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thesis entitled

INVESTIGATING INJURIOUS SPECIES INTRODUCTIONS
AS ENVIRONMENTAL CRIMES

presented by

Jill Lynn Finster

has been accepted towards fulfillment
of the requirements for the

Master of Science	degree in	Fisheries and Wildlife

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May 7, 2007
Date

INVESTIGATING INJURIOUS SPECIES INTRODUCTIONS AS ENVIRONMENTAL CRIMES

By

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Fisheries and Wildlife

2007

ABSTRACT

INVESTIGATING INJURIOUS SPECIES INTRODUCTIONS
AS ENVIRONMENTAL CRIMES

By

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Aquatic invasive species (AIS) threaten the sustainability of Great Lakes ecosystems by degrading habitat, competing with native and naturalized species, and disrupting essential food-web structures. The intentional and accidental release of AIS into the Great Lakes constitute environmental crimes under state and federal statutes. An imprecise definition of "invasive," limited authority through non-comprehensive legislation, inconsistent regulations, and insufficient staff and financial resources hinder the investigation of environmental crimes. Therefore, current enforcement is less effective than it should be to deter future releases. This thesis considers the release and potential invasion of three species of non-native Asian carp into the Great Lakes basin as an environmental crime. This example illustrates the legislative gaps and ineffective enforcement mechanisms that collectively contribute to unlawful releases going unpunished. To promote successful prosecution of accidental and intentional releases, investigative procedures must be improved. To this end, the development of a standardized investigative is proposed.

ACKNOWLEDGEMENTS

I would like to thank the members of my research committee: Dr. Bill Taylor, Dr. Ed McGarrell, Dr. Chris Goddard, and Dr. Robyn Mace for the invaluable guidance and support they provided throughout this project. In particular, Dr. Goddard's mentorship and counsel provided me both the practical direction and vision that were essential to this project. Dr. Taylor and Dr. McGarrell are committed to furthering the field of environmental crime studies and, to this end, created a unique partnership with the Federal Law Enforcement Training Center. I was the first MSU student to undertake and graduate from the FLETC training program and I am grateful to Dr. Taylor and Dr. McGarrell for facilitating my participation. The commissioners, staff, and extended community of the Great Lakes Fishery Commission generously provided support, shared their expertise, and continually challenged me to take my thinking to the next level. I would like to extend my sincere appreciation to the members of the Great Lakes Law Enforcement Committee for "showing me the ropes" and allowing me to learn about conservation law enforcement from the very best. I would also like to thank the U.S. Fish and Wildlife Service staff members at the Federal Law Enforcement Training Center. A very special thank-you goes to C.J. Ross and Rick Giovengo for giving me an incredible opportunity and for helping me to achieve my goals. In addition, I am very grateful to my classmates and instructors from the Land Management Police Training Program #604 for being such an invaluable part of a very memorable experience. Finally, my deepest thanks to my friends and colleagues for their editing, insight, and moral support: Gavin Christie, John Dettmers, Marc Gaden, Ted Lawrence, and Eric Wingfield.

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INTRODUCTION

The Great Lakes are an extremely valuable and unique resource for both the United States and Canada. The Great Lakes commercial, recreational, and tribal fisheries are collectively valued at more than $4 billion annually (Talhelm 1988). For more than five decades, efforts have been underway to protect the fishery resource from the introduction of, and extensive harm caused by, injurious species. Biological pollution – the introduction and establishment of undesirable plant and animal species not native to a system – has been increasing steadily in the Great Lakes basin and presents one of the biggest threats to the future of the Great Lakes. The establishment of injurious species results in great economic losses, as well as extensive ecosystem damage.

To date, 182 non-native species have become established in the Great Lakes basin (Ricciardi 2006). For a non-native species to become newly established in an ecosystem (defined by the presence of reproducing populations) multiple introductions are often required. For the purposes of this thesis, the term introduction refers to the intentional or unintentional release of a non-native species into aquatic or terrestrial ecosystems. **Chapter 1** begins by defining injurious species and discussing their impacts on both the environment and economy of the Great Lakes region. The impacts of unintentional and intentional unauthorized introductions of aquatic injurious species have had devastating effects on fisheries productivity and economic vitality of coastal communities.

The impending invasion of three species of Asian carp into the Great Lakes basin is examined in **Chapter 2**. Asian carp were imported into the United States for uses in aquaculture; since escaping from farm fish ponds in the early 1970s, these fish have steadily moved northward through the Mississippi and Illinois River basins. The negative

impacts of Asian carp on both the ecosystem and economy in the regions they have invaded have been considerable. As these fish near the Great Lakes basin, multiple levels of government have made significant efforts to prevent these fish from entering the Great Lakes ecosystem.

The field of environmental crime, focusing primarily on chemical pollution and physical damage, is limited in scope and the result is that a number of activities that are environmentally degrading are characterized by inadequate legislation, investigative complications, and insufficient penalties. **Chapter 3** provides a definition of environmental crime that broadens the current scope and facilitates the inclusion of all chemical, physical, and biological activities that have the potential to cause environmental harm. The challenges associated with applying the model of standard criminal law to environmental crime are also discussed in chapter 3. The standard of proof requirements vary dramatically between the fields of criminal justice and natural resource management. Consequently, investigations of environmental crimes are often not able to attain the level of proof needed to meet the requirements of criminal provisions of environmental regulations. Lastly, chapter 3 argues that the omission of the importation and introduction of injurious species in the current definition of environmental crime is a prime example of the detrimental effect such a limited definition can have on effective enforcement and ecosystem management. For example, the response to the escape of Asian carp from aquaculture facilities and the impending invasion into the Great Lakes basin illustrates the effects of inadequate legislation and enforcement governing injurious species at all levels of government.

Despite the great risk to ecosystem function arising from the importation and introduction of injurious species, United States law addressing accidental or unlawful introductions is inadequate. The difficulty in ascribing value to the impact of injurious species introductions on the economics and integrity of the fisheries ecosystem has resulted in weak regulations and relatively low penalties associated with their release. **Chapter 4** outlines international, federal, and state regulations that govern the importation and introduction of injurious species. The chapter primarily focuses on the Lacey Act of 1900 (18 U.S.C. 42), which is implemented by the United States Fish and Wildlife Service (USFWS), and serves as the strongest enforcement tool to regulate the importation and introduction of injurious species. The Lacey Act is a strong regulatory mechanism to address injurious species importations and introductions, although the process to list species as injurious is slow, cumbersome, and reactionary when in fact, it should be quick, streamlined, and precautionary. Further, penalty provisions for both civil and criminal infractions under the Lacey Act are universally weak and address only intentional importations and introductions. Chapter 4 argues that, as Asian carp approach the Great Lakes basin, the unsuccessful efforts to list Asian carp as injurious under the Lacey Act illustrate its ineffectiveness to facilitate a strong enforcement response to injurious species introductions. A discussion of the future legislative needs to address aquatic injurious species concludes chapter 4. A comprehensive approach to address injurious species importations and introductions should clearly empower the federal government to develop a coordinated approach among all levels of government to address prevention, early detection, rapid response, control, and management.

Chapter 5 begins with a review of the National Institute of Justice's framework for investigating environmental crime scenes. Although this framework was developed to address illegal waste dumping cases, it is used to provide a foundation for the development of a more comprehensive framework to outline the investigation of all types of environmental crimes. Environmental crime scene investigations are relatively new; as a result, chapter 5 focuses on the administrative, scientific, and resource allocation challenges that currently face the development of investigative techniques and protocols. Lastly, chapter five proposes future research needs and recommendations for the development of an investigative framework for the introduction of injurious species.

CHAPTER 1

AQUATIC INJURIOUS SPECIES IN THE GREAT LAKES BASIN

Injurious species threaten the long-term viability of many aquatic systems nationwide by causing irreversible environmental damage. The establishment of many injurious species has had devastating effects on entire aquatic ecosystems such as: decreased fisheries productivity; destroyed and altered habitat; and reduced survival of native species, many of which are listed as threatened or endangered (Ricciardi 2006). Injurious species introductions constitute one of the greatest threats to the nation's aquatic ecosystems. A single species can cause significant, permanent damage to ecological health and the establishment of injurious species contributes to significant economic losses. For the most part, these introductions are largely unregulated in the United States.

DEFINING INJURIOUS SPECIES. There are a number of terms, such as nonindigenous, exotic, naturalized, and non-native, that refer to species that have become established in an ecosystem outside of their native range. In many cases, such as Pacific salmon in the Great Lakes, non-native species were introduced intentionally by fisheries management agencies to provide a fishery (Tanner and Tody 2002; Goddard 2002). These terms are simply a statement of fact; that is, they identify the species as not being a native inhabitant. Other terms, such as injurious species, attach a value judgment to the species by attributing negative economic, social, or environmental consequences to the establishment of that species. The Lacey Act of 1900 (18 U.S.C. 42) defines injurious species as those species that are "...injurious to the health and welfare of humans, to the

interests of forestry, agriculture, or horticulture and to the welfare and survival of wildlife" (50 C.F.R. 16.3). Building upon this definition, an injurious fish is defined as: "...any species that can significantly adversely affect the long-term survival of native species, the integrity or sustainability and functioning of natural communities or genetic variation within indigenous species" (Chadderton 2003, p. 74).

Geography, politics, and culture affect the ways in which society places value on a specific species or ecosystem. Consequently, the value judgments that contribute to the classification of a species as "injurious" are constantly being redefined. Given the changing values associated with particular non-native species, not all non-native species are categorized as injurious; often these species provide a benefit to the region in which they have become established as a food or recreational fish or prey source. Therefore, in some areas, the category of injurious species may include non-native species that threaten the sustainability of populations of highly valued planned or unplanned introduced species, in addition to native species (Chadderton 2003).

INJURIOUS SPECIES IN THE GREAT LAKES. The Great Lakes has the highest rate of discovery of non-native species compared with any other freshwater ecosystem; a new species is discovered every 28 weeks (Ricciardi 2006). While there are currently 182 non-native species known to be established in the Great Lakes basin, it is important to again note that not all of these species are considered injurious, as many have been intentionally introduced to support the intense commercial and recreational fisheries in the region. Each year, federal, provincial, state, and tribal agencies stock more than 33 million fish; non-native coho (*Oncorhynchus kisutch)* and chinook salmon (*Oncorhynchus tshawytscha)* comprise a significant portion of these programs (Ebener et

al. 2005). As native lake trout *(Salvelinus namaycush)* and deep-water cisco *(Coregonus johannae)* populations declined in the 1950s due to a combination of over-fishing and sea lamprey predation, populations of non-native alewife *(Alosa pseudoharengus)*, a small pelagic planktivore, dominated the system. In response, Great Lakes fishery management agencies began stocking non-native predators, including brown trout *(Salmo trutta trutta)*, coho and chinook salmon, and rainbow trout *(Oncorhynchus mykiss)* in an effort to control the alewife population (Tanner and Tody 2002). Today, as these non-native predator species flourish, management agencies are now struggling to maintain an adequate prey source (i.e. alewife population) to support the ongoing demand by the recreational fishery.

While only a small proportion (<10%) of non-native species that become established result in negative impacts, the small fraction that do cause harm inflict significant damage on both the environment and the economy (Ricciardi and Rasmussen 1998). It should be noted that the categorization of damage/harm to the environment resulting from the establishment of non-native species will vary with individuals and over time. Previous invasions have demonstrated that a single species can cause significant, permanent damage to the economic and ecological health of a region. As the parasitic sea lamprey *(Petromyzon marinus)* spread through the Great Lakes in the 1920s and 1930s after the opening of the Welland Canal, the native lake trout population was decimated. The sea lamprey is the only injurious species for which a control program has proven effective; even with control, they remain a permanent, destructive element of the Great Lakes fishery (Christie and Goddard 2003). Most—if not all—fishery management

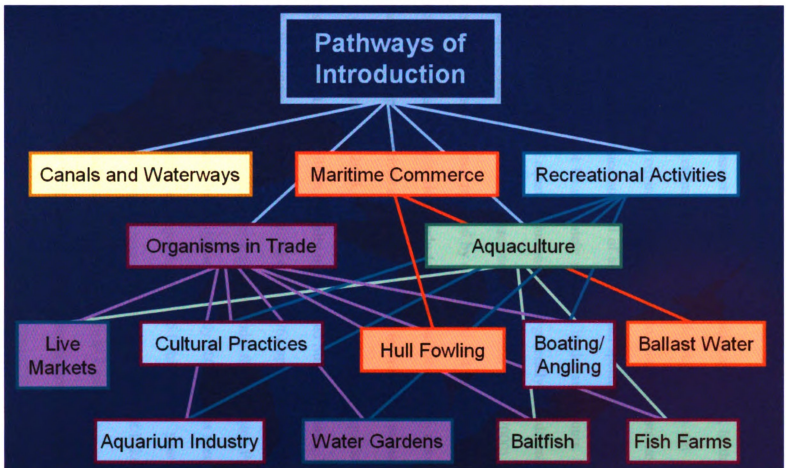
decisions made by federal, provincial, state, and tribal agencies in the Great Lakes must take sea lamprey control into account.

VECTORS OF INTRODUCTION. Injurious species enter aquatic ecosystems through five primary vectors, or pathways: maritime commerce, recreational activities, organisms in trade, aquaculture, and canals and waterways (GLRC 2005). Each of these vectors has a number of sub-pathways (figure 1). The first vector, maritime commerce, includes ballast water discharge and hull fouling as sub-pathways. The second and third vectors, recreational activities and organisms in trade, each share many of the same sub-pathways, including: cultural releases, introductions through the aquarium and water garden industries, and boater and angler mediated releases. The organisms in trade vector also shares sub-pathways with the fourth vector, aquaculture; they are: live markets, the baitfish industry dealing with both cultured and wild-caught organisms; and commercial and private fish farms. The fifth pathway through which injurious species enter aquatic ecosystems is canals and waterways, which facilitate the expansion of aquatic species.

In the previous forty years, with the impacts of globalization, the introduction and spread of non-native species have increased greatly (Stanley 1991; Taylor et al. *in press*). The unintentional import through international trade has been identified as the primary pathway through which aquatic injurious species currently enter the United States (Jenkins 1996). Human population growth, the increased demand for efficient movement of goods and people, and the continual modification of the environment have led to a lax regulatory regime with regard to intentional and unintentional importations of injurious species (Stanley 1991). Further, while the rate of international exchange continues to increase exponentially, inspectors tasked with ensuring shipments entering

Figure 1

VECTORS OF INTRODUCTION OF INJURIOUS SPECIES INTO THE GREAT LAKES BASIN



The five primary vectors through which injurious species enter the Great Lakes Basin are: Canals and Waterways, Maritime Commerce, Recreational Activities, Organisms in Trade, and Aquaculture. Each vector has a number of sub-pathways.

the United States are free from injurious species lack proper training in identification and handling (Pimentel 2005).

ECONOMIC AND ENVIRONMENTAL IMPACTS OF INJURIOUS SPECIES. In the case of most injurious species, precise estimates of the economic impacts are not available, because a formula for translating environmental damage into economic costs has not been developed. Certainly, the continued survival of an individual species or the preservation of a particular ecosystem cannot be accurately measured in dollar amounts. Efforts to quantify the economic impact of aquatic injurious species generally include only control expenditures and conservative damage assessments (Pimentel et al. 2000). Damage assessments generally include losses reported by commercial and sport fishery industries, maintenance costs incurred by various industries that utilize aquatic resources for operation, and federal appropriations allocated to state and federal agencies mandated to implement control programs. In 2005, the negative economic impact of aquatic injurious species was estimated at $14.2 billion annually in the United States (Pimentel, 2005). By comparison, the Environmental Protection Agency (2006) spent approximately $1.5 billion on the clean-up of contaminated sites designated under the Superfund Program in 2006. At a regional level, economic losses due to the nearly 200 injurious species in the Great Lakes basin were estimated at approximately $5.0 billion per year in 2005 (Pimentel 2005). The sea lamprey control program, facilitated by the Great Lakes Fishery Commission, operates on an annual budget of approximately $17 million.

It is important to note that the figures presented above do not reflect the extensive environmental and ecosystem losses caused by the introduction of these injurious species. Injurious species pose a threat by direct predation, competing for food and space –

particularly spawning areas, degrading habitat, and altering native gene pools and food webs (Ricciardi 2006). The degree to which native fish and their habitats are impacted depends on the nature of the native biodiversity within the ecosystem and the life history characteristics of the invading species (Ricciardi 2001). Injurious species are a form of biological pollution, in which the effects are often permanent and irreversible. Small releases of live organisms differ from chemical pollution in that there is not a half-life to mitigate damage. Biological pollutants are extremely difficult or impossible to remove from the system once introduced and the problem is further exacerbated by the fact that the pollutants can potentially reproduce (Chapman 2003).

The establishment of injurious species in aquatic ecosystems throughout the United States is credited with being a major catalyst in the endangerment and extinction of many native species (Jenkins 1996). Current estimates indicate that forty-four fish species native to the United States are threatened or endangered by nonindigenous species and an additional twenty-seven native species have been greatly harmed due to introductions of non-native fish. Furthermore, as more than half of the 750,000 species present in the United States have not yet been described, damage assessments cannot accurately define the extent of environmental loss due to injurious species (Pimentel et al. 2000). There is no question in the scientific community that injurious species are the "most pervasive and insidious" threat to biodiversity (Jenkins 1996. p. 300).

EXPANDING RANGE OF ESTABLISHED SPECIES. Once injurious species enter a system, a number of ecological and life history factors can promote their establishment and dispersion. These include: lack of natural predators, the ability of the invader to become an effective predator in the new system, the availability of essential habitats

(such as spawning and rearing habitats), and the degree of adaptability of the invaders (Pimentel 2000). The history of invasion in the Great Lakes supports the Simberloff – Von Holle "invasional meltdown" model, which posits that as more and more injurious species enter a system, the system becomes more susceptible to future invaders due to the disruption to native communities and altered habitat caused by previous introductions. Furthermore, varying degrees of interaction between non-native species may facilitate the dispersal and success of other non-native populations (Ricciardi 2001).

CHAPTER 2

THE IMPENDING INVASION OF ASIAN CARP INTO THE GREAT LAKES BASIN

There are three species of Asian carp that have now been established in wild populations in the United States – grass carp (*Ctenopharyngodon idella*), bighead carp (*Hypophthalmichthys nobilis*) and silver carp *(Hypophthalmichthys molitrix*). Populations of a fourth species of Asian carp, black carp (*Mylopharyngodon piceus*), have been reported in the wild, yet it is not clear if black carp have yet established reproducing populations (Chick et al. 2003). Grass carp are established in water systems throughout the United States. Although the three other species of Asian carp have not yet invaded the Great Lakes basin, silver and bighead carp have become established and abundant in the Mississippi and Illinois River basins and are within close proximity of the Great Lakes. While black carp primarily remain in captivity today, individual black carp have been discovered in the wild (Chick et al. 2003). Given the history of Asian carp escapement from aquaculture, it is likely only a matter of time before black carp become established. In addition, the similarity of appearance between the grass and black carp makes escape of black carp by contamination of grass carp stocks likely (Nico and Fuller 2007). Due to their voracious appetites, high fecundity, and ability to adapt to most types of environment, Asian carp species pose a significant threat to native species in the Great Lakes.

ASIAN CARP: IMPORTATION INTO THE UNITED STATES. Asian carp were brought into the United States for uses in aquaculture as food fish and for biological control of

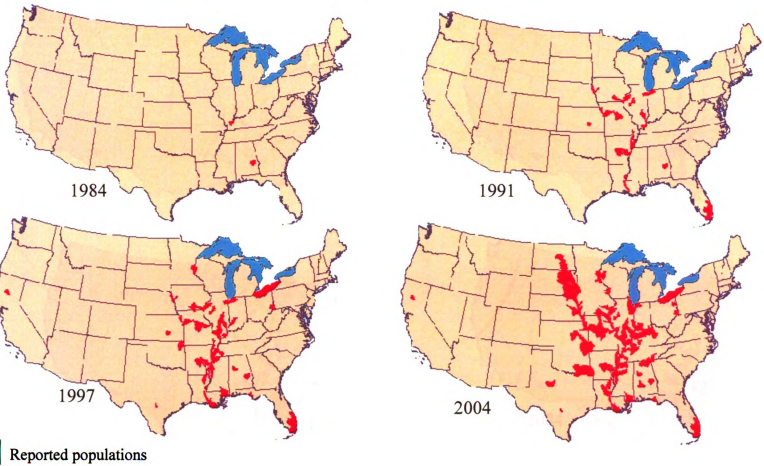
plankton and vegetation in aquaculture and ornamental ponds (Rasmussen 2002). Grass carp were imported into the United States in 1962 from Taiwan and Malaysia. Black carp, native to China, contaminated these shipments and were later intentionally introduced in the 1980s to control snails in fish culture ponds in the southern United States (Nico and Fuller 2007). Bighead carp were imported from China in 1972. A year later, in 1973, silver carp were brought into the United States from China and eastern Siberia (Freeze and Henderson 1982).

ASIAN CARP: RELEASE. In the 1970s, bighead and silver carp became problematic in the southern United States, primarily Arkansas. In the mid to late 1970s, these fish escaped or were released from farm fish ponds. In the early 1990s, the presence of silver and bighead carp in the Arkansas River was reported (Koel et al. 2000). In 1993, massive flooding provided extensive spawning and rearing habitat for floodplain spawning fishes, thereby allowing the Asian carp to complete multiple spawning events in 1993 and permitting high survival rates for their offspring. Since their escape from aquaculture facilities, the fish have dramatically altered the environments they invaded. A small number of black carp reportedly escaped into the Osage River, in the Missouri River drainage, from a fish culture pond in the Ozarks during a flood in 1994 (Nico and Fuller 2007).

ASIAN CARP: NORTHWARD SPREAD. Given their ability to travel long distances in short periods of time, silver and bighead carp spread quickly throughout the Mississippi and Illinois River basins (figures 2, 3). They have out-competed native fish, such as bigmouth buffalo (*Ictiobus cyprinellus)*, gizzard shad *(Dorosoma cepedianum)* and paddlefish (*Polyodon spathula*), to become the most abundant species in some areas of

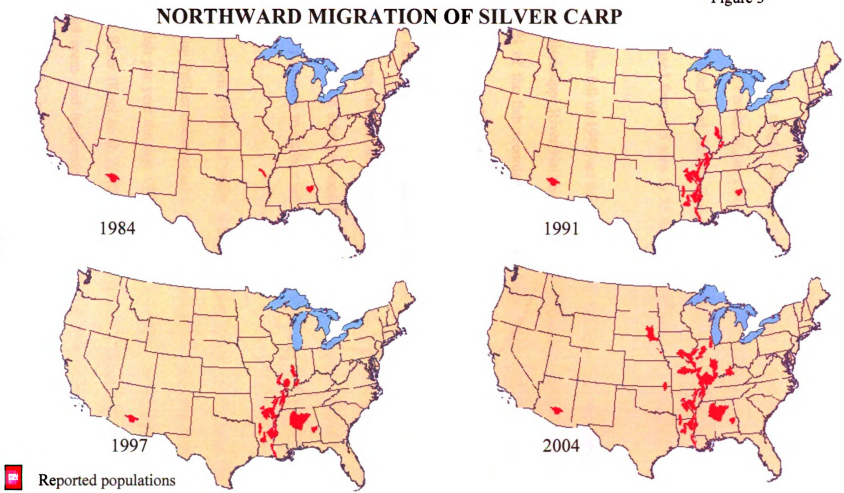
Figure 2

NORTHWARD MIGRATION OF BIGHEAD CARP



Bighead carp have steadily moved northward throughout the Mississippi and Illinois River basins. Populations of bighead carp have been detected within 50 miles of Lake Michigan. [Images reproduced from the U.S. Geological Survey Nonindigenous Aquatic Species Database].

Figure 3



Silver carp have become established throughout the Mississippi and Illinois River basins. Should silver carp enter the Great Lakes basin, fishery biologists are concerned they will become a permanent, destructive element of the ecosystem. [Images reproduced from the U.S. Geological Survey Nonindigenous Aquatic Species Database].

those systems. The Upper Mississippi River Long Term Resource Monitoring Project first discovered a single bighead carp in Pool 26 of the Illinois River, which is downstream of Peoria, IL, in 1991; in 2000, over 100 bighead carp were recorded in the same area (Koel et al. 2000). Between 1994 and 1997, commercial harvest of bighead carp increased from 5.5 tons to 55 tons in the Mississippi River basin (Chick and Pegg 2001).

In the fall of 1999, an investigation of a fish kill in the off-channel waters of the Upper Mississippi River National Wildlife Refuge near St. Louis Missouri documented that 97% of the fish recorded were Asian carp, while only four native species were present, represented by only one individual each (Conover et al. *in review*). During this time period, commercial fisherman began reporting they were abandoning fishing sites, because they were unable to lift nets that were "loaded" with Asian carp (Rasmussen 2002). It is important to note that, currently, there is a small commercial harvest of these fish for conversion into fish meal (Conover et al. *in review)*. This market, however, was generated primarily to replace the commercial fishery that was lost due to the Asian carp invasion.

Between 1999 and 2000, the Upper Mississippi River Long Term Resource Monitoring Project documented a 600-fold increase in Asian carp numbers – from less than 3 fish per year through 1999 to over 600 in 2000 – in the LaGrange Reach of the Illinois River (Koel et al. 2000). Sampling during the summer of 2000 in isolated off-channel areas and backwaters of the Mississippi River, downstream from St. Louis, documented the presence of bighead carp at a ratio of 5:1 to native paddlefish (Rasmussen 2002).

In 2001, during the "great round goby round up" in the Mississippi River basin, several dead Asian carp were observed floating in the Starved Rock Pool of the Illinois River, which is within 70 miles of Lake Michigan. The state of decay of these fish indicated they had likely floated some distance downstream (Rasmussen 2002).

ASIAN CARP: CURRENT SITUATION IN THE GREAT LAKES BASIN. Bighead and silver carp have steadily made their way northward toward the Great Lakes through the Chicago Sanitary and Ship Canal (figures 4A, 4B). Fish sampling surveys on the Mississippi River and the Chicago Sanitary and Ship Canal have been used to track the migration of Asian carp. Agencies report that silver and bighead carp are currently within 50 miles of Lake Michigan (Conover et al. *in press*). In the Mississippi River, self-sustaining populations of bighead carp have been observed near Clinton, Iowa and self-sustaining populations of silver carp have been observed near New Boston, Illinois (both locations are south of the Wisconsin border). Nevertheless, sightings of the species have been seen as far north as Alma, Wisconsin, which is south of Minneapolis (Conover et al. *in press*). While it is unknown whether black carp are reproducing in the wild. live black carp have been observed at the mouth of the Illinois River, near St. Louis, and in the Red River, in Louisiana (Nico and Fuller 2007).

Research indicates that Asian carp are well-suited to the climate of the Great Lakes region, which is similar to their native eastern hemisphere habitats (black: 22°N to 51°N; bighead: 21°N to 47°N; silver: 21°N to 54°N) (Nico et al. 2005; Kolar et al. 2005). In addition, Asian carp prefer temperature ranges similar to those preferred by valuable recreational and commercial species in the Great Lakes such as yellow perch (*Perca flavescents)*, salmon, and lake trout (Ferber 2001). All species of Asian carp are very

CHICAGO SANITARY AND SHIP CANAL

Figure 4A. The Chicago Sanitary and Ship Canal connects the Great Lakes and Mississippi River system via the Illinois River. [Image adapted from Moy, P. 2005].

Figure 4B. The electrical barrier runs through the water column to generate a strong electrical current. Fish are deterred from passing through the electrical field. [Image adapted from the U.S. Army Corps of Engineers].

prolific and spawn in moving waters. Bighead and silver carp are filter feeders and consume a variety of planktonic organisms, which comprise an important element of all fishes diets during their early life history stages (Chick et al. 2001) These life historycharacteristics indicate that portions of the Great Lakes are perfectly suited for Asian carp (Kolar et al. 2005). Fishery biologists are concerned that if allowed into the basin, they will make the lakes home, spread, and deprive native and highly valued introduced fish of food (Rasmussen 2002). Asian carp have the ability to become established rapidly, reproduce in large numbers, and become the dominant species in an ecosystem (Kolar et al. 2005). Once established, there is very little chance fishery managers will be able to control Asian carp populations. Like sea lampreys, Asian carp will become a permanent element of the Great Lakes (Ferber 2001; Chick and Pegg, 2001).

Based on the adverse environmental and economic effects they have had in the Mississippi and Illinois River basins, there is little doubt that an Asian carp colonization of the Great Lakes would seriously disrupt the ecosystem by drastically altering the food web. The Great Lakes commercial, sport, and tribal fisheries will be greatly threatened if bighead and silver carp enter the basin (Conover et al. *in press*). If Asian carp enter the system, these fish will likely become a permanent, noxious feature of the Great Lakes environment as they decimate food sources native and highly valued introduced fish rely on.

Efforts to block the transmigration of Asian carp between the Mississippi River system and the Great Lakes basin have been extensive. Many local, state, and federal agencies have collaborated to design, build, fund, and operate two electrical dispersal

barriers in the Chicago Sanitary and Ship Canal. The first dispersal barrier (barrier I) was activated in 2002 and was designed to prevent movement of injurious fishes across the artificial connection between the Great Lakes and Mississippi River system (Conover et al. *in press)*. Given this was an experimental barrier, it was designed to have a relatively short life span and is currently failing (GLRC 2005). The second barrier (barrier II) is under construction and was designed to be a permanent structure. It will be necessary to retrofit barrier I to create a lengthy barrier system (over 1,000 feet) on the canal and provide some redundancy (Conover et al. *in press)*. Both barriers are operated by the United States Army Corps of Engineers (USACOE). Federal and state appropriations totaling more than $15 million have been directed towards the construction these barriers, which will cost approximately $500,000 each year to operate (Conover et al. *in press)*. Agencies report that both bighead and silver carp are within 20 miles of Barrier I (GLRC 2005).

In addition, the state of Illinois and stakeholders have developed a rapid response plan that will be implemented should Asian carp approach the barriers. The development of this plan was funded by the Great Lakes Fishery Commission. This plan calls for the application of the piscicide rotenone, which will eradicate the population of Asian carp within the lower 5 miles of Lockport Pool, thereby preventing their northward migration into Lake Michigan. The plan has outlined a procedure for the delivery of an adequate supply of rotenone within 24 hours of the discovery of Asian carp past a specific location (the Lockport Pool) in the Chicago Sanitary and Ship Canal. Rotenone is not an Asian carp specific piscicide, therefore, all fish species in the treated portion of the canal will be killed (Chapman et al. 2003). The primary species that occupy this stretch of water are:

common carp *(Cyprinus carpio carpio)*, goldfish *(Carassius auratus auratus)*, and gizzard shad. A single application will cost an estimated $500,000.

OTHER POTENTIAL INVADERS FROM AQUACULTURE FACILITIES. There are a number of species currently reared in aquaculture facilities throughout the United States, that if released or allowed to escape, pose a similar threat to the Great Lakes basin. For example, tilapia *(Oreochromis sp.)*, one of the leading species being farm-raised in the United States, requires environmental conditions that are present within the Great Lakes basin (Fitzsimmons 2006). Furthermore, tilapia are considered an injurious species in many areas of the world, including areas within the Mississippi River system. Other species currently being raised in the United States that may find the Great Lakes a suitable environment include: striped bass *(Morone saxatilis)* and zander *(Sander lucioperca)*.

A number of agencies, including the Environmental Protection Agency (EPA), the Food and Drug Administration (FDA), the National Marine Fisheries Service (NMFS), the United States Department of Agriculture (USDA), the United States Fish and Wildlife Service (USFWS), and numerous state environmental agencies have regulatory authority over aquaculture facilities (National Aquaculture Association 2004). These agencies are tasked with ensuring that the aquaculture industry undertakes practices that are in line with state and federal ecosystem and watershed management objectives. One of the responsibilities of these regulatory agencies is to ensure measures are taken to prevent cultured species from reaching the wild; however, current aquaculture practices, such as the use of net pens, increase the risk of escapement by allowing facilities to "rope off" an area within a watershed in which cultured fish are raised.

CHAPTER 3

ENVIRONMENTAL CRIMES

The study of environmental crime is relatively new; statutes and regulations that define modern environmental law were enacted after the first Earth Day in 1970 (McGregor 1994). Non-comprehensive legislation, an imprecise definition, and insufficient resources all contribute to the omission of numerous environmentally harmful acts from the current field of environmental crime. As a result, environmental crime scenes are not able to be processed with the same rigor as more traditional crime scenes. The imminent invasion of Asian carp into the Great Lakes basin illustrates the limited scope of the current approach to environmental crime.

For the purposes of this thesis, environmental crimes include all biological, chemical, and physical alterations to the environment that cause, or have the potential to cause, significant damage to the ecosystem. Within this context, and for the purposes of this thesis, environmental crime does not include natural resource violations such as the illegal take of fish and wildlife. Ideally, all environmental violations should be responded to in the same scrupulous manner as more traditional crimes. The unlawful introduction of injurious species is an environmental crime that has caused immeasurable harm to date and continues to pose significant risk to the Great Lakes region. By drawing comparisons between traditional and environmental criminal legal definitions and processes, the foundation for investigating the introduction of injurious species will be developed.

DEFINING ENVIRONMENTAL CRIMES. The term "environmental crime" is one that is commonly used, but the term lacks a consistent, and, therefore, a precise definition

(Clifford 1998). Environmental law, and by extension environmental crime, is a study characterized by regulatory complexity, interdisciplinary structures, and scientific uncertainty. Found in various statutes, bylaws, ordinances, regulations, and common law, this body of governing principles is rooted in international, federal, state, and local legislation (McGregor 1994). A review of the literature concerning environmental law and policy exemplifies the limiting manner by which environmental crimes are currently viewed. Chemical pollution, as defined by federal statutes such as the Clean Air Act, the Clean Water Act, and the Resource Conservation and Recovery Act is the dominate focus of current literature on environmental law and investigation.

Existing research tends to identify environmental crime as a category of other, well-established criminological theories, namely white-collar crime (Clifford 1998). This is primarily a result of the fact that most of the research in the field of environmental crime is focused on violations, particularly illegal dumping, committed by corporations and businesses. Despite the narrow focus of current literature, it is imperative to understand that the definition of an environmental crime is not limited to chemical pollution; rather, habitat destruction and the importation and introduction of injurious species are designated as environmental crimes by various regulations. As criminal justice theorist E.H. Sutherland argues, strictly using the legal standard when considering potentially criminal actions is limiting, particularly given the infancy of environmental legislation (Clifford 1998).

In an effort to broaden the scope of environmental crime studies, but to also set some guiding parameters, the following definition is used:

> "An environmental crime is an act committed with the intent to harm or with a potential to cause harm to ecological and/or biological systems and for the purpose of securing business or personal advantage" (Clifford 1998, p. 26).

When translated into legislation, this definition will provide for a distinction between strict liability (liability without fault) and culpable knowledge (some degree of knowing) (Clifford 1998). Further, it is not limited by the requirement that a specific act be defined in existing regulations. Rather, it provides the general criteria of "harmful" to qualify an act as a crime. The importation and introduction of an injurious species would, using this definition, qualify as an environmental crime.

The term environmental crime implies that some sort of crime has been committed. Nevertheless, given the limited scope of environmental law, there are no criminal charges for many offenses against the environment (Clifford 1998). Many acts that would be designated as an environmental crime under the above definition, such as the introduction of Asian carp into the Mississippi River basin from aquaculture facilities, are not considered a violation under existing statutes. As a result, in most cases, there is insufficient data on the frequency, extent, and exact nature of the crimes being committed against the environment and society. Increased efforts to expand existing research on environmental crimes must be made to include all violations against the environment.

BEYOND A REASONABLE DOUBT VS. PREPONDERANCE OF EVIDENCE. The study of environmental crime is interdisciplinary, requiring input from both the disciplines of natural resource management and criminal justice. Each discipline operates under different frameworks. As discussed above, the requirement for certainty is the foundation

of the criminal justice system. This system operates under the highest standard of proof defined by the legal system: beyond a reasonable doubt. The concept of certainty in the field of natural resource management, however, is impossible to achieve in most cases. The innumerable ecosystems and environments that comprise the planet earth are living systems that are constantly changing. As a result, natural resource management agencies operate under the lowest standard of proof within the legal system: preponderance of evidence, which can be defined as "more likely than not." Clearly, the great disparity between the proof standards further lends to the challenges associated with environmental law.

Natural resource management agencies have been forced to move towards the stricter standard to define environmental crimes, develop adequate laws and penalties, and provide proof of such activities in a court of law. The limited scope of the current definition of environmental crime requires natural resource management agencies to first prove that a specific act is harmful to the ecosystem. Subsequent to this determination, enforcement personnel must then provide proof of the responsible party.

To further facilitate the field of natural resource management operating under the stricter standard of proof, efforts must focus on developing a comprehensive understanding of what constitutes environmental harm. This, in turn, will support the development of a more comprehensive definition of environmental crime. As a result, natural resource management agencies will be in a better position to demonstrate that a specific act resulted in environmental harm, thereby promoting the ability of natural resource management agencies to meet the standard of proof requirements within the criminal justice system.

APPLYING THE MODEL OF STANDARD CRIMINAL LAW TO ENVIRONMENTAL CRIME.

The development of laws and policies regulating actions that directly or indirectly harm the environment is in its initial stages. Fortunately, legislation about actions that degrade the environment is being developed at a rapid pace; yet, requisite regulations are complex, have broad applicability, and must be rational, despite changing values (Burns and Lynch 2004). Originating with the Code of Hammurabi and the Ten Commandments, definitions of traditional crimes are based upon thousands of years of common practice and acceptance, establishing what is morally and civilly proper. Environmental law is an emerging legal discipline and unlike the traditional legal code, prohibited activities have neither been specified nor listed. As a result, society often lacks the wherewithal or moral knowledge to specifically and generally determine what constitutes environmentally harmful practices. Primarily, each law has been promulgated to address a specific environmental component, such as air or water, which, therefore, leads to a disconnected approach to natural resources law enforcement.

Comparing environmental crimes to the model of traditional crimes reveals a number of challenges that contribute to the limited scope of current environmental law. Traditional law is rooted in the standard of "contemporary reasoned judgment" – that is, what a reasonable person would do at the time the law was enacted. Applying this same standard to environmental law is difficult given two factors: the scientitic uncertainty that characterizes environmental function and management and the changing societal values that dictate what behaviors are acceptable. Historically, elements of the earth were considered a replenishable commodity; therefore, there were no regulations to guide the way in which natural resources were used. Scientific understanding of the impacts of human and ecosystem interactions has increased exponentially within the past few

decades; as a result, societal awareness about the implications of both chemical and biological pollution is far greater than before. This awareness has been manifested in campaigns that promote activities that are "environmentally friendly," or "green." Whereas twenty years ago the practice of anglers dumping their bait buckets was not only common, but condoned, today millions of dollars are poured into campaigns such as *Habitatitude* that seek to make people aware that dumping bait is environmentally destructive (Michigan Sea Grant 2007). The challenge that environmental law-makers face is defining what is "reasonable" to determine a legal standard in an environment that is characterized by such a state of change.

Further complicating the efforts to regulate activities that affect the environment is the fact that the natural resources that comprise the public environment, such as air and water, are a common property resource (Hardin 1968). That is, the "commons" are resources that are publicly owned and available to everyone. Thus, the actions of one person that negatively impact the environment have effects on not only those in the surrounding areas but, to a certain extent, everyone. Further, the collective impact of individual environmental crime results in significant ecological damage. By the same token, the groups and individuals that have a social, economic, or legal interest in eliminating and prosecuting environmentally destructive activities are innumerable (Findlay et al. 2003). As environmental law has developed, it is clear that the concept of the environment as a common property resource further separates environmental law from private property laws and commensurate regulatory controls through the civil process that have been developed under the traditional model.

Philosophies of environmental enforcement include administrative (regulatory), civil, and criminal enforcement (Clifford 1998). As with traditional crimes, the standard of proof varies depending on the applicable regulation and the degree of the offense. Administrative enforcement, which is mainly focused on pollution regulation, is primarily carried out in the United States by the Environmental Protection Agency (EPA). As administrative regulatory strategies, which are focused on achieving voluntary compliance, continue to fail to deter violations, enforcement approaches are increasingly moving towards the criminalization of environmentally destructive practices (Situ and Emmons 2000). Yet, stricter criminal sanctions are rarely used. Under the United States Criminal Code, for a particular activity to constitute a crime, certain factors, or elements must have occurred. Each element of a crime must be proven beyond a reasonable doubt to secure a conviction. Except for strict liability crimes, there are varying degrees of culpability (*mens rea*) contained within criminal statutes: intentionally, knowingly, recklessly, and negligently (Clifford 1998). Stricter *mens rea* requirements are often associated with crimes classified as being more severe in nature and have more stringent proof requirements and harsher penalties (Situ and Emmons 2000).

Generally, environmental statutes contain both strict liability and "knowing" provisions (Clifford 1998). In strict liability cases, the proving of intent at any level is not required within the elements of the crime. That is, committing the act constitutes guilt, even if the act was done in ignorance. Most environmental laws also contain civil and criminal provisions depending on the nature and duration of the violations. For example, if a corporation exceeds regulatory discharge levels for an extended period of time, the company may be civilly liable under the Clean Water Act. If that same company,

however, alters an output device so that waste is disposed of in a nearby river, that company can be held criminally liable.

For environmental crimes that are defined by the criminal code, a number of criteria are considered when establishing the elements of the crime: the type of act, the specific act (s), the actor(s), the status of the actor(s) (i.e. rank or position within a company, if applicable), and the applicable sanction (Clifford 1998). For each act, it must be determined if it is necessary to demonstrate direct harm to the environment to establish guilt (i.e. reduced quality of the environment) or if the potential to harm is sufficient. In addition, the application of most environmental laws today distinguish between individual violators from corporations; often, stronger penalties are associated with corporate violators. Given the complexity of environmental laws, the varying regulatory structures, and the broad range of crimes the field encompasses, classifying environmental violations has proven extremely difficult.

THE INTRODUCTION OF ASIAN CARP AS AN ENVIRONMENTAL CRIME. Due to the limited perspective of current environmental crime legislation, introductions of injurious species have not been responded to as environmental crimes. Irreversible damage due to these introductions, however, has occurred in most watersheds and the economic toll these species generate is mounting. The current situation in the Mississippi River basin is a direct result of multiple unintentional and, possible intentional, releases from aquaculture facilities. Further, instances of bighead and silver carp being discovered in watersheds far outside of their known range strongly indicate that these fish are being unlawfully introduced. Yet, as entire ecosystems are being severely damaged and forever altered, there has been virtually no effort to determine who is responsible and, therefore,

liable. Rather, the onus is on the federal and state governments to mitigate damage and prevent further spread. The impending invasion of Asian carp into the Great Lakes basin clearly demonstrates the vulnerability of the ecosystem, the inadequacy of existing laws, and the need for more comprehensive legislation.

CHAPTER 4

REGULATION OF INJURIOUS SPECIES IMPORTATIONS AND INTRODUCTIONS

Despite the magnitude of devastation arising from the establishment of injurious species in the United States, the existing legislation addressing unlawful importations and introductions of non-native species is inadequate. Strong importation laws are needed as a first line of defense against unlawful introductions. Stricter regulation of non-native species importation is needed to reduce the risk of introduction and establishment of injurious species (GLRC 2005). Without strong legislation and specific regulations governing both importation and introduction of non-native species, enforcement is nearly impossible. Enforcement and penalty provisions provided in federal and state regulations provide neither adequate nor sufficient protection or restitution. To increase detection and prosecution of these illegal activities, as well as to serve as a deterrent to committing them, stronger, enforceable regulations and associated penalties must be established.

INJURIOUS SPECIES LEGISLATION: INTERNATIONAL REGULATIONS. Internationally-based regulations to govern the importation and introduction of non-native species are nearly non-existent. There are two primary agreements that address exotics: the International Plant Protection Convention and the Convention of Biological Diversity. The International Plant Protection Convention only addresses pests on terrestrial crops and does not apply to aquatic invaders. The Convention of Biological Diversity has the potential to protect native biodiversity, but lacks strong implementation. Article 8h calls for parties to "...as far as possible and as appropriate...prevent the introduction of,

control, or eradicate those alien species which threaten ecosystems, habitats, or species" (Jenkins 1996). Yet, without specific enforcement provisions and a regulated evaluation and listing process for potential importations, the convention does little in terms of the actual management of intentional and unintentional introductions. In addition, according to Chapman (2003), "None of the provisions or regulations in the [convention] mention live seafood or contain provisions for live organisms that pass directly to consumers for consumption." The assumption, it seems, is that border inspections of shipments importing live organisms is an adequate response to the threat posed by unlawful non-native species introductions. The number of wildlife inspectors in the United States, the resources allocated to training, and the degree of risk analysis, however, has failed to keep pace with the volume of trade of live aquatic species and the increased risk of unauthorized or unintentional introductions (Jenkins 1996).

Overall, bans or restrictions on imports would likely be considered unfair restraints on trade by the World Trade Organization (WTO), the General Agreement on Tariffs and Trade (GATT), the North American Free Trade Agreement (NAFTA) and other international agreements. Further, any bans or restrictions on imports must be based on science, and that is difficult given the uncertainty of quantifying or predicting the ecological and economic impacts of the potential introduction of non-native species. It is likely that only by eliminating the gaps in research and scientific understanding with respect to quantifying the economic and environmental damage caused by the introduction of injurious species that trade restrictions will be supported.

INJURIOUS SPECIES LEGISLATION: FEDERAL REGULATIONS. Within the United States, the state and federal regulations regarding the importation and legal and illegal

introduction of non-native species developed haphazardly. Opposition from the aquaculture and pet-trade industries to increased regulation of importation fueled the development of lenient regulations, as many state and federal legislators agreed with the arguments that stringent regulations would have adverse effects on businesses. As a result, importation of non-native species into the United States, historically, has not been recognized as a problem and is, therefore, characterized by light regulation and minimal enforcement. Regulation of non-native species introductions is more complicated in that it occurs at various levels of government and varies dramatically between jurisdictions. Once state and federal agencies acknowledged the potential for damage caused by non-native introductions, and lacking centralized leadership and coordination, a conglomeration of ineffective regulations were developed. Enforcement of these regulations is difficult due to regulatory disparities between the states and other levels of government and social misconceptions about the degree of harm posed by, and the perceived benefit of, non-native species (Stanley et al. 1991). Legal challenges to regulating interstate commerce have further contributed to hesitation in both the legal and law enforcement realms.

At the federal level, the Department of Interior, through Congress, delegates authority to the USFWS to regulate importations and introductions of injurious species. Statutory authority governing activities dealing with the release of injurious species has been delegated to the USFWS through the interpretation of a number of acts – that is, the authority has not been specifically granted. The 1871 Act (16 Stat. 593) established the first conservation agency within the United States, the United States Commission of Fish and Fisheries (COF). In 1903, the COF was transferred to the Bureau of Fisheries

(USBF) under the Department of Commerce until the Department of Interior took over in 1939 (NOAA 2006). The 1871 act provided the foundation upon which the USFWS was established in 1940 (Madison 2006). In 1956, the Fish and Wildlife Act (16 U.S.C. 742a – 742j) was enacted, authorizing the Secretary of Interior to "take steps required for the...conservation, and protection of fisheries resources." This general provision, however, has not yet been used to develop a policy on injurious species. The Endangered Species Act (ESA – 16 U.S.C. 1531–1543), passed in 1973, prohibits the introduction of any non-native species if that proposed introduction threatens a species listed as endangered in the United States. Cases involving an ESA claim must prove that the welfare of an endangered species was further threatened due to the introduction in question (Stanley et al. 1991).

In addition to interpreted statutory authority, the USFWS was delegated oversight of importations and introductions of non-native fish by Executive Order 11987, signed in 1977. This order prohibited federal agencies and other agencies receiving federal funding from importing and introducing non-native species and exporting native species for introduction outside the United States. As a result, intentional introductions of non-native species by federal agencies (i.e. stocking) has ceased. Nevertheless, this executive order does not regulate the states. Although the USFWS has requested the states to get formal opinions from the USFWS about projects that involve non-native species importations and introductions, there is no mandate to require such.

While the statutes discussed above provide some authority to the USFWS to regulate injurious species, the strongest, most comprehensive authority comes from the Lacey Act of 1900. This statute makes it unlawful to "import, export, transport, sell,

receive, acquire, or purchase any fish or wildlife already taken, possessed, transported, or sold in violation of state, federal, Indian tribal, or foreign wildlife laws or regulations" (18 U.S.C. 42; 50 CFR 16.3). In addition, it authorizes the Secretary of Interior to establish regulations regarding the importation and introduction of injurious species and allows the USFWS to prohibit the introduction of any species that are potentially injurious to native fish and wildlife. Specifically, the act contains an injurious wildlife provision (50 CFR 16.13 (2)) which lists particular species banned for interstate commerce and possession (Stanley et al. 1991). It is important to note that the Lacey Act does not explicitly define "injurious." Rather, each species in question is subjectively evaluated by the USFWS to determine if it is potentially injurious to human beings, to the interests of agriculture, horticulture, and forestry, or to wildlife or wildlife resources of the United States. While the Lacey Act is the strongest enforcement tool against the introduction of species classified as injurious, it only addresses intentional importations and introductions of a very limited number of species.

Under the Lacey Act, there are two avenues that can be used to regulate the importation and introduction of injurious species. The first is that the species in question is listed as injurious. As stated above, the injurious wildlife provisions of the Lacey Act, under Title 18 of the United States Criminal Code, restricts the importation and interstate transportation of wildlife deemed to be injurious or potentially injurious. The process for adding a species to the list, however, is very cumbersome. Although the USFWS has the authority to issue emergency regulations, it generally operates through the standard notice and comment process. That is, the USFWS posts a notice in the Federal Register of its intent to add a species to the list of injurious species and the notice generally provides for

a 60 to 90 day public-comment period. This has the duel drawback of allowing necessary listings to be delayed considerably, as well as providing a cue to importers to increase the quantity of imports before the importation is prohibited. As a result, only a very small number of species are listed as injurious under the Lacey Act (three families of fishes, one species of crustacean, one species of mollusk, and one reptile species) while hundreds await review. To further complicate the matter, there is currently one person nationwide tasked with reviewing the listing requests (GLRC 2005). Due to these limitations, the Lacey Act list of injurious species does not include many species that have been identified as injurious by individual states. As a result, this patchwork of regulations precludes effective regulation and enforcement and provides a myriad of pathways for intentional and unintentional introductions.

The second avenue for regulating the importation and introduction of injurious species under the Lacey Act is if the species is imported or possessed in violation of state or foreign law. That is, for the USFWS to have jurisdiction, the species in question must have been transported across state lines. According the Environmental Crimes Section of the United States Department of Justice, once the USFWS has established authority over the case, several factors are evaluated to determine whether to prosecute under the Lacey Act. The first factor assessed is the strength of the underlying state law; this determination, made on a case-by-case basis, evaluates the strength of the case against the accused. The second factor used to determine if the case will be prosecuted under the Lacey Act is the adequacy of penalties provided for by state law. In most cases, it is the discretion of the federal/state prosecutor that determines if a case will be pursued under the Lacey Act or prosecuted by the state in which the violation occurred (Webb 2006).

If a case is successfully prosecuted under the Lacey Act, the penalty provisions are the most severe available for violations concerning live fish commerce. Civil infractions, which entail the transportation, acquisition, or receipt of injurious wildlife in violation of United States, Indian tribal, foreign, or state law, with a market value less than $350, can result in penalties not to exceed the maximum provided for in the underlying law or $10,000, whichever is less. Criminal violations, which involve the sale or purchase of injurious wildlife taken in violation of United States, Indian tribal, foreign, or state law with a market value more than $350, are punishable by fines not to exceed $20,000 or imprisonment for not more than five years, or both. In addition, there is a clause within the Lacey Act that states if any other violation occurs, a misdemeanor charge can be laid with an associated penalty of $10,000 or one year imprisonment (Lacey Act, 18 USC 42).

Despite the relatively strong penalty provisions provided for under the Lacey Act, a number of factors limit their effectiveness. First, as Special Agent Dan Sheill stated, the criminal provisions of the Lacey Act are rarely applied to the unlawful importation and introduction of injurious species (pers. com. 2005). Secondly, even the harshest monetary sanctions are often perceived by the violators as "the cost of doing business" (Clifford 1998). Given the increased difficulties with investigating and successfully prosecuting biological pollution cases, monetary violations are likely even less of a deterrent. When the expected fine from violating an environmental statute is considerably less than taking the measures necessary to remain compliant, the choice is often to act outside of the law.

While the penalty provisions for civil and criminal violations of the Lacey Act are significant, the listing process for injurious species remains a major weak point in the legislation. The hurdles associated with listing species have not gone unnoticed. Throughout the years, several amendments have been proposed to improve the administration of the injurious wildlife provision. In 1973, the USFWS proposed implementing a "clean list" approach, whereby all non-native species were deemed injurious and only species on the "clean" list would be permitted. An overwhelming number of comments were received, however, that criticized this approach arguing that it was too limiting to pet and aquaculture industries. The list of permitted species was expanded and the amendment was again unsuccessfully proposed in 1975. In 1977, the USFWS tried a different tactic by proposing a more extensive list of prohibited species, known as a "dirty list" approach. Yet, once again, proponents from the hobby fish and aquaculture industries voiced great opposition and the proposal failed (Stanley et al. 1991).

In addition to the authority delegated to the USFWS, there are federal statutes that address injurious species outside of the scope of the USFWS. For example, the National Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA – 16 U.S.C. 4701) gives authority to the Secretary of Transportation, in consultation with the USFWS Director and Secretary of Commerce for Oceans and Atmosphere, to establish regulations regarding ballast water discharge (Stanley et al. 1991). In 1990, in an unprecedented move, Congress used this act to bypass the listing process under the USFWS. After zebra mussels (*Dreissena polymorpha*) were introduced into the Great Lakes, likely via ballast water of ocean-going vessels, they spread rapidly and now result in significant economic

costs to power plants and water supply facilities as they rapidly colonize all types of surfaces including water-intake pipes. Zebra mussels also negatively affect the ecosystems they invade as they are extremely efficient filter feeders (USGS 2007). Due to the extensive damage caused by zebra mussels, Section 1208 of NANPCA was amended, through congressional directive (H.R. 5390), to add zebra mussels to the list of injurious species under the Lacey Act.

LEGISLATION ADDRESSING INJURIOUS SPECIES: STATE REGULATIONS. State regulations vary dramatically depending on the type of species proposed for importation and the purpose of the importation. Nearly every state prohibits the introduction of non-native fish without a permit; however, all state agencies do not need to seek federal approval or undergo peer review by other states prior to introducing non-native fish species (Courtenay and Fuller 2004). With regard to importation of species for commercial use, such as baitfish and the aquarium trade, there is no model code or overarching set of regulations between the states. As a result, each jurisdiction has a different approach to regulating potentially injurious species, such as Asian carp. Generally, these regulations have evolved over time in a reactive response to increasing levels of risk posed by specific species (Alexander 2003). Further, commercial aquaculture industries have sought exemption from state regulation by having the state agriculture administration oversee aquaculture activities. In many states, this approach has been taken. Yet, in most states, the Department of Agriculture does not have a legal commitment to conserve the natural resources of that state. Therefore, there is little incentive to ensure sound environmental practices are instituted in aquaculture facilities.

Non-federal penalty provisions are almost universally inadequate. Most states impose some type of misdemeanor penalty on violators of their various live fish commerce laws, but none of them are sizeable enough to be a meaningful deterrent – particularly not to a large-scale aquaculture operation. The fines for non-aquacultural offenses such as importing, unpermitted stocking, and release, average roughly $100. The maximum fines associated with aquaculture law violations and other infractions associated with large commercial operations, such as bait dealers, average about $5,000. Certain states include short jail terms in the sentencing guidelines, but rarely are violators sentenced to incarceration. (Alexander 2003).

In addition to inadequate legislation governing the introduction of injurious species, there are many deterrents to effective enforcement of the existing regulations. These include: limited resources to police, unsubstantial inspection and levy fines; inadequate education and training for enforcement staff; limits in authority of state and federal laws; fines that are too low to deter violations; and, a lack of or limited political will to exercise authority under existing state and federal laws (Alexander 2003). Given the myriad of responsibilities placed upon state and tribal conservation officers, regulation of laws that lack clearly enforceable provisions and meaningful penalties often falls short on a long list of priorities.

REGULATION OF ASIAN CARP INTRODUCTIONS. For nearly five years, there has been an intense, on-going effort by all of the states, various governmental and non-governmental agencies and concerned citizens in the Great Lakes basin to list the silver, bighead, and black carp as injurious under the Lacey Act. In July of 2002, the USFWS proposed an amendment to add the black carp to the list of injurious species; the

comment period was closed and then reopened in July 2003 and reopened again in August 2005. In August 2004, the Office of Management and Budget designated the proposed rule as "significant" meaning the USFWS was required to prepare and submit assessments of the potential economic and environmental costs and benefits of the regulatory action. According to Executive Order 12866 (section 3(f)(1)) (1993), a proposed rule will be designated as significant if it has an annual economic effect of $100 million or more or adversely affects "any sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, or tribal governments or communities." In July 2003, a proposal to list the silver carp was submitted and in October 2005 the proposed rule was designated as "significant." Lastly, in September 2003, the USFWS proposed adding the bighead carp to the injurious species list. To date, none of these species have been listed as injurious under the Lacey Act. This is curious as the USFWS has developed a management plan, *Management and Control Plan for Asian Carps in the United States* in which strategies and recommendations for reducing the risk of intentional and unintentional introductions are presented (Conover et al. *in press).* Clearly, this is a case in which short-term economic interests have outweighed long-term environmental and economic interests.

In addition to the failed federal efforts to list Asian carp as injurious, states within the Great Lakes basin have acted out of necessity to prevent the introduction of these species. Coordinated through the Great Lakes Law Enforcement Committee, the individual states and the Province of Ontario have individually promulgated regulations prohibiting the importation, exportation, transportation, sale, purchase, and acquisition of live Asian carp (figure 5). The development of these regulations on an individual

Figure 5

REGULATION OF ACTIVITIES PERTAINING TO ASIAN CARP WITHIN THE GREAT LAKES BASIN

	SILVER	BLACK	BIGHEAD	GRASS	
				DIPLOID	TRIPLOID
ILLINOIS	All activities banned	All activities banned	All activities banned	All activities permitted except for aquaculture purposes	All activities permitted except for aquaculture purposes
INDIANA	All activities banned	All activities banned	All activities banned	All activities banned	may be cultured and sold with permit and reporting reqs
MICHIGAN	All activities banned	All activities banned	All activities banned	All activities banned	All activities banned
MINNESOTA	All activities banned	All activities banned	All activities banned	All activities banned	All activities banned
OHIO	All activities banned	All activities banned	All activities banned	All activities banned	may be imported and sold with permit from Chief, Ohio Div of Wildlife
PENNSYLVANIA	All activities banned	All activities banned	All activities banned	All activities permitted except importation	All activities permitted except importation
NEW YORK	All activities banned	All activities banned	All activities banned except in 5 boroughs of NYC; must be killed upon point of sale	All activities banned	certified triploid can be cultured in waters (permit req'd) no lgr than 5 acres with no in- or outlet
WISCONSIN	possession[1] prohibited, transportation[2] and importation[3] regulated	possession[1] prohibited, transportation[2] and importation[3] regulated	possession[1] prohibited, transportation[2] and importation[3] regulated	possession[1] prohibited, transportation[2] and importation[3] regulated	possession[1] prohibited, transportation[2] and importation[3] regulated
ONTARIO	Live sale, culture and possession banned	Live sale, culture and possession banned	Live sale, culture and possession banned	Live sale, culture and possession banned	Live sale, culture and possession banned

[1]Listed as a game fish; [2]No live rough fish (with exceptions) may be transported in state without a permit (29.407(4)); [3]Import of any fish requires permit from Dept. of Agriculture, import of non-native species requires additional permit from DNR.

In response to the increased threat of Asian carp entering the Great Lakes basin, the states and Province of Ontario promulgated regulations to minimize the risk of accidental or intentional release.

jurisdictional basis was not the most efficient or effective approach to what ideally should have been a national effort. The use of the Lacey Act would stop immediately the interstate transportation of these species and significantly lessen the risk of introductions through the live fish trade. In recognition of the need for immediate action, Congresswoman Judy Biggert from Illinois introduced Bill H.R. 83, the *Asian Carp Prevention and Control Act*, in January 2007. Through this Act, if passed, congress will amend the Lacey Act by adding certain species of Asian carp to the list of injurious species, thereby prohibiting their importation, interstate transportation, and introduction.

FUTURE LEGISLATIVE NEEDS TO ADDRESS INJURIOUS SPECIES. Efforts to prevent further injurious species introductions must occur more proactively (i.e. before a potentially injurious species is imported into the United States), provide a comprehensive approach, and receive a better financial commitment from all levels of government to reduce the economic and environmental havoc these species create (Jenkins 1996). International, federal, state, and local agencies involved in ecosystem management must unite in a coordinated approach to establish a comprehensive program to address injurious species introductions. It could be envisioned that the Association of Fish and Wildlife Agencies (AFWA), which represents all of North America's fish and wildlife agencies, could initially provide direction on the nature and format of such a program, which could then be further developed at federal, state, and local levels.

The Law Enforcement Committee of AFWA is in a prime position to facilitate the development and implementation of a comprehensive injurious species program. This committee serves as a conduit for the transfer of information between fisheries managers and law enforcement agencies. AFWA specifically functions "...to investigate and

advisewith respect to the introduction of new species and varieties of fish and wildlife; to assist in the enactment of laws for the adequate protection and management of natural resources; and, to obtain as far as possible uniformity in same; and to correct irregularities and inconsistencies in existing laws" (AFWA 2007). While the USFWS has the primary authority to regulate the importation and introduction of injurious species in the United States, AFWA provides a forum in which all levels of government in North America can address the increasing threat of injurious species through inter-jurisdictional cooperation and coordination.

A comprehensive program must implement a holistic approach to develop "...the best management options and control tools to restrict, reduce, and maintain the target species at levels of insignificant impact, while minimizing danger to the environment, human health, and the economy" (Conover et al. *in press).* Elements of a comprehensive program include: a screening process, rapid response plans, control measures, and research, education and outreach components. Further, a comprehensive program should be regularly evaluated to assess its effectiveness (GLRC 2005).

SCREENING PROCESS. The screening process component to prevent importations in the first place is imperative. A comprehensive program should implement a screening process to evaluate proposed importations whereupon the onus is placed on the importer to prove the innocuousness of the species proposed for importation. Currently, through the Lacey Act, the onus is on the government to prove the injuriousness of the species. This approach has proven to be woefully inadequate and has contributed to species such as snakehead (*Channidae*) and Asian swamp eel (*Monopterus albus*) invading and irreversibly altering entire ecosystems. Regardless of the reason for the proposed

importation, the responsibility should be on the importer to demonstrate that the species proposed for importation does not pose a threat in any way to native species or ecosystems. Further, consistent parameters guiding the evaluation of injuriousness should be established to reduce subjectivity throughout the process. Ricciardi and Rasmussen (1998) set forth three primary guidelines for a screening process: identify potential geographic donor regions, such as: regions with similar climates, large-scale shipping patterns, and growing economies; generate a general biological profile of the species to include genetic variability, tolerance limits, and the current size of distribution; and, utilize invasion history as predictive criterion. These guidelines, which provide a comprehensive evaluation of the invasion and impact potential, were developed using concepts from marine and terrestrial invasion biology (Riccardi and Rasmussen 1998). Risk assessments, in which the probability of establishment and the consequences of establishment are used to determine the overall organism risk potential in the United States, should be conducted for each proposed non-native species import and funded by the proponent. In addition, Jenkins (1996) argues that, at a minimum, screening programs should include an evaluation of both the current and projected pathways of introductions, as well as institutional and technological capabilities for preventing, controlling, and eradicating non-native species. Further, for all proposed importations of non-native species, the importer must specify the measures to prevent the escape of the non-native species, and ideally post a bond or demonstrate insurance coverage sufficient to cover all costs associated with the implementation of a rapid response plan or an ongoing control program, should the species escape.

RAPID RESPONSE AND CONTROL MEASURES. Rapid response plans to address unlawful introductions and control and management programs, should an injurious species become established, are integral components of a comprehensive plan. Risk assessments conducted during the screening phase, prior to importation, should include a thorough assessment of available measures to contain the imported species if it escapes. The control, containment, and eradication measures should be documented for each proposed introduction. Rapid response plans should be developed and approved by the management agencies for all species approved for importation and should be implemented if an accidental or intentional introduction occurs.

In most cases of biological pollution, eradication efforts have proven futile. Once a species has become established, it is essentially impossible to eradicate it without destroying habitat. As a result, efforts to control (i.e. reduce the number of species in the wild) and contain (i.e. minimize the further spread) the invader are, in most cases, the only options. Even if a species is susceptible to control techniques, control measures are often difficult and expensive. Further, success of a control program is further dictated by criteria such as: species recruitment, probability of reinvasion, non-target mortality, target population densities and the socio-political climate (Chadderton 2003). Systems that have sustained significant damage from long-established invaders and systems that have multiple populations of injurious species present further challenges to developing an effective control program (Zavelta et al. 2001).

Both control and containment measures require "...indefinite investments of time, tools and money to keep the invader at bay" (Zavaleta et al. 2001). The current level of resources devoted to the problem of injurious species is far from being in proportion to

the environmental and economic damage they inflict; this must be rectified in the future (Pimentel 2000). Heretofore, the responsibility and the costs of control of injurious species have fallen on the state and federal governments. In the future, proponents of importation of non-native species should be required to "post a bond" or have insurance to pay for any required control measures.

RESEARCH. Research is another critical component of a comprehensive injurious species management program. Agencies tasked with regulating injurious species importations should be obligated to conduct research to identify additional species of concern and possible routes of entry (Stanley et al. 1991). In addition, research is needed to assess problem areas of importation, evaluate the effectiveness of the screening process, and to develop and review rapid response, control, containment, and eradication programs. From an enforcement perspective, research needs include determining the extent of accidental and intentional introductions and developing mechanisms to effectively deter future introductions (Chadderton 2003).

Currently, there is proposed legislation that would address many of the recommendations presented above. The *National Aquatic Invasive Species Act* (NAISA – S. 725) includes provisions that address prevention, early detection, rapid response, control, management, and coordination among various levels of government. Further, elements such as research, outreach and education are included in the Act (GLRC 2005). While NAISA is the most promising response to the threat posed by injurious species, to be truly effective it must be amended to include delegation of authority to enforce the proposed provisions. In addition, other revisions, such as placing the burden of proof of noninjuriousness on the importer, would strengthen this proposed legislation. If passed,

this Act would be a major step towards closing many of the regulatory gaps that presently exist.

The penalty provisions provided under the Lacey Act are the best starting point for developing deterrence strategies. According to Ricciardi (1998), "The most consistent attribute of an injurious species is human commensalisms. Most successful invaders, particularly major pest species, use dispersal mechanisms that involve human activity." Additional research must be dedicated to developing recommendations for methods to control human vectors of dispersal (Ricciardi 2006). Clearly, enforcement with the purpose of educating unknowing violators and deterring those who intentionally introduce injurious species is essential. Further, implementation of disincentive rules and regulations are essential to prevent the release of live organisms (Chadderton 2003). In addition to implementing higher enforcement standards, more stringent penalties would serve to deter violations, while also mitigating the costs of control programs for existing injurious species. Through implementation of such measures by all management agencies, the unauthorized introduction of injurious species will be branded as "socially unacceptable," thereby creating yet another layer of deterrence.

CHAPTER 5

ENVIRONMENTAL CRIME INVESTIGATIONS

Given that environmental regulation is still relatively new, the development of environmental crime investigative techniques is really just emerging. Until the previous decade, environmental crime scene investigation was essentially overlooked within the field of criminal justice. The study of environmental crime "...lacks a theoretical framework [which] slows efforts to develop a comprehensive understanding of the phenomenon, and this in turn delays enactment of preventive measures and enforcement provisions" (Clifford 1998). Unlike traditional crime scene investigations, a comprehensive strategy does not exist for processing environmental crime scenes. While an investigative framework exists for physical and chemical environmental crimes, such as illegal waste dumping, there is no protocol in place for investigating the introduction of injurious species. Yet, investigations are often an imperative element needed to meet the standard of proof for criminal prosecution of unlawful importation and introduction violations under the Lacey Act.

Further, a number of challenges, including administrative, scientific, and resource allocation issues, currently dilute environmental legal and enforcement authority. Ecosystem variability and the lack of regular assessment complicate the process in that it is harder to prove the negative impact of the crime (Walker 1998). Moreover, the scientific uncertainty, costs, and changing societal values surrounding environmental violations have stalled the development and application of environmental crime investigation techniques. These issues must be addressed and appropriately managed to

advance the field of environmental crime investigation and create a more comprehensive approach to addressing environmental violations of all types.

To promote successful prosecution of accidental and intentional releases of injurious species, investigative procedures must be developed. Crime scenes must be thoroughly processed and investigated to meet the burden of proof set forth in each statute. To this end, a standardized investigative framework to guide procedures specific to the type of environmental violation is needed.

EXISTING FRAMEWORK FOR ENVIRONMENT CRIME SCENE INVESTIGATIONS. The National Institute of Justice (NIJ) developed an agenda for the investigation and prosecution of illegal waste dumping cases (figure 6). This framework provides a solid starting point for the development of a more comprehensive investigative strategy for investigating all types of environmental crimes and defines a process that involves eight steps. It is important to note that not all investigations would follow the sequence exactly, nor include each step. The first step is the detection of the offense or the possibility that that an offense has or will occur. The second step includes the collection of data on the state of the ecosystem prior to the violation, as well as background information on any possible offenders. Surveillance of suspects and collection of evidence are the third and fourth steps, respectively. The collection of evidence typically involves both the prosecutor's office and the natural resource agency. The fifth step, laboratory analysis, seeks to prove that a violation meeting the legal requirements for prosecution under the applicable statute did occur. Filing charges, the sixth step, occurs if the prosecutor determines that criminal prosecution is merited. Other decisions include whether the charges will be at the felony or misdemeanor level, or if the case should be pursued in

Figure 6

INVESTIGATION AND PROSECUTION OF ENVIRONMENTAL CRIME

1 Detection of Offense	2 Collection of Background Information	3 Surveillance of Suspects	4 Evidence Collection	5 Laboratory Analysis	6 Charging	7 Adjudication	8 Cleanup and Compliance
• Tips from employees and citizens • Information from Governmental groups • Information from agencies - routine inspections - monitoring - targeted inspections - law enforcement	• Environmental "rap-sheet" on suspects	• Aerial photography • Sewer discharge monitoring • Stake-out (surveillance van, video monitoring)	• Preparation/ execution of search warrant • Collection of samples for laboratory analysis • Interviews • Collection of documents	• Establish presence of material meeting legal requirements for prosecution • Preparation of expert witness testimony • Maintenance of chain of custody	• Determination as to criminal or civil process (this decision may come earlier) • Indictment/ information	• Plea negotiation • Trial • Sentencing/ settlement (possibility of cleanup as condition of probation) • Debarment from government contracting	• Monitoring cleanup and compliance • Collection of fines and penalties

This framework outlines the eight primary steps of investigating and prosecuting environmental crimes. While this framework was developed to apply primarily to illegal waste dumping cases, it can be adapted to apply to other types of environmental crimes. [Framework adapted from the National Institute of Justice; Hammett and Epstein 1993].

civil court. The next step, adjudication, includes the prosecution offering a plea agreement or bringing the case before a jury or bench trial. In addition, sentencing is done at this stage. Cleanup and compliance is the final step in the framework of investigating and prosecuting an environmental crime (Hammett and Epstein 1993). This step is usually monitored by the regulatory agency and involves the collection of fines and/or prison sentences. Clearly, processing the crime scene is an essential component of the framework; from assessing the state of the environment prior to the violation to collecting samples representative of the damage caused, investigating violations is vital to maintaining sustainable ecosystems.

CHALLENGES OF ENVIRONMENTAL CRIME SCENE PROCESSING. Developing a protocol for processing chemical, physical, and biological environmental crime scenes presents a number of unique challenges. Administrative difficulties include the lack of a single, precise, all-inclusive definition of "environmental crime" and numerous incomprehensive regulations which fail to criminalize many activities that degrade the environment (Burns and Lynch 2004). In addition, there are many scientific hurdles that must be overcome before environmental crime scenes can be processed and investigated with the same rigor as traditional crimes. Lastly, inadequate allocation of resources dedicated to investigating crimes which adversely impact the environment continues to impede the advancement of environmental crime scene processing. All of these challenges reciprocate to create an immense gap in what needs to be a comprehensive strategy to address environmental crime. Given the relative paucity of environmental crime scene investigation protocols, a review of the current challenges facing the field provides a forum on which existing capabilities and recommendations are presented.

ADMINISTRATIVE CHALLENGES. One of the greatest inadequacies of the current state of environmental policy and management is that there is not a single accepted source that defines "environmental crime." Toxic and hazardous waste disposal are the traditional foci of regulations, research, and resource allocation. Environmental regulations, such as the Clean Air Act, prohibit specific actions, thereby, including them under the umbrella of environmental crime. This practice, however, has led to a number of crimes being omitted from the development of environmental crime investigation and prosecution protocols. Examples of these crimes include: overuse of land; destruction of habitat; and, introduction of injurious species. While each of these activities is prohibited by various statutes, the fragmented approach to defining them as crimes has resulted in ineffective investigation and prosecution (Clifford 1998).

Part of the struggle with defining environmental crime is the lack of a traditional human victim; even though thousands of native fish may die due to the unlawful introduction of an injurious species, there is no "corpse," in the traditional sense. Furthermore, due to the "downstream effect," whereby a crime may happen in one location, but the effects of it are felt far from the origin, it is exceptionally difficult to measure the degree of harm of a specific act. Although there are many data sources on environmental crime, the majority of them focus on pollution levels and none of them provide a comprehensive measure of anthropogenic environmental degradation (Burns and Lynch 2004).

Environmental law presents a number of unique challenges to enforcement personnel. In addition to being relatively new and incredibly complex, it is highly interdisciplinary as it overlaps with many other disciplines such as constitutional,

administrative, and criminal law, as well as tort claims, property rights, and international trade. Environmental law challenges traditional boundaries and, due to the influence of industry and development, is subject to intense debate about the nature of the requisite scientific evidence. Lastly, and perhaps the most complex challenge presented by environmental law, is the degree of scientific uncertainty that surrounds it. Often, the extent, or even existence, of problems is unknown, while the effects of are long-term (Walker 1998). Each of the challenges that complicate regulation of the environment has significant implications for how laws, penalty provisions and investigative procedures will be developed, which will, in turn, impact how violators will be prosecuted.

Jurisdictional issues also present unique challenges when enforcing environmental laws and investigating environmental crimes. Given the interconnectedness of all elements of an ecosystem, a single offense can cascade through an ecosystem, thereby triggering responses from multiple agencies at all levels of government. Depending on the violation, the elements of the ecosystem affected, and the location of the offense, federal, provincial, tribal, state, and/or local enforcement agencies may have primary jurisdiction. Furthermore, different states bestow differing levels of authority on conservation officers. Therefore, the degree to which an officer is mandated to investigate environmental crimes will also vary between states (Falcone 2004).

Environmental crime scene processing requires a unique collaboration between and within natural resource management agencies and law enforcement agencies. To accurately charge and penalize each violator, law enforcement personnel should have an assessment of the environmental conditions both before and after the act occurred (Situ and Emmons 2000). This assessment must be compared to the evidence gathered from

the investigation to determine the extent of the damage to the environment/ecosystem. Charges and adjudication are then based upon the results of the investigation and the prescribed required clean-up. The exchange of information between law enforcement and natural resource agencies is not only essential for crime scene analysis, investigation, and prosecution, it is also integral to the development of management strategies needed to offset the impact of the crime, to deter future violators, and to re-emphasize the value of the resource.

SCIENTIFIC CHALLENGES. Challenges within the realm of science, for the most part, can be remedied fairly easily. It is not a lack of technology or understanding of ecosystem functioning that hinders investigations. Rather, it is generally the disjointed relationship between natural resource law enforcement and environmental law that creates roadblocks to establishing a scientifically sound protocol for investigating various environmental crimes. That being said, there are a number of areas in which investigations would be greatly improved and cases made stronger through further development of investigative practices and technologies.

Evidence collection is often the biggest hurdle in prosecuting an environmental crime. For many environmental crimes, it is nearly impossible to prove a violation occurred and assign responsibility unless an individual or group is caught in the act of violating a specific statute. Evidence collection is vital not only to prove a crime occurred, but is also integral to determining the duration and magnitude of the offense. This has clear implications for the prosecution of the violator and is particularly relevant when arguing a crime has been committed against the environment. Practical difficulties such as the time and nature of the offense, weather conditions, and access to the crime scene

often preclude officers from gathering sufficient evidence (Molino 1995). Despite the many practical difficulties officers face, sufficient evidence is often available, but not adequately collected. This is indicative of a poor understanding of criminal proceedings and inadequate first responder training of enforcement authorities (Situ 1997). In the majority of environmental criminal cases, there is only one chance to gather evidence. Therefore, conservation officers, who are usually the first on the scene of discovery, must be educated in evidence collection and handling. Conservation officer training programs should include instruction on environmental crime scene processing techniques. The Land Management Police Training (LMPT) Program, which all Department of Interior conservation officers must complete, provides a brief crime scene processing section, but does not address specific environmental crime investigative techniques. Addressing this gap in all state and federal conservation officer training curriculums is essential to promoting a more effective response – by conducting investigations that promote successful prosecutions and deter future violators – to environmental crimes. An increased ability to meet a higher standard of proof will heighten the response to, and awareness of, environmental crimes through successful prosecution.

Evidence gathered must be measurable in some way to prove a violation occurred and, as a result, that the ecosystem was harmed, or that the potential for harm was present. To accurately interpret the evidence gathered, it is necessary to understand the status of the ecosystem that has been damaged. Reports should include an evaluation of impacts to species, habitats, and ecosystem process, as well as the degree to which they were affected. Ambient conditions, which will vary depending on the type and location of the violation, must be included for an accurate assessment of damage. Storing, testing, and

interpretation techniques for each type of evidence must be standardized to offset legal disputes about the admissibility of the evidence (Molino 1995). Training programs, such as the LMPT program, should work with biologists and ecologists to develop a basic module for environmental crime scene processing. Standardized investigative techniques must be incorporated into conservation officer training programs; federal and state agencies should jointly develop these guidelines to promote consistent enforcement practices.

The development of fish and wildlife genetic databases has significantly enhanced the investigation and prosecution of a certain wildlife crimes. This relatively new phenomena, first used in a criminal trial in 1996 (*Beamish* v. *Her Majesty The Queen*, Docket # AD-0693), is developing rapidly given the degree of understanding achieved through work on the human genome project. In fact, technological advances are occurring far faster than the development of regulations and case law that are needed to apply them (Dove 1999). A database which contains mitochondrial DNA sequences from various species traded on the black market has been established by the National Fish and Wildlife Forensics Laboratory (NFWFL). Currently this black market business, second only to drug smuggling, generates an estimated $10 billion annually and is flourishing because the risk of getting caught is minimal compared with the high profit margin (Kazmar 2000; Duffy 2002). Samples collected from confiscated illegal shipments of wildlife and products derived from their parts, can be compared to test samples in the database to identify the type of species. In addition, individual animal identification protocols, used to match various products to a specific carcass, have been developed. The database will greatly advance efforts to increase enforcement of illegal wildlife shipments.

Another database, which will be used for the forensic identification of caviar, is currently being constructed. This database will allow investigators to determine the species source for sturgeon and paddlefish caviar shipments (Fain et al. 2000). Sturgeon, which are over-fished and illegally traded for their caviar, are currently listed as an Appendix II species under the Convention of International Trade of Endangered Species of Flora and Fauna (CITES 2006). The development of this database will help curb the extent of illegal harvest and trade of these endangered species by promoting the potential to identify the origin of the poached animal.

ALLOCATION OF FUNDING, STAFF, AND EQUIPMENT. The administrative and scientific challenges discussed above are all joined by one underlying factor: the lack of resources dedicated to the study of environmental crime. The field is characterized by unfunded mandates and over-extended natural resource conservation departments charged with enforcing laws and regulations pertaining to the environment.

The primary resource needed to investigate environmental crimes is trained and committed officers. As Edgar Espinoza, deputy director of the NFWFL, stated, "There are way too many people [investigating] people crime and way too few people investigating wildlife crime" (Dove 1999). As annual budgets designated to natural resource agencies continue to dwindle, conservation law enforcement, falling short on a long list of priorities, is one of the functions that is hardest hit. As a result, fewer officers, often with minimal investigative training and tools are assigned to cover larger areas and given a greater number of responsibilities (Falcone 2004). Michigan, a state that takes great pride in the unique natural resources afforded by the Great Lakes, clearly illustrates the distressing condition of natural resource law enforcement. According to the Michigan

Department of Natural Resources (MDNR), the state employs only 146 conservation officers to cover more than 9,000 miles of shoreline and nearly 100,000 square miles of surface area (MDNR 2006). While states continue to struggle with budgetary limitations, which preclude maintaining a full force of officers to protect the resources of that state, the federal government has also been forced to operate with an insufficient number of officers. Currently, USFWS, the premier federal law enforcement authority for fisheries and wildlife, is operating with approximately 225 agents nationwide (USFWS 2006).

In addition to requiring more conservation officers to fulfill the mandate of protecting the nation's natural resources, comprehensive training programs that address all aspects of investigation and crime scene processing are needed. Conservation officers routinely have enforcement responsibilities within federal and state parks and forests, watersheds, wetlands, private property, and urban areas within their purview (Falcone 2004). Given that crimes can occur anywhere and will affect all types of landscape, conservation officers must be trained to process crime scenes in any medium. Furthermore, training must include instruction on collecting biological evidence in a manner that meets the strict requirements set forth by the criminal justice system. To be of value to a criminal investigation, all evidence must be properly recognized, documented, collected, and preserved. The methods employed in the initial stages of evidence collection, for all types of crime, will be rigorously scrutinized in court; if even one step in the sequence is skipped, or done improperly, the evidence will likely be ruled inadmissible. In addition, the credibility of the officer comes under scrutiny when challenges to the investigative procedures are raised in court (Lee and Ladd 2001).

While the forensic technology to identify individual species is available, or is nearly available, the resources dedicated to the development of the procedures and databases are woefully inadequate. Whereas state and federal law enforcement officers have a number of state-wide crime labs, in addition to the Federal Bureau of Investigation's National Crime Lab, wildlife officers have only one crime lab at their disposal. The National Fish and Wildlife Forensics Lab was founded in 1975 by the USFWS and is located in Ashland, Oregon. The NFWFL not only serves the USFWS and conservation officers from all 50 states, but also provides investigative assistance to the 165 signatory nations of CITES (Falcone 2004). Annually, operating on a budget of $2.2 million, the NFWFL participates in approximately 1,000 cases and processes 3,000–4,000 samples (Dove 1999). There is an undisputable need for forensic analysis dedicated to environmental crimes; however, resource limitations continue to hinder further development of forensic technology and analysis.

INVESTIGATING THE INTRODUCTION OF ASIAN CARP INTO THE GREAT LAKES BASIN. Despite the degree of risk presented by the introduction of Asian carp, the commercial demand for them to be sold live has outweighed the threatened environmental destruction. Asian carp are raised in aquaculture facilities, imported into the Great Lakes basin, and transported throughout the region to be sold live in numerous fish markets. There are, therefore, countless opportunities for accidental or intentional releases to occur. The first point of prospective release occurs at aquaculture facilities. Unintentional releases from aquaculture facilities can usually be attributed to inadequate precautionary measures to prevent escape, such as cage culture occurring in areas susceptible to flooding. Despite the fact that an unintentional release from an aquaculture facility is the reason for the current dismal state of the Mississippi River basin, where Asian carp have decimated

native fish populations, aquaculture is still appallingly under-regulated. Although most states require a permit to culture non-native fish, state Department of Agricultures are usually tasked with monitoring the facilities to ensure the permit provisions are being followed (Alexander 2003). The Department of Agriculture, in most states, does not have enforcement authority, however, so the involvement of the state natural resource agency conservation officers must be specifically requested by the Department of Agriculture.

A report prepared for the Ontario Ministry of Natural Resources on the risk of invasion posed by the aquarium trade and live food industry stated that importation, interstate commerce, and trade are among the most prevalent pathways through which Asian carp can enter the Great Lakes (Goodchild 1999). The report estimated that more than 900,000 pounds of live Asian carp were imported through Michigan to the Greater Toronto Area from aquaculture facilities in the southern United States annually (Goodchild 1999; Mandrak and Cudmore 2004). Efforts to list the black, silver, and bighead carp as injurious species under Title 18 of the Lacey Act, thereby prohibiting the importation and interstate commerce, have been futile. In the absence of federal leadership, state and provincial fisheries management agencies have promulgated regulations to ban the importation, possession, transportation, purchase, sale, release, and export of live Asian carp. Yet, state regulations cannot interfere with interstate commerce; therefore, fish can still be transported live into and throughout the basin, creating a major avenue for unlawful release.

There is also great potential for Asian carp to be introduced into the Great Lakes via the live market industry. Most requirements for obtaining a license to sell live fish lack substance in that there is no criteria governing the issuance of the license; typically,

the payment of a fee and a documentation of sales are all that are required. Therefore, there are few parameters guiding the storage, display, and sale of live fish. In addition to the continual threat of unintentional release, one of the primary consumer groups of these fish – Asian communities – present a unique threat of intentional release. In the Asian culture, there is a belief that one can "...accrue merits by freeing captive animals into the wild as a form of prayer to the gods" (Severinghaus and Chi 1999). In certain Asian communities in the United States, this custom, called "prayer animal release" has lead to the practice of purchasing two live fish from a market and releasing one live animal for each one killed (Alexander 2003). Research is currently being conducted to determine the prevalence of this practice.

Despite the state prohibitions on possessing live Asian carp, numerous instances of these fish being caught in the wild, outside of their range of distribution, have been documented (Kolar 2005; Mandrak and Cudmore 2004). These cases clearly demonstrate that the regime governing the trade and the enforcement response to unlawful releases of live non-native organisms clearly falls far short of what is necessary to protect the Great Lakes from invasion by injurious species. In addition to the need for a comprehensive program to address injurious species importations and introductions, a stricter enforcement response must be implemented to deter accidental and intentional introductions.

A fundamental component of a comprehensive strategy to address unlawful introductions of injurious species must be the formulation of a more appropriate enforcement response to unlawful releases; that is, releases must be investigated and prosecuted in a manner which is consistent with the extent of destruction they could

cause. More often than not, regardless of whether an introduction was accidental or intentional, investigations to determine where the fish originated are rarely conducted. Currently, there is no set protocol for responding to a silver or bighead carp found in the wild outside of their range. If a conservation officer is even informed, the extent of action taken is that the fish is confiscated. Due to the regulatory and investigative challenges discussed earlier, efforts to prove how the fish was released or to determine the fish's origin are minimal, if taken at all.

The first step to developing a stricter enforcement regime, which will greatly improve the ability to conduct investigations of releases, is to increase inspections and monitoring of importations of non-native fish. The lack of resources dedicated to conducting inspections of live shipments of wildlife at ports of entry to the United States is alarming. In 2002, there were only 97 inspectors at the 32 ports designated for fish and wildlife importations to inspect the 223 million live fish that were imported into the United States (GLRC 2005). Complete inspection of a shipment of live species is nearly impossible due to the need for expedient processing of shipments crossing the border. To this end, the aquarium pet trade has been referred to as the "most under-regulated aspect of live fish commerce" (Alexander 2003). Trafficking routes used for smuggling illegal wildlife shipments, drugs, and arms capitalize on areas where border enforcement is lax. Certainly, if billions of dollars worth of illicit black market goods are successfully being smuggled into the United States, shipments of fish containing potentially injurious species enter with ease. Proactive enforcement measures targeted at preventing shipments of unapproved species from entering the United States is the first – and strongest – line of defense (GLRC 2005).

Another location in which inspections and monitoring is vital is at sites where potentially injurious species are regularly handled (Alexander 2003). For example, by conducting regular inspections and taking samples from watersheds in which aquaculture facilities are located, a defensible baseline to compare changes in the ecosystem, should an introduction occur, would be provided. The cost of these inspections and assessments should be covered by the aquaculture industry. Furthermore, standardized, long-term monitoring would facilitate meeting the standard of proof to successfully prosecute the accidental or intentional release as an environmental crime. Increased monitoring at locations where these fish are regularly handled, such as aquaculture facilities, will increase public awareness of the potential harm these fish would cause if introduced into the wild. Education is a key component of any successful enforcement program and must be targeted to groups most likely to be responsible for accidentally or intentionally releasing non-native fish (GLRC 2005). Regular monitoring of ecosystems, conducting inspections, taking samples, and educating user groups will increase the investigative potential and the number of successful prosecutions will rise, which, coupled with adequate penalties, will, in turn, serve as a mechanism of deterrence for future unlawful introductions.

As evidenced by technology advances in the field of DNA analysis for threatened and endangered species, it is clear that the ability to develop a database on imported species is available currently. By mandating that genetic samples from each species approved for importation into the United States be recorded in a national database, the possibility of identifying the origin of injurious species, and the party responsible for releasing it, would be far more likely. Undoubtedly, a genetic database for imported

aquatic species would be a costly venture; yet, when compared to the economic devastation caused by the establishment of injurious species, development of a database is an expense that can be easily justified. Again, the cost to establish this database should not be borne by the state and federal governments, but rather be a cost of importing non-native aquatic species. Despite the fact that a cost analysis for the production and maintenance of a database for imported fish species has not been conducted, other databases provide some insight to the projected costs. The Norwegian Directorate of Fisheries operates a minke whale genetic database using tissue archives. Collection and storage for individual samples over a five-year period was approximately $83 while genetic analyses averaged $276 per sample (Palsboll et al. 2006). A number of factors, such as the type of sample collected (i.e. tissue versus fin clip), will dictate the financial commitment needed. One possible solution for curbing the cost to the government is to include the cost of sample collection in the terms of the permit for importation. Further, should a genetic analysis of the sample be required to determine the origin of an unlawful release, restitution and or civil penalties should be used to recover that cost.

The need for a database to trace the origin of the fish is clear when one examines the current investigative response to an unlawful introduction. Reports of silver and bighead carp being recovered from areas outside their range of distribution have been far too frequent. The following case of a suspected intentional release exemplifies the inadequate enforcement response and the need to address the gaps and limitations in the trade regime immediately. In the summer of 1991, a live bighead carp was discovered in a fountain on University Avenue in downtown Toronto, Ontario, near the shores of Lake Ontario (Mandrak and Cudmore 2004). Conservation officers determined that the fish

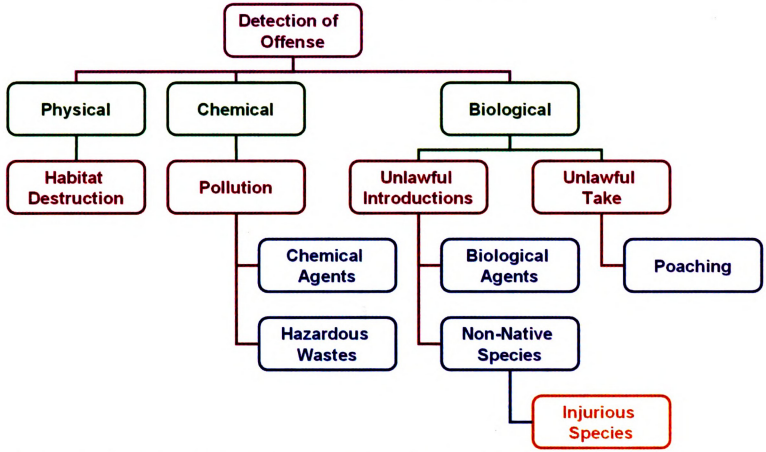
was most likely purchased from a nearby fish market, but there was no way to ascertain which market sold the fish nor who, specifically, released the fish.

RECOMMENDATIONS FOR DEVELOPING AN INVESTIGATIVE FRAMEWORK FOR INJURIOUS SPECIES INTRODUCTIONS. The prosecution of the unlawful introduction of non-native species from an aquaculture facility, would, in most states, involve the state Department of Agriculture, the state Department of Natural Resources, and the USFWS, at a minimum. Furthermore, depending on the extent of dispersion of the injurious species, and whether the species becomes established, private landowners and other states may also become involved. Future research in this area must first focus on developing a framework to identify all types of environmental crimes in which all elements of an ecosystem are considered. Building upon that framework, efforts should then be directed towards developing a comprehensive protocol for the investigation and prosecution of each type of environmental crime identified in the above framework to facilitate an effective enforcement response.

A comprehensive environmental crime investigative framework should first focus on distinguishing what type of offense occurred (figure 7). Given the potential variability and remoteness of most environmental crime scenes, this step can be especially challenging for conservation officers (Molino 1993). After an initial assessment to establish personal safety and to secure the crime scene, the officer should assess whether the violation is biological, chemical, or physical in nature. This first distinction should trigger the involvement of certain agencies, such as the Department of Natural Resources and the Environmental Protection Agency. For example, in the State of Michigan, a violation concerning hazardous waste would invoke the involvement of the state Department of Environmental Quality, whereas the unlawful alteration of shoreline

Figure 7

Environmental Crime Classifications: A Proposed Framework



This proposed framework provides an initial overview of specific types of environmental crimes. This framework is not comprehensive and should be further developed as part of a comprehensive approach to responding to environmental crime.

would trigger the Department of Natural Resources. Of course, the jurisdiction in which the violation occurred would dictate what agency would have primary enforcement authority. Given that many environmental crimes are spread across several jurisdictions, however, cooperative agreements between agencies throughout a region should be developed to govern the investigative process.

Future research should focus on expanding the framework proposed in Figure 7 to include all environmental crimes. Each type of crime (i.e. physical, chemical, and biological) should be expanded to include specific classifications of environmental crimes. For example, biological pollution (i.e. unlawful introduction) should be included as a category of environmental crimes of a biological nature. Unlawful introductions should encompass all activities that involve adding something to the ecosystem that is not naturally occurring in that system. This category could then be further divided into several categories including the release of biological warfare agents (i.e. anthrax) and non-native species. The introduction of injurious species would be considered a subcategory of the introduction of non-native species.

After the type of offense is ascertained, the scene should be processed using standardized procedures. Again, while the NIJ protocol provides a starting point, an investigative framework should further outline each step for different categories of violations. A framework to guide the investigative process for all types of environmental crimes should be developed to standardize protocols for processing various environmental crime scenes. The major limitation of the National Institute of Justice's (NIJ) protocol is that it was designed to apply to illegal waste dumping cases and is too broad to be applied to other forms of environmental crime (Hammett and Epstein 1993).

Yet, processing a scene in which a hospital disposes of medical waste in a nearby wetland is vastly different than investigating a fish market owner dumping unsold live non-native fish into a river. Just as in more traditional crime scene processing, the type of offense, and the initial degree of harm caused by the crime, should dictate the level of response. Depending on the specific type of offense, an investigative framework should guide the procedures to be followed to accurately process the scene. For example, the second step outlined in the NIJ protocol is broadly defined as data collection. A complete framework, however, should specify the types of data (i.e. fish sampling surveys after the violation for comparison to prior baseline surveys) that should be obtained for each type of investigation. More sophisticated data collection techniques will be necessary for certain types of environmental crimes and should be developed as the need is identified. Similarly, evidence collection, the fourth step in the NIJ protocol, needs to be specifically addressed for each type of crime scene. Using the violation example above, evidence that could be useful in the prosecution of the live fish dealer would include copies of the sales permit, records of the types of fish purchased and sold, the sales records of the wholesaler, and sales logs to document how much product was left at the closing time of the market. Regardless of the type of crime committed, there is always some form of evidence available. Conservation officers need to be trained to recognize and collect all forms of evidence as it is a vital component of any successful prosecution.

Creating an investigative framework is the first step towards successfully prosecuting cases of introductions of injurious species. Conservation officers are charged with protecting the nation's natural resources; to fulfill this mission, environmental crimes must not be minimized when compared to more traditional crimes.

CONCLUSION

In conclusion, introductions of injurious species threaten ecosystems throughout the country; many of these systems cannot tolerate even one new invader. It is clear that the regulations, enforcement practices, and existing penalties are not serving as an effective deterrent. As a result of the minimal enforcement response directed towards unlawful introductions, the message being sent is that these activities are not significant and do not have severe consequences.

Efforts to prevent further injurious importations and introductions must occur more proactively, be comprehensive, and receive strong financial commitment from all levels of government for enforcement. Society must place a higher value on the environment, in turn prompting the government to make its protection a higher priority. Environmental agencies must seek to increase the public awareness of the threat injurious species pose, because increased awareness will translate into an increase in funding for required management and enforcement efforts.

During the course of this research, it has become apparent that there a number of areas in which future research is needed to advance the ideas and recommendations submitted throughout this paper. Chapter 4 presents a discussion on the future legislative needs to address injurious species and chapter 5 focuses primarily on what is needed to advance environmental crime investigative techniques. This research presented an argument for why injurious species introductions should be classified, investigated, and prosecuted an environmental crime. Future research needs presented throughout this paper (figure 8) are essential to advance the definition of, and response to, environmental crimes.

Figure 8

Environmental Crime: Future Research Needs

- Expansion of the Environmental Crime Classification Framework (figure 7) to include all types of environmental crimes
- Identification of the acceptable level of the standard of doubt for successful prosecution of environmental crimes (will likely vary depending on type and degree of violation)
- Development of a screening program to assess the degree of risk associated with proposed importations of non-native aquatic species
  - Identification of species of concern and potential routes of entry
- Development of an insurance program to be implemented as part of a screening process for proposed importations of non-native aquatic species
- Determination of the extent of accidental and intentional introductions of injurious species
  - Identification of effective deterrence mechanisms
- Quantification of environmental and economic damage caused by the introduction of injurious species
  - Identification of adequate penalties to provide restitution
- Identification of methods to control human-mediated introductions of injurious species
  - Development of education and outreach programs
- Development of an Aquatic Injurious Species Genetic Database
  - Identification of cost-efficient sampling procedures
- Identification of investigative procedures for all environmental crimes (as outlined in the Environmental Crime Classification Framework)
  - Development of baseline measurement of ecosystem conditions (i.e. monitoring program) by which samples taken after a suspected violation can be measured
- Development of law enforcement training programs for biological evidence collection and handling procedures

Strengthening the legislation against, and improving the enforcement of, the intentional and unintentional importation and introduction of injurious species will facilitate the development of stronger, enforceable regulations and associated penalties, which will, in turn, ultimately serve as a deterrent. The USFWS, which has the authority to regulate the importation and introduction of injurious species, needs to recognize and exercise its mandate to lead this movement. Regulations must be promulgated to establish a strict screening process, effective control, containment and eradication procedures, and clearly defined regulations with stringent enforcement provisions.

To ensure the sustainability of the Great Lakes basin, the introduction of injurious species must be responded to within the context of a more comprehensive definition of environmental crime. Moreover, establishing a framework to facilitate the development of investigative procedures for all types of environmentally harmful activities is imperative to preventing further environmental damage.

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