Climate Competitors

Activity

Students play a game that illustrates the role climate change may play in the introduction and spread of aquatic nuisance species.

Grade level: 6-8
Subjects: Ecology, Science
Setting: Gymnasium, outdoors
Duration: 1-2 class periods
Key Terms: adaptations, climate change, ecosystem, global warming, greenhouse gasses, invasive species, native, non-native

Objectives

- Students discuss how adaptations enable a species to live within a specific environment or habitat.
- Students begin to understand how climate change may alter aquatic ecosystems and impact organisms living in those environments.
- Students learn how physical or biological adaptations may allow invasive species to thrive in environments impacted by climate change.

Materials

- Species cards – one per student (16 native, 16 invasive species)
- Climate change spinner
- Adaptation spinner
- Laminated climate change & adaptation signs (8 total)

Background

What is global warming and what does it have to do with climate change?

The term **global warming** refers to the gradual rise in the earth's average temperature over the last century. This steady increase has generally been attributed to an abnormal elevation of atmospheric gasses collectively called greenhouse gasses. The function of greenhouse gasses is to absorb and emit solar radiation, warming the surface of the earth. Without greenhouse gasses the planet would be too cold to sustain human life. Atmospheric concentrations of greenhouse gasses have fluctuated naturally throughout earth's history due to volcanic activity

and biological processes such as photosynthesis and cellular respiration. However, with the onset of the Industrial Revolution over 265 years ago, greenhouse gasses have steadily increased due to human related activities such as deforestation, agriculture (i.e., methane produced by grazing cattle), and the burning of fossil fuels for cars, factories and electricity production. As a result, more solar radiation is trapped against the earth and global temperatures rise. Rising global temperatures may lead to **climate change**, or long term shifts in weather patterns which may include changes in precipitation, temperature (air/water), wind, humidity and length or timing of seasons.

How does climate change affect native flora and fauna in freshwater aquatic ecosystems?

An **ecosystem** includes all of the plants, animals, soil, water, rocks, microorganisms and people living and interacting together in the same area or environment. Ecosystems contain biotic or living parts, as well as abiotic or non-living parts. Biotic factors include all of the living things inhabiting an area such as plants, animals, bacteria, fungi and humans, and the interactions between them. Abiotic factors are the physical and chemical components of an ecosystem including sunlight, soil, water and climate. There is a very fine balance between biotic and abiotic factors in an ecosystem. Changes in even a single component can have a significant impact. A disruption such as a flood, drought or the introduction of a new species can alter the delicate balance of the ecosystem.

Within an aquatic ecosystem, climate change may increase water temperatures, modify the quantity and timing of river flow regimes, reduce water quality (i.e., increase sediments and pollutants, decrease oxygen levels) and increase the need for water development activities such as canal and reservoir construction. Increased water temperatures may force cold water species to migrate to higher latitudes or altitudes. Those organisms unable to relocate may die from thermal stress. Warmer water temperatures and modified flow regimes can influence growth rates and alter important life history events such as hibernation, migration and reproduction timing. Rising temperatures can disrupt food web interactions, increase disease transmission and may open the door for new biological invasions.

All organisms whether native, non-native or invasive, possess specific **adaptations** – or characteristics that enable them to live in a particular environment or habitat. All adaptations have a purpose such as helping the organism avoid predators, acquire food, reproduce, or survive in an ever-changing environment. These adaptations are what make an organism successful in a specific habitat. Invasive species (including aquatic nuisance species) often have physical traits or biological adaptations that enable them to live in a wide variety of habitats, reproduce and spread rapidly, and outcompete native species for important resources such as food and preferred habitats. Although climate change will affect different organisms in different ways, invasive species may ultimately benefit from climate change because of their ability to quickly adapt to changing conditions. Climate change induced increases in water

temperature, precipitation and carbon dioxide levels may help some aquatic nuisance species expand into new areas or allow a once benign species to become invasive.

Common characteristics of aquatic nuisance species that may give them an advantage under climate change – Not all aquatic nuisance species will have all of these traits, but most have one or more of these traits.

- Have few or no natural predators.
- Can live in many different aquatic habitats such as ponds, lakes, rivers, streams, ditches, estuaries, reservoirs, or puddles. Also known as a habitat generalist.
- Tolerate a wide range of aquatic conditions (e.g., water temperature, salinity, water velocity and substrate types).
- Can physiologically adapt to changing environmental conditions.
- Produce MANY offspring.
- Grow rapidly, mature quickly, and/or reproduce frequently.
- Possess unique modes of reproduction (e.g., fragmentation (small piece starts a new plant), asexual reproduction (offspring are from a single parent only)).
- Utilize multiple dispersal methods (e.g., wind, water current, volitional movement, hitchhiking on cargo ships or recreational gear).
- Can live out of water, or travel on land for a period of time.
- Quickly colonize disturbed habitats.
- Eat a wide range of food types. Also known as a food generalist.

<u>Preparation</u>

- Mark off start and finish line in gymnasium or outdoor area.
- Lead the class in a 20 minute review/discussion before moving outdoors for the activity.
    - Begin with a general discussion about adaptations. Remind students that different adaptations can help an animal acquire a specific type of food, move faster, avoid predators, or live in a specific habitat.
    - Choose a native organism (from species cards) and have the students discuss the adaptations that make it successful in its environment.
    - Discuss the adaptations many aquatic nuisance species have that give them an advantage over native species (see *Invent the Ideal Invader*).
    - Briefly introduce climate change and discuss what climate induced changes may occur in aquatic environment as a result of global warming.
    - Ask students how they think a changing climate might impact native and invasive species. Will native or invasive species do better after these changes?
    - Tell students that they will now participate in an activity that illustrates how adaptations may influence the survival of an organism impacted by climate change.

Directions

- Introduce the rules of the activity. Give each student a species card and go over the meaning of the symbols depicted on the back of their cards (see symbol key).
- Gather students in a gymnasium or outdoor area.
- Line students up shoulder to shoulder on the start line.
- Explain that students will move forward using heel-to-toe steps when an adaptation is spun on the game spinner and the instructor holds up the symbol for the appropriate adaptation.
- Students will move backwards using heel-to-toe steps when a climate change impact is spun on the game spinner and the instructor holds up the symbol for the appropriate climate change impact.
- Explain that the number of steps taken forward or back is indicated by the number of symbols on the back of their species card. For example, three growth symbols is equivalent to three heel-to-toe steps forward.
- If a student is caught taking too large or more steps than is indicated on their card, they must move back 5 steps.
- Continue to spin the adaptation and climate change game wheels alternately until at least ten students have crossed the finish line. These students have won the race for survival and are a part of the aquatic ecosystem.
- Have the members of the aquatic ecosystem line up along the finish line, with native and aquatic nuisance species on opposite sides.
- Have students that did not make it into the ecosystem sit in front of the standing students.
- One at a time, have each student in the aquatic ecosystem read their species name, state whether they are a native or an aquatic nuisance species, and explain what adaptations or climate change effects helped them make it to the finish line first.
- Ask some of the sitting students why they did not make it to the finish line.
- Explain that the organisms with the best adaptations for survival under the given conditions took more steps forward. If the activity is repeated, the results may or may not be the same because the climate and/or an organism's ability to adapt to a changing environment is not entirely predictable.
- Redistribute species cards and repeat the activity multiple times so students can observe different outcomes depending on what events were spun on the wheel(s).

Evaluation

Discuss the following as a class:

- How did the outcomes differ between rounds, if at all?
- Were certain species always included or always excluded from the ecosystem? Why?
- What characteristics of aquatic nuisance species made them more successful or unsuccessful under climate change? How about native species?

- What happens to those organisms that did not cross the "finish line"? Possible answers: migrate to new areas, survive but decline in abundance or perish.

Extensions

- Ask students to journal or write a paragraph about one of the following critical thinking questions:
    - Why do some organisms have difficulty adapting to a changing environment?
    - Will native or invasive species be more successful if the climate becomes warmer? Why? Possible answer: we don't know yet. Climate change will increase opportunities for some organisms and decrease them for others. Scientists predict that invasive species will have the upper hand because of their general adaptability to changing environments and tendency to colonize disturbed environments more quickly than native species. Invasive species also do well when environmental conditions become more suitable or are more similar to their native "home" climate. On the other hand, extreme temperature changes (drought or freezes) may reduce the range where certain species may live.
    - Are there any ANS that might do poorly if the climate becomes warmer over time? Possible answer:
        - Organisms with specific habitat or temperature needs.
        - Organisms with limited ability to move to new locations (e.g., mussels, plants).
        - Organisms that are more susceptible to changes in temperatures (e.g., amphibians, organisms at high altitudes).
- Create a poster that illustrates the impact climate change may have on an organism of their choice (native or invasive).

Source

This activity is an adaption of "What makes a good Invader?" a lesson from the Great Lakes Aquatic Invasive species and Climate Change K-12 Curriculum by Pennsylvania Sea Grant, www.paseagrant.org/education/curriculum/.

References

- www.epa.gov/climatechange/
- U.S. Environmental Protection Agency (EPA). (2008) Effects of climate change for aquatic invasive species and implications for management and research. National Center for Environmental Assessment, Washington, DC; EPA/600/R-08/014. Available at http://www.epa.gov/ncea.

KEY

Growth: on a scale of 1-5, with more icons meaning the species has a high growth rate.

Reproduction: on a scale of 1-5, with more icons meaning the species has a high rate of reproduction (i.e., reproduces frequently or has many offspring).

Spread: on a scale of 1-5, with more icons meaning the species is easily spread and/or is quick to colonize disturbed habitats.

Habitat: on a scale of 1-5, with more icons meaning the species can live in many different aquatic habitats (e.g., ponds, lakes, rivers, streams, ditches, estuaries, reservoirs, puddles).

↑Temperature: on a scale of 1-5, with more icons meaning the species is more sensitive to changes in water temperature.

↑ Flows: on a scale of 1-5, with more icons meaning the species is less tolerant of high flows or flooding conditions.

Drought: on a scale of 1-5, with more icons meaning the species is less drought tolerant.

Human Disturbance: on a scale of 1-5, with more icons meaning the species is more sensitive to human induced water development activities such as canal and/or reservoir construction.