

OFFICER SNOOK'S **EVASIVE INVASIVES**



**AN INTRODUCTION TO
INVASIVE AND AQUATIC NUISANCE SPECIES**

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SPONSOR LETTER

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National Standards

This book conforms to the following national education standards:

National Middle School Standards Grades 5-8

Content Standard C – Life Science

- Regulation and Behavior (P. 4)
- Populations and Ecosystems (P. 4, 10, 12)
- Diversity and Adaptations (P. 8)

Content Standard F – Science in Personal and Social Perspectives

- Populations, Resources, and Environments (P. 6)
- Risks and Benefits (P. 6)
- Natural Hazards (P. 6)
- Science and Technology in Society (P. 14)
- Science as a Human Endeavor (P. 14)

National High School Standards Grades 9-12

Content Standard C – Life Science

- Interdependence of Organisms (P. 4, 6, 10, 12)
- Matter Energy and Organization in Living Systems (P. 4, 6, 10, 12)
- Behavior of Organisms (P. 6, 10, 12)

Content Standard F – Science in Personal and Social Perspectives

- Population Growth (P. 6, 10, 12)
- Environmental Quality (P. 6, 8, 14)
- Natural and Human-Induced Hazards (P. 6, 8, 12)
- Science Technology in Local, National and Global Challenges (P. 12)

For a complete list of national education standards and their definitions this book conforms too, please contact the Officer Snook Water Pollution Program at: officersnook@aol.com.

INTRODUCTION

Hi! My name is Officer Snook. My mission is to prevent water pollution around the world. Since 1994, I have been helping the United States Coast Guard educate people about the serious impacts water pollution has on the environment and our lives.



Water pollution is the act or process in which a change in a water environment causes harm to living organisms or makes water unfit for one or more uses. Water pollution can be chemical, physical or biological in nature, and can harm water environments in a variety of ways. Some well-known effects of water pollution include the following:

- surface and groundwater contamination
- habitat modification and destruction
- harm to or death of plants, animals and humans
- loss of important fresh drinking water supplies

Keep in mind, however, that the effects of pollution on the environment can be complex. For example, pollution from one source can weaken an ecosystem's ability to fight off harm from other types of pollution. Similar to how a virus impacts your immune system, when an ecosystem's health is weakened, it becomes more vulnerable to harm from outside influences, such as invasive species.

As part of my overall effort to prevent all types of water pollution, I created this book to help you learn more about invasive species and, in particular, Aquatic Nuisance Species (ANS). ANS are invasive species of plants and animals that produce harmful effects on aquatic and marine ecosystems and on human uses of water-related resources. ANS are considered a form of water pollution because of their negative impacts on water ecosystems.

Humans are the number one cause of water pollution, but you can also prevent pollution from occurring. By being conscious of your actions and their effects on water ecosystems, you can live in better harmony with the environment.

It is my hope that by understanding more about invasive species and their effects on the environment and your life, you will help protect our fragile ecosystems and prevent water pollution. Remember...

YOU ARE THE SOLUTION.
HELP OFFICER SNOOK STOP WATER POLLUTION!

WHAT IS AN INVASIVE SPECIES?

An ecosystem is a community where plants and animals interact with each other in a supportive way. There are many different types of ecosystems around the world. When plants and animals are in their native ecosystems, they are part of the natural food web and are a beneficial part of their surroundings. Their populations and ranges are controlled by natural predators, native diseases, geographic boundaries and competition for food.

Sometimes, however, plants or animals move out of their native geographic ranges and into new areas, often because of human interaction. When this happens, a plant or animal is considered to be an “alien” species. Many alien species are not necessarily harmful to their non-native environments and, in fact, can be beneficial to people. Corn, wheat and rice are examples of alien species introduced into North America that have benefited people. However, when an alien species becomes harmful to an ecosystem where it is not native, it is called “invasive.”

Invasive species, also known as exotic species, can be plants, animals and even disease-causing microbes. They are classified as biological pollutants because they are living organisms that disturb the ecological balance of the environment. Like other forms of pollution, biological pollutants can have devastating impacts on the environment. However, unlike other pollutants, the impacts of biological pollutants often increase over time, even after introduction sources have been eliminated. This is because once established, biological pollutants have the ability to multiply and spread.

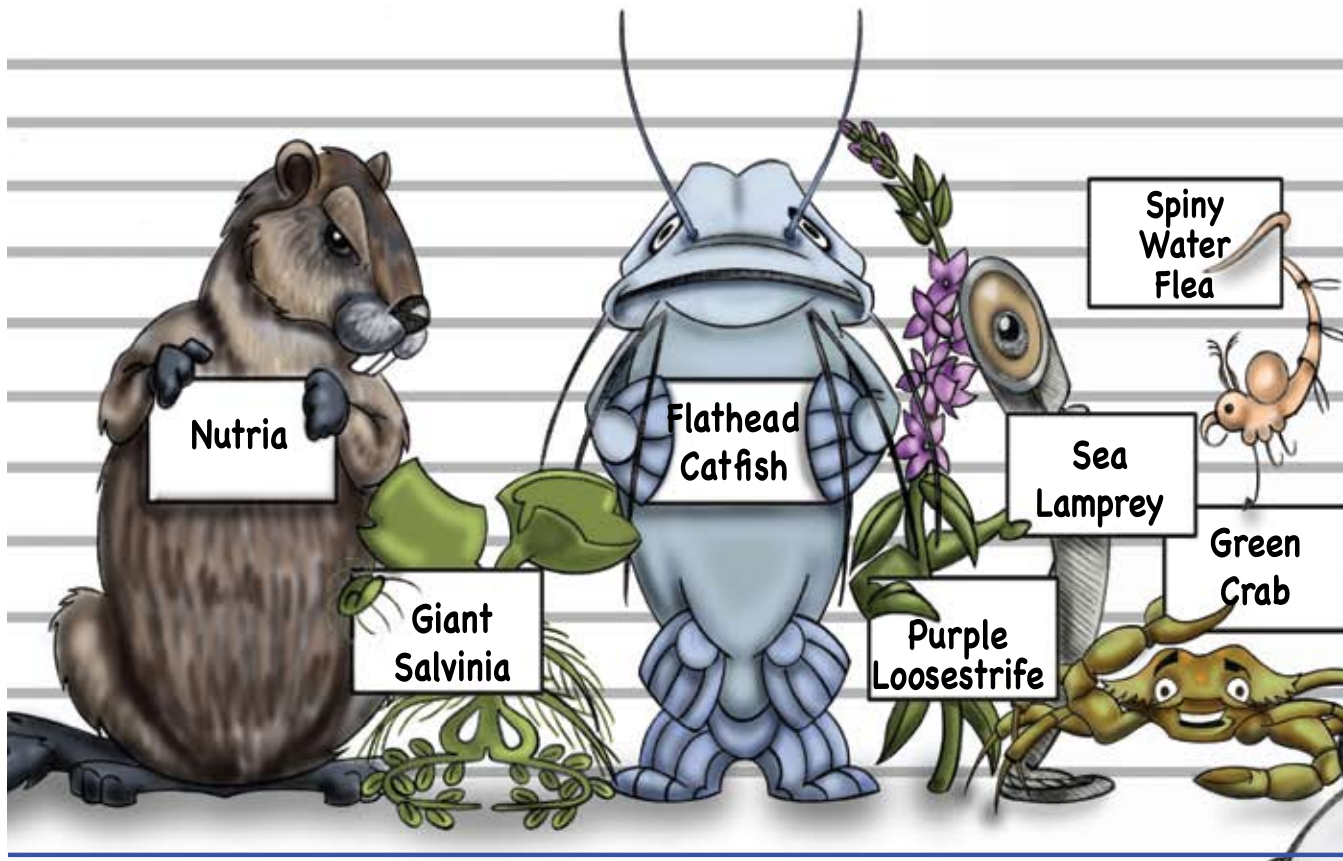
There are over 4,500 species of invasive plants and animals known to have established populations in the United States. Each year, this number grows. Many are Aquatic Nuisance Species (ANS), impacting aquatic or marine environments. While some invasive species have had only minor impacts on their surroundings, others have had widespread and devastating effects.

The official definition of an invasive species in the United States is outlined in Executive Order 13112, which was signed by President Clinton in 1999. The Order defines an invasive species as “an alien species whose introduction does or is likely to cause economic or environmental harm, or harm to human health.”



QUESTION TO THINK ABOUT: What local law enforcement agency or agencies are responsible for the prevention and management of invasive species in your area? If you happened to find an invasive species, what phone number(s) can you call to report it?

WHAT IS AN INVASIVE SPECIES?



Invasive species are biological pollutants. What other types of pollution are impacting water bodies in your area? What are the sources of these pollutants and how can they be prevented?



HOW INVASIVES MOVE AROUND

Like other forms of water pollution, the vast majority of invasive species enter, or are introduced into, non-native ecosystems through human actions. People have aided the movement of invasive species from one habitat to another throughout human history, both intentionally and accidentally.

Over the years, advances in technology have allowed humans to move themselves and their goods more quickly, more frequently and farther to more destinations around the world than ever before. This has also allowed a greater number of invasive species to move into new areas as well. As globalization and international trade continue to increase, so too will the number of invasive species introductions.

Studies conducted by the Smithsonian Environmental Research Center show that the number of ANS entering the United States has increased dramatically in recent years (Ruiz, et al. 2003). San Francisco Bay, for example, had 117 alien species introduced over a period of 109 years from 1851 to 1960. However, from 1960 to 1995, a period of only 35 years, an additional 117 species were introduced. Alien species now make up over 90% of the species found in San Francisco Bay (Pimentel, D. 2003).

While some invasive species are introduced into an ecosystem on purpose, many enter by accident. Transport of invasive species can occur by land, air and water. Common vectors or means of transportation include automobiles, trains, airplanes and boats. Often, an invasive species will “hitch a ride” on one of these vectors without anyone knowing it.

Boats are considered the primary vector for the transportation and introduction of Aquatic Nuisance Species (Smith, 2002). Many ANS are transported by ships in their ballast water. Ballast water is water stored in the hull of a large ship to help maintain its balance, stability and maneuverability. Ships typically take in ballast water in one part of the world and release it in another. By doing this, they unwittingly transport and release ANS. In addition to ballast water transfer, “fouling organisms” such as barnacles, seaweeds and mussels can move from one location to another by attaching themselves to the hull or anchor of a boat.



Regardless of how invasive species enter an ecosystem, once established in an area, their effects can be devastating. The next section explains more about some of the impacts ANS can have.

QUESTION TO THINK ABOUT: In general, if an invasive species is introduced into an area on purpose, is it more or less likely to cause harm to the environment than one that is introduced by accident? Explain why or why not.

VECTORS

AIR



SEA



LAND



IMPACTS OF INVASIVE SPECIES

When invasive species become established in an ecosystem, serious problems can occur. Invasive species are capable of causing severe and sometimes irreversible environmental damage, substantial economic losses, and can even have significant impacts on human health, safety and quality of life.

Economic Impacts

It is estimated that invasive species cost Americans over \$137 billion each year (Pimental et al 2001). Of this figure, approximately \$9 billion annually is attributed to ANS. Industries such as commercial and recreational fishing, tourism, recreational boating, shipping, agriculture, aquaculture and drinking water production have all been negatively impacted by ANS. Costs associated with repairing damage to infrastructure and managing and controlling ANS are growing rapidly. This has put a strain on many state and local budgets. Billions of dollars have already been spent in areas such as the Great Lakes and San Francisco Bay alone.

Ecological Impacts

Invasive species also cause severe ecological damage. They degrade habitat quality, threaten biodiversity and disrupt entire ecosystems. Invasive species pose a serious threat to the survival of native species of plants and animals. Approximately 42% of endangered species in the United States are at risk of extinction primarily because of impacts from invasive species (Wilcove, et al 1998). Impacts include predation, parasitism and competition for the same habitat, nesting sites and food sources. In fact, impacts from invasive species are thought to have caused or contributed to more than 70% of native North American freshwater species' extinctions during the 20th Century (Williams et al 1989).

Human Impacts

Besides causing economic problems, invasive species can harm humans in other ways as well. For example, they can increase health risks by spreading or introducing diseases. Outbreaks of diseases such as cholera have been directly attributed to Aquatic Nuisance Species. ANS can also cause life-safety issues. There have been documented cases of people drowning in canals, rivers, and lakes due to entanglement in invasive aquatic plants. ANS and other invasive species can even alter entire landscapes and ecosystems, resulting in an increased risk of damage from natural disasters such as hurricanes and wildfires.



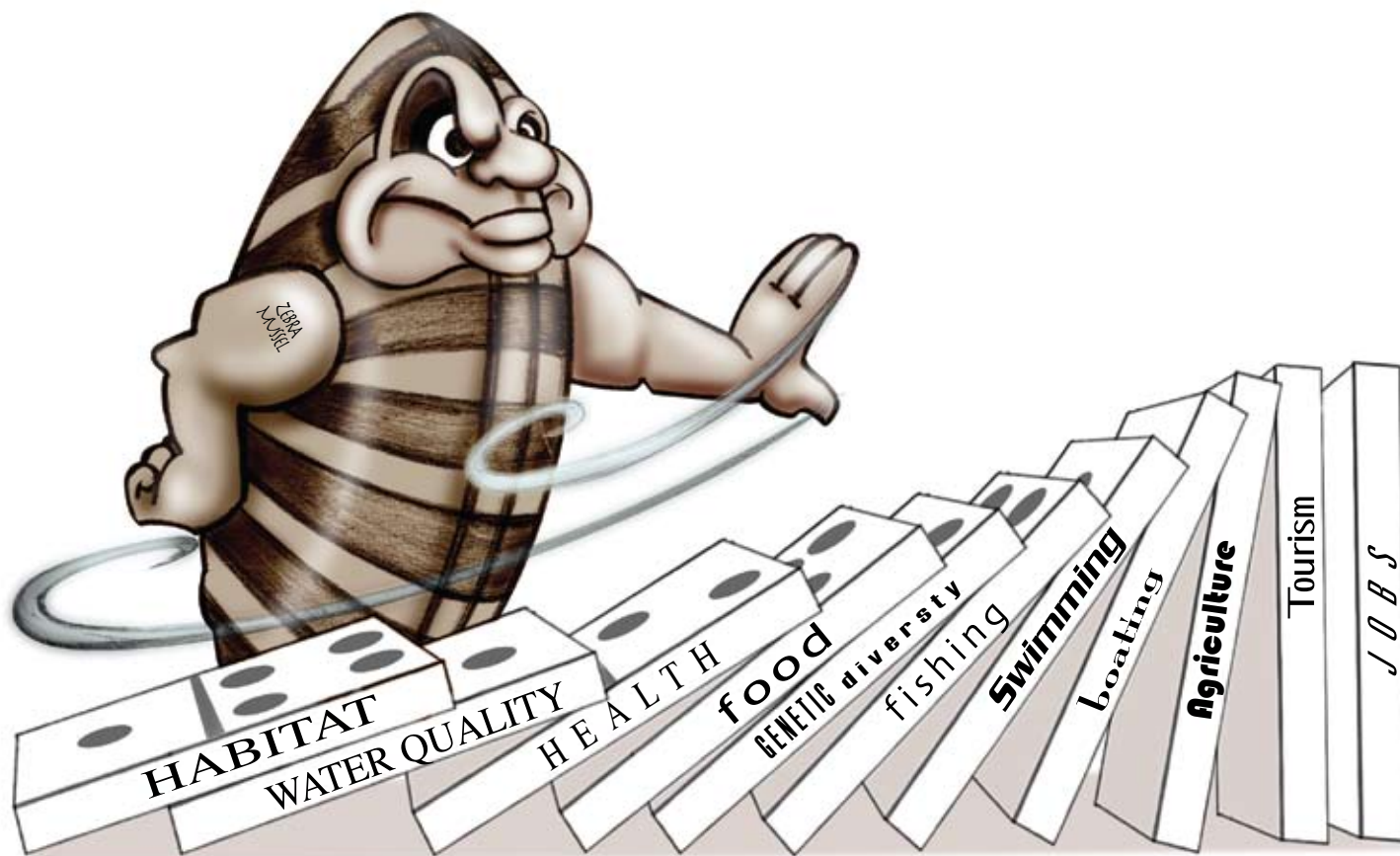
The next two sections provide some examples of ANS that have become major problems in the United States.

QUESTION TO THINK ABOUT: Suppose you were president of the U.S. and there were no invasive species in the country. You would have an extra \$137 billion in your annual budget. What would you use the money for? Think about what the needs of the country are. How could that money best be spent?

ECONOMIC IMPACTS OF ANS

ANNUAL COST OF ANS IN THE U.S. (Source: D. Pimental, 2003)

ANS	Cost per year
Fish	\$5.4 billion
Zebra/Quagga Mussels	\$1 billion
Asiatic Clam	\$1 billion
West Nile Virus	\$1 billion
Aquatic plants	\$500 million
Shipworm	\$205 million
Green Crab	\$100 million
Purple Loosestrife	\$45 million



AQUATIC NUISANCE PLANTS

If plants live, grow or reproduce in water, they are considered aquatic plants. Aquatic plants are vital to ecosystems because they protect shorelines from erosion, act as natural filters against pollution, and provide oxygen, food, shelter and habitat for wildlife. There are three types of aquatic plants:

1. Floating plants have no attached roots and float on the water's surface.
2. Emergent plants have roots attached to soil and grow partially in and out of water.
3. Submerged plants live and grow completely underwater.

Aquatic nuisance plants are often referred to as invasive weeds. They typically grow and spread quickly and can become devastating to a waterway within a short period of time. Invasive weeds can block navigation channels and interfere with flood control. They can hinder recreational activities such as boating, fishing and swimming, and their presence can affect local tourism and property values. They also clog water and irrigation pipes and provide areas for mosquitoes to live in and breed. Invasive weeds have become a major problem in many areas of the United States. Here are a few examples:

Water Hyacinth (*Eichhornia crassipes*)

The water hyacinth is a floating plant native to South America. It was first introduced to Florida and Louisiana in the late 1880s as a decorative plant. Since then, it has become widespread in many waterways throughout the southeastern United States, California and Hawaii. The water hyacinth can displace native plants, block sunlight needed for photosynthesis, and reduce the amount of oxygen in the water, resulting in the death of native fish and plants. It also affects recreational and commercial activities by forming thick mats of vegetation that obstruct waterways, clog irrigation pipes and poses a safety hazard.

Purple Loosestrife (*Lythrum salicaria*)

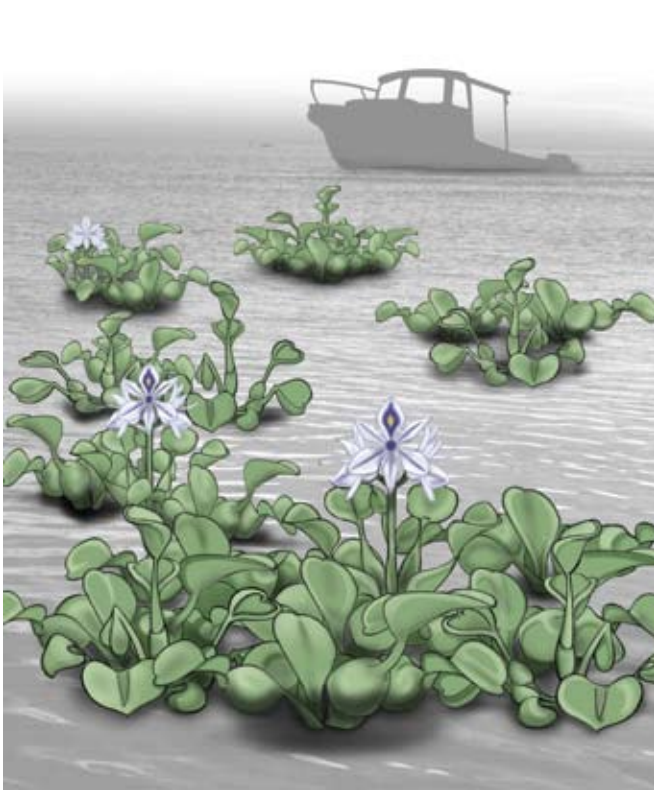
Nicknamed the “marsh monster,” the purple loosestrife is an emergent plant native to Eurasia. It was first introduced in the United States about 200 years ago, and has since spread to almost every state. The purple loosestrife is highly competitive and aggressive. A single plant can produce over 300,000 seeds. Purple loosestrife causes tremendous damage to wetland areas it colonizes by “crowding out” native plants. As purple loosestrife has almost no value to native wildlife as a source of food or shelter, this results in a loss of valuable wildlife habitat and eventual failure of the entire ecosystem.

Hydrilla (*Hydrilla verticillata*)

Hydrilla is a submerged plant native to Africa that was originally brought into the United States for use in aquariums. Hydrilla was first observed in Florida in 1960, and has since spread throughout the southern, mid Atlantic and western regions of the United States. Hydrilla can thrive in a variety of environmental conditions, including freezing temperatures, low light levels, drought, and in waters with extremely high or low amounts of nutrients. The plant is easily spread from one water body to another, often by boaters and fishermen who unknowingly transport small fragments of the plant on their boats, trailers or fishing equipment. Hydrilla form large, dense populations which can displace native plants, restrict water flow and “choke” waterways, preventing commercial and recreational opportunities.

QUESTION TO PONDER: What is the most destructive invasive plant species in your area? If this species were eliminated, how do you think the environment and your community as a whole would benefit? Explain your reasoning.

AQUATIC NUISANCE PLANTS



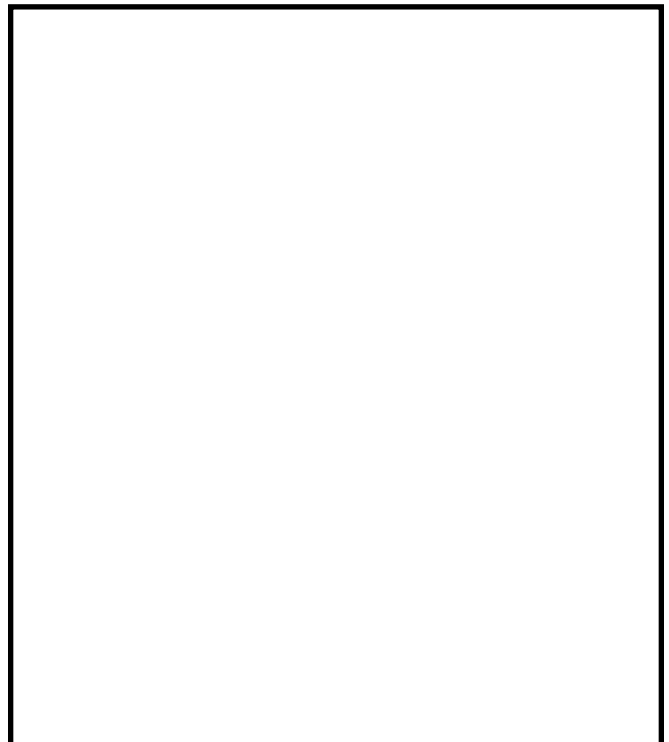
Water Hyacinth (*Eichhornia crassipes*)



Purple Loosestrife (*Lythrum salicaria*)



Hydrilla (*Hydrilla verticillata*)



Draw the most destructive invasive plant species in your area.

AQUATIC NUISANCE ANIMALS

The introduction of aquatic nuisance animals, also called aquatic invasive animals, can have devastating consequences on the environment as well. There are many types of aquatic nuisance animal species, including amphibians, crustaceans, fish, mammals, reptiles and mollusks.

Aquatic invasive animals affect native species primarily through predation, parasitism, competition (for food, habitat, etc.), introduction and transmittal of diseases, habitat destruction, and alteration of genetic diversity. Impacts often result in a significant decrease in native species' populations, and even extinction. However, effects can be felt on a greater scale. Entire ecosystems can be disrupted or destroyed, and humans can be directly impacted as well. The following are a few examples of aquatic nuisance animals that have caused serious problems in the United States.

Zebra Mussel – *Dreissena polymorpha*

Zebra mussels are thumbnail-size mussels native to the Caspian Sea region of Asia. They were first discovered in North America in Lake St. Clair in 1988, most likely having been transported by ballast water. Since then, the mussel has spread throughout the Great Lakes, the Mississippi River basin and beyond. Zebra mussels reproduce and spread rapidly. A single female mussel can produce as many as one million eggs each year. Once established, zebra mussels can have a major ecological impact on an aquatic environment. By feeding on important microscopic food sources such as phytoplankton and eliminating native mussel species, zebra mussels alter entire aquatic ecosystems. They can attach themselves to almost anything and are notorious for clogging water intake pipes used by utilities and farmers. It is estimated that zebra mussels alone cost taxpayers over \$1 billion a year in damages and mitigation control (Pimental, et al 2003).

European Green Crab – *Carcinus maenas*

The European Green Crab is a saltwater crab that has become one of the most damaging aquatic nuisance animals along both coasts of the United States. Native to the Baltic and North seas in Europe, the crab was first introduced along the Atlantic coast of the United States in the mid 1800s. In 1990, the crab established a population in San Francisco Bay and has since spread along the Pacific coast from Monterey Bay, California, north into Canada. Green crabs prey on native species of mollusks, crustaceans, fish and worms. Green crabs have been responsible for reducing populations of native species by more than 90% in some areas (Grosholz, et al 2000). Green crabs cost the commercial fishing industry an estimated \$44 million per year in economic losses (Lafferty, et al. 1996).

Eurasian Ruffe – *Gymnocephalus cernuus*

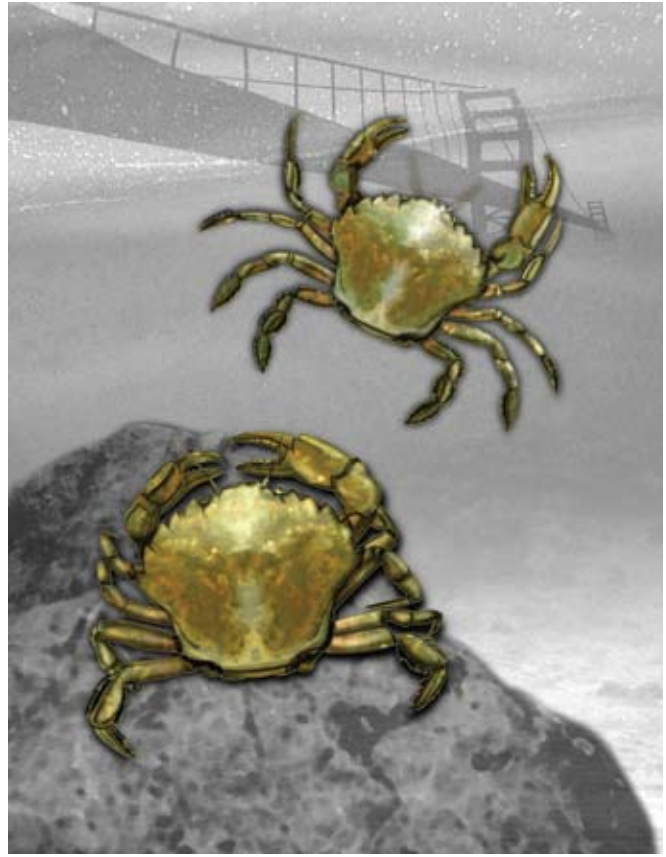
The Eurasian ruffe, designated an aquatic nuisance species in 1992, is a small freshwater fish that is a member of the perch family. Transported from eastern Europe in the ballast water of ships, the ruffe was first introduced into Lake Superior in the mid 1980s. Since then, the ruffe has spread into parts of Lake Huron, Lake Michigan and the St. Louis River as well. The Eurasian ruffe reproduces and grows rapidly. It is an aggressive and voracious eater, threatening commercially important species such as walleye, shiners and native perch.

QUESTION TO PONDER: Which types of ANS are able to spread more quickly between water bodies – invasive plants or invasive animals? Explain your answer and provide some examples to back your reasoning.

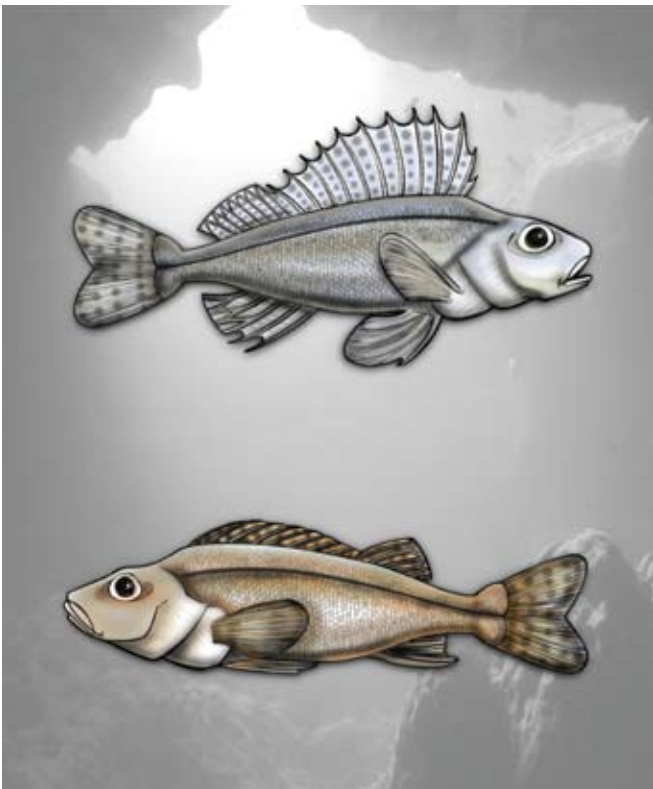
AQUATIC NUISANCE ANIMALS



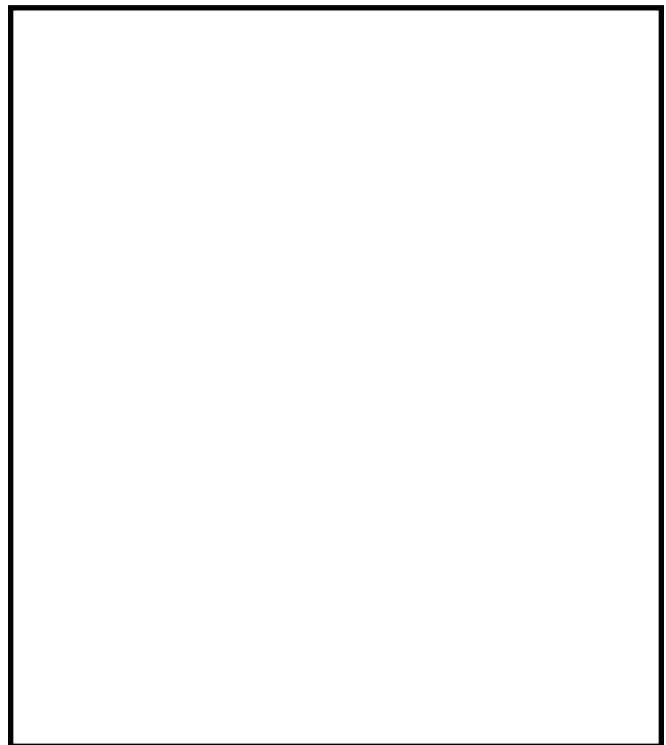
Zebra Mussel – *Dreissena polymorpha*



European Green Crab – *Carcinus maenas*



Eurasian Ruffe – *Gymnocephalus cernuus*



Draw the most destructive aquatic invasive animal in your area.



SOLUTIONS – HOW YOU CAN HELP!

The only real way to stop an invasive species from causing harm is to prevent it from entering the environment in the first place. This is because once established, invasive species are almost impossible to eradicate. Managing their impacts and controlling their spread then become the best options.

To help prevent the introduction and spread of invasive species, laws have been passed at federal, state and local levels. For example, because many ANS are introduced through ballast water transfer, the U.S. Coast Guard in 2004 initiated a mandatory ballast water management program for all ships entering U.S. waters (source: U.S. Coast Guard). Large penalties are given to ships that do not comply. But no matter how many laws are passed, it is up to individuals such as you to prevent the introduction and spread of invasive species. Here are some ways you can help:

In General:

- Don't release exotic pets or plants into the environment.
- Buy and plant only native trees and plants.
- Learn to identify invasive species in your area and report sightings to the proper authorities.
- Inspect, clean and dry all equipment used in water-related activities after each use.
- Prevent and help clean up pollution on land and in the water.
- Obey all related laws and educate others about the negative impacts of invasive species.

Recreational water users play a key role in preventing the spread of aquatic nuisance species. Some tips to remember the next time you're out on the water include the following:

Scuba Divers and Snorkelers:

- Inspect your equipment and remove any plants, mud or animals before leaving the water.
- Drain water while at the dive site from buoyancy compensators, regulators, tank boots and any other equipment that may hold water.
- Wash your suit and all equipment in hot water (at least 104° F) and dry completely.

Waterfowl Hunters:

- Use elliptical, bulb-shaped or strap anchors on decoys.
- Inspect and clean decoy lines and anchors as you bring them on board.
- Thoroughly clean clothes and all equipment before using again.

Fishermen:

- Know and observe all live bait collection laws in your area.
- Never release live bait into a different body of water.
- Thoroughly wash and dry all fishing tackle, buckets, nets, waders, etc. after each use.
- Report any alien species that you see or catch to the proper authorities.

QUESTION TO PONDER: Which would you rather create – a program to prevent the initial introduction of an invasive species in your area or a program to manage the impact and spread of an already-established invasive species? Explain which program would be more effective in your area and why.

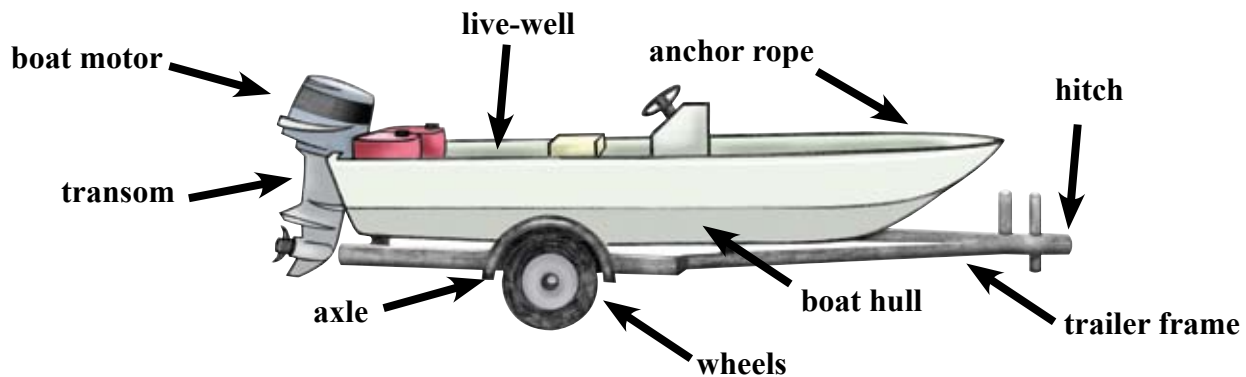
TIPS FOR BOATERS

ANS often spread between waterways by “hitching” a ride on boats and boat trailers. Because of this, it is important for boaters to take extra care and properly clean their boats after each use. Here are some tips for boaters to follow:

Recreational Boaters

- Spray your boat and trailer with high-pressure water and then rinse with hot water after each use.
- Drain and flush the motor, live well, bilge and transom wells with hot water.
- Remove all visible vegetation from your boat, propeller, anchor, trailer and any other equipment that was in the water.
- Dry your boat and equipment for at least 5 days before entering another body of water.

Some places where Aquatic Nuisance Species can hide and hitchhike to new waters:



Personal Watercraft (Jet Ski-drive systems)



In addition to the instructions above, people who use personal watercraft with jet-drive systems (such as Jet Skis) should also:

- Avoid running your engine through aquatic plants when on the water.
- Push or winch the watercraft onto the trailer when leaving the water.
- Once on the trailer, run the engine for five to ten seconds to blow out excess water which may contain ANS.
- Carefully inspect the engine and steering nozzle for fragments of aquatic plants or other ANS. Be sure the motor is turned off first!

SOME HELPFUL WEBSITES

USDA's National Invasive Species Information Center

www.invasivespeciesinfo.gov.

U.S. Federal Aquatic Nuisance Species Task Force

www.anstaskforce.gov/default.php

NOAA's National Center for Research on Aquatic Invasive Species

www.glerl.noaa.gov/res/Programs/ncrais/

US EPA Great Lakes Invasive Species Home Page

www.epa.gov/glnpo/invasive/

REFERENCES

- (1) Ruiz, GM and JT Carlton. 2003. Invasion vectors: a conceptual framework for management. In: *Invasive Species: Vectors and Management Strategies*, pp. 457-504. Island Press, Washington.
- (2)-(4) Pimental, D. 2003. Economic and Ecological Costs Associated with Aquatic Invasive Species, Cornell University. *Proceedings of the Aquatic Invaders of the Delaware Estuary Symposium*, Malvern, Pennsylvania, May 20, 2003, pp. 3-5.
- (3) Smith, Dr. L. David, 2002. Written testimony of Dr. L. David Smith, Assistant Professor, Department of Biological Sciences and Environmental Science and Policy Program, Smith College, Northampton, MA 01063. Presented to U.S. House of Representatives Subcommittee on Environment, Technology & Standards, Washington D.C., June 20, 2002. Available: www.house.gov/science/hearings/ets02/jun20/smith.htm.
- (5) Wilcove, et al. 1998. Quantifying threats to imperiled species in the United States. *BioScience* 48(8): 607-615.
- (6) Williams et al. 1989. Fishes of North America Endangered, Threatened, or of Special Concern. *Fisheries* 14: 2-20.
- (7) Pimental et al. 2001. Environmental and economic cost of nonindigenous species in the United States. *BioScience* 50: 53-56.
- (8) Grosholz et al. 2000. The impacts of a nonindigenous marine predator in a California bay. *Ecology* 81: 1206-1224.
- (9) Lafferty et al. 1996. Biological control of marine pests. *Ecology* 77: 1989-2000.
- (10) U.S. Coast Guard. April 2005. *Sea Partners Campaign Train-the-Trainer Guide*. 30-40.

To learn more about invasive species and what you can do to help, visit the National Invasive Species Information Center website at: www.invasivespeciesinfo.gov.

BACK COVER

SPONSOR LOGO