LiMPETS Long-term Monitoring Program and Experiential Training for Students
Student Scientists on our Sanctuary Shores

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Program
Mission

To provide authentic, hands-on classroom and coastal field monitoring experiences that connect teachers, students, and the community to the ocean.
LiMPETS Objectives

• To create a new generation of informed and engaged ocean stewards.

• To develop students’ skills and interest in the environmental sciences and motivate some students to pursue a career in the sciences.

• To establish a long-term, baseline dataset that can be used by students, scientists, and resource managers to better assess the health of CA’s intertidal.
Our Citizen Scientists

- High School: 60%
- Middle School: 20%
- College: 10%
- Education Partners: 10%
LiMPETS - Program Overview

Rocky Intertidal Monitoring
- 30 species of invertebrates and algae
- 4 survey methods: vertical transect, random quadrats, total counts, size measurements of owl limpets.

Sandy Beach Monitoring
- Pacific mole crab
- 5 random transects through swash
- Abundance, size, sex, and distribution
LiMPETS Sites
Sandy Beach Monitoring Sites 2010

LiMPETS Sites
Rocky Intertidal Monitoring Sites 2010
Key Elements of Program

1. Teacher Workshop
2. Student In-Class Training
3. Monitoring
4. Data Entry
LiMPETS is an environmental monitoring and education program for students, educators, and volunteer groups throughout California. Approximately 3,500 teachers and students along the coast of California are collecting rocky intertidal and sandy beach data as part of the LiMPETS network. Join us—learn the process of science and help to protect our local marine ecosystems.

"This was an experience that I will never forget!"

— student, Burlingame High School
LiMPETS Successes

- Ocean Literacy
- Improving Data Quality Control and Data Access
- Informing Marine Management
LiMPETS Successes
Ocean Literacy
Change in teacher knowledge, 06-07 (N=30)

- Can define marine sanctuary: 100% PRE, 100% POST
- Can define intertidal zone: 77% PRE, 100% POST
- Can describe 2 threats to CA intertidal: 69% PRE, 92% POST
- Can describe physical characteristics of intertidal: 62% PRE, 92% POST
- Can name at least 3 CA marine sanctuaries: 85% PRE, 31% POST
Science Literacy is #1 Reason Teachers Participate (2007-2010; N=58)

1. Authentic Scientific Investigation & Science Literacy

2. Hands-on OUTDOOR learning; connects students with local ocean habitat.

3. Increased awareness of ocean issues and human impacts.

4. Students get a sense for a career in the sciences.

5. Easy to Participate
LiMPETS Successes
Data Quality Control & Access

New Sand Crab Datasheet

Sand Crab Datasheet

Transect number 1
Name of person entering data

Sample #1

- Check this box if zero crabs were found in sample

<table>
<thead>
<tr>
<th>Crab gender</th>
<th>Crab size (mm)</th>
<th>Tally</th>
<th>Delete</th>
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Add a Crab to the Sample
New Online Graphing Tools

Mole Crab Abundance at Crissy Field Beach: 2001-10
New Online Graphing Tools
Vertical Distribution of Aggregating Anemones: Fitzgerald Marine Reserve 2007-10
LiMPETS Successes
Informing Marine Management:

1. Oil spills
2. North-Central Coast MPA Baseline Characterization
3. Annual Sanctuary Reports
LiMPETS Successes
Informing Marine Management:

Simple protocols can yield reliable data

Figure 2. Replicate counts of large owl limpets (*Lottia gigantea*) and the orange and purple varieties of ochre sea stars (*Pisaster ochraceus*) in the same delineated area at Natural Bridges on two different dates by 2-3 teams each of professional researchers in the PISCO program (solid bars) and students from Aptos High School (open bars).

Osborn et al., California and the World Ocean ‘02, conf proc.
Informing Marine Management: LiMPETS and MPAs

1. LiMPETS awarded 3 yrs of funding to help establish baseline for NCC MPAs.

2. Results will help lay foundation for future assessments of effectiveness of MPAs. Will inform CA whether data is useful & can complement research conducted by scientists.

3. In the process, students and teachers learn about Sanctuaries AND state MPAs.
Informing Marine Management: Sandy Beaches

- Mole crabs are vital link in sandy beach food web.

- Mole crabs are focal species for MPA baseline characterization of beaches.

- No long-term dataset exists beyond LiMPETS.
Summer Abundance (± SE) of Mole Crabs (*E. analoga*) at Ocean Beach, San Francisco: 2003-2010
ENSO, PDO, and Abundance of Mole Crabs (*E. analoga*) at Ocean Beach, San Francisco: 2001-10
Informing Marine Management: Rocky Intertidal

- Other datasets exist (PISCO and MARINe) beyond LiMPETS.

- Focal species for MPA baseline assessments include:
  - cover of mussels
  - cover of algal species
  - abundance of harvested species
Rocky Intertidal Data:
Size Frequency of Owl Limpets at Natural Bridges and Almar Ave, Santa Cruz, CA: 2003 vs. 2009

Natural Bridges: MPA

Almar Ave: Non-MPA
Mean Abundance of Sunburst Anemones (*A. sola*) at Fitzgerald Marine Reserve: 2007-2010

![Graph showing the mean abundance of Sunburst Anemones from 2007 to 2010. The y-axis represents the count per 10 m², ranging from 0 to 2.5. The x-axis represents the years 2007 to 2010. The abundance increased from 2007 to 2010.]
Cumulative Frequency of Acorn Barnacles (*Balanus/ Chthamalus* spp.) Along a Vertical Transect at Duxbury Reef: 2005 vs. 2010
LiMPETS and the Future:
LiMPETS and the Future
ONMS Education Strategic Plan 2010-2020

**Goal 1**
Demonstrate Education Management Excellence

*Outcome:* A skilled team of education experts with a strong reputation for developing and delivering high-quality marine education materials and programs that effectively respond to ocean and Great Lakes issues in national marine sanctuaries.

**Goal 2**
Enhance Ocean and Climate Literacy through National Marine Sanctuaries

*Outcome:* Increased number of ocean- and climate-literate people who are capable of making informed and responsible decisions that may impact the ocean and its resources.

**Goal 3**
Develop and Strengthen Strategic Education Partnerships

*Outcome:* Increased visibility of the National Marine Sanctuary System and enhanced programming through strategic and effective education partnerships.
LiMPETS and the Future
Five-Year Strategic Plan 2010-2015

GOAL 1
Enhance scientific credibility.

GOAL 2
Identify strategic funding sources.

GOAL 3
Build and maintain core staff.

GOAL 4
 Cultivate strategic and effective partnerships.

GOAL 5
Augment education content and standardize implementation of LiMPETS.
LiMPETS and the Future
Number of Student Served Annually: 2005-10

<table>
<thead>
<tr>
<th>Year</th>
<th># Students</th>
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<tbody>
<tr>
<td>2005-2006</td>
<td>681</td>
</tr>
<tr>
<td>2006-2007</td>
<td>892</td>
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<tr>
<td>2007-2008</td>
<td>1155</td>
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<tr>
<td>2008-2009</td>
<td>1496</td>
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<tr>
<td>2009-2010</td>
<td>1684</td>
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LiMPETS and the Future

The California State Standards and Ocean Literacy Principles

The LiMPETS curriculum is aligned with the following:

- the California Education Standards in science and math for grades 6–12.
- the Ocean Literacy Principles and Concepts, which identifies the content knowledge that an ocean literate person should know by the end of 12th grade, www.oceanliteracy.org. Each Ocean Literacy Principle is supported by Fundamental Concepts comparable to those underlying the National Science Education Standards.

The table below outlines the core standards addressed by each activity in Unit Two for grades 6 – 12.

<table>
<thead>
<tr>
<th>Activity</th>
<th>CA State Science and Math Standards</th>
<th>Ocean Literacy Principles</th>
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<tbody>
<tr>
<td>The Essentials of LiMPETS In-Class Preparation</td>
<td>Grade 6 Earth Science: 2.c. Students will learn that beaches are dynamic systems in which the sand is moved along the coast by the action of waves. Grades 6 – 12: Investigation and Experimentation. Students will learn about tools and methods used to monitor the sandy beach and will understand why long-term cumulative data is important.</td>
<td>2.d. Sand is redistributed by waves and coastal currents seasonally.</td>
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<tr>
<td>Monitoring Mole Crabs in the Classroom</td>
<td>Grade 8: Investigation and Experimentation 9.b. Students will evaluate the accuracy of the measurements. Grades 6 – 12: Investigation and Experimentation. Students will use tools to practice monitoring the sandy beach and will understand why long-term cumulative data is important.</td>
<td>5.h. Tides and waves cause zonation patterns along the shore.</td>
</tr>
<tr>
<td>Investigating the &quot;Crab&quot; in Mole Crabs</td>
<td>Grade 7: Structure and function in living systems 5.a. Students will understand that the anatomy of mole crabs illustrates the complementary natures of structure and function.</td>
<td>5.d. Ocean biology provides unique examples of life cycles &amp; adaptations.</td>
</tr>
<tr>
<td>Sandy Beach Food Chain, Trophic Levels, and Biomagnification Game</td>
<td>Grade 6: Math - Number sense 1.0. Students will compare and order fractions or decimals. Students will solve problems involving fractions. Grade 6: Ecology 5.a.b.c.e. Organisms in sandy beach ecosystems exchange energy and nutrients among themselves and with the environment.</td>
<td>6.a. The ocean affects every human life. It affects human health.</td>
</tr>
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</table>

Unit 2 | Engage and Prepare: In-class Introductory Activities for Sandy Beach Monitoring

Using this curriculum

CA State Standards and Ocean Literacy Principles

ACTIVITY: The Essentials of LiMPETS In-class Preparation
- Student Crossword Puzzle
- Crossword Answer Key
- Sandy Beach Fact Sheet
- Mole Crab Fact Sheet
- Field Sampling Techniques Fact Sheet

ACTIVITY: Monitoring Mole Crabs in the Classroom
- Mole Crab Cards

ACTIVITY: Investigating the "Crab" in Mole Crabs
- Mole Crab Coloring Page

ACTIVITY: Sandy Beach Food Chain, Trophic Levels, and Biomagnification Game
- Playing cards

ASSESSMENT: Student Reflection
Data Analysis Unit

Graphing 101: Tracking a keystone species over time

- Students will be able to read and interpret graphs
- Students will understand why long-term monitoring of intertidal species is important

Global Climate Change Exploration: Impact on Intertidal Species

- Students will be introduced to the potential impacts of global climate change on intertidal species.
- Students will use critical thinking skills to determine how the range of a warm water species may be affected by global climate change

Exploring MPAs: Do They Matter?

- Students will be able to define MPAs and explain their importance.
- Students will use critical thinking skills to determine if applying protections to areas affects species abundance and size.
The Future: Increasing monitoring effectiveness and data robustness by establishing a **Scientific Advisory Team**.

- Local LiMPETS Coordinators
- Science Advisory Team
- Trained teachers and students

**LiMPETS Dataset**
The Future: Creating a more balanced effort from all three participating sanctuaries

*Hiring of local coordinator at Pacific Grove Museum of Natural History
Funding of LiMPETS:
Lack of adequate funds leads to creative solutions

- Fundraised money (FMSA, PGMNH)
- Sanctuary budget
  - Staff time
  - In-kind support
- Future: both sides have needs to keep the partnership effective and strong.
The Future: OCNMS and LiMPETS?

- Reviewing current methods, protocols, and species with their coastal habitats.
- Piloting program with 4 schools, starting with rocky intertidal monitoring.
- Evaluate and decide from there.
Conclusions

LiMPETS is unique:
• a student-based citizen science program
• collects long-term data for California’s national marine sanctuaries

LiMPETS has already been successful:
• increasing ocean literacy
• currently informs marine management

LiMPETS has big plans for the future:
• a premier ocean education program
• increasing robustness and use of our dataset
How to get involved in LiMPETS
www.limpetsmonitoring.org

Get Involved

Who can participate?
We work with many different types of school groups, informal educational programs, and community organizations. The majority of our participants are high school teachers and students.

What is involved?
1. Training: Teachers or group leaders complete a training by the local LiMPETS coordinator.
2. Preparation: Everyone should learn to correctly identify algae and invertebrates and practice the monitoring methods used in the field.
3. Monitoring: We recommend that you explore your monitoring site and practice the monitoring techniques at least once before monitoring begins. How frequently should you monitor? That's up to you. Some participants monitor monthly once per year. Others monitor monthly.
4. Data Entry: Enter the data online.
5. Analysis: Develop research questions and use the online graphing tools to analyze results.
6. Communication: Sharing your results is important! Some participants attend scientific meetings, others create informational brochures, or lead community events.

Support
We provide direct support and a variety of resources to community groups in a 50-mile radius of a National Marine Sanctuary office. Offices are located in San Francisco, Monterey, and Santa Barbara. Services include equipment loan, assistance in the classroom and the field, support with data entry and analysis, and more. Everyone is welcome, regardless of location.

How do I get started?
1. Contact the LiMPETS coordinator in your area.
2. Learn the protocol: Your LiMPETS coordinator will ask you to complete a training before starting a LiMPETS program at your school or organization. For more information about LiMPETS training workshops in your area.
3. Choose an established monitoring site. A LiMPETS Coordinator can help you.
4. Borrow, build, or purchase monitoring equipment.

"This was an experience that I will never forget!"
— student, Bartigana High School
Questions?