

Results of Surveillance for Eurasian Ruffe and Round Goby in Lake Huron, 2006

Anjanette Bowen

*U.S. Fish and Wildlife Service
Alpena National Fish and Wildlife Conservation Office
145 Water Street, Federal Building Room 204
Alpena, Michigan 49707*

Results of Surveillance for Eurasian Ruffe and Round Goby in Lake Huron, 2006

Anjanette Bowen

U.S. Fish and Wildlife Service, Alpena National Fish and Wildlife Conservation Office
145 Water Street, Federal Building Room 204, Alpena, Michigan 49707

Abstract. – Monitoring for new and expanding populations of aquatic invasive species has been on-going in Lake Huron since 1992 and in the St. Marys River since 2000. Populations of invasive Eurasian ruffe *Gymnocephalus cernuus* and round goby *Neogobius melanostomus* have been documented in the fall using small-mesh bottom trawling gear at ports and rivers in nearshore areas. In 2006, eight Lake Huron and five St. Marys River locations were sampled to detect new and document existing populations of these invasives. No new populations of gobies were discovered, and ruffe continue to be absent from our catch. However, gobies continued to persist at all Lake Huron locations where they previously became established. In 2006 the relative abundance of gobies decreased when compared to last sampling at five of the eight locations. Catch rates ranged from a low of 0.07 fish/minute at Port Dolomite near Cedarville, to a high of 13.3 fish/minute at the National Gypsum port in Tawas. Abundances were up in the Thunder Bay area and at the National Gypsum port, and gobies composed a major portion of the total catch in the Cheboygan River, Thunder Bay River, and at National Gypsum. Ruffe and gobies remain undetected in the St. Marys River.

Introduction

The U.S. Fish and Wildlife Service (Service) Alpena National Fish and Wildlife Conservation Office has monitored Lake Huron ports and rivers since 1996 to collect information on existing benthic fish communities and to detect and monitor new or existing populations of aquatic invasive species (AIS). In 2000, efforts were expanded to include channels and ports in the St. Marys River. Two invasive fish species, the Eurasian ruffe (ruffe) *Gymnocephalus cernuus* and the round goby (goby) *Neogobius melanostomus*, are of particular concern.

Eurasian ruffe were discovered in the Great Lakes in 1986 at the Duluth-Superior harbor in western Lake Superior (Pratt et al. 1992), and gobies were discovered in the St. Clair River in 1990 (Jude et al. 1992). Both species likely were first introduced into the Great Lakes from the ballast water of ocean-going ships (Mills et al. 1993).

Ruffe and gobies have the potential to disturb the ecosystem when present in high numbers by disrupting the food web and habitat of native fish and invertebrate species. Both species mature as early as age 2 and spawn several times in a season, so they can become abundant quickly (Charlebois et al. 1997, Ogle 1998). They also have complex sensory features that allow them to

more readily detect predators and feed in darkness (Jude et al. 1995, Ogle 1998). They have been known to prey on fish eggs and small fish and may impact the reproduction and populations of other species (Adams and Maitland 1998, French and Jude 2001). The larger size and aggressive nature of the round goby has been found to negatively affect spawning and habitat use of other benthic fish species including mottled sculpin *Cottus bairdii* and logperch *Percina caprodes* (Balshine et al. 2005, Janssen and Jude 2001). These characteristics provide the ruffe and goby a competitive advantage over native species (Jude 1997, Holker and Thiel 1998).

Within Lake Huron ruffe have maintained a limited distribution. Ruffe were first found in Lake Huron in 1995 from the Thunder Bay River in Alpena, Michigan (Ruffe Control Committee 1996). No expansion or new populations have been detected within the lake since that time. The ruffe population in the Thunder Bay River peaked in 1999 and has declined abruptly in subsequent years. Ruffe have not been captured from the Thunder Bay area since the spring of 2003.

Although gobies were first found in Lake Huron in 1994, they were first detected during our survey efforts in 1997 at the mouth of the Saginaw River in Essexville, Michigan (Bowen 2007, Schaeffer et al. 2005) (Table 1). We soon detected gobies at other shipping ports including Alpena (1998) and National Gypsum (1999), then over time at rivers and ports in the northern part of the lake including the Cheboygan River (2002) and Port Dolomite (2002) (Bowen 2007, Schaeffer et al. 2005). This report summarizes efforts conducted in 2006 to monitor the distribution and abundances of ruffe and goby in nearshore areas of Lake Huron and the St. Marys River.

Methods

A 4.9-m, small-mesh, otter trawl (3.8-cm stretch mesh body, and 6.35-mm square-mesh cod liner) was used to sample for ruffe and goby in Lake Huron and the St. Marys River. Surveillance

was conducted in locations where these species may have been transported in ballast water, mainly shipping ports, shipping channels and river mouths (Ruffe Control Committee 1996). Sampling was also conducted at locations where preferred habitat was found including areas with turbid water, soft substrates, and water depths of 3-8 meters. Sampling took place in September and October (9/18-10/04) of 2006. Effort consisted of a total of 15 to 30 minutes of trawling at each sampling location. Tows lasted five minutes at 1200 RPM. In total, 43 tows were conducted in Lake Huron and 21 tows in the St. Marys River. Water depth was measured with a Furuno depth sounder at the beginning and end of each tow, and bottom water temperatures were measured with a YSI digital thermometer at each location.

The catch was separated by species, and then total lengths were recorded on a maximum of 15 specimens of each species. All round goby were retained and euthanized, while non-target species were returned unharmed to the water. Relative abundance was determined for goby and expressed as catch-per-minute-of-effort (CPE) for each location.

Results

Thirteen locations in U.S. waters of Lake Huron and the St. Marys River were surveyed in 2006 (Figure 1). In total, 215 minutes of effort were conducted at eight locations in Lake Huron (Table 2) and 105 minutes of effort were conducted at five locations in the St. Marys River (Table 3).

No ruffe or gobies were detected in the St. Marys River (Table 3), nor have been to date. Within Lake Huron, ruffe were not detected at any sampled locations (Table 2), nor were they captured from the Thunder Bay area where they were formerly established (Figure 2). Gobies were previously discovered at all eight Lake Huron locations and continue to persist in those areas (Table

2). A synopsis of the goby catch at each location beginning with northern sites and following with southern sites is presented below.

Port Dolomite

Gobies were a minor component of the total catch from Port Dolomite (Figure 1) in 2006. The CPE for gobies was 0.07 fish/minute (Table 2). Gobies collected averaged 62 ± 36.0 mm in total length (95% confidence interval). They composed 7% of the total catch (Figure 3) where slimy sculpins *Cottus cognatus* were most abundant and composed 46% of the total catch. Three other species were represented in the catch, including johnny darter *Etheostoma nigrum*, ninespine stickleback *Pungitius pungitius*, and rainbow smelt *Osmerus mordax*. The relative abundances of these non-target species are provided in Appendix I for reference.

Cheboygan River

Gobies were the major portion of the total catch from the Cheboygan River (Figure 1) in 2006. The CPE for gobies was 2.7 fish/minute (Table 2). They were the most abundant species captured from the river and composed 78% of the total catch (Figure 3). Gobies collected averaged 84 ± 11.4 mm in total length (95% confidence interval). Four other species, bluegill *Lepomis macrochirus*, gizzard shad *Dorosoma cepedianum*, rock bass *Ambloplites rupestris*, and smallmouth bass *Micropterus dolomieu*, were captured. The relative abundances of these non-target species are provided in Appendix I for reference.

Thunder Bay Area

The Thunder Bay area consists of two sampling locations - one site in Thunder Bay at the main shipping channel and one site in the Thunder Bay River ending at the river mouth (Figure 1). Gobies were captured from both sampling locations. Catch rates were very similar for the two sites, and ranged from 2.3 fish/minute in the Thunder Bay shipping channel to 2.4 fish/minute in the Thunder Bay River (Table 2) and represents an increase in overall abundance from 2005 (Figure 4). While goby remained the most abundant species captured from the Thunder Bay River and composed 86 percent of the total catch, they composed only ten percent of the total catch in the main shipping channel within Thunder Bay due to large numbers of emerald shiners *Notropis atherinoides* and rainbow smelt present in the catch. Therefore, although gobies remained very abundant, proportionally they did not represent the same dominance in the combined catch as in past years (Figure 4). Within the bay small numbers of three additional species were captured from the shipping channel. including mimic shiner, rock bass, and yellow perch. Small numbers of six other species were captured from the river in addition to gobies, including mimic shiner *Notropis volucellus*, walleye *Sander vitreum*, yellow perch *Perca flavescens*, bluegill, rock bass, and smallmouth bass. The relative abundances of these non-target species are provided in Appendix I for reference.

The average length of gobies varied between the two sampling locations. Gobies collected from the Thunder Bay River were larger and averaged 74 ± 7.4 mm in total length (95% confidence interval) as compared to those collected from the Thunder Bay shipping channel, which averaged 33 ± 8.0 mm in total length (95% confidence interval).

National Gypsum

Gobies were the major portion of the total catch from the National Gypsum port (Figure 1) in 2006. The CPE for gobies was 13.3 fish/minute (Table 2). They were the most abundant species captured at the port and composed 83% of the total catch (Figure 3). Gobies collected averaged 62 ± 5.0 mm in total length (95% confidence interval). Three other species, mimic shiner, bluegill, and rainbow smelt were captured in addition to gobies. The relative abundances of these non-target species are provided in Appendix I for reference.

AuGres River

Gobies were a minor component of the total catch from the AuGres River (Figure 1) in 2006. Their CPE was 1.03 fish/minute (Table 2). Gobies collected at the AuGres River averaged 90 ± 16.9 mm in total length (95% confidence interval). They composed 11% of the total catch (Figure 3) where yellow perch were most abundant and composed 60% of the total catch. Thirteen other species were represented in the catch, including black crappie *Pomoxis nigromaculatus*, bluntnose minnow *Pimephales notatus*, channel catfish *Ictalurus punctatus*, largemouth bass *Micropterus salmoides*, pumpkinseed sunfish *Lepomis gibbosus*, silver redhorse *Moxostoma anisurum*, spottail shiner *Notropis hudsonius*, trout-perch *Percopsis omiscomaycus*, white perch *Morone Americana*, johnny darter, logperch, mimic shiner, and rock bass. The relative abundances of these non-target species are provided in Appendix I for reference.

Saginaw River

Gobies were a minor component of the total catch from the Saginaw River mouth (Figure 1) in 2006. Their CPE was 1.70 fish/minute (Table 2). Gobies collected at the Saginaw River mouth

averaged 67 ± 11.1 mm in total length (95% confidence interval). They composed 7% of the total catch (Figure 3) where channel catfish were most abundant and composed 81% of the catch. Four other species were represented in the catch, including freshwater drum *Aplodinotus grunniens*, emerald shiners, white perch, and yellow perch. The relative abundances of these non-target species are provided in Appendix I for reference.

Harbor Beach DTE Dock

Gobies were a minor component of the total catch from the DTE dock in Harbor Beach (Figure 1) in 2006. Their CPE was 0.90 fish/minute (Table 2). Gobies collected at Harbor Beach averaged 70 ± 7.5 mm in total length (95% confidence interval). They composed 9% of the total catch (Figure 3) where white perch were most abundant and composed 87% of the total catch. Four other species were represented in the catch, including logperch, mimic shiner, rock bass, and spottail shiner. The relative abundances of these non-target species are provided in Appendix I for reference.

Twenty three non-target species were captured from Lake Huron sampling locations and 17 non-target species were captured from St. Marys River sampling locations in 2006. The relative abundance of these species is provided in the Appendix for reference.

Discussion

Ruffe continue to be absent from Lake Huron and have possibly become extirpated. The sole known location of ruffe within the lake, found at the Thunder Bay River and surrounding area, has languished following a peak in the population in 1999, and ruffe have not been captured there since

2003. The enactment of voluntary ballast water restrictions by the Great Lakes Carriers Association (GLCA) soon following the initial discovery of ruffe in Thunder Bay in 1995 (Harkins 1996) likely helped prevent the spread of ruffe to new areas within the lake by limiting the transport of ballast out of the Thunder Bay River. We cannot explain why ruffe have not migrated or expanded their range out of Thunder Bay to other parts of Lake Huron through unassisted migration, as they have along Lake Superior's southern coast.

We also do not know why the population in Thunder Bay faltered following 1999, but suspect it may be related to one or a combination of factors including goby invasion of the area, our efforts to remove ruffe, and/or possible recruitment failure of the 1999 year class. Gobies, which are known egg and fry predators (French and Jude 2001), have the potential to prey on ruffe eggs and fry and could possibly impact the success of ruffe reproduction where the two species co-exist. Gobies were first confirmed in Thunder Bay in 1997 when the Lafarge Corporation reported one impinged on their water intake screens. In 1998 they were captured during our trawling survey efforts there and by 1999 they were the most abundant bottom dwelling species captured from the Thunder Bay shipping channel. The rapid increase in goby abundance corresponded with the increase in ruffe abundance in 1999. By 2000, ruffe had declined and goby remained the most abundant bottom dwelling species captured. Although we did not examine goby diets, it may be possible that the large abundance of gobies may have consumed a large number of ruffe eggs and fry, impacting the success of ruffe reproduction in 1999 and beyond.

Additionally, our fall survey efforts using a small-mesh bottom trawl captured mainly young-of-the-year (YOY) ruffe (unpublished data) and the removal of large numbers of YOY from the 1999 year class, coupled with a subsequent adult removal effort using small-mesh gillnets in the spring prior to spawning, also may have impacted ruffe recruitment and reproduction. Young-of-the-year ruffe have

not been captured during fall trawling surveys since 2000 and adults have not been captured during spring gillnetting removal efforts since 2003. Although both efforts are on-going, continued surveillance is needed in the Thunder Bay area to confirm whether ruffe have truly been extirpated from there.

Gobies, however, have become widely distributed within the lake and have been captured at all eight Lake Huron sampling locations since 2004 (Table 1). The lack of widespread ballast regulations likely has allowed gobies to spread via intra-lake shipping from infested ports to areas around Lake Huron (Clapp et al. 2001, Schaeffer et al. 2005). Where goby densities have become high, the behavioral exclusion of juveniles by adult gobies has probably led to additional unassisted range expansion (Ray and Corkum 2001). Also, the prior invasion of zebra mussels *Dreissena polymorpha*, a prey item for the goby in its native range, has facilitated their rapid and successful colonization around the lake (Jude 1997).

Although gobies continued to persist at all previously sampled areas within the lake, we observed a general decrease in their relative abundance at five locations in 2006 including the Cheboygan River mouth, Port Dolomite near Cedarville, AuGres River mouth, Saginaw River mouth, and the DTE dock at Harbor Beach (Figure 3). Three of the southern locations (AuGres River, Saginaw River, and DTE in Harbor Beach) were not sampled in 2005 so comparisons could only be made to the 2004 survey making it difficult to determine if this decline is an actual trend. We can simply note that abundances were lower in 2006 than in 2004 at these locations. Gobies comprised less than ten percent of the total catch at the Saginaw River mouth and the DTE dock in Harbor Beach in 2006, but were the most abundant species in these same locations in 2004 where they composed 45 and 83 percent of the total catch, respectively (Figure 3). The USGS, Great Lakes Sciences Center has seen similar declines over the same time period in their offshore trawling efforts (Jeff Schaeffer personal communication).

A decline in abundance following a rapid increase is a common trend with many aquatic invasive species (Moyle and Light 1996) and may partly explain our observations.

We did observe an increase in the relative abundance of gobies at a few locations including the two locations in the Thunder Bay area and at the National Gypsum port near Tawas (Figures 3 and 4). Within the Thunder Bay area, the abundance of gobies increased from 2005 to 2006 in both the Thunder Bay River and the Thunder Bay shipping channel. This was a change from past years when the abundance of gobies had declined within the area following their peak from 2000-2002 (Figure 4). The National Gypsum port is a southern location that was not sampled in 2005 and the 2006 data were compared to those collected during 2004. From 2004 to 2006, there was approximately a six fold increase in the relative abundance of gobies at this port. Gobies are well established in both areas and have been the dominant bottom dwelling species for a number of years (Schaeffer et al. 2005). Gobies remained the most abundant bottom dwelling species at these locations, with the exception of the Thunder Bay main shipping channel where gobies were a minor portion of the total catch in 2006 due to unusually high numbers of emerald shiners and rainbow smelt which dominated the catch. Gobies also remained the most abundant component of the total catch at the Cheboygan River in 2006 despite the noted reduction in their relative abundance (Figure 3).

The St. Marys River remains free of ruffe and goby despite being the single source and relatively confined vector for shipping traffic into Lake Superior. Both ruffe and goby have been found at ports in Lake Superior and Lake Huron, and could potentially be introduced into the St. Marys River via shipping ballast water that is occasionally purged. Unassisted range expansion through migration of these species is also a threat to the St. Marys River. Within Lake Huron, gobies have been documented within 30 km of the St. Marys River to the south at Port Dolomite (unpublished data) and within Lake Superior ruffe have been captured approximately 60 km from the river to the north at the Tahquamenon

River (Gary Czypinski, personal communication). As such, goby may be poised to enter the river from existing populations in the south and ruffe may be poised to enter the river from existing populations in the north. Continued surveillance is needed to locate any ruffe or goby in the St. Marys River prior to establishment of populations, when numbers are still low and when control may be an option for eradication.

In order to detect new populations, control existing populations, and prevent establishment of additional populations of ruffe and goby in Lake Huron and the St. Marys River, survey efforts will continue in 2007 and beyond.

Literature Cited

- Adams, C.E. and P.S. Maitland. 1998. The ruffe population of Loch Lomond, Scotland: its introduction, population expansion, and interaction with native species. *J. Great Lakes Res.* 24: 249-262.
- Balshine, S., A. Verma, V. Chant, T. Theysmeyer. 2005. Competitive interactions between round gobies and logperch. *J. Great Lakes Res.* 31:68-77.
- Charlebois, P.M., E.J. Marsden, R.G. Goettel, R.K. Wolfe, D.J. Jude, and S. Rudnika. 1997. The round goby, *Neogobius melanostomus* (Pallas), a review of European and North American literature. Illinois-Indiana Sea Grant Program and Illinois Natural History Survey, Special Publication 20, Champaign, Illinois.
- Clapp, D.F., P.J. Scheeberger, D.J. Jude, G. Madison, and C. Pistis. 2001. Monitoring round goby *Neogobius melanostomus* population expansion in eastern and northern Lake Michigan. *J. Great Lakes Res.* 27: 335-341.
- French III, J.R.P. and D.J. Jude. 2001. Diets and diet overlap of nonindigenous gobies and small benthic native fishes co-inhabiting the St. Clair River, Michigan. *J. Great Lakes Res.* 27: 300-311.
- Harkins, R.W. 1996. Memorandum Re: Interim measures to reduce the risk of transfer of ruffe from Alpena, Michigan. Lake Carriers' Association Memorandum dated November 1, 1996.
- Holker, F. and R. Thiel. 1998. Biology of ruffe (*Gymnocephalus cernuus* (L.)) – A review of selected aspects from European literature. *J. Great Lakes Res.* 24(2):186-204.

- Janssen, J. and D.J. Jude. 2001. Recruitment failure of mottled sculpin *Cottus Bairdi* in Calumet Harbor, Southern Lake Michigan, induced by the newly introduced round goby *Neogobius melanostomus*. *J. Great Lakes Res.* 27(3): 319-328.
- Jude, D.J. 1997. Round gobies: cyberfish of the third millennium. *Great Lakes Research Review* 3(1):27-34.
- Jude, D.J., R.H. Reider, and G.R. Smith. 1992. Establishment of Gobiidae in the Great Lakes basin. *Can. J. Fish. Aquat. Sci.* 49:416-421.
- Jude, D.J., J. Janssen, and G. Crawford. 1995. Ecology, distribution, and impact of the newly introduced round and tubenose gobies in the biota of the St. Clair and Detroit Rivers. In *The Lake Huron Ecosystem: Ecology, Fisheries, and Management*. Eds. M. Munawar, T. Edsall, and J. Leach, pp. 447-460. *Ecovision World Monograph Series*, S.B.P. Academic Publishing, The Netherlands.
- Mills, E.L., J.H. Leach, J.T. Carlton, and C.L. Secor. 1993. Exotic species in the Great Lakes – a history of biotic crises and anthropogenic introductions. *J. Great Lakes Res.* 19:1-54.
- Moyle, P.B., and T. Light. 1996. Biological invasions of fresh water: empirical rules and assembly theory. *Biol. Conserv.* 78:149-161.
- Ogle, D.H. 1998. A synopsis of the biology and life history of ruffe. *J. Great Lakes Res.* 24(2):170-185.
- Pratt, D.M., W.H. Blust, and J.H. Selgeby. 1992. Ruffe, *Gymnocephalus cernuus*: newly introduced in North America. *Can. J. Fish. Aquat. Sci.* 49:1616-1618.
- Ray, W.J., and L.D. Corkum. 2001. Habitat and site affinity by the round goby. *J. Great Lakes Res.* 27:329-334.
- Ruffe Control Committee. 1996. Ruffe control program. Submitted to the Aquatic Nuisance Species Task Force by the Ruffe Control Committee, Thomas R. Busiahn, Chairman. U.S. Fish and Wildlife Service, Fishery Resources Office, Ashland, WI. 30 pp. Unpublished MS.
- Schaeffer, J.S., A. Bowen, M. Thomas, J.R.P. French III, and G.L. Curtis. 2005. Invasion history, proliferation, and offshore diet of the round goby *Neogobius melanostomus* in western Lake Huron, USA. *J. Great Lakes Res.* 31:414-425.

Table 1. Progression of round goby detected at Lake Huron ports over time. The “X” represents years when goby were captured and the “O” represents years when goby were not captured. Blanks represent un-sampled years.

Location (North to South)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
<u>Lake Huron</u>												
Cedarville - Port Dolomite	O	O	O	O	O	O	O	X	O	O	X	X
Cheboygan - Cheboygan River mouth	O	O	O	O	O	O	O	X	X	X	X	X
Alpena - Thunder Bay area	O	O	O	X	X	X	X	X	X	X	X	X
Tawas – National Gypsum port		O	O	O	X	X		X		X		X
AuGres – AuGres River mouth			O	O	O					X		X
Essexville – Saginaw River mouth			X	O	X	X		X	X	X		X
Carrollton – Saginaw River								X		X		
Harbor Beach – Detroit Edison port				O				X		X		X



Figure 1. Surveillance sites in Lake Huron (▲) and the St. Marys River (● inset).

Table 2. Summary of surveillance activities in Lake Huron during 2006.

Location (N to S)	Effort	Date	Ave. Depth (m)	Ave. Temp. (C)	Ruffe CPE	Goby CPE
Lake Huron						
Cedarville - Port Dolomite Dock	30.0	9/27/2006	7.4	9.2	0	0.1
Cheboygan - Cheboygan River Mouth	30.0	9/19/2006	7.3	17.2	0	2.7
Alpena - Thunder Bay Shipping Channel	30.0	9/20/2006	6.1	11.0	0	2.3
Alpena - Thunder Bay River Mouth	30.0	9/18/2006	6.7	19.4	0	2.4
Tawas – National Gypsum Dock	15.0	9/21/2006	6.2	13.9	0	13.3
AuGres – AuGres River Mouth	30.0	10/02/2006	2.5	12.0	0	1.0
Essexville – Saginaw River Mouth	20.0	10/04/2006	8.9	15.2	0	1.7
Harbor Beach – DTE Dock	30.0	10/03/2006	5.3	15.1	0	0.9
					Mean Ruffe CPE	Mean Goby CPE
	Total Effort				0	3.1
	215.0 Minutes					

Table 3. Summary of surveillance activities in the St. Marys River during 2006.

Location (N to S)	Effort	Date	Ave. Depth (m)	Ave. Temp. (C)	Ruffe CPE	Goby CPE
St. Marys River						
Sault Ste. Marie - Municipal Harbor	25.0	9/25/2006	4.2	13.2	0	0
Sault Ste. Marie - Channel South of Sugar Isl. Ferry	10.0	9/26/2006	4.0	11.7	0	0
Sault Ste. Marie - Channel South of Sugar Isl. Ferry	20.0	9/27/2006	9.4	11.7	0	0
Sault Ste. Marie – Munuscong Channel	20.0	9/26/2006	6.3	9.1	0	0
De Tour Village - Coal Dock	15.0	9/28/2006	7.8	12.0	0	0
De Tour Village - Maud Bay	15.0	9/28/2006	7.8	12.0	0	0
					Mean Ruffe CPE	Mean Goby CPE
	Total Effort				0	0
	105.0 Minutes					

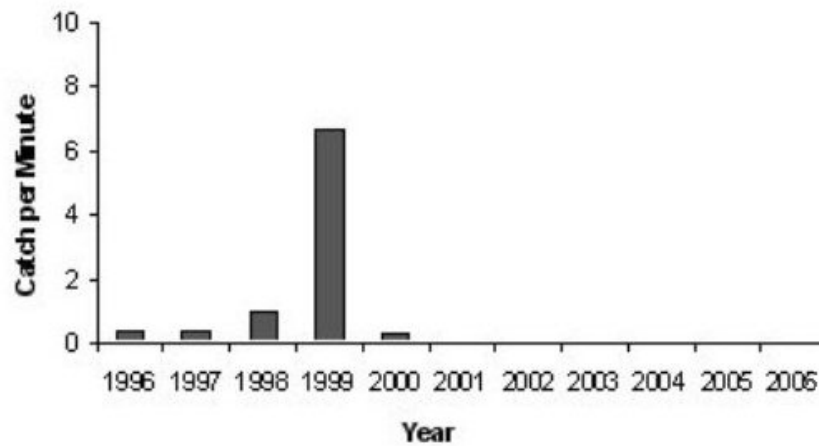


Figure 2. Relative abundance of Eurasian ruffe in the Thunder Bay area, 1996-2006. Sampling was conducted with a 4.9-m bottom trawl, and effort was measured in minutes trawl was fished on the bottom. The sampling location spans from the Second Avenue Bridge downstream to the TB buoy in Thunder Bay.

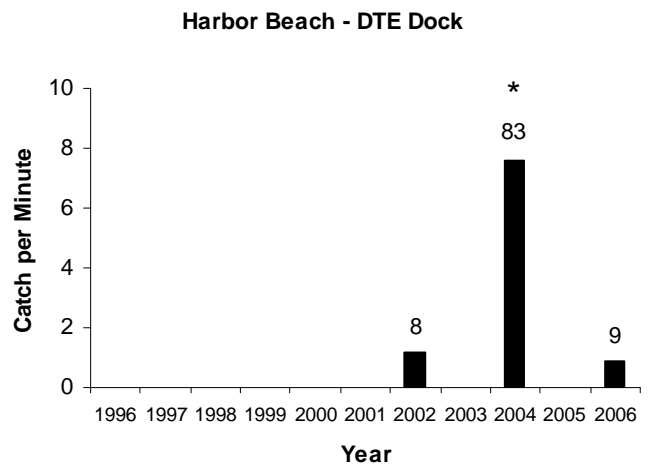
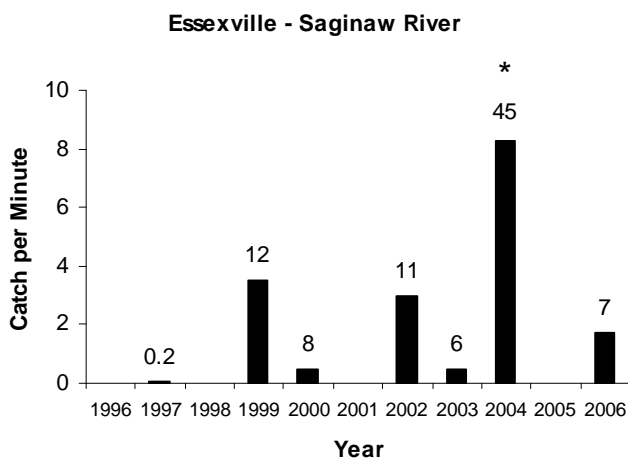
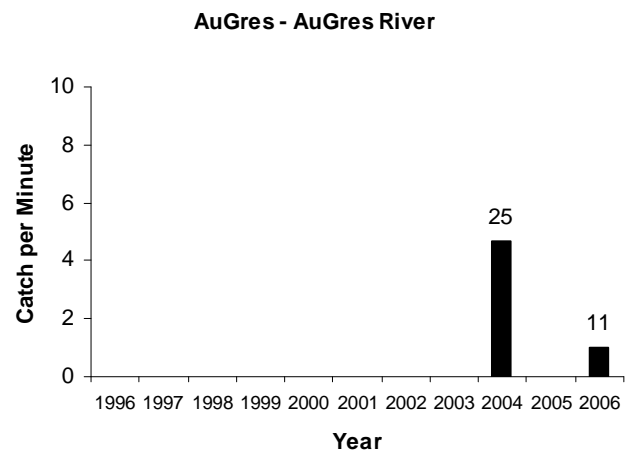
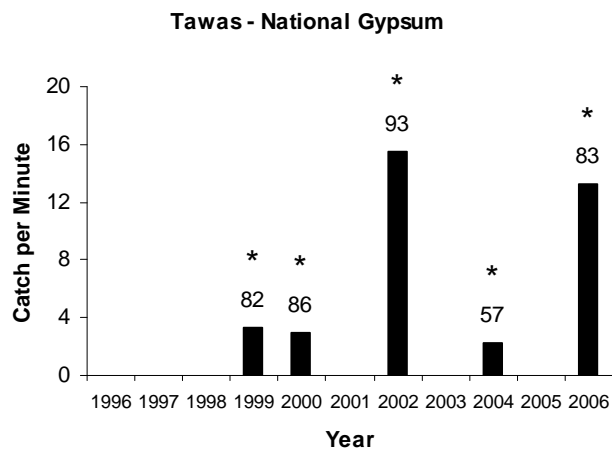
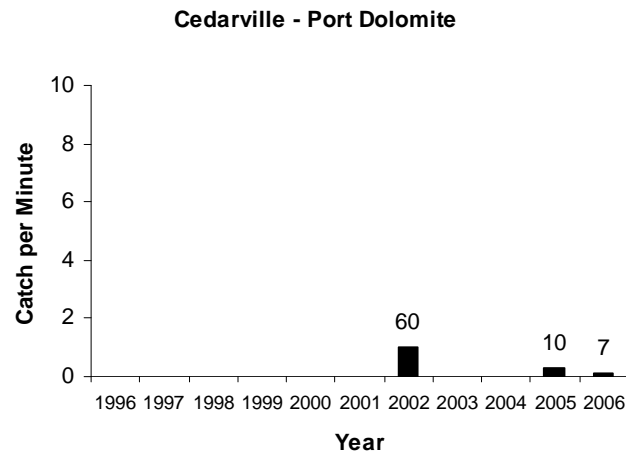
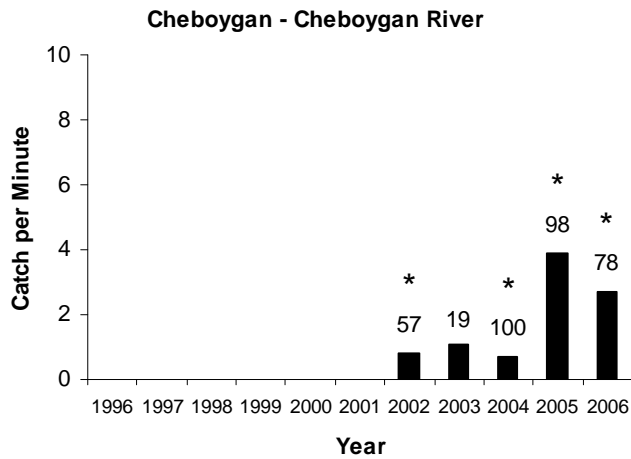


Figure 3. Relative abundance of round gobies at selected ports in Lake Huron, 1996-2006. Sampling was conducted with a 4.9-m bottom trawl, and effort was measured in minutes the trawl was fished on the bottom. The number above each bar indicates percentage of catch made up by gobies. The “*” indicates when gobies were most abundant.

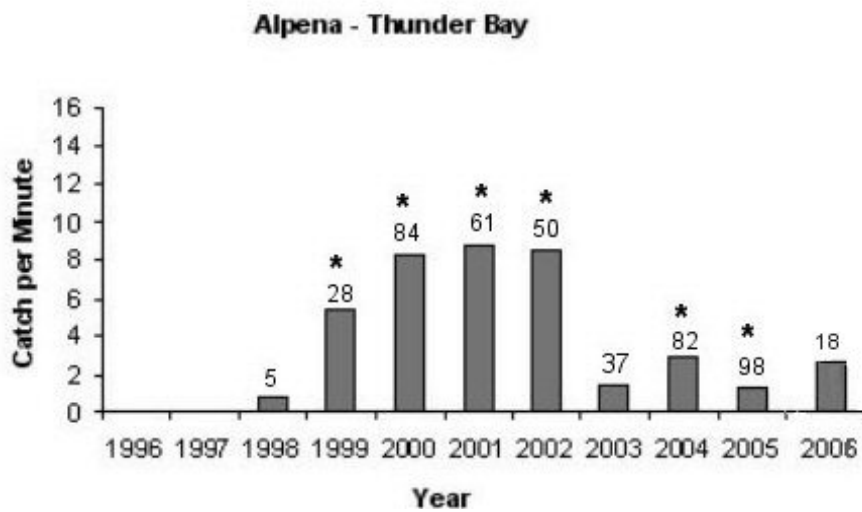


Figure 4. Relative abundance of round gobies in the Thunder Bay area of Lake Huron, 1996-2006. Sampling was conducted with a 4.9-m bottom trawl, and effort was measured in minutes the trawl was fished on the bottom. The number above each bar indicates percentage of catch made up by gobies. The “*” indicates when gobies were most abundant.

Appendix I

Relative abundance (catch per minute) of non-target species captured from Lake Huron in 2006.

Common name	Scientific name	Cedarville Port Dolomite	Cheboygan Cheboygan River	Alpena Shipping Channel	Alpena Thunder Bay River	Tawas National Gypsum	AuGres AuGres River	Essexville Saginaw River	Harbor Beach DTE Port
Black crappie	<i>Pomoxis nigromaculatus</i>						0.80		
Bluntnose minnow	<i>Pimephales notatus</i>						0.07		
Bluegill	<i>Lepomis macrochirus</i>		0.03		0.03	0.20			
Channel catfish	<i>Ictalurus punctatus</i>						0.10	19.25	
Emerald shiner	<i>Notropis atherinoides</i>			9.50				0.05	
Freshwater drum	<i>Aplodinotus grunniens</i>							1.85	
Gizzard shad	<i>Dorosoma cepedianum</i>		0.03						
Johnny darter	<i>Etheostoma nigrum</i>	0.07					0.03		
Largemouth bass	<i>Micropterus salmoides</i>						0.13		
Logperch	<i>Percina caprodes</i>						0.07		0.07
Mimic shiner	<i>Notropis volucellus</i>			0.27	0.03	0.07	0.07		0.03
Ninespine stickleback	<i>Pungitius pungitius</i>	0.17							
Pumpkinseed sunfish	<i>Lepomis gibbosus</i>						0.13		
Rainbow smelt	<i>Osmerus mordax</i>	0.20		10.57		2.53			
Rock bass	<i>Ambloplites rupestris</i>		0.57	0.10	0.10		0.13		0.03
Silver redhorse	<i>Moxostoma anisurum</i>						0.03		
Slimy sculpin	<i>Cottus cognatus</i>	0.43							
Smallmouth bass	<i>Micropterus dolomieu</i>		0.13		0.10				
Spottail shiner	<i>Notropis hudsonius</i>						0.93		0.23
Trout-perch	<i>Percopsis omiscomaycus</i>						0.03		
Walleye	<i>Sander vitreum</i>				0.03				
White perch	<i>Morone americana</i>						0.03	0.30	8.50
Yellow perch	<i>Perca flavescens</i>			0.07	0.10		5.50	0.65	

Appendix II

Relative abundance (catch per minute) of non-target species captured from the St. Marys River in 2006.

Common name	Scientific name	Sault Ste. Marie Municipal Harbor	Sault Ste. Marie Sugar Island Channel	Sault Ste. Marie Munuscong Channel	DeTour Coal Dock	DeTour Maud Bay
Alewife	<i>Alosa pseudoharengus</i>				0.07	
Bluntnose minnow	<i>Pimephales notatus</i>	0.68	0.43	0.13		
Brook stickleback	<i>Culaea inconstans</i>	0.08				
Brown bullhead	<i>Ictalurus nebulosus</i>		0.03			
Emerald shiner	<i>Notropis atherinoides</i>					0.67
Gizzard shad	<i>Dorosoma cepedianum</i>				0.27	
Johnny darter	<i>Etheostoma nigrum</i>	0.12	0.03	0.20	0.40	0.07
Logperch	<i>Percina caprodes</i>	0.08	0.20	0.55		
Mimic shiner	<i>Notropis volucellus</i>	10.36	0.23		1.33	10.53
Rock bass	<i>Ambloplites rupestris</i>	0.08	0.03	0.13		
Rainbow smelt	<i>Osmerus mordax</i>	5.44			39.00	4.87
Slimy sculpin	<i>Cottus cognatus</i>	0.08	0.07			
Spottail shiner	<i>Notropis hudsonius</i>	0.12	0.03	0.10	6.33	10.60
Trout-perch	<i>Percopsis omiscomaycus</i>	0.28			2.27	5.33
White perch	<i>Morone americana</i>				0.07	0.13
White sucker	<i>Catostomus commersonii</i>	0.08				
Yellow perch	<i>Perca flavescens</i>	0.04	0.07	0.03		

The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people."

Equal opportunity to participate in and benefit from programs and activities of the U.S. Fish and Wildlife Service is available to all individuals regardless of race, religion, color, or physical or mental disability. For more information please contact:

U.S. Department of the Interior
Office for Equal Opportunity
1849 C. Street, N.W.
Washington, D.C. 20240