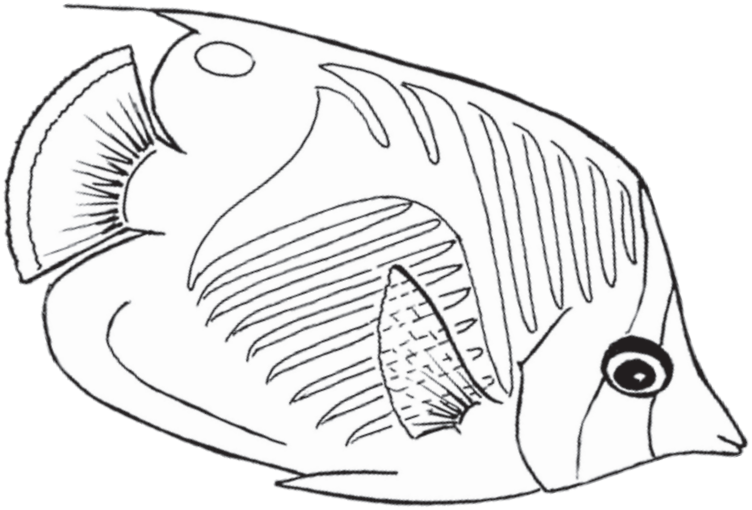


Hanauma Bay Education Program

Grade 6
Matter and Energy Transfers

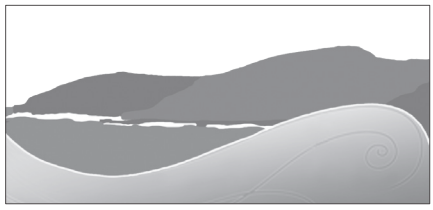
UNIHI-SEAGRANT-EE-08-01

Matter and Energy Transfers

BENCHMARKS:
6.3.1 Describe how matter and energy are transferred within and among living systems and their physical environment.

6.6.1 Compare how heat energy can be transferred through conduction, convection, and radiation. (Observe examples of energy transfer during visit; post-visit classroom activity can investigate heat energy transfer questions).

GLOS:
2. Community Contributor
3. Complex Thinker
4. Quality Producer
5. Effective Communicator



BIG IDEA(S)
The goal of the Hanauma Bay Education Program (HBEP) for grade 6 is to clarify how matter (i.e., chemical energy) and energy (i.e., light and heat) can be transformed and transferred through and between organisms and the physical environment at Hanauma Bay.

Another critical observation at the bay is how heat energy is transferred through radiation, conduction and convection in the terrestrial and aquatic environments.

EVIDENCE/CRITERIA:
Students should know and be able to do the following as a result of the teaching strategies in this lesson:

1. Describe how living organisms at Hanauma Bay transfer matter and energy to survive in their physical environment.

2. Compare the different ways heat energy is transferred through radiation, conduction and convection at Hanauma Bay.

The quality of the formative and summative tasks will by assessed by the teacher (or peers) as an indicator of student learning and achievement of benchmarks (e.g., group and individual charting of ideas, completion of learning sheets, KWL, SEEI of different concepts, Hanauma Bay food web).

LEARNING EXPERIENCES:
• To engage students, the field trip will begin with a walking tour of selected areas of Hanauma Bay. Careful observations (using worksheets and appropriate prompts) will be supplemented with visuals, manipulatives and interactive experiences in the Hanauma Bay Education Program (HBEP) classroom.

• Learning activities will vary instructional and learning strategies to address all learning styles (e.g., verbal/linguistic, visual, kinesthetic, interpersonal).

• If necessary, teachers will organize teams (prior to the field trip) to ensure appropriate pairing of special needs students.

• Introduction to and adequate preparation on specific, relevant science concepts will maximize the value of the HBEP experience.

• Precise group protocols and safety directions (e.g., on the bay ledge area) will be clarified before the walking tour.

PRIOR KNOWLEDGE:

• Students' current/prior knowledge, dispositions, misconceptions, and skills can be assessed with the worksheets provided in the tool kit (e.g., KWL sheets and concept summary pages).

• Definitions and concepts to cover before the field trip: matter, energy, food web, photosynthesis, cellular respiration, types of energy – mechanical, potential, chemical, wave, light, heat (radiation, conduction, convection).

TEACHER PREPARATION:

Teacher will introduce students to the concepts discussed in standards 6.3.1 and 6.6.1 in the classroom prior to the Hanauma Bay trip. Refer to the worksheets provided in the grade 6 tool kit to facilitate student learning prior to the field trip. Summarizing student understanding on chart paper will support review of selected concepts in the HBEP classroom. (Bring charts and worksheets on the day of the field trip.)

Definitions:

Living systems- Groups of living things that are self-organizing and that exchange energy and matter with their environment.

Physical environment- The surroundings in which a living organism exists. The physical environment includes water, land forms, sand, soil, climate.

Matter- Matter occupies space, has mass, and is composed predominantly of atoms consisting of protons, neutrons, and electrons. Atoms make up elements like carbon, hydrogen, oxygen and nitrogen.

Energy- The ability to do work. The ability to make things move or to make new chemical compounds. Work is done when a force (a push or a pull) acts on something for a distance. Energy can transform from one type of energy (chemical energy) to another type of energy (mechanical energy). Energy never goes away, it just transforms from one type of energy to another type of energy. Living organisms use energy to grow (make new molecules), reproduce, move (contract muscles), breathe, etc.

Food web- A network of feeding relationships. Food chains are a sequence of transfers of matter and energy from organism to organism in the form of food (chemical energy). Plants, which convert solar energy to food by photosynthesis, are the primary food source. In a

predator chain, a plant-eating animal (herbivore) is eaten by a carnivore. The final link is made up of decomposers that break down dead organisms and organic waste (detritus). Food chains overlap and interconnect into a food web because most organisms consume more than one type of animal or plant.

Photosynthesis- The process that plants use to make food. Plants convert energy from sunlight into chemical energy that they can use. Using the energy from sunlight, plants convert water and carbon dioxide into sugar. Oxygen is also produced.

Cellular respiration- The process that cells use to produce the energy that they need for reproduction, growth, movement etc. Sugar and oxygen are converted to energy and waste products of carbon dioxide and water.

Types of energy Mechanical energy/kinetic energy (wind energy, wave energy), light energy, radiation, heat energy, chemical energy, electrical energy.

Mechanical energy- This is the most common type of energy that we see around us. All moving objects have a type of mechanical energy called kinetic energy. When objects move, some of this energy can turn into heat energy. When a fish is swimming, this movement is mechanical energy. In this process the fish also generates heat.

Potential energy- Stored energy that can be translated into other forms of energy, such as kinetic energy. The food that the fish eats is potential energy which then can be converted to other forms of energy.

Chemical energy– Energy stored in matter in the form of chemical bonds between atoms and molecules. Chemical energy can be used by living things to move, reproduce, grow, etc.

Wave energy- Energy can travel in the form of waves. At Hanauma Bay we can observe ocean waves. Movement in the water due to wave energy can influence the types of fish, invertebrates, and limu (algae) living in an area. For example, in an area with lots of wave energy "surge zone" fish have different swimming adaptations.

Light energy- The transfer of energy as electromagnetic waves. Only part of the electromagnetic spectrum is visible (i.e., red, orange, yellow, green, blue, indigo, violet). UV light has shorter wavelengths compared to visible light. Radiation of light energy can occur through empty space (e.g., sun heats Earth through radiation.) When light hits the surface of matter it is reflected (bounced off), refracted (deflected slightly as it passes through), or absorbed (by atoms and usually converted to another form e.g., thermal energy).

Heat energy- Energy moving from a higher temperature object to a lower temperature object. The heat energy of a substance is determined by how active its atoms and molecules are. A hotter object is one whose atoms and molecules are excited and show rapid movement. A cooler object's atoms and molecules will be less excited and show less movement.

Conduction- The transfer of heat from a warmer substance to a cooler substance through direct contact. On contact, the energy from the faster-moving particles is transferred to the

slower-moving particles until the particles in both substances are moving at the same speed and their temperature has equalized.

Convection- The transfer of heat in a fluid through currents (particles move because of temperature differences. Molecules in hot medium move fast therefore density decreases and molecules rise. Conversely, molecules in a cold medium sink because density is higher. These temperature/density differences create circulation of molecules (i.e., currents). Therefore, convection currents transfer thermal energy throughout the water.

Additional Resources:
Fitting Algae into the Food Web- Energy Flow thru the Ecosystem:
http://www.bigelow.org/edhab/fitting_algae.html

INSTRUCTIONAL STRATEGIES (At the Bay):

The 2-hour field trip to Hanauma Bay will provide relevant ecosystem connections to the benchmarks being addressed. After the initial orientation to appreciate the uniqueness of the facility, students will review prior knowledge relevant to their bay experiences before taking a structured walking tour of key areas.

Classroom Activities: (30 minutes)

- View Hanauma Bay Education video (10 minutes)
- Pre-assessment of energy knowledge in small groups, using a KWL
- Class review of definitions and key concepts for energy and matter flow through the ecosystem
- Trace matter and energy flow interactions in the environment
- Supplies needed: grade level benchmarks on chart paper, blank chart paper, marker pens, blank laminated cards, overhead pens, copies of partially completed student KWL worksheets, class charts of key concepts.

Walking Tour / Field Observations: (30 minutes)

- Clarify field observation protocols/ distribute data sheets
- Walking tour in assigned groups
- Observations on the near shore ledge
- Observations in the parking lot
- Supplies needed: clipboards, pencils, observation data sheets for tour, fish/invertebrate ID cards or books

After the walking tour, assemble back in the classroom and utilize observation data to build food webs. Chart agreements. *Supplies needed for classroom activities: benchmarks written on chart paper, laminated organism and arrow cards with velcro backing, chart paper, pens, colored dots, blank laminated cards, overhead pens, camera (optional).*

If time allows, implement the following extension or optional activities:

INSTRUCTIONAL STRATEGIES (Back at the school):

• **Extension Activity:** Identify how the food web uses different types of energy. Using colored dots to represent each different type of energy (e.g., light, chemical, mechanical, heat), identify where in the food web each type of energy is being transferred or transformed and explain the process and/or end results.

• **Summative SEEI (State, Elaborate, Exemplify, Illustrate)** in narrative form to determine the quality of student understanding. Trace the energy and matter flow through a food web at Hanauma Bay. Begin with the following conceptual statement: *Living organisms at Hanauma Bay transfer matter and energy to survive in their physical environment.*

Or start with the energy statement: *Heat energy is transferred in a variety of ways at Hanauma Bay through radiation, conduction and convection.*

• **Inquiry Investigations** are a variety of independent inquiries to answer the heat transfer questions generated from the walking tour data collection at Hanauma Bay. In other words, use the inquiry process to answer student wonderings about radiation, conduction or convection in the transfer of heat energy.

• **Supplemental Activity**. Focus on human impact by adding humans to the food chain. Contrast the energy and matter flow through the ecosystem at Hanauma Bay with and without fish feeding. *Resources: fish feeding pictures and history. Pre and post feeding estimates of fish biomass, fish diversity information, amount of food added to the system by humans, online web sites with relevant data. Follow the logic template (sample attached).*

ASSESSMENTS (FORMATIVE):

The following formative assessments help to inform instruction and provide learner feedback during the learning activities at the bay:

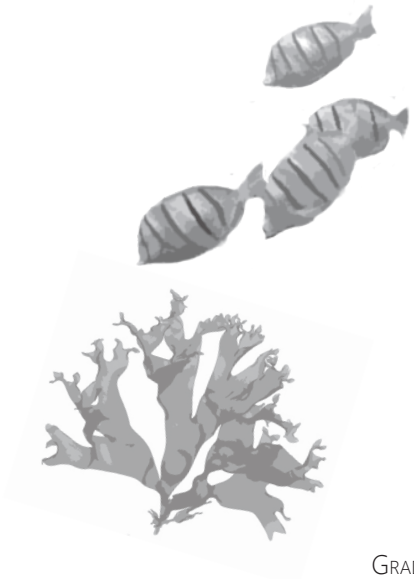
• Prior knowledge check: KWL on energy and/or matter flow

• Class review of relevant science concepts

• Typical (generic) food web interactions

• Unique (specific) food web(s) at Hanauma Bay

• Energy transformations observed at Hanauma Bay



EVALUATION (SUMMATIVE)

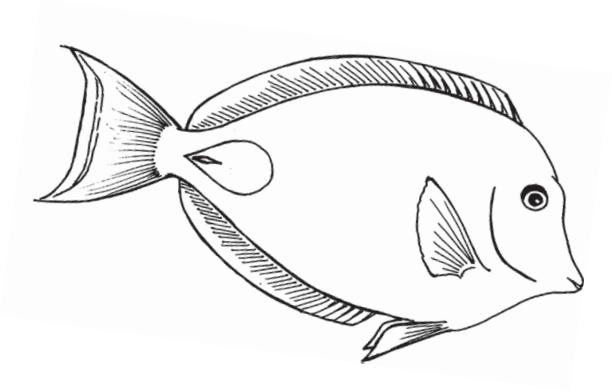
Student work can be evaluated to make judgments on learning results using the following tasks:

• Completion and refinement of original KWL sheets.

• Diagram and description of Hanauma Bay food webs as examples of matter/energy flow within/ among living systems and their physical environment.

• Narratives using the SEEI format: the flow of matter or energy transformations and transfers that affect survival of organisms at Hanauma Bay or heat energy transfers through radiation, conduction or convection.

• Optional extensions: logic of human impact at Hanauma Bay (refer to attached template) or inquiry investigations related to heat energy transfers.



Grade 6 Shoreline Observation: Food Chains and Webs

Name: ..... Date: .....

1. Place a check mark next to each type of marine life that you observed today.

Producers-Photosynthetic:

Limu: Algae

Ko'a: Coral

Algae Eaters-Herbivores:

Amaama: Striped Mullet

Manini: Convict Tang

Wana: Rock Boring Sea Urchin

'A'ama: Flat Rock Crab

Pipipi: Black Nerite

Pūpū Kōlea: Dotted Periwinkle

Pāku'iku'i: Achilles Tang

Umaumalei: Orangespine Unicornfish

Uhu: Redlip Parrotfish

Pāo'o: Zebra Blenny

Kūpīpī: Blackspot Sergeant

Unauna: Hermit Crab

2. Add any other marine life that you observed that is not on the list.

Animal Eaters-Carnivores:

'Ōmilu: Bluefin Trevally

Puhi: Snowflake Moray Eel

Moano: Manybar Goatfish

Hinālea: Saddleback Wrasse

'Āwela: Christmas Wrasse

Humuhumunukunukuāpua'a: Reef Triggerfish(*eats algae too)

Plankton Eaters:

Āholehole: Hawaiian Flagtail

Mamo: Hawaiian Sergeant

Coral Eaters:

Lauhau: Fourspot Butterflyfish

Kikākapu: Threadfin Butterflyfish

Kikākapu: Raccoon Butterflyfish

Sponge Eaters:

Kihikihi: Moorish Idol

3. Did you observe any marine life feeding or near its food source?

If yes, note them below:

Type of Marine Life	Food Source

Grade 6 Shoreline Observations

Grade 6 Shoreline Observation: Energy Observations

Name: ..... Date: .....

Describe and give example(s) of each type of energy or energy transfer that you observe at the bay.

1. Describe each type of Energy:	**2. Example of each type of Energy:**
Solar Energy-	Solar Energy-
Mechanical Energy-	Mechanical Energy-
Heat Energy-	Heat Energy-
Wave Energy-	Wave Energy-
Wind Energy-	Wind Energy-
Electrical Energy-	Electrical Energy-

3. Describe Heat Energy Transfer:	**4. Example of Heat Energy Transfer:**
Conduction-	Conduction-
Convection-	Convection-
Radiation-	Radiation-

Grade 6 Shoreline Observations

Logic of Human Impact at Hanauma Bay

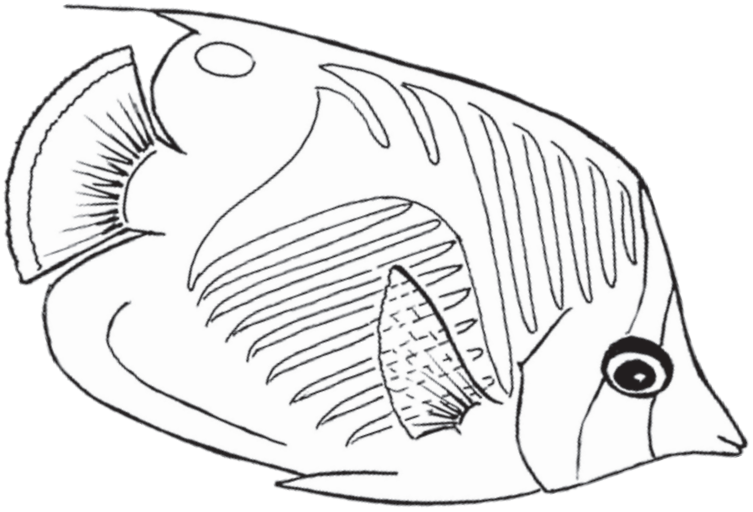
Point of View	**Purpose**	**Assumptions**
Human actions will always have consequences for the environment, both positive and negative.	To determine the impact of humans on the marine and terrestrial ecosystems at Hanauma Bay.	• Awareness and anticipation of the implications of certain actions are valuable proactive strategies. • Humans can control how their actions will impact the environment.
Questions • How has modifying the energy and matter flow (e.g., fish feeding ban) affected the marine ecosystem, specifically the homeostasis? • How has the management of visitor numbers affected the terrestrial and aquatic ecosystems at the bay? • How has fish biomass and diversity changed with the implementation of visitor guidelines?	**Information**	

Concepts

Conclusions

Implications

Reflections



Hanauma Bay Education Program

Grade 6
Matter and Energy Transfers

Tool Kit

UNIHI-SEAGRANT-EE-08-01

Hanauma Bay Grade 6

Cellular Respiration

STATE:

Cellular respiration converts chemical energy from food to appropriate energy forms to support life processes.

ELABORATE:

In other words…

cellular respiration is the process (occurring in mitochondria of cells), that chemically combines oxygen with food molecules (sugar) to release energy. Both plant and animal cells need chemical energy in the form of a molecule called ATP (adenosine triphosphate) and cellular respiration is the process that produces / replenishes the ATP supply in the cell. The cell is then able to conduct cellular activities using this available ATP. These activities include making molecules the cell needs (e.g., enzymes, hormones, cell structures, etc.), getting rid of wastes, contraction of muscles for movement, cell reproduction for growth, development or maintenance of structures.

EXEMPLIFY:

For example…

Shrimp, snails and herbivore fish (e.g. butterflyfish and tangs) eat algae growing in the reef ecosystem. Cellular respiration chemically combines the digested plant material (glucose) with oxygen (diffusing into the cells from the water), to release energy that is used to produce ATP molecules and waste products of carbon dioxide and water. The ATP is now available for the animals to move muscles to escape from predators, move in the environment to find more food, produce more cells through mitosis to grow or replace damaged cells, produce gametes (sperm and eggs) for reproduction. These are examples of some of the many activities that occur as a result of the energy that the mitochondria release through cellular respiration.

ILLUSTRATE:

$C_6H_{12}O_6 + O2 \rightarrow CO_2 + H_2O +$ ATP energy

Glucose + Oxygen → carbon dioxide + water + adenosine triphosphate

Hanauma Bay Grade 6

Food Webs

STATE:

Food webs show transfers of matter and energy in interconnected feeding relationships.

ELABORATE:

In other words…

a food web is a system of several overlapping food chains. A food chain shows only one energy path in an ecosystem. But most organisms are part of more than one food chain. Food webs show a more complete picture of the flow of energy in an ecosystem. All organisms need energy from food to survive. Organisms (producers, consumers, decomposers) are grouped based on how they get the energy they need to live. A food chain traces the path of energy as it moves from one organism to the next in the ecosystem. As with most ecosystems, the energy in Hanauma Bay starts with the sun. This light energy is taken in by the producers (e.g., algae, plants, bacteria) and converted to food energy through photosynthesis. The chemical energy in the food then moves through different levels of consumers (herbivores: plant-eaters, carnivores: eat herbivores and other carnivores, omnivores: feed on producers and consumers). Arrows show the direction of energy movement in a food chain or web. The movement of energy ends with the many bacteria and fungi that live in the substrate (sand, mud, reef) at the bottom of the bay. These decomposers feed on the wastes and remains of marine organisms. As they feed, they break down the organisms' tissues into valuable materials that are then returned to the ocean ecosystem.

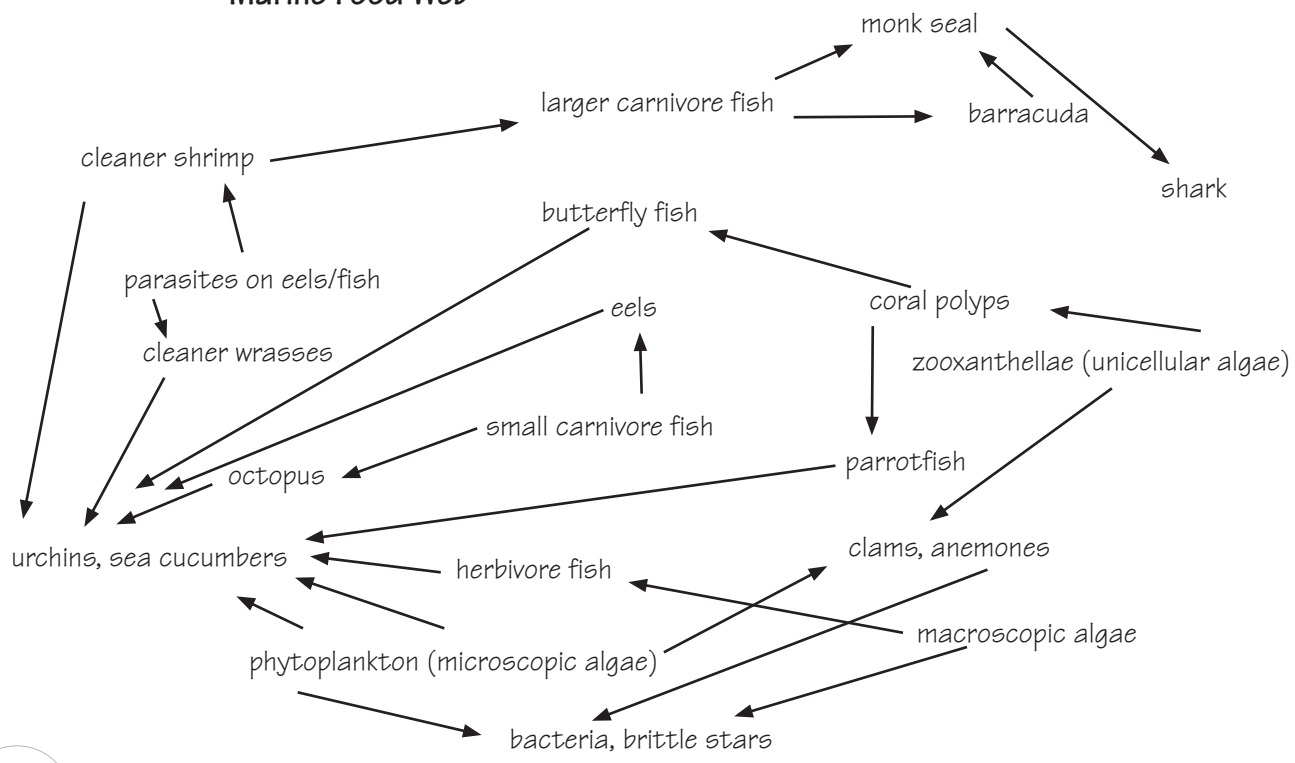
EXEMPLIFY:

For example…typical food webs in Hanauma Bay start with producers (e.g. phytoplankton,limu) that are eaten by herbivores (e.g., zooplankton, featherduster worms, surgeonfish, sea urchins, tangs, snails, butterflyfish) which are then eaten by carnivores or omnivores (e.g., mamo, crabs, eels, octopus, snappers, goatfish, barracuda, wrasse); the apex predator carnivore being the ulua or shark. Decomposers include organisms like crabs, sea cucumbers, urchins, brittle stars and bacteria will break down waste and marine organism remains into useable materials in the ecosystem.

ILLUSTRATE:

Draw food web using arrows to show direction of energy / matter movement from producers to consumers (herbivores, carnivores or omnivores) and finally to decomposers.

Marine Food Web



Hanauma Bay Grade 6

Photosynthesis

STATE:

Photosynthesis converts light energy into chemical energy to support survival of life forms on Earth.

ELABORATE:

In other words…

photosynthesis is the process that happens in green plants (and some other organisms) that uses sun energy to combine inorganic molecules (carbon dioxide and water) to form an organic molecule (glucose) and a waste product of oxygen (gas). Photosynthetic cells contain the green pigment, chlorophyll, which traps energy from the sun to conduct the process of photosynthesis. The glucose produced in the process is the chemical energy source that is transferred to other living things in food chains/webs through predator-prey interactions. Therefore, light energy is transformed to chemical energy in photosynthesis. Photosynthetic organisms are the **producers**. Chemical energy (glucose) is passed on to primary (herbivores), secondary (carnivores) and tertiary (apex) **consumers** and used to produce the ATP energy they need for survival. *The process that produces ATP for all living things is cellular respiration (see separate SEEI for cellular respiration).*

EXEMPLIFY: *For example…*

Macro algae (limu) and microscopic algae floating in the water (phytoplankton) trap sun energy with their chlorophyll molecules. Through photosynthesis these producers (algae) transform light energy into chemical energy (glucose). When the algae are eaten by herbivores (e.g., manini, butterflyfish, snails) or omnivores (e.g., nenue, crabs, shrimp) the chemical energy is tranfered to the consumer to be used for all the cell activities necessary for survival. These activities include making enzymes and hormones, cell division to grow larger or repair body parts, using the ATP energy to move muscles to search for food or escape from predators.

ILLUSTRATE:

$CO_2 + H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + O_2$

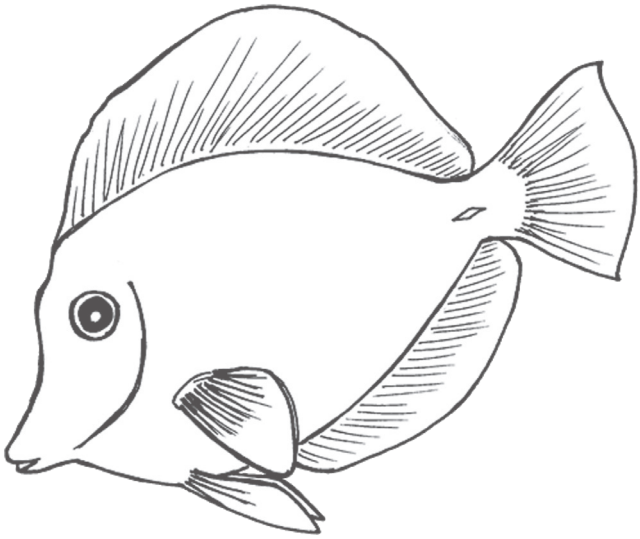
carbon dioxide + water + sunlight → glucose + oxygen

STATE:

ELABORATE:

EXEMPLIFY:

ILLUSTRATE:



Hanauma Bay Education Program

Grade 7
Interactions of Organisms in the Marine Environment

UNIHI-SEAGRANT-EE-08-01

Interactions of Organisms in the Marine Environment

BENCHMARKS:
7.3.1-Explain how energy moves through food webs, including roles of photosynthesis and cellular respiration.

7.3.2-Explain the interaction and dependence of organisms on one another.

7.3.3-Explain how biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem

GLOS:
2. Community Contributor
3. Complex Thinker
4. Quality Producer
5. Effective Communicator

BIG IDEA(S)
Grade 7 Hanauma Bay Education Program (HBEP) curriculum clarifies various processes, relationships, and factors that may affect the survival of organisms, carrying capacity of the environmental niche, and sustainability of the marine ecosystem.

EVIDENCE/CRITERIA:
Students should know and be able to do the following as a result of the teaching strategies in this lesson:

1. Use examples of creatures living in Hanauma Bay to explain how energy moves through food webs, including roles of photosynthesis and cellular respiration.

2. Use examples of creatures living in Hanauma Bay to explain the interaction and dependence of organisms on one another.

3. Use examples from the Hanauma Bay ecosystem to explain how biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem.

The quality of the formative and summative tasks will be assessed by the teacher (or peers) as an indicator of student learning and achievement of benchmarks (group and individual charting of ideas, completion of learning sheets, KWL, SEEI of different concepts, Hanauma Bay food web).

LEARNING EXPERIENCES:
• To engage students, the field trip will begin with a walking tour of selected areas of Hanauma Bay. Careful observations (using worksheets and appropriate prompts) will be supplemented with visuals, manipulatives and interactive experiences in the Hanauma Bay Education Program (HBEP) classroom.

• Learning activities will vary instructional and learning strategies to address all learning styles (e.g., verbal/linguistic, visual, kinesthetic, interpersonal).

• If necessary, teachers will organize teams (prior to the field trip) to ensure appropriate pairing of special needs students. Precise group protocols and safety directions (e.g., on the bay ledge area) will be clarified before the walking tour.

• Introduction to and adequate preparation on specific, relevant science concepts will maximize the value of the HBEP experience. Group collaboration on concept clarification (refer to underlined terms in definition section of teacher preparation) prior to the field trip; charting of understandings; sharing with peers; and completion of selected Tool Kit worksheets will facilitate student preparation for the field trip. Completed student work should be brought to the bay to post in the HBEP classroom.

PRIOR KNOWLEDGE:

• Students' current/prior knowledge, dispositions, misconceptions, and skills can be assessed with the worksheets provided in the Tool Kit (e.g. KWL sheets and concept summary pages).

• Definitions and concepts to cover before the field trip: Food web, photosynthesis, cellular respiration, carrying capacity, sustainability, ecosystem, biotic, abiotic, interaction, dependence.

TEACHER PREPARATION:

Teacher will introduce students to the concepts discussed in standards 7.3.1, 7.3.2, 7.3.3 in the classroom prior to the Hanauma Bay trip.

Refer to the worksheets provided in the grade 7 tool kit to facilitate student learning prior to the field trip. Summarizing student understanding on chart paper will support review of selected concepts in the HBEP classroom (bring charts and worksheets on the day of the field trip).

Definitions:

Food Web- A network of interconnected feeding relationships. Food chains are a sequence of transfers of matter and energy from organism to organism in the form of food. Plants, which convert solar energy to food by photosynthesis, are the primary food source. In a predator chain, a plant-eating animal is eaten by a larger animal. The final link is made up of decomposers that break down dead organisms and organic wastes. Food chains overlap and interconnect into a food web because most organisms consume more than one type of animal or plant.

Photosynthesis- The process by which plants convert energy from sunlight into chemical energy that they can use. Using the energy from sunlight plants convert water and carbon dioxide into sugar. Oxygen is also produced.
Marine example: Energy from the sun can be used by the zooxanthellae in coral.These unicellular algae that live in the coral polyps use the light energy (trapped by the chlorophyll) to change inorganic molecules of water and carbon dioxide into organic sugar (glucose) that can be used by the coral animals as chemical energy for survival.

Cellular Respiration- The process that cells use to produce the energy they need to survive. Sugar and oxygen is converted to energy for growth, reproduction, movement, etc., with waste

products of carbon dioxide, water, and heat. Marine example: The manini eats algae, and uses the sugars from the algae to survive. In other words, the sugar combines with oxygen (absorbed from the water) to change sugar molecules into energy that the manini can use to grow and develop, swim from predators, search for food, reproduce, repair damaged body cells, etc.

Carrying Capacity- The population of living things that an ecosystem can support, given the amount of food, water, and habitat available in that ecosystem.

Sustainability- Degree to which present interactions between human society and nature can continue over the long term without significant damage or impact to the environment, individuals or society.

Ecosystem- A unit consisting of all of the living (biotic) and non-living (abiotic) parts of the environment (e.g., coral reef ecosystem; rocky shoreline; sandy/muddy bottoms; open ocean; marine/brackish/fresh water ecosystems).

Biotic- The living parts of the environment (animals, plants, bacteria, fungi).

Abiotic- The non-living parts of the environment (soil, minerals, rocks, water, sunlight, wind, temperature atmospheric gases like oxygen and carbon dioxide).

Interaction-mutual or reciprocal action/influence. Different species of organisms living together in the environment interact with one another. They interact with each other in three main ways:

(1) Competition (food, water, space resources determine survival of certain organisms)
(2) Predation (predator/prey feeding relationships keep populations in check)
(3) Symbiosis (mutualism, commensalism & parasitism describe close relationships between two species)

Dependence- Relying on another for support/survival. In feeding relationships, herbivores (plant-eaters) are consumers who are dependent on producers (plants) for food/survival. Carnivores are consumers who are dependent on herbivores or other carnivores for food. Omnivores are dependent on both producers and consumers. All symbiotic relationships are examples of dependence but vary in which organisms are dependent. In parasitism, one organism is dependent on the other for survival, harming the host organism in the process. Commensalism involves one organism being dependent on the other, not harming or helping the other organism (only one benefits). Finally, mutualism is a relationship where both organisms are dependent on each other for survival (both benefit from the interaction).

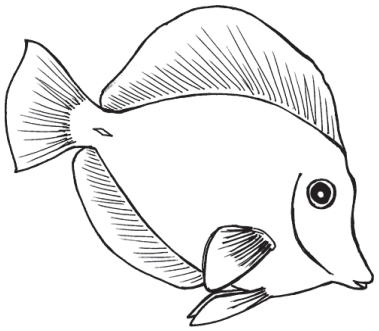
General Overview of the Animal Kingdom:

Invertebrates (sponges, cnidaria, flatworms, roundworms, segmented worms, mollusks, arthropods, echinoderms)

Vertebrates (fish, amphibians, reptiles, birds, mammals)

Hanauma Bay Invertebrates (herbivores, carnivores, omnivores):
• Worms: Feather duster, Christmas tree worm, flatworms
• Molluscs: Box jelly, Portuguese man-o-war, day octopus, oval squid, horned helmet, cowry, cone shell
• Arthropods: Banded coral shrimp, spiny lobster, black/rock crab, hermit crab
• Echinoderms: Sea urchins (echinothrix, echinometra, colobocentrotus, tripneustes), sea cucumber, sea stars, brittle stars

Hanauma Bay Fish Families (herbivores, carnivores, omnivores):
• Blenny (zebra, shortbodied)
• Boxfish (spotted, cowfish)
• Butterfly fish (fourspot, forceps, milletseed)
• Damselfish (kupipi)
• Flagtail (aholehole)
• Goatfish (weke, kumu)
• Milkfish (awa)
• Mullet
• Parrotfish (uhu)
• Rudderfish (nenue)
• Surgeonfish/tangs (palani, yellow tang, manini)
• Wrasse (hinalea)
• Ladyfish (awaawa)
• Hawkfish
• Frogfish
• Lizardfish



• Sharks and Rays

Hanauma Bay Reptiles and Mammals:
• Green, and hawksbill turtles
• Spinner dolphins
• Monk seal
• Humpback whales

Hanauma Bay Producers:
• Phytoplankton
• Microscopic/macroscopic green, brown, red algae (limu) attached to reef
• Macroscopic (benthic and floating algae): Halimeda, sargassum, padina, turbinaria

INSTRUCTIONAL STRATEGIES (At the Bay):
The 2-hour field trip to Hanauma Bay will provide relevant ecosystem connections to the benchmarks being addressed.

Site Observations: After the initial park orientation to appreciate the uniqueness of the nature preserve, students will observe key areas from the upper park lookout to identify different areas that will be referenced in the HBEP classroom. Students will assemble in the classroom to review relevant concepts learned previously and to continue learning activities focused on the grade 7 benchmarks.

Classroom Activities:

- View Hanauma Bay Education Video (10 minutes)
- Assessment of ecosystem knowledge in small groups, using a KWL
- Class review of definitions and food web interaction concepts in the ecosystem (e.g., photosynthesis, cellular respiration, interaction vs. dependence, carrying capacity, sustainability)
- Group work to construct a marine food web using laminated pictures connected with arrows to show the direction of energy flow. Utilize observation data to build food webs.
- Focus on matter and energy flow interactions of zooxanthellae and coral reefs, metabolic processes influencing organism survival, factors affecting optimum coral reef growth, conditions affecting carrying capacity and sustainability of the reef ecosystem at Hanauma Bay.
- If time permits, utilize relevant visuals to describe symbiotic relationships typically found in the marine ecosystem; factors influencing optimum growth of different coral species; or human activities affecting carrying capacity and sustainability of the Hanauma Bay ecosystem.
- Supplies needed: *Grade level benchmarks on chart paper, blank chart paper, marker pens, laminated organism and arrow cards with velcro backing, blank laminated cards, overhead pens, copies of partially completed student KWL worksheets, class charts of key concepts.*

http://oceanservice.noaa.gov/education/kits/corals/media/supp_coral02a.html

Extensions:

- Optimum growth conditions (coral reefs)
- Impact of humans and environmental conditions on Hanauma Bay populations
    - o Fish feeding
    - o Predictions of reef with more/fewer algae-eaters

INSTRUCTIONAL STRATEGIES (Back at the school)

- **Extension Activity:** Identify how the food web uses different types of energy. Using colored dots to represent each different type of energy (e.g., light, chemical, mechanical, heat), identify where in the food web each type of energy is being transferred or transformed and explain the process and/or end results.

- **Summative SEEI** (State, Elaborate, Exemplify, Illustrate): In narrative form to determine the quality of student understanding. Select one of the SEEI statements provided in the grade 7 tool kit or create a focused statement that students will demonstrate their understanding of the benchmark concepts after visiting Hanauma Bay.

- **Long-term Inquiry Investigations:** Independent inquiries to investigate factors that influence coral larvae growth (per Gerry Davis, NOAA). In other words, use the inquiry process to answer student wonderings about the effects of different environmental conditions on optimum coral larvae survival. Alternative inquiries could also focus on biotic and abiotic factors influencing the growth of specific macroscopic algae species in Hanauma Bay (e.g. turbinaria, the preferred food of turtles).

• **Supplemental Activity:** Review of the literature comparing the Northwest Hawaiian Islands and the main Hawaiian Islands to support a point of view for the following question, "What would a reef be like if there were less top predators or carnivores like ulua, sharks, etc. vs. more top predators or carnivores?"

• **Social Studies Learning Activity:** Keeping in mind the food web concepts learned and the discussions of how people may affect food webs, students will research the positive and negative impacts (historically and currently) that humans have on Hanauma Bay. In other words, summarize the events that have previously occurred and the current practices that govern the management of the Hanauma Bay Nature Preserve.

ASSESSMENTS (FORMATIVE):

The following formative assessments help to inform instruction and provide learner feedback during the learning activities at the bay:

• KWL worksheets completed at the school (focused on 3 different benchmarks).

• SEEI worksheets to clarify concepts prior to field trip (refer to tool kit).

• Group review in the HBEP classroom (charting) of photosynthesis vs. respiration, interaction vs. dependence, carrying capacity vs. sustainability.

• Group charts of major concepts such as the food web, photosynthesis, cellular respiration, carrying capacity, sustainability, interaction, dependence (to post in the HBEP classroom).

• HBEP classroom discussion including the definitions of biotic/abiotic and identification examples of each in the bay's ecosystem.

• Group charting of food web definition.

• Collaborative creation of food web (wall with cards, arrows and yarn).

• Group definitions of cellular respiration.

• SEEI of benchmarks 7.3.1 and 7.3.2.

• Factors/optimum conditions for coral survival.

• Drawing/description of reefs where algae-eater populations vary (more/less).

EVALUATION (SUMMATIVE):

Student work can be evaluated to make judgments on learning results using the following tasks:

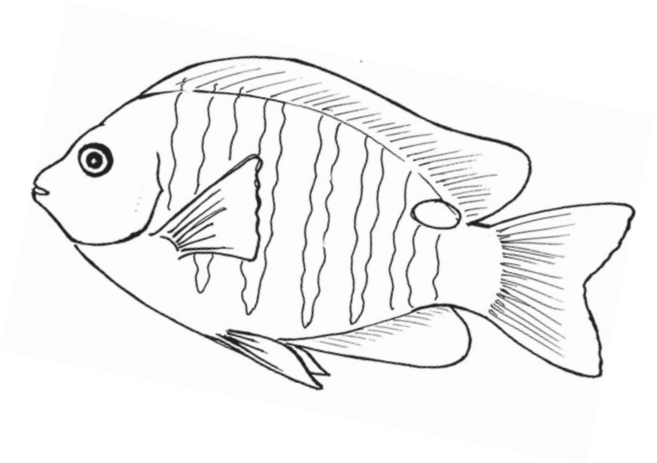
• Use the SEEI model/criteria to show learning. Teacher provides the appropriate food web conceptual statement and students input additional information to clarify and elaborate (give more detail) on the statement. Give an example of an authentic food web found in Hanauma Bay and describe how the organisms in your food web interact. Create a labeled diagram to illustrate the food web described.

• Use SEEI to connect benchmarks 7.3.1 and 7.3.2 in a narrative format.

• Complete and refine the original KWL sheets

• Optional extensions: Logic of human impact at Hanauma Bay (refer to attached template) or lab reports of inquiries on the factors affecting optimum growth of algae or coral larvae.

• Essential question: What is the carrying capacity of people at Hanauma Bay?



Grade 7 Hanauma Bay Observations

Name: ..... Date: .....

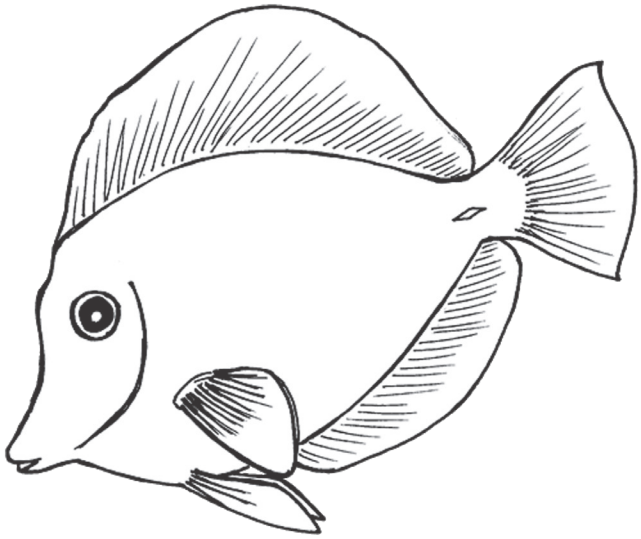
Key Points of Reference:

- Reef
- Key hole / Open Water
- Rocky shoreline

Essential Question: How do interactions of organisms in different areas of Hanauma Bay vary?

Observations:

Wonderings / Questions:



Hanauma Bay Education Program

Grade 7
Interactions of Organisms in the Marine Environment

Tool Kit

UNIHI-SEAGRANT-EE-08-01

Grade 7 Conceptual Statements for SEEI Strategy

- Solar energy that enters the ecosystem is converted into chemical energy that moves through the ecosystem by way of food webs.

- Matter in an ecosystem (i.e. food, water, air) is constantly being changed in form and recycled through the environment.

- Energy stored in the cells and tissues of organisms is passed through the ecosystem by way of the food chain / webs.

- Organisms at each level use chemical energy to carry out their life processes. In addition, energy is lost at each level as heat to the environment. Consequently only 10% of the energy present at one level is passed to the next feeding level.

- Plants, algae and some bacteria take in carbon dioxide from the environment and use it to make food through the process of photosynthesis. Oxygen is released back to the environment as a waste product of this process.

- Most organisms get energy by combining oxygen from the air with food in a process known as cellular respiration. Carbon dioxide is released back into the environment as a waste product of respiration.

- Food webs show transfers of matter and energy in interconnected feeding relationships.

- Photosynthesis converts light energy into chemical energy to support survival of life forms on Earth.

- Cellular respiration converts chemical energy from food to appropriate energy forms to support life processes.

- Photosynthesis and cellular respiration support movement of energy through food webs in Hanauma Bay.

- Marine organisms interact and depend on each other for survival in a variety of ways at Hanauma Bay.

• Biotic and abiotic factors affect the carrying capacity and sustainability in the Hanauma Bay ecosystem. In other words, factors like available resources, disease, competition, predation, climate, and habitat affect the health and carrying capacity of the ecosystem at Hanauma Bay.

• Carrying capacity of an ecosystem is determined by the availability of food, water and favorable habitat.

• The carrying capacity of an ecosystem is the size of the population that can be supported indefinitely upon the available resources and services of that ecosystem.

• Sustainability involves the long-term interaction of humans and nature without damage to the environment or society.

• Living within the limits of an ecosystem depends on the amount of resources available in the ecosystem, the size of the population, and the amount of resources each individual is consuming.

• Sustainable development meets the needs of the present without compromising the needs of future generations to meet their own needs.

• Sustainable development improves the quality of human life while living within the carrying capacity of the ecosystems.

• A sustainable community is one which recognizes that growth occurs within some limits and is ultimately limited by the carrying capacity of the environment.

Hanauma Bay Grade 7

Carrying Capacity

STATE:

The carrying capacity of an ecosystem is determined by the availability of food, water and habitat/shelter.

ELABORATE:

In other words…

The number of living organisms that can be supported by a particular ecosystem is influenced by three basic factors. One of the crucial factors is the availability of food -- quantity as well as type of food. The presence or quantity of available water is another important factor that determines the number of individuals that are able to survive in that environment . Finally, all organisms require a specific space in order for them to survive. These three factors – food, water, shelter—will determine the carrying capacity of an ecosystem.

EXEMPLIFY: *For example…*

at Hanauma Bay the different fish populations are affected by the quantity of food available to each species. If the population increases, the food supply decreases; consequently the population of fish is affected. Or if the fish require a specific habitat to live in and the space is destroyed or occupied by others, that would affect population numbers.

ILLUSTRATE:

"*Oh Fish*" scenario demonstrates the effects of food, water, shelter/habitat on the carrying capacity of the environment for a population of fish (first without fishermen, and later with fishermen introduced to the environment).

Hanauma Bay Grade 7

Food Webs

STATE:

Food webs show transfers of matter and energy in interconnected feeding relationships.

ELABORATE:

In other words…

a food web is a system of several overlapping food chains. A food chain shows only one energy path in an ecosystem. But most organisms are part of more than one food chain. Food webs show a more complete picture of the flow of energy in an ecosystem.

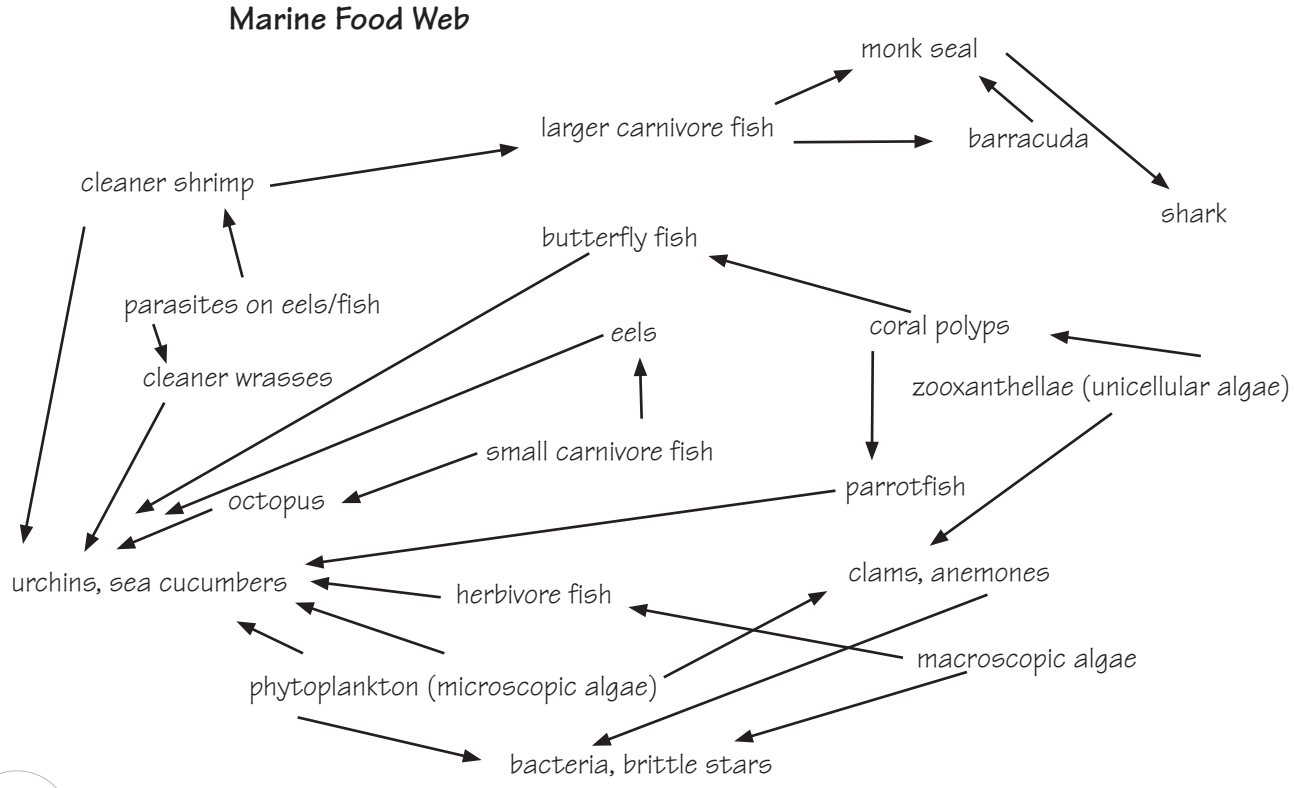
All organisms need energy from food to survive. Organisms (producers, consumers, decomposers) are grouped based on how they get the energy they need to live. A food chain traces the path of energy as it moves from one organism to the next in the ecosystem. As with most ecosystems, the energy in Hanauma Bay starts with the sun. This light energy is taken in by the producers (e.g. algae, plants, bacteria) and converted to food energy through photosynthesis. The chemical energy in the food then moves through different levels of consumers (herbivores: plant-eaters, carnivores: eat herbivores and other carnivores, omnivores: feed on producers and consumers). Arrows show the direction of energy movement in a food chain or web. The movement of energy ends with the many bacteria and fungi that live in the substrate (sand, mud, reef) at the bottom of the bay. These decomposers feed on the wastes and remains of marine organisms. As they feed, they break down the organisms' tissues into valuable materials that are then returned to the ocean ecosystem.

EXEMPLIFY:

For example…typical food webs in Hanauma Bay start with producers (*e.g.* phytoplankton,limu) that are eaten by herbivores (*e.g.* zooplankton, featherduster worms, surgeonfish, sea urchins, tangs, snails, butterflyfish) which are then eaten by carnivores or omnivores (*e.g.* mamo, crabs, eels, octopus, snappers, goatfish, barracuda, wrasse)…..the apex predator carnivore being the ulua or shark. Decomposers include organisms like crabs, sea cucumbers, urchins, brittle stars and bacteria will break down waste and marine organism remains into useable materials in the ecosystem.

ILLUSTRATE:

(draw food web using arrows to show direction of energy / matter movement from producers to consumers (herbivores, carnivores or omnivores) and finally to decomposers.



Hanauma Bay Grade 7

Photosynthesis

STATE:

Photosynthesis converts light energy into chemical energy to support survival of life forms on Earth.

ELABORATE:

In other words…

photosynthesis is the process that happens in green plants (and some other organisms) that uses sun energy to combine inorganic molecules (carbon dioxide and water) to form an organic molecule (glucose) and a waste product of oxygen (gas). Photosynthetic cells contain the green pigment, chlorophyll, which traps energy from the sun to conduct the process of photosynthesis. The glucose produced in the process is the chemical energy source that is transferred to other living things in food chains/webs through predator-prey interactions. Therefore, light energy is transformed to chemical energy in photosynthesis. Photosynthetic organisms are the **producers**. Chemical energy (glucose) is passed on to primary (herbivores), secondary (carnivores) and tertiary (apex) **consumers** and used to produce the ATP energy they need for survival. *The process that produces ATP for all living things is cellular respiration (see separate SEEI for cellular respiration).*

EXEMPLIFY: *For example…*

Macro algae (limu) and microscopic algae floating in the water (phytoplankton) trap sun energy with their chlorophyll molecules. Through photosynthesis these producers (algae) transform light energy into chemical energy (glucose). When the algae are eaten by herbivores (e.g manini, butterflyfish, snails) or omnivores (e.g. nenue, crabs ,shrimp) the chemical energy is tranfered to the consumer to be used for all the cell activities necessary for survival. These activities include making enzymes and hormones, cell division to grow larger or repair body parts, using the ATP energy to move muscles to search for food or escape from predators.

ILLUSTRATE:

$CO_2 + H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + O_2$

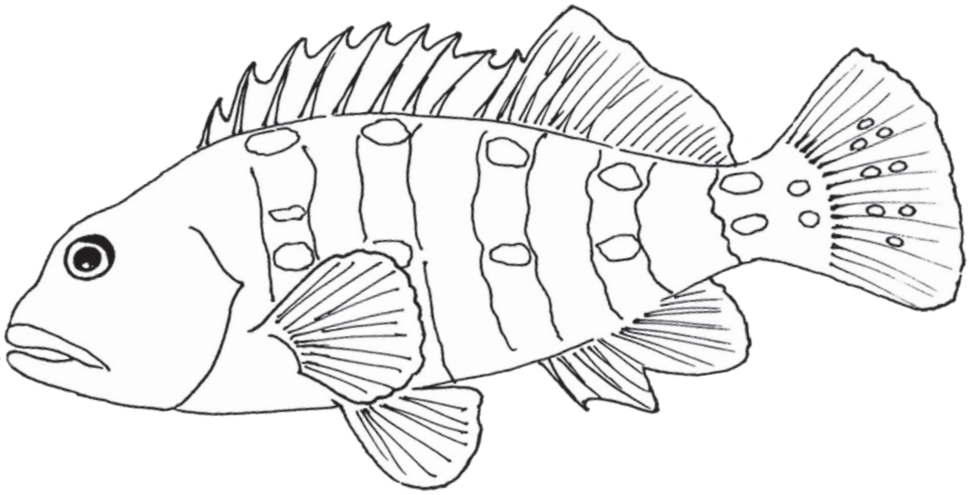
carbon dioxide + water + sunlight → glucose + oxygen

STATE:

ELABORATE:

EXEMPLIFY:

ILLUSTRATE:



Hanauma Bay Education Program

Grade 8
Rock Cycle and Plate Tectonics

UNIHI-SEAGRANT-EE-08-01

Rock Cycle and Plate Tectonics

BENCHMARKS:
8.8.1 Compare the characteristics of the three main types of rocks.

8.8.2 Illustrate the rock cycle and explain how igneous, metamorphic, and sedimentary rocks are formed.

8.8.5 Explain the concepts of continental drift and plate tectonics.

GLOS:
2. Community Contributor
3. Complex Thinker
4. Quality Producer
5. Effective Communicator

BIG IDEA(S)
Grade 8 Hanauma Bay Education Program (HBEP) curriculum focuses on the HCPS III Standard 8 benchmark: understand the Earth as a system (i.e., components and processes). In particular, the lesson uses Hanauma Bay as the venue to explaining the different types of rock, the rock cycle and the hot spot theory related to the formation of the Hawaiian Islands.

EVIDENCE/CRITERIA:
Students should know and be able to do the following as a result of the teaching strategies in this lesson:

• compare the characteristics of igneous, metamorphic, and sedimentary rocks
• diagram the rock cycle and explain relationship with the formation of each type
• explain the plate tectonics/hot spot theories and how they support the formation of the Hawaiian Islands

The quality of the formative and summative tasks will be assessed by the teacher (or peers) as an indicator of student learning and achievement of benchmarks (e.g., group and individual charting of ideas, completion of learning sheets, KWL, SEEI of different concepts, geology models).

LEARNING EXPERIENCES:
• To engage students, the field trip begins with a walking tour to the top lookout of Hanauma Bay. From this vantage point students record careful landform observations and respond to specific geology guide questions. Worksheet data will be utilized in the Hanauma Bay Education Program (HBEP) classroom, supplemented with visuals, manipulatives and interactive experiences.

• Learning activities will vary instructional and learning strategies to address all learning styles (e.g., verbal/linguistic, visual, kinesthetic, interpersonal). Kinesthetic experiences infused with probing questions in the classroom will connect concepts with real world/relevant data.

• If necessary, teachers will organize teams (prior to the field trip) to ensure the most effective / supportive learning environment for all students. Precise group protocols and safety directions will be clarified before the walking tour.

• Introduction to and adequate preparation on specific, relevant science concepts will maximize the value of the HBEP experience. Group collaboration on concept clarification (refer to definitions in teacher preparation section) prior to the field trip; charting of understandings; sharing with peers; and completion of selected tool kit worksheets will facilitate student preparation for the field trip. Completed student work should be brought on the field trip to post in the HBEP classroom.

PRIOR KNOWLEDGE:

• Students' current/prior knowledge, dispositions, misconceptions, and skills can be assessed with the worksheets provided in the tool kit (e.g., KWL sheets and concept summary pages).

• Definitions and concepts to cover before the field trip: igneous, metamorphic, sedimentary rock; rock cycle; continental drift, plate tectonics, hot spot (refer to teacher prep section).

TEACHER PREPARATION:

Teacher will introduce students to the concepts discussed in standards 8.8.1, 8.8.2, 8.8.5 in the classroom prior to the Hanauma Bay trip. Refer to the worksheets provided in the grade 8 tool kit to facilitate student learning before the field trip. Summarizing student understanding on chart paper will support review of selected concepts in the HBEP classroom. (Bring charts and worksheets on the day of the field trip.) Teacher should focus on concepts not emphasized in the HBEP classroom (e.g., metamorphic rock, continental drift theory). The Hanauma Bay field trip will focus on igneous and sedimentary rock fitting into the rock cycle, the connection of the rock cycle to the plate tectonics theory, and the formation of the Hawaiian Islands (including the Hanauma Bay region on O'ahu).

Animation of the rock cycle:
http://www.classzone.com/books/earth_science/terc/content/investigations/es0602/es0602page02.cfm?chapter_no=investigation
Plate boundaries animation:
http://www.classzone.com/books/earth_science/terc/content/visualizations/es0804/es0804page01.cfm?chapter_no=08

Definitions:

Types of rock: classified according to formation.

Igneous rock- High temperatures deep in the Earth's crust cause rocks and minerals to melt, forming a liquid called magma. Magma that reaches Earth's surface=lava. Igneous rocks form when magma/lava cools and becomes solid.

Metamorphic rock- Over time, heat and pressure inside the Earth squeeze and melt existing rocks. Process changes grain size and even minerals that make up those rocks, forming new type of rock. This metamorphic rock has been changed in form by pressure and heat.

Sedimentary rock- Solid material composed of pieces of rocks, minerals, remains of living things and dissolved minerals that come out of water (e.g., lime). These sediments are layered, building up over time, pressing down on older layers underneath, cemented by dissolved minerals (e.g., calcite). Sedimentary rocks are formed over a long period of time from sediments joined together with pressure and various cementing material (e.g., rock salt=mineral coming out of solution and settling on ocean floor; chalk=sedimentary rock from remains of once-living things).

Rock cycle- Constant changing in the form and structure of different types of rocks. Rocks of each type have been changed into other types by natural forces—broken, heated, pressed, and pushed around over and over again. Rock cycle involves the following changes: melting (igneous), cooling and hardening, weathering and erosion, compacting and cementing sedimentary), heat and pressure (metamorphic), etc.

Continental drift- A theory that states that Earth's continents were once joined in a single large landmass that broke apart and that the continents have drifted to their current locations.

Plate tectonics- A theory that suggests that all that continents have moved (and are still moving) as they "sit" on various sections of the Earth's crust ("plates"). The driving force for the movement of the different plates is a convection current occurring in the mantle layer below the crust. As heat rises to the surface, less dense molten material (magma) meets the crust layer and spreads out, cools, becomes more dense, begins to sink-constantly being pushed by new hot, molten material from deep in the Earth. As the magma moves under the crust, "plates" with their continents are moved in the same direction as the flow of the magma.

Hot spot- A crack in the crust where magma oozes to the surface. The slow build-up of magma forms a seamount (sub-surface) or an island if it emerges above water.

INSTRUCTIONAL STRATEGIES (At the Bay):

The 2-hour field trip to Hanauma Bay will provide relevant ecosystem connections to the benchmarks being addressed.

Site observations: After the initial park orientation to appreciate the uniqueness of the nature preserve, students will record observations from the upper park lookout to focus data collection to 3 specific areas of the bay. After 20 minutes, students will assemble in the classroom to review relevant concepts learned previously and utilize site observations to continue learning activities focused on the grade 8 benchmarks.

Classroom activities:

- View Hanauma Bay Education Video (10 minutes)
- Review of prior learning: plate tectonics theory, igneous rock, and hot spot theory connected to the formation of island chains.
- Powerpoint presentations/interactive activity to focus on the formation of Hanauma Bay and the Hawaiian Island chain.
- Collaborative activity to determine age sequence of the main Hawaiian Islands, using laminated cards with velcro backing.
- Debrief questions 1 and 2 from site observation worksheet to elaborate on the specific geologic formation of Hanauma Bay.

- Group activity- build a model to demonstrate understanding of the connection between the Hawaiian Islands and the rock cycle. Choosing the appropriate medium from the variety of materials provided, students will create a model of a selected volcanic formation or process, fitting on a 10" x 15" foam board base (size of a soda box). Each model should be labeled and have an attached explanation of how the formation was created in nature.

- Supplies needed: *Grade level benchmarks on chart paper, blank chart paper, marker pens, laminated volcano cards with velcro backing, blank laminated cards, overhead pens, 10" X 15" foam boards for each team (8-10), empty soda box for each team, variety of building materials, copies of partially completed student KWL worksheets, class charts of key concepts.*

- Additional learning activities:
    - Create poster/slide with pictures of three rock types; igneous, metamorphic, sedimentary– and connect rock observations on an additional walking or slide tour of the bay, identifying specific areas where different rocks are found at the bay. Chart the rock types with pictures/drawings and descriptions.
    - Highlight properties/characteristics (similarities and differences) of rock types in a venn diagram or matrix format.

INSTRUCTIONAL STRATEGIES (Back at the school)

- **Debrief** of the rock types/cycle in classroom: Find a good visual of the rock cycle and have teams chart their understanding of where/how the Hawaiian Islands connect to types of rock and the rock cycle.

- **Extension Activity: 8.5.1-** Describe how changes in the physical environment affect the survial of organisms. This benchmark could be its own lesson. Hanauma Bay connections to this benchmark: how are living things affected by geologic changes during eruptions? After eruptions? Long after the volcano is dormant? Create appropriate prompt questions related to the shape of bay, currents, formation of ledges, sand movement, type of soil eroding, nutrients.

- **Summative SEEI** (State, Elaborate, Exemplify, Illustrate) in narrative form to determine the quality of student understanding. Select one of the SEEI statements provided in the grade 8 tool kit or create a focused statement that students will demonstrate their understanding of the benchmark concepts after visiting Hanauma Bay.

- **Supplemental Activity:** Create an interactive display or model of the rock cycle/hot spot theory, relating it to the Hawaiian Islands, and the movement of the Pacific Plate. Students should explain clearly, accurately and thoroughly how the display/model shows the process of formation of the Hawaiian Islands, movement of the Pacific Plate, and/or subsidence.

- **Optional geology investigations:** Variations in the width and elevation of the ledges are related to differences in exposure to waves and in exposure to daily heating and drying of the sea cliffs behind the ledge. Physical and chemical weathering by salt and rainwater contribute to the retreat of the cliff. Wave action does not cut out the bench but protects that water-covered area from erosion taking place above the water.

Variation of sand types in different parts of the bay. Why? What was responsible? Nature controlled or human impact?

ASSESSMENTS (FORMATIVE):

The following formative assessments help to inform instruction and provide learner feedback during the learning activities at the bay:

• SEEI on the formation of Hanauma Bay. Refer to original student worksheets when discussing craters at the bay.

• SEEI on the hot spot theory supported by data on the age of the Hawaiian Islands.

• Students should be able to discuss how the island age sequence activity supports the hot spot theory, and plate tectonics covered in the power point presentation. SEEI on the formation of the Hawaiian Island chain supporting plate tectonics and the hot spot theory.

• Create poster/slide with pictures of three rock types – igneous, metamorphic, sedimentary— and connect rock observations on walking/slide tour of the bay (identify specific areas where types of rock are found at Hanauma Bay). Chart of rock types; with visuals and descriptions. Students categorize Hanauma Bay rock samples.

• Review rock cycle (using chart) and relate to Hawaiian Islands/Pacific Plate data. Explain the connection between the Hawaiian Islands and the general rock cycle.

• Hawaiian Island age sequence activity - posting of cards with group explanations.

• Group writing to summarize concepts after each classroom activity including island age sequence activity and geology model activity (e.g., group collaboration to create SEEI template to summarize understanding of concept). Teacher will take student work back to class for completion, peer review, and debrief.

• SEEI to check understanding of geology concepts. Allow students (or pairs) to create own conceptual statement and demonstrate their understanding of that specific conceptual statement. Share learning with class for peer feedback.

EVALUATION (SUMMATIVE)

Student work can be evaluated to make judgments on learning results using the following tasks:

• Revisit/refine KWL sheets

• After completing a thorough debrief of field trip activities, students will compose a SEEI (narrative form) to demonstrate understanding of the grade8 benchmarks connected to a visit to Hanauma Bay: Hawaiian rock types, rock cycle and the Hawaiian Islands, plate tectonics/ hotspot theories and the Hawaiian Island chain.

• Sharing models with other classes/grade levels/schools to demonstrate learning of grade 8 benchmarks.

Grade 8 Hanauma Bay Observations

Name: ..... Date: .....

(1) Describe how you think Hanauma Bay was formed.

Use the picture of Hanauma Bay provided:

- Sketch the bay's volcanic crater(s)
- Number the crater(s)
- Circle and label the coral reef in Hanauma Bay

(2) Which side of Hanauma Bay is higher?

- Label the higher side on your sketch
- Why do you think one side is higher?

- Describe the appearance (e.g. color) of the rocks and cliffs around Hanauma Bay.

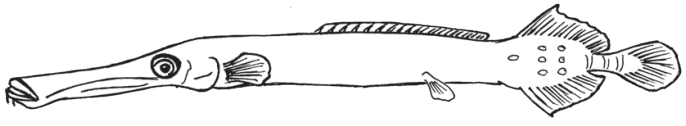
- Are the r ocks at Hanauma Bay sedimentary? Igneous? Metamorphic? Explain your answer.

(3) From the vantage point of the highest lookout, look for the Ko`olau mountain range. Circle and label the Ko`olau range on the picture of Hanauma Bay.

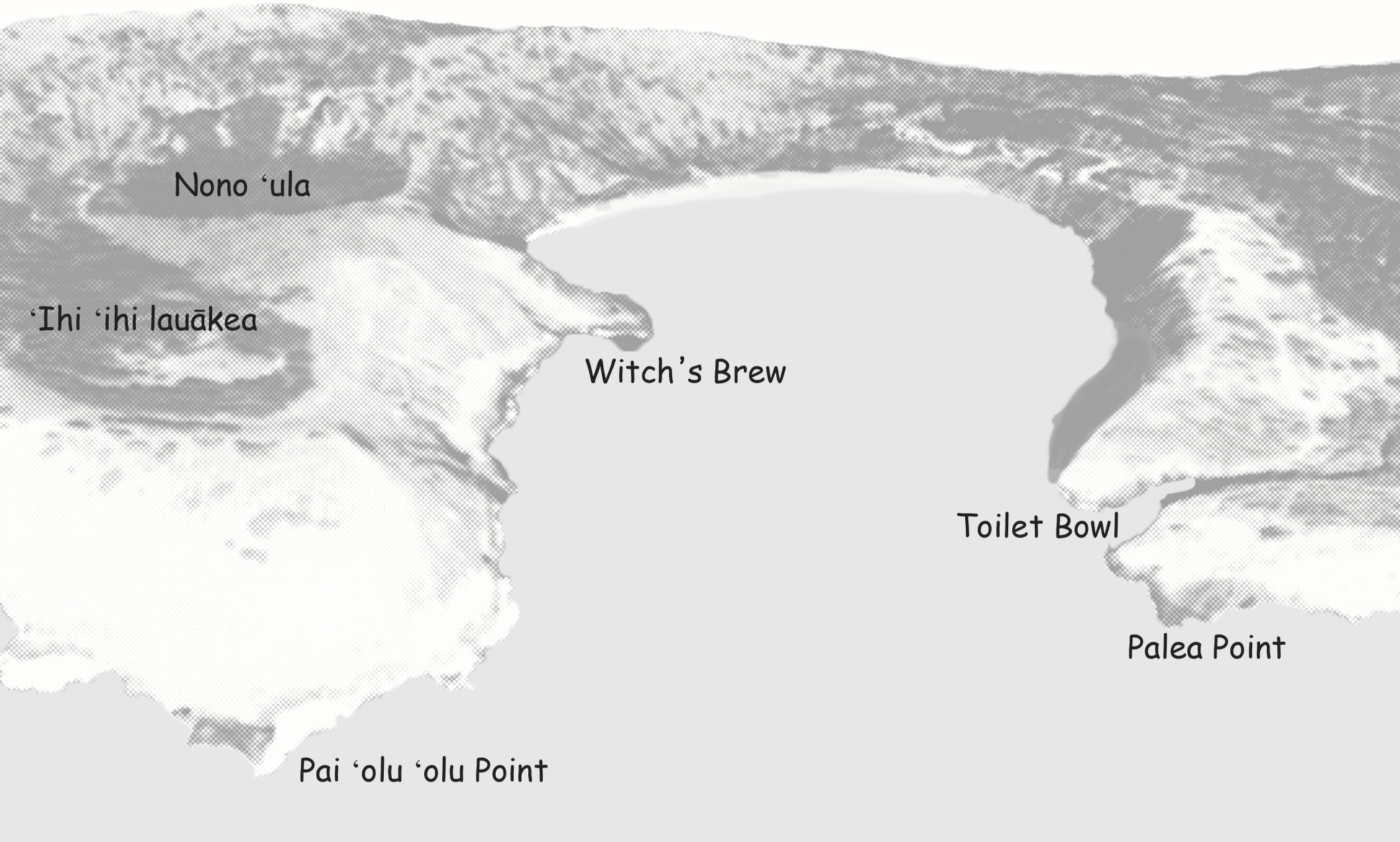
- Do you think the Ko`olau mountain range is older or younger than Hanauma Bay?

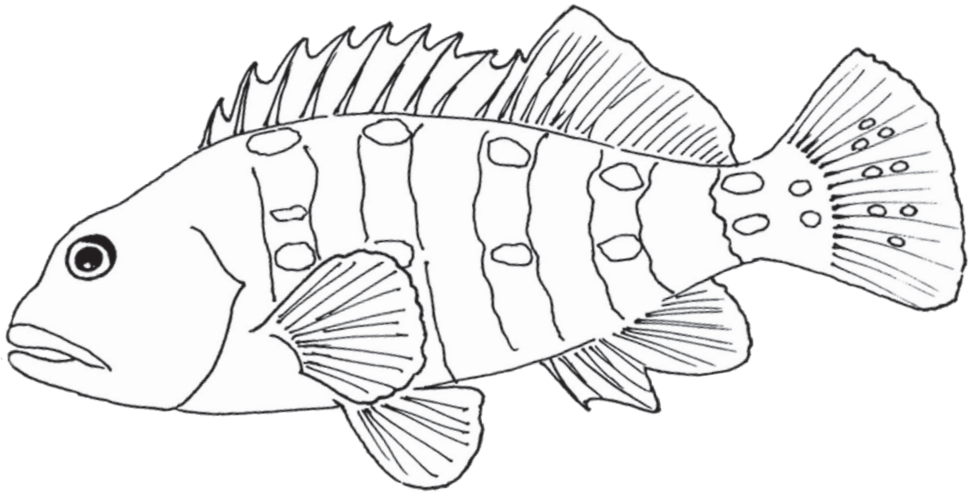
- What Hawaiian Island is nearest to the hot spot? Explain why.

- Draw and label an arrow pointing in the direction of the Big Island.



Hanauma Bay


Nono ʻula
ʻIhi ʻihi lauākea
Witch's Brew
Toilet Bowl
Palea Point
Pai ʻolu ʻolu Point



Hanauma Bay Education Program

Grade 8
Rock Cycle and Plate Tectonics

Tool Kit

UNIHI-SEAGRANT-EE-08-01

Geology of the Hawaiian Islands

Formation of the Island of O'ahu

Characteristic	Wai'anae Range	Ko'olau Range	Hanauma Bay
Type of volcano formation	Shield and post-shield (not andesitic which are explosive continental eruptions, lower temperatures, high SiO_2)	Shield (gentle eruptions) and rejuvenation (basaltic eruptions = low SiO_2 & high temperatures)	Rejuvenation Stage (basaltic, explosive hydromagmatic eruptions -- under water vents blasting through rock and reefs to form tuff)
Age	4 million years ago	1.8 - 2.5 million years ago	40,000 years (Koko Crater) 30,000 years ago (Hanauma)
Comparative Geologic Age	Oldest range	Younger range	Youngest crater in Honolulu Series (1 million years ago)…also includes Punchbowl and Diamond Head (hydromagmatic eruption)
When extinct?	2.8 million years ago	1.8 million years ago before rejuvenation stage 60,000 to 30,000 years ago	Still possible??
Caldera / summit region	Lualualei Valley	Pali = remnants of crater wall after major landslide into the water	
Area of O'ahu	1 / 3 of O'ahu	2 /3 of O'ahu	

Hanauma Bay Grade 8

Plate Tectonics

STATE:

The formation of the Hawaiian Archipelago supports the Plate Tectonics Theory.

ELABORATE:

In other words…

Scientists believe that our land masses (continents and islands) sit on huge plates of earth's crust. These plates are in constant, though very slow, motion on the surface of the earth and are continuously being formed and consumed. Most of the creation and consumption of the plates takes place at the edges, where plates can slide under, collide with, or pull farther apart from others. Molten mantle below the crustal plates is hot and less dense in certain areas, cooler and more dense in other areas. The temperature differences of the magma results in material rising (hot areas), moving sideways, and eventually sinking (cooler areas)back to the interior of the earth. This movement of magma forms huge convection currents in the mantle layer, which in turn moves the plates sitting on top of the mantle. Depending on the plate, the direction of the movement is determined by the location of the magma rising to the surface, moving sideways, and sinking deep into a trench (moving under another plate). Islands in a linear chain form as the plate passes over a stationary hot spot, with an island forming on the plate from a limited eruption; the plate moves on and the next island forms with a subsequent eruption, and so on...forming younger islands as the plate continues to move.

EXEMPLIFY: *For example…*

The Hawaiian Islands sit on the Pacific Plate, which is moving from the southeastern edge of the Pacific Basin (off the shore of South America) in a northwesterly direction (toward Japan). The Hawaiian Archipelago, extending from the Northwest Hawaiian Islands (e.g. Kure Atoll, Midway, Necker, Nihoa) through the main islands (e.g. Kauai – Oahu – Maui - Big Island) is sitting on the Pacific Plate and therefore moving in the same northwesterly direction as the plate. Data on age of the islands that support the plate tectonics theory: Kauai is the oldest of the main islands - formed earliest, Oahu the next oldest – formed later, then Maui and finally the Big Island is the youngest island - still "growing". In addition to the age of the islands the arrangement of the archipelago in a relatively straight line suggests that the islands were formed when the plate slowly moved in a northwesterly direction over a stationary hot spot where magma was oozing from the deep mantle layer, forming the islands one at a time.

ILLUSTRATE:

The Hawaiian Islands forming one at a time as the Pacific Plate moves over the hot spot is like soft candy being squeezed (intermittent squirts) from an overhead tube, dropping to a conveyor belt, which slowly moves the separate pieces in a particular direction.

Map of the Hawaiian Archipelago showing the linear arrangement of the islands, from oldest (Kure Atoll) to youngest (Big Island).

Hanauma Bay Grade 8

Hot Spot Theory

STATE:

The ***hot spot theory*** is supported by data from the formation of the Hawaiian Islands.

ELABORATE:

In other words…

EXEMPLIFY: *For example…*

ILLUSTRATE:

STATE:

ELABORATE: *In other words…*

EXEMPLIFY: *For example…*

ILLUSTRATE: