Nonindigenous Fish in Inland Waters: Response Plan to New Introductions

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Executive Summary

Over the past two decades, introductions of nonindigenous fish to North America have increased rapidly (Mills et al. 1993; OTA Report 1993). In Minnesota waters of Lake Superior, ruffe *Gymnocephalus cernuus*, round goby *Neogobius melanostomus*, threespine stickleback *Gasterosteus aculeatus*, and white perch *Morone americana* have been found in recent years. The rudd *Scardinius erythrophthalamus* and the tubenose goby *Proterorhinus marmoratus,* both present in the Great Lakes Basin, will undoubtedly enter Minnesota waters in the near future. Grass carp *Ctenopharyngodon idella* have been found in Minnesota waters of the Mississippi River. Recent introduction of nonindigenous fish to Minnesota's inland waters have the potential to cause severe impacts on native and naturalized fish communities and their habitats.

This plan describes the Minnesota Department of Natural Resources' goals to prevent and manage newly introduced nonindigenous fish species in Minnesota's inland waters. The primary objectives of this plan are to curtail introduction and dispersal of nonindigenous fish into Minnesota's inland waters and to manage them in an environmentally sound manner. To achieve this objective, the MNDNR will pursue the following goals in collaboration with other federal, state, and tribal entities:

1) Develop a coordinated response to inland nonindigenous fish introductions;
2) Prevent new introductions of nonindigenous fish into inland waters;
3) Contain new nonindigenous fish species found in inland waters to existing locations; and
4) Manage nonindigenous fish in inland waters.

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Introduction

Over the past two decades, introductions of nonindigenous fish to North America have increased rapidly (Mills et al. 1993; Courtney 1984; OTA 1993). Ruffe *Gymnocephalus cernuus*, round goby *Neogobius melanostomus*, three spine stickleback *Gasterosteus aculeatus*, and white perch *Morone americana* have been found in recent years in Minnesota waters of Lake Superior. The rudd *Scardinius erythrophthalamus* and the tubenose goby *Proterorhinus marmoratus*, both present in the Great Lakes Basin, are expected to enter Minnesota waters in the near future. Grass carp *Ctenopharyngodon idella* have been found in Minnesota waters of the Mississippi River. The introduction of nonindigenous fish to Minnesota's inland waters could have severe impacts on native and naturalized fish communities and their habitats. Potential impacts include elimination of native fish species, reduction of growth and survival of native fish species, and changes in the structure of the native fish community and their habitat (Moyle et al. 1986). Additionally, sport and commercial fisheries have been reduced or closed due to nonindigenous fish introductions.

This plan describes the Minnesota Department of Natural Resources' goals for management of newly introduced nonindigenous fish species in Minnesota's inland waters. The primary objectives of the MNDNR's nonindigenous fish response plan for inland waters are to: 1) prevent or curtail introduction and dispersal of nonindigenous fish into Minnesota's inland waters; and 2) manage them in an environmentally sound manner where they occur. To achieve this, the MNDNR will work toward meeting the following goals: 1) develop a coordinated response to inland nonindigenous fish introductions; 2) prevent new introductions of nonindigenous fish into inland waters; 3) contain new nonindigenous fish species in inland waters to existing locations; and 4) manage nonindigenous fish in inland waters.

Potential Nonindigenous Fish Invaders

The following are descriptions of each of the nonindigenous fish species of concern to Minnesota at the present time. This is not an exhaustive list. Included are those species with the highest risk of introduction into Minnesota's inland waters. It is presumed that additional nonindigenous fish invasions will occur in the future. They will be treated as indicated in this plan.

Ruffe *Gymnocephalus cernuus*

Ruffe, a small Eurasian percid, were first identified in Lake Superior in 1987. It was presumably introduced through the ballast water from transoceanic vessels (Pratt et al. 1992). Since they were first collected in 1986, ruffe have become a significant component of the fish community in the St. Louis River estuary of Lake Superior and have continued to expand their range (Lindgren et al. 1997; Slade et al. 1994; Selgeby 1993). Currently, ruffe have not spread to inland Minnesota waters. They have been found in Duluth Harbor and along the North Shore of Lake Superior to Taconite Harbor.

The ruffe is designated a prohibited exotic species by the MNDNR. Ruffe have the potential to severely impact native fish communities because they mature quickly, have a high reproductive capacity, avoid predation, and adapt to a wide variety of environments. The fish is aggressive and has no commercial or sport fishing value (Jensen et. al 1996). After ruffe were introduced in Loch Lomond, Scotland, the perch *Perca fluviatilis* population apparently declined while the ruffe population increased (Maitland et al. 1983; Maitland and East 1989; Maitland 1990). This trend has recently reversed.

In Europe, ruffe generally mature at age two or three. They spawn between mid-April and July, depending on location, water temperature, and habitat (Collete et al. 1977; Hokanson 1977; Neja 1988). In its native range, ruffe have been found to spawn intermittently, laying eggs in two or more batches (Koshelev 1963; Travkina 1971; Fedorova and

Vetkasov 1974; Kolomin 1977; Craig 1987; Neja 1988; Jamet and Desmolles 1994). Histological examination of ovaries taken from ruffe in the Duluth harbor suggests that these fish are also batch spawners, which gives them a survival advantage over native species because their spawning success is affected less by unfavorable environmental variables (Leino and McCormick 1996). Other recent work suggests that ruffe only spawn once in a season with older fish spawning in advance of younger fish (Brown et. al 1998). Additional information is forthcoming in the International Ruffe Symposium (1997), as well as recent masters thesis at UM-Duluth and UW-Superior.

Ruffe can thrive in a wide range of temperatures and habitats. In Europe, ruffe are found in fresh and brackish waters and in all types of lakes and low gradient rivers. Ruffe are more tolerant of eutrophic conditions than yellow perch *Perca flavenscens* and are capable of feeding in water below the photic zone (Bergman 1988). Ruffe and yellow perch exhibit overlapping diets, especially in early life stages. The ruffe is considered an opportunistic feeder, preying first on fish eggs and zooplankton, then switching to chironomids and other macroinvertebrates. Most Minnesota game fish appear to avoid ruffe as few are found in their stomach contents. Ruffe have been blamed for declines of up to 50% in whitefish populations *Coregonus* spp. in Russia, supposedly because of predation on whitefish eggs (Sterligova and Pavloskiy 1984).

Yellow perch are the principle prey for many popular sport fish species in Minnesota. Because ruffe have the potential to compete with yellow perch and other fish, they are considered a high risk when reaching State inland waters.

White Perch *Morone americana*

White perch are distributed along the Atlantic coast of North America (Scott and Crossman 1973), usually in brackish waters. Presumably, the species gained access to Lake Ontario via the Oswego River (Scott and Christie 1963). It is now found throughout the Great Lakes, including Minnesota waters of Lake Superior. White perch are designated as a prohibited exotics species in Minnesota.

White perch spawn in the spring, generally in shallow water. They are a very fecund species and have become dominant in the fish community in Lake Ontario despite the presence of other established species (Scott and Crossman 1973). White perch are potential competitors with native fish species for both food and habitat, and may also prey upon them. White perch become piscivorous by the time they are 25 cm long, which potentially places them in competition with yellow perch throughout most of their life stages (Sierszen et al. 1996). In waters where white perch have become established, they often become stunted and undesirable to the sport angler.

Round Goby *Neogobius melanostomus*

Round goby are a small bottom-dwelling fish native to the Black and Caspian Seas. Both round goby and tubenose goby *Proterorhinus marmoratus* were first discovered in 1990 in North America in the St. Clair River near Detroit, Michigan (Jude et al. 1992). Presumably, goby were introduced through ballast water discharge from transoceanic vessels. Tubenose goby have not been as successful as round goby, which spread into all the Great Lakes except Ontario. Three round goby specimens were captured in the St. Louis River estuary of Lake Superior during 1995 and 1996. None were collected in 1997.

Round goby prefer riprap, breakwaters, rocky or coarse gravel inshore areas with abundant interstitial spaces for escape cover. Round goby migrate to deeper water in winter (Miller 1986). Their diet consists of macroinvertebrates including amphipods, polychaetes, chironomids, bivalves, and occasionally, small fish and fish eggs (Jude et al. 1992). Round goby can grow to larger sizes (215-250mm) than native sculpin *Cottus* spp., darters *Etheostoma* spp., and logperch *Percina caprodes* which occupy similar habitats. This size differential, plus the round goby's ability to spawn every 18-20 days, up to six times per year (Jude et al. 1992), appears to give this species a competitive edge over native fish.

Round gobies have affected mottled sculpin populations in the St. Clair River, Michigan, and southern Lake Michigan. Other species that might be affected include logperch and lake sturgeon. If round goby invade the Mississippi River basin, impacts to darters and other benthic species may be significant.

Round goby are poised for expansion into the Mississippi River through the Calumet River of the Chicago Waterway, which is the link between Lake Michigan and the Illinois River. This is the same route that zebra mussels took to reach the Mississippi River and eventually lead to infestations in Lake Pepin.

Round goby are effective invaders because they: 1) are aggressive fish that feed voraciously and compete for spawning sites with some native fish; 2) have a well developed sensory system that enables them to feed in complete darkness; 3) can survive in degraded water quality conditions; and 4) are able to spawn over a long period of time thereby taking advantage of optimal temperatures and feeding conditions (Marsden and Jude 1995).

Rudd *Scardinius erythrophthalamus*

Rudd, a member of the minnow family (Cyprinidae), are native to western Europe and Asia. They were intentionally stocked into Wisconsin waters during the 1920s and into the Hudson River drainage in 1936 (MacNeill 1993). Escape from waters where rudd were introduced, extensive propagation as a bait species in southern states, and subsequent importation by other states have resulted in numerous inland introductions of rudd in at least 11 states. The rudd has not yet been collected in Minnesota waters. It has the potential to be introduced and spread in Minnesota waters as it is widely used as a bait species and can be misidentified as a golden shiner *Notemigonus crysoleucas*, another bait species. Illegal bait minnow importation from surrounding states with rudd infested waters has the potential to introduce rudd into Minnesota waters.

Young rudd consume macroinvertebrates, zooplankton, and occasionally small fish. Mature rudd feed mainly on submerged aquatic plant material and are inefficient processors of the available food supply. They inhabit weedy shoreline areas of lakes and rivers, and can adapt to a wide range of environmental conditions, including poor water quality. Rudd could affect Minnesota inland waters by: 1) increasing the nutrient loading due to its inefficient means of processing plant material; 2) depleting aquatic vegetation and potentially reducing the reproductive success of native fish species using near shore areas for spawning and nursery sites; 3) competing with native fish species for food and habitat in juvenile stages; and 4) disrupting established predator/prey relationships.

Threespine Stickleback *Gasterosteus aculeatus*

The range of threespine stickleback in North America extends along the east coast from Chesapeake Bay north to Hudson Bay and Baffin Island, and along the west coast from Alaska and British Columbia to California (Scott and Crossman 1973). In addition, this species is commonly found in Lake Ontario, but had not been found above Niagara Falls before 1979. Since 1980, threespine stickleback have been found in lakes Huron, Michigan, and Superior. In 1994, threespine stickleback were found in LTV Steel's cooling water in Taconite Harbor on Lake Superior. It was later found in the St. Louis Estuary.

Although the threespine stickleback does not appear to be a great threat to Minnesota inland waters, it could compete with the native ninespine stickleback *Pungitius pungitius*. Both species have similar diets, which include zooplankton, oligochaetes, and chironomids (Bigelow and Schroeder 1953; Stedman and Bowen 1985). Spawning sites differ slightly between the two species. Threespine stickleback inhabit more open areas and build nests on sandy substrate near vegetation, while the native ninespine stickleback prefer more vegetated areas (Greenbank and Nelson 1958; Hagen 1967; Wootton 1976). Although the two species have coexisted in Lake Ontario for years, studies on competitive

interactions are lacking. However, recent research on competitive interactions in co-existing brook stickleback populations indicate that three-spine stickleback can reduce this species.

Nonindigenous Fish Management Plan

The nonindigenous fish management plan for inland waters has four goals.

The first goal is to develop and maintain a coordinated public and private response plan to new inland introductions of nonindigenous fish species.

The second goal is to prevent new introductions of nonindigenous fish into inland waters. Preventing nonindigenous introductions is more cost effective as it reduces efforts for control and inland fish management.

The third goal is to contain new nonindigenous fish species found in inland waters to existing locations. New introductions of nonindigenous fish species in Minnesota's inland waters will be documented so that a coordinated response can be developed to contain them.

The fourth goal is to manage nonindigenous fish once they have been found in Minnesota inland waters. Management begins with routine surveys of the population and associated aquatic communities. Where possible, management should include controlling or eradicating harmful nonindigenous fish populations in an ecologically sound manner. Management also includes research to improve inland nonindigenous fish management (control) in Minnesota.

Predator enhancement has been tried and evaluated as a management technique to control the ruffe population in the St. Louis River estuary. In 1988, the MNDNR, Wisconsin DNR, and the USFWS agreed to attempt to increase predator numbers by implementing restrictive harvest regulations on walleye and northern pike. In addition to these regulatory changes, a stocking program for walleye, muskellunge, and northern pike was initiated. Initial results indicate that, from 1988-1990 the ruffe population increased, while yellow perch abundance declined (Selgeby 1993). During this time period, walleye and northern pike abundance remained relatively stable. These results indicated that the predators in the St. Louis River estuary were unable to check the expansion of the ruffe population. However, MNDNR index netting from 1992-1996 has shown a significant decline in ruffe catch-per-unit-of-effort, suggesting other more complicated predator-prey interactions (Lindgren et al. 1997).

The St. Louis River estuary is an open system, where fish movement into Lake Superior could effect the overall predator density in the St. Louis River estuary. It may be more feasible to control ruffe or other nonindigenous fish species by predator enhancement in an inland water body. In Russia, stocking of pike perch in a closed inland waterway was effective in reducing ruffe populations (Mikheev, personal communication 1997). Predator population manipulations should be targeted at species with the greatest potential for controlling the nonindigenous species. It is important to note that applying the wrong predator management strategy may actually enhance conditions for the nonindigenous species by reducing the abundance of important prey species that may occupy a niche similar to that required by the nonindigenous fish.

Fish toxicants (piscicides) are widely used to eradicate all or portions of a fish community, in order to reestablish desirable fish species which may then exist free from predation, competition, or interference by undesirable fish (Marking 1992). At the present time, four piscicides are registered by the U.S. Environmental Protection Agency (EPA) for use in the United States. Approved compounds include the general fish toxicants antimycin and rotenone, and the selective fish toxicants 3-trifluoromethyl-4-nitrophenol (TFM) and Bayluscide. Antimycin and rotenone are approved piscicides for use in Minnesota waters, and TFM is in the process of re-registration for use in the Great Lakes. A description of each of the piscicides listed above, along with its potential use as a control method for nonindigenous fish in inland waters is found in Appendix A.

Chemical control of nonindigenous fish populations in inland water bodies depends upon the distribution and abundance of the nonindigenous fish species, the size and nature of the infested water body, and selection of a piscicide based upon its selectivity to the species of concern. Management alternatives using chemical control are: 1) site-specific treatment of an isolated population; 2) species specific treatment; and 3) eradication by lake-wide reclamation. A nonindigenous fish action plan summarizing management options is in Appendix B.

Goal 1: Develop a coordinated response to inland nonindigenous fish introductions.

Objective 1: Develop and maintain a coordinated response plan to inland nonindigenous fish introductions.

Problem: There are many parties with potential interest in harmful exotic species management. If introductions of nonindigenous fish in inland waters occur, it will be important to keep appropriate parties apprised of these infestations, seek their input regarding management actions, and include their perspective in developing regulations for prohibited or regulated nonindigenous fish.

Strategy A: Identify a contact person within the MNDNR Fisheries Section for nonidigenous species.

Action 1. Assign a person from MNDNR Section of Fisheries staff to serve as the nonindigenous fish contact. This person will be responsible for the reporting of nonindigenous fish, and will have other responsibilities as stated throughout this plan. An important first step in this plan is to determine what species of nonindigenous fish are of concern. This could be addressed by using a rating system similar to one developed to rate introductions from the aquarium trade. (Appendix C).

Strategy B: Identify constituent groups concerned with nonindigenous fish and establish opportunities for their involvement.

Action 1. Identify constituent groups concerned or potentially affected by nonindigenous fish management and regulations.

Action 2. Establish opportunities for involving interested and affected groups in future activities such as research, monitoring, education, regulations, and management of nonindigenous fish in inland waters. Potential groups and their roles and responsibilities could include the following:

Indian Reservations - monitoring, education
U.S. Fish and Wildlife Service - education, funding source for state and interstate aquatic nuisance species plans.
U.S. Geological Survey, Biological Resources Division - research, data base
MN Sea Grant - research, outreach, education, report confirmation
MNDNR Fisheries - report confirmation, monitoring, management, research, regulation, education
MNDNR Ecological Services (Exotic Species Program) - education, regulation, report confirmation
University of Minnesota - research, education
Minnesota Lake Associations - monitoring, education
Shoreland Owners - monitoring, education
Citizens - monitoring, education
Environmentalists - monitoring, education
Bait dealers - monitoring, education
Aquarium and water garden trade - monitoring, education
Angling and Conservation Groups - monitoring, education

Goal 2: Prevent new introductions of nonindigenous fish into inland waters

Objective 1: Prevent accidental introductions of nonindigenous fish into Minnesota inland waters.

Problem: Ecologically harmful nonindigenous fish species, specifically identified in this plan, are present in Minnesota's border waters, but have not yet been found in any inland waters. These fish could enter Minnesota's inland waters from recreational activities such as boating and angling, or through the com-

mercial activities of the bait industry, aquarium trade, commercial fishing, or private aquaculture.

Strategy A: Increase public awareness regarding nonindigenous fish.

Action 1. Develop and distribute informational materials about nonindigenous fish species. The MNDNR's Exotic Species Program, MN Sea Grant, and others have developed informational materials about several harmful exotic species, including the ruffe, rudd, and round goby. The MNDNR distributes this information at a variety of events, including the State Fair, sport shows, and during presentations to lake associations, schools and other groups. In addition to these informational items, materials regarding state regulations about nonindigenous fish should be distributed to licensed bait dealers, private fish hatcheries, commercial fishing operators, aquarium stores, licensed guides, Minnesota Department of Agriculture, National Park Service, and DNRs of neighboring states and provinces. The MNDNR will continue to distribute these materials and will work with MN Sea Grant and the USFWS to update them as necessary.

Action 2. Post informational signs at all public and private accesses on infested waters. In 1997, the MNDNR developed an "Exotics Species Alert" sign for infested waters and a "Help prevent the spread of . . ." for all waters. Both signs were produced and distributed to Trails and Waterways offices. DNR accesses along the Duluth harbor have been posted with these signs warning about the ruffe, white perch, and round goby. As new harmful nonindigenous fish species invade Minnesota waters and are the basis for designating infested waters, stickers for these species will be available and added to the "Exotic Species Alert" signs.

Action 3. Include a listing of new nonindigenous fish and infested waters in the Fishing Regulations Synopsis. The Fishing Regulations Synopsis contains information about harmful exotic species present in Minnesota waters. This should be updated yearly to include new nonindigenous fish species and infestations in inland waters.

Strategy B: Use regulations to prevent the spread of nonindigenous fish into inland waters.

Action 1. Restrict bait harvest in infested waters. The state of Minnesota established regulations in 1989 prohibiting the taking of any fish for bait purposes from Minnesota waters of Lake Superior and the lower St. Louis River watershed. In 1996, the MNDNR adopted permanent rules that prohibit the taking of wild animals from infested waters for bait (M.R.6216.4000).

Action 2. Prohibit the importation, taking, possession, introduction, and transportation of live harmful (see Strategy A, Action 3) nonindigenous fish species. Several statutes and rules are in place to address the above actions regarding harmful nonindigenous fish. Minnesota Statute 84D.05 prohibits the possession, importation, purchase, sale, propagation, transport, and introduction of a prohibited exotic species, except as further specified in the statute. Minnesota Rule 6216.0250 designates prohibited exotic species.

Action 3. Enforce state regulations on importation and transportation of harmful nonindigenous fish species, as well as minnow harvest from infested waters.

Action 4. Prohibit hobby aquarists from collecting activities in infested waters.

Objective 2. Prevent intentional introductions of nonindigenous fish into inland waters.

Problem: Ecologically harmful nonindigenous fish species present in Minnesota's border waters have the potential to enter inland waters by intentional means. Possible motives for intentional introductions include, but are not limited to means of aquatic vegetation control (grass carp), bait, aquaculture, and aquarium trade activities.

Strategy A: Use the regulatory process to review proposed intentional introductions of nonindigenous fish species.

Action 1. The intentional introduction of "regulated exotic species" is only allowed in unique situations under permit from the DNR (see Minnesota Rules adopted under M.S. 84D). Proposed introductions of "unlisted aquatic species" must follow the review process required by statute (MS 840.06) and proposed Minnesota Rule 6216.0290 (Appendix D).

Strategy B: Prosecute unlawful intentional introductions of nonindigenous fish.

Goal 3: Contain new nonindigenous fish species in inland waters to existing locations.

Objective 1: Document distribution of nonindigenous fish species in inland waters.

Problem: The MNDNR lacks a protocol for reporting, confirming, and a database on the distribution of nonindigenous fish species.

Strategy A: Document historic distribution and new infestations of nonindigenous fish in inland and border waters.

Action 1: Develop an inland nonindigenous fish report database. New findings of nonindigenous fish will be added to the database. This database will be available on the GIS-based program that currently records the statewide distribution of other exotic species.

Strategy B: Confirm new reported findings of nonindigenous fish in inland and border waters.

Action 1: Confirm public reports of nonindigenous fish. If a nonindigenous fish specimen is collected in Minnesota waters, appropriate individuals will be invited to examine the specimen(s) to verify identification. Field sampling will be done to confirm nonindigenous fish reports. A list of the nonindigenous fish species of concern, habitat types, and recommended sampling gear has been developed (Table 1).

Action 2: Report inland and border waters nonindigenous fish findings to the USGS, Biological Resources Division. The MNDNR and MN Sea Grant regularly report new occurrences of exotic species in Minnesota to the USGS, Biological Resources Division in Gainesville, Florida. This notification should be done for inland and border waters nonindigenous fish findings after field confirmation. Enforcement notification may be pertinent in some instances.

Action 3: Update MDNR Section of Fisheries lake or stream management plans to include the exotic species management strategies.

Action 4: Update lists of infested waters in boating regulations, fishing synopsis, state statutes, and educational materials.

Objective 2: Contain new introductions of nonindigenous fish to known locations.

Problem: Once established, a nonindigenous fish species will likely spread into other inland waters. Likely human vectors include activities such as boating and angling, bait harvest, and commercial fishing. Natural movement of the species through connecting basins in the watershed is likely.

Strategy A: Reduce the risk of further inland dispersal of nonindigenous fish populations by humans.

Action 1: Prepare information packets, radio/television spots, local press releases, and provide public contacts using current information. A local press release should be prepared immediately upon documentation of a nonindigenous fish presence in any inland water body. Press releases should identify the infested water(s), explain the potential threats and potential control measures, and who to contact for more information. Support for management techniques will depend on public awareness. Public meetings should be held with shoreland owners, lake associations, resort associations, and other constituent groups to explain potential threats, answer questions, and to gain support for management options.

Action 2: Post public and private accesses on infested waters. "Exotic Species Alert" signs should be posted at public and private accesses on the infested water body

immediately upon documentation of the presence of a nonindigenous fish species.

Action 3: Prohibit bait harvest in the infested waters. Revise the official infested waters list through expedited emergency rule making so that Minnesota Rule 6216.4000, which prohibits harvest of bait from infested waters, applies to the new infestation.

Action 4: Regulate commercial fishing and private aquaculture activities in infested waters. Sport fishing for cisco with gill nets, commercial fishing, and private aquaculture activities should be restricted on water bodies infested with select nonindigenous fish. In 1996, the MNDNR adopted M.R. 6216.0400 which places restrictions on the use of equipment used for commercial fishing in infested waters. M. R. 6216.500 prohibits the transport of live fish from infested water, and regulates the disposition of water used to transport live fish from infested waters. M.R. 6216.0500, subp. 5 also prohibits the licensing of infested waters for aquatic farms or private hatcheries.

Action 5: The MNDNR may consider restricting sport fishing in infested waters.

Action 6: Prohibit water appropriation from infested waters. Minnesota Rule 6216.0500, Subp.4 prohibits the transport or diversion of water from infested waters except by permit.

Goal 4: Manage nonindigenous fish in inland waters

Objective 1: Survey and monitor the infested water body, connecting waters, and the surrounding watershed.

Problem: An effective control or eradication plan can not be initiated until the extent of an infestation is known. An assessment of the potential long term impacts to the ecosystem can not be determined without an evaluation of the native fish community before or at the time of the infestation.

Strategy A: Determine relative abundance and distribution of the nonindigenous fish in a timely manner.

Action 1: Determine relative abundance and distribution of nonindigenous fish in the water body. Once the presence of a nonindigenous fish is documented, relative abundance and distribution should be determined. The infested water body should be surveyed using the most effective sampling tools (Table 1). Subsequent management strategies will be dependent on the results of these investigations. Water bodies containing populations of nonindigenous fish will be regularly monitored to determine if the population is self sustaining.

Action 2: Determine relative abundance and distribution in the watershed. If a nonindigenous fish population is established throughout the water body, adjoining water bodies should also be surveyed.

Strategy B: Survey associated aquatic communities in the infested waters if control measures are considered.

Action 1: Survey the aquatic community in the infested water body. A survey of the entire fish community should be conducted before any control or eradication measures are considered. This will allow the MNDNR to evaluate the effects of nonindigenous fish, assess the occurrence of threatened or endangered species, and provide a baseline for evaluation of any control measures that are considered or implemented. Additional evaluation of aquatic communities (e.g., aquatic macroinvertebrates, zooplankton, aquatic macrophytes, etc.) may be needed if control or eradication measures are considered.

Objective 2: Control or eradicate inland populations of nonindigenous fish in an ecologically sound manner.

Problem: Once established, populations of nonindigenous species often experience rapid population growth. Limited opportunities may exist to manage populations of nonindigenous fish in inland waters through fish community alteration or chemical control.

Strategy A: Restrict the inland movement of nonindigenous fish populations.

Action 1: Use barriers and other technology as appropriate that will help slow or stop dispersal of nonindigenous fish. If a harmful species is found in a water body that has an inlet or an outlet, a physical barrier should be installed if it will prevent/slow migration to other waters. A barrier design that has been effective for sea lamprey may also prove to be effective for the ruffe (Great Lakes Fisheries Commission-Ruffe Task Force 1992). New physical designs to control round goby may be useful in future applications.

Strategy B: Use biological control to control nonindigenous fish populations.

Action 1: Consider the feasibility of attempting to control harmful nonindigenous fish populations by predator protection and enhancement.

Action 2: Consider the feasibility of attempting to control harmful nonindigenous species by intensive predator stocking. This management option should only be used in conjunction with predator protection (Action 1), and only if surveys indicate poor predator reproduction. Evaluation of these efforts, both before and after this enhancement, is required.

Strategy C: Attempt to control or eradicate inland nonindigenous fish populations with the use of piscicides.

Action 1: Consider attempting to control isolated populations of harmful nonindigenous fish by partial treatment with general piscicides. Widely distributed species will be difficult to control with toxicants, especially in moderate to larger sized water bodies. However, chemical treatment may be useful for limiting the size of a nonindigenous fish population in infested waters, especially if other control measures fail. If an isolated population of a new nonindigenous fish is found in a water body (e.g. found only in one bay of a small lake), partial or "spot treatment" of the infested water body could be conducted using rotenone. Rotenone is less expensive and more readily obtainable than either antimycin or the more selective piscicides. This is an important consideration in spot treatments, since the treatment should be done as soon as possible after the presence of a nonindigenous fish is documented, and before the species spreads throughout the water body. Rotenone is probably the best choice for spot treatments of species when the effectiveness of the more expensive selective piscicides is unknown.

Action 2: Consider attempting to control harmful nonindigenous fish populations by treatment with selective piscicides. Selective piscicides, such as TFM, Bayluscide, and antimycin (under certain conditions) could be used in certain situations to control nonindigenous fish. These chemicals could selectively control the targeted nonindigenous fish while having a minimal impact on non-target species. The potential use of TFM and antimycin for selectively controlling ruffe is described in Appendix A. This technique should be considered experimental if it is employed to control an ecologically harmful nonindigenous fish population in Minnesota inland water body.

Action 3: Consider attempting to eradicate harmful nonindigenous fish populations with a lake-wide (full) reclamation project. Lake-wide reclamation to eradicate a nonin-digenous fish population should be considered only after all other feasible control options have been considered, or the invading species could spread to other important waters. Since the cost of a reclamation project is directly related to the volume of the lake (Johnson 1978), it is more likely that lake-wide reclamation would be recommended for smaller lakes than larger lakes. Complete eradication of all fish species should be the goal. A thorough reconnaissance should be conducted to determine whether potential refuge areas such as dense stands of flooded timber or brush, floating bog shorelines, ground water spring flows, or seepage areas can be treated. Other factors to consider include whether any threatened or endangered species are present in the lake, the value of the existing fisheries, whether there is a potential for the nonindigenous fish species to spread to more valuable waters, and whether the lake has a history of complete winterkills.

Action 4. No action will be taken. There may be situations where no control

action on a nonindigenous fish population is ecologically or economically feasible and prudent. In these cases, research and monitoring of the nonindigenous fish in its new environment combined with public education to prevent further spread will be the only management actions taken.

Objective 3. Support and conduct research needed to improve inland nonindigenous fish management through experimental management.

Problem: Little information on the life history and ecology of nonindigenous fish in their new environments is available because they usually behave differently than in their native habitat. In addition, many of the management actions recommended for controlling nonindigenous fish populations have not been thoroughly tested and therefore should be considered experimental.

Strategy A: Conduct research on nonindigenous fish in an infested water body.

Action 1: Implement management actions as experiments. All management actions recommended under Objective 2 should be considered experimental. The disadvantage of a "natural experiment" research model such as this is that the potentially harmful nonindigenous fish is already present before research is implemented. However, historical base-line data for many lakes are available and useful.

Strategy B: Conduct research prior to inland nonindigenous fish infestation.

Action 1: Conduct research by use of a "controlled introduction." A controlled introduction, in which a nonindigenous fish is intentionally introduced into a "closed water body", allows study of the potential impacts of a nonindigenous fish population on the entire aquatic community and evaluation of the effectiveness of control measures. A major disadvantage of this procedure is that the introduction could serve as a source of dispersal for a nonindigenous fish. Another disadvantage is that results in a closed system may not be representative of what would happen in larger open systems. Further, a closed system may be difficult to find. This action may be very controversial with our constituency and should only be undertaken after careful evaluation of the risks. Such an experiment would only be undertaken where a complete lake wide reclamation was feasible.

Strategy C: Conduct and support research on the life history, ecology, and impacts of nonindigenous fish.

Action 1: Conduct research on the life history and ecology of a nonindigenous fish population in a newly infested inland water body. This option could apply when a water body is infested but no management control options are implemented. By conducting this type of research, important information on the life history and ecology of the nonindigenous fish in its new environment could be obtained that could be beneficial in controlling the species.

Action 2: Support and monitor research on harmful nonindigenous fish conducted by others.

Table 1. Summary of preferred habitats and recommended gear types for sampling potential nonindigenous fish species in Minnesota inland waters.

Species	Preferred Habitat	Suggested Gear Types
Ruffe	lakes: deeper waters during day, shallows/ littoral areas at night; turbid water/soft bottoms without vegetation rivers: slower moving water (ruffe can tolerate a wide range of habitats including eutrophic conditions)	3/8" mesh Fyke/trap nets 3/4"-1-1/2" bar mesh gill nets seining bottom trawls night electrofishing push net for night spring sampling
White Perch	can tolerate a wide range of habitats and are known to spawn over many different bottom substrates	Fyke nets/ trap nets - mesh size? 1½-2" bar mesh gill nets electrofishing? bottom trawls
Round Goby Tubenose Goby	goby are bottom dwelling fish, rock/gravel substrate with interstitial spaces for escape cover in littoral areas of lakes and rivers tubenose uses vegetation for spawning	SCUBA electrofishing/electrical grids bottle traps/minnow traps trot lines, angling (See Charlebois, et al. 1997) bottom trawls seining Windermere nets - modified
Rudd	lakes: quiet vegetated littoral areas rivers: vegetated backwater areas (rudd are seldom found in open water without vegetation)	trap nets seining electrofishing
Threespine Stickleback	shallow sandy bottoms near vegetation in lakes and rivers	seining electrofishing minnow traps

Note: These gear types are only suggestions. Any gear should be tried if the recommended types fail and introduction of a nonindigenous fish species is suspected or known.

Literature Cited

Bergman, E. 1988. Foraging abilities and niche breadths of two percids, *Perca fluviatilis* and *Gymnocephalus cernua*, under different environmental conditions. Journal of Animal Ecology 57:443-453.

Bigelow, H. B., and W. C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish and Wildlife Service Fisheries Bulletin 74, Volume 53: 577 pages, Washington D.C.

Bills, T. D., and M. A. Boogaard. 1994. Ruffe control research. Progress Report. National Biological Survey, La Crosse, Wisconsin.

Brown, W.P., J.H. Selgeby, and H.L. Collins. 1998. Reproduction and early life history of ruffe (*Gymnocephalus cernuus*) in the St. Louis River, a Lake Superior tributory. Journal of Great Lakes Research. 24(2):217-227.

Charlebois, P.M., J.E. Marsden, R.G. Goettel, R.K. Wolfe, D.J. Jude, and S. Rudnika. 1997. The round goby, *Neogobius melanostomas* (Pallas), a review of European and North American literature. Illinois-Indiana Sea Grant Program and Illinois Natural History Survey. INHS Special Publication No. 20. 76pp.

Collette, B. B., and P. Banarescu. 1977. Systematics and zoogeography of the fishes of the family Percidae. Journal of the Fisheries Research Board of Canada 34:1450-1463.

Courtenay, W.R. Jr., and J.R. Stauffer Jr. 1984. Distribution, Biology, and Management of Exotic Fishes. John Hopkins University Press. Baltimore.

Craig, J. F. 1987. The biology of perch and related fish. Timber Press, Portland, Oregon.

Fedorova, G. V., and S. A. Vetkasov. 1974. Biological characteristics and abundance of Lake Ilmen ruffe. Journal of Ichthyology 13:943-946.

Great Lakes Fishery Commission Ruffe Task Force. 1992. Ruffe in the Great Lakes: A threat to North American fisheries. Great Lakes Fishery Commission Ruffe Task Force, Ann Arbor, Michigan.

Greenbank, J., and P. R. Nelson. 1958. Life history of the threespine stickleback *Gasterosteus aculeatus* Linnaeus in Karluk Lake and Bare Lake, Kodiak Island, Alaska. U. S. Fish Wildlife Service Fisheries Bulletin 153, Volume 59: 537-559.

Hagen, D. W. 1967. Isolating mechanisms in threespine sticklebacks (*Gasterosteus*). Journal of Fisheries Research Board of Canada 24(8): 1637-1692.

Hokanson, K. E. F. 1977. Temperature requirements of some percids and adaptations to the seasonal temperature cycle. Journal of the Fisheries Research Board of Canada 34:1524-1550.

Jamet, J. L., and F. Desmolles. 1994. Growth, reproduction and condition of roach (*Rutilus rutilus*, L.), perch (*Perca fluviatilis*, L.) and ruffe (*Gymnocephalus cernuus*, L.) in eutrophic Lake Aydat (France). Internationale Revue der Gesamaten Hydrobiologie 78:305-322.

Jensen, D.A., M. McLean, D.H. Ogle, and J. Gunderson. 1996. Ruffe: a new threat to our fisheries. Minnesota Sea Grant Fact Sheet, Duluth.

Johnson, M. W. 1978. The management of lakes for stream trout and salmon. Minnesota Department of Natural Resources, Section of Fisheries Special Publication Number 125, St. Paul.

Jude, D. J., R. H. Reider, and G. R. Smith. 1992. Establishment of Gobiidae in the Great Lakes basin. Canadian Journal of Fisheries and Aquatic Science 49:416-421.

Kolomin, Y. M. 1977. The Nadym River ruffe, *Acerina cernua*. Journal of Ichthyology 17:345-349.

Koshelev, B. V. 1963. Morpho-ecological peculiarities of oogeneses in related species of percoid fishes. Tr. Inst. Morfol. Zhivotn. Acad. Nauk Severtsova. 38:189-231. [Translated from Russian by U.S. EPA library TR77-99]

Leino, R. L., and J. H. McCormick. 1996. Reproductive characteristics of ruffe, *Gymnocephalus cernuus*, in the St. Louis River Estuary, Western Lake Superior: A histological examination of the ovaries over one annual cycle. Final Report to Minnesota Department of Natural Resources. (Also a Sea Grant Reprint.)

Lindgren, J. P., P. W. Ongstad, and J. R. Spurrier. 1997. The St. Louis Bay Fishery 1986-1994. Minnesota Department of Natural Resources, Section of Fisheries, Study 4 Report, Job 422, St. Paul.

MacNeill, D. 1993. Biology and potential impacts of the rudd in the Great Lakes. New York Sea Grant Fact Sheet, Buffalo.

Maitland, P. S., K. East, and K. H. Morris. 1983. Ruffe *Gymnocephalus cernua*, new to Scotland, in Loch Lomond. Scottish Naturalist 1983:7-9.

Maitland, P. S., and K. East. 1989. An increase in numbers of ruffe, *Gymnocephalus cernua*, in a Scottish loch from 1982 to 1987. Aquaculture and Fisheries Management 20:227-228.

Maitland, P. S. 1990. Biology of fresh waters, Second edition. Blackie and Son, Limited, London.

Marsden, J. E., and D. J. Jude. 1995. Round gobies invade North America. Ohio Sea Grant Fact Sheet, Columbus.

Marking, L. L. 1992. Evaluation of toxicants for the control of carp and other nuisance fishes. Fisheries 17(6):6-8.

Miller, P. J. 1986. Gobiidae. Pages 1019-1095. *IN* P.J.P. Whitehead, M.L. Bauchot, J.C. Hureau, J. Nielsen, and E. Toronese, editors. Fishes of the North-east Atlantic and the Mediterranean, Volume III. UNESCO, Paris.

Mills, E. L., J. H. Leach, C. L. Secor, and J. T. Carlton. 1993. What's next? The prediction and management of exotic species in the Great Lakes (report of the 1991 workshop). Great Lakes Fishery Commission, Ann Arbor, Michigan.

Moyle, P. B., H. W. Li, and B. A. Burton. 1986. The Frankenstein effect: impact of introduced fishes on native fishes in North America. Pages 415-426 *IN* R.H. Stroud, editor. Fish culture in fisheries management. American Fisheries Society, Bethesda, Maryland.

Neja, Z. 1988. On some problems of reproduction of ruffe, *Gymnocephalus cernuus* (L., 1758) in the Lake Dabie. Acta Ichthyologica et Piscatoria 18:33-50.

Pratt, D. M., W. H. Blust, and J. H. Selgeby. 1992. Ruffe, *Gymnocephalus cernuus*: Newly Introduced in North America. Canadian Journal of Fisheries and Aquatic Sciences 49:1616-1618.

Scott, W. B., and W. J. Christie. 1963. The invasion of the lower Great Lakes by the white perch, *Roccus americanus* (Gmelin). Journal of Fisheries Research Board of Canada 20(5): 1189-1195.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184, Ottawa.

Selgeby, J. H. 1993. Trophic relations of ruffe and the status of ongoing research in the St. Louis River Estuary, Lake Superior, 1992. United States Fish and Wildlife Service, National Fisheries Research Center- Great Lakes, Ann Arbor, Michigan.

Sierszen, M. E., J. R. Keough, and C.A. Hagley. 1996. Trophic analysis of ruffe (*Gymnocephalus cernuus*) and white perch (*Morone americana*) in a Lake Superior coastal food web, using stable isotope techniques. Journal of Great Lakes Research 22(2):436-443.

Slade, J. W., S. M. Pare, and W. R. MacCallum. 1994. Surveillance for ruffe in the Great Lakes, 1993. Ashland Fishery Resources Office, United States Fish and Wildlife Service station report, Ashland, Wisconsin.

Stedman, R. M., and C.A. Bowen II. 1985. Introduction and spread of the threespine stickleback (*Gatererosteus aculeatus*) in Lakes Huron and Michigan. Journal of Great Lakes Research 11(4):508-511.

Sterligova, O. P., and S. A. Pavlovskiy. 1984. Consumption of whitefish, *Coregonus lavaretus*, eggs by ruffe, *Gymnocephalus cernua*, and invertebrates. Journal of Ichthyology 25:166-169.

Travkina, G. L. 1971. Use of quantitative assessment to characterize the state of fish ovaries. Journal of Ichthyology 11:120-123.

U.S. Congress, Office of Technology Assessment. 1993. Harmful Non-indigenous Species in the United States. OTA-F-565. Washington, DC: U.S. Government Printing Office.

Wooton, R. J. 1976. The Biology of the sticklebacks. Academic Press. New York.

Appendix A. Description of Potential Nonindigenous Fish Piscicides

Antimycin A

Although antimycin is considered a general fish toxicant, recent toxicity testing conducted by the Biological Resources Division (BRD) of the USGS, La Crosse, Wisconsin (Bills and Boogaard 1994) indicated that antimycin was not selective for ruffe over brown trout, but ruffe were significantly more sensitive to antimycin than yellow perch. Estimated concentrations of Antimycin required to kill 100% of the ruffe would produce a 25% mortality among non-target fish. This may preclude the use of this toxicant as a selective treatment to eradicate ruffe. Antimycin also has been formulated as a bottom-release compound which is effective in killing fish eggs. This bottom formulation may have potential use as a selective treatment for ruffe or other bottom dwelling species by toxifying only the bottom 5 cm of water. Toxicity testing by BRD also found that antimycin was more selective for ruffe than black bullhead and yellow perch under cold water conditions (Great Lakes Fishery Commission-Ruffe Task Force 1992). Antimycin could be used in a complete reclamation to eradicate a nonindigenous fish species, but rotenone would also work while being less expensive and easier to obtain.

Rotenone

Rotenone is considered a general fish toxicant and is used in Minnesota for both partial (spot treatments) and complete lake reclamation projects. This toxicant was also tested by the BRD for its selectivity on ruffe. Twenty-four hour LC50s for ruffe, brown trout, and yellow perch showed ruffe and brown trout were similar in sensitivity to rotenone, and yellow perch were about twice as resistant (Bills and Boogaard 1994). As with antimycin, significant mortality of non-target fish would probably occur at concentrations of rotenone that would kill 100% of the ruffe.

TFM

TFM is a selective fish toxicant currently used as a lampricide in tributaries of the Great Lakes. Toxicity tests conducted on rivers that currently have ruffe populations showed a significant selectivity of TFM for ruffe over brown trout and yellow perch (Bills and Boogaard 1994). Concentrations of TFM required to kill 100% of the ruffe killed less than 25% of the non-target fish. TFM may have the potential to be used as a selective control measure against ruffe in inland waters.

Bayluscide

Bayluscide has been used as a lampricide and molluscicide in the United States and Canada (Marking 1992). Bayluscide has been formulated as a bottom release compound by BRD. It has potential to be used as a selective piscicide, but is not currently registered for use in Minnesota waters.

Appendix B: Nonindigenous Fish Action Plan

This appendix is intended to provide an outline of potential scenarios and responses to nonindigenous fish in inland waters of the state. It should be used as a guide for determining the appropriate management action(s).

1. Determine reliability of reported nonindigenous fish sighting including voucher specimen
2. If deemed reliable, conduct targeted sampling for confirmation of nonindigenous fish
3. If confirmed via target sampling:
   - A. Inform designated contact person that maintains nonindigenous fish database
   - B. Determine extent of infestation by:
     - 1). Targeted sampling of other similar habitats in the water body
     - 2). Conduct an assessment of connecting and adjoining waters, if a nonindigenous fish is found in other areas of the water body
     - 3). Status of native aquatic communities
4. Assessing the factors to consider for action:
   - A. Size and location of infested water
     - 1). Likelihood of spread to adjacent waters
     - 2). Distance to urban population centers
     - 3). Current angling pressure (include commercialization)
     - 4). Cost to treat successfully
     - 5). Likelihood of success based on available options.
   - B. Status of existing fish community
     - 1). Stable aquatic community
     - 2). Perturbed aquatic community
   - C. Potential to spread to other waters
     - 1). Links to adjacent waters
     - 2). Value of potentially infected waters
     - 3). Angling pressure (include commercialization)
   - D. Anticipated public response
     - 1). Concern with use of chemicals
     - 2). Concern over potential lost angling opportunities (include commercialization)
       - a. With chemical treatment
       - b. Without chemical treatment
     - 3). Apathy
   - E. Treatment options
     - 1). Barriers
     - 2). Biological
     - 3). Chemical
     - 4). Combination
     - 5). Status quo
   - F. Benefit:cost
     - 1). Lost recreational/commercial value if not treated
     - 2). Cost to attempt to control noningenous fish
     - 3). Cost to treat with toxicants and stock
     - 4). Cost to maintain control over nonindigenous fish

G. Feasibility
    1). Public attitude
    2). Probability of success
    3). Effect on aquatic community
    4). Aquatic avenues for spread/reintroduction

5. Determine appropriate management options:
    A. Involvement of stakeholders/interest groups
    B. Containment by education/regulations
    C. Management options
        1). Small discrete infestion of a large basin
            a. Consider targeted control with piscicides
            b. Monitoring/research
            c. Risk of basin-wide spread
        2). Widespread infestation in a small lake
            a. Consider targeted control with piscicides if a priority management water or if there is a high risk of further spread to other important waters
            b. Install barriers if appropriate to prevent/slow spread to other waters
            c. Monitoring/research
        3). Widespread infestation on large lake or river
            a. Install barriers if appropriate to prevent spread to other waters
            b. Consider biological control
            c. Consider chemical control with selective piscicides
            d. Monitoring/research
        4). No control actions feasible on water body
            a. Monitor/research only
            b. Continue education to prevent spread to new locations

6. Prepare or revise Fisheries Management Plan
    A. Fish community population monitoring, management, and research
    B. Containment/control strategies
    C. Communication plan
    D. Education plan developed or updated

Appendix C: Rating System for the Risk of Nonindigenous Fish Species Introductions into Minnesota Inland Waters

		Points
1.	Status in Minnesota	
	A. Indigenous species	0
	B. Naturalized nonindigenous fish species (present in Minnesota for decades)	10
	C. Species not present in the state	20
	D. Ecologically harmful nonindigenous species	30
2.	Ability of nonindigenous fish species to maintain sustainable populations in Minnesota waters	
	A. Highly adaptable to all waters	30
	B. Moderately adaptable to Minnesota waters	20
	C. Can sustain populations in some waters of the state	10
	D. Cannot sustain populations in Minnesota waters	0
3.	Potential biological or ecological risk of unwanted introductions into lakes and streams.*	
	A. High biological risk of introductions into lakes and streams	30
	B. Moderate biological risk of introductions into lakes and streams	20
	C. Low biological risk of introductions into lakes and streams	10
	D. No biological risk of introduction into lakes and streams	0
4.	Species abundance and distribution in waters surrounding the state	
	A. High	30
	B. Moderate	20
	C. Low	10
	D. Rare	0

* Biological risk may depend on whether it is a prolific species and whether its niche closely overlaps that of other species, or it competes with indigenous species.
* When ranking this category consider only what impacts the species would have if it were introduced where it is not currently present (do not factor in the current distribution of the species).

Rating by Factor -	Based on total from above
30 points	High risk of introduction, great concern
20 points	Moderate risk of introduction, medium concern
$\leq$10 points	Low risk of introduction, little concern

Appendix D: Index to Selected Minnesota Regulations Regarding Harmful Exotic Species

MINNESOTA STATUTES - HARMFUL EXOTIC SPECIES

M.S. 84D.01	DEFINITIONS.
M.S. 84D.02	HARMFUL EXOTIC SPECIES MANAGEMENT PROGRAM.
M.S. 84D.03	INFESTED WATERS; LIMITED INFESTATIONS OF EURASIAN WATER MILFOIL.
M.S. 84D.04	CLASSIFICATION OF EXOTIC SPECIES. (Classes; Criteria)
M.S. 84D.05	PROHIBITED EXOTIC SPECIES. (Prohibited activities; Seizure)
M.S. 84D.06	UNLISTED EXOTIC SPECIES. (Process; Classification)
M.S. 84D.07	REGULATED EXOTIC SPECIES.
M.S. 84D.08	ESCAPE OF EXOTIC SPECIES.
M.S. 84D.09	AQUATIC MACROPHYTES. (Transportation prohibited; Exceptions)
M.S. 84D.10	PROHIBITED ACT; WATERCRAFT.
M.S. 84D.11	PERMITS. (Prohibited exotic species; Regulated exotic species, Standard)
M.S. 84D.12	RULES. (Required rules; Authorized rules; Expedited rules)
M.S. 84D.13	ENFORCEMENT; PENALTIES. (Criminal Penalties; Civil penalties)
M.S. 84D.14	CERTAIN SPECIES NOT SUBJECT TO CHAPTER.

MINNESOTA RULES - HARMFUL EXOTIC SPECIES

M.R. 6216.0100	PURPOSE.
M.R. 6216.0200	DEFINITIONS.
M.R. 6216.0230	NOMENCLATURE.*
M.R. 6216.0250	PROHIBITED EXOTIC SPECIES. (Designation; Aquatic plants; Fish; Invertebrates; Mammals)
M.R. 6216.0260	REGULATED EXOTIC SPECIES.
M.R. 6216.0265	PERMITS FOR PROHIBITED AND REGULATED EXOTIC SPECIES.
M.R. 6216.0270	UNREGULATED EXOTIC SPECIES.
M.R. 6216.0280	ESCAPE OF EXOTIC SPECIES.
M.R. 6216.0290	PROCESS FOR REVIEW OF INTRODUCTIONS OF UNLISTED EXOTIC SPECIES.
M.R. 6216.0300	DESIGNATION, NOTICE, AND MARKING OF INFESTED WATERS AND LIMITED INFESTATIONS OF EURASIAN WATER MILFOIL.
M.R. 6216.0350	DESIGNATED INFESTED WATERS.
M.R. 6216.0400	RESTRICTED ACTIVITIES ON INFESTED WATERS. (Prohibition of taking bait from infested waters; Prohibition of sport gill netting for whitefish and ciscoe in infested waters; Commercial fishing restrictions in infested waters; Prohibition on entry into delineated areas marked for limited infestation of Eurasian water milfoil)
M.R. 6216.0500	TRANSPORTATION OF WATER FROM INFESTED WATERS.
M.R. 6216.0600	VIOLATIONS; CONFISCATIONS.

* All underlined are currently proposed.