Ha`awina
for Mokauea Island
Curriculum for Mokauea Island

Aloha,

These pages provide a framework to introduce students to Mokauea Island for a learning experience(s) that is experiential, relevant and engaging. Located in urban Honolulu, off-shore from the Honolulu Airport, Mokauea Island provides an opportunity for youth to learn about Mokauea’s rich history as a Hawaiian fishing village, the ahupua’a, human impact on our environment and caring for our ocean environment through service learning.

Between 2009-2010, approximately 2,000 students have visited Mokauea Island. The development of this curriculum has been a partnership of the Mokauea Fisherman's Association and Kai Makana. At its core is a rotation of learning activities that have been field tested. Building upon the experiences that have been gained over the years of hosting student visits, the lessons have been created to engage the students through experiential learning and inquiry. The learning experience begins with getting to the island; newcomers are given an orientation to paddling in an outrigger canoe and everyone paddles in unison. Once on-island, they are greeted by a resident member of the Mokauea Fisherman's Association and introduced to the history of the island and its ahupua’a. Students then rotate to learning stations or ha’awina (lesson).

The learning stations or ha’awina are: Fishpond Ecology, Water Quality, Coastal Plants, and Marine Debris. Typically, a student group will experience 2-3 ha’awina per visit. The determination of which ha’awina and activities are conducted is a factor of: the conditions of that day, availability of the guides and the teacher’s preference. Student groups that are planning to visit Mokauea Island more than once, may choose to focus on one ha’awina per visit and have a learning experience with greater depth.

This set of curriculum has been written for high school students. Hawaii department of education standards and benchmarks relevant to each ha’awina are listed. Adaptations to the curriculum can be made for younger ages by consulting with Mokauea's representative beforehand.

We wish to express our Appreciation to the Office of Hawaiian Affairs, Grant # 2394, for the funding to develop this first edition of the curriculum. A special Mahalo to the individuals who worked on the curriculum: Daniel Amato, Barbara Mayer, Kēhaulani Souza and Debra Shiraishi-Pratt, with support from Jeff Kuwabara and Ray Tabata.

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LOKO I’A O KE’EHI HA’AWINA - Fishponds of Ke‘ehi

**Overview:** The overall goal of the Kai Makana Loko I’a O Ke‘ehi ha‘awina is for students to: (a) gain a general understanding that Ke‘ehi was a thriving fishing village with over 13 fishponds, 7 fisheries and home to our ali‘i; (b) an awareness that Mokauea is the only fishing village left on O‘ahu and only one of the two left in the Hawaiian Islands.

**Lessons:**

- **Pre-Field Trip Classroom Lesson:** “Loko I’a O Ke‘ehi?”
  The purpose of this pre-field trip lesson is to introduce students to the methods that cultural anthropologists use to collect information about a community that has been drastically altered and have students thinking about the adaptations to the coastal area that was once a thriving fishing community.

- **Field Trip Lesson:** “Mokauea Island – History of Ke‘ehi”
  Students will learn about the wahi pana (storied place) of the Ke‘ehi and Mokauea area. A Kai Makana volunteer will perform this lesson at Mokauea Island. There is no teacher preparation needed.

- **Post-Field Trip Classroom Lesson:**
  This post-field trip activity is designed to get students to reflect on what they observed and/or learned in conducting research like a cultural anthropologist reviewing the past to help navigate the future.

**Vocabulary:**

- Wahi Pana- a storied place
- Loko I‘a- Fishpond
- Mokauea Island- Last Hawaiian Fishing Village on O‘ahu
- Kahaka‘aulana- One of the Mokauea Islands and the summer home to the Hawaiian Ali‘i
- Moku‘oe‘o Island in Ke‘ehi Lagoon also called Damon Island
**Hawai‘i Department of Education Standards & Benchmarks:** Kai Makana activities are targeted to high school. In the listing below, these high school science course abbreviations are used:

**Strand Cultural Anthropology**  
**Standard 3: Understand varieties of economic and political patterns**

**Topic** Economic Evolution and History  
**Benchmark SS.CA.3.1** Trace the development of food acquisition from hunting-gathering through the rise and spread of agriculture and pastoralism  
Sample Performance Assessment (SPA) The student: Compares conflicting and peaceful transitions from hunter-gatherer to agricultural and pastoral systems of food acquisition.

**Topic** Economic Systems  
**Benchmark SS.CA.3.2** Compare the economic systems (e.g., resource bases, production and distribution modes, and/or socioeconomic allocation patterns) of agrarian, industrial, and post-industrial societies  
Sample Performance Assessment (SPA) The student: Assesses how railroad systems affect agrarian and rural societies.

**Topic** Political Systems  
**Benchmark SS.CA.3.3** Compare how different kinds of political organization (e.g., democratic, communist, theocratic, military/police state) have managed authority, freedom, laws, values, and conflict  
Sample Performance Assessment (SPA) The student: Evaluates, in terms of strength and weakness, the role of habeas corpus in the legal systems of various types of political organization.

**Strand Cultural Anthropology**  
**Standard 4: Understand varieties of belief and creativity**

**Topic** Comparative Religion  
**Benchmark SS.CA.4.1** Compare the beliefs, symbols, and practices of various religions  
Sample Performance Assessment (SPA) The student: Distinguishes between the theological and social beliefs of monotheistic and polytheistic religions.

**Topic** Cultural Exchange  
**Benchmark SS.CA.4.2** Describe ways that cross-cultural encounters have affected artistic expression  
Sample Performance Assessment (SPA) The student: Provides examples of the influence of British architecture on India’s public buildings.

**References/Resources:**  
kaimakana.org
**LOKO I’A O KE’EHI HA’AWINA - Fishponds of Ke‘ehi**

**Pre-Field Trip Classroom lesson:**

**Time required:**
One class period

**Lesson Overview:**
The purpose of this pre-field trip lesson is to introduce students to the methods that cultural anthropologists use to collect information about a community that has been drastically altered and have students thinking about the adaptations to the coastal area that was once a thriving fishing community. Teachers may also opt to have a homework assignment to visit the Kai Makana website at kaimakana.org to get them oriented with the history. This short classroom activity is should be performed along with other activities to prepare students for the content topics of the field trip to Mokauea Island by:

**Vocabulary:**

- **Wahi Pana** - A storied place
- **Loko I’a** - Fishpond
- **Mokauea Island** - Last Hawaiian Fishing Village on O‘ahu
- **Kahaka‘aulana** - One of the Mokauea Islands and the summer home to the Hawaiian Ali‘i
- **Moku‘oe‘o** - Island in Ke‘ehi Lagoon also called Damon Island

**Materials:**

3 Maps: Map 1: Aerial of Ke‘ehi Lagoon (present)
    - Map 2: 1927-1930 USGS Map of Ke‘ehi Lagoon
    - Map 3: Aerial Photo of first map with overlay of old fishponds

*for the classroom as a whole:*

Place maps on chock board in front of class along with this information on the fishponds.
<table>
<thead>
<tr>
<th>Fishpond Name, Acres</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ananoho: Acres: 52</td>
<td>A 52 acre oval-shaped pond with walls approximately 4700 feet long. The walls are 3 feet high and 6 feet wide and constructed of coral.</td>
</tr>
<tr>
<td>Auiki: Acres: 12</td>
<td>A 12 acre pond adjoining Ananoho. The walls extend 900 feet and the pond is partially filled</td>
</tr>
<tr>
<td>Pahouiki: Acres: 14</td>
<td>A 14 acre pond enclosed in a coral stone wall 1050 feet in length. There are two makaha and one house on this loko.</td>
</tr>
<tr>
<td>Pahounui: Acres: 26</td>
<td>A 26 acre pond opened to Loko Pahouiki. A wall 2600 feet surrounds this larger pond and there are two makaha and one house on the wall.</td>
</tr>
<tr>
<td>Apili: Acres: 28</td>
<td>A 28 acre pond adjoining Loko Pahounui. The wall surrounding Apili is 1500 feet.</td>
</tr>
</tbody>
</table>

**Teacher Preparation:**

Mokauea Island is within Ke‘ehi Lagoon that is situated within Kalihi Ahupua‘a, Mokauea ili, Honolulu (Kona) District, O‘ahu. Ke‘ehi Lagoon is between Honolulu Harbor and the International Airport. Mokauea Island (traditionally consisted of three islands, today only two remain) the other island is called Kahaka’aulana. Mokauea Island is just across Sand Island also known as (Ka Moku Akulikuli, Mauliola and Kahololoa). Kahaka’aulana in the past was documented as being destroyed by dredging, part of this Island is still in Ke‘ehi Lagoon. In the middle of industrial Honolulu is the site of O‘ahu’s last remaining Hawaiian fishing village, and one of only two left in Hawaii. In 1779 European explores documented 500 fishing villages in the Hawaiian Islands.

The Mokauea fishing community is a traditional fishing village, now commonly known as Mokauea Fisherman's Association. The people of this fishing village can trace their genealogy back to the second migration. The earliest known reference to the islands is in the Hi‘iakaikapiliopiopele mo‘olelo which makes reference to one of the Mokauea Islands named Kahaka’aulana. Another reference is found in Namakalehu who describes in the oral history legend of Kahikilaulani the coming to Hawaii of migrating Polynesians nearly 1,000 years ago. The first migrations to Hawaii have been established around 500 A.D., the second wave arriving in Hawaii around 600 years later. It is believed that the arrival of Kahikilaulani at
Kahakaʻaulana, across Mokaua on the same reef, occurred during this second wave of migrations from the southern hemisphere.

In 1839 Kamehameha III’s constitution and code of laws assigned Keʻehi to be the royal fishing grounds and placed as kapu. He knew the great abundance of fish in this area and the need to preserve this natural resource.

The United States Fish Commission Report in 1903 (Cobb 1905: 748) listed twelve fishponds located on the periphery of Keʻehi Lagoon that were in operation in 1901 with a total of 857 acres.

Ananoho and Auiki were completely filled in during World War II at which time an Army port and warehouse complex was built. Later, this became part of the Kapalama Military Reservation. Today, this area is where the Plant Quarantine and Measurement Standards and Commodities (MS & C) buildings are situated, used now by the Department of Agriculture. (see map 3).

Prior to dredging of the seaplane runways in 1941, it was possible to walk through the then shallow and clear Keʻehi Lagoon waters from the Kaliihi Kai shoreline to most of the islands in the lagoon such as Mokaua and Kahakaʻaulana Island. Thus one translation of the name Keʻehi is to tread upon, Hawaiians usually gave names for specific geographical or spiritual meaning. The resulting interchange was a devastating factor in the cultural landscape and lifestyle of the fishing community of these islands.

Keʻehi Lagoon was divided into several important fisheries including Mokaua, Halawa, Moanalua, Kaliawa, and others. Ancient fishing rights were attached to these fisheries. Mokaua Island and Kahakaʻaulana Island were once part of the Mokaua fishery in the ahupuaʻa of Kalihi.

From 1900-1972, the seven fisheries, 41 fishponds which include Pearl Harbor, and six major islands of the Keʻehi Lagoon area were drastically altered or altogether destroyed by dredging. These alterations of the physical environment of the Keʻehi Lagoon area took an incredible toll. The first Federal Fish Commission Report in 1902 revealed that although half of the Hawaiian fishponds had been destroyed or were inoperative by the time of the study in 1900, the remainder produced over 560,000 pounds of fresh fish annually (mostly amaʻama and awa). Most of the ponds that were still operative in the Keʻehi Lagoon area, ideally suited for Hawaiian fishpond aquaculture with fresh water supplies, sunlight, and a protected estuary. Not one remains in existence today.

In 1972 Mokaua and Kahakaʻaulana were the only remaining inhabited islands, and the last fishing village in Honolulu. In that year, plans for nearby airport expansion led to Federal and State attempts to evict the last Mokaua fishing families to prepare for future dredging and filling for airport developments, the latter primarily in response to the increase in tourism.
In 1975, the Mokaua families were ordered off the island. Several fishermen were arrested for trespassing on land they had lived on for generations. In June of 1975, without due process, government agents burned down five fishermen’s homes destroying their means of livelihood and all personal belongings.

The event was aired on the news and an aroused populace and news media rallied to the fishermen’s cause. The fishermen, with the help of John Kelly and his environmental group Save Our Surf, quickly organized into a non-profit educational corporation known as the Mokaua Fishermen’s Association (MFA). Following an intense campaign of public exposure, the State and Federal agencies began negotiations with the MFA.

In response to the MFA’s claims to historicity of their community and lifestyle, Governor Ariyoshi ordered a formal historical study of the area and its fishing community by the State Historic Preservation Officer. The study concluded that Mokaua was “an area of important historic concern.” This finding qualified the island community for preservation status under various Federal and State statutes and stopped any further eviction actions.

The fishermen and their families rebuilt their homes, and the MFA began their work restoring and reviving the fishing village with the cooperation of the Army and groups of students, teachers, scholars, and scientists.

Over the last 30+ years, some progress towards creating an educational center was made on the island. But with a swing in politics in the 1990’s and changing island family dynamics, participation in restoration efforts on Mokaua Island came to a near halt.

Since 2005, Kai Makana has been leading an effort to environmentally and culturally restore Mokaua Island. Adopting the vision of the Mokaua fishermen, our goal is re-create a living example of a traditional Hawaiian subsistence fishing village. The fishing village at Mokaua will be a learning center that will allow for scientific studies and the perpetuation and practice of Hawaiian fishing and seafaring culture.

**Suggested Procedures:**

Instruct the students as follows:

1. Print out each map for each child or group the students into 4 or 5.

2. Each map will have about 2 or 3 discussions questions.

3. Map 1
   
   a. Orient the students to the area of Ke’ehi -- go over place names-Mokaua, Kahaka’aulana etc.

   b. Identify the natural, un-natural and man made characteristics of the area.
c. Locate the natural resources on the photo such as streams, fresh water - get them to think about where we get our food from now as compared to in the past. We now have 90% of our food shipped in.

4. Map 2

a. Orient students to this 1927 map - point out place names ex. Mokaua, Quarantine Island (is the present Sand Island) as depicted on map.

b. Discuss the 13 fishponds in the area and the 857 acres that it covered. What did it take to sustain this many fishponds?

c. Compare and contrast the two maps.

5. Map 3

a. Orient the students to the overlay, point out that the blue color was where the fishponds were.

b. How did this affect the fishing community, the natural resources in this area?

c. Was this progress a positive or negative result? Was the community self sustainble then or now?
LOKO I‘A O KE‘EHI HA‘AWINA - Fishponds of Ke‘ehi
Post-Field Trip Classroom lesson:

**Time required:** (30 min) This assignment may be an individual homework and/or processed by a group discussion.

**Lesson Overview:** This post-field trip activity is designed to get students to reflect on what they observed and/or learned in conducting research like a cultural anthropologist reviewing the past to help navigate the future.

**Suggested Procedures:** Teachers may opt to have students select (A) one of two writing topics to be worked on individually as homework or (B) to facilitate a classroom discussion.

A) Individual Writing Assignments:

1. Based on your background research and your visit to Ke‘ehi and Mokaua, write an essay on how you feel about the history and the current situation of Ke‘ehi.

2. Based on what we know now, what are some of the lessons you have learned about sustainability and the ways of the Hawaiian fishing village? Have we progressed as a society for the better?

B) Class Discussion

1. Divide the class into two groups; have one group support the idea of a sustainable traditional Hawaiian fishing village versus the way it is now.
CANOE PADDLING HA‘AWINA

Overview: The overall goal of the Kai Makana Canoe paddling ha‘awina is for students to (a) gain a general understanding of paddling in an outrigger canoe (b) an awareness of how Hawaiian ancestors traveled from island to island and worked together as one.

Lessons:

- **Pre-Field Trip Classroom Lesson:** “Learning the basic of canoe paddling”
  The purpose of this pre-field trip lesson is to learn the basic paddling techniques and names of the waʻa. Basic safety and helpful hints to be safe in the ocean.

- **Field Trip Lesson:** “Mokauea Island – Paddling”
  Students will gain first hand experience of what they viewed in the paddling video. They will have a brief lesson on the beach before they paddle over to Mokauea Island.

- **Post-Field Trip Classroom Lesson:**
  This post-field trip activity is designed to get students to reflect on what they observed and/or learned about paddling a canoe as one team.

Vocabulary:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waʻa-</td>
<td>(Canoe)</td>
</tr>
<tr>
<td>Hoe</td>
<td>(Paddle)</td>
</tr>
<tr>
<td>Ama</td>
<td>(Float/outrigger)</td>
</tr>
<tr>
<td>‘Iako</td>
<td>(Cross beam)</td>
</tr>
</tbody>
</table>

Hawai`i Department of Education Standards & Benchmarks: Kai Makana activities are targeted to high school. Kai Makana’s Paddling Ha’awina can be used in the context of the following high school Physical Education standards & benchmarks.

Standard 2: COGNITIVE CONCEPTS: Understand movement concepts, principles, strategies, and tactics as they apply to the learning and performance of physical activities
**TOPIC:** Fundamental Skills

**BENCHMARK PE.9-12.2.1:** Apply concepts, principles, tactics, and strategies to acquire, assess, and improve movement skills

**SAMPLE PERFORMANCE ASSESSMENT:** The student: Independently applies concepts, principles, tactics, and strategies to improve performance and/or help others to reach personal activity goals (e.g., self-assesses performance in badminton and selects an appropriate drill to improve lob).

**TOPIC:** Team Sports

**BENCHMARK PE.9-12.2.2:** Evaluate tactics and strategies for modified and traditional activities

**SAMPLE PERFORMANCE ASSESSMENT:** The student: Assesses tactics and strategies in a variety of modified and traditional activities (e.g., zone/man to man defense, pick and roll).

**TOPIC:** Safety and Play Etiquette

**BENCHMARK PE.9-12.2.3:** Assess the importance of rules and procedures for safe and fair play during physical activities

**SAMPLE PERFORMANCE ASSESSMENT:** The student: Demonstrates knowledge of the rules and procedures, as well as cooperation and fair play, when participating in competitive and non-competitive physical activities (e.g., independently arbitrates rule violations during physical activity without conflict).

**References/Resources:**
http://www.islandpaddlerhawaii.com/
http://www.kanuculture.com/intro/
http://pvs.kcc.hawaii.edu/

The Hawaiian Canoe by Tommy Holmes
Hawaiian Antiquities by David Malo
History of the Hawaiian People by Abraham Fornander
Ruling Chiefs by S.M. Kamakau Mary Kawena Pukui
CANOE PADDLING HA’AWINA
Pre-Field Trip Classroom Lesson:

E lauhoe mai na wa’a; i ke ka, i ka hoe; i ka hoe, i ke ka; pae aku i ka ‘aina (327) “Everybody paddle the canoes together; bail and paddle, paddle and bail, and the shore will be reached. "If everybody pitches in, the work is quickly done. ‘Olelo No’eau

**Time required:**
One class period

**Lesson Overview:**
The purpose of this pre-field trip lesson is to learn the basic paddling techniques and names of the wa’a (canoe). Basic safety and helpful hints to be safe in the ocean.

This short classroom activity is designed to be done along with other activities to prepare students for the content topics of the field trip to Mokauea Island by:

1. Introducing students to a traditional way of inter island transportation of our Hawaiian ancestors.
2. Students will understand the importance of laulima (Cooperation) and lōkahi (unity and harmony) with others, in order to get to a common destiny.
3. Reviewing vocabulary for the parts of the wa’a.

During the field trip the students will be broken into groups of six or seven given a paddle and paddle over to Mokauea. Please advise the students to wear the appropriate clothing and footwear; clothes that can get wet, and reef walkers or shoes that they don't mind getting wet, hat and sunscreen.

**Vocabulary:**

<table>
<thead>
<tr>
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<th>Description</th>
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<tbody>
<tr>
<td>Wa’a</td>
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<tr>
<td>‘Iako</td>
<td>(Cross beam)</td>
</tr>
</tbody>
</table>

- See Diagram of parts of a wa’a
Materials:

_for the classroom as a whole:_ Paddling Video

Teacher Preparation:

Watch the Nappy Napoleon Paddling Video

Suggested Procedures:

Please go over the following with your students:

Important Safety Information

- Make sure all students can swim, if not they need to wear a life vest.
- Always enter and exit the wa’a from the ama or left side of the wa’a.
- Never stand in the wa’a or lean to the right, the wa’a will huli (flip).

Wa’a Etiquette

The wa’a is extremely expensive to purchase and repair. So please treat it as your own.
It is believed that wa'a is a living element. Each wa’a has a distinct and separate personality on the water. The wa’a is part of the team, and carries all paddlers safely onto the water and home again. We expect all paddlers to treat the wa’a with respect and never take it for granted or treat it discourteously.

Never sit or lean on a wa'a except in the designated seat area once the canoe is in the water. Even sitting in the seat on land can cause the wa’a to crack. When the wa’a is lifted, be sure the ama and 'iako are supported and off the ground. The wa'a should not be dropped, but set down lightly.

Don't step over the body of the wa'a. If you need to move to the other side, walk around the wa'a. It is a gesture of courtesy to the wa'a to do so. Do not swear in the wa'a.

Helpful Hints:

• Try paddling with locked elbows. This will force you to sit up and rotate. Add the minimum bend necessary to your arms for comfort later when you have mastered this.

• Try to keep a flat back and keep your chin up, this will afford the maximum oxygen uptake and will help keep your shoulder and neck muscles relaxed.

• Don't forget to get drive from your leading leg. Always keep the leg on your paddling side extended forward to help you brace - this means when you switch the paddle at a Hut, you must also switch which leg is forward.

• Keep your face muscles relaxed and remember to breathe! Breathing in synchronization with your paddling helps you maintain an even stroke.

• Keep your concentration in the canoe and remember that is it the thoughtful application of power that makes each and every stroke count.
CANOE PADDLING HA‘AWINA
Field Trip Lesson:

**Time required:**
~10 minutes is estimated time it takes to paddle over to Mokauea Island

**Lesson Overview:**
Students will gain first hand experience of what they viewed in the paddling video. They will have a brief lesson on the beach before they paddle over to Mokauea Island.

**Vocabulary:**

- **Wa’a**: (Canoe)
- **Hoe**: (Paddle)
- **Ama**: (Float/outrigger)
- **‘Iako**: (Cross beam)

**Materials:**
*per student:*
- reef walkers

**Suggested Procedures:** (Kai Makana volunteers will conduct this part)

1. [Review classroom lesson], e.g., Each student should be familiar with the names of the parts of the wa’a.
2. Break students up into designated groups
CANOE PADDLING HA‘AWINA
Post-Field Trip Classroom Lesson:

**Time required:** (15 min) This assignment may be an individual homework and/or processed by a group discussion.

**Lesson Overview:** This post-field trip activity is designed to get students to reflect on what they observed and/or learned about paddling a canoe as one team.

**Suggested Procedures:** Teachers may opt to have students select (A) one of two writing topics to be worked on individually as homework or (B) to facilitate a classroom discussion.

A) Individual Writing Assignments:

1. Imagine having no car and your only means of transportation was a canoe. Evaluate and discuss the pros and cons.

2. Describe how you felt in a Hawaiian wa‘a. What do you think it would take to travel from island to island? Visit the Polynesian Voyaging Society web site http://pvs.kcc.hawaii.edu/index.html and conduct research of how life on a sailing canoe was like and write a response paper.

B) Class Discussion

1. Find your pre-visit list of helpful hints and re-evaluate your experience. Compare your list to what was learned on the fieldtrip. What was similar/different? What surprised you?
FISH POND ECOLOGY HA`AWINA

Overview:

The overall goal of the Mokauea fish pond ecology ha`awina is for students to (a) understand marine food webs (b) collect field data such as sampling fish pond benthic habitats, fish populations and plankton at Mokauea Island (c) prepare graphs from collected data and test hypotheses.

Lessons:

- **Pre-Field Trip Classroom Lesson:** “Living in Harmony: Food Web Ecology”
  The purpose of this pre-field trip lesson is to introduce the concept of food webs and flow of energy in a marine ecosystem. Using a ball of yarn, students will participate in an activity which highlights the interconnectedness of the food web. Students will be asked to make some hypothesis regarding the diversity of the fish pond and lagoon ecosystems. An additional pre-lesson will familiarize students with phytoplankton using a power point presentation.

- **Field Trip Lesson:** “Mokauea’s Fish Pond Food Web”
  The purpose of this is to familiarize students with field sampling procedures of plankton, benthic habitats, and fish populations. Students will also learn to use a microscope to observe plankton and other microscopic fishpond organisms. The food web dynamics of the Mokauea fish pond will be observed and discussed.

- **Post-Field Trip Classroom Lesson:** “Measuring Diversity of Fish Pond Food Webs”
  The purpose of this post-field trip lesson is to introduce students to the species diversity measure the Simpson’s Index, create graphs to summarize field data, and compare this to previous group’s results on the web. These results will then be used to support or refute the class’s initial hypotheses. An individual assignment will be given where students will create a food web for the Mokauea fish pond.

**Hawai`i Department of Education Standards & Benchmarks:** Kai Makana activities are targeted to high school. In the listing below, these high school science course abbreviations are used:

- PS = physical science
- BS = biological science
- ES = earth science
Kai Makana’s fish pond ecology ha`awina can be used in the context of the following high school science and social studies standards & benchmarks--

**Standard 1, all sciences: SCIENTIFIC INVESTIGATION:** Discover, invent, and investigate using the skills necessary to engage in the scientific process.

- **SC.PS/B/BS/ES/ENV/MS.1.1** Describe how a testable hypothesis may need to be revised to guide a scientific investigation.
- **SC.PS/B/BS/ES/ENV/MS.1.2** Design and safely implement an experiment, including the appropriate use of tools and techniques to organize, analyze, and validate data.
- **SC.PS/B/BS/ES/ENV/MS.1.3** Defend and support conclusions, explanations, and arguments based on logic, scientific knowledge, and evidence from data.
- **SC.PS/B/BS/ES/ENV/MS.1.4** Determine the connection(s) among hypotheses, scientific evidence, and conclusions.
- **SC.PS/B/BS/ES/ENV/MS.1.5** Communicate the components of a scientific investigation, using appropriate techniques.
- **SC.PS/B/BS/ES/ENV/MS.1.6** Engage in and explain the importance of peer review in science.
- **SC.PS/B/BS/ES/ENV/MS.1.7** Revise, as needed, conclusions and explanations based on new evidence.

**Standard 2, all sciences: NATURE OF SCIENCE:** Understand that science, technology, and society are interrelated.

- **SC.PS/B/BS/ES/ENV/MS.2.1** Explain how scientific achievements and emerging technology have influenced society.
- **SC.ES/MS.2.3** Explain the impact of humans on the Earth system.

**Standard 3, MS: OCEANOGRAPHY:** Understand the physical features of the ocean and its influences on weather and climate.

- **SC.MS.3.3** Explain how the ocean participates in the geochemical cycling of elements.
- **SC.MS.3.6** Explain how erosion occurs and the effects of sedimentation.

**Standard 4, MS/ENV/B: LIFE SCIENCE:** Understand the interconnections of living
systems.

SC.ENV.4.3 Explain how ecosystems respond to human activities.

SC.ENV.4.6 Describe how the availability of resources (e.g., energy, water, oxygen, minerals) limits the amount of life an environment can support

Standard 5, ENV/MS: INTERDEPENDENCE OF ORGANISMS

SC.ENV.5.2 Assess the effect of human actions on an environmental system.
SC.MS.5.2 Compare the characteristics of marine organisms (e.g., planktonic, invertebrate, vertebrate)

References/Resources:

http://www.kaimakana.org/mirp.htm

http://cmore.soest.hawaii.edu/education/teachers/science_kits/plankton_kit.htm

http://en.wikipedia.org/wiki/Species_richness#Productivity

http://www.countrysideinfo.co.uk/simpsons.htm

http://www.bigelow.org/foodweb/chain0.html

http://kingfish.coastal.edu/biology/sgilman/770Food%20WebsChallenges.htm

http://cmore.soest.hawaii.edu/education/teachers/science_kits/plankton_kit.htm

http://cmore.soest.hawaii.edu/education/teachers/science_kits/requestform.htm
**FISH POND ECOLOGY HA`AWINA**  
**Pre-Field Trip Classroom Lesson:**  
“Living in Harmony: Food Web Ecology”

**Time required:**  
30 minutes

**Lesson Overview:**  
The purpose of this pre-field trip lesson is to introduce the concept of food webs and flow of energy in a marine ecosystem. Using a ball of yarn, students will participate in an activity which highlights the interconnectedness of the food web. Students will be asked to make some hypothesis regarding the diversity of the fish pond and lagoon ecosystems. An additional pre-lesson will familiarize students with phytoplankton using a power point presentation.

**Teacher Background:**
Like on land, the fundamental source of energy in the marine environment is sunlight. This radiant energy can only be used by organisms that carry out **photosynthesis**. These organisms are able to use the energy of light to transform carbon dioxide and water into organic compounds that contain high energy in their chemical bonds (e.g., glucose). Because they do not require the presence of other life forms they are called **autotrophs**, or self-feeding. Autotrophs use the energy stored within the simple carbohydrates to produce other more complex organic compounds, such as proteins, lipids, and starches, which are required for life. The autotrophs are commonly referred to as **primary producers**. The organic matter generated by autotrophs is used directly or indirectly to feed **heterotrophs**, whose name means "to feed on others." Heterotrophs cannot make their own food and require the presence of autotrophs. The flow of energy through the ecosystem -- by the interaction between autotrophs and heterotrophs -- can be expressed as **trophic (or feeding) levels**. In simple cases, the movement of matter and energy from the producer level through the various consumer levels is what is known as the food chain. It starts with plants, which are consumed by plant-eating heterotrophs (herbivores), which are in turn consumed by animal-eating heterotrophs (carnivores). An example of a simple food chain would begin with small floating algae (phytoplankton), which are eaten by microscopic animals (zooplankton). These would be eaten by small fish, such as sardines, that filter the microscopic plankton. Larger fish, such as tuna, would consume the small fish. You would find yourself at the end of this example food chain when you eat a tuna sandwich.

The final link in all food chains is made up of **decomposers**, those heterotrophs that break down dead organisms and organic wastes. A food chain in which the primary consumer feeds on living plants is called a grazing pathway. That in which the primary consumer feeds on dead plant matter is known as a **detritus pathway**. Both pathways are important in accounting for the energy budget of the whole ecosystem. Recent discoveries show that very small plankton -- **bacteria** and micrograzers -- are key to
maintaining the flux of carbon and energy within marine ecosystems. Bacteria consume **dissolved organic material (DOM)** that cannot be directly ingested by larger organisms. DOM includes zooplankters' liquid wastes and jellylike substance ("cytoplasm") that leaks out of phytoplankton cells. When these marine bacteria are later eaten by micrograzers such as flagellates and ciliates, the formerly "lost" carbon and energy are recycled back into the marine food web. Better still, as bacteria absorb DOM, they release nutrients that facilitate phytoplankton growth. Much is not known about the microbial loop: for instance, scientists are working to discover how -- and if -- this microbial loop links to the traditional energy pathway from plankton to small fish to big fish.

In the flow of **energy** through the ecosystem, energy is lost at each trophic level. Some of this loss is due to metabolic needs, such as moving, and some is due to the formation of inedible tissue such as shells. Typically, only between 10% and 40% of the energy stored at each level can be used directly by the following trophic level. Therefore, few food chains extend beyond five members (from producer through decomposer) because the energy available at higher trophic levels is not enough to support further consumers. The flow of energy through the ecosystem drives the flow of mass (nutrients) within the ecosystem. Nutrients are chemical elements and compounds that are necessary for life. Unlike energy from the Sun, which originates from outside the ecosystem and is continuously lost, nutrients are cycled within the living (biotic) and non-living (abiotic) components of the ecosystem. The flow of nutrients such as carbon, oxygen, nitrogen, or phosphorus is called biogeochemical cycling. Decomposers play a key role in the biogeochemical cycles by returning nutrients to the soil, water, or air.

**Vocabulary:** (see above background info)

- energy
- photosynthesis
- phytoplankton
- zooplankton
- autotrophs
- primary producers
- heterotroph
- trophic level
- dissolved organic material (DOM)
- bacteria
- decomposers
- carnivore
- herbivore
- Omnivore
Materials:
for the classroom as a whole: Ball of yarn or long string/rope, Free C-MORE Science Kit “Plankton”. To check availability of the kit, go to http://cmore.soest.hawaii.edu/education/teachers/science_kits/requestform.htm

Suggested Procedures:
Pre-Lesson 1: Introduction to the Food Web

Time required: 20 minutes. Advance preparation time is an additional 10 minutes.

Advance Preparation:
1. Download and Print out Food Web Cards from the web: http://www.bigelow.org/foodweb/food_web_cards.html

Instructional Procedures:

1. Familiarize students with the concepts found in the teacher background information on Food webs, Producers, Consumers and other items listed as vocabulary.

2. Organize your class into a circle.

3. Hand one card to each student and have each student familiarize himself / herself with their card. Is their organism an herbivore (plant-eater)? A carnivore (animal-eater)? Omnivore (eats plants and animals)? A producer (i.e., photosynthesizes)?

4. Give the end of the yarn or string to the "Sun" person. Discuss why the food web begins with the sun.

5. The students decide which organisms depend on the sun. Pass the yarn to one "producer" and back to the sun; then to another producer and back to the sun.

6. Then pass the yarn from herbivores back and forth to the producers. Each herbivore should say something about what they eat and their role in the food web.

7. Then pass the yarn from herbivores to the predators that prey on those herbivores. Again, each organism should announce its role in the food web. Eventually the yarn will pass to the top predators. They should describe to the class how they are dependent on the other organisms. When each student has had the yarn passed to him / her at least once, the game stops. Note how interconnected everyone is.

8. Ask the students to create a hypothesis regarding which group of organisms is most abundant in the Mokauea fish pond. Is it the primary producers, or consumers? What
about the most abundant group of organisms in the lagoon? Which is ecosystem has a higher diversity, the fish pond or lagoon?

**Pre-Lesson 2: Introduction to Plankton**

**Time required:** 5 minutes. Advance preparation time is an additional 10 minutes.

**Structure:** This lesson enables students to develop the requisite background knowledge on plankton through a short power point presentation.

**Advance Preparation:**
1. Load the narrated PowerPoint presentation entitled “Introduction to Plankton” on to your computer.
2. Speakers are included in the kit for playing the narrated presentation. Set up the speakers by following the instructions attached to the bag containing the speakers.
3. If you prefer to present the information yourself, a **POWERPOINT SCRIPT** and unnarrated version of the PowerPoint presentation is included on the CD.

**Instructional Procedures:**
1. Play the short, narrated PowerPoint presentation (approximately 5 minutes) to familiarize your students with marine plankton. Or alternatively, you may use the POWERPOINT SCRIPT to narrate the PowerPoint yourself.
2. Review the main topics of the PowerPoint presentation with your students.

**References:**

http://www.bigelow.org/foodweb/chain0.html
http://kingfish.coastal.edu/biology/sgilman/770Food%20WebsChallenges.htm
http://cmore.soest.hawaii.edu/education/teachers/science_kits/plankton_kit.htm
http://cmore.soest.hawaii.edu/education/teachers/science_kits/requestform.htm
http://www.kaimakana.org/mirp.htm
FISH POND ECOLOGY HA`AWINA
Field Trip Lesson:
“Mokaeua’s Fish Pond Food Web”

Time required: 
30 minutes

Lesson Overview: 
The purpose of this is to familiarize students with field sampling procedures of plankton, benthic habitats, and fish populations. Students will also learn to use a hand-held magnifiers and a microscope to observe plankton and other microscopic fishpond organisms. The food web dynamics of the Mokaeua fish pond will be observed and discussed.

Teacher Background: (see pre-field trip lesson)

Vocabulary: (see pre-field trip lesson)

Materials: 
per student: notebook and pencil

for the classroom as a whole: Free C-MORE Science Kit “Plankton”, Mokaeua island will provided: 3 PVC sampling quadrats, big buckets, small buckets, 3 sets of sediment sieves, 75 meter rope, organism identification cards, and hand-held magnifiers.

Suggested Procedures:

1. Before arriving at Mokaeua Island, secure the plankton tow to the rear of the canoe.

2. Upon arrival at the island, remove the plankton tow and collect the plankton sample by unscrewing the cod end from the net. Pour the sample into the plastic Bottle and label it “Lagoon”. Reattach the cod end to the plankton net and thoroughly rinse the plankton net and attached line with fresh water as soon as possible after collecting the sample, particularly the cod end.

3. Attach the plankton tow to the end of the 75 meter rope provided at the island. Have one student hold the plankton tow at the northwest end of the island. Have another student walk to the opposite end of the fish pond paying to rope out as they walk along the shore of the pond. When the students have the line tightly strung across the pond, tell them to release the tow and quickly pull it across the pond. It is important not to let the tow touch the sediment on the bottom of the pond. When the tow nears the
shallow water, remove the tow and collecting the sample in another bottle and label it “Fish Pond”.

4. Place the plankton water samples in the shade until they can be observed.

5. Locate the 0.25 meter PVC sampling quadrats, shovels, buckets, and sediment sieves. Break students into sampling groups A, B and C. Bring students to the north end of the fish pond near the shallow mud. Place the quadrats in the shallow water where seaweed make up at least 50% of the quadrat.

6. Tell the students to remove the top 4 inches of sediment under the quadrat and place all the contents in the bucket.

7. Now have the students use the sediment sieves to sort out the contents of the quadrat. Stack all the sieves on top of each other and pour the contents of the bucket on to the sieve. Shake the sieve continue to pour pond water over the stack of sieves while removing each layer one at a time. Observe the contents of each sieve layer and record what is found. Use the laminated organism sheets to aid in identification. If the organism is unknown, you may record the species as shrimp A, B, C etc.

8. Assign a few students to fish watch duty and provide them with fish identification cards. Have them stand near the edge of the pond at the makaha or gate. Tell them to stand very still and record all the fish they observe in a 5 minute period. If the fish is unknown, you may record the species as fish A, B, C etc.

9. Introduce the hand-held magnifiers and dissecting microscope to the students and show them how to operate them. Use the hand-held magnifiers to locate plankon and then view the samples under microscope and identify organisms present with the aid of the phytoplankon and zooplankon ID guides provided in C-MORE kit. Record organisms found.

10. Have the students use the microscope to observe the finer scale organisms from the sieve and record their identity using the laminated organism sheets.

11. Rinse all of the plankton lab supplies with fresh water. These include the plankton net and line, plastic bottle, plastic beakers, plastic droppers, and Petri dishes. Please allow these items to dry prior to repacking.

12. Engage the students in a discussion of what they found in the pond. What are the primary producers, consumers, and decomposers? How does energy pass though the food web in the fish pond?
FISH POND ECOLOGY HA`AWINA
Post-Field Trip Classroom Lesson:
“Measuring Diversity of Fish Pond Food Webs”

Time required: 30 minutes

Lesson Overview:
The purpose of this post-field trip lesson is to introduce students to the species diversity measure the Simpson’s Index, create graphs to summarize field data, and compare this to previous group’s results on the web. These results will then be used to support or refute the class’s initial hypotheses. An individual assignment will be given where students will create a food web for the Mokaeua fish pond.

Teacher Background:

Species diversity: This is the number of different species in a particular area (species richness) weighted by some measure of abundance such as number of individuals or biomass. However, it is common for conservation biologists to speak of species diversity even when they are actually referring to species richness.

Species richness is the number of different species in a given area. Species richness is the fundamental unit in which to assess the homogeneity of an environment. Typically, species richness is used in conservation studies to determine the sensitivity of ecosystems and their resident species.

Factors affecting species richness:

Latitude: There is a strong inverse correlation in many groups between species richness and latitude: the farther from the equator, the fewer species can be found, even when compensating for the reduced surface area in higher latitudes due to the spherical geometry of the earth. Equally, as altitude increases, species richness decreases, indicating an effect of area, available energy, isolation and/or zonation (intermediate elevations can receive species from higher and lower).

Productivity: The latitudinal gradients of species richness may be result from the energy available to the ecosystems. At lower latitudes, there are higher amounts of energy available because of more solar radiation, more resources (for example, minerals and water); as a result, even higher levels of species richness can be allowed at lower latitudes. Factors that increase productivity, such as nutrient addition, often lead to lower species richness because more productive species out-compete less productive ones. In nature, therefore, high species diversity and high productivity are often not positively correlated."

Relationship between endemism and species richness: The levels of endemism and that of species richness are frequently positively correlated. However, on some oceanic
islands, there are high levels of endemism but the levels of species richness are quite low.

The most common formula for working out Species Diversity is the

**Simpson's index (D)**, which uses the following formula:

\[
D = \frac{\sum n(n-1)}{N(N-1)}
\]

The value of D ranges between 0 and 1

With this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of D, the lower the diversity. A low D value suggests a stable and ancient site, while a high D value could suggest a polluted site, recent colonization or agricultural management.

As an example, let us work out the value of D for a single quadrat sample of ground vegetation in a woodland. Of course, sampling only one quadrat would not give you a reliable estimate of the diversity of the ground flora in the wood. Several samples would have to be taken and the data pooled to give a better estimate of overall diversity.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number (n)</th>
<th>n(n-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodrush</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Holly (seedlings)</td>
<td>8</td>
<td>56</td>
</tr>
<tr>
<td>Bramble</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Yorkshire Fog</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Sedge</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total (N)</strong></td>
<td><strong>15</strong></td>
<td><strong>64</strong></td>
</tr>
</tbody>
</table>

Putting the figures into the formula for Simpson's Index

\[
D = \frac{\sum n(n-1)}{N(N-1)}
\]
\[ D = \frac{64}{15(14)} \]

\[ D = \frac{64}{210} \]

\[ D = 0.3 \text{ (Simpson's Index)} \]

**Vocabulary:** (see above background info)
- Energy
- Photosynthesis
- Diversity
- Richness
- Simpson’s Index
- Quadrat
- Endemism
- Latitude

**Materials:**
- *per student:* pencil
- *for the classroom as a whole:* computer with internet, projector, printer

**Suggested Procedures:**

1. Introduce key concepts of species richness and diversity to students.

2. On the classroom projector, log on to Kai Makana’s web site ([http://www.kaimakana.org/mirp.htm](http://www.kaimakana.org/mirp.htm)) and view past groups results of organisms found in Mokauea's fish pond. Show the students the graphs of species richness (# of individuals of a species) and estimates of Simpson’s Index.
3. Now have the students count the number of each species found in the transects and fish counts. As a class, create a bar graph of species richness and calculate Simpson’s Index adding the results of all transects together. What environmental or social factors at Mokauea Island may be influencing this index? Was the class hypotheses (pre-field lesson) supported or rejected? Upload the class results to the web to add to the fish pond data set.

4. Individual assignment: Create a food web for the Mokauea Fish Pond using the template provided below. Fill in the 12 blank boxes with fish pond organisms. Trace the paths of energy from the sun, though the food web to humans by drawing connecting lines.
Mokauea Fish Pond Food Web
WATER QUALITY HA`AWINA

Overview:

The overall goal of the Mokauea water quality ha`awina is for students to (a) learn about water quality parameters which influence aquatic ecosystems (b) experience sampling water at Mokauea Island and perform water quality tests (c) prepare graphs to describe the results and test hypotheses.

Lessons:

- **Pre-Field Trip Classroom Lesson:** “What is water quality and how do we test it?”
  The purpose of this pre-field trip lesson is to familiarize students with water quality parameters, field assay procedures and how environmental factors influence these parameters. The water quality parameters pH, DO, Salinity, Temperature, Turbidity, Nitrogen and Phosphorus will be defined in class. Students will be broken in to groups and given a particular assay to run using tap water. Students will discuss the hypothesis that water quality parameters are different in the pond compared to the lagoon channel.

- **Field Trip Lesson:** “Water sampling and quality testing”
  Students will conduct water quality assessment to test the hypothesis that the water quality of the fishpond is different than the lagoon channel water quality. Tests for pH, DO, Salinity, Temperature, Turbidity, Nitrogen and Phosphorus will be conducted at three stations in the pond and the lagoon channel.

- **Post-Field Trip Classroom Lesson:** “Results analysis and hypothesis testing”
  This post-field trip lesson is to allow students to share field results and discuss whether their hypothesis was supported or refuted. Students will prepare graphs of their group’s results comparing fishpond, lagoon, and tap water parameters. These results will then be compared an online data bank of previous results and students will upload their data to the website. A lab report maybe assigned as assessment.

**Hawai`i Department of Education Standards & Benchmarks:** Kai Makana activities are targeted to high school. In the listing below, these high school science course abbreviations are used:
- PS = physical science
- BS = biological science
- ES = earth science
ENV = environmental science
MS = marine science
B= botany

Kai Makana’s water quality strand can be used in the context of the following high school science and social studies standards & benchmarks--

**Standard 1, all sciences: SCIENTIFIC INVESTIGATION:** Discover, invent, and investigate using the skills necessary to engage in the scientific process.

- **SC.PS/B/BS/ES/ENV/MS.1.1** Describe how a testable hypothesis may need to be revised to guide a scientific investigation
- **SC.PS/B/BS/ES/ENV/MS.1.2** Design and safely implement an experiment, including the appropriate use of tools and techniques to organize, analyze, and validate data.
- **SC.PS/B/BS/ES/ENV/MS.1.3** Defend and support conclusions, explanations, and arguments based on logic, scientific knowledge, and evidence from data
- **SC.PS/B/BS/ES/ENV/MS.1.4** Determine the connection(s) among hypotheses, scientific evidence, and conclusions.
- **SC.PS/B/BS/ES/ENV/MS.1.5** Communicate the components of a scientific investigation, using appropriate techniques
- **SC.PS/B/BS/ES/ENV/MS.1.6** Engage in and explain the importance of peer review in science.
- **SC.PS/B/BS/ES/ENV/MS.1.7** Revise, as needed, conclusions and explanations based on new evidence.

**Standard 2, all sciences: NATURE OF SCIENCE:** Understand that science, technology, and society are interrelated.

- **SC.PS/B/BS/ES/ENV/MS.2.1** Explain how scientific achievements and emerging technology have influenced society.
- **SC.ES/MS.2.3** Explain the impact of humans on the Earth system.

**Standard 3, MS: OCEANOGRAPHY:** Understand the physical features of the ocean and its influences on weather and climate.

- **SC.MS.3.3** Explain how the ocean participates in the geochemical cycling of elements.
- **SC.MS.3.6** Explain how erosion occurs and the effects of sedimentation.
- **SC.MS.3.7** Describe the relationship between fresh bodies of water, watersheds, and the ocean.
Standard 4, MS/ENV/B: LIFE SCIENCE: Understand the interconnections of living systems.

SC.MS.4.1 Differentiate freshwater, brackish, and saltwater ecosystems
SC.B.4.2 Evaluate the effect of biotic and abiotic factors (e.g., succession, competition, human influences) on plant stability within the environment
SC.ENV.4.3 Explain how ecosystems respond to human activities.
SC.MS.4.5 Explain how chemical factors (e.g., pH, salinity, dissolved O2, nutrients) affect the distribution of life in the ocean.
SC.ENV.4.6 Describe how the availability of resources (e.g., energy, water, oxygen, minerals) limits the amount of life an environment can support

Standard 5, ENV: INTERDEPENDENCE OF THE ENVIRONMENT AND HUMAN SOCIETIES:
SC.ENV.5.2 Assess the effect of human actions on an environmental system.

Standard 6, MS: INTERDEPENDENCE OF HUMANS AND THE OCEAN: Understand the interdependence of humans and the ocean.
SC.MS.6.4 Explain how human activities and development lead to marine pollution (e.g. point sources, non-point sources).
SC.MS.6.5 Describe how urbanization has impacted the ocean.

Standard 8, ES: PHYSICAL, EARTH, AND SPACE SCIENCES:
SC.ES.8.1 Describe how elements and water move through solid Earth, the oceans, atmosphere, and living things as part of geochemical cycles

References/Resources:

http://waterontheweb.org/under/waterquality/index.html
http://waterontheweb.org/under/waterquality/index.html
http://en.wikipedia.org/wiki/Salinity
http://en.wikipedia.org/wiki/Nutrients
http://qa.water.usgs.gov/edu/watercycleprint.html
http://www.backpacklab.com/aqua.cfm

Mokaua Island image from Google maps is found at:
http://maps.google.com/maps?f=d&hl=en&geocode=&saddr=&daddr=mokaua+island&sll=21.309746,157.885101&sspn=0.012074,0.018389&ie=UTF8&ll=21.308367,-157.891967&spn=0.012074,0.018389&z=16

State Dept of Health Water quality data:
Hawaii tap water reports on web from Board of Water Supply:
http://www hbws.org/cssweb/display.cfm?sid=1081
WATER QUALITY HA`AWINA
Pre-Field Trip Classroom Lesson:
“What is Water Quality and How Do We Test It?”

Time required:
One class period

Lesson Overview:
The purpose of this pre-field trip lesson is to familiarize students with water quality parameters, field assay procedures and how environmental factors influence these parameters. The water quality parameters pH, DO, Salinity, Temperature, Turbidity, and Nitrogen, and Phosphorus will be defined in class. Students will be broken in to groups and given a particular assay to run using tap water. Students will discuss the hypothesis that water quality parameters are different in the pond compared to the lagoon channel.

Teacher Background:

The water cycle (known scientifically as the hydrologic cycle) refers to the continuous exchange of water within the hydrosphere, between the atmosphere, soil water, surface water, groundwater, and plants.

The pH of a sample of water is a measure of the concentration of hydrogen ions. The term pH was derived from the manner in which the hydrogen ion concentration is calculated - it is the negative logarithm of the hydrogen ion (H+) concentration. At higher pH, there are fewer free hydrogen ions. A change of
one pH unit reflects a tenfold change in the concentrations of the hydrogen ion. For example, there are 10 times as many hydrogen ions available at a pH of 7 than at a pH of 8. The pH scale ranges from 0 to 14. A pH of 7 is considered to be neutral. Substances with pH of less that 7 are acidic; substances with pH greater than 7 are basic.

As marine plants photosynthesize, they intake dissolved carbon dioxide which acts like carbonic acid (H₂CO₃) in water. CO₂ removal, in effect, reduces the acidity of the water and so pH increases. In contrast, respiration of organic matter produces CO₂, which dissolves in water as carbonic acid, thereby lowering the pH. For this reason, pH may be higher during daylight hours and during the growing season, when photosynthesis is at a maximum. Respiration and decomposition processes lower pH. Like dissolved oxygen concentrations, pH may change with depth in a lake, due again to changes in photosynthesis and other chemical reactions.

**Oxygen saturation** or **dissolved oxygen (DO)** is a relative measure of the amount of oxygen that is dissolved or carried in a given medium. Like terrestrial animals, fish and other aquatic organisms need oxygen to live. As water moves past their gills (or other breathing apparatus), microscopic bubbles of oxygen gas in the water, called dissolved oxygen (DO), are transferred from the water to their blood. Like any other gas diffusion process, the transfer is efficient only above certain concentrations. In other words, oxygen can be present in the water, but at too low a concentration to sustain aquatic life. Oxygen also is needed by virtually all algae and all macrophytes, and for many chemical reactions that are important to pond functioning. Oxygen saturation is calculated as the percentage of dissolved O₂ concentration relative to that when completely saturated at the temperature of the measurement depth. Recall that as temperature increases, the concentration at 100% saturation decreases. The DO concentration for 100% air saturated water at sea level is 8.6 mg O₂/L at 25°C (77°F) and increases to 14.6 mg O₂/L at 0°C.

**Temperature** is a thermodynamic property of a fluid, and is due to the activity of molecules and atoms in the fluid. The more the activity (energy) in an object, the higher the temperature. Temperature is a measure of the heat content. In physics and thermodynamics, heat is the process of energy transfer from one body or system due to thermal contact. Most aquatic organisms are poikilothermic - i.e., "cold-blooded" - which means they are unable to internally regulate their core body temperature. Therefore, temperature exerts a major influence on the biological activity and growth of aquatic organisms. To a point, the higher the water temperature, the greater the biological activity. Fish, insects, zooplankton, phytoplankton, and other aquatic species all have preferred temperature ranges. As temperatures get too far above or below this preferred range, the number of individuals of the species decreases until finally there are few, or none. For example, we would generally not expect to find a thriving trout fishery in ponds or shallow lakes because the water is too warm throughout the ice-free season.
Turbidity refers to how clear the water is. The greater the amount of total suspended solids (TSS) in the water, the murkier it appears and the higher the measured turbidity. The major source of turbidity in the open water zone is typically phytoplankton, but closer to shore, particulates may also be clays and silts from shoreline erosion, resuspended bottom and organic detritus from stream and/or wastewater discharges. Dredging operations, channelization, increased flow rates, floods, or even too many bottom-feeding fish may stir up bottom sediments and increase the cloudiness of the water. High concentrations of particulate matter can modify light penetration, cause shallow lakes and bays to fill in faster, and smother benthic habitats - impacting both organisms and eggs. As particles of silt, clay, and other organic materials settle to the bottom, they can suffocate newly hatched larvae and fill in spaces between rocks which could have been used by aquatic organisms as habitat. Fine particulate material also can clog or damage sensitive gill structures, decrease their resistance to disease, prevent proper egg and larval development, and potentially interfere with particle feeding activities. If light penetration is reduced significantly, macrophyte growth may be decreased which would in turn impact the organisms dependent upon them for food and cover. Reduced photosynthesis can also result in a lower daytime release of oxygen into the water. Effects on phytoplankton growth are complex depending on too many factors to generalize. The Secchi disk depth provides rapid method for assessing the clarity of a body of water. A Secchi disk is a circular plate divided into quarters painted alternately black and white. The disk is attached to a rope and lowered into the water until it is no longer visible. Secchi disk depth, then, is a measure of water clarity. Higher Secchi readings mean more rope was let out before the disk disappeared from sight and indicates clearer water. Lower readings indicate turbid or colored water. Clear water lets light penetrate more deeply into than does murky water. This light allows photosynthesis to occur and oxygen to be produced.

Salinity is the saltiness or dissolved salt content of a body of water. It is a general term used to describe the levels of different salts such as sodium chloride, magnesium and calcium sulfates, and bicarbonates. Salinity is roughly the number of grams of dissolved matter per kilogram of seawater. The technical term for saltiness in the ocean is salinity. In oceanography, it has been traditional to express salinity not as percent, but as parts per thousand (%), which is approximately grams of salt per kilogram of solution. Other disciplines use chemical analyses of solutions, and thus salinity is frequently reported in mg/L or ppm (parts per million). In 1978, oceanographers redefined salinity in the Practical Salinity Scale (PSS) as the conductivity ratio of a sea water sample to a standard KCl solution. Ratios have no units, so it is not the case that a salinity of 35 exactly equals 35 grams of salt per liter of solution. On average, seawater in the world's oceans has a salinity of about 3.5%. This means that every kilogram, or every liter, of seawater has approximately 35 grams (1.2 oz) of dissolved salts (mostly, but not entirely, the ions of sodium chloride: Na+, Cl−). The average density of seawater at the ocean surface is 1.025 g/ml; seawater is denser than freshwater (which reaches a maximum density of 1.000 g/ml at
a temperature of 4 °C (39 °F)) because of the salts’ added mass. The freezing point of sea water decreases with increasing salinity and is about −2 °C (28.4 °F) at 35 g/l.

A nutrient is a chemical that an organism needs to live and grow or a substance used in an organism's metabolism which must be taken in from its environment. Nutrients are the substances that enrich the body. They build and repair tissues, give heat and energy, and regulate body processes.

Oversupply of plant nutrients in the environment can cause excessive plant and algae growth. Eutrophication, as this process is called, may cause imbalances in population numbers and other nutrients that can be harmful to certain species. For example, an algal bloom can deplete the oxygen available for fish to breathe. Causes include water pollution from sewage or runoff from farms (carrying excess agricultural fertilizer). Nitrogen and phosphorus are most commonly the limiting factor in growth, and thus the most likely to trigger eutrophication when introduced artificially. The nutrients which most influence aquatic primary producers are inorganic nitrogen compounds (NO3 −, NO2 –, NH4 +), phosphate (PO4 3-) and silicate (SiO4 3). Tropical reefs commonly have almost undetectable levels of nutrients. Any nutrient source (wastewater, fertilizer, animal wastes) has the potential to increase photosynthesis, and impact marine ecosystems.

**Vocabulary:** (see above for definitions)

pH-
Dissolved Oxygen-
Salinity-
Turbidity-
Nutrients (Nitrogen and Phosphorus)-

**Materials:**

*per student*: notebook and pencil

*for the classroom as a whole*: Water quality testing kit

**Hanna Marine Science Backpack Lab** (Mokauea Island may have one to use)

**Teacher Preparation:**

Use the images of Mokauea Island to familiarize students with the fish pond and lagoon ecosystem at Mokauea. This will help students to make hypotheses about water quality parameters in the pond and in the lagoon channels. Read instructions, teacher’s manual, and view CD-Rom. It would be a good idea to do a test run of all water quality tests in the Hanna Marine Science Backpack Lab.
Photo of Mokaua Island from the air.

Another Mokaua Island image from Google maps is found at:  
http://maps.google.com/maps?f=d&hl=en&geocode=&saddr=&daddr=mokaua+island&sll=21.309746,157.885101&sspn=0.012074,0.018389&ie=UTF8&ll=21.308367,157.891967&spn=0.012074,0.018389&z=16

**Suggested Procedures:**

1. Introduce the water cycle to students and follow water from rain to percolation, underground aquifer, runoff to ocean, submarine groundwater discharge and evaporation.

2. Define and discuss water quality parameters pH, DO, Salinity, Temperature, Turbidity, and Nutrients on the board and have students copy to notes.

3. Break up students into six potential field teams and give each team an assay kit to use.

4. Distribute tap water samples and have each team perform their assay on tap water and record the results. Have each group write down what environmental factors could effect this parameter in the field. What do you predict the value of this parameter will be in a marine environment such as a fish pond?

5. Discuss the results with the class as a whole. Have each group share their predictions about the marine value of their parameters and what environmental factors could influence this.

6. Show the fish pond photos of sampling sites in the lagoon and inside the pond. Ask the students to create a hypothesis regarding the water quality of the
lagoon compared to inside the fishpond. Example. (The water quality parameters of the lagoon channel sites will have similar values to those of the fish pond sites). Let the students know that their hypothesis will be tested at Mokauea Island during the field trip.
WATER QUALITY HA`AWINA
Field Trip Lesson:
“Water Sampling and Quality Testing”

**Time required:**
~1/3 of the time that the visitors have on Mokaua Island

**Lesson Overview:**
Students will conduct water a quality assessment to test the hypothesis that the water quality of the fishpond is different than the lagoon channel water quality. Tests for pH, DO, Salinity, Temperature, Turbidity, Nitrogen, and Phosphorus will be conducted at three stations in the pond and the channel.

**Teacher Background:** (see pre-field lesson)

**Vocabulary:** (see pre-field lesson)

**Materials:**
*per student:* notebook and pencil

*for the classroom as a whole:* Water quality testing kit
**Hanna Marine Science Backpack Lab** (Mokaua Island may have one to use)

**Teacher/On-island Volunteer Preparation:**

1. Locate labeled sampling sites in fishpond and lagoon.

**Suggested Procedures:**

1. Review classroom lesson, e.g., What environmental factors influence the levels of pH, DO, Salinity, Temperature, Turbidity, and Nitrogen, and Phosphorus in marine environments?

2. Discuss the hypothesis: Fish pond and channel waters are similar/ different. Ask students which parameters may change between the two water bodies and why.

3. Break students up into designated teams, pass out sampling bottles and equipment. Each bottle will designate a parameter and site to test. Allow students to collect water samples and return to bench to conduct chemistry if necessary.
4. Record results on a white board and notebook. A quick discussion of results is recommended if time permits.
WATER QUALITY HA`AWINA
Post-Field Trip Classroom Lesson:
“Results Analysis and Hypothesis Testing”

Time required:
One-half class period minimum

Lesson Overview:
This post-field trip lesson is to allow students to share field results and discuss whether their hypothesis was supported or refuted. Students will prepare graphs of their group’s results comparing fishpond, lagoon, and tap water parameters. A lab report may be assigned as assessment.

Teacher Background: (see pre-field lesson)

Vocabulary: (see pre-field lesson)

Materials:
per student: graph paper, pencil, ruler

for the classroom as a whole: A computer with an internet connection and projector is ideal.

Teacher Preparation: Locate previous group’s water quality results on Kai Makana’s website and review trends in data.

Suggested Procedures:

1. Using a projector, log on to Kai Makana’s web site and view past group’s water quality results. http://www.kaimakana.org/mirp.htm

2. Then have the class fill in the excel spreadsheet (provided online) with each team’s results. Make sure to save this spreadsheet and send it to Kai Makana to be added to the online data set.

3. Have each student create a graph of their team’s results for fishpond, lagoon, and tap water parameter values. Each student should prepare a short paragraph explaining which environmental factors influence the parameter and how these factors change within the pond, lagoon and groundwater (tap water).

4. Introduce other types of water quality assessment used by state and federal agencies such as Fecal coliform, enteroccci, clostridium, etc and beach monitoring programs. State Dept of Health Water quality data:
Introduce tap water reports on web from Board of Water Supply:
http://www hbws.org/cssweb/display.cfm?sid=1081
COASTAL PLANTS HA`AWINA

**Overview:** The overall goal of the Kai Makana Coastal Plant ha`awina is for students to (a) gain a general understanding of the adaptations of coastal plants; (b) an awareness of native coastal plants, how they were used by Hawaiians, and the challenges of revegetation; and (c) an understanding of the challenges that Introduced plants often present.

**Lessons:**

- **Pre-Field Trip Classroom Lesson:** “What’s Different with Coastal Plants?”
  The purpose of this pre-field trip lesson is to review botanical terms and have students thinking about the adaptations of coastal plants that they are likely to observe on Mokauea Island.

- **Field Trip Lesson:** “Mokauea Island – Coastal Plants”
  Students will observe common adaptations of coastal plants, become familiar with traditional Hawaiian stories and usage of coastal plants, discuss the challenges presented by non-native plants and be introduced to current efforts to replant Mokauea Island with native plants.
  Schedule permitting, students may be involved in revegetation efforts.

- **Post-Field Trip Classroom Lesson:**
  This post-field trip activity is designed to be get students to reflect on what they observed and/or learned about coastal plants.

**Vocabulary:**

- **Native** – broad category for species that are in an area as the result of only natural processes, with no human intervention.

- **Endemic** - the ecological state of being unique to a particular geographic location, such as a specific island, habitat, or other defined zone. To be endemic means that it is found only in that part of the world and nowhere else. [Wikipedia]

- **Indigenous** - A plant that is native to the area, but not unique to the area. It can be found naturally occurring in other parts of the world. [Wikipedia]
Non-Native/Introduced – a species that is living outside its native distributional range, which has arrived there by human activity, either deliberate or accidental.

Polynesian Introduced – species that were brought by Hawaiian ancestors when voyaging north from Polynesia. Example: taro.

Non-Native/ Alien/Exotic/Invasive – Several terms are used to describe species that were brought to an area, either deliberately or accidentally. In Hawaii, many non-native plants were deliberately brought to the islands for gardens by reproduced and spread into the natural environment. Fast spreading non-natives, that adversely affect the habitats they invade economically, environmentally or ecologically are typically referred to as Invasives. [Wikipedia]

Lenticels = pores in a mangrove’s root that allows for the absorption of oxygen and other gases directly from the atmosphere

Propugule = a ready-to-go seedling (i.e., mangrove) which can produce its own food via photosynthesis.

Viviparous = live bearing

Hawai`i Department of Education Standards & Benchmarks: Kai Makana activities are targeted to high school. In the listing below, these high school science course abbreviations are used:

- ENV = environmental science
- MS = marine science
- PAH = Plants and Animals in Hawaii
- B = Botany

Kai Makana’s coastal ha’awina can be used in the context of the following high school science and social studies standards & benchmarks--

Standard 1, all sciences: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills necessary to engage in the scientific process.

- SC. /ENV/MS/PAH/B.1.4 Determine the connection(s) among hypotheses, scientific evidence, and conclusions.
- SC. /ENV/MS/PAH/B.1.7 Revise, as needed, conclusions and explanations based on new evidence.
Standard 2, all sciences: NATURE OF SCIENCE: Understand that science, technology, and society are interrelated.

SC. /ENV/MS/PAH/B.2.1 Explain how scientific achievements and emerging technology have influenced society.
SC.ES.2.3 Explain the impact of humans on the Earth system.

Standard 3, PAH: ORGANISMS AND THE ENVIRONMENT: Understand the unity, diversity, and interrelationships of organisms, including their relationship to cycles of matter and energy in the environment.

SC.PAH.3.6 Explain how human actions (e.g. conservation, introduction of non-indigenous species, destruction and fragmentation of native habitat, hunting, over harvesting, poor land practices, stream diversion have impacted organisms in Hawaii since the first Polynesians.

Standard 4, B: PLANTS & THE ENVIRONMENT – Understand interactions between plants and the environment.

SC.B.4.1 Describe how plant products (e.g. drugs, timber, herbs, fossil fuels, fibers) impact human life.

Standard 5, MS: STRUCTURE, FUNCTION & INTERDEPENDENCE– Understand the structure, function, and interdependence of marine organisms.

SC.MS.5.1 Explain how adaptations help animals (plants) survive in a marine environment.

References/Resources:


Hawaiian Ethnobotany Database. Bishop Museum’s online database. www2.bishopmuseum.org/ethnobotanydb/index.asp

“Hawaiian Heritage Plants,” Angela Kay Kepler, Univ. of Hawaii Press, June 1998. In a series of essays, the author weaves cultural and biological, historical and geographic, aesthetic and spiritual aspects of Hawaiian ecology into non-technical accounts of 32 plants important to early Hawaiians, 240 pgs.

COASTAL PLANTS HA`AWINA
Pre-Field Trip Classroom Lesson:

**Time required:** part of one class period; about 15 minutes

**Lesson Overview:** This short classroom activity is designed to be done along with other activities to prepare students for the content topics of the field trip to Mokauea Island by:

1. Introducing students to the environment of a Hawaiian coastal zone – sandy or volcanic, high exposure to sun, wind and heat, and common plants.

2. Thinking about adaptations that one is likely to observe among coastal plants.

3. Reviewing vocabulary for Endemic, Indigenous and Introduced (either by Polynesian or by later populations) to Hawaii

**Materials:** none

**Teacher Preparation:**
The coastal zone is above the reach of the waves, but greatly influenced by the sea. To survive, land plants of this habitat must be tolerant of salt spray, sandy soil or barren lava rock, strong winds, scorching sun, and little fresh water.

Adaptations for survival near the sea give coastal plants a special “look.” Silvery leaf hairs and shine surfaces help reflect the sun’s rays to prevent heating and slow evaporation. Thick, waxy leaf surfaces and succulent tissues help prevent water loss. Rosette leaf arrangements help some plants stay cool by minimizing leaf surfaces exposed to the sun and may even help radiate heat. Many coastal plants grow low to the ground and have small leaves – protections against the drying effects of the wind. Shallow, spreading root systems help anchor plants on shifting sands or barren rock.

Some plants, like the *naupaka kahakai*, are indigenous – found naturally in Hawaii as well as other places. Other, like the *ohai* are endemic – unique species found only in Hawaii.

Healthy shores and healthy reefs are a part of Hawaii’s heritage. Just as plants of the uplands protect the watershed with a cloak of vegetation, the coastal plants secure dunes and slow shoreline erosion. And, many coastal plants serve
traditional uses and hold cultural significance in Hawaii and throughout the Pacific.

Sadly, human activities have altered or destroyed the natural profile and vegetation along much of Hawaii’s shores. Some shoreline developments and homes are built on the shore rather than behind it; landscaping often uses exotic ornamentals rather than adapted native plants. On less developed shorelines, recreational activities like motor cross racing, camping and even hiking break the dunes, break the protective cover of vegetation causing dunes to erode and allowing aggressive weeds to crowd out remaining species.

[from: Waikiki Aquarium’s Coastal Gardens handout]

**Suggested Procedures:**
Instruct the students as follows:

a) Imagine yourself to be a plant that has just taken root in a coastal area. Your goal is to survive, grow and reproduce. Imagine what your leaves, roots, and seeds look like.

b) On a sheet of paper make a list of characteristics and adaptations that you would expect to find among coastal plants.

Encourage the students to bring their list on the trip to compare their observations of adaptations against their expectations. Review the terms below that are important when discussing Hawaii’s flora:

**Native** – broad category for species that are in an area as the result of only natural processes, with no human intervention.

**Endemic** - the ecological state of being unique to a particular geographic location, such as a specific island, habitat, or other defined zone. To be endemic means that it is found only in that part of the world and nowhere else. [Wikipedia]

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COASTAL PLANTS HA`AWINA
Field Trip Lesson:

**Time required:** 45 minutes

**Lesson Overview:**

Students will observe common adaptations of coastal plants, become familiar with traditional Hawaiian stories and usage of coastal plants, discuss the challenges presented by non-native plants and be introduced to current efforts to replant Mokaua Island with native plants. Schedule permitting, students may be involved in revegetation efforts. Student groups will experience one or more of the activities below. The selection of activity(ies) will vary, depending on input from the teacher, conditions on the day and the readiness of logistics to support the activity(ies).

A) Adaptations of Coastal Plants

The coastal zone is above the reach of the waves, but greatly influenced by the sea. To survive, land plants of this habitat must be tolerant of salt spray, sandy soil or barren lava rock, strong winds, scorching sun, and little fresh water.

Adaptations for survival near the sea give coastal plants a special “look.” Silvery leaf hairs and shine surfaces help reflect the sun’s rays to prevent heating and slow evaporation. Thick, waxy leaf surfaces and succulent tissues help prevent water loss. Rosette leaf arrangements help some plants stay cool by minimizing leaf surfaces exposed to the sun and may even help radiate heat. Many coastal plants grow low to the ground and have small leaves – protections against the drying effects of the wind. Shallow, spreading root systems help anchor plants on shifting sands or barren rock.

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Sadly, human activities have altered or destroyed the natural profile and vegetation along much of Hawaii’s shores. Some shoreline developments and
homes are built on the shore rather than behind it; landscaping often uses exotic ornamentals rather than adapted native plants. On less developed shorelines, recreational activities like motor cross racing, camping and even hiking break the dunes, break the protective cover of vegetation causing dunes to erode and allowing aggressive weeds to crowd out remaining species.

[from: Waikiki Aquarium’s Coastal Gardens handout]

**Activity:** Break the students into groups of 3-4. Distribute one card and grease pencil per group of the laminated worksheet, “Handout 1 – Adaptations of Coastal Plants.” Ask them to look around and select 2 plants (native or non-native) plus the pickleweed. Using the laminated identification cards, write down the names of the 2 selected plants (pickleweed has already been pre-selected and is in the third column). Examine the plants for common traits/characteristics of adaptations of coastal plants and check off those that are associated with the plant.

**Materials Needed:** Handout 1 – Adaptations of Coastal Plants, laminated plant identification cards

Note: Instruct the students to be careful when walking among the newly planted coastal plants. The roots are shallow and spread out. Beneath the surface, one’s footstep may be breaking the fragile roots. As a rule of thumb: stay 2-3 feet away from the native plants.

For obvious reasons, student may skip the row regarding shallow roots since we do not native plants uprooted. The pickleweed exhibits many of the classic adaptations of coastal plants and it IS okay to pull up a few to observe the roots.

**Discussion:** Ask the students to share some of their findings and via their sharing review the adaptations. Ask the student if they had any surprises in their observations

**B) Native Plants**

**Activity** Distribute the laminated plant identification card. Ask the students to identify native plants that:

___ Has a *mo`olelo* that tells of a forbidden love.

___ Had a medicinal use by the Hawaiians.
Was used by Hawaiians to make cordage.

[Activity - The Case of the Strongest Cord: Why was cordage valuable in old Hawai`i and what properties make cordage strong and flexible?  [Excerpts taken from:  Aloha Aina: Ahupua`a 2]

Materials Needed: laminated cards, natural fibers, and/or raffia, popsicle sticks, Handout #2]

Hawaiians depended on plants and other natural resource in the ahupua`a for living and survival.

Cordage was used for a variety of implements: fish hooks, fish lines, fish nets, houses, canoes, weapons, musical instruments, games, feather work, basketry, and tools such as adze. Strong cordage was made by twisting plant fibers together and specific plants were used for their strength, stretch and “non-slip” qualities.

Distribute the laminated card, “Cordage Made and Used by Hawaiians.” Guide the students through a visual examination of the variety of ways that cordage was used.

Point out the different fibers and plants that were used for making cordage.

Discussion: Challenge the students to think of factors affecting the usefulness of cordage for a variety of tasks in old Hawaii (e.g., net fishing, line fishing, canoe building, hauling logs, house construction, lashing tools and weapons). Lead students to identify the following factors: breaking point, knot strength, stretch, abrasion resistance and weather resistance.

Activity: Invite the students to make about 12 inches of their own cordage from niu, hau, grasses, vines, ti leaves (or raffia). Once they have created their cordage, invite them to test their cordage by tying two popsicle sticks in an “X”. At the end, take a sampling of the ties and “test” the ties for: wiggle (back-n-forth), abrasion resistance (rub the top of the cordage with something rough), or water resistance (soak the tie with water). At the conclusion of the activity, encourage the students to think of the importance of making cordage well – for lashings on a canoe that is making a channel crossing, for shelter, for fishing, etc.
C) Non-Native Plants

Imagine Mokauea Island before the arrival of mangrove plants, kiawe trees, and pickleweed. Let’s take a moment to learn about these two newcomers to Mokauea Island. Distribute the laminated Non-Native plants card on Mangroves and Pickleweed.

Allow the students a few minutes to read the information card. Break the students into groups of 3-4 and ask them to take a close up view of the mangrove and pickleweed. Ask the students to think/view the following:

Mangroves

Observe the prop roots. Locate a lenticel on the prop roots. Note if the leaves are soft and leafy or waxy? Observe the seeds – can you find a seed in its early stage? Partially mature? Reached the propugule stage? Does an immature seed float as well as a propugule? How many different types of invertebrates (crabs, shrimp, starfish) can you find among the mangrove roots?

Pickleweed

Observe the small, succulent leaves that reduce water loss; the silvery “hairs” that reflects the sun’s rays to reduce heat and water loss; the rosette pattern of the leaves that helps the plant stay cool by minimizing leaf surfaces exposed to the sun. Pickleweed have the ability to filter out the salt and moves it to the tips of the leaves. Leaves with heavy concentrations of salt turn red and drop off. Can you observe red leaves? Observe the shallow roots spreading root systems that help to anchor the plant on shifting sands.

D) Revegetation

The long-range goal for Mokauea Island is to replant it with native plants, one section at at time. Mokauea is overgrown with red mangrove, pickleweed, and long thorn kiawe. Efforts to accomplish this have included:

- Massive clean-up of trash and removal of mangrove and kiawe trees. Mangrove and kiawe are fast-spreading invasive plants.
The kiawe has thorns which can grow up to three inches in length. We are attempting to eradicate the mangrove from the fishpond and contain it to the south end of the island. Their removal from the island continues to be a significant challenge for the project.

- An experimental test plot was established and has been maintained by students at Farrington High School. This has been an important first step to learn what plants would be most suitable on the island. The students have brought native plants from their school nursery and are responsible for caring for their plots and monitoring progress.

- Pickleweed is being removed in sections and replaced with native plants.

This effort has not been without setbacks. Volunteers have had to learn which plants survive the best, how best to install the driplines, and how to protect the driplines from tearing (note: the number one cause is people stepping on the fragile black plastic lines).

If your visit to Mokaua Island includes service work for revegetation, please follow safety precautions: wear gloves (there is broken glass and kiawe thorns), drink water, and have sun protection.
Adaptations of Coastal Plants

Use the laminated plant identification cards to identify and then select 3 coastal plants (native or non-native). Check off those traits/characteristics that are common adaptations of coastal plants. Note: It is unlikely that one plant will exhibit all of the traits/characteristics.

<table>
<thead>
<tr>
<th>Trait/Characteristic</th>
<th>Name of Plant #1:</th>
<th>Name of Plant #2:</th>
<th>Name of Plant #3:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silvery leaf hairs and shiny leaf surface</td>
<td></td>
<td></td>
<td><strong>Pickleweed</strong></td>
</tr>
<tr>
<td>Rosette (circular) arrangements of leaves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Succulent leaves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small leaves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thick waxy surfaces (leaf or root)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growing low to the ground</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waxy seeds that float</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shallow, spreading roots</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Examples of Cordage Made and Used by Hawaiians

Drum Beater for Knee Drum. Made from *niu* (coconut) fiber. Bishop Museum, Ethnobotany

Fine cordage made from *olona* for fishing. Bishop Museum, Ethnobotany

Cordage made from *olona* and coconut for a hula pahu. Bishop Museum, Ethnobotany.
2-ply Cordage made from `Ahu `awa for house lashings.

Bishop Museum Ethnobotany

Lashings made from the grass *uki `uki* were used for constructing the roofs of homes. www.botany.hawaii.edu

Fishing hook made from bone and cordage. Bishop Museum.
Non-Native Invasive Plants

**Mangroves** – from the family of plants, *Rhizophoraeae*. Found in muddy tidal areas, estuaries, and coastline where sediments collect. Found in tropical areas around the world (Africa, U.S., Central America & Carribbean, South America, Asia). There are over 54 species of mangroves; the most common one is Hawaii is the introduced Red Mangrove.

Mangroves thrive with “its feet in salt water” and has many adaptations that help it to survive, thrive and reproduce in the coastal waters.

**Roots with pores** - Red mangroves have stilt roots that props the plant above water level. Because the muddy tidal waters are low in oxygen, the mangrove root has pores in their bark, called lenticels that allows for the absorption of oxygen and other gases directly from the atmosphere. Mangroves store gases directly inside the roots, processing them even when the roots are submerged during high tide.

**Limiting salt intake** - The root significantly impermeable and have an ultra-filtration mechanism to exude the sodium salts. Salt which does accumulate in the shoot concentrates in old leaves which the plant then sheds.

**Limiting Water Loss** – Mangroves can limit the amount of water they lose through their leaves. They can restrict the opening of their stomata and vary the orientation of their leaves to avoid the harsh midday sun.

**Increasing survival of offspring** – Mangrove sees are buoyant and therefore suited for water dispersal. Unlike most plants, whose seeds germinate in soil, many mangroves are *viviparious*. The seeds germinate while still attached to the parent tree. Once germinated, the seedling grows either within the fruit to forma propugule (a ready to go seedling) which can produce its own food via photosynthesis. The mature propugule then drops into the water which can transport it...
great distances. Propugules can survive dessication and remain dormant for over a year before arriving in a suitable environment and taking root.

The introduction of mangroves and subsequent efforts to remove them are controversial. Mangroves are invasive and can rapidly settle tidal areas; however, there are benefits as well. The mangroves roots can slow tidal waters and lead to sediment deposits that leads to a buildup of the tidal area and help to stabilize coastlines. It can provide habitat for algae, juvenile fishes, barnacles, crab, shrimp, sponges and has been referred to as “nursery grounds” for fisheries.

**Pickleweed** – from the family *Batis*. Also known as Turtleweed, Saltwort or Beachwort. It is found in coastal salt marshes. A native of tropical areas in the Americas and Australia. The plant gets its name from the facts that the fleshy stalks look vaguely pickle-like and that it tastes salty, like a pickle.

It is a halophytic (salt tolerant) plant. While other plants that are exposed to salty soil or water, tend to lose their stored water, pickleweed has adapted well to the salty environment:

a) Its leaves are small and swollen. Its fleshy leaves are covered with very fine hairs that reduce the amount of water the plant loses to the air.

b) When the roots of the pickleweed plant take up salt water, the plant’s cells filter out the salt. The cells move the salt to the tips of the leaves. As concentration of salt gets higher and higher, the leaves turn red. When the leaves cannot hold any more salt, usually during late fall, they begin to die, and eventually fall off. This process keeps the roots and stems of the plant salt-free, and allows the plant to grow new leaves during the next season.

Few animals eat the plant because it is too salty.

The plant is an evergreen low shrub - when it is starting out and colonizing new mud the plant is low to the ground, but once established it can grow bushy and up to 32 inches tall. It produces a small flower and its pepper-corn sized seeds can be a source of proteins and cancer-fighting antioxidants.

Pickleweed is becoming rare in some part of the U.S. and some scientist have suggested adding it to the endangered species list. In contrast, it was accidentally introduced to Hawaii and is regarded as an invasive plant.

[Source: Wikipedia]
**COASTAL PLANTS HA`AWINA**  
**Post-Field Trip Classroom Lesson:**

**Time required:** (15 min) This assignment can be asked of students either as individual homework and/or processed by a group discussion.

**Lesson Overview:** This post-field trip activity is designed to be get students to reflect on what they observed and/or learned about coastal plants.

**Suggested Procedures:** Teachers may opt to have students select (A) one of two writing topics to be worked on individually as homework or (B) to facilitate a classroom discussion.

A) Individual Writing Assignment

1. Report on the importance of one of the native coastal plants found on Mokaua Island. Your research should include how it was used by Hawaiians, unique botanical features, geographic areas where it can be found, a photo, and a *moolelo* (Hawaiian story/legend/chant). Be sure to cite your source(s).

2. Report on the a non-native coastal plant in Hawaii; i.e., Red Mangrove. Your research might include its origins, how it was introduced to Hawaii, unique features, geographic areas where it has spread to, and list the primary challenges and benefits of its presence in Hawaii. Be sure to cite your sources and use more than one source.

B) Class Discussion

1. Find your pre-visit list of characteristics and adaptations that you had expected to find among coastal plants. Compare your list to what was learned on the fieldtrip. What was similar/different? What surprised you?

2. [If the cordage activity was done] What things did you consider when making your cordage? If you were to try it again, what would you do differently? If your supply of the raw fiber was limited, what might you do to increase your supply?
The overall goal of the Kai Makana marine debris ha`awina is for students to (a) gain a general understanding of the marine debris problem and (b) understand and practice their personal responsibility to the issue of land-based marine debris.

Lessons:

- **Pre-Field Trip Classroom Lesson: “What Is Marine Debris?”**
  This short (about 15 minute) classroom activity is designed to be done along with other activities to prepare students for the activities they will do on their Mokauea Island field. In this classroom activity students will be introduced to what marine debris is, that it could come from land-based sources like household trash, and that perhaps a lot of marine debris might be plastic or other synthetics.

- **Field Trip Lesson: “Marine Debris Activity”**
  Students will participate in a marine debris sorting activity on Mokauea Island, using items from the Island.

- **Post-Field Trip Classroom Lesson: “Postcard to the Future”**
  This short activity is designed to be one of several activities to follow the field trip to Mokauea Island. It can be done in the classroom, or as a homework assignment. Each student will write a short “postcard” to his/her potential future grandchild, explaining about the MD problem, what he/she did about marine debris while on Mokauea, and what he/she has pledged to do in his/her own daily life to help solve the MD problem.

**Hawai`i Department of Education Standards & Benchmarks:** Kai Makana activities are targeted to the high school level. In the listing below, these high school science course abbreviations are used:
- **PS** = physical science
- **BS** = biological science
- **ES** = earth science
- **ENV** = environmental science
- **MS** = marine science
- **B** = botany

Kai Makana’s marine debris ha`awina can be used in the context of the following high school science and social studies standards & benchmarks:
Standard 1, all sciences: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills necessary to engage in the scientific process.
  SC.PS/B/BS/ES/ENV/MS.1.4 Determine the connection(s) among hypotheses, scientific evidence, and conclusions.
  SC.PS/BS/ES/ENV/MS.1.7 Revise, as needed, conclusions and explanations based on new evidence.

Standard 2, all sciences: NATURE OF SCIENCE: Understand that science, technology, and society are interrelated.
  SC.PS/B/BS/ES/ENV/MS.2.1 Explain how scientific achievements and emerging technology have influenced society.
  SC.ES.2.3 Explain the impact of humans on the Earth system.

Standard 3, MS: OCEANOGRAPHY: Understand the physical features of the ocean and its influences on weather and climate.
  SC.MS.3.7 Describe the relationship between fresh bodies of water, watersheds, and the ocean.

Standard 4, ENV: LIFE SCIENCE: Understand the interconnections of living systems.
  SC.ENV.4.3 Explain how ecosystems respond to human activities.

Standard 5, ENV: INTERDEPENDENCE OF THE ENVIRONMENT AND HUMAN SOCIETIES:
  SC.ENV.5.1 Explain how economic and societal decisions affect global and local ecosystems.
  SC.ENV.5.2 Assess the effect of human actions on an environmental system.
  SC.ENV.5.3 Explain how population growth and natural resource consumption affect global sustainability.
  SC.ENV.5.6 Explain why recycling and conservation of resources are important.

Standard 6, MS: INTERDEPENDENCE OF HUMANS AND THE OCEAN: Understand the interdependence of humans and the ocean.
  SC.MS.6.4 Explain how human activities and development lead to marine pollution (e.g. point sources, non-point sources).
  SC.MS.6.5 Describe how urbanization has impacted the ocean.

Social Studies Standard 5: PARTICIPATION AND CITIZENSHIP: Understand roles, rights (personal, economic, political), and responsibilities of American citizens and exercise them in civic action.
  SS.9PD.5.2 Investigate how citizens can monitor and advocate for a local, state, or national issue.
  SS.9PD.5.5 Demonstrate the role of a citizen in civic action by selecting a problem, gathering information, proposing a solution, creating an action plan, and showing evidence of implementation.
References:


“Hawaii Content and Performance Standards III Database” http://standardstoolkit.k12.hi.us/index.html (February 1, 2010.)


“Marine Debris” http://cmore.soest.hawaii.edu/education/teachers/science_kits/marine_debris_kit.htm (February 1, 2010.)

“Marine Debris 101” http://marinedebris.noaa.gov/marinedebris101/welcome.html (February 1, 2010.)


MARINE DEBRIS HA`AWINA
Pre-Field Trip Classroom Lesson:
“What is Marine Debris?”

**Time required:**
part of one class period; about 15 minutes

**Lesson Overview:**
This short activity is designed to be done in the classroom along with other activities to prepare students for the activities they will do on their Mokaua Island field. In this classroom activity students will be introduced to what marine debris is, that it could come from land-based sources like household trash, and that perhaps a lot of marine debris might be plastic or other synthetics.

**Teacher Background:**
Marine debris is a problem of the global ocean. The increase in human population, plus the increased generation/use of long-lasting, single-use, disposal items (e.g., plastics) have resulted in an increase in the amount of man-made trash in the ocean. This amount of trash impacts the natural environment in many ways. One way is to cause the deaths of diverse kinds of marine animals due to ingestion and entanglement; another example is to provide an increasing number of floating objects on which invasive marine species can be passively distributed on ocean currents. Part of the solution to this problem is to make all of us, including students, aware of our role in the problem. The first figure below is from UC-Berkeley, and the second is from the US Environmental Protection Agency; see the References section in the Marine Debris Ha`awina Overview for complete citations.

![Current Population Situation](image_url)

**Current Population Situation**

It took the human species:
300,000 years to reach first billion
130 years to add second billion
30 years to add third billion
15 years to add fourth billion
12 years to add the fifth and sixth billion
**Vocabulary:**

*ahupua`a* = from The Pocket Hawaiian Dictionary: the Hawaiian unit of “land division, usually extending from the uplands to the sea”

*hypothesis* = from the HI-DOE’s website: “a tentative answer to a research question, based on what is known by the researcher, and what has been observed”

*marine debris* = according to NOAA (the federal government agency, National Oceanic and Atmospheric Administration), marine debris is any “persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes.” (“Debris” is pronounced dah-bree.)

**Materials:**

*per student:*
- piece of family trash, as a homework requirement

*for the classroom as a whole:*
- a collection of items, representing typical land-based trash from a family
- boxes/bins for recycling of items after the lesson
- scrap paper to make signs for categories of trash content
Teacher Preparation:

1. Perhaps have a look at C-MORE’s 3-lesson marine debris curriculum kit, which is available free for up to a week loan. The kit comes with all equipment necessary to do the in-classroom lessons, and is aligned to HI-DOE benchmarks and standards. See the online citation in the References section in the Marine Debris Ha`awina Overview.

2. Give students a homework assignment to bring to class one piece of their family’s trash, but nothing smelly, too personal or dangerous! Tell them you don’t want them grabbing a piece of trash from a school trashcan at the last minute; no fair! The lesson will be more interesting if there’s a variety of trash.

3. To facilitate the lesson, the teacher should be prepared with a variety of typical family-type trash gleaned from various sources.

4. Make signs, using scrap 8.5” x 11” paper, to tape in different areas of the classroom: paper/cardboard, glass, plastic (including Styrofoam and synthetic fabrics like nylon or polyester), natural fabric (like wool or cotton), metal, wood, rubber, and “other.”

5. Write NOAA’s definition of marine debris on the chalk/whiteboard, or on a poster-sized piece of paper, at the front of the classroom.

6. Be prepared to model appropriate recycling behavior with the students’ homework trash. Perhaps the school has a recycling program you could take advantage of, or perhaps you could ask different students to volunteer and/or get extra credit if they follow an honor system to take a category of trash home for recycling.

Suggested Procedures:

1. As each student enters the classroom, check off his/her homework credit for having brought a piece of trash. If a student didn’t bring a piece of trash, he/she doesn’t get credit...but have them use a piece of trash that you’ve brought.

2. Point out the signs you’ve taped around the classroom. Ask students to stand in groups next to the sign that names what their trash is made from, or mostly made from.

3. Once students have grouped themselves, call on a few who would like to show the trash they brought, telling what the trash is.
4. Briefly discuss such questions as--
   - Which category has the greatest amount of trash?
     (Answers will vary; perhaps plastic will be the largest category.)
   - Which category might take the longest to rot?
     (suggested answer: It is thought that most plastics and synthetics will never rot; it is suspected that they will last forever. The reason for this suspicion is that these materials are not natural; they are man-made. Synthetics are expected to degrade, from solar ultraviolet and abrasion, into smaller and smaller pieces, eventually reaching the level of single molecules. At that point, there is no known chemical or bacterial system to decompose them into the basic building blocks of carbon dioxide, water and similar simple molecules. Actually, there are some plastics that decompose in the presence of oxygen, but these are not widely used in society. In comparison, estimates of decomposition time for some of the other long-lived trash would be--
       o glass, which is made from natural minerals like silicate, could take hundreds or even thousands of years to breakdown into sediment-sized pieces.
       o aluminium can -- 200 years
       o steel can -- 50 years
       o cigarette filter -- 80 years)
   - Raise this question with students -- If their family’s trash can/bin accidentally blew over in a storm, and all the trash came out, where would it end up?
     (suggested answer: As part of an ahupua`a, the trash would mostly likely wash into a stream system and eventually enter the ocean.)
   - What is marine debris?
     (suggested answer: Most students will have seen the NOAA definition of marine debris that you’ve posted at the front of the classroom, and they may point to that. Good! If needed, help them correctly pronounce debris, originally a French word. And it’s fine to simplify the definition to something like “man-made trash/rubbish in the ocean.” If there’s time, ask students to share any experiences they’ve had with marine debris in Hawai`i or elsewhere.)

5. Tell students that during their time on Mokauea Island, they will participate in a marine debris activity. In preparation for the field trip, ask them to form hypotheses for these questions:
   - What kinds of marine debris are found on the island?
   - What is the island’s most common category of marine debris?
- Does most of the island’s marine debris come from ocean-based sources, like fishing, or from land-based sources, like people’s household trash?
Current Population Situation

It took the human species:
300,000 years to reach first billion
130 years to add second billion
30 years to add third billion
15 years to add fourth billion
12 years to add the fifth and sixth billion
Plastics generation and recovery, 1960 to 2006
MARINE DEBRIS HA`AWINA
Field Trip Lesson:
“Mokauea Island -- Marine Debris Activity”

**Time required:**
~20 minutes, or ~1/3 of the time that the visitors have on Mokauea Island

**Lesson Overview:**
Students will participate in a marine debris sorting activity on Mokuea Island, using items from the Island.

**Teacher Background:**
none, beyond what is provided in the Marine Debris Strand Pre-Field Trip Classroom Lesson: “What is Marine Debris?”

**Materials:**
*per student or pair of students:*
- “Mokauea Island Marine Debris Tally” paper on a clipboard, with a pencil tied to the clipboard
- reusable, perhaps cloth, shopping bag (from a store like Safeway or Long’s)
- for Option B (see below): marine debris previously collected from Mokuea Island; divided equally among the reusable shopping bags

*for the group as a whole:*
- poster(s) showing impact of marine debris on marine life, big (e.g., Hawaiian monk seals) and small (e.g., plankton)
- for option A (see below): 1 large trash bag (to collect all the marine debris picked up from the beach)
- a jar of microplastic mixed in with white sand
- ~1 cup of water

**On-island Kai Makana Preparation:**
1. Prepare enough clipboards, papers, pencils and collecting bags.
2. Get out the poster(s) showing marine debris impacts.
3. Get ~1 cup of water

**Suggested Procedures:**
1. Ask students about the activity they did on marine debris in their classroom before today’s field trip:
   - What is marine debris?
   - Ask if anyone knows what’s wrong with MD; does it hurt anything; is it bad, and if so: how? Show the poster(s) showing marine debris impacts.
• As a few students what their hypotheses/predictions are for these 3 questions--
  o What kinds of marine debris are found on the island?
  o What is the island’s most common category of marine debris?
  o Does most of the island’s marine debris come from ocean-based sources, like fishing, or from land-based sources, like people’s trash?

2. Point out that Mokauea Island probably catches trash washed by rivers down from the land and into the ocean, as well as trash washed in from elsewhere by ocean currents. By catching the MD, the Island is showing us that there's a problem with the way we’re currently managing our environment, both as people living on the land and as fisherpersons out on the ocean.

3. Tell the students that they are now going to participate in an activity to find out what marine debris Mokauea has come ashore.

• **Marine Debris Activity, Option A** -- The preferred activity is for students to “mālama Mokauea” by actually participating in an on-island beach cleanup.
  o For Option A, organize the students into pairs. Give each pair a clipboard assembly and ask each of them to write his/her name on the paper. Since they are working together, they will enter the data twice, once in each data table. Later, back in the classroom, the paper will be torn in half so there will be a data table for each of them to use individually for a post-field trip activity.
  o Go over the “Mokauea Island Marine Debris Tally” with the students, pointing out that the categories are the same categories that they used in the classroom to sort their items of family trash.
  o Give each pair of students their collecting bag, pointing out that these bags are reused with each field trip.
  o Tell the students to follow you, and take them to the beach where they will conduct the cleanup.
  o Tell students they have _____ minutes to collect & tally marine debris.
  o When time is up, have students follow you back to where they started.
  o Ask them what seem to be the answers to the 3 questions that they started with--
    i. What kinds of marine debris are found on the island?
    ii. What is the island’s most common category of marine debris?
    iii. Does most of the island’s marine debris come from ocean-based sources, like fishing, or from land-based sources, like people’s trash?
  o Ask the students to--
    i. give you their tally paper,
ii. stack their clipboards in a designated place, and
iii. dump their trash into the large trash bag, which will be taken off the island with the island’s regular household-generated trash (...or could the school group volunteer to carry it back in the canoe and school bus to their school?...or perhaps keep it and add it to the collection of marine debris that is used in option B, see below?)
   o Thank the students for their service to the island!...and send them onto the next activity in their field trip to Mokaua Island.

- **Marine Debris Activity, Option B** -- It may not be possible for an actual beach cleanup to be a really effective lesson for at least 2 reasons: (a) perhaps (good news!) there isn’t any marine debris washed up on the island’s beaches on the day of the field trip, or (b) there’s not enough of it to make for an effective activity for each of several groups of students, as they rotate among the field trip activities. In either case, the students will sort marine debris previously collected on Mokaua.
   o For option B, as with option A, hand out the clipboards and go over the “Mokaua Island Marine Debris Tally.”
   o Point to the reusable grocery bags. Tell the students that each one holds an assortment of marine debris actually collected on Mokaua Island.
   o Tell them that each partnership will be given one of these bags to sort. Perhaps suggest to them that when they get their bag, they should take out all the marine debris -- perhaps putting it on a table in the shelter or just on the ground. They should tally each item on their clipboard data paper, and then return the marine debris to their grocery bag.
   o Tell the students they have _____ minutes to sort the debris; ready, set, go...but do a careful job!
   o When time is up, ask them what seem to be the answers to the 3 questions that they started with--
     i. What kinds of marine debris are found on the island?
     ii. What is the island’s most common category of marine debris?
     iii. Does most of the island’s marine debris come from ocean-based sources, like fishing, or from land-based sources, like people’s trash?
   o Ask the students to--
     i. give you their tally paper,
     ii. stack the clipboards in a designated place, and
     iii. return the bags with the marine debris in them to another designated place.
As with option A, thank them for their participation in understanding the marine debris problem!...and send them onto the next activity in their field trip to Mokauea Island.

4. After marine debris sorting option A or B, if there’s time, show the students a jar containing a mixture of sand and microplastic. Add water to it, shake it up, and point out the microplastic, most of which should be floating, while the sand sinks to the bottom of the jar. Marine debris is an environmental problem, both on a mega- and micro-scale!

5. After all groups have cycled through the marine debris activity, and are ready to travel by canoe back to Sand Island, give all the tally sheets to the teacher; he/she will use them for the post-field trip activity in the classroom. And perhaps the group will be taking the marine debris with them to dispose of it properly!
MARINE DEBRIS HA‘AWINA
Post-Field Trip Classroom Lesson:
“Postcard to the Future”

**Time required:**
part of one class period; about 15 minutes

**Lesson Overview:**
This short activity is designed to be one of several activities to follow the field trip to Mokauae Island. It can be done in the classroom, or as a homework assignment. Each student will write a short “postcard” to his/her potential future grandchild, explaining about the MD problem, what he/she did about marine debris while on Mokauae, and what he/she has pledged to do in his/her own daily life to help solve the MD problem.

**Teacher Background:**
(see pre-field lesson)

**Vocabulary:**
(see pre-field lesson)

**Materials:**
* per student:
  - double-sided “Postcard from Mokauae”
  - each student’s copy of “Mokauae Island Marine Debris Tally” that they completed on Mokauae Island

* for the classroom as a whole:
  - No special supplies needed.

**Teacher Preparation:**
1. Xerox back-to-back copies of “Postcard from Mokauae” to provide enough for one per student, plus extras for mistakes.
2. Cut each full-page “Mokauae Island Marine Debris Tally” from the field trip in half.
3. Write these 3 questions on the board at the front of the classroom:
   - What kinds of marine debris are found on the island?
   - What is the island’s most common category of marine debris?
   - Does most of the island’s marine debris come from ocean-based sources, like fishing, or from land-based sources, like people’s trash
**Suggested Procedures:**

1. Remind the students of their marine debris activity on Mokaua Island; perhaps recall any high points that occurred.

2. Pass out each student’s copy of “Mokaua Island Marine Debris Tally."

3. Remind students of the sorting activity they did with family trash in the classroom. Point to the 3 questions that they hypothesized about before the field trip, which are written on the front board. Ask the students to examine their data to see if their hypotheses were correct for each question. Perhaps ask a few students to share what their data was like.

4. Also remind students of the pictures they saw during the marine debris activity that showed them how marine debris can be an environmental problem.

5. Tell students that they performed a service on their Mokaua field trip, either by (Option A) participating in a beach cleanup and/or (Option B) by learning about the actual problem from pre-collected Island marine debris. It’s now time for them to be a part of the solution, and they’re going to do it in an unusual way: each of them is going to write a “postcard” to the future!

6. You will give each of them a make-believe postcard from Mokaua Island. They must each “invent” a make-believe grandchild, boy or girl, of theirs that exists in the future. Write that child’s name and fictitious address on the proper place in the postcard. Then, write a brief message to that child, saying how your marine debris experience on Mokaua helped the environment, and what step you’ve decided to take in your personal life to help solve the marine debris problem...so that it won’t be a problem for this future grandchild’s environment.

7. Collect the postcards, perhaps display them for awhile on a class bulletin board, perhaps grade them. Ultimately, return the cards to the students and suggest they put them somewhere at home to remind them to mālama their environment!
Post Card to the Future!

Mokaua Island

place stamp here