# TABLE OF CONTENTS

## GRADE 7 – CORAL REefs UNIT

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgements</td>
<td>i</td>
</tr>
<tr>
<td>Introduction</td>
<td>v</td>
</tr>
<tr>
<td>Unit Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Unit Map</td>
<td>7</td>
</tr>
<tr>
<td>Culminating Activity Rubrics</td>
<td>12</td>
</tr>
<tr>
<td>Learning Log – Student Assessment Overview</td>
<td>15</td>
</tr>
<tr>
<td>Lesson 1: Fishing Links</td>
<td>19</td>
</tr>
<tr>
<td>Student Sheets</td>
<td>30</td>
</tr>
<tr>
<td>Lesson 2: Passing on the Energy</td>
<td>37</td>
</tr>
<tr>
<td>Student Sheets</td>
<td>44</td>
</tr>
<tr>
<td>Lesson 3: Are We Related?</td>
<td>49</td>
</tr>
<tr>
<td>Student Sheets</td>
<td>63</td>
</tr>
<tr>
<td>Lesson 4: Looking to the Kūpuna (Elders)</td>
<td>65</td>
</tr>
<tr>
<td>Student Sheets</td>
<td>76</td>
</tr>
<tr>
<td>Lesson 5: Investigating Kahaluʻu Bay – Part 1</td>
<td>87</td>
</tr>
<tr>
<td>Student Sheets</td>
<td>95</td>
</tr>
<tr>
<td>Lesson 6: Investigating Kahaluʻu Bay – Part 2</td>
<td>115</td>
</tr>
<tr>
<td>Student Sheets</td>
<td>123</td>
</tr>
</tbody>
</table>

## APPENDICES

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oli (Chants)</td>
<td>A-1</td>
</tr>
<tr>
<td>Field Sites</td>
<td>A-15</td>
</tr>
<tr>
<td>Unit Resources</td>
<td>A-19</td>
</tr>
</tbody>
</table>

## ITEMS IN BINDER POCKETS

- Coral Reef Cards
- Pre- Post-Test and Answer Sheet
ACKNOWLEDGEMENTS

*Project Aloha ‘Āina* would not have been possible without the help of many people and agencies that offered expertise and kōkua. The project team extends a sincere mahalo nui loa to those who are working to share their knowledge and restore field sites that are such an integral part of the project to “Uncle” Fred Takebayashi and Willis Motooka, who are working tirelessly to *mālama* Waikalua Loko; to Dr. Charles P.M. “Doc” Burrows of ‘Ahahui Mālama I Ka Lökahi, for his dedication to preserving Kawai Nui Marsh; to Arleone Dibben-Young for her extensive work to *mālama* the wetlands of Moloka‘i; to Uncle Pilipo Solatorio for sharing the traditions of his kūpuna in Hālawa, Moloka‘i; to Lei Ishikawa for her work to restore lo‘i in Waihe‘e, Maui; to Denby Freeland-Cole for her work to bring Kapoho Village on Maui to life for students; to Glynnis Nakai for her efforts to care for Maui wetlands; to Stacy Sproat at Waipā Foundation for perpetuating Hawaiian culture and lifestyle through *ma ka hana ka 'ike* (by doing one learns); to Keoni Turalde & Prana Mandoe of He Ola Hou ke Kumui Niu for welcoming us into the Lihikai Cultural Learning Center on Hawai‘i Island; to Uncle Henry Leong for his wealth of *mahi ‘ai* (farming) knowledge and commitment to the preservation of *kalo* diversity; and to John Kahiaopo at the Department of Land, and Natural Resources Division on Hawai‘i Island who has supported us in both the wetlands and stream life units.

The team also wishes to thank Dr. Lea Albert, Windward District Superintendent of the Hawai‘i State Department of Education (DOE), for her encouragement and support; Colleen Murakami, DOE Environmental Education Specialist, for her oversight and assistance with the project assessment; Keoni Inciong and Gwen Takeguchi of DOE Hawaiian Studies, for their support and all of the dedicated teachers, consultants, and resource people who contributed their mana‘o and continue to work toward the vision of *Project Aloha ‘Āina*.

**FIELD TEST TEACHERS**

**Grades 3 through 6**
- Diane Abraham
- Marcia Clinton
- Kalei Cosma
- Dionne DeCosta
- Rose Enos
- Diane Hirata
- Heidi Jenkins
- Kahea Kaohelaulii ‘i Farias
- Adeline Keama
- Mary Kalilikane
- Audrey Kido
- Norbert Larsen
- Malia Mataele

**Grades 7 through 10**
- Franklin Allaire
- Pauahi Bogac
- Tina Chan
- Malcolm Cogbill
- Melody Cosma
- Sheila Cyboron
- Dwight Doane
- Maile Domingo
- Jody Hisaka
- Kaui Kanakaole
- Kristina Lee
- Elaine Mahoney
- Mimi Verhoeven
- Ulu Victor
- Sandra Webb
PARTICIPATING SCHOOLS
Academy of the Pacific
Ali‘iolani Elementary School
James B. Castle High School
Hālau Lōkahi Charter School
Hāna High School
Kapolei High School
Kapunahala Elementary School
Kaunakakai Elementary School
Ke Kula ‘o Samuel M. Kamakau Charter School
Kilohana Elementary School
King Intermediate School
Kualapu‘u Elementary School
Kula Kāiapuni ‘o Ānuenue
Maunawili Elementary School
Māilikini High School
Moanalua Middle School
Pālolo Elementary School
Pū‘ōhala Elementary School
St. Anthony School
Stevenson Middle School

HAWAI‘I STATE DEPARTMENT OF EDUCATION CONSULTANTS
Sheila Cyboron
Dwight Doane
Tracy Doane
Naidah Gamurot
Audrey Kido
Kristina Lee
Kawehi Lucas
Amanda Miyamoto
Colleen Murakami
Phyllis Nakasuji
Edna Narimatsu
Elizabeth Shigeta
Donna Therrien
Gwen Takeguchi
Ululani Victor

FIELD SITE ASSISTANCE: REVIEWERS, INSTRUCTORS, AND SITE HOSTS
Dr. Adam Asquith: University of Hawai‘i at Mānoa Sea Grant College Program
‘Ao‘ao O Nā Loko I‘a O Maui
Samantha Birch, Caroline Neary, and Cindi Punihaole: The Kohala Center
Dr. Charles P.M. “Doc” Burrows, Ron Walker, Dr. Steve Montgomery, Kaimi Scudder, and Malia Helelā: ‘Ahahui Mālama I Ka Lōkahi
Dr. David R. Bybee: Brigham Young University-Hawai‘i
Shayna Carney, Hanalei National Wildlife Refuge
Denby Freeland-Cole, Maui Coastal Land Trust
Andy Collins, Matt Limtiaco, and Ann Bell: Papahānaumokuākea Marine National Monument
Chris Cramer: Maunalua Fishpond Heritage Center
Tom Cummings and Leon Geschwind: Bishop Museum
Conservation Council for Hawai‘i
Arleone Dibben-Young: Ahupua‘a Natives
Adrianne Dillard and Theone Kanuha: Kula no na Po‘e Hawai‘i
Kawika Duvachelle: Hoolehua Plant Materials Center
Ati Jeffers-Fabro: Hawai‘i Department of Land and Natural Resources, Division of Aquatic Resources
Jay Franey: Hawai‘i Nature Center, Maui
Eric B. Guinther: Biological Services, AECOS, Inc.
Mark Heckman, Carlie S. Wiener, and Malia Rivera: Hawai‘i Institute of Marine Biology
Greg Hong: Owner Bayview Golf Park and Dan Motohiro: Staff.
Lei Ishikawa, Paeloko
Jon Jokiel: Kaloko Honokōhau National Historical Park, Kona, Hawai‘i
Donnalyn Kalei and Donna Kaneko: Hawai‘i Community College for hosting our Teacher Training Workshop on Hawai‘i Island
Linda Koch: Hawai‘i State Department of Health
Kim Langley and Signe Opheim: Coordinating Group on Alien Pest Species
Tweetie and John Lind: Kapahu Farm, Hāna, Hawai‘i
Rene Mansho, Schnitzer Steel Corp.
Dr. Darlene E. Martin: Keauhou-Kahalu‘u Education Group, Kamehameha Schools
Dr. Floyd W. McCoy: Associate Professor of Geology and Oceanography, Windward Community College
Kathleen McGovern-Hopkins: University of Hawai‘i at Mānoa Sea Grant College Program
Carole McLean: Friends of He‘eia State Park
Naomi McIntosh and Patty Miller: Hawaiian Islands Humpback Whale National Marine Sanctuary
Willis Motooka: Retired Castle High School Teacher
Glynnis Nakai: Refuge Manager, Keālia Pond National Wildlife Refug
Luana Neff for sharing the gift of her voice in oli with us
Joe O‘Reilly, Malia Rivera and Jennifer I. Barrett: Hawai‘i Institute of Marine Biology Community Education and Outreach Program
Hōktulani Holt-Padilla, Hawaiian Cultural Advisor
Mahina Paishon Duarte and Lee Ann Ānuenue Punua: Paepae o He‘eia-Friends of He‘eia Fishpond
Kala Ocampo: Naiwa Landfill & Recycle Molokai Center
Papakōlea Community Association
John Reppun and Kaipo Faris: Kualoa-He‘eia Ecumenical Youth (KEY) Project
John Souza: Waste Reclamation Center
Stacy Sproat, Mala Fu, Lea Weldon and Ryan Like: Waipā Foundation
Mark Paikuli-Stride: Aloha ‘Āina Health Center
Rebekah Sluss: County of Hawai‘i Dept. of Environmental Management, Recycling Section
Annette W. Tagawa and Mike Yamamoto: Department of Land and Natural Resources, Division of Aquatic Resources
Fred Takebayashi, Willis Motooka, Kathy McGovern-Hopkins, and Dick Chapman: Waikalua Loko Fishpond Preservation Society
Rick Tamanaha: Tamahaha Organic Papaya Farm
Dr. Clyde S. Tamaru: University of Hawai‘i at Mānoa Sea Grant College Program
Amy Tsuneyoshi, Arthur Aiu and Diane Moses: Honolulu Board of Water Supply
Lea Weldon, Kari Shozuya, Ryan Kaipo Like: Waipā Foundation
Noe Yamashita: Ali‘i Fishpond

HAWAIIAN TRANSLATORS
Jessica Kāhealani Lono
Ululani Makue
Ānuenue Grades K-6 Teachers

CURRICULUM ASSESSMENT
Sara Moshman, MetaLogic, Inc., Lincoln, Nebraska
Colleen Murakami, Hawai‘i DOE Environmental Education Specialist

ASSISTANCE WITH WORKSHOP SITES
Janice Espiritu, Kaunakakai, Moloka‘i
Geraldine and Kuki Ka‘iwi, Hāna, Maui
Dr. Darlene Martin, Kona, Hawai‘i
Penny Martin, Moloka‘i
Patty Miller, Maui
Charles Nā‘umu, Kula Kaiapuni ʻo Ānuenue
Stacy Sproat, Waipā Foundation, Kaua‘i
Dr. Clyde S. Tamaru, O‘ahu
Lehua Mark Vincent, Principal, Keaukaha Elementary School, Hilo, Hawai‘i

PHOTOGRAPHS
Kapono Ciotti
Hawai‘i C’s Aquaculture
Ka‘ōhua Lucas, Pacific American Foundation
Randy Magnus
John P. Hoover, Marine Life Author and Photographer
Joylynn Paman, Pacific American Foundation
Bo Pardau
Doug Sell

iv Project Aloha ‘Āina © 2010 Pacific American Foundation and The Kohala Center
Dr. Allison Sherwood, Assistant Professor of Botany, University of Hawai‘i at Mānoa
Dr. Jennifer E. Smith, National Center for Ecological Analysis and Synthesis, University of California at Santa Barbara
Russell Sparks, Department of Land and Natural Resources – Division of Aquatic Resources
Forest and Kim Starr, U.S. Geological Survey
Keoki Stender
Annette Tagawa and Mike Yamamoto, Department of Land and Natural Resources – Division of Aquatic Resources
Eric VanderWerf, Pacific Rim Conservation
Andrew Walsh
**PROJECT ALOHA ‘ĀINA**

If you plan for a year, plant *kalo*
If you plan for ten years, plant *koa*
If you plan for one hundred years, teach the children.

- Puanani Burgess

---

**A CULTURAL FOUNDATION**

The words aloha (love, respect, honor) and ‘āina (land, lit., “that which nourishes”) are the heart and soul of Hawaiian culture. Memories of family *pā‘ina* (parties), backyard jam sessions late into the night, spending time with grandma and grandpa and sunny days working in a *lo‘i*, mud squishing between your toes—these are just some of the things that might come to mind. Imagine the power of two simple words to say so much. But what do they mean?

**The Spirit of Aloha ‘Āina**

*Lōkahi*: Relationship

Aloha ‘āina brings an understanding and perspective that shapes everything we do. Its spirit and essence begin with *lōkahi* or the sense of being connected to all things. Kupuna Malia Craver spoke of aloha as a ‘triangle’ of relationships between us as individuals and the creator/s and our ancestors (*ke akua, nā akua, nā kūpuna*), humanity (as caretakers), and creation (*‘āina, kai, lani*).

This mutuality between all things exists on many levels: spiritual, social, and the scientific.

**Ho‘oma‘ama‘a: Practice**

The spirit and essence of aloha ‘āina invites each of us into the practice of love and respect within the “lōkahi-triangle.” This idea can be seen in the Hawaiian word *ho‘oma‘ama‘a*. It means to grow in familiarity with a person, place or idea. This practice must be holistic affecting every corner of the triangle. To look at the *‘āina* as just a science project without growing in its spiritual dimension is like needing glasses for reading but choosing not to wear them! At the same time, the benefits of the *‘āina* are for those who come with the proper mindset from kindergartener to *kupuna*!

How can we grow in our understanding of *aloha ‘āina, lōkahi* and *ho‘oma‘ama‘a*? How would it shape our lives in ways that are meaningful? What source/sources might help us discover and understand these foundational elements? Words like *ike*, (knowledge) and *a‘o*, (to teach or learn) are good
labels, but what are the sources of our learning?

**Na Kumupa‘a: The Sources**

**Puke: Written Things**
Sources that help in understanding the concept and practice of *aloha ‘āina* are books and curricula like the one you’re holding. The standard works, both Hawaiian and western, play an important part. They also represent the partnering of two cultures. Yet these materials, though they enhance, cannot take the place of *ke‘ala kahiko*, the ancient way.

**‘Ohana and Mo‘olelo: Family Knowledge**
It is hard to separate the two sources ‘*Ohana/Mo‘olelo* and *Wahi Pana* since neither can exist without the other when we speak of our ancient Hawaiian culture. ‘*ike* and ‘*a‘o* grow from the context of ‘*ohana* (family). For generations, from time immemorial, the relationship between the people and the sky, the land and sea has been remembered and passed down within families. The meaning of the word *mo‘olelo* (foundational story) comes from the word *mo‘o*; often a reference to a person’s family lineage or genealogy.

Knowledge of fishing patterns connected to the moon’s (Hina) cycle, the planting of crops linked to the movement of the sun (la)—families perpetuated these understandings. Many still do. At the same time, ‘*ike* and ‘*a‘o*, though they agree on major points of culture, can vary from family to family and region to region. O‘ahu, Kaua‘i and Ni‘ihau were unique from the southern islands in many ways. We must keep this in mind when we speak of ‘Hawaiian culture’. Like this curricula, Hawai‘i always embraced different, and often, innovative ways. This too is a reflection of *aloha ‘āina*.

**Wahi Pana: Sacred Land**
We must keep our eyes on the land! As the most isolated *pae ‘āina* or archipelago on planet Earth, Hawai‘i stands out in many ways. The world comes here! Most would agree that its people, its style; even its smells are beyond compare. “Land of Aloha!” We also use the words *wahi pana* to remind ourselves that the land is not just a resource; it is sacred, it is family. This too is foundational to understanding and experiencing *aloha ‘āina*.

‘*Āina – that which nourishes – encompasses land, ocean, heavens, land-based water systems, plants and animals. *Al*oha ‘*āina* is a way of life that is evident in Hawaiian practices such as:

- Treating land as a family member
- Showing reverence and respect for all life forms and asking permission to take from the environment
- Taking from the ‘*āina* only what is needed, and using what is taken
- Living with nature’s cycles by refraining from harvesting during spawning cycles of
marine life, and planting, fishing or harvesting by phases of the moon
• Practicing protocol such as oli (chant) when visiting sites

Shaping the future while preserving a heritage, Project Aloha ‘Āina is working to provide Hawai‘i’s youth with culturally relevant curricula to inspire them to embrace aloha ‘āina as a way of life. This educational project fosters foundational learning experiences that reflect Native Hawaiian culture and core values. A major goal of the project is to inspire Hawai‘i’s youth to excel in science, math, social studies and language arts standards and to care for resources within their ahupua‘a (land division).

The lessons provided in each unit encourage students to explore their individual relationship to the ‘āina and ways that they can care for the place where they live. This multidisciplinary journey will take them through readings, reflections in writing, interviews with kāpuna (elders), creative collaborative projects, problem-solving in math and science, and investigations in their ahupua‘a. Getting to know the place where they live and giving back to that place in a meaningful way through community service, are essential elements for students participating in Project Aloha ‘Āina.

PROJECT OVERVIEW

All of the lessons are designed to help students meet selected Hawai‘i Content and Performance Standards developed by the Department of Education, as well as Na Honua Mauli Ola, Hawai‘i Guidelines for Culturally Healthy and Responsive Learning Environments, developed by the Native Hawaiian Education Council in partnership with Ka Haka ‘Ula O Ke‘elikōlani College of Hawaiian Language, University of Hawai‘i at Hilo. Hawai‘i DOE General Learner Outcomes (GLOs) are also addressed in students’ culminating projects.
PROJECT-BASED LEARNING

The units in this teacher’s guide are designed thematically and support integrated project-based learning that is anchored in the core curriculum. The units immerse students in scientific inquiry and into related social studies explorations. Math and language arts skills are incorporated as a means for students to interpret and express their findings.

To begin their Aloha ‘Āina journey, students are provided with a “map” to guide their way in the form of a Student Assessment Overview. This document, which is provided in each Unit Introduction, lays out the individual and culminating group projects for students along with the standards that they will be striving to achieve. Students are given this document at the beginning of the unit so that they can chart their course and keep track of their progress as they journey through the lessons. Suggestions for students’ culminating projects are provided in the unit, however the form of those projects is left up to the creativity of the students.

ASSESSMENT

Each lesson includes formative assessments and summative assessments are provided at the end of the unit. The formative assessments are labeled as Learning Logs at the elementary and intermediate level and Journals at the high school level. Two summative assessment tools are provided with the unit: 1) the culminating project rubrics, and 2) a pre- and post-test, which is designed to guide instruction and assess each student’s gains. These tests were developed in cooperation with the Hawai‘i Department of Education as a means of helping students to reach standard benchmarks. The tests are now available for students to take online through the DOE Lotus Notes. For more information, see the test provided in the binder pocket.

PLACE-BASED LEARNING

To enable students to learn about the many aspects of their local environment, the Aloha ‘Āina team worked with teachers and administrators to map out a Grades 3 – 12 program of exploration that covers different environments and practices. The units, which were originally developed for the Kāne‘ohe ahupua‘a on windward O‘ahu have now been adapted for the following sites:

- Kaua‘i Gr. 3 – 7 (Waipā)
- O‘ahu Gr. 3 – 5 (Kalihi);
- Gr. 3 – 8 (Wai‘ane) and 3 – 6 (Waikiki)
- Moloka‘i Gr. 3 – 6
- Maui Gr. 3 – 7 (Kīhei and Waihe‘e) and Gr. 9 (Hāna)
- Hawai‘i Gr. 3 – 7 (Hilo) and Gr. 6 – 7 (Kona)

These adaptations include locally relevant readings, maps, and presentations. Additional units focusing on gardening for Grades 7 – 8 were also written in collaboration with the Waipā Foundation in Hanalei, Kaua‘i.
<table>
<thead>
<tr>
<th>Grade Level Topics</th>
<th>Essential Questions</th>
<th>Values Emphasized</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grade 3 Wetlands</strong></td>
<td>How do wetlands help our community and how can we kōkua (help) to care for wetlands?</td>
<td>Kōkua (Helping; assisting)</td>
</tr>
<tr>
<td><strong>Grade 4 Ahupua’a – Fishponds &amp; Lo’i</strong></td>
<td>How do Hawaiian practices nurture a healthy relationship to the ‘āina, and how can we give back to the ‘āina today?</td>
<td>Laulima (Cooperating) Mālama (Caring)</td>
</tr>
<tr>
<td><strong>Grade 5 Stream Life</strong></td>
<td>How do people affect stream life, and what can we do to bring lōkahi (balance) back to the stream community?</td>
<td>Lōkahi (Balance; harmony)</td>
</tr>
<tr>
<td><strong>Grade 6 Conservation</strong></td>
<td>How has technology changed the way we consume and dispose of products and what can we do to reduce waste and ho’ōla (to heal) our ahupua’a?</td>
<td>Ho’ōla (To heal) Kuleana (Responsibility)</td>
</tr>
<tr>
<td><strong>Grade 7 Coral Reefs</strong></td>
<td>How are human activities affecting coral reefs in and what can we do to hoʻihi (respect) the ocean and promote sustainability?</td>
<td>Hoʻihi (Respect)</td>
</tr>
<tr>
<td>Grades</td>
<td>Unit Title</td>
<td>Question</td>
</tr>
<tr>
<td>------------</td>
<td>------------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>7-8</td>
<td>Gardening</td>
<td>How do we grow healthy foods and mālama ʻāina (care for the land) so that the land will</td>
</tr>
<tr>
<td></td>
<td></td>
<td>continue to nurture us in the future?</td>
</tr>
<tr>
<td>7-8</td>
<td>Streams</td>
<td>What is the overall health of our kahawai (stream) in our ahupua’a, and what is our kuleana</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to mālama (care for) it?</td>
</tr>
<tr>
<td>Grade 8</td>
<td>Landforms</td>
<td>How did geologic forces shape our ahupua’a, and what do Hawaiian moʻolelo (stories) reveal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>about local landforms and the need to hōʻihi (respect) them?</td>
</tr>
<tr>
<td>9-12</td>
<td>Streams</td>
<td>What issues are affecting our streams and how can we improve water quality and care for these</td>
</tr>
<tr>
<td></td>
<td></td>
<td>resources?</td>
</tr>
<tr>
<td>9-12</td>
<td>Fishponds</td>
<td>How can we increase the productivity of Waikalua Loko and why should we take action to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mālama the pond?</td>
</tr>
<tr>
<td>9-12</td>
<td>Forests</td>
<td>Why are native Hawaiian forests home to so many native and endangered species and how can</td>
</tr>
<tr>
<td></td>
<td></td>
<td>we raise public awareness about the need to mālama (care for) forests?</td>
</tr>
</tbody>
</table>

*Project Aloha ʻĀina © 2010 Pacific American Foundation and The Kohala Center*
ORGANIZATION OF THIS TEACHER’S GUIDE

Each grade level unit contains the following elements:

UNIT INTRODUCTION – a general background on the topics presented and a description of the lessons. The Introduction includes the following components:

• Unit Map – an overview for the teacher of the standards, essential question, key concept and assessment for each lesson
• Rubrics – for assessing students’ performance on the culminating papers and projects
• Student Assessment Overview (also referred to as “Our Challenge” in Grade 3) – a “map” of the unit that provides students with expectations and a list of Learning Log sheets that they will complete as formative assessment. The document is referred to as a Journal for Grades 9-12. This overview includes a cover that students can use for their Learning Logs or Journals.

INSTRUCTIONAL ACTIVITIES – Each unit includes four to six lessons that are designed to be taught sequentially. The lessons include background information for teachers, Hawai‘i DOE benchmarks, and a list of materials needed and materials provided, which include pages that are to be duplicated for students such as:

• Student readings
• Maps
• Learning Log or Journal sheets
• Data sheets
• Activity cards

The teaching suggestions included in each lesson and the estimated time for completing the lesson have been refined based on a field test that was conducted with teachers during the course of the project. The teaching suggestions are designed to help students meet the standards, but they are, of course, only suggestions since there are many different and effective ways to approach the activities.

APPENDICES – The Appendices include the following documents to help prepare your students for field trips:

• Field Sites Appendix – Management tips, directions to sites, lists of what to bring on field trips
• Oli Appendix - Hawaiian and English versions of selected chants and mele
• Unit Resources – Additional readings or other materials to supplement the units
UNIT CDs

The CDs provided with this teacher’s guide contain files that are designed to supplement the unit. These CDs include the following files:

- **Oli** (Chants) – a folder with audio files of selected oli to introduce students to protocol. The Hawaiian and English versions of these chants are provided in written form in the Appendices.

- **PowerPoint Presentations** – Most of the units have one or two PowerPoint presentations that supplement the lessons and highlight key features of the environments students are investigating.

PROJECT WEB SITE

The project Web site link is at [www.thepaf.com](http://www.thepaf.com) home page. The Web page includes announcements and registration forms for workshops. Contact information for arranging some of the field trips is also located on this site.

**ALOHA ‘ĀINA VIDEO**

The project video, provided on DVD, is designed to introduce your students to the vision of Project Aloha ‘Āina. That vision is that everyone in Hawai‘i lives by the values of aloha ‘āina and that communities work together to achieve their vision of a healthy environment for all in harmony with the land and the sea. This 30-minute program portrays students discovering the gifts that the ‘āina provides in their ahupua‘a. It’s a journey of discovery that includes mo‘olelo, ‘oli, wonderful music, beautiful places and meaningful relationships between people and the place where they live. We welcome you to join us in the journey.
The vision of *Project Aloha 'Āina* is that everyone in Hawai'i lives by the values of *aloha 'āina* and that communities work together to achieve their vision of a healthy environment for all in harmony with the land and the sea.

After watching the *Aloha 'Āina* DVD, take a moment to reflect on your vision of *aloha 'āina*. Describe why you think *aloha 'āina* is important.

The 'Ōlelo No’eau that Liko and Kepa learn in the program is

\[
\begin{align*}
\text{He ali'i ka ‘āina;} \\
\text{He kauwā ke kanaka.} \\
\text{The land is chief.} \\
\text{People are its servant.}
\end{align*}
\]

*(Mary Kawena Pukui, ‘Ōlelo Noeau No. 531)*

What does this ‘Ōlelo No’eau mean to you?

Choose one of the values that were emphasized in the video.

- Lōkahi
- Kōkua
- Laulima
- Mālama

Write a paragraph giving an example of how you live by this value.
Aloha ‘Āina

Grade 7 – Coral Reefs

Kahalu‘u

‘Ike I ke au nui, me ke au iki.
Know the big currents and the little currents.
Is very well versed.
(Mary Kawena Pukui ‘Ōlelo No‘eau No. 1209)

Value emphasized in this unit: Hō‘ihi (Respect)
How are human activities affecting Kahalu‘u Bay and what can we do to hō‘ihi (respect) the bay and promote sustainability?
Coral Reefs

“Hanau ka ‘Uku-ko’ako’a, Hanau kana, he Ako’ako’a, puka”
[Born the coral polyp, Born of him a coral colony emerged]
- (Kumulipo, The Hawaiian Hymn of Creation, compiled by Rubellite Kawena Johnson, 1981)

He pūko’a kani ʻāina.
A coral reef that grows into an island.
A person beginning in a small way gains steadily until he becomes firmly established.
(Mary Kawena Pukui, ʻŌlelo Noʻeau No. 932)

Like a coral reef growing into an island, this unit investigation of Kahaluu Bay provides an opportunity for students to gain steadily in their knowledge until their respect for the special qualities of the bay and surrounding area becomes firmly established.

Kahaluu Bay is indeed a special place. Kahaluu and the two ahupua‘a in Keauhou encompass an area that is renowned for its wahi kapu and wahi pana (sacred and storied sites). The winds that blow through these ahupua‘a seem to carry the voices of the past—a past steeped in Hawaiian culture where ali‘i directed the building of numerous and impressive heiau (temples).

The porous lavas of the area gave birth to numerous freshwater springs where people collected water, and to brackish pools, some for commoners and others for chiefs, where people bathed after braving the high surf. Fishing traditions passed down through the generations reflect a simpler time when families shared their catch, and when people fed the manō (sharks) in the bay who would not bother swimmers. It was a time before people arrived in droves to enjoy the beauty of the sea and snorkel and frolic in the waves.

Recreation Impact
Approximately 400,000 people visit Kahaluu Beach Park each year. Visitors were trampling the coral, feeding the fish, and approaching endangered marine animals; all of which had a negative impact on the bay. Today that picture is changing with the ReefTeach program. ReefTeach is a partnership between the University of Hawai‘i Sea Grant College Program for West Hawai‘i and The Kohala Center. ReefTeach trains volunteers to teach visitors about proper reef etiquette. More than 350 volunteers have been trained over the course of the program to greet visitors and share information with them. The volunteers also monitor the water and have been able to document the effectiveness of their efforts.

During the course of this unit, students are conducting two investigations. One is a team research project on a topic of students’
choice that addresses human impact on Kahalu’u Bay. Some of the suggested topics are: overfishing, shoreline hardening, water quality, global warming, marine debris and tourism. Background information about these topics is included in Lesson 5 and in some of the student readings provided in the Unit Resources.

The other area of investigation is to solve the “Mystery of the Mostly Missing Sand.” This study will include some of the topics that are suggested for group research and will provide students with a focus in their field investigation of Kahalu’u.

**FISHERIES MANAGEMENT AREA**

Kahalu’u and Keahou make up one of the nine fisheries management areas (FMAs) in West Hawai’i. FMAs extend from the high tide water line on shore out to a depth of 600 feet. Within this area, fishing is allowed, but certain activities are prohibited and fishing is regulated. For example, commercial collecting for aquariums requires registration with the Hawai’i Department of Land and Natural Resources (DLNR) and adherence to guidelines. Similarly, lay nets must be registered with the DLNR and there are strict guidelines about size, identification and use of the nets. For details see the W. Hawai’i Regional FMAs document provided in the Unit Resources.

**GILL NETS**

“Lay gill nets are monofilament meshing that can be strung together for hundreds, even thousands of feet and indiscriminately kill huge numbers of fish and other marine life with no regard to species, age, or season. Lay gill nets destroy habitat. They damage coral and sea grass beds, destroy critical nursery, foraging, spawning, and refuge areas for fish and shellfish. At times, massive nets drift away with the current or are forgotten, entangling endangered monk seals, sea turtles, and a range of other marine life. Common practice is to leave nets unattended in nearshore waters for long hours and often overnight. Lay gill nets have severely damaged our coral reef
ecosystems and depleted (our) fish stocks” (KAHEA, 2006).

In March, 2007, Governor Linda Lingle signed lay gill net restrictions into law. The law:
--Eliminates all lay gill nets around the island of Maui and three much depleted areas on O’ahu, and restricts use of the nets statewide;
--Prohibits the setting of lay gill nets overnight;
--Limits their length to 125 feet and mesh size;
--Requires nets to be registered and marked;
--Requires that nets not be left unattended for more than 30 minutes (Fair Catch Hawai‘i).

**MARINE DEBRIS**

According to the National Oceanic and Atmospheric Administration (NOAA), Marine debris is typically defined as any man-made object discarded, disposed of, or abandoned that enters the coastal or marine environment. It may enter directly from a ship, or indirectly when washed out to sea via rivers, streams and storm drains.”

“Marine debris is a historical problem that is continuing to grow. Every year, marine debris injures and kills marine mammals, interferes with navigation safety, has adverse economic impacts to shipping and coastal industries, and poses a threat to human health. Our oceans and waterways are constantly polluted with a wide variety of marine debris ranging from soda cans and plastic bags to derelict fishing gear and abandoned vessels” (NOAA, 2007).

**WATER QUALITY**

When excess nutrients, such as nitrates and phosphates from human sewage and lawn or golf course fertilizers from surface and groundwater sources wash onto the reef, conditions are favorable for fleshy limu species to grow more rapidly. Excess nutrients may also cause phytoplankton blooms that, in turn, impact the turbidity (clarity) of the water and subsequent coral development. In their investigation during this unit, students will measure different indicators of water quality including turbidity, nitrates, and phosphates.

**ALOHA ’ĀINA**

Early Hawaiians recognized the direct connection between human activities on land and the health of the ocean environment. From the Hawaiian perspective, the guiding principle of aloha ʻāina leads to caring for resources and limiting harvesting from the land or sea to only what is needed for survival. The ocean is viewed as an integral part of the ʻāina, not as separate from land. And land is viewed as ”chief.”

**UNIT OVERVIEW**

The essential question addressed in this unit is: How are human activities affecting Kahaluʻu Bay and what can we do to hōʻihi (respect) the bay and promote sustainability? Students explore this question by building their knowledge about the bay’s reefs and the interdependence of coral reef organisms as well as the integral relationship between the land and sea. During the unit, students work in groups to
research one of the human impacts on the bay. Groups then present their research to the community to help spread the word about caring for the bay.

In the first lesson, **Fishing Links**, students explore relationships among coral reef organisms and Hawaiian ʻaumakua (family guardians). They also reflect on their own relationship to the marine environment.

After viewing a video clip of fish in the new Papahānaumokuākea Marine National Monument in the Northwestern Hawaiian Islands, students play a “Fishing Links” game using coral reef cards to make food chains.

In the second lesson, **Passing on the Energy**, students conduct a demonstration of the flow of energy in a coral reef food chain compared to a Hawaiian fishpond food chain. Students also watch video clips of longtime Kahaluʻu residents to learn about fishing practices in the past.

The third lesson, **Are We Related?** challenges teams of students to apply clues about features of organisms to identify and explain how scientists organize species by phylum. They play a phylum fishing card game to reinforce what they have learned about organisms in different phyla in the ocean.

In the fourth lesson, **Looking to the Kūpuna (Elders)**, students work in teams, each researching the major findings from expeditions in the Northwestern Hawaiian Islands. They share their findings with the class and draw conclusions about what the “kūpuna” islands can teach us about the coral reefs in the main Hawaiian Islands.

In the next lesson, students work in teams to begin **Investigating Kahaluʻu Bay Part 1**.

As part of their investigation, they are challenged to solve “The Mystery of the Mostly Missing Sand.” Their challenge is to determine approximately how large the sand beach was a few decades ago and which of the “suspects” are responsible for taking the beach away. As part of their investigation, students work with models, piece together evidence from readings and websites and then develop hypotheses.

The culminating activity, **Investigating Kahaluʻu Bay, Part 2**, challenges students to put their scientific investigative skills into action. Students collect evidence in a field study at Kahaluʻu Bay, to complete the investigations they began in Lesson 5. As a culminating activity, students write a persuasive paper applying what they’ve learned in the unit to take a stance on what is affecting the future health of the Kahaluʻu Bay and what can be done to hōʻihi (respect) this magnificent natural and cultural resource.

**REFERENCES**


### Grade 7 Unit Map

**Unit Essential Question:** How are human activities affecting Kahalu‘u Bay and what can we do to hō‘ihi (respect) the bay and promote sustainability?

**Project:** Students investigate how human activities are affecting Kahalu‘u Bay and solve the “Mystery of the Mostly Missing Sand.”

**Student Products:** Learning Logs with completed student sheets, drawings, diagrams, papers, reflections, self-assessments, case report and culminating activity product

**Culminating Activity:** Students share what they have learned about the need to care for the bay with others in the community.

**Value Emphasized:** Hō‘ihi (Respect)

---

### 1. Fishing Links

**[2—3 Class Periods]**

How are coral reef organisms dependent on one another for survival?

<table>
<thead>
<tr>
<th>Hawai‘i DOE Standards and General Learner Outcomes (GLOs)</th>
<th>Hawai‘i DOE Benchmarks, GLOs, and Nā Honua Mauli Ola (NHMO)</th>
<th>Key Concepts</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science 3: Life and Environmental Sciences ORGANISMS AND THE ENVIRONMENT Cycles of Matter and Energy</td>
<td>SC.7.3.2: Explain the interaction and dependence of organisms on one another. LA.7.4.1: Write in a variety of grade-appropriate formats for a variety of purposes and audiences. LA.7.3.3 Describe how historical or cultural influences help explain a text.</td>
<td>Coral reef organisms are dependent on one another in a number of ways including predator/prey relationships, parasitism, and mutually beneficial symbiotic relationships. Apex predators at the top of the food chain are found in greater numbers in healthy reef ecosystems.</td>
<td>Complete Learning Logs that show how organisms are interdependent, and compare and contrast predator/prey and symbiotic relationships in the coral reef community. Write a reflection about their personal relationship with the marine environment.</td>
</tr>
<tr>
<td>Language Arts 4: Writing CONVENTIONS AND SKILLS Range of Writing</td>
<td>NHMO: 3.16 Apply cultural and traditional knowledge of the past to the present.</td>
<td>Hawaiians have personal and spiritual relationships with land and sea organisms that represented their family ‘āumakua (spiritual guardians). The names of these particular family ‘āumakua are still passed from generation to generation.</td>
<td></td>
</tr>
</tbody>
</table>
### 2. PASSING ON THE ENERGY [2—3 Class Periods]

How much energy and matter are available at different steps in an ocean food chain and how does this relate to harvesting fish?

<table>
<thead>
<tr>
<th>DOE Standards and General Learner Outcomes (GLOs)</th>
<th>Hawai‘i DOE Benchmarks, GLOs, and Nä Honua Mauli Ola (NHMO)</th>
<th>Key Concepts</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science 3: Life and Environmental Sciences ORGANISMS AND THE ENVIRONMENT Cycles of Matter and Energy</td>
<td>SC.7.3.1: Explain how energy moves through food webs, including the roles of photosynthesis and cellular respiration. SC.7.3.2: Explain the interaction and dependence of organisms on one another. MA.7.1.1: Solve problems using fractions, decimals, and percents. NHMO 3.3 Understand and appreciate the importance of Hawaiian cultural traditions, language, history, and values.</td>
<td>Organisms are linked to each other through the cycling of matter and flow of energy through food chains. Organisms need energy for life functions such as growth, respiration, and reproduction. Energy is not destroyed as it moves through a food chain; it is just converted from an ordered, concentrated form such as the chemical energy in food, into a more dispersed and less useable form such as heat energy. Since energy is lost at each level in a food chain, Hawaiian fishponds are an ingenious and efficient way of producing fish.</td>
<td>Write an explanation of how energy moves through the coral reef food chain, including the percentage of energy used at each level and the roles of photosynthesis and cellular respiration. Explain how organisms in a coral reef food web are dependent on one another. Use representations, models, equivalent forms, or other appropriate strategies to solve problems that involve fractions, decimals, or percents.</td>
</tr>
</tbody>
</table>

### 3. ARE WE RELATED? [2—3 Class Periods]

How do we classify marine organisms by their degree of relatedness?

| Science 4: Life and Environmental Sciences: STRUCTURE AND FUNCTIONING IN ORGANISMS Classification | SC.7.4.4: Classify organisms according to their degree of relatedness. | Organisms can be classified according to similarities in their anatomical features. | Complete a phylum booklet with illustrations that depict at least two organisms from each phylum studied, and written descriptions of anatomical features that distinguish each phylum. |
### 4. Looking to the Kūpuna (Elders) [3—4 Class Periods]
What do older coral reefs in the Northwestern Hawaiian Islands (NWHI) reveal about changes to reefs in the Main Hawaiian Islands (MHI) over time?

<table>
<thead>
<tr>
<th>Hāwaiʻi DOE Standards and General Learner Outcomes (GLOs)</th>
<th>Hāwaiʻi DOE Benchmarks, GLOs, and Nā Honua Mauli Ola (NHMO)</th>
<th>Key Concepts</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science 1: The Scientific Process: SCIENTIFIC INVESTIGATION Scientific Inquiry</td>
<td>SC.7.1.3: Explain the need to revise conclusions and explanations based on new scientific evidence.</td>
<td>Evidence from NOWRAMP excursions has revealed that apex predators are much more dominant in the reefs of the NWHI compared to the MHI.</td>
<td>Using scientific data from the NOWRAMP expedition, write a comparison of the reefs of the NWHI and the reefs of the MHI.</td>
</tr>
<tr>
<td>Science 2: The Scientific Process: NATURE OF SCIENCE Science, Technology, and Society</td>
<td>SC.7.2.1: Explain the use of reliable print and electronic sources to provide scientific information and evidence.</td>
<td>Scientific evidence reveals that the biomass of the coral reefs in the NWHI is much greater than the biomass of the reefs in the MHI.</td>
<td>Explain what a shifting baseline for the reefs of the MHI is and describe how scientific evidence from the NWHI causes us to revise conclusions about our reefs in the MHI.</td>
</tr>
<tr>
<td>Language Arts 1: Reading: CONVENTIONS AND SKILLS Locating Sources / Gathering Information</td>
<td>LA.7.1.2: Use a variety of grade-appropriate print and online sources to research an inquiry question.</td>
<td>Over the years, there tends to be a shifting baseline for healthy, balanced reefs due to gradual human impacts over time. The reefs of the NWHI provide a baseline by which we can measure change in the MHI reefs brought on by human activities such as overfishing, pollution, and the introduction of invasive species.</td>
<td></td>
</tr>
</tbody>
</table>

### 5. Investigating Kahaluʻu - Part 1 [3—4 Class Periods]
How are human activities affecting Kahaluʻu Bay and what can we do to hōʻihi (respect) the bay and promote sustainability?

| Science 1: The Scientific Process SCIENTIFIC INVESTIGATION Scientific Inquiry | SC.7.1.1: Design and safely conduct a scientific investigation to answer a question or test a hypothesis. | Kahaluʻu has a number of wahi kapu and wahi pana (sacred and storied sites) that show the cultural significance of this area. A number of the sites are being restored. Kahaluʻu has changed over the years due to increased human use of the area, changes in fishing practices, development, and hardening of the shoreline. We can care for the bay by teaching others about reef etiquette and learning about and respecting cultural sites. | Students complete Learning Log 7 with: |
| Language Arts 5: Writing RHETORIC Meaning | LA.7.5.1: Connect selected details, examples, reasons, and/or facts to the insight, message, or thesis in a meaningful way. | | • summary of evidence gathered |
| | | | • hypotheses about what the loss of sand at Kahaluʻu |
| | | | • the method they will to test their hypotheses |
### 6. Investigating Kahaluu’u - Part 2  
[3—4 Class Periods plus field trip and presentation]

How are human activities affecting Kahaluu’u Bay and what can we do to hō’īhi (respect) the bay and promote sustainability?

<table>
<thead>
<tr>
<th>Hawai’i DOE Standards and General Learner Outcomes (GLOs)</th>
<th>Hawai’i DOE Benchmarks, GLOs, and Nā Honua Mauli Ola (NHMO)</th>
<th>Key Concepts</th>
<th>Assessment</th>
</tr>
</thead>
</table>
| Science 1: The Scientific Process SCIENTIFIC INVESTIGATION  | SC.7.1.1: Design and safely conduct a scientific investigation to answer a question or test a hypothesis. | Ma ka hana ka ‘ike.  
By doing one learns. | Measure the area of sandy beach at Kahaluu’u today and calculate the former extend of the beach based on old photographs and measurements taken at the site. |
|  | SC.7.1.2: Explain the importance of replicable trials. | There are different ways to display our data so that we can interpret our findings, draw conclusions, and show how the conclusions are linked to the data. | Display data collected in tables and appropriate graphs. |
|  | SC.7.3.3: Explain how biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem. | We can promote sustainability by sharing what we have learned with others and by actions such as fishing responsibly, being good reef visitors, and preventing pollution. | Complete Learning Logs 8-9 with written conclusions from their investigation, including adjustments based on evidence, and the importance of replicable trials. |
| Math 4: Measurement FLUENCY WITH MEASUREMENT  | MA.7.4.1 Determine how measurements such as perimeter and area, of common shapes are affected when one of the attributes is changed in some way. |  |  |
|  | MA.7.11.1: Design a study, collect data, and select the appropriate representation (line graph, bar graph, circle graph, histogram, stem and leaf plot, box and whisker plot) to display the data. |  |  |
## Grade 7 Unit Map

<table>
<thead>
<tr>
<th>Hawai‘i DOE Standards and General Learner Outcomes (GLOs)</th>
<th>Hawai‘i DOE Benchmarks, GLOs, and Nā Honua Mauli Ola (NHMO)</th>
<th>Key Concepts</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language Arts 4: Writing</td>
<td>LA 7.4.5: Cite various grade-appropriate sources using a consistent format when reporting information.</td>
<td></td>
<td>Complete a culminating paper that answers the unit essential question.</td>
</tr>
<tr>
<td>Citing Sources</td>
<td>LA.7.5.1: Connect selected details, examples, reasons, and/or facts to the insight, message, or thesis in a meaningful way.</td>
<td></td>
<td>Work with their teammates to present their unit project about the bay to others in the school or community.</td>
</tr>
<tr>
<td>Language Arts 5: Writing</td>
<td>LA.7.6.2: Give short prepared oral presentations incorporating information from research to inform and persuade.</td>
<td></td>
<td>Complete Learning Log 10—a self-assessment of their work with their team.</td>
</tr>
<tr>
<td>RHETORIC</td>
<td>GLO 2: Cooperate with and help and encourage others in group situations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meaning</td>
<td>GLO 5: Communicate effectively and clearly through speaking, using appropriate forms, conventions, and styles to convey ideas and information.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language Arts 6: Oral Communication</td>
<td>NHMO 8.1: Be keen observers of their natural environment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONVENTIONS AND SKILLS</td>
<td>NHMO 8.6: Honor and respect personal and community resources.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussion and Presentation</td>
<td>NHMO 8.10: Preserve, protect and sustain a healthy environment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLO 2: Community Contributor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLO 5: Effective Communicator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NHMO 8.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NHMO 8.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NHMO 8.10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**RUBRIC FOR INDIVIDUAL CULMINATING PAPER** - How are human activities affecting Kahalu'u Bay and what can we do to hōʻihi (respect) the bay and promote sustainability?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Language Arts 5: Writing Clarity and Design</strong></td>
<td>My writing is focused. My key points are very clearly stated in an organized way.</td>
<td>My writing is organized and clear. I make my key points in a way that is easy to follow.</td>
<td>I have some good ideas but I did not organize them before I started to write. It is difficult to understand what I’m trying to say.</td>
<td>My writing is not organized. I’m not sure of what I’m trying to say or how to say it.</td>
</tr>
<tr>
<td>Is my writing organized, focused and clear?</td>
<td>Points:</td>
<td>Points:</td>
<td>Points:</td>
<td>Points:</td>
</tr>
<tr>
<td>Did I write an introductory paragraph that clearly states what I cover in my paper?</td>
<td>Points:</td>
<td>Points:</td>
<td>Points:</td>
<td>Points:</td>
</tr>
<tr>
<td>Did my conclusion clearly summarize the problem and solutions?</td>
<td>Points:</td>
<td>Points:</td>
<td>Points:</td>
<td>Points:</td>
</tr>
</tbody>
</table>

**Language Arts 4 and 5: Writing Citing Sources and Meaning**

| Points: | Points: | Points: | Points: |

**Science 3: Organisms and the Environment: Interdependence and NHMO 14-10**

| Points: | Points: | Points: | Points: |

(name)
<table>
<thead>
<tr>
<th>Language Arts 4: Writing Conventions and Skills</th>
<th>My paper has no errors in spelling, punctuation or grammar!</th>
<th>My final paper is almost free of spelling, punctuation and grammatical errors.</th>
<th>I corrected some of my spelling, punctuation and grammatical errors, but not all of them.</th>
<th>I never revised my paper to correct errors in spelling, punctuation or grammar.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did I correct my spelling, punctuation and grammar?</td>
<td>Points: ____</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Grade 7
**RUBRIC FOR GROUP CULMINATING PROJECT AND PRESENTATION** - How are human activities affecting Kahalu‘u Bay and what can we do to hō‘ihi (respect) the bay and promote sustainability?

<table>
<thead>
<tr>
<th>TEAM MEMBERS: ___________________________________________</th>
<th>DATE: ____________________</th>
<th>TOTAL POINTS: __________</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Hawai‘i DOE Benchmarks, GLOs, and Nā Honua Mauli Ola (NHMO)</th>
<th>Kūlia (Exceeds Standard)</th>
<th>Mākaukau (Meets Standard)</th>
<th>‘Ano Mākaukau (Almost at Standard)</th>
<th>Mākaukau ‘Ole (Below Standard)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLO 2: Community Contributor</td>
<td>Excellent use of photographs, computer-generated or handmade visual aids to enhance presentation and clarify main points.</td>
<td>Good use of photographs, computer-generated or handmade visual aids to illustrate key ideas.</td>
<td>Use of additional visuals or higher quality visual aids would help illustrate key points.</td>
<td>Visual aids were poor quality and/or not closely related to key points.</td>
</tr>
<tr>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
</tr>
<tr>
<td>GLO 5: Effective Communicator</td>
<td>Your presentation was very organized. The team explained major points and provided great examples to clarify ideas.</td>
<td>Good organization and explanation of major ideas.</td>
<td>Organization was beginning to show in team presentation, but needs work to have a flow of logic.</td>
<td>Team needs to spend time on organization so that your major points can be understood.</td>
</tr>
<tr>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
</tr>
<tr>
<td>GLO 5: Effective Communicator</td>
<td>You really connected with the audience. You demonstrated confidence by making eye contact, facing the audience, standing straight, speaking clearly and using appropriate gestures.</td>
<td>Team spoke loud enough for people to hear and made eye contact with the audience. Your straight posture demonstrated confidence.</td>
<td>Team communicated clearly for some of presentation. Delivery was better when there was eye contact with the audience.</td>
<td>Team did not communicate clearly. You spoke too softly and did not make eye contact with the audience.</td>
</tr>
<tr>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
</tr>
<tr>
<td>Language Arts 6: Oral Communication Science 3: Organisms and the Environment and NHMO: 8.6</td>
<td>Your team was very informed about the effects of human activities on the bay and what can be done to promote sustainability. Very little reference to notes made for a smooth presentation. Maika‘i!</td>
<td>Knowledge of content was evident in your presentation. Your presentation was well organized with brief reference to notes.</td>
<td>Your team used notes too frequently and paused too often in delivery of information. It appeared that you did not know the content well.</td>
<td>Your presentation was read so team did not seem prepared or knowledgeable.</td>
</tr>
<tr>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
<td><strong>Points:</strong> ______</td>
</tr>
</tbody>
</table>
LEARNING LOG

ALOHA ‘ĀINA – CORAL REEFS

STUDENT’S NAME: ____________________________________________

SCHOOL: ____________________________________________________

DATE STARTED: ______________________________________________

DATE ENDED: ________________________________________________

Project Aloha ‘Āina © 2010 Pacific American Foundation and The Kohala Center
STUDENT ASSESSMENT OVERVIEW

UNIT ESSENTIAL QUESTION
How are human activities affecting Kahaluʻu Bay and what can we do to hōʻihi (respect) the bay and promote sustainability?

NĀ HONUA MAULI OLA (NHMO) – HAWAIIAN GUIDELINES IN THIS UNIT
• Apply cultural and traditional knowledge of the past to the present.
• Understand and appreciate the importance of Hawaiian cultural traditions, language, history, and values.
• Be keen observers of their natural environment.
• Honor and respect personal and community resources.
• Preserve, protect and sustain a healthy environment.

GENERAL LEARNER OUTCOMES (GLOS) IN THIS UNIT
• GLO 2: Cooperate with and help and encourage others in group situations.
• GLO 5: Communicate effectively and clearly through speaking, using appropriate forms, conventions, and styles to convey ideas and information.

INDIVIDUAL LEARNING LOG
You are responsible for completing student sheets and other written and illustrated assignments and keeping them in your Learning Log. You earn points for each assignment. Following is a checklist of the assignments you will need to complete in your Learning Log:

<table>
<thead>
<tr>
<th>LESSONS, STANDARDS, AND LEARNING LOGS</th>
<th>COMPLETED ✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fishing Links - Science 3, Language Arts 4</td>
<td>Learning Logs – 1 and 2</td>
</tr>
<tr>
<td>2. Passing on the Energy - Science 3, Math 1</td>
<td>Learning Logs – 3 and 4</td>
</tr>
<tr>
<td>3. Are We Related? - Science 4</td>
<td>Learning Log – 5</td>
</tr>
<tr>
<td>4. Looking to the Kūpuna (Elders) - Science 1 and 2, Language Arts 1</td>
<td>Learning Log – 6</td>
</tr>
<tr>
<td>5. Investigating Kahaluʻu Part 1 - Science 1, Language Arts 5</td>
<td>Learning Log – 7</td>
</tr>
<tr>
<td>6. Investigating Kahaluʻu Part 2 - Science 1 and 3, Math 4 and 11, Language Arts 4, 5 and 6</td>
<td>Learning Logs 8 - 10</td>
</tr>
</tbody>
</table>
GROUP PROJECT: DUE AT END OF UNIT ON _______________
- Work with a team to complete and present a project that educates others in the community about how human activities are affecting coral reefs in Kahaluʻu Bay and what can we do to hōʻīhi (respect) the bay and promote sustainability.
- We will divide into teams that will each explore a different topic related to this question. Your team can select from the following list of topics or select a different topic (with approval):

GROUP PROJECT TOPICS
Effect of ________________ on coral reefs of Kahaluʻu Bay and what is being done to solve the problem
Groups select one:
- Overfishing
- Pollutants
- Marine debris
- Shoreline hardening
- Global warming
- Tourism
- Other ________________
- Present information about the problem using photographs and/or other visuals either in a PowerPoint presentation or using display boards.
- Include solutions, by addressing what is being done and/or what should be done to solve the problem.
- Grades will be based on a rubric that we will review.

INDIVIDUAL PROJECT: DUE AT END OF UNIT ON ________________
Write a paper on the topic your group explored to explain how human activities are affecting coral reefs and what can be done to keep the reefs of Kahaluʻu Bay healthy for the future.

CRITERIA FOR GRADING
Your paper should include:
- An introductory paragraph that clearly states what is covered in the paper
- At least two paragraphs that describe how the problem is affecting the coral reefs in the bay, including information from research
- At least one paragraph with a thoughtful and accurate explanation of how human activities today could affect future generations’ ability to use the bay (sustainability)
- A paragraph with a clear statement of what should be done to show hōʻīhi (respect) for Kahaluʻu Bay and why
- A conclusion that clearly summarizes the problem and solutions
- Organization of ideas for clarity
- Correct use of writing conventions (spelling, punctuation, and grammar)
- Use of at least three references and proper citation of references
FISHING LINKS

How are coral reef organisms dependent on one another for survival?

HAWAI‘I DOE STANDARD BENCHMARKS

Science 3: Life and Environmental Sciences:
ORGANISMS AND THE ENVIRONMENT
Cycles of Matter and Energy
• SC.7.3.2 Explain the interaction and
dependence of organisms on one another

Language Arts 4: Writing: CONVENTIONS
AND SKILLS
Range of Writing
• LA.7.4.1 Write in a variety of grade-
appropriate formats for a variety of
purposes and audiences such as poems or
pieces to reflect on learning and to solve
problems

STANDARD PRACTICED
Language Arts 3: Reading: LITERARY
RESPONSE AND ANALYSIS
Interpretive Stance
• LA.7.3.3 Describe how historical or cultural
influences help explain a text.

NĀ HONUA MAULI OLA
NHMO: ‘Ike Mauli Lāhui – Cultural Identity
• 3.16 Apply cultural and traditional
knowledge of the past to the present.

MATERIALS
Provided:
✓ Learning Log cover (provided in the Unit
Introduction)
✓ Student Assessment Overview (provided in
the Unit Introduction)
✓ ReefTeach PowerPoint
✓ Coral Reef Cards (provided in Unit
Resources)
✓ Challenge Cards
✓ Student Reading 1
✓ Learning Logs - 1 and 2
✓ movie clip (LottaFish.mov provided on
Navigating Change Video Clips CD)
✓ Save Haven DVD
✓ map of Hawaiian Archipelago

Needed:
✓ folders (one per student for Learning Logs)
✓ large envelopes (to hold coral reef card sets)
✓ paper clips

ASSESSMENT
Students:
• Complete Learning Logs that show how
coral reef organisms are interdependent,
and compare and contrast predator/prey
and symbiotic relationships.
• Write a reflection about their personal
relationship with the marine environment.

TIME
2 - 3 class periods

SKILLS
analyzing, classifying, comparing and
contrasting, writing

ACTIVITY AT A GLANCE
Students explore relationships among coral reef
organisms, Hawaiian ‘umakua (family
guardians), and their own relationship to the
marine environment. After viewing a video clip
of fish in the Northwestern Hawaiian Islands,
students play a “Fishing Links” game using
coral reef cards to make food chains.
**Key Concepts**

- Coral reef organisms are dependent on one another in a number of ways including predator/prey relationships, parasitism, and mutually beneficial symbiotic relationships.
- Apex predators at the top of the food chain are found in greater numbers in healthy reef ecosystems.
- Hawaiians have personal and spiritual relationships with land and sea organisms that represent their family ‘aumakua (spiritual guardians). The names of these particular family ‘aumakua are still passed from generation to generation.

**Advance Preparation**

- Make a copy of the Learning Log cover and Student Assessment Overview (provided in the Unit Introduction) for each student.
- Make a copy of the Student Reading and Learning Logs 1 and 2 for each student.
- Copy the challenge cards and cut them out.
- Preview the ReefTeach PowerPoint and either prepare to present it or let students view it on their own and take notes.
- Preview the Safe Haven DVD and the movie clip (Lottafish.mov) provided with this unit.
- Refer to the chart below and make a copy of each of the coral reef cards indicated on the chart (cards provided in the Unit Resources). Six groups of students will each need one set of six cards (one food chain from producers - decomposers). If you have a large class, make some extra sets of food chain cards.
- Place each food chain set in an envelope with the apex predator card clipped to the outside. Write a team number on each envelope.

**Vocabulary**

- Apex predator – the carnivore at the top of the food chain, such as a manō (shark), ulua (giant trevally) or kākū (great barracuda)
- ‘Aumakua – family or personal gods spiritual guides; deified Hawaiian ancestors or guardians
- Commensalism – a symbiotic relationship where one species benefits and the other is not affected.
- Coral polyp – a tiny animal with a soft body and feeding tentacles that surround the mouth
- Food chain – a series of organisms interrelated in their feeding habits, the smallest being fed upon by a larger one, which in turn is eaten by an even larger one
- Food web – a series of organisms related by predator/prey activities; a pattern of predator/prey relationships in a community of organisms
- Interdependence – a relationship of mutual need
- Mutualism – a symbiotic relationship where both species benefit
- Parasitism – a symbiotic relationship where one species benefits, but the other is harmed
- Producers - organisms that use energy from the sun to produce their own food
- Phytoplankton – tiny floating or drifting plant organisms in the water
- Symbiotic relationship – a close ecological relationship between the individuals of two or more individual species
- Zooxanthellae – algae that live in the tissues of coral polyps
### Coral Reef Card Food Chains

<table>
<thead>
<tr>
<th>Producers</th>
<th>Herbivores</th>
<th>Omnivores</th>
<th>Carnivores</th>
<th>Apex Predator Carnivores</th>
<th>Scavengers / Decomposers</th>
</tr>
</thead>
<tbody>
<tr>
<td>phytoplankton ← (copy 2)</td>
<td>kio po’apo’ai (feather duster worm) →</td>
<td>pāpa’i (blue pincher crab) →</td>
<td>weke ‘ula (goatfish) → (copy 2)</td>
<td>ulua (giant trevally) (copy 4)</td>
<td>ula (banded spiny lobster) ←</td>
</tr>
<tr>
<td>limu manauea (algae) ←</td>
<td>leho kupa (cowry snail) ←</td>
<td>he’e (octopus) ←</td>
<td>pūhi (moray eel) ← (copy 2)</td>
<td>ulua (giant trevally) ←</td>
<td>pokipoki (common box crab) ←</td>
</tr>
<tr>
<td>rice coral ← (copy 2)</td>
<td>uhu (parrotfish) ←</td>
<td>pūhi (moray eel) ←</td>
<td>ulua (giant trevally) ←</td>
<td>loli (sea cucumber) ←</td>
<td></td>
</tr>
<tr>
<td>limu (spiny seaweed) ←</td>
<td>ina (sea urchin) ←</td>
<td>hinālea lau-wili (saddleback wrasse) ←</td>
<td>weke ‘ula (goatfish) ←</td>
<td>manō (shark) ← (copy 2)</td>
<td>ula (banded spiny lobster) ←</td>
</tr>
<tr>
<td>rice coral ←</td>
<td>kikākapu (ornate butterflyfish) ←</td>
<td>roi (peacock grouper) or to’a (snapper) ←</td>
<td>pāpio (young ulua) ←</td>
<td>manō (shark) ←</td>
<td>pe’a (brittle star) ← (copy 2)</td>
</tr>
<tr>
<td>phytoplankton ←</td>
<td>zooplankton ←</td>
<td>mamo (banded damsel fish) ←</td>
<td>kākū (barracuda) ←</td>
<td>ulua (giant trevally) ←</td>
<td>pe’a (brittle star) ←</td>
</tr>
</tbody>
</table>

(The arrows in the chart on the previous page indicate the flow of nutrients from the producers through the consumers and back into the ecosystem through the decomposers. Some of the scavengers/decomposers are also carnivores, feeding on small shrimp or fish in addition to dead plants and animals.)

### Teacher Background Information

The coral reef ecosystem is a beautiful and complex community with abundant examples of interdependence among plants and animals. This activity introduces students to the importance of corals and understanding how to care for our reefs through the ReefTeach program, which is a partnership between the University of Hawai‘i Sea Grant College Program for West Hawai‘i and The Kohala Center. The program was designed to teach visitors to Kahaluu’u Bay to care for the coral reefs.

This activity also introduces students to the area where most of the coral reefs in the state are found—the Papahānaumokuākea Marine National Monument that was established by President George W. Bush on June 15, 2006. This is one of the largest marine protected areas in the world, covering 1,200 miles of ocean wilderness.
The Monument’s reefs provide habitat to more than 7,000 marine species; a quarter of which are found only in the Hawaiian Archipelago. As students become more familiar with the Monument, they will see how it provides us with a baseline with which to measure change to our reefs in the main Hawaiian Islands (MHI). The Safe Haven DVD provided with this unit will introduce your students to the cultural and ecological significance of this protected area.

**Symbiotic Relationships**

The corals, which form the physical basis of this ecosystem, are unique in the dual role they play as both producers and carnivores. Corals also display a type of symbiotic relationship known as mutualism, where both species benefit. Corals are made up of tiny polyps that have a S-shaped gut with an opening surrounded by tentacles with tiny stinging cells. These cells capture zooplanktons that drift in the currents. Within the tissues of the polyps are zooxanthellae—the single-celled algae that have a symbiotic relationship with the coral polyp. Through the process of photosynthesis, these algae use the sun’s energy to convert water and carbon dioxide into sugar. The coral polyp benefits from this food production and the algae benefits from the protective habitat the polyp provides.

**Predator/Prey Relationships**

Predator / prey relationships maintain balance in the coral reef community. Although as students will discover in this unit, human activities are upsetting this balance. The movie clip provided with this lesson shows the large number of apex predators - ulua and sharks - in the coral reefs in the Papahānaumokuākea Marine National Monument in the Northwestern Hawaiian Islands (NWHI). To sustain this high number of apex predators, there needs to be a healthy reef with plenty of herbivores, omnivores and low-level carnivores. Exploring relationships between marine plants and animals and between ourselves and the coral reef lays a foundation of knowledge for understanding how we can better care for the marine environment.

**Hawaiian Relationships – `Aumakua**

As a language arts connection to the science presented in this activity, students are presented with a story about a family’s relationship to its `aumakua — the manō (shark). The story provides insight into important cultural beliefs and a way for students to examine different types of human relationships with other organisms.

In Hawaiian cultural beliefs, `aumakua have the ability to take many forms such as a shark, owl, mudhen, lizard, eel, caterpillar and even a rock or a plant. Their forms would often change from marine life to a terrestrial plant or animal form or non-living matter. One example is the peʻelua (caterpillar) who would often become the loli (sea cucumber) in the ocean. “The
TEACHING SUGGESTIONS

1. Introduce students to the essential question for the unit and hand out the Student Assessment Overview and review it.
   • Distribute the materials for the Learning Logs.
   • Have students glue the Learning Log cover to the folder and glue the assessment overview to the inside cover.
   • Review the unit culminating projects and assign due dates.

2. Show the video clip of fish from the NWHI (Lottafish.mov) and discuss it.
   Discussion Questions
   • How is this reef different from areas where you go swimming or fishing?
   • Why do you think there are so many large apex (top of the food chain) predators – ulua and sharks? (Record students’ ideas on the board.)
   • Where do you think this reef is located?

3. Show the map of the Hawaiian Archipelago and the Safe Haven DVD.
   • Point out the NWHI where this movie was recorded and explain that this is now the Papahānaumokuākea Marine National Monument.
   • Show the Safe Haven DVD and ask students to watch for ways that the NWHI are different from the Main Hawaiian Islands (MHI).
   • Discuss how human impact would be different in this isolated region of the archipelago compared to the MHI.

4. Present the ReefTeach PowerPoint presentation that describes how coral reefs are formed and the threats to reefs.
   • Explain that the ReefTeach program was developed to address threats to coral reefs in Kahaluʻu Bay and that students will have an opportunity to participate in the program when the class visits the bay later in the unit.
   • Ask students to take notes of actions that people need to take to be good reef visitors.

5. Distribute Learning Log 1 about relationships and ask students to complete it in preparation for a “Fishing Links” game.
Discussion Questions

• What species do you think are needed on the reef for the manō (shark) to survive?
• How is the relationship between coral and zooxanthellae symbiotic? What type of symbiotic relationship is it? (mutualism – both species benefit)
• What is another example of a symbiotic relationship?
• How would you describe your relationship to the marine environment?

6. Go over the rules to play a Fishing Links game with the coral reef cards.

• Divide the class into six teams (or more if the class is large). Ask each team to have paper and pen ready.
• Distribute an apex predator coral reef card to each team. Show them that there is text on the back of the cards.
• Explain that the objective of the game is to complete a food chain that shows the species needed to support the team’s apex predator.
• Tell teams that you have the cards that each team needs to complete a food chain and review food chains with the class (producers, herbivores, omnivores, carnivores and decomposers).
• Explain that to receive a coral reef card, teams must correctly answer a challenge card. They will have one minute to write a response.
• The first team to create the longest food chain (in the correct order) wins.

7. Play the Fishing Links game.

• Ask a volunteer to draw a challenge card and read it to the class.
• Give teams one minute to write the answer to the challenge card.
• Go around the room and read the teams’ responses. Give a coral reef card from the team’s envelope to each team with a correct response.
• If a team doesn’t answer the challenge card correctly, no food chain card is given.
• Once all challenge cards are read, stop distributing food chain cards and challenge teams to create a food chain with no missing links.
• Declare the team with the longest food chain the winner. (To check for accuracy, review the Coral Reef Card Food Chains chart.)

8. Hand out the remaining coral reef cards and ask teams to complete the food chains.

• Review their food chains.
• Have teams share at least one of the “Did you know?” facts from their coral reef cards that they found to be interesting.
• Have students revisit their responses on Learning Log 1 and update it with the species needed to support the apex predators.
• Use the challenge cards from the game to assess students’ knowledge, either by conducting interviews with students, or by having students select a card and write an answer.

9. Distribute Learning Log 2 and ask students to complete it with the missing links in the food chains.

10. Distribute the Student Reading about manō as ‘aumakua.
• Ask students to complete the reading and write a reflection about manō as ‘aumakua.
• Ask for volunteers to share some of their reflections about the Hawaiian relationship to ‘aumakua.
• Discuss students’ reflections and reinforce the concept of caring for something that cares for you.

REFERENCES


RESOURCES


ADAPTATIONS / EXTENSIONS

Science 3: Organisms and the Environment - Have students design ways to create three-dimensional coral reef food chains and display them in the school. Challenge them to make the organisms to scale using the actual size or a scaled down version. Create some math challenges where students compare the relative sizes of organisms from the producers through the apex predators.


Science 3: Organisms and the Environment - Challenge students to research another type of symbiosis such as commensalism, where the organisms live together, either with, on, or in another without causing injury to either; amensalism, where neither species benefits and one is harmed; parasitism where one species benefits and the other is harmed; or mutualism, where each species benefits.

Web sites with information on coral reefs are listed below.

- http://www.waquarium.org/
- http://www.coralreefnetwork.com/
- http://www.hawaii reef.noaa.gov/about/welcome.html
- http://www.bishopmuseum.org/research/natsci/fish/fishimages.html
- http://www.cals.ncsu.edu/course/ent591k/symbiosis.html
**Fishing Links**

Instructions: Copy one set of Challenge Cards and cut them out.

---

**Challenge Cards**

An herbivore on the reef has parasites on its scales. Describe the relationship and name the fish that will help this herbivore.

---

Divers who do not clean their gear can unintentionally introduce a non-native limu to the reef. This limu grows quickly and smothers some of the coral. How would this affect the reef?

---

You hear from your kūpuna that there used to be many more uhu (parrotfish) on the reef than there are today. How might the decline in these fish affect the coral reef community?
Global warming increases water temperatures during the summer and can cause some coral bleaching on the reef. The bleached coral usually dies. What organism that had a symbiotic relationship with the coral must now find a new home?

The reefs surrounding the Northwestern Hawaiian Islands have many more apex predators than the reefs surrounding the main Hawaiian Islands. Why do you think there is such a difference?

The producers in the coral community need nutrients to survive. Nutrients are made available by organisms that feed on dead or decaying plants and animals. Give an example of one of these scavengers or decomposers.
**FISHING LINKS GAME**

An herbivore on the reef has parasites on its scales. Describe the relationship and name the fish that will help this herbivore. *(Answer: Cleaner wrasse feeds on the parasites – symbiotic relationship of mutualism where both species benefit.)*

Global warming increases water temperatures during the summer and can cause some coral bleaching on the reef. The bleached coral usually dies. What organism that had a symbiotic relationship with the coral must now find a new home? *(Answer: zooxanthellae)*

Divers who did not clean their gear can unintentionally introduce a non-native limu to the reef. This limu grows quickly and smothers some of the coral. How would this affect the reef? *(Answer: Corals would die and fish that feed on coral or animals that live on the reef would decline.)*

The reefs surrounding the Northwestern Hawaiian Islands have many more apex predators than the reefs surrounding the main Hawaiian Islands. Why do you think there is such a difference? *(Answer: Reefs in the main Islands have been overfished so there are not enough smaller fish to support many apex predators.)*

You hear from your kūpuna that there used to be many more uhu (parrotfish) on the reef than there are today. How might the decline in these fish affect the coral reef community? *(Answer: There would be fewer fish for carnivores to eat and the limu (seaweed) that the fish eat could overgrow the coral.)*

The producers in the coral community need nutrients to survive. Nutrients are made available by organisms that feed on dead or decaying plants and animals. Give an example of one of these scavengers or decomposers. *(Answer: crabs, shrimp, lobster, brittle stars)*
FISHING LINKS

NAME: ____________________________________ DATE: _______________

PREDATOR/PREY RELATIONSHIPS
Many predator/prey relationships exist to support the largest predators in the bay—the manō (shark) and the ulua (giant trevally). These predators at the top of the food chain are called apex predators. Think of all of the life that is required to support the manō.

Make a list of the species that you think need to exist on the reef in order for the manō and the ulua to survive.

In the Northwestern Hawaiian Islands (NWHI), apex predators make up 54% of the reef. In the main Hawaiian Islands these top-level predators make up only 3% of the reef. Why do you think there is such a difference? List your ideas below:
A symbiotic relationship is a close ecological relationship between two or more species. One type of symbiotic relationship is mutualism where both species benefit. Some examples are:

**Koʻa (Coral) and Limu (Algae)**

Corals are made up of tiny polyps that have a sac-like gut with an opening surrounded by tentacles with tiny stinging cells. These cells capture zooplankton—very tiny animals that drift by in the currents. Living inside the coral’s tissues are single-celled algae called zooxanthellae. These algae use the sun’s energy to convert water and carbon dioxide into food that the polyps utilize. The algae benefit from this relationship by being protected from animals that feed on it.

**STOP BY THE CLEANER’S!**

**Pōʻou (Cleaner Wrasse)**

This tiny fish is only a few inches long. If it nibbles on bait that it does not find tasty, its skin will change to a paler shade of color (Titcomb, 1977).

The pōʻou has an interesting behavior. It picks parasites off the bodies of other fishes. These cleaner wrasses tend to “set up shop” in a particular area of the reef. Fishes in need of a cleaning know these locations or “cleaner stations” and stop by for a cleaning. When these fish arrive, they pose motionless which attracts the cleaner to come and inspect and then pick off and feed on irritating parasites (Hobson, 1972).

**YOUR RELATIONSHIP TO THE CORAL REEF**

Write a paragraph or a poem that summarizes your relationship to the coral reef.
FISHING LINKS

RELATIONSHIPS TO MANŌ (SHARKS)

Longtime residents of Kahaluʻu will tell you about the manō of this place; that the sharks of Kahaluʻu did not attack people. The “king” sharks, who were known as Kehau and Laenui, were made offerings by the people. Another king shark, known as Moanalihia, controlled the “lesser” sharks of the bay. According to local lore, a Japanese man drowned near Paniau Point. His body remained in the bay for several days and none of the manō of Kahaluʻu attacked his body. As the story goes, a Keauhou shark did come and bite off the leg of the drowned man, but the Kahaluʻu sharks chased this manō away. The manō of Kahaluʻu also helped local folks recover the drowned man by nosing his body out from where it became caught under rocks in the bay (Maly, 2004).

Excerpts from: The Honolulu Advertiser Sunday, January 14, 2001
By Katherine Nichols, Advertiser Staff Writer

Kahu Charles Kauluwehi Maxwell Sr. will never forget the day he saw a free diver off Molokaʻi tossing away every other fish he spearied. "All of a sudden, this huge tiger (shark) came up and took the fish," said Maxwell, a former police officer who is now a cultural practitioner on Maui. "I thought he was going to be attacked. Then I realized: He's feeding his 'aumakua. The man said, 'Wherever I go, this manō (shark) help me. He follow me all over.'"

Maxwell, 63, who has been given the title of "kahu," meaning a shepherd or religious leader, also serves as a consultant to the Maui Ocean Center. He told another story about a tour boat that sank off Molokaʻi in the 1930s. Sharks swarmed, and all of the tourists were attacked and killed. The captain of the boat, however, started to chant. "His 'aumakua appeared, offered his dorsal fin and carried the captain to shore,” said Maxwell. "Even in modern times, things like this happen. People try to explain, but you can't. A lot of our culture cannot really be explained."

In Western culture, the shark is the predator, which, when it kills, must be killed. It's the “Jaws” syndrome. But the relationship between traditional Hawaiians and sharks was, and is, far more complex: The Hawaiian way is to value all creatures as having a rightful place in the ecosystem. Sharks are useful game, yet it is also believed that some sharks are the embodiment of gods, family deities called 'aumakua.

But where does this belief fit today? How do contemporary Hawaiians, especially those who spend time in the ocean, reconcile the two conflicting views of sharks?
In Hawaiian, 'aumakua is defined as a guardian spirit or family protector. Though some view the practice as a religious one involving worship, most, like Maxwell, a Christian, regard it as a continuation of an ancient belief system, a cultural practice that does not interfere with other religious beliefs. For those who have a relationship with their 'aumakua today, it remains a powerful force.

"An 'aumakua was actually a dead ancestor's spirit that was deified into an entity," explained Maxwell. "Could be clouds or trees or animals." But the best known of the 'aumakua seems to be the shark. Why? "We're ocean people," said Maxwell. "In ancient times, you either lived in the mountains or the ocean. The owl, the eel and the whale were also famous 'aumakua."

Blood Relationship
This does not mean every owl or shark is an 'aumakua. And even if a shark is your 'aumakua, "not every shark is going to be gracious to you," said Carol Silva, a researcher of Hawaiian culture. "'Aumakua are identified very specifically by body markings, and are named. They are part of the family. There is a direct connection, a blood relationship."

How is this unique and enduring tie to an 'aumakua determined?
Paul Brown, 35, a fisherman, free diver and teacher at Kaimuki High School, said his family’s 'aumakua can be traced several generations back to his roots on the Kohala coast at 'Upolu Point on the Big Island.

Maxwell said that his grandmother fed the sharks, and everyone knew the sharks had been their family's 'aumakua for several thousand years. "It would be a cultural insult if I asked my parents, 'How did we get this 'aumakua?' You're just told." Western man, he said, "thinks everything has to be in black and white to be fact."

Beyond the stories, Silva said that there is "usually some kind of sign," when an 'aumakua makes itself known, by behaving in a non-threatening manner, or even coming to the aid of a family member in a dangerous situation. The recognition between human and animal is instant and mutual.

Where the 'aumakua resides is usually determined by a significant family event that occurred there. "Maybe the family had a miscarriage or a stillborn and sent the fetus or the child out to sea," said Silva. "Or maybe the family had a drowning. Wherever this event occurred, if a sea animal showed up in that area, this is generally seen as a reincarnation."

The affinity is often so strong that older family members make significant efforts to introduce their children and grandchildren to the relative who resides in the ocean. Silva said she knows of a man in Kona whose grandfather led him on a diving expedition into a specific cave to acquaint him with their shark 'aumakua.
Care and feeding

But the connection is not limited to meeting and greeting. “Care and feeding of your 'aumakua was an essential part of this symbiotic relationship,” said Silva. "The 'aumakua shark would drive off all bad sharks and carry its mortal family members to safety, but in return, family members were responsible for scraping the barnacles off the shark's back, and making sure it was well.”

A clergyman called Kaiwi told author Martha Warren Beckwith the following story for a 1917 magazine article. Speaking of a shark 'aumakua and its family of fishermen, he said, "The men give out some of the first catch, then it disappears, and they always come back with full nets. Only when the shark appears do they have luck. Sometimes the 'aumakua tells them beforehand in a dream that it has gathered the fish together."

Maxwell says most Hawaiians will not speak about their 'aumakua with anyone outside their families. Ka'uhane Lee, a canoe paddler of Hawaiian, Chinese and Tahitian descent and owner of the Lomi Shop, agreed: "It's kapu to have (your 'aumakua) known," she said. "It's only known for certain reasons and purposes."

Power of sharks

Both Maxwell and Silva believe that ancient Hawaiians' relationship with the environment helped them connect more readily with their 'aumakua. Said Maxwell: "In ancient times, there was one penalty for polluting the ocean or taking things out of turn: death. Every wind, every piece of land, every cloud had a name and a story. Hawaiians could talk to the trees, mountains and the animals, and they would answer. But we've lost that." In fact, he said, every Hawaiian "has an 'aumakua, and sometimes two from their mother's side and their father's side but most people don't know."

Hawaiians did kill sharks, but only for specific purposes, and given that they used nothing more than a canoe and a spear or fishhook, obviously they took sharks in small quantities. And they wasted nothing. Leighton Taylor wrote in "Sharks of Hawai'i Biology and Cultural Significance" (University of Hawai'i Press, 1993) that Hawaiians used the teeth as cutting tools, ate the meat of the shark, and used the skin to stretch across ceremonial drums.

However, Maxwell has written, "In ancient times, families were careful not to eat certain forms of animal life if their 'aumakua was thought to appear in that form, for if they did, they knew the punishment could be as severe as death."
FISHING LINKS

NAME: ___________________________   DATE: __________________

Fill in the “missing links”—the herbivores, omnivores, and carnivores that connect the producers to the apex predators.

<table>
<thead>
<tr>
<th>PRODUCERS</th>
<th>HERBIVORES</th>
<th>OMNIVORES</th>
<th>CARNIVORES</th>
<th>APEX PREDATORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytoplankton</td>
<td></td>
<td></td>
<td></td>
<td>Manō (Hammerhead Shark)</td>
</tr>
<tr>
<td>Limu</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coral</td>
<td></td>
<td></td>
<td></td>
<td>Ulua (Giant Trevally)</td>
</tr>
</tbody>
</table>

Explain how nutrients are made available to the producers.
Reprinted with permission from A Teacher's Guide to Navigating Change.
PASSING ON THE ENERGY

How much energy and matter are available at different steps in an ocean food chain and how does this relate to harvesting fish?

HAWAI’I DOE STANDARD BENCHMARKS

Science 3: Life and Environmental Sciences - ORGANISMS AND THE ENVIRONMENT
Cycles of Matter and Energy
• SC.7.3.1 Explain how energy moves through food webs, including the roles of photosynthesis and cellular respiration.
• SC.7.3.2 Explain the interaction and dependence of organisms on one another.

Math 1: Numbers and Operations - NUMBER SENSE
Numbers and Number Systems
• MA.7.1.1 Solve problems using fractions, decimals, and percents.

NĀ HONUA MAULI OLA
NHMO: ‘Ike Mauli Lāhui – Cultural Identity
• 3.3 Understand and appreciate the importance of Hawaiian cultural traditions, language, history, and values.

ACTIVITY AT A GLANCE
Students view a DVD about Hawaiian fishponds, including Kaloko in Kona. They conduct a demonstration of the flow of energy in a coral reef food chain compared to a Hawaiian fishpond food chain.

MATERIALS
Provided
✓ Coral Reef Cards (provided in Unit Resources)
✓ Energy flow diagram
✓ Learning Logs - 3 - 4
✓ Kahea Loko: The Call of the Pond DVD

Needed
✓ colored yarn (20 meters)
✓ scissors
✓ meter stick
✓ signs or labels titled Ocean, Fishpond, Used Energy

ASSESSMENT
Students:
• Write an explanation of how energy moves through the coral reef food chain, including the percentage of energy used at each level and the roles of photosynthesis and cellular respiration.
• Explain how organisms in a coral reef food web are dependent on one another.
• Use representations, models, equivalent forms, or other appropriate strategies to solve problems that involve fractions, decimals, or percents.

KEY CONCEPTS
• Organisms are linked to each other through the cycling of matter and flow of energy through food chains.
• Organisms need energy for life functions such as growth, respiration, and reproduction.
• Energy is not destroyed as it moves through a food chain; it is just converted from an ordered, concentrated form such as the chemical energy in food, into a more dispersed and less useable form such as heat energy.
• Since energy is lost at each level in a food chain, Hawaiian fishponds are an ingenious and efficient way of producing fish.
TIME
2 – 3 class periods

SKILLS
modeling, measuring, analyzing, using scientific vocabulary

ADVANCE PREPARATION
- Make copies of the following coral reef cards for the demonstration:
  - Coral Reef:
    - 5 phytoplankton
    - 2 limu (algae)
    - 4 uhu (parrotfish)
    - 2 pūhi (moray eel)
    - 1 ulua (giant trevally)
  - Fishpond:
    - 5 phytoplankton
    - 2 limu (algae)
    - 4 awa (milkfish)
- Copy Learning Logs 3 and 4 for each student.
- Cut two 10-meter lengths of colored yarn.
- Prepare to project the energy flow diagram provided with this lesson.
- Preview the Kāhea Loko DVD and if time is limited, cue it to the section on Kaloko – Honokōhau to highlight the local fishponds in Kona.

VOCA BULARY
- caloric energy – energy from food (measured in calories)
- cellular respiration – the process in which the chemical bonds of energy-rich molecules such as glucose are converted into energy usable for life processes.
- ecosystem – a system formed by the interaction of a community of organisms with their environment
- heat energy – a form of energy that causes a rise in temperature, expansion, evaporation, or other physical change
- loko kuapā – Hawaiian fishpond with a rock wall (kuapā) built out on the reef flat; this type of pond is unique to Hawai‘i.
- photosynthesis – the production of carbohydrates using sunlight energy to combine carbon dioxide and water in the presence of chlorophyll

TEACHER BACKGROUND INFORMATION

Energy is the most essential need for any organism to survive. To get energy, it needs food as a fuel and oxygen to burn it. Phytoplankton, which comprise more than 99 percent of all the plant life in the ocean, are the most important producers. These tiny plants and the many different types of limu (algae) living on the reef capture the energy from the sun, which is then passed on through a complex food web to herbivores, omnivores, carnivores and decomposers.

The amount of energy foods can produce is measured in units called calories. A food calorie, or kilocalorie, is the amount of heat required to raise the temperature of 1 kilogram (2.2 pounds) of water 1 degree Celsius (1.8 degrees Fahrenheit). As a rule of thumb, 90 percent of the caloric value of a plant or animal is lost to respiration and other bodily functions at each step in a food chain. The reason that so much energy (90
percent) is lost at each level in the food pyramid is that organisms use energy for living functions such as growth, respiration and reproduction. The body changes the calories in food into energy, which is necessary for every act from blinking an eye to running a race, rebuilding damaged cells, or regulating body systems. The energy is not destroyed—it is just converted from an ordered, concentrated form such as the chemical energy in food, into a more dispersed and less useable form such as heat energy.

**Eating Low on the Food Chain**

In early Hawai‘i, fish and shellfish provided the major part of the protein in the diet of its people. The ocean around the Hawaiian Islands contained a plentiful supply of fish, however, ocean fishing was and still is dangerous, time-consuming, and greatly dependent on weather conditions. By raising herbivorous fish in fishponds, the early Hawaiians were able to assure a plentiful supply of protein in a much more efficient way. During World War II, an important bit of research was done by Professor W. Hiatt at the University of Hawai‘i (1947). He discovered something the Hawaiians had known for at least 500 years and maybe even longer. It was this: “The most efficient way to produce protein for human consumption is to cultivate the herbivor [sic] link in the food chain – cultivate the fish that only eat algae (limu). Hiatt felt this discovery revealed the true genius of the Hawaiians” (Dieudonne, 2002). The food pyramids on the following page illustrate the efficiency of eating lower on the food chain.

Ten thousand pounds of limu in the ocean ecosystem will only produce about 10 pounds of large, carnivorous fish - the kind usually targeted by ocean fishers. 10,000 pounds of limu
(algae) is enough to raise 1,000 pounds of herbivorous ʻama ʻama (striped mullet fish) or awa (milkfish) in the fishpond (Henry, 1993).

**Kaloko – Honokōhau**
The Kaloko fishpond is a loko kuapā, a type of fishpond that is unique to Hawaiʻi. The kuapā (stone wall) at Kaloko is five times larger than the average Hawaiian fishpond (National Park Service, n.d.). This impressive wall is a testament to the engineering skills of the Hawaiians who constructed this pond wall to withstand Kona’s high winter surf. The wall is constructed by dry stacking; no cement is used. This allows the water to flow through the wall, absorbing the energy of the surf. The angle of the wall also helps to deflect the waves. And the placement of the wall shows the astute observation and engineering skills of those who constructed the pond. The waves first break on the outer reef and before they break again, the waves encounter the kuapā, which was strategically placed to rob the waves of their energy. “Masons describe the work not so much as placing the rock in the right spot, but listening to where the stone wants to be…” (National Park Service, n.d.)

The kuapā at Kaloko withstood the Kona surf for hundreds of years. Once the pond was abandoned and cement was added to the wall, the wall broke down in storms of 1950s.

**TEACHING SUGGESTIONS**

1. **Review food chains from the prerequisite activity.**
   - Ask students how many pounds of phytoplankton and smaller organisms they think would be required in the food chain to support an apex predator such as an ulua.
   - Write their ideas on the board.

2. **Discuss the processes of photosynthesis and cellular respiration.** Write the following statement on the board and discuss the process of photosynthesis by which plants utilize energy from the sun to produce sugar from carbon dioxide and water:
   
   
   6 molecules of water + 6 molecules of carbon dioxide
   produce ⇒ 1 molecule of sugar + 6 molecules of oxygen

   - Discuss the process of cellular respiration where animals break down the chemical bonds in the sugar molecules, thus reducing stored energy.

3. **Discuss the ways in which food gives us energy for daily activities and how caloric energy from food is converted to heat energy.**
   - Ask students how much caloric energy they think is provided from eating a serving of fish. [As a general guideline, 4.5 ounces of mahimahi contain 139 calories, 4.5 ounces of aku (bonito or skipjack tuna) contain 178 calories, and 4.5 ounces of aʻu (swordfish) contain 198 calories.]
   - Discuss why we need protein in our diets.
4. Ask students to describe the kinds of food early Hawaiians ate for protein. Show the video Kāhea Loko: The Call of the Pond.
   • As students watch the video have them make note of how the ponds work to grow herbivorous fish such as ‘ama’ama (striped mullet) and awa (milkfish).
   • Discuss students’ observations of the ponds at Kahaloko - Honokōhau. Make note of the method of reconstructing the walls as this will be revisited later in the unit.

5. Set up a demonstration to compare the flow of energy through a fishpond and reef.
   • Hold up 10 meters of string and explain that this represents the total amount of “energy” that is stored in 10,000 pounds of phytoplankton and limu. Ask students:
     “Could you feed fish to more people from this amount of phytoplankton and limu if the fish came from an ocean ecosystem or a fishpond ecosystem and why?”
   • Record the students’ ideas on the board.
   • Explain that students will model a simple food chain in each of the two ecosystems to find out which is more efficient at providing protein.
   • Put the Ocean label on one side of the room and the Fishpond label on the other.
   • Place the Used Energy label in the center of the room.

6. Assign roles and distribute coral reef cards for two food chains.
   • See the demonstration set-up on the following page and distribute the number of coral reef cards indicated and have students gather under the ocean or fishpond signs. Note: there are no cards for the “humans” to hold.
   • Ask students arrange themselves and hold up their coral reef cards in order of a food chain. Have students representing humans stand at the end of each food chain.
   • Begin with the ocean passing on the energy demonstration. See instructions in 7. on following page for distributing the string that represents the energy in the two food chains.

**DEMONSTRATION SET-UP**

<table>
<thead>
<tr>
<th>OCEAN</th>
<th>USED ENERGY</th>
<th>FISHPOND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students – hold cards to represent:</td>
<td>The producers use 90% of their energy (900 cm goes to Used Energy) and pass on 10% (100 cm) to the next level in the food chain.</td>
<td>Students – hold cards to represent:</td>
</tr>
<tr>
<td>Phytoplankton – 5</td>
<td></td>
<td>Phytoplankton – 5</td>
</tr>
<tr>
<td>Limu - 2</td>
<td>[10 meters (1,000 cm) of string = their combined stored energy]</td>
<td>Limu – 2</td>
</tr>
<tr>
<td>[10 meters (1,000 cm) of string = their combined stored energy]</td>
<td></td>
<td>[10 meters (1,000 cm) of string = their combined stored energy]</td>
</tr>
</tbody>
</table>
Uhu (parrotfish) – 4
Pühi (eel) – 2
Ulua (trevally) - 1

<table>
<thead>
<tr>
<th></th>
<th>Uhu and Awa use 90 cm and pass on 10 cm to next level in food chain. Pühi uses 9 cm and passes on 1 cm to Ulua.</th>
<th>Awa (milkfish) - 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human – 1</td>
<td>Human fishing Ulua in ocean receives 0.1 cm of the energy. Human fishing in fishpond receives 10 cm.</td>
<td>Human – 1</td>
</tr>
</tbody>
</table>

7. **Conduct the “Passing on the Energy” demonstration.**

**Ocean Ecosystem**

a) Limu and phytoplankton: Get 10 meters (1000 cm) of string representing the total amount of energy (calories) stored in these producers.

b) Ask students which fish would eat the phytoplankton and limu and get energy. (The uhu feeds on limu.)

c) The limu and phytoplankton which are much more numerous than the uhu use 90% of the energy for their living and growing needs. How much energy is then passed onto the uhu? Have students measure 10 percent of the string (100 cm), cut it off, and pass it to the uhu.

d) Place the remaining 900 cm into the Used Energy pile.

e) Ask students which fish would eat the uhu. (the pühi) How much energy can be passed onto the pühi? (10 percent = 10 cm). Have the students measure and cut the string and put 90 cm into the Used Energy pile.

f) Repeat the process for the next step in the chain, and have the students measure and discard 9 cm of string, and pass 1 cm to the ulua. How much energy does the ulua need for its life processes, and how much can be passed on to the humans? (The ulua needs 90%, leaving 0.1 cm for the humans.) Have the students attempt to measure and cut the string, discarding the larger portion and giving the tiny bit remaining to the human.

**Demonstration – Fishpond Ecosystem**

a) Repeat the process for the fishpond ecosystem – the phytoplankton and limu start with 1000 cm of energy and pass 100 cm to the awa. The awa then passes 10 cm to the human.

8. **Review the demonstration with students.** Draw the food pyramids on the board (see Teacher’s Background Information) and compare the pounds of fish available at the top of the food chain to students’ earlier estimations.

**Discussion Questions**

- Which ecosystem is more efficient from the point of view of producing fish for human consumption? Why? (The fishpond, since humans are eating herbivores and there are fewer levels for energy to be lost.)
• What happens to the energy at each level in the food chain? And why is so much energy lost at each level? **Project the energy flow diagram to aid this discussion.** (The energy is not destroyed – it is just converted from an ordered, concentrated form such as the chemical energy in food, into a more dispersed and less useable form such as heat energy. Energy is lost at each level because organisms use it for living functions such as growth, respiration, and reproduction.)

• How do these models differ from what actually happens in an ocean or fishpond ecosystem? (Models are simplified examples of what happens in reality. We demonstrated the concept using only simple, linear food chains. We didn’t include zooplankton or many other organisms. A real ecosystem is much more difficult to analyze. Complex food webs with other herbivores and predators and other factors such as water temperature and quality and weather conditions could affect the outcome.)

9. **Distribute Learning Logs 3 and 4 and ask students to complete the assessment activities.**
   • Discuss their answers to the questions about fishing practices in the past and what we can learn from this to mālama (care for) Kahaluʻu Bay today.

**REFERENCES**


   http://www.nps.gov/kaho/historyculture/upload/kaloko%20wall.pdf

The sun gives off electromagnetic radiation that is converted into two useful forms of energy:

**THERMAL ENERGY**

**Thermal energy** increases the vibration of electrons resulting in heat. It can also be re-radiated back to space. Thermal energy warms the earth, heats the atmosphere, drives the water cycle and produces air and water currents.

**CHEMICAL ENERGY**

**Chemical Energy:** Some special molecules convert light energy into chemical energy by storing it in their chemical bonds (e.g., photosynthetic pigments absorb light energy and convert and store it in the chemical bonds of sugar).

**Producers:** Most of the energy produced by the plants is lost as heat energy. The remaining energy is stored as chemical energy in the bonds of organic molecules. This is the energy available to the herbivores and the decomposers when the plants are eaten.

**First level consumers** consume energy stored in plants. Most of the energy consumed is used for maintenance, growth and reproduction. The energy not respired (approximately 10%) is the stored biomass available to next level of the food chain.

**Second level consumers** obtain chemical energy from first level consumers.

**Third level consumers**

**Energy Loss:** Approximately 90% of the stored energy is lost as heat at each trophic level through homeostasis (e.g., respiration and digestion) as well as growth and reproduction.

**Decomposers** break down wastes and dead plants and animals.

**STUDENT CHALLENGE:** Identify at least two marine organisms for each of the major groups: producers, each level of consumers, and decomposers.
PASSING ON THE ENERGY

NAME: ___________________________  DATE: ________________

Before going to Kahalu‘u Bay later in this unit, we need to gather evidence about how the area has changed over time. Interviews of people who have lived in the area for a long time provide a good source of information. Listen to the interview of Kupuna Mitchell Fujisaka on The Kohala Center website and take notes about how fishing practices and Kahalu‘u Bay have changed over time.

Go to: http://www.kohalacenter.org/kahaluubay/culture.html and select the video of Kupuna Mitchell.

Kupuna Mitchell was born in 1936 and in his interview he describes what it was like to grow up in Kahalu‘u. At 5:37 minutes into the interview he talks about how fishing in the bay has changed over time.

What does Kupuna Mitchell say about how the ocean has changed?

What are some of the fishing practices he describes?

How are these fishing practices different from the way people fish today?
Go to: http://www.kohalacenter.org/kahaluubay/culture.html and select the video of Allen Wall.
At 13:30 minutes into the video, Allen Wall talks about coming down to the beach in Keauhou as a child and then describes fishing practices.

How does Mr. Wall describe life in Keauhou at that time?

What does Mr. Wall say about fishing along the bay?

What kind of fish were people catching back then and what does he say about cleaning the fish?

What can we learn from ways of the past to help us mālama (care for) the ocean today?
PASSING ON THE ENERGY

NAME: _____________________________  DATE: ________________

• Use a solid arrow → to show the direction of the flow of energy from one organism to another in the coral reef food web.
• Use a dashed arrow --- to show the flow of “Used Energy” for each organism.

Used Energy

% of energy used for cellular respiration at each level in the food web = ____
PASSING ON THE ENERGY

NAME: ___________________________ DATE: ________________

1. Explain how energy moves through the coral reef food web.

2. Describe the role of photosynthesis in the flow of energy.

3. Describe the role of cellular respiration in the flow of energy.

4. Write a math statement that explains the percentage of energy used for cellular respiration and the percentage of energy passed on to each level in the food chain.

5. Find out about Kaloko – Honokōhau in Kona. What type of fishpond is Kaloko and how large is this significant pond in our community? Find out: What happened when cement was added to the stone walls of the pond? See: http://www.nps.gov/kaho/
ARE WE RELATED?

How do we classify marine organisms by their degree of relatedness?

HAWAI‘I DOE STANDARD BENCHMARK

Science 4: Life and Environmental Sciences: STRUCTURE AND FUNCTIONING IN ORGANISMS
Classification
• SC.7.4.4 Classify organisms according to their degree of relatedness.

ACTIVITY AT A GLANCE
Student teams apply clues about features of organisms to identify and explain how scientists organize species by phylum. They play a phylum fishing card game to reinforce what they have learned.

MATERIALS
Provided:
✓ clue cards
✓ phylum fishing cards
✓ Learning Log – 5
✓ Kahalu‘u Bay Tidepool Identification Cards (provided on CD)

Needed:
✓ box labeled Kahalu‘u Bay
✓ chart paper
✓ colored markers
✓ dictionaries

ASSESSMENT
Students:
• Complete a phylum booklet with illustrations or photographs that depict at least two organisms from each phylum studied, and written descriptions of anatomical features that distinguish each phylum.
• Analyze the degree of relatedness among selected organisms and list anatomical features that are characteristic of organisms in different phyla.

KEY CONCEPT
• Organisms can be classified according to similarities in their anatomical features.

TIME
2 - 3 class periods

SKILLS
observation, analysis, classification, research, use of scientific vocabulary

ADVANCE PREPARATION

□ Copy five complete sets of the phylum fishing cards and one set of clue cards. Using a different colored marker for each set of phylum fishing cards, draw a line down the back of the cards so that you can easily reassemble the sets.
□ Cut the sets of cards out and laminate.
□ Copy Learning Log 5 for each student.
□ Gather some of the materials listed under References at the end of this lesson.
☐ Prepare to project the Kahaluʻu Bay Tidepool Identification cards (provided on CD) in the classroom for students to review.

**Vocabulary**
invertebrate – animals without a backbone or spinal column
mantle – folds of the body that line the shell and secretes the shell of molluscs

**Phyla and Representative Organisms**
Some of the phyla and representative organisms found in the bay are:

**Chordata**
- bony fishes, cartilaginous fish (sharks and rays); and reptiles (turtle).
- Common reef fish include: hīnālea (wrasses), uhu (parrotfish), butterflyfish, damselfish, surgeonfish, tangs, and weke (goatfish)

**Echinodermata**
- black, brown, and red sea cucumbers, several sea urchins: ina (short-spined boring urchins), long-spined wana, red slate pencil urchins, and collector urchins

**Mollusca**
- oysters, clams, snails, squid, octopus

**Arthropoda**
- lobster, crab, shrimp

**Cnidaria**
- coral polyps, jelly fish, sea anemones

**Annelida**
- feather duster worm, fire worm

Phylum – a primary division of a kingdom such as the animal kingdom (pl. phyla)

Radula – flexible tongue-like organ with rows of horny teeth used for feeding

Vertebrate – an animal with a backbone or spinal column

**Teacher Background Information**

**Cyanobacteria:** blue-green algae

**Chlorophyta** (green seaweeds) *Ulva, Halimeda, Caulerpa, Codium, Dictyosphaeria*

**Phaeophyta** (brown seaweeds) *Padina, Sargassum, Dictyota, Dictyopteris*

**Rhodophyta** (red seaweeds) *Gracilaria, Asparagopsis, Hypnea, Acanthophora, Laurencia*

Hawaiians were keen observers of nature and many of their classifications of plants and animals match family or phyla that scientists use for classification today. For example, similar names such as ʻōhiʻa ʻai, ʻōhiʻa ha, and ʻōhiʻa are all plants in the Myrtle family. The visual resemblance and similar anatomical features of organisms provide clues to their relatedness with other organisms.

In this activity, students classify organisms according to similar features and see the relatedness among coral reef organisms in different phyla.
TEACHING SUGGESTIONS

1. Discuss how Hawaiian names indicate the keen observation skills of the people of early Hawai‘i in recognizing similarities among related plants or animals.
   • Show the coral reef card with the picture of the lauwiliwilinukunuku‘oi‘oi (common longnose or forceps butterflyfish) to students and ask them to come up with adjectives to describe what it looks like.
   • Write the Hawaiian name on the board and ask if anyone knows what it means (lau, leaf; wiliwili, native dryland forest tree; nukunuku ‘oi‘oi, sharp-beaked). Discuss the meaning of the name (its compressed body resembles the wiliwili leaf and its snout is long).
   • Show the coral reef card for the ornate butterflyfish and write its Hawaiian name on the board: lauhau kïkäkapu. Ask if anyone knows what the names mean (kïkä, strong; kapu, taboo; lauhau refers to the leaf of the hau tree). Explain that the name means “strongly prohibited” and that this fish is described as sacred in chants.

2. Challenge students to analyze features of a variety of marine organisms and group the organisms according to phyla.
   • Discuss the way scientists classify plants and animals.
   • Divide the class into five teams and have each team sit around a table.
   • Give each team a clue card for a phylum (or phyla) of marine life in the ocean: 1) Chordata, 2) Cnidaria, 3) Arthropoda and Annelida, 4) Mollusca, and 5) Echinodermata.
   • Encourage students to use a dictionary to look up unfamiliar terms on their clue cards.
   • Distribute a full set of phylum fishing cards to each team and challenge teams to study the organisms on the cards and use the information on their clue cards to identify the animals that belong in their phylum.
   • Circulate and check each team’s accuracy.

3. Give each team some chart paper and markers and ask students to present the animals in their phylum to their classmates.
   • Their presentations should include a list of the features that distinguish the phylum and a display of the animals on the cards.
   • Post each team’s chart paper in the classroom for everyone to see.
   • Alert students to pay close attention to these presentations since they will need the information in a team card game to follow. Ask them to take notes of key features in each phylum.
4. **Play a phylum card fishing game to reinforce what students have learned.**
   - Collect and shuffle all of the cards. See directions provided at the end of this activity. If you have a large class, have students play the game in smaller groups.

5. **Project the Kahaluʻu Bay Tidepool Identification Cards in the classroom.**
   - Introduce students to the plants and animals they may observe in the tidepools of Kahaluʻu during their field trip later in the unit.
   - Ask students to identify features that the organisms in each group have in common.

6. **Distribute Learning Log 5 and challenge students to create phylum booklets.**
   - Review the directions on the Learning Log with students.
   - Challenge students to conduct research to list anatomical features that distinguish each organism in a phylum. (Internet searches will allow them to easily gather information on each phylum.) Note: if time is limited, have students work in teams with each student completing one phylum for a booklet, or with students pooling their talents as artists, researchers, and writers.
   - Have students share their booklets with other classes or display them in the school library.

**Adaptations / Extensions**

**Language Arts: Writing: Range** - Have students each select one phylum card and conduct research to learn more about the organism. Ask them to search for cultural information about relationships (see writing prompt). Have students combine their research to create a class phylum book to share with others.

Have groups of students each select one phyla from the Kahaluʻu Bay Tidepool Identification sheets and conduct research about the organisms, using the coral reef cards provided with this unit and resources listed at the end of this lesson.

**Writing Prompt**

In the Hawaiian view, humans are related to all life and the gods are manifest in the plants and animals, the water, and the land. Choose one of the phylum cards and find out how Hawaiians viewed this plant or animal through pilina ʻāina (relationships with the land) and pilina akua (relationships with gods).
RESOURCES

Classification of Living Things. Web site created and maintained by Dr. Dennis O’Neil. Behavioral Sciences Department, Palomar College, San Marcos, California.  


Farber & Associates. 2004. Final Environmental Assessment for Koʻieʻie Fishpond Revitalization Project Kaʻonoʻulu, Maui, Hawaiʻi. (No publication information available.)


Profiles of Marine Life. Waikīkī Aquarium.  


**Phylum Fishing Game**

**Objective**
To match organisms by phylum and display the most sets of correctly matched organisms.

**Game Set-up**
Place the five sets of shuffled cards in a box to represent Kahalu‘u Bay. Assemble teams around the “Bay.”

**To Play**
- A representative from each team fishes for five cards from the “Bay” without looking.
- Teams organize their cards and display any phylum matches, picture side up on the table in front of them. A match consists of at least two organisms (they may be the same species) that belong to a phylum.
- Teams may challenge the phylum matches of their classmates. The first team to indicate a challenge proceeds. If the team challenges successfully, they take the cards that were incorrectly displayed and return them to the “Bay.” The challenging team then receives an extra turn. If they challenge unsuccessfully, they lose a turn. (See the box below for types of organisms in each phylum.)
- Teams take turns drawing a card from the “Bay” or taking a card from the displays of another team.
- After the first round, if the card they draw constitutes a match with any of their cards, they have the option of holding onto the cards or displaying them. However, once teams have at least three cards in a phylum, they must display the cards for others to see.

**To End the Game**
The game ends when the first team runs out of cards. At this time, teams holding onto matches will not be able to count them. Only the matches displayed will count. Teams receive one point for each card correctly displayed in a phylum match.

### Phyla and Representative Organisms

**Chordata:** bony fishes, cartilaginous fish (sharks and rays); and reptiles (turtle)

**Echinodermata:** sea urchins, sea stars, sea cucumbers

**Mollusca:** oysters, clams, snails, squid, octopus

**Arthropoda:** lobster, crab, shrimp

**Cnidaria:** coral polyps, jelly fish, sea anemones

**Annelida:** feather duster worm, fire worm
**ARE WE RELATED?**

Instructions: Copy and cut out one set of clue cards (one card for each group of students).

<table>
<thead>
<tr>
<th>CHORDATA</th>
<th>ECHINODERMATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animals with backbones or spinal column. Find all of the vertebrates and then figure out a way to place them in three groups.</td>
<td>Means “spiny skin.” Most of these invertebrates are covered by hard plates and have spines or other projections. Their body parts are arranged symmetrically around a “mouth” but they don’t have a head. Who are they?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MOLLUSCA</th>
<th>ARTHROPODA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invertebrates that have three major features: 1) a specialized “foot” used for creeping, digging, or grasping; 2) a mantle that encloses their internal organs (and sometimes secretes a shell); and 3) a radula modified teeth used for feeding. Who are they?</td>
<td>Invertebrates with jointed legs, segmented bodies, and gills or tracheae. Who are they?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CNIDARIA</th>
<th>ANNELIDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invertebrates that have cnida or nematocysts used for feeding. Their body forms can be sedentary such as polyps or moving medusa. Who are they?</td>
<td>Segmented worms. Some have bristles; some move, and others remain stationary.</td>
</tr>
</tbody>
</table>
**ARE WE RELATED?**

**PHYLUM FISHING CARDS - INVERTEBRATES**

Instructions: Copy and cut out five sets of cards to be distributed one to each group of students.

Phylum: Mollusca

<table>
<thead>
<tr>
<th>Pā (Black-Lipped Pearl Oyster)</th>
<th>Kio Nahawele (Hawai‘i Mussel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>© J.P. Hoover</td>
<td>© J.P. Hoover</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pūpū Kupa (Rounded Cockle)</th>
<th>Leho Kupa (Snakehead Cowry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>© J.P. Hoover</td>
<td>© J.P. Hoover</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mūhe‘e (Squid)</th>
<th>He‘e Pūloa (Ornate Octopus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>© J.P. Hoover</td>
<td>© J.P. Hoover</td>
</tr>
</tbody>
</table>
**Phylum: Cnidaria**

*Pa’imalu* (Portuguese Man-of-War)

*Glass Sea Anemone*

**Phylum: Echinodermata**

*Pōhaku Puna* (Finger Coral)

*Ko’o* (Cauliflower Coral)

*Weli* (Conspicuous Sea Cucumber)

*‘Ina Kea* (Rock-Boring Sea Urchin)
Phylum: Arthropoda

Wana (Long-Spined Sea Urchin)

Pe’a (Spiny Brittlestar)

Ula (Spiny Lobster)

‘Alakuma (Seven-Eleven Crab)

Pokipoki (Box Crab)

‘Ōpae Kai (Harlequin Shrimp)
Phylum: Annelida

*Kio Poʻapoʻai* (Feather Duster Worm)  
*ʻAha Hululu* (Orange Fire Worm)

Phylum: Chordata – Bony Fish

*Hinālea Lauwili* (Saddleback Wrasse)  
*Ulhu* (Spectacled Parrotfish)

*Mamo* (Sergeant Major)  
*Pūhi Lau Milo* (Undulated Moray Eel)
<table>
<thead>
<tr>
<th>Lauwiliwilinukunuku‘o‘oi (Common Longnose or Forceps Butterflyfish)</th>
<th>Kikākapu (Ornate Butterflyfish)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Lauwiliwilinukunuku‘o‘oi" /></td>
<td><img src="image2" alt="Kikākapu" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pualu (Yellowfin Surgeonfish)</th>
<th>Māneoneo (Sailfin Tang)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Pualu" /></td>
<td><img src="image4" alt="Māneoneo" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weke ʻUla (Yellowfin Goatfish)</th>
<th>Ulua Akea (Giant Trevally or Jack)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5" alt="Weke ʻUla" /></td>
<td><img src="image6" alt="Ulua Akea" /></td>
</tr>
</tbody>
</table>
Phylum: Chordata – Cartilaginous Fish

**Pāpio (Young Trevally or Bigeye Jack)**

**To’au (Blacktail Snapper)**

**Roi (Peacock Snapper)**

**Kākū (Great Barracuda)**

**Hihiʻmanu (Hawai‘i Stingray)**

**Māno Kihikihi (Scalloped Hammerhead Shark)**
Phylum: Chordata – Reptiles and Mammals

**Honu** (Green Sea Turtle)  
[Image of Honu (Green Sea Turtle)]

**Nai’a** (Bottlenose Dolphin)  
[Image of Nai’a (Bottlenose Dolphin)]
## LEARNING LOG 5

**Are We Related?**

**Name:** __________________________ **Date:** __________

Your Challenge: Complete a phylum booklet.
- Draw pictures of at least two organisms from each phylum we studied.
- Write descriptions of at least three anatomical features that make each phylum unique. The first page is started for you. Add additional pages to complete the other phyla.

**Phylum: Chordata**

<table>
<thead>
<tr>
<th>Draw it.</th>
<th>Describe it. What are the anatomical features of these organisms? Do some research and find out more about each phylum.</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Eel" /></td>
<td>• a vertebrate with a backbone</td>
</tr>
</tbody>
</table>

Complete additional pages for: Echinodermata, Mollusca, Arthropoda, Cnidaria, and Annelida.
**ARE WE RELATED?**

**LEARNING LOG 5**

<table>
<thead>
<tr>
<th>NAME: ______________________________</th>
<th>DATE: ______________</th>
</tr>
</thead>
</table>

**Phylum: __________________________**

<table>
<thead>
<tr>
<th>Draw two organisms from the phylum.</th>
<th>Describe it. What are the anatomical features of these organisms? Do some research and find out more about each phylum.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>