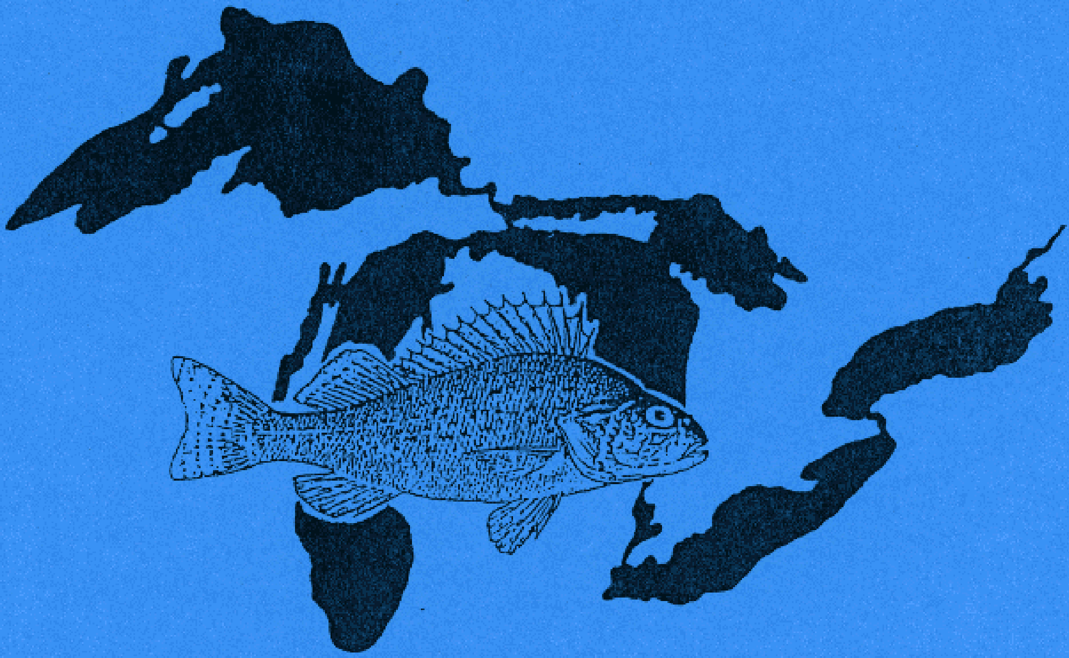
Ruffe In The Great Lakes:

A Threat To North American Fisheries



By

Great Lakes Fishery Commission
Ruffe Task Force
2100 Commonwealth Boulevard
Suite 209
Ann Arbor, Michigan 48105-1563

Great Lakes Fishery Commission

ESTABLISHED BY CONVENTION BETWEEN CANADA AND THE UNITED STATES TO IMPROVE AND PERPETUATE FISHERY RESOURCES

16 September 1992

The Honourable Barbara McDougall
Secretary of State for
External Affairs
Lester Pearson Bldg,
125 Sussex Drive
Ottawa, ON K1A OG2 Canada

Mr. Lawrence Eagleburger
Acting Secretary
U.S. Department of State
. 2201 C Street, NW
Washington, DC 20520

Dear Mrs. McDougall and Mr. Eagleburger:

Further to. our correspondence of 4 August 1988 and 2 November 1990, the Great Lakes Fishery Commission is alerting its Contracting Parties to the need for action because of the threat posed by a recently introduced fish, the ruffe. The ruffe is a perch-like fish from Europe which scientists believe was introduced into Lake Superior at Duluth Harbor with a discharge of ballast water from an ocean-going vessel.

First discovered in 1987, the ruffe is now the most abundant fish in Duluth Harbor, and is spreading beyond the harbor into western Lake Superior. In 1991 it was documented in Thunder Bay, Ontario, where it may have been discharged with ballast water from a lake vessel that ballasted at Duluth. Coincident with an exponential growth in ruffe numbers, the yellow perch population in Duluth Harbor has declined 50%, a figure distressingly similar to the decline of perch in Loch Lomond when that Scottish lake was invaded by ruffe. Ruffe have little value as a food or sport fish, nor are they utilized by most predator fish. Yellow perch are the mainstay of many coastal towns around the Great Lakes -- they are the most valuable commercial species in Lakes Erie and Ontario, the second most valuable species in Lakes Huron and Michigan, and the most sought after sport fish in the Great Lakes. Valuable fisheries may collapse if ruffe proliferate in these lakes.

A task force sponsored by the Commission at the request of Great Lakes fishery managers suggests that only a two-year window of opportunity remains for containing the ruffe before it explodes into the rest of the Great Lakes. Research is needed on basic biology, as well as on chemical and physical means of suppression. In particular, the sterile male release technique needs to be developed for eradicating founder populations of ruffe as they appear. The task force estimates the total cost of containment at \$1.035 to \$1.855 million U.S. annually.

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2100 Commonwealth Blvd. | Suite 209 | Ann Arbor, MI 481051563
Phone (313) 667-3209 / FTS378-2077 | FAX (313) 668-2531 / FTS378-2531

The Commission commends to you the enclosed report of its task force, and recommends that priority be given to studying the biology and distribution of ruffe, to preventing its spread to other watersheds, and to developing the sterile male release technique. If containment techniques are not developed in time to thwart the ruffe in the Great Lakes, they will be valuable later when the ruffe threatens other watersheds.

The Commission offers its Lake Committees as a forum for coordinating U.S. and Canadian action on the ruffe. The United States should utilize the 1990 Non-indigenous Aquatic Nuisance Control and Prevention Act, and Canada should act through Fisheries and Oceans Canada and/or the Ontario Ministry of Natural Resources. We request that the two countries move quickly to establish a coordinated approach to containing and managing the ruffe in North America.

Sincerely,

Paul Sutherland
Chairman

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Coast Guard - Cam Wallace, Tom Daley
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Council of Lake Committees
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U.S. Advisors

Ruffe In The Great Lakes:

A Threat To North American Fisheries

By

Great Lakes Fishery Commission
Ruffe Task Force
2100 Commonwealth Boulevard
Suite 209
Ann Arbor, Michigan 48105-l 563

March 1992
Great Lakes Fishery Commission
Ruffe Task Force

RUFFE IN THE GREAT LAKES: A THREAT TO NORTH AMERICAN FISHERIES

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EXECUTIVE SUMMARY

In the fall of 1991, the Great Lakes Fishery Commission organized a special task force of fisheries biologists and administrators to evaluate the status of the ruffe, *Gymnocephalus cernuus*, in the Great Lakes and to examine what threat this exotic fish might pose to fishery resources. The Task Force has examined the European literature, reviewed data gathered in the Duluth/Superior Harbor area, and extensively discussed this information with regard to potential impacts on endemic fish communities. The available information and conclusions reached are summarized in the Task Force report entitled "Ruffe in the Great Lakes: A Threat to North American Fisheries."

The Ruffe Task Force has concluded that the ruffe is a serious threat to North American fishery resources, and that, unless prompt measures are taken to prevent its further spread, the ruffe will continue to be transported or migrate to new sites in the Great Lakes and much of North America.

The ruffe has become established in the Duluth/Superior

Harbor and in the harbor at Thunder Bay, Ontario. Specimens have also been collected at the mouths of rivers along the south shore of Lake Superior 30 miles east of Duluth.

During its brief history in the Duluth/Superior Harbor area, the ruffe has quickly become the most abundant species in the local fish community. As ruffe numbers have increased, populations of yellow perch, walleye, and of most endemic forage species have declined sharply. Yellow perch numbers declined by 50 percent in only three years. This shift in the fish community is similar to population changes in Europe where ruffe quickly replaced the European perch (*Perca fluviatilis*) after its introduction into Loch Lomond and to a 50 percent decline in whitefish abundance that occurred in a Russian lake. The Task Force has concluded that the ruffe poses a serious threat to yellow perch, walleye, and possibly whitefish fisheries in the Great Lakes and to most inland freshwater fishery resources. Should ruffe become established in Lake Erie, the world's largest perch/walleye fishery, the potential economic impact could reach an annual economic loss of $90 million. The commercial whitefish harvest in the Great Lakes has a landed value of about $10 million and the projected impact of ruffe on this fishery would be a loss of $5 million annually plus losses in job opportunities and other economic activities that could reach another $2 billion. Although it is unlikely that invasions by the ruffe would destroy the nation's entire freshwater sport fishery resources, even an overall loss of only 10 percent would cost over $7 billion, a significant economic impact.

The Ruffe Task Force urges that immediate action be taken to prevent further introductions or distributions by shipping or other human activities, that measures be taken to contain ruffe to the presently colonized sites, that attempts be made to destroy any new colonizations that are detected, and that efforts be made to reduce numbers of ruffe at the sites where it has become established. The Task Force report presents a recommended Management Plan for dealing with ruffe in the Great Lakes and provides estimated costs of accomplishing the tasks involved. The needed actions are listed according to priority, chronological schedules are provided, and estimated costs are included in a comprehensive 5-year plan. An annual budget of about $1,225,000 per year is needed to accomplish the recommended program.

The Management Plan consists of four primary objectives. These are:

I. Contain ruffe to present sites and prevent further introductions or distributions.

II. Increase biological understanding of the ruffe.

III. Reduce populations of ruffe at present sites.

IV. Conduct research on control methods that specifically target ruffe.

The Task Force strongly urges that implementation of the highest priority tasks or sub-tasks begin in 1992 and that the remaining facets of the program be added as quickly as possible.

The Task Force feels that a window of opportunity exists during which it is still possible to contain the ruffe and to prevent colonization of additional waters. This window is expected to remain open for only 2 more years. If actions are not taken during this time, any future control efforts would be greatly increased in scope, complexity, and cost. The likelihood of success would also be greatly reduced.

Although presently available technologies are not adequate to eradicate ruffe from a large area such as the Duluth/Superior Harbor, the Task Force feels that containment is biologically feasible on a cost effective basis.

The Management Plan utilizes all known control techniques and places emphasis on those measures that will have the least effect on the environment. In instances where the use of toxicants might be needed, the use would be limited in scope and involve the most selective compounds available.

Since the Great Lakes constitute international waters, a bi-national effort is required. Eight states, one province, tribal agencies, and the U.S. and Canadian federal governments must be active participants. Two options are available for coordinating execution of the Management Plan.

One option would be to have a single agency designated to coordinate the program, to collect and report on changes in the status or ruffe, to receive funds, and to oversee dispersal of monies to cooperators. The logical coordinator under this scenario would be the Great Lakes Fishery Commission.

A second option would be to establish separate U.S. and Canadian control programs - probably headed by the U.S. Fish and Wildlife Service and either the Canadian Department of Fisheries and Oceans or the Ontario Ministry of Natural Resources.

Task Force members are about evenly divided concerning which option should be implemented. They feel that either option could be used effectively. The basic over-riding concern of the Task Force relates to which option can be implemented most quickly, not which agency should head the control effort. <u>It is imperative that the management plan be initiated in 1992 and fully operational in 1993</u>.

The bi-national aspects of the Management Plan will require separate funding initiatives. International negotiations associated with having the Great Lakes Fishery Commission serve as the coordinating agency could delay initiation of the Management Plan by as much as 18 months. However, once the procedural requirements were satisfied, the GLFC could move quickly and freely to accomplish the various tasks and sub-tasks.

Having federal agencies, such as the Fish and Wildlife Service and the Department of Fisheries and Oceans, lead the programs would mean less delay in implementing containment/control efforts. Funding would probably be simpler at the outset. Delegation of authority to control ruffe would probably be easier to accomplish under this scenario. Disadvantages would concern problems associated with interagency distributions of funds and complex regulations related to contracted research. In light of the need for expeditious action, the Task Force would support designation of the USFWS as the lead agency in the U.S. in either a permanent or interim capacity. In Canada, further discussions will be necessary between CDFO and OMNR. Responsibility for the control program could later be transferred to the Great Lakes Fishery Commission if so desired.

I. INTRODUCTION

The ruffe, Gymnocephalus cernuus, (Figure 1) has successfully established itself in waters of Lake Superior. Ruffe were first verified in the St. Louis River by the Wisconsin Department of Natural Resources (WI DNR) in 1987. This discovery was presented to the Lake Superior Committee (LSC) of the Great Lakes Fishery Commission (GLFC) at its Annual Meeting in March 1988.

A coordinated field sampling effort was rapidly organized and in place by ice-out in the spring of 1988. The effort involved the United States Fish and Wildlife Service (USFWS), Minnesota Department of Natural Resources (MN DNR), Wisconsin Department of Natural Resources (WI DNR), Great Lakes Indian Fish and Wildlife Commission (GLIFWC), and the Fond du Lac Band of Lake Superior Chippewa. Findings indicated the ruffe were widely distributed in the estuary and river and that they became sexually mature as one-year-olds.

Two widely separated locations are known to have populations of ruffe. See Figure 2. The first identified collections were in the harbor at Duluth, Minnesota and in the estuary of the St. Louis River in 1986. Seven individuals of at least 3 different year classes were captured in the harbor area of Thunder Bay, Ontario in 1991.

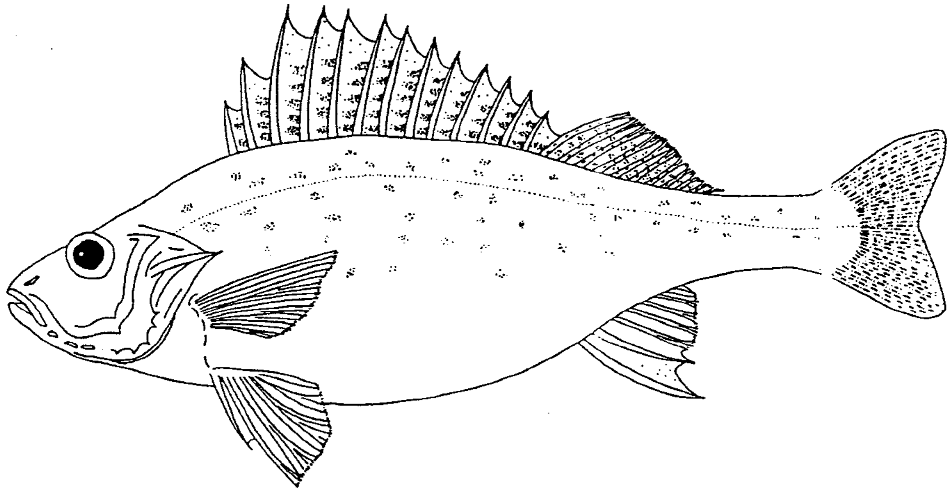

Figure 1. A 165-mm long (total length) gravid female ruffe (Gymnocephalus cernuus) taken from the St. Louis River. Note the prominent preopercular spines, the long, strong dorsal spines, and the two strong anal spines. Overall body form is similar to that of a chunky yellow perch (Perca flavescens) while coloration resembles that of the walleye (Stizostedion vitreum). The spotted dorsal is marked similarly to that of a sauger (Stizostedion canadense).

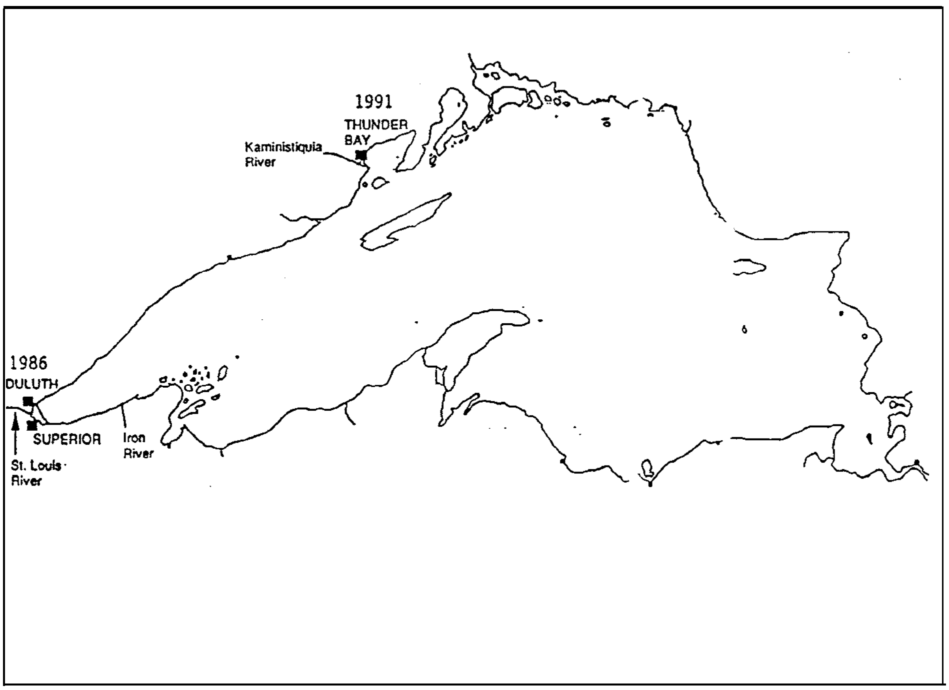

Figure 2. Sites where ruffe (Gymnocephalus cernua) have been captured in Lake Superior.

Although the precise source and exact dates of introductions cannot be established, fishery workers agree that larval ruffe were probably carried across the Atlantic Ocean from mainland Europe in ballast water of freighters and released when ballast was dumped during loading operations upon arrival in the Great Lakes.

Larval ruffe were first collected in 1986 but were not recognized until the winter of 1987-88. A 17.5 cm male captured in 1987 was found to be 5+ years in age. Reproduction was also observed in 1987 and successful year classes have been recorded each year since. If the adult fish captured in 1987 represents the original stock, the date of introduction was probably in 1982 or 1983.

When the presence of ruffe was confirmed, fishery agencies were uncertain about the impacts the exotic might have on the existing fish community. The States of Minnesota and Wisconsin combined forces to study the biology of the ruffe in 1988 and were joined by the U.S. Fish and Wildlife Service. In 1989, both states implemented regulations to restrict the spread of ruffe to other areas by anglers and bait dealers. They also began enhanced stockings of northern pike, walleye, and muskellunge in an effort to increase predation on ruffe.

Reviews of literature on the ruffe indicate that the fish is widespread in continental Europe and that it occurs from the Arctic Circle to the Mediterranean Sea. Individual fish can become sexually mature at one year so the reproductive potential is great. In its native habitats, the ruffe frequently becomes overly abundant and stunting is common. The fish is an aggressive competitor and has no value as a commercial or forage species or for angling. The ruffe is considered a problem species in waters where it has been introduced. Although well-designed studies on interactions between the ruffe and endemic fishes are not available, the ruffe quickly replaced the European perch (Perca fluviatilis) in Loch Lomond, Scotland (Maitland, et. al. 1983; Maitland and East 1989). Perch declined by 88% whereas ruffe increased from 12% to 90% of the fish community (Maitland 1990). The ruffe has also been blamed for declines of 50 percent in whitefish populations (Coregonus spp.) in Russia, supposedly because of predation on whitefish eggs (Pavlosky and Sterligova 1987).

The literature generally describes G. cernuus as a benthophagic feeder, consuming primarily chironomid larvae, Cladocera, and copepods. However, several reports list the ruffe as an active predator on fish eggs. Adams and Tippett (1991) reported that 84% of the total biomass in the diet of ruffe during December and January consisted of powan eggs (Coresonus lavaretus). In the Soviet Union, G. cernuus was reported to feed extensively on eggs of the whitefish, Coregonus lavaretus palassi (Sterligova and Pavlovsky 1984). Ruffe also take smelt eggs (Osmerus eperlanus) and extensively feed on Powan (whitefish) eggs during the winter in Loch Lomond (Maitland 1991). Maitland and East (1989) also report that, in addition to invertebrates, ruffe consume small fish and fish eggs. In a 2-year study by Boron and Kuklinska (1987), only chironomids, Cladocera and copepods were observed in the stomachs of ruffe. However, because their collections were made only during non-spawning seasons of the year, any predation on fish eggs would not have been evident. The Task Force is convinced there is sufficient basis for concern about potential predation on eggs of whitefish in the Great Lakes, especially if ruffe colonize whitefish spawning areas. Most fish species adjust their feeding patterns according to the availability of acceptable prey. There is little reason to think that ruffe would do otherwise.

Predation on chironomids and zooplankton places the ruffe in direct competition with young yellow perch in the Duluth/Superior harbor and estuary. Ruffe colonize virtually all areas of a lake and are capable of feeding even in deep waters where there is little or no light penetration. Perch, on the other hand, occupy and feed only in those areas where there is sufficient light for sight feeding (Bergman 1991, 1988). This difference in the breadth of their respective niches gives ruffe a distinct competitive advantage over perch (Bergman, 1988).

The North American perch (Perca flavescens) closely resembles _Perca fluviatilis_, its European cousin, in biology and life history. Since the ruffe successfully Out-competed the European perch, it is very likely to do the same to the American species. Preliminary data collected on the ruffe interaction with yellow perch in the Duluth Harbor indicate that the competitive process may already be on-going. The limited data on walleye/ruffe interactions suggest that walleye are not able to compete successfully with ruffe in their early life history.

Yellow perch are the species most sought by commercial fishermen and sport anglers in the Great Lakes. Walleye are also a popular species and valuable fisheries for this species exist in Lake Erie, Saginaw Bay of Lake Huron, Green Bay of Lake Michigan, and other areas of the Great lakes. Loss of these important fisheries due to colonization by ruffe would have severe economic impacts. These impacts are discussed in detail in Chapter 3.

The major population of ruffe in Lake Superior is centered in the vicinity of the Duluth Harbor and the estuary and lower reaches of the St. Louis River. The habitat covers a minimum of 20 square miles. Movement out of the harbor area occurred in 1990 and 1991 and ruffe have been captured from both the Brule and Iron Rivers, more than twenty seven miles east of the Duluth Harbor. Specimens are also being collected in Lake Superior proper, well outside the harbor area.

The second known population is in the extensive harbor area of Thunder Bay, Ontario and the estuary of the Kaministiquia River. To date, 7 specimens have been captured at this site: 5 were young-of-the-year, 1 was a yearling, and the other was a III+ adult. Biologists suspect that this population originated in the Duluth Harbor and that it was transported to Thunder Bay via ballast water. It is noteworthy that 6 of the 7 specimens were taken in the area of the Incan Superior slip. Thunder Bay is located 160+ nautical miles from Duluth. No specimens have been taken in the intervening miles.

If the population at Thunder Bay follows the same pattern as was recorded at Duluth, the present low numbers will increase to a million of ruffe in less than 5 years.

Since their first detection in 1986, the abundance of ruffe has increased every year. Ruffe are now considered the most abundant of the 60 fish species (Table 1) in the Duluth Harbor area. Other endemic forage species have declined. The 1991 population of ruffe is estimated at 2 million adult fish.

Studies on feeding preferences of the stocked predators (See Chapter II) indicate that they consume few or no ruffe. Thus, some readers might feel that the decline in endemic forage species could be the result of increased predation on native fishes by the stocked predators at a time when the forage species are also having to compete with ruffe for food and habitat. On the other hand, index netting has not shown that the stocked fish actually increased the standing crop of adult walleye and northern pike.

The policy of increasing the numbers of stocked predators should be examined for the following reasons: First, the premise that there may be no increase in standing crop of stocked fish seemed to be in contrast with the possibility that anglers are circumventing the reduced bag limits by making more than one trip per day to increased angling success. Increased angling success alone seems to show an increase in the standing crop of predatory fish. Second, with the exception of bullhead, studies have shown that the stocked predators are consuming few or no ruffe.

The Task Force is of the opinion that, although no definitive conclusion could be reached at this time, the observed decline in the abundance of native forage fishes is directly related to the increasing abundance of ruffe more so than to increased predation due to stocking.

Conclusions about the overall impact of the ruffe on commercial and sport species cannot be reached at this time. Ruffe were introduced at a time when the endemic fish community was rebounding after pollution abatement in the St. Louis River and its estuary. The resource had not yet reached stable levels when ruffe became established. That fact, plus the heavy stocking of predator species, has resulted in a complex mix of native and stocked predators, endemic forage species, and the ruffe. The only concrete conclusion reached to date is that the ruffe continues to increase in numbers and that many native species are declining.

Fishery management officials in the United States and Canada have watched changes in the fish community with considerable concern. Neither the States of Wisconsin and Minnesota nor the U.S. Fish and Wildlife Service have had adequate funds to do more than monitor the population, to document the spread of ruffe, and to conduct limited studies on their biology and behavior.

The Great Lakes Fishery Commission approached the U.S. federal government for funding to support development of a special Task Force to review existing data on the present situation, to develop a comprehensive report on the status of ruffe in North America, to gather information on existing efforts to control the ruffe, to identify needs for further study, to develop a consensus of what course of action should be pursued, and to recommend management actions for the future should other new populations be discovered elsewhere in the Great Lakes.

This document was prepared by the Ruffe Task Force. It is the result of several meetings and contains data and written contributions provided by biologists and managers who have worked with ruffe. Because of its recent introduction, data on all aspects of ruffe biology and its

Table 1. Fish Species in the St. Louis Estuary

Family	Common Name	Scientific Name
Amiidae	*Bowfin	Amia calva
Acipenseridae	**Lake sturgeon**	Acipenser fulvescens
Petromyzontidae	**Silver lamprey** **Sea lamprey**	Ichthyomyzon unicuspis Petromyson marinus
Anguillidae	American eel	Anguilla rostrata
Clupeidae	Alewife	Alosa pseudoharengus
Salmonidae	Lake herring Pink salmon Chinook salmon Coho salmon Rainbow trout Brown trout Lake trout Brook trout Splake	Coregonus artedii Oncorhynchus gorbuscha Oncorhynchus tshawytscha Oncorhynchus kisutch Oncorhynchus mykiss Salmo trutta Salvelinus namaycush Salvelinus fontinalis
Osmeridae	Rainbow smelt	Osmerus mordax
Cottidae	Spoonhead sculpin Slimy sculpin Mottled sculpin	Cottus ricei Cottus cognatus Cottus bairdi
Umbridae	Central mudminnow	Umbra limi
Esocidae	Northern pike Muskellunge	Esox lucius Esox masquinongy
Cyprinidae	Lake chub Carp Golden shiner Emerald shiner Common shiner Spottail shiner Mimic shiner Bluntnose minnow Fathead minnow Blacknose dace Longnose dace Creek chub	Couesis plumbeus Cyprinus carpio Notemigonus crysoleucas Notropis atherinoides Notropis cornutus Notropis hudsonius Notropis volucellus Pimephales notatus Pimephales promelas Rhinichthys atratulus Rhinichthys cataractae Semotilus atromaculatus

Table 1. Fish Species in the St. Louis Estuary continued

Family	Common Name	Scientific Name
Catostomidae	Longnose sucker	Catostomus catostomus
	White sucker	Catostomus commersoni
	Silver redhorse	Moxostoma anisurum
	Shorthead redhorse	Moxostoma macrolepidotum
Ictaluridae	Black bullhead	Ictalurus melas
	Yellow bullhead	Ictalurus natalis
	Brown bullhead	Ictalurus nebulosus
	Channel catfish	Ictalurus punctatus
	Stonecat	Noturus flavus
	Tadpole madtom	Noturus gyrinus
Percopsidae	Trout-perch	Percopis omiscomaycus
Gadidae	Burbot	Lota lota
Gasterosteidae	Ninespine stickleback	Pungitius pungitius
	Brook stickleback	Culaea inconstans
Percichthyidae	White bass	Morone chrysops
	White perch	Morone americana
Centrarchidae	Rockbass	Ambloplites rupestris
	Pumpkinseed	Lepomis gibbosus
	Bluegill	Lepomis macrochirus
	Smallmouth bass	Micropterus dolomieui
	Largemouth bass	Micropterus salmoides
	Black crappie	Pomoxis nigromaculatus
Percidae	Johnny darter	Etheostoma nigrum
	Yellow perch	Perca flavescens
	Logperch	Percina caprodes
	Walleye	Stizostedion vitreum
	Ruffe	Gymnocephalus cernuum
Sciaenidae	Freshwater drum	Aplodinotus grunniens

* Identification has not been verified

life history are not available. Population trends for ruffe and endemic species are currently too short to permit statistically valid conclusions on cause/effect relationships. As a result, the Task Force has used published data on European experiences and compared the information collected from the Duluth ruffe population to predict their impact on the local fish community. The report represents the best judgment of upper level State, Provincial, Federal, and Tribal fishery resource managers and is not intended to be a definitive scientific report. Personnel on the Task Force and contributors to the report are listed in Appendix A.

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II. LIFE HISTORY

A. Biology of Ruffe

James H. Selgeby and Derek H. Ogle

The ruffe (Gymnocephalus cernuus) is a small Eurasian percid that was introduced to the Great Lakes in the St. Louis River estuary at Duluth, Minnesota. The presence of ruffe was reported to the Lake Superior Lake Committee in March 1988 by the Wisconsin Department of Natural Resources. That report triggered subsequent actions by the Great Lakes Fishery Commission, the U.S. Fish and Wildlife Service, the States of Wisconsin and Minnesota, the Great Lakes Indian Fish and Wildlife Commission, the University of Minnesota, and the Minnesota Cooperative Fish and Wildlife Research Unit.

To evaluate the effects of invading ruffe on a native fish community and to study the biological and population characteristics of ruffe, the Ashland Biological Station focused its research efforts in the St. Louis River estuary in 1989, 1990, and 1991. Trawling was conducted at 40 locations within the estuary on nine or ten dates during each open-water season to collect population data on all fish species present. Additional intensive sampling in the spring and fall yielded data for population estimations and specimens for laboratory studies. Trawling, electrofishing, netting, and creel census operations provided samples of predator stomachs for determinations of their food habits. Analyses of food taken by ruffe and predators are currently being conducted by a graduate student at the University of Minnesota. Documentation of the food selected by yellow perch (a potential competitor of ruffe), black bullheads, white perch (another invader), troutperch, logperch, johnny darters, channel catfish, and emerald and spottail shiners is being done at the Ashland Biological Station. Basic life history studies including growth, maturation, fecundity, food, distribution, abundance, and movements of these and other species are also being conducted.

Habitat and Distribution

The fish appear to be closely associated with the bottom. They are found in the deepest channels (8 to 10 meters deep) at ice-out, move into the shallows to spawn, mainly remain in water 1 to 3 meters deep throughout the summer, and return to the deeper channels in September and October. Ruffe occupy virtually all habitats in the St. Louis River estuary but appear to prefer mid-depth channels during the day: at night they range into shallower water to feed. Within the St. Louis River system, ruffe are widely distributed but are most abundant in downstream sections of the river (near Lake Superior) and least abundant in upstream riverine areas. Upstream migration in the St. Louis River is blocked by a dam located approximately 25 miles from the river mouth.

Abundance

Abundance of ruffe in the St. Louis River increased sharply in 1988 to 1991 (Figure 3). The population expansion appears to have been exponential during this 4-year period. From 1989 to 1991, the estimated spawning (adult) population increased from about 200,000 fish in 1989 to 1.8 million fish in 1991 (Figure 4). These spawning populations gave rise to year classes of varying strength (Figure 5), suggesting that environmental conditions may affect year class success. Although the 1991 year class appears relatively weak, it still numbers 150,000 or more fish. The estimate for the 1991 year class may be low since sampling conditions were very difficult in late 1991 due to heavy rains and severe flooding.

As population density of ruffe has increased there is growing evidence of intra- and inter-specific competition. First year growth of ruffe has declined (Figure 6) and (as noted above) the proportion of mature one-year-old ruffe has also declined. Another indicator of increasing population pressure within the St. Louis River is the buildup of ruffe populations in Lake Superior proper. A summer gillnet survey conducted by WI DNR took no ruffe in the lake before 1991 but took ruffe at several locations in 1991. USFWS trawl sampling in Lake Superior in the vicinity of the Superior entry to the Duluth Harbor in 1991 consistently yielded substantial numbers of ruffe. Similar surveys in this area took few ruffe in previous years. In 1990 and 1991, ruffe were taken by trout anglers or smelt seiners at the mouths of Amnicon, Brule, and Iron Rivers, which are 15, 24, and 30 miles east of the St. Louis River estuary, respectively.

Fish Community Association

As abundance of ruffe increased from 1988 to 1991, the abundance of several cohabiting native species declined sharply. Yellow perch (Figure 7), troutperch (Figure 8), spottail shiners (Figure 9) and emerald shiners (Figure 10) all declined about 75% in their abundance. There was also an unexpected decline in the size of walleye year classes (Figure 11) that has paralleled those of the previously mentioned species. During 1989 to 1991, spawning populations of yellow perch declined over 50% (Figure 12) and perch year class strength has varied (Figure 13) at approximately the reciprocal of that observed for ruffe. The number of yellow perch taken in gill nets by Minnesota biologists declined sharply after 1987 (Figure 14). This decline coincided with a marked increase in ruffe.

Reproduction

Ruffe in the estuary grow very rapidly and attain about 50% of their ultimate length (about 180-200 mm) in their first year. Ruffe become sexually mature at an early age. of several thousand fish examined in 1988, all except two

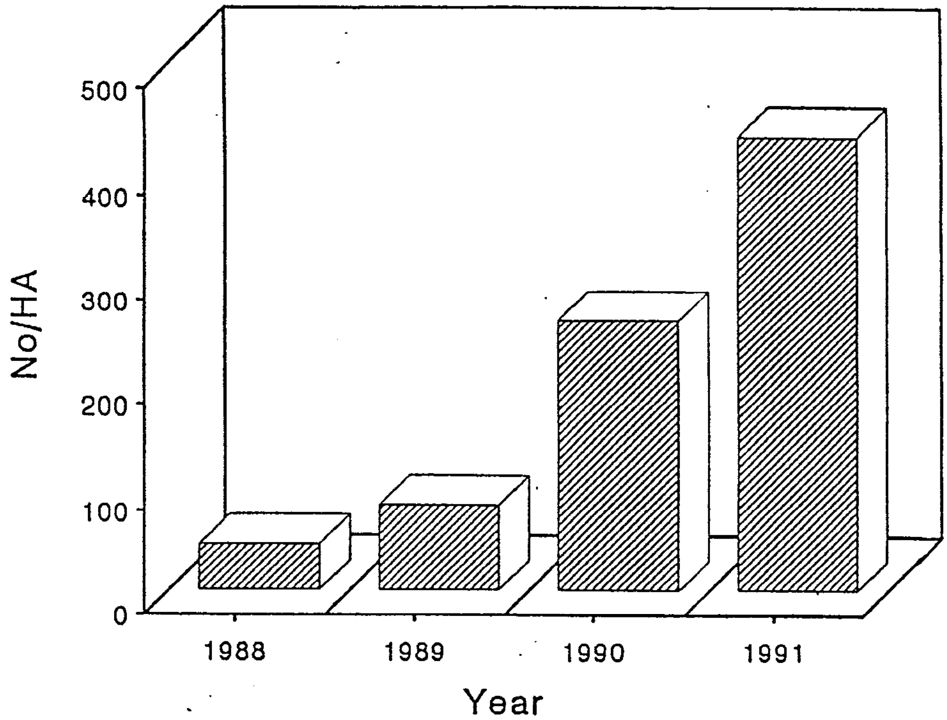

Figure 3. Abundance of ruffe (No./HA) in the St. Louis River, 1988-91.

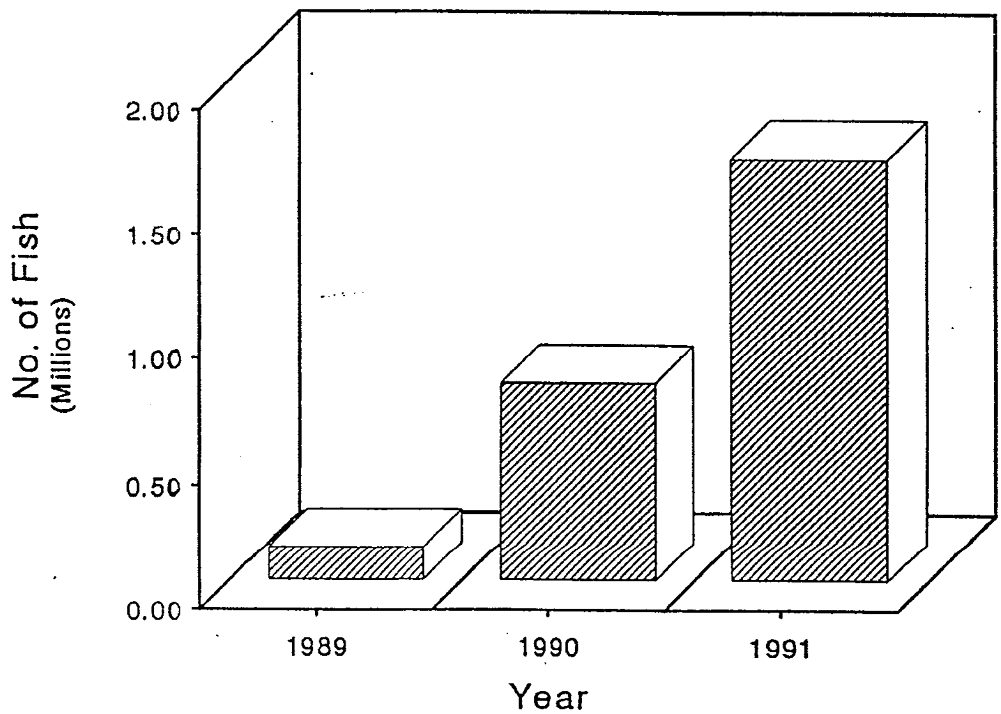

Figure 4. Estimated spawning population of ruffe in the St. Louis River, 1989-91.

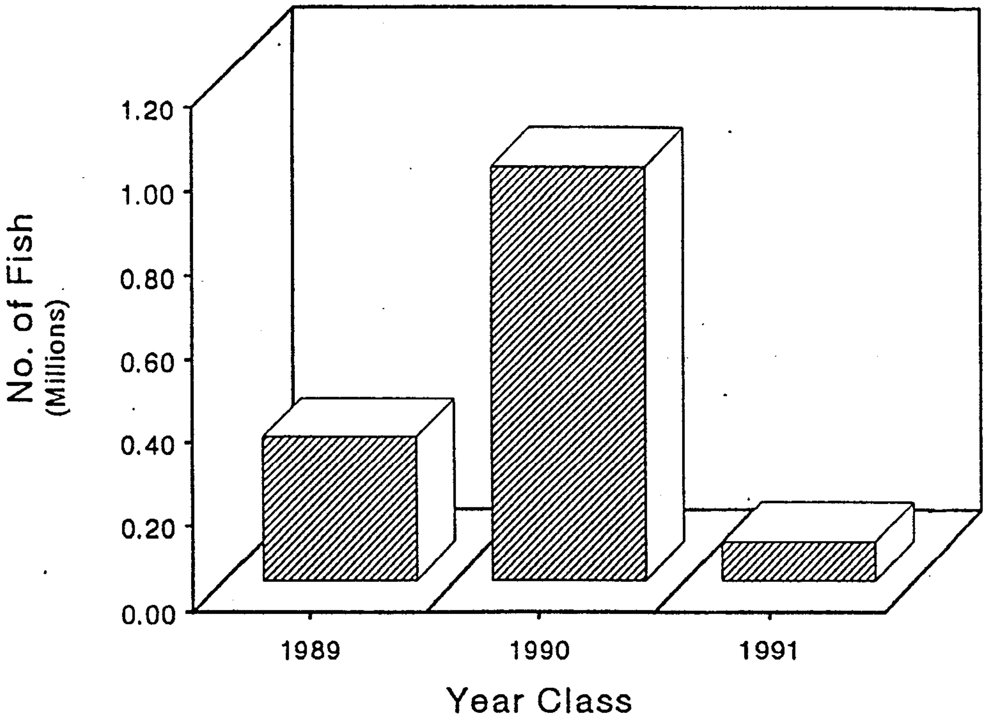

Figure 5. Estimated population of Y-O-Y ruffe in the St. Louis River, 1989-91.

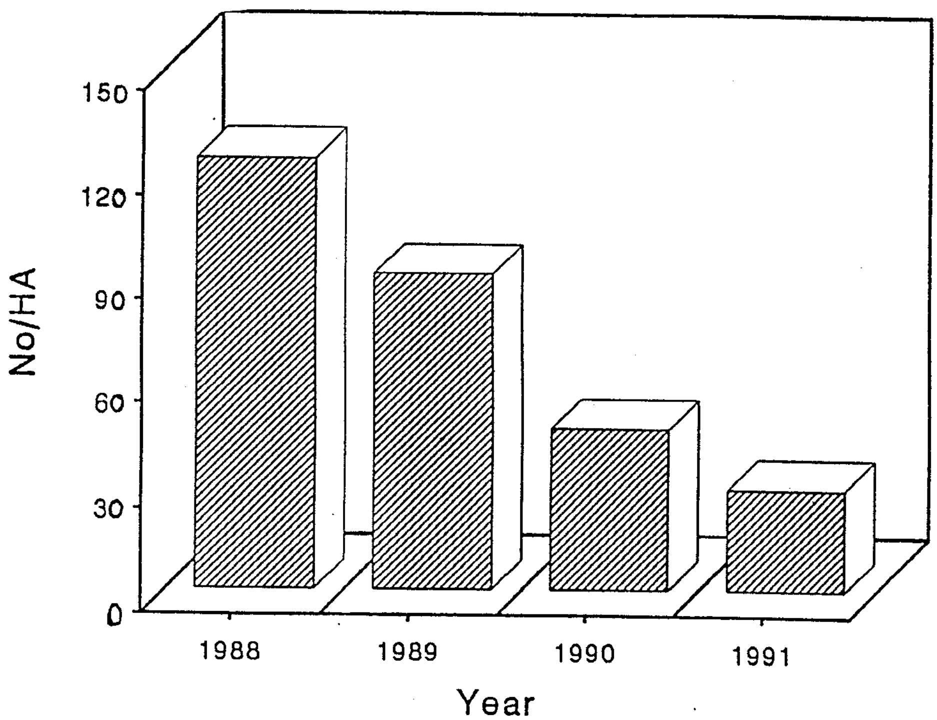

Figure 6. Average length of Y-O-Y ruffe (August-September) 1989-91.

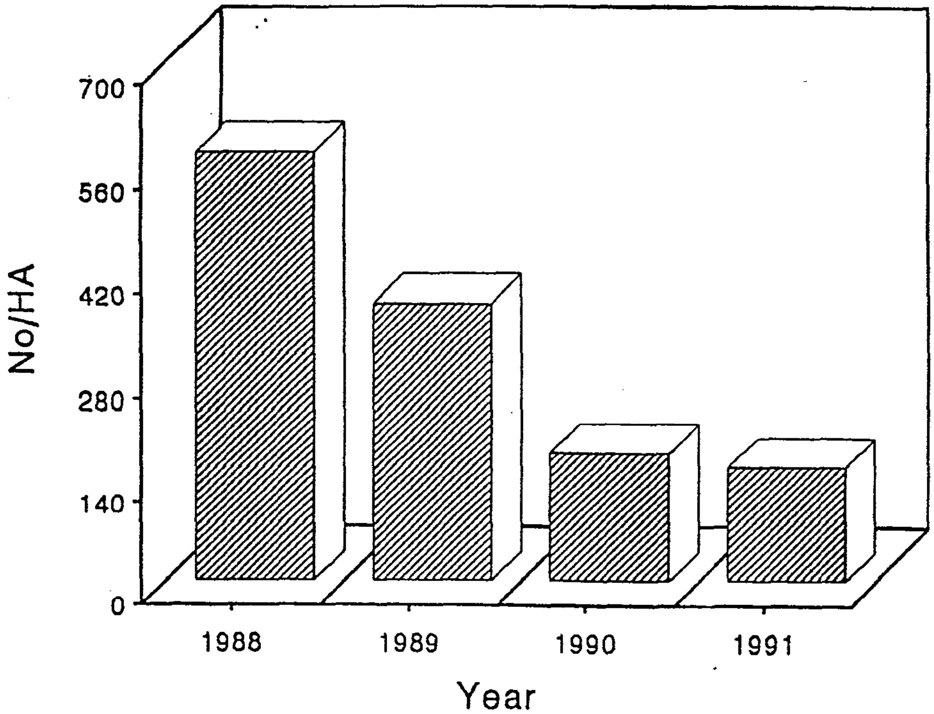

Figure 7. Abundance of yellow perch (No./HA) in the St. Louis River, 1988-91.

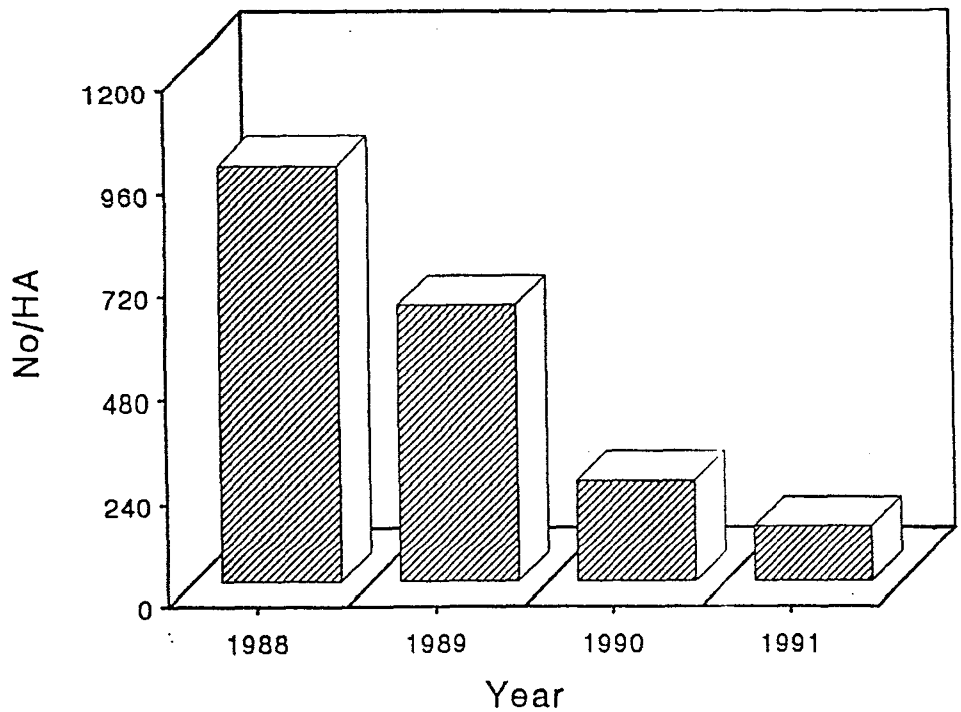

Figure 8. Abundance of troutperch (No./HA) in the St. Louis River, 1988-91.

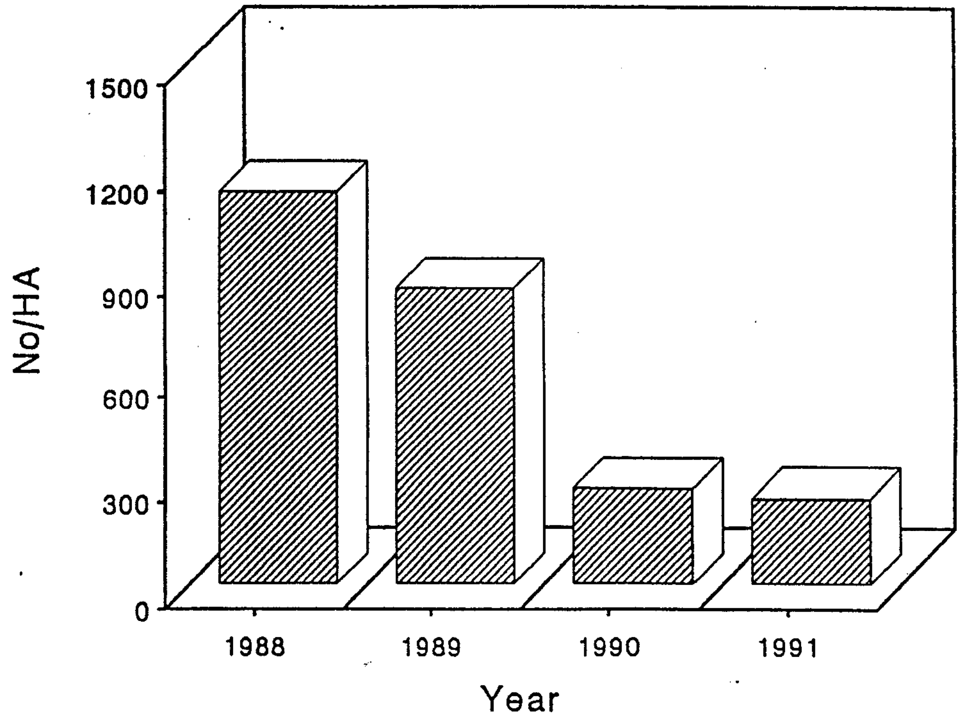

Figure 9. Abundance of spottail shiners (No./HA) in the St. Louis River, 1988-91.

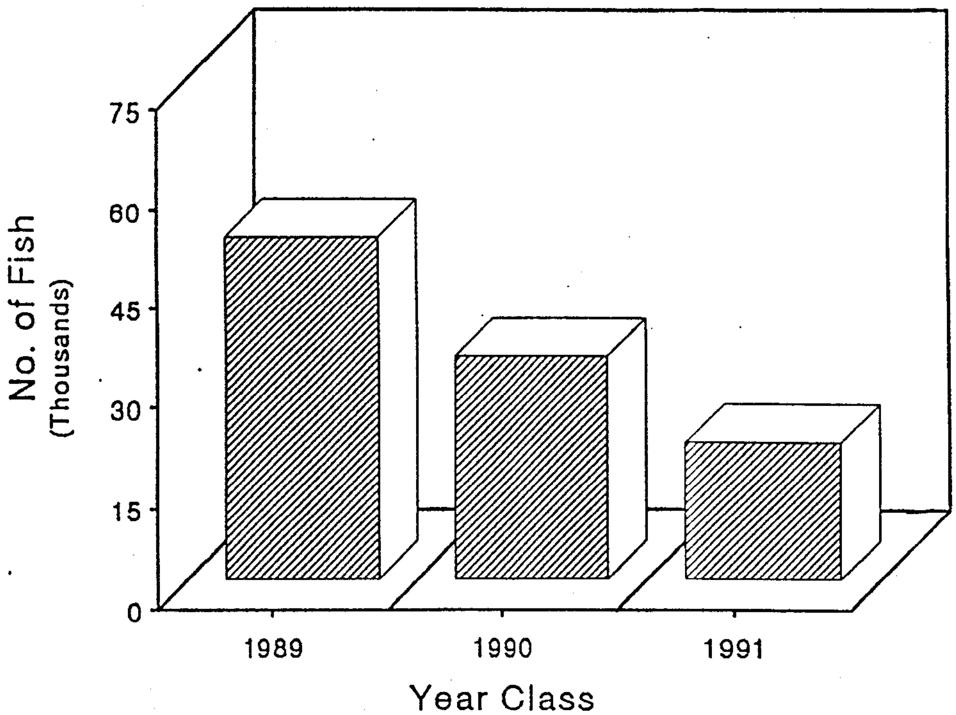

Figure 10. Abundance of emerald shiners (No./HA) in the St. Louis River, 1988-91.

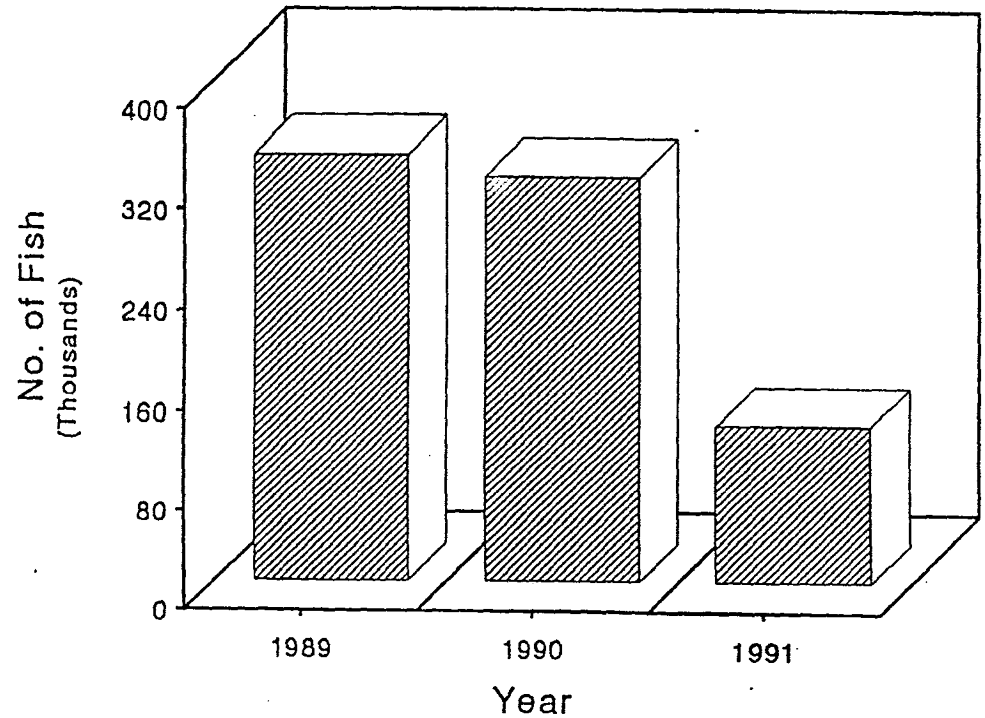

Figure 11. Estimated population of Y-O-Y walleye in the St. Louis River, 1989-91.

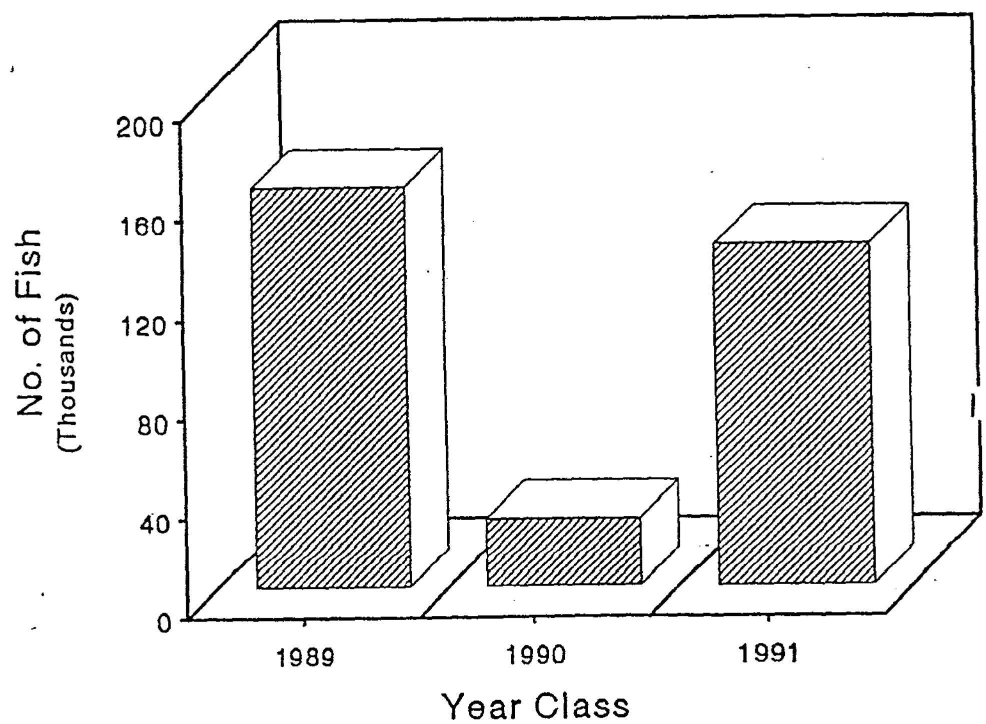

Figure 12. Estimated spawning population of yellow perch in the St. Louis River, 1989-91.

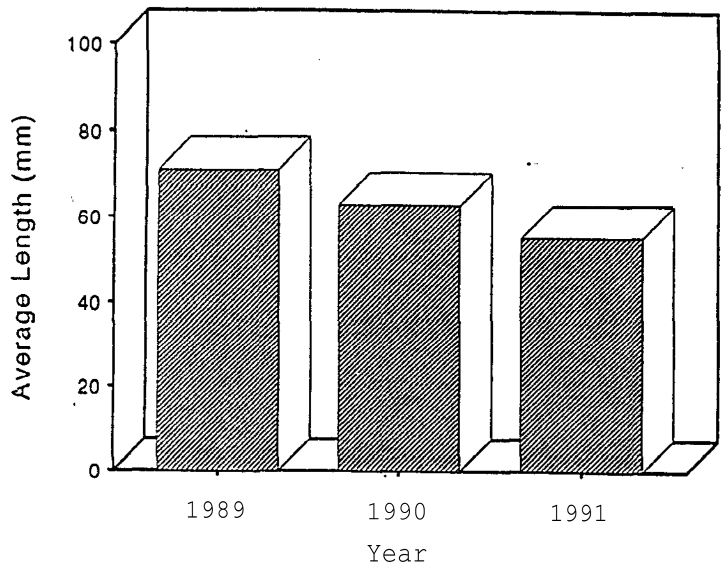

Figure 13. Average length of Y-O-Y ruffe (August-September) 1989-91.

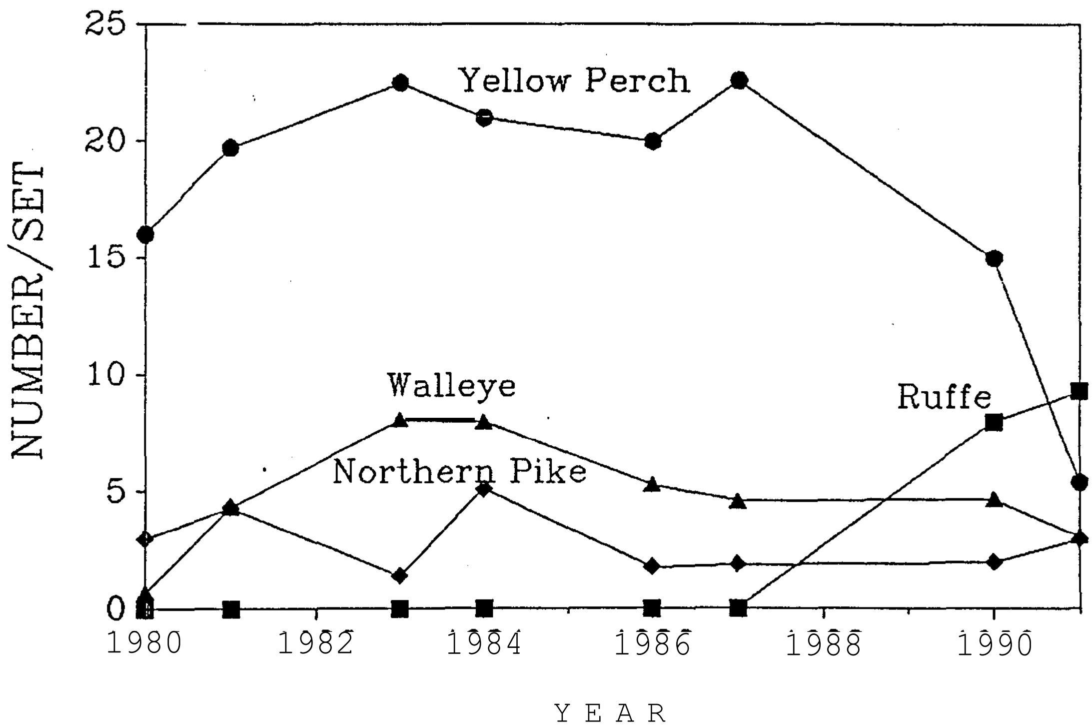

Figure 14. Number of walleye, yellow perch, northern pike and ruffe per gill net lift on the St. Louis River (1980-1981) Minn. DNR Data.

very small females were mature at one year of age. In 1989, 1990 and 1991, first-year-growth slowed each year and higher proportions of yearlings were immature (Figure 15). Fecundity is moderately high (450,000 eggs/150mm female) but much less than that reported in European literature.

Diet

Data on food preferences of ruffe are based on analyses of 480 size-stratified stomachs collected In 1989. During their first two months of life, ruffe fed on microcrustaceans, primarily Cladocera, and then switched to

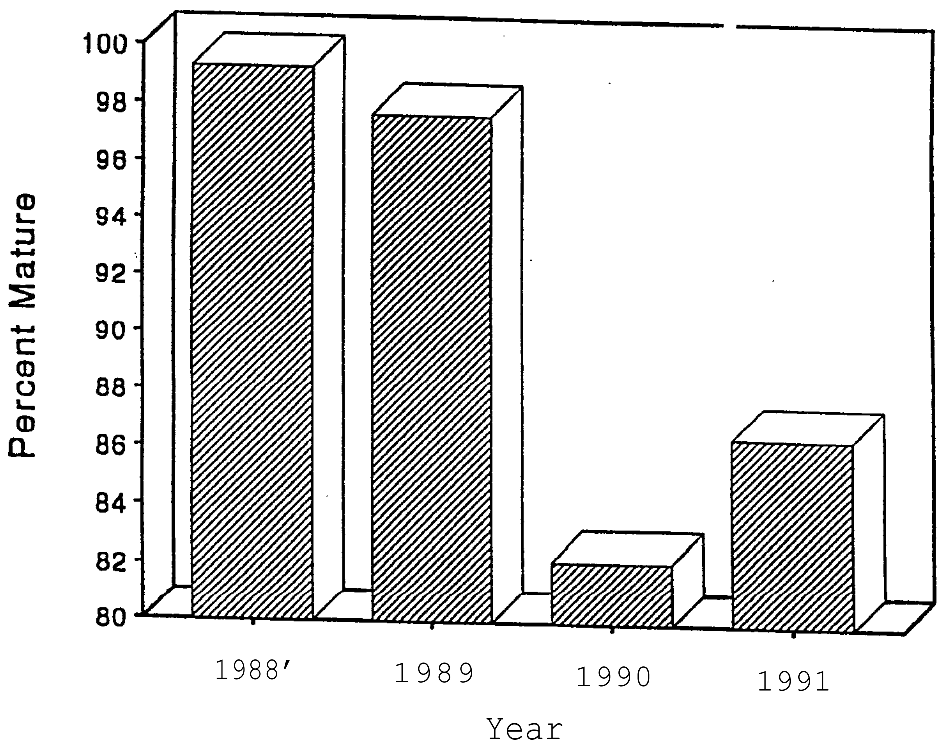

Figure 15. Percentage of 1 Year Old Ruffe That Matured Each Year, 1988-91.

macrobenthos in the late summer and fall. Adult ruffe less than 120 mm in length fed predominantly on Chironomidae and other macrobenthos but ate microcrustaceans early in the year. Larger adult ruffe (greater than 120 mm in length) fed almost exclusively on macrobenthos, especially midges and burrowing mayflies.

Diel sampling indicated that adult ruffe migrated into shallow areas at dusk to feed and that they fed there throughout the night before they migrated back to deeper channels at dawn. Feeding by adult ruffe ceased during the day. Young-of-the-year ruffe also fed most heavily at night but they continued to feed, mainly on microcrustaceans, during the day.

<u>Predation on Ruffe</u>

Data on the diets of the major potential predators is based on 959 stomachs collected in 1989 and 494 in 1990. The effective sample size (i.e., stomachs that contained identifiable prey organisms), however, was considerably less. In the following analysis, the sample size (N) and diet composition refer only to samples in which prey fish were positively identified to species. In addition, we report the sample ***size*** and number of ruffe eaten by yellow perch and black bullheads. These species are considered potential competitors with ruffe.

Walleye fed primarily on smelt and emerald shiners. In late summer, spottail shiners, johnny darters, and logperch were also consumed. No ruffe were found in walleye stomachs in either 1989 or 1990.

Northern pike fed predominately on emerald shiners. In both 1989 and 1990, spiny-rayed fish (yellow perch and black crappie) and benthic fish (troutperch and johnny darters) were found in the diet. In 1989, two northern pike each contained a single YOY ruffe; in 1990, one northern pike was found to have consumed a single adult ruffe.

Smallmouth bass ate more diverse forage species than walleye and northern pike. Smallmouth bass fed mostly on centrarchids in 1989 and johnny darters in 1990, but yellow perch and troutperch were also eaten. In 1989, one bass consumed one YOY ruffe; while in 1990, three bass had each eaten one YOY ruffe and one bass contained a single adult ruffe.

Black bullheads were the primary predator on ruffe during the open water months sampled. Of a total of 290 piscivorous-sized black bullheads (greater than 160 mm) with food in their stomachs in 1990, ten had eaten a total of eleven young-of-the-year ruffe. Black bullheads are more abundant in the system than other predators.

Emerald shiners were the most common prey of large yellow perch in 1990, but johnny darters and ruffe were also important. Three perch had each consumed two YOY ruffe and two perch had each eaten a single YOY ruffe. In 1988 and 1989 combined, 1038 piscivorous yellow perch (110 mm or larger) were found to have eaten a total of two ruffe.

The only other fish found to have eaten ruffe were several burbot and a single black crappie. Burbot may be important predators in winter when many enter the river to spawn but data on their winter food preferences are very limited.

IMPLICATIONS FOR MANAGEMENT

1. Ruffe became the most abundant species in six years or less. Concurrent with their population growth were declines in virtually every other endemic species. This pattern follows fish community changes reported from Europe. If the trends continue, there will be drastic adverse changes in existing fish communities wherever ruffe gain entry.
2. The limited data (less than 3 years) show a consistent decline in yellow perch and walleye, especially in the success of young of the year. In Scotland, ruffe quickly replaced the European perch (*Perca fluviatilis*). If the presently observed trends continue, ruffe are likely to severely reduce angling and commercial fisheries for yellow perch and walleye.
3. Few of the native predators are currently feeding on ruffe. Unless feeding patterns of predators change in the future, ruffe will continue to be a highly aggressive, dominant, undesirable biological pollutant and contribute little toward a desirable fish

community.

4. Food habits of the ruffe suggest that they may compete directly with young of the year of nearly all of the 60 endemic fish species, As ruffe grow, they feed heavily on preferred food organisms of yellow perch and young walleye.
5. Studies on diel distribution indicate that ruffe prefer low light conditions. They congregate in deep water during daylight hours. Such aggregations may be vulnerable to physical removal by effective gear such as trawls.
6. Ruffe seek deep water areas as water temperatures fall. Large numbers of ruffe occur in dredged areas and shipping lanes. Such grouping behavior may make ruffe susceptible to chemical control.

RESEARCH NEEDS

1. Complete a risk assessment of potential effects of ruffe on yellow perch and walleye populations in the Great Lakes must be done after the 1992 field season to provide managers with insight about the future impact of ruffe on yellow perch and walleye fisheries in Lake Erie and other areas.
2. Measure the size and recruitment of existing populations of ruffe and co-existing native species at Duluth and Thunder Bay. Obtain data on the basic biology of ruffe and co-existing species to determine

whether populations are interacting and whether native species populations are being adversely affected by increasing ruffe populations.

3. Document distribution and movements of ruffe at existing sites; study movements, behavior, and distribution of ruffe on seasonal, reproductive, and diel basis with regard to temperature, turbidity, depth, light penetration, and current.
4. Describe changes in fish community structure and determine causes of these changes. Document mechanisms by which ruffe out-compete endemic species and why ruffe are successful. Study predation on ruffe by native species to determine if there is increased utilization as endemic species decline in abundance or as familiarization occurs.
5. Elucidate features of the early life history of the ruffe such as the time and location of prespawning aggregations, location and sites of egg deposition, time and environmental conditions of egg incubation, movements, growth, food, and habitat selection of and by larval ruffe.
6. Model the impacts of the top-down predator control strategy on ruffe and on the native fish species through use of bioenergetics. Use accumulated data and bioenergetics model to predict the predator load needed to affect/reduce certain levels of ruffe abundance.

B. Potential for Range Expansion

Dennis Pratt

The ruffe inhabits both lakes and rivers in its native Eurasian range extending from the Mediterranean Sea north to the Arctic Circle. This means that ruffe possess adequate adaptability to survive throughout all U.S. and Canadian waters.

It is believed that the cold water temperatures of Lake Superior are slowing the spread of the ruffe from the initial invasion location in the St.Louis estuary on the extreme western end of Lake Superior. At present it is not known whether ruffe can reproduce in the open waters of Lake Superior. Tributary estuaries and warm or cool water embayments will likely be used by ruffe for reproduction and colonization, The availability of these two habitat types will play a large role in the expansion by the ruffe. Monitoring the dispersal of ruffe from established population centers is a prerequisite to any efforts to slow or block range expansion.

Ruffe can either disperse on their own or be carried elsewhere by man. Natural dispersal will likely be the slower of the two methods, in which ruffe stray from existing populations and colonize new territories. The ruffe has expanded its range along Lake Superior's south shore to the Amnicon River in 1988 (8 miles from the St.

Louis), the Brule River in 1989 (20 miles), and the Iron River in 1991 (27 miles).

The ruffe have already moved more than 27 miles eastward from Duluth along the south shore of Lake Superior and have reached several river systems in that area. If the active movement eastward continues, the fish will rapidly reach river systems that provide access to many inland lakes and streams. Since the headwaters of north- and southward flowing systems are not far apart, the probability of human transfer across the divide is very likely. Even if ruffe receive no human assistance, it appears likely that the fish will eventually reach the lower Great Lakes. From Lake Michigan, a direct water route to the Illinois River is provided by the existing Chicago canal. If ruffe reach the Illinois River, they will then have access to the entire Ohio, Mississippi and Missouri River basins; i.e., access to most of the inland freshwater angling lakes and streams.

At Thunder Bay, the Kaministiquia River provides access to inland waters of western Ontario. If the ruffe move along the northern shore of Lake Superior from Thunder Bay, they will gain access to numerous additional river systems.

Ruffe dispersal by human activity has the potential for moving ruffe over long distances to other parts of the Great Lakes and North America.

Ballast water drawn from ports with high ruffe populations and dumped elsewhere is the most likely passive dispersal method. Angling bait transfer is the next most likely. Shuttles of freighters from port to port could move ruffe great distances very quickly. The best example of such a possibility is the frequent direct runs by the vessel "Incan Superior" between Duluth-Superior and Thunder Bay. The Incan Superior travels from Duluth-Superior to Thunder Bay without cargo except for ballast water approximately 150 times per year.

Twenty major fisheries on the Great Lakes considered to be at risk from ruffe invasion are shown in Figure 16.

Population pressure is likely to result in continued movements of ruffe along the southwest shore of Lake Superior where there are suitable habitats, such as bays and rivermouths (Chequamegon Bay). The spread to inland waters might be accomplished through use of ruffe as baitfish by anglers. This was the probable route of introduction to Loch Lomond in Scotland.

Great Lakes ports receiving ballast water that originated in Duluth-Superior or Thunder Bay will need to be monitored for developing ruffe populations (See Figure 16). The inbound cargo list at the Duluth-Superior port includes limestone from Stoneport, Calcite, Drummond Island, Port Dolomite, and Port Inland. All of these ports are located in the area just downstream of the St. Mary's River on Lakes Huron and Michigan. Other cargo includes petroleum (from Whitting, Indiana), newsprint (from Thunder Bay), and salt, Canadian oats, and wood pulp.

Monitoring river mouths and estuaries and warm or cool water embayments of Lake Superior adjacent to known ruffe populations should be done annually to maintain awareness of any range expansion. At present, the area from the Keweenaw waterway in the Upper Peninsula of Michigan to Black Bay in Ontario should receive a major monitoring focus. Future ruffe colonization can be expected in Chequamegon Bay, Portage Lake, Black Bay, Nipigon Bay, and Whitefish Bay.

Ruffe appear to concentrate twice annually so monitoring should be done during those periods. The major concentration occurs during the spring pre-spawn period when water temperatures are between 40 to 50 degrees F. A second concentration occurs during late fall as ruffe move out of the shallows to deep water, such as the 10 to 30 foot deep shipping lanes, for the winter. Trawling is the most effective monitoring gear because ruffe are bottom hugging by nature. Monitoring by seining during smelt spawning runs in the spring also provides a unique assessment opportunity. Concentrations of ruffe align very closely with rainbow smelt spawning activity. If shore seining is used to monitor ruffe, night seining is recommended.

Angler awareness of ruffe identification is also essential since anglers will begin catching two to three-year-old fish as local abundance increases.

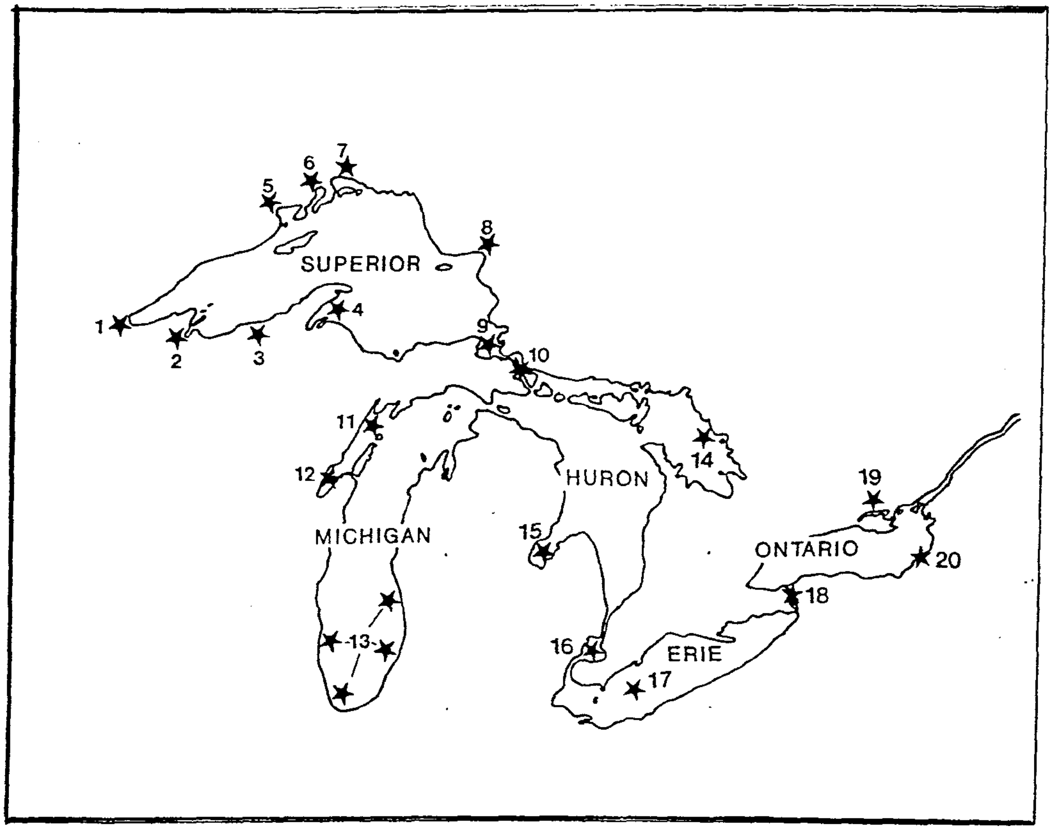

Figure 16. Great Lakes Fisheries Considered To Be At Risk By Ruffe Invasion.

Lake Superior
1. St. Louis River - MN/WI
2. Chequamegon Bay, Bad River, Kakagon Sloughs -WI
3. Ontonagon River - MI
4. Keweenaw Bay, Huron Bay, Sturgeon River, LacLabelle - Ml
5. Thunder Bay. Kaministikwia River, Current River - Ontario
6. Black Bay - Ontario
7. Nipigon Bay, Nipigon River, Jackfish River - Ontario
8. Michipicoten Bay - Ontario
9. Whitefish Bay, Goulais River, Batchawana Bay, Batchawana River, Montreal River - Ontario/MI
10. St. Mary's River - Ontario/MI

Lake Michigan
11. Georgian Bay - Ontario
12. Green Bay, Fox River, Sturgeon Bay - WI
13. Southern Lake Michigan near shore, Muskegon River, St. Joseph River - WI/IL/IN/MI

Lake Huron
14. Georgian Bay - Ontario
15. Saginaw Bay, Tittabawasee River, Saginaw River - Ml
16. Lake St. Claire. St. Claire River. Detroit River - Ml/Ontario

Lake Erie
17. Lake Erie, All - Ml/OH/PA/NY/Ontario
18. Niagara River - NY/Ontario

Lake Ontario
19. Bay of Quinte - Ontario
20. Oswego River, Block River - NY

IMPLICATIONS FOR MANAGEMENT

1. Ruffe have successfully established populations at two locations in Lake Superior and have dispersed about 30 miles from the original site of colonization. Transfers to new locations via shipping vessels, in bait containers or shipments, or by other human activity are highly probable. Also, unless they are contained or controlled, the fish will continue to move along the lakeshore to invade additional favorable habitats, such as inland streams and lakes.

RESEARCH NEEDS

1. Must document movements and new colonizations as they occur. A ruffe "watch" must be put into action by fishery agencies around the western half of Lake Superior and at all likely ports in the Great Lakes where transport by shipping is probable.
2. A central office should be established to receive and record all documented reports of new colonizations by ruffe along with all known data concerning the mode or route of introduction.

III. POTENTIAL FOR ECONOMIC DAMAGE

Fred P. Meyer

The potential for ecological and economic damage is substantial. Although North American experience with ruffe is still very new, the limited information gathered to date suggests that the impact on fishery resources is following patterns reported in European situations. Perch/walleye communities are probably the most vulnerable but warmwater fisheries based on centrarchids are also likely to be affected.

In Loch Lomond (Scotland), ruffe increased from 12% to 90% of the fish community in 7 years. At the same time, European perch declined from a relative abundance of 68% to 12% - an 88% decline (Maitland 1990; Maitland and East 1989). In Russia, the abundance of a whitefish (*Coregonus lavaretus palassi*) declined by 50% soon after ruffe became established (Pavlovsky and Sterligova 1987). The limited data available on ruffe/perch interactions in North America indicate that population shifts of similar magnitude may be occurring in the Duluth harbor area.

If this trend continues and the resulting change in the fish community parallels that observed in Europe, perch and walleye fisheries may ultimately decline to 25% or less of their present levels. Impacts on the forage base also are indicated by the information available from Duluth (See

Chapter Two) but no data are available on ruffe interactions with these species. If the forage base collapses, perch and walleye fisheries will be damaged to an even greater degree.

While ruffe will probably not compete directly with the top predators or larger sportfish species in the Great Lakes, their impact on yellow perch, walleye, the forage base, and commercial species, such as whitefish and chubs, could be considerable. Perch also provide an important portion of the food base for walleye. Any decline in perch stocks would have severe ramifications for walleye stocks.

Yellow perch are the most valuable component of commercial fisheries in Lakes Erie and Ontario (See Table 2). In Huron and Michigan, it ranks second after lake whitefish in both lakes (GLFC 1986, 1987a, 1987b: USFWS National Fisheries Center 1986, 1990). In his 1985 assessment, Talhelm (1988a) reported that the total Great Lakes commercial fishery (all species) generated $270 million U.S. in total regional economic activity plus 9,000 worker-years of employment in many small towns on the shores of the Great Lakes. Commercial fisheries in the province of Ontario (all species and all lakes) have a landed value of $48.1 million - no multiplier used (Personal Communication-David Payne, Ontario MNR).

Yellow perch attracted the most anglers and effort of any sport fish in the Great Lakes (Talhelm 1988b). 'Talhelm (1988a) reported that the Great Lakes sport fishery (all species) generated $4 billion in regional economic activity plus 75,000 worker years of employment.

Walleye and yellow perch are very popular sport fishes in inland waters and in the Great Lakes. If the ruffe were to cause declines in these species severe economic losses would result. Lake Erie probably represents the largest fishery for perch and walleye in North America. Although

Table 2. Relative Value of Major Commercial Fish Species in Each of the Great lakes in 1986. ($000 U.S.)*. Source: Great Lakes Fishery Commission, Annual Report for 1986.

SPECIES	SUPERIOR	MICHIGAN	HURON	ERIE	ONTARIO
Lake Whitefish	2,705	3,845	3,428	--	164
Yellow Perch	51	3,378	1,028	15,074	754
Walleye	--	--	--	5,871	--
Smelt	157	792	--	2,415	--
Chubs	235	1,832	986	--	--
Lake Herring	963	--	--	--	--
Lake Trout	697	--	--	--	--
Bullheads	--	--	--	--	432
White Bass	--	--	--	1.824	--
Carp	--	--	135	92.4	--
EEL	--	--	--	--	204
White Perch	--	--	--	--	74
Channel Catfish	--	--	356	--	--
Alewife		1,013			
TOTAL VALUE* $000 US	4,804	10,860	5,933	26,276	1,628

*) No economic multiplier used

complete data are not available, 1990 statistics compiled by the Ontario Ministry of Natural Resources provide insight to the value of these fisheries (Table 3). The combined commercial and sport value of the perch and walleye harvests in Lake Erie is estimated at over $101 million. If ruffe cause a decline of yellow perch and walleye in Lake Erie similar to that observed in Loch Lomond (88% decline), the economic loss would be over $89 million. The limited data currently available from the Duluth Harbor area indicate that perch declined by 50 percent during 1989-1991 and that young-of-the-year walleye also showed a marked decline. These declines coincided with sharp increases in ruffe abundance.

Lake whitefish also constitute a valuable commercial fishery in the upper Great Lakes (see Table 2). The 1986 value ($U.S.) was nearly $10 million. Although no data are presently available on ruffe/whitefish interactions in Lake Superior, the European literature reports a 50% decline in whitefish after ruffe became established. A similar effect in the Great Lakes would mean a $5 million annual economic loss.

Anglers in the 8 states in the U.S. portion of the Great Lakes basin spent nearly $6 billion while fishing (Table 4). Over $4.4 billion of that total was spent angling in waters other than the Great Lakes. In Ontario, anglers spent a total of $1.76 billion while fishing in

Table 3. Summary of the Harvest of Yellow Perch and Walleye from Lake Erie - 1990 (Ontario MNR Data).

JURISDICTION	HARVEST OF YELLOW PERCH (000's KGS)		HARVEST OF WALLEYE (000's of KGS)	
	COMMERCIAL	SPORT	COMMERCIAL	SPORT
ONTARIO	3204	U/K	6115	180
OHIO	1590	249	0	5705
MICHIGAN	U/K	105	0	1867.5
PENNSYLVANIA	64	U/K	5	U/K
NEW YORK	17	U/K	0	117.5
TOTAL (000's KGS)	4895	354	6120	7870
TOTAL VALUE (000'S $US)	$18,356[2)]	$5,310[3)]	$12,730[2)]	$65,478[3)] = $101,874

1. U/K indicates unknown
2. In 1990, the average value for yellow perch in Ontario was $4.50/KG ($3.75 U.S.); for walleye, it was $2.50 KG ($2.98 U.S.)
3. Multiplier of 4X used on commercial price to estimate sport value

Table 4. Expenditures by Anglers in Inland Waters of States and Provinces in the Great Lakes Basin (Millions of $)*

State/ Province	Freshwater Other Than Great Lakes	Great Lakes **Only**	Total Fresh-water **Angling**
Illinois	$ 686.928	$ 95.548	$ 782.476
Indiana	511.711	23.285	534.996
Michigan	622.088	619.454	1,241.542
Minnesota	666.713	39.356	706.069
New York	293.451	132.626	426.077
Ohio	535.094	393.307	928.401
Ontario **	-	-	1,763.600
Pennsylvania	586.046	110.813	696.859
Wisconsin	528.686	52.759	581.445
TOTALS ***	$4,430.717	$1,467.148	$5,897.865

*) Data from 1985 National Survey of Fishing, Hunting and Wildlife Associated Recreation, U.S. Department of the Interior, Fish and Wildlife Service. 1988. Washington, D.C. 167pp.

**) Data from 1985 National Sport Fishing Survey, Department of Fisheries and Oceans Canada and Ontario Ministry of Natural Resources.

***) No economic multipliers used.

inland waters and the Great Lakes. No breakdown between the two waters was available.

Nationwide, U.S. anglers spent $17.8 billion fishing in freshwaters other than the Great Lakes (U.S. Department of the Interior, 1988). In the Great Lakes, expenditures totalled $1.6 billion. None of the above figures have been adjusted by the application of economic multipliers. Most economists apply multipliers that range from 4 to 12 to determine the value of a resource to society. If a conservative multiplier of 4 is used, the overall value of inland freshwater fishing (other than the Great Lakes) in the Great Lakes basin states approaches $18 billion. The value of fisheries in the Great Lakes per se is worth over $6 billion. Application of a 4X multiplier nationwide places the overall value of inland freshwater fishery resources at $71 billion.

Although it is unlikely that invasions by the ruffe would destroy the entire North American freshwater fishery resource, even an overall loss of only 10 percent would be over $7 billion, a significant economic impact. The anticipated loss in ruffe-infested waters is expected to be much higher. Localized waters, especially those with yellow perch/walleye communities, could suffer very great damage with far reaching economic impacts. No data are available on interactions between ruffe and centrarchids. However, the potential for economic losses in those fisheries is also considerable.

NATIVE AMERICAN CONCERNS

The fishery resources of the Great Lakes and waters within this vast drainage basin represent a great asset to many tribes both in the United States and Canada. Tribal commercial and subsistence fisheries occur throughout much of Lake Superior, as well as in areas of Lakes Michigan and Huron. Inland waters of Wisconsin, Minnesota, Michigan, and Ontario also support tribal commercial and subsistence fisheries. For example, the Red Lake Chippewa band in Minnesota permits commercial fishing for various species including walleye and yellow perch in on-Reservation waters. Several Lake Superior Chippewa bands regulate harvest of walleye and other fish from scores of inland waters in Wisconsin and Michigan.

If ruffe were to colonize inland waters then populations of yellow perch, other forage fish, and predator species like walleye could be severely harmed. The more immediate threat posed by expansion of ruffe in Lake Superior is to walleye populations which spawn in waters of the Bad River Reservation and perhaps to Lake Superior whitefish stocks.

A rough economic value has been calculated for only a small number of the various tribal fisheries. For example, the "food substitution" value of the inland fishery in Wisconsin to the Lake Superior Chippewa has been estimated at $650,000 annually. The value of the commercial fishery in U.S. waters of Lake Superior to four Chippewa tribes was estimated at $1.13 million in 1988. If all jobs associated with this fishery were lost then dislocation costs would be an additional $15 million. Red Lake commercial fishery sales totalled $2.4 and $4.4 millionin 1990 and 1991, respectively. Dislocation costs for approximately 400 fishers would be an additional 47.5 million dollars. Inclusion of all the other tribal fisheries in the Great Lakes and its basin would likely result in a total economic value of several hundred million dollars.

IMPLICATIONS FOR MANAGEMENT

1. European experiences following colonization by ruffe indicate that ruffe may be capable of impacting all cool- and warmwater fisheries in North America, especially those for perch and walleye.
2. Although impacts of ruffe on warmwater species are presently unknown, experiences with cool water fisheries strongly imply that ruffe will not be a useful addition to such communities and that the potential for damage to warmwater fisheries is substantial.

RESEARCH NEEDS

1. Must continue to document population changes among sport and commercial species in ecosystems where ruffe become established.

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IV. CONTROL AND CONTAINMENT

This chapter discusses the various population control techniques used in fisheries management. Each technique is briefly discussed to explain if it might be useful as an option to help control ruffe.

Few organized efforts to control, eradicate, or contain ruffe in European waters have been reported. Reports of the effects of fisheries management on European percids contain only brief remarks about ruffe and none of the papers are related directly to control. Generally, the managers were attempting to enhance desired species, usually pike-perch (Stizostedion lucioperca) and perch (Perca fluviatilis).

In Lake **Võrtsjärv** in Estonia, a shallow, eutrophic body of water, commercial trawling was attempted as a means to reduce large numbers of ruffe and other low value fishes but it caused excessive mortality among immature pike-perch and did not reduce the numbers of ruffe or other undesirable fish (Pihu and **Mäemets** 1982). Overfishing had greatly reduced the abundance of predators and allowed forage species to become overly abundant. Cessation of trawling coupled with mass-stockings of eels (species not identified) were credited with a resurgence of valuable fish species, Esocids also increased while the number of "small fish" declined. Eels were noted to feed heavily on small ruffe.

In Lake Balaton, in Hungary, eutrophication, habitat destruction, and the introduction of exotic species caused major changes in the endemic fish community. Pike-perch and European perch almost disappeared and ruffe declined (Biro 1977). The introduction of eels (Anguilla Anguilla) was cited as a possible factor in the decline of ruffe.

No organized efforts to control or contain ruffe in European waters have been reported. However, several methods that might control or limit the spread of ruffe populations in the Great Lakes are being considered. Three control methods (chemical toxicants, mechanical and electrical barriers, and sterile male releases) are currently used to control populations of sea lampreys (Petromyzon marinus) in the Great Lakes. Their potential application for containment or removal of ruffe is being evaluated. In addition, removal by stocking additional predators, by intensive fishing, and integrated pest management methods are proposed or already in *use.*

A. Predator Enhancement

John R. Spurrier and Dennis Pratt

The USFWS, WI DNR, and MN DNR held meetings in the fall of 1988 to review the collected data and to develop recommendations for control of the ruffe. Tactics that were considered included top-down predator control by increased stocking of predators, chemical treatment of the lower St. Louis River system, and stocking sterile males.

Treatment of the Duluth/Superior Harbor with piscicides was not considered feasible because of the ruffe's wide distribution within the system. The sterile male technique did not appear practical due to the large ruffe population that had already become established.

Top-down predator control was chosen as a tactic that could be implemented immediately and that might provide a check to ruffe expansion. The plan was to increase the number of predators in the fish community immediately through more restrictive angling regulations coupled with a massive predator stocking program. The following regulatory actions were taken:

1. Reduce the daily bag limit of walleyes from 6 to 2 and establish a minimum size limit of 15 inches.
2. Reduce the daily bag limit of northern pike from 6 to 2.
3. Increase the minimum size limit on muskellunge to 36 inches.

In addition, Wisconsin delayed the season opening on walleye and northern pike from the Saturday nearest May 1 to the Saturday nearest May 15. Minnesota is in the process of implementing the same delay in the season opener. Both **states also delayed the muskellunge season until the** Saturday closest to Memorial Day.

A creel census conducted the first season that the regulations were in place (1989) compared harvest, angling pressure, and catch rates with those noted in creel surveys conducted from 1980 thru 1982. The results suggest that regulations were effective in controlling the harvest of predators, particularly walleyes, but it is uncertain if the over-all population of predators increased.

An ambitious predator stocking program was initiated jointly by Wisconsin and Minnesota with an annual goal of 300,000 walleye fingerlings, 10,000 musky fingerlings, and 11,000 to 33,000 northern pike yearlings. While these quotas were not always reached, significant numbers of predators have been stocked since 1989 (See Table 5).

An extensive sampling schedule involving trap nets, seines, gill nets, and trawls has been carried out annually since 1989 by the USFWS, WI DNR, MN DNR, and GLIFWC. The purpose of the sampling is to monitor predator and ruffe abundance, predator and ruffe food habits, and any changes in the fish community structure. Evaluation of the results has not been completed. Studies are on-going.

FUTURE PROGRAMS

Minnesota and Wisconsin are committed to continue the regulations, as well as the stocking of predators. Assessment efforts must be continued.

Data from the sampling program will provide the basis for evaluating the top-down predator stocking program and provide baseline data on which to evaluate future additional or alternative strategies **and tactics that may be applied.**

IMPLICATIONS FOR MANAGEMENT

1. It is too early to conclude whether the enhanced predator stocking was effective. As preferred endemic forage species decline, the predators may switch to ruffe. Regulatory Controls, stocking and continued assessment are needed.
2. Predator stocking is a relatively low cost technique that could be quickly and easily implemented. Because it is on-going, popular with the public, and lends itself to public education about the problem posed by ruffe, the present stocking of predators should continue until its success or failure can be documented. Until a final decision is in hand, the technique should not be used alone at other locations where ruffe might appear.
3. Predator stocking may actually be detrimental if the stocked species do not eventually prey on ruffe. In such instances, the added predators may increase removal of endemic forage species that are competing with ruffe. Unless stocked fish can be effectively marked for future identification, stocking may actually mask declines in reproductive success by native fishes.
4. Predator stocking may become a "put and take" fishery that is very popular with the public but not effective as a management technique.

RESEARCH NEEDS

1. Assessment of predator/prey relations between ruffe and endemic predators should continue.
2. A technique for marking small predators (especially walleye) is urgently needed.
3. Assessment of annual year classes of ruffe and endemic predator species to document changes and clarify cause/effect relationships.
4. Continue population assessments of predators with particular emphasis on stocked vs. native components of the populations.

Table 5. Number of Predators Planted by the States of Wisconsin and Minnesota in Ruffe Control Efforts, 1989-1991.

WIDNR	SIZE	1989	1990	1991
WALLEYE	Fry	250,000	--	--
	Fingerling	11,656	59,976	100,000
MUSKELLUNGE	Fingerling	5,000	5,000	4,658
LARGE MOUTH BASS		--	--	42,772
MN DNR				
WALLEYE	Fry	630,000	4,512,710	5,900,000
	Fingerling	25,000	17,595	26,453
NORTHERN PIKE	0.5-3 lbs	9,000	39,090	17,830
MUSKELLUNGE	Fingerling	1,000	4,215	4,855

B. Physical Removal

Thomas R. Busiahn

Under most circumstances, physical removal of a significant portion of a fish population in a large, open system as a management technique is a dubious proposition. Ruffe have no commercial or recreational value so unsubsidized public fisheries will not induce a high fishing mortality rate. This evaluation considers the potential for achieving population suppression by means of commercial fishing gear operated under government contract or by government-owned fishing gear operated by agency personnel.

In Europe, commercial trawling for pike-perch and European perch caused extensive mortality among small fish of these species. Although pike-perch were the target species, trawls also captured significant numbers of ruffe but the harvest did not reduce ruffe populations because of their high reproductive capacity. It should be emphasized that the European efforts were not directed at ruffe and that those reports do not represent attempts to control or reduce ruffe abundance.

Most Task Force members have concluded that the behavior of ruffe to congregate in deep water with reduced light should make them susceptible for selective removal.

Several experimental gears have been used in attempts to capture ruffe for study, including electrofishing, fyke nets, gill nets, and trawls. Only trawls captured sufficient numbers of ruffe for study so it must be assumed that trawling is the only gear with potential for achieving the objective. Incidental catches of non-target species will occur with any type of nets but trawling will allow most non-target species to be released alive. Trawls can also be outfitted with excluder devices that prevent large fish from entering the cod end of the net.

The operation of trawls with intent to maximize the catch of ruffe must be matched with the habitat occupied by ruffe. The St. Louis River estuary is extensive and complex, with shallow flats (63%), natural river channels (16%), and dredged navigation channels (21%). Ruffe occur in most parts of the estuary but show a marked preference for dredged and deep channels during the day. The Ashland Biological Station has estimated the numbers of ruffe in 3 habitat types in 3 separate zones (9 strata). The 3 strata with highest density of ruffe (675-840 per hectare) make up 25% of the estuary but contain 75% of the ruffe population (Table 6).

The small research trawl operated by the Ashland Biological Station with a 22-foot vessel can cover about 0.75 hectares per hour. A larger commercial trawl could cover 2 hectares per hour. The following scenarios consider trawling at 25 hours per week. (The rest of the time would be spent for transit, set-up, repair work, and disposing of the catch). The number of weeks to be spent trawling is set at 24 from mid-April through October.

The three scenarios for physical removal (Table 7) are based on several unstated assumptions regarding catchability and distribution of ruffe, and the logistics of trawl operations. Much of the St. Louis River estuary is shallow and inaccessible to large vessels. It is questionable whether a large vessel could operate effectively throughout the entire area. The conclusions presented are a first cut at assessing the feasibility of physical removal.

CONCLUSIONS

Projected costs and results of implementing the three scenarios are presented in Table 8. It is feasible to achieve the objective to remove one million ruffe (50% of the population) from the St. Louis River estuary using a trawl or trawls capable of covering at least 2 hectares per hour, and operated full-time for about 6 months (the ice-free season). Two small vessels could achieve similar results. However, a removal rate of 50% would not effectively reduce the population of a prolific species like the ruffe. Therefore, multiple trawlers or a combination of techniques must be employed to effectively reduce the population.

IMPLICATIONS FOR MANAGEMENT

1. It is not known whether heavy fishing pressure will effectively reduce the ruffe population. To be successful, physical removal will have to harvest over 80% of the population (preferably >90%) each year for five consecutive years. This will require a minimum investment of at least $300,000.
2. Although ruffe congregate in deep water areas seasonally and during daylight hours, other species also inhabit those waters. Trawling for ruffe will capture some walleye, catfish, and other non-target species. Incidental mortality among the by-catch must be evaluated.
3. Physical removal can be implemented without compromising the predator enhancement project since it will act as an additional form of mortality.
4. The cost/effectiveness of physical removal must be evaluated. This will require continuation of on - going population assessments of ruffe and native species for at least five years.
5. In order to identify the sites where trawling will be the most effective, it will be necessary to match a detailed topographical map of the bottom in the Duluth harbor and the estuary and lower reaches of the St. Louis River with data on distribution of ruffe.

RESEARCH NEEDS

1. Trawls may need to be modified to maximize the harvest of ruffe. A study should be made of marine trawls to identify the most useful type.
2. Excluder devices should be tested for their effectiveness in reducing the by-catch, especially of predators, such as walleye.
3. The extent of the by-catch and its impact on populations of non-target species must be assessed.
4. Other types of gear that might take advantage of tendencies of ruffe to avoid light or to congregate in deep water should be evaluated. An example might be a basket trap similar to those used to fish for catfish in the Mississippi River or for lampreys in Scandinavia.
5. Behavior and distribution studies should be conducted on the uncaught ruffe population to determine if they migrate into the harvested areas.

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Table 6. Estimated Number of Ruffe per Hectare in 3 Habitat Types and 3 Zones of the St. Louis River Estuary. (Number of hectares in parentheses). Data from the Ashland Biological Station, U.S. Fish and Wildlife Service.

	FIATS	UN-DREDGED CHANNELS	DREDGED CHANNELS
Lower Estuary (Below Highbridge)	75 (993)	840 (261)	675 (580)
Middle Estuary (Between Bridges)	66 (353)	0 (218)	750 (215)
Upper Estuary (Above Bong Bridge)	12 (1368)	360 (297)	293 (91)

Table 7. Descriptions of 3 Scenarios for Physical Removal of Ruffe from the St. Louis River Estuary.

SCENARIO 1: Large commercial trawler under government contract, 2 ha/hr coverage, 1200 ha coverage over 24-week season. Trawl all undredged channels in lower estuary twice. Trawl all dredged channels in mid and lower estuary once. Two-person boat crew, including captain, and one on-board agency technician.

SCENARIO 2: Refit the government-owned vessel "Carlson" for trawling. Staff with agency employees and operate as in Scenario 1.

SCENARIO 3: Agency-owned vessel (25-foot length) with 2-person crew, 1 ha/hr coverage, 600 ha coverage over 24-week season. Trawl all undredged channels in lower estuary twice. Trawl 100 ha of dredged channel.

Table 8. Projected Results and Costs of 3 Scenarios for Physical Removal of Ruffe From the St. Louis River Estuary.

	PROJECT NUMBER OF RUFFE REMOVED	COSTS START-UP	COSTS OPERATIONS
Scenario 1	907,500	$ 40,000	$125,000
Scenario 2	907,500	$200,000	$150,000
Scenario 3	490,000	$ 65,000	$ 75,000

C. Chemical Control

Terry D. Bills & Terry J. Morse

Fish toxicants are widely used to eradicate some or all of the fish in a body of water in order for desirable fishes to exist free from predation, competition, or interference by undesirable fishes (Lennon et al 1970). At the present time, 4 piscicides are registered by the Environmental Protection Agency (EPA) for use in the United States. The approved compounds include rotenone and antimycin (general fish toxicants) and 3-trifluoromethyl-4-nitrophenol (TFM) and Bayluscide (selective fish toxicants). In Canada, approval by Environment Canada is required.

Prior to the 1960's, specialized formulations designed to toxify specific strata within a lake system were nonexistent. Ayerst Corporation then developed an antimycin-coated sand granule that released the toxicant uniformly from the surface to a depth of 5 feet. Further refinements of the formulation permitted uniform toxification of a 15 or 30-foot column of water (Radonski 1975).

In addition to formulations of fish toxicants developed for special uses: selective fish toxicants, such as TFM, were developed that would kill larval sea lampreys with only a minimal impact on nontarget organisms. Other specialized formulations of toxicants have been developed to treat specific areas in the water column to minimize the impact on nontarget organisms. Research personnel at the U.S. Fish and Wildlife Service National Fisheries Research Center-La Crosse, Wisconsin developed formulations of antimycin and Bayluscide that would control sea lamprey larvae in lentic habitats by toxifying only the bottom 5 cm of water.

Laboratory studies were conducted by the National Fisheries Research Center; La Crosse, Wisconsin, and Marquette Biological Station; Marquette, Michigan to assess the susceptibility of ruffe to fish toxicants. The test results indicate that ruffe can be killed by a variety of piscicides and that, generally, they are much more sensitive than most endemic fishes. Only 0.2 $\mu g/\ell$ (.2 ppb) of antimycin was needed to kill ruffe - approximately 1/3 of the level that kills yellow perch and rainbow trout (Figure 17). Rotenone was even more selective in that the level needed to kill ruffe was about 1/24 that needed to kill rainbow trout and 1/40 that which killed yellow perch. See Figure 18). It is interesting to note that ruffe are also more sensitive to the lampricides TFM (Figure 19) and Bayer 73 (Figure 20) than most other fishes. Two experimental piscicides were also tested. Ruffe were about equal to rainbow trout in their susceptibility to Baythroid (Figure 21) and much more susceptible than yellow perch and bluegill. Salicylanilide I was also selective against ruffe by a ratio of 1:2 (Figure 22).

It is clearly evident that chemical agents would be effective against the ruffe. However, eradication would be difficult, if not impossible to achieve. The cost of a reclamation effort would be extremely high, given the large water area involved. It is estimated that a single application of antimycin (Fintrol) or rotenone would cost about $730 per surface acre. If the entire 20 square miles (12,800 acres) were to be treated, the cost would exceed $9 million dollars.

The cost of an eradication effort is so high that such a program is not feasible. However, the use of a chemical toxicant to greatly reduce the ruffe population when the fish are congregated in deep water channels (winter) or in spawning areas (spring) might be effective, especially if incorporated into an integrated pest management plan.

If a selective control effort was to be mounted, it is estimated that 1,300 acres would have to be treated at a cost of $949,000. Selective treatment might remove 50% of the population at best and it would be necessary to treat each year to contain the ruffe.

In addition to the costs for labor and chemical, a number of expensive mammalian safety studies would be required by the U.S. Environmental Protection Agency before approval to treat might be granted. It is estimated that $7 million might be needed to conduct the needed research.

Any efforts to manage or contain the ruffe may include the use of chemical control measures. Complete chemical reclamation of the St. Louis River and harbor area to eradicate the ruffe is not feasible. Aside from public sentiment against chemical treatment of a 13,000 acre river system, the cost would be prohibitive. Chances for complete eradication of the ruffe from the system are minimal. Development of a selective toxicant for the ruffe could require years of research and millions of dollars with only a limited chance of success. During the interim, the ruffe would continue to spread throughout major watersheds in the United States and Canada.

Large populations of ruffe are known to inhabit deep areas of the Duluth Harbor in close association with the bottom, particularly as water temperatures decrease to near **7°C.** Because of the schooling habits of the ruffe in coldwater, antimycin and rotenone were tested against ruffe, yellow perch, and black bullheads under coldwater conditions (6 to 7°C) to determine if ruffe could be selectively killed in the presence of these species. Under these conditions, rotenone was selective for ruffe vs black bullheads; however, yellow perch were killed by the same concentration of rotenone required to kill ruffe (1.0 mg/ℓ). Antimycin was selective for ruffe vs both black bullheads and yellow perch. Ruffe were killed by an antimycin concentration of 1.0 µg/ℓ, while 4.7 µg/ℓ were required to kill yellow perch. No black bullheads were killed in any of the antimycin exposures. It may be possible to significantly reduce the number of ruffe by using a bottom-release formulation of a currently registered fish toxicant with minimal impacts on nontarget organisms.

Antimycin, one of the toxicants that has been formulated as a bottom-release formulation, is also effective for killing fish eggs. As spawning areas for the ruffe are identified, treatment of those areas with a bottom release formulation could significantly reduce the success of a year class. Both bottom-release strategies have the potential to reduce ruffe populations within the harbor area while other control measures are being investigated.

IMPLICATIONS FOR MANAGEMENT

1. Sensitivities, habitat preferences, and congregating behavior of ruffe suggest that chemical control would be highly effective if environmental and safety

concerns can be satisfied.

2. If specialized formulations and delivery systems can be developed to target ruffe, it may be possible to significantly reduce the ruffe population through selective control.
3. Chemical treatments would probably reduce the ruffe population but eradication is likely to be impossible in the Duluth harbor area.
4. Chemical treatments might be feasible for reducing or eradicating ruffe in new locations before they disperse. Areas such as the mouth of the Brule River or the Incan slip would be likely sites.
5. Regulatory authorities in the U.S. and Canada should be consulted to determine:
   a) if emergency authorization could be granted to treat new colonizations.
   b) what additional environmental and human safety studies would be required on currently registered fish toxicants and on any special formulations that might be developed to target ruffe.
6. It will be necessary to map distribution of ruffe in the Duluth harbor and estuary to pinpoint concentrations that might be treated.
7. Public attitudes in the U.S. and Canada should be assessed to develop an appreciation of their concerns and potential support or opposition to chemical

applications.

a. Use of chemical control could be the corner stone of an Integrated Pest Management project.

9. Chemical treatments would be expensive and would have to be repeated annually or every several years in order to contain ruffe to their present sites.

RESEARCH NEEDS

1. Field studies should be conducted using the presently approved fish toxicants under experimental use permits to determine if laboratory results can be applied under field conditions.

2. Studies should be run on representatives of the endemic forage base to determine whether piscicides are likely to affect non-target species in the fish community.

3. Formulations development should be done on approved fish toxicants to determine if ruffe can be effectively targeted for selective control.

4. Regulatory agencies will require additional tests to assure human safety and environmental protection. Negotiations should be conducted with Environment Canada and the U.S. EPA to clarify the minimum requirements and the costs for conducting the needed studies.

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Figure 17. Relative sensitivities of selected fishes to Antimycin (LC99.9).

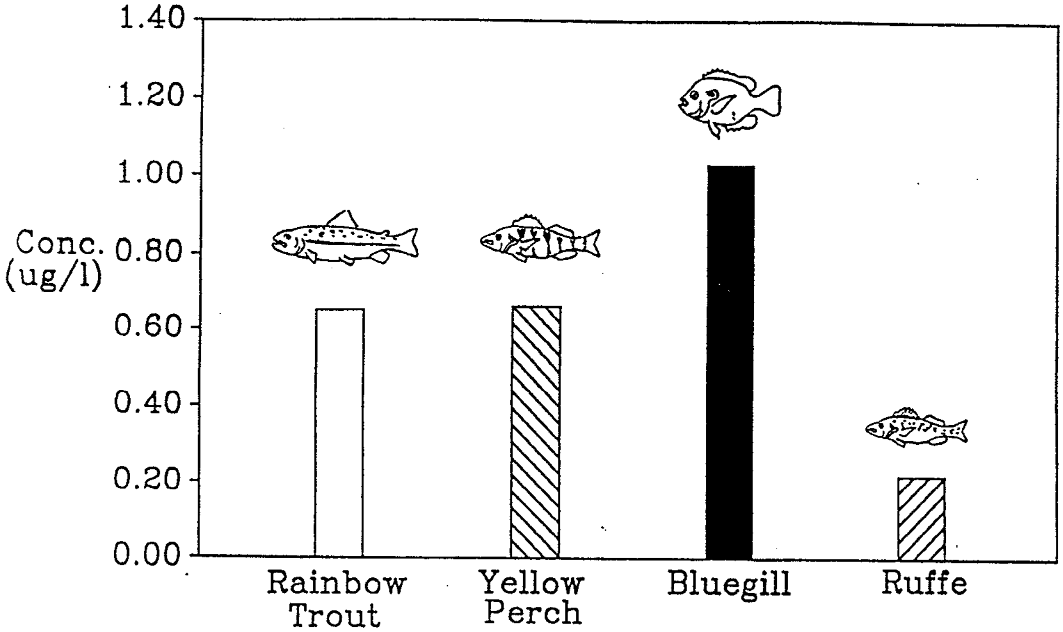


Figure 18. Relative sensitivities of selected fishes to Rotenone (LC99.9).

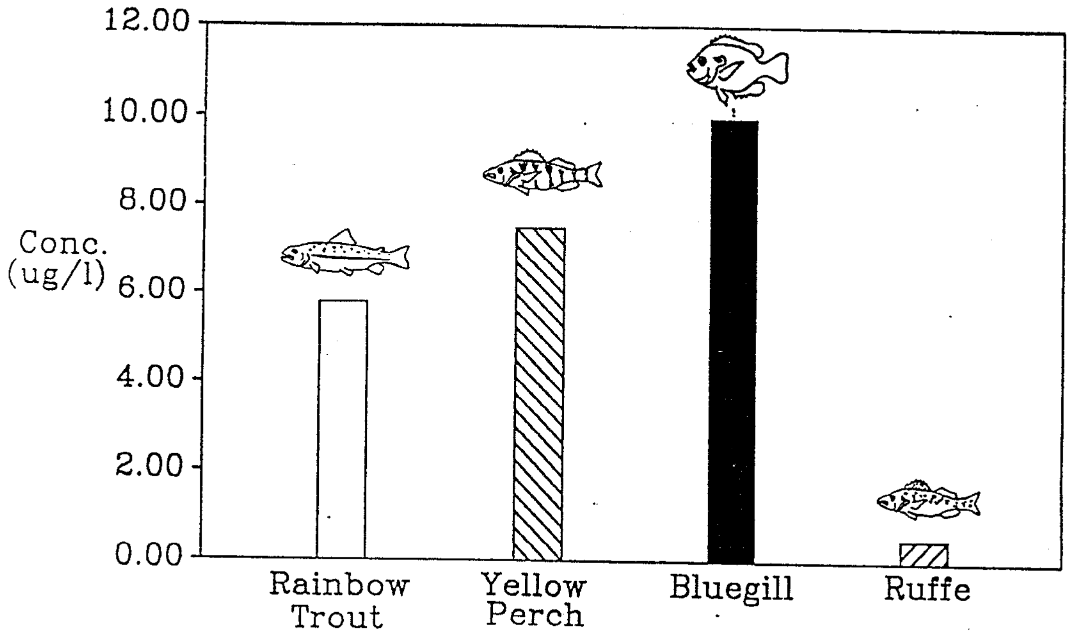


Figure 19. Relative sensitivity of selected fishes to TFM (LC99.9).

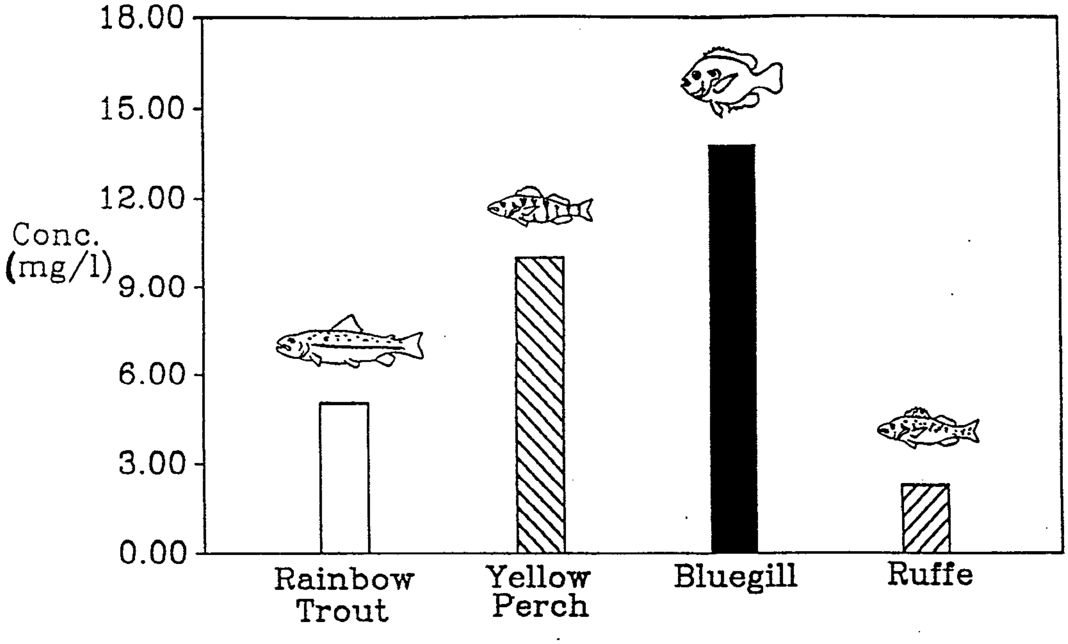


Figure 20. Relative sensitivities of selected fishes to Bayer 73 (LC99.9).

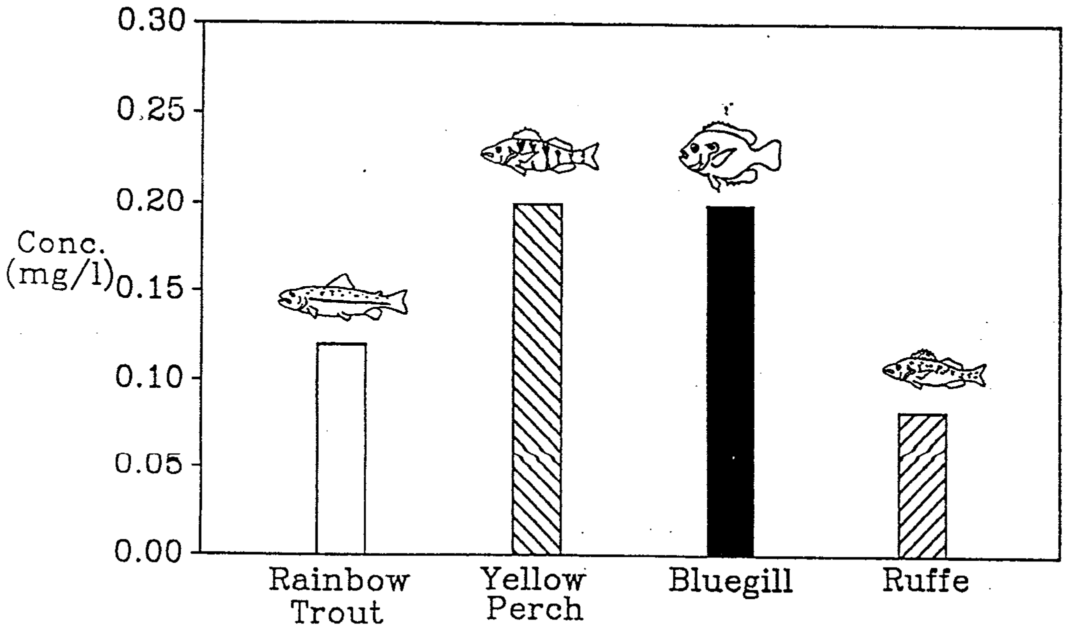


Figure 21. Relative sensitivities of selected fishes to Baythroid (LC99.9).

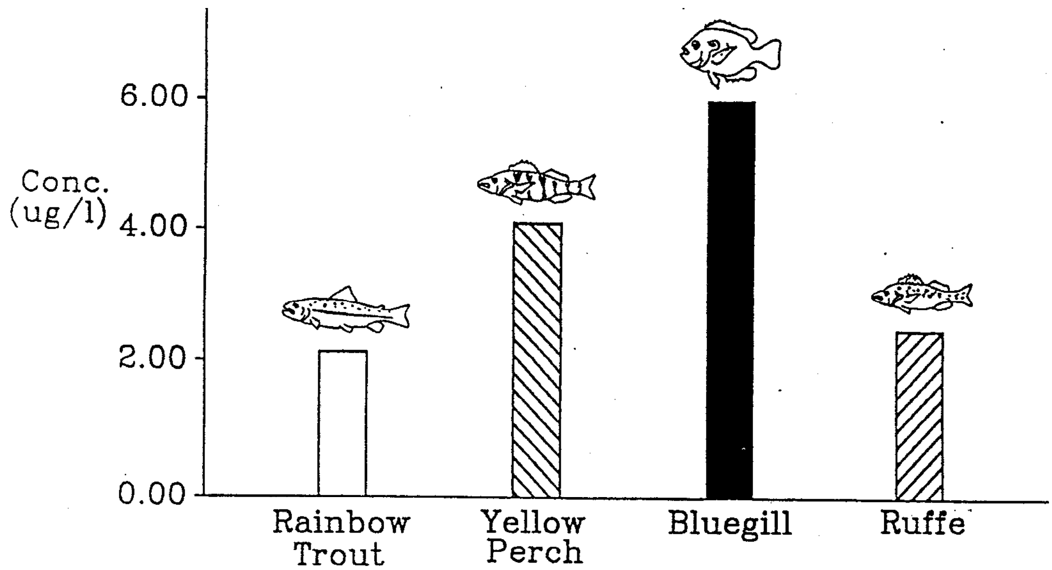
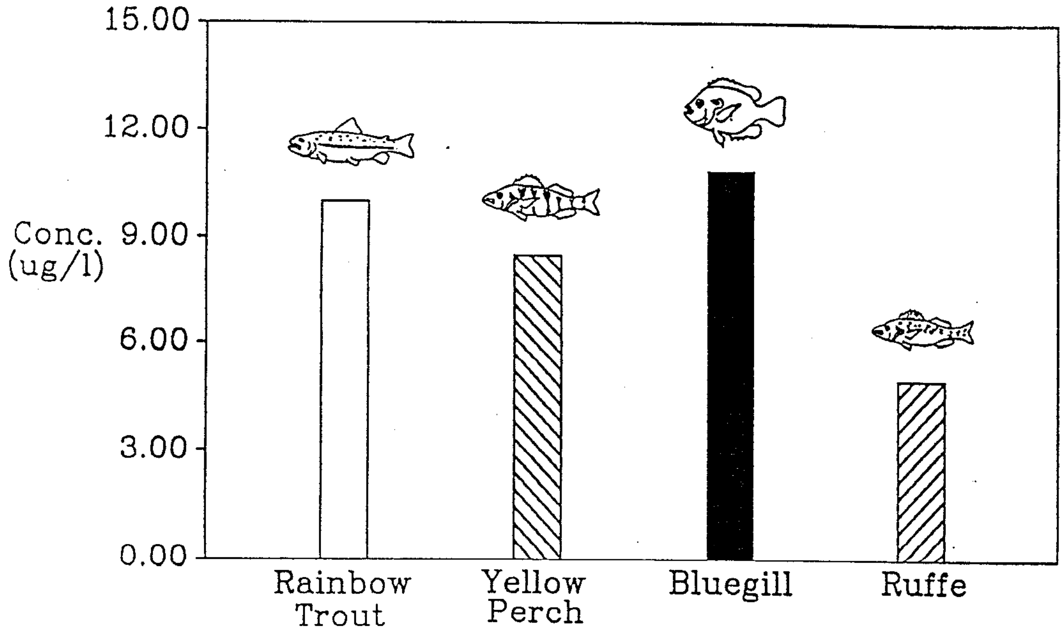


Figure 22. Relative sensitivity of selected fishes to Salicylanilide 1 (LC99.9).



D. Barriers

The construction of vertical barriers in tributary streams to the Great Lakes for the purpose of controlling the establishment of new ruffe populations and to limit their distribution is under consideration. A barrier design that has been effective in denying or limiting access to streams by sea lampreys might be effective with the ruffe. Although, in most cases, the barriers deny lampreys access to spawning habitat during their spawning season, this would not be the case with the ruffe because it's preferred spawning habitat also includes lentic areas.

Because the ruffe is able to effectively reproduce in lentic habitats, vertical barriers would not provide effective control or containment of the ruffe. At best, barriers constructed close to the mouth of a river might exclude the ruffe from large river systems only as long as there is no rise in water level that would inundate the barrier at any time during the year. Since ruffe would take up residence below a barrier, any rise in water level above the barrier would provide opportunity for up-river movement.

The species would continue to propagate in lentic habitats and spread throughout the Great Lakes, including to large embayments where they could significantly impact existing fisheries. Furthermore, the construction of barriers on large river systems is not practical, especially on rivers on which shipping occurs. The construction of barriers on small streams, especially those not inhabited by sea lampreys, would not be cost effective.

E. Sterile Male Releases

Fred P. Meyer

A number of exotic pests have been contained through the release of large numbers of sterile males. In theory, sufficient numbers of sterile males are introduced into the pest population to assure that they out-compete normal males for mating partners. Under ideal circumstances, the technique is highly effective, as was shown in efforts to control the screw worm fly in the United States. Best results are achieved when females mate only once in their lifetime. If the life cycle of the pest involves multiple mating with a number of partners, if the pest deposits eggs over an extended period, of if the pest reproduces intermittently (several times) during a year, the success rate declines.

In the case of ruffe, reproduction is the result of intermittent polygamous matings that occur over an extended season. Any effort to overwhelm the odds for fertilization by normal males would require massive stockings of sterile males. To be effective, a sterile male release program should involve a ratio of at least 10:1 sterile to normal males. The 1991 population of ruffe is estimated to be about 2 million adults. If half are males, a release of at least 10 million sterile males would be required to have any effect on ruffe reproduction.

In integrated pest management programs, efforts are usually made to reduce the target population as far as possible through the use of other techniques - usually chemical toxicants. If this can be done, the required number of sterile males is reduced, project costs decline, and the likelihood of success increases. Given these conditions, use of sterile male releases is not feasible unless the population can be first reduced significantly.

On the other hand, when a new colonization is first identified, and while numbers are still low, a sterile male release program might be effective in reducing or preventing reproduction.

The pest species against which sterile male programs have been directed have been organisms that reproduce only once or within a single season. In the case of a fin fish, such as the ruffe, sexual maturity is achieved at one year of age and reproduction may occur annually for the ensuing 6 or 7 years. Chemosterilization has been used effectively to sterilize sea lampreys and a sterile male release program is underway as part of an integrated control effort. Ruffe differ significantly from sea lampreys in that they spawn intermittently during the spring and summer for several years, whereas individual sea lampreys only spawn once in their lifetime. At this time, it is unknown if chemosterilization with bisazir will effectively sterilize a ruffe for all of its life. Because gonadal development rises and declines during each spring and summer, it is possible that the sterilizing effects may not last beyond one season. The answer to this question can only be determined by laboratory studies that will require several years. During the interim, it is likely that the ruffe will continue active expansion of their range.

A question also exists as to how often and how much stocking would be required to prevent reproduction when ruffe have reached the mouth of a river. Studies would be required to determine if sterile male releases could be used to prevent the colonization of inland river systems.

<u>IMPLICATIONS FOR MANAGEMENT</u>

1. Sterile male releases require large numbers of fish (about 10:1 over the estimated number of normal males. Ample numbers of fish are available but it is unknown if they will survive capture, treatment, and transportation.
2. If ruffe survive treatment, sterile male releases could be done in the near future.
3. Successful application of a sterile male release project is dependent on life-long neuterization of treated fish with no loss of libido, aggressiveness, and reproductive behavior.

4. Approval by state and provincial regulatory agencies would be required. This area can be explored immediately.
5. The public would have to be well-informed about any proposed sterile male releases to enlist their support.

RESEARCH NEEDS

1. Techniques must be developed to harvest, hold, chemosterilize, and transport ruffe with minimal mortality.
2. The long term effectiveness of chemical neutering on fin fishes should be studied in suitable surrogate species.
3. Techniques (other than chemosterilization) for neutering fin fish should be evaluated for their effects on libido, fertility, and reproductive behavior.

F. Managing Ship Ballast

Margaret R. Dochoda & Dennis Pratt

Unloaded ships may carry up to 30% of their deadweight tonnage in the form of ballast water, in dedicated ballast tanks, or in cargo holds. For example, a typical trans-oceanic cargo ship capable of transporting 20,000 metric tons of cargo may carry 5000 metric tons (1,320,000 U.S. gallons) of ballast water. Water taken on board as ballast often contains animals and plants typically found in the harbor. Organisms that enter through the intake gratings located below the waterline (usually each hole is less than 2 cm in diameter) and survive impeller blades of the pump (Schormann et al. 1990) are potential colonizers of new areas where the ballast water is discharged. Ballast water can be discharged or taken on at dockside or as the ship progresses. It can also be exchanged while a ship is underway.

Newly-hatched ruffe (3.7 mm long) are pelagic (in the upper water column) for a short time but return to near-bottom waters at 13 mm in length (Pratt 1989). It is during their pelagic phase that young ruffe are most likely to be drawn in with ballast water and subsequently released in other harbors.

BALLAST WATER MANAGEMENT TO CONTAIN RUFFE

Ships that call in ports where ruffe are present should not be allowed to take on ballast water from the harbor, bay, or approach channels during periods when ruffe are vulnerable to entrainment.

Harbors that receive ships from ruffe-inhabitated ports should be monitored each spring for early detection of the presence of ruffe.

If ruffe are discovered in receiving harbors, the ballast water management strategy will then have to be reviewed for any needed revisions.

DEFINITIONS

Ships: Lake and ocean-going vessels carrying water for ballast purposes.

Ports with ruffe: In 1991, ruffe were reported in Duluth-Superior and Thunder Bay Ports in Lake Superior. Chequamegon Bay, on the south shore of Superior, is at risk of being invaded by ruffe via natural range extension from the Duluth Harbor. Chequamegon Bay should also be avoided as a source for ballast water.

Harbor, bay, or approach channels: Ruffe are most concentrated in the harbor or bay, but may also be found in large numbers in-approach channels in the spring and winter.

When ruffe are vulnerable to entrainment: If the perforated plates over the intake tubes are intact, ruffe are vulnerable to entrainment in ballast water only when they are small and pelagic; i.e., during their first month or so of life. This period will vary with the commencement and length of the ruffe spawning season. Ruffe typically spawn from mid-April to early June when water temperatures reach 50' to 59" F (Pratt 1989). Ships should avoid taking on ballast water during the period of May through July from ports known to contain ruffe.

Harbors receiving shins from ruffe-inhabited ports -

Information need: What are the destinations of ships that call at ruffe-infested ports?

Monitored each spring: Channels should be monitored for the presence of ruffe using bottom trawls as water temperatures approach **50°** in the spring.

Sterile male release: A technique that might be used to prevent reproduction in small populations of pest species if containment efforts fail and ruffe manage to establish a new population. Information need: Culture and handling techniques for ruffe, effective sterilization techniques.

Eradicate or extirpate: Although eradication of the ruffe from North American does not appear possible with current technology, the eradication of newly-established populations of ruffe (for example in Thunder Bay) may be possible with implementation of an integrated program of currently available techniques.

Ballast war management strategy review and revision: The appearance of ruffe at new sites where natural range extension was not a factor would warrant review of the ballast water management strategy for needed revisions. At the least, any newly-colonized port should be added to those at which taking on ballast water must be avoided. Ports may be delisted if ruffe are not detected using acceptable monitoring techniques for five consecutive springs.

IMPLEMENTATION

Avoidance of ballast water from Lake Superior ports known to be inhabited by ruffe should be requested for an interim period, even if eradication measures cannot be mounted **at** this time. Special ballast water **management** measures would provide fishery managers outside Lake Superior with a period of time during which they could alert communities and educate fishermen concerning potential ruffe colonization and associated disruptions of aquatic resources. It will be incumbent on the managers to monitor the harbors for ruffe in order to provide needed feedback to the shipping community about the continued need for avoiding ballast water from ruffe-infested ports in Lake Superior.

If eradication measures are funded, the success of the containment program will largely depend on the commitment by the shipping community to observing the special ballast water management measures that will be required in ruffe-infested ports. Education and monitoring of feedback will be important factors in maintaining cooperation and should be major components of any management program. The following representatives of shipping associations on the Great Lakes have asked their members to abide by a 1990 request from the Great Lakes Fishery Commission that they avoid taking on ballast water in the Duluth-Superior Harbor or its approach channels during the months of June and July: Les MacArthur (Canadian shipping Association), William Hall (Lake Carriers Association), and Ivan Lantz (Shipping Federation of Canada).

Bill Scott of Incan Superior Ltd. has expressed a similar willingness to cooperate but questioned the ability of his liner to comply. The Incan Superior carries twelve railroad carloads of newsprint from Thunder Bay, Ontario to Duluth-Superior Harbor every few days. The empty Incan Superior must take on ballast water for the return trip to Thunder Bay. The ship may differ from other vessels in the Great lakes in that it has a higher center of gravity. This should be determined. If the ship cannot navigate in the Duluth-Superior Harbor without its cargo or ballast water, alternatives to out-of-port ballasting should be developed. It may be possible to fill ballast tanks with municipal water through deck access points or firelines.

Regulations and enforcement would be a less desirable alternative than voluntary compliance or a cooperative approach to problems, such as those presented by the Incan Superior. However, regulation and enforcement may be' necessary to assure compliance. Regulation could be invoked under the U.S. Nonindigenous Aquatic Nuisance Control and Prevention Act of 1990 and the Canadian Fisheries Act or additional Canadian Acts.

IMPLICATIONS FOR MANAGEMENT

1. Unless procedures can be developed in the immediate future to prevent transfers via ballast water, ruffe are likely to be spread throughout the Great Lakes by the shipping industry.
2. A record or listing should be made of all ships that leave Duluth and Thunder Bay, their destinations, and ports that might be visited enroute to identify sites

of likely new colonizations.

3. Ports that receive unloaded or partially loaded ships that visited Duluth should be monitored annually for possible colonization by ruffe.
4. Shipping companies and ship captains should be educated about the ruffe problem and consulted about how ballasting needs could be adjusted to avoid fish transfers from Duluth and Thunder Bay. If effective changes can be identified, they should be written into regulations required of all shipping.
5. Alternate control procedures for dealing with ballast water should be explored. The concept of using other water sources or using a sterilant in the ballast tanks might be a feasible preventive measure.
6. The U.S. Coast Guard and its Canadian equivalent should be contacted to determine if it is possible for the INCAN to safely delay ballasting until it is several miles outside the Duluth harbor.
7. Compliance with any ballasting regulations would be difficult to determine and enforce. Voluntary compliance would be important and very desirable.
7. Determine availability and cost of alternate water **sources** for ballasting in the Duluth harbor.
8. Determine condition of grates over ballast intake ports and incidence of broken or missing grates.

INFORMATION NEEDS

1. What is the incidence of corroded or missing ballast intake plates on ships calling at ruffe-infested ports?

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G. Regulatory Control Measures

Richard L. Hassinger

Fishery-related regulations are being used to prevent the spread of ruffe from the St. Louis River estuary to inland waters of Minnesota and Wisconsin. The regulations ban possession of ruffe and taking of the fish for bait purposes.

The State of Minnesota established the following regulations regarding the ruffe through an order issued by the Commissioner of the Department of Natural Resources.

Possession - The taking, possession, and transportation of ruffe is prohibited statewide. (see Appendix B. - MN DNR Commissioner's Order No. 2331)

Bait The taking of any fish for bait purposes from Minnesota waters of Lake Superior and the St. Louis River downstream of the Fond du Lac Dam, including any and all outflows, estuaries, streams, creeks, or waters adjacent to or flowing into the above described waters is prohibited. (see Appendix B).

The State of Wisconsin used its rule-making procedures to establish these ruffe regulations:

Possession - The possession of ruffe is prohibited. (see Appendix C- WI NR 20.03, NR 20.10, NR 23.08, and NR 26.27)

Bait Prohibits the harvest of bait by nets or traps, except smelt and shiners in Lake Superior and its tributaries upstream to the first dam or natural barrier. (see Appendix C).

The use of regulations has also been used in both Wisconsin and Minnesota in an attempt to increase predation on ruffe by native fish. In the St. Louis River, both in Minnesota and Wisconsin, daily limits of northern pike and walleye were reduced from 6 to 2 per day. (See Appendix D - MN DNR Commissioner's Order No. 2372, Sec. 3, Subd. 1). At the present time, additional walleye and northern pike are being stocked in an effort to increase predator populations.

The use of enforcement as a **containment** tactic is closely tied to education of the public. Ensuring compliance with the regulations requires that the public, anglers, and boaters be adequately informed about the restrictions. The Minnesota and Wisconsin regulations were featured in news releases, placed on signs at all public access points, and highlighted in the "Guide to Regulations" that is issued annually. All bait dealers in the areas were advised of the prohibition against-bait harvesting. Enforcement officers routinely checked anglers and advised them of the ban on possession of ruffe. Checks of anglers also provided a way to monitor public acceptance of the regulations.

The regulations were effective in identifying the ruffe as a deleterious species in the minds of anglers and bait dealers and aided in public compliance with the restrictions.

Identification of the ruffe as a pest species has increased public and scientific interest in the fish. As a result, scientists outside the area are requesting fish for use in research. At the same time, specimens are sought for use in displays and aquariums. Draft guidelines (Appendix E) have been proposed to deal with the problem of how to make specimens available for legitimate **uses** while, at the same time, preventing releases of ruffe.

IMPLICATIONS FOR MANAGEMENT

1. All jurisdictions (state, provincial, tribal, and federal) are at risk from ruffe colonization. Consequently, all should develop uniform regulations **concerning the taking, possession and transportation of**

ruffe.

2. Uniform regulation should be adopted by all jurisdictions concerning use of ruffe for scientific, educational, or display purposes.
3. The federal government should initiate action to have ruffe declared an injurious species under the Lacey Act.

RESEARCH NEEDS

(none)

H. Public Education

William J. Rendall

Public awareness of the introduction and potential impacts of the ruffe is crucial to preventing its spread to inland waters and to the other Great lakes. Awareness of special regulations regarding its transportation and possession is also important. Therefore, a public education campaign is an important containment strategy in the management of the ruffe. The secondary benefits of increased public awareness would be public support for funding to control the ruffe.

Since ruffe can be accidently transported by boaters and anglers, awareness efforts should focus primarily on these water users, but also should include the general public in communities near ruffe infestations. A ruffe public awareness campaign, when possible and appropriate, should also be integrated into public awareness campaigns about other exotic species for several reasons:

1) The public will have a difficult time remembering and comprehending the impacts of several exotic species if they are presented in separate campaigns. It is important that the audience remember a message about how to prevent the spread of exotics, such as not transporting water, aquatic plants, or fish. A uniform set of guidelines would apply to the ruffe as well as to other exotic species, such as the white perch, zebra mussel, European spiny water flea, and Eurasian water-milfoil.
2) The cost for a campaign to contain the ruffe will be less if it is incorporated into campaigns to control other aquatic exotic species.
3) By including a number of species in one campaign, it will reach a larger audience and arouse more concern than warnings. about a single species with a relatively small distribution would generate by itself.

A ruffe awareness campaign could incorporate a variety of methods to communicate with the public. The following are examples of available techniques:

Posters - used in Minnesota to increase public awareness about Eurasian water-milfoil, purple loosestrife, and zebra mussels.

Signs already in use in Wisconsin and Minnesota concerning ruffe in the Duluth/Superior area. See Appendix 5. Signs have also been used to alert boaters about areas with Eurasian watermilfoil and zebra mussel infestations and to inform them about precautions to take to prevent the further spread of these pests.

PSA (Public Service Announcements) - video public service announcements have been used in Minnesota to increase awareness about Eurasian watermilfoil. The Minnesota DNR has paid to have these PSA's aired but also relied on free air time. Unfortunately, showings have often been at poor audience viewing times.

Video News Releases - have been used in Minnesota in conjunction with a Milfoil Awareness Day to raise public awareness about regulations prohibiting the transportation of milfoil.

Brochures - have been prepared about nearly all of the major exotics. In the future, all major aquatic exotics should be covered by one high-quality brochure. This would simplify the distribution of materials to schools, civic groups, sportsmen, boaters, and anglers, fishing tournaments, boat shows, and other events. The Minnesota DNR plans to do a brochure on exotic aquatic organisms in cooperation with the Minnesota Sea Grant Program and the University of Minnesota. The 1992

Minnesota Fishing Regulations brochure contains a section on harmful exotic species. The ruffe is listed with a reminder that it is illegal to possess or transport this fish.

News Articles - can play an important role if placed in newspapers, magazines, and other publications.

IMPLICATIONS FOR MANAGEMENT

1. Educate anglers and boaters by posting signs at public access areas around Duluth, Superior, Thunder Bay and for considerable distances in all directions. The posters should provide a good picture of a ruffe, explain why they are a problem, and indicate who to call if any are found.
2. Updates on the distribution of ruffe, the perceived threat, and control efforts should be provided to the media and natural resource agencies on a regular basis.
3. Must create an "exotics awareness" among young people. This will require educational materials geared for school age children and high school students.
4. Must share information concerning problems caused by ruffe with the rest of the Great Lakes scientific community (i.e., Great Lakes Panel on Exotics Species, American Fisheries Society, OTA, Etc.).
5. Educational materials should emphasize that the ruffe is an exotic species from Europe that poses a real threat to North American fishery resources. It should

be characterized as a noxious fish that is avoided by sport fishes, is poor bait, and of no value for sport, commercial, or subsistence fishing. Its presence threatens yellow perch and walleye populations in particular.

RESEARCH NEEDS

(none)

V. STRATEGY

Any strategy to deal with the ruffe is faced with a time problem. Unless actions are taken in 1992 to limit further expansion of its range, the distribution may soon become so large that containment will not be possible. Containment must begin in 1992. To allow the ruffe to continue to spread while control methods are being researched would be analogous to Nero fiddling while Rome burned.

Fishery Biologists agree that eradication of ruffe from the Duluth Harbor/St. Louis River system is not feasible at the present time with existing technologies. This Task Force recommends that control efforts first center on containment of the fish to its present distribution. Unless the ruffe can be contained in the immediate future, the opportunity may be lost and future control efforts would be very costly. Except for several fish toxicants and physical removal, no techniques are available for immediate implementation. Although a number of promising alternate control concepts have been discussed, all are still experimental and will require at least 5 to 10 years of further research before any might be available for field application. However, if containment can be achieved, the scientific community will have additional time to research and evaluate new control techniques.

A five point program is needed to deal with all aspects of the proposed containment effort. These include:

1. Prevention of human-assisted transfers to new sites.
2. -Attempt immediate eradication of any new colonies.
3. Educate the shipping industry and the public about the hazards posed by ruffe, the damage that might be caused, and the need for their containment.
4. Reduce the existing populations.
5. Conduct research on new control methods.

Containment also involves immediate cessation of all human-assisted transfers, whether they be via shipping ballast water, bait fish sales, or released by the curious or uninformed public. The shipping industry must be brought into the picture to inform them of the nature and magnitude of the ruffe problem, to discuss when and how ruffe can be transferred in ballast water, and to enlist their voluntary cooperation and participation in ending transfers of ruffe by the shipping industry. It is important that the industry be made to understand that regulatory control may be imposed if voluntary compliance is not achieved.

Transfers by anglers, bait dealers, or by individuals who are curious about ruffe also represent a viable route for the introduction of the fish to new waters. Closing this possible breach of containment efforts must be an immediate priority. It involves regulatory changes to prohibit the taking and possession of live ruffe and education of the entire public about the threat they pose to fishery resources. In addition, fishery agencies in the Great Lakes Basin should immediately develop uniform regulations concerning the ruffe and designate a single, central office to which all reports of new colonizations should be reported. These regulations should be widely publicized and accompanied by public information brochures, video tapes, posters, and oral presentations. Also, a uniform set of guidelines must be developed to accommodate needs of research scientists to acquire needed animals for the testing of new control methods, to provide specimens for teaching purposes, and to prevent the use of live ruffe in educational displays and public aquariums.

If the ruffe is allowed to extend its range while new control methods are being researched, it may become so widely established that new technology may arrive too late to be useful. Every effort must be made to eradicate or contain any new colonies of ruffe outside of the Duluth and Thunder Bay sites. This means that the lower reaches and estuaries of the Brule, Iron, and Amnicon Rivers must be treated in 1992 with a fish toxicant to eradicate or reduce the small populations present in those areas. Only the most selective fish toxicant available should be used. If these streams cannot be treated in 1992, ruffe will continue their eastward movement along the south shore of Lake Superior and **the area to be treated will increase significantly. If** ruffe should reach the Chequamegon Bay area, eradication may not be possible and the "containment area" will be much more difficult to deal with.

Monitoring of population changes in ruffe and endemic species must continue. It is important that the impact of ruffe on the native fish community be documented if we are to be able to predict impacts if the ruffe appear elsewhere. Evaluation of the top-down predator stocking control effort requires at least 5 more years of monitoring. Data on distribution and behavior of ruffe will contribute significantly to an understanding of its life history and are vital to any selective removal effort. Seasonal distribution data may provide vital information as to when ruffe are most susceptible to control techniques.

When containment mechanisms are in place and operating, efforts should be made to reduce the existing ruffe populations at Duluth and Thunder Bay. It may be possible to remove a large portion of the population in the Duluth Harbor area by heavy fishing with trawls. This approach should be tested in 1992 if possible, providing that adequate funds are available to pay for sufficient fishing effort to remove 85 to 90% of the estimated population.

Field testing should be conducted as soon as possible (1992) to determine if available fish toxicants could be used to selectively remove ruffe from the existent fish community. Formulations development to enhance delivery to areas inhabited by concentrations of ruffe should follow if the field tests yield promising results.

Regulatory agencies should immediately (1992) be contacted to determine their position regarding fish toxicant applications as emergency actions to contain or reduce ruffe populations. At the same time, any needed additional safety studies should be identified and negotiated to clarify the minimum data required.

Studies should be initiated as soon as funds are available (1992, if possible) to explore the potential of sex alterations or reproductive manipulations (such as sterile male releases) can be used as population control measures. These studies will require at least 5 years for completion so multi-year funding must be developed.

VI. RECOMMENDED CONTROL ACTIONS AND BUDGET NEEDS

The Ruffe Task Force urges that immediate action be taken to prevent further introductions or distributions by shipping or other human activities, that measures be taken to contain ruffe to the presently colonized sites, that attempts be made to destroy any new colonizations that are detected, and that efforts be made to reduce numbers of ruffe at the sites where it has become established.

A management plan has been developed to accomplish the strategy and actions discussed in Chapter V. The objectives and needed tasks are listed according to priority, chronological schedules are provided, and estimated costs are included in a comprehensive 5-year plan. See Table 9. An annual budget of about $1,225,000 per year is requested to accomplish the recommended program.

The Management Plan consists of four primary objectives. These are:

I. contain ruffe to present sites and prevent further introductions or distributions.

II. Increase biological understanding of the ruffe.

III. Reduce populations or ruffe at present sites.

IV. Conduct research on control methods that specifically target ruffe.

The Task Force strongly urges that implementation of the highest priority tasks or sub-tasks begin in 1992 and that the remaining facets of the program be added as quickly as possible.

The Task Force feels that a window of opportunity exists during which it is still possible to contain the ruffe and to prevent colonization of additional waters. This window is expected to remain open for only 2 more years. If actions are not taken during this time, any future control efforts would be greatly increased in scope, complexity, and cost. The likelihood of success would also be greatly reduced.

Although presently available technologies are not adequate to eradicate ruffe from a large area such as the Duluth/Superior Harbor, the Task Force feels that containment is biologically feasible on a cost effective basis.

The Management Plan utilizes all known control techniques and places emphasis on those measures that will have the least effect on the environment. In instances where the use of toxicants might be needed, the use would be limited in scope and involve the most selective compounds available.

Since the Great Lakes constitute international waters, a bi-national effort is required in any ruffe management plan. Eight states, one province, Tribal agencies, and the U.S. and Canadian federal governments must be active participants. Two options are available for coordinating execution of the Management Plan.

One option would be to have a single agency designated to coordinate the program, to collect and report on changes in the status or ruffe, to receive funds, and to oversee dispersal of monies to cooperators. The logical coordinator under this scenario would be the Great Lakes Fishery Commission.

A second option would be to establish separate U.S. and Canadian control programs - probably headed by the U.S. Fish and Wildlife Service and the Canadian Department of Fisheries and Oceans or the Ontario Ministry of Natural Resources.

Task Force members are about evenly divided concerning which option should be implemented. They feel that either option could be used effectively. The basic over-riding concern of the Task Force relates to which option can be implemented most quickly, not which agency should head the control effort. It is imperative that the management plan be initiated in 1992 and fully onerational in 1993.

The bi-national aspects of the Management Plan will require separate funding initiatives. International negotiations associated with having the Great Lakes Fishery Commission serve as the coordinating agency could delay initiation of the Management Plan by as much as 18 months. However, once the procedural requirements were satisfied, the GLFC could move quickly and freely to accomplish the various tasks and sub-tasks.

Having federal agencies, such as the Fish and Wildlife Service in the U.S. and the Department of Fisheries and Oceans or Ontario Ministry of Natural Resources in Canada, lead the programs would mean less delay in implementing containment/control efforts. Funding would probably be simpler at the outset. Delegation of authority to control ruffe would probably be easier to accomplish under this scenario. Disadvantages would concern problems associated with interagency distributions of funds and complex regulations related to contracted research. In light of the need for expeditious action, the Task Force would support designation of the USFWS and CDFO or OMNR as lead agencies in either a permanent or interim capacity. Responsibility for the control program could later be transferred to the Great Lakes Fishery Commission if so desired.

Table 9. Management Plan for Ruffe in the Great Lakes (1992-1996)

OBJECTIVES & TASKS	PRIORITY	1992	1993	1994	1995	1996	COST ($000's)	WHO SHOULD DO IT
OBJECTIVE I: CONTAIN RUFFE TO PRESENT SITES								
TASK I.A. Prevent Further Introductions								
1. Require ballast exchange/treatment before entering Great Lakes	1	<-------	ON-	GOING	-------	------->	-	Shipping industry, USCG, Can. CG
2. Press for application of ballast water requirements to other waters	1		-	-	-	-	?	USCG, Can. CG, shipping industry
TASK I.B. Halt Interlake & Intralake Transport of Ruffe in Ballast Water								GLFC
1. Educate shipping industry about ruffe problem, how ruffe can be transported, and need for their assistance	1	10	10				10/yr	GLFC
2. Contact shipping industry for input on ballast water procedures and changes in intake design. Press for program of voluntary cooperative compliance	1	25	25				25/yr	GLFC
3. Encourage shipping industry to avoid loading ballast water in harbors at Duluth and Thunder Bay	1	-	-	-	-	-	-	GLFC
4. Prevent uptake in Duluth-Thunder Bay freight car ferry ballast system	1	-	-	-	-	-	-	Owner, USCG, FWS-Reg. 3, DFO, OMNR, Can. CG
5. * Develop alternative techniques for avoiding transport	1		50	50			50/yr	GLFC, USCG, Can. CG
6. Research ways to sterilize ballast water or eliminate ruffe in ships	1		20	20			20/yr	GLFC Contract
7. Assess effectiveness of all measures to prevent dispersal	1		-	-	-	-	-	All Agencies
TASK I.C. Have Ruffe Declared Injurious Exotic Species	1	-						All Agencies
TASK I.D. Treat Lower Reaches of Amnicon, Iron, Brule and Kaministiquia Rivers with Lampricides to Assess Impacts on Ruffe	1	100	100				25	FWS-Reg. 3, FWS-LaX

Table 9. Management Plan for Ruffe in the Great Lakes (1992-1996) Continued

OBJECTIVES & TASKS	PRIORITY	1992	1993	1994	1995	1996	COST ($000's)	WHO SHOULD DO IT
TASK I.E. Establish Surveillance System to Watch For and Report New Colonizations by Ruffe Throughout the Great Lakes		-	-	-	-	-	-	All Agencies, FWS-Reg.3
1. Establish an office to rconduct a program of surveillance for ruffe in areas likely to be colonized.	1	165	90	90	90	90	90/yr	All Agencies, FWS-Reg.3
2. Develop stand-by response capability to deal with new colonizations and to coordinate any control (eradication) efforts	2	25	25	25	25	25	25/yr	All Agencies, FWS-Reg.3
TASK I.F. Educate Anglers and the Public How to Identify Ruffe and Create Public Awareness of Problem								
1. Place posters at bait shops, boat landings, access areas, beaches and parks	1		-	-	-	-	-	All Agencies
2. Develop public information program for presentation at schools, conservation clubs, civic organizations, etc.	1	-	-	-	-	-	-	All Agencies
3. Develop news articles, television videotapes, brochures, etc. for use by media publicizing need to control ruffe, provide periodic updates and progress reports	1	-	-	-	-	-	-	All Agencies
TASK I.G. Treat Any New Occurrences ASAP After Discovery Using Every Available Method	1		50	50	50	50	50/yr	FWS-Reg. 3
OBJECTIVE II: INCREASE BIOLOGICAL UNDERSTANDING OF RUFFE								
TASK II.A. Continue On-Going Assessments at Duluth and Thunder Bay	1	150	150	150	150	150	150/yr	All Agencies
TASK II.B. Define Areas of Ruffe Concentrations by Season, Water Temperatures, Spawning, Light Intensity, Etc.	1	50	50				50/yr	GLFL
TASK II.C. Complete Risk Analysis Involving Ruffe and Perch/Walleye Fish Communities	1	10	10				10/yr	OMNR & GLFL
TASK II.D. Define Mechanisms of Competition Between Ruffe and Endemic Species	2	50	50	50	50	50	50/yr	GLFL

Table 9. Management Plan for Ruffe in the Great Lakes (1992-1996) Continued

OBJECTIVES & TASKS	PRIORITY	1992	1993	1994	1995	1996	COST ($000's)	WHO SHOULD DO IT
OBJECTIVE III: REDUCE POPULATIONS OF RUFFE AT PRESENT SITES								
TASK III.A. Continue Stocking and Evaluation of Enhanced Predator Program in Duluth Harbor	1	50	50	50	50	50	50/yr	MN DNR & WI DNR GLIFWC
TASK III.B. Begin Physical Removal by Trawling in Duluth Harbor		-						
1. Test various gear designs & excluder devices	1	100						FWS-Reg. 3, GLIFWC
2. Conduct operational fishing effort	1	100	300	300				FWS-Reg. 3
3. Test other harvest techniques such as traps, baits, etc.	2	50	50					FWS-Reg. 3
4. Evaluate effectiveness of physical removal efforts	2			50	50			All Agencies
TASK III.C. Clarify Agency Attitudes Regarding Use of Chemical Toxicants Under "Emergency Need" Situations, Obtain Emergency Use Permits	1	-					-	OMNR,DFO, FWS-LaX, GLIFWC
TASK III.D. Test Available Fish Toxicants Against Ruffe Under Field Conditions	1	50					50	FWS-LaX
TASK III.E. Determine Effects of Fish Toxicants Against Non-Target Fish Species Under Field Conditions	1	50					50	FWS-LaX
TASK III.F. Clarify Additional Safety Studies by Regulatory Agencies to Obtain Permission to Use Chemical Toxicants Under Non-Emergency Status	2	-					-	OMNR,DFO, FWS-LaX, GLIFWC
TASK III.G. Register Available Fish Toxicants for Use in Ruffe Control	3			250	250	250	250/yr	FWS-LaX
TASK III.H. Treat Areas Having Concentrations of Ruffe with Selective Toxicant	3			250	250	250	250/yr	FWS-Reg. 3
TASK III.I. Evaluate Effectiveness of Control Efforts	3			50	50	50		All Agencies
TASK III.J. Formulations Development of Bottom Toxicants	3		50	100	100	100		FWS-LaX

Table 9. Management Plan for Ruffe in the Great Lakes (1992-1996) Continued

OBJECTIVES & TASKS	PRIORITY	1992	1993	1994	1995	1996	COST ($000's)	WHO SHOULD DO IT
OBJECTIVE IV: CONDUCT RESEARCH ON CONTROL METHODS								
TASK IV.A. Research Methods to Neuter or Produce Sterile Male Fish That Do Not Reduce Libido or Alter Normal Breeding Behavior	1	50	50	50	50	50	50/yr	FWS-Lax GLFC Contract
TASK IV.B. Test Available Chemosterilants on Surrogate Species of Fin Fish	1		40	40	40	40	40/yr	FWS-LaX
TASK IV.C. Use Models to Calculate Ratio of Sterile to Normal Males Needed and Number of Years for Program Per Area Release	3					-	-	FWS-LaX
TASK IV.D. Clarify Regulatory Positions of State, Provincial, Tribal and Federal Agencies Regarding Release of Sterile Males	3					-	-	GLFC
TASK IV.E. Release Chemosterilized Ruffe at Newly Colonized Sites on Experimental Basis	3					150	150	OMNR FWS-Reg. 3
TASK IV.F. Develop New Selective Fish Toxicants for Ruffe Control								
1. Test new candidate compounds	4			25	25	50		FWS-LaX
2. Conduct mammalian, safety, and environmental studies	5					250	250/yr	FWS-LaX
3. Register effective new fish toxicants	5					250	250/yr	FWS-LaX
	TOTALS	1,035	1,170	1,600	1,230	1,855		

VII. SUMMARY OF RESEARCH NEEDS

BIOLOGY OF RUFFE

1. Conduct a risk assessment of the potential impact of ruffe on yellow perch and walleye in the Great Lakes.
2. Determine annual populations of ruffe and endemic species at Duluth and Thunder Bay.
3. Study movements, behavior, and distribution of ruffe on a diel and seasonal basis.
4. Document changes in fish community structure and determine causes and mechanisms of changes.
5. Elucidate reproduction and early life history of ruffe.
6. Develop a model of the impacts of the top down predator control strategy on ruffe and native fishes through use of bioenergetics.

RANGE EXPANSION

1. Document movements and new colonizations by ruffe.
2. Determine mechanism by which ruffe reached new locations if range expansion occurs.

ECONOMIC EFFECTS

1. Develop annual records of harvests of economically important fishes in the Great lakes and study trends.
2. Determine the role ruffe may have played in any significant changes in the harvest.

PREDATOR ENHANCEMENT

1. Assess predator/prey relations between ruffe and endemic predators.
2. Develop long term techniques for marking walleye at small sizes and at stocking.
3. Continue population assessments of predators, especially of stocked and native components.

PHYSICAL REMOVAL

1. Develop trawl design specifically for taking ruffe.
2. Develop excluder devices to minimize by-catch of predator species.
3. Determine nature and extent of the by-catch and its impact on the survival of endemic species.
4. Test other types of gear and attractants or repellents.
5. Conduct behavior and distribution studies on ruffe in response to removal.

CHEMICAL CONTROL

1. Conduct field trials on ruffe using available piscicides.
2. Determine potential impacts of fish toxicants on endemic species.
3. Develop special formulations of fish toxicants to target concentrations of ruffe.
4. Develop techniques to hold, chemosterilize, and transport ruffe.
5. Conduct safety studies required by EPA.

OTHER CONTROL METHODS

1. Develop effective method for sterilizing finfish without destroying libido.
2. Evaluate potential of introducing a lethal genetic factor into ruffe populations.
3. Evaluate irradiation, triploidy, and other techniques as possible control methods.

BALLAST CONTROL

1. Develop alternate methods to eradicate live organisms in ballast water.
2. Determine condition of grates over ballast intake ports and incidence of broken or missing grates.
3. Identify "high risk" ports by developing a map of port destinations of vessels that visit Duluth and Thunder Bay harbors.

Appendix A. Task Force Members and Contributors

TASK FORCE MEMBERS

G. Burton Ayles
Regional Director - Fisheries & Habitat Management
CAR - DFO
Department of Fisheries and Oceans
Freshwater Institute
501 University Crescent
Winnipeg, Manitoba R3T 2N6
CANADA

John Christian
Assistant Regional Director for Fisheries
and Federal Assistance
U.S. Fish & Wildlife Service
Federal Building - Fort Snelling
Minneapolis, MN 55111

Margaret R. Dochoda
Great Lakes Fishery Commission
2100 Commonwealth Boulevard
Suite 209
Ann Arbor, MI 48105-1563

Richard L. Hassinger
Fish & Wildlife Division
Minnesota Department of Natural Resources
Box 20
500 Lafayette Road
St. Paul, MN 55155

Bryan A. Henderson
Ontario Ministry of Natural Resources
Fisheries Research Section
P.O. Box 5000
Maple, Ontario 6LA 1S9
CANADA

Neil E. Kmiecik
Great Lakes Indian Fish & Wildlife Commission
P.O. Box 9
Odanah, WI 54861

Fred P. Meyer
518 No. 1st Street
LaCrescent, MN 55947

Robert A. Peoples, Jr.
U.S. Fish & Wildlife Service
Division of Fish & Wildlife Management Assistance
1849 "C" Street, N.W.
820 ARL SQ
Washington, D.C. 20240

Jan E. Riffe, Director
National Fisheries Research Center
P.O. Box 818
La Crosse, WI 54602-0818 ,

Jon G. Btanley, Director
National Fishery Research Center-Great Lakes
1451 Green Road
Ann Arbor, MI 48105

Michael J. Talbot
Wisconsin Department of Natural Resources
101 South Webster Street
P.O. Box 7921
Madison, WI 53707

Robert Thomson, Lake Manager
Lake Superior Management Unit
Ontario Ministry of Natural Resources
435 South James Street
Thunder Bay, Ontario P7C 5G6
CANADA

CONTRIBUTORS

Terry D. Bills
National Fisheries Research Center
P.O. Box 818
La Crosse, WI 54602-0818

Thomas R. Busiahn
U.S. Fish & Wildlife Service
Ashland Fishery Resources Office
2800 East Lakeshore Drive
Ashland, WI 54806

Margaret R. Dochoda
Great Lakes Fishery Commission
2100 Commonwealth Boulevard
Suite 209
Ann Arbor, MI 48105-1563

Richard L. Hassinger
Minnesota Department of Natural Resources
Fish & Wildlife Division
Box 20, 500 Lafayette Road
St. Paul, MN 55155

Bryan A. Henderson
Ontario Ministry of Natural Resources
Fisheries Research Section
P.O. Box 5000
Maple, Ontario 6LA 1S9
CANADA

Neil E. Kmiecik
Director, Biological Services Division
Great Lakes Indian Fish & Wildlife Commission
P.O. Box 9
Odanah, WI 54861

Charles C. Krueger
206D Fernow Hall
Cornell University
Ithaca, NY 14853

Fred P. Meyer
518 No. 1st Street
LaCrescent, MN 55947

Terry J. Morse
U.S. Fish & Wildlife Service
Marquette Biological Station
446 East Crescent Street
Marquette, MI 49855

Derek H. Ogle
Minnesota Cooperative Fish & Wildlife Research Unit
University of Minnnesota
St. Paul, MN 55108

Dennis Pratt
Wisconsin Department of Natural Resources
1705 Tower Avenue
Superior, WI 54880

William J. Rendall
Minnesota Department of Natural Resources
Box 20
500 Lafayette Road
St. Paul, MN 55155

James H. Selgeby
U.S. Fish & Wildlife Service
Ashland Biological Station
2800 East Front Street
Ashland, WI 54806

John Spurrier
Minnesota Department of Natural Resources
5351 North Shore Drive
Duluth, MN 55804

Appendix B. Minnesota Department of Natural Resources Commissioner's Order No. 2331.

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

COMMISSIONER'S ORDER NO. 2331

REGULATIONS PROHIBITING THE TAKING,
POSSESSION AND TRANSPORTATION OF
WHITE PERCH AND RIVER RUFFE STATEWIDE, AND
PROHIBITING THE TAKING OF FISH
FOR BAIT PURPOSES FROM LAKE SUPERIOR
AND PORTIONS OF THE ST. LOUIS RIVER

Pursuant to authority vested in me by Minn. Stat. § 97A.045, subds. 1 and 4, and other applicable law, I, Joseph N. Alexander, Commissioner of Natural Resources, hereby prescribe the following regulations prohibiting the taking, possession and transportation of white perch and river ruffe statewide and prohibiting the taking of fish for bait purposes from Lake Superior and portions of the St. Louis River.

Section 1. The taking, possession and transportation of white perch and river ruffe is prohibited statewide.

sec. 2. The taking of any fish for bait purposes from any of the waters described in this section is prohibited:

All Minnesota waters of Lake Superior and all waters of the St. Louis River downstream of the Fond du Lac Dam in St. Louis and Carlton Counties, including any and all outflows, estuaries, streams, creeks or waters adjacent to or flowing into the above-described waters.

Dated at Saint Paul, Minnesota, this & day of

Qu7, 1989.

JOSEPH N. ALEXANDER, Commissioner
Department of Natural Resources

APPROVED AS TO FORM AND EXECUTION

HUBERT H. HUMPHREY, III
Attorney General

~~C. PAUL FARACI~~
~~Deputy Attorney General~~
JAMES M. SCHOESSLER
Assistant Attorney General

Appendix C. Wisconsin NR 20.03, NR 20.10, NR 23.08, and NR 26.27.

ORDER OF THE STATE OF WISCONSIN NATURAL RESOURCES BOARD RENUMBERING, AMENDING AND CREATING RULES

....

IN THE MATTER of renumbering s. NR 20.03(1) (c)4., (d)6. and (e)4. and 5., amending ss. NR 20.10(1), 21.04(2), (3) and (11), 21.08, (intro.), 23.08, and 26.27 and creating s. 20.03(1)(c) 4., (d)6. and (e)4., Wisconsin Administrative Code, pertaining to bait dealers and sport fishing in outlying waters, Wisconsin-Minnesota boundary waters, Wisconsin-Michigan boundary waters and inland waters

FM-50-88

....

Analysis Prepared by Department of Natural Resources

Statutory authority: ss. 29.085, 29.137(5), 29.174(1), (2)(a) and (3) and .227.11(2), Stats.
Statutes interpreted: ss. 29.085 and 29.174(2)(a), Stats.

The rules:

1. Prohibit the harvest by nets or traps of any fish except smelt and shiners in Lake Superior and its tributaries upstream to the first dam or natural fish barrier.

2. Further restrict angling on the St. Louis River by delaying the opening of the angling, season for walleyes and northern pike from the Saturday nearest May 1 to the Saturday nearest May 15, and for muskellunge from the Saturday nearest May 1 to the Saturday nearest Memorial Day. The rules also establish a 15-inch minimum length limit on walleyes and increase the minimum length limit for muskellunge from 30 to 36 inches and reduce the daily bag limit on walleyes from 6 to 2 and on northern pike from 5 to 2.

3 Further restrict sport angling on the Nemadjl river, Allouez bay, Little Pokegama bay, Pokegama bay, and Kimballs bay, Douglas county, by delaying the opening of the angling season for walleyes and northern pike from the first Saturday in May to the Saturday nearest May 15, establishing a 150-inch minimum length limit on walleyes, increasing the minimum length limit for muskellunge from 32 to 36 inches, and reducing the daily bag limit on walleyes and northern pike from 5 to 2, and

4. Extend the refuge period on the St. Louis river, Douglas county, from the period of March 1 to May 15, to the period of March 1 to May 18.

SECTION 1. NR 20,03(1)(c)4., (d)6. and (e)4. and 5. are renumbered to be NR 20.03(1)(c)5., (d)7. and (e)5. and 6., respectively.

SECTION 2. NR 20.03(1)(c)4., (d)6. and (e)4. are created to read:

Kind of fish and locality	Open season (both dates inclusive)	Daily bag limit	Minimum length (inches)
(c) WALLEYE AND SAUGER			
4. The Nemadji river, Allouez bay, Little Pokegama bay, Pokegama bay, and Kimballs bay, Douglas county	Saturday nearest May 15 to March 1	2 in aggregate	15
(8) NORTHERN PIKE (See also NR 20.04)			
6. The Nemadji river, Allouez bay, Little Pokegama bay, Pokegama bay, and Kimballs bay, Douglas county	Saturday nearest May 15 to March 1	i	No size limit
(e) MUSKELLUNGE (includes hybrid muskellunge)			
4. The Nemadji river, Allouez bay, Little Pokegama bay, Pokegama bay, and Kimballs bay, Douglas county	Saturday nearest Memorial Day to March 1	1	26

SECTION 3. NR 20,10(1) is-amended to read:

NR 20.10 MINNOW NETS, TRAPS AND SEINES. (1) USE LIMITED. (a) No fish other than smelt and shiners may be taken with nets or traps from Lake Superior or its bays or tributaries except as provided in ss. NR 20.05(2)(q) and (3), and 21.06(1)(d) or in waters upstream from the following:

1. Ashland county - Bad river - oCor;eer Falls
   Brunsweiller river - state hwy. 13
   Marengo river - State hwy. 13
   Potato river - Guerney Falls
   White river - White river dam
2. Bayfield county - Iron river - Orienta dam
   Little Sioux river - falls in NE1/4 of the NE1/4, section 13. township 49 north, range 5 west.
   Siskiwit river - falls in SW1/4 of the NW1/4, section 35, township 51 north, range 6 west.
3. Douglas county - Amnicon river - Amnicon Falls .
   Black river - Big Manitou Falls
   Middle river - U.S. hwy. 2
   Poplar river - U.S. hwy. 2

4. Iron county - Montreal river - Superior Falls dam

(b) No ~~persons-shall~~ person may set, use, or operate any minnow seine, minnow dip net or minnow traps in any of the inland waters of this state for taking, catching, or killing fish of any variety, other. than as specified in this section.

SECTION 4. NR' 21.04(2), (3) and, (11) are amended tu read:

Kind of fish and locality	Open season (both dates inclusive;	Daily bag limit	Minimum length (inches)
(2) WALLEYE AND SAUGER			
(a) ~~St.-Louis-river-and~~ St. Croix river downstream to Prescott	Saturday nearest May 1 to March 1	6 in aggregate	No size limit
(b) Mississippi river from Prescott downstream	Continuous	6 in aggregate	No size limit
(c) St. 'Louis river	Saturday nearest May 15 to March 1	2 in aggregate	15
(3) NORTHERN PIKE			
(a) ~~St.-Louis-river-and~~ St. Croix river downstream to Prescott	Saturday nearest May 1 to March 1	5	No size limit

Kind of fish and locality	Open season (both dates inclusive)	Daily bag limit	Minimum length (inches)
(b) Mississippi river Prom Prescott downstream	Continuous	5	No size limit
(c) St. Louis river	Saturday nearest May 15 to March 1	2	No size limit
(11) MUSKELLUNGE			
(a) ~~St. Louis river,~~ St. Croix river and Mississippi river from Prescott downstream	Saturday nearest May 1 to March 1	i	50 inches
(b) St. Louis river	Saturday nearest Memorial Day to March 1		36 inches

SECTION 5. **NR 21.08(intro.)** is amended to read:

NR 21.08 **MINNOW** NETS AND **TRAPS.** Except as Provided in ss. NR 20.09(2)(g) and (3) and 21.06(l)(d), no fish other than smelt and shiners mav be taken with nets or traps in the St. Louis river. Only those minnow seines, minnow dip nets, cast nets, minnow traps or crayfish scoops described below and operated in the manner specified may be used for the taking of minnows: (23.11,29.137,29.085)

SECTION 6. NR 23.08 is amended to read:

NR 23.08 MINNOWS. No person may sell, trade or barter minnows taken from Wisconsin-Michigan boundary waters, Except as provided in ss. NR 20:09(2)(g) and (3), and 21.06(1)(d) and 23.07, no fish other than smelt and shiners may be taken with nets or traps in the Montreal river downstream from the Superior Falls dam.

SECTION 7, NR 26.27(i) is amended to read:

NR 26.27 FISH REFUGES, ~~(1)~~ The following described areas are hereby created and established as fish refuges and ~~it shall be unlawful for any~~ no person ~~or persons to~~ may take, disturb, catch, capture, kill or fish for fish in any manner from March 1 to May ~~15~~ 18 each year, both dates inclusive, in, on or along the following described water areas:

The foregoing rule was approved and adopted by the State of Wisconsin Natural Resources Board on ________________________

The rules shall take effect on the first day of the month following publication in the Wisconsin administrative register as provided in s. 227,22(2)(intro,), Stats.

Dated at Madison, Wisconsin ________________________

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

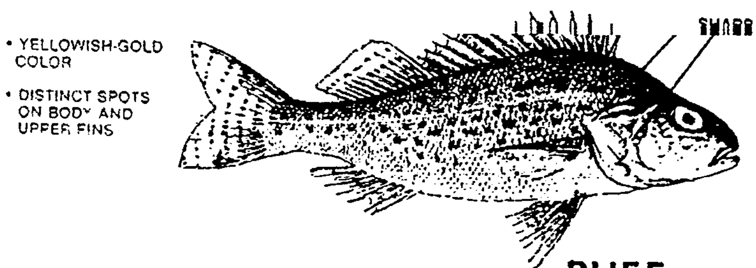
BY ________________________
Carroll D. Besadny, Secretary

(SEAL)

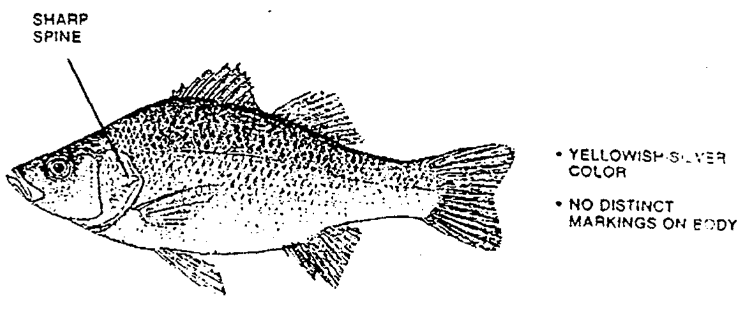
ATTENTION

EXOTIC FISH

THE FISH SHOWN BELOW HAVE BEEN FOUND IN THE ST. LOUIS RIVER BY DULUTH/SUPERIOR. THE WISCONSIN AND MINNESOTA DNR'S ARE LOOKING FOR THESE FISH. IF FOUND. TURN IN TO YOUR LOCAL DNR OFFICE OR DESTROY IMMEDIATELY. DO NOT TRANSPORT.



RUFF



WHITE PERCH

STATS OF MINNESOTA

DEPARTMENT OF NATURAL RESOURCES

COMMISSIONER'S ORDER NO. 2372

REGULATIONS FOR THE TAKING OF FISH FROM THE MINNESOTA-WISCONSIN BOUNDARY WATERS AND THE TRANSPORTING OF SUCH FISH IN MINNESOTA BY HOLDERS OF WISCONSIN LICENSES; SUPERSEDING COMMISSIONER'S ORDER NO. 2337

Pursuant to authority vested in me by Minn. Stat. §§ 97A.045, 97C.395, 97C.401 and other applicable law, I, Joseph N. Alexander, Commissioner of Natural Resources, hereby prescribe the following regulations for the taking *of* fish from the Minnesota-Wisconsin boundary waters hereinafter described, and the transporting of such fish in Minnesota by holders of Wisconsin licenses.

Section 1. Subdivision 1. For the purposes of this order, the terms defined in this section shall have the meanings ascribed to them.

SUM. 2. "Boundary waters" means all. those portions of the Mississippi River and Lake Pepin extending from the mouth of the St. Croix River to the southern boundary of the State *of Minnesota and* lying between the Burlington Northern main railroad tracks on the Wisconsin side and the Chicago, Milwaukee, St. Paul and Pacific railroad tracks on the Minnesota side, including all sloughs and backwaters, bays and newly extended water areas lying between said railroad tracks; all those portions of Lake St. Croix and the St. Croix River as far as the same lie along the boundary between the State of Minnesota and the State ot Wisconsin; and all those portions of the St. Louis River, including St. Louis Bay and Superior Bay, as far as tie same line along the boundary between said states downstream to an imaginary line drawn between the northwest bank of the Nemadji River where it forms a junction with Superior Bay and the southvest bank of the Superior entry channel where it forms a junction with Superior Bay.

SUM. 3. 'Rough fish' includes carp, dogfish, redhorse, sheepshead , suckers, eelpout, garfish. buffalo fish, quillback, mooneyes, goldeyes, shad, eels, bullheads, amur car? and catfish, except that only catfish' 15 inches or over in length when taken under commercial license with commercial fishing gear downstream from the Taylors Falls Dam shall be considered rough fish.

SUM. 4. 'Minnows' shall include all members of the minnow family (Cyprinidae) except carp and goldfish: shad, mudminnows, willow cat and all members of the sucker family (Castostomidae) not over 12 inches in length; and bullheads, ciscoes, herring, whitefish, goldeyes and mooneyes not over 7 inches in length.

SUM. 5. "Game fish' means all species and sire categories not included as rough fish and minnows, and catfish taken by angling.

SUM. 6. 'Commercial operator' means any person properly licensed to take fish in the Minnesota-Wisconsin boundary waters by means of a net, Set line, Or other legal equipment for the purpose of sale.

Subd. 7. "minimum length" means the length of a fish measured in a straight line from the tip of the nose to the end of the tail fin. When measuring turtles, it means the length of the dorsal surface of the carapace (top shell) measured from side to side across the shell at midpoint.

Sec. 2. The taking and possession of fish of any species covered by this order from the Minnesota-Wisconsin boundary waters is prohibited except as herein permitted or as otherwise expressly authorized pursuant to law.

Sec. 3. SPORT FISHING.

Subdivision 1. Subject to all applicable laws and regulations not inconsistent herewith, the species of fish hereinafter named may be taken in the Minnesota-Wisconsin boundary waters, or such portion thereof as is specified, by angling during the time specified for each species in the following table.

Species and Open Season	Daily & Possession Limits
Large and small Mouthed Bass St. Louis River and St. Croix River Saturday preceding Memorial Day to March 1 Mississippi River and Lake Pepin Continuous	5 in aggregate 12 inch minimum size limit St. Louis River and St. Croix River upstream of Highway 70 near Pine City. 14 inch minimum downstream of Highway 70 and Mississippi River including Lake Pepin.
Walleye and Sauger St. Louis River and St. Croix River Saturday nearest May 1 to	6 of either or both in aggregate, except in St. Louis Rive

Sunfish and Blueqills Continuous	25
Perch Continuous	25
Bullheads Continuous	No limits
Paddlefish (Spoonbill Catfish)	No open season
Rough fish Continuous	No limits
Muskellunge [minimum site limit - 36 inches) Saturday nearest Memorial oay to March 1	1
All other species	Govcrncd by inland regulations of state in which taken

subd. 2. Any species of fish not specified in this order may be taken and possessed only as authorized for the inland waters of the state in which taken.

SUM. 3. Except as hereinafter provided, no person shall use or operate more than two lines or two poles with one line attached to each pole, one line or one pole with more than two baits, or a single treble hook, or fish with an unattended line, or take fish by snagging. Any fish hooked (snagged) in any part of the body except the mouth shall immediately be unhooked and returned to the water. It shall be lawful to take fish by trolling from a motor driven &at,

sailboat or other boat while such boat is in motion and by use of tvo tip-ups not more than 400 feet from the angler.

Subd. 4. No person shall buy or sell or offer to buy or sell any fish taken by angling in the Minnesota-Wisconsin boundary waters, except that rough fish may be bought and sold at any time.

Subd. 5. No person shall fish from any point or from any boat within the area from the Taylors Falls (St. Croix Falls) dam on the St. Croix River to 50 feet downstream from the pier in the center of the river. Such closed areas shall be marked with suitable signs or buoys designating the closed areas.

Subd. 6. Buildings, vehicles, tents, fish houses or similar encLosures may be used on the ice for fishing purposes on the boundary waters. All such enclosures or shelters shall be removed from the ice on or before March 1 of each year. Portable shelters may be used after March 1 by persons actively engaged in fishing, but such shelters shall be removed daily when not in use. The door of any such enclosure or shelter shall be equipped with a latch which will' permit the door to be readily opened from the outside at all times while the enclosure or shelter is occupied. Residents of Minnesota and Wisconsin may angle bank-to-bank from fish houses, shelters or enclosures and shall comply with the law and regulations of their respective states relating to licensing and identification of fish houses. Residents of other states shall comply with the law and regulations of the state in which they hold nonresident licenses.

Subd. 7. No person shall use a spear, dip net, or bow and arrow in any manner at any time for the purpose of taking any game fish. or have in possession or under control any fish spear, spring gaff, or similar device in a fish house. Rough fish may be taken by means of a spear, dip net not to exceed 24 inches in diameter, or bow and arrow except crossbow, from sunrise to sunset only, from the Saturday nearest May 1 to March 1. No person shall have in possession on the water or immediate banks of the water any spear except during the open season for spearing.

subd. 8. Any fish taken and not released freely into the water immediately after capture shall be considered to be in possession and part of the bag limit, and may not be released after such possession.

subd. 9. Any person permitted by law to take fish by angling may take, possess, and transport turtles and tortoises for personal use in any manner except by explosives, drugs, poisons, lime and other deleterious substances or by the use of traps, turtle hooks and nets other than landing nets, except that snapping turtles of the species Chelydra serpentina may not be possessed in excess of a limit of 3 nor of a size where the width including the curvature measured from side to side across the shell at the midpoint is less than 10 inches.

subd. 16. No person shall fish in the St. Louis River from Fond du Lac Dam downstream approximately one-half mile to the Minnesota-Wisconsin boundary cable at any time. No person shall fish in the St. Louis River from the Minnesota-Wisconsin boundary cable downstream to the Highway 23 bridge from March 1 through May 18 each year.

Sec. 4. MINNOWS.

Subdivision 1. Subject to all other applicable laws and regulations not inconsistent herewith, minnows may be taken in the Minnesota-Wisconsin boundary waters except the St. Louis River by seine, dip net, cast net or trap, and may not be possessed in excess of 12 dozen, except that holders of a minnow deaier's license (Minn. Stat. § 97A.475, subd. 26) say possess minnows without limit and holders of commercial set line licenses may possess dead minnows without limit for set line bait purposes. The taking of minnows for bait purposes is prohibited in the St. Louis River.

Subd. 2. No person shall take minnows with any seine exceeding 50 feet in length or 5 feet in depth, nor any seine which has mesh exceeding one-half inch, stretch measure, nor any cast net which exceeds 7 feet in diameter or has mesh exceeding one-half inch, stretch measure.

Subd. 3. No person shall take minnows with any dip net which has a frame exceeding 6 feet in diameter or 6 feet on each side, or which has a net more than 4 feet deep.

SUM. 4. No person shall take any minnows with any trap exceeding 24 inches in length or 16 inches in diameter, or with a trap which has an opening at its throat exceeding 1-1/2 inches in diameter. All traps used in taking minnows shall have securely attached thereto a metal Label or tag bearing in the English language the name and address of the operator thereof. All minnow traps shall be raised and the minnows removed therefrom at least once every 24 hours.

Subd. 5. Carp minnows may be transported for sale or for bait only by boat or other floating conveyance and only on the boundary waters where taken.

Sec. 5. S&T LINES.

Subdivision 1. Subject to all other applicable laws and regulations not inconsistent herewith, rough fish may be taken from April 1 to October 31, both dates inclusive, in the Mississippi River and Lake Pepin by licensed commercial operators with the use of set lines or trot lines.

Subd. 2. No person shall set or operate more than 4 set lines (trot lines), with not to exceed 100 hooks attached to each line or 400 hooks in the aggregate, nor set set lines in any manner which obstructs any type of boat travel in more than three-fourths the width of any bay, slough or channel.

Subd. 3. No person using set lines (trot lines) shall use any frogs, game fish, or bullheads of any size, or parts thereof, for bait.

subd. 4. All set lines (trot lines) shall have attached the metal identification tag provided with the license. At one end of every set line (trot line) there shall be a white flag, not less than 16 inches square, the upper end of which shall extend at least two feet above the water, which shall be legibly numbered with figures at least 3 inches in height corresponding with the number of the license authorizing the use of such set line, or a non-metallic buoy of permanent buoyancy and of at least one gallon displacement of white or yellow color bearing the markings described above.

Subd. 5. Set lines shall be lifted and fish removed at least once every 24 hours and shall be set or lifted only between one hour before sunrise and one-half hour after sunset.

Sec. 6. **SEINES.**

Subdivision 1. Subject to all other applicable laws and regulations not inconsistent herewith, rough fish may be taken by commercial operators with the use of seines of any size, only in those portions of the Minnesota-Wisconsin boundary waters lying south of the U. S. Highway 8 bridge at St. Croix Falls.

Subd. 2. *From* (October 1 to April 30, both dates inclusive, not sore than 100 pound? of catfish of a length *not* less than 15 inches may be taken in any day with the use of seines.

Subd. 3. No seine haul shall be made without the operator first having notified the local conservation officer and area fisheries supervisor of the intent to do so.

Sec. 7. GILL NETS.

Subdivision 1. Subject to all other applicable laws and regulations not inconsistent herewith, rough fish may be taken in the Mississippi River and Lake Pepin by commercial operators with the use of gill nets having a mesh measuring 3-1/2 inches oc larger, bar or square measure, measured while in use and inside the knots. NO gill netting shall be used as a drag seine or drift net at any time.

SUM. 2. Every gill net shall be attached to an end stake, pole, or anchored buoy bearing a white flag, not less than 16 inches square, the upper end of which shall extend at least 2 feet above the water or ice at all times when the net is set oc in operation, which shall be legibly numbered with figures at least 3 inches in height corresponding with the number of the license authorizing the use of such nets.

SUM. 3. All gill nets shall be lifted and emptied of fish at least once every 24 hours when set in open water and at least once every 48 hours when set under the ice, unless otherwise authorized by the Commissioner of Natural Resources or authorized agent.

SUM. 4. No gill net shall be set in such a manner as to obstruct any type of boat travel in more than three-fourths the width of any slough, bay or channel.

sec. 8. All fish nets are subject to tagging requirements as set forth in Commissioner's Order No. 1473.

Sec. 9. No person other than the license holder or a licensed helper shall tend commercial fishing gear.

Sec. 10. NO commercial net or set line may be used or operated in any waters within 900 feet below any dam on the Mississippi River.

Sec. 11. All game fish taken in any commercial fishing operation shall be returned to the water immediately when they appear in the fishing operation. The provisions of Commissioner's Order No. 1365 shall not apply.

Sec. 12. The Commissioner of Natural resources or an authorized agent may require any operator of any seine, set line, or gill net to cease the fishing operations when it has been determined that such operations are detrimental to game fish or other protected wildlife. Commercial gear, unless otherwise specified, may not be used or operated in Pool 4 of the Mississippi River between Mile Post 780 and 797 from March 1 through May 31, both dates inclusive.

Sec. 13. The Director of the Division of Fish and Wildlife may authorize the use of such other nets under contract or permit as may be agreed upon between the States of Minnesota and Wisconsin.

Sec. 14. No net or set line shall be set, lifted, hauled or operated in any manner between one-half hour after sunset and one hour before sunrise of the following morning, except for the purpose of completing a seine haul with the permission of the Commissioner of Natural Resources or an authorized agent.

Sec. 15. No licensed commercial operator or any crew member or any person in the &at shall have in possession any game fish or sport angling equipment while operating licensed commercial gear or while traveling to or from the place of operation of such gear.

Sec. 16. NO person shall have in possession or under control any unlicensed commercial fishing gear or a basket trap (slat net), trammel net, or wooden trap which might be used for the purpose of taking, catching or killing fish in any of the counties bordering the boundary waters as specified in this order.

Sec. 17. All commercial operators required to make reports under the law shall report to the Commissioner of Natural Resources, on forms to be furnished by the Commissioner of Natural Resources, such information pertaining to the commercial fishing activities as may be required by the commissioner.

Sec. 18. TURTLES AND TORTOISES.

Turtles and tortoises taken incidental to licensed commercial fishing operations or by persons possessing traps as permitted by Minn. Stat. § 97A.475, subd. 36 may be possessed and sold without limit subject to the following restrictions.

Subdivision 1. Snapping turtles (Chelydra serpentina) may not be possessed if the width including the curvature measured from side to side across the shell at the midpoint is less than 10 inches.

Subd. -2. Traps constructed of webbing shall be of mesh size *not less* than 3 inches bar measure or 6 inches extension measure. Traps constructed of wire mesh shall have at least one square opening in the top panel measuring at least 4 inches on a side and one of the same dimension near the bottom in each of the side panels.

Subd. 3. Traps must be set in water shallow enough to place the top no deeper than 3 inches below the water surface.

SUM. 4. Traps shall be checked and serviced at intervals not exceeding 48 hours.

Subd. 5. No licensee may operate more than 40 traps.

Subd. 6. When in use, each trap shall have affixed a metal or plastic tag, visible from above, bearing in the English language the name, address and license number of the operator. Such tags shall be of metal or plastic and shall be of dimensions no less than 2-1/2 inches in length by 5/8 inches in width.

Sec. 19. No carp or amur carp taken in commercial fishing shall be returned to the water.

Sec. 20. Commercial operators licensed in either Minnesota or Wisconsin may land their nets, set lines or turtle traps on either the Minnesota or Wisconsin banks of those parts of Lake Pepin, the Mississippi River, Lake St. Croix and the St. Croix River in which the particular nets or set lines landed are permitted under this order. No commercial operator shall operate in the bayous and sloughs beyond the banks of the Mississippi River, Lake Pepin, Lake St. Croix or the St. Croix River, except in the state of residence.

Sec. 21. Crayfish and mussels shall be taken from

COMMISSIONER'S ORDER NO. 2372

March 1 Mississippi River and Lake Pepin Continuous	2 walleye. 15 inch minimum size limit for walleye on the St. Louis, St. Croix, Mississippi Rivers, and Lake Pepin except no size limit in Pool 3 of the Mississippi River between the Red Wing Dam and Hastings.
Northern Pike St. Louis River and St. Croix River Saturday nearest May 1 to March 1 Mississippi River and Lake Pepin Continuous	5, except St. Louis River 2 northern pike
Catfish Continuous	10
Sturgeon All waters above the Red Wing Dam (minimum size limit - IS inches) Saturday nearest May 1 to October 31	1
All waters below the Red Wing Dam Rock (Lake) Sturgeon (minimum size limit - 45 inches) Saturday nearest May 1 to October 31	1
Shovelnose (Hackleback) Sturgeon (no minimum size limit) continuous	10
White Bass and Yellow Bass Continuous	25
Crappies Continuous	25
Rock Bass Continuous	25

Minnesota-Wisconsin boundary waters in accordance with inland regulations.

Sec. 22. Subdivision 1. Residents of Minnesota and Wisconsin holding resident angling licenses from their respective states, and residents of states other than Minnesota and Wisconsin holding nonresident angling licenses from either state, may fish in the Minnesota-Wisconsin boundary waters. Only one angling license and the limits allowed on that license are valid on Minnesota-Wisconsin boundary waters. Commercial operators must have appropriate licenses as required by law.

Subd. 2. Where regulations differ between states, the exercise of the more liberal regulations is limited to persons licensed by the more liberal state and confined to the territorial waters of the more liberal state. The provisions of this subdivision do not apply to fish houses, which are subject to Sec. 3, subd. 6 of this order.

Sec. 23. Any lawful holder of a resident or nonresident angling license or commercial fishing license from the State of Wisconsin, having lawfully taken fish in the Minnesota-Wisconsin boundary waters, may land therewith on the Minnesota side of said waters, subject to the provisions of Sections 20 and 22 hereof, and may transport such fish to the State of Wisconsin by the most convenient, practicable route over the following described highways or roads in the State of Minnesota or any part thereof:

COMMISSIONER'S ORDER NO. 2372

Beginning at the intersection of the south line of the state with state Trunk Highway (STH) 26: thence northerly on STH 26 to the junction thereof with U.S. Hwy. 16: thence northerly on U.S. Hwy. 16 to the junction thereof with U.S. Hwy. 61; thence northerly on U.S. Hwy. 61 to the junction thereof with STH 95: thence northerly on STH 95 to the junction thereof with U.S. Hwy. 8: thence easterly on U.S. Hwy. 8 to the St. Croix River at Taylors Falls; also all highways or roads lying between the above-described route and said boundary waters.

All highways or roads reaching any bridge, ferry or landing on the St. Croix River at or north of Taylors Falls or on the St. Louis River where said rivers, respectively, form part of said boundary waters, and lying within 2 miles of any part of said rivers,

Sec. 24. Commissioner's Order No. 2337 is hereby superseded.

Dated at St. Paul, Minnesota, this 7 day of May, 1990.

STEVEN G. THORNE, Deputy Commissioner
Department of Natural Resources

APPROVED AS TO FORM AND EXECUTION

HUBERT H. HUMPHREY, III
Attorney General

C. PAUL FARACI
Deputy Attorney General

STATE OF MINNESOTA
DEPARTMENT OF STATE
FILED
MAY 8 - 1990
Secretary of State

Appendix E. Commissioner’s Order No. 2372, Section 3, Subdivision 1.

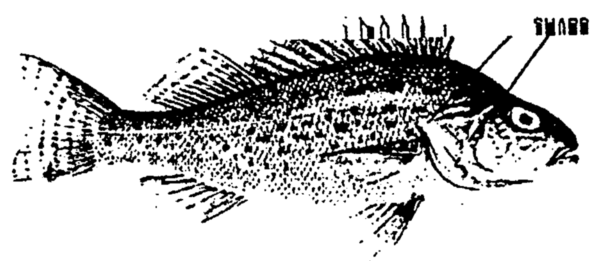
218 723 4880
NOV-05-1991 14:15 FROM French River TO Central Office P.02

ATTENTION

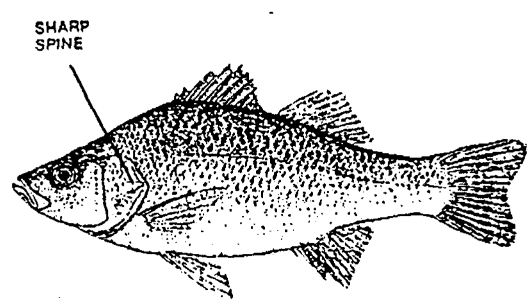
EXOTIC FISH

THE FISH SHOWN BELOW HAVE BEEN FOUND IN THE ST. LOUIS RIVER BY DULUTH/SUPERIOR. THE WISCONSIN AND MINNESOTA DNR’S ARE LOOKING FOR THESE FISH. IF FOUND. TURN IN TO YOUR LOCAL. DNR OFFICE OR DESTROY IMMEDIATELY. DO NOT TRANSPORT.

- YELLOWISH-GOLD COLOR
- DISTINCT SPOTS ON BODY AND UPPER FINS



RUFF



- YELLOWISH-SILVER COLOR
- NO DISTINCT MARKINGS ON BODY

WHITE PERCH

Appendix F.

DRAFT

PROCEDURES FOR THE HOLDING OF RUFFE (*Gymnocephalus cernus*) FOR RESEARCH OR DISPLAY PURPOSES

Justification and Proposal for the Importation or Transfer of Ruffe from Sources of Wild Stock

A full written proposal must be made available to the appropriate provincial/state authorities at least 6(?) months prior to any proposed importation or transfer of ruffe fish or eggs from known sources of wild stock in the Great Lakes basin. Ruffe fish or eggs can be imported or transferred only for research or informational display purposes. Proponents are advised that importations or transfers of ruffe require compliance with provincial/state regulations or policies.

The importation/transfer proposal must include the following information.

a) Source of fish or eggs.
b) Location where the research will be conducted or the display facility will be established.
c) A brief description of the research to be conducted, or rationale for the display.
d) Description of the quarantine/display unit including: number of tanks to be used, tank capacity, safeguards against escape or accidental release of fish or eggs, number of fish or eggs to be held, duration of research/ display, method of effluent treatment, where the effluent will be discharged.

Protocols for a Research Quarantine Facility

These protocols are designed to prevent the escape or accidental release of live ruffe fish or eggs into surface waters.

Design

The proponent must submit plans for quarantine facilities to the appropriate provincial/state authorities for review and approval 6(?) months in advance of the proposed importation or transfer.

-An approved quarantine facility is an enclosed culture system which permits the isolation and maintenance of fish while preventing their introduction into surface waters. The fish must be reared under conditions which adhere to accepted guidelines for the care and use of experimental animals. All effluent must be chlorine treated (S-10 ppm available Cl for 15 mins) in a retention tank designed to prevent the escape or accidental release of live fish or eggs. The treatment system must be equipped with a fail-safe backup system which ensures continuous operation. The quarantine facility must be physically separated from all other fish stocks and completely enclosed with solid walls and ceiling to prevent entry by birds, domestic and wild animals, or unauthorized personnel.

Operation and Maintenance

1) Personnel. Access to the quarantine facility must be restricted to authorized personnel only. These personnel should be properly trained in operational procedures to ensure that no live fish or eggs leave the quarantine unit.

2) Records. Daily records of fish/egg introductions and mortalities must be maintained and provided for inspection. At the conclusion of the research all fish and/or eggs must be accounted for, destroyed and disposed of. A final quarantine report must be provided to the provincial/state authorities at the conclusion of the research.

3) Disposal of Dead Fish or Eggs. Dead fish or eggs must be placed directly into a container of 10% formalin for a minimum of 24 hrs prior to disposal. Picked eggs must not be disposed of directly down a drain because of the possibility of releasing viable fertilized eggs into surface waters.

4) Holding Mature Fish. If the sex of the fish is known or can be determined! the mature fish should be held separately to prevent spawning while the fish are being held. If spawn is to be collected, the fish should be tagged after spawning to identify the sexes. If the broodfish are to be retained after spawning, the sexes should be held in separate tanks.

Protocol for a Display Tank

These protocols are designed to prevent the escape or accidental release of live ruffe fish or eggs into surface waters.

Design

The proponent must submit plans for display tank(s)/facility(ies) to the appropriate provincial/state authorities for review and approval 6(?) months in advance of the proposed importation or transfer.

An approved display tank must be enclosed within a structure that permits public viewing, but prevents the introduction of fish of eggs into surface waters. The fish must be reared under conditions which adhere to accepted guidelines for the care and use of experimental animals. All effluent must be chlorine treated (5-10 ppm available Cl for 15 mins) in a retention tank designed to prevent the escape or accidental release of live fish or eggs. The treatment system must be equipped with a fail-safe backup system which ensures continuous operation. The display tank(s) must be physically separated from all other fish stocks and completely enclosed with solid walls and ceiling to prevent entry by birds, domestic and wild animals. The display area should be designed for the public to easily view the fish; but the tanks should be constructed and situated to prevent tampering or the removal of fish by unauthorized personnel.

Operation and Maintenance

1) Personnel. Direct access to the fish being held in display tanks must be restricted to authorized personnel only. These personnel should be properly trained in the tank operational procedures to ensure that no live fish or eggs are released from the display tank.

2) Records. Daily records of fish/egg introduction and mortalities must be maintained, and provided for inspection. When the fish are no longer required for display purposes all fish must be accounted for, destroyed and disposed of. A final report must be provided to the provincial/state authorities giving notification of the termination of the display.

3) Disposal of Dead Fish or Eggs. Dead fish or eggs must be placed directly into a container of 10% formalin for a minimum of 24 hrs prior to disposal.

If the fish are no longer required for display purposes they must be destroyed by an overdose of anesthetic and disposed of by incineration or burial. If eggs are present they must be collected and placed in a container of 10% formalin for a minimum of 24 hours prior to disposal by incineration or burial.

4) Holding Mature Fish. If the sex of the fish is known or can be determined, the mature fish should be held separately to prevent spawning while the fish are on display.

Prepared by Brian Souter, Fisheries & Oceans, Winnipeg (Manitoba), Canada