

Duxbury Reef Rocky Intertidal Restoration Project

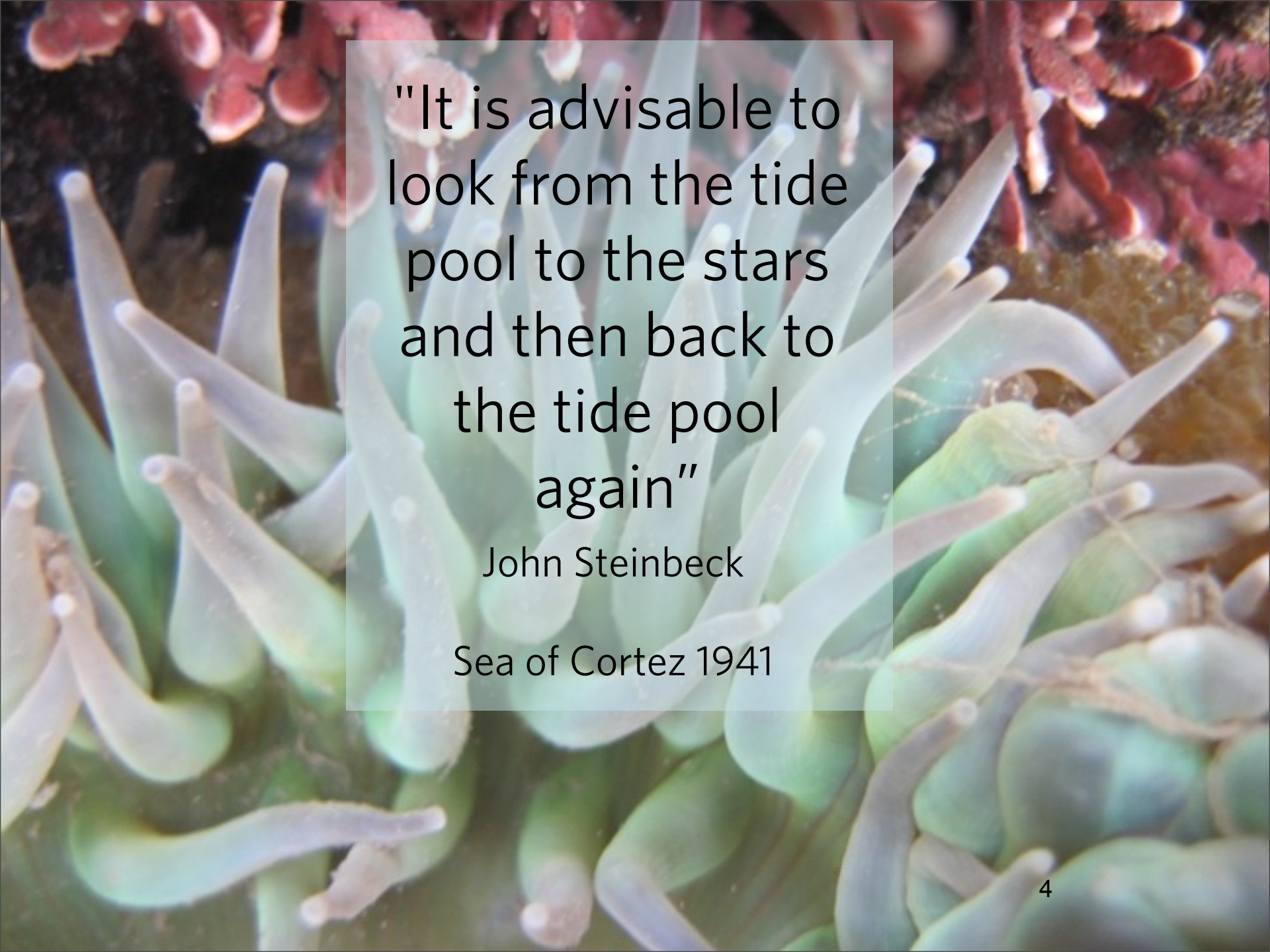
A photograph showing a rocky intertidal reef area. In the foreground, a weathered wooden fence with a post and rail design runs across the frame. Beyond the fence, the ground is covered in green and brown vegetation. In the background, waves are crashing against a rocky shoreline under an overcast sky.

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Educate and
engage volunteers
to work as roving
naturalists and
become citizen
scientists at
Duxbury Reef.






"It is advisable to
look from the tide
pool to the stars
and then back to
the tide pool
again"

John Steinbeck

Sea of Cortez 1941

A coastal landscape with a large red flower in the foreground and a tide pool in the background. The flower is a tall, slender stalk with a dense, conical cluster of small, bright red tubular flowers. The background shows a rocky coastline with a tide pool reflecting the sky, and a blue sky with light clouds.

"It is advisable to
look from the tide
pool to the stars
and then back to
the tide pool
again"

John Steinbeck

Sea of Cortez 1941

Duxbury
August 22, 1849



At least ten more ships have wrecked on the reef.

Polaris 1914





Reef-a ridge of jagged rock or coral just above or below the surface of the sea.

Supports a diverse assemblage of invertebrates and algae.



Duxbury Reef is the largest shale reef in North America.

The mudstone is exposed at low tide.

Softer layers and fractures form parallel tidal channels.

Ridges extend seaward a half a mile into Bolinas Bay.



Hundreds of species of vertebrates, invertebrates and algae and can be found at Duxbury.



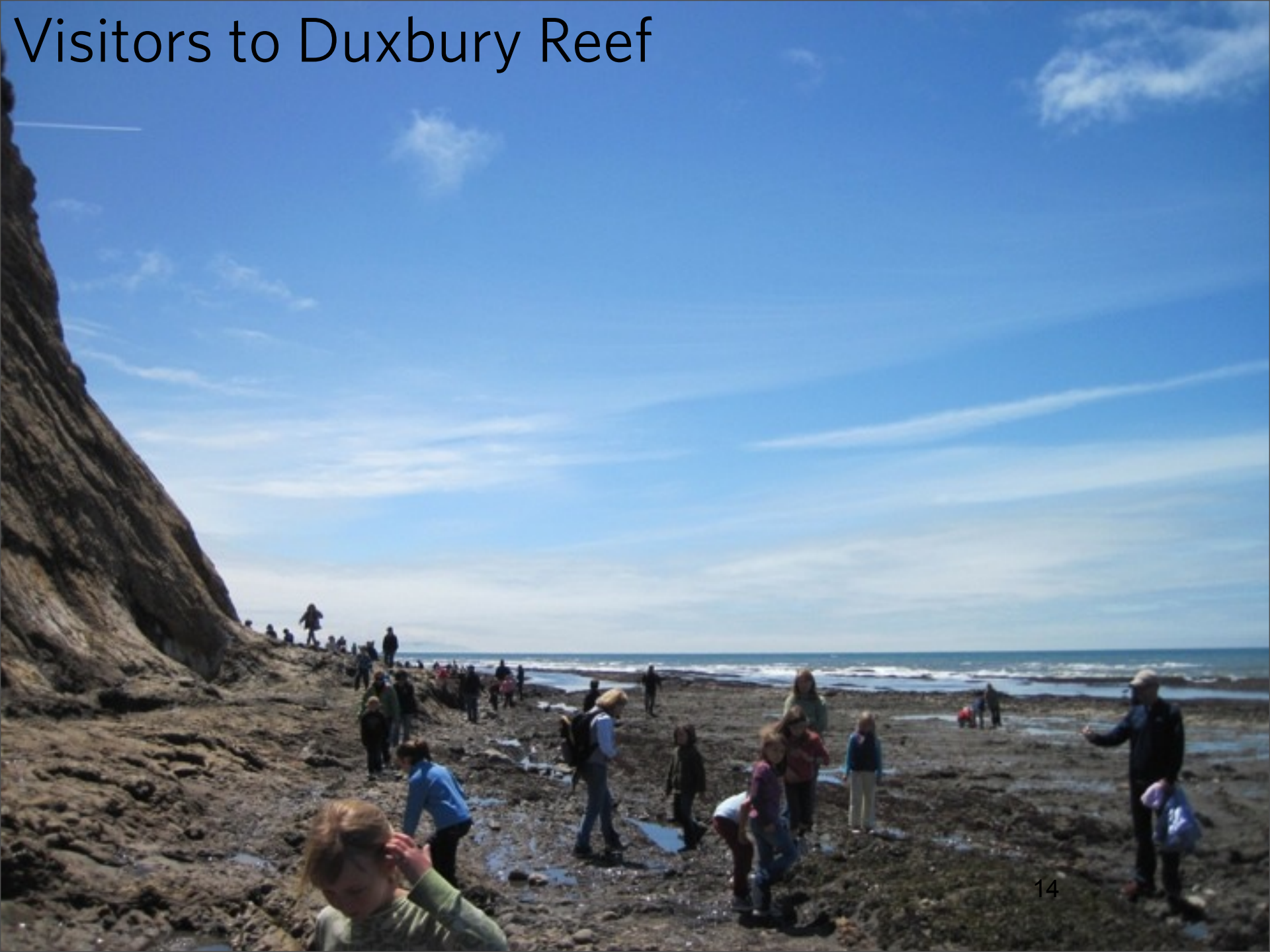
Visitors to Duxbury Reef



Visitors to Duxbury Reef



Visitors to Duxbury Reef



Human impacts on the rocky intertidal

Trampling



Rock Rolling



Extraction/Collecting/Poaching

Lack of 'Tidepool Etiquette'



Collecting



Fig. 1. Two members of the general public digging into the soft shale of Duxbury Reef for clams.

Chan 1972

The American Biology Teacher

Visitors 1969

From Chan 1972
The
American
Biology
Teacher



Fig. 2. Dozens of school children on Duxbury Reef during the period of conservation education.

Area of Special
Biological
Significance

Duxbury Marine
Reserve
(Since 1971)

**Duxbury State
Marine Park
no take-except
fin fish
and abalone**



DUXBURY REEF RESERVE

A LIVING TREASURE TO BE PROTECTED BY ALL OF US

IT IS AGAINST THE LAW TO REMOVE MUSSELS, CLAMS, STARFISH
OR ANY KIND OF TIDEPOOL LIFE.

FISHING IS LEGAL. HOWEVER, REMOVAL OF MUSSELS FOR BAIT IS ILLEGAL.

POINT REYES-FARALLON ISLANDS NATIONAL MARINE SANCTUARY
CALIFORNIA STATE MARINE RESERVE C.A.C.T. 14
MARIN COUNTY PARKS AND RECREATION



Gordon Chan, Drake High School teacher and College of Marin professor, found that once an on-site education program was enacted, intertidal visitors to the reef:

Collected fewer animals and seaweeds

Were more responsible with their actions

And in general had less of an impact than visitors before the education program began.



Fig. 3. Dozens of school children on Duxbury Reef during the period of conservation education.

This program has similar goals...



Inspire and educate.

Promote stewardship.

Involve local residents.

Prevent collecting.

Minimize trampling.



The Rocky Reef Intertidal Restoration Project's primary goal is to reduce visitor use impacts at Duxbury Reef through education.



Visitor use impacts are not the only threat to Duxbury Reef.....



Christopher M.
Ran aground
in 2005



NPS Photo



SS Cape Mohican October 1996



http://mapping2.orr.noaa.gov/portal/sanfranciscobay/sfb_html/pics/mohican.jpg

SS Cape Mohican October 1996



http://www.dfg.ca.gov/ospr/spill/nrda/nrda_mohican.html

SS Cape Mohican Oil Spill 1996

Five hundred and sixteen intertidal acres were oiled by this spill.

At least 600 birds were killed.

The SS Cape Mohican Trustee Council is made up of representatives from; the National Parks Service, the U.S Fish and Wildlife Service, the National Oceanographic and Atmospheric Association, California Department of Fish and Game, California Department of Recreation and Parks.

The trustee council selected this project to restore the impacted rocky intertidal area at Duxbury Reef.

The Duxbury Reef Rocky Intertidal Restoration Project is funded by SS Cape Mohican Trustee Council Restoration Dollars.



SS Cape Mohican Oil Spill 1996

It is difficult to directly measure the damage and recovery of the ecosystem at Duxbury reef.

At the time of the spill, we did not have sufficient baseline data with which to measure impacts and/or recovery.

A monitoring system has been set up to characterize the reef and serve as baseline data in the unfortunate event of another spill.

Can we restore and/or minimize visitor impact and harvesting damage to the reef with a community-based education and stewardship program?





NATIONAL MARINE
SANCTUARIES

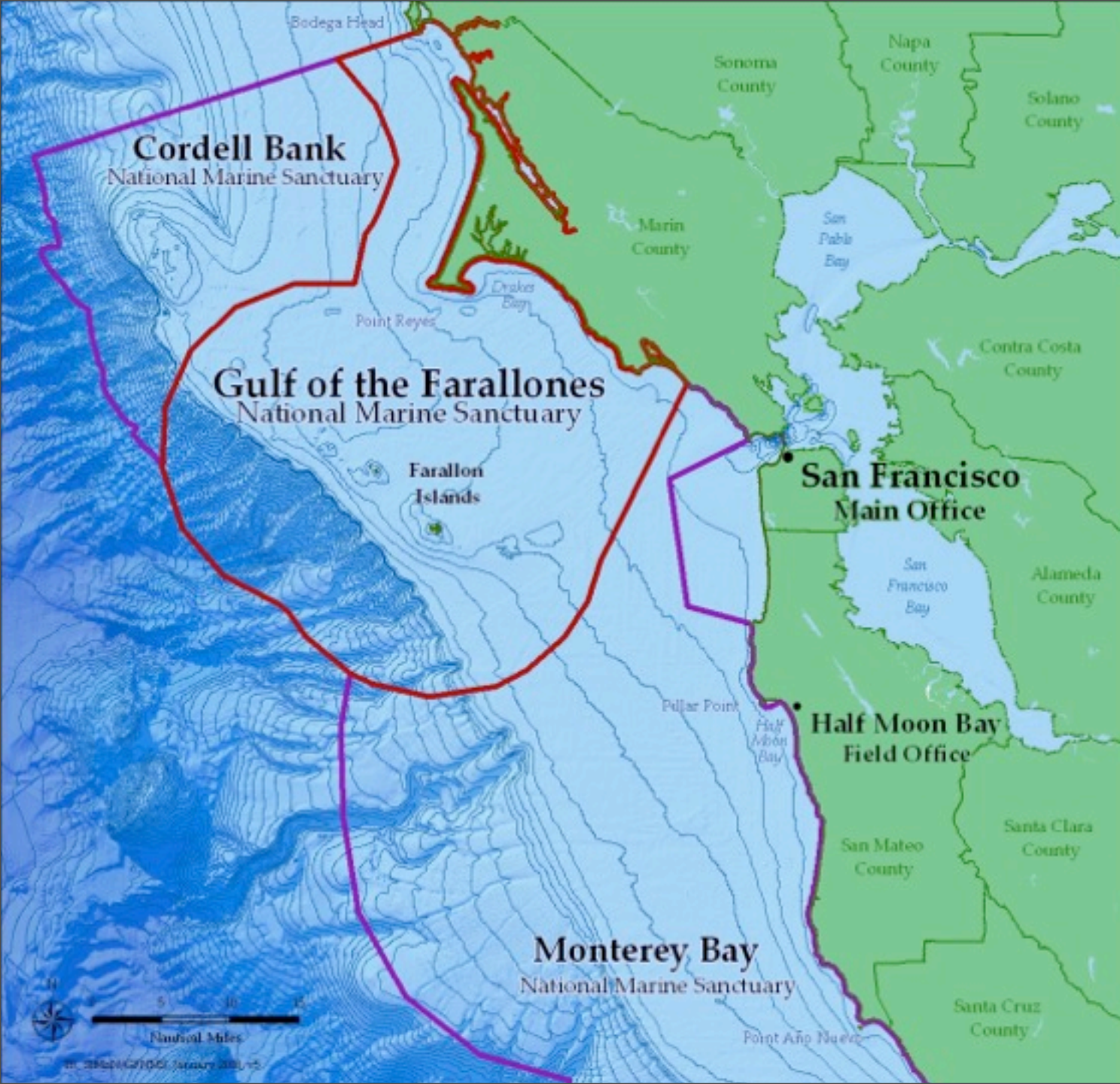
GULF OF THE
FARALLONES



CALIFORNIA
ACADEMY OF
SCIENCES



TENERA Environmental



Coordinates,
oversees and
supports the
Duxbury
Rocky
Reef
Intertidal
Restoration
Project

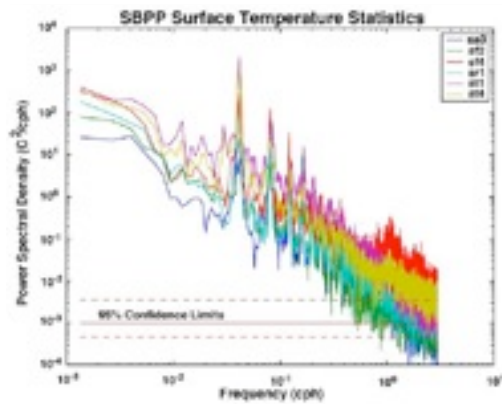
Environmental consulting firm, founded in 1975

Offices in San Luis Obispo & Lafayette

Resource analysis, permitting, regulatory compliance

Fitzgerald Marine Reserve resource assessment (San Mateo Co.)

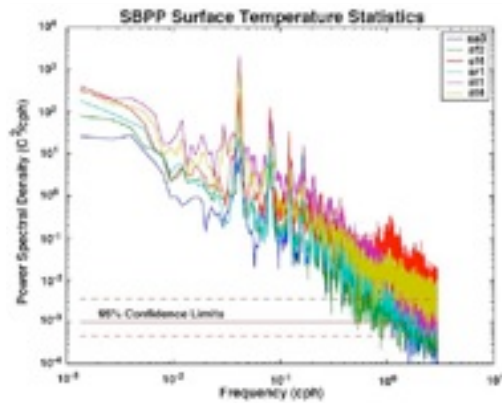
Exxon Valdez oil spill impact and recovery monitoring (NOAA)



Tenera conducts the regular research monitoring at Duxbury Reef.

They have been monitoring since 2006.

The data they have collected will help us understand the reef and is a baseline which we can use in case of another disaster and to test the effectiveness of our restoration project.



The academy brings a long history of research, education and stewardship to this project.

The 'new' academy has had over 3,000,000 visitors since re-opening in 2008.

There are close to 500 academy docents, many of whom will receive additional training through this program.

The academy has the ability to educate visitors on rocky intertidal natural history, convey a conservation and stewardship message to a large audience.



CALIFORNIA
ACADEMY OF
SCIENCES



National Marine Sanctuary-California Coast Exhibit

Designed and financed in partnership

Habitats of the sanctuaries

Touch tide pool

Education and Conservation

CAS docents inspire and make connections



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ACADEMY OF
SCIENCES



Duxbury Reef Restoration Program



Trains Rocky Shore Naturalists on tidepool etiquette, natural history, biology and ecology of intertidal invertebrates and algae.

The Rocky Shore Naturalists:

Serve as roving docents and educate and interact with visitors to Duxbury.

Conduct visitor counts on weekends and days with significant low tides.

Monitor permanent research sites at Duxbury Reef.

Work in the California Coast exhibit at the California Academy of Sciences and make connections between the exhibit and our local National Marine Sanctuaries.

A major component of the restoration is the development of a corps of community-based volunteers. Rocky Shore Naturalists.









Out in the Sanctuary
engaging visitors....

Tidepool







*Making the connections between animals and habitats and our sanctuary...
and working with scientists to better understand Duxbury Reef...*

Main Access to Duxbury Reef



Visitor Counts

Preliminary visitor use data
2006-2008

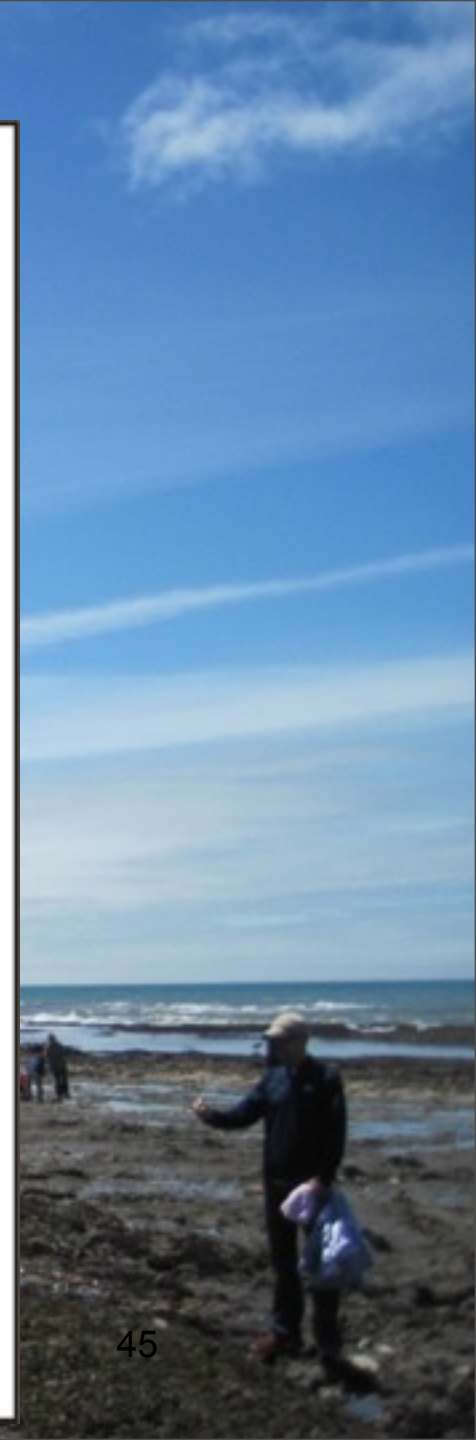
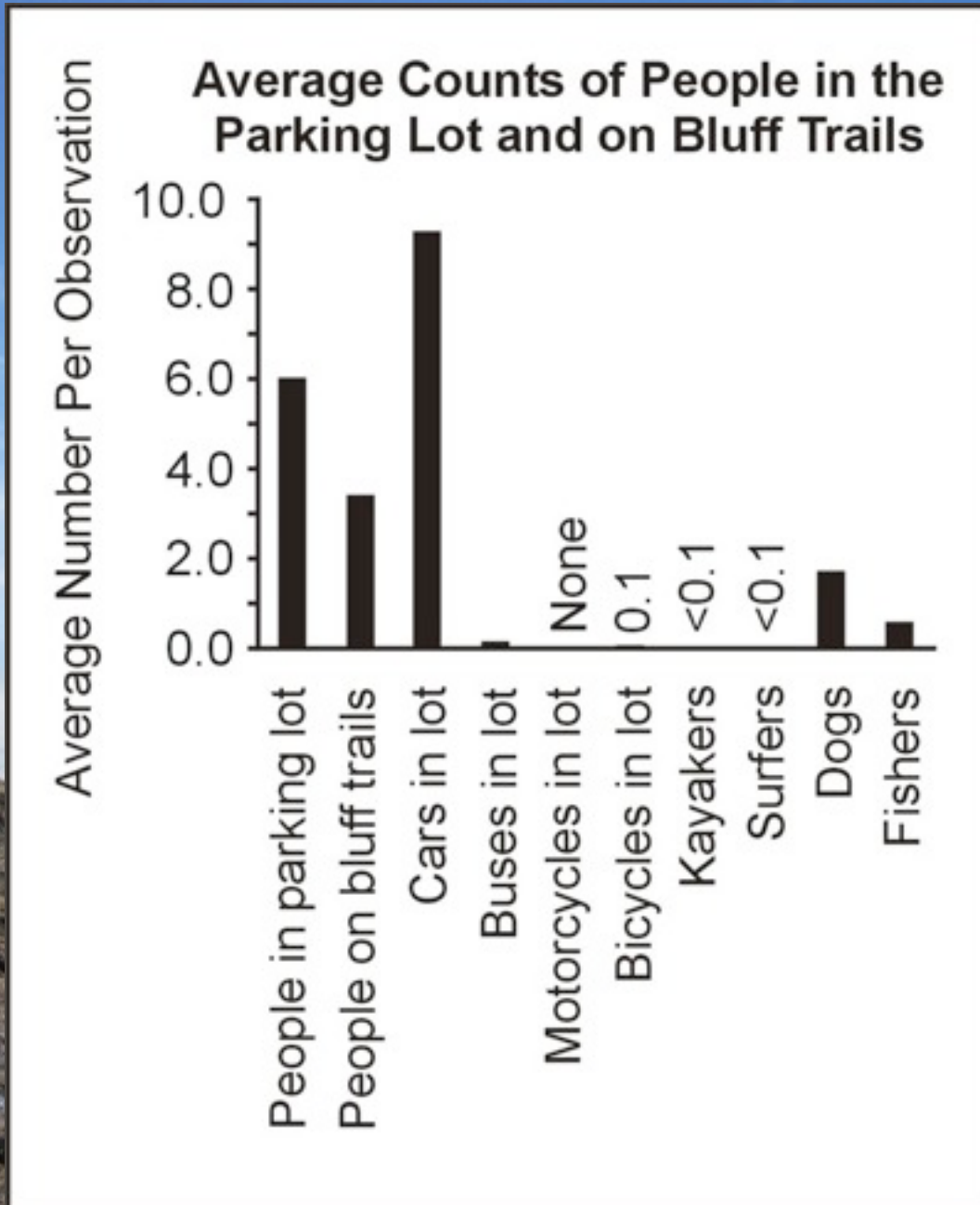
Taken one hour before low tide, at low tide and one hour after low tide on selected optimal low tide days

This visitor count data informed research site placement.

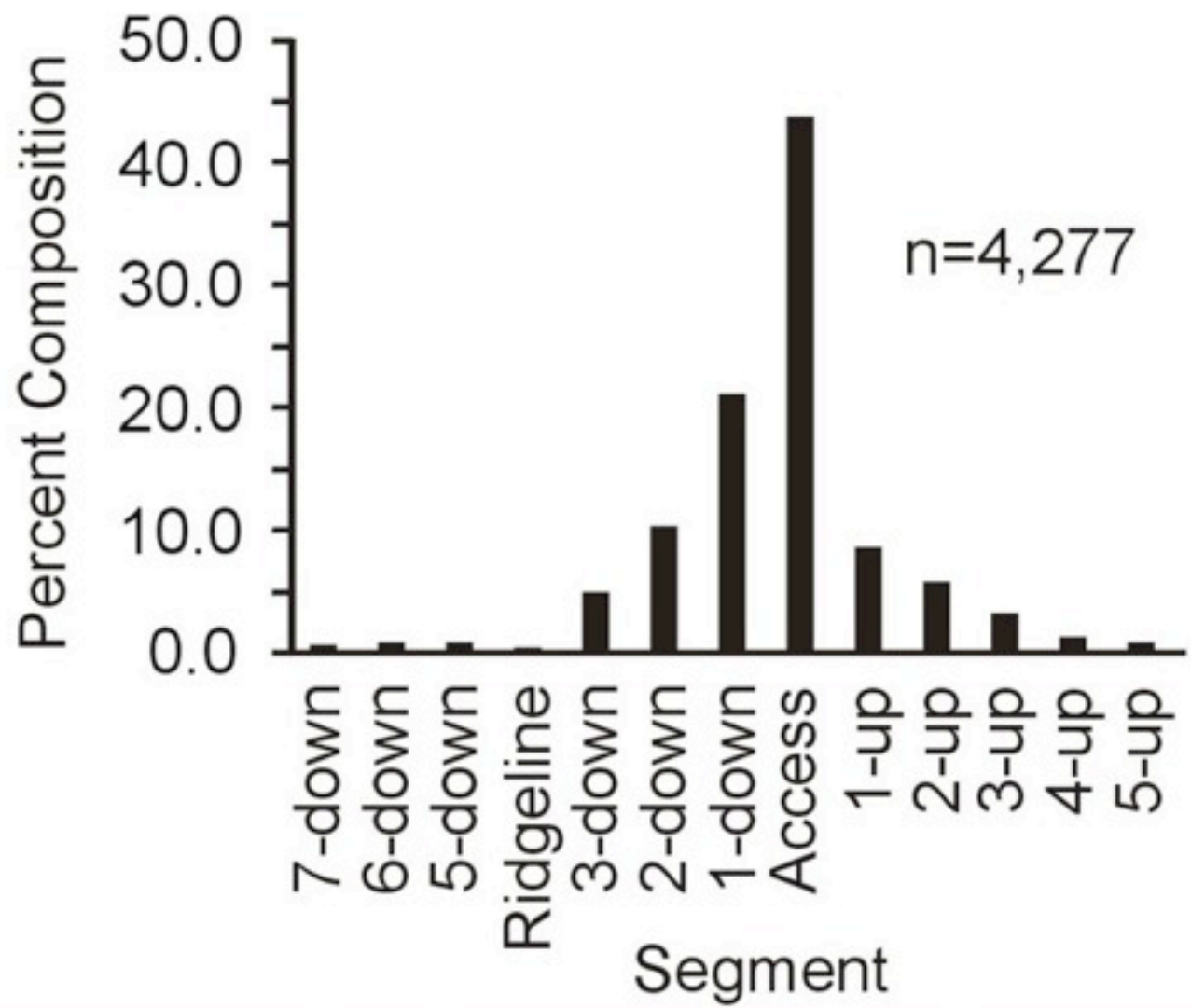
Rocky Shore Naturalists conduct visitor counts.

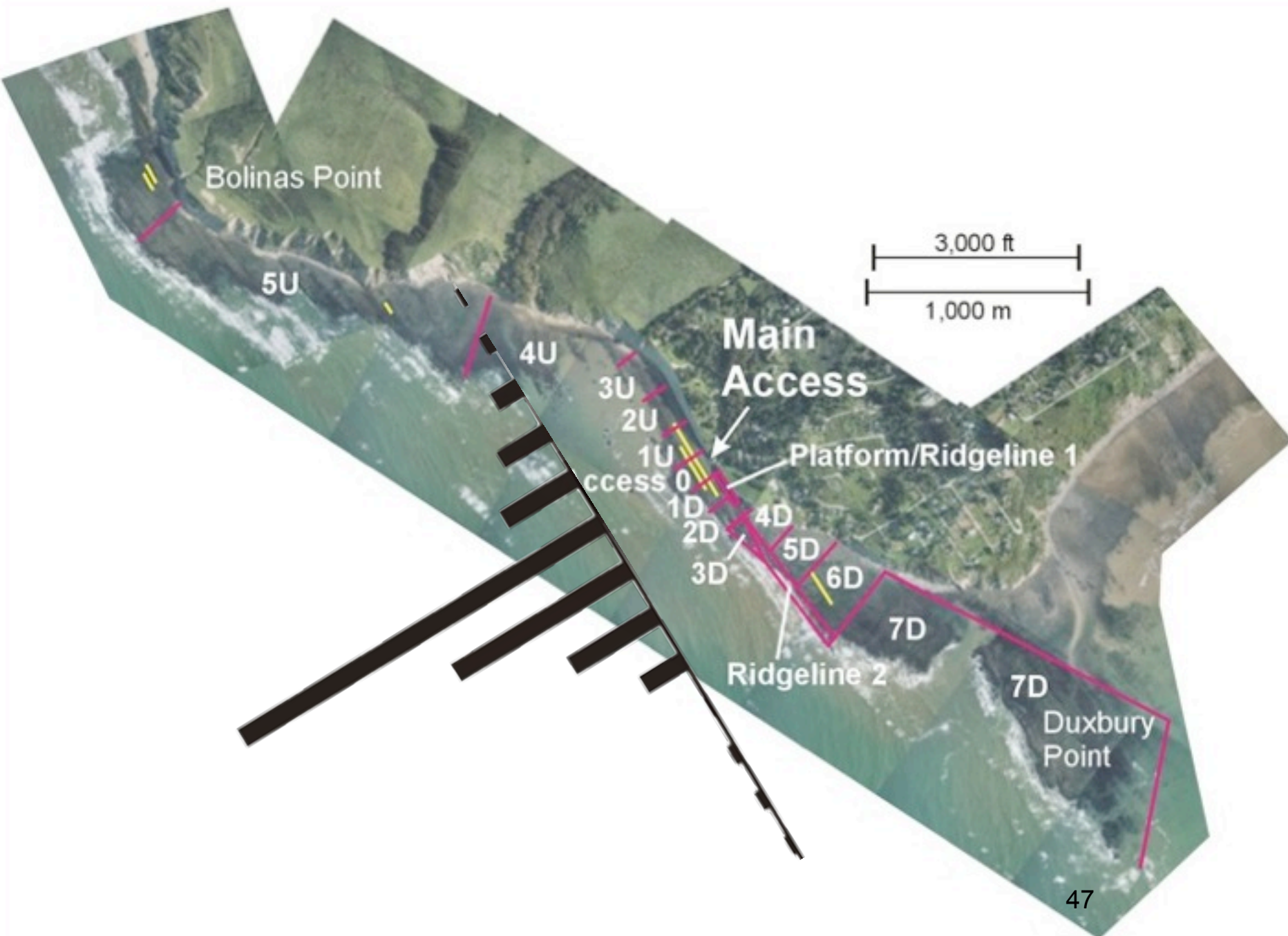


Visitors to Duxbury Reef



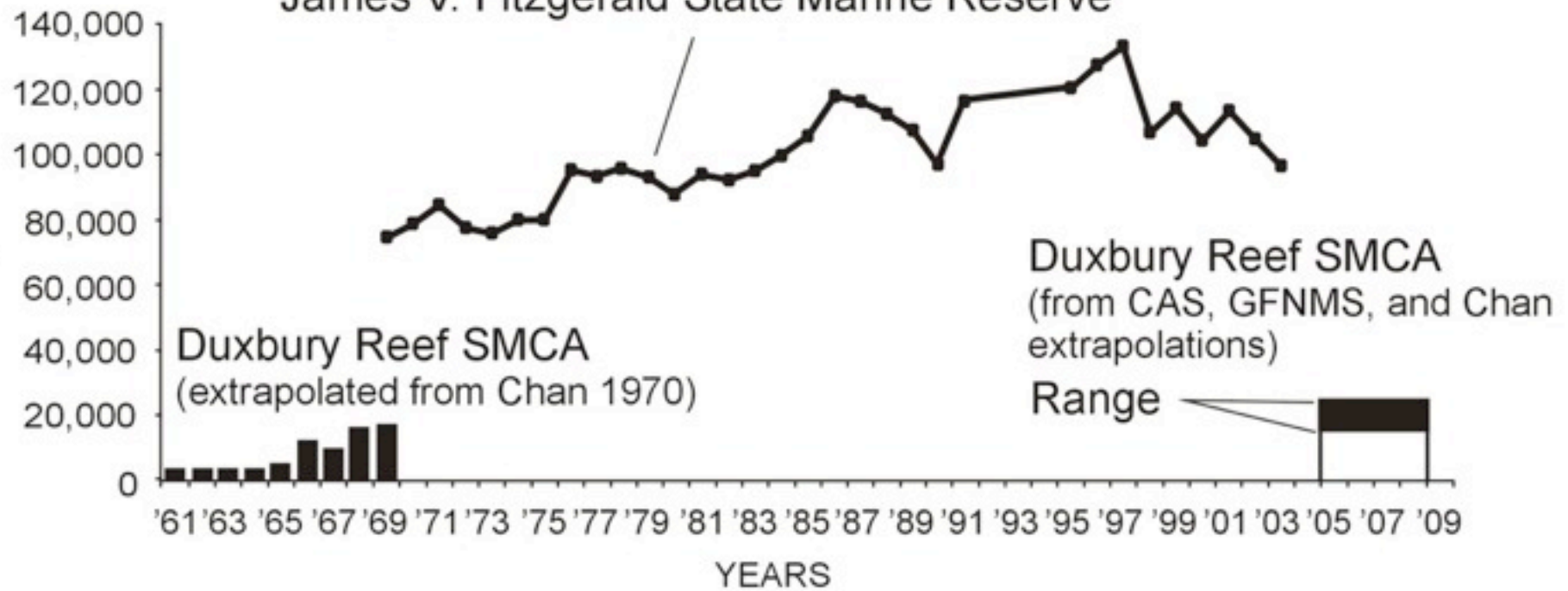
Proportion of People in Shore Segments Standardized to Shore Segment Length



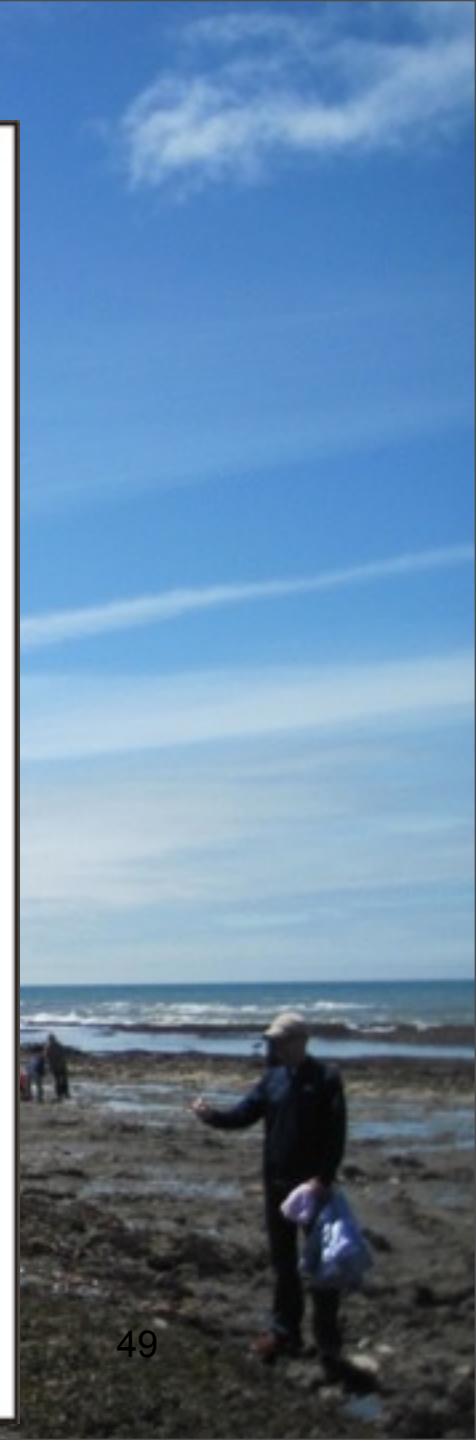
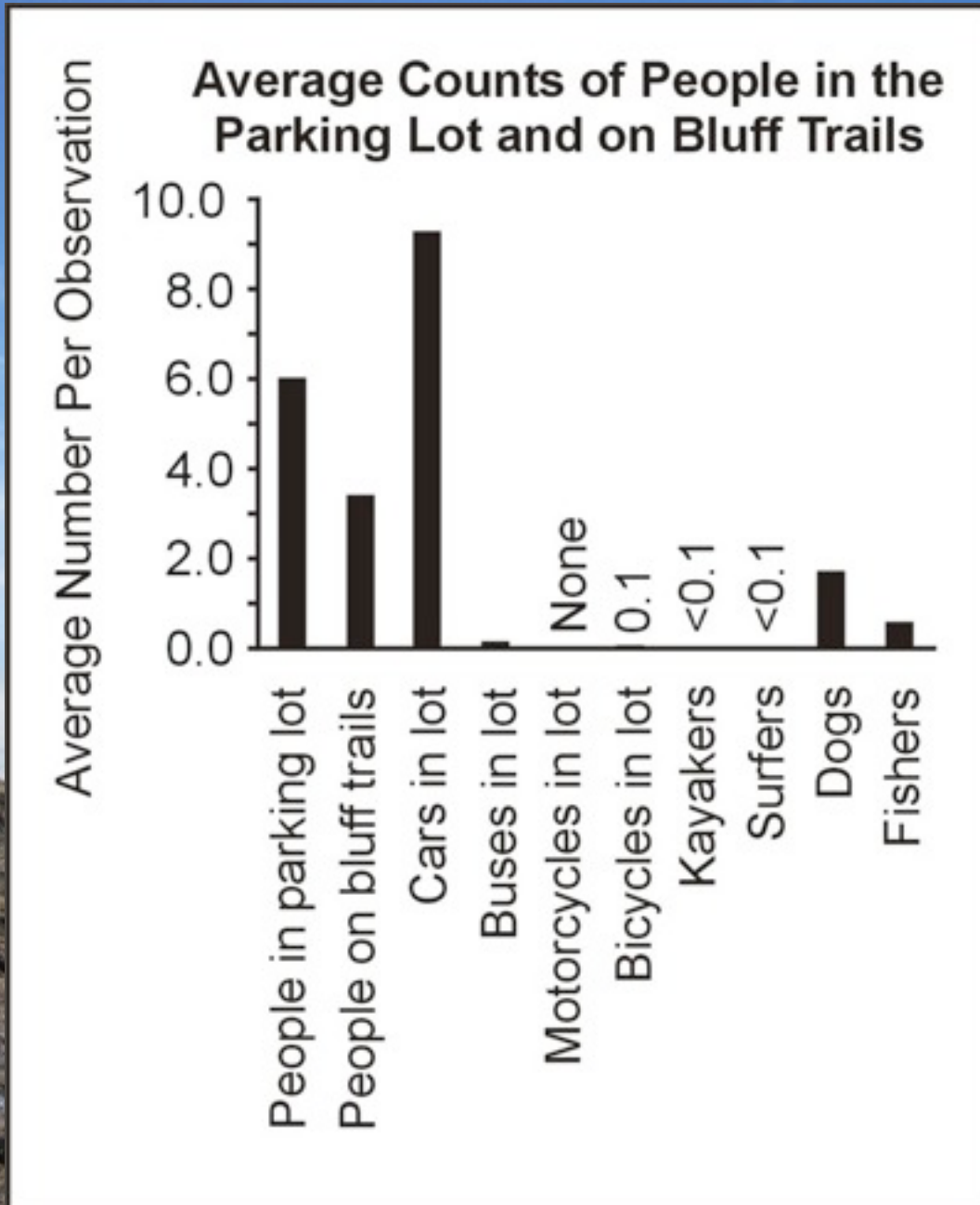


Annual Attendance at Two MPAs in the GFNMS

James V. Fitzgerald State Marine Reserve

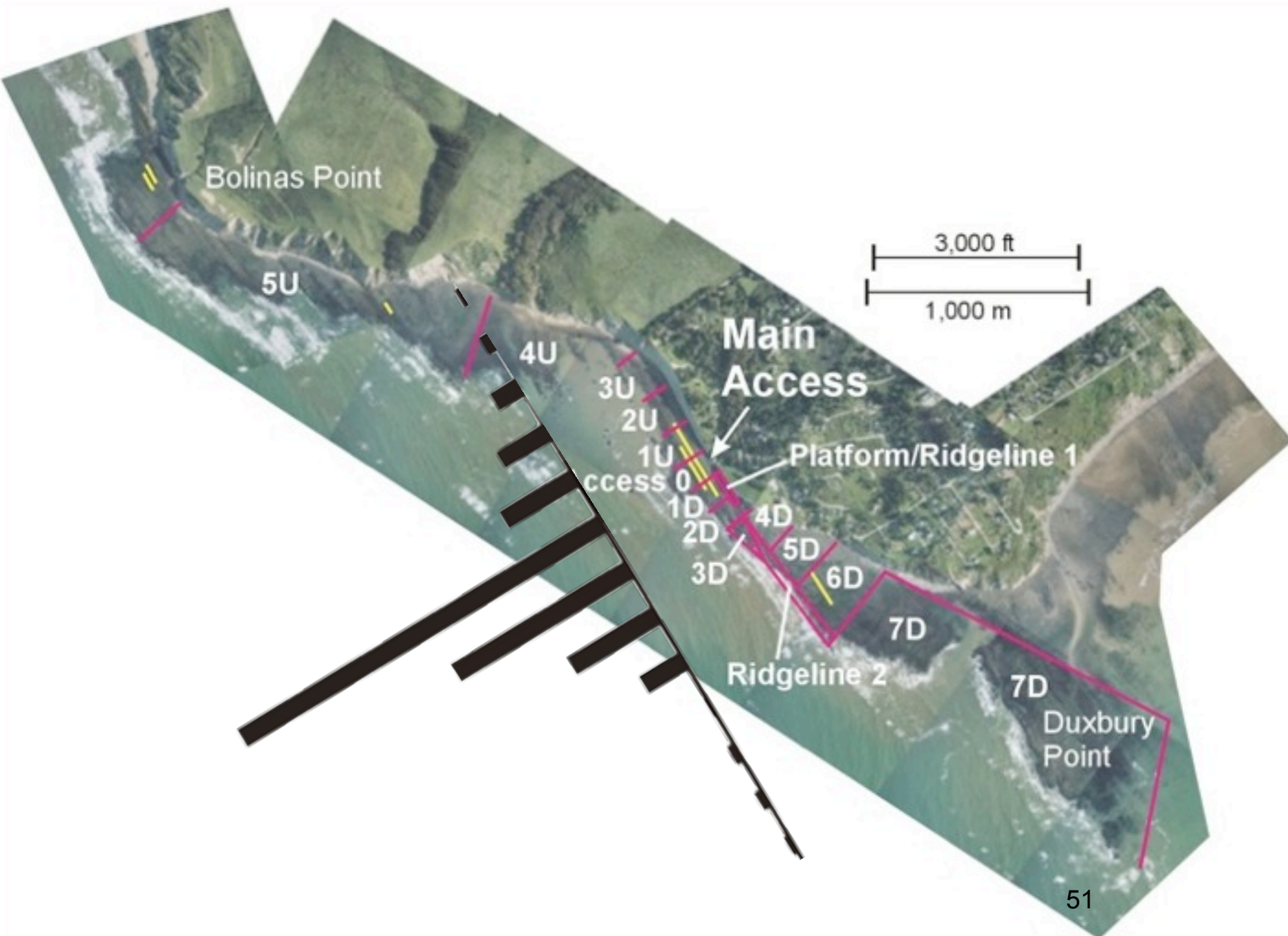


Visitors to Duxbury Reef



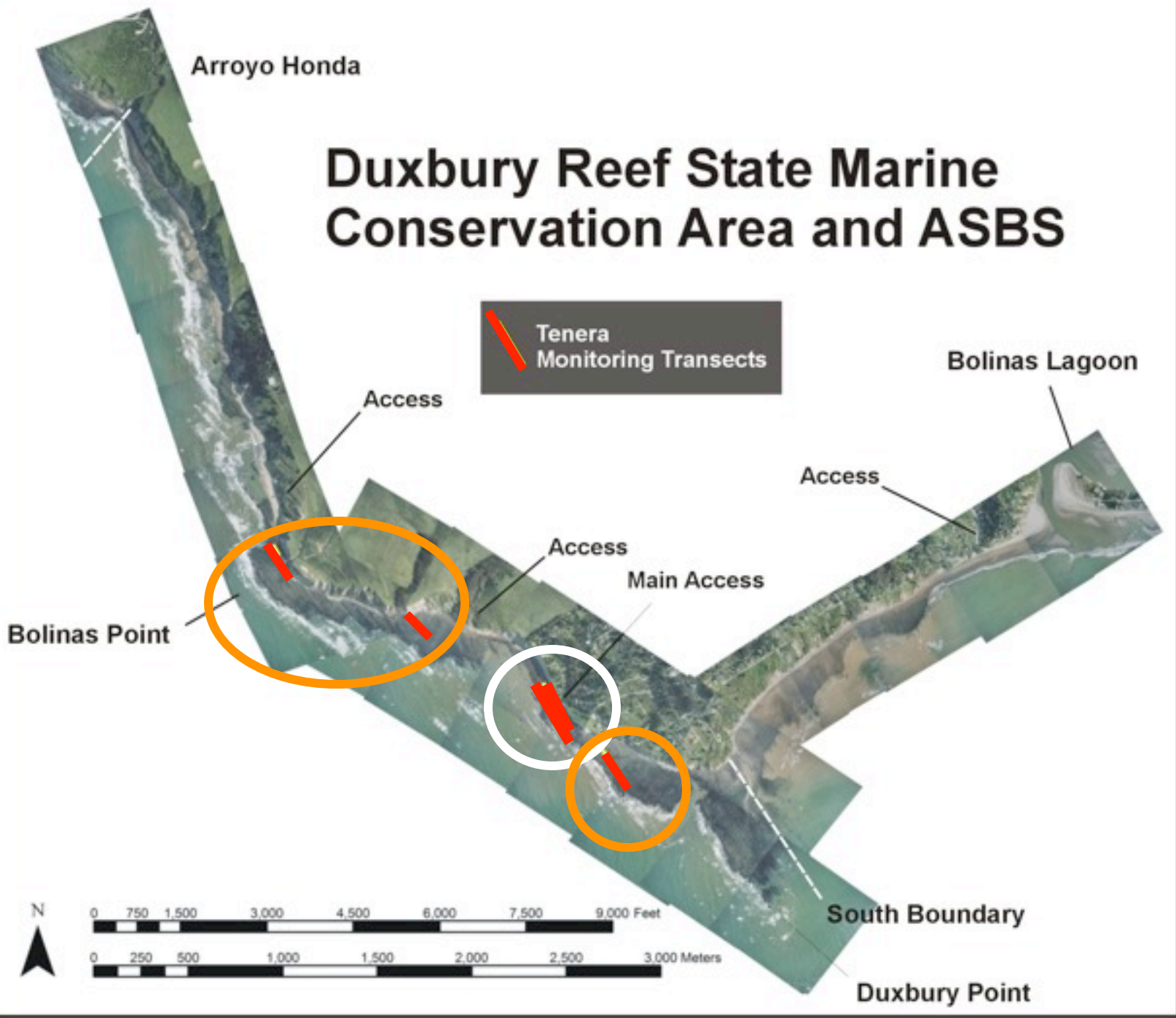
We need a more effective way to count visitors and to understand Duxbury usage.





Duxbury Reef State Marine Conservation Area and ASBS

Tenera Monitoring Transects



Arroyo Honda

Bolinas Lagoon

Access

Access

Bolinas Point

Access

Main Access

South Boundary

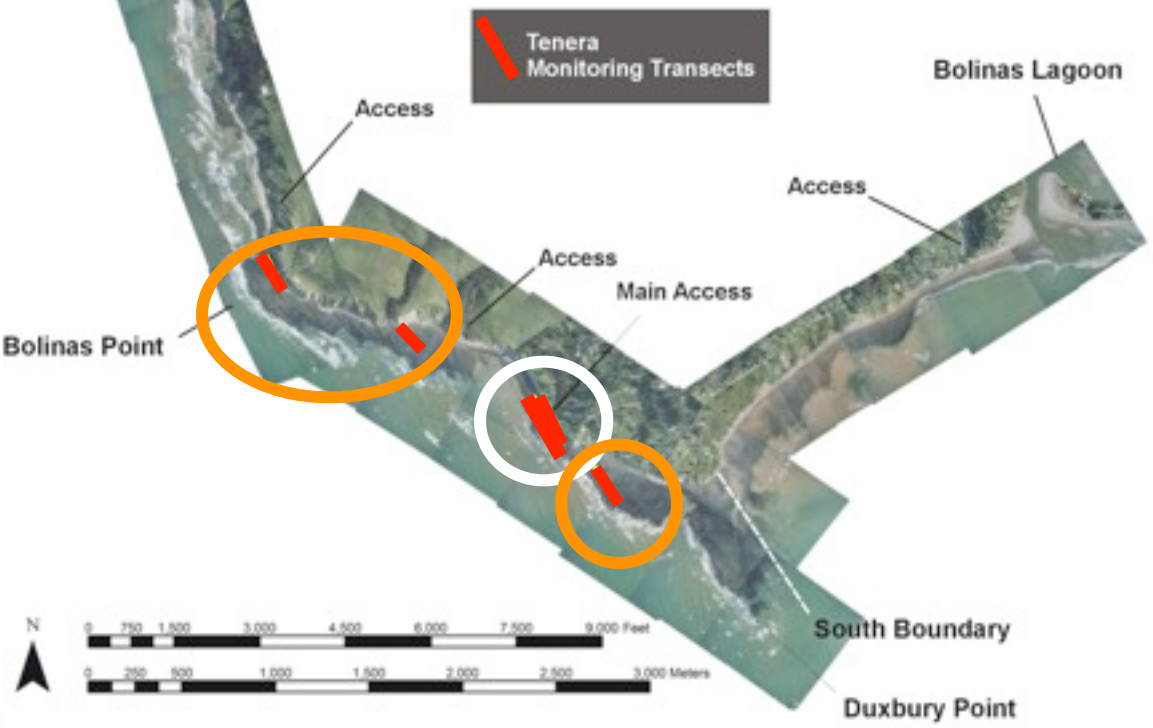
Duxbury Point

N

0 750 1,500 3,000 4,500 6,000 7,500 9,000 Feet

0 250 500 1,000 1,500 2,000 2,500 3,000 Meters

Duxbury Reef State Marine Conservation Area and ASBS



Tenera monitors transects twice a year:
At the access
North-low use
South low use

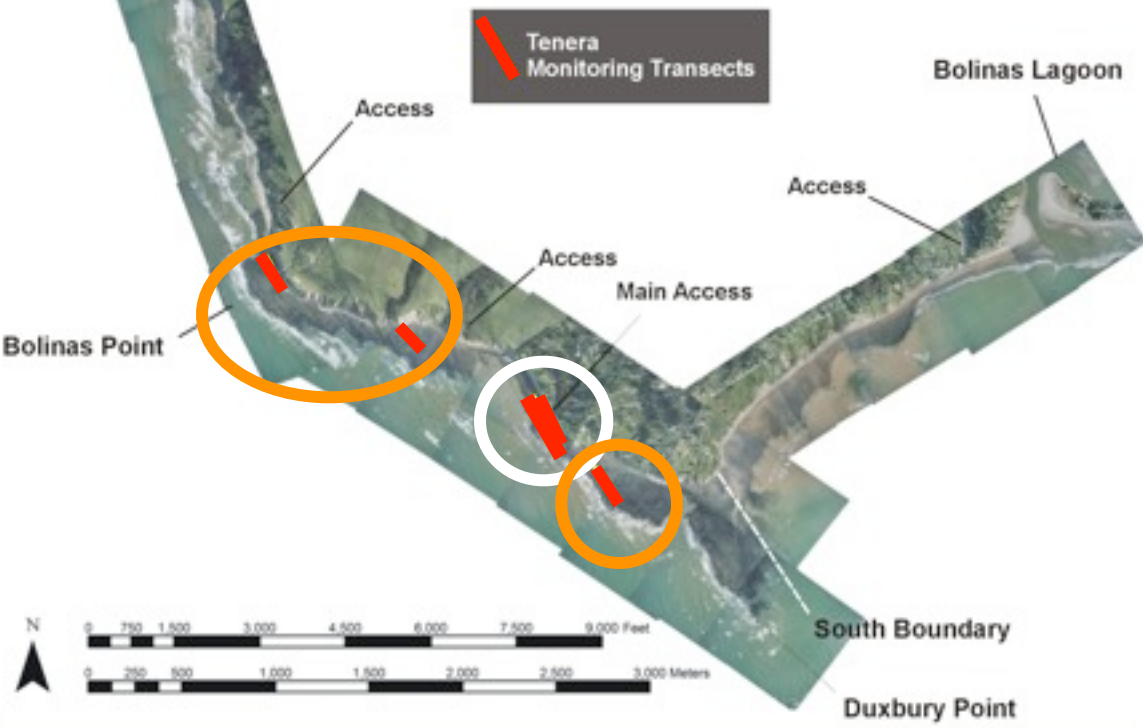
Tenera Environmental Monitoring





Monitoring Site Markers

Duxbury Reef State Marine Conservation Area and ASBS



Tenera monitors transects twice a year:
At the access
North-low use
South low use

Volunteers monitor three transects:
Site 1 -at the access
Site 2- low traffic north of the access
Site 3- low traffic south of the access

Monitoring Design

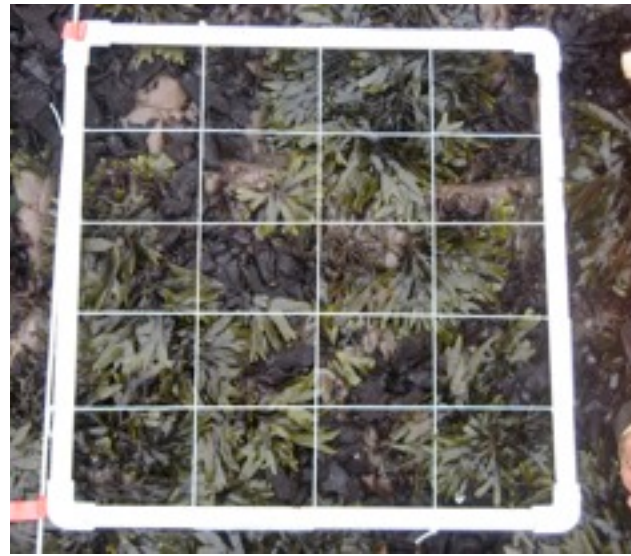


Fucus gardneri



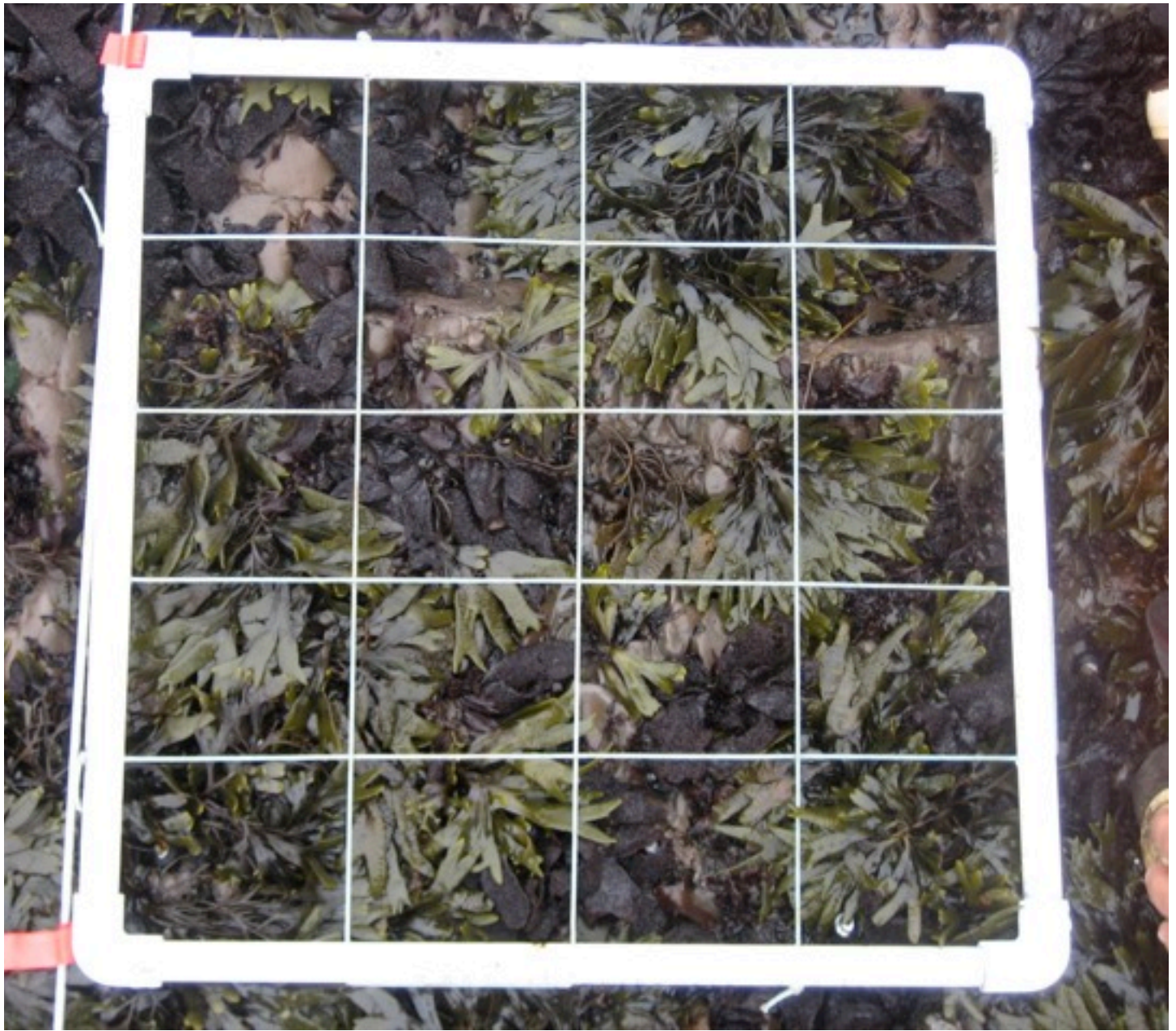
Sensitive to trampling













Volunteer Monitoring of *Fucus*- Quarterly

Aug 2009

Volunteer
Photo
Monitoring
Monthly





Sept 2009

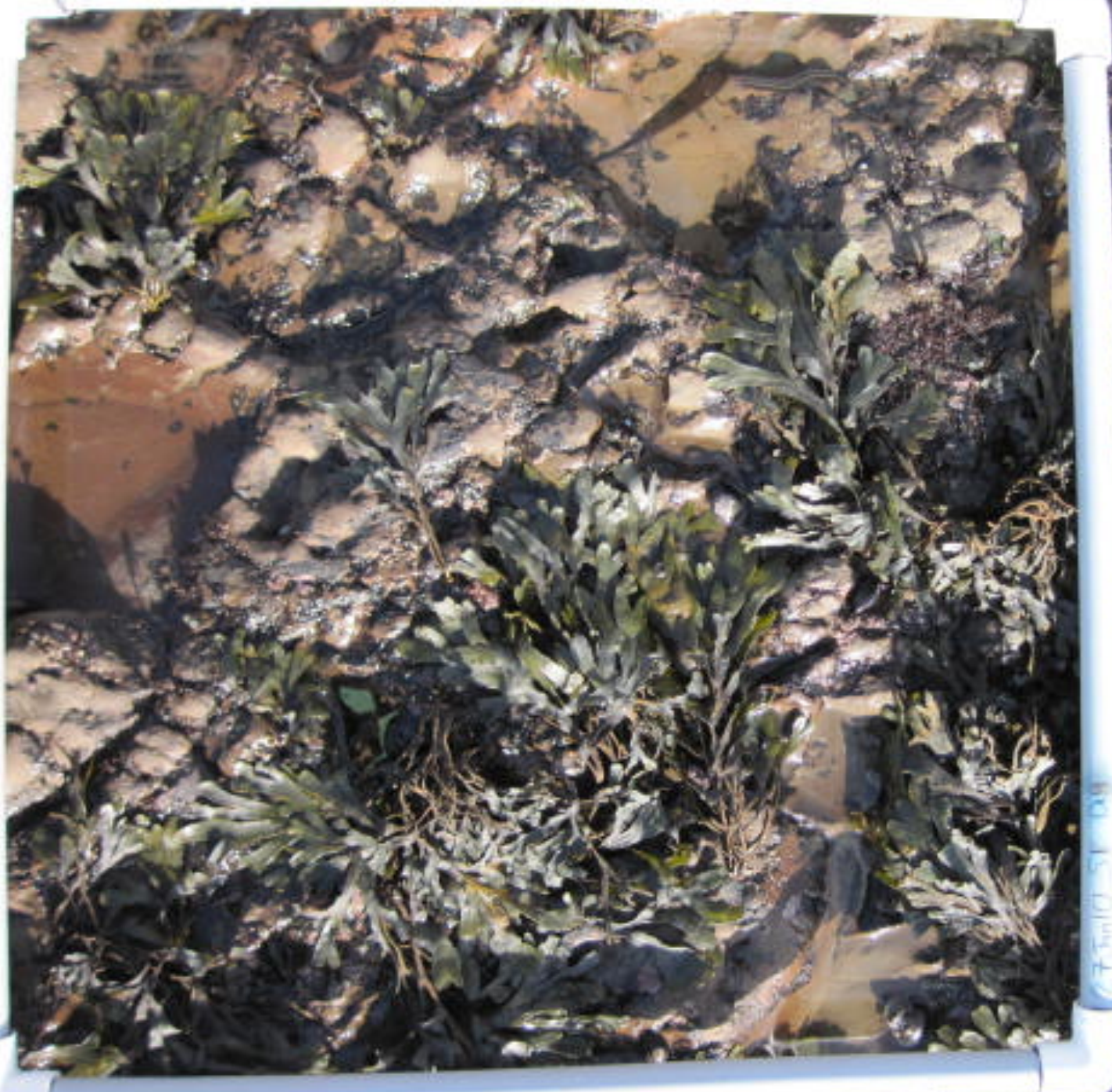
Oct 2009



Photo by [unreadable]

Nov 2009





Jan 2010

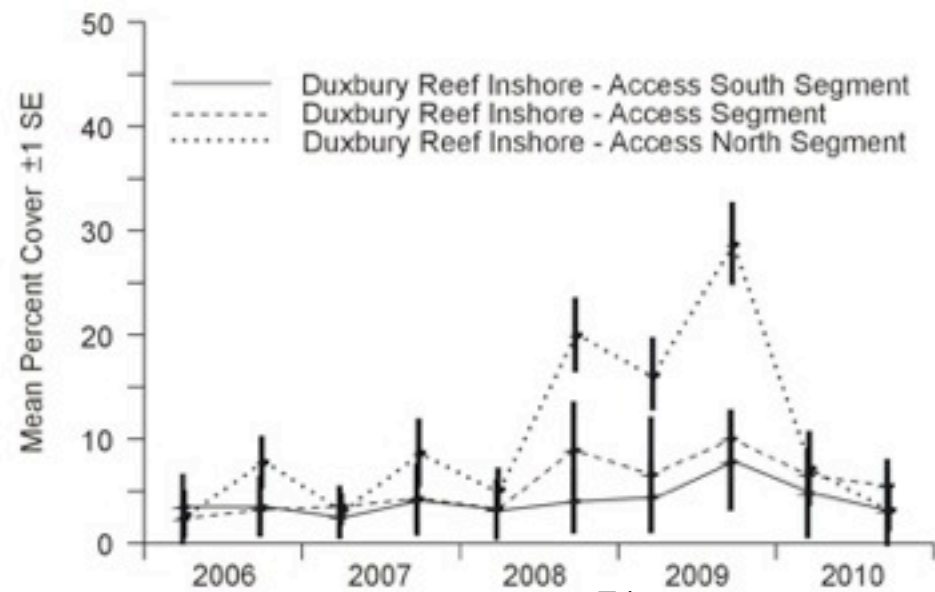
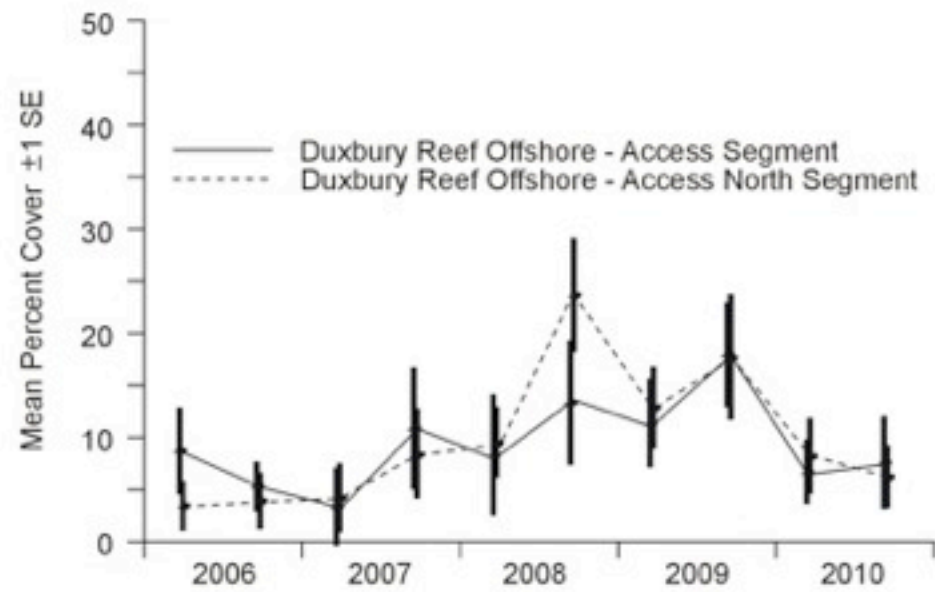
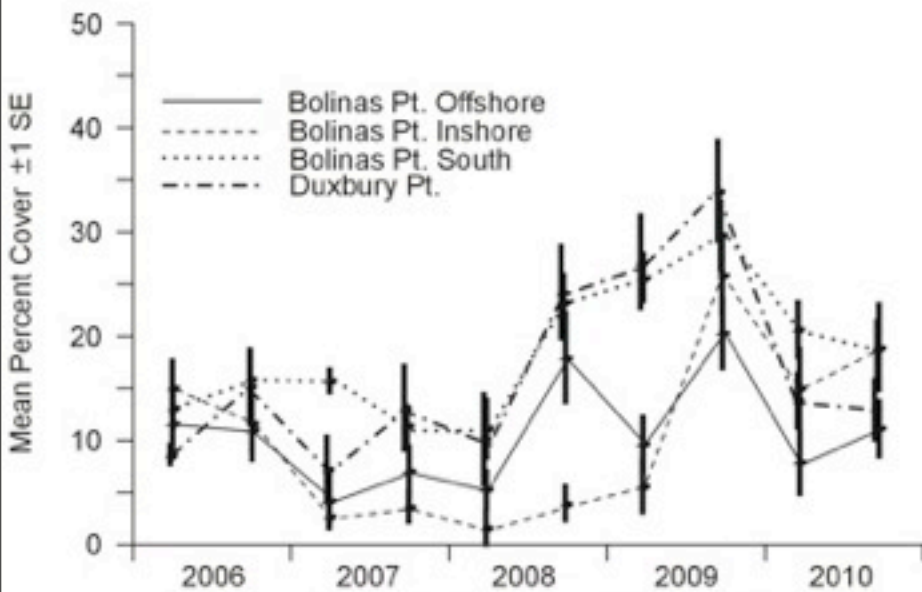


Mar 2010

May 2010



18 May 10 SI 04



Duxbury Reef Restoration Program

The background image shows a coastal scene. In the foreground, there are dark, rocky rocks with some green seaweed. The middle ground features a wide expanse of ocean with white-capped waves breaking. In the background, a prominent, light-colored cliff face rises from the water's edge, topped with some trees and a few buildings under a clear sky.

Establish baseline data on species abundance and distribution

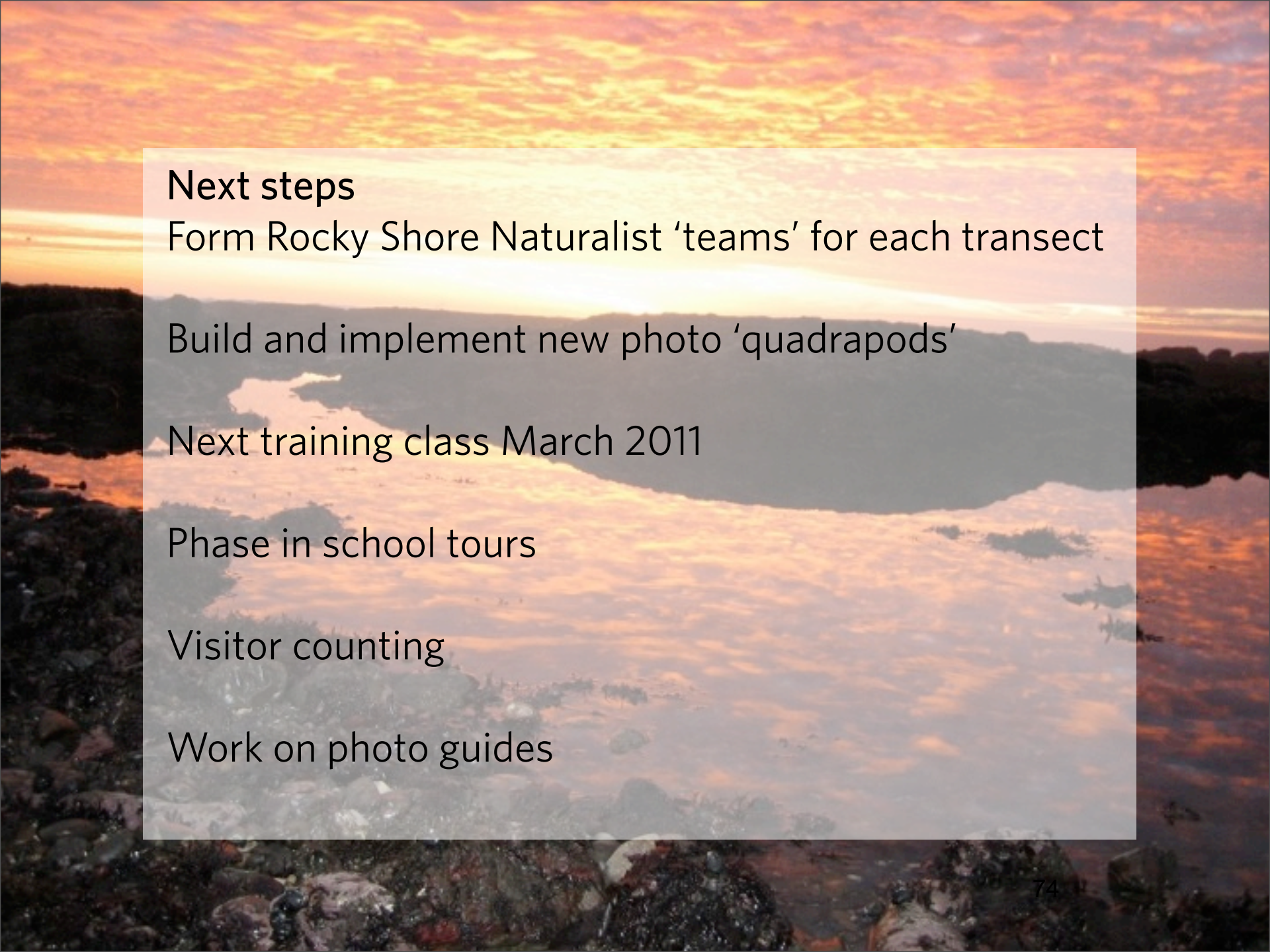
Establish baseline data on visitor use and pre-trip education

Using visitor information and monitoring data, determine biological patterns relative to visitor patterns

Determine if increased resource stewardship facilitates species and habitat recovery

Duxbury Reef Restoration Project Objectives

- 1) Characterize visitor use of the reef and conduct baseline monitoring.
- 2) To develop a community based reef protection program to avoid further injury and facilitate the natural recovery of intertidal rocky habitat at Duxbury Marine Reserve
- 3) To increase stewardship of the rocky intertidal habitat
- 4) To provide on-site education and interpretation of reef natural history and ecology
- 5) To enhance visitor experience and protection of the reef
- 6) To educate CAS visitors about the GFNMS and make connections between exhibits and 'our backyard'



Next steps

Form Rocky Shore Naturalist 'teams' for each transect

Build and implement new photo 'quadrads'

Next training class March 2011

Phase in school tours

Visitor counting

Work on photo guides



Phidiana hiltoni

