Aquatic Nuisance Species Effects on Sustainability of LAKE CHAMPLAIN

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AQUATIC NUISANCE SPECIES

Aquatic nuisance species (ANS) are non-native organisms that threaten the diversity or abundance of native species in infested waters. ANS also interfere with our current uses of the water, including commercial and agricultural industry or fisheries and recreational activities. Some of these species have been intentionally introduced to the Lake in order to benefit the fisheries industry. However, most have entered the Lake via the Champlain Canal, the Richelieu River, or over land through human activities such as boating and bait transport.

At least 22 known ANS have been introduced into the Lake Champlain Basin, including zebra mussels, sea lamprey, alewife, purple loosestrife, Eurasian watermilfoil & waterchestnut. Eurasian watermilfoil and water chestnut, two nonindigenous plant species, crowd out native species and impede recreational activities such as fishing, boating and swimming by forming dense stands. Purple loostrife, a nonindigenous wetland plant, continues to spread throughout the Basin, displacing native species and threatening the diversity and stability of wetlands. Sea lamprey have limited the potential of native trout and salmon fisheries within Lake Champlain while zebra mussels are displacing the Lake's native mussel species, and are encrusting boats, historic shipwrecks, popular swimming areas, and water intake lines. Countless other non-indigenous plant and animal species such as hydrilla, quagga mussel, and Eurasian ruffe threaten to enter the Basin from neighboring waters.

Public health and safety is also a concern. Zebra mussels, for example, can potentially facilitate the cycling of heavy metals and other toxins into aquatic food webs ultimately resulting in increased exposure to humans when they consume fish and other aquatic organisms. Preferential feeding by zebra mussels can also result in greater concentrations of the toxic blue-green algae, *microcystis*.

SIGNIFICANT AQUATIC NUISANCE SPECIES OF LAKE CHAMPLAIN BASIN

The following species currently exist in the Lake Champlain Basin and are considered priority species for management. Each species, with the exception of alewives, has caused, and continue to cause, significant negative ecological and economic impacts within the Lake Champlain Basin.

Plants

- **Purple loosestrife (*Lythrum salicaria*)** This hardy perennial plant invades marshes and lakeshores, out-competing cattails and other native wetland plants. It has distinguishing magenta-colored flowers, and a single stalk may produce as many as 300,000 seeds. Purple loostrife may grow in densities of up to 80,000 stalks per acre and create monospecific stands that decrease biodiversity. Because of this, it is unsuitable for habitat needs such as cover, food or nesting sites for a wide range of native wetland animals including ducks, geese, bitterns, muskrats, frogs, toads and turtles. It also destroys spawning areas for commercial fish such as the Northern pike. Certain insects will breed only on native plants, such as cattails. When purple loostrife gets established and chokes out native plant life, insects will no longer return to breed and in return some bird species will have less food and will move to new habitat. Purple loosestrife, a wetland plant from Europe and Asia, was introduced to the East Coast of North America in the 1800's. The plant was likely introduced to the Lake Champlain Basin as an ornamental. It has been reported in 151 towns in Vermont and currently infests an estimated 1,500 acres of wetlands in the Lake Champlain Basin of Vermont. An unknown, but significant amount of wetlands are infested within the Lake Champlain Basin of New York and Quebec as well.

- **Eurasian watermilfoil (*Myriophyllum spicatum*)** Eurasian watermilfoil forms large, dense floating canopies of surface vegetation that can out-compete and eliminate native aquatic vegetation as well as native fish and wildlife populations. The vegetation prevents light penetration for native plants, raises the pH of the water, decreases dissolved oxygen levels, and increases water temperature. Eurasian watermilfoil can proliferate in high densities in lakes, producing habitat conditions that cause serious impairments to water recreation such as boating, fishing, and swimming. It thrives in disturbed areas where native plants cannot adapt to alteration, such as along altered waterways. Eurasian watermilfoil's distinguishing feature is its leaves, which are finely divided and occur in whorls of 3 or 4 along the stem, with 12 to 16 pairs of thin leaflets about 12 inches long. It is a perennial plant, and dispersal is almost exclusively due to fragmented stems sinking and developing roots. It was first discovered in Lake Champlain in 1962, when it was unintentionally introduced from Europe by either the aquarium trade or for ornamental cultivation. It now occupies an extensive range throughout the Lake and at least 40 other bodies of water throughout the Basin. New infestations of Eurasian watermilfoil are discovered nearly every year. Fragments attached to trailered boats are the likely cause of these overland introductions.

- **Water chestnut (*Trapa natans*)** This annual, floating aquatic plant is fast-growing and creates large surface canopies of vegetation that kill submerged native plants due to decreased light penetration. It is of little food value to fish and other aquatic species and alters wildlife habitat with its dense mats. The decomposition of plants leads to reduced dissolved oxygen levels in the water, which may increase the potential for fish kills. Extensive growth of water chestnut in southern Lake Champlain severely restricts boat traffic and other recreational activities such as fishing and swimming. The distinguishing feature of water chestnut is its triangular surface leaves with toothed edges that form a rosette. The submerged leaves are feather-like and grow to a height of 16 feet. These plants are spread due to plant fragments floating long distances and establishing new colonies. The seeds also attach to waterfowl and are transported to new areas. Water chestnut is native to Europe, Asia, and Africa and was first introduced to Lake Champlain in the 1940's, likely through the Champlain Barge Canal. Populations of water chestnut also exist in several inland lakes in the southern portion of Vermont.

Animals

- **Sea lamprey (*Petromyzon marinus*)** The sea lamprey is a top predator which kills nearly any large fish species by attaching to them and feeding on their body fluids. Each adult lamprey can kill up to 40 pounds (18Kg) of fish during its parasitic phase. The invasion of sea lamprey has resulted in substantial economic losses to recreational fisheries. During the 1970's, sea lamprey became a noticeable problem when Vermont and New York state biologists attempted to reintroduce landlocked salmon and lake trout to the Lake. Attacks by adult sea lamprey on salmon, lake trout, and other fish species limited the full development of the Lake Champlain fishery, and restricted recreational and associated economic opportunities. Sea lampreys swim upstream to spawn, which is probably the main reason they originally entered the Lake. It is believed to have entered through the Champlain Barge Canal, which connects the Poultney River at the southern tip of the Lake to the Hudson River.

- **Zebra mussel (*Dreissena polymorpha*)** Zebra mussels feed on large quantities of phytoplankton and some small forms of zooplankton, which native fish depend on for survival. As filter feeders, they are capable of filtering 1 liter of water per day. The zebra mussel is highly opportunistic; in many areas all firm submerged surfaces are densely covered by adults who attach themselves with byssal threads. Entire populations of Lake Champlain native mussels are disappearing due to heightened competition for food and because zebra mussels attach to their shells, which inhibit their ability to feed, respire and reproduce. This leads to eventual starvation or disease. They reproduce rapidly; when water temperatures rise above 50° F, females will lay up to 1 million eggs. Many of the Lake's hundreds of historic shipwrecks and other cultural artifacts, some of which date back to the Revolutionary War, are becoming encrusted with zebra mussels, diminishing their scientific and historic significance. Zebra mussels also clog water intake systems, such as those used by power plants and water treatment systems. Additionally, zebra mussels have covered submerged surfaces in many of the Lake's popular swimming areas and swimmers complain of being cut by their sharp shells. Zebra mussels were first discovered in the southern end of the Lake in 1993, and can now be found throughout the entire length of the Lake. Zebra mussel larvae, known as veligers, were found in Lake George in 1995 and 1997, but adults have not yet been found. It is native to Eastern Europe and likely entered Lake Champlain through the Champlain Barge Canal. The inland infestations were likely caused by the overland transport of contaminated boats.

- **Alewife (*Alosa pseudoharengus*)** Alewives, members of the herring family, have been recently introduced to the Lake Champlain Basin and have not yet caused any significant negative impacts. The nonnative fish has caused substantial degradation in other regions and has the potential to do so in the Lake Champlain Basin. It has the potential to displace native smelt populations and poses a significant threat to other native fisheries within the Basin if allowed to spread. A brief window of opportunity potentially exists to contain the alewife population to its small current range within the Basin. Alewives are native to Atlantic coastal regions, and were first discovered in Lake St. Catherine in Poultney, Vermont in 1997. It is suspected that the alewife was intentionally introduced to Lake St. Catherine by anglers hoping to increase the numbers of forage fish available to sport fishes. The Lake St. Catherine population poses a primary threat to Lake Champlain, as the outlet of Lake St. Catherine flows into the Champlain Barge Canal.

Potential Aquatic Nuisance Species to Lake Champlain

Other non-indigenous plant and animal species that have the potential to become problematic are found throughout the Lake Champlain Basin. Many of these species have not been well documented and the full extent of their distribution and impacts within the Basin is not known. The current list of species includes:

Plants

flowering rush (*Butomus umbellatus*)
European frog's bit (*Hydrocharis morsus-ranae*)
common reed (*Phragmites australis*)
yellow floating heart (*Hyphoides peltata*)
curly leaf pondweed (*Potamogeton crispus*)
slender-leaved naiad (*Najas minor*)

Animals

gizzard shad (*Dorosaoma cepedianum*)
white perch (*Morone americana*)
mud bithynia (*Bithynia tentaculata*)
Chinese mysterysnail (*Cipangopaludina chinensis*)
rusty crayfish (*Orconectes rusticus*)
Eurpean rudd (*Scardinius erythrophthalmus*)
blueback herring (*Alosa aestivalus*)
common carp (*Cyprinus carpio*)
goldfish (*Carassius auratus*)

Potential Aquatic Nuisance Species outside the Basin

Other aquatic or wetland species also have the potential to be introduced to the Lake Champlain Basin. These species exist in nearby waters or are sold through nurseries, aquarium stores, or bait shops within or near the Lake Champlain Basin. They currently are not known to be established in the wild within the Basin, but it is possible that some are established but have not been detected. If introduced to the Basin, each of these species could have significant ecological and economic impacts. The current list of species includes:

Plants

fanwort (*Cabomba caroliniana*)
Brazilian elodea (*Egeria densa*)

hydrilla (*Hydrilla verticillata*)
parrot's feather (*Myriophyllum aquaticum*)
variable-leaved watermilfoil (*Myriophyllum heterophyllum*)

Animals

spiny water flea (*Bythotrephes cederstroemi*)
fishhook water flea (*Cercopagis pengoi*)
Asiatic clam (*Corbicula fluminea*)
quagga mussel (*Dreissena bugensis*)
Eurasian ruffe (*Gymnocephalus cernuus*)
round goby (*Neogobius melanostomus*)
tubenose goby (*Proterothinus marmoratus*)
amphipod (*Echinogammarus ischnus*)

Potential interactions with native/desireable species

- **Predation, competition, and habitat modification** Invasive species interact with native species through predation, competition and habitat modification. Non-native species prey on the eggs, larvae, juveniles and adults of our native species and compete with all of these life stages for forage and living space. This interspecific competition affects the sustainability of the Lake Champlain fisheries. Each new species introduced to the system requires food and living space in order to survive. Most invasive species are good competitors and may be able to displace or out-compete desirable species. Some species may not be competitors, but may alter the water's habitat characteristics to the degree that native species no longer thrive in that area.

- **Competition** For some interactions the impact is readily apparent; big fish feed on little fish and there are only so many little fish to go around. But other interactions are somewhat less obvious. Zebra mussels are filter feeders. This means they pump water over their gills and strain out the tiny animal and plant plankton. This is the food that young sport and commercial fish rely on once their yolk sac is absorbed and they begin to feed. If these young fish do not get enough to eat at this critical life stage, they quickly starve to death. Eurasian watermilfoil and water chestnut both form dense mats of plant material that choke out native plant life. These invasive species provide little nutritional value and can eliminate native fish species as a result.

- **Predation** The destructive feeding habits of the lamprey are well known. Each lamprey can kill as much as 40 pounds of fish during the parasitic phase of its life cycle. Lampreys do not usually feed on their host to the point that it kills them—they feed until they are satisfied or the fish becomes debilitated then they release prior to the death of the host. The host may be weakened by blood loss or succumb to infection of the wound, which may be the eventual cause of death or serious decline in health. The fish that do survive are left with unsightly scars.

Alewives are known predators on yellow perch larvae and may be a contributing factor in the declining number of yellow perch in certain parts of Lake Champlain.

- **Habitat modification** Zebra mussels affect the habitat fish live in. As zebra mussels feed they remove plant plankton from the water; this in turn causes the water to become clearer. This can have two effects: First, it can make larval fish more susceptible to predation by making them easier for predators to see. Second, light can penetrate deeper into the water column. Fish that prefer darker water such as smelt and walleye may seek deeper water to evade the penetrating rays of the sun. As the smelt move to deeper water, so do their salmonid predators. Thus, the clearing of the water by zebra mussels can affect the behavior and distribution of sport fish.

  The other effect of zebra mussels is on the lake bottom (*benthic*) habitat. As zebra mussels colonize the cobble and other hard substrate on the lake bottom, they can fill crevices and spaces between the rocks that formerly created feeding sites and shelter for small invertebrates, fish and fish eggs. The fouling and clogging of spawning substrate leaves eggs more vulnerable to predators.

Effects of Invasive Species

The consequence of these interactions is a shift in biomass from desirable, economically important species to species that may be neither desirable nor exploitable. Though the total mass of living tissue may remain relatively constant, there will be more lampreys or zebra mussels instead of lake trout or salmon. Rarely does an invasive species fill an "empty" ecological niche or exploit a new resource within an ecosystem. Each new species added to the system takes away forage or habitat from another. This may extend to the point of elimination of the original species but most often will result in the reduction of the abundance or physical condition of the original species.

Affects on humans

Aquatic nuisance species affect our lives in various ways. They impede recreational activities such as boating when aquatic plants such as watermilfoil and water chestnut grow in dense mats and impede navigation. Zebra mussels can be a nuisance when then colonize on rocks near swimming areas where the sharp edges of their shells often cut people's feet. They have also been notorious for congregating on and clogging drainage pipes and water lines.

Generally for us, users of the Lake Champlain resources, the greatest problem with invasive species is that they adversely affect the ways in which we use the ecosystem. We rely on stable ecosystems for recreational and commercial uses. Invasive species cause rapid and often undesirable changes in the features of the ecosystem we come to rely on for our own exploitation. Often we may be unaware of subtle ecosystem changes caused by invasive species. It is not until these alterations of food webs, recruitment and behavior affect the ways we use the natural resources of the lake do we become aware of or concerned about the invaders themselves or their effects. The effects we observe are fewer fish caught, and the fish we catch are thinner or not the species we desire.

PATHWAYS FOR INTRODUCTION

Economic interests drive urban and infrastructure development. Multiple transport mechanisms, such as interconnected waterways, move ANS into and around the Lake Champlain Basin. ANS move through the waterways by self-propulsion and/or with the aid of water currents, humans, fish and other animals.

Canals

The **Champlain Barge Canal** is a significant source of ANS entry into the Lake Champlain Basin. The Canal connects the southern end of Lake Champlain to the Hudson-Mohawk watershed, which in turn is connected to the Great Lakes drainage basin by the **Oswego-Erie Canal** System. The Canal has likely been responsible for the entry to the Basin of numerous ANS, including the zebra mussel, blueback herring, water chestnut, white perch, mud bythnia, and sea lamprey. The **Chambly Canal** and the **Richelieu River**, which flows out of the northern end of Lake Champlain and ultimately into the St. Lawrence River, have similar potential to move nonindigenous species into and out of the Lake Champlain Basin.

Tributaries

The **Connecticut River**, although not within the Lake Champlain Basin, is a significant source of entry for ANS into Vermont. Once ANS enter the state via the Connecticut River, the potential for their spread into the Lake Champlain Basin greatly increases. The **St. Lawrence River** is another potential pathway for exotic species to reach Lake Champlain, as it connects to the Great Lakes and the Atlantic Ocean.

Recreational boating

Recreational boating is another likely means of ANS introduction to the Lake Champlain Basin via boat movement through the interconnected waterways or by overland boat transport. Some species enter the boat's bilge system and live to be transported and pumped into other bodies of water. Other species can adhere to the boat's hull and be transported in the same manner.

Intentional stocking

Other activities that may contribute to the transport and dispersal of aquatic nuisance species in the Lake Champlain Basin include intentional stocking of fish species along with their associated (free-living and parasitic) organisms. The fish trade industry is a potential vector for the introduction of non-native species. While some introduced species may be beneficial, many have less desirable effects.

Release or escape

There are also contributions from the release or escape of organisms associated with pet industries (goldfish), pest management practices, bait handling, water transport, and ornamental/landscape practices. Live bait harvested from the wild can carry with it unwanted minnows or other fish species as well as fragments of invasive plants. Similarly, organisms released by well-meaning gardeners can potentially become nuisances once they become established.

EXOTICS AS ECOLOGICAL INDICATORS

Aquatic nuisance species provide signals about the integrity of natural terrestrial and aquatic systems. Their presence suggests that the surrounding habitat has undergone alteration or degradation. There are two specific global trends that consistently and strongly encourage invasions of aquatic nuisance species. They are **land-use changes** and **pathways to introduction**.

CONSISTENT TRENDS THAT PROMOTE INVASION

Land use

The following land-use changes such as **urbanization** and **agriculture** replace, fragment, and degrade natural systems.

- **Forests** In order to initiate these activities, natural forests are cut or burned. This promotes new growth where exotic species often are the first to take root.
- **Meadows** Meadows are often plowed or paved, burying native species and creating altered habitat that may be more suited to exotic species.
- **Wetlands** Many times wetlands are drained and filled with soil so that development can take place. This eliminates habitat for aquatic plants and animals, and allows potential exotic species to establish themselves in the newly created terrain.
- **Roads** Roads are often cut through wild ecosystems to allow for access and transport of building materials. This creates what is called an "edge effect", where previously dense forest habitat is now exposed to wind, sun, and increased moisture. New species that favor these conditions will establish themselves here, while native species will regress away from these areas.
- **Riparian zones** Urbanization and agriculture may also require the removal of shoreline vegetation and the destruction of riparian zones where many native species thrive. Once this habitat is altered, native species may no longer thrive here, leaving an open niche for exotic species to fill.

Increased pathways

Another way to encourage invasions by exotic species is with the increase in the number of pathways that promote species movement into a new area.

- **Worldwide trade** One such vector is the growth in worldwide trade. With this, the remotest regions of the world are connected to global markets by truck, train, ship and airplane.
- **Aquaculture and horticulture** Exotic species of fish and plants are often imported either by accident when attached to other goods, or intentionally for use in aquaculture or horticulture.
- **Deliberate stocking** Certain individuals take the initiative to deliberately stock non-native fishes into rivers and lakes in order to benefit the fishing community.
- **Live bait** Other activities are not deliberate, but still manage to introduce native species into a waterbody, such as when fishermen dump live bait into waterways after a day of angling.
- **Boat trailers** Another example of this is the trailering of boats from one waterway to another. Upon doing so, exotic species may cling to the sides of the vessel or remain in the bilge water, only to be released into a new body of water upon arrival.
- **Restoration** Some pathways to introduction may come with good intentions, such as the use of exotic plants in marsh restoration projects. Although these activities may suit the need at the time, some of these species may become uncontrollable once they establish themselves within a community, and compete with native vegetation or wildlife.

LESS CONSISTENT TRENDS THAT PROMOTE INVASION

Global temperature changes

- Changes associated with global warming/cooling may affect the water temperature of lakes and rivers which may favor exotic species over natives.
- Temperature changes may cause shifts in primary productivity that alter water quality and food webs and in turn affect native species.
- Temperature changes may either extend or shorten the length of reproductive stages or growing seasons which in turn affects the population of that species.
- Some temperature changes may lead certain species to expand their habitat range, which causes them to encroach and compete with another species habitat.

Large scale disturbances

- An increase in the frequency of large scale disturbances such as fire promote the invasion of exotic species.
- Disturbances open habitat niches for colonization by non-native plant life.
- Exotic plant life can enhance fire by altering the amount, distribution, and rate of accumulation of fuel.

- **Carbon dioxide** Rising levels of atmospheric carbon dioxide promote the increase of certain exotic species. Some non-native plants have been shown to respond well to increases in carbon dioxide levels.
- **Nitrogen** Heavy nitrogen deposition resulting from air pollution and fertilizer use may cause exotic species of plants or animals to thrive, while harming native species accustomed to normal amounts of nitrogen.

- **Rainfall** Potential rainfall changes may harm native species that require certain amounts of moisture, while benefiting exotic species that thrive under the changing conditions.

MANAGEMENT OF AQUATIC NUISANCE SPECIES

Plants

- **Purple loosestrife** Over the last 50 years many efforts have been made to control and limit the spread of purple loosestrife including burning, mowing, hand-pulling, water level manipulation, chemical application and biological control. Because of the enormous numbers of seeds and root and stem replication, the purple loosestrife plant is very difficult to eradicate and to control to an acceptable degree. Mowing and burning are not permanent controls; damaged stands can quickly regenerate. Water level manipulation may alter the natural community composition and threaten some desirable or native species. Hand pulling is effective in small infestations, but care must be taken to remove the perennial rootstock as well as the plants. It is easiest to remove young plants from moist soil. Plants should be pulled prior to seed production in the early summer, then dried and burned. Chemical application has demonstrated high control effectiveness. However, most chemicals are not target-plant specific, and the effects of herbicides on ecosystems are harmful and not fully understood.

  Five thousand dollars were spent by the United States Fish and Wildlife Service (USFWS) each year between 1986 and 1991 on chemical controls for purple loostrife in the Missisquoi National Wildlife Refuge on the northeast end of Lake Champlain. An additional $30,000 has been spent since 1996 in an ongoing effort to control purple loosestrife throughout Vermont with leaf-eating beetles (*Galerucella pusilla* and *Galerucella calmariensis*) (website: northeastans.org). Control with leaf-eating beetles may be able to reduce purple loosestrife density by about 90%. Also, once the beetle populations are established, the beetles will continue to control loosestrife on a long-term self-sustaining basis. The cost after release is relatively minimum (Wu, 2003).

- **Eurasian watermilfoil** Detailed watermilfoil studies have been conducted for many of Lake Champlain's bays and for 35 other lakes within the Basin, but many areas have little or no study regarding the presence and extent of infestation. Because Eurasian watermilfoil is spread by plant fragments transported by waves, wind, currents, people, and to some extent, animals, it is not easily controlled.

Control mechanisms that have been employed in the Basin include mechanical harvesting, diver-operated suction harvesting, hydro-raking, installation of bottom barriers, lake level drawdown, fragment barriers, handpulling, and biological control using a species of aquatic weevil.

Since 1982, more than $3 million of federal, state, and local funds (excluding salaries and administrative costs) and thousands of volunteer hours have been spent to control Eurasian watermilfoil populations in the state of Vermont alone.

➲ **Water Chestnut** While there has not been a detailed survey of the extent of water chestnut in the Lake Champlain Basin, populations are established between Whitehall, New York and Ferrisburgh, Vermont, and in a few other waterbodies in the Basin. The most extensive infestations are limited to southern Lake Champlain; several hundred acres are estimated to be infested. Despite mechanical harvesting and handpulling of water chestnut since 1982 on Lake Champlain, budget constraints in recent years have prevented effective management of the plant. Water chestnut management on Lake Champlain between 1982 and 1998 has involved hundreds of volunteer hours and more than $2.7 million in state and federal funds.

Animals

➲ **Sea lamprey** Efforts to reduce sea lamprey populations in the Lake as part of an experimental control program were initiated in 1990, and a long-term plan to manage sea lamprey in the Lake is needed. Control strategies currently include the use of the lampricides 3-trifluoromethyl-4-nitrophenol (TFM) in 13 streams and Bayer 73 on five tributary deltas. In addition, the installation of physical controls or low head barrier dams, including those on Lewis Creek in Vermont, and the Boquet and Great Chazy Rivers in New York, may alleviate the need for chemical lamprey treatment in all or portions of certain tributaries. It was found that the experimental control program successfully reduced sea lamprey parasitism in Lake Champlain. As a result of this program, total lake trout catch was increased since 1990 by 76%; of those 42% were longer than 25 inches in length. The application of treatments to selected tributaries and deltas has continued recently in order to maintain some of the gains seen during the experimental program. This is a temporary measure until long-range policies and sea lamprey management strategies are approved. The lamprey treatment program is a joint project among the Vermont Fish and Wildlife Department, New York State Department of Environmental Conservation, and the US Fish and Wildlife Service. Expenditures on control measures to reduce the populations of sea lamprey in Lake Champlain have been approximately $320,000 per year between 1990-1997. The total costs incurred for sea lamprey controls in Lake Champlain have exceeded $9 million.

➲ **Zebra mussel** Because no effective zebra mussel control methods exist, education efforts are focused on reducing and slowing their spread to other lakes. Management actions have focused on controlling the mussels' attachment to surfaces and water intake pipes and on preventing further spread. The Vermont state fish culture station in Grand Isle, Vermont has spent more than $3 million on the design and installation of zebra mussel control mechanisms. Municipal water facilities and industrial facilities that draw water from Lake Champlain have spent in excess of $2 million on cleaning, monitoring and controlling zebra mussels. The impacts of zebra mussel infestations on the ecosystem and underwater cultural articfacts are also not well understood, but ongoing worldwide research may offer some understanding of possible effects.

- **Alewife** Current efforts are being made to contain the alewife population to its small current range within the Basin. Management alternatives are currently being reviewed by the Vermont Dept. of Fish & Wildlife and the U.S. Fish & Wildlife Service should the alewife population suddenly increase.

Stop the spread

Stopping the spread of non-native invasive species needs to be a joint effort—each of us must take the responsibility to modify our behavior with the intention of protecting the ecosystem. Make it a habit to drain water from the live well, bait well, motor and bilge areas of your boat before you leave the ramp at the end of the day. Clean weeds of the trailer, motor, anchor or other areas where they may become tangled. Dispose of live bait in the trash—do not release it into the water. Finally, wash your boat with hot water (105° F) or let it dry for five days before going to another water body.

Prevention is the key to preserving our resources for generations to come. Share your knowledge with others and help them take the necessary steps so we can preserve our Lake Champlain future together.

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