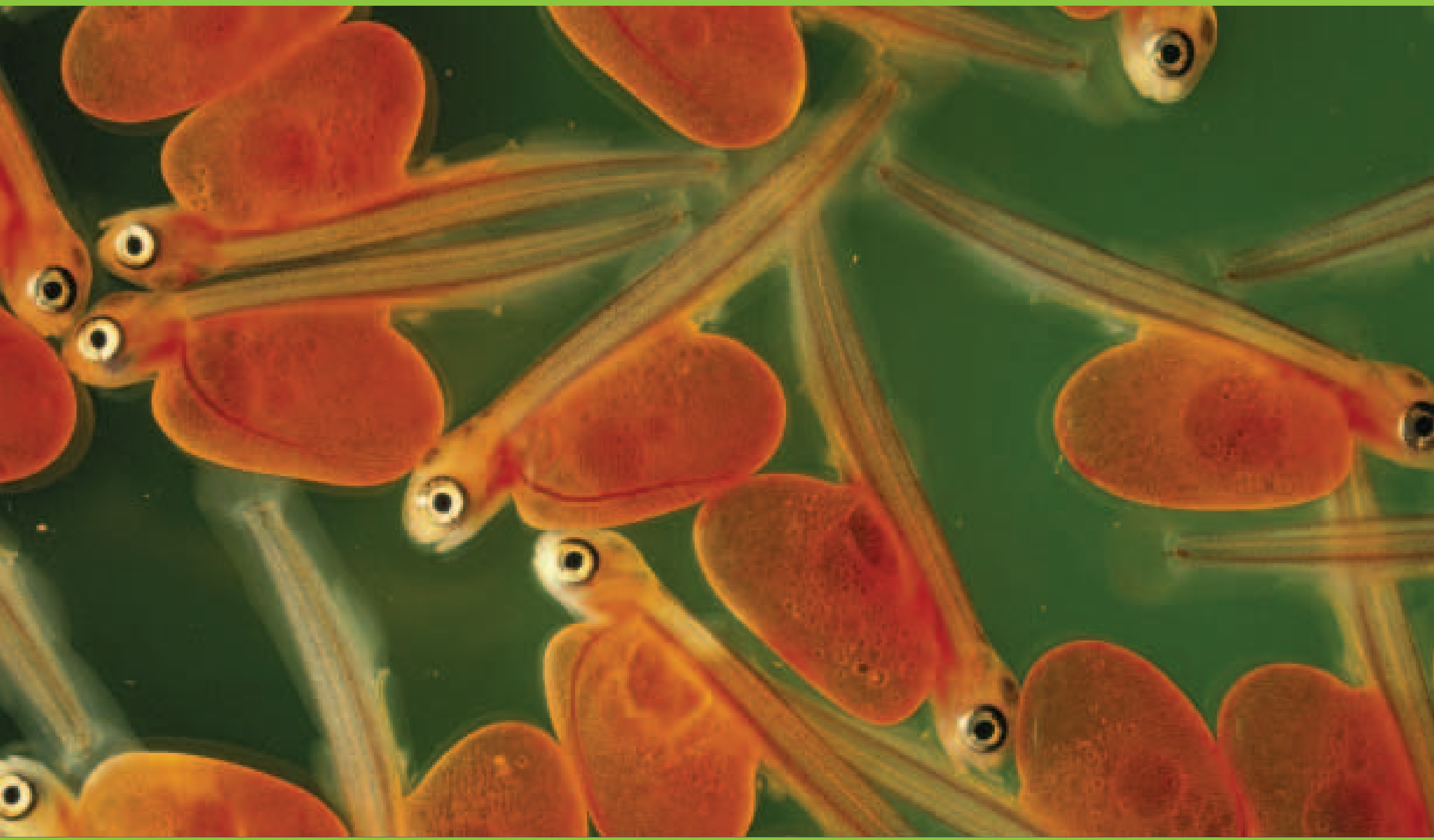
AIS-HACCP

Aquatic Invasive Species–Hazard Analysis and Critical Control Point

A preventative system to control the spread of invasive species



Training Curriculum

Sea Grant
Great Lakes Network

AIS-HAACP

Aquatic Invasive Species – Hazard Analysis and Critical Control Point Training Curriculum

Second Edition

Edited by Jeffrey L. Gunderson and Ronald E. Kinnunen

This course manual is adapted from the "HACCP: Hazard Analysis and Critical Control Point Training Curriculum," developed by the National Seafood HACCP Alliance for Training and Education. It is written for wild baitfish harvesters, fish farmers (both private and public), fishery managers and researchers, and law enforcement personnel. Fish farmers culturing aquatic invasive species for food or other purposes can also apply this HACCP approach. This manual identifies critical pathways through which aquatic invasive species and/or non-target aquatic species could be moved to new waterbodies. It explains an approach (called AIS-HACCP) to prevent the inadvertent transfer of these species.

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Table of Contents

Overview

Introduction 1

Hazards – Aquatic Invasive Pathogens, Plants, Invertebrates, and Vertebrates 5

Getting Ready for HACCP 17

HACCP Principles

Principle 1: Hazard Analysis 19

Principle 2: Determine the Critical Control Points 22

Principle 3: Establish Controls 27

Principle 4: Critical Control Point Monitoring 29

Principle 5: Corrective Actions 32

Principle 6: Verification Procedures 35

Principle 7: Record-Keeping Procedures 38

Sources of Information on Preparing AIS-HACCP Plans 40

Appendices

Appendix 1: Best Management Practices for Combating AIS during Field Operations 42

Appendix 2: Steps in Completing an AIS-HACCP Plan 47

Appendix 3: AIS-HACCP Pre-plan Example – Wild Harvested Baitfish 50

Appendix 4: AIS-HACCP Plan Example – Waterfleas on Management Agency Equipment 52

Appendix 5: AIS-HACCP Plan Example – Conservation Officers Patrolling Inland Lakes 57

Appendix 6: AIS-HACCP Plan Example – Wild Harvested Emerald Shiners 65

Appendix 7: AIS-HACCP Plan Example – White Suckers Cultured for Sale as Baitfish 72

Appendix 8: Blank AIS-HACCP Plan Forms 78

Appendix 9: Sample Reporting Form 82

Introduction

Objectives:

- Provide an overview of this course
- Provide an introduction to AIS-HACCP
- Present the seven HACCP Principles
- Define terms used in this manual

Gizzard shad spawning in Lake Powell and Asian carp making their way up two major North American rivers highlight the reality that fishery management agencies and fish farmers can spread aquatic invasive species (AIS).

To deal effectively and fairly with potential AIS vectors, it is important to characterize operations according to their risks of spreading AIS. Risk assessments for individual operations could ensure that unnecessary and ineffective AIS regulations will not disrupt the economy of these industries or the activities of research, management, and enforcement personnel.

AIS might spread to new areas as wild-harvested baitfish or cultured fish are transported from infested waters. Some management agencies have closed AIS-infested areas to harvest and culture, some states have banned the importation of live bait, and others only allow AIS-free bait into their state or specific watersheds. The activities of fisheries managers, researchers, and enforcement officers might also contribute to the ever-widening distribution of AIS. Although most fisheries activities pose minimal risk for spreading AIS, paths for dispersing AIS are diverse… fortunately, they are also manageable.

One approach to this problem is to adapt the Hazard Analysis and Critical Control Point (HACCP – pronounced "has-sip") concept used by the seafood industry to minimize health risks associated with seafood consumption. The advantages of this system are that it manages diverse hazards, fosters partnership between industry and government regulators, and is effective when properly applied. The HACCP approach concentrates on points that are critical to product safety. It also aims at minimizing risks, and increasing communication between decision-makers, regulators, and the industry.

The U.S. Food and Drug Administration (FDA) issued seafood regulations based on the principles of HACCP in 1995. These regulations specify that HACCP-trained personnel perform certain jobs to ensure safe processing and importing of fish and fishery products. Just as HACCP applies to the fish processing industry, it can help ensure product safety in other business processes. The baitfish/aquaculture trade can reduce the risk of contaminating wild baitfish/aquaculture products with unwanted aquatic species by adapting the HACCP approach.

This manual supports a one- to 1½-day course on AIS-HACCP. While it serves as a stand-alone document for developing AIS-HACCP plans, it is best used during the course and as a reference for course attendees.

Course Objective

This course is designed to train fish farmers, bait harvesters, management agencies, researchers, and enforcement personnel in the use of HACCP fundamentals to control the spread of AIS via their operations. Here, the goal of the HACCP approach is to prevent the spread of AIS while maintaining viable baitfish and aquaculture industries and allowing appropriate field activities for fishery researchers, managers, and enforcement personnel. HACCP is an approach that brings decision-makers, management agencies, researchers, and industry representatives together to establish a plan to prevent the spread of AIS. The HACCP approach can also be used to certify AIS-free products for those businesses that choose to seek this certification. Course attendees will learn how to apply HACCP principles to their unique situations.

The HACCP approach stresses communication between industry and resource managers. Through documentation and communication, AIS-HACCP helps anyone who may inadvertently move AIS avoid the hardships of over-regulation and the pitfalls of ignoring AIS in their work. For the AIS-HACCP concept to be adopted, the industry, resource management agencies, researchers, enforcement personnel and appropriate decision-makers must accept it.

Course Format

This AIS-HACCP course is divided into:

1) HACCP fundamentals

2) A work session to develop a baitfish/aquaculture or resource management, field research, or enforcement AIS-HACCP plan

The first segment defines the seven fundamental principles of HACCP. As each principle is discussed, participants will see how it fits into the development of an AIS-HACCP plan. This segment also presents information about specific hazards and will help you understand HACCP principles and how they interrelate.

The second segment demonstrates how to develop an AIS-HACCP plan. During this part of the course, participants will divide into teams to write a plan based on their experiences.

Expectations for Participants

HACCP is a common-sense technique used to control AIS hazards in wild baitfish and aquaculture products that can also be incorporated into resource management, field research, or enforcement operations. It is an important environmental safety management system and can be integrated into any operation. You are encouraged to ask questions and to contribute first-hand experiences to discussions. The more you contribute and ask questions during the training, the less complicated the HACCP system will seem and the easier it will be to implement an AIS-HACCP plan for your situation.

How to Use This Manual

This manual is yours. Become familiar with it. Learn where the definitions are, where the forms are that will help you develop an AIS-HACCP plan, and where to find other basic information. Make as many notes and marks in the text as needed for assisting in creating and understanding an AIS-HACCP plan. Use the manual as a reference. This manual is not copyrighted, so copy its forms as necessary or copy the whole manual to share with others.

The Meaning and Importance of HACCP

Many people may not have heard the term "HACCP" until recently. However, it is neither a new term nor a new concept. HACCP is merely an acronym that stands for "Hazard Analysis and Critical Control Point." But the concept behind this term is important. HACCP is a preventive system of hazard control rather than a reactive one. Many operations can use it to reduce the risk that products and equipment will be contaminated by AIS and will therefore prevent the spread of these unwanted species to new water bodies. To ensure uncontaminated fish, water, and equipment the HACCP system is designed to identify AIS hazards, establish controls, and monitor these controls. Hazards can be aquatic nuisance fish or other aquatic vertebrates, invertebrates, plants, and parasites or pathogens.

The Pillsbury Company pioneered the HACCP concept for food production during its efforts to supply the U.S. space program in the early 1960s. Pillsbury decided that their existing quality control techniques were inadequate. The company found that the end-product testing necessary to assure against contamination during food production would be so extensive that little food would be available for space flights.

The only way to ensure safety, Pillsbury concluded, would be to develop a preventive system that kept hazards from occurring during production. Since then, Pillsbury's system has been recognized worldwide as the state-of-the-art measure for hazard control. It is not a zero-risk system, but it is designed to minimize the risk of hazards.

The Seven HACCP Principles

1) Conduct a hazard analysis. Prepare a list of steps in the process where significant hazards occur and describe preventive measures.

2) Identify the critical control points (CCP) in the process.

3) Establish controls for each CCP identified.

4) Establish CCP monitoring requirements. Establish procedures for using monitoring results to adjust the process and maintain control.

5) Establish corrective actions to be taken when monitoring indicates a deviation from an established critical limit.

6) Establish procedures to verify that the HACCP system is working correctly.

7) Establish effective record-keeping procedures that document the HACCP system.

These principles will be explained in the following chapters. HACCP regulation and other domestic and international HACCP control systems are based on these principles. AIS-HACCP is a preventive system to help ensure that fish, water, and equipment are free of AIS.

The AIS-HACCP concept focuses on the parts of the operations and processes most likely to spread AIS. The AIS-HACCP approach allows decision-makers, regulators and others to look at various operations and evaluate how potential hazards are being handled.

With AIS-HACCP, the emphasis is on understanding the entire process. This requires the decision makers, management agencies, and industry to communicate and work with one another. Outside reviewers will have the opportunity to evaluate the AIS-HACCP plan and determine if critical hazards have been properly identified and if hazards are consistently controlled. Everyone involved shares the responsibilities of developing and implementing AIS-HACCP plans.

Definitions and Acronyms

As you learn more about HACCP, you will need to understand some terms. To assist you, the most common definitions are found below. Refering to these terms will help you develop and implement your own AIS-HACCP plan.

AIS: Aquatic Invasive Species

BMP: Best Management Practice

Control: (a) (verb) To manage the conditions of an operation to maintain compliance with established criteria. (b) (noun) The state in which correct procedures are being followed and criteria are being met.

Control Limit (CL): A criterion that must be met for each control measure associated with a critical control point.

Control Measure: Factors that can be used to control an identified aquatic invasive species hazard (sometimes referred to as a preventive measure).

Control Point: Any point, step or procedure at which aquatic invasive fish or other aquatic vertebrates, invertebrates, and plants can be controlled.

Corrective Action: Procedures followed when a deviation from a critical limit occurs at a CCP.

Critical Control Point (CCP): A point, step or procedure at which control can be applied to prevent or eliminate an aquatic invasive species hazard.

CCP Decision Tree: A sequence of questions asked to determine whether a control point is a critical control point.

Deviation: Failure to meet a critical limit.

HACCP: Hazard Analysis and Critical Control Point.

HACCP Plan: The written document based upon principles of HACCP that delineates the procedures to be followed to ensure the control of a specific process or procedure.

HACCP System: The result of the implementation of the HACCP plan.

HACCP Team: The group of people responsible for developing a HACCP plan.

HACCP Plan Validation: The initial review by the HACCP team to ensure that all elements of the HACCP plan are accurate.

Hazard: An aquatic invasive parasite or pathogen, plant, invertebrate, or fish or other aquatic vertebrate that is reasonably likely to be transported to a new waterbody and establish reproducing populations that could negatively impact existing species, recreation, or other existing use of water resources in the absence of its control.

Monitor: To conduct a planned sequence of observations or measurements to assess whether a CCP is under control and to produce an accurate record for future use in verification.

Operating Limits: Criteria more stringent than critical limits that are used by an operator to reduce the risk of AIS contamination. For example, if a certain chemical concentration is required to control an AIS hazard, the operating limit is generally set above the minimum concentration needed to ensure effective treatment.

Risk: An estimate of the likely occurrence of a hazard.

Severity: The seriousness of a hazard (if not properly controlled).

Validation: Verification focused on collecting and evaluating scientific and technical information to determine if the AIS-HACCP plan, when properly implemented, will effectively control the AIS hazards.

Verification: The use of methods, procedures or tests, in addition to those used in monitoring, that determine if the HACCP system complies with the HACCP plan and/or whether the plan needs modification.

Hazards – Aquatic Invasive Pathogens, Plants, Invertebrates, and Vertebrates

Objectives:

- Introduce AIS hazards:
    - Aquatic invasive pathogens
    - Aquatic invasive plants
    - Aquatic invasive invertebrates
    - Aquatic invasive fish and other aquatic vertebrates
- Review characteristics of certain AIS species

To perform a hazard analysis for the development of an AIS-HACCP plan, everyone involved must recognize potential hazards. The HACCP plan is designed to control all reasonable AIS hazards. Such hazards are categorized into four classes: parasites and pathogens, plants, invertebrates, and fish and other aquatic vertebrates.

Hazard: An aquatic invasive parasite or pathogen, plant, invertebrate, or fish or other aquatic vertebrate that is reasonably likely to be transported to a new waterbody and establish reproducing populations that could negatively impact existing species, recreation, or other existing use of water resources in the absence of its control.

Species considered AIS vary from state to state. Consult with resource management agencies and Regional Aquatic Nuisance Species Task Forces to determine which species are considered AIS hazards. Aquatic invasive parasites or pathogens include: whirling disease (*Myxobolus cerebralis*), Heterosporis sp., Asian tapeworm (*Bothriocephalus acheilognathi*), spring viremia of carp (*Rhabdovirus carpio*), and largemouth bass virus.

Aquatic invasive plants include: Eurasian watermilfoil (*Myriophyllum spicatum*), water chestnut (*Trapa natans*), hydrilla (*Hydrilla verticillata*), curly-leaf pondweed (*Potamogeton crispus*), and purple loosestrife (*Lythrum salicaria*).

Aquatic invasive invertebrates include: zebra mussel (*Dreissena polymorpha*); quagga mussel (*D. bugensis*); Asiatic clam (*Corbicula fluminea*); spiny (*Bythotrephes longimanus*), fishhook (*Cercopagis pengoi*), and lumholtzi (*Daphnia lumholtzi*) water-fleas; rusty crayfish (*Orconectes rusticus*); Chinese mitten (*Eriocheir sinensis*) and green (*Carcinus maenas*) crabs.

Aquatic invasive fish include: Eurasian ruffe (*Gymnocephalus cernuus*), round goby (*Neogobius melanostomus*), white perch (*Morone americana*), rudd (*Scardinius erythrophthalamus*), threespine (*Gasterosteus aculeatus*) and fourspine (*Apeltes quadracus*) sticklebacks, smelt (*Osmerus mordax*), and Asian carps – black (*Mylopharyngodon piceus*), grass (*Ctenopharyngodon idella*), silver (*Hypophthalmichthys molitrix*), and bighead (*Hypophthalmicthys nobilis*). Other aquatic vertebrates include amphibians or reptiles that may be identified as nuisance species.

Hazards

The following descriptions review the unique life histories and characteristics of selected AIS that make them of environmental and economic concern. Note how moving water, fish, or equipment can spread AIS. Not all AIS are covered in this section, so you will need to gather additional information to develop effective AIS control strategies. For information on other species see pages 40-41(sources of info. chapter) or the Web sites listed at the end of this chapter (page 16).

Parasite and Pathogen Hazards

Aquatic invasive parasites and pathogens include viruses, bacteria, and invertebrates that have a variety of life history strategies that allow them to be easily transferred from one location to another in water, on equipment, on or in infected fish, or in some cases, in mud on your boots.

Whirling Disease (*Myxobolus cerebralis*)

Whirling disease is caused by a microscopic parasite that infiltrates the head and spinal cartilage of fingerling trout. This European myxosporean parasite causes whirling disease in many salmonid fish species and has spread to hundreds of streams in the northeastern and western United States. Whirling disease now affects wild fish and fish hatcheries in 23 states and is having negative impacts in some areas. This parasite employs both a fish host and an aquatic worm host known as a tubifex worm. The parasite becomes engulfed by a tubifex worm, which acts as its intermediate host. This relationship produces a free-floating life phase of the parasite that eventually attaches to trout and salmon. After coming into contact with the host fish, the parasite penetrates the head and spinal cartilage of fingerling trout where it multiplies rapidly, putting pressure on the organ of equilibrium. This causes the fish to swim erratically (whirl) and have difficulty feeding and avoiding predators. It is this whirling effect that has provided the name for disease.

Once established in a stream, the parasite cannot be eradicated, nor can its worm host, without significantly damaging the ecosystem. Whirling disease has no known human health effects. This parasite produces myxospores that are nearly indestructible and can remain dormant for up to 30 years in water and mud. Because an infected fish can harbor tens of thousands of the myxospores, it is recommended that discarded skeletal parts and fish entrails go to a landfill when possible. Anglers should not discard these parts in the water where the fish was caught, nor should they be disposed of in a kitchen disposal. Whirling disease myxospores can survive most wastewater treatment systems.

Infected fish and fish parts are the primary vector for transmitting whirling disease. It may also be transmitted by birds and it is possible anglers could carry the parasite on fishing equipment. However, live infected fish are the main vector for the spread of the parasite. It is important to not transport live fish or carry fish or fish parts from one water body to another. If you are fishing in waters known to be infected by whirling disease, take care to rinse all mud and debris from equipment and wading gear, and drain water from boats before leaving the infected drainage.

Spring Viremia of Carp (*Rhabdovirus carpio*)

Spring viremia of carp (SVC) is a virus that can cause significant mortality of common carp (*Cyprinus carpio*) and is considered a problem in Europe, the Middle East, and Russia. It was found in North America in koi and then in a lake in northern Wisconsin where it caused a common carp die-off. Many of the Asian carps and goldfish seem to be susceptible to the virus. There is little known about the susceptibility of native North American Cyprinids, many of which are valuable baitfish species or are important in food webs. Some are endangered.

The virus seems to spread through fish feces and enters the fish through the gills. Blood sucking parasites, including some leeches and the fish louse *Argulus*, have also been implicated in the spread of the disease. Because it survives in water and mud, and can survive desiccation–boats, nets, boots, equipment, and possibly birds might spread the virus. Many factors determine how the disease will affect a population, but temperature seems to play a key role. The disease seems to cause highest mortality in the spring as water starts to warm above 54°F. Research suggests that maximum mortality can be expected in water temperatures below 64°F. The virus apparently starts replicating before the fish's immune response (which is slower in cooler water) can counteract the infection. Once the water temperature increases above 68°F, the immune function of susceptible fish increases and mortality is reduced. Signs of infection are often nonspecific and include darkened skin, pop-eye, ascites (dropsy), pale gills, hemorrhage in the gills, skin, and eye, and protruding vent with a thick mucoid fecal cast. Behaviorally, infected fish may exhibit lethargy, decreased respiration rate, and loss of equilibrium. Laboratory tests are required to confirm a diagnosis of the virus and only approved labs can confirm SVC.

Heterosporis

Heterosporis is a parasite that infects fish muscle tissue and causes it to appear white and opaque, almost as if the fish was already cooked or had freezer burn. This is a newly identified microsporidian parasite of fish. It doesn't appear to directly cause mortality in fish but in severely infected fish, the parasites' spores can make up most of the fillet rather than muscle tissue. There is no evidence that the parasite can infect humans, however, it can alter the appearance and quality of the fillet so much that it does not appear edible. *Heterosporis* has been found primarily in yellow perch, but also in walleye. Laboratory studies suggest many other species might be susceptible to infection. Fish with *Heterosporis* have been found in Wisconsin, Minnesota, and Ontario, the first places in the Western Hemisphere. While direct evidence is unavailable, there is concern that fish-eating birds may be able to spread the parasite. Until we know more about how this parasite spreads, we must make sure we don't facilitate its spread through fishery management, research, and enforcement activities or through the stocking of fish or sale of baitfish. Research shows that microsporidians are susceptible to desiccation. Until we learn more about this microsporidian parasite, follow the recommendations adapted from the Wisconsin Department of Natural Resources:

1. Place infected fish in the garbage, burn them, or bury them. Do not throw infected fish back into a lake or river.
2. Thoroughly dry all equipment (outside of boats, trailers, nets, boots, etc.) when moving from one water body to another.
3. Drain and flush all live wells, bait buckets, and bilges away from lakes and rivers, so water does not run into a water body.

Plant Hazards

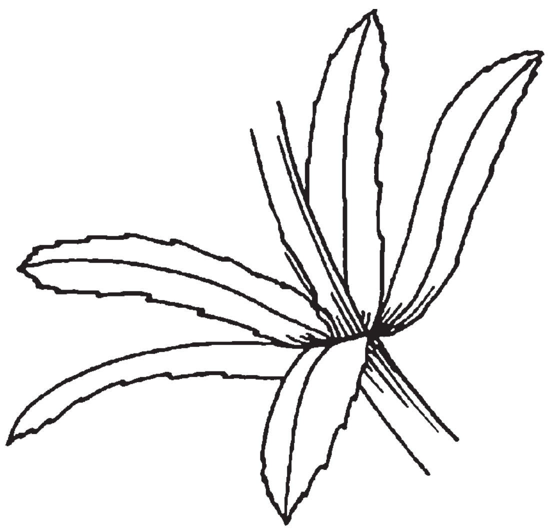
When live fish are harvested from infested waters, there is a risk that plant AIS can be moved. These hazards can come with the fish, the water, or clinging to equipment used in infested waters. Many aquatic invasive plant species reproduce by fragmentation. Small pieces of the plant can settle to the bottom, take root, and grow even after being out of water for many days or even weeks in some moist, cool conditions. Care must be taken to prevent the transport of viable plant fragments to uninfested waters. In addition, many plants can produce seeds or tubers that can survive long periods before germinating.

Eurasian Watermilfoil (*Myriophyllum spicatum*)

Eurasian watermilfoil is a submersed aquatic plant that has long stems with feathery leaves attached in whorls of four. Each leaf typically has 12 or more pairs of leaflets, one of the key characteristics used to differentiate between Eurasian and northern watermilfoil. Eurasian watermilfoil is an exotic species that came to North America from Europe. It was discovered in the eastern U.S. sometime before 1950 and has since spread to at least 47 states and three Canadian provinces. Eurasian watermilfoil can interfere with recreational and other uses of the lakes and rivers by producing dense mats at the water surface. These mats are similar to, but can be more extensive than those produced by native vegetation. Matted milfoil can displace native aquatic plants and alter environmental conditions, which in turn may harm fish and wildlife. Milfoil is spread from one body of water to another primarily by the introduction of plant fragments. Fragmentation is the principal means of reproduction in this species. A milfoil fragment only a few inches long can form roots and grow into a new plant. Milfoil fragments are most abundant from mid to late summer but can be transported from a lake year-round. Zebra mussels can colonize Eurasian watermilfoil and be moved to new locations along with the plant fragments.

Water Chestnut (*Trapa natans*)

European water chestnut is an aquatic plant native to Eurasia. It usually is rooted in the mud of quiet streams, ponds, freshwater regions of estuaries, and on exposed mud flats. Water chestnut bears a rosette of floating leaves (similar to small birch leaves) on a submersed stem usually three feet long but it may reach 15 feet. An inconspicuous flower with four white petals is located at the center of the leafy rosette. Water chestnut has become an AIS in North America because of its ability to reproduce rapidly and form extensive floating mats. It impedes navigation, interferes with recreation, and can impact aquatic ecosystems by eliminating other aquatic plant species in the shade of the floating canopy and because it has low food value for wildlife. Fish farming and baitfish harvest would be severely restricted by an infestation of water chestnut. In addition, it produces large, hard, nut-like fruits with sharp spines that can be hazardous to swimmers and people walking on beaches. The seeds can remain viable for up to 12 years.



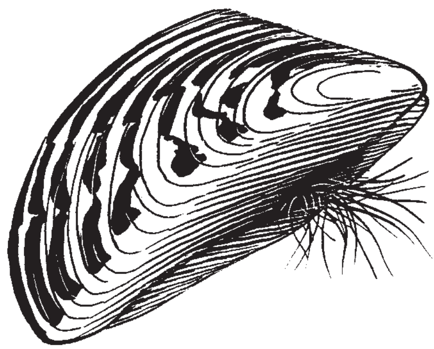
Hydrilla (*Hydrilla verticillata*)

Hydrilla is an extremely prolific aquatic plant that has already infested millions of acres of lakes, rivers, and irrigation systems throughout the southern U.S. Hydrilla resembles a number of plants, especially *Elodea*. The leaves are spear-shaped with saw-tooth edges. They have small spines on the underside of the leaf center vein, and the leaf margins are serrated. It was first found in a Florida river and drainage canal in 1960. It is believed to have been imported for aquariums.

When hydrilla invades, important native submersed plants are shaded out and eliminated. Near the water surface it branches profusely and produces greater stem density than any other submersed aquatic plant. As a result, recreational and commercial boating becomes difficult, seining or trapping fish is nearly impossible and swimming becomes unpleasant and even dangerous. Like Eurasian watermilfoil, hydrilla can form new plants from fragments containing one or more whorls of leaves. Hydrilla usually doesn't form seeds, but it is so efficient in using low light levels and available nutrients that the fragments can produce large stands in a few months. In the late summer to early winter hydrilla also produces structures called tubers from fragments that grow down into the bottom mud. Studies have shown that a single fragment of hydrilla can form thousands of tubers in one growing season. The tubers can rest for several years before sprouting, although many sprout the first spring after they form. These long-lived reproductive structures make hydrilla difficult to eradicate because the removal of plant material doesn't harm tubers. The presence of tubers also requires safe and proper disposal of dredge spoils.

Invertebrate Hazards

When live fish are harvested from infested waters, there is a risk of moving AIS invertebrates. These hazards can come with the fish and water, or cling to equipment used in infested waters. Some aquatic invertebrates can produce resting eggs that resist freezing and drying, and they can produce eggs and larvae that are too small to see without aid of a microscope. Other invertebrates, like zebra mussels, can attach to boats, equipment, and vegetation, and survive out of the water long enough to be moved to other waters. As a result, aquatic invasive invertebrates present differing challenges.

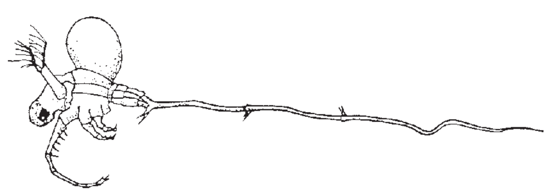


Zebra Mussels (*Dreissena polymorpha*)

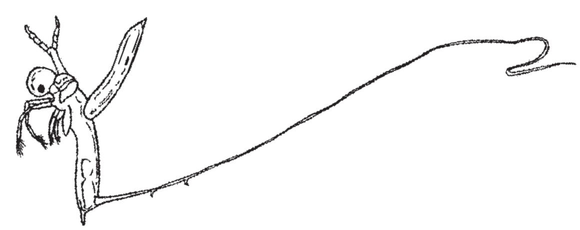
Zebra mussels were discovered in Lakes St. Clair and Erie in 1988. Since then, they have infested all the Great Lakes except Lake Superior (although some tributaries and bays are infested) and have spread to hundreds of inland lakes and to large river systems in the U.S. Closely-related quagga mussels (*Dreissena bugensis*) have also been found spreading throughout the Great Lakes. The rapid spread and abundance of both mussels can be partly attributed to their reproductive cycles. A fully mature female mussel may produce up to one million eggs per season. Eggs are fertilized outside the mussel's body and within a few days become free-swimming microscopic larvae called veligers that soon develop small clam-like shells. Veligers swim, feed, and drift with the current for three to four weeks before they settle on firm objects such as rocks, clams, docks, and boats. They attach to hard surfaces with sticky, secreted fibers called byssal threads. Zebra and quagga mussels can also colonize soft muddy bottoms when hard objects deposited on the mud serve as a substrate. As a few mussels begin to grow, they in turn serve as substrate for additional colonization, forming mats of zebra mussels over soft sediment.

Mussel colonies can reach densities of up to 100,000 mussels per square meter. Mussels filter phytoplankton from the water and so can reduce the food for zooplankton, which in turn are food for larval and juvenile fish as well as forage fish that support sport and commercial fisheries. This competition for phytoplankton, the base of the food web, could have negative and sustained environmental impacts. Zebra mussels have contributed to increased water clarity in areas they have infested. As a result, rooted aquatic plants have become a problem in some of these areas, because turbidity no longer shades them out. Filtering of the water by mussels has also resulted in noxious blue-green algae blooms in some areas. Zebra and quagga mussels also rapidly accumulate persistent contaminants and pass them up the food chain, which increases the risk of exposure to humans. The mussel's affinity for hard surfaces clogs pipes used to draw water from infested areas.

Power and municipal water treatment plants, industrial water users, irrigation systems, and even cooling water inlets of boat engines can be colonized and clogged. Native mussels (many of which were threatened or endangered already) have been completely eliminated as zebra mussels heavily colonized their shells. Zebra mussels also affect beaches. The sharp edge of mussel shells found in windrows along swimming beaches can be a hazard to unprotected feet. Because zebra mussels and quagga mussels can cause such dramatic problems for the environment and water users, including fish farmers and baitfish producers, it is imperative to keep this species out of uninfested waters and prevent them from entering aquaculture facilities.



Spiny Waterfleas (*Bythotrephes longimanus*)



Fishhook Waterfleas (*Cercopagis pengoi*)

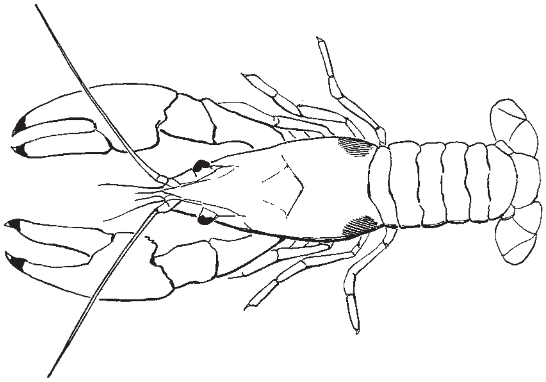
Spiny and fishhook waterfleas are easily recognized by their shapes. The tail spine is their distinguishing feature and separates them from all other free-swimming lake invertebrates, or zooplankton. The spine often comprises 70 to 80 percent of the animal's total length, and has from one to four pairs of thorn-like barbs. Fishhook waterfleas can be distinguished from spiny waterfleas by the loop at the end of their tails and by a more pointed brood pouch.

Spiny and fishhook waterfleas belong to the class Crustacea, a group of animals including crabs and shrimp that possesses a hard exoskeleton (outer shell). Like all other Crustacea, they shed their exoskeleton (molt) in order to grow. These waterfleas have a remarkable influence on the biological communities of the lakes they invade, largely because of their rapid reproduction. Females carry their offspring on their backs in a balloon-like brood pouch, which can be filled either with developing embryos or resting eggs. Frequently, females exhibit a rapid and unusual method of reproduction known as parthenogenesis, or asexual reproduction. By this method, females produce from one to ten eggs that develop into new females without mating or fertilization. Female offspring are genetic replicas of the mother. The generation time of this parthenogenic life cycle (embryo to adult female) varies with water temperature, because, as with all Crustacea, rates of metabolism rise and fall with temperature.

During the summer when the surface water of the lake is warm, spiny and fishhook waterfleas can produce a new generation without fertilization (parthenogenesis) in less than two weeks. Because males are not needed for parthenogenesis, they are rarely found when food is plentiful, or when environmental conditions favor rapid population growth. Sex of offspring is not determined genetically, but rather by environmental factors; when food becomes limited or when the lake cools in the fall, males are produced. Adult females sense declining environmental quality and respond by producing male rather than female offspring. These males mate with females to produce resting eggs. The resting eggs are carried as orange-brown spheres in the female brood pouch. They are later released and sink to the lake bottom where they can survive over winter. In spring or early summer, these eggs hatch into juvenile females that begin parthenogenic reproduction.

Resting eggs can remain dormant for long periods, offering an explanation for the arrival of these waterfleas in North America from northern Europe. Resting eggs also allow waterfleas to be easily spread to new waters if fishing lines, nets, or equipment are fouled with egg-laden females. Research has also shown that resting eggs can survive the passage through the alimentary canal of fish. Spiny and fishhook waterfleas eat smaller zooplankton like *Daphnia*. *Daphnia*, however, are also important food items for small, juvenile fish. These waterfleas thus compete directly with young fish for food.

To the detriment of some fish, rapid population growth enables invasive waterfleas to monopolize the food supply at times. Although fish eat spiny and fishhook waterfleas, small fish have difficulty swallowing their barbed spine. Growth rates and survival of these young fish may be adversely affected by the presence of spiny and fishhook waterfleas in the ecosystem, because of competition for food. Fishhook waterfleas have also become a significant nuisance to anglers. They catch on fishing lines while trolling, and accumulate in such high numbers and with such density at the tip of fishing rods that the line cannot be reeled in. At times, charter and recreational anglers have stopped fishing during periods of the waterfleas' peak abundance. Fishhook waterfleas also foul commercial fishing nets.



Rusty Crayfish (*Orconectes rusticus*)

Rusty crayfish have invaded portions of all New England states except Rhode Island. They have also been documented as AIS in New York, Pennsylvania, New Jersey, Illinois, Iowa, Missouri, Michigan, Minnesota, Wisconsin, New Mexico, and many areas in Ontario, Canada. Although native to parts of some Great Lakes states, rusty crayfish have caused a variety of ecological problems beyond their natural range. Anglers probably spread rusty by bringing them north as bait. As rusty crayfish populations increased, they were harvested for the regional bait market and for biological supply companies; such activities probably helped spread the species further.

Environmentally sound ways to eradicate or control introduced populations have not been developed, and none are pending. The best way to prevent further ecological problems is to prevent or slow their spread into new waters.

Mature rusty crayfish mate in late summer, early fall, or early spring. The male transfers sperm to the female, which she stores until her eggs are ready to fertilize, typically in the spring (late April or May) as water temperatures begin to increase. The stored sperm are released as eggs are expelled and external fertilization occurs. Because of this reproductive strategy, if a female has previously mated, theoretically one female crayfish could start a new population.

They are aggressive, often displacing native or existing crayfish species. Perhaps the most serious impact of invading rusty crayfish is the destruction of aquatic plant beds. Rusty crayfish have reduced aquatic plant abundance and species diversity. This can be especially damaging in lakes where beds of aquatic plants are not abundant. Although other crayfish eat aquatic plants, rusty crayfish eat more because of a higher metabolic rate. They also grow larger, hide less from predators (and therefore feed longer), and attain high population densities.

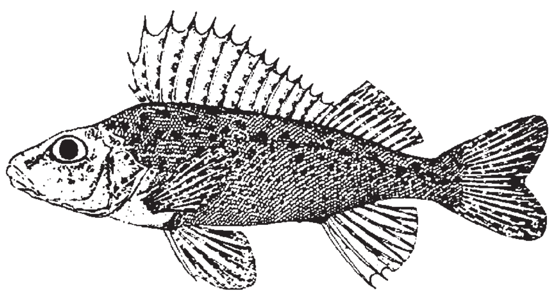
Rusty crayfish, especially juveniles, also feed heavily on benthic invertebrates like mayflies, stoneflies, midges, and side-swimmers. Rusty crayfish are estimated to consume twice as much food as similar-sized native species. Rusty crayfish are more likely to compete with juvenile game fish and forage species for benthic invertebrates than are native crayfish.

Fish eat rusty crayfish, but they are less desirable than many of the invertebrates they replace because of their thick exoskeletons. For fish, less food or lower food quality means slower growth, which can reduce survival.

Rusty crayfish may harm fish populations by eating fish eggs. While rusty crayfish consume fish eggs, their relationship to fishery declines is unstudied. Observations and circumstantial evidence suggest that bluegill, bass, and northern pike populations frequently decline following introduction of rusty crayfish. The declines are probably a result of reduced abundance and diversity of aquatic plants, but reduced food (such as mayflies, midges, and side-swimmers) and egg predation may also play a role. Because impacts and population abundance of rusty crayfish vary in lakes that appear similar, it is not possible to predict what will happen when they invade a new lake. Nevertheless, rusty crayfish are clearly an aggressive AIS. Cabin owners on heavily-infested northern Wisconsin and Minnesota lakes have even stopped swimming because rusty crayfish occupy their favorite swimming area throughout the day. They fear getting pinched by this large-clawed crayfish.

Fish and Other Vertebrate Hazards

When live fish are harvested from infested waters, aquatic invasive fish or other vertebrates like amphibians or reptiles might be moved to uninfested waters. These hazards can come with the fish or the water used to haul the fish. Separating fish or other vertebrate AIS after harvest is difficult and is best accomplished by preventing an infestation in your ponds or facility or by harvesting during times of the year or times of the day when fish are spatially segregated.

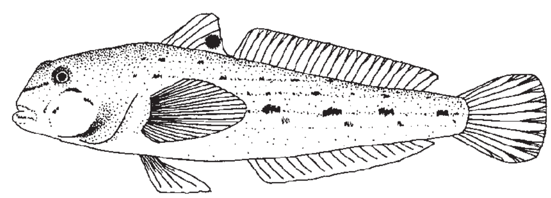


Eurasian Ruffe (*Gymnocephalus cernuus*)

Eurasian ruffe are small (typically four to six inches), aggressive fish native to Eurasia. They were introduced into the St. Louis River, a tributary of western Lake Superior, in the mid-1980s from the release of freshwater ballast from ocean-going vessels. Because ruffe mature quickly, have a high reproductive capacity, adapt to a wide variety of environments, and compete with native fishes, they are considered a serious threat to the delicate predator-prey balance vital to sustaining healthy commercial and sport fisheries across North America. They have a faster first-year growth rate than most of their competitors.

Due in part to a high reproductive rate, ruffe populations can rapidly increase. For example, ruffe became the most abundant fish in the St. Louis River in less than ten years. Ruffe prefer darkness and spend their days in deeper water, moving into the shallows to feed at night. They have a well-developed system of subsurface canals on their head and lateral line that contain sensory organs called neuromasts. Neuromasts give ruffe the ability to detect extremely small vibrations given off by both predators and prey. This allows them to avoid predators and to find prey in nearly complete darkness, giving them a competitive advantage over native fishes.

Ruffe have spread about 190 miles east of Duluth along the south shore of Lake Superior. They were also moved via ballast water to Thunder Bay, Ontario, on Lake Superior, to Alpena, Michigan, on Lake Huron, and to northern Lake Michigan. There is concern that ruffe may negatively impact yellow perch populations in the Great Lakes. Yellow perch are an extremely valuable recreational and commercial species that in the past experienced recruitment problems in a number of the Great Lakes. Ruffe reportedly consume fish eggs, which could harm native fish populations in areas where ruffe become abundant.



Round Goby (*Neogobius melanostomus*)

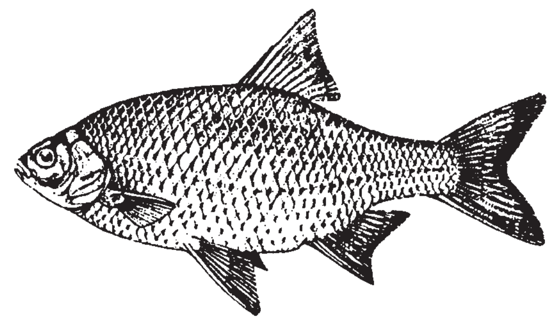
Round gobies were first discovered in the St. Clair River, the channel connecting Lakes Huron and St. Clair, in 1990. This species comes from around the Black and Caspian seas, the same area of the world as the zebra mussel. They most likely arrived in ballast water discharged by transoceanic vessels. When they reach a new area gobies are capable of rapid population growth. Densities of round gobies in rocky areas have exceeded 300 per square meter.

Round gobies are bottom-dwelling fish that sit on rocks and other substrate. They are typically 0.5 to 5.5 inches, but can grow to ten inches.

Gobies have large heads, soft bodies, and dorsal fins lacking spines; they loosely resemble large tadpoles. Their unique feature is a fused pelvic fin, which forms a suctorial disk. In flowing water, this suction cup-like disk aids in holding the fish to the substrate. Round gobies look similar to sculpins, a native, bottom-dwelling fish occasionally caught by anglers. Round gobies possess four characteristics that make them effective invaders:

- Aggressiveness–they feed voraciously and may eat the eggs and fry of native fish such as sculpins, darters, and log perch. They also aggressively defend spawning sites in rocky habitats.
- A well-developed sensory system–their ability to detect movement is enhanced allowing them to feed in complete darkness, which gives them an advantage over native fish.
- Robustness–they are able to survive under degraded water quality conditions.
- Extended spawning–they spawn over a long period during summer, taking advantage of optimal temperature and food conditions.

The diet of round gobies consists mainly of clams, zebra mussels and large invertebrates, but they also eat fish eggs, small fish, and insect larvae. Round gobies have reduced local populations of sculpins. Predation on eggs and fry of lake trout and lake sturgeon may limit recruitment of these species in the Great Lakes. Because zebra mussels concentrate contaminants and gobies feed heavily on them, gobies can increase contaminants in other fish that feed on them. Gobies have also proven a nuisance to anglers because they aggressively take live bait and interfere with fishing for more desirable species.



Rudd (*Scardinius erythrophthalamus*)

The rudd, a member of the minnow family, is widely distributed throughout western Europe and Asia. Rudd were intentionally stocked in North America beginning in the 1920s. Escape from waters where rudd were introduced, extensive propagation as a bait species by southern states, subsequent importation by other states, and release from bait buckets have resulted in numerous inland introductions of rudd in at least 11 states.

In North America, the extent of successful natural reproduction is unknown because rudd have been found at low densities at most locations. Rudd closely resemble a common baitfish, the golden shiner, and show similarities to goldfish. In Europe, rudd frequently hybridize with closely related minnow species. As adults, rudd primarily feed on submersed aquatic vegetation. They can consume up to 40 percent of their body weight in aquatic vegetation per day. Rudd inhabit quiet surface waters and shallow areas along the shorelines of lakes, river backwaters, and canals. They seldom move into open water.

Rudd reportedly do not compete effectively with other minnow species in Europe, but may compete with trout and the plankton-eating fry stages of perch and pike. They are frequent prey of European northern pike, perch, and brown trout. While rudd may not appear as much of a nuisance as some other AIS, rudd may have several impacts in North America:

- Accelerate the aging process of infested lakes–rudd consume large amounts of aquatic vegetation, promoting the release of nutrients through fecal waste and broken plant fragments. Phosphorus and other nutrients can increase algal blooms and reduce water clarity.

- Reduce the reproductive success of native fish–the depletion of aquatic vegetation in near shore areas may damage spawning sites or nursery habitats.
- Hybridization–rudd may hybridize with golden shiners. Although rudd-shiner hybrids were found to be sterile, the reproductive success of golden shiners and other native species could be affected.
- Competition–rudd may compete with young native fish for food and habitat.

Asian Carp

black (*Mylopharyngodon piceus*)
grass (*Ctenopharyngodon idella*)
silver (*Hypophthalmichthys molitrix*)
bighead (*Hypophthalmicthys nobilis*)

Carp have been intentionally brought into North America from Asia for a variety of reasons. Grass carp have been used effectively for aquatic vegetation control. Black carp have been used to control snail populations that serve as an intermediate host for a parasitic trematode, the yellow grub, which infects cultured catfish. Bighead carp were introduced into private fish farms to control phytoplankton and improve water quality. Silver carp were also imported for phytoplankton control and as a food fish.

The native ranges of these carps include Pacific drainages centered primarily in China. These carps have escaped or have been released into natural waters of the U.S. The grass carp has the widest distribution while the black carp has the most restricted (Approximately 30 escaped into the Osage River, Missouri when high water flooded hatchery ponds in 1994). All except the black carp are reproducing in the wild.

Potential environmental impacts of the four Asian carps differ by species. Black carp could negatively impact native aquatic communities by feeding on and reducing, populations of native mussels and snails, many of which are considered endangered or threatened. Because bighead carp are planktivorous and attain a large size, they can deplete zooplankton populations. A decline in the availability of plankton can reduce populations of native species that rely on plankton for food, including all larval fishes, some adult fishes, and native mussels. Adult fishes most at risk from such competition in the Mississippi and Missouri rivers are paddlefish, bigmouth buffalo, and gizzard shad. Like bighead carp, silver carp could damage native species because they feed voraciously on plankton required by larval fish and native mussels. This species could also compete with adults of some plankton-eating native fishes, such as gizzard shad. The effects of grass carp introduction on a water body are complex and apparently depend on the stocking rate, macrophyte abundance, and community structure.

Negative effects involving grass carp include competition for food with invertebrates (e.g., crayfish) and other fishes, significant changes in the composition of macrophyte, phytoplankton, and invertebrate communities, interference with the reproduction of other fishes, and decreases in nursery areas and habitat for other fishes. In addition, grass carp may carry parasites and diseases known to be transmissible or potentially transmissible to native fishes. For instance, it is believed that grass carp imported from China were the source of the Asian tapeworm (*Bothriocephalus acheilognathi*) in North America.

For more information on Aquatic Invasive Species visit these Web sites:

http://nas.er.usgs.gov

http://www.sgnis.org

http://www.great-lakes.net/envt/florafauna/invasive/invasive.html

http://www.glc.org/ans/anspanel.html

http://www.nbii.gov/invasive/spp.html

http://www.entryway.com/seagrant/

http://www.ucc.uconn.edu/~wwwsgo/aen.html

http://www.seagrant.umn.edu/exotics/

http:// www.miseagrant.umich.edu

http://www.iisgcp.org

http://www.protectyourwaters.net

http://www.whirling-disease.org

Getting Ready for HACCP

Objective:

- Describe the steps preceding AIS-HACCP planning

AIS-HACCP systems are designed to prevent and control AIS hazards associated with wild baitfish harvest/aquaculture operations from harvest to distribution, and they can also be incorporated into resource management, field research, and enforcement operations. AIS-HACCP systems must comply with current Best Management Practices (BMPs). See Appendix 1 for a list of common BMPs. BMPs are activities routinely conducted to ensure healthy, lively, good quality bait that is as free of other aquatic organisms as possible. BMPs affect every aspect of baitfish and aquaculture operations and should be prerequisite to AIS-HACCP.

Preliminary Steps

HACCP is often thought of in terms of its seven basic principles. However, it also includes five preliminary steps. Failure to properly address the preliminary steps may lead to ineffective design, implementation, and management of the AIS-HACCP plan. These steps are summarized in Appendix 2, and reviewed fully in the following chapters.

1) Management Commitment

For an AIS-HACCP plan to work, it is extremely important to have the support of everyone in the company or agency. Without it, the plan will not become a company or agency priority or be effectively implemented.

2) AIS-HACCP Training

Education and training are important elements in developing and implementing an AIS-HACCP program. Employees who will be responsible for the AIS-HACCP program must be adequately trained in its principles. This course is designed to meet that need.

3) AIS-HACCP Team Assembly

Assembling a team is an important step in building an AIS-HACCP program. Although one person may be able to analyze hazards and develop a plan successfully, many businesses and agencies find it helpful to build a team. When only one person develops the AIS-HACCP plan, some key points can be missed or misunderstood. The team approach minimizes this risk. It also encourages ownership of the plan, builds company or agency involvement, and brings in different areas of expertise. Teams can also include people from Sea Grant, resource management agencies, Cooperative Extension, universities or community colleges, or other local experts. Generic AIS-HACCP examples (see appendices 4-7), and published information on AIS can provide additional assistance.

4) Description and Intended Use of Product

Once a HACCP team is established, the members first describe the product and/or the process that may spread AIS. In the case of management, research, and enforcement activities, actions that potentially spread AIS must be described. In the case of aquaculture or baitfish production, the product, its distribution, intended customers (e.g., wholesale bait dealers, bait retailers, sport anglers, private pond/lake owners), and consumer use of the product (e.g., bait for sportfishing, forage fish, stocking in sportfish ponds or aquaculture operations, fish for fee operations, food) must be described.

5) Development and Verification of the Product or Process Flow Diagram

A flow diagram (see Appendix 3, and appendices 4-7) shows the steps involved in the research, management, enforcement, or fish production activity. This step provides an important visual tool that the AIS-HACCP team can use to complete the remaining steps of the plan. Only a clear, simple, but complete, description of the process is needed. It is important to include all the steps within the control of the agency or business developing the AIS-HACCP plan. The flow diagram should be clear and complete enough so that people unfamiliar with the process can quickly comprehend your operational procedures. Since the accuracy of the flow diagram is critical to conduct a hazard analysis, the steps outlined in the diagram must be verified. If a step is missed, a significant hazard may not be addressed. The AIS-HACCP team should evaluate the entire process or operation and make any changes required in the flow chart. The evaluation allows each team member to gain an overall picture of how the process or operation is conducted.

Principle 1: Hazard Analysis

Objectives:

- Describe hazard analysis
- Demonstrate the use of a hazard analysis worksheet
- Present the concept of control measures to control AIS hazards

The hazard-analysis step is fundamental to the AIS-HACCP system. To establish a plan that effectively prevents the movement of AIS, it is crucial to identify significant AIS hazards and measures to control them. As previously stated, a hazard is an AIS fish or other aquatic vertebrate, invertebrate, plant, or pathogen that may be spread to new water bodies.

Considerations for the HACCP Team

During the hazard analysis, the significance of each potential hazard should be assessed by considering risk (likelihood of occurrence) and severity. The estimate of risk is usually based upon a combination of experience, AIS infestation data, and information in the technical literature. Severity is the seriousness of a hazard and defining this will require close communication with resource management agencies and university experts.

For some AIS-HACCP plan developers, the expertise necessary to properly assess the risk and severity of the AIS hazards is available within the agency or company.

The HACCP team has the initial responsibility to decide which AIS hazards are significant and must be addressed by the HACCP plan. Keep in mind that there may be differences of opinion, even among experts, as to the significance of a hazard. The HACCP team may rely on guidance materials and the opinions of experts who assist in the development of HACCP plans.

Hazard Analysis

One approach to hazard analysis divides it into two activities: brainstorming and risk assessment. Brainstorming should result in a list of potential hazards at each operational step (see Figure 1, page 25) in the process.

All potentially significant hazards must be considered. To assist in this, the following AIS hazards should be addressed:

- Pathogens (e.g., whirling disease, spring viremia of carp)
- Plants (e.g., Eurasian watermilfoil)
- Invertebrates (e.g., spiny and fishhook waterfleas, zebra mussels)
- Fish (e.g., round gobies, ruffe) and other aquatic vertebrates (nuisance amphibians or reptiles)

After identifying hazards, the team conducts an analysis of the risks and severity of each of the AIS hazards to determine the significance of potentially moving these to new waterbodies. However, AIS-HACCP focuses solely on significant hazards that are reasonably likely to occur. Without this focus, it would be tempting to try to control too much and lose sight of truly relevant hazards.

Hazard Analysis Worksheet

A hazard analysis worksheet can be used to organize and document the considerations in identifying AIS hazards (see appendices 4–7). A blank worksheet is available in Appendix 8. List each step in the process flow diagram in column 1. Record the results of the hazards brainstorming in column 2. Record the results of the risk assessment in column 3, with the justification for accepting or rejecting the listed potential hazards in column 4.

Control Measures

Control Measures: Factors that can be used to control an identified aquatic invasive species hazard (sometimes referred to as a preventive measure).

Control measures are actions and strategies that can be used to prevent or eliminate an AIS hazard or reduce it to an acceptable level. In practice, control measures encompass a wide array of actions.

For each identified potential hazard on the hazard analysis worksheet, describe in column 5 control measures that may be used to control or prevent the hazard. If the hazard will be controlled at a subsequent step, then simply state that in column 5. See examples in appendices 4–7.

First-time HACCP writers often identify too many hazards! This can dilute your ability to focus efforts and control the truly significant hazards. Accordingly, it is essential that only significant AIS hazards be identified and controlled with the HACCP system. The dilemma is deciding what is significant. A hazard must be controlled if it is: 1) reasonably likely to occur, AND 2) if not properly controlled, it is likely to result in an unacceptable risk of spreading AIS to new water bodies.

Examples of Control Measures

An important difference between the seafood HACCP program and this one is that science-based controls are currently lacking. As a result, control measures are best determined with the help of resource management agencies, Sea Grant, university, college, or other local experts. The following are examples of possible control measures (not proven controls) that could be applied to three types of hazards:

1. Fish Hazards Example – Eurasian ruffe

In ruffe-infested waters, harvest baitfish during the day in the shallow water where the ruffe are unlikely to occur. If there is a chance that ruffe have been harvested with baitfish and if there is an appropriate size difference, separate ruffe from the baitfish with grading steps at the holding facility.

2) Invertebrate Hazards Example - Waterfleas

In spiny waterflea- and fishhook waterflea-infested waters, harvest baitfish in spring or early summer when females are not present or not carrying resting eggs. Females carrying resting eggs quickly die when removed from the water on nets and other gear, but resting eggs can survive. Because waterfleas are not strong swimmers they can be separated from fish in holding facilities using proper flow control.

3) Plant Hazards Example – Eurasian Watermilfoil

Remove all plant fragments during the harvest and holding steps.

4) Pathogens Hazards Example – Whirling Disease

Remove all mud from boots, nets, and other equipment before leaving a water body containing whirling disease or have designated (with appropriate tags) equipment that is only used in whirling disease-infested waters.

Case Study: White Perch

White perch (*Morone americana*) are members of the temperate bass family, native to both fresh and salt water along the Atlantic coast, including some landlocked coastal ponds and lakes. The species is thought to have entered the Great Lakes above Niagara Falls via the Erie Canal, which connects Lake Erie to the Hudson River drainage. A pair of adult white perch was captured in Lake Erie in 1953, but they did not become abundant until the early 1980s. By 1988, white perch were described as Lake Erie's second most abundant species.

The discovery of white perch in the Ohio River during the early 1990s brought a double measure of concern to fisheries management agencies. The findings showed that this invasive species had reached an extensive inland drainage system, but also raised a serious question: had white perch been introduced to the Ohio River through stocking efforts as agencies imported the similar striped bass (*Morone saxatilis*) from the East Coast to enhance sport fishing?

A more likely pathway became apparent when a private lake manager in southeast Ohio contacted Ohio Sea Grant Extension to inquire about potential commercial markets for the large number of white perch he was removing from his chain of four membership-only fishing lakes. An investigation showed that the lakes indeed contained large populations of white perch. Multiple age classes were present, indicating successful reproduction, and many of the fish were quite large, ranging up to 250 mm (10 inches).

These four lakes are connected by an overflow drainage that leads into Little Beaver Creek, a tributary of the Ohio River. They receive overflow water from other pay fishing lakes situated further up the basin. The lakes typically spill their dams during heavy storms in late spring, a time when larval and juvenile white perch are present.

Discussions with the lake manager concerning possible origins of the white perch revealed that several years previously, managers of the upstream pay lakes purchased white bass (*Morone chrysops*) from Lake Erie to stock for fishing. These white bass are captured in shore seining operations and transported from Lake Erie to pay fishing lakes in southern Ohio and neighboring states. White bass and white perch, being in the same genus, look confusingly similar. Probably white perch were present in one or more shipments and became established in the stocked lakes. During spring overflows, their young were carried into the downstream lakes and eventually into the Ohio River.

White perch have established a viable population in the Ohio River, giving them potential access to the entire Mississippi River drainage. This range expansion of an AIS might have been prevented if a program such as AIS-HACCP had been available in the early 1980s. AIS-HACCP training for live fish haulers in Ohio is planned.

Principle 2: Determine the Critical Control Points

Objectives:

- Define critical control point (CCP)
- Examine the relationship between a significant hazard and a CCP
- Discuss how a CCP may change between species, raised/harvested, and different AIS
- Review the use of a decision tree to select a CCP
- Offer examples of CCPs

For every significant hazard identified during the hazard analysis (Principle 1) there must be one or more critical control points (CCPs) where the hazard is controlled. The CCPs are the points in the process where the HACCP control activities will occur.

Critical Control Point: Any point, step or procedure at which aquatic invasive fish or other aquatic vertebrates, invertebrates, plants, and pathogens can be controlled.

Hazards can be prevented at CCPs.

In some cases AIS hazards can be eliminated by:

- Avoiding infested waters.
- Choosing when, where, and how to sample or harvest.
- Tagging fishery management, research, and enforcement equipment used in infested waters for use *only* in infested waters.
- Treating all equipment used in infested waters with chemicals, dehydration, freezing or other appropriate measures to kill AIS.
- Separating AIS from baitfish or fish for stocking while in holding through grading, chemical treatment, or other control measures.
- Separating AIS manually from baitfish or other live fish.
- Selling the contaminated baitfish or other fish for purposes other than release into public waters (e.g., sell fish for growout in recirculation aquaculture).
- Culturing only sterile AIS.

Control Point: Any step at which AIS can be controlled.

It may not be possible to fully eliminate or prevent a hazard. In some cases and with some hazards, minimization may be the goal of the AIS-HACCP plan, yet addressing all AIS hazards is important. Resource management agencies and others developing AIS-HACCP plans should acknowledge and understand any limitations of the AIS-HACCP plan to control particular hazards. When AIS-HACCP plans cannot satisfactorily control AIS hazards, other approaches to prevent the spread will be required.

CCPs vs. Control Points

Some points in the flow diagram may be control points but not CCPs. A HACCP plan can lose focus if points are unnecessarily identified as CCPs. Only points at which significant AIS hazards can be controlled are considered CCPs. A tendency exists to designate too many CCPs.

A CCP should be limited to that point or those points at which control of the significant hazards can best be achieved. For example, an AIS plant fragment can be controlled by avoiding infested areas of the lake, by picking each fragment off of a net before leaving the lake, and by freezing the net for 48 hours before going to uninfested waters. However, avoiding infested areas or picking off plant fragments would not necessarily be considered CCPs if freezing the net for 48 hours best controlled the hazard. Differentiating between CCPs and control points will vary from operation to operation and depend on their unique situation. When designating CCPs, consider any applicable state statutes or rules. For example, if it is illegal to transport AIS overland, then CCPs must comply.

Multiple CCPs and Hazards

A CCP can be used to control more than one hazard. For example, holding fish in flowing water for 12 hours might be a CCP to separate baitfish from AIS plant fragments and *Daphnia lumholtzi* because neither can swim against the current and will be flushed from the system. Likewise, more than one CCP may be needed to control a hazard. In controlling plant fragments, both the flow rate and the length of time fish are held in the tank could be CCPs if holding time to eliminate AIS plant fragments is based on a minimum flow rate. An example of a CCP used to control more than one management, research, and enforcement AIS hazard might be pressure washing all boats, trailers, and equipment after leaving infested waters. This could eliminate plant fragments, zebra mussels, and mud (that might transmit whirling disease).

CCPs are Product- and Process-Specific

CCPs identified for one process or product may be different for the same process or product in a different situation. For example, the hazards of dip-netting shiners at night may be quite different than seining shiners during the day from the same infested water body. Also, the hazard of management, research, and enforcement activities for moving larval zebra mussels differ depending on the time of year. CCPs can differ for the same process or product because the hazards and the best points for controlling them may change with differences in:

- Sampling/harvest methods
- Facility layout
- Holding tank design
- Transportation techniques
- Type and use of equipment
- Source of water

Species behavior relative to conditions

Although HACCP models and generic HACCP plans can be useful in considering CCPs, each process or product must be considered separately. See appendices 4–7 for examples of CCPs.

CCP Decision Tree

In Principle 1, you learned how to determine where hazards enter a process. Often the best place to control a hazard is at the point of entry. But this is not always true. The CCP can be several steps away from the point where the significant hazard is introduced. A series of four questions can help to identify CCPs for a process (see questions below and Figure 1, page 25). The questions are referred to as the CCP Decision Tree and are asked at each step identified in Principle 1 with a significant hazard. Properly used, the CCP Decision Tree can be a helpful tool in identifying CCPs.

Question 1. Do control measures exist at this step or subsequent steps for the identified hazard?

If your answer is "yes," ask question 2.

If your answer is "no," then ask, "Is control at this step necessary to prevent or minimize the hazard?" If this answer is "no" too, the step is not a CCP for that hazard. If the answer is "yes," then you have identified a significant hazard that is not being controlled. In this case, the step, process or product must be redesigned to include a control measure. Sometimes there is no reasonable control measure available. In such cases, HACCP does not provide assurance that the process or product is AIS-free.

Question 2. Does this step eliminate or reduce the likely occurrence of a significant hazard to an acceptable level?

Consider if this is the best step at which to control the hazard. If the answer is "yes," then the step is a CCP; move to the next significant hazard. If the answer is "no," ask question 3.

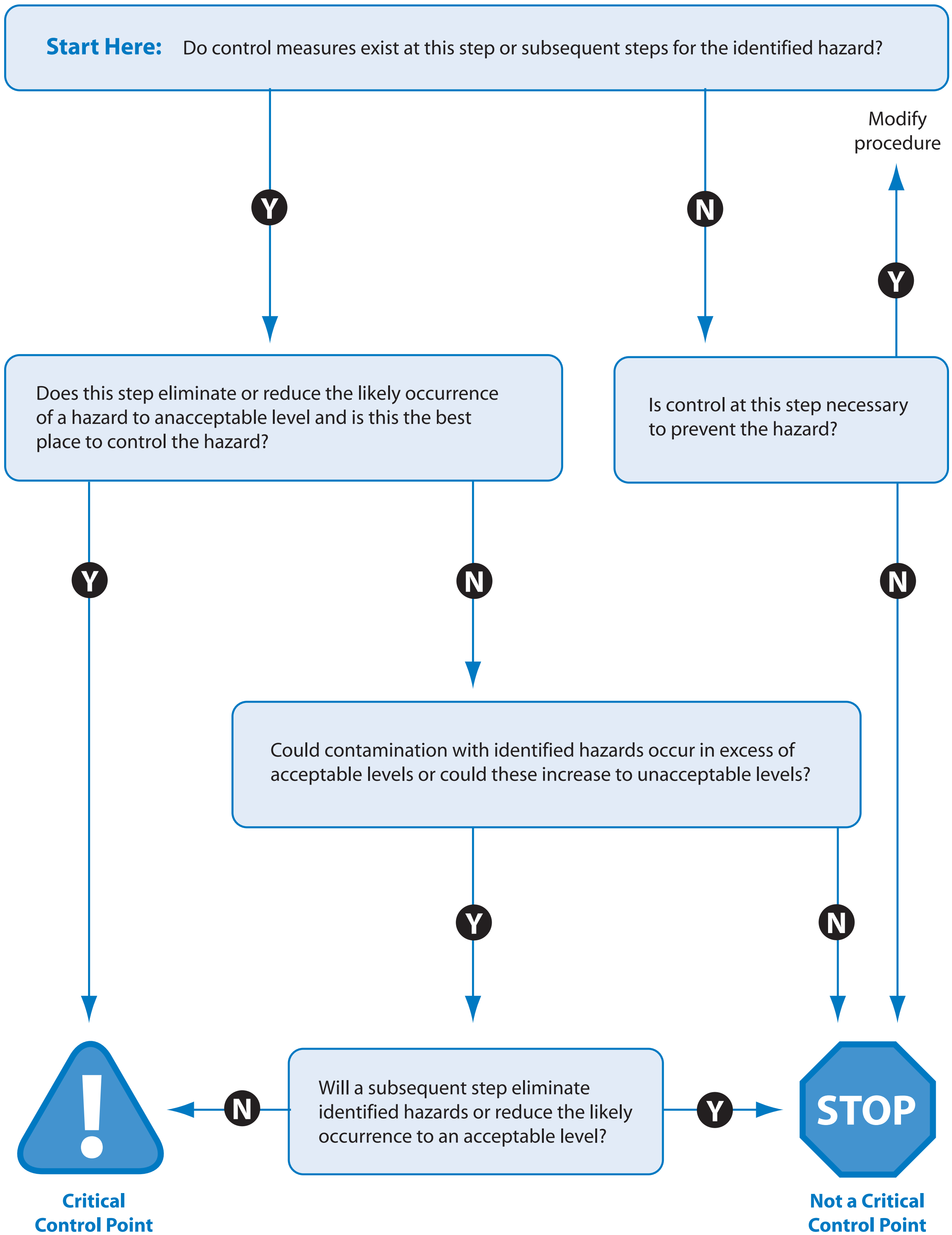
Question 3. Could contamination with a hazard or hazards occur, or increase at this step?

For example, if you continue to add fish harvested from infested waters to holding tanks, you may be adding an AIS that had already been removed from the system. If the answer is "no," then the step is not a CCP for that hazard. If the answer is "yes," then ask the fourth question.

Question 4. Will a subsequent step eliminate the hazard or hazards or reduce the likely occurrence to an acceptable level?

If you answer "no," then this step is a CCP. If you answer "yes," then this step is not a CCP for this hazard. In this case, be sure the hazard is controlled by a subsequent processing step.

Figure I–CCP Decision Tree



Case Study: New Zeland Mudsnail

New Zealand mudsnails (NZMS, *Potamopyrgus antipodarum*) are an invasive species in North America. They breed rapidly, survive in high densities, and change their newfound environments in fundamental ways. NZMS can reach densities of 750,000 per square meter. Fishery managers and ecologists are concerned that NZMS could spread across the continent and damage populations of native species by taking over space and grazing. Invertebrate studies show serious declines in midge and mayfly populations in the rivers of western North America where mudsnails are present. Widespread changes to the foundations of freshwater aquatic food webs are expected if mudsnails hitchhike their way across the continent.

In New Zealand, where these mudsnails are native, several trematode parasites and at least three fish species are controlling populations. NZMS have a great capacity for reproduction. They produce clones asexually, meaning a single snail can create a new population. One snail can release over 200 juveniles per year, so a single individual could be responsible for a population of 3,000,000 to 4,000,000 snails in two years.

NZMS were detected in central Idaho's Snake River in 1987. No one really knows how NZMS found their way to the mountain states of western North America, but some speculate that mudsnails were shipped to a western fish hatchery along with trout eggs being used by private and government hatchery managers to supplement mountain fisheries.

Hatchery managers, whose jobs include maintaining and improving recreational fisheries by stocking fish, often hatch trout eggs and grow fish in their hatcheries for planting in American streams. They sometimes use eggs from other regions to supplement local egg supplies, in part because they want to provide anglers with diverse fishery populations. In the process of importing eggs, which arrive in small refrigerated boxes, hatchery biologists routinely treat their supplies with agents such as iodine and hydrogen peroxide (for disinfecting and anti-fungal protection, etc.) to reduce the chance that common diseases will affect the stock. Although sanitizing agents control fungi and diseases, the NZMS has a defense mechanism allowing some individuals to survive: NZMS have a tiny cover for their shell opening (called an operculum) that they can close when they experience environmental stress. These very small snails could have arrived in North America in a box of trout eggs and, with their opercula closed, survived the hatchery manager's sanitizing treatment.

Following the AIS-HACCP process, biologists determined there is no known method of "cleaning" fragile trout eggs to insure the death of hitchhiking NZMS. Therefore, biologists must make sure their egg supplies are AIS-free upon ordering.

Recent research shows that thoroughly freezing or drying potentially contaminated equipment is a simple control method to limit the spread of the NZMS to uninfested areas. Such control methods could be easily incorporated into AIS-HACCP plans

Principle 3: Establish Controls

Objectives:

- Define controls used at each critical control point
- Describe how to establish controls
- Describe operating limits

Controls must be established for each CCP identified in the hazard analysis. A control represents the boundaries that are used to ensure that a process or product is AIS-free. Each CCP must have one or more controls for each significant AIS hazard. When the process deviates from the control limits, corrective action must be taken to ensure an AIS-free product. Examples of controls might be a minimum flow rate and time that baitfish are held in the holding tank to ensure that aquatic invasive plant fragments are trapped in the outlet filters. In this case, adhering to a minimum flow rate and time controls the aquatic plant hazard. In the case of management, research, or enforcement activities an example might be to freeze nets or other equipment for a specific time period during which both temperature and time must be monitored.

Control: (a) (verb) To manage the conditions of an operation to maintain compliance with established criteria. (b) (noun) The state in which correct procedures are being followed and criteria are being met.

Establishing Controls

In many cases, the appropriate control may not be readily apparent or available. Tests may need to be conducted or information gathered from sources such as scientific publications, regulatory guidelines, experts, or experimental studies. If the information needed to define controls is not available, a conservative value should be selected. The rationale and reference material used to establish controls should become part of the support documentation for the HACCP plan.

Control Limit: A criterion that must be met for each control measure associated with a critical control point.

Often a variety of options exist for controlling a particular hazard. Practicality and experience typically drives the selection of the best control option and the best control limit.

In many cases, it is not practical to continually monitor the harvested wild baitfish, wild fish, or cultured fish to ensure there are no AIS. Alternatively, controls may be set to assure that the harvest/holding/grading practices achieve the necessary elimination or containment of AIS.

Establishing Operating Limits

If monitoring shows a trend toward lack of control at a CCP, personnel should take action before the control limit is exceeded. The point where personnel take such an action is called the operating limit. Operating limits should not be confused with control limits. Operating limits are more stringent and thus established at a level that would be reached before the control limit is violated.

Operating Limit: Criteria that are more stringent than critical limits and that are used by responsible personnel to reduce the risk of AIS contamination. For example, if a certain chemical concentration is required to control an AIS hazard, the operating limit is generally set above the minimum concentration needed to ensure effective treatment.

The process should be adjusted when the operating limit is exceeded to avoid violating critical limits. These actions are called process adjustments. A processor may use these adjustments to avoid loss of control and the need to take corrective action. Spotting a trend toward loss of control early and acting on it can save added stress on fish caused by procedures to separate AIS, or worse yet, product destruction.

Corrective action is only required when the control limit is exceeded. For example, a control limit could involve equipment only used in infested waters unless it has dried for 7 days. The control limit is drying for 7 days, but if the process is conducted outside and the weather has been cool and damp, sufficient drying may not have occurred to eliminate the hazard. In this case, an operating limit might be 7 days without rain. This example demonstrates how operating limits might be used.

Operating limits may be selected for various reasons:

- For quality (e.g., separating fish by species & size)
- To avoid exceeding a control limit (e.g., a flow rate in holding tanks could be higher than the control limit to ensure that any aquatic plant fragments are trapped in the outlet filter or a disinfectant solution could be stronger than needed to ensure control)

When a corrective action is necessary, operators must be able to identify and segregate the affected equipment or lots of fish. If lot sizes are big, segregation and corrective action are more difficult but still necessary, even if control limits were exceeded for only a small amount of the product. Segregating fish into smaller holding tanks means far less product may be involved when a violation of a control limit occurs. Consequently, wise operators keep fish harvested from certain locations segregated from other fish already in the holding facility.

See appendices 4-7 for sample controls and control limits.

Principle 4: Critical Control Point Monitoring

Objectives:

- Define monitoring
- Explain the need for monitoring
- Design a monitoring system
- Review methods and equipment used for monitoring controls
- Examine frequency of monitoring
- Define who should monitor

Monitoring is important to ensure that the controls designed to eliminate or minimize AIS hazards are consistently met.

Monitor: To conduct a planned sequence of observations or measurements to assess whether a CCP is under control and to produce an accurate record for future use in verification.

Purpose for monitoring:

- To identify trends that may require adjustments to ensure continued control over the hazards
- To identify when there is a loss of control (a deviation occurs at a CCP)
- To provide written documentation of the hazard control system

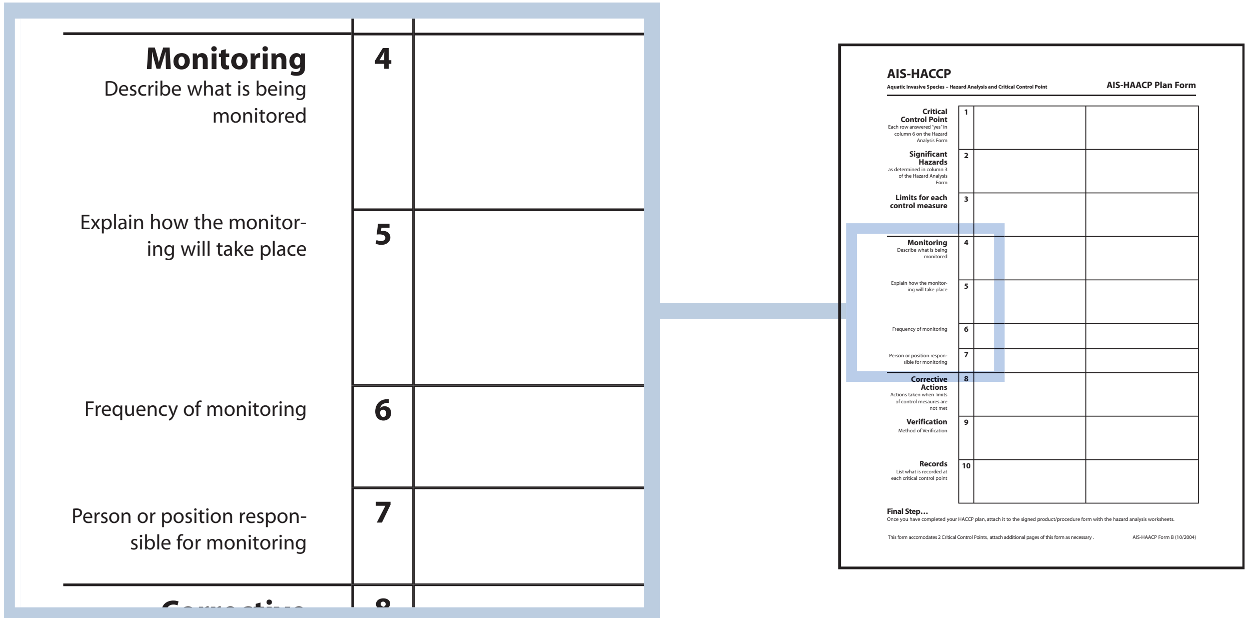
Monitoring is the process that personnel rely upon to maintain control at a CCP. Accurate monitoring indicates when there is a loss of control at a CCP and a deviation from a control limit. When a control limit is compromised, a corrective action is needed. Reviewing the monitoring records and finding the last recorded value that meets the control limit can determine the extent of the problem needing correction. Monitoring also provides a record that production and processes were completed in compliance with the AIS-HACCP plan, which is useful for verification as discussed in Principle 7.

Design of a Monitoring System

The preventive measures discussed in Principle 1 and the control limits discussed in Principle 3 are intended to control the hazards at each CCP. Monitoring procedures are used to determine if the preventive measures are being enacted and the control limits are being met.

Monitoring procedures must identify:

- What will be monitored (column 4)–usually a measurement or observation to assess if the CCP is operating within the control limit.
- How the control limits and preventive measures will be monitored (column 5)–usually physical or chemical measurements or observations.
- How frequently monitoring will be performed (column 6)–can be continuous or intermittent.
- Who will perform the monitoring (column 7) –someone trained to perform the monitoring task.



Specify the monitoring procedure for each CCP in columns 4-7 on the AIS-HACCP Plan Form.

What will be Monitored

Monitoring may mean measuring a characteristic of the product or of the process to determine compliance with a control limit. Examples include:

- Measurement of water flow rate or tank water exchange rate
- Measurement of freezer temperature when freezing nets to kill AIS
- Observations of the presence/absence of AIS
- Measurements of any chemical concentrations for treatments used to kill AIS
- Determination of the sex or ploidy of cultured AIS
- Observation of the effectiveness of pressure washing boats, trailers, nets, and other equipment

Monitoring may also involve observing if a preventive measure at a CCP is being performed. For instance:

- Checking with management agencies for lists of infested waters
- Checking that fish purchased from wholesalers did not come from AIS-infested waters

How Control Limits and Preventive Measures will be Monitored

Monitoring must be designed to provide rapid (real-time) results. There is no time for lengthy analytical testing because control limit failures must be detected quickly and an appropriate corrective action instituted before distribution occurs or infested equipment makes its way to uninfested waterbodies.

Physical and chemical measurements are preferred monitoring methods because testing can be done rapidly. Physical measurements include:

- Time and temperature. This combination of measurements is often used to monitor the destruction or control of AIS risks on traps, nets, and other equipment. For example, nets used in Eurasian watermilfoil-infested waters in Minnesota must be frozen for 48 hours or dried for 10 days before using in other waters.
- Water flow rate. Since plant fragments, eggs, and many invertebrates cannot swim against the current, holding fish in flowing water to separate them from AIS may be one way to

control the hazard. Measuring flow rate and the time it takes for one complete water exchange are examples of physical measurements that may need to be monitored.

- Visual examination. Observations for the presence of AIS contamination on equipment or in baitfish or fish for stocking or regular surveys for AIS in waters considered to be uninfested are ways to monitor AIS hazards.

When developing an AIS-HACCP plan, selecting monitoring equipment requires consideration. Equipment used for monitoring CCPs varies with the condition being monitored. Examples of monitoring equipment include:

- Thermometers
- Clocks
- Scales
- Flow meters
- Chemical analytical equipment

The equipment chosen for monitoring at the CCP must be accurate. Consider the reliability of monitoring equipment when setting the control limit. Periodic calibration or standardization is necessary to ensure accuracy and is further discussed in Principle 6 (page 35).

Monitoring Frequency

Monitoring can be continuous or intermittent. Where possible, monitor continuously. Continuous monitoring is possible for many types of physical and chemical parameters, but will not control the hazard on its own. The continuous record needs to be observed periodically and action taken when needed. This too, is a component of monitoring. The length of time between checks will directly affect the amount of rework or product loss when a critical limit deviation is found. In all cases, the checks must be performed in time to ensure that the irregular product or equipment is isolated before being moved to uninfested waters.

When it is not possible to monitor a CCP on a continuous basis, it is necessary for the monitoring interval to be short enough to detect possible deviations from control limits or operating limits. The frequency of intermittent monitoring should be partially determined from historical knowledge of the product and process.

Who Monitors

Assigning the responsibility for monitoring is an important consideration when developing an AIS-HACCP plan. Individuals assigned to CCP monitoring can be:

- Owner/operator
- Employees/helpers
- Manager, researcher, or enforcement officer

Including all personnel in AIS-HACCP activities has the advantage of building a broad base of understanding and commitment to the program.

Those responsible for monitoring a CCP should:

- Be trained in the CCP monitoring techniques
- Fully understand the importance of CCP monitoring
- Have ready access to the monitoring activity
- Accurately report each monitoring activity
- Immediately report control limit infractions so that prompt corrective actions (Principle 5) can be taken

The monitor's duties should require that all unusual occurrences and deviations from controls be reported immediately to make sure adjustments and corrective actions are made in a timely manner. All records and documents associated with CCP monitoring must be signed or initialed by the person doing the monitoring.

The monitor's name is recorded in column 7 of the HACCP plan form (see appendices 4–7).

Principle 5: Corrective Actions

Objectives:

- Describe corrective actions
- Provide examples and components of corrective actions

Corrective actions must be taken when controls at a CCP have been compromised. When possible, determine these actions while developing the HACCP plan.

Corrective Action: Procedures followed when a deviation from a critical limit occurs at a critical control point.

When controls are violated at a CCP, institute the predetermined, documented corrective actions. These corrective actions should state procedures to restore process control and determine the environmentally-safe disposition of the affected product or equipment. It may be possible, and is always desirable, to correct the problem immediately.

Corrective actions include:

- Isolating and holding fish for safety evaluation
- Diverting the affected fish to another use where AIS contamination would not be considered critical
- Using an alternative measure to disinfect nets, equipment, and other gear
- Halting management, research, or enforcement activities until hazard control is regained
- Using some method to separate AIS from the fish
- Rejecting fish
- Destroying fish

Corrective actions are implemented when monitoring results indicate a deviation from control limits. Effective corrective actions depend heavily on an adequate monitoring program.

The primary objective is to establish an AIS-HACCP program that permits rapid identification of deviations from a control limit. The sooner the deviation is identified, the more easily corrective actions can be taken and the greater the potential for minimizing the amount of noncompliant product or equipment. The responsibility of making corrective actions should be assigned to an individual who understands the process, product, and AIS-HACCP plan and who has the authority to make decisions.

All corrective actions taken should be documented. Documentation helps to identify recurring problems so that the AIS-HACCP plan can be modified. Additionally, records provide proof of product or equipment disposition.

Components of Corrective Actions

Effective corrective action plans must:

- Correct and eliminate the cause of the deviation and restore control of the AIS hazard.
- Identify the product or equipment that was possibly contaminated with AIS and determine its disposition

1) Correct - Eliminate - Control

Corrective actions must bring the CCP back under control. A corrective action should take care of the immediate (short-term) problem as well as provide long-term solutions. The objective is to implement a short-term fix so that control can be re-established as soon as possible without further deviations. An unanticipated or reoccurring control limit failure necessitates a re-evaluation of the AIS-HACCP plan. A permanent solution to eliminating or minimizing the initial cause or causes for the deviation should be implemented if necessary. Specific instructions for corrective actions must be available to all workers in the operation and should be part of the documented AIS-HACCP plan.

2) Identify Product or Equipment - Determine its Disposition

When a deviation occurs, identify the nonconforming product or equipment. As previously discussed, there are several steps that may be used for determining product or equipment disposition and developing a corrective action plan. If products or equipment are to be tested and released or used in uninfested waters, the sampling method is important. The limits of sampling plans must be understood. A faulty sampling protocol can result in accepting an undesirable product. It may be prudent to consult an expert.

Corrective actions are usually written in an "if/then" format. The "if" part of the corrective action describes the condition and the "then" part describes the action taken. For example: "if" nets brought to uninfested waters are tagged for use in infested waters, "then" they must be pressure washed prior to use.

Corrective Action Records

Predetermined corrective actions are written into the AIS-HACCP plan. When control limits are exceeded and a corrective action occurs, it is recorded. A corrective action report form is helpful.

The corrective action report should contain:

- Product or equipment identification (e.g., product/equipment description, amount of product/equipment on hold)
- Description of the deviation
- Corrective action taken including final disposition of the affected product/equipment
- Name of the individual responsible for taking the corrective action
- Results of evaluations

AIS-HACCP plan records should contain a separate file in which all deviations and corresponding corrective actions are maintained in an organized fashion. Corrective actions are recorded in column 8 of the AIS-HACCP plan form. See appendices 4-7 for examples.

Case Study: Emerald Shiners

For many years, the Pennsylvania Fish and Boat Commission (PFBC) commonly transferred adult emerald shiners to inland lakes. Adult emerald shiners were historically planted into new impoundments and in lakes that area fishery managers identified as lacking sufficient forage for desired game fish populations.

In the spring, adult emerald shiners in Lake Erie congregate in large schools near the shore, making them easily captured with shore seines. The PFBC formerly had fish production personnel capture the shiners by seining and loading them on hatchery trucks for immediate distribution to lakes designated for stocking. While collecting emerald shiners for relocation to inland lakes, PFBC personnel briefly examined each net for round gobies and zebra mussels before loading them from the lake for shipment.

In summer 1999, Pennsylvania Sea Grant hosted an AIS-HACCP program for baitfish wholesalers and dealers at Presque Isle State Park, Erie, Pennsylvania. Local bait dealers holding collection permits for emerald shiners in Lake Erie and personnel from several of PFBC's hatcheries and its Lake Erie Research Unit attended. One of the hatchery representatives described the protocol for collecting emerald shiners. The group concluded that more extensive grading and separation techniques (critical control points) were necessary during harvest and before shipment to eliminate gobies and zebra mussels.

After attending the AIS-HACCP program, PFBC personnel from the Lake Erie Research Unit shared their concerns about the transfer of emerald shiners with fisheries management staff. A lengthy review followed, resulting in a PFBC policy change. The fisheries management staff determined that even though extensive grading and separation techniques could nearly ensure AIS-free shipments, the overall benefit of transferring emerald shiners as a forage base supplement was not worth the risk of introducing a new invasive species to the inland waterways of Pennsylvania. As a result, the policy of using emerald shiners as forage for inland lakes was discontinued in 2000.

Principle 6: Verification Procedures

Objectives:

- Define verification
- Describe AIS-HACCP plan verification
- Explain validation and review

Verification: The use of methods, procedures or tests, in addition to those used in monitoring, that determine if the HACCP system is in compliance with the HACCP plan and/or whether the plan needs modification.

Although it is complex, the proper development and implementation of the verification principle is fundamental to the successful execution of the AIS-HACCP plan. HACCP has spawned a new adag—"trust what you can verify," which speaks to the heart of the verification principle. The purpose of verification is to provide a level of confidence that the plan is based on solid science, is adequate to control the hazards associated with producing and selling live fish, or conducting resource management, research, or enforcement activities, and is being followed.

Elements associated with this principle include validation and reviews. Confusion sometime arises because the HACCP plan includes verification procedures for individual CCPs and for the overall plan.

Elements of Verification:

- Validation
- CCP verification activities
    - Calibration of monitoring devices
    - Calibration record review
    - Targeted sampling and testing
    - CCP record review
- AIS-HACCP system verification
    - Observations and reviews
- Regulatory agencies

Validation

Before the AIS-HACCP plan is implemented, it is validated. From hazard analysis through each CCP verification strategy, validation requires a scientific and technical review of the rationale supporting every phase of the AIS-HACCP plan. Validation ensures that an effectively-implemented plan is sufficient to control likely AIS hazards associated with baitfish harvest and production of fish for stocking or in resource management, field research, or enforcement activities. Validation provides objective evidence that the plan has a scientific basis. It often incorporates fundamental scientific principles, scientific data, expert opinion, or specific observations or tests.

Validation: The element of verification focused on collecting and evaluating scientific and technical information to determine if the AIS-HACCP plan, when properly implemented, will effectively control the AIS hazards.

Validation can be performed by the AIS-HACCP team or by an individual qualified by training or experience. The scope and time needed to validate a plan may be similar to developing it. Components of the plan should be validated before relying on the HACCP plan and when factors warrant. These factors could include: sampling/harvesting fish from a new lake; changing the sampling/harvest gear or techniques; new scientific information about potential hazards or their control; or new AIS infestations.

Verification of CCPs

Verification activities developed for CCPs are essential to ensure control procedures used are properly functioning and that they are operating and calibrated within appropriate ranges for AIS control. Additionally, CCP verification includes supervisory review of CCP calibration, monitoring, and corrective action records to confirm compliance with the AIS-HACCP plan. CCP verification may also include targeted sampling and testing.

Calibration of Monitoring Devices

Verification includes calibration of monitoring devices or review of calibration records to assure the accuracy of measurements. Regular calibration of CCP monitoring equipment is important. If the equipment is out-of-calibration, then monitoring results will not be accurate. Significant deviations could render monitoring results completely unreliable. If this happens, the CCP could be considered out of control since the last documented acceptable calibration. This condition should be considered when establishing the frequency of calibration.

Calibration Record Review

Keep and review calibration records. Reviewing the equipment calibration records involves checking the dates and methods of calibration, and the test results (e.g., equipment passing or failing).

Targeted Sampling and Testing

Verification may also include targeted sampling, testing, and other periodic activities. If you are relying on others to verify through compliance records that the fish they sell to you are AIS-free, then you may want to check targeted samples to substantiate their claims. Typically, when a monitoring procedure is not as stringent as desired, it should be coupled with a strong verification strategy.

CCP Record Review

At least two types of records are generated at each CCP: monitoring and corrective action. These records are valuable management tools, providing documentation that CCPs are operating within established safety parameters and that deviations are handled appropriately. However, records are meaningless unless someone periodically uses them.

AIS-HACCP System Verification

In addition to the verification activities for CCPs, verify the complete AIS-HACCP plan at least annually or whenever there is a system failure or a significant change in the product or process. The AIS-HACCP team is responsible for ensuring that this verification is performed.

System Verification Activities

Systematic verification activities include on-site observations and record reviews. An unbiased person who is not responsible for performing the monitoring activities usually performs reviews.

System verification should occur at a frequency that ensures the plan is being routinely followed. This frequency depends on a number of conditions, such as the variability of the process and product.

Role of the Regulatory Agencies in AIS-HACCP Plan Verification

Until the AIS-HACCP approach is jointly accepted and used by industry and resource management agencies, there is no official role of the resource management agencies in reviewing AIS-HACCP plans. The major role of resource management agencies could be to verify that plans are effective and are being followed. Verification normally occurs at the facility or the water body being harvested.

AIS-HACCP plans are unique documents prepared by the fish producer, manager, researcher, or enforcement officer to ensure the control of AIS hazards. AIS-HACCP plan reviewers must have access to records that pertain to CCPs, deviations, corrective actions, and other information pertinent to the plan that may be needed for verification. The plans may, however, contain proprietary information and must be appropriately protected by the regulatory agency or other plan reviewers.

Principle 7: Record-Keeping Procedures

Objectives:

- Describe the purpose and importance of record keeping
- Identify the types of records needed
- Describe records review process

Accurate record keeping is an essential part of a successful AIS-HACCP program. Records provide documentation that the control limits have been met or appropriate corrective actions were taken when the limits were exceeded. Likewise, they provide a means of monitoring so adjustments can be made to prevent AIS contamination.

Types of Records Needed

1) AIS-HACCP Plan and Support Documents

AIS-HACCP support documents include the information and data used to develop the plan. This includes the written hazard-analysis worksheet and records of information used in performing the hazard analysis and establishing the controls.

Support documents include:

- Current geographic range of AIS infestations
- Data establishing the adequacy of barriers to AIS contamination of equipment or product
- Correspondence with consultants or other experts
- List of the AIS-HACCP team and their responsibilities
- Summary of the preliminary steps taken in the development of the AIS-HACCP plan

2) Monitoring Records

AIS-HACCP monitoring records are primarily kept to demonstrate control at CCPs. These records provide a useful way to determine if control limits have been violated. Periodically, a manager should review the records to ensure that the CCPs are being controlled in accordance with the plan. Monitoring records also provide a means by which regulators (if involved) can determine whether a firm or agency is in compliance with its AIS-HACCP plan.

By tracking the values recorded on monitoring records, an operator or manager can determine if a process is approaching its control limit. Trends can be identified through record review to make necessary adjustments. If timely adjustments are made before the control limit is violated, operators can reduce or eliminate the labor and material costs associated with corrective actions.

CCP monitoring records for Eurasian watermilfoil might include:

- Written observations regarding the presence/absence of Eurasian watermilfoil fragments in harvested bait.
- A sign-out sheet that has a place to record that appropriate tags on equipment (designating it be used only in infested waters) were checked prior to taking the equipment.

- Number of water exchanges in holding tanks with baitfish taken from Eurasian watermilfoil-infested waters.

3) Corrective Action Records

See Principle 5: Corrective Actions, page 32.

4) Verification Records

Verification records (Principle 6: Verification Procedures, page 35) should include:

- Modifications to the AIS-HACCP plan (e.g., changes in handling and distribution)
- Personnel audit records verifying compliance with guarantees or certifications
- Verification of the accuracy and calibration of all monitoring equipment
- Results of in-house, on-site inspections
- Results of equipment evaluation tests

Record Monitoring Information

Record monitoring information at the time the observation is made. False or inaccurate records filled out before the operation takes place or ones that are completed later are inappropriate.

Computerized Records

When computerizing records, include controls to ensure that records are authentic, accurate and protected from unauthorized changes. Regular back-up of files is necessary to prevent loss of records from a computer malfunction.

Record Review

Monitoring records for CCPs and control deviations should be reviewed in a timely manner by supervisors. All records should be signed or initialed and dated by the reviewer.

Monitoring Records

Include monitoring records for each of the activities identified in columns 4 to 7 of the AIS-HACCP plan. The names of these records should be entered in column 9 of the form. Corrective actions should be recorded in column 8.

Sources of Information on Preparing AIS-HACCP Plans

Objective:

- Identify other sources of information that will help with AIS-HACCP plan development

As you develop your unique AIS-HACCP plan, look to the appendices for examples and forms. Gathering information from a variety of sources is usually the best way to begin, then focus on the information that applies to your situation. Sources of information include:

The Baitfish/Wild Fish Harvester and Aquaculturist

You, your employees, and your colleagues know your operation and water better than anyone. Experience is an excellent source of information. You may already know about hazards that can affect your product, and you may have already implemented suitable controls, perhaps for purposes other than AIS.

State, Federal, Tribal Natural Resource Managers

Federal, state and tribal natural resource managers can be good sources of information. They may point out potential hazards based on their field assessments, but it will usually be your responsibility to implement effective control measures.

Trade Associations

Trade associations can also provide useful information. Trade journals are beginning to cover AIS topics and often provide general information on potential hazards and controls. Articles on specific processes or products can be useful. Some trade organizations provide services such as consulting, educational programs, and publications that can help identify hazards and control measures.

Suppliers and Buyers

Suppliers of cleaning materials and fish handling equipment can provide information on potential hazards and control measures. A buyer could notice a rogue species in one of your products and request only baitfish that are certified free from AIS. Note, however, that not all buyer's specifications relate to AIS.

Sea Grant/Cooperative Extension

Many universities have Sea Grant or Cooperative Extension programs. These programs provide continuing education and technical assistance to industry. Extension specialists and agents can assist in identifying potential hazards and control measures. Also, a wealth of publications on AIS are available through Sea Grant.

Publications

Textbooks, government publications and scientific literature provide excellent AIS information. These publications usually include a list of additional references. Scientific journals are available in most university libraries. Summaries of information from scientific journals are also available from Sea Grant, Cooperative Extension, and in other publications.

HACCP: Hazard Analysis and Critical Control Point Training Curriculum

The HACCP curriculum was developed to help seafood processors learn about the HACCP process. The material contained in this AIS curriculum is based on it.

Computer-Accessible Information Sources

AquaNIC (Aquaculture Network Information Center)
www.aquanic.org

AquaNIC, maintained at Purdue University, West Lafayette, Indiana, is a gateway to electronic resources on aquaculture. Fact sheets, technical bulletins, and other publications can be viewed on your computer monitor, or downloaded. *AquaNIC* also contains an image directory that holds hundreds of pictures, short videos and slides in a variety of common formats. *AquaNIC* links to other aquaculture databases on the Internet.

sgnis (Sea Grant Nonindigenous Species Site)
www.sgnis.org

sgnis is a peer-reviewed national information center that contains a comprehensive, searchable collection of research publications and educational materials produced by the National Sea Grant College Program. This site includes research findings, training and educational materials, newsletters, distribution maps, a Sea Grant Graphics Library of slides, illustrations, and videos, with links to Sea Grant personnel and related Web sites.

National Aquatic Nuisance Species Clearinghouse
www.entryway.com/seagrant/

Sea Grant's *National Aquatic Nuisance Species Clearinghouse* is the home of North America's most extensive technical library of publications related to the spread, biology, impacts and control of zebra mussels and other important aquatic nuisance, nonindigenous and invasive species.

United States Geological Survey
nas.er.usgs.gov

The nonindigenous aquatic species site of the U.S. Geological Survey is a repository for a large database of AIS information. Scientific reports, U.S. distribution maps, regional contact lists and general information are available on this site.

United States Fish and Wildlife Service
www.haccp-nrm.org

The U.S. Fish and Wildlife Service is using HACCP to prevent the spread of aquatic invasive species. Their Web site contains useful information and links for developing AIS-HACCP plans.

Appendix 1

Best Management Practices to Prevent the Spread of Aquatic Invasive Species During Field Operations

Natural resources fieldwork could unintentionally spread AIS and non-target species (potentially invasive) to new habitats during monitoring, collection, surveying, and fish stocking activities. AIS, including aquatic plants, invertebrates, fish, as well as pathogens and diseases can spread to uninfested waters through two significant pathways:

1) movement on equipment (i.e., boats, trailers, nets, waders, water collection devices, etc.),

2) through the transfer of baitfish and fish raised for stocking in public and private waters.

The following "best management practices" (BMPs) are guidelines addressing pathways for potential overland movement of AIS to other waters. Interrupting these pathways is critical.

Such guidelines developed for water-based recreation were federally approved in 2000 (Federal Register, 2000). However, the problem of overland transport is not limited to recreational water users; federal, tribal, and state natural resource managers, baitfish and private aquaculturists, researchers, consultants, and enforcement personnel can also move AIS. Except in jurisdictions where statutes, rules, regulations, and permits apply, these guidelines are voluntary and are intended as the basis for site-specific operations. They are adapted from the recreational guidelines referenced above and from a report by the U.S. Army Corps of Engineers (http://www.wes.army.mil/el/zebra/zmis/zmishelp/decontamination_and_disinfection_procedures.htm).

These BMP guidelines are based on the following principles:

1) Assume every water body is contaminated and that boats and equipment should always be considered contaminated.

2) Keep one set of equipment for use only on infested waters (it's easy and effective).

3) Keep boat and equipment clean between trips and let dry for as long as possible.

4) Decontaminate equipment following each use, whenever possible.

Aquatic Invasive Species Control for Boats and Field Equipment

General precautions:

- Avoid using boats and equipment on both infested and uninfested waters (e.g., use dedicated boats, tanks, and equipment) or those that have not been thoroughly cleaned and disinfected.
- Visit uninfested or least-infested sites first, whenever practical.
- Inspect and disinfect holding and transport tanks following each use.
- Pump spring, well or filtered water into hauling tanks when transporting fish or other live organisms to other waters – avoid use of lake or river water during transport. Do not contaminate on-board pumps or drains on transport trucks with lake or river water. (In many states and provinces, it is illegal to transport

water from designated infested waters without a permit. Check with your local state natural resource agency before conducting field activity.)

Decontamination of Boat, Motor, Trailer and Equipment*

- Inspect and remove aquatic plants, animals, and mud from boat (keel, trim tabs, transducer), motor lower unit, trailer (rollers, bunks, wiring, lights, axle), anchor as well as waders, boots, nets and all equipment paying particular attention to cracks and crevices.
- Drain lake or river water from motor or jet drive, bilge, livewell, tubs, tanks, and sampling equipment before leaving water access.
- Dispose of unwanted plants, fish, worms, crayfish, snails, or clams in the trash.
- Scrub or scrape boat hulls and equipment, if infested with attached zebra mussels.
- Roll out nets and hand clean or rinse with high pressure, hot tap water.
- Power wash boat, motor, and trailer, personal gear (waders, boots, scuba gear) and field sampling equipment (anchors, benthic grabs, plankton nets, ropes, bottles, tubs) with high pressure, hot tap water, OR
- Dry boat, motor, and trailer in the sun for at least five days and equipment for at least 10 days or freeze for two days before reuse.

* *For difficult-to-clean equipment, consider using a method of disinfecting below.*

Disinfecting

Each treatment identified below effectively disinfects equipment. However, implementing more than one can improve efficacy and save time and effort. As an example, inspection, removal, and drying are an effective integrated approach to treat for zebra mussels. While zebra mussel larvae (veligers <1 mm) may survive out of water for only a few hours, juveniles (e.g., 1 – 7 mm long) may survive a couple of days, and adults (e.g., up to 44 mm) up to 21 days under ideal conditions. Using the inspection and removal process eliminates the most 'stubborn' and resilient stages of juveniles and adults. Combining inspection and removal with drying will kill remaining larvae, effectively eliminating the risk for spread.

Physical Treatments:

Scrub, scrape and/or crush life stages of AIS, including zebra mussels. Small zebra mussels on smooth surfaces feel like fine sandpaper. Due to their size, they are delicate and easily damaged or crushed via scrubbing or scraping. Power washing will also likely damage their shells and wash them off.

Hot Water:

Rinse contaminated equipment with 140°F tap water for 20-30 minutes using a garden sprayer, high pressure sprayer or self-service car wash. If this period of time is not practical, rinse as long as possible. While hot water can kill zebra mussels, the emphasis of this treatment is to remove any unwanted species by rinsing them off the boat, motor, trailer and equipment.

Drying (Desiccation) and Freezing:

Exposure to warm, dry air and/or direct sunlight is effective for killing aquatic plants and animals. Drying boats, motors and trailer for five days is recommended by the Voluntary Guidelines on Recreational Activities. The U.S. Army Corps of Engineers (http://www.wes.army.mil/el/zebra/zmis/zmishelp/decontamination_and_disinfection_procedures.htm) recommends drying equipment for at least 10 days or freezing for 2 days before reuse.

Chemical Treatments:

Another option to treat field equipment, especially difficult-to-clean equipment, is through chemicals. Several chemicals listed below are effective for controlling all life stages of zebra chemicals. Several chemicals listed below are effective for controlling all life stages of zebra mussels, if properly applied. While these chemicals may not have been specifically tested against other AIS, they may be effective; more research is needed in this area. Efficacy of treatment depends upon the concentration used and contact time. Following chemical treatment, drain disinfectant into a suitable container for disposal or reuse, if possible. Also, be sure to rinse all surfaces with clean water and dry everything thoroughly.

All life stages:

- 250 mg/L ROCCAL (benzalkonium chloride) for 15 minutes

Veligers and settlers:

- 100% vinegar dip for 20 minutes
- 1% table salt for 24 minutes

Gallons of Water	Cups of Salt
5	2/3
50	6 1/4
100	12 2/3

Veligers:

- 500 mg/L hydrogen peroxide for 60 minutes
- 167 mg/L formalin for 60 minutes
- 250 mg/L chlorine bleach (5% sodium hypochlorite) for 60 minutes
  100 ml bleach in 20 L water or
  3 fluid oz. bleach in 5 gal. water

Additional Strategies:

Use certified 'clean' fish, brood fish, wild-caught feeder fish, or fingerling sources.

Isolate fish or brood stock collected from known infested water bodies in dedicated tanks, ponds or raceways.

Place fish or brood stock in a holding facility or tanks before transporting to allow for depuration of fish's digestive tracts.

Zebra Mussel Control for Fish Production Facilities

Several low regulatory priority (LRP) chemicals approved by the U.S. Food and Drug Administration for prophylactic use to treat fish diseases are also effective in controlling zebra mussels in the absence or presence of fish. (It is important to note that none of these LRP chemicals are registered for zebra mussel control.) Before any full-scale treatment, it is highly recommended that any chemical be site-verified (pilot-tested) for treatment efficacy before full-scale treatment. Toxicity of these chemicals can be strongly influenced by water quality conditions, including temperature, pH, hardness, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and salinity. Consult with your state's Department of Agriculture, Sea Grant, or fish and wildlife agency office for licensing and registered applicators.

No known chemical kills zebra mussels with 100% effectiveness while being safe for all species of fish. However, there are three salts, including sodium, potassium, and calcium chloride, that are already FDA-approved for LRP use, which means they can be used under specific conditions. For example, sodium chloride can be used up to 10,000 mg/L and potassium chloride is approved for use up to 2,000 mg/L as an osmoregulatory aide to relieve stress and prevent shock of fish. Furthermore, dilute formalin, used for various fungus and parasite treatments is also effective in killing veligers in the presence of fish in conjunction with potassium chloride (see below).

Control of Zebra Mussels (all life stages) in Tanks, Ponds, and Raceways without Fish:

Drain tank, pond, or raceway to the extent possible and treat using:

- 1-5 mg/L Rotenone for 24 hours (the powder formulation is recommended because zebra mussels may detect the carriers in the liquid formulation and close their shells)

- 2 mg/L chelated copper for 48 hours

Control of Zebra Mussel Larvae (veligers) in Water Without Fish:

Drain tank, pond, or raceway to the extent possible and treat using:

- 167 mg/L formalin for 1 hour
- 500 mg/L hydrogen peroxide for 1 hour

Control of Zebra Mussel Larvae (veligers) and Settlers During Fish Transport and Holding:

[Only use a water source free of adults.]

Sodium chloride:

- 10,000 mg/L (1%) for 24 hours at 12°C

  Safe for: rainbow trout, lake trout, brown trout, fathead minnow, channel catfish, smallmouth bass, bluegill, yellow perch, and walleye

- 20,000 mg/L (2%) for 6 hours at 17°C

  Not safe for: rainbow trout, channel catfish, bluegill, or fathead minnow

Calcium chloride:

- 10,000 mg/L (1%) for 24 hours at 12°C

  Safe for: smallmouth bass, bluegill, walleye, and lake trout

  Not safe for: rainbow trout, channel catfish, yellow perch, or fathead minnow

Potassium chloride:

- 2,500 mg/L (0.25%) for 24 hours at 12°C

  Safe for: lake trout, rainbow trout, brown trout, channel catfish, smallmouth bass, and fathead minnow

  Not safe for: walleye or yellow perch

- 10,000 mg/L (1%) for 6 hours at 12°C

  Safe for: lake trout, brown trout, channel catfish, bluegill, yellow perch, and fathead minnow

  Not safe for: rainbow trout, smallmouth bass, or walleye

- 750 mg/L for 1 hour followed by dilute formalin (25 mg/L for 2 hours) at 20°C (Note: this shorter treatment is more convenient for transporting fish and still kills 100% of the veligers)

  Safe for: fingerling (50-75 mm) walleye, saugeye, sunshine bass, largemouth bass, and channel catfish (25-30 mm), and larger (150-200 mm) rainbow trout, golden trout, brown trout, and muskellunge. Note: adding 0.5% sodium chloride decreased formalin's effectiveness at killing veligers. (Edwards et al. 2002)

Formalin:

- 100 mg/L for 2 hours at 20°C

  Safe for: fingerling (50-75 mm) largemouth bass, channel catfish (25-30 mm), and larger (150-200 mm) rainbow trout, golden trout, brown trout, and muskellunge. Note: adding 0.5% sodium chloride decreased formalin's effectiveness at killing veligers.

Zebra Mussel Monitoring for Fish Production Facilities

Early detection of zebra mussels (and other unwanted AIS) will minimize impacts on and prevent the spread from fish production facilities. During early infestation, attached zebra mussels are likely to be small (1/4-1/2 inch long) and the number attached low. Early colonization of post-settlers feels gritty on smooth surfaces. Zebra mussels tend to avoid direct sunlight, so they will mostly be found first in darkened areas (e.g., on undersides of stones).

- Dedicate raceways and tanks to hold fish collected from known infested water.
- Collect water samples to test for microscopic zebra mussel larvae using a 63 micron mesh zooplankton net.

- Inspect hard surfaces throughout the system including walls and floors of tanks and raceways, especially corners, seams, screens, and the underside of any equipment left in the system, OR
- Hang a PVC pipe (2 feet long, 4-inch diameter) vertically, a brick, or a series of microscope slides in a shady spot near the floor or bottom of the facility system for routine checking for settlers.
- Keep records of monitoring activity for veligers, where the fish from a pond were shipped to, if wild/hatchery/well water used in the transport load, monitoring of the wild water for veligers or adult zebra mussels, periodic inspections of the holding facilities or rearing ponds.

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Appendix 2

Steps in Completing an AIS-HACCP Plan

AIS-HACCP is a system to prevent the spread of invasive fish and other aquatic vertebrates, invertebrates, plants, and pathogens. It applies to a diverse industries and resource management, research, and enforcement activities and provides opportunities for industry and government partnerships.

Baitfish/aquaculture operators and fishery managers, researchers, and enforcement officers can use it to reduce the risk that products, equipment, and activities will spread unwanted species into new water bodies. AIS-HACCP plans are useful for fish that will be stocked into other waters, for baitfish wild harvest or culture, and for natural resource management, research, and enforcement activities that might spread AIS. It concentrates on points in the process that are critical to the safety of the product, minimizes the risks, and stresses communication between regulators and industry.

A blank AIS-HACCP Plan Form and a Hazard Analysis Worksheet are in Appendix 9. Using these standardized forms will help in developing a plan and expedite review. A written hazard analysis will be useful when performing AIS-HACCP plan reassessments and for justifying why certain hazards were or were not included in the AIS-HACCP plan.

Developing AIS-HACCP Plans:

Preliminary Steps

1. Document general information
2. Describe the harvest, production, management, research, or enforcement activity
3. Describe the method of transportation, distribution and storage of fish, gear, boats, etc.
4. Identify the intended use and consumer (if applicable)
5. Develop a flow diagram

Hazard Analysis Worksheet

6. Set up the Hazard Analysis Worksheet
7. Identify the potential AIS-related hazards
8. Complete the Hazard Analysis Worksheet
   - Understand the potential hazard
   - Determine if the potential hazard is significant
   - Identify the critical control points (CCP)

AIS-HACCP Plan Form

9. Complete the AIS-HACCP Plan Form
   - Set the critical limits (CL)
   - Establish monitoring procedures: What, How, Frequency, Who
   - Establish corrective action procedures
   - Establish verification procedures
   - Establish a record-keeping system

Preliminary Steps

1: Document general information.

Record the name and address of your facility or agency in the spaces provided on the first page of the Hazard Analysis Worksheet and the AIS-HACCP Plan Form (Appendix 9).

2: Describe the cultured or wild harvested fish (if applicable).

Identify the market name or Latin name (species) of the fish.

examples:

- Fathead minnows (*Pimephales promelas*)
- Golden shiners (*Notemigonus crysoleucas*)
- White sucker (*Catostomus commersoni*)
- Walleye (*Sander vitreus*)

Fully describe the product.

examples:

- Fathead minnows graded on 16 grader
- Golden shiners graded on 21 grader
- White suckers ungraded
- Rosy red minnows from Arkansas, held in ponds until distribution
- White suckers graded on a 23 grader
- Walleye fingerlings 5 – 8 inches
- Yellow perch fingerlings 2.5 – 3 inches

For management, research, and enforcement activities:

- Completely describe research or management activities
- Describe all equipment and gear that will be used
- Identify when and how activities will be conducted

Record this information in the spaces provided on the first page of the Hazard Analysis Worksheet and the AIS-HACCP Plan Form.

3: Describe the harvest, production, management, research, or enforcement activity.

Identify how the product or the samples are collected, stored, and distributed. Identify whether any special shipping or handling methods are used.

examples:

- Wild harvested with seines, held in tanks, graded, then trucked to retail stores
- Pond-raised, seined, then held in different ponds over the winter, trucked to retail stores
- Pond-raised, trapped from ponds, then transferred directly to lakes for stocking
- Anglers on three lakes are checked for violations each day for a given period of time
- Electroshocking and seining are conducted on 10 lakes to assess year class strength

Record this information in the spaces provided on the first page of the Hazard Analysis Worksheet and the AIS-HACCP Plan Form.

4: Identify the intended use and customer (if applicable).

Identify how the product will be used.

examples:

- Live fishing bait
- Feeder fish (feeding pond or aquarium fish)
- Stocking into public waters
- Stocking into private waters
- Stocking into aquaculture production facility (indoor or outdoor)
- Scale and stomach samples will be brought back to the office for analysis
- Fish will be brought back for captive brood stock

Identify your intended customer or user of the product.

examples:

- General public
- A wholesaler
- A retail store
- Fish farmer
- State agency

Record this information in the spaces provided on the first page of the Hazard Analysis Worksheet and the AIS-HACCP Plan Form.

5: Develop a flow diagram.

The purpose of the flow diagram is to provide a clear, simple description of the steps involved in producing your fishery products or conducting your management, research, and enforcement activities. The flow diagram should cover all of the steps in the process that your firm or agency performs. The flow diagram should be verified on-site for accuracy. Examples of flow diagrams can be found in appendices 3-8.

Hazzard Analysis Worksheet

6: Set up the Hazard Analysis Worksheet.

Record each of the steps from the flow diagram in column 1 of the Hazard Analysis Worksheet.

7: Identify the potential AIS-related hazards.

Record the AIS-related hazards for each step. Use your own expertise and that of others to identify AIS hazards related to your fish production, or management, research, or enforcement practices. Check with appropriate agencies to determine if the waters in which you conduct activities are infested with invasive species.

Even if you think you have effective hazard controls in place, record the hazard. For example, your equipment might be free of AIS plant material because of the: 1) absence of AIS in the area of harvest or sampling in an infested water body; or 2) existence of inadvertent hazard controls (procedures you typically use in the course of your activities that may remove AIS).

8: Complete the Hazard Analysis Worksheet.

Completing the Hazard Analysis Worksheet requires understanding potential hazards, determining if each potential hazard is significant, and identifying critical control points for each significant hazard associated with your product or activities.

AIS –HACCP Plan Form

9: Complete the AIS-HACCP Plan Form.

Copy the Critical Control Points from column 6 of the Hazard Analysis Worksheet to column 1 of the AIS-HACCP Plan Form. Enter the associated hazard(s) from column 2 of the worksheet to column 2 of the plan form. If you did not identify significant hazards and CCPs, you do not need to complete an AIS-HACCP plan.

Complete the AIS-HACCP Plan Form by designing techniques, methods, and treatments to deal with each significant hazard in column 2. For each significant hazard:

- set critical limits
- establish monitoring procedures
- establish corrective action procedures
- establish a record keeping system
- establish verification procedures

After you completed these steps for each hazard, the AIS-HACCP plan form is finished.

To signify that the AIS-HACCP plan has been accepted for implementation, the responsible individual on-site or a higher level official should sign and date the first page of the plan form.

Appendix 3

AIS-HACCP Pre-plan Example

Wild Harvested Baitfish

Note: The planning process and plans shown in appendices 4–8 are examples. These examples may not encompass your situation since AIS-HACCP plans vary with state regulations and are usually tailored to product, species, and facility.

The following illustrates the use of a process narrative and flow diagram used in plan development.

Meet the fictitious ABC Baitfish Company, which sells emerald shiners harvested from waters infested with Eurasian watermilfoil. The owner documented the following information to help his operation create an AIS-HACCP plan.

A written description should accompany an AIS-HACCP plan. Describing the steps needed to produce a product offers a reference for the fish farmer or baitfish harvester and facilitates communication with the staff and state resource management agencies.

ABC Baitfish Company Narrative Description

Harvest

Emerald shiners are seined late in the fall when they concentrate in shallow areas of Lake Exotica. Large seines are deployed around schools of shiners in relatively vegetation-free areas. The ends of the seine are pulled together and the shiners are loosely bagged in the seine. They are then dip-netted into 5-gallon buckets filled with about 1.5 gallons of lake water. Buckets with shiners and some lake water are then dumped into the hauling truck, which contains salted (0.5% solution), aerated, well water from the culture/holding facility. An estimate of the volume of shiners is obtained by recording the number of gallons of shiners taken in each seine haul. When leaving the harvest site visible plant material is removed from the seine, dip-nets, waders, and any other equipment used in the harvest process. The nets used in harvesting shiners from Lake Exotica are only used in Lake Exotica at this time of year. They will be frozen during the winter months before they are used on another waterbody.

Transporting to Facility

Emerald shiners from a number of seine hauls are placed in the hauling truck and taken to the holding facility. The shiners and water on the truck are drained directly into holding tanks at the culture/holding facility.

Holding

Emerald shiners are held in flow-through concrete tanks. Well water is sprayed in at one end of the tank and a screened standpipe at the other end of the tank drains the overflow. Agitation aerators are placed in the tank to ensure proper oxygen levels are maintained. Tanks are cleaned daily to remove dead fish, debris, and any plant material. Shiners from subsequent harvests are added to the tank until the tank's holding capacity is reached.

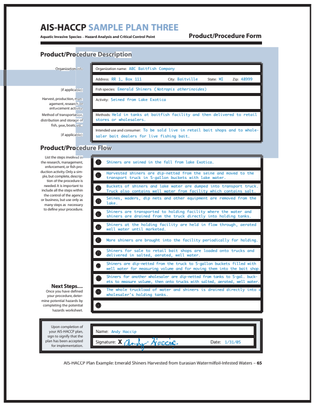
Transporting to Wholesalers/Retailers

When shiners are sold to retail bait shops, the shiners are dip-netted into 5-gallon buckets and then loaded onto a truck filled with salted (0.5% solution), aerated, well water. Aeration is accomplished using bottled pure oxygen released into the tanks via air stones. Upon arrival at the retail bait shop, shiners are dip-netted from the truck and placed in 5-gallon buckets with a known amount of well water to measure the volume sold and to transport the shiners into the retail bait shop.

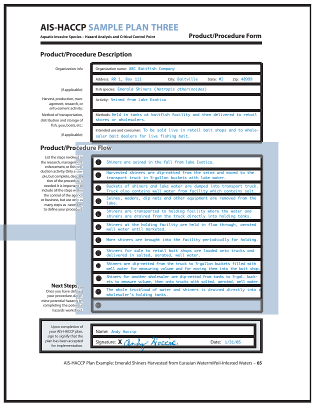
When shiners are sold to another wholesaler, they are dip-netted from the holding tanks into 5-gallon buckets, their volume is measured, and they are loaded onto a truck carrying salted, aerated, well water. Aeration is accomplished using bottled pure oxygen released into the tanks via air stones. When the truck arrives at the wholesale facility, the shiners and water are drained directly into the wholesaler's holding tanks.

After describing the process of producing fish from start to end in a written narrative, summarize the narrative description in a flow diagram. The flow diagram will be important in the next step of AIS-HACCP plan development, which is conducting the hazard analysis. The flow diagram for the ABC Baitfish Company is depicted below.

Organization name: ABC Baitfish Company			
Address: RR1, Box 111	City: Baitville	State: MI	Zip: 48999
Fish species: Emerald shiners (*Notropis atherinoides*)			
Activity: Seined			
Methods: Held in tanks at baitfish facility then delivered to retail stores or wholesalers.			
Intended use and consumer: To be sold live in retail bait shops and to wholesale dealers for fishing bait.			



1	Shiners are seined in the fall from Lake Exotica.
2	Harvested shiners are dip-netted from the seine and moved to the transport truck in 5-gallon buckets with lake water.
3	Buckets of shiners and lake water are dumped into transport truck. Truck also contains well water from facility to which salt has been added.
4	Shiners are transported to holding facility where the water and shiners are drained from the truck directly into holding tanks.
5	Shiners at the holding facility are held in flow through, aerated well water until sold.
6	More shiners are brought into the facility periodically for holding.
7	Shiners for sale to retail bait shops are put into 5-gallon buckets and loaded onto trucks and delivered in salted, aerated, well water.
8	Shiners are dip-netted from the truck to 5-gallon buckets filled with well water for measuring volume and for moving them into the retail bait shop.
9	Shiners for sale to another wholesaler are dip-netted from tanks to 5-gallon buckets to measure volume, and then onto trucks containing salted, aerated, well water.
10	The whole truckload of water and shiners is drained directly into a wholesaler's holding tanks.



AIS-HACCP SAMPLE PLAN ONE

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

Product/Procedure Form

Product/Procedure Description

Organization info	Organization name: Department of Waters and Lands
	Address: 123 Main Street City: Capital City State: NY Zip: 11111
(if applicable):	Fish species: Forage fish assessment
Harvest, production, management, research, or enforcement activity:	Activity: Trawling
Method of transportation, distribution and storage of fish, gear, boats, etc.:	Methods: Boat & gear trailered to public landing sites. Fish are captured with a trawl for assessment, then released. No fish are brought back to the office. Sometimes more than one lake is sampled per day.
(if applicable):	Intended use and consumer: N/A

Product/Procedure Flow

List the steps involved in the research, management, enforcement, or fish production activity. Only a simple, but complete, description of the procedure is needed. It is important to include all the steps within the control of the agency or business, but use only as many steps as necessary to define your procedure.

1	Agency biologists launch their research boat on Lake Ono and conduct fish sampling using a standard trawl net at two offshore stations.
2	After those two sampling runs, boat is trailered to another lake where they sample fish with trawls. The journey between the two lakes takes approximately 2 hours.
3	Fish sampling efforts are continued on the second lake, Lake Bono, with the same type of trawl net at two different locations.
4	After the 2 sampling sessions, the boat is driven back to the original on-land secure storage facility.
5	
6	
7	
8	
9	
10	
11	
12	

Next Steps…

Once you have defined your procedure, determine potential hazards by completing the potential hazards worksheet.

Upon completion of your AIS-HACCP plan, sign to signify that the plan has been accepted for implementation.

Name: Andy Haccip

Signature: X Andy Haccip Date: 1/31/05

Protential Hazards Worksheet

Potential AIS Hazards

List all relevant species

Examples: round goby, tubenose goby, non-native amphibians, etc.

AIS Fish and Other Vertebrates

N/A

Examples: Dreissenid mussels, spiny waterfleas, etc.

AIS Invertebrates

Cercopagis pengoi is present in Lake Ono.

Examples: Eurasian watermilfoil, water chestnut, etc.

AIS Plants

Eurasian watermilfoil is present in Lakes Ono *and* Bono

Examples: whirling disease, heterosporis, spring viremia of carp, etc.

AIS Pathogens

N/A

Next Step…
Once you've identified potential hazards, complete a hazard analysis form.

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	2 Hazards Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	3 Are AIS hazards significant? (Yes/No)	4 Justification Justify your decisions for column 3.	5 Control What control measures can be applied to prevent the significant hazards?	6 CCP Is this step a critical control point? (Yes/No)
Work Flow Step 1 At the start of the day agency biologists launch their research boat on Lake Ono and conduct routine fish sampling using a standard trawl net at two offshore stations.	Fish/Other Vert.	No	No AIS fish are found in any lakes typically sampled with this boat and equipment.	Nets and equipment should be inspected and fish removed before sampling as a precaution.	No
	Invertebrate *Cercopagis pengoi*	No	Ono was the first recorded site for this species. It has been present in Ono for 4 yrs.		No
	Plant Eurasian Watermilfoil (EWM)	No	EWM has been present in this lakes for 10 years.		No
	Pathogens	No	AIS Pathogens not present		No
Work Flow Step 2 The research boat is trailered to Lake Bono. The overland journey takes approximately 2 hours. Once they arrive at the second lake they continue the fish sampling efforts	Fish/Other Vert.	No	No AIS fish are in Lake Ono.		No
	Invertebrate *Cercopagis pengoi*	Yes	Adults & eggs could be on nets and other collecting equipment, the anchor and boat.	Nets, equipment, and the boat can be washed and/or treated to remove or kill the hazard.	Yes
	Plant Eurasian Watermilfoil (EWM)	No	EWM has been in Lake Bono for 8 years.		No
	Pathogens	No	AIS Pathogens not present		No

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

AIS-HACCP SAMPLE PLAN ONE

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	2 Hazards Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	3 Are AIS hazards significant? (Yes/No)	4 Justification Justify your decisions for column 3.	5 Control What control measures can be applied to prevent the significant hazards?	6 CCP Is this step a critical control point? (Yes/No)
Work Flow Step 3 After the 2 sampling sessions, the boat is driven back to the boat launch and returned to the Agency's secure, on-land storage facility.	Fish/Other Vert.	No	No AIS fish present in either lake	Nets and equipment should be inspected and fish removed before sampling as a precaution.	No
	Invertebrate	No	No known AIS invertebrates present in Lake Bono.		No
	Plant Eurasian Watermilfoil (EWM)	Yes	Both lakes are infested with EWM that could be transferred to uninfested waters.	Nets, boats and equipment washed/ treated prior to use in uninfested waters.	No
	Pathogens	No	AIS Pathogens not present		No

Work Flow Step	Fish/Other Vert.				
	Invertebrate				
	Plant				
	Pathogens				

Appendix 4

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

AIS-HACCP SAMPLE PLAN ONE

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

AIS-HAACP Plan Form

Critical Control Point Each row answered "yes" in column 6 on the Hazard Analysis Form	**1**	The research boat is trailerd to a second lake. The overland journey takes approximately 2 hours. Once they arrive at the second lake they continue the fish sampling efforts at two locations	After the 2 sampling sessions, the boat is driven back to the agency's secure, on-land storage facility
Significant Hazards as determined in column 3 of the Hazard Analysis Form	**2**	*Cercopagis pengoi* is present in Lake Ono. It could be transported from there to uninfested lakes.	Nets and collecting gear could have Eurasian watermilfoil attached which could be released into an un-infested lake.
Limits for each control measure	**3**	No live adults or resting eggs left on boats or equipment. Boats and equipment are washed with high pressure hoses, nets are tagged and only used in infested waters	No viable Eurasian watermilfoil left on boats or equipment or boats and equipment tagged and only used on EWM infested waters or dried for 10 days.
Monitoring Describe what is being monitored	**4**	Presence of adult C. p. or eggs. Ensure that the boat and all equipment is power washed and nets tagged for use in infested waters only are not brought to Lake Bono.	Presence of EWM. Monitor that boat and all equipment have been sufficiently power washed, properly tagged, or dried for 10 days
Explain how the monitoring will take place	**5**	Visual inspection for adults. Visually inspect tag on nets. Visually inspect boats for any debris that could indicate power washing was not effective.	Visual inspection for EWM fragments. Visually inspect nets and equipment for appropriate tags.
Frequency of monitoring	**6**	Each time boat and equipment are used in Lake Ono.	Each time equipment is used in EWM infested lake.
Person or position responsible for monitoring	**7**	Staff	Staff
Corrective Actions Actions taken when limits of control mesaures are not met	**8**	Cease operation and secure clean AIS-free nets, boats, or equipment before proceeding	Cease operation and secure clean AIS-free nets, boats, or equipment before proceeding
Verification Method of Verification	**9**	Records review.	Records review.
Records List what is recorded at each critical control point	**10**	Record washing, drying, or treatment procedures used on boats and gear. Record that nets were inspected for a tag prior to trawling.	Record washing, drying, or treatment procedures used on nets and gear. Record that nets were inspected for proper tags prior to employee leaving the storage facility at the end of the day.

Final Step…

Once you have completed your HACCP plan, attach it to the signed product/procedure form with the hazard analysis worksheets.

AIS-HACCP SAMPLE PLAN TWO

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

Product/Procedure Form

Product/Procedure Description

Organization info	Organization name: Department of Resource Enforcement
	Address: 123 Main Street City: Outlaw City State: MI Zip: 11111
(if applicable):	Fish species: N/A
Harvest, production, management, research, or enforcement activity:	Activity: Checking for violations by boat on several area lakes
Method of transportation, distribution and storage of fish, gear, boats, etc.:	Methods: Moored boat is taken from lake and trailered to other lakes for enforcement activities.
(if applicable):	Intended use and consumer: N/A

Product/Procedure Flow

List the steps involved in the research, management, enforcement, or fish production activity. Only a simple, but complete, description of the procedure is needed. It is important to include all the steps within the control of the agency or business, but use only as many steps as necessary to define your procedure.

1	Conservation Officers (COs) depart office trailering boat. COs retrieve moored boat at Lake Woo and trailer it into water at landing at Lake Zoo for safety checks and fishing enforcement.
2	COs patrol the lake. While patrolling, COs come upon an illegally set net. They anchor, inspect and pull the net, and bring it aboard.
3	COs return to landing. Boat is driven onto trailer. Trailer is driven out of water. Net is stored in rear of vehicle.
4	After the 2 sampling sessions, the boat is driven back to the original on-land secure storage facility.
5	COs continue to Lake Yoo. COs arrive at Lake Yoo for routine patrol. Boat and trailer are backed into water at boat landing.
6	While patrolling, COs come upon a suspicious float in adjacent wetland. COs anchor, don waders and inspect float. Float is not attached to anything. COs return to boat, remove waders, pull-up anchor and continue circuit of lake.
7	COs complete circuit of Lake Yoo and return to landing and boat is driven onto trailer. Trailer is driven out of water. COs return to office, store illegally-set net for future destruction.
8	Next morning, COs depart office in vehicle with same boat trailered behind. COs arrive at Lake Poo for routine patrol. COs back boat and trailer into water at boat landing.
9	
10	
11	
12	

Next Steps…

Once you have defined your procedure, determine potential hazards by completing the potential hazards worksheet.

Upon completion of your AIS-HACCP plan, sign to signify that the plan has been accepted for implementation.

Name: Andy Haccip	
Signature: X Andy Haccip	Date: 1/31/05

Appendix 5

Potential AIS Hazards

List all relevant species

Examples: round goby, tubenose goby, non-native amphibians, etc.	AIS Fish and Other Vertebrates N/A
Examples: Dreissenid mussels, spiny waterfleas, etc.	AIS Invertebrates Zebra mussels are present in lakes Woo and Yoo.
Examples: Eurasian watermilfoil, water chestnut, etc.	AIS Plants Eurasian watermilfoil is present in Lake Zoo.
Examples: whirling disease, heterosporis, spring viremia of carp, etc.	AIS Pathogens N/A

Next Step…
Once you've identified potential hazards, complete a hazard analysis form.

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	2 Hazards Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	3 Are AIS hazards significant? (Yes/No)	4 Justification Justify your decisions for column 3.	5 Control What control measures can be applied to prevent the significant hazards?	6 CCP Is this step a critical control point? (Yes/No)
Work Flow Step 1 In morning, COs depart office in vehicle with boat trailer behind. COs retrieve moored boat at Lake Woo and load onto trailer. COs arrive at Lake Zoo for safety checks and fishing enforcement. Boat and trailer are backed into water at boat landing.	Fish/Other Vert.	No	AIS Fish not present	Nets and equipment should be inspected and fish removed before sampling as a precaution.	No
	Invertebrate Zebra mussels	Yes	Woo is infested with z.m. & could be moved as adults on boat or plants and as larvae in any standing water.		Yes
	Plant	No	AIS Plants not present in Lake Woo.		No
	Pathogens	No	None present		No
Work Flow Step 2 COs patrol the lake. While patrolling, COs come upon an illegally set net. They anchor, inspect and pull the net, and bring it aboard.	Fish/Other Vert.	No	AIS fish not present in Lake Woo.		No
	Invertebrate Zebra mussels	Yes	Zebra mussels from Lake Woo could be present on the boat.	Hazard controlled at previous step.	No
	Plant	No	AIS Plants not present in Lake Woo.		No
	Pathogens	No	None present		No

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

Appendix 5

AIS-HACCP SAMPLE PLAN TWO

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	**2 Hazards** Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	**3** Are AIS hazards significant? (Yes/No)	**4 Justification** Justify your decisions for column 3.	**5 Control** What control measures can be applied to prevent the significant hazards?	**6 CCP** Is this step a critical control point? (Yes/No)
Work Flow Step 3 COs return to landing. Vehicle and trailer are retrieved. Trailer is backed into water at boat landing. Boat is driven onto trailer. Trailer is driven out of water. Net is stored in rear of vehicle.	Fish/Other Vert.	No	AIS Fish not present		No
	Invertebrate	No	AIS invertebrates not present in Lake Zoo		No
	Plant Eurasian water-milfoil	Yes	Lake Zoo infested with EWM and could be moved to another lake on equipment.	Before leaving boat landing, remove all weeds from equipment (trailer, motor, anchor, etc.)	Yes
	Pathogens	No	None present		No
Work Flow Step 4 COs continue to Lake Yoo. COs arrive at Lake Yoo for routine patrol. Boat and trailer are backed into water at boat landing.	Fish/Other Vert.	No	AIS fish not present in Lake Woo.		No
	Invertebrate	No	None Present		No
	Plant Eurasian water-milfoil	Yes	EWM present and could be introduced into Yoo on boat, trailer or equipment.	Hazard controlled in previous step.	No
	Pathogens	No	None present		No

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

AIS-HACCP SAMPLE PLAN TWO

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	2 Hazards Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	3 Are AIS hazards significant? (Yes/No)	4 Justification Justify your decisions for column 3.	5 Control What control measures can be applied to prevent the significant hazards?	6 CCP Is this step a critical control point? (Yes/No)
Work Flow Step 5 COs patrol the lake. While patrolling, COs come upon a suspicious float in adjacent wetland. COs anchor, don waders and inspect float. Float is not attached to anything. COs return to boat, remove waders, pull-up anchor and continue circuit of lake.	Fish/Other Vert.	No	AIS Fish not present		No
	Invertebrate	No	AIS invertebrates not present in Lake Zoo.		No
	Plant Eurasian water-milfoil	Yes	EWM entangled on boat anchor could be introduced into Lake Zoo.	Hazard controlled in previous step.	No
	Pathogens	No	None present		No
Work Flow Step 6 COs complete circuit of Lake Yoo and return to landing. Vehicle and trailer are retrieved. Trailer is backed into water at boat landing. Boat is driven onto trailer. Trailer is driven out of water. COs return to office and store illegally-set net for future destruction.	Fish/Other Vert.	No	AIS fish not present in Lake Woo.		No
	Invertebrate Zebra mussels	Yes	Z.M. could be introduced into next lake as adults on weeds ensnared on equipment, and as larvae in any standing water or in coiled wet anchor rope.	At landing, remove weeds from equipment. Drain water, rinse equipment (including waders & anchor rope) with high-pressure sprayer or hot water. If net not disposed of, freeze or dry for 1week before use.	Yes
	Plant	No	AIS Plants not present in Lake Woo.		No
	Pathogens	No	None present		No

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	2 Hazards Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	3 Are AIS hazards significant? (Yes/No)	4 Justification Justify your decisions for column 3.	5 Control What control measures can be applied to prevent the significant hazards?	6 CCP Is this step a critical control point? (Yes/No)
Work Flow Step 7 Next morning, COs depart office in vehicle with same boat trailered behind. COs arrive at Lake Poo for routine patrol. COs back boat and trailer into water at boat landing.	Fish/Other Vert.	No	AIS Fish not present in Lake Yoo.		No
	Invertebrate Zebra mussels	Yes	Zebra mussels present in Lake Yoo.	Hazard controlled at previous step.	No
	Plant	No	AIS plants not present in Lake Yoo.		No
	Pathogens	No	None present in Lake Yoo		No

1 Activity	2 Hazards	3	4 Justification	5 Control	6 CCP
Work Flow Step	Fish/Other Vert.				
	Invertebrate				
	Plant				
	Pathogens				

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

Appendix 5

AIS-HACCP SAMPLE PLAN TWO

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

AIS-HAACP Plan Form

Critical Control Point Each row answered "yes" in column 6 on the Hazard Analysis Form	**1**	In morning, COs depart office in vehicle with boat trailer and retrieve moored boat at Lake Woo and load onto trailer. COs arrive at Lake Zoo for safety checks and fishing enforcement.	COs return to landing for trailer. Trailer is backed into water at landing. Boat is driven onto trailer. Net is stored in rear of vehicle.
Significant Hazards as determined in column 3 of the Hazard Analysis Form	**2**	Zebra mussels could be moved to Lake Zoo as adults on boat or plants and as larvae in any standing water.	EWM and could be moved to another lake on equipment.
Limits for each control measure	**3**	Before leaving landing, all organisms (e.g., weeds and adult mussels) are removed from equipment & water is drained. All equipment is rinsed with a high-pressure sprayer or hot water.	Before leaving boat landing, remove all weeds from equipment (trailer, motor, anchor, etc.)
Monitoring Describe what is being monitored	**4**	Presence of adult mussels or plant fragments.	Presence of plant fragments.
Explain how the monitoring will take place	**5**	Visual inspection. High pressure rinsing.	Visual inspection.
Frequency of monitoring	**6**	Each time equipment leaves Lake Woo.	Each time boat leaves Lake Zoo.
Person or position responsible for monitoring	**7**	Driver	Driver
Corrective Actions Actions taken when limits of control mesaures are not met	**8**	If adults or plant fragments found on equipment, remove before going to uninfested waters.	If plant fragments found on equipment, remove before going to uninfested waters.
Verification Method of Verification	**9**	Records review.	Records review.
Records List what is recorded at each critical control point	**10**	Record time of rinsing and visual inspection.	Record time of visual inspection.

Final Step…

Once you have completed your HACCP plan, attach it to the signed product/procedure form with the hazard analysis worksheets.

AIS-HAACP Plan Form

Critical Control Point Each row answered "yes" in column 6 on the Hazard Analysis Form	1	COs complete circuit of Lake Yoo and return to landing for trailer. Boat is loaded on Trailer then driven out of water. COs return to office, store illegally-set net for future destruction.	
Significant Hazards as determined in column 3 of the Hazard Analysis Form	2	Zebra mussels present in Lake Yoo could be introduced into next lake as adults on weeds ensnared on net, trailer, waders or propeller, and as larvae in any standing water.	
Limits for each control measure	3	At landing, remove weeds from equipment & drain water. Rinse equipment (including waders) with high-pressure sprayer/hot water. If net not disposed of, freeze or dry for 10 days before use.	
Monitoring Describe what is being monitored	4	Presence of adult or juvenile mussels or plant fragments. Freezing/ drying of net. Rinse or dry all equipment.	
Explain how the monitoring will take place	5	Visual inspection for plant fragments. Length of time net is frozen or dried. Record of rinsing method or length of time of drying.	
Frequency of monitoring	6	Each time equipment leaves Lake Yoo. Each time a net is confiscated from Lake Yoo.	
Person or position responsible for monitoring	7	Driver	
Corrective Actions Actions taken when limits of control mesaures are not met	8	If adults or plant fragments found on equipment, remove before going to uninfested waters. If equipment not properly dried use a hot water or high pressure rinse.	
Verification Method of Verification	9	Records review.	
Records List what is recorded at each critical control point	10	Record time of rinsing and visual inspection. Record length of time of freezing or drying activities	

Final Step…

Once you have completed your HACCP plan, attach it to the signed product/procedure form with the hazard analysis worksheets.

AIS-HACCP SAMPLE PLAN THREE

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

Product/Procedure Form

Product/Procedure Description

Organization info	Organization name: ABC Baitfish Company
	Address: RR 1, Box 111 City: Baitville State: MI Zip: 48999
(if applicable):	Fish species: Emerald Shiners (*Notropis atherinoides*)
Harvest, production, management, research, or enforcement activity:	Activity: Seined from Lake Exotica
Method of transportation, distribution and storage of fish, gear, boats, etc.:	Methods: Held in tanks at baitfish facility and then delivered to retail stores or wholesalers.
(if applicable):	Intended use and consumer: To be sold live in retail bait shops and to wholesaler bait dealers for live fishing bait.

Product/Procedure Flow

List the steps involved in the research, management, enforcement, or fish production activity. Only a simple, but complete, description of the procedure is needed. It is important to include all the steps within the control of the agency or business, but use only as many steps as necessary to define your procedure.

1	Shiners are seined in the fall from lake Exotica.
2	Harvested shiners are dip-netted from the seine and moved to the transport truck in 5-gallon buckets with lake water.
3	Buckets of shiners and lake water are dumped into transport truck. Truck also contains well water from facility which contains salt.
4	Seines, waders, dip nets and other equipment are removed from the lake.
5	Shiners are transported to holding facility where the water and shiners are drained from the truck directly into holding tanks.
6	Shiners at the holding facility are held in flow through, aerated well water until marketed.
7	More shiners are brought into the facility periodically for holding.
8	Shiners for sale to retail bait shops are loaded onto trucks and delivered in salted, aerated, well water.
9	Shiners are dip-netted from the truck to 5-gallon buckets filled with well water for measuring volume and for moving them into the bait shop.
10	Shiners for another wholesaler are dip-netted from tanks to 5-gal. buckets to measure volume, then onto trucks with salted, aerated, well water.
11	The whole truckload of water and shiners is drained directly into a wholesaler's holding tanks.
12	

Next Steps…

Once you have defined your procedure, determine potential hazards by completing the potential hazards worksheet.

Upon completion of your AIS-HACCP plan, sign to signify that the plan has been accepted for implementation.

Name: Andy Haccip

Signature: X Andy Haccip Date: 1/31/05

Protential Hazards Worksheet

Potential AIS Hazards

List all relevant species

Examples: round goby, tubenose goby, non-native amphibians, etc.	AIS Fish and Other Vertebrates None at this time.
Examples: Dreissenid mussels, spiny waterfleas, etc.	AIS Invertebrates None at this time.
Examples: Eurasian watermilfoil, water chestnut, etc.	AIS Plants Eurasian watermilfoil found in Lake Exotica.
Examples: whirling disease, heterosporis, spring viremia of carp, etc.	AIS Pathogens None at this time.

Next Step…
Once you've identified potential hazards, complete a hazard analysis form.

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	2 Hazards Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	3 Are AIS hazards significant? (Yes/No)	4 Justification Justify your decisions for column 3.	5 Control What control measures can be applied to prevent the significant hazards?	6 CCP Is this step a critical control point? (Yes/No)
Work Flow Step 1 Shiners are seined.	Fish/Other Vert.	No	AIS not present		No
	Invertebrate	No	AIS not present		No
	Plant Eurasian Watermilfoil	Yes	Lake Exotica is infested with EWM	Hazard controlled at subsequent step	No
	Pathogens	No	AIS not present		No
Work Flow Step 2 Harvested shiners are dip-netted from the seine and moved to the truck in 5-gal buckets with lake water.	Fish/Other Vert.	No	AIS not present		No
	Invertebrate	No	AIS not present		No
	Plant Eurasian Watermilfoil	Yes	Lake Exotica is infested with EWM	Hazard controlled at subsequent step	No
	Pathogens	No	AIS not present		No

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	2 Hazards Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	3 Are AIS hazards significant? (Yes/No)	4 Justification Justify your decisions for column 3.	5 Control What control measures can be applied to prevent the significant hazards?	6 CCP Is this step a critical control point? (Yes/No)
Work Flow Step 3 Buckets of shiners and lake water are dumped into transport truck.	Fish/Other Vert.	No	AIS not present		No
	Invertebrate	No	AIS not present		No
	Plant Eurasian Watermilfoil	Yes	Lake Exotica is infested with EWM	Hazard controlled at subsequent step	No
	Pathogens	No	AIS not present		No
Work Flow Step 4 Seines, waders, dip nets and other equipment are removed from the lake.	Fish/Other Vert.	No	AIS not present		No
	Invertebrate	No	AIS not present		No
	Plant Eurasian Watermilfoil	Yes	Lake Exotica is infested with EWM and could be moved on equipment.	Remove plant fragments, freeze nets.	Yes
	Pathogens	No	AIS not present		No

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	**2 Hazards** Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	**3** Are AIS hazards significant? (Yes/No)	**4 Justification** Justify your decisions for column 3.	**5 Control** What control measures can be applied to prevent the significant hazards?	**6 CCP** Is this step a critical control point? (Yes/No)
Work Flow Step 5 Shiners are transported to holding facility where the water and shiners are drained from the truck directly into holding tanks.	Fish/Other Vert.	No	AIS not present		No
	Invertebrate	No	AIS not present		No
	Plant Eurasian Watermilfoil	Yes	Lake Exotica is infested with EWM	Hazard controlled at subsequent step	No
	Pathogens	No	AIS not present		No
Work Flow Step 6 Shiners at the holding facility are held in flow through, aerated well water until marketed.	Fish/Other Vert.	No	AIS not present		No
	Invertebrate	No	AIS not present		No
	Plant Eurasian Watermilfoil	Yes	EWM Could be present in tanks	Time, flow rate and cleaning tanks	Yes
	Pathogens	No	AIS not present		No

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

AIS-HAACP Plan Form

Critical Control Point Each row answered "yes" in column 6 on the Hazard Analysis Form	1	Seines, waders, dip nets and other equipment are removed from the lake.	Shiners at the holding facility are held in flow through, aerated well water until marketed.
Significant Hazards as determined in column 3 of the Hazard Analysis Form	2	Eurasian watermilfoil could be moved to uninfested lakes	Eurasian watermilfoil could be moved with baitfish to retail outlets
Limits for each control measure	3	Plant fragments are removed from waders, buckets, other equipment. Nets are frozen for 48 hours before use in uninfested waters.	Shiners held in flowing water for at least 18 hours. Tank bottoms and sides are swept before loading shiners to ensure plant fragments are no longer present. Flow rate maintained at 50 gal/min.
Monitoring Describe what is being monitored	4	Presence of plant fragments and time and temp.	Time, flow rate, and presence of plant fragments
Explain how the monitoring will take place	5	Visual inspection, clock and thermometer	Clock, timer and known volume container, and visual inspection
Frequency of monitoring	6	Each time equipment leaves lake	Each lot of shiners
Person or position responsible for monitoring	7	Manager	Manager
Corrective Actions Actions taken when limits of control mesaures are not met	8	If time and temperature not obtained, refreeze for entire time. If plant fragments found on other equipment, remove before going to uninfested waters.	If plant fragments are found, hold for another 18 hours. If flow rate drops, increase flow and hold for 18 hours.
Verification Method of Verification	9	Records review	Records review
Records List what is recorded at each critical control point	10	Record time in freezer and time out. Record temperature. Record time of visual inspection of equipment leaving the lake.	Record time shiners were brought in, and time loaded out. Record flow rate, and time of visual inspections

Final Step…

Once you have completed your HACCP plan, attach it to the signed product/procedure form with the hazard analysis worksheets.

AIS-HACCP SAMPLE PLAN THREE

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

AIS-HAACP Plan Form

Critical Control Point Each row answered "yes" in column 6 on the Hazard Analysis Form	1	More shiners are brought into the facility for holding.	
Significant Hazards as determined in column 3 of the Hazard Analysis Form	2	Eurasian watermilfoil could be moved with baitfish to retail outlets	
Limits for each control measure	3	Shiners added at drain end of tank, separated by screen from other shiners, held in flowing water > 18 hrs. Tank bottoms/sides swept before loading to ensure plant fragments are not present. Flow maintained at 50 gal/min.	
Monitoring Describe what is being monitored	4	Time, flow rate, and presence of plant fragments	
Explain how the monitoring will take place	5	Clock, timer and known volume container, and visual inspection,	
Frequency of monitoring	6	Each lot of shiners	
Person or position responsible for monitoring	7	Manager	
Corrective Actions Actions taken when limits of control mesaures are not met	8	If plant fragments are found, hold for another 18 hours. If flow rate drops, increase flow and hold for 18 hours.	
Verification Method of Verification	9	Records review	
Records List what is recorded at each critical control point	10	Record time shiners were brought in, and time loaded out. Record flow rate, and time of visual inspections	

Final Step…

Once you have completed your HACCP plan, attach it to the signed product/procedure form with the hazard analysis worksheets.

Appendix 6

Product/Procedure Description

Organization info	Organization name: ABC Baitfish Company
	Address: RR 2, Box 555 City: Fishtown State: MI Zip: 48999
(if applicable):	Fish species: White suckers (*Catostomous commersoni*)
Harvest, production, management, research, or enforcement activity:	Activity: Seined and trapped from grow out ponds.
Method of transportation, distribution and storage of fish, gear, boats, etc.:	Methods: Held in tanks on-site, then delivered to retail stores or wholesalers. Some held in aerated ponds over winter for sale in the spring.
(if applicable):	Intended use and consumer: To be sold in retail bait shops for fishing bait.

Product/Procedure Flow

List the steps involved in the research, management, enforcement, or fish production activity. Only a simple, but complete, description of the procedure is needed. It is important to include all the steps within the control of the agency or business, but use only as many steps as necessary to define your procedure.

1	Obtain eggs from wild suckers. Place in hatchery jars in facility.
2	As the fry hatch they flow into tanks where they are collected and counted (volumetrically).
3	Fry are stocked into leased ponds -- Pond A (ID #), Pond B (ID #), and Pond C (ID #).
4	Suckers are trapped each week after July 20 to determine if they are market size.
5	Each pond is seined when suckers reach market size. As many suckers as possible are seined before freeze up.
6	Suckers brought to holding facility for holding and grading. Holding tanks have flow through well water that discharges into wetland, then Rock Creek.
7	Well water with salt added is used to transport suckers. Suckers are sold to retail shops and wholesalers for export to other states.
8	Some suckers are stocked into aerated Pond D to be held over winter. Pond D has no outflow.
9	Pond D is seined and the suckers brought into holding tanks, graded and then trucked in well water w/salt to retail shops.
10	
11	
12	

Next Steps…
Once you have defined your procedure, determine potential hazards by completing the potential hazards worksheet.

Upon completion of your AIS-HACCP plan, sign to signify that the plan has been accepted for implementation.

Name: Andy Haccip

Signature: X Andy Haccip Date: 1/31/05

Appendix 7

Protential Hazards Worksheet

Potential AIS Hazards

List all relevant species	
Examples: round goby, tubenose goby, non-native amphibians, etc.	AIS Fish and Other Vertebrates None at this time.
Examples: Dreissenid mussels, spiny waterfleas, etc.	AIS Invertebrates None at this time.
Examples: Eurasian watermilfoil, water chestnut, etc.	AIS Plants None at this time.
Examples: whirling disease, heterosporis, spring viremia of carp, etc.	AIS Pathogens None at this time.

Next Step…
Once you've identified potential hazards, complete a hazard analysis form.

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	2 Hazards Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	3 Are AIS hazards significant? (Yes/No)	4 Justification Justify your decisions for column 3.	5 Control What control measures can be applied to prevent the significant hazards?	6 CCP Is this step a critical control point? (Yes/No)
Work Flow Step 1 Obtaining eggs, hatching them, and collecting fry.	Fish/Other Vert.	No	AIS fish species have not been found in river where sucker eggs were collected.		No
	Invertebrate	No	AIS invertebrates have not been found in river where sucker eggs were collected.		No
	Plant	No	AIS plants have not been found in river where sucker eggs were collected.		No
	Pathogens	No	No AIS pathogens present		No
Work Flow Step 2 Fry are stocked.	Fish/Other Vert.	No	No AIS fish have been found in hatchery source water or in hatchery.		No
	Invertebrate	No	No AIS invertebrates have been found in hatchery source water or in hatchery.		No
	Plant	No	No AIS plants have been found in hatchery source water or in hatchery.		No
	Pathogens	No	No AIS pathogens present		No

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

AIS-HACCP SAMPLE PLAN FOUR

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	**2 Hazards** Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	**3** Are AIS hazards significant? (Yes/No)	**4 Justification** Justify your decisions for column 3.	**5 Control** What control measures can be applied to prevent the significant hazards?	**6 CCP** Is this step a critical control point? (Yes/No)
Work Flow Step 3 Suckers are harvested from ponds.	Fish/Other Vert.	No	Ponds haven't been contaminated with AIS & most of the transport water is well water.		No
	Invertebrate	No	Ponds not contaminated with AIS & most of the transport water is well water.		No
	Plant	No	Ponds not contaminated with AIS & most of the transport water is from well.		No
	Pathogens	No	No AIS pathogens present		No
Work Flow Step 4 Suckers are held and graded in tanks at the facility.	Fish/Other Vert.	No	Well water used & all nets and other equipment are only used in the facility.		No
	Invertebrate	No	Well water used & all nets and other equipment are only used in the facility.		No
	Plant	No	Well water used & all nets and other equipment are only used in the facility.		No
	Pathogens	No	No AIS pathogens present		No

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	2 Hazards Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	3 Are AIS hazards significant? (Yes/No)	4 Justification Justify your decisions for column 3.	5 Control What control measures can be applied to prevent the significant hazards?	6 CCP Is this step a critical control point? (Yes/No)
Work Flow Step 5 Suckers are trucked to retail stores or to wholesalers' facilities.	Fish/Other Vert.	No	Well water used & all nets and other equipment are only used in the facility.		No
	Invertebrate	No	Well water used & all nets and other equipment are only used in the facility.		No
	Plant	No	Well water used & all nets and other equipment are only used in the facility.		No
	Pathogens	No	No AIS pathogens present		No
Work Flow Step 6 Suckers are moved to aerated ponds for the winter.	Fish/Other Vert.	No	Facility not infested & if trucks have used contaminated fish/water, they are drained/rinsed prior to use.		No
	Invertebrate	No	Facility not infested & if trucks have used contaminated fish/water, they are drained/rinsed prior to use.		No
	Plant	No	Facility not infested & if trucks have used contaminated fish/water, they are drained/rinsed prior to use.		No
	Pathogens	No	No AIS pathogens present		No

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

AIS-HACCP SAMPLE PLAN FOUR

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

Hazard Analysis Worksheet

1 Activity Activity, Harvest or Aquaculture Step (from flow diagram)	**2 Hazards** Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	**3** Are AIS hazards significant? (Yes/No)	**4 Justification** Justify your decisions for column 3.	**5 Control** What control measures can be applied to prevent the significant hazards?	**6 CCP** Is this step a critical control point? (Yes/No)
Work Flow Step 7 Suckers are harvested from over-winter ponds and brought to holding facility	Fish/Other Vert.	No	Ponds haven't been contaminated with AIS & most of the transport water is well water.		No
	Invertebrate	No	Ponds haven't been contaminated with AIS & most of the transport water is well water.		No
	Plant	No	Ponds haven't been contaminated with AIS & most of the transport water is well water.		No
	Pathogens	No	No AIS pathogens present		No
Work Flow Step 8 Suckers are trucked to retail stores and wholesalers' facilities.	Fish/Other Vert.	No	Facility isn't infested and trucks are drained/rinsed before loading.		No
	Invertebrate	No	Facility isn't infested and trucks are drained/rinsed before loading.		No
	Plant	No	Facility isn't infested and trucks are drained/rinsed before loading.		No
	Pathogens	No	No AIS pathogens present		No

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

AIS-HACCP

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

Product/Procedure Form

Product/Procedure Description

Organization info	Organization name:
	Address: City: State: Zip:
(if applicable):	Fish species:
Harvest, production, management, research, or enforcement activity:	Activity:
Method of transportation, distribution and storage of fish, gear, boats, etc.:	Methods:
(if applicable):	Intended use and consumer:

Product/Procedure Flow

List the steps involved in the research, management, enforcement, or fish production activity. Only a simple, but complete, description of the procedure is needed. It is important to include all the steps within the control of the agency or business, but use only as many steps as necessary to define your procedure.

1
2
3
4
5
6
7
8
9
10
11
12

Next Steps…

Once you have defined your procedure, determine potential hazards by completing the potential hazards worksheet.

Upon completion of your AIS-HACCP plan, sign to signify that the plan has been accepted for implementation.

Name:
Signature: **X** Date:

This form is the first page of the AIS-HACCP plan, please attach Hazard Analysis Worksheets & Plan Forms.

AIS-HAACP Form A (10/2004)

Protential Hazards Worksheet

Potential AIS Hazards

List all relevant species	
Examples: round goby, tubenose goby, non-native amphibians, etc.	AIS Fish and Other Vertebrates
Examples: Dreissenid mussels, spiny waterfleas, etc.	AIS Invertebrates
Examples: Eurasian water-milfoil, water chestnut, etc.	AIS Plants
Examples: whirling disease, heterosporis, spring viremia of carp, etc.	AIS Pathogens

Next Step…

Once you've identified potential hazards, complete a hazard analysis form.

AIS-HACCP

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

Hazard Analysis Worksheet

1 Activity	**2 Hazards**	**3**	**4 Justification**	**5 Control**	**6 CCP**
Activity, Harvest or Aquaculture Step (from flow diagram)	Potential AIS hazards introduced or controlled at this step (from potential hazards worksheet)	Are AIS hazards significant? (Yes/No)	Justify your decisions for column 3.	What control measures can be applied to prevent the significant hazards?	Is this step a critical control point? (Yes/No)

Work Flow Step ◯	Fish/Other Vert.				
	Invertebrate				
	Plant				
	Pathogens				

Work Flow Step ◯	Fish/Other Vert.				
	Invertebrate				
	Plant				
	Pathogens				

Next Step…

Once you have determined the critical control points of your procedure, you may enter them in row 1 of the HACCP plan form.

This worksheet accomodates only 2 steps, attach additional pages of this form as necessary .

AIS-HACCP

Aquatic Invasive Species – Hazard Analysis and Critical Control Point

AIS-HAACP Plan Form

Critical Control Point Each row answered "yes" in column 6 on the Hazard Analysis Form	1		
Significant Hazards as determined in column 3 of the Hazard Analysis Form	2		
Limits for each control measure	3		
Monitoring Describe what is being monitored	4		
Explain how the monitoring will take place	5		
Frequency of monitoring	6		
Person or position responsible for monitoring	7		
Corrective Actions Actions taken when limits of control mesaures are not met	8		
Verification Method of Verification	9		
Records List what is recorded at each critical control point	10		

Final Step…

Once you have completed your HACCP plan, attach it to the signed product/procedure form with the hazard analysis worksheets.

This form accomodates 2 Critical Control Points, attach additional pages of this form as necessary .

Great Lakes Indian Fish and Wildlife Commission

Fall Survey 2004 – Aquatic Nuisance Species Inventory Sheet

Crew Leader: ____________________

Crew Members: ____________________

Date: ____________________

Lake: ____________________

County: ____________________

Landing: ____________________

Known Exotics:

- ❑ Purple Loosestrife
- ❑ Rusty Crayfish
- ❑ Curly-leaf Pondweed
- ❑ Smelt
- ❑ Zebra Mussel
- ❑ Eurasian Watermilfoil
- ❑ Flowering Rush
- ❑ Heterosporis
- ❑ Spiny Water Flea
- ❑ Yellow Iris
- ❑ Oriental mystery snail

Previous Waters:

What was the last lake this boat was in?

____

Was the boat taken through a car wash?

❍ Yes ❍ No

Was the boat Power Washed?

❍ Yes ❍ No

Were any of the following disinfected?

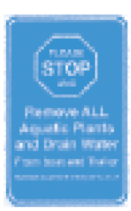
- ❑ Boat
- ❑ Horse tank
- ❑ Ropes
- ❑ Trailer drain holes
- ❑ Dip nets
- ❑ Droppers
- ❑ Measuring board
- ❑ Aerator

Prior to launching the boat:

UTM (GPS) Coordinates of landing:

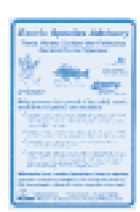
__________ E __________ N

Circle any of the following exotic species signs present at landing:



green

white



yellow

Listed species on signs:

- ❑ Rusty crayfish
- ❑ Eurasian watermilfoil
- ❑ Purple loosestrife
- ❑ Other: ____________________

Boat landing observations:

- ❑ Zebra mussels
- ❑ Purple loosestrife
- ❑ Curly-leaf pondweed
- ❑ Oriental mystery snail
- ❑ Other•: ____________________

• If a newly ID-ed or suspected exotic species is observed, collect a sample

Check the following for aquatic vegetation:

- ❑ Anchor
- ❑ Axle
- ❑ Motor
- ❑ Wheels
- ❑ Prop
- ❑ Trailer
- ❑ Lights/wiring
- ❑ Rollers
- ❑ Transom

After Loading up the boat:

Check the following for aquatic vegetation:

- ❑ Anchor
- ❑ Axle
- ❑ Motor
- ❑ Wheels
- ❑ Prop
- ❑ Trailer
- ❑ Lights/wiring
- ❑ Rollers
- ❑ Transom

Was the boat plug pulled so that the boat can drain away from the lake and storm drains?

❍ Yes ❍ No

Comments: ____________________

Notes

Notes