**Grade Level:** 9-12

**Subject Area:** Ecosystems

**Classroom Size:** 10 students

**Time Required:** 4 hours

**Common Core and Next Generation State Standards**

**HS-LS2-6.** Students will evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

**HS-LS2-7.** Students will design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

**HS-LS2-8.** Students will evaluate the evidence for the role of group behavior on an individual and species’ chances to survive and reproduce.

[**CCSS.ELA-Literacy.RST.9-10.3**](http://www.corestandards.org/ELA-Literacy/RST/9-10/3/) Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

[**CCSS.ELA-Literacy.RST.9-10.4**](http://www.corestandards.org/ELA-Literacy/RST/9-10/4/) 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.

[**CCSS.ELA-Literacy.RST.11-12.4**](http://www.corestandards.org/ELA-Literacy/RST/11-12/4/) 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.

[**CCSS.ELA-Literacy.RST.11-12.8**](http://www.corestandards.org/ELA-Literacy/RST/11-12/8/) Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

**Background:**

        Kelp forests are a complex ecosystem that supports many interconnected food webs. They are inhabited by thousands of different varieties of marine life.

        The giant kelp is the largest and the most common algae found along the California coasts. Known as *Macrocystis pyrifera,* giant kelp is able to grow as long as 150 feet and stretch into mile wide kelp forests. It has 3 main structures: the holdfast, stipe, and the blade. The holdfast helps to anchor the kelp onto hard surfaces, the stipe provides support to the blades, and the blades absorb the nutrients that the kelp requires for photosynthesis.

Kelp is a protist, not a plant because it is a type of brown algae. Kelp forests typically live in cold water, which is why they are commonly found in California waters. Kelp forests are analogous to terrestrial forests; they both play vital roles as ecosystems. Kelp forests offer a variety of habitats for all trophic levels.

        A large amount of biodiversity can be found in kelp forests because they offer food, shelter, and diverse habitats for various marine life populations, including semi-aquatic mammals. For instance, many small invertebrates like crabs and snails that are found on the kelp serve as prey for active predators like sea otters, California Sheephead, and lingcod. Sea urchins are one of the biggest threats to kelp forests throughout the Pacific coast because they feed off any nutrients that they can find; consequently, they eat kelp when there is scarce food available to them. Sea urchin populations are controlled by predators, including the California Sheephead, spiny lobster, and the sea otter. Unfortunately, because the populations of these predators are threatened, sea urchins can overpopulate and eat kelp uncontrollably. Thus, a lack of food for sea urchins urges them to eat the holdfasts of the kelp and this causes the kelp to drift off.

        Fortunately, there are kelp restoration programs that function to help restore kelp populations in urchin barrens and dying areas. Volunteers of these programs plant lab-grown kelp and remove sea urchins to repopulate kelp forests. These restored areas are continually monitored for progress. However, they are unable to control the damage caused by commercial kelp harvesting because it has grown into a billion dollar industry.

**Field Trip Description**

        Students will go on a field trip to the California Science Center to view the exhibits on Ecosystems.

        The California Science Center Ecosystems exhibit is composed of 7 zones; each of them describing the type of environment that zone is (e.g. habitats, weather conditions, significance to community). Students will specifically visit the Extreme Zone and Forest Zone.

        The Extreme Zone provides background information on some of the harshest environments in the world like deserts and the very deep depths of the ocean. This exhibit offers a Touch Zone where students will be able to touch real invertebrates found on rocky shores such as sea urchins, limpets, and sea stars.

        The Forest Zone contains two exhibits: the rain forest and kelp forest. Students will only view the kelp forest section. The California Science Center has its own kelp restoration project and it has successfully collaborated with the Santa Monica Baykeepers in removing 120,000 sea urchins from the Palos Verdes Peninsula. The California Science Center grows its own kelp too. It has a 188,000 gallon tank filled with kelp, fish, and invertebrates. The Kelp Forest exhibit will be followed by a trip to the Diversity on Display where they show different species of marine life in tanks to be seen by the public. They will be able to see lobsters, anemone, sea stars, and more. The California Science Center also has a dive show that the students will see upon arrival.

**Objectives/Goals:**

Students will be able to do the following:

* Students will be able to identify the parts of kelp and explain their function
* Students will be able to identify common species of fish and invertebrates that inhabit kelp forests
* Students will be able to explain the importance of kelp for marine life
* Students will take a dry fish survey by spotting any fish/invertebrates that live in kelp forests they recognize from prior knowledge
* Students will be able to interact with shore line invertebrates that can be found in kelp forests
* Students will use the scientific method to design, evaluate, and refine a solution for reducing the impacts of human activities on kelp forests
* Students will evaluate the evidence for the role of group behavior on the ability of sea urchin population​s to survive and reproduce
* Students will evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem
* Students will find evidence that the complex interactions in ecosystems will remain constant in stable conditions but may change in different circumstances and this may result in a new ecosystem

**General Outline of the Program:**

* Students will form groups and devise experiments evaluating how to maintain kelp forests in the presence of various predators. They will then test their experiment in small tanks containing sea urchins and they will compare their results to the results of their peers.
* Students will individually respond to the question as to how organisms living in kelp forests contribute to their ecosystem.
* Students will form groups and devise hypotheses analyzing what will happen to kelp if it was immersed in warm water. Students will then elaborate about their hypothesis with their peers.
* Students will take a dry fish survey by spotting any fish/invertebrates that live in kelp forests they recognize from prior knowledge.

**Project Outline**

**Grade Level:** 9-12

**Subject Area:** Ecosystems

**Classroom Size:** 10 students

**Time Required:** 4 hours

This four-hour long program will educate students about what kelp forests are and about their vital role in the marine environment. Students will be enriched with an understanding of how kelp forests supports other organisms in the marine environment and of how they are threatened by various invertebrates.

**Common Core and Next Generation State Standards Related to the Program**

Grades 9-12:

**HS-LS2-6, HS-LS2-7, HS-LS2-8**

Grades 9-10:

[**CCSS.ELA-Literacy.RST.9-10.3**](http://www.corestandards.org/ELA-Literacy/RST/9-10/3/)**,** [**CCSS.ELA-Literacy.RST.9-10.4**](http://www.corestandards.org/ELA-Literacy/RST/9-10/4/)

Grades 11-12:

[**CCSS.ELA-Literacy.RST.11-12.4**](http://www.corestandards.org/ELA-Literacy/RST/11-12/4/)**,** [**CCSS.ELA-Literacy.RST.11-12.8**](http://www.corestandards.org/ELA-Literacy/RST/11-12/8/)

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