

This report is the first quarterly report submitted in partial fulfillment of Research Contract No. 6S-1047 between the Department of Fish and Game and the Pacific Gas and Electric Company. Through this contract the Department of Fish and Game is to conduct ecological monitoring studies to determine what changes, if any, have occurred in the base line inventory of the marine biota with special reference to fish and to abalone conducted during 1970 and 1971.

Quarterly reports will be followed by annual reports. Full tables and species lists will be included in each annual report.

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DIABLO CANYON POWER PLANT SITE ECOLOGICAL STUDY  
QUARTERLY REPORT NO. 1 1/

by  
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ABSTRACT

The second phase of ecological studies at the Diablo Canyon Power Plant site was initiated in July 1973. The first phase conducted during 1970-71 involved baseline ecological surveys with special reference to abalone and bony fishes. The objectives of this second phase are to quantitatively monitor abalone and algal communities, including predators and competitors, along permanent intertidal and subtidal transects established during the first phase.

During the quarter nine permanent transects were located and marked with new buoys. Surveys on seven of these transects were completed, and the commercial sea urchin and red abalone fisheries operating in the Diablo Cove area were monitored.

Sea otter activities between Diablo Cove and Pt. Buchon were recorded to determine the location of the herd and their general food habits. Little evidence of feeding activity has been observed in Diablo Cove.

Temperature tolerance studies, began in March 1973 on red abalones, were continued. Problems in obtaining viable abalone larvae hampered this project.

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1/ Marine Resources Administrative Report No. 9, November 1973

2/ Marine Resources Laboratory, Marine Resources Region, 411 Burgess Drive, Menlo Park, California 94025

## INTRODUCTION

The second phase of ecological studies at the Diablo Canyon Power Plant site was initiated in July 1973. The first phase conducted during 1970 and 1971 involved baseline ecological surveys with special reference to abalone and bony fishes. The final report of these studies was submitted to the company early in 1973. The objectives of this second phase are to quantitatively monitor abalone and algal communities, including predators and competitors, along permanent intertidal and subtidal transects established during the first phase. This general objective includes the following specific objectives:

1. Quantitatively measure effect of presence of sea otters, commercial sea urchin fishery, and recent natural environmental changes in and around Diablo Cove on the biotic communities along the permanent transects.
2. If need arises, establish abundance indices for animals and plants not affected by sea otter foraging, the sea urchin fishery and environmental changes.
3. Maintain established permanent transects.
4. Continue and complete studies on temperature effects upon embryological, larval and post-larval red abalone.

## OPERATIONS

We began field work in July; two days were spent locating and placing new marker buoys on the permanent subtidal transects. All but two of the transects have been reestablished. Also, in July we began monitoring the

commercial sea urchin fishery and abalone fishery, and sea otter activities. Commercial sea urchin and abalone fishermen were interviewed whenever possible to determine fishing locations and catch per unit of effort. At least once each week sea otter population density and locations between Pt. Buchon and Diablo Canyon were determined by shore observers.

In September we began fall surveys along the permanent subtidal transects established during previous studies in 1970 and 1971. Our methods are the same as used during the earlier surveys. In addition, we are quantifying about 25 additional species of invertebrates along each transect. Red algae abundance and species composition is being determined by subjectively placing a  $1/4 \text{ m}^2$  quadrat in areas of high algae density near each transect, all algae within each quadrat is removed, preserved in 10 percent formalin, and returned to the laboratory for sorting to species and wet and dry weight determination.

Seven of the permanent transects were surveyed during September. When counts of red abalone and abalone associates are compared with counts made in 1971 the following trends appear (Table 1): Red abalone, *Haliotis rufescens*; rock crabs, *Cancer antennarius*; red sea urchins, *Strongylocentrotus franciscanus*; and cabezon, *Scorpaenichthys marmoratus*; numbers were generally lower, while sun star, *Pycnopodia helianthoides*, counts were up. Two commercial urchin fishermen were interviewed; their total catch consisted of 240,312 red urchins (3,876 lbs). Both boats had been fishing in the cove north of Lion Rock. All urchin fishermen quit fishing early in September when the local buyer discontinued operations.

Several commercial abalone fishermen began harvesting in the Diablo Canyon area in September. We will keep records of boats observed in the

TABLE 1. Comparison of Counts of Red Abalone and Associates at Permanent Subtidal Station - Diablo Canyon - 1971 and 1973

Species	Station:	7		8		9		10		11		12		13	
		1971	1973	1971	1973	1971	1973	1971	1973	1971	1973	1971	1973	1971	1973
<i>Haliotis rufescens</i>		5.0	1	1.7	7	0.3	2	0.0	0	0.0	1	0.0	0	89.5	48
<i>Cancer antennarius</i>		1.3	0	1.7	0	0.3	0	0.0	0	0.0	0	0.0	0	1.5	1
<i>Pycnopodia helianthodes</i>		3.0	0	1.3	1	4.3	5	3.3	4	1.0	11	0.3	4	3.5	1
<i>Strongylocentrotus franciscanus</i>		275	131	258	222	355	363	109	86	84	89	31	29	118	73
<i>Scorpaenichthys marmoratus</i>		0.3	1	1.7	0	0.3	1	0.0	0	0.3	0	0.3	0	0.5	2

area and then obtain their catches from our Biostatistical Section at the end of the year.

The main concentrations of sea otters between Pt. Buchon and Diablo Cove were observed feeding as far south as the cove north of Lion Rock. This herd contained between 26 and 73 otters. A few individuals were observed in the cove inside Lion Rock. We have observed very little evidence of otter feeding activity inside Diablo Cove during our diving surveys.

Shore counts of bull kelp, *Nereocystis luetkeana*, in Diablo Cove were made in September. A total of 10,100 plants were observed.

#### ABALONE TEMPERATURE TOLERANCE STUDIES

Samples of adult red abalones were obtained from the Diablo Canyon region in early August and early September. The August sample yielded a moderate number of sexually mature specimens. These were induced to spawn upon being thermally stimulated. Male specimens spawned readily, but females released only limited numbers of viable eggs. Only a small percentage of the eggs proceeded to develop normally, and correspondingly, very few of these obtained the veliger larval stage. The September sample did not contain any sexually mature female abalones. Because of the poor success in obtaining sufficient numbers of larvae, we again opted to examine upper thermal tolerance limits of adult specimens.

Test animals were first acclimated at either 20°C (68°F) or 22°C (71.6°F). Four test runs were accomplished. Observations were recorded for survival duration (Table 1) and loss of attachment ability (Table 2). Survival and attachment duration were found to significantly increase with acclimation when compared to non-acclimated test animals.

TABLE 2. Percent Survival of Adult Red Abalone, *Haliotis rufescens*, Subjected to Instantaneous Elevated

Temperature Shock

Acclimation Temp. °C	Test Temp. °C	No. of Test Animals	Percent Survival														
			1	3	6	12	24	36	48	60	72	84	96	108	120		
20	31	10	100	100	40	0	0	0	0	0	0	0	0	0	0	0	0
22	24	10	100	100	100	100	100	100	100	100	100	90	90	90	80	80	80
22	26	10	100	100	100	100	100	50	0	0	0	0	0	0	0	0	0
22	28	6	100	100	100	17	0	0	0	0	0	0	0	0	0	0	0

TABLE 3. Percent Remaining Attached of Adult Red Abalone, *Haliotis rufescens*, Subjected to Instantaneous Temperature Shock.

Acclimation Temp. °C	Test Temp. °C	No. of Test Animals	Percent Survival												
			Exposure Time, Hours												
			1	3	6	12	24	36	48	60	72	84	96	108	120
20	31	10	0	0	0	0	0	0	0	0	0	0	0	0	0
22	24	10	100	100	100	100	100	100	100	90	90	90	80	80	80
22	26	10	100	100	80	0	0	0	0	0	0	0	0	0	0
22	28	6	100	33	0	0	0	0	0	0	0	0	0	0	0



Project biologists met with P.G.&E. biologists, Jim Adams and John Warrick, to review the study progress and techniques.

MAN-DAYS SPENT AT DIABLO CANYON POWER PLANT SITE

JULY 1 - SEPTEMBER 30, 1973

Subtidal Surveys:	July 9 - 10
Participants:	Gotshall, Laurent, Burge, Schultz, Martindale, Boettcher.
	September 3 - 5
Participants:	Gotshall, Laurent, Benech
	September 25 - 27
Participants:	Gotshall, Laurent, Benech
Commercial Fishery Surveys: (Urchin & Abalone)	July 17, 18, 23
Participants:	Thomas
Sea Otter Surveys:	July 16, 20, 25
Participants:	Thomas
	August 2, 6, 8, 11, 12, 13, 14, 20
Participants:	Thomas
	September 14, 17, 19
Participants:	Benech
Total man-days during quarter*:	230
Total man-days at site:	55
Boat days lost to breakdown:	1
Total stations surveyed:	7
Travel time man-days:	3.5
Boat time (hours):	12.5
Laboratory time man-days:	171.5

\*Non-project personnel man-days not included in totals.

PROJECT PERSONNEL:

Daniel W. Gotshall	Senior Marine Biologist-Project Leader
Robert N. Lea	Associate Marine Biologist
Laurence L. Laurent	Assistant Marine Biologist
Margaret M. Hughes	Stenographer II
Leslieann Thomas	Seasonal Aid
Suzanne Benech	Seasonal Aid
John Glabe	Seasonal Aid

NON-PROJECT PERSONNEL:

Earl Ebert	Senior Marine Biologist Marine Resources Region
Richard Burge	Associate Marine Biologist Marine Resources Region
Steve Schultz	Assistant Marine Biologist Marine Resources Region
E. Martindale	Lieutenant, Fish and Game boat "RAINBOW"
Ken Boettcher	Fish and Game Warden