GRADE 5 UNIT 2 OVERVIEW

Life in a Wetland

Introduction

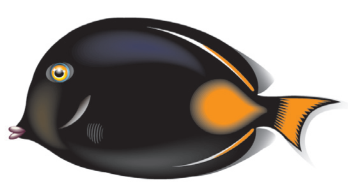
Wetlands are flooded, or water-saturated areas composed of habitats where unique living species–plants, fish, animals, and migratory organisms–dwell. Wetland species have special adaptations for survival, such as specialized root structures and the ability to survive in saline environments. Swamps and marshes play invaluable, but often misunderstood, roles in coastal land areas worldwide.

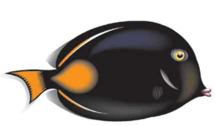
Hawai‘i’s coastal marshes act as natural buffers that retain, filter, and slowly release into the ocean filtered runoff water. This prevents an overabundance of nutrients from flowing to coral reef habitats and offsetting the delicate balance of healthy coral reef habitats. Marshes also buffer coastal land from the erosive pounding of ocean storms.

Hawai‘i’s wetlands have always been much more than just natural curiosities. Native Hawaiian Ahupua‘a systems of land and resource management sometimes used wetland areas for fishponds and taro patches. The Native Hawaiians understood the benefits to managing these fragile resources carefully.

In this unit, students learn all about wetlands and ecosystems through classroom instruction, multimedia presentations, discussions, field trips, lab experiments, and extensive print and Internet searches. Acting as naturalists, students discover complex living ecosystems consisting of producers, consumers, and decomposers that play interdependent roles in a unique food chain cycle that allows wetland residents to survive and reproduce. This knowledge is reinforced through diagramming exercises and games designed to jog students’ memories.

Students identify and categorize species endemic to Hawai‘i, and those that are not. They also read about the intentional or unintentional introduction of non-native organisms to the islands, such as rats and frogs, and the impact these organisms have on wetlands’ ecosystems. They are introduced to ongoing governmental programs to eradicate these destructive non-native pests and mammal predators from wetlands. The establishment of protected state and federal wildlife refuges and sanctuaries has also helped conservation efforts. Through acquired knowledge, students also begin to realize the need to educate others concerning overuse and irresponsible dispensing of toxic chemicals that may wash into, and destroy wetland and coral reef habitats. Lastly, students in small groups focus on wetland topics of interest and, referring to acquired knowledge, prepare visual aids for use during oral class presentations.





At A Glance

Each Lesson addresses HCPS III Benchmarks. The Lessons provide an opportunity for students to move toward mastery of the indicated benchmarks.

ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	**LESSON,** *Brief Summary,* Duration
What is a wetland? How do the living (producers, consumers, and decomposers) and nonliving (soil, air, water, and sunlight) things interact with each other in the wetlands? How is the carbon cycle related to the food chain? How does energy flow among producers, consumers and decomposers?	Science Standard 3: Life and Environmental Sciences: SC.5.3.1 Describe the flow of energy among producers, consumers, and decomposers. SC.5.3.2 Describe the interdependent relationships among producers, consumers, and decomposers in an ecosystem in terms of the cycles of matter.	**Lesson 1:** **The Wetland Ecosystems** In this lesson, students learn some basic concepts about a wetland ecosystem. The lesson begins with a classroom discussion of what students already know about wetlands. Students learn about organisms within an ecosystem and their interdependence. They read about producers, consumers, and decomposers, and how these various organisms make up the food chain within an ecosystem. They also read about the carbon cycle and discover how it relates to the food chain. Students diagram a wetland food chain identifying producers, consumers, and decomposers, then they use their food chain diagrams to illustrate the flow of energy through the carbon cycle. The lesson ends with a short student research activity to assist them in further understanding a wetland ecosystem. One 45-minute period One 60-minute period

ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	LESSON, *Brief Summary,* Duration
How do wetlands play a role in the healthy marine environments? How are wetlands and ocean environments related? Why is it important to preserve the wetlands?	Science Standard 1: The Scientific Process: Scientific Investigation: SC.5.1.2 Formulate and defend conclusions based on evidence. Science Standard 2: The Scientific Process: SC.5.2.1 Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world.	**Lesson 2: Nature's Water Filter** In this lesson, students learn more about how the wetland plays a role in maintaining healthy marine environments. Through participation in a lab simulation that will demonstrate how water filtration occurs in a wetland students will discover why it is important to preserve our wetlands. The lesson encourages students to work cooperatively in small groups to conduct the filtration simulation and prepare a lab report. One 45-minute period
How has the size of Hawai'i's wetlands changed over time? How has the food chain of Hawai'i's wetlands been affected by introduced species and human activity? How have humans impacted wetland ecosystems?	Science Standard 3: Life and Environmental Sciences: SC.5.3.2 Describe the interdependent relationships among producers, consumers, and decomposers in an ecosystem in terms of the cycles of matter.	**Lesson 3: Are Hawai'i's Wetlands Changing?** Students first discuss and brainstorm how changes in the land can impact the wetland environment and food chains. Then, students read about the introduction of non-native organisms to the islands, and the effect these organisms have on the fragile ecosystems of Hawai'i. Students learn to identify several organisms that have altered the food chain of Hawai'i's coastal marshes. Together the class diagrams the resulting food chain on the board. Students then compare the food chain they made in previous lessons with the current food chain. Lastly, students play a Wetland Predator and Prey game in which they take on the roles of native and non-native organisms. Two 45-minute periods

ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	**LESSON,** *Brief Summary,* Duration
How can doing your part in a group research project help educate others about Hawai'i's wetlands? How can we deepen the public's understanding of the wetland ecosystem and how the organisms function within that ecosystem? How can educating others about Hawai'i's wetlands make a difference?	Science Standard 3: Life and Environmental Sciences: SC.5.3.2 Describe the interdependent relationships among producers, consumers, and decomposers in an ecosystem in terms of the cycles of matter. Language Arts Standard 6: Oral Communication: LA.5.6.1 Use speaking skills to fill a prescribed role in group activities. LA.5.6.2 Give informal presentations or reports to inform. LA.5.6.3 Recall oral messages by noting key ideas and relating them to the speaker's purpose.	**Culminating Lesson: Wetland Investigators** In this lesson, students learn how to research a topic effectively, and then work in small groups to research one of four Hawai'i wetlands. Students learn to conduct searches efficiently, to collaborate effectively, and to engage good speaking and listening skills while working in small groups. Students conduct searches on the Internet and in printed resources to gather information as they assume the role of naturalists. Students synthesize their new knowledge into a short oral report, and prepare a visual aid to use. Together, the class develops an oral presentation rubric that will be used by all students. In small groups they deliver their oral presentations to the class, while other students must recall key ideas from presentations as they actively listen as members of the audience. In conclusion, each student must conduct self- and peer-assessments of the presentations. Two 45-minute periods (research) Two 45-minute periods (work on report and visual aid) Two 45-minute periods (presentations)

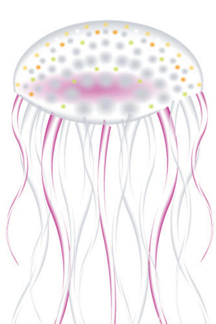
"Hawaii Content & Performance Standards III Database." Hawaii Department of Education. June 2007. Department of Education. Dec. 17 2007.

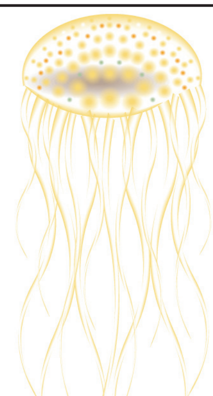
Benchmark Rubric

I. HCPS III Benchmarks*

Below is a general Benchmark Rubric. Within each lesson, there are other assessment tools and additional rubrics specific to the performance tasks of each lesson topic.

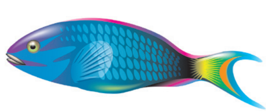
Topic		**Scientific Inquiry**	
Benchmark SC.5.1.2		Formulate and defend conclusions based on evidence	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Formulate and defend conclusions that are supported by detailed evidence and make connections to the real world	Formulate and defend conclusions that are supported by evidence	Make conclusions that are partially supported by evidence	Make conclusions without evidence
Topic		**Unifying Concepts and Themes**	
Benchmark SC.5.2.1		Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Consistently select and use models and simulations to effectively represent and investigate features of objects, events, and processes in the real world	Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world	With assistance, use models or simulations to represent features of objects, events, or processes in the real world	Recognize examples of models or simulations that can be used to represent features of objects, events, or processes
Topic		**Cycles of Matter and Energy**	
Benchmark SC.5.3.1		Describe the cycle of energy among producers, consumers, and decomposers	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Explain and give detailed examples of the cycle of energy among producers, consumers, and decomposers	Describe the cycle of energy among producers, consumers, and decomposers	Describe a part of the energy cycle with an example (e.g., describe one or two parts of a food chain)	Recognize an example of part of an energy cycle

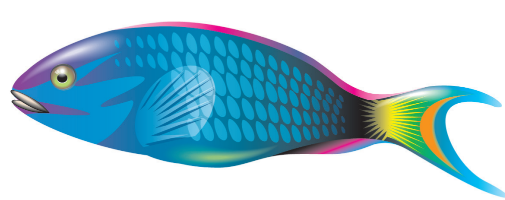




Topic		**Interdependence**	
Benchmark SC.5.3.2		Describe the interdependent relationships among producers, consumers, and decomposers in an ecosystem in terms of the cycles of matter	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Explain and give examples of how specific relationships among producers, consumers, and decomposers in an ecosystem affect the cycling of matter	Describe the interdependent relationships among producers, consumers, and decomposers in an ecosystem in terms of the cycling of matter	Identify a few relationships between producers, consumers, or decomposers in an ecosystem in terms of the cycling of matter	Recall, with assistance, that matter cycles in an ecosystem among producers, consumers, and decomposers
Topic		**Discussion and Presentation**	
Benchmark LA.5.6.1		Use speaking and listening skills to fill a prescribed role in group activities	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use speaking and listening skills to fill a prescribed role in group activities, in a highly effective way	Use speaking and listening skills to fill a prescribed role in group activities	Use some speaking and listening skills that assist in filling a prescribed role in group activities, in a limited way	Use irrelevant speaking and listening skills that do not relate to a prescribed role in group activities

Topic		**Discussion and Presentation**	
Benchmark LA.5.6.2		Give informal presentations or reports to inform	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Give highly effective informal presentations or reports that clearly inform	Give effective informal presentations or reports to inform	Give marginal informal presentations or reports that somewhat inform	Give ineffective informal presentations or reports that do not inform





Topic		**Critical Listening**	
Benchmark [LA.5.6.3]		Recall oral messages by noting key ideas and relating them to the speaker's purpose	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Recall oral messages accurately by clearly noting key ideas and relating them to the speaker's purpose, in a highly effective way	Recall oral messages by noting key ideas and relating them to the speaker's purpose, with no significant errors	Recall part of an oral message by noting a few key ideas and relating them to the speaker's purpose, or recall an oral message with a few significant and/or many minor errors	Recall little of an oral message by noting very few key ideas and not relating them to the speaker's purpose, or recall an oral message with many significant errors

**HCPS III Benchmarks are from the Hawai'i Department of Education's Website:*
http://doe.k12.hi.us/standards/index.htm.

II. General Learner Outcomes*

Below is a list of the HIDOE General Learner Outcomes (GLOs). Each Unit of the Lessons from the Sea Curriculum addresses the GLOs. Within some lessons, there is more specific mention of individual GLOs with specific pertinence.

I. Self-directed Learner. (The ability to be responsible for one's own learning.)

II. Community Contributor. (The understanding that it is essential for human beings to work together.)

III. Complex Thinker. (The ability to demonstrate critical thinking and problem solving.)

IV. Quality Producer. (The ability to recognize and produce quality performance and quality products.)

V. Effective Communicator. (The ability to communicate effectively.)

VI. Effective and Ethical User of Technology.
(The ability to use a variety of technologies effectively and ethically.)

Science Background for the Teacher

Note: Bolded words found within this section are defined in the *Science Background for the Teacher Glossary.* The footnotes refer to the references found in the *Science Background for Teacher Bibliography* at the end of this section.

What is a wetland and why are they important?[1] (Lesson 1)

Wetlands refer to an area of land where water covers the soil, or is present at or near the soil surface for all or parts of the year. There are two main types of wetlands: coastal and inland. Coastal wetlands are closely linked to **estuaries** and are affected by the rise and fall of the tides. Estuaries occur at the mouths of rivers where the fresh water meets the ocean water, creating an environment of varying **salinities**. **Halophytic** plants have special **adaptations** that allow them to thrive in saline environments. Certain grasses and grass-like plants can be found in the salt marshes that characterize coastal wetlands on the Atlantic and Pacific coasts of the U.S. The halophytic trees and shrubs of mangrove swamps found in south Florida, Puerto Rico, and Hawai’i characterize tropical wetlands.

Inland wetlands, found in central states, exist along floodplains and isolated low-land depressions surrounded by dry land. The **marshes**, **swamps**, and **bogs** of inland wetlands are dominated by **hydrophytic**, **herbaceous** plants, shrubs, and trees and tend to be seasonal, meaning they appear dry for parts of the year. They also possess special adaptations that allow them to thrive in water saturated soils.

Wetlands are important for many reasons. They are productive ecosystems harboring a variety of species of microbes, plants, insects, amphibians, reptiles, fish, birds, and mammals. They provide refuge and food to these organisms, many of which live some, or part, of their **life cycle** in a wetland. Wetlands trap sediments and excess nutrients from surface water run-off before it reaches open water, acting as a natural filter in maintaining water quality. Wetlands are important in flood protection, acting as sponges that slowly release surface water, rain, and snowmelt to the surrounding environment, controlling flood heights. Wetland plants hold soil in place with their roots, absorb wave energy, and break up the flow of rivers and streams, therefore protecting shorelines and river banks from erosion.

As much as one third of all threatened and endangered species in the U.S. live in wetlands, and as much as half of them use wetlands at some point in their lives. Numerous bird species migrate to wetlands to breed and feed, mammals take refuge there, and many commercially valuable game fish and shellfish breed and mature in wetlands. Commercially valuable food resources, resulting in an annual catch of $15 billion per year, including shrimp, oysters, and many species of fish, depend on wetlands.

The National Marine Fisheries Service (NMFS) has estimated that Hawaiʻi has lost about 12% of its 59,000 acres of wetlands in the last 200 years. *Waikīkī*, once largely composed of wetlands, is the most extreme example of how humans can transform natural wetlands in *Hawaiʻi*. Other examples include the *Kawai Nui* marsh in *Kailua*, *Oʻahu*, the *Lokoʻawa Pond* on *Hawaiʻi*, and *Lāiʻe* wetlands in *Maui*.

For some interesting aerial images of some of these wetlands from the early 1900's to 1990's, see http://www.hear.org/naturalareas/index.html
For general information on wetlands see:
http://www.epa.gov/owow/wetlands/vital/toc.html

What are some plants and animals that can be found in Hawai‘i's wetlands?[2] (Lesson 1)

While it is estimated that only 1% of Hawai‘i's recreational and commercial fish species are dependent on wetlands, many other important organisms live in Hawai‘i's wetland habitats. Mullet (*‘ama‘ama*), milkfish (*awa*), shrimp (*‘opae*) and Hawaiian anchovies (*nehu*) depend on wetlands for food and breeding grounds. Waterfowl endemic to Hawai‘i, such as the Hawaiian stilt (*ae‘o*), Coot (*‘alae kea*), and Duck (*koloa*); live in wetlands and are endangered in part due to the loss of wetland habitats in Hawai‘i. All three of these birds spend most of their lives eating aquatic plants, water insects, fish, worms, and crabs. The black-crowned night heron (*‘auku‘u*) is the main predator of the wetland, eating juvenile fishes and even the young of other wetland birds.

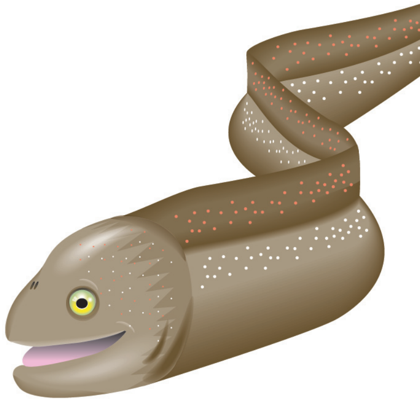
Plants common in wetland habitats include the invasive California grass (also known as *para*), a large grass growing up to 1 meter (3.28 feet) tall. Para grass is not a true hydrophyte, but is common in wetlands. The common cattail, with its characteristic brown, bob flower, is also an invasive that out-competes native wetland plants by forming extensive **rhizome** mats, and the abundant, invasive water hyacinth is a floating plant with violet flowers that spreads quickly over wetland ponds. Native wetland plants of Hawai‘i include: the *kāmole*, or primrose willow, a herbaceous shrub with yellow four-petal flowers, the *makai kaluhā*, an indigenous wetland bulbrush with light brown flower heads, and the *neke*, or swamp fern, with leathery green fronds that can grow to 1 meter (3.28 feet) in length.

For more wetland plants and animals see
http://library.thinkquest.org/J0110028/splash.htm

What are some of the characteristics of wetland organisms?[3] (Lesson 1)

Plants and animals have many different adaptations that allow them to thrive in wetland environments. As mentioned for plants, many of them are hydrophytes, growing in water-saturated soils or completely submersed. Others are halophytes, growing in waters and soils influenced by the sea. Plants with specialized root structures (rhizomes) that grow above the soil, allow the gaseous transfer of oxygen into the roots to be transported to all parts of the plant. Plants that grow in high salinity environments, for example mangroves, have specialized adaptations that allow them to secrete salt onto their leaves to be washed or blown away by rain or wind. Given that the soils of wetlands are saturated and soft, plants have also adapted specialized supporting structures to help anchor them into the soil. *Buttresses* are a type of *prop root* found on mangrove trees that grow on the lower part of the stem or trunk to provide the plant with extra support. Other plants, like the cattails or grasses, grow horizontal root structures (rhizomes) that spread low to the ground to provide support. A key adaptation that animals have developed to live in the variable environment of wetlands is the ability to adjust their physiological tolerance to varying salinities. This is best described in *euryhaline* fish and invertebrate species that **migrate** from fresh, **brackish**, and saltwater. Euryhaline organisms are able to withstand differing amounts of salinity due to special cellular processes that allow them to regulate the amount of internal salt concentrations relative to the external environment. Hawaiian flag-tail (*āholehole*) and striped mullet (*‘ama‘ama*) are two such fish that can migrate from salt to brackish water to forage.

For information on estuaries (wetlands influenced by the sea)
see http://oceanservice.noaa.gov/education/kits/estuaries/welcome.html



How do living (producers, consumers, and decomposers), and nonliving (soil, air, water, and sunlight) things interact with each other in the wetlands?[4] (Lesson 1)

Plants, animals, and microbes in the wetland interact to form the wetland food chain. Sunlight provides energy for the primary producers or plants to convert nutrients available in the soil to be able to grow. The plants are either used as a food source by primary consumers, like aquatic invertebrates and herbivorous fishes, or their leaves may fall and are decomposed by microbes or fungi that help break down the tissue into the very same nutrients that are available for plants to grow in the first place. These primary consumers are a food source for predators like carnivorous fishes, birds, and mammals. Wetlands are very productive habitats due to the very high primary productivity that exists in the form of plant material. Microbes also play an important role in the decomposition process of all the plant material in the water-saturated, oxygen-depleted soil, also called **hydric soil**. Microbes break down plant and animal **organic** matter into **inorganic** compounds that are used as nutrients by plants.

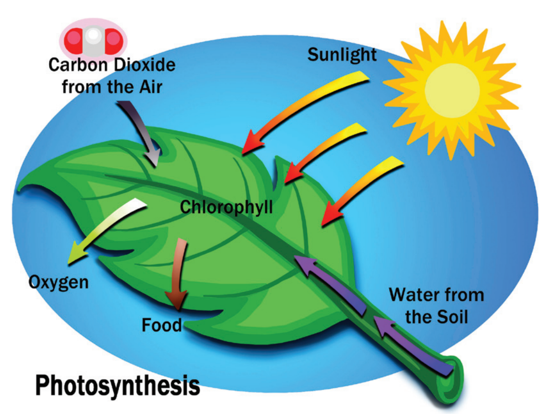
What is the carbon cycle, and how does it relate to the food chain?[5] (Lesson 1)

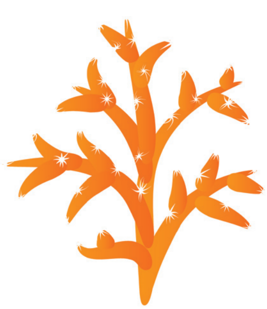
Carbon is present in all organic substances, from the fossil fuels we use to provide energy to the DNA that is present in all life on Earth. Carbon (C) is the fourth most abundant element in the universe after hydrogen (H), helium (He), and oxygen (O), and is the *building block* of life. The global carbon cycle can be divided into two categories: the geological, which operates over large time scales (millions of years), and the biological/physical, which operates at shorter time scales (days to thousands of years). **Here we will focus on the biological/physical carbon cycle (Photosynthesis and Respiration).**

Biology plays an important role in the movement of carbon in and out of the land and ocean through the processes of **photosynthesis** and **respiration**. Most forms of life on Earth depend on the production of sugars from solar energy and carbon dioxide (photosynthesis) from primary producers (e.g., plants), and the **metabolism** (respiration) of consumers to convert those sugars into the chemical energy that facilitates growth and reproduction.

Plants, animals, and soil interact to make up the basic cycles of nature. In the carbon cycle, plants absorb carbon dioxide from the atmosphere and use it, combined with water they get from the soil, to make the energy they need for growth. The process of photosynthesis converts the carbon atoms from carbon dioxide into sugars. Animals such as primary consumers eat the plants and use the carbon to build their own tissues. Other animals, or secondary consumers, eat the primary consumers, and then use the carbon for their own needs. These animals return carbon dioxide into the air when they breathe and when they die, since the carbon is returned to the soil during decomposition. The carbon atoms in soil may then be used by a new plant or small microorganisms. Ultimately, the same carbon atom can move through many organisms and even end up in the same place where it began.

For more information on the carbon cycle as well as great images see:
http://earthobservatory.nasa.gov/Features/CarbonCycle/carbon_cycle2.php





Give an example of food chains found in Hawai'i's wetlands.[6] (Lessons 1)

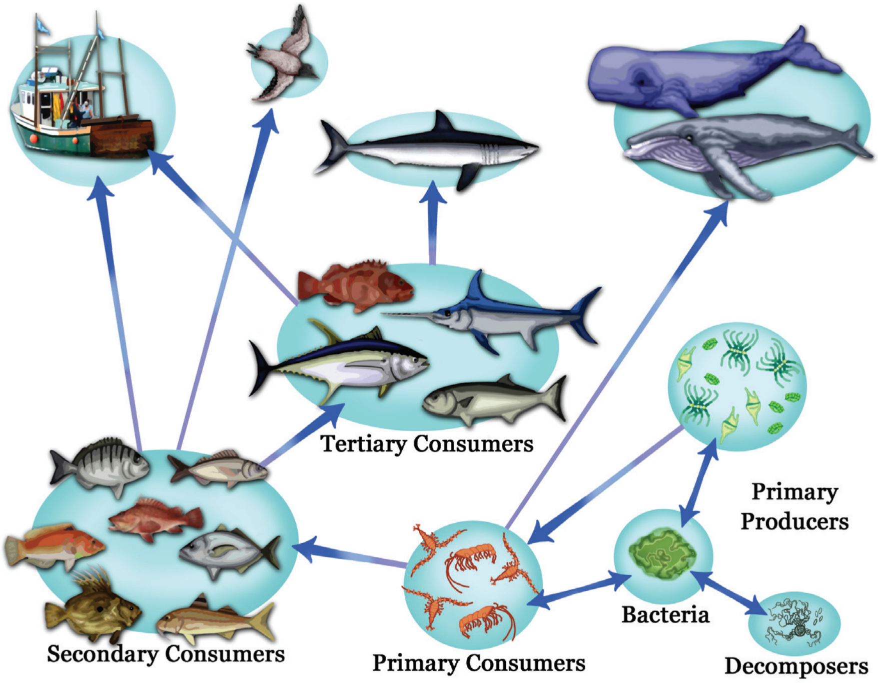
Juvenile striped mullet (*'ama'ama*) and milkfish (*awa*) live in the protective and food rich habitat of the wetland. These juveniles eat a variety of things, from algae to insect larvae. Although predation is less significant in the wetland compared to the reef, the danger from potential prey organisms is still present. The black-crowned night heron (*'auku'u*) is a top predator in Hawaiian wetlands, and is often seen perched on the sides of ponds and marsh areas, searching for a fish to catch. This food chain would look something like:

Plants		Insects		Juvenile Fishes		Night Herons
	→		→		→	

which equals:

Primary producers → **primary consumers** → **secondary consumers** → **tertiary consumers**

See Food Web Diagram Below:
This diagram is depicting a food web, which consists of several smaller food chains.



For more information concerning food chains, see
http://www.arcytech.org/java/population/facts_foodchain.html

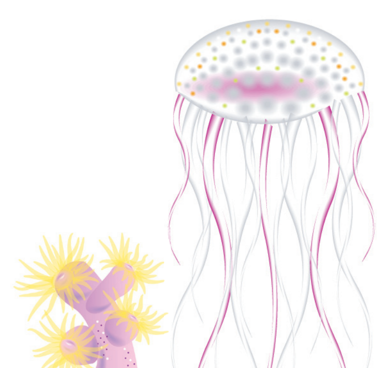
What has caused the decrease and changes in Hawai‘i’s wetlands?[7] (Lessons 3)

Many factors contribute to the decrease and changes occurring in Hawaiian wetlands. The most significant impact is urbanization of wetland habitats. This means that humans have, and continue to change the wetland habitats to make urban communities, aid in farmland drainage, and build boat harbors and marinas. *Ka‘elepulu Pond* in *Kailua*, *O‘ahu* is an excellent example of how **urbanization** converted our marshland to an urban community. Methods of draining (removing water) like **stream channelization**, dredging (diverting the water), or filling of wetlands were used to provide land for a golf course, housing, and recreational use. This results in an increase in pollution and nutrients into the wetland, and as such, compromises the habitat quality of the wetland for native species to thrive. Often, as a result of human populations moving into wetlands, invasive species are introduced, dramatically changing the community structure of the wetland by out-competing, or over-eating native wetland plants and animals. The mongoose is one such example; it eats bird eggs and fishes that are native to wetlands. Tilapia is another introduced fish that is such an aggressive eater; it out-competes food resources for native fishes.

For more information see http://library.thinkquest.org/J0110028/splash.htm

Science Background for the Teacher Glossary

adaptation: a feature of an organism that has evolved over a period of time by the process of natural selection such that it increases its long-term reproductive success.
bog: soft, spongy, water-saturated, usually acidic soil in an area full of accumulated plant material, associated with Inland wetlands.
brackish water: a mix of salt and fresh water.
buttress: prop root structure on the lower part of a trunk or stem to aid in support.
estuary: semi-enclosed coastal body of water with one or more rivers and streams running into it and an open connection to the sea.
halophytic: a plant that possesses a physiological adaptation to grow in salty soil or water.
herbaceous: having little or no woody tissue (such as that of a tree), and persisting usually for a single growing season.
hydric soil: soil that is formed under saturated conditions where the top portion becomes anoxic.
hydrophytic: a plant that can grow completely submerged in water or in water-saturated soil.
inorganic: chemical compounds that lack carbon; matter not derived from plants or animals.
life cycle: the development, maturation, and adult stages through which an organism passes during its lifetime.
marsh: a tract of soft, wet, flat land characteristic of wetlands, usually dominated by grasses.
metabolism: the sum of processes that exist in organisms that allow energy to be stored and released for the organism to function.
migration: movement of an organism from one locality to another.
organic: carbon containing compounds.
photosynthesis: the creation of carbohydrates like glucose from sunlight, carbon dioxide (CO2), and water (H2O) carried out by plants and organisms that contain light harvesting organelles, light chloroplasts.



prop root: discrete root structures found on mangroves and some herbaceous plants that grow out from the lower portion of the trunk or stem to aid in structural support.
respiration: the breakdown of carbohydrates, proteins, and fats to release the energy stored in these compounds to drive growth and reproduction.
rhizome: horizontal, shallow root masses that produce shoots above ground, and roots below ground.
salinity: the amount of dissolved salts present in a liquid.
salt marsh: a specific type of marsh land that is found in the transition zone between estuaries and land; dominated by halophytic, herbaceous plants, and grasses.
stream channelization: reconstructing a natural stream path in an effort to restrict or control its flow.
urbanization: the spreading of human developments (houses, shopping center, golf courses) into undeveloped land.
wetlands: an area of land where water covers the soil, or is present at or near the soil surface, for all or parts of the year.

Science Background for the Teacher - Bibliography

1-8 Science background information condensed and/or compiled from the following sources:

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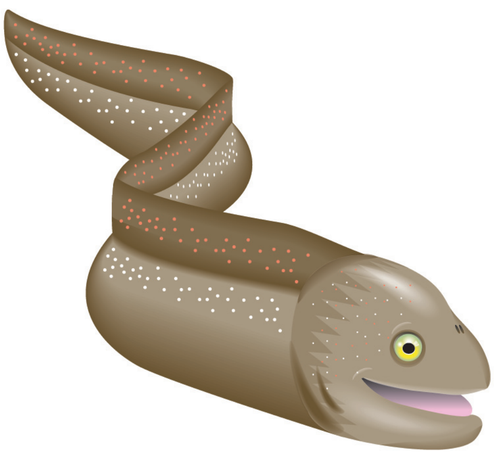
NOAA Resources

Below is a list of resources compiled by the Outreach Education Office of the National Oceanic and Atmospheric Administration. The science standards and the ocean literacy principles addressed in this unit were used as a guideline in selecting the following resources. To access the print resources listed below, contact NOAA's Outreach Education Office directly:

Outreach Unit
NOAA Office of Public and Constituent Affairs
1305 East West Highway #1W514
Silver Spring, MD 20910
Phone: (301) 713-1208
Email: NOAA-OUTREACH@noaa.gov
http://www.education.noaa.gov/

Resources:

- Bays & Estuaries NOAA/Project WET activity book.
- Exploring an Estuary: Where Rivers Meet the Sea, developed by NC NERR.
  http://www.masgc.org/pdf/masgp/01-007.pdf
- Celebrate Wetlands, activity book developed by NOAA and Project WET.
- Find a list of NOAA lesson plans and activities, organized by grade level at the estuaries.gov site.
  http://www.estuaries.gov/estuaries101/resources/default.aspx?ID=333
- NOAA NERRS Estuarine Education Resources – Estuaries 101:
  http://www.estuaries.gov/estuaries101/Teachers/Default.aspx?ID=79
- NOAA Ocean Service Estuaries discovery kit (Primarily for grades 9-12, but can be adapted or used as background material for the teacher).
  http://oceanservice.noaa.gov/education/kits/estuaries/welcome.html



OCEAN LITERACY ESSENTIAL PRINCIPLES

1. The Earth has one big ocean with many features.
   - 1g. The ocean is connected to major lakes, watersheds and waterways because all major watersheds on Earth drain to the ocean. Rivers and streams transport nutrients, salts, sediments, and pollutants from watersheds to estuaries and to the ocean.

3. The ocean is a major influence on weather and climate.
   - 3f. The ocean has had, and will continue to have, a significant influence on climate change by absorbing, storing and moving heat, carbon and water.

5. The ocean supports a great diversity of life and ecosystems.
   - 5d. Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.
   - 5f. Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is "patchy." Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.
   - 5i. Estuaries provide important and productive nursery areas for many marine and aquatic species.

6. The ocean and humans are inextricably interconnected.
   - 6g. Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Lesson 1: 1g. 3f. 5i.
Lesson 2: 1g. 5i.
Lesson 3: 1g. 5d. 5f. 5i.
Culminating Lesson: 1g. 5i. 6g.

CLIMATE LITERACY ESSENTIAL PRINCIPLES

3. Life on Earth depends on, is shaped by, and affects climate.
   - 3a. Individual organisms survive within specific ranges of temperature, precipitation, humidity, and sunlight. Organisms exposed to climate conditions outside their normal range must adapt or migrate, or they will perish.

Lesson 1: 3a.

NOAA Marine Science Career - Case Studies

Marion Ano

TNC Marine Fellow

Marion Ano is an Assistant Marine Coordinator for the The Nature Conservancy, Hawaii. The Nature Conservancy (TNC) is a conservation organization that works around the world to protect ecologically important lands and waters.

Marion grew up in Hawai'i and she spent a lot of time playing in the ocean, which later inspired her to work in the marine environment. Her great-grand-father was a fish and game warden for the island of O'ahu; he passed on the knowledge of the islands and the ocean to her father. As she grew up and became more aware of the issues facing Hawaii's unique environments, she remembered the stories from her father about her great-grandfather's lessons of being a responsible environmental steward and she wanted to learn more.

Upon graduating from high school, she went to the University of Washington and received a degree in Geological Sciences. Then she came back to Hawai'i and worked as a Science Laboratory Assistant at Hawaii Pacific University, a science teacher at **Paepae o Heeia** for two years, and then taught fishpond management on **Molokai**. Then, in 2008, she began her two-year fellowship with The Nature Conservancy to learn the ropes of marine conservation in Hawai'i. During this time, her mentors at **Paepae o Heeia** and **Ka Honua Momona** (**Hi'ilei Kawelo, Mahina Paishon, Anuenue Punua, Noelani Yamashita, Uncle Mervin Dudoit, and Manuel Mejia**) inspired her to pursue Marine Conservation as a career and to bridge the gap between balancing the needs of people and caring for our marine environment.

Right now she has been working on two projects with the Nature Conservancy:
The first project involves alien algae removal and the second project uses complex computer programs to model what would happen to the levels of water runoff in the He'eia watershed if you did different types of restoration activities.

Project 1: Marion works with a local organization called **Mālama Maunalua** to help teach a lab section of a Kapi`olani Community College Biology class to remove algae and collect data within 3 plots (marked areas). She helps the students learn about invasive species and the scientific process, while collecting data. The cool thing is the data they collect can help scientists at the Nature Conservancy and The State of Hawaii learn about what happens when the invasive algae is removed so they can plan future projects. Marion's favorite thing about the alien algae project is that it teaches the students, **ʻAʻohe pau ka ʻike i ka hālau hoʻokahi,** (translantion: all knowledge is not taught in one school), one learns from many sources. Marion tells us, in marine conservation you have to work with many different people, who all know a lot of different things, and each person holds a piece of the puzzle to help protect our lands and sea.

Project 2: The computer project using Geospatial Information Systems or GIS helps her make computer models of a watershed to help managers, scientists, and community members decide where to place restoration efforts: **loʻi** (taro fields), restored native wetlands and restored loko wai (natural freshwater ponds) for raising and restoring anadromous and freshwater native fish species. Although this project involves sitting in front of a computer for long periods of time, she likes that she can use technology to restore marine and coastal habitats using information from scientists and indigenous knowledge from local Hawaiian practitioners.

What can you do? You may wonder. Well, Marion told us volunteering is a great way to get to know people in the field of marine conservation, and figure out what really interests you. "Get involved in one of the great projects that help protect and care for Hawaii's wetland ecosystems in your area or start a project in your own *ahupua'a* or watershed." The real obstacle for Marion during her experience has been time, because there are so many things she is interested in participating in or supporting, but she says "you have to focus your work to make a meaningful contribution in this field." But once you find what you are interested in there are a lot of passionate and dedicated people that will help you along the

Glossary of Cooperative Learning Techniques

In an effort to maximize student engagement and learning, the NOAA Sea Earth and Atmosphere curricular resources were designed using cooperative learning techniques. This guide defines the expectations for implementation of each technique.

What is Cooperative Learning?

Cooperative learning may be broadly defined as any classroom learning situation in which students of all levels of performance work together in structured groups toward a shared or common goal. According to Johnson, Johnson and Holubc, (1994): "Cooperative learning is the instructional use of small groups through which students work together to maximize their own and each other's learning." In classrooms where collaboration is practiced, students pursue learning in groups of varying size: negotiating, initiating, planning and evaluating together. Rather than working as individuals in competition with every other individual in the classroom, students are given the responsibility of creating a learning community where all students participate in significant and meaningful ways. Cooperative learning requires that students work together to achieve goals which they could not achieve individually.

Jigsaw

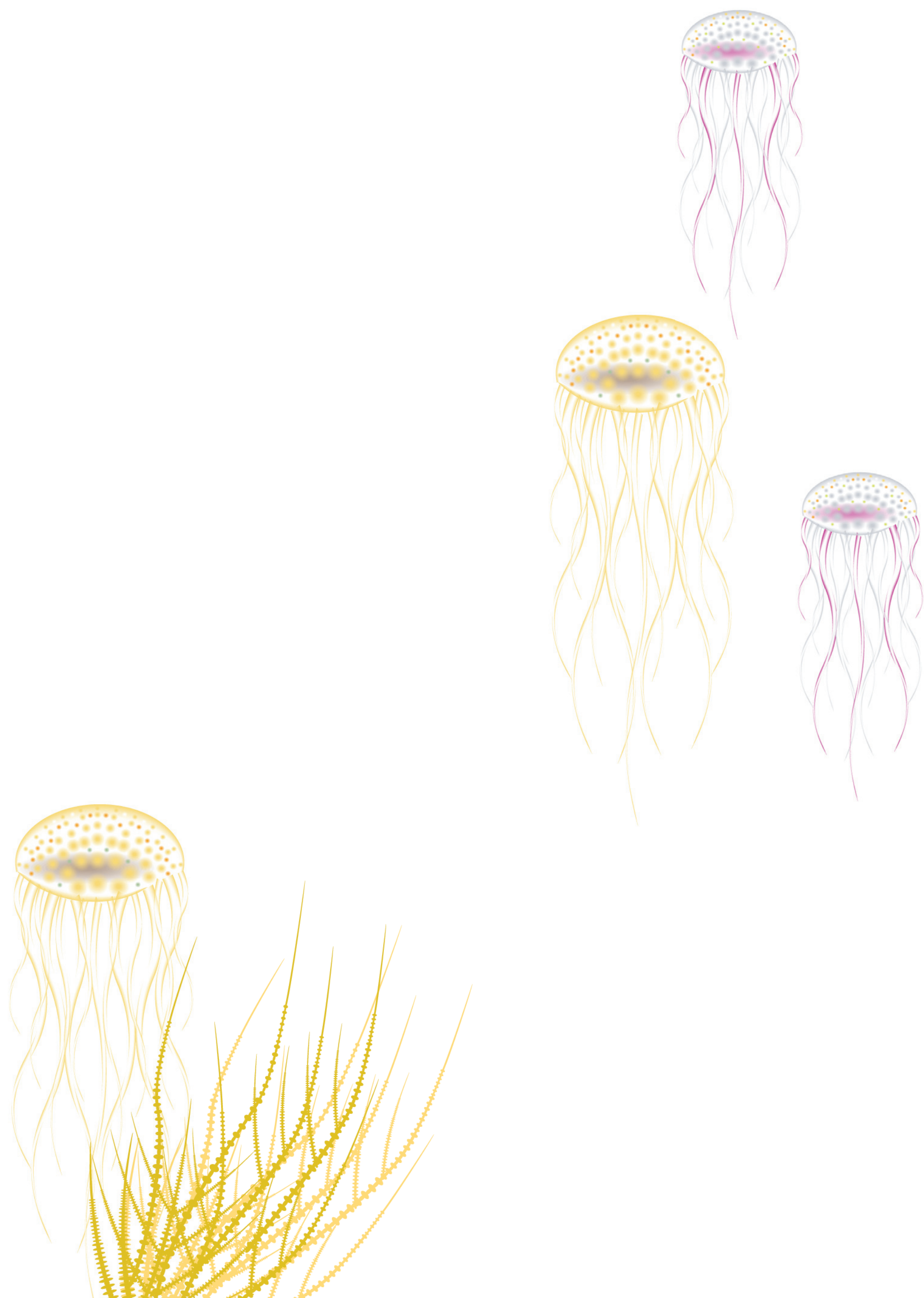
To Jigsaw materials refers to the use of a strategy in which each student on a team receives only a piece of the material that is to be learned in which that student becomes the "expert." Once the material is learned each member of the team takes a turn teaching the other members their assigned content. This type of dynamic makes the students rely on the other members of their team to learn all of the material.

Think-Pair-Share

This four-step discussion strategy incorporates wait time and aspects of cooperative learning. Students (and teachers) learn to LISTEN while a question is posed, THINK (without raising hands) of a response, PAIR with a neighbor to discuss responses, and SHARE their responses with the whole class. Time limits and transition cues help the discussion move smoothly. Students are able to rehearse responses mentally and verbally, and all students have an opportunity to talk.

Numbered Heads

This structure is useful for quickly reviewing objective material in a fun way. The students in each team are numbered (each team might have 4 students numbered 1, 2, 3, 4). Students coach each other on material to be mastered. Teachers pose a question and call a number. Only the students with that number are eligible to answer and earn points for their team, building both individual accountability and positive interdependence.



KWL Chart

A pre-assessment tool consisting of three vertical columns. Students list what they "**K**now" about a topic. What they "**W**ant" to know about a topic. The last column students share what they have "**L**earned" about a topic.

KWL CHART

Be sure to bullet your list.

Use content words only (nouns, verbs, names of people and places, dates, numbers, etc.).

WHAT DO I KNOW?	WHAT DO I WANT TO KNOW? *or* WHAT DO I WANT TO SOLVE?	WHAT HAVE I LEARNED?
•		•

Role Cards

Assign students to cooperative learning groups. Once students are in their groups the teacher will hand out premade role cards that will help each member of the group contribute to the completion of the given task. Before roles are assigned, the teacher should explain and model the task as well as the individual roles for students so that they know and understand how his/her individual role will contribute to the success of the group completing the task. When this technique is used, taking on a different role will aid in student proficiency.

Example of role cards:

Role Card #1

Facilitator:

Makes certain that everyone contributes and keeps the group on task.

Role Card #2

Recorder:

Keeps notes on important thoughts expressed in the group. Writes final summary.

Role Card #3

Reporter:

Shares summary of group with large group. Speaks for the group, not just a personal view.

Role Card #4

Materials Manager:

Picks up, distributes, collects, turns in, or puts away materials. Manages materials in the group during work.

Role Card #5

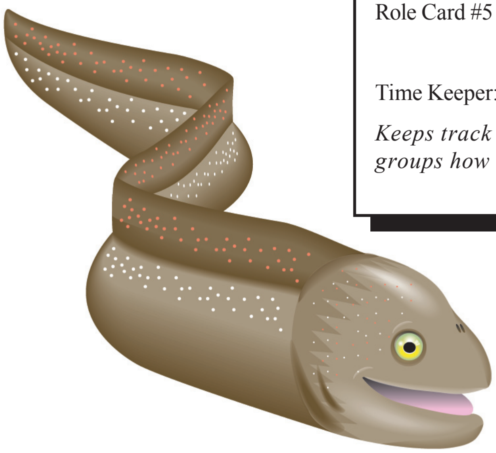
Time Keeper:

Keeps track of time and reminds groups how much time is left.

Role Card #6

Checker:

Checks for accuracy and clarity of thinking during discussions. May also check written work and keeps track of group point scores.



Round Table

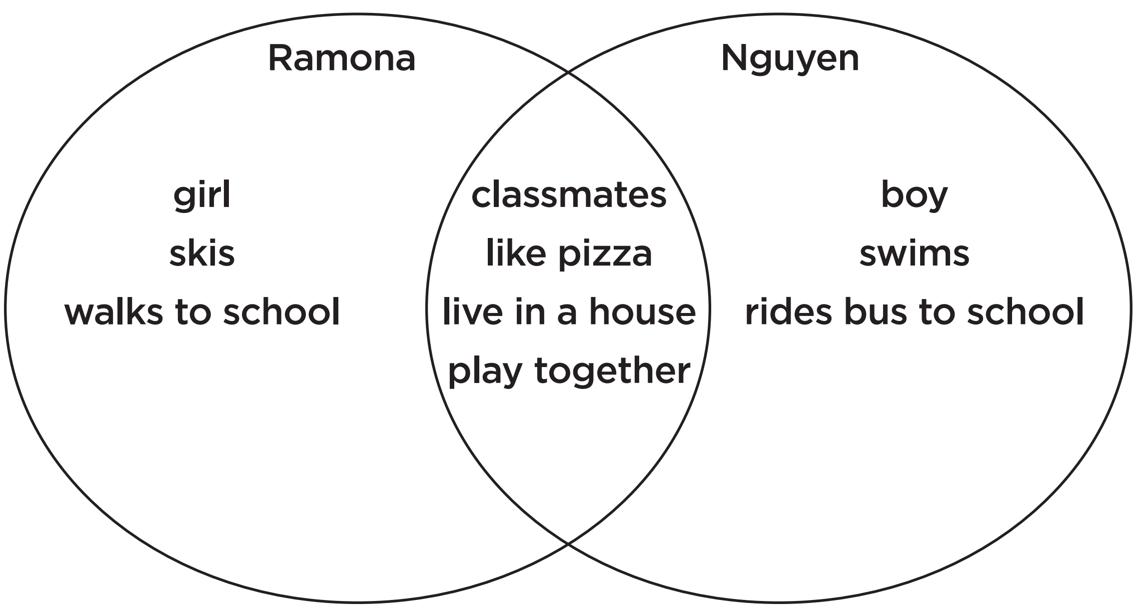
Round table can be used for brainstorming, reviewing, or practicing while also serving as a team builder. Students sit in teams of 3 or more, with one piece of paper and one pencil. The teacher asks a question which has multiple answers. Students take turns writing one answer on the paper, then passing the paper and pencil clockwise to the next person. When time is called, teams with the most correct answers are recognized. Teams reflect on their strategies and consider ways they could improve.

Three-Step Interview

This involves structured group activity with students. Using interviews/listening techniques that have been modeled; one student interviews another about an announced topic. Once time is up, students switch roles as interviewer and interviewee. Pairs then join to form groups of four. Students take turns introducing their pair partners and sharing what the pair partners had to say. This structure can be used as a team builder, and also for opinion questions, predicting, evaluation, sharing book reports, etc.

Venn Diagram

A diagram using circles to represent sets, with the position and overlap of the circles comparing and contrasting the relationships between two given pieces of information.



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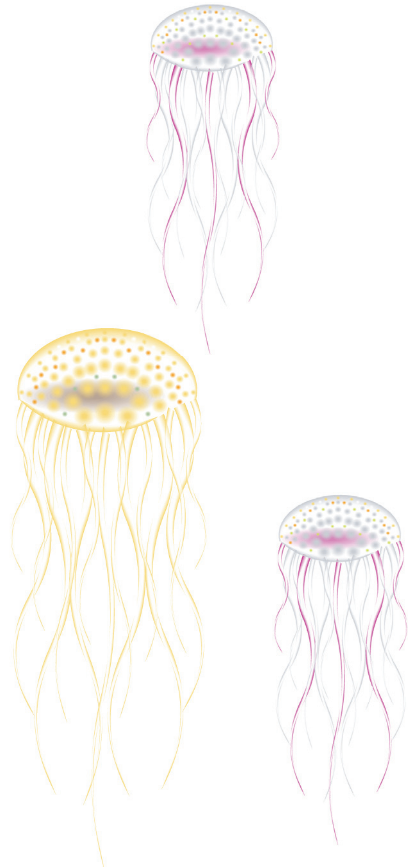

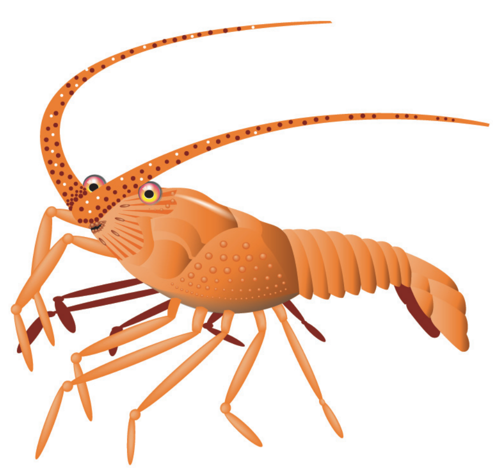

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