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Application of the Ecologically Significant Species Criteria to the Aquatic Community of the Bay of Quinte, Lake Ontario

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Canada

Foreword

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

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

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ABSTRACT

The Bay of Quinte is a large, Z-shaped bay on the north shore of Lake Ontario's eastern basin. The bay is a highly productive system and has a wide range of fish habitats, including shallow vegetated areas, sand and gravel flats and steep sided, thermally stratified areas. This report applies the ecologically significant species (ESS) criteria used in marine ecosystems to identify species that are important to maintain the ecosystem function in the Bay of Quinte, and evaluate the application of these criteria in a freshwater context.

A comprehensive species list of aquatic organisms was compiled from sampling records, index monitoring records and published data sets. Species were evaluated by a group of experts for their potential to be ecologically significant based on one or more of the following criteria:

1) important trophodynamic role;
2) providing three-dimensional structure;
3) posing a threat to ecosystem function; or,
4) sensitive species that are easily depleted by human activity.

Of the 456 species of aquatic organisms present in the Bay of Quinte, 13 were identified as ecologically significant. Species accounts were written for each of the identified species. All of the ESS criteria developed for marine systems were found to be useful and applicable in a freshwater context. The application of the ESS criteria in fresh water, similar to its use in the marine environment, is reliant on the use of expert opinion, and will benefit from greater inclusion of published information.

Application des critères relatifs aux espèces d'importance écologique à la communauté aquatique de la baie de Quinte, dans le lac Ontario

RÉSUMÉ

La baie de Quinte est une vaste baie en forme de Z située sur la rive nord du bassin est du lac Ontario. Cette baie constitue un système très fécond dans lequel foisonne un large éventail d'habitats de poissons, notamment des zones de végétation peu profondes, des platins de sable et de gravier, ainsi que des zones de stratification thermique à parois escarpées. Le présent rapport explique l'application des critères relatifs aux espèces d'importance écologique (EIE) utilisés dans les écosystèmes marins pour désigner les espèces qui sont importantes pour maintenir les fonctions écosystémiques de la baie de Qunite, et présente une évaluation de l'application de ces critères dans un milieu d'eau douce.

Une liste exhaustive des différentes espèces d'organismes aquatiques a été compilée d'après les registres d'échantillonnage, les registres de surveillance d'indice et des ensembles de données publiés. Les espèces ont été évaluées par un groupe d’experts en fonction de leur potentiel de constituer une EIE selon un ou plusieurs des critères suivants :

1) leur important rôle trophodynamique;
2) leur structure tridimensionnelle;
3) la menace qu'elles constituent pour la fonction écosystémique;
4) les espèces vulnérables qui sont facilement décimées par l'activité humaine.

Des 456 espèces d'organismes aquatiques que compte la baie de Quinte, 13 ont été désignées comme des EIE. Le compte des espèces a été consigné pour chacune des espèces relevées. Tous les critères relatifs aux EIE élaborés pour les systèmes marins se sont avérés utiles et applicables en milieu d'eau douce. L'application des critères relatifs aux EIE en eau douce, à l'instar de leur utilisation en milieu marin, dépend du recours à l'opinion des experts et tirera profit d'une plus grande inclusion de l'information publiée.

INTRODUCTION

In Canadian marine systems, the Oceans Action Plan has used specific criteria to identify ecologically sensitive habitats and species that require enhanced management (DFO 2005). These conservation priorities include

1) Ecologically and Biologically Significant Areas (EBSA);
2) Ecologically Significant Species (ESS);
3) Depleted or rare species; and,
4) Degraded areas.

The designation of ESS can also include properties at the community level, such as biodiversity and productivity. These community-based properties, however, have proven to be difficult to assess and subsequently manage in marine ecosystems (DFO 2006). Because of this inherent difficulty with assessing and managing community-level properties, this report will focus on the implementation of the ESS criteria with regards to defining significant species.

In the context of ESS, to define a species as "significant" implies that, if the species were removed from, or severely depleted within the system, the effect on the ecosystem would be substantially greater than an equal perturbation on most other species (DFO 2006).

The purpose of this report is to apply the criteria for identifying ESS, to date used exclusively in marine ecosystems, within a freshwater context. The Bay of Quinte is used as a case study for freshwater ecosystems to evaluate the application of the ESS criteria in a freshwater context. The Bay of Quinte was previously chosen as the pilot case for this evaluation of ESS criteria as an EBSA within Lake Ontario. This *a priori* designation of EBSA, followed by designation of ESS within the ecosystem, is the reverse of the typical procedure where ESS are defined within the predetermined ecosystem boundaries. Once ESS have been defined, the areas within the ecosystem that are important for the ESS can then help to define the EBSA (e.g. McQuinn et al. 2012). In this report, however, the *a priori* identification of the area of interest should provide a satisfactory pilot case for evaluation of the ESS criteria in a freshwater context.

The Bay of Quinte, located on the north shore of Lake Ontario's eastern basin, is a 254 km^2 Z-shaped bay. It is divided into three sections, based on the areas of its Z-shape: the upper bay, from Trenton to Deseronto, is the shallowest section (average depth 3.2 m); the middle bay, from Deseronto to Glenora (average depth 6.3 m); and, the lower bay, from Glenora to Amherst Island is the deepest section (average depth 23.8 m) (Hurley and Christie 1977).

The Bay of Quinte has a wide range of fish habitats, such as shallow vegetated areas, sand and gravel flats, and steep-sided, thermally stratified areas, and is home to 81 fish species (Appendix 1). The upper bay is the most eutrophic of the bay sections and tends to have the most macrophyte cover, while the Adolphus Reach (lower bay) is the most oligotrophic of the bay sections and tends to thermally stratify. There are four major tributaries that flow into the Bay of Quinte: the Trent River, Moira River, Salmon River, and Napanee River; all of which are located in the upper bay section. There is significant water exchange between the lower bay and the open waters of Lake Ontario.

Historically, the Bay of Quinte has been subjected to widespread eutrophication caused by phosphorous inputs from anthropogenic sources, causing algal blooms and associated lack of dissolved oxygen and turbidity increases. The upper bay section was particularly affected due to its shallow bathymetry and the inputs of nutrients of terrestrial origin through the major tributaries. Subsequent to the reduction of phosphorus inputs, coupled with the invasion of the Zebra Mussel (*Dreissena polymorpha*), the eutrophication has been reversed (Chu et al. 2004).

Water clarity has increased, phytoplankton biomass has declined, and macrophyte cover has increased (Chu et al. 2004).

The Bay of Quinte is a highly productive system in the Lake Ontario north shore ecoregion. Index of Biotic Integrity scores for the Bay of Quinte are consistently higher than those seen in reference locations, both nearby and throughout Lake Ontario (Brousseau et al. 2011). Piscivore biomass and centrarchid species richness showed the same trend (Brousseau et al. 2011). The high productivity of the Bay of Quinte, relative to adjacent areas of Lake Ontario, supports recreational, commercial, and Aboriginal fisheries for many species including Walleye (*Sander vitreus*), Yellow Perch (*Perca flavescens*), Lake Whitefish (*Coregonus clupeaformis*), and Largemouth Bass (*Micropterus salmoides*).

METHODS

A comprehensive list of aquatic species present in the Bay of Quinte was compiled from various sampling records, index monitoring records, and published data sets. Data sets included fish community data published by Hoyle et al. (2012), DFO index monitoring and sampling data, Bay of Quinte aquatic invertebrate monitoring records, DFO zooplankton sampling data, aquatic invasive species reported from the Bay of Quinte, and macrophyte species reported by Crowder and Bristow (1986).

Once the species list was compiled, each species was evaluated for its potential to be ecologically significant in the Bay of Quinte, and assigned potential significance based on the criteria laid out by DFO (2006). These criteria for defining ESS include:

1) Species that have important trophodynamic roles including important forage species, highly influential predator species, nutrient importing or exporting species, and species that carry out other important ecosystem functions, such as decomposers;
2) Species that provide three-dimensional structure that is important for biodiversity;
3) Species that comprise a threat to ecosystem structure and function if abundant, such as harmful algal species; and,
4) Sensitive species that are easily depleted by human activity.

Species were assessed on the above criteria by a group of scientists familiar with the taxa in question and the Bay of Quinte. The scientists consulted for the selection process included DFO Science staff, Ontario Ministry of Natural Resources staff and staff from the local conservation authority–Quinte Conservation. Expert opinion was the basis for assigning significance to individual species and a list of the species deemed to be ecologically significant was created. Each trophic level was evaluated for species of potential significance, beginning with primary producers (both phytoplankton and aquatic vegetation), up to and including large predatory fishes. For the purposes of this analysis, only true aquatic species were considered, thus, waterfowl, reptiles, and amphibians were excluded. For each ESS, a species account was written based on the template used in McQuinn et al. (2012).

To examine the community property of biodiversity, a plot of cumulative Index of Relative Importance, a measure of a species' dominance in the community, was plotted for the 50 fish species identified by Hoyle et al. (2012) as having measurable relative importance within the Bay of Quinte ecosystem.

RESULTS

When all data sources were combined, 456 taxa of aquatic organism were identified as present in the Bay of Quinte (Appendix 1). Taxa included viruses, bacteria, algae, aquatic plants, protozoa, invertebrates, zooplankton, and fishes. Not all groups were identified to the same taxonomic level. Of the identified taxa, 13 were identified as ESS (Table 1). No significant viruses, bacteria, protozoa, or phytoplankton species were identified. Similarly, no native zooplankton or benthic invertebrates were identified as ecologically significant. These taxa were not included in the list of ESS because the dominant species in these communities fluctuate seasonally and between years. Although these communities provide important ecosystem functions, any one particular species was not deemed to have a substantially larger impact on the ecosystem than others. The only lower trophic level species that were identified as significant were harmful invasive species. There may also be a significant knowledge gap where lower trophic level species are concerned, as much of the available research is focused on higher trophic levels. Native submerged aquatic vegetation was also identified as ecologically significant, being the main provider of three-dimensional structure in the ecosystem. Each of the four criteria for identifying ESS was used to designate at least one species as significant in the Bay of Quinte ecosystem, with four species being identified by multiple criteria.

Table 1. *Thirteen species from the Bay of Quinte and the associated criteria used to identify them as ecologically significant.*

Common Name	Scientific Name	Trophodynamics	Structure	Harmful	Sensitive
Aquatic Vegetation	N/A		X		X
Eurasian Watermilfoil	*Myriophyllum spicatum*			X	
Zebra / Quagga Mussel	*Dreissena polymorpha / D. rostriformis bugensis*	X	X	X	
Fishhook Waterflea	*Cercopagis pengoi*			X	
American Eel	*Anguilla rostrata*				X
Alewife	*Alosa pseudoharengus*	X			
Bridle Shiner	*Notropis bifrenatus*	X			X
Lake Whitefish	*Coregonus clupeaformis*	X			
White Perch	*Morone americana*	X		X	

Common Name	Scientific Name	Trophodynamics	Structure	Harmful	Sensitive
Largemouth Bass	*Micropterus salmoides*	X			
Yellow Perch	*Perca flavescens*	X			
Walleye	*Sander vitreus*	X			
Round Goby	*Neogobius melanostomus*	X		X	

The cumulative index of relative importance (IRI; Figure 1) indicates that eight fish species contribute substantially (>80%) to the IRI of fishes in the Bay of Quinte ecosystem. Four of these eight species (Yellow Perch, Alewife, White Perch and Walleye) were identified by expert opinion as ESS in the Bay of Quinte. The other four of the eight species that contribute substantially to IRI [Brown Bullhead (*Ameiurus nebulosus*), Bluegill (*Lepomis macrochirus*), Pumpkinseed (*Lepomis gibbosus*) and White Sucker (*Catostomus commersonii*)] were not deemed to play significant roles in the ecosystem that met the ESS criteria, based on expert opinion.

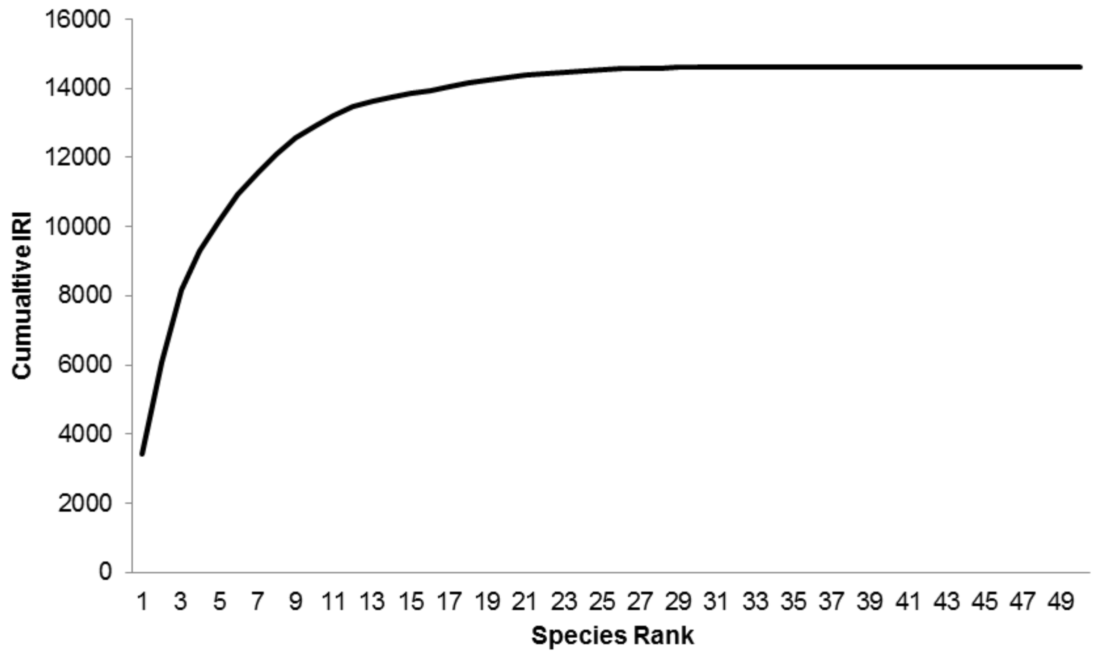

Figure 1. Cumulative Index of Relative Importance (IRI) for the 50 fish species identified in Hoyle et al. 2012 as having measurable relative importance in the Bay of Quinte.

SPECIES ACCOUNTS

Submerged Aquatic Vegetation

Description

Submerged aquatic vegetation (SAV) in the Bay of Quinte is found throughout the shallower depths of the bay, and is particularly abundant in the upper bay section. The shallow fringes around the middle and lower bays also have significant SAV coverage. The extent of SAV in the Bay of Quinte has varied over time. Historically, the bay was mesotrophic, with abundant macrophyte growth in shallow regions. Phosphorous inputs due to human activity caused subsequent eutrophication and the density and extent of SAV declined, limiting growth of SAV in the upper bay to depths of 2 m or less (Crowder and Bristow 1986). The implementation of phosphorous control measures, coupled with the invasion of the Bay of Quinte by dreissenid mussels, has led to an increase in water clarity and a resurgence of the SAV community (Leisti et al. 2012). There are 52 species of aquatic plants found in the Bay of Quinte (Appendix 1).

Biology

Submerged aquatic vegetation provides habitat for many aquatic invertebrates, such as amphipods, isopods, midge larvae, Trichoptera larvae, and small gastropods. The Endangered Pugnose Shiner (*Notropis anogenus*) is often found in association with stands of SAV, including American wildcelery (*Vallisneria americana*) (COSEWIC 2013), which is found in the Bay of Quinte. SAV also provides food for waterfowl, such as Greater Scaup (*Aythya marila*), Lesser Scaup (*Aythya affinis*), and Common Goldeneye (*Bucephala clangula*), which feed on the stems, leaves, and fruits (Korschgen and Green 1988).

Significance

SAV is ecologically significant due to the three dimensional structure that it provides for many aquatic organisms. Aquatic invertebrates, such as amphipods, isopods, midge larvae, Trichoptera larvae and small gastropods, all utilize SAV. These aquatic invertebrates are more abundant (3–7 x more abundant) in beds of native vegetation than in beds of the introduced Eurasian watermilfoil (*Myriophyllum spicatum*) (Keast 1989). Native aquatic vegetation is also used by several fishes, such as Bluegill, Pumpkinseed and Yellow Perch, which are more abundant in beds of mixed native species of macrophytes, including American wildcelery, than in beds of the invasive Eurasian watermilfoil (Korschgen and Green 1988). The Endangered Pugnose Shiner is found in association with stands of SAV which it utilizes for spawning habitat (COSEWIC 2013). SAV also provides an abundant food source for waterfowl species, such as Greater Scaup, Lesser Scaup and Common Goldeneye, which feed on the tubers and associated invertebrates (Schloesser and Manny 2007). SAV is also sensitive to disturbances from human activity. In the Bay of Quinte, the density and extent of SAV beds was severely affected due to human-induced eutrophication and has subsequently recovered as water clarity increased.

Eurasian Watermilfoil (*Myriophyllum spicatum)*

Description

The Eurasian watermilfoil is a perennial submerged aquatic macrophyte. The Eurasian watermilfoil has feathery green leaves that circle around the stem in groups of four or five. Leaves have 12 or more thread-like segments, distinguishing it from the native species (*Myriophyllum sibiricum*), which has 22 or fewer segments on each leaf. Eurasian watermilfoil grows in dense mats that reach to the surface and produces small red flowers that grow on 5–20 cm spikes that rise above the water.

Biology

Eurasian watermilfoil grows in water 0.5–7 m deep, but is most commonly found in 1–3 m, particularly in eutrophic waterbodies or systems with nutrient enrichment (Aiken et al. 1979). Eurasian watermilfoil typically colonizes new sites by vegetative fragments that detach from axillary buds that appear in the late winter and early spring (Aiken et al. 1979). This species also undergoes autofragmentation during the growing season. The loose fragments develop roots and eventually sink to the bottom and root to produce new plants.

Growth occurs rapidly throughout the spring and summer and dense mats of vegetation are formed. Small flowers are produced on 5–20 cm spikes that rise above the water in late July–early August. The stigmas ripen before the stamens in individual flowers as the spikes rise, so that cross-pollination is much more likely to occur than self-fertilization (Aiken et al. 1979). The seeds are viable and have the ability to lie dormant for long periods before germination. Though sexual reproduction occurs in this species, the majority of reproduction is asexual, vegetative reproduction. Significant die–down of the stems occurs in the fall, leaving propagating root crowns that overwinter and produce the axillary buds the following spring to begin the cycle again.

Eurasian watermilfoil is an invasive species, native to Europe, Asia, and northern Africa. It was likely introduced to North America via the aquarium trade or ship ballast water. It was first observed in Canada in Lake Erie in 1961, and has subsequently spread to all five Great Lakes and many inland waters. Eurasian watermilfoil outcompetes native aquatic plants, causing a loss of native plant biodiversity and abundance (Boylen et al 1999). The invasion of Eurasian watermilfoil has also been linked to the loss of diversity in small littoral zone fishes (Lyons 1989).

Significance

The Eurasian watermilfoil is an ESS because it is a harmful invasive species. Once established, Eurasian watermilfoil outcompetes the native littoral zone vegetation, causing a reduction in native species richness and abundance (Boylen et al. 1999). The formation of dense vegetation mats can create pockets of stagnant water at the surface, allowing surface water temperatures to increase and lead to algal blooms above the matted vegetation. Dissolved oxygen levels at the base of dense stands of Eurasian watermilfoil are also depressed (Unmuth et al. 2000). The dense mats that reach the surface are also detrimental to the Bridle Shiner (*Notreopis bifrenatus*), a native fish species of Special Concern, which requires a layer of 15–20 cm of open water above the vegetation for spawning (Boucher et al. 2011). Eurasian watermilfoil invasion has also been linked to declines in the abundance of Pugnose Shiner, an Endangered species in Canada (COSEWIC 2013).

Dreissenid Mussels (*Dreissena polymorpha*, *Dreissena rostriformis bugensis)*

Description

Two species of small, invasive bivalve mussel have established populations in the Bay of Quinte; Zebra Mussel and Quagga Mussel (*Dreissena rostriformis bugensis*). The Zebra Mussel is typically triangular in shape with the base flattened allowing it to sit flat on its underside. Colour is black or brown with light-coloured zigzag stripes. Adult Zebra Mussel average 2–2.5 cm, reaching a maximum of 5 cm (Mackie and Schloesser 1996). The Quagga Mussel resembles the Zebra Mussel, both having pointed anterior and flared posterior ends of their shell. The Quagga Mussel, however, is rounded at the base (Spidle et al. 1994). Colouration is similar to that of the Zebra Mussel, with a prevalent concentric stripe pattern. Quagga Mussels average 2 cm and reach a maximum size of 4 cm.

Biology

Both species of dreissenid mussel have a lifespan of 1.5–3 years in temperate climates, and reach sexual maturity within 6 weeks of settling to the substrate. Females produce upwards of 30,000 eggs each reproductive cycle, with multiple cycles in a year. Each female may produce in excess of 1,000,000 eggs in a single year (Mackie and Schloesser 1996). Eggs are released into the water column and, after fertilization occurs, the mussel lives as a planktonic veliger for 8–240 days. During this time, the larval mussel goes through 3 stages of development, finally settling to substrate where it will form a permanent attachment to any hard substrate with thread-like byssus (Ackerman et al. 1994). The Zebra Mussel forms dense colonies on any hard, living or non-living substrate, while Quagga Mussels tend to form dense colonies in deeper waters, often on soft substrates.

The adult dreissenid mussel is a filter feeder. Laboratory studies show that a single Zebra Mussel can filter in excess of 3 L of water in a single day (Kryger and Riisgard 1988), removing all particulate matter. Both species of dreissenid mussel feed on the filtered plankton and excrete the undigested material in a mucous encapsulated pellet, known as pseudofeces (Mackie and Schloesser 1996).

Dreissenid mussels are preyed on by a variety of benthic feeding fishes. Predators include Lake Sturgeon (*Acipenser fulvescens*) (Jackson et al. 2002), Lake Whitefish (Pothoven et al. 2001), Common Carp (*Cyprinus carpio*) (Tucker et al. 1996), Freshwater Drum (*Aplodinotus grunniens*) (French and Bur 1996), and Round Goby (*Neogobius melanostomus*) (Ray and Corkum 1997). They are also preyed on by crayfishes. Dreissenid mussels are competitors with native unionid mussels, which they outcompete for food and encrust with settling larvae.

Significance

Both dreissenid mussel species are invasive in North America with significant impacts on aquatic food webs (Higgins and Vander Zanden 2010). The Zebra Mussel was first introduced to the Great Lakes from the Black and Caspian Sea region of Europe in 1986 (Hebert et al. 1989), and subsequently spread to all five Great Lakes and many inland waters. The Quagga Mussel was first discovered in the Great Lakes in 1990 (May and Marsden 1992) and has subsequently proliferated to the point where Quagga Mussel has displaced Zebra Mussel as the dominant mussel species in many locations in Lake Ontario (Wilson et al. 2006). Through their filter feeding, the dreissenid mussels have substantially increased water clarity in areas where they have proliferated (Heath et al. 1995). In the Bay of Quinte, dreissenids are estimated to consume greater than 50% of the pelagic primary production (Koops et al. 2006). This increased water clarity has allowed for increased macrophyte growth, resulting in increases in macrophyte density and extent of coverage. The increase in water clarity and, subsequent macrophyte proliferation, has also affected fish communities. Light-sensitive predators, such as the Walleye, are forced to deeper waters, while day-active, littoral zone predators, have proliferated in waters that have been invaded by dreissenid mussels (Strayer et al. 2004). The dreissenid mussels also feed on plankton, reducing the food availability for small fishes.

The invasion of dreissenid mussels has had a detrimental impact on native unionid mussel populations (Gillis and Mackie 1994). The juvenile mussels settle on any hard substrate, including the shells of unionids. The unionid becomes encrusted, often leading to its death (Baker and Hornbach 1997).

The dreissenid mussels are also significant forage species. They are preyed on by several native benthic fishes, as well as non-native species such as Round Goby, and Common Carp. The presence of Zebra Mussel as a widely available and abundant food source likely facilitated the invasion and spread of Round Goby (Ray and Corkum 1997).

Dreissenid mussels are also structure-providing species. The dense colonies formed by these mussels act as a shelter for benthic invertebrates, such as amphipods, including the invasive *Echinogammarus ischnus*. Where colonies are formed on areas of soft substrate, the result is a change in substrate characteristics, replacing areas of soft substrate with the hardened substrate of the mussel bed. The pseudofeces that dreissenid mussels produce may also serve as a food source for benthic invertebrates.

Fishhook Waterflea (*Cercopagis pengoi)*

Description

The Fishhook waterflea (*Cercopagis pengoi*) is a large, invasive zooplankton in the order Cladocera. Fishhook waterflea reach a length of 6–13 mm, of which the long tail comprises the majority of the total length (5–10 mm). The tail has 3 pairs of barbs and a loop at the end which distinguish the species. Fishhook waterflea have a clearly defined, globular head with a large eye. Females have a defined brood pouch (Rivier 1998).

Biology

Fishhook waterflea exhibits changes in abundance throughout the year. Abundance of adults and juveniles is lowest in the winter. Females appear in the spring and reproduce parthenogenetically and abundance increases rapidly. In the fall, sexual reproduction occurs and resting ephippial eggs are laid. The resting eggs overwinter and hatch out in the following spring. Resting eggs can also be produced when environmental conditions are poor, and hatch when conditions improve (Rivier 1998).

The highest densities of Fishhook waterflea have been found at the bottom of the epilimnion and no diel vertical migration was observed in Great Lakes populations (Bushnoe et al. 2003), although such vertical migrations have been observed in other populations.

Fishhook waterflea preys on other zooplankton and has been linked to declines in other zooplankton species such as *Bosmina longirostris* (Benoit et al. 2002). Because it preys on other zooplankton, fishhook waterflea is a direct competitor with planktivorous fishes (Bushnoe et al. 2003). The long tail and spines make fishhook waterflea difficult for smaller fishes to ingest, however, larger planktivorous fishes are not deterred by the length of the tail.

Significance

Fishhook waterflea is an ecologically significant invasive species. Native to the Black and Caspian seas of Europe, fishhook waterflea was introduced to the Great Lakes via ship ballast water (Mills et al. 1993). It has subsequently been identified in all five Great Lakes. This large zooplankton species is also a significant predator of smaller zooplankton and has been linked to declines in abundance of species such as *Bosmina longirostris* (Benoit et al. 2002). It is also a competitor for small planktivorous fishes such as Rainbow Smelt (*Osmerus mordax*), and young-of- the-year Alewife (*Alosa pseudoharengus*). Larger planktivorous fishes, such as adult Alewife, prey on fishhook waterflea, though no change in growth or condition of Alewife was observed in Lake Ontario subsequent to invasion by fishhook waterflea (O’Gorman et al. 2008).

American Eel (*Anguilla rostrata)*

Description

The American Eel (*Anguilla rostrata*) is an extremely elongated fish with a small, pointed head and protruding lower jaw. Pelvic fins are absent and the elongated dorsal and anal fins join with the tail. Adult American Eel have a metallic bronze or black back and are able to change colour in response to environmental conditions and lighting. Maximum size in Ontario is 120.0 cm total length and a weight of 2.3 kg (Holm et al. 2009).

Biology

American Eel is catadromous; it grows and matures in freshwater and spawns in the Sargasso Sea in the Atlantic Ocean, where the adults die after spawning. Upon hatching, the leaf-shaped leptocephalus larvae migrate westward toward the continental shelf. The larvae undergo metamorphosis, changing into transparent glass eels that possess the body shape of the adults, but lack pigmentation. Once the young eels reach the nearshore waters they develop pigmentation and become known as “elvers”. The elvers become more pigmented and begin to migrate upstream into fresh water, at which time they are known as “yellow eels”. During migration, the yellow eels undergo maturation and further metamorphosis to become “silver eels”. It is at this stage that sexual differentiation occurs (Scott and Crossman 1998). The silver eels migrate as far as Lake Ontario, where they continue to grow and mature for up to 20 years before making the seaward migration to spawn. Only female American Eels migrate as far inland as Ontario waters (Holm et al. 2009).

The American Eel prefers cool water, with a soft bottom comprised of sand or silt. During the day, American Eels may bury themselves in the soft sediment and among vegetation and other debris, emerging at night to feed on smaller fishes, frogs and invertebrates. Young American Eels are preyed on by larger fishes (Scott and Crossman 1998).

Significance

The American Eel is a sensitive species. This species is designated as Threatened by COSEWIC and Endangered by COSSARO. American Eel abundance in Lake Ontario has undergone a dramatic decline due to barriers to migration in the form of dams and hydro-electric turbines (COSEWIC 2012). Declining abundances of American Eel has resulted in the loss of an important predator of small fishes from the ecosystem.

Alewife (*Alosa pseudoharengus)*

Description

The Alewife is a small, laterally compressed fish with a deep body. The Alewife has a single dorsal fin, a distinctly forked tail, and rough keel along the ventral edge. The Alewife is silvery in colour, with a greyish green back and a black spot behind the head at eye level. Average total length in Ontario is 15 cm with a maximum of 30.9 cm (Holm et al. 2009).

Biology

The Alewife is normally an anadromous species, living in the ocean and travelling up freshwater tributaries to spawn. The Alewife found in the Great Lakes are landlocked, spending the majority of their lives in the open waters of the lake, moving into shallow beach areas to spawn in the late spring. Spawning takes place at night over shallow sand and gravel areas. Females lay up to 12,000 eggs that hatch in 3–6 days (Scott and Crossman 1998). After spawning, adults return to deeper offshore waters. The juveniles remain on the spawning grounds until the late larval stage and then begin to migrate towards deeper, offshore areas.

Both adult and juvenile Alewife feed almost exclusively on zooplankton, mainly feeding on copepods, cladocerans, mysids, and ostracods (Scott and Crossman 1998). Alewife are preyed on by larger piscivorous fishes, such as Chinook Salmon (*Oncorhynchus tshawytscha*), Lake Trout (*Salvelinus namaycush*), Walleye, Northern Pike (*Esox lucius*), and Smallmouth Bass (*Micropterus dolomieu*) (Scott and Crossman 1998).

Significance

The Alewife is an ecologically significant invasive species in the Bay of Quinte because it is an abundant prey item in the pelagic areas of the bay. Alewife comprise an important food source for a number of large piscivorous fishes. The increase in macrophyte growth in nearshore areas, corresponding to increased water clarity due to dreissenid mussel invasion, has led to the decline of Alewife in these areas from historically high population levels (Hurley 1986), although they remain one of the more abundant species in the system (Hoyle et al. 2012).

Bridle Shiner (*Notropis bifrenatus)*

Description

The Bridle Shiner is a small minnow with an elongated body and a dark lateral stripe that extends from the tip of the snout and upper lip, to the base of the caudal fin. There is a single soft dorsal fin that starts above or slightly behind the origin of the pelvic fin. The back is straw coloured with large scales that are darkly outlined, there is a light yellow stripe above the dark lateral stripe, and the belly is white. During the breeding season, males develop small nuptial tubercles on the pectoral fins and head. Maximum size in Ontario is 5.5 cm in length (Holm et al. 2009).

Biology

The Bridle Shiner lives for a maximum of 2 years and spawns only once in its lifetime. Spawning occurs in the spring and summer in areas with abundant macrophyte growth that has 15–20 cm of open water above the vegetation (Boucher et al. 2011). The eggs are released above the vegetation and settle downwards. After hatching, the juveniles remain among the spawning vegetation, using it for cover.

Bridle Shiner is a warm water species that inhabits clear, highly vegetated waters, typically containing mud or silt substrates. This species feeds mainly on zooplankton and small aquatic insects that are found on or above the aquatic vegetation in which the Bridle Shiner feeds. Living plant material and detritus may also be eaten by the Bridle Shiner (Scott and Crossman 1998).

The Bridle Shiner, where abundant, is preyed on by larger fish species such as Black Crappie (*Pomoxis nigromaculatus*), Smallmouth Bass, Yellow Perch, and White Perch (*Morone americana*) in Lake Ontario (Scott and Crossman 1998).

Significance

The Bridle Shiner is an ESS in the Bay of Quinte due to its sensitivity. This species is designated as Special Concern under the *Species at Risk Act*. Main threats to the species are industrial and agricultural pollution (Boucher et al. 2011). The Bridle Shiner is a sight-feeding species, thus, it is particularly vulnerable to increases in turbidity. Proliferation of invasive macrophyte species, such as Eurasian watermilfoil, that grow densely to the surface, also pose a risk to the Bridle Shiner in the form of loss of spawning habitat (Boucher et al. 2011). Where locally abundant, this species is also a forage species, preyed on by larger fish species.

Lake Whitefish (*Coregonus clupeaformis)*

Description

The Lake Whitefish has an elongated body, with a forked tail, single soft dorsal fin followed by an adipose fin. The head of the Lake Whitefish is small and the mouth is small and sub-terminal. Body colouration is silvery with a pale greenish-brown back and silvery-white undersides. The average total length in Ontario is 40 cm with a maximum total length of 74 cm (Holm et al. 2009).

Biology

Lake Whitefish may live in excess of 20 years (Scott and Crossman 1998). Male Lake Whitefish tend to reach sexual maturity at a younger age than females and maturity is reached between 4–8 years of age. Spawning occurs in shallow water over hard substrate, in the fall when temperatures drop to 7.8°C. Females broadcast eggs over the rocky spawning grounds and lose up to 11% of their body weight at spawning. Fertilized eggs develop over the winter at temperatures ranging from 0.5°C–6.1°C and hatch in the spring (Scott and Crossman 1998). Larval Lake Whitefish form aggregations in shallow water along steep shorelines and move into deeper water by early summer.

Juvenile Lake Whitefish feed on invertebrates such as copepods and cladocerans and, by early summer when movement into deeper water occurs, they also begin to include benthic organisms such as chironimid larvae, gastropods, amphipods, and isopods.

Adult Lake Whitefish are schooling fish, preferring deeper, cool waters. Adults are benthic feeders, consuming insect larvae, amphipods, and molluscs (including dreissenid mussels). Small fishes and fish eggs, including those of their own species, are also eaten. Lake Whitefish is prey to several species, including Lake Trout, Northern Pike, and Walleye, while several species will prey on juvenile Lake Whitefish (Scott and Crossman 1998).

Significance

Lake Whitefish is an ESS due to multiple roles. It is an influential predator of invertebrates and small fishes. The species is also a significant forage item for several species such as Lake Trout, Northern Pike, and Walleye.

White Perch (*Morone Americana)*

Description

The White Perch is a deep-bodied fish with a long, laterally compressed body. The White Perch has 2 dorsal fins, the first spiny rayed, connected weakly to the soft-rayed second dorsal fin, unlike the dorsal fins of the closely related White Bass (*Morone chrysops*) which are separated. The colour is pale olive or silvery green on the sides with a darker back and silvery white belly (Scott and Crossman 1998). The body of the White Perch is deepest anterior to the dorsal fin, further distinguishing it from the White Bass, which is deepest at the dorsal fin (Holm et al. 2009).

Biology

Native to eastern North America, the White Perch invaded the Great Lakes through the Oswego River system. They subsequently became numerous in the the lower Great Lakes, particularly in the Bay of Quinte region of Lake Ontario (Minns and Hurley 1986).

White Perch spawn in the spring in shallow water when temperatures reach 15 ˚C, with no preference for specific substrate type (Scott and Crossman 1998). Females deposit up to 300,000 eggs, which hatch in approximately four days after they are laid. The average lifespan for White Perch is 3–5 years, with a maximum known age of 17 years (Scott and Crossman 1998). White Perch reach an average total length of 15.5 cm in Ontario, with a maximum of 29 cm (Holm et al. 2009).

White Perch is a schooling species that exhibits diel vertical movement, rising to the surface at night and returning to deeper waters during the day. Juvenile White Perch feed on plankton, switching to fishes and aquatic insects as they grow. Small White Perch are preyed on by larger piscivorous fishes, such as Walleye and Northern Pike, and other White Perch. The adults, however, are seldom preyed upon (Scott and Crossman 1998).

Significance

The White Perch is an ecologically significant predator in the Bay of Quinte. This species is one of the most numerous and important species in the system (Hoyle et al. 2012). The White Perch feeds on aquatic invertebrates and small fishes including Yellow Perch, Johnny Darter (*Etheostoma nigrum*), and smaller White Perch. This species is also potentially harmful in the Bay of Quinte; in the past it has reached very high abundance levels (Hurley 1986, Minns and Hurley 1986), competing with native species, such as Yellow Perch, for food.

Largemouth Bass (*Micropterus salmoides)*

Description

The Largemouth Bass is a large fish with a moderately compressed, elongated body. There are two dorsal fins attached, the first is spiny, containing 9–11 spines, the second is soft-rayed. The mouth is large, extending past the eye, distinguishing this species from the related Smallmouth Bass, whose mouth extends only to the eye. Body colour is light to dark green with a darker back and black blotches that form a lateral stripe along the middle of the body. The maximum size in Ontario is 55.9 cm total length and a weight of 4.7 kg (Holm et al. 2009). Females tend to be larger than males at a given age (Scott and Crossman 1998).

Biology

The Largemouth Bass may live in excess of 15 years in Ontario, with males reaching sexual maturity at 3–4 years and females maturing at 4–5 years of age. Spawning occurs in the late spring to early summer. Once water temperature reaches 16.7–18.3 °C, male Largemouth Bass excavate and guard nests in shallow, protected areas with emergent vegetation. Females may spawn in the nests of multiple males, and a single female will lay from 2000–109000 eggs. Eggs hatch in 3–5 days. After hatching, the fry remain on the bottom of the nest until the yolk-sack is absorbed, after which time they rise off the bottom and remain in a school. Males guard the eggs and fry for up to 30 days after hatching (Scott and Crossman 1998).

Largemouth Bass prefer warm shallow vegetated areas, using sunken timber and aquatic macrophytes as cover from which to ambush prey. Juvenile Largemouth Bass feed on invertebrates, such as cladocerans, mayfly nymphs, amphipods and chironimid larvae. As Largemouth Bass grows in size, smaller fishes become the main part of the diet, along with crayfishes, frogs and large aquatic insects. Main prey fish species of the Largemouth Bass are Gizzard Shad (*Dorosoma cepedianum*), Bluntnose Minnow (*Pimephales notatus*), Golden Shiner (*Notemigonus crysoleucas*), Bluegill, Pumpkinseed, and Yellow Perch, as well as cannibalizing smaller individuals of their own species (Scott and Crossman 1998).

Juvenile Largemouth Bass are competitors to other warmwater species such as Bluegill, Pumpkinseed and Yellow Perch, while adult Largemouth Bass compete with other large piscivores, such as Northern Pike, Muskellunge (*Esox masquinongy*), and Smallmouth Bass, for food resources. Smaller individual Largemouth Bass are preyed on by other fishes as well as fish-eating birds, such as Great Blue Heron (*Ardea herodias*), however, adult Largemouth Bass tend to be large enough to avoid predation (Scott and Crossman 1998).

Significance

The Largemouth Bass is an ecologically significant predator species that has the potential to affect populations of many smaller fishes. The Largemouth Bass is abundant in the highly vegetated Bay of Quinte, and preys on many native fish species.

Yellow Perch (*Perca flavescens)*

Description

The Yellow Perch has an oblong body shape with two dorsal fins, the first dorsal fin has 13–15 spines and the second dorsal fin has 1–2 spines and 12–15 rays. The mouth of the Yellow Perch is large, extending to below the middle of the eye. There are no large canine teeth present, distinguishing Yellow Perch from the related species Walleye, and Sauger (*Sander canadensis*). The Yellow Perch has a yellow to green body, with a darker back and 6–8 dark vertical bars that extend from the back down the sides of the body. The belly is lighter in colour. Males in spawning season have orange or red pelvic and anal fins. The maximum size in Ontario is 38.4 cm and maximum weight is 1.1 kg (Holm et al. 2009).

Biology

Yellow Perch live a maximum of 9 or 10 years. Females are larger than males and reach sexual maturity by age 4. Males reach maturity as early as age 1, but typical age at maturity for males is age 3.

Yellow Perch begin spawning movements early in the spring. Males arrive first at the spawning grounds in nearshore areas, followed by the arrival of females. Spawning occurs at water temperatures from 6.7–12.2 °C, typically over aquatic vegetation or sunken timber. Up to 109,000 eggs are released in a gelatinous string by a single female. Eggs hatch in 8–10 days (Scott and Crossman 1998).

Juvenile Yellow Perch feed mainly on cladocerans, ostracods and chironimid nymphs. Larger individuals continue to feed on aquatic invertebrates, such as decapods and Odonata nymphs but also prey on smaller fishes and fish eggs. Yellow Perch tend to travel in schools and feed mainly in the morning and evening, with little to no feeding activity at night (Scott and Crossman 1998).

Yellow Perch is preyed on by many larger fishes such as Northern Pike, Largemouth Bass, Smallmouth Bass, Walleye, and large Yellow Perch. Juvenile and adult Yellow Perch are competitors to Lake Whitefish, and various centrarchid species for food resources (Scott and Crossman 1998).

Significance

Yellow Perch is an ESS because it is an abundant prey item for larger fishes. The Yellow Perch is also an influential predator in the Bay of Quinte, preying on a wide variety of aquatic invertebrates and small fishes.

Walleye (*Sander vitreus)*

Description

Walleye has an elongated, slightly compressed body with a spiny dorsal fin followed by a soft dorsal fin. It has a long, blunt snout with a large terminal mouth. The colour ranges from olive brown to golden brown with a darker dorsal surface with 5–12 dark saddles, and white undersides. The Walleye has a pronounced white patch at the tip of the lower lobe of the caudal fin and distinctively large, opaque eyes. The average total length (TL) in Ontario is 42 cm with a maximum size of 92.7 cm TL and 10.1 kg in weight (Holm et al. 2009).

Biology

Walleye reach a maximum age of 15 years in the Bay of Quinte, and attain a length of 21 cm by the end of their first year of growth. Males reach sexual maturity at 2–4 years, while females reach maturity at 3–6 years (Scott and Crossman 1998).

Shortly after ice out in the spring, Walleye begin spawning related movements, with males typically reaching the spawning grounds first, followed by the females. Spawning occurs when water temperatures reach 6.7°C–8.9°C. Spawning takes places in rocky, white-water areas in tributaries, as well as on boulder to coarse gravel shoals in lakes. The Walleye is a broadcast spawner, females deposit up to 600,000 eggs, depending on size. The eggs fall into crevices in the substrate and hatch in 12–18 days. By 10–15 days after hatching the young disperse upwards in the water column (Scott and Crossman 1998).

Juvenile Walleye feed on invertebrates such as copepods and cladocerans. As the juveniles increase in size, their diet switches from invertebrates to fishes and the habitat shifts from the water column to the bottom. Adult Walleye often hide in sunken timber, boulder shoals, weedbeds, and other structure to shelter from the sunlight and feed most actively at night (Scott and Crossman 1998).

Adult Walleye prey on a number of fish species such as Yellow Perch, Alewife, Rainbow Smelt, Emerald Shiner (*Notropis atherinoides*), and White Sucker. Walleye will utilize any available small fish as prey, including cannibalizing smaller Walleye. Walleye are known competitors of Yellow Perch, Sauger, Lake Whitefish, and Smallmouth Bass. The main predators of adult Walleye are Northern Pike, while several species will predate upon smaller Walleye (Scott and Crossman 1998).

Significance

The Walleye is an ESS as a highly influential predator. Walleye are abundant in the Bay of Quinte and provide a controlling influence on the food web through predation on a wide variety of fishes. The Bay of Quinte is the most productive spawning and nursery habitat in Lake Ontario supporting the Walleye population.

Round Goby (*Neogobius melanostomus)*

Description

The Round Goby is a small fish with a cylindrical body and a large head with raised eyes. It has a spiny dorsal fin, followed by a soft dorsal fin. There is a distinctive black spot at the base of the spiny dorsal fin. The pelvic fins of the Round Goby are fused together to form a suctorial disc, which easily distinguishes them from other fish species. The body of the Round Goby is tan with brown or black markings. Spawning males are black. Average total length in Ontario is 7.5 cm and the largest specimen on record in Ontario is 21.5 cm TL (Holm et al. 2009).

Biology

Round Goby reach a maximum age of 4 years and reach sexual maturity in the second or third year. Male Round Goby build nests in cavities, often in colonies that contain several nests. Several females may lay eggs in a single male's nest, depositing up to 600 eggs on the ceiling, walls, and floor of the nest in a single layer. The male guards the nest and tends the eggs, which hatch in approximately 2 weeks at 21°C. Females may spawn multiple times in a season and spawning occurs repeatedly from May through September (Corkum 2010).

Round Goby is a benthic species, inhabiting rocky or sandy areas. It often burrows into soft substrate or takes refuge in rock crevices. Round Goby feed mainly on invertebrates, including plankton, amphipods, and aquatic insects. Fish eggs and small fishes may also be consumed. Adult Round Goby feed mainly on dreissenid mussels which they are able to crush with their pharyngeal teeth (Ray and Corkum 1997).

Round Goby is preyed on by many larger species including Smallmouth Bass, Freshwater Drum, Walleye, and Yellow Perch. Round Goby is an aggressive competitor, impacting many small benthic species such as Mottled Sculpin (*Cottus bairdii*) and Logperch (*Percina caprodes*).

Round Goby is an invasive species, native to the Ponto-Caspian region of Europe, and was first reported in the Great Lakes region in 1990 (Mills et al. 1993). The species was likely introduced to North America in ship ballast water. It has since spread to all five Great Lakes, as well as many inland waters.

Significance

The Round Goby is an ESS because of its role as a forage species, as it is preyed on by a large variety of larger fishes. It is also a harmful species. Subsequent to its invasion in the Great Lakes, the Round Goby has negatively impacted several native benthic species. Due to its aggressive nature and high reproductive output, it is able to outcompete native species for food and nest sites.

DISCUSSION

The criteria for identifying ESS were readily interpretable and applicable in the freshwater context, using the Bay of Quinte as an example ecosystem. The list created by this process should be viewed as a representative list, not a definitive one. Although each species in the ecosystem is likely to have some role to play, the species that are designated as ESS were deemed to have the most impact on community structure and function. In this case, the determination of which species are the ESS in this ecosystem was based on expert opinion. In the case of the Bay of Quinte, which is a highly studied ecosystem, the aquatic community is well known and there are a sufficient number of expert individuals to make informed designations of ESS. In less intensely studied systems, such as remote northern systems, this may prove problematic. The reliance on expert opinion for the designation of EBSA and ESS is not restricted to freshwater systems. This has been recognized as a potential shortcoming in its application in the marine environment as well (DFO 2012). In some cases, there is sufficient published information to supplement the expert opinion for the designation of particular ESS. For example, Joseph et al. (2013) provided ample evidence for the designation of Eelgrass (*Zostera marina*) as an ESS based on the structural complexity that it provides, and its use as a food source and nursery area for many species in coastal marine areas. In the case of the Bay of Quinte, published information exists to supplement designation of some of the species. Much of the information on particular species, however, is often general and derived from studies conducted elsewhere, thus, the reliance on expert opinion.

One potential shortcoming of the implementation of ESS that has been identified is the tendency to focus on commercially valuable and charismatic species (DFO 2012). When designating ESS, it is important to separate the ecological significance from the economic or cultural significance. In some instances, species, such as Walleye in the Bay of Quinte, may be significant economically and culturally, as well as ecologically but this should not be considered a general rule.

The use of the Bay of Quinte as the ecosystem for this study was predetermined based on its importance within the broader Lake Ontario ecosystem. This is contrary to the manner in which important areas have been identified in marine systems. In many of the marine cases, large geographic areas were considered, often based on the Large Ocean Management Areas (LOMAs). EBSAs within the LOMA are then identified based on areas that are important for aggregation, feeding, migration and other life history processes of the ESS within the system. This technique has been used to define EBSAs in such large-scale systems as the Canadian Arctic (DFO 2011) and the Pacific coast of British Columbia (DFO 2012). By necessity, the areas that are considered when applying the criteria in freshwater will be smaller than those considered in the marine environment. In the context of the Great Lakes, which are relatively well studied, considering each lake separately as an ecosystem to determine ESS and EBSA will likely suffice. However, when considering inland systems, employing a broader scale than individual lakes, such as the watershed or regional scale, may be necessary due to the vast number of inland waterbodies and the lack of information on many of the lesser-studied systems.

When considering lower trophic levels and the community-level properties, it was found that the significant species varied between years and among seasons. This made it difficult to designate any single species as significant in the lower trophic levels. The use of area-based techniques (EBSA) may better account for these properties. Additionally, considering a group of species collectively, as we have treated SAV, and Kenchington et al. (2011) have treated corals and sponges, may prove useful in capturing community-level processes.

Although no significant gaps were identified in the application of these criteria in the freshwater context, there are, however, some considerations to the application of these criteria.

First, most of the identified ESS were associated with the trophodynamic criterion. The identification of significant species through trophic interactions cannot be expected to be static. The significant trophic species in the Bay of Quinte have shifted over the past 40 years as the ecosystem has changed. For example, Alewife and White Perch were historically considered to be important trophic and harmful species (Minns et al. 1986) but have declined in abundance in recent years (though still numerous in the system), while Largemouth Bass have become important predators as water clarity and macrophyte coverage have improved (Hoyle et al. 2012). Second, in the Bay of Quinte, structure was limited to aquatic plants, which may differ from some marine systems where corals are important (e.g. Kenchington et al. 2011). Third, given their ability to stabilize sediments and serve as habitat (Vaughn et al. 2008), further consideration should be given to the potential for native mussels to serve as significant structure in freshwater ecosystems. Finally, in the Bay of Quinte, all identified harmful species were high-impact aquatic invasive species; however, this should not be interpreted as a definitive result for freshwater ecosystems. There are other harmful species that are known to affect freshwater ecosystems (e.g. harmful algal blooms, Landsberg 2002) that should be considered, along with invasive species.

The Bay of Quinte is a diverse and productive aquatic system, supporting a wide range of recreational, commercial, and Aboriginal fisheries in Lake Ontario. It is an ecologically significant area in the Lake Ontario north shore ecoregion, producing higher index of biotic integrity (IBI) values and increased diversity and biomass of centrarchid fishes than nearby areas of Lake Ontario (Brousseau et al. 2011). The application of the ESS criteria, previously used solely in marine systems, has proven useful in designating species as significant in the Bay of Quinte ecosystem. Several species have been identified as ecologically significant and management of these species will be important to maintain the structure and function of the Bay of Quinte ecosystem.

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APPENDIX

Aquatic species present in Bay of Quinte, Lake Ontario.

Family or Taxon	Genus	Species	Common Name
Virus	*Novirhabdovirus*		Viral Hemorrhagic Septicemia (VHS) virus
Algae	*Anabaena*	*crassa*	
Algae	*Anabaena*	*lemmermannii*	
Algae	*Anabaena*	*planctonica*	
Algae	*Anabaena*	*spiroides*	
Algae	*Aphanizomenon*	*gracile*	
Algae	*Cyanodictyon*	*reticulatum*	
Algae	*Cyanodictyon*	*planctonica*	
Algae	*Cyclotella*	*pseudostelligera*	diatom
Algae	*Microcystis*	*botrys*	
Algae	*Microcystis*	*novacekii*	
Algae	*Pseudanabaena*		
Algae	*Stephanodiscus*	*binderanus*	diatom
Plant (aquatic)	*Chara*	*braunii*	stonewort
Plant (aquatic)	*Chara*	*globularis*	stonewort
Plant (aquatic)	*Nitella*	*flexilis*	stonewort
Plant (aquatic)	*Drepanocladus*		moss
Plant (aquatic)	*Riccia*	*fluitans*	Liverwort
Plant (aquatic)	*Typha*	*latifolia*	Cattail
Plant (aquatic)	*Najas*	*flexilis*	Bushy Pondweed
Plant (aquatic)	*Najas*	*guadalupensis*	Bushy Pondweed
Plant (aquatic)	*Potamogeton*	*crispus*	curlyleaf pondweed
Plant (aquatic)	*Potamogeton*	*friesii*	pondweed
Plant (aquatic)	*Potamogeton*	*pectinatus*	Sago Pondweed
Plant (aquatic)	*Potamogeton*	*pusillus*	pondweed
Plant (aquatic)	*Potamogeton*	*perfoliatus*	Clasping Leaf Pondweed
Plant (aquatic)	*Potamogeton*	*zosterifolius*	Flat Stemmed Pondweed
Plant (aquatic)	*Zannichellia*	*palustris*	Horned Pondweed
Plant (aquatic)	*Alisma*	*gramineum*	Water Plantain
Plant (aquatic)	*Alisma*	*plantago-aquatica*	Water Plantain
Plant (aquatic)	*Sagittaria*	*latifolia*	Arrowhead
Plant (aquatic)	*Elodea*	*canadensis*	Canadian Waterweed

Family or Taxon	Genus	Species	Common Name
Plant (aquatic)	*Vallisneria*	*americana*	American Wildcelery
Plant (aquatic)	*Hydrocharis*	*morsus-ranae*	European frogbit
Plant (aquatic)	*Calamagrostis*	*canadensis*	Bluejoint
Plant (aquatic)	*Phalaris*	*arundinacea*	Reed Canary Grass
Plant (aquatic)	*Glyceria*		Manna Grass
Plant (aquatic)	*Carex*		Sedge
Plant (aquatic)	*Eleocharis*	*acicularis*	Needle Rush
Plant (aquatic)	*Lemna*	*minor*	Duckweed
Plant (aquatic)	*Lemna*	*trisulca*	Star Duckweed
Plant (aquatic)	*Spirodela*	*polyrhiza*	Big Duckweed
Plant (aquatic)	*Heteranthera*	*dubia*	Mud Plantain
Plant (aquatic)	*Juncus*		Rush
Plant (aquatic)	*Polygonum*	*amphibium*	Smartweed
Plant (aquatic)	*Ceratophyllum*	*demersum*	Hornwort Coontail
Plant (aquatic)	*Nuphar*	*variegatum*	Yellow Water Lily
Plant (aquatic)	*Ranunculus*	*aquatilis*	Water Crowfoot
Plant (aquatic)	*Cardamine*	*pensylvanica*	Bittercress
Plant (aquatic)	*Callitriche*	*hermaphroditica*	Water Starwort
Plant (aquatic)	*Impatiens*	*capensis*	jewelweed
Plant (aquatic)	*Hypericum*	*virginicum*	Marsh St. John's Wort
Plant (aquatic)	*Epilobium*		Willow Herb
Plant (aquatic)	*Myriophyllum*	*spicatum*	Eurasian Watermilfoil
Plant (aquatic)	*Myriophyllum*	*exalbescens*	Milfoil
Plant (aquatic)	*Sium*	*suave*	Water Parsnip
Plant (aquatic)	*Asclepias*	*exaltata*	Milkweed
Plant (aquatic)	*Cuscuta*	*gronovii*	Dodder
Plant (aquatic)	*Lycopus*	*americanus*	Water Horehound
Plant (aquatic)	*Scutellaria*	*epilobiifolia*	Skull Cap
Plant (aquatic)	*Utricularia*	*intermedia*	Bladderwort
Plant (aquatic)	*Utricularia*	*minor*	Bladderwort
Plant (aquatic)	*Galium*	*triflorum*	Bedstraw
Plant (aquatic)	*Campanula*	*aparinoides*	Marsh Bluebell
Plant (aquatic)	*Solidago spp.*		Goldenrod
Protozoa	*Heterosporis*		microsporidian
Turbellaria	Turebellaria		flatworm
Turbellaria	*Dugesia*	*tigrina*	flatworm

Family or Taxon	Genus	Species	Common Name
Turbellaria	*Neorhabdocoela*		flatworm
Platyhelminthes	*Hydrolimax*	*grisea*	flatworm
Platyhelminthes	*Procotyla*	*fluviatilus*	flatworm
Nematode	Nemata spp.		roundworm
Nematode	Mermithidae		roundworm
Nemertea	*Prostoma*	*canadensis*	ribbon worm
Nemertea	*Prostoma*	*graecense*	ribbon worm
Annelid	*Potamothrix*	*bedoti*	oligochaete
Annelid	*Potamothrix*	*moldaviensis*	oligochaete
Annelid	*Alboglossiphonia*	*heteroclita*	Glossophoniidae
Annelid	*Gloiobdella*	*elongata*	Glossophoniidae
Annelid	*Arcteonais*	*lomondi*	oligochaete
Annelid	*Dero*	*digitata*	oligochaete
Annelid	*Dero*	*flabelliger*	oligochaete
Annelid	*Lumbriculus*	*variegatus*	oligochaete
Annelid	*Mooreobdella*	*fervida*	oligochaete
Annelid	*Slavina*	*appendiculata*	oligochaete
Annelid	*Stylaria*	*lacustris*	oligochaete
Annelid	*Stylodrilus*	*heringianus*	oligochaete
Annelid	*Uncinais*	*uncinata*	Naididae
Annelid	*Nais*	*communis*	tubificidae
Annelid	*Nais*	*pseudobtusa*	tubificidae
Annelid	*Nais*	*simplex*	tubificidae
Annelid	*Nais*	*variabilis*	tubificidae
Annelid	*Aulodrilus*	*limnobius*	tubificidae
Annelid	*Aulodrilus*	*pigueti*	tubificidae
Annelid	*Aulodrilus*	*pluriseta*	tubificidae
Annelid	*Ilyodrilus*	*templetoni*	tubificidae
Annelid	*Limnodrilus*	*hoffmeisteri*	tubificidae
Annelid	*Limnodrilus*	*profundicola*	tubificidae
Annelid	*Limnodrilus*	*claparedianus*	tubificidae
Annelid	*Peloscolex*	*ferox*	tubificidae
Annelid	*Potamothrix*	*bavaricus*	tubificidae
Annelid	*Potamothrix*	*bedoti*	tubificidae
Annelid	*Potamothrix*	*hammoniensis*	tubificidae
Annelid	*Potamothrix*	*moldaviensis*	tubificidae

Family or Taxon	Genus	Species	Common Name
Annelid	*Potamothrix*	*vejdovskyi*	tubificidae
Annelid	*Quistradrilus*	*multisetosus*	tubificidae
Annelid	*Tubifex*	*tubifex*	tubificidae
Cnidaria	*Hydra*		Hydra
Polychaete	*Manayunkia*	*speciosa*	Plychaete worm
Hirudinea	*Erpobdella*	*punctata*	leech
Hirudinea	*Glossophonia*	*complanata*	leech
Hirudinea	*Helobdella*	*stagnalis*	leech
Molluscs	*Dreissena*	*polymorpha*	zebra mussel
Molluscs	*Dreissena*	*rostriformis bugensis*	quagga mussel
Molluscs	*Pisidium*	*amnicum*	pea clam
Molluscs	*Pisidium*	*casertanum*	pea clam
Molluscs	*Pisidium*	*compressum*	pea clam
Molluscs	*Pisidium*	*conventus*	pea clam
Molluscs	*Pisidium*	*dubium*	pea clam
Molluscs	*Pisidium*	*equilaterale*	pea clam
Molluscs	*Pisidium*	*fallax*	pea clam
Molluscs	*Pisidium*	*ferrugineum*	pea clam
Molluscs	*Pisidium*	*henslowanum*	Henslow's pea clam
Molluscs	*Pisidium*	*idahoense*	pea clam
Molluscs	*Pisidium*	*lilljeborgi*	pea clam
Molluscs	*Pisidium*	*nitidum*	pea clam
Molluscs	*Pisidium*	*punctatum*	pea clam
Molluscs	*Pisidium*	*rotundatum*	pea clam
Molluscs	*Pisidium*	*subtruncatum*	pea clam
Molluscs	*Pisidium*	*variabile*	pea clam
Molluscs	*Pisidium*	*ventricosum*	pea clam
Molluscs	*Pisidium*	*walkeri*	pea clam
Molluscs	*Sphaerium*	*corneum*	fingernail clam
Molluscs	*Sphaerium*	*nitidum*	fingernail clam
Molluscs	*Sphaerium*	*simile*	fingernail clam
Molluscs	*Sphaerium*	*striatinum*	fingernail clam
Molluscs	*Musculium*	*lacustre*	fingernail clam
Molluscs	*Musculium*	*partumeium*	fingernail clam
Molluscs	*Musculium*	*transversum*	fingernail clam

Family or Taxon	Genus	Species	Common Name
Molluscs	*Lampsilis*	*radiata*	Eastern Lamp Mussel
Molluscs	*Bithynia*	*tentaculata*	faucet snail
Molluscs	*Amnicola*	*limosa*	snail
Molluscs	*Amnicola*	*walkeri*	snail
Molluscs	*Potamopyrgus*	*antipodarum*	New Zealand mud snail
Molluscs	*Valvata*	*lewisi*	Fringed Valvata snail
Molluscs	*Valvata*	*piscinalis*	European valve snail
Molluscs	*Valvata*	*sincera*	valve snail
Molluscs	*Valvata*	*tricarinata*	valve snail
Molluscs	*Ferrissia*	*parallela*	snail
Molluscs	*Fossaria*	*obrussa*	snail
Molluscs	*Gyraulus*	*parvus*	snail
Molluscs	*Helisoma*	*anceps*	ram's horn snail
Molluscs	*Marstonia*	*decepta*	snail
Molluscs	*Physella*	*gyrina*	snail
Molluscs	*Planorbula*		snail
Molluscs	*Pleurocera*	*acuta*	snail
Molluscs	*Pseudosuccinea*	*columella*	American ribbed fluke snail
Rotifera	*Anuraeopsis*	*fissa*	Rotifer
Rotifera	*Anuraeopsis*	*navicula*	Rotifer
Rotifera	*Ascomorpha*	*ecaudis*	Rotifer
Rotifera	*Ascomorpha*	*ovalis*	Rotifer
Rotifera	*Ascomorpha*	*saltans*	Rotifer
Rotifera	*Asplanchna*	*priodonta*	Rotifer
Rotifera	*Asplanchna*	*brightwelli*	Rotifer
Rotifera	*Brachionus*	*angularis*	Rotifer
Rotifera	*Brachionus*	*calyciflorus*	Rotifer
Rotifera	*Brachionus*	*urceolaris*	Rotifer
Rotifera	*Conochiloides*	*dossuarius*	Rotifer
Rotifera	*Conochilus*	*unicornis*	Rotifer
Rotifera	*Euchlanis*		Rotifer
Rotifera	*Filinia*	*brachiata*	Rotifer
Rotifera	*Filinia*	*longiseta*	Rotifer
Rotifera	*Filinia*	*terminalis*	Rotifer
Rotifera	*Gastropus*	*stylifer*	Rotifer
Rotifera	*Kellicottia*	*bostoniensis*	Rotifer

Family or Taxon	Genus	Species	Common Name
Rotifera	*Kellicottia*	*longispina*	Rotifer
Rotifera	*Keratella*	*cochlearis tecta*	Rotifer
Rotifera	*Keratella*	*hiemalis*	Rotifer
Rotifera	*Keratella*	*quadrata*	Rotifer
Rotifera	*Keratella*	*serrulata*	Rotifer
Rotifera	*Lecane*	*luna*	Rotifer
Rotifera	*Lecane*	*mucronata*	Rotifer
Rotifera	*Notholca*	*acuminata*	Rotifer
Rotifera	*Notholca*	*caudata*	Rotifer
Rotifera	*Notholca*	*laurentiae*	Rotifer
Rotifera	*Notholca*	*squamula*	Rotifer
Rotifera	*Ploesoma*	*hudsoni*	Rotifer
Rotifera	*Ploesoma*	*lenticulare*	Rotifer
Rotifera	*Ploesoma*	*truncatum*	Rotifer
Rotifera	*Polyarthra*	*dolichoptera*	Rotifer
Rotifera	*Polyarthra*	*euryptera*	Rotifer
Rotifera	*Polyarthra*	*major*	Rotifer
Rotifera	*Polyarthra*	*remata*	Rotifer
Rotifera	*Polyarthra*	*vulgaris*	Rotifer
Rotifera	*Pompholyx*	*sulcata*	Rotifer
Rotifera	*Synchaeta*	*grandis*	Rotifer
Rotifera	*Synchaeta*	*kitina*	Rotifer
Rotifera	*Synchaeta*	*pectinata*	Rotifer
Rotifera	*Synchaeta*	*stylata*	Rotifer
Rotifera	*Trichocerca*	*capucina*	Rotifer
Rotifera	*Trichocerca*	*clylindrica*	Rotifer
Rotifera	*Trichocerca*	*elongata*	Rotifer
Rotifera	*Trichocerca*	*longiseta*	Rotifer
Rotifera	*Trichocerca*	*multicrinis*	Rotifer
Rotifera	*Trichocerca*	*porcellus*	Rotifer
Rotifera	*Trichocerca*	*pusilla*	Rotifer
Rotifera	*Trichocerca*	*rouseseleti*	Rotifer
Rotifera	*Trichocerca*	*similis*	Rotifer
Rotifera	*Trichocerca*	*tetractis*	Rotifer
Rotifera	*Tylotrocha*	*monopus*	Rotifer
Crustacea	*Diaptomus*	*reighardi*	Calanoid Copepod

Family or Taxon	Genus	Species	Common Name
Crustacea	*Diaptomus*	*sanguiensis*	Calanoid Copepod
Crustacea	*Epischura*	*lacustris*	Calanoid Copepod
Crustacea	*Eurytemora*	*affinis*	calanoid copepod
Crustacea	*Leptodiaptomus*	*ashlandi*	Calanoid Copepod
Crustacea	*Leptodiaptomus*	*minutus*	Calanoid Copepod
Crustacea	*Leptodiaptomus*	*sicilis*	Calanoid Copepod
Crustacea	*Leptodiaptomus*	*siciloides*	Calanoid Copepod
Crustacea	*Limnocalanus*	*macrurus*	Calanoid Copepod
Crustacea	*Senecella*	*calanoides*	Calanoid Copepod
Crustacea	*Skistodiaptomus*	*oregonensis*	Calanoid Copepod
Crustacea	*Cyclops*	*scutifer*	Cyclopoid Copepod
Crustacea	*Cyclops*	*vernalis*	Cyclopoid Copepod
Crustacea	*Diacyclops*	*thomasi*	Cyclopoid Copepod
Crustacea	*Eucyclops*	*agilis*	Cyclopoid Copepod
Crustacea	*Eucyclops*	*speratus*	Cyclopoid Copepod
Crustacea	*Macrocyclops*	*albidus*	Cyclopoid Copepod
Crustacea	*Macrocyclops*	*ater*	Cyclopoid Copepod
Crustacea	*Mesocyclops*	*edax*	Cyclopoid Copepod
Crustacea	*Microcyclops*	*varicans*	Cyclopoid Copepod
Crustacea	*Orthocyclops*	*modestus*	Cyclopoid Copepod
Crustacea	*Paracyclops*	*poppei*	Cyclopoid Copepod
Crustacea	*Tropocyclops*	*extensus*	Cyclopoid Copepod
Crustacea	Harpacticoida		Harpacticoid Copepod
Crustacea	*Acroperus*	*harpae*	Cladoceran
Crustacea	*Alona*	*costata*	Cladoceran
Crustacea	*Alona*	*guttata*	Cladoceran
Crustacea	*Alona*	*affinis*	Cladoceran
Crustacea	*Alona*	*rectangula*	Cladoceran
Crustacea	*Alonella*	*excisa*	Cladoceran
Crustacea	*Bosmina*	*longirostris*	Cladoceran
Crustacea	*Bythotrephes*	*longimanus*	spiny waterflea
Crustacea	*Camptocercus*	*rectirostris*	Cladoceran
Crustacea	*Cercopagis*	*pengoi*	fish-hook waterflea
Crustacea	*Ceriodaphnia*	*lacustris*	Cladoceran
Crustacea	*Ceriodaphnia*	*quadrangula*	Cladoceran
Crustacea	*Chydorus*	*canadensis*	Cladoceran

Family or Taxon	Genus	Species	Common Name
Crustacea	*Chydorus*	*sphaericus*	Cladoceran
Crustacea	*Daphnia*	*ambigua*	Cladoceran
Crustacea	*Daphnia*	*catawba*	Cladoceran
Crustacea	*Daphnia*	*galeata mendotae*	Cladoceran
Crustacea	*Daphnia*	*longiremis*	Cladoceran
Crustacea	*Daphnia*	*parvula*	Cladoceran
Crustacea	*Daphnia*	*pulex*	Cladoceran
Crustacea	*Daphnia*	*pulicaria*	Cladoceran
Crustacea	*Daphnia*	*retrocurva*	Cladoceran
Crustacea	*Diaphanosoma*	*birgei*	Cladoceran
Crustacea	*Diaphanosoma*	*brachyurum*	Cladoceran
Crustacea	*Disparalona*	*hamata*	Cladoceran
Crustacea	*Dunhevedia*		Cladoceran
Crustacea	*Eubosmina*	*coregoni*	waterflea
Crustacea	*Eurycercus*	*lamellatus*	Cladoceran
Crustacea	*Graptoleberis*	*testudinaria*	Cladoceran
Crustacea	*Holopedium*	*gibberum*	Cladoceran
Crustacea	*Ilyocryptus*	*spinifer*	Cladoceran
Crustacea	*Leptodora*	*kindtii*	Cladoceran
Crustacea	*Macrothrix*	*laticornis*	Cladoceran
Crustacea	*Ophryoxus*	*gracilis*	Cladoceran
Crustacea	*Paralona*	*pigra*	Cladoceran
Crustacea	*Pleuroxus*	*denticulatus*	Cladoceran
Crustacea	*Pleuroxus*	*procurvus*	Cladoceran
Crustacea	*Polyphemus*	*pediculus*	Cladoceran
Crustacea	*Scapholeberis*	*kingi*	Cladoceran
Crustacea	*Sida*	*crystallina*	Cladoceran
Crustacea	*Simocephalus*	*serrulatus*	Cladoceran
Crustacea	*Simocephalus*	*vetulus*	Cladoceran
Crustacea	*Candona*		Ostracod
Crustacea	*Cyprididae*		Ostracod
Crustacea	*Cytherissa*		Ostracod
Crustacea	*Cytherissa*	*lacustra*	Ostracod
Crustacea	*Hemimysis*	*anomala*	mysid shrimp
Crustacea	*Mysis*	*relicta*	mysid shrimp
Crustacea	*Diporeia*		amphipod

Family or Taxon	Genus	Species	Common Name
Crustacea	*Diporeia*	*hoyi*	amphipod
Crustacea	*Echinogammarus*	*ischnus*	amphipod
Crustacea	*Crangonyx*		amphipod
Crustacea	*Crangonyx*	*gracilis*	amphipod
Crustacea	*Gammarus*	*fasciatus*	amphipod
Crustacea	*Hyalella*	*azteca*	amphipod
Crustacea	*Caecidotea*		Isopod
Crustacea	*Caecidotea*	*racovitzai*	Isopod
Hydracarina	*Forelia spp.*		Water Mite
Hydracarina	Hydrachnidae		Water Mite
Hydracarina	*Hygrobates*		Water Mite
Hydracarina	*Krendowskia*		Water Mite
Hydracarina	*Lebertia*		Water Mite
Hydracarina	*Limnesia*		Water Mite
Hydracarina	*Neumania*		Water Mite
Hydracarina	*Piona*		Water Mite
Hydracarina	*Prostigmata*		Water Mite
Hydracarina	*Unionicola*		Water Mite
Insecta	*Caenis*		Mayfly
Insecta	*Hexagenia*		Mayfly
Insecta	*Stenacron*	*interpunctatum*	Light Cahill Mayfly
Insecta	*Enallagma*		Damselfly
Insecta	*Agrypnia*		Caddisfly
Insecta	*Cheumatopsyche*		Caddisfly
Insecta	*Lepidostoma*		Caddisfly
Insecta	Leptoceridae		Caddisfly
Insecta	*Leptocerus*	*americanus*	Caddisfly
Insecta	*Molanna*		Caddisfly
Insecta	*Oecetis*		Caddisfly
Insecta	*Polycentropus*		Caddisfly
Insecta	*Triaenodes*		Caddisfly
Insecta	*Cypria*		Orthoptera
Megaloptera	*Sialis*		Alderfly
Insecta	*Coloeptera*		Aquatic Beetle
Insecta	*Dubiraphia*		riffle beetle
Insecta	Elmidae		riffle beetle

Family or Taxon	Genus	Species	Common Name
Insecta	*Stenelmis*		riffle beetle
Insecta	*Stenelmis*	*crenata*	riffle beetle
Insecta	*Ablabesmyia*		non-biting midge
Insecta	*Bezzia*		midge
Insecta	Ceratopogonidae		midge
Insecta	*Antocha*		Crane Fly
Insecta	*Chaoborus*		Glassworm midge
Insecta	*Chaoborus*	*albatus*	Glassworm midge
Insecta	*Chaoborus*	*punctipennis*	Glassworm midge
Insecta	*Chironomini*		Chironimid midge
Insecta	*Chironomus*	*anthracinus*	Chironimid midge
Insecta	*Chironomus*	*atritibia*	Chironimid midge
Insecta	*Chironomus*	*plumosus*	Chironimid midge
Insecta	*Chironomus*	*semireductus*	Chironimid midge
Insecta	*Cladopelma*		Chironimid midge
Insecta	*Cladotanytarsus*		Chironimid midge
Insecta	*Clinotanypus*		Chironimid midge
Insecta	*Coelotanypus*		Chironimid midge
Insecta	*Conchapelopia*		Chironimid midge
Insecta	*Cricotopus*		Chironimid midge
Insecta	*Cryptochironomus*	*digitatus*	Chironimid midge
Insecta	*Cryptochironomus*	*fulvus*	Chironimid midge
Insecta	*Cryptotendipes*		Chironimid midge
Insecta	*Demicryptochironomus*		Chironimid midge
Insecta	*Dicrotendipes*	*modestus*	Chironimid midge
Insecta	*Dicrotendipes*	*nervosus*	Chironimid midge
Insecta	*Einfeldia*		Chironimid midge
Insecta	*Endochironomus*	*nigricans*	Chironimid midge
Insecta	*Endochironomus*	*subtendens*	Chironimid midge
Insecta	*Glyptotendipes*		Chironimid midge
Insecta	*Harnischia*		Chironimid midge
Insecta	*Heterotrissocladius*		Chironimid midge
Insecta	*Microchironomus*	*nigrovittatus*	Chironimid midge
Insecta	*Micropsectra*		Chironimid midge
Insecta	*Microtendipes*		Chironimid midge
Insecta	*Nilothauma*	*babiyi*	Chironimid midge

Family or Taxon	Genus	Species	Common Name
Insecta	*Parachironomus*		Chironimid midge
Insecta	*Paracladopelma*		Chironimid midge
Insecta	*Paralauterborniella*		Chironimid midge
Insecta	*Paramerina*		Chironimid midge
Insecta	*Paratendipes*		Chironimid midge
Insecta	*Phaenopsectra*		Chironimid midge
Insecta	*Polypedilum*	*aviceps*	Chironimid midge
Insecta	*Polypedilum*	*halterale*	Chironimid midge
Insecta	*Polypedilum*	*illinoense*	Chironimid midge
Insecta	*Potthastia*	*longimana*	Chironimid midge
Insecta	*Procladius*		Chironimid midge
Insecta	*Procladius*	*bellus*	Chironimid midge
Insecta	*Psectrotanypus*		Chironimid midge
Insecta	*Pseudochironomus*		Chironimid midge
Insecta	*Stempellina*		Chironimid midge
Insecta	*Stempellinella*		Chironimid midge
Insecta	*Stictochironomus*		Chironimid midge
Insecta	Tanypodinae		Chironimid midge
Insecta	*Tanytarsus*		Chironimid midge
Insecta	*Tribelos*		Chironimid midge
Petromyzontidae	*Petromyzon*	*marinus*	Sea Lamprey
Petromyzontidae	*Ichthyomyzon*	*unicuspis*	Silver Lamprey
Acipenseridae	*Acipenser*	*fulvescens*	Lake Sturgeon
Lepisosteidae	*Lepisosteus*	*osseus*	Longnose Gar
Amiidae	*Amia*	*calva*	Bowfin
Anguillidae	*Anguilla*	*rostrata*	American Eel
Clupeidae	*Alosa*	*pseudoharengus*	Alewife
Clupeidae	*Dorosoma*	*cepedianum*	Gizzard Shad
Cyprinidae	*Carassius*	*auratus*	Goldfish
Cyprinidae	*Cyprinus*	*carpio*	Common Carp
Cyprinidae	*Notemigonus*	*crysoleucas*	Golden Shiner
Cyprinidae	*Notropis*	*anogenus*	Pugnose Shiner
Cyprinidae	*Notropis*	*atherinoides*	Emerald Shiner
Cyprinidae	*Notropis*	*bifrenatus*	Bridle Shiner
Cyprinidae	*Notropis*	*cornutus*	Common Shiner
Cyprinidae	*Notropis*	*heterodon*	Blackchin Shiner

Family or Taxon	Genus	Species	Common Name
Cyprinidae	*Notropis*	*heterolepis*	Blacknose Shiner
Cyprinidae	*Notropis*	*hudsonius*	Spottail Shiner
Cyprinidae	*Notropis*	*stramineus*	Sand Shiner
Cyprinidae	*Cyprinella*	*spiloptera*	Spotfin Shiner
Cyprinidae	*Rhinichthys*	*cataractae*	Longnose Dace
Cyprinidae	*Pimephales*	*notatus*	Bluntnose Minnow
Cyprinidae	*Pimephales*	*promelas*	Fathead Minnow
Cyprinidae	*Semotilus*	*corporalis*	Fallfish
Cyprinidae	*Scardinius*	*erythrophthalmus*	Rudd
Catostomidae	*Carpiodes*	*cyprinus*	Quillback
Catostomidae	*Catostomus*	*commersoni*	White Sucker
Catostomidae	*Hypentelium*	*nigricans*	Northern Hogsucker
Catostomidae	*Moxostoma*	*anisurum*	Silver Redhorse
Catostomidae	*Moxostoma*	*carinatum*	River Redhorse
Catostomidae	*Moxostoma*	*erythrurum*	Golden Redhorse
Catostomidae	*Moxostoma*	*macrolepidotum*	Shorthead Redhorse
Catostomidae	*Moxostoma*	*valenciennesi*	Greater Redhorse
Catostomidae	*Ictiobus*	*cyprinellus*	Bigmouth Buffalo
Ictaluridae	*Ameiurus*	*melas*	Black Bullhead
Ictaluridae	*Ameiurus*	*nebulosus*	Brown Bullhead
Ictaluridae	*Ictalurus*	*punctatus*	Channel Catfish
Ictaluridae	*Noturus*	*flavus*	Stonecat
Ictaluridae	*Noturus*	*gyrinus*	Tadpole Madtom
Osmeridae	*Osmerus*	*mordax*	Rainbow Smelt
Salmonidae	*Oncorhynchus*	*tshawytscha*	Chinook Salmon
Salmonidae	*Oncorhynchus*	*kisutch*	Coho Salmon
Salmonidae	*Oncorhynchus*	*gorbuscha*	Pink Salmon
Salmonidae	*Oncorhynchus*	*mykiss*	Rainbow Trout
Salmonidae	*Salmo*	*salar*	Atlantic Salmon
Salmonidae	*Salmo*	*trutta*	Brown Trout
Salmonidae	*Salvelinus*	*namaycush*	Lake trout
Salmonidae	*Salvelinus*	*namaycush x fontinalis*	Splake
Salmonidae	*Coregonus*	*artedii*	Cisco
Salmonidae	*Coregonus*	*clupeaformis*	Lake Whitefish
Salmonidae	*Prosopium*	*cylindraceum*	Round Whitefish

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Hiodontidae	*Hiodon*	*tergisus*	Mooneye
Esocidae	*Umbra*	*limi*	Central Mudminnow
Esocidae	*Esox*	*americanus vermiculatus*	Grass Pickerel
Esocidae	*Esox*	*lucius*	Northern Pike
Esocidae	*Esox*	*masquinongy*	Muskellunge
Percopsidae	*Percopsis*	*omiscomaycus*	Trout-perch
Gadidae	*Lota*	*lota*	Burbot
Atherinidae	*Labidesthes*	*sicculus*	Brook Silverside
Fundulidae	*Fundulus*	*diaphanus*	Banded Killifish
Gasterosteidae	*Culaea*	*inconstans*	Brook Stickleback
Gasterosteidae	*Gasterosteus*	*aculeatus*	Threespine Stickleback
Gasterosteidae	*Pungitius*	*pungitius*	Ninsepine Stickleback
Cottidae	*Cottus*	*bairdii*	Mottled Sculpin
Cottidae	*Cottus*	*cognatus*	Slimy Sculpin
Moronidae	*Morone*	*americana*	White Perch
Moronidae	*Morone*	*chrysops*	White Bass
Centrarchidae	*Ambloplites*	*rupestris*	Rock Bass
Centrarchidae	*Lepomis*	*gibbosus*	Pumpkinseed
Centrarchidae	*Lepomis*	*macrochirus*	Bluegill
Centrarchidae	*Micropterus*	*dolomieu*	Smallmouth Bass
Centrarchidae	*Micropterus*	*salmoides*	Largemouth Bass
Centrarchidae	*Pomoxis*	*nigromaculatus*	Black Crappie
Percidae	*Etheostoma*	*flabellare*	Fantail Darter
Percidae	*Etheostoma*	*nigrum*	Johnny Darter
Percidae	*Percina*	*caprodes*	Logperch
Percidae	*Percina*	*copelandi*	Channel Darter
Percidae	*Perca*	*flavescens*	Yellow Perch
Percidae	*Sander*	*canadense*	Sauger
Percidae	*Sander*	*vitreus*	Walleye
Scianidae	*Aplodinotus*	*grunniens*	Freshwater Drum
Gobiidae	*Neogobius*	*melanostomus*	Round Goby