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Cutlip Minnow
(Exoglossum maxillingua) in Ontario

Ontario Recovery Strategy Series

Recovery strategy prepared under the *Endangered Species Act, 2007*

2013

Natural. Valued. Protected.

Ministry of Natural Resources

Ontario

About the Ontario Recovery Strategy Series

This series presents the collection of recovery strategies that are prepared or adopted as advice to the Province of Ontario on the recommended approach to recover species at risk. The Province ensures the preparation of recovery strategies to meet its commitments to recover species at risk under the Endangered Species Act (ESA) and the Accord for the Protection of Species at Risk in Canada.

What is recovery?

Recovery of species at risk is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a recovery strategy?

Under the ESA a recovery strategy provides the best available scientific knowledge on what is required to achieve recovery of a species. A recovery strategy outlines the habitat needs and the threats to the survival and recovery of the species. It also makes recommendations on the objectives for protection and recovery, the approaches to achieve those objectives, and the area that should be considered in the development of a habitat regulation. Sections 11 to 15 of the ESA outline the required content and timelines for developing recovery strategies published in this series.

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. There is a transition period of five years (until June 30, 2013) to develop recovery strategies for those species listed as endangered or threatened in the schedules of the ESA. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

What's next?

Nine months after the completion of a recovery strategy a government response statement will be published which summarizes the actions that the Government of Ontario intends to take in response to the strategy. The implementation of recovery strategies depends on the continued cooperation and actions of government agencies, individuals, communities, land users, and conservationists.

For more information

To learn more about species at risk recovery in Ontario, please visit the Ministry of Natural Resources Species at Risk webpage at: **www.ontario.ca/speciesatrisk**

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Cette publication hautement spécialisée Recovery strategies prepared under the *Endangered Species Act, 2007*, *n'est disponible qu'en Anglais en vertu du Règlement 411/97 qui en exempte l'application de la Loi sur les services en français. Pour obtenir de l'aide en français, veuillez communiquer avec Cathy Darevic au ministère des Richesses naturelles au 705-755-5580.*

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DECLARATION

The recovery strategy for the Cutlip Minnow was developed in accordance with the requirements of the *Endangered Species Act, 2007* (ESA). This recovery strategy has been prepared as advice to the Government of Ontario, other responsible jurisdictions and the many different constituencies that may be involved in recovering the species.

The recovery strategy does not necessarily represent the views of all of the individuals who provided advice or contributed to its preparation, or the official positions of the organizations with which the individuals are associated.

The goals, objectives and recovery approaches identified in the strategy are based on the best available knowledge and are subject to revision as new information becomes available. Implementation of this strategy is subject to appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy.

RESPONSIBLE JURISDICTIONS

Ontario Ministry of Natural Resources
Fisheries and Oceans Canada

EXECUTIVE SUMMARY

The Cutlip Minnow (*Exoglossum maxillingua*) is a member of the minnow family, Cyprinidae, and is easily distinguished from other minnow species in Canada by its tri-lobed lower jaw. In Ontario, this species is at the northern extent of its range and is distributed in the lower Ottawa River and St. Lawrence River drainage areas. Limited research sampling has been done on the Cutlip Minnow; therefore, it is difficult to know whether the species is in decline. Recent surveys indicate that the Cutlip Minnow has disappeared from some historic sites, but new populations, low in abundance, have been found within the St. Lawrence River and surrounding tributaries, which may indicate that the species status is stable.

The Cutlip Minnow is listed as threatened under the *Endangered Species Act*, *2007* (ESA). It is listed as a priority species to be re-assessed by the Committee on the Status of Species at Risk in Ontario (COSSARO). The Cutlip Minnow was last assessed as “not at risk” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in April 1994. Currently, this species is not listed on Schedule 1 of the federal *Species at Risk Act* (SARA).

Information collected from sites where Cutlip Minnow has been found seems to indicate that this species prefers warm to cool clear or tea-coloured streams that have a moderate to swift current. It prefers pools or channels that have firm bottoms with cobble or gravel substrates and large flat rocks or logs to hide under. In Ontario, Cutlip Minnow have been found along edges of fast (flowing) water habitats; they have also been found in lakes within Quebec, but less frequently. During spawning, the Cutlip Minnow needs clear, silt-free water with substrates consisting of small cobble and gravel. Limiting factors for this species include, but may not be limited to, its limited distribution, based on the probability that Cutlip Minnow dispersed into Ontario toward the end of the last glacial period after other colonization routes had disappeared and direct species competition. As information on Cutlip Minnow and its habitat preferences during certain life stages is lacking, threats identified in this document are based on potential negative impacts. More sampling and research is required to determine the extent of these and any other threats. Threats to this species’ survival and recovery include siltation and turbidity, dredging and channel/shoreline alterations, contaminants and toxic substances, invasive species, bait harvest and climate change.

Knowledge gaps for this species are extensive. There is information regarding biology and ecology for portions of the United States but information specific to Ontario is lacking. Knowledge gaps include the species’ current distribution, abundance, biology, habitat needs for specific life stages, water quality parameters (preference and impacts of water quality), effectiveness of different types of sampling gear and threat clarification including the potential effects of dams.

The recovery goal is to maintain and increase existing Cutlip Minnow populations and their habitat and, where feasible, restore areas with degraded habitat within the

historical range of Cutlip Minnow in Ontario. The protection and recovery objectives are to:

1. improve the understanding of current population distribution, abundance and dynamics (age structure, recruitment, seasonal migration, mortality, population isolation/genetics/ability to recolonize);
2. increase knowledge of specific habitat requirements for all life stages;
3. ensure current habitat is protected and restore habitat where feasible;
4. assess current and potential threats to the species and its required habitat; implement mitigation measures to reduce effects of various threats;
5. improve awareness of the Cutlip Minnow and its habitats; and
6. maintain or increase current population levels.

It is recommended that those reaches currently occupied by Cutlip Minnow and historical reaches with high potential for rehabilitation and a reasonable likelihood of recolonization be prescribed as habitat within a habitat regulation under the ESA. Within these reaches, only those areas that meet the functional (spawning, nursery, and adult life stages) habitat characteristics described for the various life stages of Cutlip Minnow should be identified as habitat within the habitat regulation. However, since habitat is poorly understood for some of the required life stages, the actual and historical presence of the species should drive recovery decisions until habitat needs are more fully researched and understood. More sampling and studies should be conducted to refine knowledge of the habitat needs for this species. As our understanding of habitat requirements for the required life stages improves, prescribed habitat may be refined and expanded.

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1.0 BACKGROUND INFORMATION

1.1 Species Assessment and Classification

COMMON NAME: Cutlip Minnow
SCIENTIFIC NAME: *Exoglossum maxillingua*
SARO List Classification: Threatened
SARO List History: Threatened (2004)
COSEWIC Assessment History: Not At Risk (1994)
SARA Schedule 1: No Schedule. No Status.
CONSERVATION STATUS RANKINGS: GRANK: G5 NRANK: N4 SRANK: S1S2

The glossary provides definitions for technical terms, including the abbreviations above.

1.2 Species Description and Biology

Species Description

The Cutlip Minnow, *Exoglossum maxillingua* (LeSueur 1817), is a stocky, small- to medium-sized member of the minnow family (Cyprinidae). This species has a distinctive appearance and is unlikely to be confused with other minnow species found in Ontario. It has a blunt snout, a wide caudal peduncle and a trilobed lower jaw consisting of two fleshy lateral lobes and a central boney lobe. Its lower jaw is the Cutlip Minnow's most defining feature and the reason for its common name. The average total length of this species is 100 mm and the Ontario record is 140 mm (Holm et al. 2009). The adult colouration of the Cutlip Minnow varies from olive-grey or -green to almost black dorsally, grey to silver laterally and white or light-coloured ventrally (Scott and Crossman 1973, Pappantoniou et al. 1984a, Holm et al. 2009). The colouration of males and females is very similar but the male, when in spawning condition, is much darker when viewed from the top and males often have a dark lateral band (Van Duzer 1939). Van Duzer (1939) stated that adult males are often larger and more robust than females, with males ranging from 102 to 140 mm and females not usually exceeding 76 mm. Young-of-year and juvenile Cutlip Minnow up to 76 mm also have a dark stripe along the midline of each side of the body (from the snout to the tail) and a distinct dark spot on the base of the caudle peduncle (Scott and Crossman 1973, Holm et al. 2009). Pigmentation is noticeable on specimens as early as six days old and consists of a dark lateral band and a dark caudal spot (Van Duzer 1939).

Species Biology

Cutlip Minnow feed along the bottom of streams and rivers and are most active in the daytime (Johnson 1981, Collin and Ali 1994). Its diet consists primarily of insect larvae, mainly non-biting midges (chironomid) and caddisfly (trichoptera) larvae, with some molluscs, crayfishes, mites and fish eggs (Breder and Crawford 1922, Haase and Haase 1975, Johnson 1981, Pappantoniou et al. 1984a, 1984b). In two studies by Pappantaniou et al. (1984a, 1984b), it was found that chironomid larvae were most prevalent in smaller specimens (less than 65 mm) while trichoptera made up the major food item in larger specimens (greater than 66 mm).

The Cutlip Minnow has also been referred to as an “eye-picker”, as it has been observed attacking the eyes of other species using the central boney lobe of its lower jaw (Johnson and Johnson 1982, Pappantoniou and Dale 1986). This activity usually occurs as a result of overcrowding.

Within Pennsylvania and New York, the average life span for the Cutlip Minnow has been found to be just over four years (Haase and Haase 1975, Pappantoniou et al. 1984a, 1984b) with some specimens reaching five years of age (Haase and Haase 1975). A study in Virginia and Pennsylvania (Jenkins and Burkhead 1993) found that yearlings and some two-year-old Cutlip Minnow were not sexually mature.

The Cutlip Minnow spawning period occurs in the spring and observations of complete or almost complete nests have been made within Rotary Creek in Cornwall, Ontario at the end of May (B. Hickey, pers. comm. 2012). Additional spawning activity observations were made on the St. Lawrence River within the Thousand Island region, near Gananoque, Ontario by Jenkins and Jenkins (1980) from June 24 to July 8. These observations were made when water temperatures ranged from 16.1 to 18.9ºC (Jenkins and Jenkins 1980). No other observations of spawning behaviours or timing have been made in Ontario. Within the United States, studies have shown that the Cutlip Minnow spawns from early May until July when temperatures range from 16.1 to 22.5ºC (Van Duzer 1939, Fuiman and Loos 1978, Jenkins and Burkhead 1993). A nesting male has also been observed in early May in central New York state, when the water temperature was 13.9ºC (Hankinson 1922). Male Cutlip Minnow arrive at the spawning location before the females and build nests using different sized gravel. These nests are generally circular in appearance, relatively flat, and range in dimension from 30.5 to 46.0 cm wide and 7.6 to 15.2 cm high (Van Duzer 1939). The St. Lawrence River Institute of Environmental Sciences (SLRIES) has observed Cutlip Minnow spawning in Rotary Creek and believes that nest sizes are generally smaller than what Van Duzer (1939) observed, although no actual measurements have been taken (B. Hickey, pers. comm. 2012). Spawning occurs during the daytime on the upstream slope of the nest when the male is ready and involves the female approaching the nest and sliding in beside the male. The pair press their bodies together and vibrate, simultaneously releasing the eggs and sperm. During the spawning period, a single male may spawn with the same or other females more than once. Spawning may last anywhere from six to eight days in the early part of the season and one to three days in the later part of the

spawning period. The male Cutlip Minnow continuously rebuilds and repairs the nest and keeps it clear of silt and debris (Van Duzer 1939).

The eggs of the Cutlip Minnow become lodged within the interspatial spaces of the gravel within the upstream areas of the nest. The eggs are spherical, with one flat edge; are yellowish in colour; and measure 2.0 mm to 2.6 mm (Van Duzer 1939, Buynak and Mohr 1980) in diameter. The fecundity of the Cutlip Minnow is 345 to 1,177 eggs (Fuiman and Loos 1978). The duration of the incubation period in unknown. No parental care is provided to the young (Van Duzer 1939).

Larval Cutlip Minnow stay within the nest for at least six days after hatching (Van Duzer 1939). Newly hatched larvae range in total length from 5.5 to 5.7 mm (Buynak and Mohr 1980). The yolk sac is evident from three to eight days after hatching (Van Duzer 1939, Fuiman and Loos 1978). The observed length of larval specimens at this time ranges from 7.8 to 10 mm (Van Duzer 1939, Fuiman and Loos 1978).

1.3 Distribution, Abundance and Population Trends

The Cutlip Minnow has never had a wide distribution in Canada and has been found only in Ontario and Quebec. It is considered more widespread and not considered a Species at Risk in Quebec. In Ontario, the species status is likely stable, although lost from a number of historical locations new populations, low in abundance, have been found within the St. Lawrence River and surrounding tributaries (S. Reid pers. comm. 2013). Cutlip Minnow is known to occur only in the southeastern portion of Ontario, within the St. Lawrence and lower Ottawa River drainage areas. It has been found (and voucher specimens retained) within the Delisle River, North Raisin River, Raisin River, Little Rideau Creek, St. Lawrence River (including Lake St. Francis) and Hoasic Creek (Scott and Crossman 1973, Crossman and Holm 1996). No voucher specimens are known to exist prior to 1936 (Crossman and Holm 1996). Nash (1908) stated that the species occurred in Lake Ontario but no voucher specimens exist to validate that claim. Cutlip Minnow may also occur historically in the Garry River, Beaudette River and Rigaud River watersheds, which are located within the Raisin Region Conservation Authority, but information (including voucher specimens) to support this claim was unavailable. Appendix 1 shows the rivers where Cutlip Minnow has been found (either historically or currently) and confirmed with voucher specimens; years when sampling has occurred; and the number of specimens collected (if known). Figure 1 depicts confirmed occurrences and distribution within Ontario. The cut-off for current records is 20 years.

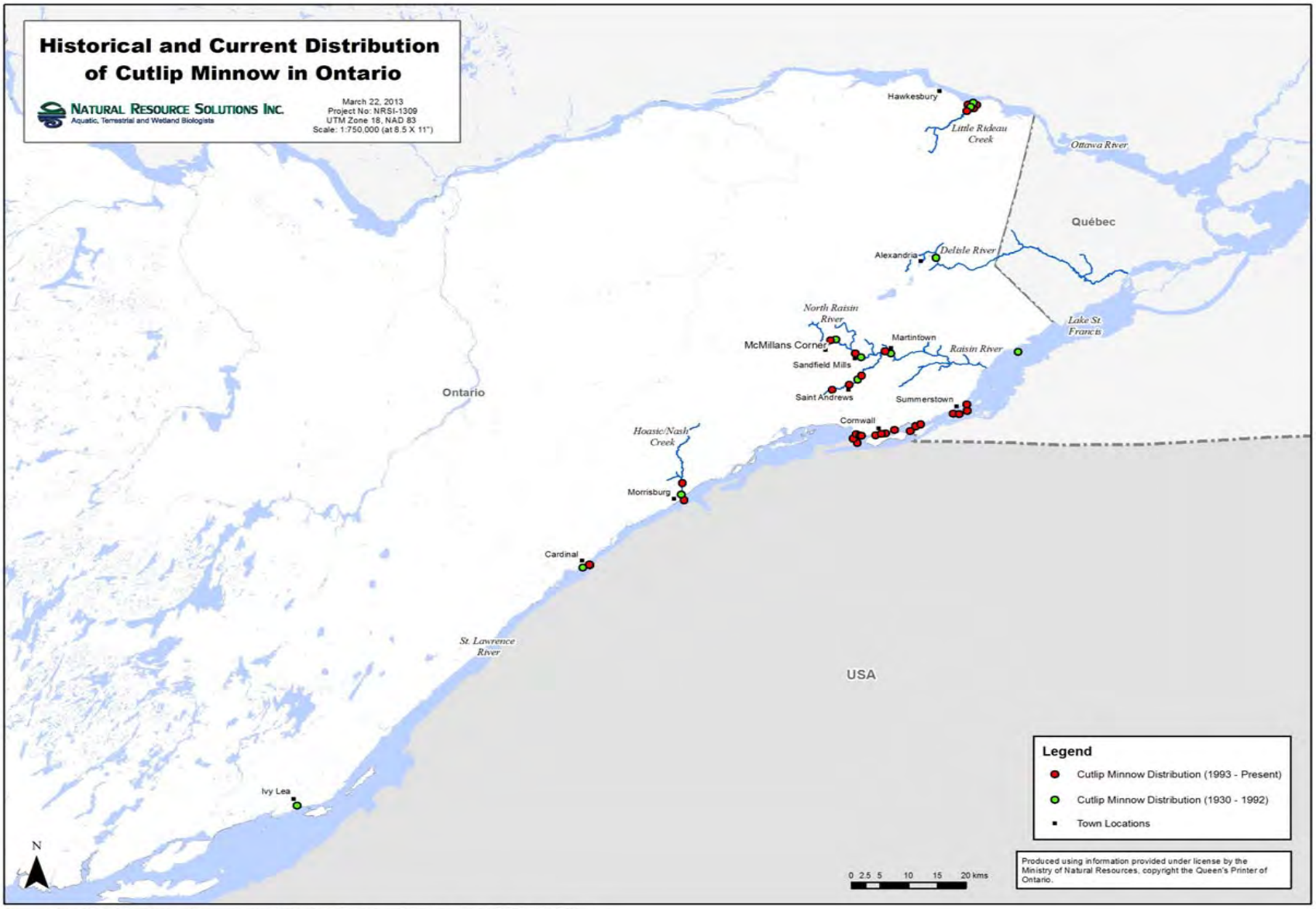

Figure 1. Confirmed occurrences of Cutlip Minnow in Ontario

Delisle River

The Delisle River drains into Lake St. Francis (St. Lawrence River). Cutlip Minnow were found at two sites (two and four individuals collected) in 1938 (Crossman and Holm 1996) downstream of Alexandria, Ontario. An additional two Cutlip Minnow were captured in 1939 at a site downstream of Alexandria. In 1943, Cutlip Minnow were considered by bait dealers to be common around the area downstream of Alexandria (Toner 1943). Sampling within the same stretch of river was conducted again in 1946, 1970, 2004, and 2010 and yielded no Cutlip Minnow (Dextrase and Reid 2004, Jacobs 2011).

Raisin River

In 1973, Cutlip Minnow were captured at three sites in the Raisin River during a stream survey conducted by the Ontario Ministry of Natural Resources (OMNR) (Crossman and Holm 1996, Dextrase and Reid 2004). The first site, located downstream of Martintown,was sampled again in 2004 by the OMNR and yielded four Cutlip Minnow (Dextrase and Reid 2004). At the other two sites sampled in 1973, which were located east of Saint Andrews, Ontario, three and five Cutlip Minnow were found. In 2008, the Raisin Region Conservation Authority (RRCA) conducted sampling between the two sites east of Saint Andrews and captured 26 Cutlip Minnow. Additional sites along the Raisin River were sampled by the RRCA in 2009 and 2010. The first site surveyed in 2009 was located to the west of Saint Andrews and five Cutlip Minnow were captured. The second site surveyed in 2009 was located to the east of Saint Andrews and two Cutlip Minnow were captured. The surveys conducted by RRCA were sampling for presence-absence and may not accurately reflect the population size. The additional two sampling sites surveyed in 2010 were located near Highway 401 in Cornwall and upstream of Williamstown. No Cutlip Minnow were found at either site (Jacobs 2009, 2010, 2011).

North Raisin River

In 1973, the OMNR captured Cutlip Minnow at a site downstream of Sandfield Mills. In 1989, sampling conducted by the Royal Ontario Museum resulted in the capture of six Cutlip Minnow (Crossman and Holm 1996, Dextrase and Reid 2004). The site was surveyed again in 2004 by the OMNR and nine Cutlip Minnow were found (Dextrase and Reid 2004). In 2009, the RRCA sampled a stretch of the North Raisin River, located upstream of Sandfield Mills, and found an additional six Cutlip Minnow (Jacobs 2010).

Little Rideau Creek

Cutlip Minnow were sampled from Little Rideau Creek near the outlet to the Ottawa River in 1978, and again in 1989 (Crossman and Holm 1996). In 2004, the OMNR conducted sampling at the same location and captured 15 Cutlip Minnow.
These specimens ranged in size, indicating that different age groups were present (Dextrase and Reid 2004). In July 2010, the OMNR sampled three locations on Little Rideau Creek, one of which being the same location as in previous years and the other two were further upstream, and yielded 98 Cutlip Minnow (Hogg 2010). One of these locations was re-sampled in October 2010, which also resulted in the capture of Cutlip

Minnow (S. Reid, pers. comm. 2013). While conducting the sampling in 2004, the OMNR also sampled Hughes Creek as it had similar habitat to Little Rideau Creek; however, no Cutlip Minnow were captured (Dextrase and Reid 2004).

Hoasic/Nash Creek

Cutlip Minnow were first captured in Hoasic or Nash Creek (both names are recognized) in 1938 near the town of Morrisburg, Ontario. Additional sampling was conducted at this site in 1967, 1989 and 2004, and no Cutlip Minnow were captured (Crossman and Holm 1996, Dextrase and Reid 2004). Upstream of this site, Cutlip Minnow were captured in 2008 by the South Nation Conservation Authority (M. Scheerder, pers. comm. 2012).

St. Lawrence River

Cutlip Minnow have historically been found throughout the St. Lawrence River, as far upstream as Ivy Lea and downstream to the Quebec border (Scott and Crossman 1973, Crossman and Holm 1996, Dextrase and Reid 2004). From 1936 to 1994, Cutlip Minnow were found in seven areas along the St. Lawrence River (including Lake St. Francis). These sites are located near the towns of Ivy Lea, Cardinal, Cornwall (the reef area and the waterfront area), Summerstown (Jacob's Island and Little Hog Island) and south of Bainsville within Lake St. Francis. In 1994, Beak Consultants Limited (1996) captured eight individuals at six separate sites along the Cornwall waterfront.

In 2008, sampling was conducted at Cornwall Reef, Jacob's Island and Little Hog Island by the SLRIES (MacKenzie and Hickey 2008). Each site was sampled two to four times during August to November. The Cutlip Minnow was only observed at Jacob's Island, where specimens were captured during both of the sampling trips. The sampling at Jacob's island yielded 1 specimen on the first trip and 10 specimens on the second trip. In 2009, the SLRIES re-sampled four of the sites sampled in 2008 and also four additional sites that were located upstream of Cornwall, Ontario (MacKenzie and Hickey 2010). The sites were sampled one to eight times during the season, depending on weather and location. Throughout the sampling, Cutlip Minnow were captured at the Cardinal site (one specimen over three sampling events), Morrisburg (one specimen over three sampling events) and Jacob's Island (three specimens over five sampling events). In 2008, the SLRIES also sampled 11 randomly selected sites and 1 supplemental site to determine Cutlip Minnow occurrence. The species was found at two of the randomly selected sites, near Hamilton Island and Colquhoun Island, and was also found in Rotary Creek (the supplemental site). In 2009, five additional sites, as well as the sites near Hamilton Island, Colquhoun Island and Rotary Creek, were sampled. Cutlip Minnow were captured from Colquhoun Island and Rotary Creek (MacKenzie and Hickey 2008, 2010).

Population Sizes and Trends

It is difficult to determine abundance and population trends for this species from the sampling data currently available. However, from this information, it appears that the Cutlip Minnow has been extirpated from the Delisle River but is still extant within the Raisin River and North Raisin River, Little Rideau Creek, Hoasic Creek and the St.

Lawrence River, although the overall health of these populations remains unknown. The occurrences within the St. Lawrence River appear to be widespread and may represent different populations, as Cutlip Minnow were captured at different locations from west of Cardinal to east of Cornwall, Ontario, a stretch more than 80 km (MacKenzie and Hickey 2010). Although this species has been found throughout the St. Lawrence River, it has never been captured in great abundance at any of the sites, with most sites having only a single fish captured (MacKenzie and Hickey 2010). The Cutlip Minnow is known to First Nation communities within the St. Lawrence River drainage area and although they do not attach special significance to the species itself, it (along with all minnows) is considered important in relation to the health of the aquatic community. The Mohawks of the Akwesasne are seeing a decrease in all minnow populations and believe that, through global warming, a majority of the species are migrating north into the smaller tributaries (H. Lickers, pers. comm. 2012).

In Quebec, this species is more abundant than in Ontario and is more widespread in its distribution, having been found at 274 sites before 1977 (Crossman and Holm 1996). The current status of the overall population of Cutlip Minnow within Quebec is undetermined as there have been no population assessments or inventories for this species (N. Vachon, pers. comm. 2012). However, regional sampling for fish communities occurs through Quebec's Réseau de Suivi Ichtyologique (Fish Monitoring Network) and since 2002, they have only captured Cutlip Minnow at 15 of the 26 drainage areas and 20 of the 134 waterbodies where it was historically present (Vachon 2012).

In New York state, Cutlip Minnow is considered abundant in many streams. The New York State Department of Environmental Conservation compared the frequency of occurrence of Cutlip Minnow in comprehensive stream samples from the 1930s and the 2000s from the St. Lawrence and Lake Ontario watersheds. This study showed that both watersheds had minor gains in the frequency of catch for Cutlip Minnow (D. Carlson, pers. comm. 2012) as well as some losses, in no real pattern. In an assessment of interstate streams in the Susquehanna River Basin, conducted in 2009, the Cutlip Minnow was found in four of the five locations sampled in New York and in five of the six sites within Pennsylvania near the New York border (Shank 2009).

1.4 Habitat Needs

In Ontario limited detailed habitat studies have been completed for this species. Cutlip Minnow has been observed in streams with various flow regimes and stream widths but most frequently occur in fast-moving sections of moderate-sized streams. The widths of the streams vary from 1 to 20 m, although in some areas of Lake St. Francis in Quebec widths can be several kilometres (Van Duzer 1939, Scott and Crossman 1973, Crossman and Holm 1994). This species inhabits areas with combinations of gravel, cobble and sand over a firm rocky bottom (Scott and Crossman 1973, Crossman and Holm 1994, B. Jacobs, pers. comm. 2012). Although, in Quebec, this species has been found inhabiting areas with hard clay or shale bottoms (Dumont, pers. obs. In Crossman

and Holm 1996) and areas where aquatic vegetation is present (Bernatchez and Giroux 2000). The Cutlip Minnow has a preference for warm to cool water (Scott and Crossman 1973) but the range of preferred water temperatures is not known. Additionally, information regarding the preferred dissolved oxygen levels, pH, conductivity and turbidity range for Cutlip Minnow is not known. In the United States, where more detailed habitat studies have been conducted, Cutlip Minnow have been observed along the bottom of pools and channels within clear streams (Van Duzer 1939). The influence of turbidity on habitat suitability remains unclear.

Recent sampling in Ontario has shown that most Cutlip Minnow were captured within the slightly slower sections of riffles, edges of pools (but not directly in pools) and eddy areas where the water is clear or tea-coloured (B. Jacobs, pers. comm. 2012). However, Reid and Parna (S. Reid, pers. comm. 2013) were successful at capturing Cutlip Minnow from a large pool within Little Rideau Creek in 2010 and Van Duzer (1939) captured Cutlip Minnow in pool habitats within the United States. It is unclear if apparent differences in habitat use between these studies are real or simply an artifact of differences in sampling methods. Reid and Parna (S. Reid, pers. comm. 2013) used a bag seine and Van Duzer (1939) used a net to capture the fish, whereas Jacobs (2012) used a backpack electrofisher. The use of a backpack electrofisher within a pool may potentially drive fish to the edge of a riffle as fish move away from the electric field (B. Jacobs, pers. comm. 2012). Van Duzer (1939) found Cutlip Minnow primarily in pools that ranged in depths from 0.6 to 1.2 m. The Cutlip Minnow prefers habitats without extensive silt and aquatic macrophytes (Van Duzer 1939, Scott and Crossman 1973, Crossman and Holm 1994). In-stream habitat includes logs, vegetation, overhanging banks and large flat rocks, which are all important for shelter; however, the flat rocks are used more extensively, especially during spawning (Hankinson 1922, Van Duzer 1939, Haase and Haase 1975, Pappantoniou et al. 1984a, 1984b). Observations of this species in Lake Cromwell, in Terrebonne County, Quebec, showed that this species primarily stayed within the littoral zone (i.e., <2m), and that 80 percent of the Cutlip Minnow were captured at depths of 0.5 m (Heinermann and Ali 1985).

The needs of spawning Cutlip Minnow consist of water depths ranging from 0.3 to 0.9 m (Van Duzer 1939, Lane et al. 1996a) in areas with a constant flow and a high abundance of varying sizes of gravel. They are often found in association with Common Shiner (*Luxilus cornutus*) (Van Duzer 1939).

Nursery habitat consists of water depths of 0.1 to 2.0 m with high percentages of gravel and lower percentages of sand (Lane et al. 1996b). Although information pertaining to flow is limited, it is likely that nursery habitats are found in slow- to moderate-flowing run and pool habitats. Limited information is available regarding the habitat use and seasonal movement of this species.

Fall and overwintering habitat for this species is unknown. Previous studies have shown that fall surveys yielded a lower number of Cutlip Minnow from areas where they were abundant during the spring and summer months (Haase and Haase 1975). A site on Rotary Creek, in Cornwall, Ontario had an abundant number of Cutlip Minnow during

summer sampling, but Cutlip Minnow were absent by November (MacKenzie and Hickey 2010), suggesting seasonal movement between habitats.

1.5 Limiting Factors

The main limiting factor for the Cutlip Minnow in Ontario is its limited distribution. The Cutlip Minnow most likely dispersed into Ontario towards the end of the last glaciation period after other colonization routes had disappeared. This limited distribution is in large part due to the fact that the Cutlip Minnow probably dispersed from an Atlantic Coastal refugium (Mandrak and Crossman 1992), since its range coincides with other Atlantic refugium species, such as Eastern Silvery Minnow and, to a lesser extent, Bridle Shiner. The Common Shiner has been identified as a potential species that may out-compete the Cutlip Minnow for food and for spawning areas. Common Shiners have also been observed harassing male Cutlip Minnow while spawning, which can result in the end of spawning activities for the Cutlip Minnow (Scott and Crossman 1973). More targeted sampling and information is needed before other limiting factors for Cutlip Minnow can be determined.

1.6 Threats to Survival and Recovery

Due to the lack of scientific study of the Cutlip Minnow, the following threats to the Ontario population are broad and speculative in some instances. Current threats that have the potential to negatively impact Cutlip Minnow survival and recovery potential include siltation and turbidity, dredging and shoreline/channel alterations, contaminants and toxic substance, invasive species, climate change and bait harvest.

Siltation and Turbidity

Since the Cutlip Minnow prefers areas with limited silt and clear, flowing water, it is likely that an increase in siltation and turbidity would negatively affect this species. Cutlip Minnow was historically found within the Delisle River in Ontario, but recent sampling indicated that the water is turbid and there is a high agricultural presence (primarily dairy farming) throughout the Delisle River area (Jacobs 2011, Dextrase and Reid 2004). Habitat degradation as a result of unimpeded cattle access to the stream, which was observed downstream of a site of the North Raisin River, could also harm the species as more sediment is entering the watercourse. The major land use within the Raisin River sub-watershed is agricultural with only 2.3 percent of the river flowing through public lands; this is a concern for known populations of Cutlip Minnow as it shows that the system has been influenced opening it up for siltation and turbidity issues (RRCA 2007). During spawning, this species chooses nest location based on the need for clean substrates; during the breeding season, male Cutlip Minnow have been observed sweeping silt and sediments off the nest in order to prevent suffocation of the eggs (Van Duzer 1939). In areas with increased siltation, males may not be able to find suitable locations or effectively clear their nest areas, resulting in decreased egg survival. Since the Cutlip Minnow is a benthic feeder, an increase in turbidity may result

in the inability to detect and capture food. Siltation of gravel substrates may also reduce the abundance of invertebrate prey, which will negatively affect the Cutlip Minnow.

Dredging and Shoreline\Channel Alterations

In Ontario, Cutlip Minnow is found within rivers where there is the potential for dredging or for shoreline/channel alterations, which would have a negative impact on this species. Within the headwaters of the Raisin River watershed there are sections that are classified as municipal drains that require maintenance under the *Drainage Act*. Within the St. Lawrence River system there are sections of shoreline that have been heavily altered and need to be maintained, mainly in response to development. As the Cutlip Minnow is a sensitive species, these maintenance processes still have the potential to negatively affect it, especially if these processes change sediment loads, the bed of the river (and substrates) or flow characteristics. For example, a common implementation strategy to reduce bank erosion is shoreline hardening. However, shore hardening may alter flow pattern and velocity within a river, which may in turn cause such issues as erosion and channel instability at sites downstream where Cutlip Minnow may reside. Although there have been little investigations into how degradation of in-stream habitat affects Cutlip Minnow populations, Kemp and Spotila (1997) captured Cutlip Minnow less frequently from urbanized sites than from non-urbanized streams in Pennsylvania.

Contaminants and Toxic Substances

No studies have been conducted with regards to specific impacts of contaminants and toxic substances on Cutlip Minnow populations, although since this species prefers clear, silt-free habitat any destruction or degradation to this habitat will have a negative impact on the species. Pollution, which may arise from point and non-point sources, such as urban runoff, industry, automobiles, sewage treatment plants and agricultural runoff, has the potential to impair water quality and consequently pose a threat to this species. Pesticides and fertilizers that are commonly used during agricultural practices may end up in watercourses through runoff. The effect of these substances on the Cutlip Minnow specifically has yet to be studied; however, agricultural runoff has been found to negatively affect the immune systems of such species as salmonids, carp and goldfish (Dunier and Siwicki 1992). In addition, the nitrogen and phosphorus components of agricultural and urban runoff encourage the growth of algae, impairing water quality by decreasing the amount of dissolved oxygen available for fishes.

Invasive Species

The impacts of invasive species on the Cutlip Minnow have not been studied. The Round Goby (*Neogobius melanostomus*), a recent invader in the Great Lakes and St. Lawrence River, has similar habitat requirements as the Cutlip Minnow and has the potential to compete for food, spawning areas and other habitat components. Studies in the St. Clair River have shown that increases in Round Goby populations have resulted in declines of native benthic species such as Mottled Sculpin (*Cottus bairdii*) and Logperch (*Percina caprodes*) (Jude et al. 1995). Round Goby are known to feed on the eggs of other fishes (Holm et al. 2009) and, therefore, may also feed on the eggs of Cutlip Minnow. The Round Goby is now considered to have established populations

within the St. Lawrence River up to Cornwall, although it has also been collected as far as St-Romuald in Quebec City (Fuller et al 2012). The Round Goby has also been collected in small numbers within the Raisin River (Jacobs 2011). A large number of Round Goby was captured at the Ivy Lea site, where Cutlip Minnow have historically been found; this may show that they utilize the same habitat. It is likely that the Round Goby will continue to expand its distribution and increase in numbers throughout the St. Lawrence and Ottawa Rivers and their tributaries, and thus has the potential to impact existing Cutlip Minnow populations. However, the distribution of Round Goby within tributaries may be influenced by the presence of dams, which may act as a potential barrier thus preventing the species from influencing Cutlip Minnow populations within upper reaches of the streams. Within the Raisin Region Conservation Authority there are two dams on rivers that currently or historically had Cutlip Minnow present. Brendan Jacobs (RRCA) caught a Round Goby in 2010 just upstream of Williamstown, which is approximately 15 km from the Martintown dam (B. Jacobs, pers. comm. 2013). No Round Gobies were caught upstream or immediately downstream of the dam. Round Gobies have also been captured on the lower part of the Delsisle River, downstream of historic Cutlip Minnow locations (B. Jacobs, pers. comm. 2013).

Climate Change

The effects of climate change in regards to the Cutlip Minnow population have not been studied and are challenging to predict. Studies have shown that a changing climate may result in an increased chance of flooding, redistribution of the annual hydrograph, higher temperatures within streams, and a reduced amount of water throughout the year (Nelitz et al. 2010, Dove-Thompson et al. 2011). Higher water temperatures within streams may not negatively affect the species as they are a cool- to warm-water species (Scott and Crossman 1973) and seem to tolerate the warmer temperatures of rivers in northeastern United States and Virginia. A reduction in water levels and volumes associated with climate change has the potential to reduce habitat availability at critical periods of the year (e.g., overwintering, nursery and spawning). In addition, reduced water levels and changes to hydrology have the potential to alter benthic macroinvertebrate communities, thereby effecting prey availability. While climate change may have an overall negative impact on the species, there is potential for some populations to benefit (e.g., increase in water temperatures may allow for dispersal into previously unsuitable habitats).

Bait Harvest

The effect of bait harvesting on the Cutlip Minnow population is unknown. Historically, bait dealers in Eastern Ontario (specifically near Ivy Lea and the Delisle River) considered the species common (Crossman and Holm 1996) and likely harvested it for bait. Therefore, it is plausible that historical bait harvesting may have had an impact on this species. Recently, the probability of harvesting Cutlip Minnow as bycatch during bait fish harvesting was assessed through harvest models and stock co-occurrence and the risk of it being harvested was found to be very low (Drake and Mandrak, in press). In addition the Cutlip Minnow is not legally allowed to be used as bait under the ESA and the Ontario Fishing Regulations.

1.7 Knowledge Gaps

There are numerous knowledge gaps that exist in relation to the distribution, abundance, biology, population dynamics and factors limiting recovery of Cutlip Minnow in Ontario. Specifically, these knowledge gaps include the following:

- Clarification of potential threats is needed for this species as limited information has been collected in past years. Specific information about the effects of each threat on Cutlip Minnow is required, as well as how to mitigate or reduce their impact on Cutlip Minnow populations. The impacts of dams on different populations of Cutlip Minnow should also be evaluated. Currently there is a dam on the St. Lawrence River at Cornwall and one at Martintown on the Raisin River. The effects of the dams on the Cutlip Minnow distribution are unknown, although the species is found above each of the dams.
- There is a need to conduct in-depth, targeted sampling for this species to determine the full extent of its distribution as well as its preferred habitats throughout all life stages and seasons within Ontario.
- Water quality parameters (effects of water quality, preferences and limitations) are also unknown.
- The effectiveness of different types of sampling gear (electrofishing, seining and minnow traps) is also a knowledge gap for this species.

2.0 RECOVERY

2.1 Recovery Goal

The recovery goal is to maintain and increase existing Cutlip Minnow populations and their habitats and, where feasible, restore areas with degraded habitat within the historical range of Cutlip Minnow in Ontario.

2.2 Protection and Recovery Objectives

Table 1. Protection and recovery objectives

No.	Protection or Recovery Objective
1	Improve the understanding of current population distribution, abundance and dynamics (age structure, recruitment, seasonal migration, mortality, population isolation/genetics/ability to recolonize).
2	Increase knowledge of specific habitat requirements for all life stages.
3	Ensure current habitat is protected and restore habitat where feasible.
4	Assess current and potential threats to the species and its required habitat. Implement mitigation measures to reduce effects of various threats.
5	Improve awareness of the Cutlip Minnow and its habitat.
6	Maintain or increase current population levels.

2.3 Approaches to Recovery

The following table lists the protection and recovery objectives and approaches that are recommended.

Table 2. Approaches to recovery of the Cutlip Minnow in Ontario

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
1. Improve the understanding of current population distribution, abundance and dynamics (age structure, recruitment, seasonal migration, mortality, population isolation/genetics/ability to recolonize).				
Critical	Short-term	Management	**1.1** Develop a standardized index sampling approach that allows for spatial and temporal comparisons of abundance, for all age classes. – Evaluate gear effectiveness and required effort to detect and quantify abundance at a site.	Knowledge Gaps • abundance • population status
Critical	Short-term	Management	**1.2** Ensure data from various agencies involved in Cutlip Minnow sampling is entered into NHIC database and create up-to-date mapping of current distribution.	Knowledge Gaps • distribution
Critical	Short-term	Research, Inventory, Monitoring and Assessment	**1.3** Evaluate population status at extant and historical locations. – Conduct targeted surveys to determine abundance at known sites and confirm extirpation at historical sites. – Identify age classes present at known locations to assess the health of the populations. – Conduct targeted sampling at new sites having suitable habitat conditions within the species current range.	Knowledge Gaps • distribution • basic biology • population status • abundance • interactions between species • habitat utilized

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Necessary	Short-term	Research	**1.4** Examine seasonal migration/movements on a few healthy populations. – Conduct sampling using tagging.	Knowledge Gaps • basic biology • habitat utilized • threat clarification
Necessary	Short-term	Research	**1.5** Evaluate fish communities in current/historic locations to provide insights into interactions among species.	Knowledge Gaps • interactions among species • threat clarification Threats • invasive species
2. Increase knowledge of specific habitat requirements for all life stages.				
Critical	Short-term	Monitoring and Assessment, Research	**2.1** Conduct sampling to determine locations, habitat requirements and seasonal variability in habitat use for all life stages. – Utilize an established standardized protocol, such as the Ontario Stream Assessment Protocol, for habitat collection in wadeable streams. – Establish a protocol for sampling Cutlip Minnow habitat in large, non-wadeable streams and rivers.	Knowledge Gaps • distribution • habitat utilized • basic biology • threat clarification
Critical	Short-term	Management, Research	**2.2** Determine water quality parameters and contaminant levels at current locations and through experiments to identify suitable conditions and threshold limits.	Knowledge Gaps • water quality • threat clarification Threats • siltation/turbidity • contaminants and toxic substances

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Necessary	Long-term	Management	**2.3** Develop a habitat suitability model and map areas with potential suitable habitat to guide in locating additional populations. – Determine adequate sites through field investigations.	Knowledge Gaps • distribution
3. Ensure current habitat is protected and restore habitat where feasible.				
Critical	Short-term	Management	**3.1** Implement best management practices to mitigate the effects of dredging, and channel/ shoreline alterations.	Knowledge Gaps • water quality • threat clarification Threats • siltation/turbidity • habitat degradation • dredging and channel/shoreline alteration
Critical	Short-term	Management, Protection	**3.2** Ensure habitat is afforded protection under the *Endangered Species Act* and other applicable legislation.	Threats • habitat degradation
Beneficial	Ongoing	Protection, Education and Outreach, Stewardship	**3.3** Work with agricultural landowners to reduce agricultural runoff and pollution, through the implementation of best management practices such as Controlling Soil Erosion on the Farm, and Pesticide Storage, Handling and Application.	Threats • contaminants and toxic substances • siltation/turbidity • habitat degradation
Beneficial	Long-term	Education and Outreach	**3.4** Educate and assist private landowners with maintaining healthy aquatic ecosystems (e.g. Implement tile drain valves to reduce the loading of deleterious substances). Inform interested groups about best management practices and stewardship programs.	Threats • contaminants and toxic substances • siltation/turbidity • habitat degradation • dredging and channel/shoreline alteration

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Beneficial	Long-term	Protection, Stewardship	**3.5** Encourage riparian plantings along banks to reduce erosion. This should be done through the promotion of best management practices and stewardship programs.	Threats • siltation/turbidity • contaminants and toxic substances
Beneficial	Ongoing	Protection, Stewardship	**3.6** Work with Conservation Authorities, stewardship groups and other organizations to use best management practices (e.g. build silt traps in areas where necessary) to improve water quality.	Threats • siltation/turbidity
4. Assess current and potential threats to the species and its required habitat. Implement mitigation measures to reduce effects of various threats.				
Critical	Short-term	Protection, Research	**4.1** Determine specific effects of sediment loading and siltation.	Knowledge Gaps • threat clarification Threats • siltation/turbidity
Necessary	Short-term	Protection, Researcg	**4.2** Conduct research to identify specific upper thresholds for turbidity experimentally.	Knowledge Gaps • threat clarification Threats • siltation/turbidity
Necessary	Long-term	Protection, Management	**4.3** Conduct research to determine physiological thresholds of dissolved oxygen and common contaminants such as urban and agricultural pollution (including nitrogen and phosphorus) and use this knowledge to develop best management practices and guidelines.	Knowledge Gaps • water quality • threat clarification Threats • contaminants and toxic substances

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Necessary	Long-term	Research	**4.4** Assess potential impacts of invasive species (e.g. Round Goby) on Cutlip Minnow.	Knowledge Gaps • interactions between species • threat clarification Threats • invasive species
Beneficial	Ongoing	Management, Education and Outreach	**4.5** Assess relative impacts of incidental catch/harvest during baitfish harvesting to determine potential impact on Cutlip Minnow populations.	Knowledge Gaps • threat clarification Threats • bait harvest
5. Improve awareness of the Cutlip Minnow and its habitat.				
Necessary	Ongoing	Protection, Management, Communications	**5.1** Where possible address recovery objectives for Cutlip Minnow in other species recovery strategies for species whose distribution overlaps with that of Cutlip Minnow (e.g. Pugnose Shiner and Channel Darter).	Knowledge Gaps • interactions between species • threat clarification • scientific monitoring
Necessary	Ongoing	Education and Outreach, Communications, Stewardship	**5.2** Promote incentives available to farmers to protect species at risk and aquatic habitats (e.g., Species at Risk Farm Incentive Program).	Threats • siltation/turbidity • contaminants and toxic substances • habitat degradation
Necessary	Ongoing	Education and Outreach	**5.3** Coordinate recovery actions with other conservation groups, interested landowners, and the public.	Threats • siltation/turbidity • contaminants and toxic substances

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
Necessary	Short-term,	Education and Outreach	**5.4** Work with First Nation communities in Eastern Ontario and encourage sharing of information related to Cutlip Minnow, including Aboriginal Traditional Knowledge.	Knowledge Gaps • distribution • habitat utilized • basic biology • abundance • interactions
Beneficial	Long-term	Management	**5.5** Engage interested agencies (i.e. municipalities and private landowners) within the known range to educate them about the species and what they can do to help the species. Ensure that the needs of the species are addressed in ongoing management approaches.	Threats • habitat degradation
Beneficial	Long-term	Protection	**5.6** Raise public awareness about Cutlip Minnow and importance of habitat protection.	Threats • bait harvest • contaminants and toxic substances • siltation/turbidity • habitat degradation
Beneficial	Ongoing	Education and Outreach	**5.7** Work with bait harvesters licensed to operate in Eastern Ontario and emphasize importance of proper identification of fishes, and encourage the reporting of incidental captures to MNR.	Knowledge Gaps • distribution • threat clarification Threats • bait harvest

Relative Priority	Relative Timeframe	Recovery Theme	Approach to Recovery	Threats or Knowledge Gaps Addressed
6. Maintain or increase current population levels.				
Critical	Short-term	Management, Protection	**6.1** Establish a long-term monitoring program to assess health of current populations. – Long-term monitoring program should be standardized and repeatable to provide a reasonable estimate of abundance, and track population changes temporally. – Monitoring should be implemented collaboratively among Conservation Authorities, municipalities, stewardship groups and government agencies.	Knowledge Gaps • threat clarification • scientific monitoring Threats • siltation/turbidity • contaminants and toxic substances • habitat degradation • invasive species • climate change
Critical	Short-term	Management, Protection	**6.2** Protect habitat at current locations through the implementation of best management practices and stewardship programs. Work with landowners to establish site specific stewardship plans at known Cutlip Minnow sites.	Knowledge Gaps • threat clarification • scientific monitoring Threats • siltation/turbidity • contaminants and toxic substances • habitat degradation • invasive species • climate change
Necessary	Long-term	Management, Protection	**6.3** Review and evaluate goals and objectives to determine progress and identify any changes that may need to be made.	Knowledge Gaps • threat clarification • scientific monitoring

2.4 Performance Measures

The effectiveness of recovery objectives and approaches should be assessed through long-term monitoring programs and will measure the current distribution, abundance and health of Cutlip Minnow populations. The goals and objectives set out in this recovery strategy should be reviewed and evaluated every five years to determine progress and to identify any changes or additional information (threats) that should be included. It should be emphasized that many of the recommendations are targeted at learning more about the species. It is anticipated that as knowledge increases approaches need to evolve to reflect our better understanding of the species and its habitat requirements.

Performance measures to evaluate the effectiveness of the recovery objectives include:

- increase in population size at current sites;
- increased knowledge of current populations including distribution, abundance, and dynamics;
- identification of habitat requirements for all life stages;
- reduction of known threats at current locations; and
- awareness of Cutlip Minnow improved through land owner contact and public notices, resulting in improved habitat at current and historic locations.

2.5 Area for Consideration in Developing a Habitat Regulation

Under the ESA, a recovery strategy must include a recommendation to the Minister of Natural Resources on the area that should be considered in developing a habitat regulation. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species. The recommendation provided below by the author will be one of many sources considered by the Minister when developing the habitat regulation for this species.

It is recommended that those reaches currently occupied by Cutlip Minnow and historical reaches with high potential for rehabilitation and a reasonable likelihood of recolonization be prescribed as habitat within a habitat regulation under the ESA. Within these reaches, only those areas that meet the functional (spawning, nursery, and adult life stages) habitat characteristics described for the various life stages of Cutlip Minnow should be identified as habitat within the habitat regulation. These reaches should include the important habitat features, such as spawning areas, pools and channels with firm bottoms, and substrates consisting of large flat rocks and varying sizes of gravel. As the species has been found in lakes within Quebec, the area of consideration for lake populations should include the littoral zone to a depth of 2.0 m (Heinermann and Ali 1985). The littoral zone depth should also be applied to bay areas within the St. Lawrence.

Fall and Overwintering Habitat

The habitat utilized during the fall and winter months is unknown for this species. As recent sampling within Rotary Creek in Cornwall, Ontario has found that Cutlip Minnow were absent by November (MacKenzie and Hickey 2010), this species may leave the shallower riffle sections to head to deeper water (most likely pools) to overwinter. The overwintering habitat of this species should be included in the habitat regulation after more research has been conducted.

There remains a limited amount of information about the amount of habitat needed and where these habitats may be located. However, since habitat is poorly understood for some of the required life stages, the actual and historical presence of the species should drive recovery decisions until habitat needs are more fully researched and understood. More sampling and studies should be conducted to refine knowledge of the habitat needs for this species. As our understanding of habitat requirements for the required life stages improves, prescribed habitat may be refined and expanded.

GLOSSARY

Benthic: Associated with the bottom of a body of water.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): The committee established under section 14 of the *Species at Risk Act* that is responsible for assessing and classifying species at risk in Canada.

Committee on the Status of Species at Risk in Ontario (COSSARO): The committee established under section 3 of the *Endangered Species Act, 2007* that is responsible for assessing and classifying species at risk in Ontario.

Conservation status rank: A rank assigned to a species or ecological community that primarily conveys the degree of rarity of the species or community at the global (G), national (N) or subnational (S) level. These ranks, termed G-rank, N-rank and S-rank, are not legal designations. The conservation status of a species or ecosystem is assigned using a number from 1 to 5, preceded by the letter G, N or S reflecting the appropriate geographic scale of the assessment. The numbers mean the following:

1 = critically imperilled
2 = imperilled
3 = vulnerable
4 = apparently secure
5 = secure

Eddy*:* A current of water moving contrary to the direction of the main current, usually in a circular motion.

Endangered Species Act, 2007 (ESA): The provincial legislation that provides protection to species at risk in Ontario.

Extant: A species or population that still is present or in existence.

Extirpated: A species that lives elsewhere in the world or lived at one time but no longer lives in the wild in Ontario.

Hydrograph: A graph of the water level or rate of flow of a body of water as a function of time, showing the season change.

Invasive species: A harmful alien species whose introduction or spread threatens the environment, the economy or society, including human health.

Littoral Zone: Near-shore area in a lake or pond where sun penetrates all the way to the bottom.

Species at Risk Act (SARA): The federal legislation that provides protection to species at risk in Canada. This Act establishes Schedule 1 as the legal list of wildlife species at risk. Schedules 2 and 3 contain lists of species that at the time the Act came into force needed to be reassessed. After species on Schedules 2 and 3 are reassessed and found to be at risk, they undergo the SARA listing process to be included in Schedule 1.

Species at Risk in Ontario (SARO) List: The regulation made under section 7 of the *Endangered Species Act, 2007* that provides the official status classification of species at risk in Ontario. This list was first published in 2004 as a policy and became a regulation in 2008.

Threatened: A species not listed as endangered but likely to become endangered if steps are not taken to address factors threatening to lead to its extinction or extirpation.

Viable: Capable of sustaining life.

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APPENDIX 1
Sampling Locations of Cutlip Minnow in Ontario

River	Site Location (nearest town/island in Ontario)	Year Sampled	# of Cutlip Minnow captured (if known)
Delisle River	Alexandria	1936	2
		1938	4
		1939	2
		1946	0
		1970	0
		1973	0
		1978	0
		2004	0
		2010	0
Raisin River (North Branch)	East of McMillans Corner	1973	unknown
		2009	6
	Sandfield Mills	1973	5
		1989	6
		2004	9
Raisin River	West of St. Andrews	2009	5
	St. Andrews	2009	2
	East of St. Andrews	1973	3, 5
		2008	26
	Martintown	1973	unknown
		2004	4
	West of Williamstown	2010	0
Tributary to Raisin River	Cornwall	2010	0
Hoasic/Nash Creek	East of Morrisburg	1938	unknown
		1967	0
		1989	0
		2004	0
		2008	1
Little Rideau River	East of Hawkesbury	1978	21
		1989	3
		2004	15
		2010	98
		2010	unknown
Rotary Creek	Cornwall	2008	13, 24, 64, 29
		2009	62
St. Lawrence River	Ivy Lea	1936	4
		1937	unknown
		2009	0
	Cardinal	1981	11
		1994	1

River	Site Location (nearest town/island in Ontario)	Year Sampled	# of Cutlip Minnow captured (if known)
		2009	1
	Morrisburg	2008	0
		2009	1
	Riverside Heights	2008	0
		2009	0
	Cornwall (reef)	1994	unknown
		2009	0
	Cornwall (Waterfront area)	1994	3
		1994	1
		1994	1
		1994	1
		1994	1
		1994	1
		2009	0
		2009	0
	Cornwall (Crab Island)	2009	unknown
	Cornwall (Colquhoun Island)	2008	2
		2009	2
	Glen Walter	2009	0
	Summerstown (Jacob`s Island)	1994	1
		2008	1
		2009	3
	Summerstown (Little Hog Island)	1994	1
		2008	0
		2009	0
	Summerstown (Hamilton Island)	2008	1
		2009	0
	Lake St. Francis (south of Bainsville)	1938	4