

## Surveillance for Ruffe in the Great Lakes - An Overview

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Abstract - The establishment of nonindigenous aquatic species is a perturbation that challenges resource managers in the Great Lakes basin to understand the dynamics of the present system, and predict patterns for the future. The effects of invasive species and their eventual distribution are difficult to predict. Surveillance programs are used by managers as a means of identifying newly established populations, tracking range expansions, assessing the impacts of introduced species on native populations, and evaluating control or management strategies. The ruffe, *Gymnocephalus cernuus*, like the zebra mussel, is believed to have been introduced to the Great Lakes through ballast water discharge. Since its discovery, surveillance programs have continued to track range expansion and monitor species abundance in areas where ruffe have already colonized as well as in areas where ruffe are likely to colonize. In addition to conducting field surveys, the education of public water users has been instrumental to increasing surveillance efforts. In several cases, recreational anglers were first to report the presence of ruffe at new locations, findings that were later verified with fish sampling gear. Communication with the maritime industry has guided surveillance efforts to shipping ports where ruffe may colonize via ballast water transport. The probability of detection by surveillance sampling of new colonies of ruffe appears to be rather high, because ruffe are highly selective toward favorable habitat at low population densities. Western Lake Superior surveys have documented the natural movement of ruffe, changes in fish species abundance, and the ability of ruffe to become the dominant fish species. Preliminary results suggest declines in native fish populations following the successful establishment of ruffe. Surveys in areas where ruffe have not yet invaded provide information regarding native or currently existing populations, without which it is difficult to determine the effects of an invasion. The proactive management approach exemplified by the Great Lakes Ruffe Surveillance Program, conducted by the U.S. Fish and Wildlife Service and the Ontario Ministry of Natural Resources, provides a model response to species invasions.

### INTRODUCTION

The introduction of nonindigenous species is a perturbation that alters ecosystem dynamics, affecting population and community structure as well as species abundance and diversity. Understanding the ecological effects of introduced nonindigenous species, including costs and benefits, challenges resource managers. In the Great Lakes, over 140 aquatic organisms have been introduced since the 1800s (Dermott 1997, Mills et al. 1993, Zaranko 1996). The rate of introductions has increased as mechanisms of travel and transport

advance and waterways are connected through man-made canals and channels. For example, the opening of the St. Lawrence Seaway coincides with increasing numbers of introductions (Mills *et al* 1993).

Upon the discovery of a newly introduced species, managers are immediately challenged to determine the extent of the invasion, including the current distribution, abundance, and immediate impacts of the organism. In addition, managers are asked to assess or predict range expansions, pathways of dispersal, and potential long-term impacts to invaded waters. These factors contribute to the decision-making process

regarding the need for control as well as the potential success of control alternatives.

To make these assessments and predictions, it seems clear that managers need information regarding the ecological conditions prior to an invasion, including species composition and abundance, interactions between species, and habitat availability. Further, managers need to gain an understanding of the biology and ecology of the introduced species and its potential mechanisms of dispersal. Information regarding the new organism's role in its native waters or other areas of introduction contributes significantly to the decision-making process. However, pre-invasion information including investigations of the community as a whole (i.e. all trophic levels) is often sparse or incomplete.

The need for surveillance programs is emphasized by the introduction of nonindigenous species. Surveillance programs provide managers with the opportunity to 1) *identify newly established populations early*, 2) *track or detect range expansions*, 3) *estimate potential impacts of introductions or range expansions by gathering baseline data on pre-existing populations and habitat*, and 4) *evaluate control or management strategies*. The information that can be obtained through effective surveillance programs may contribute significantly to the decision-making process regarding the risk of further expansion and impacts to native fauna, as well as the need for control, or the continuation of control implementation.

The Great Lakes Ruffe Surveillance Program (the Program) exemplifies how such a program can be conducted effectively. The Program provides a model illustrating how management agencies can respond effectively to surveillance needs for nonindigenous species introductions. The Program has played and continues to play a critical role in management decisions.

## BACKGROUND

The ruffe (*Gymnocephalus cernuus*) is a small percid fish thought to have been introduced into the Great Lakes in the early to mid 1980s via ballast water discharge from trans-Atlantic shipping. It was first collected and identified in 1987 in fish collections from the St. Louis River, the westernmost tributary of Lake Superior, by Wisconsin Department of Natural Resources (Pratt *et al.* 1992). Re-examination of ichthyoplankton samples collected in 1986 confirmed their earliest known presence in the river (Simon and Vondruska 1991, Pratt *et al.* 1992). Since then, ruffe populations have continued to increase in abundance and distribution, expanding their range along the southwestern shoreline of Lake Superior. In 1991, ruffe were collected in Thunder Bay, Ontario, likely transported there in the ballast water of ships departing

the St. Louis River (Busiahn 1997). By 1993, ruffe had expanded as far east as the Bad River, Wisconsin, approximately 156 km (97 mi) from the St. Louis River (Slade *et al.* 1994). In 1994, ruffe continued their eastward expansion, being collected in the Ontonagon River, Michigan, approximately 300 km (186 mi) east of the St. Louis River (Slade *et al.* 1995). In 1995, ruffe were collected for the first time outside of Lake Superior at the mouth of the Thunder Bay River, Lake Huron near Alpena, Michigan (Kindt *et al.* 1996) (Figure 1). This expansion marked a critical turning point in the management or control of ruffe in the Great Lakes.

The importance of and need for consistent surveillance was recognized early in the history of the ruffe invasion. In 1992, a Ruffe Control Committee (the Committee) was convened by the national Aquatic Nuisance Species Task Force. The Committee was charged to develop and refine a control program in accordance with the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (P.L.101-636) that minimizes the risk of harm to the environment and to the public health and welfare (Busiahn and McClain 1995). In developing their plan for control, the importance of surveillance became more apparent as a means of early detection to design and target areas for control as well as to evaluate proposed control efforts.

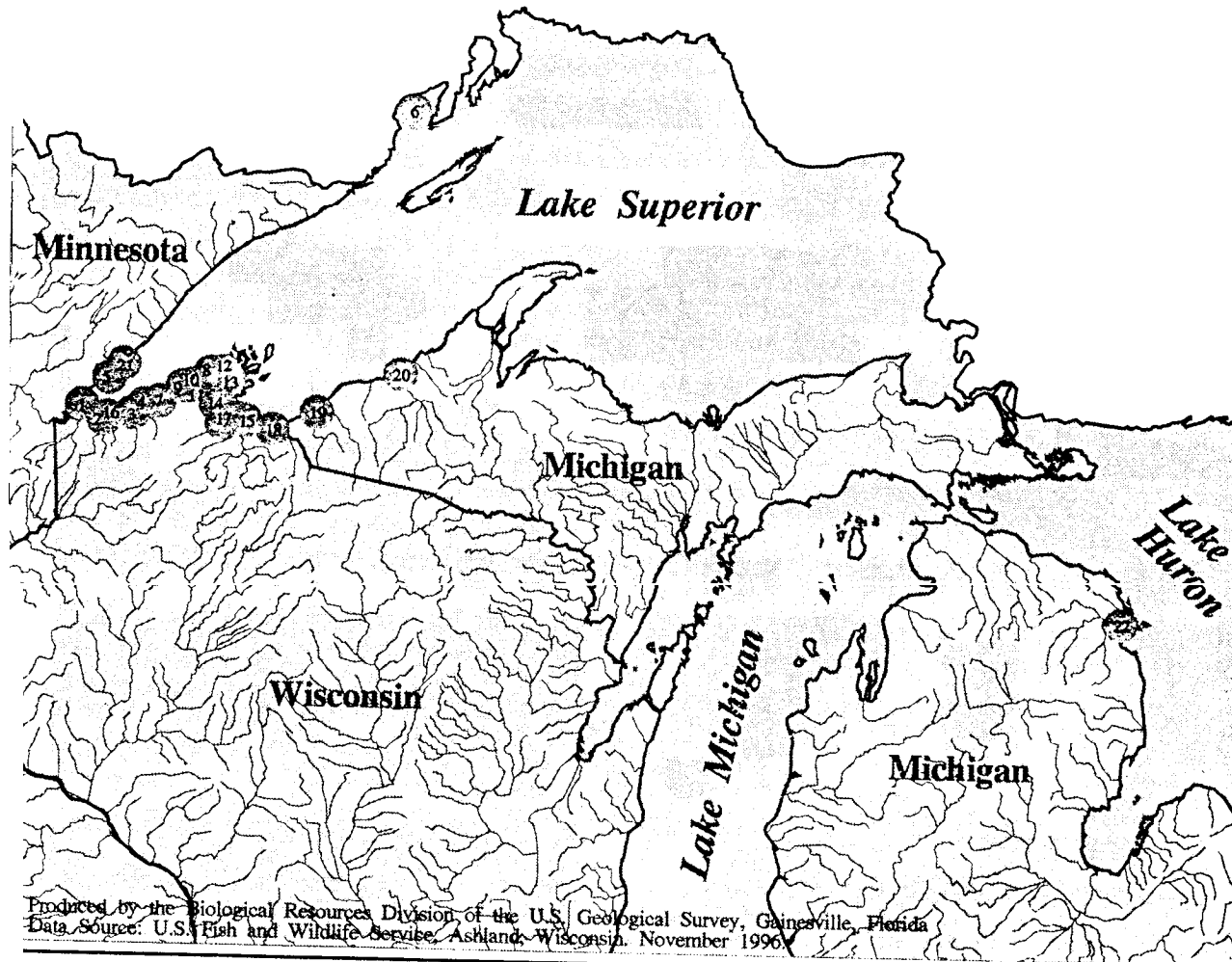
Surveillance was identified as one of the eight primary objectives of the Ruffe Control Program. The objective specifically required a coordinated program that would successfully identify newly established populations of ruffe. This was distinguished within the Ruffe Control Program from efforts to investigate established populations of ruffe and the subsequent changes in ecosystem dynamics following their successful establishment.

The Ruffe Control Program also identifies the U.S. Fish and Wildlife Service (the Service) and the Ontario Ministry of Natural Resources (OMNR) as the lead agencies coordinating surveillance efforts.

## RUFFE SURVEILLANCE PROGRAM

The Ashland Fishery Resources Office is the main contact for all ruffe activities conducted by the Service and has led surveillance efforts in the upper Great Lakes, including Lakes Superior, Michigan, and Huron, since 1992. The collection of ruffe near Alpena, Michigan, in Lake Huron in 1995 initiated the involvement of the Service's Alpena Fishery Resources Office. Since 1996, surveys in Lake Huron and northern Lake Michigan have been conducted by the Alpena Fisheries Resources Office. Surveillance efforts on the lower Great Lakes were initiated in 1993 by the Service's Lower Great Lakes Fishery Resources Office. And finally, Ontario's program, initiated in 1991, is led by the Lake Superior Management Unit

# Confirmed Ruffe Sightings. (*Gymnocephalus cernuus*)



## Year of First Observation

### Lake Superior

1. St. Louis River, 1986.
2. Amnicon River, 1988.
3. Brule River, 1989.
4. Iron River, 1991.
5. Stony Point, 1991.
6. Thunder Bay, Canada, 1991,
7. Flag River, 1992.
8. Sand River, 1992.
9. Bark Bay Slough, 1993.
10. Lost Creek Slough, 1993.
11. Siskiwit River, 1993.
12. Rasberry River, 1993.
13. Red Cliff Creek, 1993.
14. Sioux River, 1993.
15. Bad River, 1993.
16. Middle River, 1993.
17. Chequamegon Bay, 1994.
18. Saxon Harbor, 1994.
19. Black River, 1994.
20. Ontonagon River, 1994.
21. Two Harbors, 1995.

### Lake Huron

22. Thunder Bay River, 1995.



United States  
Fish and Wildlife  
Service

United States  
Geological Survey

Figure 1. Locations where the presence of ruffe has been confirmed.

in Thunder Bay, Ontario.

The current Program implemented by both agencies consists of three components: field surveys, a mail survey, and public education. This report will provide a brief overview of each component and how they have contributed to the overall success of the Program.

### Field Surveys

The primary objective of the field survey component is to locate new populations of ruffe and describe their age/size composition. The second objective is to describe the fish community at each location surveyed. The field survey component, if conducted effectively, can provide managers with information towards early detection, range expansion, pre-existing populations, and control evaluation.

Field surveys for ruffe throughout the Great Lakes target estuaries, bays, river mouths, and waterways on the periphery of the ruffe's range and in or near shipping ports where ruffe could potentially colonize through inter- or intra- lake shipping activities. Most of the sampling targets the deepest habitat available at any given site, including natural holes or channels in rivers and estuaries or in the dredged shipping channels. The primary means of fish collection is bottom trawling; however, electrofishing, seines, gill-nets, fyke nets, and modified windemere traps are also used. Each survey site is visited two to three times between May and October based on habitat suitability and distance from the periphery of the known range.

Since field surveys were initiated in 1992 by the Ashland Fishery Resources Office, the number and

location of survey sites has changed in response to expanding ruffe populations. Figure 2 represents a comprehensive overview of all the sites surveyed in the upper Great Lakes, 1992 - 1996. Surveillance at all of these sites, with one exception, was being conducted by the Ashland Fishery Resources Office. The one exception is the site in Thunder Bay, Ontario. Trawling effort there is led by the OMNR. As mentioned previously, the Alpena Fishery Resources Office is now participating in the Program, leading surveillance efforts in Lake Huron and northern Lake Michigan. Surveillance in Lakes Erie and Ontario is conducted by the Lower Great Lakes Fishery Resources Office. Seven sites on Lake Erie are surveyed, and one site on Lake Ontario (Figure 3). Surveys in the lower lakes target areas where ruffe may potentially colonize through inter-lake ballast transfers.

Sampling procedures include measuring environmental and water quality parameters, such as water temperature, dissolved oxygen levels, depth, and Secchi transparency, prior to each trawl. The average depth of the trawled area, average tow speed, and total time is recorded for each tow. All fish collected are identified, counted, and measured to the nearest mm (TL). When more than 50 individuals of any single species are collected in a single tow, a random selection of 50 individuals are measured, providing an adequate sample size to infer size composition of the total number. Fish that can not be identified in the field, such as small juveniles, are preserved and identified in the lab. Any ruffe that are collected are measured, placed in zip-lock bags and frozen for later analysis. Age determination of ruffe is determined in the laboratory by examining the second dorsal spine.

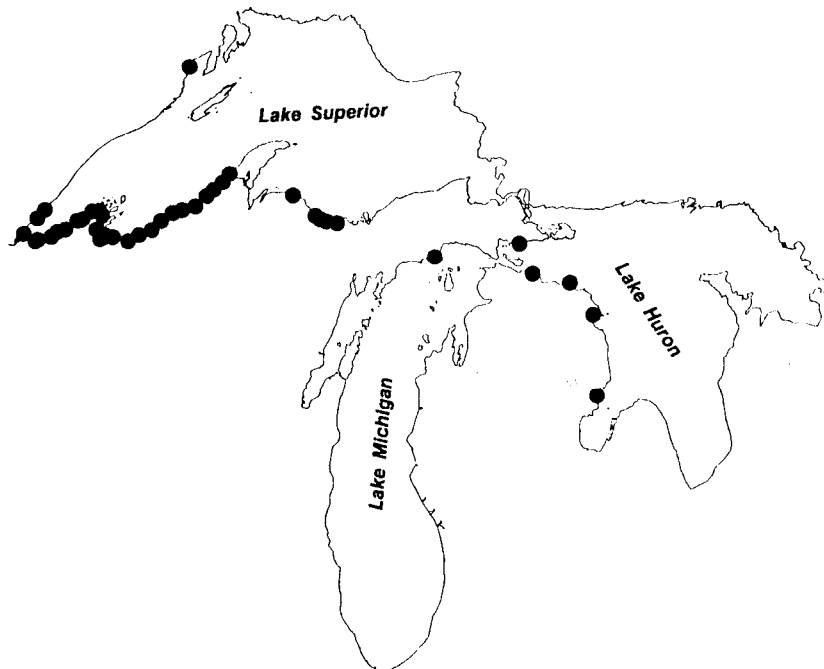
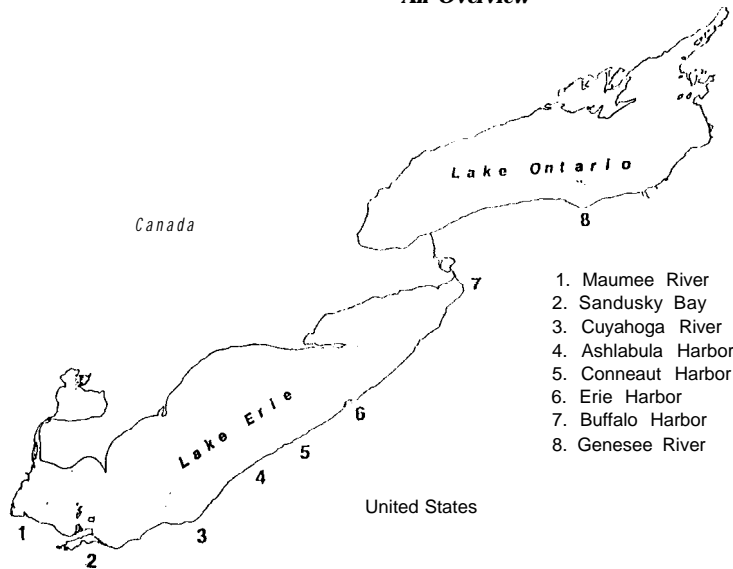


Figure 2. Locations Surveyed for Ruffe in the Upper Great Lakes

**Surveillance for Ruffe in the Great Lakes  
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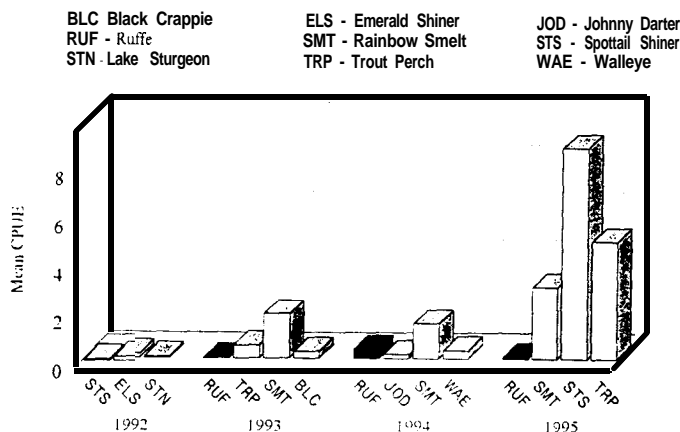


**Figure 3. Locations Surveyed for Ruffe in the Lower Great Lakes.**

With approximately 50 sites surveyed annually, reporting and analyzing results can become exhaustive. An annual report, summarizing the expansion of ruffe confirmed that year, as well as common species collected, has been prepared and distributed since 1992 (Slade and Kindt 1992; Slade *et al.* 1994; Slade *et al.* 1995; Kindt *et al.* 1996; Czipynski *et al.* 1997). The report provides an extensive table identifying the number and species of every fish collected. Detailed information regarding fish collected at each of the sites is found in the individual reports and will not be presented within the scope of this report. Several survey locations from the upper lakes that have been important in the history of the ruffe invasion are presented in this paper, as an example of how managers might use this information, especially when examining fish composition prior to or early in the invasion. Since bottom trawling is the primary method of collection, all of the data presented was selected from trawl efforts.

The Bad River in western Lake Superior has been sampled annually since the program was initiated in 1992 (Figure 1). Ruffe were first collected there in 1993, marking the extent of its eastward expansion through that year (Figure 4). However, since only a small number of ruffe have been collected at the site each year, totaling only 13 ruffe since 1993, the Bad River continues to be sampled as part of the Program.

Surveillance has also been conducted in the Ontonagon River, Lake Superior, since 1992 (Figure 1). However, ruffe were not collected there until 1994 (Figure 5). This finding, together with the collection of ruffe in the Black River, Lake Superior, the same year, marked the first collections of ruffe in Michigan waters. The single ruffe collected in the Ontonagon River marked the farthest range expansion documented in a single year. In addition, the expansion occurred over a geographic area of Lake Superior's southern shoreline possessing some of the most unfavorable ruffe



**Figure 4. Mean catch per unit effort (#fish/minute trawling) for the most commonly collected species in the Bad River, 1992-1995. Three letter abbreviations for common names are used to indicate species on the x-axis. The collection of ruffe is indicated by black bars.**

RUF - Ruffe  
TRP - Trout-perch  
SMT - Rainbow Smelt  
WAE - Walleye  
YEP - Yellow Perch  
STS - Spottail Shiner  
WHS - White Sucker

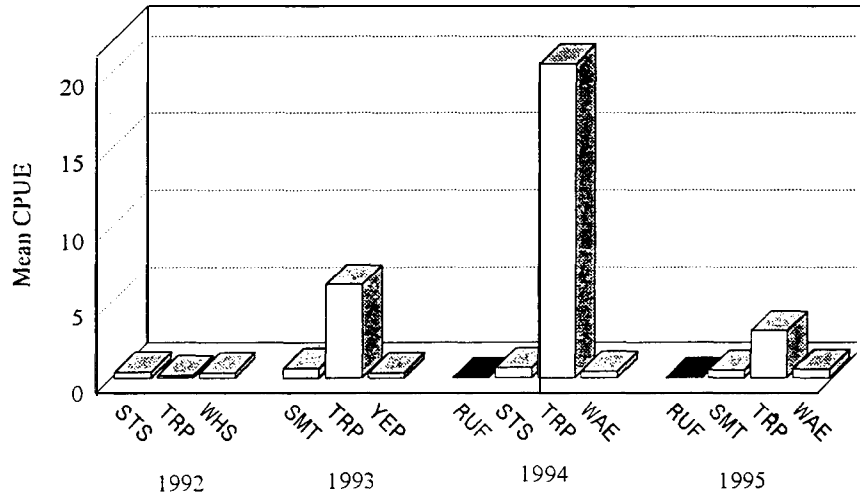


Figure 5. Mean catch per unit effort (#fish/minute trawling) for the most commonly collected species in the Ontonagon River, 1992-1995. Three letter abbreviations for common names are used to indicate species on the x-axis. The collection of ruffe is indicated by black bars.

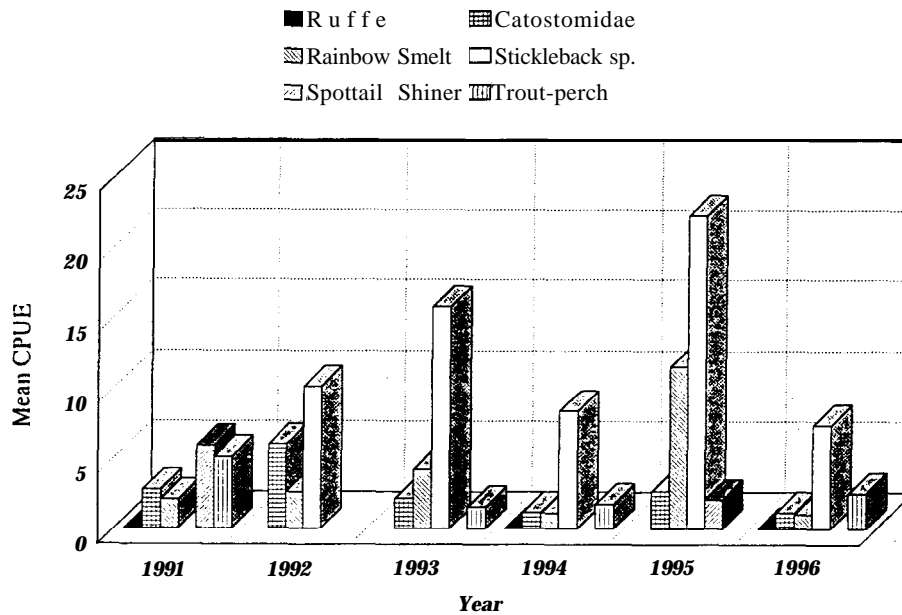


Figure 6. Mean catch per unit effort (#fish/minute trawling) for the most commonly collected species in Thunder Bay, Ontario, 1991-1996. Ruffe (black bars) were detected in surveillance efforts 1991, 1994, and 1996.

habitat. It had previously been hoped that the unsuitable habitat might provide a natural barrier slowing expansion. Although only one other ruffe was collected in 1995 surveys, the sighting causes additional concerns because of its close proximity to the entrance of the Keweenaw Waterway, the pathway to eastern Lake Superior.

Surveillance efforts were initiated in Thunder Bay, Ontario, by the OMNR in 1991 to verify the presence of ruffe in the harbor following the capture and reporting of a single ruffe by an angler (Figure 1). Although ruffe were confirmed in trawl catches in 1991, they were not caught again in the Bay area until 1994, and then again in 1996 (Figure 6). Six ruffe were collected in 1996, amounting to a total of 15 ruffe collected from Thunder Bay. The need to continue surveillance seems apparent as numbers have remained very low over the six years since they were first found.

### **Mail Survey**

To increase the comprehensiveness of the Program, both agencies recognized the role that public and private agencies, organizations, or individuals could play in surveillance efforts. In 1994, the OMNR initiated a program expanding its surveillance capabilities. A voluntary program was established targeting agencies, organizations, or individuals that routinely collect or handle Great Lakes fish or that expect to conduct fishery surveys in the Great Lakes. In 1995, the Service initiated a similar program, lead by the Ashland Fishery Resources Office.

Each year potential participants are contacted twice through the mail. The first mailing is an informational packet that includes educational materials such as brochures, pamphlets, and identification cards regarding the ruffe. An explanation of the program, the role of participants in surveillance and the importance of documenting range expansions is included. The first mailing also encourages participants to report any potential ruffe sightings immediately to the Service or to OMNR. In the fall, following the field season, a follow-up questionnaire is mailed encouraging participants to provide information regarding their sampling efforts and fish collection. The information requested is simple, including sampling location, collection method/gear, a general approximation of the number of fish handled, and the presence or absence of ruffe.

To provide some insight to the scope of this component, in 1995 the Ashland Fishery Resources Office sent out 439 packets to agencies and tribal commercial fishermen in the upper lakes. Response rates from both Canadian and U.S. participants have been low. However, even with low response rates, overall surveillance within the Great Lakes is increased substantially through this initiative. For example,

Canadian responses in 1996 expanded reporting on the presence or absence of ruffe to Canadian waters of each of the Great Lakes (Figure 7). Many of the sites are included in other sampling efforts conducted by OMNR or the Canadian Department of Fisheries and Oceans, such as sea lamprey assessments or control treatment assessments, annual standard nearshore and offshore assessments, and creel surveys. Industries have been cooperative as well, providing information on species collected on intake screens, trash racks, etc.

### **Public Education**

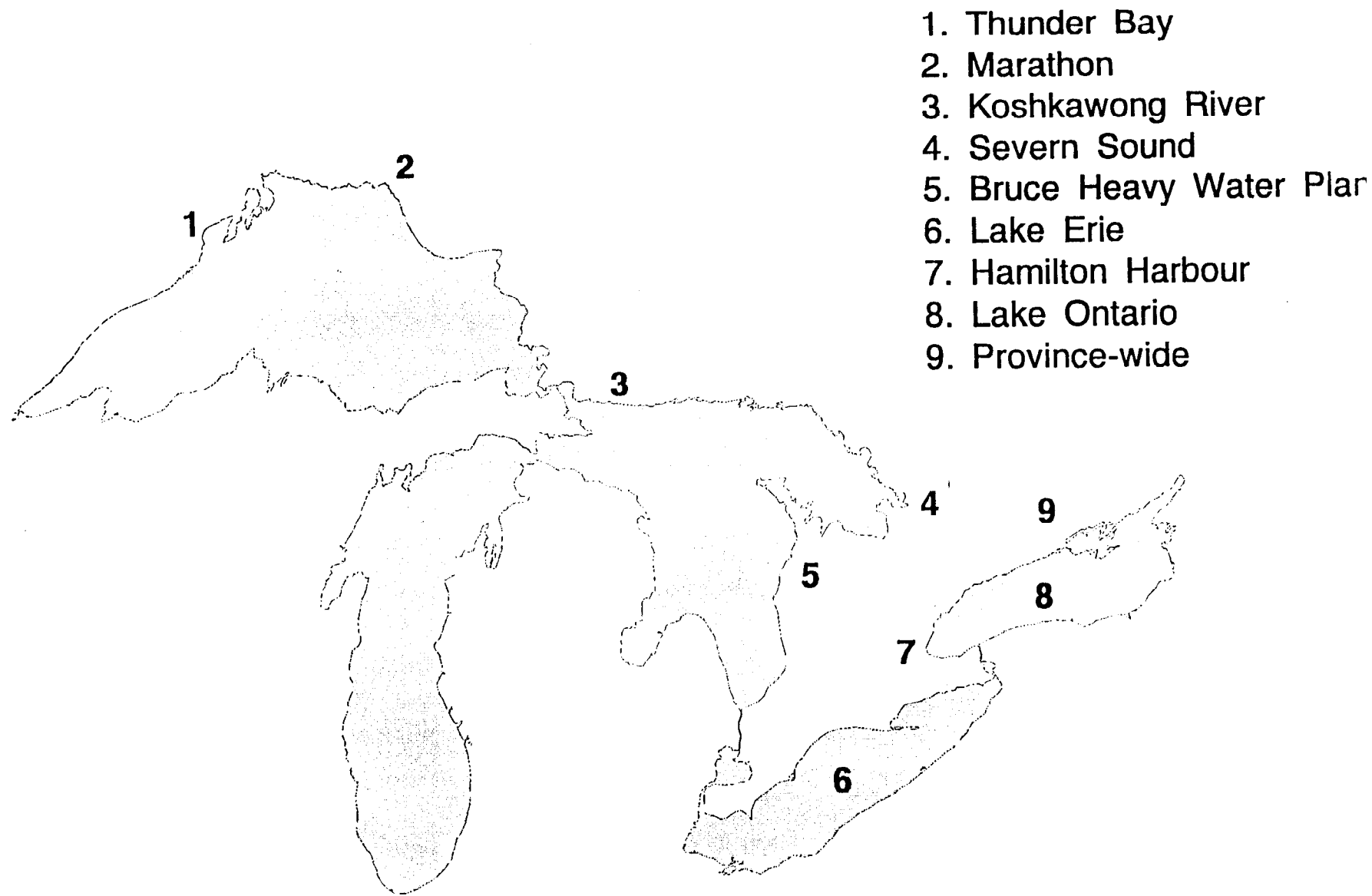
The public has historically played an important role in nonindigenous species prevention activities, especially surveillance. An informed public is critical to the success of nonindigenous species activities in general. More specifically, surveillance programs may be enhanced significantly through the participation of public water users. In several cases, recreational anglers were the first to report the presence of ruffe in new locations, findings that were then verified by surveillance crews. A public that is aware of newly introduced species, pathways of introduction, and what to do if they think they have caught a potential candidate, will contribute to surveillance efforts as well as to control or prevention efforts minimizing the risk of further introductions or range expansions. Education initiatives are the primary tools managers possess to reach public water users.

Working with Sea Grant agencies in the Great Lakes states, both the Service and OMNR have developed or assisted in the development of various educational materials targeting anglers, bait dealers and harvesters, marina owners, etc. Posters, brochures, and pamphlets have been distributed to anglers and angling groups, marinas, bait shops, and public access sites throughout the Great Lakes. Development of the Ruffe *WATCH* identification card was likely one of the most successful education initiatives. This wallet-sized card was designed so that anglers could easily store them in tackle boxes, with other fishing gear, or with their licenses. It was produced in a number of formats creating regional cards. Each card includes regional contact agencies, phone numbers for reporting potential sightings, and information regarding what to do with the candidate fish. The need for strong education programs and the support anglers may provide to surveillance has been proven, as so often anglers are the first to report sightings.

### **CONCLUSION**

The Great Lakes Ruffe Surveillance Program provides resource managers with a model response to the introduction of nonindigenous species. It exemplifies an effective means to assist managers in 1)

Figure 7. Locations included in surveillance efforts through responses to OMNR's Mail Survey questionnaire. This component has expanded their program to Canadian waters throughout the Great Lakes. (9. refers to the Invading Species Hotline established by the Ontario Federation of Anglers and Hunters.)



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**identifying newly established populations early, 2) detecting range expansion, 3) estimating potential impacts of introductions or range expansions by gathering baseline data, and 4) evaluating control or management strategies.** As shown through this overview, the effectiveness and scope of surveillance programs can be enhanced significantly by conducting a multi-agency program consisting of components that broaden surveillance capabilities. This Program, conducted by the Service and the OMNR consists of three components: field surveys, a mail survey, and public education. The implementation of these components by both agencies has expanded surveillance efforts to U.S. and Canadian waters in all five of the Great Lakes.

The field survey component assists managers to achieve all four of the above objectives. Field surveys conducted along the periphery of the ruffe's established range as well as in areas where ruffe are likely to become established, are apparently capable of detecting ruffe, even at relatively low population densities. This is likely due to the ruffe's high selectivity for favorable habitat at low densities. This ability is critical to early detection. However, managers must accept the limitations of sampling gear, realizing that absolute certainty can not be achieved (*ie.*, just because ruffe were not collected in a given area, does not mean that they are not there).

The detection of new populations or range expansions inherently provides managers with a mechanism to evaluate control measures. For example, only two range expansions of ruffe within the Great Lakes are believed to have been associated with something other than natural movement. Intra- and inter-lake ballast transfers are likely responsible for introducing ruffe to Thunder Bay, Ontario, and Alpena, Michigan. However, only the Alpena, Michigan, sighting was documented following the implementation of the Great Lakes Maritime Industry Voluntary Ballast Water Management Plan for the Control of Ruffe in Lake Superior Ports in 1993. In 1995, when field survey crews first found ruffe in Alpena, Michigan, age determination indicated that ruffe had likely been introduced into the area prior to the implementation of the ballast water control strategy.

The field survey component also provides an annual, consistent sampling program, from which fish species composition and abundance, habitat and water quality parameters can be estimated. This provides resource managers with information regarding the benthic fish community and habitat in areas where previously little to no information may have existed. Obtaining this type of information prior to the establishment of ruffe will assist managers with estimating potential impacts to the system following their invasion.

The mail survey and public education components

of the Program broaden surveillance capabilities. The amount of staff and time that can be dedicated to any fisheries program is limited. By educating other water users, surveillance is expanded beyond those limitations. Mail surveys target agencies, organizations, and individuals that routinely collect Great Lakes fish or that expect to conduct fishery surveys in the Great Lakes. This program includes government agencies, academic researchers, commercial fishermen, industries that draw water, etc. In addition, the public education component targets all potential water users. The value of public education has been proven, as anglers are often the first to report new sightings of nonindigenous species.

This Program exemplifies a pro-active management approach to nonindigenous species.

The information obtained through the Program has played and will continue to play a significant role in policy- or decision-making processes.

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