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# K-12 Partnership Lesson Plan

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# *Not in my stream!*

# *The Asian Carp invaders*

## Overview

In this lesson, students will learn about watersheds, freshwater food webs, and invasive species through a power point presentation, a matching/coloring activity and a board game. First, we will introduce students to the concepts of watersheds, food webs and invasive species. Then we will introduce the Asian Carp, an invasive species that could become a threat to the Great Lakes watershed by traveling up the Mississippi River. Students will fold, match, and color a worksheet that shows an aquatic food web with and without Asian Carp. We will discuss what differences they find and how those differences could have ecological and social effects beyond the scope of the worksheet. Next we will discuss with the students how plants and animals are not static, that is, they can change their strategies to adapt to changes in their environment. To illustrate this point, we will give students a board game they will play in pairs where native species will compete against Asian Carp to get to the “survival” finish line. We will keep track of which species wins among each pair to use as a springboard for discussion of different potential ecological consequences when Asian Carp compete with native species.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Name some organisms in a freshwater foodweb
* Explain what an invasive species is and how they have the potential to be harmful to native food webs
* Describe a watershed and name the watershed they live in
* These foundational concepts (food web, species interactions, competition for resources) will provide the students with the contextual tools they need to learn more about co-evolution and ecology in later science classes

**Length of Lesson**

* 1 hr- if you choose only some of the materials (i.e. abbreviate the powerpoint) and one of the two activities
* 2 hrs – if you use all materials and activities

**Grade Levels**

3-5

**Standards covered (NGSS)**

Disciplinary Core Ideas

 *Kindergarten*

* **K-LS1-1**: use observations to describe patterns of what plants and animals need to survive.
* **K-ESS3-1**: use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.

*2nd grade*

* **2-LS4-1**: make observations of plants and animals to compare the diversity of life in different habitats.

*3rd grade*

* **3-LS4-3**: construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

*5th grade*

* **5-LS2-1**: develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Cross Cutting Concepts

* Patterns
* Systems and system models
* Stability and change of systems

Science and Engineering Practices

* Developing and using models

**Materials**

* Powerpoint presentation (found at “Not in my stream!” lesson page on KBS GK-12 website)
* Blank paper (1 sheet per student)
* Coloring/matching handouts (1 per student) **– *see folding instructions on slide 32 in the powerpoint presentation***
* Colored pencils/crayons/markers
* Game board (1 per pair of students, made for 11x17” paper)
* Dice (1 die per pair of students)
* Game pieces (cut out, folded and taped before class; 1 carp and 1 bass per pair) ***– see folding instructions on slide 31 in the powerpoint presentation.***
* Game guide (table with actions; 1 per pair of students)

**Background**

* Topics to cover
	+ Watersheds
	+ Food webs
	+ Invasive species: how they can change food webs and how an aquatic invasive species moves within a watershed and between watersheds.
	+ Invasive species example: Asian Carp
* Watersheds
	+ Definition: A watershed is the area of land where all the water that drains off of it goes into the same place
	+ Example: The Lake Michigan watershed is made up of all the land whose rainwater (and groundwater) eventually drains into the Lake. This includes the watersheds of the individual rivers that flow into the lake. For example all the land whose rainwater drains into the Kalamazoo River (the Kalamazoo River watershed) is part of the larger Lake Michigan watershed. (see slides)
	+ Neighboring land areas that drain to different rivers or lakes are not connected through their water ways even though they are neighbors.
		- For example, rivers and lakes in western Michigan (lower peninsula) drain into Lake Michigan, while rivers and lakes in the northeastern lower peninsula drain into Lake Huron. It is impossible for a fish to swim across the state from western to eastern Michigan through waterways.
		- Another example: Northern Ohio drains into Lake Erie, but the rest of the state drains into the Ohio and eventually Mississippi River.
* Food webs
	+ Within each of these watersheds are communities of living organisms who depend on each other to survive.
	+ Definition: A food web is made up of all the individual food chains in a single ecosystem. Each living thing in an ecosystem is part of multiple food chains. Each food chain is one possible path that energy and nutrients may take as they move through the ecosystem. All of the interconnected and overlapping food chains in an ecosystem make up a food web. (<http://education.nationalgeographic.com/education/encyclopedia/food-web/?ar_a=1>)
		- Trophic levels
			* producers - make their own food (autotrophs)
			* primary consumers - eat producers (herbivores, heterotrophs)
			* secondary consumers – eat primary consumers (predators, heterotrophs)
			* decomposers - eat nonliving plant and animal remains (fungi, bacteria, insects, scavengers).
	+ Food webs represent **energy flow--**Producers capture solar energy (radiation) transform into chemical energy. Consumers eat producers to get chemical energy (can’t make it themselves like plants can); secondary consumer eats primary consumer and so on. Producers use most of the energy they get from the sun for things like respiration, digestion, repair, reproduction, staying warm. At each trophic transition (e.g. from producer to consumer) about 90% of the energy is lost due to respiration, digestion, etc. So, primary consumers get about 10% of the energy produced by autotrophs. Then, secondary consumers end up with about 1% of the energy produced by the autotrophs, and so on. This inefficiency in energy transfer limits food webs to 4-6 trophic levels. ([http://en.wikipedia.org/wiki/Energy\_flow\_(ecology)](http://en.wikipedia.org/wiki/Energy_flow_%28ecology%29))
		- See food web biomass pyramid in power point
* Invasive species –
	+ In general: An invasive species is a plant or animal species not native to a specific location and that has a tendency to spread, which can cause damage to the environment, human economy, and/or human health.
		- Typically characterized by: fast growth, rapid reproduction, high dispersal ability, ability to adapt to new conditions, tolerance of a wide range of conditions, ability to live off of a wide range of food types.
	+ Asian Carp
		- Watch this short (3 min.) & informative video (link also in power point presentation): <http://youtu.be/rPeg1tbBt0A?t=8s>.
		- There are 4 species of Asian Carp that are in the US: Silver Carp, Grass Carp, Black Carp, and Bighead Carp. The two that pose the most threat to the Great Lakes are the Silver and Bighead. They have established reproductive populations in the upper Mississippi River watershed (including the Illinois River), but have not been documented (yet?) in Lake Michgan.
		- History of introduction (how they got to Illinois shipping channel)
			* 1900- a man made canal system, the Chicago Sanitary & Shipping Canal, completed. It connects the otherwise hydrologically separated Mississippi River Basin and Lake Michigan.
			* 1970s Asian Carp were introduced into US aquaculture farms to manage algae in fish farms and sewage treatment facilities, have escaped these facilities during high flood events reaching the Mississippi River.
			* 1980s wild populations of carp documented in several parts of the Mississippi basin.
			* Installation of three electrical barriers on the Chicago Sanitary and Ship Canal in 2002, 2009, and 2011.
			* As of Dec 2014 a single sample of DNA from a silver carp was discovered in the Kalamazoo River in Michigan. The sample, taken in July, represents the first time that Michigan has experienced a positive result for silver carp eDNA in Michigan’s Great Lakes waters outside of Maumee Bay. Silver carp DNA was also found in the Fox River, a tributary to Lake Michigan in downtown Green Bay, Wisconsin. This is the second eDNA discovery in Wisconsin.
		- Map of range in US: (see powerpoint).
		- Diets for the 2 different invasive Asian Carps
			* Silver carp -can grow 12 lbs per year, reaching 40 inches long and 60 lb (about the size of a golden retriever). These are the ones that can jump 10 feet out of the water and harm boaters. They are filter feeders, mostly eating phytoplankton; used for controlling water quality including algae blooms. Certain species of blue-green algae, notably the often toxic [*Microcystis*](http://en.wikipedia.org/wiki/Microcystis), can pass through the gut of silver carp unharmed, and pick up nutrients while in the gut. Thus, in some cases, blue-green algae blooms have been exacerbated by silver carp. Also, *Microcystis* has been shown to produce more toxins in the presence of silver carp. These carp, which have natural defenses to their toxins, sometimes can contain enough algal toxins in their systems to become hazardous to eat (<http://en.wikipedia.org/wiki/Silver_carp>).
			* Bighead carp- can grow to be 5 feet long and 110 lbs. (the size of a high school student). The impact of this species in the United States is not adequately known. Because bighead carp are planktivorous and attain a large size, these carp have the potential to deplete zooplankton populations. A decline in the availability of plankton can lead to reductions in populations of native species that rely on plankton for food, including all larval fishes, some adult fishes, and native mussels. (<http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=551>). Bighead consume primarily zooplankton (up to 90% of gut contents) but also consume large amount of algae. Some debate in literature about effectiveness of introduced Bighead carp to control phytoplankton blooms, some research suggests that carp may actually increase algae abundance by reducing zooplankton numbers (<http://el.erdc.usace.army.mil/ansrp/ANSIS/html/hypophthalmichthys_nobilis_bighead_carp.htm>)
			* Filter feed through their gills, *not bottom feeders*!
		- Characteristics that make it invasive (reproductive rate, growth rate, size)
			* Reproduction rate: spawn multiple times a year, laying up to 200,000 eggs per spawning event (native competitors spawn only once a year and lay less than 100,000 eggs). In 1998 Asian carp made up 1% of fish catch; in 2008 they made up 51% of fish caught in the Upper Illinois River.
			* Growth rate - grow faster than competitors (for example, the bighead can grow to almost 10 lb in just 3 years), escape predation quickly and live a long time (up to 25 years).
			* Eating more: due to their fast growth rate they eat phytoplankton and zooplankton, often food sources for other fish, including fish larvae and juveniles.--predators that rely on those larvae and juvenile native fish are disrupted.
			* Fishermen don’t like them because they’re heavy and difficult to catch. They often require nets or a hook; because they are filter feeders they don’t bite on bait. People don’t like to cook them because their filets contain bones.
			* Migrate up streams and rivers to spawn (natural dispersers).
			* The live or very freshly killed market is most lucrative. Because of this, bighead carp are often transported live, and some feel this is a high risk factor for the eventual spread of the fish, either through release by the end purchaser, or through escape during transport. Another potential avenue for unintentional spread of bighead carp is through use as [fishing bait](http://en.wikipedia.org/wiki/Bait_fish). (<http://en.wikipedia.org/wiki/Bighead_carp>)
			* They are well-suited to the climate of the Great Lakes region, which is similar to that of their native range in Asia. ([http://www.michigan.gov/dnr/0,4570,7-153-10364\_52261\_54896-232231--,00.html](http://www.michigan.gov/dnr/0%2C4570%2C7-153-10364_52261_54896-232231--%2C00.html))
			* There are no North American fishes large enough to eat an adult Asian carp. White pelicans and eagles, however, have been seen feeding on juvenile or smaller adult Asian carp. Largemouth bass have often been observed feeding on small juvenile Asian carp, and many other native predators probably also feed on them before they grow too large. However, Asian carp produce many offspring which grow quickly and, if conditions are good, rapidly become too large to be eaten by North American predators.
	+ How an invasive species can change a foodweb
		- Beaver example
			* In its native range of North America, the number of beavers is kept in check by gray wolves who can hunt adult beavers.
			* In the 1940s the beaver was introduced into southern South America (Tierra Del Fuego) for a fur production farm. The farm failed and 25 mating pairs of beavers were released into the wild. There, it does not have natural predators, like the wolves who hunt them in North America. The number of beavers sky-rocketed, reaching 100,000 beavers within just 50 years. Beavers have a strong influence on the structure of their environment by building dams, which slow down the river creating wetlands, and cutting down specific species of trees—these can have huge effects on many different plants and animals (trees, birds, fish, etc.). Most biologists agree the beavers are having a drastic affect on the structure and function of the Tierra Del Fuego environment.
			* **So when a new species is introduced that does not have a natural predator it can have big effects on the rest of the food web. Can something like this happen to the Lake Michigan food web?**
	+ Asian Carp can eat up a large fraction of the base of the food web (plankton), affecting the rest of the native organisms that were reliant on those producers. If they reach the Great Lakes, Asian carp are likely to be very successful (see invasive characteristics above). Changes to the Great Lakes food web could hurt the commercial and recreational fishing industries.

### Activities of the session

1. Powerpoint slides
2. Draw your own food web activity – see slide 6.
	1. Goal of activity: Get a sense for the students’ prior knowledge. Let them be creative and use their own knowledge to come up with something from scratch. Student-driven learning: work with partners and the class to learn from each other.
3. Coloring/matching activity – see slides 14 & 15.
	1. Goal of activity: See how an invasive species can affect the diversity of a food web..
4. Board game – see slide 27.
	1. Goal of activity: To introduce students to the natural and human factors that can influence the “invasibility” of a river or lake; to help them see that systems can adapt (not all native food webs will crash when carp invade); to show that invasion “events” will happen multiple times throughout the watershed and over time.

**Resources**

* Powerpoint presentation, board game guide, board game pieces, printable board game and printable color and match worksheet all found on the “Not in my stream!” lesson page on the KBS GK-12 website
* US Fish & Wildlife Service Factsheet: Asian Carp- Aquatic Invasive Species <http://www.fws.gov/midwest/fisheries/library/fact-asiancarp.pdf>
* Tip of the Mitt Watershed Council, MI: About Asian Carp <http://www.watershedcouncil.org/asian-carp.html>
* Asian Carp Regional Coordinating Committee <http://www.asiancarp.us/index.htm>
	+ ACRCC flickr photos <https://www.flickr.com/photos/acrcc>
* Asian carp: Where they are, what you need to know <http://archive.freep.com/interactive/article/20110721/NEWS06/110720038/Asian-carp-Where-they-what-you-need-know>
* Fish barrier vs. carp DNA: What to believe? <http://www.jsonline.com/news/wisconsin/fish-barrier-vs-carp-dna-what-to-believe-4q5ru75-167454795.html>

**Extensions and Modifications**

Would work well in combination with GK-12 “Michigan Monsters” game (for middle/high school students) available here: <http://kbsgk12project.kbs.msu.edu/blog/2012/03/20/invasion-total-take-over-exploring-invasive-species-and-the-methods-to-control-them/>