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Part I: A Literature Review of Aquatic Invasive Species

Approximately 50,000 species have been introduced to the United States from other parts of the world (Pimentel, Zuniga, and Morrison, 2005). Although not all of them are harmful, and many non-native species are used for food and other beneficial practices, it does not take a stretch of the imagination to recognize that the unintended consequences of both accidental and purposeful introductions could be disastrous, resulting in what we now term invasive species - organisms that have spread to an area not in their native range and cause harm to the new ecosystem or human activities in the area. One study estimated that invasive species cost people in the United States about \$120 billion each year (Pimentel, Zuniga, and Morrison, 2005). This is a conservative estimate because not every known invasive species was included in the analysis. Invasive species can be terrestrial or aquatic, the former changing ecosystems on land and the latter impacting the nation's waterways. Tactics for control of terrestrial and aquatic invasive species are quite different not only because of differences in the ecosystems impacted, but because aquatic systems take up only discrete areas and species often depend on other organisms to help them spread from one water system to the next. Therefore, management of aquatic invasive species often focuses on preventing introduction of an organism to other water systems. By studying the ways that aquatic invasive species are transported, scientists are able to determine which bodies of water are most at risk of invasion,

knowledge which can then be translated into management strategies focused on those particular areas.

Aquatic invasive species cause many problems for both ecosystems and humans. Of the 958 species listed as threatened or endangered under the Endangered Species Act, 400 are primarily at risk because of invasive species (Pimentel, Zuniga, and Morrison, 2005). Invasive species are called thus because they “invade” an area since their growth and reproduction is not controlled by the factors that would limit them in their native habitat. First, predators that would control an invasive species' numbers are often absent in the new habitat. Second, many invasive species are ruderals, meaning they mature quickly, put a lot of effort into reproduction, and specialize at colonizing disturbed areas (Capers et al. 2007). This means that when any type of ecological disturbance occurs, such as flooding or drought, non-native species then have the opportunity to colonize the area and are often better at doing so than the damaged native population. Capers et al. (2007) found that density of native species can protect against take-over by non-native species because the non-native species are less able to become established and begin consuming resources if there is already a dense population of established individuals. However, they noted that most aquatic communities are in non-equilibrium conditions, meaning there is often stress and disturbance on the established natives that leaves gaps where non-native species could gain a foothold begin to out-compete the native species. Third, once the non-natives have established themselves, they often become invasive because of they have characteristics that enable them to out-compete the native population for resources.

The relationships between the organisms in the ecosystem can become unbalanced in many ways once an invasive species is established. As mentioned above, invasive species take

away resources from organisms they are in direct competition with, decrease those organisms' populations. This decreases the food source of organisms that feed on those native species, but increases the populations of the organisms that the native species feeds on. An example of the impacts of an invasive species is the introduction of the notorious zebra mussel to the Hudson River. Strayer et al. (1999) documented the impacts and found a decline in the amount of edible particles that zebra mussels filter out for their food. There was also a clear decrease in the populations of benthic consumers such as native clams that would be competing with zebra mussels for these food particles because the zebra mussels are able to out-compete them for food. Changes in sediment deposition and a decline in the macroinvertebrates consumed by zebra mussels also increase the amount of resources available for consumption by other organisms, so their populations increased. Additionally, Strayer et al. (1999) found that phosphorus and available light both doubled following zebra mussel invasion, and nitrogen levels increased as well. The populations of organisms such as bacteria and some primary producers not consumed by zebra mussels increased in response to the increase in available resources. Species that consume these primary producers or use them for habitat increased in response. The introduction of zebra mussels drastically changed the ecosystem of the Hudson River by shifting where and which resources are available. Strayer et al. wrote, "Few other human-caused events in the history of the river have had such large, wide-spread, and potentially long-lasting effects on the Hudson ecosystem" (1999, 24).

Invasive species also impact human activities. The total cost of impacts from invasive species in the Hudson River and New York State Canal is estimated as almost \$500 million each year (Pimentel 2005). Most of these costs come from a decline in fisheries which impacted revenue from commercial and sport fishing. The next biggest cost was public health

problems from pathogens and parasites such as the West Nile virus transmitted by mosquitoes that breed in aquatic areas, estimated at costing \$40 million per year (Pimentel, 2005). Public water supply systems and electric power plants had problems with invasive invertebrates (such as the zebra mussel) encroaching on and harming their water intake systems as the invasive species' populations bloomed (Pimentel, 2005). Other sectors impacted were tourism, agriculture, boaters, and bird and wildlife watchers. When invasive species are introduced to an area and grow uncontrollably, they upset not only the ecosystem, but structures and parts of life that we humans have come to depend on.

The success of a potential invasive species depends on two things, a suitable environment and propagule pressure - the number of invasive individuals reaching a new area (Leung and Mandrak, 2007). Propagule pressure is perhaps the more important of the two because prevention and management of invasive species can do more in that sector. Increased propagule pressure means an increase in the likelihood of an invasive species becoming a problem in a body of water, and keeping down the number of individuals of that species that arrive at the lake decreases the likelihood that an invasive species will become established. The next logical questions, then, are how invasive species are transported from one body of water to another and which of these modes of transport can be prevented to decrease the likelihood of invasive species introduction.

First, species that can propel themselves often migrate into connected bodies of water. It is believed that the invasive sea lamprey moved into the Great Lakes by migrating up the Hudson River (Pimentel, 2005). Other species, such as zooplankton or aquatic plants can be carried by wind, currents, or animals (Havel and Shurin, 2004). Some species can be transported in the form of eggs or even fragments of foliage (Havel and Shurin, 2004). This

makes it very easy for them to be transported accidentally by animals or other methods. These ways invasive species are spread are all very hard to control or even predict where they would spread to next.

Another important means of transportation of aquatic invasive species is by humans. Organisms, eggs, or fragments of organisms can be transported on boats or other man-made equipment used in the water. Many studies have been done to discover the importance of boats in transporting aquatic invasive species. Invasive species can be transported either attached to the outside of boats and related equipment such as trailers or in bilge tanks when ships take on water for buoyancy then move to a different spot and release it along with whatever organisms are in it (Havel and Shurin, 2004). Really, invasive species can be accidentally transported by any activity where equipment is placed in one body of water where invasive species are present then removed and placed in another body of water (Havel and Shurin, 2004).

Floerl and Inglis (2004) studied the assemblages of organisms on the bottom of boats in marinas and found that it reflected assemblages present in the marina but which organisms were present was not a determining factor in the probability of spread of invasives. MacIsaac et al. (2004), on the other hand, found that previous patterns of invasion is related to the number of boats coming into a lake possibly carrying invasive species. This makes sense given propagule pressure has a lot to do with which bodies of water are invaded. As the number of boats on a lake increases, the probability of more boats carrying invasive species also increases, raising the propagule pressure of the lake and the inevitability that invasive species will become established. Buchan and Padilla (1999) had similar results. They found that the probability of invasion of a body of water depends on the amount of long-distance recreational boater traffic and management should be focused on “high-frequency, long-distance boater

movements, and regions with the greatest volume of source and/or destination boater movement” (254).

This brings up the management implications that come from these discoveries about invasive species transport. It is not easy to control introductions by animals or keep species such as fish from migrating upstream from areas where they have already been introduced, but it may be worthwhile to attempt to keep boaters from introducing species to relatively isolated bodies of water like many lakes. New York and many other states have made laws prohibiting the possession and purposeful release of listed invasive species because a lot of aquatic invasive species were introduced through the aquarium and ornamental trade (Padilla and Williams, 2004). The next step is to keep species that have already been introduced to certain water systems from spreading to other areas. As discussed above, the most effective way to do that is to target ships and boats moving from one area of water to another because it is the method of transport of invasive species that we have the most control over.

However, it is not as easy as it seems to keep invasive species out of bodies of water. Many boaters are unaware of what they could be transporting on their equipment and move their boats to several different lakes each year without waiting long enough for the organisms attached to die or washing their equipment before placing it in another body of water. Strategies to deal with recreational boaters at lakes across the country include required checks for organic material before launching a boat and boat washes after removing the boat to reduce the risk of contamination of bodies of water where invasive species are not yet present. Ballast water is also a big problem, even though it seems as if ships could simply be required to pull in local water before moving farther upriver as opposed to moving farther with contaminated water. Yet ballast tanks are not emptied fully when drained and the organisms left will survive

in the new water pulled in (Havel and Shurin, 2004). There is talk of heating ballast water to 65 degrees Celsius before releasing it to kill all organisms (Pimentel, 2005), however this is not easy to do and is energy intensive.

All of these control strategies require significant time, effort, and money, and covering all of the bodies of water in the country would be unreasonable. Much of the literature on invasive species is focused on predicting which areas are most at risk of invasive species spread. As already stated, the bodies of water most at risk are those with the most boat traffic. However, the data can be taken further than that. Muirhead and MacIssac (2005) interviewed boaters at lakes in Canada to discover patterns in where they take their boats and which lakes have the most traffic. They discovered that certain lakes serve as “hubs” from which certain invasive species spread to other lakes. For example, the spiny waterflea has spread from Lake Muskoka to many other lakes, however at this point most of the traffic from this lake is to already invaded lakes. The authors of the paper were able to identify possible new hubs from which most outgoing traffic is to lakes where invasive species have not yet been introduced. By focusing management strategies on those new hubs, it is possible to reduce the resources needed, making management more practical.

MacIssac et al. (2004) took an alternative approach to predicting which lakes are most at risk. They developed a method to give each lake a score which correlates to the risk they have of being invaded. This score was based on the number of boats coming into the lake from lakes that have invasive species. The management implications of this kind of analysis is essentially the same: that those lakes that are most at risk should be the focus on management resources.

Invasive species are changing the world. They change ecosystems around which we

have based our infrastructure and cause billions of dollars in damage. Scientists are becoming better at understanding which management strategies are effective to prevent the spread of invasive species and have developed methods to predict how invasive species will spread to surrounding areas. However, data about and an understanding of invasive species is not enough to counter their effects. Some states have put legislation in place to take stopping invasive species to the next level. New York has developed a list of species considered invasive and has made it illegal to buy, sell, or possess those species. Minnesota has laws prohibiting placing a boat in water if it has invasive species attached, in the hopes of making boaters more aware of the dangers of invasive species and to prevent the accidental transportation of them by boats. Although many areas are irreparably damaged because of invasive species, this focus on preventing their spread will help preserve ecosystems for the future.

Part II: An Assessment of the Goals of the Government Relations Team at The Nature Conservancy

The Government Relations team at the Albany chapter of The Nature Conservancy (TNC) is responsible for furthering all of the policy initiatives of TNC in New York. David Higby, the Director of Federal Government Relations works with the New York State congressional delegation on federal legislation initiatives. Jessica Ottney-Mahar, the Director of Government Relations, works with coalitions and coordinates the policy initiatives of TNC. Amanda Lefton is a Policy Adviser, which mainly entails lobbying and working directly with the legislature to get important bills passed.

The goals of the Government Relations team has to do with policy initiatives that they want to push forward, however it would be impractical to set goals of which legislation they

want to get passed. There are so many externalities that they can not control as to which bills get made into law, that that would not be a good measure of how effective this department is. Thus, the goals of the Government Relations team have more to do with doing as much as they can to further certain legislation and setting benchmark goals along the way to make sure they're being as effective as possible. There are three main policy initiatives that the Government Relations team has been working on this year that can be used to assess how well this department reaches their goals: the Environmental Protection Fund, aquatic invasive species legislation, and climate resiliency legislation. The team set realistic goals for each of these issues in order to make sure they were furthering the legislation as much as possible.

The Environmental Protection Fund (EPF) is New York's predominant source of funding for environmental projects and provides for a wide range of issues from farmland protection to open space land acquisition to funding for zoos across the state. That the money allocated to the EPF should be increased is the one issue that almost all environmental organizations across the state can agree on. Yet, they do not agree as to how it should be segmented within the fund. A coalition called the Friends of New York's Environment that includes most of the environmental organizations in the state works together each year to put on a lobby day during budget season in support of increasing the EPF. They also work on other strategies including fundraising and awareness campaigns to help show what the EPF does for the state. The coalition has goals pertaining to fundraising and other areas, however the staff at TNC do not have a lot to do with setting and reaching these goals. Their main role is to facilitate the coalition by leading conference calls and disseminating information.

The goal this year was to get the EPF increased to \$200 million in the state budget. The executive budget put out by the governor's office only included \$157 million for the EPF, an

increase of \$4 million from last year that had already been agreed upon in last year's negotiations. So the lobby day this year was a very important benchmark in the push to have the EPF increased. In the meetings, the legislators were asked to sign on to the letters that Senator Grisanti and Assemblyman Sweeney were circulating in support of an increase in the EPF to \$200 million. The goal was to have 90 meetings scheduled and attended, and in the end it was very close to that (around 80 meetings), though a few meetings were not able to be scheduled. There were 101 signatories total to the letters circulated in both houses. The lobby day ran smoothly and feedback sheets were received for each meeting to say how it went and whether the legislator agreed to sign on to the letter. The lobby day was one big step on the way to having the EPF be allocated \$200 million, and the Government Relations team almost entirely met their goals regarding it.

The next steps for the EPF are to continue lobbying and meeting with legislators to make sure their support is continued throughout the budget negotiations, although the externalities of these negotiations make it hard to make any sort of goal regarding which legislators will fully support the EPF. Hopefully, in the final draft of the budget the EPF is increased significantly, though it is hard to say at this point how much is a realistic estimate of how much it will be allocated. However, whatever the final number is, the Government Relations staff at TNC did their best throughout the budget process to make sure it will be as high as possible by facilitating the Friends of New York's Environment coalition and organizing the lobby day.

The Government Relations team also worked on aquatic invasive species legislation. More specifically, how they are transported by boaters. This is an important problem as invasive species cause millions of dollars in damage in to the state annually. Infested lakes see

a decrease in fish and lose tourism and both commercial and recreational fishing. Invasive species have been known to clog pipes and harm infrastructure. Keeping them from spreading out of bodies of water where they already exist is key to controlling the costs associated with them. New York already has legislation prohibiting the purchase, sale, and possession of species on the state invasive species list. The next step is to prohibit boaters from transporting invasive species on their boats and equipment, even by accident. This will help to control invasive species, but also to raise awareness about their impacts.

There are several steps on the way to getting the legislation that TNC wants passed. The first step is to find a sponsor for the bill who will introduce it to the legislature. There must be a sponsor for both the assembly and the senate. Assemblyman Sweeney and Senator Grisanti are usually the go-to people to introduce TNC legislation. Once sponsors are secured, the proper language must be drafted. This takes some time and a lot of research into language that other states or areas have used. For the invasive species bill, laws from Maine, Vermont, Minnesota, Lake George, and Lake Tahoe were all compared to find the best wording for New York. The main body of the bill came from proposed regulation from the Department of Environmental Conservation that would only apply to state-owned boat launches.

Specific language was not the only comparison made between the different areas with invasive species legislation. Enforcement of the legislation is equally important, so we looked at how the different areas enforce the legislation. Minnesota is the only state that included in its legislation a certified inspector program at boat launches to check boats for organic material attached before they are put in the water. The other places most likely were not willing to put such a program in their laws because it is expensive. However the other places - Maine, Vermont, Lake George, and Lake Tahoe - all have sticker laws where boaters are either

required or encouraged to buy stickers to go towards funding for invasive species control. Different places went to different levels as far as enforcement of the laws and education about invasive species to promote self-enforcement.

This research was then synthesized into a draft bill to be introduced to the legislature. It was decided that a sticker would be required to be bought by boaters in order to pay for enforcement of the law. It is most likely that this section of the law will be dropped because many legislators would not support the increased economic strain on recreational boaters. However, it is an effective tactic to ask for more than you know will be accepted in the hopes that other parts of the bill will remain in tact as opposed to trying to make a bill which will be accepted as is from the very beginning. The next step is to continue lobbying to gain support for the bill and make sure that changes are not too grave.

It is not a realistic goal for the Government Relations team to set the number of bills they want to get passed in a year. However, they can set benchmark goals of which bills they want to introduce and what exactly the key parts of the legislation are that they want to try to keep in the as it goes through the legislative process. The team does all they can to make the bill as effective as possible both in the beginning and as it goes through the Assembly and Senate. In the case of the invasive species legislation, the goal was to prohibit the transportation of aquatic invasive species either accidentally or purposefully on boats or related equipment and anything about enforcement or funding is secondary. This legislation has not even been introduced yet, but there is a sponsor for it and they have a good idea of who the bill will be supported by. Overall, TNC has achieved their benchmark goals of doing what they can to get the invasive species legislation passed.

TNC is also working on climate resiliency legislation that is being drafted. They did not

introduce this legislation themselves, but instead commented on the draft bill. The bill made amendments to existing legislation concerning the placement of toxic waste storage and treatment facilities, acquisition of open space, what could projects would get priority funding, and the definition of sustainable development. The Government Relations team then wrote a memo stating what they believed should be changed about the bill. Most of the changes were wording issues to make the legislation stronger and revisions to which sections of law were amended. There was an attempt to make the language of the legislation encourage natural solutions such as wetland growth to minimize storm impact as opposed to man-made solution such as sea walls for the same purpose. To do so, the definition of sustainable development was changed to include natural structures to mitigate the impacts of climate change. However, TNC also looked at legislation from Connecticut to see how they included natural solutions in their legislation.

The memo to the legislature is still in the process of being drafted and the legislation may not pass anytime soon, however TNC is working to make the legislation as strong as it can if and when it becomes law. They set goals for what they want to see included in the legislation, such as a change in the definition of sustainable development and the development of natural solutions to storms and other climactic events. It is hard to say at the moment whether or not they have achieved these goals, as the bill has not progressed to that point.

It is hard to quantify the goals of the Government Relations team at The Nature Conservancy, however their benchmark goals as their policy initiatives progress gives a better idea of how their work is going. In the case of the EPF, The Nature Conservancy had a very successful lobby day and was able to acquire the support of many legislators for the duration of the budget process. Though this might not be enough to get the EPF raised to \$200 million, it

still is an achievement and fulfillment of the goals they set that would help them reach their end of raising the EPF as high as possible. For invasive species legislation, TNC drafted important legislation that is the first step to protecting New York's lakes and rivers from aquatic invasive species. Although not every aspect of the bill will pass, the core and important parts of the legislation will hopefully be maintained, partially because TNC is asking for more than it is going to get. The memo that TNC drafted about climate resiliency bill will influence lawmakers to change the legislation for the better. The Government Relations team at The Nature Conservancy do all they can to implement tactics that further legislation to maintain New York's environmental beauty for the future.

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