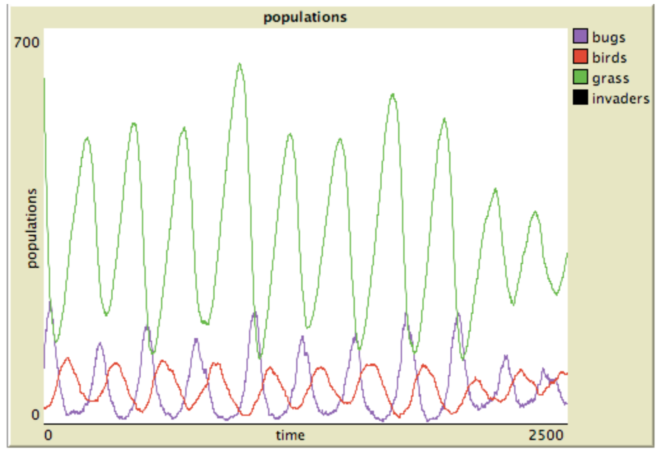
Reading 6.1 – Competition Between Populations

In the ecosystem models you used in class you discovered that population sizes can fluctuate. One type of fluctuation that can appear is repeating cycles of peaks and valleys in population size.

These cycles can appear to repeat over and over again in any population in an ecosystem. Here is an example of such cycles occurring for bugs, birds, and grass from the computer model. Notice that there are about 11-12 cycles of population size peaks and valleys for the bugs, birds, and grass in this model run.



Hunters, trappers, traders, and scientists have noticed similar cycles of population growth and decay in predator/prey interactions in the real world. One of the first recorded observations of these cycles was reported by the Hudson Bay Company between 1825 and 1925, in their records of pelt-trading of Canadian lynx and snowshoe hares.

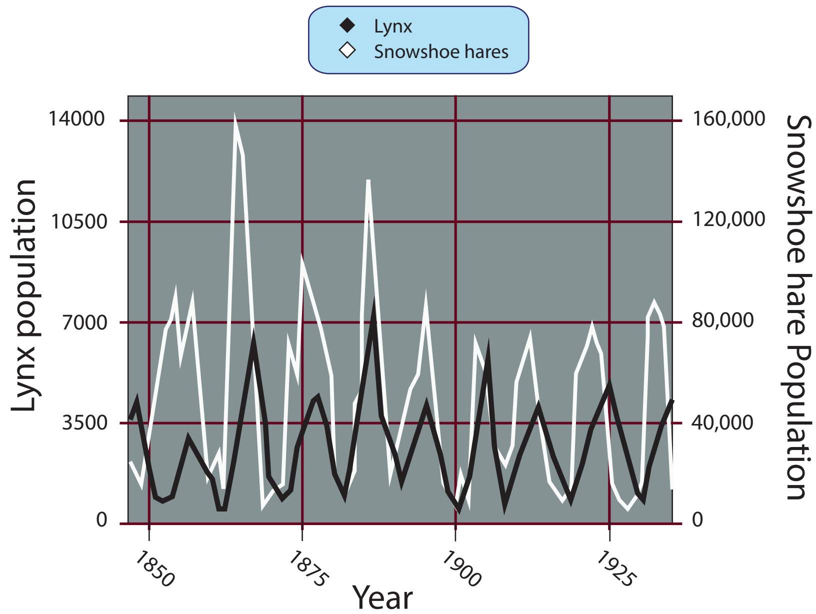

Snowshoe hare


Canadian lynx


Range of the snowshoe hare

- *Left image from http://en.wikipedia.org/wiki/File:Snowshoe_Hare,_Shirleys_Bay.jpg*
- *Middle image from http://en.wikipedia.org/wiki/File:Canada_lynx_by_Michael_Zahra.jpg*
- *Right image from http://en.wikipedia.org/wiki/File:Lepus_americanus_map.sv*

The next page show a plot of that data they collected.



Notice that the population of hares and lynx tended to exhibit these cycles because of interactions occurring between the populations in the ecosystem. In general, these cycles occur when the predator species is mostly dependent (or totally dependent) on a single prey species as its only food supply, and when there is no threat to the prey other than the specific predator. Such simple ecosystem interactions aren't typical, since most ecosystems have many more populations interacting with each other providing multiple sources of food and multiple types of predators.

But these simpler ecosystems help demonstrate how dependent each population can be on another. They show that changes in one population alter the ecosystem conditions for other populations (particularly related to the food supply) both immediately and through delayed effects.

Even though the computer model you used in class was a model of grass, bugs, and birds in an ecosystem, think about the ways the model could be reused to explore and understand the interrelated effects between the hare and lynx in their ecosystem.

Question #1: What are some reasons it might make sense to keep the model basically the same, with only minor changes to the settings in the model?

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Question #2: What are some reasons it might make sense to substantially change the computer model?

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The usefulness of a model can be evaluated by comparing its predictions to actual observations in the real world. Even when models make predictions that match exactly, it does not mean this is the only model that would do this. And even when alternate models could be created for new systems (such as the rabbit and lynx ecosystem), it may not be necessary or desirable to develop a completely new model, when an old model could be reused to accurately predict what would happen in this new system.

In class you used the computer model to introduce a new species into your old ecosystem. You found that the new species competes with native species in ways that are often difficult to predict. And you found that when you change the attributes or traits of the invasive species and native species, you could affect which species outcompeted which.

Many examples of newly introduced species outcompeting native species have occurred in the natural world in the last few hundred years. Such introduced species have traits that gives the individuals in that species a competitive advantage over the native species. When new species are introduced to ecosystems that they have not been in before, and the new species outcompetes the native species, the new foreign species is referred to as an **invasive** species.

By one estimate, over half of the existing native species listed as endangered in the world are endangered due to competition from an invasive species. One example of this are rabbits in Australia.

Before the 1700s, there were no native rabbits in Australia. In 1850, twelve wild rabbits from Europe were released for recreational hunting. Within 10 years, the rabbit population grew to in the millions. And since then, their population has grown to over 200 million. These rabbits consume native plants and have a major impact on many ecosystems across the continent.

Question #3: Why would the effect of rabbits consuming native plants end up also affecting other native animals that are plant consumers in Australia?

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In 1876, a new type of pea from Japan was introduced as a crop and ornamental plant to the Southeastern United States. After planting the species, it was discovered too late, that the Southeastern US has near-perfect environmental conditions for Kudzu to grow (hot, humid summer, frequent rainfall, and no hard freezes in the winter, as well as no natural predators in the US).

Kudzu soon began to grow in carpeting blankets of vines that outcompeted the local vegetation for light and water in many ecosystems.

Kudzu shown growing over native plants, bushes, and trees in the Southeastern US.
Image from:
http://en.wikipedia.org/wiki/File:Kudzu_on_trees_in_Atlanta,_Georgia.jpg

Different environmental conditions in the winter keep Kudzu from invading the Northern parts of the United States. Freezing temperatures, in particular, prevent Kudzu from surviving through colder winters. Other species in the Northern United States are also affected by winter freezes. Such freezes kill off many native insects and reduce their population sizes to small levels, so that they then reproduce and replensih the population in the warm months. This cycle then repeats every year.

Question #4: What other seasonal changes in weather might affect how invasive a species becomes or might affect whether it can survive in a region at all?

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More recently, the Asian Long horned Beetle was introduced into the United States and was discovered in New York City and Chicago. The beetle infests maples, poplars, willows, elms, and locust trees by burrowing into the hardwood of the tree to lay its eggs. Over time, this burrowing destroys the ability of the tree to move water from its roots to its leaves. Unlike their native ecosystems in China, Korea, and Japan, they have few natural predators in North America. In cases where infestation of native trees are detected, the local communities near these cities typically adopt a policy of cutting down the infected tree and destroying the wood in an attempt to stop further spread of the invasive species.

Question #5: Asian Long horned Beetle populations grow much larger in size than other native Beetle populations that live in native trees. Why does a lack of natural predators contribute to this outcome?

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Zebra mussels are another invasive species. They originated in lakes of southeast Russia. They were likely brought over to the US on the hulls of ships (which they attach to).

The zebra mussel filters pollution out of the water and provides food to fish that feed off the bottom of the lake.

Though they have this beneficial impact for the ecosystem, they also outcompete native species of mussels in areas where they have become invasive (such as the Great Lakes and Mississippi river waterways).

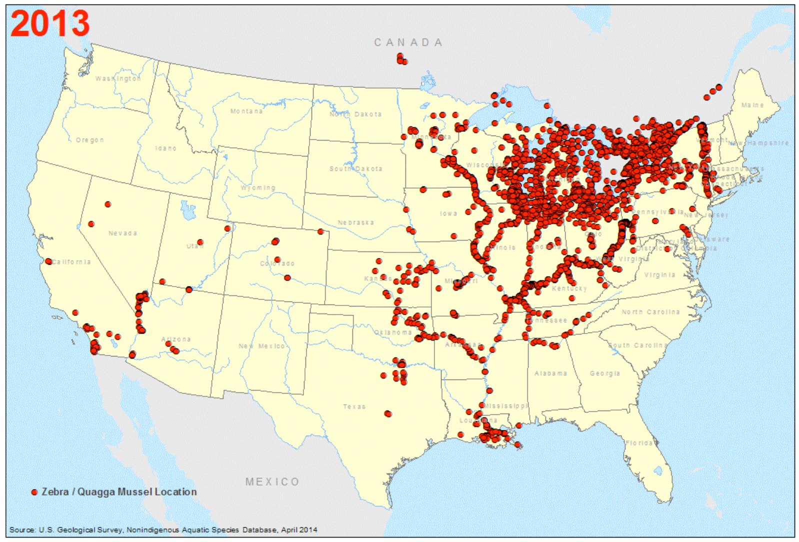

Image credit from United States Geological Survey:
http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/maps/2013.gif

Question #6: A natural predator of zebra mussels are crayfish and a type of fish called a "roach". If someone were to suggest introducing either one of these predators into the Great Lakes to combat the spread of Zebra mussels, why might this lead to other unintended impacts on other populations in the ecosystem?

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The US spends over $100 billion each year trying to control or remove invasive species and restore the native ones to the ecosystem. To find out more about the invasive plants, animals, and microbes affecting your state, you can go to http://www.invasivespeciesinfo.gov/unitedstates/state.shtml and click on your state.

Question #7: Do you think there is a single species of plant that would outcompete all native plants if it were introduced into every ecosystem in the world? ___________

Question #8: Do you think there is a single species of insect that would outcompete all native insects if it were introduced into every ecosystem in the world? ___________

Question #9: What are some of the reasons you have for your answers to question 7 and 8?

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Question #10: If you could change or add any one new trait for how one of the populations (bugs, invaders, or birds) move through the ecosystem or interact with their to surroundings, which one trait would you be interested in experimenting with?

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Question #11: How do you think this trait change would affect the competition between the different populations in this ecosystem? (Circle all that apply)

- It would give my redesigned population a competitive advantage.
- It would give my redesigned population a competitive disadvantage.
- It would give one of the other populations a competitive advantage.
- It would give one of the other populations a competitive disadvantage.
- It would give no population any competitive advantage or disadvantage.
- Other:____

In the next computer model you use in class, you will design your own new population of organisms. You will customize a sets of traits for them! Then you will test your population against your classmates designs.

Question #12: Do you think you will be able to design a population that will outcompetes all the other students populations in the same ecosystem? _______