**Pre-Planning Template - 4.2.3 Simulation Project**

Members: Erick Torres and Arianna McDonald

**Ideas:**

I chose the simulation in the NetLogo ModelSim library as my basic template.

* Make a function that will add more bugs
* Create the button to add the bugs on both the right and left side of the simulation
* Incorporate a function that can eliminate a portion of the bugs in each ecosystem, such as a illness or infection
* Alter the code so that infected bugs turn a different color or shape
* Make the button that will execute infection function
* Change the simulation so that more that one function can be executed on the simulation on one run
* Add an interactive element to the simulation that allows the user to become an outside influence on the dynamic of the ecosystem
* Change the graphic for the “invader” so that it isn’t a mouse
* Alter the mating and reproduction rate of the bugs and birds
* Create fire
* Add a button to start fire in each ecosystem

**Research & Rules:**

* Invasive species negatively impact their environment
* Species can be introduced for entertainment, novelty, military purposes, and to get rid of unwanted species that are overpopulating an area
* A lot of things can affect an ecosystem and its population like natural disasters and infection.
* Some animals prey on others for energy and livelihood, but when this species is on the decline, the predator will also suffer as they lose out on a food source.
* This concept is known as the food chain, when one organism is the source of life for another, and that organism provides the energy necessary for life for yet another organism.
* When an invasive species \*ahem\* invades, it alters the food chain and can end up clogging the wheel.
* Populations are largely dependent on one another, and it just re-enforces the concept that we need each other to survive

**Create Prompt:**

The simulation we created involves a lot of factors which each impact the outcome individually in addition to operating as a whole. We decided to incorporate different conditions to the ecosystem and add opportunities for a change based on the user’s interpretation of their simulation. Each function is it’s own little algorithm, but when the simulation is set up and run, they all collaborate and impact the ecosystem in different ways, which mimics the unpredictability of real life. While outcomes have explanations, sometimes it is hard to correlate the cause with the effect. The functions we added, the fire, infection, and addition of more bugs all do different things to the ecosystem, and when combined they can create endless possibilities. It becomes clear how invasive species can affect their ecosystems, and how the existing species will be impacted and changed. The change of variables makes the entire simulation more realistic with it’s many possibilities because in an ecosystem, really anything can happen and it is pretty sensitive to change. The fire reduces the amount of grass the bugs can eat, which can in turn affect the bird population. The infection reduces the bug population, in turn reducing the mouse and bird population, until a species has reached 0. If the bug population reaches 0, more can be added with the add bugs button, continuing the simulation without having to start over and altering conditions. Through the interaction this develops, we can see how organisms are related to one another and depend on certain conditions for survival. It is especially apparent how invasives can impact the environment they occupy and whether it is able to adapt to this change or not.

<http://www.environmentalscience.org/invasive-species>

# Invasive Species: How They Affect the Environment

# One consequence of globalization is that in addition to people and products moving across the globe, wildlife has been transported as well. This practice of transporting animals from their native regions to new areas dates back thousands of years. The Roman Empire frequently brought back animals from foreign lands to use for entertainment in the Colosseum or used them for military purposes. The practice was also a common part of European explorations of the New World, as explorers would bring back novel specimens to their home countries for zoological examinations or to arouse interest in future expeditions.

# In many cases, the transplanted animal or plant does not thrive in its new environment. A lack of proper food sources combined with the wrong climate can make for a short lifespan for the animal in its new home. In other cases, however, the specimen thrives and is able to successfully reproduce and spread throughout its new habitat. When this happens, the plant or animal can wreak havoc on the new area and become an invasive species.

## What Makes a Species Invasive?

Introducing a species into a new environment may have a variety of outcomes. An exotic or alien species is one that has been introduced to a new place, but does not necessarily have negative consequences. For example, many fish species have been introduced into the Great Lakes for sport fishing. They have no documented negative impacts and provide recreational opportunities and a food source. However, when these alien species begin to have negative consequences in the new habitat, they are called invasive species. Invasive species may cause environmental harm, economic harm, or impact human health.

A key factor that makes many species invasive is a lack of predators in the new environment. This is complex and results from thousands of years of evolution in a different place. Predators and prey often co-evolve in a phenomenon called the co-evolutionary arms race. What this means is that as prey evolve better defenses, predators in turn evolve better ways of exploiting prey. The classic example of this comes from the cheetah and antelope. Faster antelope survive better because they can better escape cheetahs. The fastest cheetahs then survive better because they can better catch the faster antelope. Neither species ultimately gains an advantage because they continually evolve in response to one another.

However, when a plant or animal enters a new environment, they will likely encounter predators who have not been evolving with them, which makes these predators unable to successfully exploit the prey. Defense mechanisms like venom, size or speed that have been matched by adaptation in predators are suddenly without match in the new environment. This can allow the species to proliferate rapidly as it no longer faces any predators.[2](http://www.environmentalscience.org/invasive-species#_ENREF_2) Many insect or fungi that are invasive in the United States come from regions where native trees have evolved resistance to their effects. When these species enter the US, they find trees that have no resistance and they can decimate forests quickly.

Invasive species may also be able to exploit a resource that native species cannot use, which allows them to take hold in the new environment. Introduced into the Western United States, barbed goatgrass thrives in serpentine soils, whereas native plants do not normally grow in them. This has given them a solid stronghold in the area. Combined with the fact that grazing animals do not like the taste of them, the grass has spread rapidly throughout California.

Some species also alter the environment in a manner that makes it more favorable for them, but less favorable for natives, which is called ecological facilitation. Yellow starthistle has also been introduced to the West Coast and secretes the chemical compound 8-hydroxyquinoline from the root. This chemical harms native plants, which allows starthistle to increase its range as its chemicals wipe out native competitors.

## Where Do Invasive Species Come From?

Invasive species may enter new environments through many routes. Some are transported to new places and established intentionally, but with unforeseen consequences. Beach vitex was planted in coastal North Carolina in the 1980's as an ornamental plant for coastal homes. However, the plant began to overtake native species after it became established. The plant also does not have the extensive root system that holds sand in place as native plants do. As it spreads, the plants hasten dune erosion by removing plants that secure the sands of the dunes.

Some invasive species were actually brought in as unsuccessful attempts to control other invasive species. In the 1800's, rats that came to the Virgin Islands on ships infested the sugar cane fields on the islands, causing massive crop damage. Farmers brought in mongoose as a predatory control for the rats. However, the rats are nocturnal and sleep in trees, whereas the mongoose are diurnal and cannot climb trees, so they were not successful at eradicating the rats. As a result, the islands now have two invasive species to contend with.

Other species are brought to different places intentionally but released accidentally, as happens sometimes with animals in zoos and aquariums. Lionfish are thought to have been introduced to the Caribbean when several of them escaped from a broken beachfront aquarium during Hurricane Andrew in 1992. Sometimes people buy exotic pets and release them when they no longer want to care for them. This has been the case with Burmese pythons that are invasive in the Everglades. These were once a popular pet because they are brightly colored and have an easy-going demeanor. However, they can grow up to 6 feet in the first year and live in excess of 20 years. A full-grown Burmese python can be up to 13 feet long and requires a specially-made enclosure and a large amount of food. This quickly becomes too burdensome for many owners, who then release them into the wild. As a result, a large population of these snakes now occupies South Florida.

A large number of invasive species have also been transported incidentally through shipping. The Great Lakes provide a good example of this. For millennia, the Great Lakes remained separated from other major bodies of water. When the St. Lawrence Seaway, a system of canals and dams, was built to connect the Great Lakes to the Atlantic Ocean, this waterway provided a conduit for invasive species to enter the area. This mainly happened through the discharge of ballast water. Ballast water is used to weigh down empty ships and then discharged when ships enter a port in order to make weight available for cargo. The water is typically from the previous port where the ship was docked, and often contains living organisms from the area. By discharging ballast water into the Great Lakes when they arrive, ships have introduced more than 56 invasive species into the area.

In the 16th century, Spanish galleons also transported invasive species, but did so through ballast soil. They would load the ship down with soil instead of water, but this soil also contained fire ants. As ships stopped at various ports along trade routes, dumping out the soil released fire ants into the areas, which were quickly able to colonize new places.

Many other examples exist of invasive species hitching rides on cargo to enter new habitats. For example, the fungus known as chestnut blight came from chestnut trees that were imported from Japan in the late 19th century. The Asian tiger mosquito was introduced accidentally in tires shipped into the United States from Asia. Naval shipworms entered the San Francisco Bay on cargo ships in the early 20th century and caused significant damage to piers and harbors.

Once they enter a new place, many different components of the habitat may facilitate their spread. Roads, for example, provide a pathway for invasives to move through new areas. The habitat alongside the road is clear of native vegetation, which makes it easy for fire ants to build mounds in this area. When areas are cleared for grazing, the lack of native vegetation means less competition with existing species and can make it easier for invasives to establish themselves.

## What Are the Consequences of Invasive Species?

Invasive species can have a number of negative impacts on the areas that they invade. Perhaps the most significant of these is the widespread loss of habitat. The hemlock woolly adelgid is an invasive insect from Asia that rapidly kills infested hemlock trees. In some parts of the Eastern United States, it is estimated that up to 80% of hemlock trees have been killed. These forests represent important habitat for many animals and with crucial habitat gone, species that rely on them may face extinction. Similarly, the health of many forests is threatened by kudzu vines, introduced from Japan in the 19th century as an ornamental plant. This plant was widely distributed across the Southeastern United States as a means of erosion control and as a food source for grazing animals. The vine soon became invasive, however, and can completely overgrow entire forests. In the process, it prevents sunlight from reaching the trees, effectively killing the forest. Additionally, the weight of the thick mats of vines on trees can cause trees to break and fall over. Its ability to quickly overgrow and destroy forests has earned it the nickname “the vine that ate the South.”

Some invaders can physically alter the habitat in addition to destruction. 50 beavers from Canada were relocated to Tierra del Fuego, an archipelago at the southern tip of South America, in 1946 to be hunted for their pelts. Since then, they have multiplied and now number in the hundreds of thousands. The trees in the region are not adapted to beaver activity as they are in North America, and most do not grow back after being gnawed by beavers. Portions of the formerly pristine forests now look like a bulldozer has plowed through them. Additionally, beaver activity creates ponds that flood portions of the forest. These bodies of stagnant water alter the nutrient cycle in forests and invasive plants thrive in them. Beavers also build dams in drainage ditches of grasslands and livestock commonly fall into them, where they become stuck and die.

Other invasive species may not destroy habitat but can have an impact by killing large numbers of endemic species. Burmese pythons, for example, are top predators in the Everglades. As such, they have decimated local mammal and bird populations. Capable of consuming deer and even alligators, these creatures eat virtually any animal they encounter in the Everglades. A number of threatened and endangered bird species have also been found in the digestive tracts of pythons, prompting concern that they could drive some species toward extinction. Lampreys in the Great Lake parasitize native fish. Because the native species have not evolved defenses to lampreys, they often die outright from wounds, or wounds become infected and eventually cause mortality. Invasives can also threaten native species by outcompeting them for resources. Asian carp introduced into the United States outcompete native fish for both food and space, leading to large declines in native fish populations. Invasive species are the second largest cause of species extinctions in the United States.

Invasive species can also impact human health. Invasive zebra mussels accumulate toxins in their tissues like PCB's and PAH's. When other organisms prey on these mussels, the toxins are passed up the food chain and can also enter animals consumed by humans. Ballast water from ships also sometimes contains harmful bacteria like cholera. Invasive animals can also be vectors for disease.

In addition to these impacts, invasive species can also have enormous economic costs. Zebra mussels in the Great Lakes can rapidly cover submerged surfaces, clogging up water intakes at water treatment facilities and power plants. Removing this invasive species costs an estimated $500 million annually in the Great Lakes alone. Power companies spend an estimated $1.5 million each year to control kudzu vines growing on power lines. Lampreys in the Great Lakes have decimated many fishery stocks to the point that they are no longer profitable. In the United States, invasive species cost an estimated $120 billion annually in control methods and in loss of environmental resources.

## What Can Be Done to Deter Invasive Species for Specific Habitats?

Many strategies have been developed to stop the damage caused by invasive species and to prevention future invasions. An important component is educating people about the dangers of transporting wildlife to new areas. Many laws and regulations have also been passed to combat the future spread of invasives. Ballast water in tankers is required to be decontaminated before it can be released from the boat. Laws have also been passed to restrict the exotic pet trade, such as banning the import of Burmese pythons in the United States.

Promoting the harvest of invasive species is another widely used technique, although it has been employed with limited success. A python hunt in Florida in 2013 provided cash awards to people for killing pythons. In Argentina, officials have tried to promote a market for beaver pelts and hunters were encouraged to hunt them. People have also used the woody vines of kudzu to craft baskets and other items. A problem encountered with this strategy is that often the demand is not nearly high enough to make a discernible impact on invasive populations. In the case of pythons, they are extremely secretive and elusive, which makes them difficult to find them for eradication.

As with many environmental problems, continued research will yield insight into effective control measures. For example, research studies have been conducted to determine how effective traps are in catching pythons. Genetic studies can also yield important information about how invasives have spread in an area and their potential to hybridize with native species. Predicting how the geographic range of an invasive species will increase is important for preparing new areas that may be invaded. Much research has also been devoted to determining the most effective ways of removing invasive plants, whether through herbicides or through mechanical destruction of the plants. Using chemicals to kill sea lampreys in the Great Lakes during their vulnerable larval stages has been shown to effectively kill them without harming other wildlife. While many invasive species may not ever be fully eradicated, increased awareness and research offer methods of preventing their spread and controlling the economic and environmental damage they can incur.

<http://www.nationalgeographic.org/encyclopedia/food-chain/>

The food chain describes who eats whom in the wild. Every living thing—from one-celled algae to giant blue whales—needs food to survive. Each food chain is a possible pathway that energy and nutrients can follow through the ecosystem.

For example, grass produces its own food from sunlight. A rabbit eats the grass. A fox eats the rabbit. When the fox dies, bacteria break down its body, returning it to the soil where it provides nutrients for plants like grass.

Of course, many different animals eat grass, and rabbits can eat other plants besides grass. Foxes, in turn, can eat many types of animals and plants. Each of these living things can be a part of multiple food chains. All of the interconnected and overlapping food chains in an ecosystem make up a food web.

**Trophic Levels**

Organisms in food chains are grouped into categories called trophic levels. Roughly speaking, these levels are divided into producers (first trophic level), consumers (second, third, and fourth trophic levels), and decomposers.

Producers, also known as autotrophs, make their own food. They make up the first level of every food chain. Autotrophs are usually plants or one-celled organisms. Nearly all autotrophs use a process called photosynthesis to create “food” (a nutrient called glucose) from sunlight, carbon dioxide, and water.

Plants are the most familiar type of autotroph, but there are many other kinds. Algae, whose larger forms are known as seaweed, are autotrophic. Phytoplankton, tiny organisms that live in the ocean, are also autotrophs. Some types of bacteria are autotrophs. For example, bacteria living in active volcanoes use sulfurcompounds to produce their own food. This process is called chemosynthesis.

The second trophic level consists of organisms that eat the producers. These are called primary consumers, or herbivores. Deer, turtles, and many types of birds are herbivores. Secondary consumers eat the herbivores. Tertiary consumers eat the secondary consumers. There may be more levels of consumers before a chain finally reaches its top predator. Top predators, also called apex predators, eat other consumers.

Consumers can be carnivores (animals that eat other animals) or omnivores (animals that eat both plants and animals). Omnivores, like people, consume many types of foods. People eat plants, such as vegetables and fruits. We also eat animals and animal products, such as meat, milk, and eggs. We eat fungi, such as mushrooms. We also eat algae, in edible seaweeds like nori (used to wrap sushi rolls) and sea lettuce (used in salads).

Detritivores and decomposers are the final part of food chains. Detritivores are organisms that eat nonliving plant and animal remains. For example, scavengers such as vultures eat dead animals. Dung beetles eat animal feces.

Decomposers like fungi and bacteria complete the food chain. They turn organic wastes, such as decaying plants, into inorganic materials, such as nutrient-rich soil. Decomposers complete the cycle of life, returning nutrients to the soil or oceans for use by autotrophs. This starts a whole new food chain.

**Food Chains**

Different habitats and ecosystems provide many possible food chains that make up a food web.

In one marine food chain, single-celled organisms called phytoplankton provide food for tiny shrimp called krill. Krill provide the main food source for the blue whale, an animal on the third trophic level.

In a grassland ecosystem, a grasshopper might eat grass, a producer. The grasshopper might get eaten by a rat, which in turn is consumed by a snake. Finally, a hawk—an apex predator—swoops down and snatches up the snake.

In a pond, the autotroph might be algae. A mosquito larva eats the algae, and then perhaps a dragonfly larva eats the young mosquito. The dragonfly larva becomes food for a fish, which provides a tasty meal for a raccoon.