Duxbury Reef
Rocky Intertidal Restoration Project

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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
"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.
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.

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
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?
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.
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
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....
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

Average Counts of People in the Parking Lot and on Bluff Trails

Average Number Per Observation

- People in parking lot
- People on bluff trails
- Cars in lot
- Buses in lot
- Motorcycles in lot
- Bicycles in lot
- Kayakers
- Surfers
- Dogs
- Fishers

0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Proportion of People in Shore Segments Standardized to Shore Segment Length

Percent Composition

Segment

n=4,277
Annual Attendance at Two MPAs in the GFNMS

James V. Fitzgerald State Marine Reserve

Duxbury Reef SMCA (extrapolated from Chan 1970)

Duxbury Reef SMCA (from CAS, GFNMS, and Chan extrapolations)

Range

YEARS
Visitors to Duxbury Reef

Average Counts of People in the Parking Lot and on Bluff Trails

- People in parking lot: None
- People on bluff trails: 0.1
- Cars in lot: 6.0
- Buses in lot: <0.1
- Motorcycles in lot: <0.1
- Bicycles in lot: <0.1
- Kayakers: 0.1
- Surfers: None
- Dogs: None
- Fishers: None
We need a more effective way to count visitors and to understand Duxbury usage.
Tenera monitors transects twice a year:
At the access
North-low use
South low use
Tenera Environmental Monitoring
Monitoring Site Markers
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

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

*Fucus gardneri*

Sensitive to trampling
Volunteer Monitoring of *Fucus*- Quarterly
Aug 2009

Volunteer Photo Monitoring Monthly
Duxbury Reef Restoration Program

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 ‘quadrapods’

Next training class March 2011

Phase in school tours

Visitor counting

Work on photo guides