

## Musical Mussels: An Invasive Species Simulation Game

Developed for BEAN by the Royal Botanical Gardens

### ACTIVITY DESCRIPTION:

Invasive species disturb or degrade ecological functions, displace native species, and often their population explodes because there are few to no biological controls in place, and native species are not adapted to compete effectively with them. In the decades since zebra mussels were introduced to Ontario, they have caused widespread ecological destruction and municipalities have spent millions of dollars trying to control their spread.

This lesson plan includes two activities for students in grade four, six, and seven. Through a matching exercise, students evaluate species' similarities and differences, categorizing species as either native, introduced/non-invasive, and invasive. Students will then role-play lake animals in a version of musical chairs to discover how and why zebra mussels are spreading through the Great Lakes and how the zebra mussels are causing increased competition for resources.

## ACTIVITY 1:

### Materials Needed:

- Resource Sheets 1-3, sorted by category: native, introduced/non-invasive, and invasive.

### TIME NEEDED:

- 15 minutes

## ACTIVITY 2:

### Materials Needed:

- 10 chairs
- Mussels Resource Sheets 1 and 2
- Sheet(s) of mailing labels
- 2 predator labels
- Music

### TIME NEEDED:

- 30-45 minutes

## CURRICULUM CONNECTIONS:

### Grade 4 – Understanding Life Systems: Habitats and Communities

- 1.2 identify reasons for the depletion or extinction of a plant or animal species, evaluate the impacts on the rest of the natural community, and propose possible actions for preventing such depletions or extinctions from happening
- 3.3 identify factors that affect the ability of plants and animals to survive in a specific habitat

## BACKGROUND:

Native species are those that evolved within the ecosystems where they are found. They are generally in balance with their neighbours and there are natural controls, often predators or parasites, which limit population growth.

Introduced species are those that are brought into an area, either on purpose or accidentally, by people. Introduced species can be either non-invasive, or invasive. Non-invasive species are introduced species that either do not appear at all in native ecosystems, or if they do, they fit fairly well into the natural system without major disturbance to native species, and may even contribute to ecological functions. Invasive species, on the other hand, definitely do not fit. They disturb or degrade ecological functions, displace native species, and often their population explodes because there are few to no biological controls in place, and native species are not adapted to compete effectively with them.

Zebra mussels are thought to have been brought over from Europe in 1986 in a freighter's ballast water. The small (1 to 5 cm) mussel was introduced to the Great Lakes when that ballast was pumped out into Lake St. Clair. By June of 1990, they had spread throughout Lake St. Clair, Lake Erie and the western end of Lake Ontario. All of the Great Lakes have now reported at least scattered concentrations of zebra mussels, usually in port areas. They will colonize practically any surface including other clams (smothering them), other zebra mussels (not smothering themselves) and even crayfish. By growing on themselves, they can even extend out over soft, muddy bottoms up to a metre from the nearest hard surface.

There are several reasons for the success of zebra mussels. 1) The plankton-rich, lower Great Lakes are perfect habitat. 2) There are no native competitors for the firm surfaces required by the mussels. 3) Their reproductive potential is enormous; each female can produce a between 40,000 and a million eggs over the course of a summer. 4) Few natural predators seem to be interested in the mussels.

Elimination of zebra mussels, once they are established, is not possible at this time, and they are probably here to stay. There is no known chemical that will kill only mussels. Chemicals such as chlorine can be used in clogged intake pipes, but the compounds formed may affect other animals as well. Control efforts are centred on limiting the spread of the mussels to inland lakes away from the Great Lakes system. People can assist in this effort by not moving any water from one lake to another, not using live bait from the Great Lakes in other lakes, and cleaning any boat before moving it from an infested lake to any other lake.



*Grade 6 – Understanding Life Systems: Biodiversity*

- 3.5 describe interrelationships within species, between species, and between species and their environment, and explain how these interrelationships sustain biodiversity
- 3.7 explain how invasive species reduce biodiversity in local environments

*Grade 7 – Understanding Life Systems: Interactions in the Environment*

- 3.2 identify biotic and abiotic elements in an ecosystem, and describe the interactions between them
- 3.3 describe the roles and interactions of producers, consumers, and decomposers within an ecosystem

## TEACHING PROCESS AND CLASS ACTIVITIES:

### ACTIVITY 1: WHAT ARE INVASIVE SPECIES?

- Divide the class into groups of 3, and give one card set to teach group. Have each student in each group take a card and read it.
- Once each student understands their plant or animal, have them explain who they are, and where they come from, to the others in their group.
- Ask each group to subdivide into two, based on the characteristics of their species, i.e. into a single and a pair (possible combinations: plants vs. animals; aquatic vs. terrestrial; type of plant or animal; native or non-native). Have them divide several times, based on different characteristics.
- In a loose circle of group clusters, popcorn and list some of the categories that were used to divide the groups. Pick out and emphasize native and non-native. Ensure that everyone understands the difference.
- Now ask the groups to divide the non-native pair using a characteristic related to being non-native. They should quickly arrive at non-invasive and invasive. Have them come up with an initial list of characteristics for invasive species.

### ACTIVITY 2: MUSICAL MUSSELS

- **Teacher prep:** Copy, cut and laminate ten mussel cards from Teacher Resource Sheet 1 onto card stock. Two will have to be repeated. Copy Teacher Resource Sheet 2 (the sheet of Zebra Mussels) onto a sheet of mailing labels. Print a large "P" on two clean labels (for predators). Assemble the chairs in two rows, back to back.
- Introduce or review the concept of basic needs: food, water, shelter/space, and others of their kind. Indicate that all animals must meet these needs.
- Introduce the rules of the simulation game. Start with two rows of five chairs, back-to-back. The chairs represent food, water and shelter/space. Choose five students to be animals in a lake, and play the game normally, having them walk around until the music stops. The students will easily find seats.
- Indicate that, since they were so successful in meeting their needs, they were able to reproduce. Add five more students and play again. The seats will now be full.
- Add five more students (due to reproduction) and play again, observing the competition for needs when the music stops. Those not finding seats/needs must return to their desks. Indicate that this often happens in nature. A few "too many" creatures are produced, and those not able to find food or other needs must leave to find them somewhere else, or die.
- Play other rounds with 15 students, choosing new students to replace those who can't meet their needs.



- After several rounds, put zebra mussel cards face down on three of the seats. Play the round, and ask those landing on mussel cards to read or interpret them. Indicate that the mussels are a new kind of animal that humans have accidentally let loose in the area, and they are competing for the same needs as the local student-animals. If students have a "no" symbol (a circle with a diagonal line) on their card, they must return to their desks along with those who couldn't find a seat.
- Pick up the mussel cards, shuffle them and put six down. Play the round with ten students (less food, water and shelter means reproduction is down). Again, those with "no" symbols must sit down.
- Pick up, shuffle and put down nine cards. Play the round with six students. Cover all ten chairs with cards (shuffling in between rounds) and play with surviving students until no one is left.
- **For Discussion:** Why did zebra mussels take over in the chair game? Why might they take over in nature?
- Play the game again, with the following modifications. Start with the same setup as before. Have ten native animals and one zebra mussel (identified by an adhesive mussels label). Add two predators (identified by a "P" label). Predators must walk around trying to tag the native animals only. They don't like zebra mussels. If they touch an animal, that animal must sit down. So native animals must avoid predators and try for a seat when the music stops. They are "safe" if they reach a seat. Play the first round.
- Add two zebra mussels for every successful mussel. If the first mussel somehow doesn't find a seat, get a new mussel and try again. Add half the number of successful native animals (four if eight found seats). Play again, and indicate that two mussels can share a seat if all the others are taken.
- Keep playing until the mussels have taken over most or all of the seats.
- **For Discussion:** Why the mussels were so successful? What impacts might zebra mussels cause in the Great Lakes? How can people prevent the spread of zebra mussels?
- **For Assessment:** Working alone or in groups, students research one possible zebra mussel control method. Students then modify the Musical Mussels simulation game to add in their control measure. Each student/group presents their control method to the class (in a poster, presentation, brochure etc.) and then plays the game with the new rules. Which control methods worked the best? Which are the most realistic? Which are the most cost effective?

**References:** <http://www.invadingspecies.com/Invaders.cfm>

A=Page&PID=1; adapted, with permission, from Fish Ways Primary/Junior Manual, Queen's Printer for Ontario, 1991.



# Resource Sheet 1a: Native Species

## SNAPPING TURTLE

I am a reptile, and native to slow moving and shallow waters, like lakes and wetlands, in Ontario. I “snap” at my prey, which include: fish, crayfish, frogs, tadpoles and aquatic plants. Birds, raccoons, skunks and foxes prey upon my eggs and babies – but enough will survive to replace me. My greatest predators are humans who eat me or hit me accidentally with their cars. I am shy and very sensitive to habitat destruction.



## GREAT BLUE HERON

I am a great blue heron and native to Ontario, but I fly south in winter. I live along the wooded Shorelines of lakes, rivers and wetlands. I feed on fish and frogs in shallow water. I have few predators as an adult bird but raccoons and some other birds will eat my eggs and babies.



## NORTHERN RIVER OTTER

I am a mammal, and native to the wooded shorelines of lakes, rivers, ponds and wetlands in Ontario. I eat fish, frogs, and crustaceans like crayfish. My natural predators include the wolf and I am used by humans who trap me for my fur.

I am harmed by water pollution and habitat destruction.



## MONARCH BUTTERFLY

I am native to Ontario, but only spend part of the year here, going on a great migration to the highlands of Mexico during the winter. As a caterpillar, I eat only milkweed plants, and a chemical from the milkweed makes me bad-tasting to birds. I may lay eggs on closely-related plants, like Dog Strangling Vine, but my caterpillars won't develop there.



# Resource Sheet 1b: Native Species

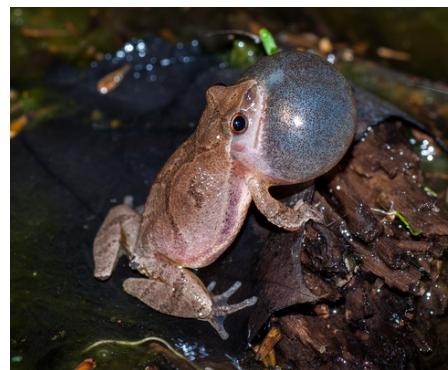
## WHITE TRILLIUM

I am a native, white spring wildflower that grows underneath moist, broad-leaved forests in southern and central Ontario. My seeds are spread by mice and ants, who eat the fleshy part and leave the seed behind. It takes me a long time to produce my single flower (up to 5 years!), so please don't pick me. I'm also the provincial flower of Ontario.



## SPRING PEEPER

I'm a small (3 cm) tree frog with a big voice, and I'm native to Ontario. I'm hard to spot and can change colour, but have a big "X" on my back. I also have adhesive toe pads that let me climb vegetation. My "peep!" is one of the first signs of spring, once I wake up from my winter hibernation under logs or bark – come listen for me along the edges of wetlands or temporary woodland ponds, but I can no longer be found in the Toronto area.



## SUGAR MAPLE

I'm a hardwood tree native to Ontario – so native that my leaf is on the Canadian flag. I'm used to make furniture, baseball bats and, of course, maple syrup. I can be found over much of southern and central Ontario. I am sensitive to pollution, particularly acid rain and salt. A small plant called Garlic Mustard is beginning to invade my understory. A lot of it can keep my seeds and saplings from growing.



## ALTERNATE LEAFED DOGWOOD

I'm a large, native shrub that lives within, or on the edges of, woodlands. My dark purple berries are eaten by many animals, including ruffed grouse and chipmunks. I am also a good landscape plant, and can either be grown from seed or purchased from a native plant nursery. I can be crowded out of wood margins by Common Buckthorn, an introduced shrub.



# Resource Sheet 2a: Introduced Species

## COLTS FOOT

I'm a small, early blooming plant native to Europe and Asia. In flower and in seed, I look a bit like a dandelion, but my leaves are way different! I'm found mostly in old fields and road edges, where few native plants grow. Sometimes I grow along natural stream banks alongside natives. Since I bloom so early, I have become an important local food source for some of the early spring insects. People make cough syrup from my leaves. I might be considered a "weed" by some farmers.



## WHITE CLOVER

I'm a small plant in the bean family that comes from Europe, Africa, and Asia. I'm used in lawns, pastures and for erosion control. I rarely grow outside of cultivated or highly disturbed areas. I can take nitrogen out of the air and make it into soil fertilizer, and native bees and butterflies love my nectar. Some native butterfly larva eat and grow on me.



## HOUSE CENTIPEDE

I'm a 25 – 50 mm long invertebrate. While my name means "hundred legs" I only have about 30. And they're fast! I'm from the Mediterranean area originally, but am now found across North America. However, like some of you couch potatoes wish, I never leave the house! I'm a predator, and eat bedbugs, ants, termites and cockroaches, so I'm doing you a favour. I do have a venomous bite, but only if you bug me. It's like a mild bee sting. I have no impact on native species or communities.



## LILLY LEAF BEETLE

I'm a shiny, red beetle with a black head. I'm originally from Europe and North Africa, and have only been in Ontario since the mid-1940's. As my name implies, I eat only lily leaves. I'm never found far from cultivated lilies, and seem to have no taste for native lily species. So I'm only a problem in your garden, at least for now.



# Resource Sheet 2b: Introduced Species

## GINKGO TREE

Dinosaurs once rubbed up against me and my close relatives, but now I'm the only one left.

Originally from Asia, I resist insects and air pollution, and so am often planted in cities. I am also used in traditional medicine. While I can live for 4000 years, I am not very aggressive, and do not invade natural areas near where I am found. I can be male or female, but more male trees are planted because my fleshy seeds smell bad. And if you handle those seeds, you may get a rash.



## EUROPEAN HARE

I am native to Europe, but now I also live in southern Ontario. I like open meadows and fields, and can be found mostly near farmlands and the edges of towns. Farmers don't like me, but I don't really compete much with native hares and rabbits. I like to eat grasses and herbs during the summer and twigs, bark, and buds in winter.



## HELLEBORE

I'm a small, broad-leaved evergreen garden plant originally from southern Europe. My rose-like flowers bloom early in the spring, and poisons in my sap make me pest-resistant. Like many garden flowers, I don't escape into natural woods or meadows.



## FOX SQUIRREL

I'm the largest tree squirrel in North America, but not native to Ontario. I'm usually found farther south in hardwood forests and agricultural areas. People tried to introduce me to Ontario, but most of these introductions failed. Right now, I'm only found on Pelee Island in Lake Erie, but I might move north if global warming allows more of the trees I like to grow in southern Ontario. Right now I don't compete much with native squirrels.



# Resource Sheet 3a: Invasive Species

## RUSTY CRAYFISH

I am originally from the south/central United States. I now live in some Ontario lakes, ponds and streams, probably brought here in bait buckets. I am an aggressive omnivore that needs to eat a lot. I eat a wide variety of aquatic plants and animals. I have fewer predators than native crayfish, in part because I get so big. I crowd out native crayfish, and can destroy native plants that I clip and eat.



## ROUND GOBY

I am an aggressive, bottom-living fish originally from Europe, probably brought here in the ballast water of large ships. I now live in some Ontario rivers and lakes. I eat many types of small aquatic species, including the eggs of my fellow fish and can survive in many types of waters. I can spawn (reproduce) up to six times in one season—this is a lot for a fish! My numbers are currently expanding, and I am replacing native fish in some areas.



## GARLIC MUSTARD

I am a small plant from Europe, originally brought here by settlers as a cooking herb. My roots produce a poison that kills off native plants, and even deer don't like to eat me. I'm now the only thing you can find growing under some southern Ontario forests, and I am slowly spreading, carried as tiny seeds by animals and people.



## DOG STRANGLING VINE

I am an aggressive vine from eastern Europe. I grow well in shade, partial shade, full sun and all soil conditions. I spread rapidly, overtop and choke out almost all native vegetation and reduce wildlife, including Monarch Butterflies. Other than cows and sheep, nothing seems to want to eat me.



# Resource Sheet 3b: Invasive Species

## MULTI-COLOURED ASIAN LADY BEETLE

I am a 'ladybug' native to Asia, and originally brought to the United States to control insect pests in trees like the pecan. My spots vary from many to few to none on a yellow to red background, and I have a musty smell. My populations began to explode in the mid-90's, moving far beyond fruit and nut trees. I'm now the most abundant ladybug by far in Ontario, and I've helped eliminate two common native ladybugs from the province, and reduced populations of others, reducing native biodiversity. In winter, you may find me in your house.



## EUROPEAN FROGBIT

I'm a free-floating aquatic plant that's native to Europe, but now found in southern Ontario. I look like a small water lily, and live in marshes and quiet lake and river edges. I can form dense mats of many plants. I out-compete other floating plants, and prevent sunlight from reaching plants growing from the bottom. I can grow from pieces of myself, and can travel from one place to another attached to boats and propellers.



## COMMON BUCKTHORN

I am a shrub or small tree, originally from Europe, with wicked thorns on my branches. I can form dense thickets, aggressively crowding out native plants and reducing biodiversity in southern Ontario. I produce lots of fruit, which either fall and sprout, or are eaten by birds and deer. They then spread my seeds in their poop, which allows me to spring up in new areas. I like light shade and will readily invade open woods.



## SPINY WATER FLEA

I'm a crustacean like lobster or shrimp, but I'm only about a centimeter long. Originally from Europe, I can now be found in many Ontario lakes – you might have seen me stuck to your fishing line. I eat three times as much as similar native water fleas, and compete for their food.

While native fish eat me, my tail spine gets caught in the throat of small ones, and they cough me out again! How much damage I might cause is uncertain at this point (image from Wikipedia).



# Mussels Resource Sheet 1a

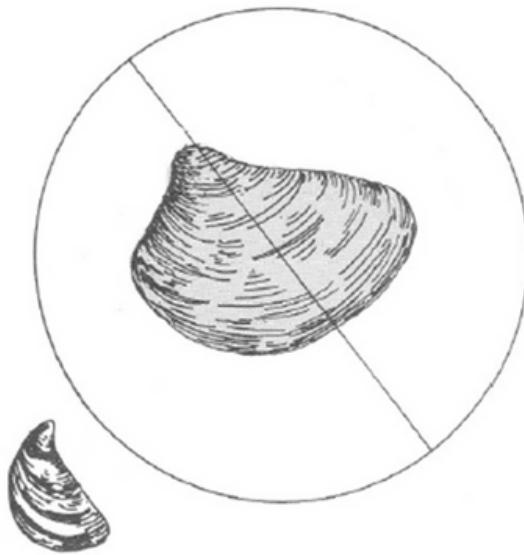
"**You're meeting your needs!**" Drum, or sheepshead, actually eat mussels, so they may benefit from their presence.



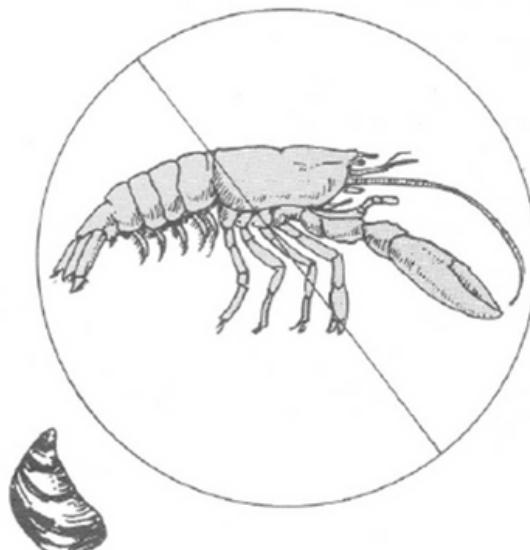
"**Zebra mussels are taking your food. You can't stay.**" Emerald shiners eat the same type of food that mussels either eat, or filter out of the water. The extent of direct effects on small plankton eaters like the emerald shiner are unknown at this time.



"**Zebra mussels are crowding you out.**" Local freshwater clams provide another hard surface for mussels to live on. They will clog the intake siphons of the clams, suffocating and starving them.



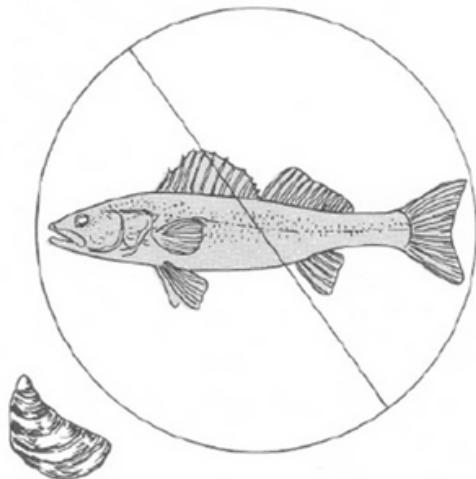
"**The zebra mussels on your back make it hard to move and find food.**" Crayfish provide another hard surface, and the weight of the mussels may make it harder to find food and avoid predation.



# Mussels Resource Sheet 1b

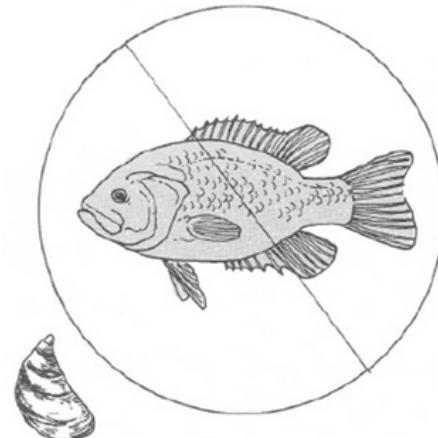
**"Zebra mussels are making the water too clear, and the light hurts your eyes. Go deeper!"**

Mussels filter and deposit large quantities of particulate matter from the water, in some cases increasing water clarity and light penetration by up to 80%. This may drive light-sensitive fishes like the walleye away from traditional, shallow water feeding areas.



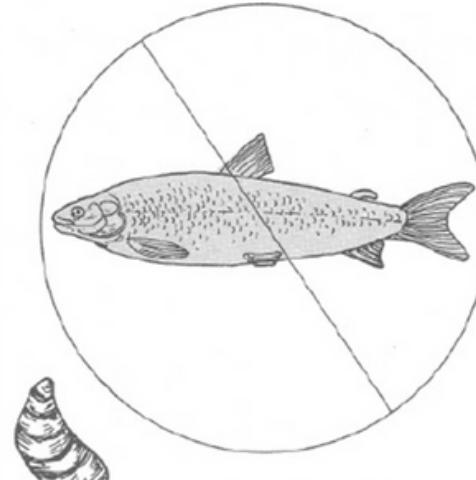
**"Your eggs won't hatch among zebra mussels.**

**Lay them somewhere else!"** Fishes such as rock bass, walleye and lake trout spawn over rocky shoals that are rapidly being colonized by zebra mussels. The build-up of mussels and their wastes reduce water circulation and foul the habitat, using up oxygen and making it acidic. These conditions may affect the hatching success of these species.



**"Because the mussels eat so much, there are fewer small fish and animals to eat. Go away!"**

Although adult whitefish do not compete directly for food with the mussels, many of the animals that whitefish eat do. If the populations of these prey species decrease as a result, the populations of larger predators like the lake whitefish may be affected.



**"Zebra mussels are clogging pipes. You can't get enough water!"** Mussels directly affect people as well, and have significantly reduced volumes entering some water treatment plants along the Lake Erie shore. Cleaning or replacing pipes is becoming a significant expense.



# Mussels Resource Sheet 2

