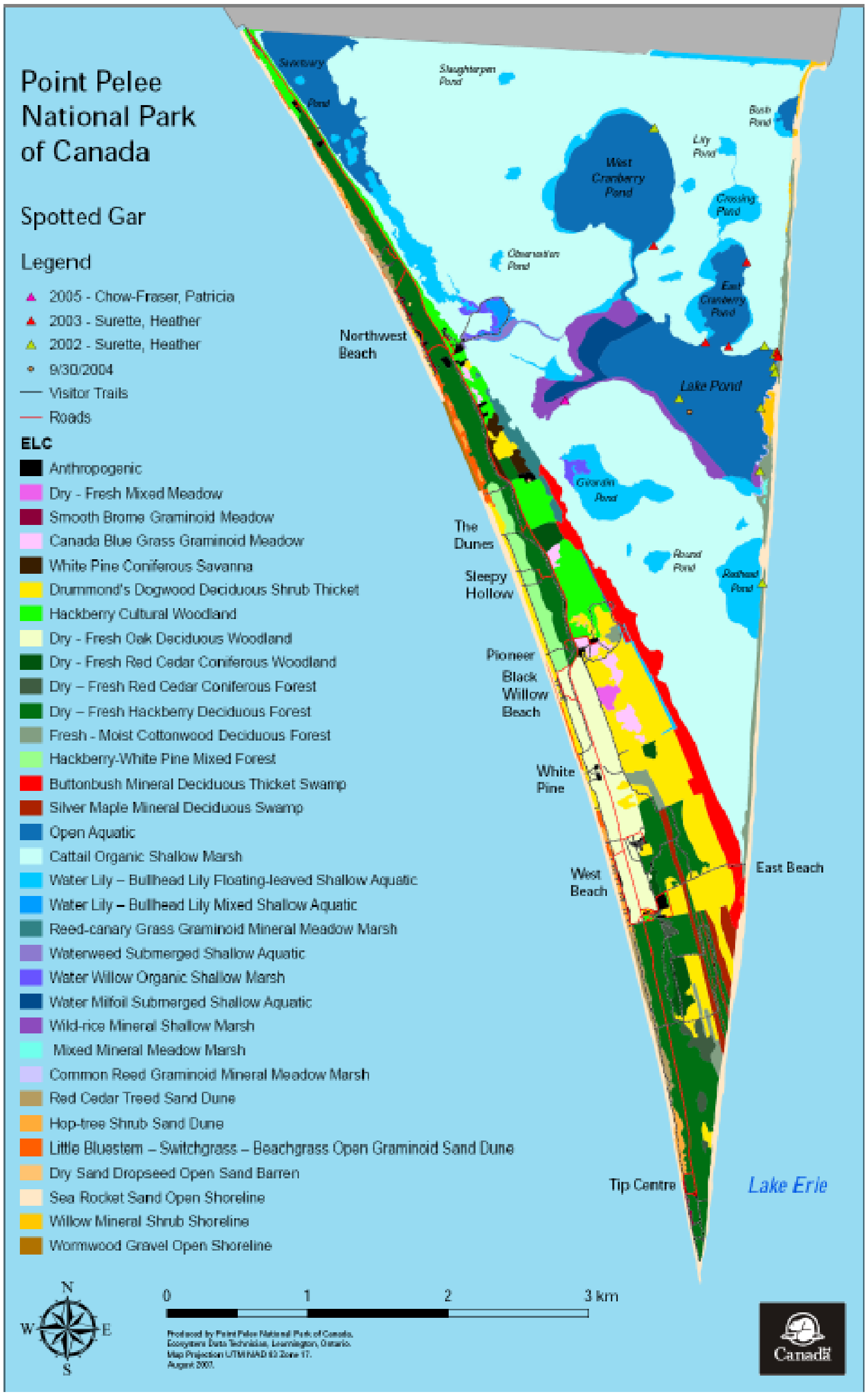



Figure 12. Spotted Gar records in Point Pelee National Park.

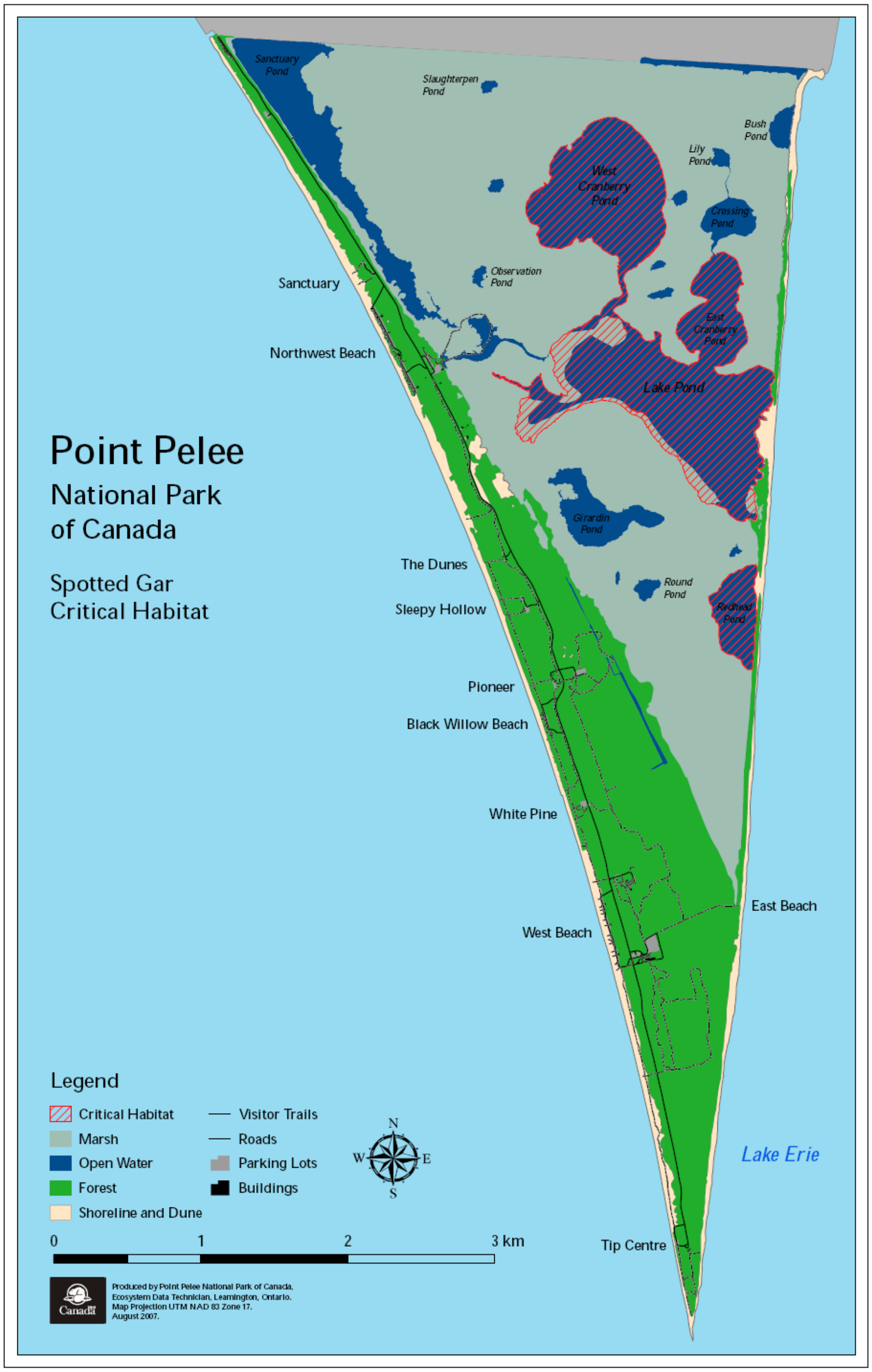



*Figure 13. Spotted Gar critical habitat in Point Pelee National Park.*

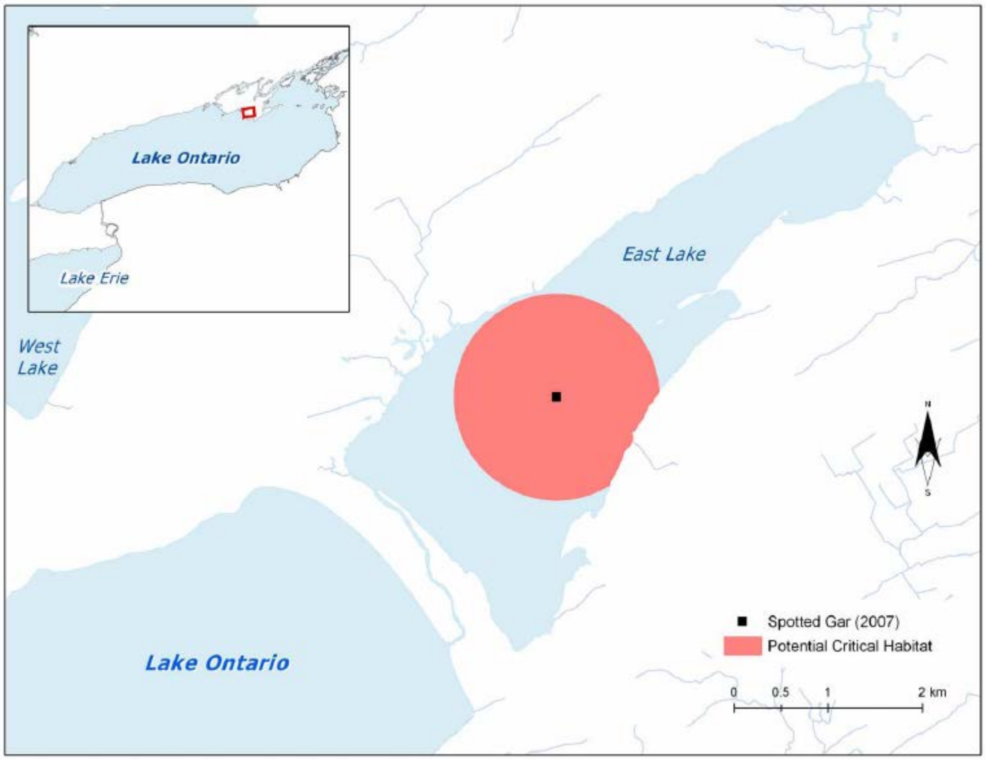



*Figure 14. Spotted Gar – estimated population range in East Lake (MAVP).*

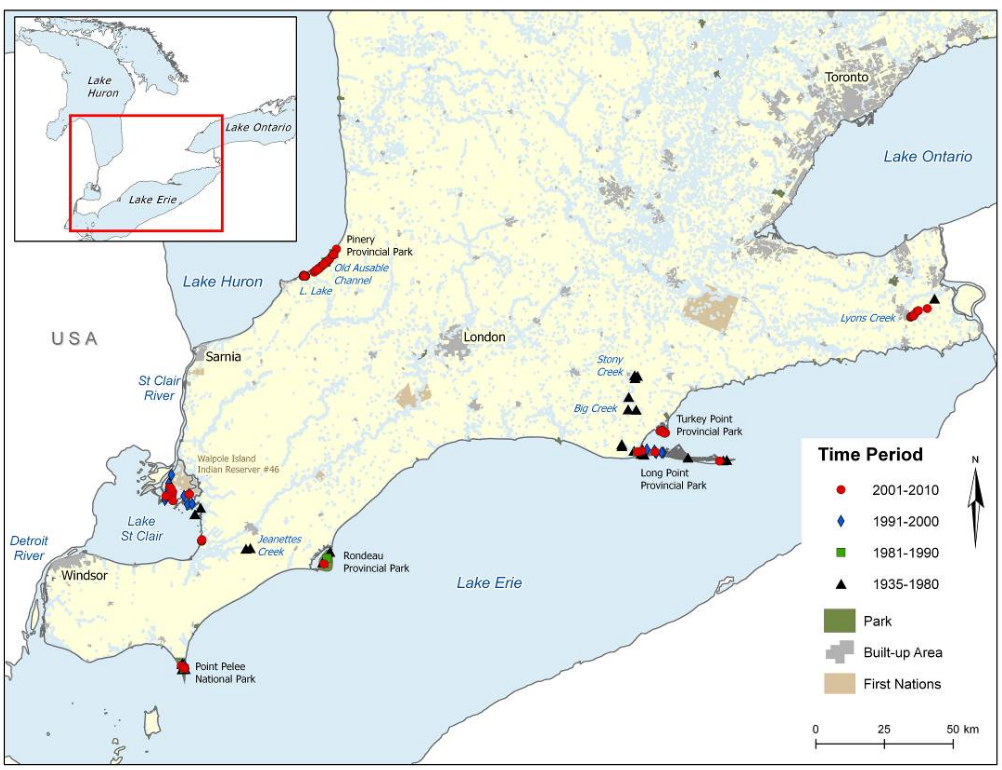



*Figure 15. Distribution of Lake Chubsucker in Canada.*

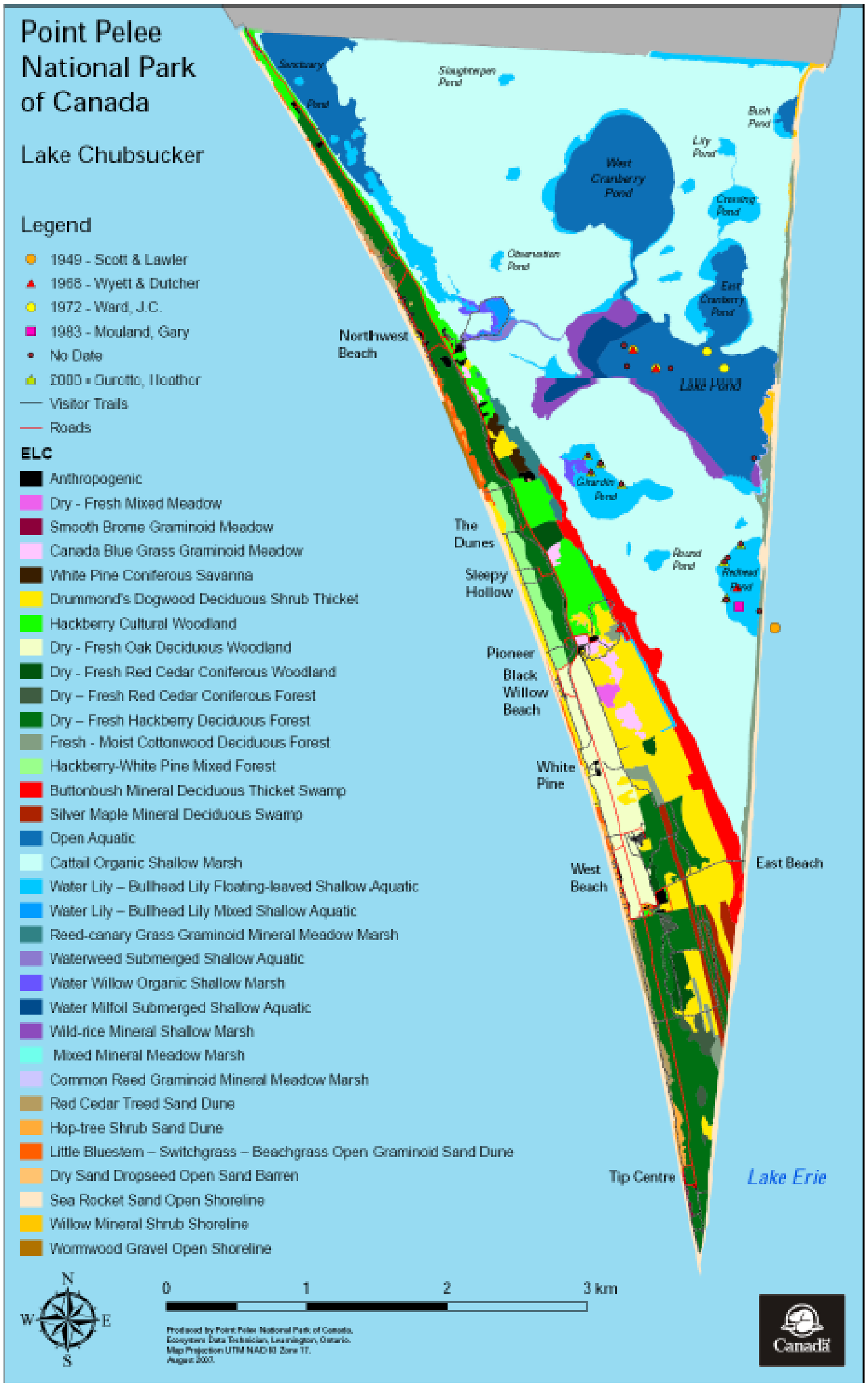



*Figure 16. Lake Chubsucker records in Point Pelee National Park.*

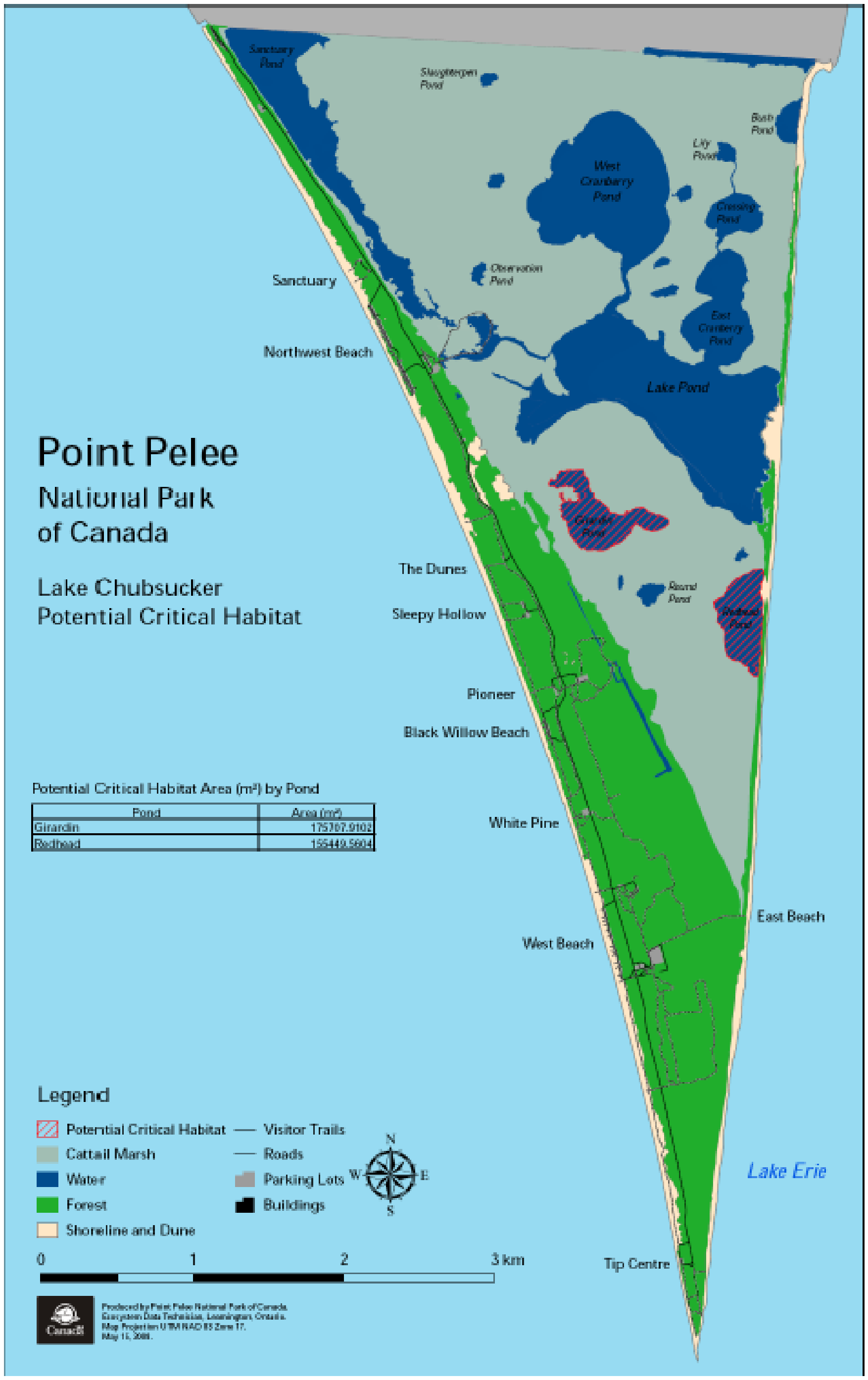



*Figure 17. Lake Chubsucker – potential critical habitat in Point Pelee National Park (Area of Occupancy).*

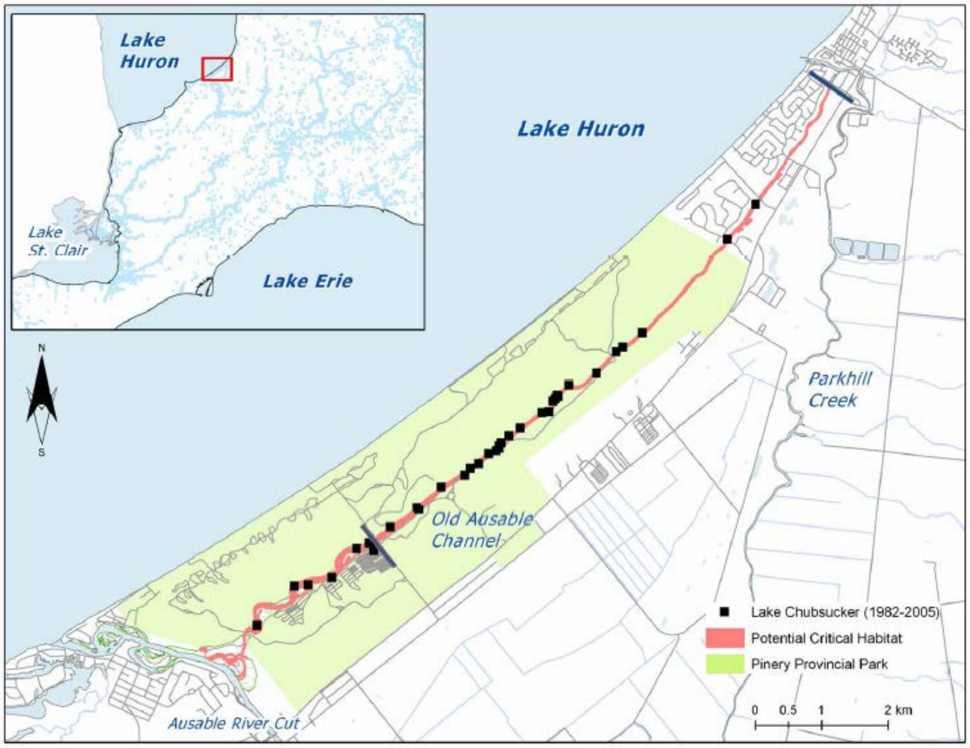



*Figure 18. Lake Chubsucker – estimated population range in the Old Ausable Channel (Area of Occupancy – Whole Waterbody).*

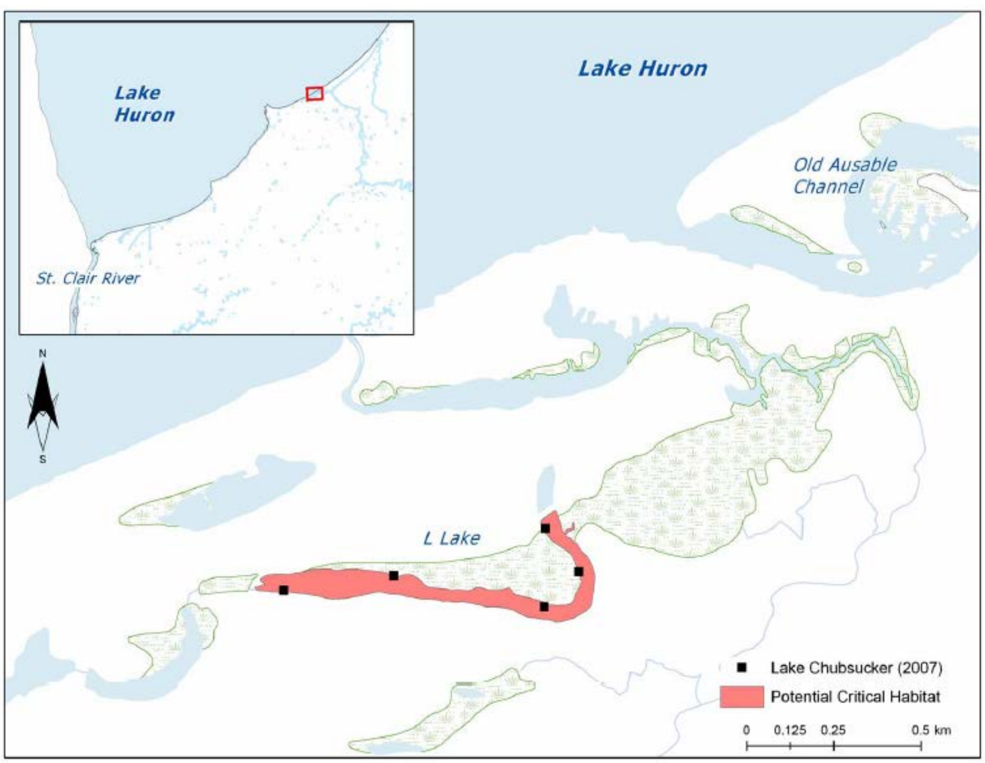



*Figure 19. Lake Chubsucker – estimated population range in L Lake (Area of Occupancy – Whole Waterbody).*

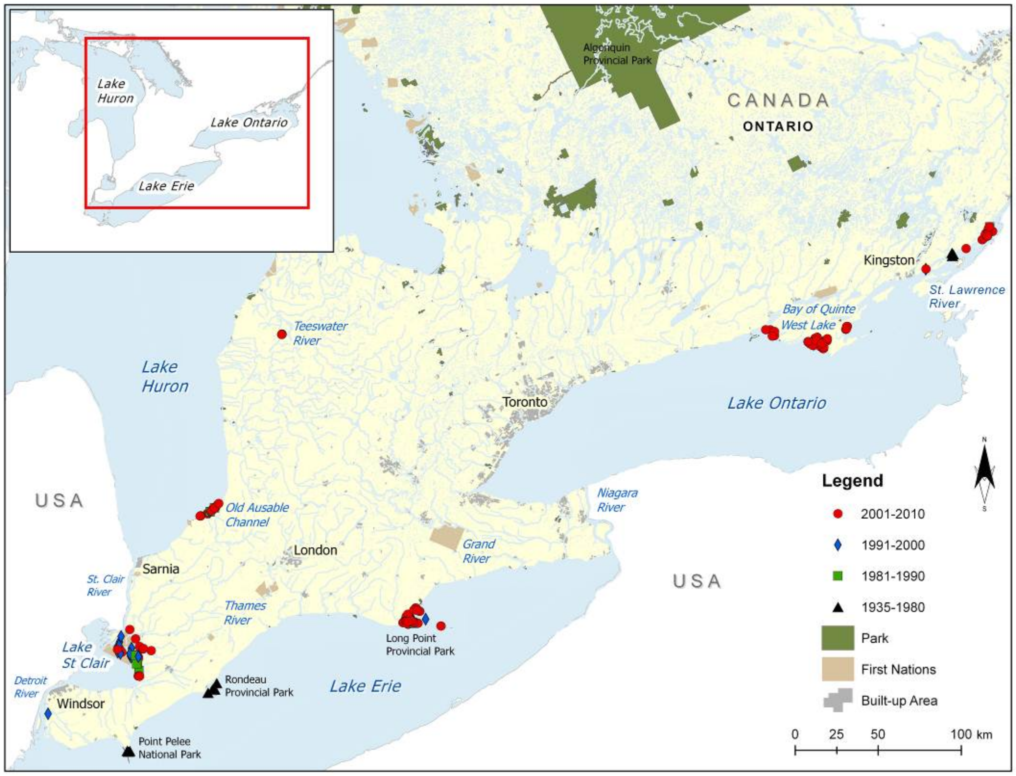



*Figure 20. Distribution of Pugnose Shiner in Canada.*

# APPENDIX 1. METHODS

*Table A1. Methods used to determine extent ($m^2$) of estimated population range for Northern Madtom, Spotted Gar, Lake Chubsucker and Pugnose Shiner. Numbers in bold were used to identify estimated population range.*

| Population | $MAPV_1$[1] | $MAPV_2$ | MACAH | $HR_W$ | $HR_M$ | AO | EC |
|---|---|---|---|---|---|---|---|
| Northern Madtom | | | | | | | |
| Detroit River | 4371 | 50 771 | n/a | 8350 | 179 | ? | n/a |
| Lake St. Clair | 16 491 | 50 771 | n/a | 31 805 930 | 4141 | n/a | n/a |
| Thames River | 4371 | 50 771 | n/a | 2470 | 179 | 1 751 412.71 | 3 218 385.39 |
| St. Clair River | 4371 | 50 771 | n/a | 5530 | 179 | n/a | n/a |
| Spotted Gar | | | | | | | |
| Point Pelee National Park | 3 566 787 | 1 545 000 | n/a | 129 170 | 141 300 | 2 202 263.69* | n/a |
| Rondeau Bay | 3 566 787 | 1 545 000 | n/a | 2 518 330 | 141 300 | 35 581 756* | n/a |
| Long Point Bay | 3 566 787 | 1 545 000 | n/a | 950 930 | 141 300 | ? | n/a |
| East Lake | 3 566 787 | 1 545 000 | n/a | 717 660 | 141 300 | n/a | n/a |
| Lake Chubsucker | | | | | | | |
| Old Ausable Channel | 102 094 | 772 500 | n/a | 210 | 1175 | 370 764.74*;<br>239 004.79* | n/a |
| Rondeau Bay | 266 852 | 772 500 | n/a | 2 518 330 | 26 867 | ? | n/a |
| Lake St. Clair | 266 852 | 772 500 | n/a | 31 805 930 | 26 867 | ? | n/a |
| Walpole Island | 266 852 | 772 500 | n/a | 1 745 000 | 26 867 | ? | n/a |
| Lake St. Clair NWA | 266 852 | 772 500 | n/a | 323 570 | 26 867 | ? | n/a |
| Big Creek NWA | 266 852 | 772 500 | n/a | 123 970 | 26 867 | ? | n/a |
| Long Point (Inner Bay) | 266 852 | 772 500 | n/a | 3 605 560 | 26 867 | ? | n/a |
| Long Point (Ponds at Tip) | 266 852 | 772 500 | n/a | 975 120 | 26 867 | ? | n/a |
| Lyons Creek | 102 094 | 772 500 | n/a | 160 | 1175 | n/a | ? |
| L Lake | 266 852 | 772 500 | n/a | 3860 | 26 867 | 63 118.04* | n/a |
| Point Pelee National Park | 266 852 | 772 500 | n/a | 1 022 160 | 26 867 | 331 157.47* | n/a |

| Population | $MAPV_1$[1] | $MAPV_2$ | MACAH | $HR_W$ | $HR_M$ | AO | EC |
|---|---|---|---|---|---|---|---|
| Big Creek Tributaries | 102 094 | 772 500 | n/a | 140 | 1175 | n/a | ? |
| Pugnose Shiner | | | | | | | |
| Old Ausable Channel | 370 | 1107 | 7123 | 210 | 49 | 370 764.74*; 239 004.79* | n/a |
| Teeswater River | 370 | 1107 | 7123 | 260 | 49 | n/a | ? |
| Cargill Mill Pond (Teeswater River) | 2220 | 1107 | 12 932 | 4350 | 1128 | n/a | n/a |
| Long Point Bay (Inner Bay) | 2220 | 1107 | 12 932 | 3 605 560 | 1128 | ? | n/a |
| Lake St. Clair | 2220 | 1107 | 12 932 | 31 805 930 | 1128 | ? | n/a |
| Walpole Island | 2220 | 1107 | 12 932 | 1 745 000 | 1128 | ? | n/a |
| Whitebread Drain | 370 | 1107 | 7123 | 80 | 49 | ? | ? |
| Little Bear Creek | 370 | 1107 | 7123 | 310 | 49 | n/a | ? |
| Detroit River | 370 | 1107 | 7123 | 8350 | 49 | n/a | n/a |
| St. Lawrence River | 370 | 1107 | 7123 | 79 520 | 49 | 152 739 975.73** | n/a |

[1]$MAPV_1$ – Minimum area per viable population (based on area per individual); $MAPV_2$ – minimum area per viable population (based on density); MACAH – minimum area for conservation of aquatic habitat; $HR_W$ – home range (D. Woolnough method); $HR_M$ – home range (C.K. Minns method); AO – area of occupancy; EC – ecological classification (i.e., ALIS).
*Area of occupancy = whole water body; **Area of occupancy calculated using population

# APPENDIX 2. OLD AUSABLE CHANNEL STUDY

## Old Ausable Channel critical habitat study - sonar bathymetry and substrate analyses

The Old Ausable Channel (OAC) is a unique, spring-fed channel with abundant aquatic macrophyte growth that supports one of the last remaining populations of Lake Chubsucker and Pugnose Shiner in Canada. Fisheries and Oceans Canada (DFO) has sampled the upper reaches of the OAC (upstream of the dam within the Pinery Provincial Park) extensively over a 3 year period for these species as well as their habitat. In 2004, comprehensive habitat data was collected through a hydro-acoustic survey utilizing a low frequency, wide-beam echo sounder system allowing for the quantification of channel bathymetry and substrate. The use of all geo-referenced datasets was used in the following analyses to identify Critical Habitat within the upper OAC for both the Pugnose Shiner and Lake Chubsucker.

## Methods

To remotely sense the substrate of the entire Old Ausable Channel and to interpolate an entire substrate surface for the OAC, sonar data were collected and used to predict the hardness of the substrate. The interpolated substrate map was compared to the actual substrate sampled at 88 points in the OAC to determine the accuracy of the interpolation.

### Sonar Data Collection

The sonar data were collected in August 2004. The entire length of the middle portion of the Old Ausable Channel, between the downstream dam and upstream culvert, was sounded using two longitudinal transects running parallel to the two shores and a wave-form transect that weaved from shore to shore.

Sonar data was collected with a Suzuki ES-2025, 50 kHz echo sounder. The transducer was mounted on an aluminum pole that was attached to a modified outboard motor mount. This mount was attached to a 2.4 m long 20 by 20 cm post that was fastened to the gunnels near amidships perpendicular to the length the 4.87 m Jon boat such that it was 60 cm beyond the starboard gunnel. The echo sounder data was sent via a cable to the QTC View sounder interface module. The data was split in the sounder interface module with one data stream continuing on to the echo sounder display and the other data stream going to a data acquisition card in a mobile computer. This data stream was collected by the QTC software and stored as echo sounder data.

To collect bathymetry data with XYZ UTM locations, we used a roving Trimble 5800 GPS receiver that communicated via a UHF radio to another Trimble 5800 GPS receiver located over a known benchmark location to provide real time correction and ±10 mm +1 ppm accuracy on the horizontal and ±20 mm +1 ppm accuracy on the vertical. The roving GPS receiver was fixed atop the sonar transducer pole and sent data via a serial cable to the mobile computer. The QTC software collected and saved the real-time GPS data as a GGA data string in a navigation data file. During data processing the GPS data files are merged with the echo sounder data to provide a XYZ values for each echo return.

To calculate water surface elevation the distance from the base of the roving receiver to the water surface was measured to the closest centimeter. To calculate bed elevation the distance from the water surface to the bottom of the transducer was measured to the nearest centimeter. The distance from the base of the receiver to the water surface, depth to the bottom of the transducer, and measured water depth were added to together and then subtracted from the measured GPS elevation value to provide a bed elevation.

### Analysis of Habitat from Sonar Data

Software developed by Quester Tangent Corporation (QTC) was used to process the echo trace data and provide a substrate classification. QTC5 raw data files, sonar and navigation, are stored separately and need to be loaded together for each individual day to begin the data processing procedure. The time stamps for each data string are ultimately what are used to combine the data. After the data files have been loaded they were filtered for quality control. Any files that had to strong (greater than 98%) or too weak (less than 5%) a signal strength were parsed from the data set. The file format was then converted to a *.FFV file that was merged with navigation. This allowed for 2D representation of the data survey. Addition data quality control filters were then run. Any data with depths between 0-0.85 m, depth spans between two consecutively collected data points greater than 0.6 m, and time span of signal greater than 2000 μs were filtered from the data set. If more than one day of sampling was completed those days were merged.

A catalogue file containing information required for echo classification was created. Classification requires a very accurate description of echo shape. The decisive element is distinguishing one echo from another; the QTC software does not attempt to associate the echo signal directly with the physical characteristics of the target. If everything remains constant, a change in echo shape will be a function of a change in the river bed.

QTC VIEW software applies algorithms to the shape of the first returning echo, translating it into 166 elements (Collins et al. 1996). The software completes a Principal Component Analysis (PCA) analysis and calculates Q values. The Q values corresponds to the first three PCA axes (Collins and McConnaughey 1998). When Q1, Q2 and Q3 for each record were plotted in a 3D display acoustically similar beds form clusters. The IMPACT software cluster analysis tools identified various data clusters and labeled them as classes. All data falling within that portion of Q-Space identified with a class was assigned that particular class identification. Useful information about the diversity or homogeneity of the dataset was available from the confidence and probability values that are output in the seabed file that was classified with the resulting catalogue file.

A substrate map was extrapolated from the class data derived from the PCA using Theissen polygons.

### Ground-Truthing Sonar Data

The substrate maps constructed based on the sonar data were ground-truthed using substrate data collected at 88 points from August 10 to August 12, 2004. Percent substrate composition was determined for each point by taking an approximately 1 liter sample of substrate, sorting it by type (clay, organic, sand, silt), and estimating the percentage of each type. For each site, the density and height of each macrophyte type (identified to lowest taxonomic level possible) was recorded.

A comparison between the sonar-derived substrate map and the point data was done by spatially joining the two layers and creating a contingency table. In addition, the data for the 88 points were used in a PCA to examine the amount of variation in these data.

### Comparing Species-at-Risk Distributions to the Substrate Data

The distributions of Pugnose Shiner and Lake Chubsucker were compared to the sonar-substrate results by spatially joining layers representing all captures of these species by DFO between 2002 and 2005, and the substrate layer.

## Results

A total of 9660 sonar points were collected (Figure A1). Based on the PCA of these data points, 10 substrate classes were identified (Table A2; Figure A1, A2). Substrate was dominated by Class 4 (present at over 68% of the sonar points) (Table A2). The classes (4, 7, 8) with the three highest frequencies were present at 89% of the sonar points (Table A2). The sites at which ground-truthing data were collected were dominated by organic substrate (Figure A3; Appendix A). The PCA of the ground-truthing data indicated very little distinct structure, with most data points grouped in a continuum along the first and second axes (Figure A3). The sonar data exhibited very little correspondence with the ground-truthing data as the sonar classes with the highest frequency of ground-truthing points (classes 4, 7, 8) had multiple classes of ground-truthed substrates (Appendix A).

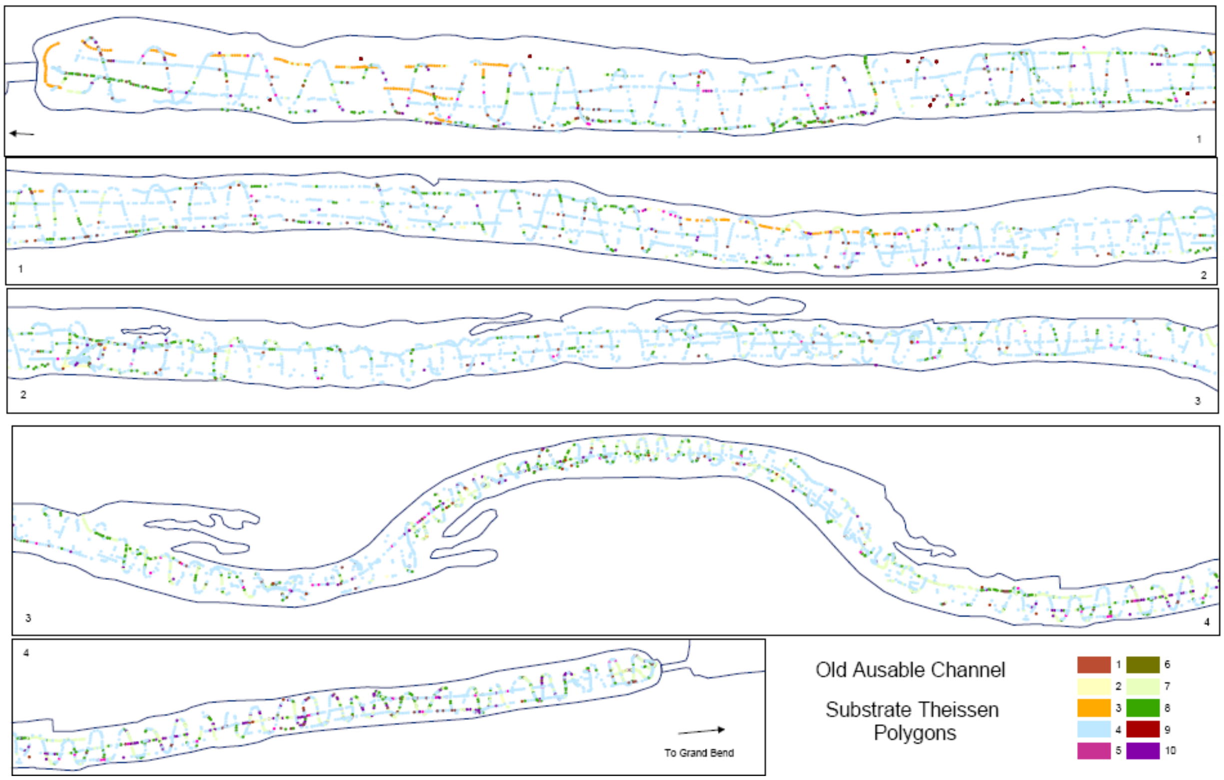



*Figure A1. Points for substrate classification derived from PCA of sonar data collected in the Old Ausable Channel, 2004.*

Table A2. *Frequency of substrate classes as identified by PCA of sonar data.*

| Class | Frequency | Relative Frequency | Cumulative Frequency |
|---|---|---|---|
| 4 | 6555 | 0.68 | 0.68 |
| 7 | 1053 | 0.11 | 0.79 |
| 8 | 984 | 0.10 | 0.89 |
| 10 | 267 | 0.03 | 0.92 |
| 3 | 250 | 0.03 | 0.94 |
| 1 | 236 | 0.02 | 0.97 |
| 9 | 141 | 0.01 | 0.98 |
| 5 | 91 | 0.01 | 0.99 |
| 2 | 63 | 0.01 | 1.00 |
| 6 | 20 | 0.00 | 1.00 |
| | 9660 | | |

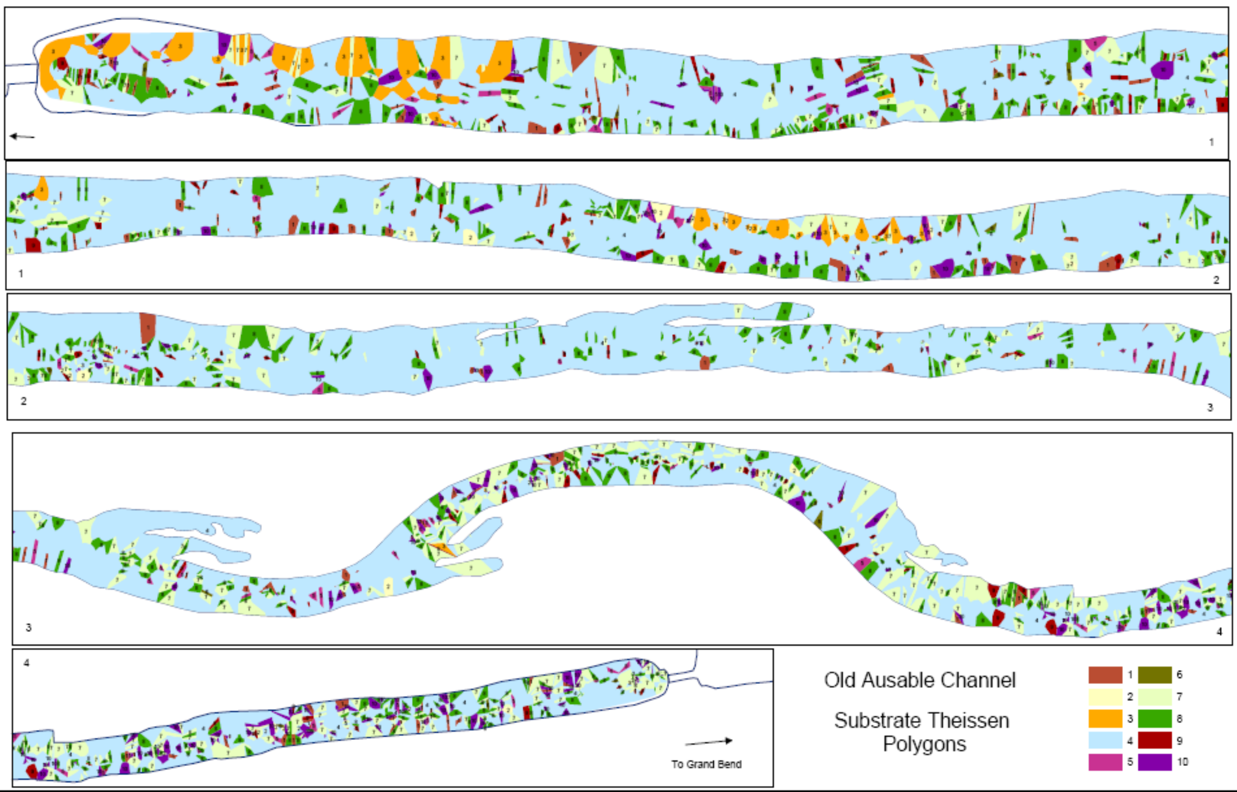
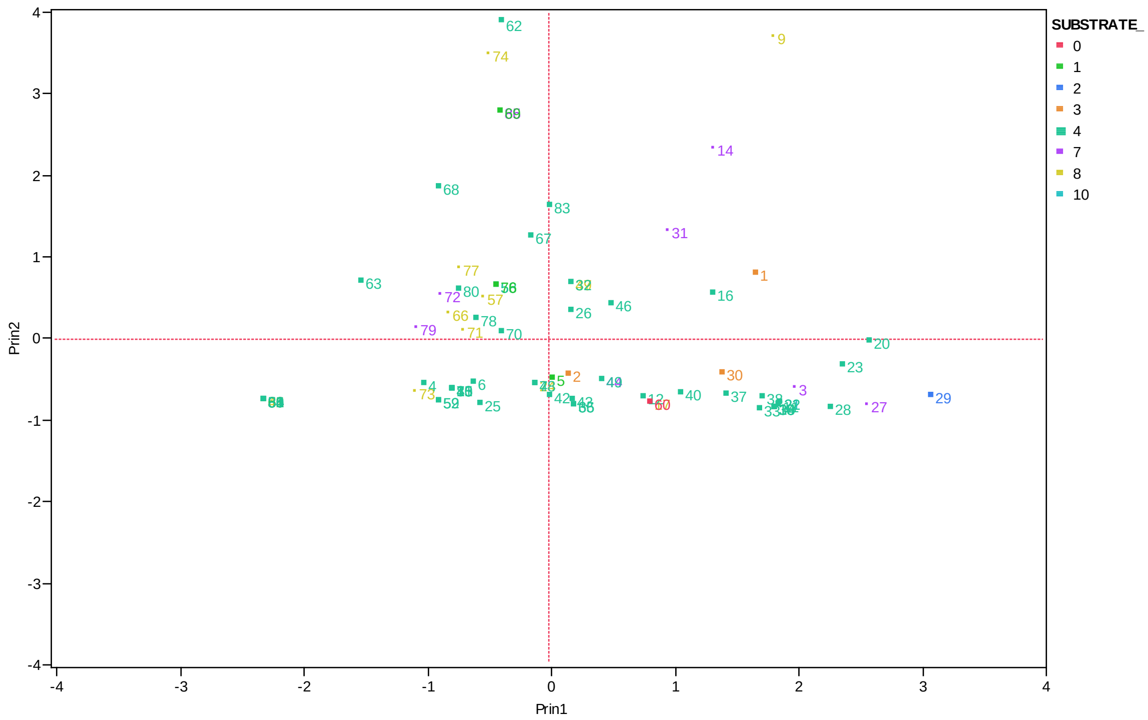



*Figure A2. Polygons for substrate classification derived from PCA of sonar data collected in the Old Ausable Channel, 2004.*

*A.*




B.

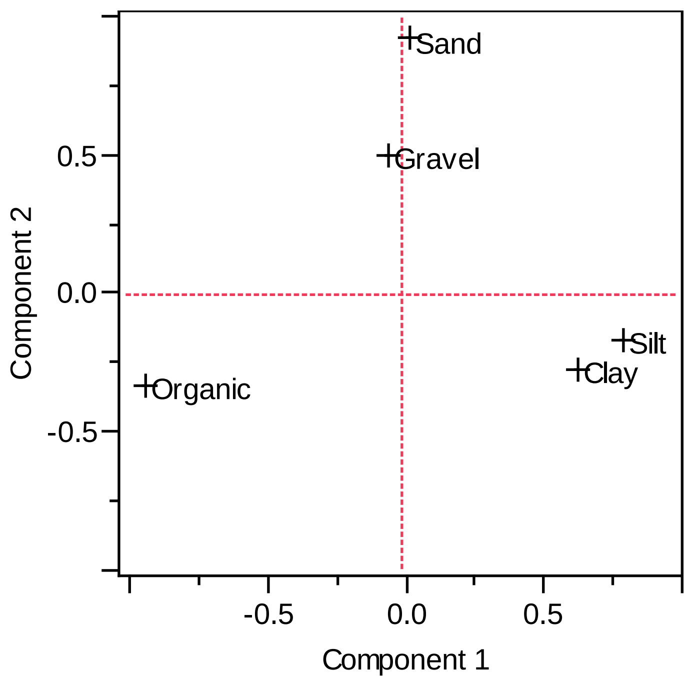



*Figure A3. Results of the principal component axes based on the ground-truth data collected at 88 points. A. Plot of first two principal component axes. The colours represent the sonar substrate class polygon (see Table A3, Figure A2) in which the point is present. B. Loading plot for the first two axes.*

*Table A3. Results of spatial join of sonar and ground-truthing substrate layers.*

| | | Mean % Ground-truthed Substrates | | | | | |
|---|---|---|---|---|---|---|---|
| **Sonar Substrate Category** | **Truthing Points Frequency** | **Clay** | **Organic** | **Organic/Clay** | **Organic/Sand** | **Sand** | **Silt** |
| | 1 | | 70 | | | | |
| 1 | 4 | | 76.25 | | | | |
| 2 | 1 | | | | | | 50 |
| 3 | 3 | | 60 | | | | 50 |
| 4 | 53 | 50 | 76.8 | 40 | | | 70 |
| 7 | 10 | 50 | 79 | | 50 | 40 | 50 |
| 8 | 13 | | 81.66667 | | | 70 | |
| 10 | 1 | | 50 | | | | |

If the sonar data matched the ground-truthed well, then a single ground-truthed substrate would have dominated each sonar class. Mapping the sonar classes onto the PCA plot of the ground-truthed data also indicates a poor match (Figure A3). This poor correspondence indicates that the sonar data do not accurately reflect the true nature of the substrate. This may be the result of a combination of the shallow nature of the habitat (sonar data may be problematic in depths of less than 1m) and interference from prop wash, particularly in the data collected in the wave-form transects (H. Bierberhofer, Canadian Hydrographic Service, Burlington, ON, pers. comm.). The numerous differences in points at the same location (Figure A1) collected in separate wave-form and longitudinal transects supports the conclusion of methodological problems with the sonar data.

**Conclusion**

Although the sonar and ground-truthing data are not corroborative, they both indicate that the substrate in the Old Ausable Channel is largely homogeneous - 68% of sonar points are classified as Class 4, and the dominant substrate of 87% of the ground-truthing sites were dominated by organic substrates. Therefore, the highly homogeneous nature of the substrate, relatively uniform depth (ground-truthing sites mean depth=1.25m ±0.31) and vegetation coverage (Appendix A), and the lack of strong correspondence of species at risk to specific substrate classes (Figure A4), depths and vegetation cover, suggest that it is difficult to partition the habitat into finer classes; therefore, the whole Old Ausable Channel (upstream of the dam in the Pinery Provincial Park) should be considered to be critical habitat for the Pugnose Shiner and Lake Chubsucker.

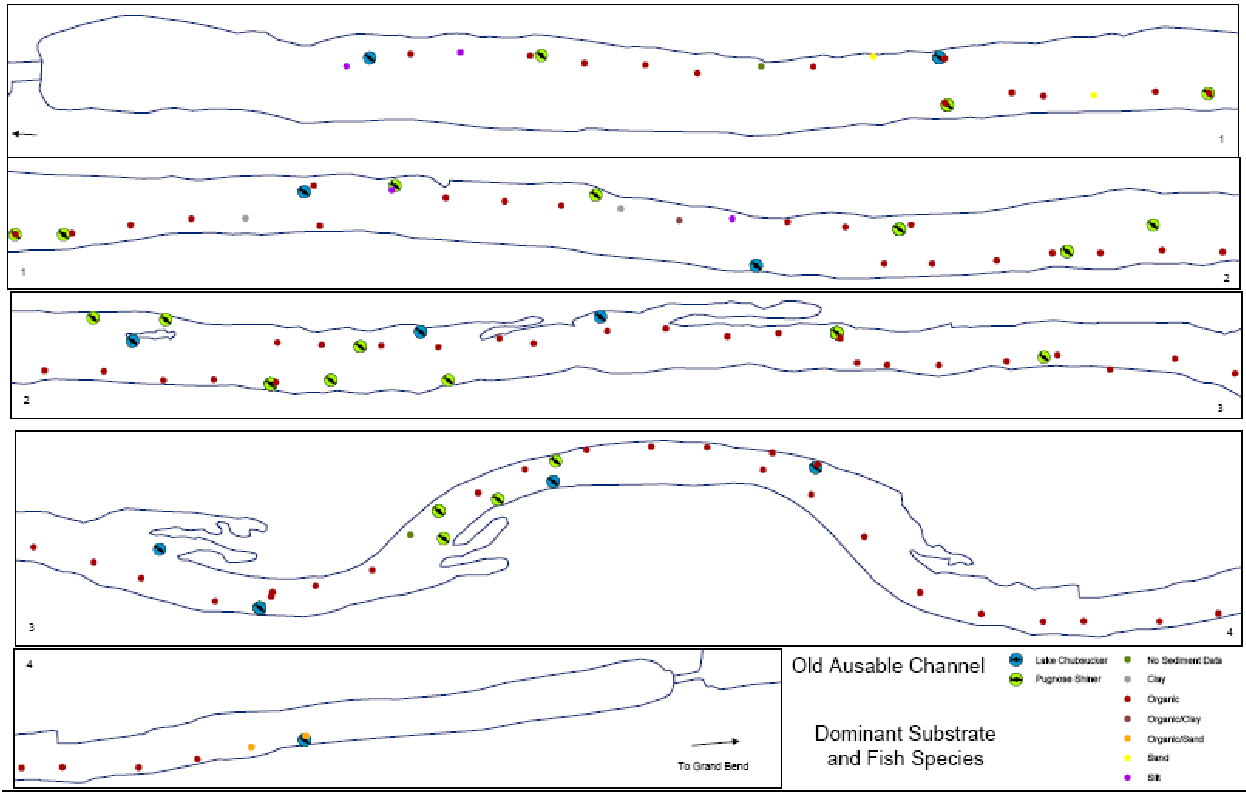



*Figure A4. The distribution of Pugnose Shiner and Lake Chubsucker in relation to dominant substrate at the 88 ground-truthed sites.*

*Appendix A. Percent substrate composition at each ground-truth site (see Figure 3) and sonar data polygon (see Figure 2) in which the point is present.*

| Site | Sonar Class | Clay | Gastropods | Gravel | Organic | Sand | Silt |
|---|---|---|---|---|---|---|---|
| 1 | 3 | 0 | 0 | 0 | 40 | 10 | 50 |
| 2 | 3 | 0 | 10 | 0 | 70 | 0 | 20 |
| 3 | 7 | 5 | 0 | 0 | 45 | 0 | 50 |
| 4 | 4 | 0 | 5 | 0 | 90 | 0 | 5 |
| 5 | 1 | 0 | 5 | 0 | 75 | 0 | 20 |
| 6 | 4 | 0 | 5 | 0 | 85 | 0 | 10 |
| 7 | 4 | 0 | 0 | 0 | 80 | 0 | 20 |
| 9 | 4 | 0 | 0 | 0 | 90 | 0 | 10 |
| 10 | 8 | 0 | 0 | 0 | 10 | 70 | 20 |
| 11 | 4 | 0 | 0 | 0 | 90 | 0 | 10 |
| 12 | 4 | 25 | 0 | 0 | 50 | 0 | 25 |
| 13 | 4 | 5 | 0 | 0 | 70 | 0 | 25 |
| 14 | 4 | 0 | 0 | 0 | 90 | 0 | 10 |
| 15 | 7 | 0 | 0 | 0 | 30 | 40 | 25 |
| 16 | 4 | 0 | 0 | 0 | 90 | 0 | 10 |
| 17 | 4 | 10 | 10 | 0 | 50 | 10 | 20 |
| 18 | 8 | 10 | 0 | 0 | 70 | 0 | 20 |
| 19 | 4 | 30 | 0 | 0 | 50 | 0 | 20 |
| 20 | 4 | 30 | 0 | 0 | 50 | 0 | 20 |
| 21 | 4 | 50 | 0 | 0 | 30 | 5 | 15 |
| 22 | 10 | 20 | 0 | 0 | 50 | 0 | 30 |
| 23 | 4 | 20 | 0 | 0 | 50 | 0 | 30 |
| 24 | 4 | 0 | 0 | 0 | 30 | 0 | 70 |
| 25 | 8 | 0 | 0 | 0 | 80 | 0 | 20 |
| 26 | 4 | 5 | 0 | 0 | 90 | 0 | 5 |
| 27 | 4 | 0 | 5 | 0 | 70 | 5 | 20 |
| 28 | 7 | 50 | 5 | 0 | 30 | 0 | 15 |
| 29 | 4 | 40 | 0 | 0 | 40 | 0 | 20 |
| 30 | 2 | 25 | 0 | 0 | 25 | 0 | 50 |
| 31 | 3 | 0 | 0 | 0 | 50 | 0 | 50 |
| 32 | 7 | 0 | 0 | 0 | 50 | 20 | 30 |
| 33 | 4 | 0 | 0 | 0 | 70 | 10 | 20 |
| 34 | 4 | 40 | 0 | 0 | 50 | 0 | 10 |
| 35 | 4 | 30 | 0 | 0 | 50 | 0 | 20 |
| 36 | 4 | 30 | 0 | 0 | 50 | 0 | 20 |
| 37 | 4 | 10 | 0 | 0 | 80 | 0 | 10 |
| 38 | 4 | 20 | 15 | 0 | 50 | 0 | 15 |
| 39 | 4 | 15 | 5 | 0 | 50 | 0 | 30 |
| 40 | 8 | 0 | 0 | 0 | 70 | 10 | 20 |
| 41 | 4 | 10 | 10 | 0 | 60 | 0 | 20 |
| 42 | 4 | 0 | 0 | 0 | 90 | 0 | 10 |
| 43 | 4 | 5 | 5 | 0 | 80 | 0 | 10 |
| 44 | 4 | 5 | 0 | 0 | 80 | 0 | 15 |
| 45 | 7 | 0 | 0 | 0 | 70 | 0 | 30 |
| 46 | 8 | 0 | 0 | 0 | 100 | 0 | 0 |
| 47 | 4 | 10 | 0 | 0 | 70 | 10 | 10 |
| 48 | 8 | 0 | 0 | 0 | 70 | 10 | 20 |

| Site | Sonar Class | Clay | Gastropods | Gravel | Organic | Sand | Silt |
|---|---|---|---|---|---|---|---|
| 49 | 4 | 0 | 0 | 0 | 80 | 0 | 20 |
| 50 | 4 | 0 | 0 | 0 | 70 | 0 | 30 |
| 51 | 4 | 0 | 0 | 0 | 100 | 0 | 0 |
| 52 | 4 | 0 | 0 | 0 | 100 | 0 | 0 |
| 53 | 4 | 10 | 0 | 0 | 90 | 0 | 0 |
| 54 | 4 | 0 | 0 | 0 | 100 | 0 | 0 |
| 55 | 4 | 0 | 0 | 0 | 100 | 0 | 0 |
| 56 | 4 | 0 | 0 | 0 | 100 | 0 | 0 |
| 57 | 4 | 0 | 0 | 0 | 80 | 10 | 10 |
| 58 | 8 | 10 | 0 | 0 | 80 | 10 | 0 |
| 59 | 4 | 0 | 0 | 0 | 80 | 10 | 10 |
| 60 | 4 | 10 | 0 | 0 | 90 | 0 | 0 |
| 61 | 0 | 10 | 0 | 0 | 70 | 0 | 20 |
| 62 | 1 | 0 | 0 | 0 | 100 | 0 | 0 |
| 63 | 4 | 0 | 0 | 5 | 70 | 15 | 10 |
| 64 | 4 | 0 | 0 | 0 | 90 | 10 | 0 |
| 65 | 7 | 0 | 0 | 0 | 100 | 0 | 0 |
| 66 | 4 | 10 | 0 | 0 | 80 | 0 | 10 |
| 67 | 8 | 0 | 5 | 0 | 85 | 5 | 5 |
| 68 | 4 | 0 | 0 | 0 | 70 | 20 | 10 |
| 69 | 4 | 0 | 0 | 0 | 70 | 30 | 0 |
| 71 | 1 | 0 | 0 | 0 | 50 | 50 | 0 |
| 72 | 4 | 15 | 0 | 0 | 80 | 5 | 0 |
| 73 | 8 | 10 | 0 | 0 | 85 | 5 | 0 |
| 74 | 7 | 5 | 0 | 0 | 85 | 10 | 0 |
| 75 | 8 | 5 | 5 | 0 | 90 | 0 | 0 |
| 76 | 8 | 10 | 5 | 5 | 70 | 10 | 0 |
| 77 | 4 | 0 | 0 | 0 | 90 | 0 | 10 |
| 78 | 1 | 0 | 0 | 0 | 80 | 10 | 10 |
| 79 | 8 | 5 | 0 | 0 | 80 | 15 | 0 |
| 80 | 4 | 0 | 0 | 0 | 85 | 5 | 10 |
| 81 | 7 | 5 | 0 | 0 | 90 | 5 | 0 |
| 82 | 4 | 5 | 5 | 0 | 80 | 10 | 0 |
| 83 | 4 | 0 | 0 | 0 | 100 | 0 | 0 |
| 84 | 8 | 0 | 0 | 0 | 100 | 0 | 0 |
| 85 | 4 | 10 | 0 | 0 | 60 | 30 | 0 |
| 86 | 4 | 0 | 0 | 0 | 100 | 0 | 0 |
| 87 | 7 | 0 | 0 | 0 | 50 | 50 | 0 |
| 88 | 7 | 0 | 0 | 0 | 50 | 50 | 0 |