Into the Outdoors

National Marine Sanctuary Foundation

National Marine Sanctuaries

MARINE SANCTUARIES MAKE CENTS!

5th-8th Grade Discussion Guide

Developed by: Emily Nienhaus-Stahl

SCIENCE CATEGORIES
Biology, Conservation, Sustainability, Environment

TIMEFRAME
30-60 minutes

MATERIALS
For Simulation Games: cards for MacroInvertebrate Mayhem, bandannas or cut pieces of cloth, rope or cones for boundaries.

KEY WORDS
Marine, Sanctuary, Sustainability, Economic, Community, Tarpon, Theory

LEARNING OBJECTIVES

Students will be able to:

- Identify the need for marine sanctuaries
- Explore the economic and community benefits of marine sanctuaries
- Determine how they can enjoy and protect marine sanctuaries themselves

ACTIVITY SUMMARY

In this activity, students will examine the economic impact of marine sanctuaries on the local community. They will weigh the positive and negative impact of making coastal waters into protected sanctuaries both for today and for the future.

BACKGROUND INFORMATION

You'll read on the website intro to this video, "it is estimated that around $8 billion is generated each year in coastal and ocean dependent economies, where National Marine Sanctuaries are located. Industries like sustainable tourism and responsible recreation benefit from the healthy ecosystem that a national marine sanctuary provides."

The video focuses on the perspective of fishing guide, Will Benton. Will lives in the Florida Keys and makes his living from leading fishing excursions. He is an advocate for protecting coastal ecosystems so the fisheries and other ecotourism can continue to provide a sustainable income well into the future for him, his children, and his community in the Florida Keys.

VOCABULARY

MARINE - Having to do with large bodies of water, such as the ocean or great lakes.

SANCTUARY - A place where organisms can take refuge, where they are protected and monitored for their own health and wellbeing.

SUSTAINABILITY - The act of planning ahead, where it is recognized that today's actions will determine tomorrow's resource availability, and resource management is prioritized for future use.

ECONOMIC - the study of production, consumption and transfer of wealth which indicates the presence of material prosperity.

COMMUNITY - a group of organisms who live in the same place and have interdependentrelationships.

TARPON - a large marine fish that is often seen around reefs in coastal waters near the Caribbean.

THEORY - a statement describing what happens and why it happens, based on scientific observations, and validated by the scientific method.

LEARNING PROCEDURE

INTRODUCTION:

In this activity, students will listen to what the main character of the video says, and speculate as to his beliefs and motivations. They will use observational evidence to support their theories about the main character, and discuss/debate with classmates respectfully, while supporting their viewpoints.

ACTIVITY 1:

1. Before watching the video, ask the students to write down the answer to this question, based on their observation while viewing. "What does Will Benton like most about Tarpon fishing?"

A. Ask students to speculate as to Will's favorite thing about Tarpon fishing BEFORE watching the video. Have them write it down.

B. Now instruct them to listen to what Will says is his favorite thing about Tarpon fishing. They should write down what they hear and observe from Will regarding his view of fishing in the Florida Keys.

2. After viewing the video, have students get together in groups of approximately 4 students. They will discuss what they observed, and put together a theory describing Will's favorite thing about Tarpon fishing, along with a list of supporting evidence gathered from their observations of the video.

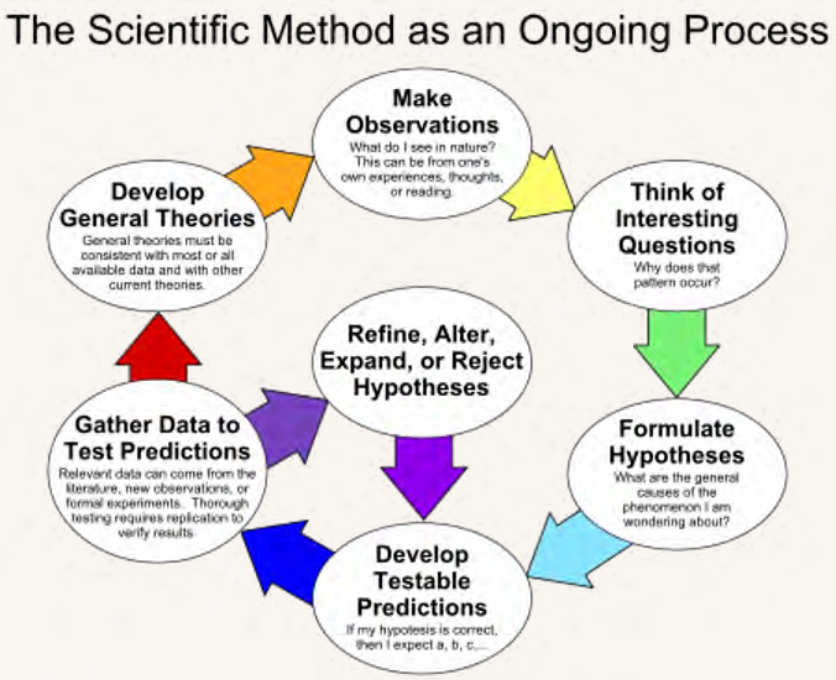
A. Students should have a statement ready in the form of a theory.

B. Students should have a list of supporting evidence ready to share.

3. Discuss the Scientific Method.

A. Define the Scientific Method as the process by which scientists use observations to make and test their theories about what happens and why it happens.

B. We can use a similar method to answer questions and evaluate statements made. We will use this method to evaluate the statements we just made, and determine whether our observations support or disprove our statements (which could also be called theories.)



4. Each student group will present their answer to the question and describe how they arrived at their conclusion about what is "Will Benton's favorite thing about Tarpon fishing".

A. Ask each group if they had considered other answers, and why they rejected those answers.

B. Ask each group what evidence they observed (heard or saw) that supported their conclusion.

C. Ask the rest of the class if they have anything else to add to the discussion at the conclusion of each group's presentation.

ACTIVITY 2:

1. Evaluate Will Benton's statement, "Hunters and fishers are often the most dedicated supporters of conservation." The continuance of hunting and fishing is based on acting out the concept of "sustainability".

A. Discuss the word "sustainable" as a class, and come up with your own group definition of the term.

B. Discuss what the opposite of sustainability might be.

C. How would hunters and fishers be affected by a lack of sustainability?

2. Often sustainability is more complex than just "don't take too many" of a particular resource. The Tarpon fish, for example, has many supporters in its ecosystem. The fish needs a place to spawn, the young need a safe place to grow, there must be plentiful food for Tarpon in all stages of growth, there must be clean water and appropriate habitat. To illustrate this concept, we will play a wildlife simulation game called "Macroinvertebrate Mayhem." A link to the game can be found in the resources below.

3. After playing the simulation game "Macroinvertebrate Mayhem," have the students debrief with you by asking these questions:

A. Think about your role in the game. Was it easy for you to find food and live through your "day in the life" of your invertebrate? What was the most difficult part of survival for you?

B. Did all invertebrates have the same situation, based on their needs?

C. What made it harder for some invertebrates to survive their day than others?

D. What happens to the population diversity of invertebrates when pressure is applied to the community?

E. If a fish like the Tarpon depended on a food source that was in the "sensitive" category, what would happen to the Tarpon population if the sensitive invertebrates were affected adversely by a degradation of their environment?

F. How did this simulation game deepen your understanding of sustainability?

4. If you have time, you may play another simulation game based on invasive species, or add invasive species into your Macroinvertebrate Mayhem game by speculating about their effect. Here are some examples:

A. If the invasive species are predators that are very aggressive at finding food, they might outcompete the older Tarpon at finding food so that they starve to death, or prey on the younger Tarpon, thus reducing the population and possibly endangering the survival of the fish.

B. If the invasive species are fish that have similar size and habitat requirements to young Tarpon, they may take the hiding spaces the young tarpon need and eat the same food, causing the young tarpon to starve or be eaten by predators for lack of hiding spots.

C. If the invasive species is a plant, it could outcompete the plants young Tarpon usually hide in, causing them to have no brooding area to grow up safely in.

CONCLUSION:

Hunters and fishers often are the biggest supporters of conservation and sustainability of threatened species because they understand the availability of their quarry is based on the health of the ecosystem the animals live in. In order to sustain ecotourism in ecosystems like the Florida Keys, the entire ecosystem must be studied, understood and supported.

EXTENDING THE LESSON

- Go to the partner website Sanctuaries.noaa.gov to see what recreation choices are available at National Marine Sanctuaries. Have students plan out a trip that they'd take to a National Marine Sanctuary of their choice. They must describe in detail what they would do for recreational activities, and what they would do to help conservation efforts by preserving the environment they're visiting. What behaviors would they avoid? What behaviors would they be sure to practice?

- Some people like to volunteer to help the places or animals they love. For example, volunteers travel every year to beaches in Mexico to help hatchling sea turtles to reach the ocean water. If you were going to volunteer at a marine sanctuary, where would you most like to go, and what would be your interest in helping there? If possible, look up the sanctuaries and the issues happening in each sanctuary by searching the Sanctuaries.noaa.gov and other websites containing information about the ecosystems and the challenges happening there.

RELATED LINKS (NATIONAL ORGANIZATIONS IN THIS LESSON)

- NOAA National Marine Sanctuaries official site: sanctuaries.noaa.gov
- Macroinvertebrate Mayhem game materials: watereducation.org/general-information/macroinvertebrate-mayhem
- Alternate source for Macroinvertebrate Mayhem game instructions: resourcesforee.weebly.com/uploads/2/7/0/2/27028195/macro_invertebrate_mayhem_directions.pdf
  (You may want to search for a tailored lesson plan for your state or area.)

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MACROINVERTEBRATE MAYHEM WORKSHEET

Friends of the Mukwonago River database, from Project Wet (20 minutes)

Developed by: Emily Nienhaus-Stahl

Students play a game that simulates changes in a stream when an environmental stressor, such as a pollutant, is introduced. They are shown a playing field and its boundaries.

A student volunteer is selected to become an "environmental stressor (e.g., sedimentation, sewage, or fertilizer). The group discusses ways that a stream can become polluted and how this can alter stream conditions (large groups will require more students to become stressors).

The class is divided into seven groups to play the game. Each group represents one type of macroinvertebrate species listed in Macroinvertebrate Groups. The number of members in each group is recorded, using a table as follows:

Organism	Tolerance	Numbers (at start/after each round)			
		Start	Round One	Round Two	Round Three
Caddisfly larva	Intolerant	5	2	2	2
Mayfly nymph	Intolerant	5	4	1	0
Stonefly nymph	Intolerant	4	4	4	2
Dragonfly nymph	Facultative	5	5	4	4
Damselfly nymph	Facultative	4	4	4	3
Midge larva	Tolerant	4	6	7	9
Rat-tailed maggot	Tolerant	4	6	9	11
TOTAL		31	31	31	31

Note: *Have at least four students in each group; for smaller classes, reduce the number of groups. For example, eliminate the stonefly nymphs and the damselfly nymph groups.*

Group members receive appropriate identification labels. The picture of each group's macroinvertebrate should face outward when labels are attached.

Students are informed that some macroinvertebrates have hindrances to crossing the field (see the following Intolerant Macroinvertebrates and Hindrances):

Intolerant Macroinvertebrates and Hindrances		
Organism	**Hindrance**	**Rational For Hindrance**
Caddisfly	Must place both feet in a bag* and hop across field, stopping to gasp for breath every five hops.	Caddisflies are intolerant of low oxygen levels.
Stonefly	Must do a push-up every ten steps.	When oxygen levels drop, stoneflies undulate their abdomens to increase the flow of water over their bodies.
Mayfly	Must flap arms and spin in circles when crossing field.	Mayflies often increase oxygen absorption by moving gills.
*Caddisfly larvae build cases and attach themselves to rocks for protection and stabilization.		

These obstacles symbolize sensitive organisms' intolerance to pollutants. Students then practice their motions.

Macroinvertebrate groups are assembled at one end of the playing field and the environmental stressor(s) at midfield. When a round starts, macroinvertebrates move toward the opposite end of the field and the stressor will try to tag them. To "survive," the macroinvertebrates must reach the opposite end of the field without being tagged by the environmental stressor. The environmental stressor can try to tag any of the macroinvertebrates but will find it easier to catch those with hindered movements.

Begin the first round of the game. Tagged macroinvertebrates must go to the sideline and flip their identification labels to display the more tolerant species (i.e., rat-tailed maggot or midge larva). Tagged players who are already in a tolerant species group do not flip their labels.

The round ends when all of the macroinvertebrates have either been tagged or have reached the opposite end of the playing field. The new number of members in each species is then recorded.

Students complete two more rounds, with all tagged players rejoining the macroinvertebrates who successfully survived the previous round. The numbers of members in each species of macroinvertebrates at the conclusion of each round is recorded. Because some players will have flipped their identification labels, there will be a larger number of tolerant species in each successive round.

The game is completed after three rounds. Discuss the outcome with students. Emphasize the changes in the distribution of organisms among groups. Have students compare population sizes of groups at the beginning and end of the game and provide reasons for the changes. Review why some organisms are more tolerant of poor environmental conditions than others. Have students compare the stream environment at the beginning of the game to the environment at the end.

Group members receive appropriate identification labels. The picture of each group's macroinvertebrate should face outward when labels are attached.

Students are informed that some macroinvertebrates have hindrances to crossing the field (see the following Intolerant Macroinvertebrates and Hindrances):

BACKGROUND INFORMATION

Macroinvertebrates (organisms that lack an internal skeleton and are large enough to be seen with the naked eye) are an integral part of wetland and stream ecosystems. Examples of macroinvertebrates include mayflies, stoneflies, dragonflies, rat-tailed maggots (maggot is the term used for the larva of some flies), scuds, snails, and leeches. These organisms may spend all or part of their lives in water; usually their immature phases (larvae and nymphs) are spent entirely in water. Larvae do not show wing buds and are usually very different in appearance from the adult versions of the insects. Nymphs generally resemble adults but have no developed wings and are usually smaller.

A variety of environmental stressors can impact macroinvertebrate populations. Urban and/or agricultural runoff can produce conditions that some macroinvertebrates cannot tolerate. Sewage and fertilizers added to streams induce the growth of algae and bacteria that consume oxygen and make it unavailable for macroinvertebrates. Changes in land use from natural vegetation to a construction site or to poorly protected cropland may add sediment to the water. Sedimentation destroys habitats by smothering the rocky areas of the stream where macroinvertebrates live. The removal of trees along the banks of a river and alteration of stream velocity can both alter normal water temperature patterns in the stream. Some organisms depend on certain temperature patterns to regulate changes in their life cycles. Other stressors include the introduction of alien species and stream channelization.

Some macroinvertebrates, such as the mayfly and stonefly nymphs and caddisfly larvae, are sensitive (intolerant) to changes in stream conditions brought about by pollutants. Some of these organisms will leave to find more favorable habitats, but others will be killed or will be unable to reproduce.

Macroinvertebrates (e.g. , rat-tailed maggots and midge larvae) that may thrive in polluted conditions are called tolerant organisms. Other organisms, called facultative organisms (e.g., dragonfly and damselfly nymphs) prefer good stream quality but can survive polluted conditions.

Water quality researchers often sample macroinvertebrate populations to monitor changes in stream conditions over time and to assess the cumulative effects of environmental stressors. Environmental degradation will likely decrease the diversity of a community by eliminating intolerant organisms and increasing the number of tolerant organisms. If the environmental stress is severe enough, species of intolerant macroinvertebrates may disappear altogether. For example, if a sample of macroinvertebrates in a stream consists of rat-tailed maggots, snails, and dragonfly nymphs, the water-quality conditions of that stream are probably poor (i.e., low oxygen level, increased sediment, contaminants). If, on the other hand, the sample contains a diversity of organisms, the stream conditions are likely good. However, baseline data is essential because some healthy streams may contain only a few macroinvertebrate species. A variety of good sources, adequate oxygen levels, and temperatures conducive to growth all characterize a healthy stream.

MACROINVERTEBRATE TOLERANCE TO POLLUTION

Artwork: Gould League of WA and Waterwatch SA

SENSITIVE MACROINVERTEBRATES

STONEFLY LARVAE

Stonefly larvae have two long tails, tubes of thread-like gills on their undersides, wing pads, antennae, and two claws on each foot. They are found among stones or plants in clear, cool, well oxygenated streams.

MAYFLY LARVAE

Mayfly larvae have three long filaments at the end of their abdomen, with wing pads and lateral gills along the abdomen. They have short antennae, and a single claw on each foot. They are found under stones in fast flowing water or among plants in slow flowing water.

CADDISFLY LARVAE

These are worm-like insect larvae with three pairs of legs on the first three body segments. They are usually found in cases made from rolled leaves or hollow twigs, with only their head and legs protruding when they move. “worm-like” appearance- 6 legs near head

DRAGONFLY LARVAE

Dragonfly larvae are short, chunky predators with wing pads and internal gills. They are found on plants, among stones and leaf litter, or on the bottom.

DAMSELFLY LARVAE

Damselfly larvae are more slender than dragonflies, have a distinct head section, and three gills on the tail tip. They are also found on plants, among stones and leaf litter, or on the bottom.

TOLERANT MACROINVERTEBRATES

BEETLE LARVAE

Beetle larvae may be confused with other animals. They are segmented, have three distinct pairs of legs, are never found in cases, but have a wide variety of forms. They are very active, aggressive predators with large mouth parts, and are found in all habitats.

BEETLES (COLEOPTERA)

Beetles have hard front wings folded side by side along the center of the back. From above, they have a more oval shape than bugs. Beetles have biting mouth parts They are found on plants, or swimming in or on the water at all levels.

BUGS (HEMIPTERA)

Bugs tend to be shield shaped when viewed from above. Their soft front wings are folded and overlap to leave a small triangle on the back, and they have sucking mouthparts They are found among the aquatic plants on the water's surface, or swimming freely at all levels of slowly flowing water. Water boatmen and backswimmers are bugs.

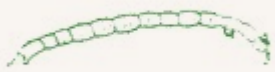
VERY TOLERANT MACROINVERTEBRATES

FLY LARVAE

There are many types of fly larvae. They are worm-like creatures with no legs, or stumpy unjointed legs, and may have a sucker on the abdomen and a brush on the head. They occur in all sorts of aquatic habitats; swimming, on rocks, or on the bottom.

MIDGE LARVAE

Midge larvae are slender worm-like creatures, sometimes red, with no legs, or stumpy unjointed legs, and bristles. They are found in all sorts of aquatic habitats; swimming, on rocks, or on the bottom.



MACROINVERTEBRATE MAYHEM GAME CARDS:

Cut and use triplicate cards for students to wear/carry.

Print and use cheat sheet cards for game conclusion and interpretation.

ORGANISM	TOLERANCE	NUMBERS (AT START AND AFTER EACH ROUND)			
		START	ROUND ONE	ROUND TWO	ROUND THREE
Caddisfly larva	Intolerant				
Mayfly nymph	Intolerant				
Stonefly nymph	Intolerant				
Dragonfly nymph	Facultative				
Damselfly nymph	Facultative				
Midge larva	Tolerant				
Rat-tailed maggot	Tolerant				
TOTAL					

Note: *this chart is used only for the Macroinvertebrate Mayhem game to illustrate to students the change in species composition over time when environmental stressors are present.*

	Group 1 Pollution Sensitive Organisms	Group 2 Somewhat pollution tolerant organisms	Group 3 Pollution tolerant organisms
Step 1: Check off the organisms found in the stream.	❑ Stonefly larvae ❑ Caddisfly larvae ❑ Mayfly nymph ❑ Riffle beetle ❑ Alderfly larvae ❑ Dobsonfly larvae ❑ Hellgramite ❑ Water Penny larvae ❑ Gilled snail ❑ Planaria ❑ Tadpole	❑ Dragonfly larvae ❑ Damselfly larvae ❑ Scud ❑ Water Scorpion ❑ Water Boatman ❑ Backswimmer ❑ Cranefly larvae ❑ Whirligig Beetle larvae/adult ❑ Water Beetle larvae ❑ Giant Water Bug ❑ Crayfish ❑ Clam	❑ Blackfly larvae ❑ Water Snails ❑ Pouch Snails ❑ Midge larvae ❑ Mosquito larvae ❑ Leeches ❑ Aquatic worms
Step 2: Add up how many different species were found in each column:			
Step 3: Multiply by the tolerance index value:	x 3	x 2	x 1
Add the results together	+	+	=

Step 4: Use this chart to determine the health of the stream.

Pollution Tolerance Index (PTI)	Stream Quality Assessment
23+	Excellent
17-22	Good
11-16	Fair
10 or less	Poor

Note: *This is the actual chart used when evaluating invertebrates students would catch at a stream. You may use it to explain how we evaluate the health of the stream by using the sensitive species as indicators of stream health.*

Caddisflies build heavy cases of pebbles, sticks or leaves to protect themselves. They absorb oxygen through their exoskeleton and are filter feeders, eating mainly small plant particles or algae.

Caddisfly Larva

*** You must place both feet in a sack and hop across the field! ***

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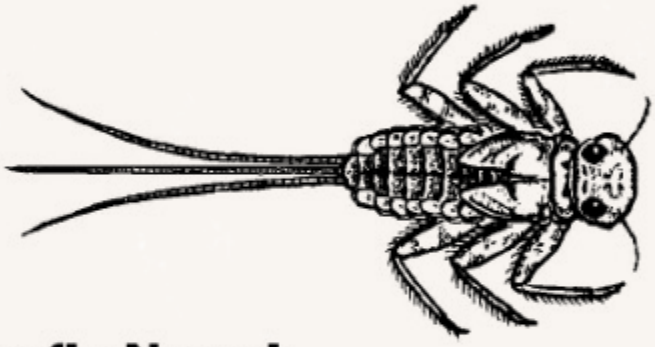
Macroinvertebrate Mayhem game cards, highly sensitive species (intolerant)

Mayflies have gills along the side of their abdomen in order to 'breathe.' Medium to high dissolved oxygen levels are needed for the mayfly to live. The mayfly nymph eats algae and small plant particles. The mayfly nymph has 1 set of wing pads on its thorax and can have 2 or 3 tails.

Mayfly Nymph

*** You must flap your arms & spin in circles when crossing the field! ***



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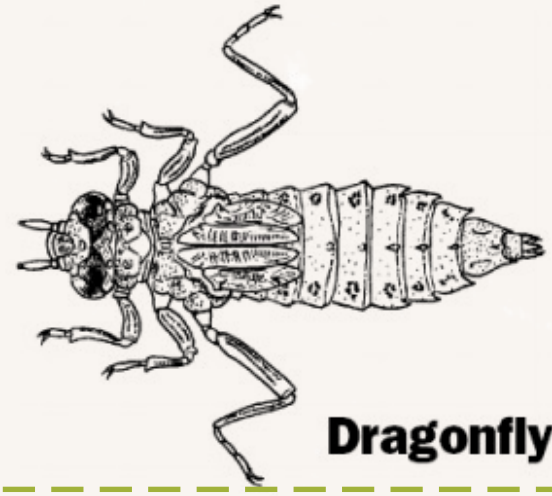
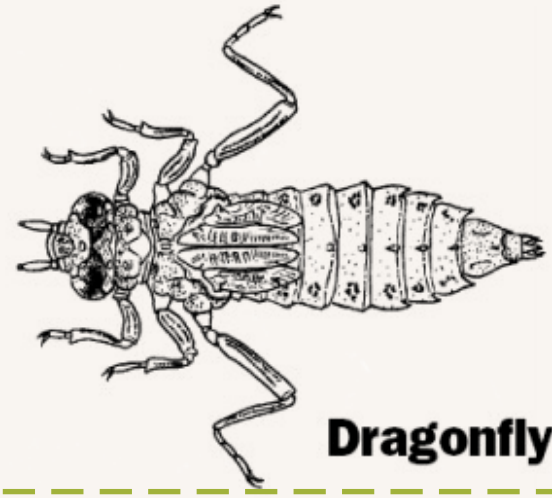


Dragonfly Nymph

A dragonfly nymph gets oxygen by pulling water into a rectal chamber where gills remove dissolved oxygen from the water. The dragonfly can expel this water like an underwater jet to help the nymph catch its prey. The dragonfly nymph is an active predator with a special jaw for grasping prey. It hides in clumps of dead leaves or sediment waiting to ambush prey from macroinvertebrates to small fish!



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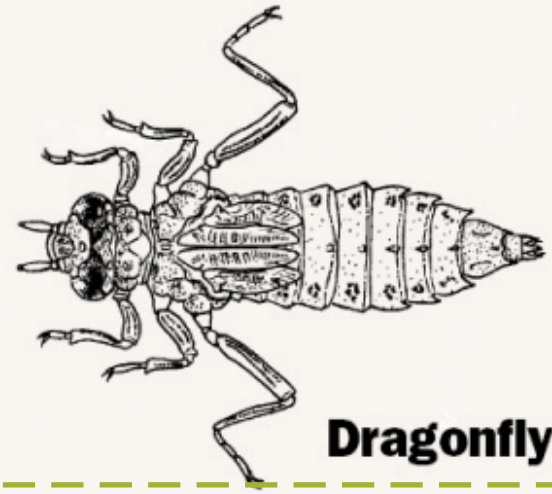

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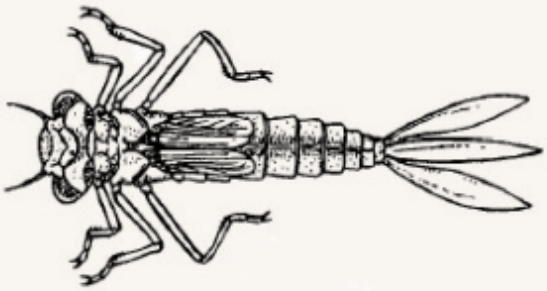
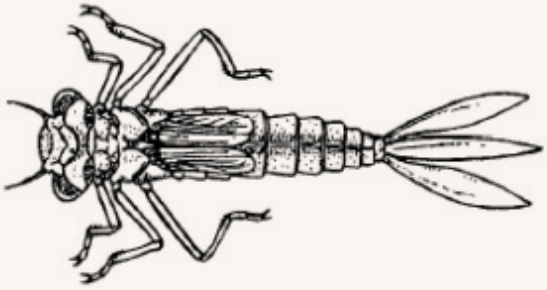
Macroinvertebrate Mayhem game cards, somewhat sensitive species (somewhat tolerant)



Damselfly Nymph

A damselfly nymph moves through water by moving its abdomen and "tails" from side to side. Gills inside the 'tails' gather dissolved oxygen from the surrounding water, which allows the damselfly to 'breathe.' The damselfly is an active predator that clings to vegetation or hides in clumps of dead leaves or sediment waiting to ambush prey.



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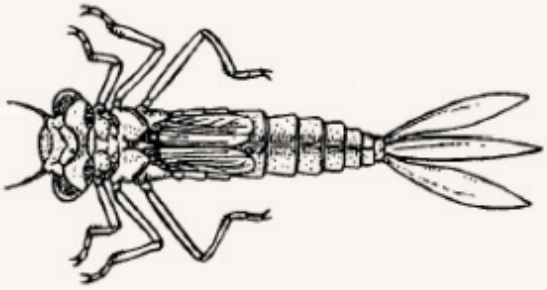

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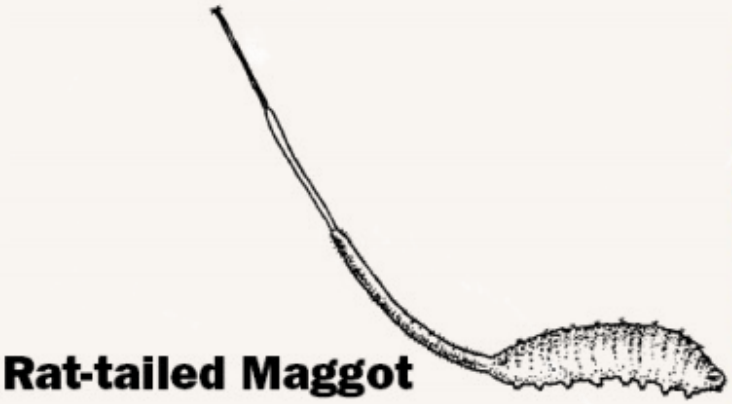
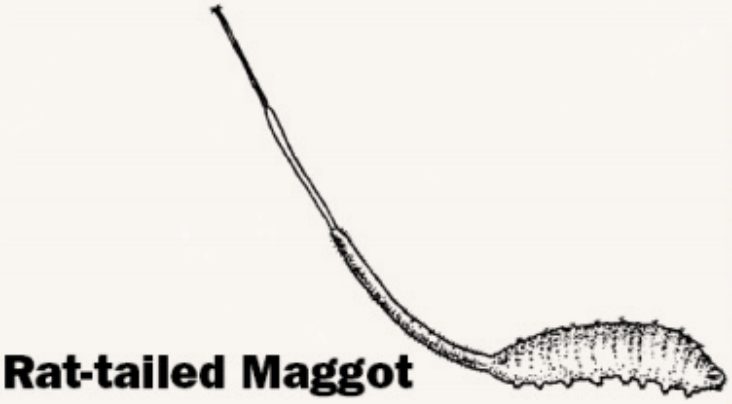
Macroinvertebrate Mayhem game cards, somewhat sensitive species (somewhat tolerant)



Rat-tailed Maggot

Rat-tailed maggots can survive low oxygen levels fatal to most invertebrates. Their name comes from their tail-like breathing tube. Rat-tailed maggots scavenge decaying matter and sewage in cool to warm water with low oxygen levels.



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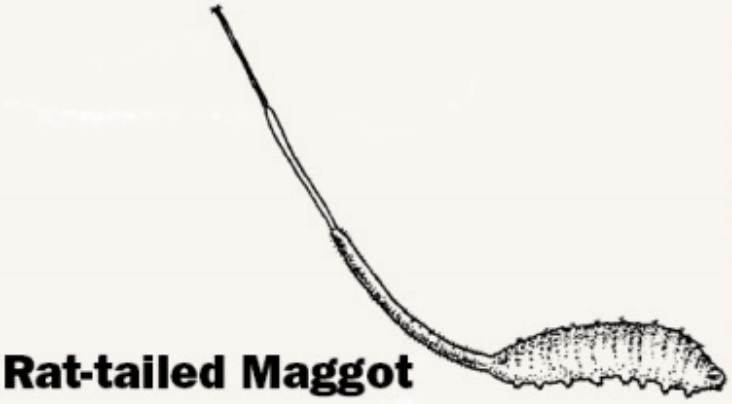

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Macroinvertebrate Mayhem game cards, mostly tolerant species (highly tolerant)

Stonefly Nymph

Stonefly nymphs absorb oxygen through their body surface and small gills that 'look like hairy arm pits' - They only tolerate water with high oxygen levels and do 'push-ups' to increase oxygen flow over their bodies when stressed. Stonefly nymphs have 2 sets of wing pads and 2 tails and a body designed to crawl over rocks in rapids to eat algae or small insects.

*** You must touch your toes every (10) steps!***

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Macroinvertebrate Mayhem game cards, highly sensitive species (intolerant)

Environmental Stressor

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Macroinvertebrate Mayhem game cards, environmental stressor (pollution, invasive species, habitat loss, predation, etc.)

INVASIVE SPECIES SIMULATION GAME

PURPOSE:

Students will see how invasive species steal resources away from native species at a rate sufficient to possibly make native species extinct.

MATERIALS AND SITE:

- Bandanas, fabric strips or other items easy to pick up and hold in multiples
- Playing space (doesn't need to be large or level, students won't move much.)

ROUND ONE

1. Tell students to spread around the area you're standing in, wherever they want to be.

2. Randomly distribute the items around on the ground.

3. Tell the students that they are individual plants. What happens when plant roots come out of the ground? (They die.) Since they are plants, their feet have to stay both planted on the ground. If their feet are not touching the ground (i.e. they take a step) they'll be considered dead and will have to sit down for the rest of the game.

4. On your mark, students will all grab as many of the items that they can. 1,2,3 … go.

5. After the items they can reach are gathered, have them count the amount each of them was able to gather. Ask for a raise of hands … Who has 1? 2? 3? … and so on, until you see the range.

6. Tell them that the items were resources. The plants that got the most resources were able to grow the biggest. The students who had the top 3 amounts grew the most and will have an advantage in round 2. What resources do plants need, by the way? (light, water, soil with nutrients and minerals)

ROUND TWO

1. Round 2 starts with the same set-up as before, but the 3 plants that gathered the most resources last time are bigger and will have more range. Those students ONLY will be allowed to move one foot to extend their reach. They must keep the other foot anchored completely - i.e. they can pivot or stretch but not pick it up.

2. On your mark, students will all grab as many of the items that they can. 1,2,3 … go.

3. After the items they can reach are gathered, have them count the amount each of them was able to gather. Ask for a raise of hands … Who has 1? 2? 3? … and so on, until you see the range.

4. The plants that got the most resources were again able to grow the biggest. The students who had the top 3 amounts grew the most and will have an additional advantage in round 3. If they already can move one foot, they can still do that plus this next thing. If they were not granted that right in round 2, they can only do this next bonus, but not pick up one foot as well (that was the reward for round 1.)

ROUND THREE

1. Round 3 starts with the same set-up as before, but the plants that gathered the most resources last time are stronger and will bud first. Those students ONLY will be allowed to start gathering early. When you start your countdown, they can gather at "1", but everyone else has to wait until "go". (Cheaters forfeit their resources and end up dead remember …)

2. On your mark, students will all grab as many of the items that they can. 1,2,3 … go.

3. After the items they can reach are gathered, have them count the amount each of them was able to gather. Ask for a raise of hands … Who has 1? 2? 3? … and so on, until a pattern is revealed.

DEBRIEF:

What kinds of things did they notice had an influence on their ability to compete for resources? Did it feel "fair"? The plants that had the advantage were growing like invasive species do. They have a better ability to dominate over other plants, and often take the resources of native species until they die, or outright kill them through hunting or poison! (Some plants put out chemicals into the soil that keep any other plant from growing there.)

Do they see how space may become the 4th resource? Plants cannot migrate to move away from overcrowded areas, or to where resource availability is better, so those individuals die. Enough of them die, and a species can become threatened, then endangered, then extinct!

ALIEN INVADERS SIMULATION GAME

PURPOSE:

To help students consider how invasive species from other countries or areas colonize a new place, and what would happen if we all tried to stop them.

MATERIALS AND SITE:

- Bandanas or fabric scraps (something easy to pick up and grab)
- A rope or two cones to make a line boundary
- A flat, wide open space suitable for running

ROUND ONE

1. Lay down the cones or rope, and have students line up on that boundary.

2. Throw out the items they'll pick up on the other side of the boundary in the playing field.

3. Explain to the students that the items represent resources. Their goal is to walk out into the playing field and pick one up, then walk back across the line.

4. Ready, set, go … let students execute your instructions.

5. After they have all returned with their item, ask them if that was hard? They'll likely respond that it was too easy. You'll make it harder in future rounds.

ROUND TWO

1. Lay out the playing field just as before, with students lined up as they were and empty hands.

2. Pick up 3 items and give them to random students.

3. Explain that only the students with an item get to go out on the playing field. While out there they can pick up an additional item and bring it back to the line. They'll pass the new item off to another student, who will now also be able to go get an additional item. (As if the first item is a passport, and they're helping transport others of their kind across the border.) Students may only move when they're carrying an item and may never have more than two items in their hands.

4. The round ends when all students have an item. Ask how that round executed differently? How did it feel different?

ROUND THREE

1. Lay out the playing field just as before, with students lined up as they were and empty hands.

2. Pick up 3 items and give them to random students.

3. Choose 2 students to stand in the playing field to catch the aliens. If they tag a student who is across the line, that student MUST drop 1 item immediately. If that means they have no items, they must return to the other side of the line. If that means they still have one item, they may return to the other side to rest and think, or they may try to grab another one.

4. The round ends when either all students on the other side of the line have one item, or no students on the other side of the line have any items. Ask them how that round played differently? How did it feel different?

ROUND FOUR

Note: Round 4 plays out just like Round 3, with one exception.

1. Lay out the playing field just as before, with students lined up as they were and empty hands.

2. Pick up 3 items and give them to random students.

3. Choose 6 students to stand in the playing field to catch the aliens. If they tag a student who is across the line, that student MUST drop 1 item immediately. If that means they have no items, they must return to the other side of the line. If that means they still have one item, they may return to the other side to rest and think, or they may try to grab another one.

4. The round ends when either all students on the other side of the line have one item, or no students on the other side of the line have any items, or in this case - if they refuse to move. Ask them how that round played differently? How did it feel different?

DEBRIEF:

In the last round, the students may realize you set up a stalemate… There is very little chance that anyone will be able to get any of the items, because there are two guardians for each runner who have the ability to cross and pick up.

Ask them to consider this interpretation: What if …

- The items were habitats
- The runners were invasive species
- The catchers were government officials trained to keep alien species out of the country or citizens trained to watch for them?

1. If no one is controlling entry, what will happen?

2. If entry is slowed by public announcement, but not patrolled, what will likely happen?

3. If some effort into stopping entry is invested by the government, what may happen?

4. If strong effort into stopping entry is invested by the government AND informed citizens, what would be the outcome?

Ask them what they think we should do concerning alien species, and how do they play a role right now? If they're not informed and do nothing, are they still playing a role? How would the outcome be different if they choose to be informed and involved, and also tell others?

This may be a great time to go do some stewardship activities involving service projects, where we will get our hands dirty removing invasive species (and helping native ones)!

The following National Common Core Standards can be met teaching;

MARINE SANCTUARIES MAKE CENTS!:

GRADE 5:

CCSS.ELA-LITERACY.RI.5.1	Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.
CCSS.ELA-LITERACY.RI.5.3	Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.
CCSS.ELA-LITERACY.RI.5.4	Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.
CCSS.ELA-LITERACY.RI.5.7	Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.
CCSS.ELA-LITERACY.RI.5.8	Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).
CCSS.ELA-LITERACY.RF.5.3	Know and apply grade-level phonics and word analysis skills in decoding words.
CCSS.ELA-LITERACY.RF.5.4	Read with sufficient accuracy and fluency to support comprehension.
CCSS.ELA-LITERACY.W.5.7	Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
CCSS.ELA-LITERACY.W.5.8	Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.
CCSS.ELA-LITERACY.W.5.9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
CCSS.ELA-LITERACY.SL.5.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.
CCSS.ELA-LITERACY.SL.5.2	Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
CCSS.ELA-LITERACY.SL.5.3	Summarize the points a speaker makes and explain how each claim is supported by reasons and evidence.
CCSS.ELA-LITERACY.SL.5.4	Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.
CCSS.ELA-LITERACY.SL.5.6	Adapt speech to a variety of contexts and tasks, using formal English when appropriate to task and situation.
CCSS.ELA-LITERACY.L.5.1	Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
CCSS.ELA-LITERACY.L.5.3	Use knowledge of language and its conventions when writing, speaking, reading, or listening.
CCSS.ELA-LITERACY.L.5.4	Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 5 reading and content, choosing flexibly from a range of strategies.

CCSS.ELA-LITERACY.L.5.6	Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal contrast, addition, and other logical relationships (e.g., however, although, nevertheless, similarly, moreover, in addition).

GRADE 6:

CCSS.ELA-LITERACY.RI.6.1	Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
CCSS.ELA-LITERACY.RI.6.3	Analyze in detail how a key individual, event, or idea is introduced, illustrated, and elaborated in a text (e.g., through examples or anecdotes).
CCSS.ELA-LITERACY.RI.6.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.
CCSS.ELA-LITERACY.RI.6.7	Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
CCSS.ELA-LITERACY.RI.6.8	Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.
CCSS.ELA-LITERACY.W.6.7	Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
CCSS.ELA-LITERACY.W.6.8	Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.
CCSS.ELA-LITERACY.SL.6.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.
CCSS.ELA-LITERACY.SL.6.2	Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.
CCSS.ELA-LITERACY.SL.6.3	Delineate a speaker's argument and specific claims, distinguishing claims that are supported by reasons and evidence from claims that are not.
CCSS.ELA-LITERACY.SL.6.4	Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.
CCSS.ELA-LITERACY.SL.6.6	Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.
CCSS.ELA-LITERACY.L.6.1	Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
CCSS.ELA-LITERACY.L.6.3	Use knowledge of language and its conventions when writing, speaking, reading, or listening.
CCSS.ELA-LITERACY.L.6.4	Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 6 reading and content, choosing flexibly from a range of strategies.
CCSS.ELA-LITERACY.L.6.6	Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

GRADE 7:

CCSS.ELA-LITERACY.RI.7.1	Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
CCSS.ELA-LITERACY.RI.7.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of a specific word choice on meaning and tone.
CCSS.ELA-LITERACY.RI.7.8	Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims.
CCSS.ELA-LITERACY.W.7.7	Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
CCSS.ELA-LITERACY.W.7.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
CCSS.ELA-LITERACY.SL.7.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.
CCSS.ELA-LITERACY.SL.7.2	Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.
CCSS.ELA-LITERACY.SL.7.3	Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence.
CCSS.ELA-LITERACY.SL.7.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
CCSS.ELA-LITERACY.SL.7.6	Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.
CCSS.ELA-LITERACY.L.7.1	Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
CCSS.ELA-LITERACY.L.7.3	Use knowledge of language and its conventions when writing, speaking, reading, or listening.
CCSS.ELA-LITERACY.L.7.4	Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 7 reading and content, choosing flexibly from a range of strategies.
CCSS.ELA-LITERACY.L.7.6	Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

GRADE 8:

CCSS.ELA-LITERACY.RI.8.1	Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
CCSS.ELA-LITERACY.RI.8.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.
CCSS.ELA-LITERACY.RI.8.8	Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.

CCSS.ELA-LITERACY.W.8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
CCSS.ELA-LITERACY.W.8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
CCSS.ELA-LITERACY.SL.8.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
CCSS.ELA-LITERACY.SL.8.2	Analyze the purpose of information presented in diverse media and formats (e.g., visually, quantitatively, orally) and evaluate the motives (e.g., social, commercial, political) behind its presentation.
CCSS.ELA-LITERACY.SL.8.3	Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced.
CCSS.ELA-LITERACY.SL.8.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
CCSS.ELA-LITERACY.SL.8.6	Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.
CCSS.ELA-LITERACY.L.8.1	Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
CCSS.ELA-LITERACY.L.8.3	Use knowledge of language and its conventions when writing, speaking, reading, or listening.
CCSS.ELA-LITERACY.L.8.4	Determine or clarify the meaning of unknown and multiple-meaning words or phrases based on grade 8 reading and content, choosing flexibly from a range of strategies.
CCSS.ELA-LITERACY.L.8.5	Demonstrate understanding of figurative language, word relationships, and
CCSS.ELA-LITERACY.L.8.6	Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

6TH - 8TH GRADE:

CCSS.ELA-LITERACY.RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts.
CCSS.ELA-LITERACY.RST.6-8.2	Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
CCSS.ELA-LITERACY.RST.6-8.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.
CCSS.ELA-LITERACY.RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
CCSS.ELA-LITERACY.RST.6-8.8	Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
CCSS.ELA-LITERACY.RST.6-8.9	Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
CCSS.ELA-LITERACY.WHST.6-8.1	Write arguments focused on discipline-specific content.

CCSS.ELA-LITERACY.WHST.6-8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCSS.ELA-LITERACY.WHST.6-8.5 With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.

CCSS.ELA-LITERACY.WHST.6-8.6 Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.

CCSS.ELA-LITERACY.WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

CCSS.ELA-LITERACY.WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

NEXT GENERATION SCIENCE STANDARDS:

GRADE 5:

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

GRADES 6-8:

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]