

Puslinch Lake Fish Habitat Assessment

**Ministry of Natural Resources
Guelph District**

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INTRODUCTION

Well before the turn of the century, Puslinch Lake was recognized as a central point for recreation for many miles around (Hans et al. 1981). The lake was used for many activities including swimming, motor boating, sailing, fishing and water skiing. However, in recent decades, the increasing thickness of organic sediments, seasonal algal blooms, extensive macrophyte growth and periodic fish kills have resulted in a greatly reduced enjoyment of these activities. Changes in Puslinch Lake are the result of eutrophication, the process of gradual nutrient enrichment, which is a natural process in all lakes. In Puslinch Lake, this process has been greatly accelerated by the effects of humans.

Recent interest in improving the recreational quality of Puslinch Lake has resulted in the identification of a number of rehabilitation options (Harden Environmental Services Ltd. 1999). To assist in fully evaluating these various options in the context of their potential impact on the existing fish populations and fish habitat of Puslinch Lake, staff from the Guelph Area office of the Ontario Ministry of Natural Resources (OMNR) conducted a fish habitat assessment of the lake in May and June of 2000. A fish habitat assessment was conducted concurrently by the Puslinch Lake Conservation Association (PLCA 2000).

DESCRIPTION OF THE STUDY AREA

Puslinch Lake has the distinction of being the largest natural body of water in Southwestern Ontario, excluding the Great Lakes. It is located in Wellington County just northeast of the City of Cambridge (Figure 1). The surface area of the lake is approximately 156 ha, with a water volume of $2.27 \times 10^6 \text{ m}^3$ and a mean depth of 1.4 m. (Harden Environmental Services Ltd. 1999). The lake measures 2.012 km by .805 km. There are five islands, the biggest of which measures 2.4ha. (Figure 2). There are a few shoals and one main deep area located off McCormick's Point.

Puslinch Lake is a natural hard water kettle lake, which serves as a catch basin, for a 972.5 ha watershed that drains towards it (CH2M Gore & Storrie Limited et al. 1996). Under certain high water conditions, the lake discharges in a northerly direction to Puslinch Lake Creek which is a tributary of Irish Creek (Figure 2). Irish Creek

discharges to the Speed River, which is a major tributary of the Grand River. A dam on Irish Creek near its mouth prevents the upstream migration of fish from the Speed River into Puslinch Lake. In the past, fill was placed near the outlet to Puslinch Lake Creek along the north shore of the lake in the winter (Dryden and Smith and Kilborn Engineering 1966). This may have had the effect of raising the lake level.

There are no permanent inflow streams and the lake is fed seasonally by a combination of local surface runoff and groundwater springs under the lake surface (Dryden and Smith and Kilborn Engineering 1966). Several intermittent watercourses discharge to Mud Bay (D. Coulson pers. comm. June 2000) (Figure 2). A channel connects Puslinch Lake to Little Lake, located to the northeast of the lake (Figure 2). Water flows between these lakes during high water conditions only. See Harden Environmental Ltd. (1999) and CH2M Gore & Storrie Limited et al. (1996) for a description of the lake's watershed, including its geology, physiology, hydrology and hydrogeology.

Water clarity is generally good in the early season, ranging from 1.0 to 2.0 meters in most years. Secchi disc depth drops to 0.4 metres or less each year due to algae and resuspended sediment (Vandermeulen and Gemza 1992). Vandermeulen and Gemza (1992) provide a description of the lake's phosphorus loads, sediment, macrophytes, water chemistry, phytoplankton, zooplankton, lake turnover rate and dissolved oxygen.

There are approximately 150 permanent homes and 50 cottages along the lake's shoreline. Two trailer parks are also present which contain 350 trailers. Most residents live along the north shore, however, McCormick's Point on the south shore also has a well-rooted resident population.

Puslinch Lake is associated with the Puslinch Lake-Irish Creek Wetland (Coulson et al. 1985) which is a Provincially Significant wetland.

PUSLINCH LAKE FISH COMMUNITY

A total of sixteen fish species are known to be present in Puslinch Lake (Appendix A). Muskellunge, which were stocked by the Department of Lands and Forests between 1953 and 1955, are now assumed to be extirpated from the lake. The last known catch from the lake was in the early 1970's (Hans et al. 1981). The Puslinch

Lake population of banded killifish is one of only a few known populations in the entire Grand River watershed.

Smallmouth bass, which were stocked by the Department of Lands and Forests between 1947 and 1964, are now considered to be rare in the lake.

The walleye population in Puslinch Lake is considered to be an introduced population. Walleye were released into the lake as early as the late 1940's (Hans et al. 1981). Between 1979 and 1981 adult walleye from the lower Grand River at Dunnville were released into the lake. A fisheries assessment conducted by the OMNR in 1987 (Halyk 1987) indicated there was some natural reproduction of walleye occurring in the lake. As recently as April 2000, several 15 – 20 cm long walleye were caught in the lake (Rick Christian, pers. comm. June 2000), indicating that natural reproduction of this species is still occurring. Most recently, the Puslinch Lake Conservation Association has been stocking walleye since 1997.

The northern pike population in Puslinch Lake is thought to be the result of an inadvertent introduction in the 1950's (Hans et al. 1981). The introduction of pike was thought to have led to a decline in the populations of both walleye and bass in the 1950's.

It is unknown if the existing black crappie population is natural or the result of stocking. Sixteen 15 – 18 cm long black crappie were released into the lake in 1957.

Growth rates of juvenile sportfish (e.g. perch, bass, and sunfish) in 1987 were very low (Halyk 1987), which suggests an inadequate food supply of invertebrates such as zooplankton.

Periodic fish kills in both summer and winter have been documented as far back as the winter of 1953 and as recently as 1992 (Coulson, in prep.). Some of these fish kills were quite significant and would be expected to result in significant adjustments to the fish community in the lake.

METHODS

The physical characteristics of a waterbody, and the habitat requirements of fish species will determine which fish species can successfully carry out their life processes in that waterbody. The following physical attributes of Puslinch Lake were described and mapped: water depth (bathymetry), shoreline characteristics, aquatic vegetation,

substrate, cover and fish spawning areas. A fish habitat assessment was conducted concurrently by the Puslinch Lake Conservation Association (PLCA 2000).

Bathymetry

The depths of the lake were recorded from June 7 – 12, 2000. Fieldwork was completed by canoe, travelling around the entire lake, using the wind as an advantage. No determined set of transects or constant speed was necessary. In shallow areas, depths were measured with a meter stick and in deeper areas the depths were measured using a weighted hand line marked in 10-cm intervals. A Hummingbird 100SX depth sounder was used to find the deepest area of the lake, but was not used the majority of the time, because of its inaccuracy at shallow depths and interference with the transducer by aquatic vegetation. A Geo Explorer II Global Positioning System (GPS) unit was used to capture the location of depth points used to create maps. A total of 166 depth points were used to generate the bathymetric map.

Using benchmark DHO No. 25-66 located on the bridge at the nearby Highway 401, it was been determined that the elevation of the top of the concrete dock at the Old Marina Restaurant is 1000.64 feet above sea level (Dryden and Smith and Kilborn Engineering 1966).

Shoreline Description

The perimeter of the lake and its islands was observed by canoe to characterize the lake shoreline. Natural vegetation types along the shoreline were classified according to the Ecological Land Classification manual for Southern Ontario (Lee et al. 1998). Cultural shorelines were classified into one of five types; vertical bank, gravel slope, cultural meadow, lawn or beach. The shoreline was surveyed on May 30, 2000 using a Geo Explorer II GPS unit to map the location of shoreline types.

Aquatic Vegetation

The extent of aquatic vegetation was determined during a cursory survey on June 22, 2000 using a canoe. Both random observations and transects were conducted. A Geo Explorer II GPS unit was used to accurately map the location of aquatic vegetation.

Aquatic vegetation units were mapped using ArcView.

Substrate

In shallow depths, substrate types were determined through visual observation using a canoe. Aerial photographs and the GPS Explorer II GPS unit were used between May 26 and May 30, 2000 to determine and map the physical extent of various substrate types. A ponar was used to collect grab samples in deeper areas on June 14, 2000. Substrate types were classified according to the criteria in the Manual of Instructions Aquatic Habitat Inventory Surveys (Dodge et al.1982).

Lake Cover

In-lake cover consists mainly of logs and stumps, but such things as tires, sunken boats and other objects can also be considered as cover. GPS data was collected from May 26 to May 30, 2000 using the Geo Explorer II and mapped in the GIS Arc View program.

Fish Spawning Areas

Nests of largemouth bass, pumpkinseed and black crappie were observed during fieldwork conducted between May 11 and May 24, 2000. The perimeter of the lake was travelled by canoe, and the locations of nests were recorded with the GPS unit. Large numbers of nests in a small area were mapped as polygons and individual nests were mapped as points. Information on spawning activities of northern pike, walleye, yellow perch and black crappie was obtained from information on file at the MNR or from anglers. Cursory observations of fish spawning activity had previously been made during fieldwork conducted in June 1999.

RESULTS

Bathymetry

Water depths recorded between June 7 and June 12, 2000 are illustrated on Figure 3. These depth contours illustrate the area where dredging occurred along the north shore of the lake in 1999 and the spring of 2000. Most of the lake is less than 2 metres in

depth. The area of the lake that is 3 metres or deeper is approximately 3.5 hectares or only about 2.2% of the 156 hectare lake. The maximum depth was found to be 5.5 meters. This deep area occupies an area of approximately 0.6 hectares or less than 0.4% of the lake.

This deep area is important to the fish population because it provides cover in the spring when vegetation has not yet grown. It also provides a cool thermal refuge during hot summer temperatures. Walleye are light sensitive, so they prefer deeper water. Deep water provides a place for fish to live in the winter because the water stays around 4°C.

The lake surface was estimated to be 0.63 m below the “normal” June level during the time period when these depths were recorded (Jeff McLintock, pers. comm. May 2000). This below normal condition was attributed to the below average precipitation that had occurred in the watershed over the past several years.

Shoreline Description

A breakdown of the shoreline types around Puslinch Lake by percent coverage is presented in Table 1 and Figure 4. This breakdown includes the shorelines of the islands. Approximately 57% of the shoreline is composed of natural vegetation (Table 1). A description of both the natural and cultural shoreline types is found in Table 2. The natural vegetation types were classified according to the Ecological Land Classification manual for Southern Ontario (Lee et al. 1998). The locations of the various shoreline types around the lake and its islands are illustrated in Figure 5.

Aquatic Vegetation

During the aquatic vegetation survey conducted on June 22, 2000, dense beds of floating rooted plants consisting of White Water-lily (*Nymphaea odorata*) and Bullhead Pond-lily (*Nuphar variegata*) were observed (Figure 6). Submerged plants consisting of Coontail (*Ceratophyllum demersii*), Muskgrass (*Chara sp.*) and filamentous algae as well as Duckweed (*Lemna sp.*) were found among these floating plants.

The extent of submerged aquatic vegetation in Puslinch Lake is known to vary throughout the vegetative growing season (Limnos Limited 1988, PLCA 2000) and between years (Vandermeulen and Gemza 1992, PLCA 2000). During some years the

aquatic macrophytes are very dense while during other years, macrophytes do not develop as extensively, presumably due to the shading effect of the murky water. Periods of high aquatic plant densities are suspected to follow major fish kills when zooplankton densities increase, resulting in improved water clarity (PLCA 2000). Aquatic plant densities have apparently receded in recent years as is typical of a rapidly eutrophying algal dominant lake state (PLCA 2000).

During the aquatic vegetation survey conducted on June 22, 2000 submerged aquatic vegetation was observed to cover virtually the entire lake bottom except for the shoal located between Big Island and the north shore of the lake. No attempt was made to determine the extent of aquatic vegetation in areas where water depth and/or turbidity prevented accurate observation.

Species diversity was low and was dominated by Coontail, with considerably lesser amounts of Water Milfoil (*Myriophyllum sp.*), Muskgrass, Curly-leaved Pondweed (*Potamogeton crispus*), Large-leaved Pondweed (*Potamogeton amplifolius*) and Sago Pondweed (*Potamogeton pectinatus*). In 1989, the lake was dominated by curly-leaved pondweed prior to the late June die-off and the nearshore was dominated by muskgrass (PLCA 2000). The growth of aquatic vegetation in 2000 was considered to be “late” because of cooler than normal water temperatures.

Figure 7 shows the extent of aquatic vegetation during the month of August 1997, interpreted from colour infrared air photos. Based on our observations of June 2000, it is apparent that these photos illustrate only those areas where aquatic vegetation has grown to the lake surface.

Limnos Limited (1988) conducted two surveys of the aquatic vegetation in Puslinch Lake in 1987. The early summer survey was completed between June 22 and June 24 and the late summer survey was completed between September 1 and September 4. Approximately 54 hectares, or only 33% of the lake supported macrophyte growth during the early summer survey (Appendix B). These observations contrast with ours in that we observed almost complete coverage of the eastern basin of the lake with submerged aquatic vegetation on June 22, 2000.

During the late summer survey, approximately 31 hectares, or only 19% of the lake supported plant growth (Appendix C). Poor water clarity was thought to limit the

macrophyte distribution to relatively shallow depths (Limnos Limited 1988). The diversity of aquatic plant species was low, and during the surveys, the growth of macrophytes was discontinuous in available habitat.

Substrate

The locations of the various substrates in the lake are illustrated in Figure 8. The majority of the lake substrate consisted of soft substrates such as muck and silt. Harder substrates consisting of gravel, rubble and boulder were limited to the shorelines of the islands, McCormick's Point and a small area along the north shore.

Lake Cover

In-lake cover in Puslinch Lake was very limited. It consisted of logs, stumps, lumber, and sunken boats. These areas are also illustrated in Figure 8.

Fish Spawning Areas

Largemouth Bass

According to Scott and Crossman (1973), the largemouth bass spawns from late spring to mid summer, with the peak of spawning usually early to mid June. Nest building by males usually begins within a few days of the time the mean water temperature reaches 15.6 degrees Celsius. Spawning grounds vary from gravelly sand to marl and soft mud, in reeds, bulrushes, or water lilies. The very aggressive territorial males sweep clean an area 61.0-91.5 cm in diameter and, depending on the hardness of the bottom, 25 - 203 mm deep, usually in 30.5 - 122.0 cm of water. Often the bottom of the nest includes the exposed roots of emergent vegetation. Nests are usually at least 9.15 m apart. Hatching takes 3 - 5 days at a water temperature prevalent in Canadian habitats.

The nesting areas of this species as observed between May 11 and May 24, 2000 are shown in Figure 9. Nests were found in 22 – 30 cm of water. In most cases, largemouth bass nests and pumpkinseed nests were found in the same general areas and these areas of mixed species were mapped as polygons or points. Largemouth bass nests

were found on a wide variety of substrates from gravelly sand to muck areas. According to Scott and Crossman (1973), these substrate types are found to be adequate for this particular species to nest on. Puslinch Lake has a large percentage of soft substrates; the nesting sites on Figure 9 can be compared to the substrate types illustrated on Figure 8.

Nest locations were generally similar to those observed by the PLCA (2000). However, the PLCA (2000) suggested that the preferred spawning habitat was in areas where gravel and rock rubble were covered by less than 15 cm of sediment. Nests were observed close to shore in areas where sediment had been compacted either by human use or by low water levels from the previous year. Nests were limited to 0.2 m of water because at deeper depths, organic muds covered the gravel so that nest excavation to stone was not possible. As stated above, we observed many nests that were not excavated to hard substrates. Both groups found high densities of nests near the outflow of the lake on the north shore.

Largemouth bass nests found during fieldwork conducted by the Ministry of Natural Resources in June 1999 were at the same locations as those found during this study. The observation and capture of numerous largemouth bass fry in Puslinch Lake by the MNR in June 10, 1999 indicates that this species reproduces successfully in the lake.

Smallmouth Bass

Smallmouth bass usually spawn over a period of 6 – 10 days in the late spring and early summer, most often late May to early July (Scott and Crossman 1973). For spawning, they require harder substrates than largemouth bass; usually sand, gravel or rocky bottoms. No smallmouth spawning activity was observed during the study, however potential spawning habitat does exist (Figure 8). The smallmouth bass population in Puslinch Lake is considered to be low.

Pumpkinseed

Spawning of this very decorative sunfish usually begins in late spring to early summer. The nest, constructed by the male, is in the shallow water of ponds, lakes or slow moving streams; usually in depths of 152 - 305 mm near shore. Nest building by males begins when water depth reaches 20 degrees Celsius. Nests are shallow

depressions at 102 - 406 mm in diameter; usually two times the length of the adult. They are found in areas of submerged aquatic vegetation and often are numerous and very close together (Scott and Crossman 1973).

In Puslinch Lake, pumpkinseed nests were observed very close together. Substrates where their nests were found ranged from clay/sand to gravel/rock. The male sweeps only deep enough to expose a clean, hard bottom. Often exposed roots are used for egg attachment (Scott and Crossman 1973). This was a typical observance in Puslinch Lake, especially in the areas where the substrate was more organic than silt. There is considerable display and swimming in a circular path during courtship and mating. Mutual bunting and nipping also stimulates spawning (Scott and Crossman 1973). All of these activities mentioned commonly occurred throughout mid-May to early June. Figure 9 illustrates that many of the pumpkinseeds were nesting in close proximity to largemouth bass, in the same general substrates, but at shallower depths. Pumpkinseed nests were generally in 18 – 30 cm of water, however at one location, nests were observed in water as shallow as 10 cm. Pumpkinseed nests found during fieldwork conducted by the Ministry of Natural Resources in June 1999 were at the same locations as those found during this study.

Pumpkinseed adults and fry were observed over nests along the north shore of the lake on June 19, 2000.

Black Crappie

This species was not observed spawning during this study. Rick Christian (pers. comm. June 2000) observed this species spawning among the boulders on the west side of St. Helen Island in June 2000. This nesting area is shown on Figure 9. Black crappie weighing up to 0.8 kg have been caught in the lake. (Rick Christian, pers. comm. June 2000).

Northern Pike

The northern pike spawn in the spring and spawning takes place immediately after ice melts in April to early May, when temperatures are at 4.4 - 11.1 degrees Celsius (Scott and Crossman 1973). Spawning then takes place during day light hours. They

usually spawn on heavily vegetated flood plains of rivers, marshes, and bays of larger lakes. Pike pair at spawning time with a larger female usually attended by one or two smaller males. They swim through and over the vegetation in water often no deeper than 178 mm.

Daryl Coulson observed pike spawning in an intermittent tributary discharging to Mud Bay in 1986. In the spring of 1993, Libor Michalak observed pike in part of the wetland that has a connection to the lake. On several occasions, as recently as the spring of 2000 (Brendan O'Farrell, pers. comm. 2000), pike have also been observed in the roadside ditches along Wellington County Road 32 near Puslinch Lake Creek. All of these areas meet the characteristics that northern pike require for spawning and nursery. These spawning areas are illustrated on Figure 10.

Yellow Perch

The yellow perch spawns in the spring, usually mid April to early May. Water temperatures of 8.9 - 12.2 degrees Celsius have been cited (Scott and Crossman 1973). Adults migrate shoreward into shallows of lakes, and often into tributary rivers to spawn. The smaller males move into spawning grounds first and then are followed by the females. Males remain longer than do the females. Spawning takes place during the night and early morning, usually near rooted vegetation, submerged brush, or fallen trees. As mentioned above, submerged brush and fallen trees are very limited in the lake. No nest is built, the eggs are transparent, which when shed are swollen, they are extruded in a unique, gelatinous, accordion folded string or tube.

In earlier observations in 1997, yellow perch eggs have been found attached to floating, woody debris (Daryl Coulson, MNR). This location is illustrated on Figure 10.

Walleye

Walleye spawning occurs in the spring or early summer (early April in Southwestern Ontario). Normally spawning begins after ice break up in a lake, at water temperatures of 6.7 - 8.9 degrees Celsius (Scott and Crossman 1973). Pre-spawning behavior may commence much earlier. Males move to spawning grounds first. Spawning grounds are the rocky areas in white water or boulder to coarse gravel shoals

of fresh water lakes. Spawning takes place at nights, in groups of one larger female and one or two smaller males, or two females and up to six males. Males are not territorial and no nest is built.

There is potentially good walleye spawning habitat, around the perimeter of Big Island and on the shoals among the three small islands south of Big Island (Figure 10). The substrate type in these areas, is primarily coarse gravel with a few boulders (Figure 8). For several years, walleye have been observed spawning among the boulders near the northwest tip of McCormick's Point, from the large crib dock southward approximately 90 meters, during the month of April (Rick Christian pers. comm. June 2000) and along the north shore of McCormick's Point (PLCA 2000). These areas are indicated as Confirmed Walleye Spawning Habitat on Figure 10.

The Puslinch Lake Conservation Association recently created a rubble shoal walleye spawning area between Summer Island and Musselshell Island (Figure 10). Unfortunately, low water levels left much of this material dry during the past season.

Brown Bullhead

Brown bullhead spawn in late spring and summer, when the water temperature reaches 21.1 degrees Celsius (Scott and Crossman 1973). One or both sexes clear a shallow nest, the diameter of which is just in excess of body length, in a bottom of muck or sand, or among roots of aquatic vegetation, usually near cover. The depth can be as shallow as 15.2 cm or as deep as 0.5 - 1.0 m. Spawning takes place in the daytime. Eggs hatch 6-9 days after spawning takes place.

There is an abundance of this species in Puslinch Lake; they were observed in large groups, individually and paired, in all areas of the lake. It is unclear if they were actually spawning, nest building or if there was a form of courtship taking place. On June 25, 1997, bullhead were observed in a nest in a hollow log in 0.9 m of water about 30 metres from the west shore of the lake (Daryl Coulson, MNR).

There were several dead brown bullhead found throughout the duration of this project, however, there was no observed cause of death, although a few lesions or gashes were seen on the body of a few, which may indicate predation by another species.

Common White Sucker

No spawning information has been gathered on this particular species. Although, several dead individuals of this species were found in the lake, the cause of death is not known. Although this species usually spawns in streams, they will spawn on lake margins (Scott and Crossman 1973).

Central Mudminnow

The central mudminnow spawns in early spring (mid-late April). A migration of pairs, move upstream and into shallow water. No nest building is reported for this species. Eggs are laid singly, are adhesive and stick to heavy vegetative habitat. The summer habitat of this species is usually heavily vegetated ponds or pools of small creeks with the bottom having a thick layer of organic material (Scott and Crossman 1973). Puslinch Lake has many areas of organic substrate that are required by this species for spawning.

Golden Shiner

Golden shiners spawn from June to August, depending on the areas they inhabit. The adhesive eggs are deposited over filamentous algae (Scott and Crossman 1973). Sometimes rooted aquatic plants will serve, but aquatic vegetation is essential for spawning. Golden shiners are known to use active largemouth bass nests, which there are many of in Puslinch Lake (Figure 9). The golden shiner prefers clear, weedy, quiet waters, with extensive shallow areas, which is one of the characteristics of Puslinch Lake. The golden shiner is considered a very important forage fish, especially for largemouth bass and muskellunge.

Spottail Shiner

The spottail shiner spawns in spring and early summer, throughout a wide Canadian range (Scott and Crossman 1973). They spawn over sandy shoals and use masses of algae, which are both normal characteristics of Puslinch Lake. There is a large area of sand that erodes from Barber's Beach (Figure 2 and Figure 8), creating a possible suitable spawning habitat for this species.

Bluntnose Minnow

This minnow builds its nest in shallow water and fights off its intruders. The minnow is relatively common in water adjacent to populated areas, which is common on Puslinch Lake. The bluntnose minnow deposits its eggs on the under surfaces of flat stones, boards, logs, broken tile, bricks or any other object that offers a suitable lower surface, but it prefers a flat stone or other object resting directly on bottom in 6 inches to 3 feet of water (Scott and Crossman 1973). The nests can be literally side by side. This minnow is an important forage fish and prefers sand and gravel or occasionally mud bottomed shallows of lakes and ponds (Scott and Crossman 1973), a common characteristic on Puslinch Lake. There are many of these described substrates throughout the lake (Figure 8).

Banded Killifish

Males select breeding areas in the quiet water of weedy pools (Scott and Crossman 1973). These areas are defended vigorously. Mud Bay (Figure 2), is usually quite sheltered and could possibly produce the required habitat needed for this species. One banded killifish was captured on June 10, 1999 at the northwest tip of Big Island.

Rock Bass

Spawning takes place in late spring and early summer. The male digs a shallow nest in areas as diverse as swamps and gravel shoals (Scott and Crossman 1973). Often nests are very close together, in an area heavily used at spawning time and defense of territory and attempts to attract and hold females are very aggressive. Rock bass generally inhabit rocky areas in shallow water lakes. These potential spawning areas are shown on Figure 8.

Iowa Darter

Characteristically, the species spawns in shallow water of lakes, or pond-like expansions in rivers, on bottom organic debris, or on fibrous roots in mud banks (Scott and Crossman 1973). Iowa darters are inhabitants of clear, standing or slowly moving

waters of lakes or rivers, having rooted aquatic vegetation, and a bottom of organic debris, sand, peat, or composite of these. All three of these are present in Puslinch Lake

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Daryl Coulson reviewed an earlier draft of the report.

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Table 1: Measurements and Percentages of Each Shoreline Type Around the Perimeter of Puslinch Lake and Its Islands.

Description	% of each class	Distance on Lake (m)
Natural		
Thicket Swamp	36	2647
Mixed Forest	17	1251
Meadow Marsh	3.1	228
Eroded Bank	0.7	53
Mineral Open Bluff	0.6	46
	Total: 57.4%	Total: 4225m
Cultural		
Vertical Bank	9.8	726.5
Gravel Slope	10.1	764
Gravel and Vegetation Slope	16	1173
Lawn	4	312
Beach	2.7	191
	Total: 42.6%	Total: 3167m

Table 2. Description of Shoreline Types Around the Perimeter of Puslinch Lake and Its Islands.

Natural (from Lee et al. 1998)
Thicket Swamp: tree cover <25% and hydrophytic shrubs >25%
Mixed Forest: both conifer and deciduous tree species.
Meadow Marsh: tree and shrub cover <25%, and grasses or sedges dominant.
Eroded Bank: bank eroded from the forest straight down to the water
Mineral Open Bluff: vegetation cover varies from patchy to barren, and tree invasion is restricted by erosion-related disturbances.
Cultural
Vertical Bank: a cultural area where the owners have built a vertical wall next to the waters edge on their property. Wood, cement and boulders were the different materials used.
Gravel Slope: a cultural area where the gravel continues up the bank at a gradual slope from the substrate with no vegetation growing.
Cultural Meadow: an area with a gradual slope; some gravel present, but consisting of more soil and some vegetation growing.
Manicured Lawn: manicured lawn that extends to the edge of the water.
Beach: where the sand has been brought into the area.

Appendix A. List of Puslinch Lake Fish Species

MNR Code	Common Name	Scientific Name
131	Northern pike	<i>Esox lucius</i>
141	Central mudminnow	<i>Umbra limi</i>
163	White sucker	<i>Catostomus commersoni</i>
194	Golden shiner	<i>Notemigonus crysoleucas</i>
201	Spottail shiner	<i>Notropis hudsonius</i>
208	Bluntnose minnow	<i>Pimephales notatus</i>
233	Brown bullhead	<i>Ameiurus nebulosus</i>
261	Banded killifish	<i>Fundulus diaphranus</i>
311	Rock bass	<i>Ambloplites rupestris</i>
313	Pumkinseed	<i>Lepomis gibbosus</i>
316	Smallmouth bass	<i>Micropterus dolomieu</i>
317	Largemouth bass	<i>Micropterus salmoides</i>
319	Black crappie	<i>Pomoxis nigromaculatus</i>
331	Yellow perch	<i>Perca flavescens</i>
334	Walleye	<i>Stizostedion vitreum vitreum</i>
338	Iowa darter	<i>Etheostoma exile</i>