Into the Outdoors

Educational Partner: Great Lakes Indian Fish & Wildlife Commission

MARK AND RECAPTURE FOR SUSTAINABILITY

7th-12th Grade Discussion Guide

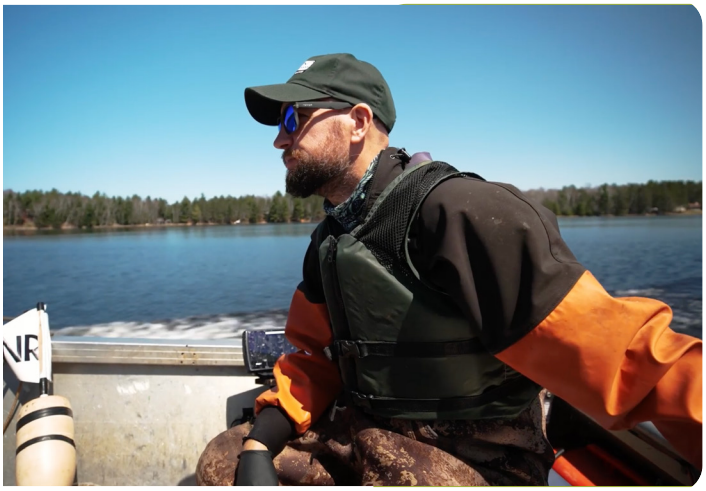
Developed by: Christina DiLorenzo

SCIENCE CATEGORIES
Ecosystems, Resource Conservation, Populations, Data Collection

TIMEFRAME
2-3 Lessons

MATERIALS
Computer access for research and presentation, poster paper, calculators, elements of habitats cards, yarn, goldfish crackers

KEY WORDS
Estimate, Spawning, Mark-Capture, Sustainable, Sample, Population



LEARNING OBJECTIVES

Students will be able to:

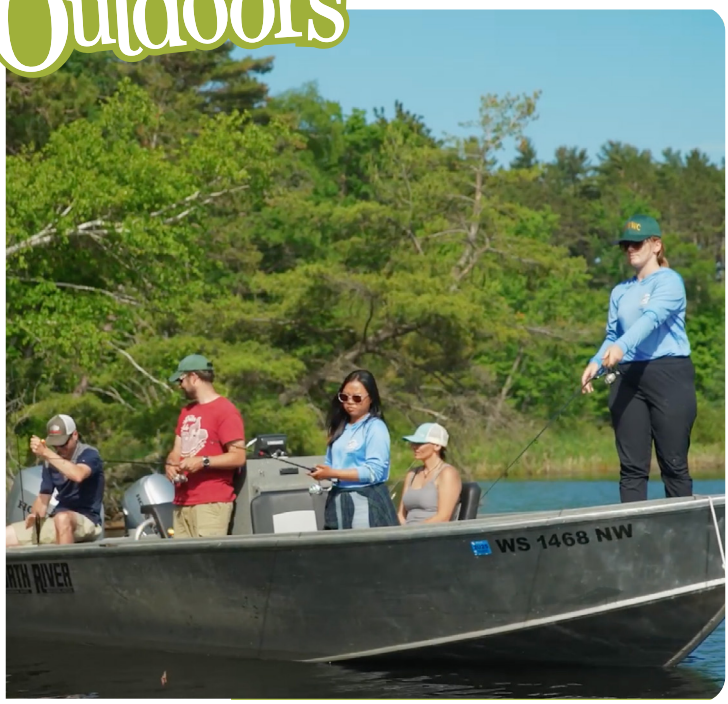
- Identify the different components in a habitat and describe how each works together within the habitat.
- experiment to find a balance between fishing and reproduction of fish.
- Investigate one method used by biologists to estimate the population size of animals in natural habitats.
- Use the mark-recapture method to estimate the number of kernels in a container.

ACTIVITY SUMMARY

In this lesson, students will learn how data plays an important role in managing walleye populations. Students will explore the methods that Wisconsin's fisheries use and will simulate an investigation that helps them to evaluate the use of data in maintaining a balance in the ecosystem.

The lesson will begin with students:

- Reviewing and thinking about components of habitats and ecosystems.
- Simulating an ocean food web to understand and demonstrate the affect small changes on one organism in a habitat can affect the overall ecosystem.
- Estimating and evaluating sample populations by utilizing the mark and recapture method.
- Developing alternative solutions to manage the walleye population.



VOCABULARY

ESTIMATE - A determination of the approximate number of something.

SPAWNING - Releasing or depositing eggs.

MARK-CAPTURE - A survey method that involved tagging or otherwise marking an initial number of fish and releasing them back into the population. A subsequent sample is taken and numbers of marked fish are compared to numbers of unmarked fish in the sample to statistically estimate population size.

POPULATION - The collection of organisms of the same species inhabiting a given geographic area.

SUSTAINABLE - Able to be maintained at a certain rate or level.

SAMPLE - A representative smaller number of a given population.

BACKGROUND INFORMATION

Sustainability is the preservation of natural resources to maintain an ecological balance. Sustainable development focuses on meeting the needs of the population without compromising the ability of future generations to meet their own needs.

Fish are an important component of the oceans' web of life. It is not always recognized how important they are as wildlife in interdependent ecosystems. Fish have been previously thought to be an unending supply of food. As technology has increased, so has the ability of the scientific community to better understand the roles fish play in the ocean and the effects people have on them and the ecosystems in which they live.

Walleye are an iconic native fish species in Wisconsin, the upper Midwest and Canada. They are noted by anglers as being the favorite fish to catch, making walleye the most popular fish in Wisconsin. Walleye populations are in decline in some Wisconsin lakes. Despite decades of research, the exact reason why walleye populations are declining is not known, although there are many impacting factors. Research suggests it is likely a combination of factors, including climate change, habitat degradation and harvest rates that at times outpace production levels. Additional research is ongoing regarding what declining production means for future walleye harvests in the region. The most important step is collecting data which measures what is leaving versus what is coming in to ensure a balance is maintained. Two methods are generally used for capturing fish to collect data: fyke nets and electrofishing. Surveyors are collecting data on the length of the fish, sex, and condition of the fish, as well as age according to dorsal spine. The data helps officials set size regulations and determine how fast the fish are being harvested (or dying). The use of the mark and recapture method is important in determining at what life stage the walleye are declining during.

There is only a short window to measure the spawning population. Walleye are broadcast spawners, releasing their egg over vegetation or rocky substrate. Fertilized eggs stick to the plants or rocks on which they land. These fish are named walleye because of the fish's large, glossy eyes which give them excellent vision in low light conditions. Walleye have a long slender body with a yellow to olive color on the sides and a white belly. The bottom tip of the tail has a distinct white mark and they have needle sharp teeth. Walleye typically weigh 1-8 pounds.

Our oceans are increasingly affected by human activities, one of which is by the ways we catch seafood. This activity focuses on the threat of fishing, and some possible solutions for that specific issue. Nearly 85% of the world's fisheries are fished to capacity or overfished. This means that wildlife populations in the ocean, from fish to turtles to seabirds, are put at risk. It also means that the people who depend on the fisheries for their own survival are at risk.

Stocking is used to maintain or restore declining walleye populations. Walleyes play a vital role in maintaining the balance in aquatic ecosystems by regulating populations of other species that they prey upon like perch or ciscoes. Understanding this helps raise awareness about preserving these valuable food sources.

LEARNING PROCEDURE

INTRODUCTION:

Ask students to describe what a habitat is (a place where something lives, an environment, etc.). Tell students a habitat is the natural home or environment of an animal, plant, or other living thing. Have students brainstorm and list the components of a habitat. Guide students with prompts for each of the components if needed.

Organize students into small groups to briefly discuss and describe different habitats. Tell students to name the elements of a chosen habitat (trees, dirt, wet, cold or warm, birds, deer, etc.). Ask students to then describe one element of the habitat and how it is connected to the other elements. Example: a bird lives in a tree, builds a nest with sticks, moss, etc, eats worms in the dirt, and gets water from nearby lakes or the rain.

Review the concept of ecosystems: the way a group of living organisms interacts with their environment.

Explain to students they will model the interconnectedness within an ecosystem. Instruct students to stand in a large circle. Each student will receive a card with an element of a habitat written on it (bird, tree, sun, soil, water, etc.). One student will start with holding a ball of yarn, then toss the yarn to another element and describe how the two are related. The process will continue until each student/element is holding a piece of the yarn. Use an example to show students the process (the tree tosses the yarn to the bird because the bird lives in the tree; the bird tosses the yarn to the worm because the bird eats the worm; etc.). Once each student is holding a piece of yarn, the teacher will announce a disruption in the ecosystem (ex. overfishing). The student holding the string representing the element will pull his or her string. The students who felt the tug will raise their hands, so other students may see who was affected. The students who raised their hands will then tug on their yarn, repeating the process. Discuss with students how these disruptions in the ecosystem can be an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants. (Additional disruptions may be announced to repeat the process as many times as desired.)

Students will discuss how and why each change in the environment affected the surrounding organisms. Students will provide suggestions for solutions to prevent these changes in the habitat and ecosystem

ACTIVITY 1:
(Discussion, worksheet, or experiment done as a class or within small groups.)

Have students imagine they are walking through the store, when they come across the seafood section. Ask, "What kind of food do you expect to be here?" (Students may list any seafood they are familiar with such as shrimp, crab, lobster, salmon, haddock, etc.)

Ask students, "Where did this come from?" As they offer answers, guide them to the question, "Did it come from a farm?"

Continue the discussion by asking if there is a difference between fishing and farming. Some specific questions to guide your discussion might be What is farming?, What is fishing?, How are fishing and farming different/the same?, Is the fish you eat from a farm or from the ocean?

Now that students have thought about a few methods used to harvest fish, tell them that this activity will focus on an ecological issue with wild-caught fish.

Review the basic concepts of a food web. Give examples if needed to help students recall that a food web is a system of interlocking and interdependent food chains. Ask students to give examples of food chains and webs that can be found in an ocean.

Introduce the activity by telling students that they will be simulating an ocean food web using colored goldfish crackers. Explain that in this ocean's food web the plain yellow goldfish eat seaweed of which there is always plenty, the green goldfish and red goldfish eat the yellow goldfish, and the dark orange goldfish eat both green goldfish and red goldfish.

Explain that in addition to its place in the food web, each fish also has a dollar value, and the purpose is to earn money. If the fish are harvested, each yellow goldfish will make a profit of $2, red goldfish will make a profit of $5 each, green goldfish will make a profit of $5 each, and dark orange goldfish will make a profit of $10 each.

Organize students into groups of four. Give each student one copy of the Overfishing Student Data Table. Have one person from each group collect supplies:

1 plate, 4 spoons, 4 straws, 4 napkins, 4 pieces of string, 1 roll of tape

Students may use the spoons, straws, strings, and/or tape to create any fishing pole they would like. The goal is to get fish out of the ocean and onto their napkin (boat). (Students may use spoons but just catch one fish at a time.)

At the start of the activity, put 8-10 of each color of goldfish into each group's ocean (paper plate). (Numbers can be adjusted as needed.) Have the students record the number of each fish in the "Year 1 Start" column of their data table.

When all the oceans are stocked and fishing poles are made, give students 30 seconds to fish. At the stopping signal, all fishing poles must be put down. Students will fill in their data tables for "Year 1 End" with the number of each species of fish that remains in their ocean. Record the value of their catch in the "Year 1 Income" column. Any fish remaining on the table, still attached to the fishing pole, or destroyed during fishing do not count. Once their tables are filled out, the students can eat the goldfish they caught. (Adjust the number of fish in each ocean to account for reproduction by adding one new fish of each species for each two that remain. There must be a food source for each species to allow for survival.) If no food source remains, remove that species from the ocean.

Repeat steps 6-8 three more times until there have been four years of fishing.

Have students use their data to create a line graph showing the changes in their fish population over time.

Have each group report to the class the final number of fish remaining in their oceans after year four. Some oceans may be completely empty of fish. Others may have established a way to fish sustainably so that there are more fish than when they started. Discuss the various strategies the different groups used (or didn't use) to manage their oceans

As a class, discuss the following questions:

- What is overfishing?
- Why does overfishing happen?
- What are the effects of overfishing?
- What is stewardship and why is it important?
- How can the world continue to fish in a sustainable manner?

ACTIVITY 2:
(Independent or team project.)

A number of individuals from a population of interest are captured, marked by some easily identifiable means, and released within a short period of time (for example, the same day). At a later date (perhaps a few days or weeks), a second sample of individuals is taken from the population. Some of the individuals in this second sample may be identified as being members of the first sample because they were previously marked.

A technique called sampling can be used to estimate population size. In this procedure, the organisms in a few small areas are counted and projected to the entire area. For instance, if a biologist counts 10 squirrels living in a 200-square foot area, she could predict that there are 100 squirrels living in a 2000 square foot area. This is a simple ratio.

Example: A biologist collected 50 liters of pond water and counted 10 mosquito larvae. How many larvae would you estimate to be in that pond if the total volume of water in the pond was 80,000 liters? Show work.

Ask students: What are some problems with this technique? What could affect its accuracy? Ask students to discuss questions from the list below:

- In your own words, define the mark and recapture method.
- How can scientists mark the animals?
- Identify at least 2 reasons why scientists would want to use a technique of determining population size rather than actually counting all the animals in that population.
- Sample Population: A pest control technician captures and applies ear tags to 23 brown rats, which he then releases. A week later he traps 29 brown rats, 11 of which have ear tags. What is the estimate of the total population of brown rats?

Have students prepare the lab materials according to the corresponding lab sheet. Students will be in small groups to complete the lab activity.

CONCLUSION:

The department of natural resources regularly collects data on population numbers in states. Discuss reasons why population numbers would be important and how this data could be used to manage wildlife populations in the state.

RELATED LINKS

- Estimating Walleye Abundance Using Mark-Recapture: https://www.youtube.com/watch?v=EuMXz4KaPOA
- Facing the Future (2002). Originally adapted from Fishing for the Future in Curriculum Guide 2002. Retrieved from www.facingthefuture.org.
- Walleye Fish Populations Are in Decline: https://www.ucdavis.edu/news/walleye-fish-populations-are-decline

Into the Outdoors

Educational Partner: Great Lakes Indian Fish & Wildlife Commission

MARK AND RECAPTURE LAB

Developed by: Christina DiLorenzo

OVERVIEW

In this lab you will:
Estimate the number of individuals in a population by utilizing the mark and recapture method.

INTRODUCTION

Scientists spend time out in the field studying the various components that make up ecosystems they are interested in researching. One important element of an ecosystem that scientists are interested in is animal populations. It is important for them to know how many individuals of a particular species reside in a specific habitat.

Unfortunately, there is no easy way to count all the members of an animal population in an ecosystem. Animals move from place to place; they hide, they hibernate, and they camouflage themselves. Researchers have developed a more efficient method of estimating population size than counting each individual of a population.

Instead of attempting to count every animal in an ecosystem, scientists use a method called the 'mark and recapture' method. A scientist will randomly capture a sample group of a population, mark the sample, and release it. Then, the scientist completes a series of recaptures where they capture additional groups and record how many individuals are 'marked.' Scientists use tags, collars, bands, or spurts of dye to mark animals under study. The ratio between the marked and unmarked animals in these 'recaptures' is the key to estimating the population size of a particular species. The following equation can be used in the mark and recapture method:

$$N = \frac{sn}{x}$$

N = Population Size
s = # of individuals marked in the 1st sample
n = TOTAL # of individuals captured in the second sample
x = # of MARKED individuals in the 2nd sampling

For example, suppose we took 200 mice out of a forest, put leg bands on them (marking them), returned them to the forest, and let them mix with the overall population. In a second capture, we then take 250 mice from that same forest and find that 50 have leg bands. So, s = 200, n = 250, and x = 50. We would then be able to estimate the total population of mice (N):

$$N = \frac{sn}{x} \quad N = \frac{(200)(250)}{50} \quad N = \frac{50{,}000}{50} \quad N = 1{,}000 \text{ mice}$$

This process is important because it allows scientists to make an estimate of how many animals comprise a population in a given area. The smaller the number of recaptures, the larger the estimate of population size. This makes sense, because if the population is very large, the marked animals you release into the wild will be mixing with a greater number of unmarked animals, so you will recapture a lower percentage of them in your second sample. The accuracy of the mark-recapture method rests on a number of assumptions being met:

- The population is closed, meaning that there are no deaths, births, immigrations and/or emigrations.
- The chance for each individual in the population to be caught is equal and constant for both the initial marking period and each subsequent recapture period.
- Sufficient time has passed between marking period and subsequent recaptures for all marked animals to be randomly dispersed through the population.
- The animals do not lose their "marks."

PRE-LAB QUESTIONS

- In your own words, define the mark and recapture method.
- How can scientists mark the animals?
- What is the equation that scientists use to find population size in the mark and recapture method?
- Identify at least 2 reasons why ecologists would want to use a scientific technique of determining population size rather than actually counting all the animals in that population.

PROCEDURE

Fill a beaker halfway with popcorn kernels.

Look at the kernels in the beaker and estimate how many kernels there are in the beaker. Everyone in the group should make separate estimates. Write your estimate in Table 1. This estimate will be compared to your actual count.

Assign a group member to be in charge of "capturing." Have that individual dig their hand into the beaker of kernels and "capture" a medium-sized handful of "animals" (kernels). Carefully count the "captured" kernels and record the information in Table 1.

"Mark" the captured kernels by swapping out the "captured" kernels and replacing them with the same number of peas. Set aside the original kernels that were replaced.

Put the marked group back into the beaker and mix up the kernels and peas by pouring them back and forth between two beakers. It is important that the peas and kernels get thoroughly mixed.

Complete a series of recaptures. Have the same designated person (the "capturer") dig their hand into the beaker to grab a medium-sized handful of peas/kernels. First, count the TOTAL NUMBER of kernels/peas and then count the "MARKED" ones (PEAS). Record both of these pieces of information on your data table. Then put all the peas/kernels back into the beaker and mix well. Repeat this procedure nine more times recording all your data on your data sheet.

After ten recaptures, dump the peas/kernels out of the beaker and carefully count each and every one to determine the actual count of your population.

Return all the peas/kernels back to their appropriate containers. Complete the data section and analysis questions.

LAB TABLE ON NEXT PAGE

ANALYSIS SECTION

Calculate the estimated size of the population (N). Show all your work.

Which is more accurate, your visual estimate or your scientific estimate (determined in question #1)? Why do you think this is so?

How might the population estimate change if there were fewer or more rounds of recapture?

In the field, how can the time of the year affect the results of a population study?

In the United States, the federal government requires that human populations be determined through the use of a census in which every person is supposed to be counted instead of using an estimating technique such as mark and recapture. What would the advantages and disadvantages be for using some sort of sampling technique to ascertain human populations instead of attempting to count every individual?

DATA SECTION

Visual Estimate (Individual):		
Number of Kernals in your first capture (all of which you "marked" - swapped out for peas): s =		
RECAPTURE DATA		
Recapture Sample Number	**TOTAL NUMBER of Recaptured Kernels/ Peas (including those already marked)**	**Number of RECAPTURED Individuals ALREADY MARKED (Peas)**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
TOTAL =		
AVERAGE =	n =	x =
ACTUAL NUMBER of Kernels/Peas in the Beaker = (you counted this)		

The following National Common Core Standards can be met teaching;

MARK AND RECAPTURE FOR SUSTAINABILITY

7TH GRADE:

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.W.7.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
CCSS.ELA-LITERACY.W.7.1.B	Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
CCSS.ELA-LITERACY.W.7.1.C	Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), reasons, and evidence.
CCSS.ELA-LITERACY.W.7.2.D	Use precise language and domain-specific vocabulary to inform about or explain the topic.
CCSS.ELA-LITERACY.W.7.2.E	Establish and maintain a formal style.
CCSS.ELA-LITERACY.W.7.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
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.7.1.C	Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.
CCSS.ELA-LITERACY.SL.7.1.D	Acknowledge new information expressed by others and, when warranted, modify their own views.

8TH GRADE:

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.8.2	Determine a central idea of a text and analyze its development over the course of the text, including its relationship to supporting ideas; provide an objective summary of the text.
CCSS.ELA-LITERACY.W.8.1.A	Introduce claim(s), acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
CCSS.ELA-LITERACY.W.8.1.B	Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
CCSS.ELA-LITERACY.W.8.1.C	Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
CCSS.ELA-LITERACY.W.8.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
CCSS.ELA-LITERACY.W.8.2.A	Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into

	broader categories; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
CCSS.ELA-LITERACY.W.8.2.B	Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
CCSS.ELA-LITERACY.W.8.2.C	Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
CCSS.ELA-LITERACY.W.8.2.D	Use precise language and domain-specific vocabulary to inform about or explain the topic.
CCSS.ELA-LITERACY.W.8.2.E	Establish and maintain a formal style.
CCSS.ELA-LITERACY.W.8.2.F	Provide a concluding statement or section that follows from and supports the information or explanation presented.
CCSS.ELA-LITERACY.W.8.3	Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.
CCSS.ELA-LITERACY.W.8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
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.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.SL.8.1.A	Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.
CCSS.ELA-LITERACY.SL.8.1.C	Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
CCSS.ELA-LITERACY.SL.8.1.D	Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.

9TH-10TH GRADE:

CCSS.ELA-LITERACY.RI.9-10.1	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
CCSS.ELA-LITERACY.RI.9-10.2	Determine a central idea of a text and analyze its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.
CCSS.ELA-LITERACY.W.9-10.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

CCSS.ELA-LITERACY.W.9-10.1.A	Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among claim(s), counterclaims, reasons, and evidence.
CCSS.ELA-LITERACY.W.9-10.1.B	Develop claim(s) and counterclaims fairly, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns.
CCSS.ELA-LITERACY.W.9-10.1.C	Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
CCSS.ELA-LITERACY.W.9-10.1.D	Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
CCSS.ELA-LITERACY.W.9-10.1.E	Provide a concluding statement or section that follows from and supports the argument presented.
CCSS.ELA-LITERACY.W.9-10.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
CCSS.ELA-LITERACY.W.9-10.2.A	Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
CCSS.ELA-LITERACY.W.9-10.2.B	Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
CCSS.ELA-LITERACY.W.9-10.2.C	Use appropriate and varied transitions to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
CCSS.ELA-LITERACY.W.9-10.2.D	Use precise language and domain-specific vocabulary to manage the complexity of the topic.
CCSS.ELA-LITERACY.W.9-10.2.E	Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
CCSS.ELA-LITERACY.W.9-10.2.F	Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
CCSS.ELA-LITERACY.W.9-10.3	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
CCSS.ELA-LITERACY.W.9-10.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
CCSS.ELA-LITERACY.SL.9-10.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CCSS.ELA-LITERACY.SL.9-10.1.A	Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
CCSS.ELA-LITERACY.SL.9-10.1.C	Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.
CCSS.ELA-LITERACY.SL.9-10.1.D	Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement,

and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.

11TH-12TH GRADE:

CCSS.ELA-LITERACY.W.11-12.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
CCSS.ELA-LITERACY.W.11-12.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
CCSS.ELA-LITERACY.W.11-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
CCSS.ELA-LITERACY.SL.11-12.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CCSS.ELA-LITERACY.SL.11-12.1.A	Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
CCSS.ELA-LITERACY.SL.11-12.1.C	Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

NEXT GENERATION SCIENCE STANDARDS:

6TH TO 8TH GRADE:

MS-ESS3.A.1	Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources.
MS-LS2-1-MI	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
SEP8	Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings.
MS-LS1-6	Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
MS-LS2-4	Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological components of an ecosystem can lead to shifts in all its populations.