

639.061  
USIC2  
C.2

California State Fisheries Laboratory  
Long Beach, California

State of California  
The Resources Agency  
DEPARTMENT OF FISH AND GAME

**LIBRARY**

Moss Landing Marine Laboratories  
P. O. Box 223  
Moss Landing, Calif. 95039

DIABLO CANYON POWER PLANT SITE ECOLOGICAL STUDY  
QUARTERLY REPORT NO. 20

April 1 - June 30, 1978

by

Daniel W. Gotshall  
Laurence L. Laurent  
and  
John J. Grant

PACIFIC GAS AND ELECTRIC COMPANY  
COOPERATIVE RESEARCH AGREEMENT 5-26-77

MARINE RESOURCES

Administrative Report No. 79-4

March 1979

MAY 17 1979

DIABLO CANYON POWER PLANT SITE ECOLOGICAL STUDY<sup>1/</sup>

QUARTERLY REPORT NO. 20

April 1 - June 30, 1978

by

Daniel W. Gotshall  
Laurence L. Laurent  
and  
John J. Grant<sup>2/</sup>

ABSTRACT

Although we continue to monitor permanent stations on a regular basis, we have suspended our 30-m<sup>2</sup> random subtidal and 1/4-m<sup>2</sup> random intertidal studies during this interim year. The 1/4-m<sup>2</sup> random subtidal study is being continued and we have added a new subtidal method of determining fish abundance.

Giant red sea urchin, *Strongylocentrotus franciscanus*, numbers continue to decline at their last "stronghold" in our subtidal study area, permanent station 15. The recruitment of juvenile blue rockfish, *Sebastes mystinus*, appears to be either late or low this year in our study areas. The most abundant fish, so far, from the new method of assessment, are adult blue rockfish, kelp greenling, *Hexagrammos decagrammus*, and gopher rockfish, *Sebastes carnatus*.

Various trends of abalone abundance at the permanent intertidal stations, increasing at some, decreasing at others, were observed during this quarter.

Sea otters, *Enhydra lutris*, seem to have reached their annual springtime peak in abundance during April and May. Several otters were seen rafting and foraging around and near the intake cove breakwaters, apparently becoming emboldened to human presence.

---

<sup>1/</sup> Marine Resources Administrative Report No. 79-4, May 1979.

<sup>2/</sup> Operations Research Branch, P.O. Box 98,  
Avila Beach, CA 93424

This is the 20th quarterly report submitted in partial fulfillment of Research Contract No. 5-26-77 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 have occurred since 1970 and 1971 in the baseline inventory of the marine biota with special reference to fishes and abalones.

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

Submitted To:

Nolan H. Daines, Vice President  
Planning and Research Department  
Pacific Gas and Electric Company  
77 Beale Street  
San Francisco, CA 94106

Submitted By:

John Radovich, Chief  
Operations Research Branch  
California Department of Fish and Game  
1416 Ninth Street  
Sacramento, CA 95814

## INTRODUCTION

Our project will not produce an annual report on the 1977-78 year as we are now working on a final report of all work performed since we arrived at the site in 1973. This final report will contain analyses of all data collected since 1973, including the present summer's subtidal studies (we are presently conducting). We expect to complete all field work by October 1978. From October through May 1979, we will concentrate all of our efforts in analyses of data, and completion and editing of the final report. We are being assisted in our data analysis by Philip Law, statistician, and Bernice Hammer, computer programmer, California Department of Fish and Game Planning Branch.

This report is a summary of work performed during the quarter and does not constitute a Department of Fish and Game environmental impact report.

## OPERATIONS

Our efforts during this quarter involved analyzing subtidal data, completing processing of algae collected at intertidal stations, surveying permanent subtidal and intertidal stations, starting surveys of random 1/4-m<sup>2</sup> subtidal stations, and conducting new subtidal fish surveys to augment our knowledge of fish populations in our study areas. Sea otter, *Enhydra lutris*, counts were continued on a daily basis (time and weather permitting).

## METHODS

### Subtidal Random Stations

Surveys of random 1/4-m<sup>2</sup> subtidal stations were conducted as before: 24 locations are selected in North Control and 24 in Diablo Cove (Figure 1).

North Control stations are selected from three depth strata: 12

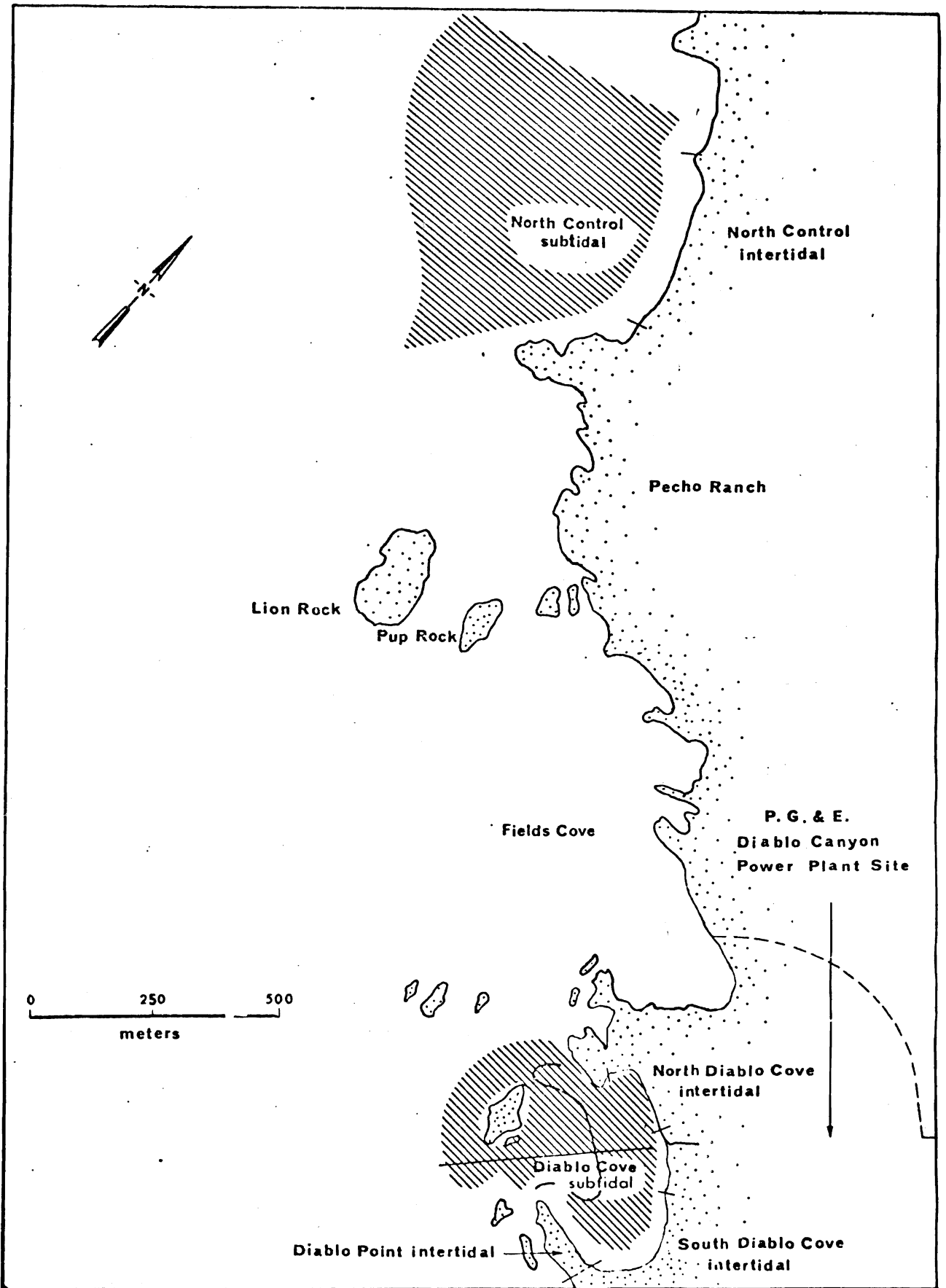


FIGURE 1. Locations of random subtidal and intertidal stations -- Diablo Canyon Power Plant Site.

stations from 2.1 to 6.1 m, 8 stations from 6.4 to 12.2 m, and 4 stations from 12.5 to 18.3 m. In Diablo Cove, 16 stations are selected from depths of 2.1 to 7.6 m and 8 stations from 7.9 to 18.3 m. These stations are equally divided between North and South Diablo Cove. Transect lines are laid out from the boat's anchor either parallel to the shore or on a north magnetic bearing. Counts of bull kelp, *Nereocystis luetkeana*, are made 1 m to either side of the transect line.

#### Permanent Subtidal Stations

Our survey methods are the same as described in our annual reports-- two divers count selected species of brown algae and invertebrates within 1 m to either side of a 30-m transect line. Estimates are also made of abundance of fishes in the area.

#### Permanent Intertidal Stations

Survey methods remain consistent with those used previously (Gotshall, Laurent, and Wendell, 1976).

#### Random Fish Species Counts

This method, new to our project, is based on the studies of coral reef species abundance by Jones and Thompson (1978). At present, this new study is an experiment and does not replace our usual frequency of occurrence fish observations at random and permanent subtidal stations. Hopefully this new method will allow us to subject the fish data to a more sophisticated statistical analysis.

The method consists of a diver recording all fish species observed during a number of time intervals as the diver swims around a particular reef or type of habitat. Each species is then given a score based on how many of the time intervals it was recorded in, with the highest values given to the first time interval and then decreasing in value to

the last time interval. In our study we opted for six intervals, 5 min. in duration. Species observed during the first interval are given a score of six, species observed during the second interval are given a score of five and so on. The highest score that a species can receive during any dive is 21.

Various statistical tests can be used to compare areas, depths, etc., such as ANOVA (one-way).

#### Sea Otters

Sea otter observations are conducted daily, weather permitting, from Lion Rock Cove south to South Cove. Binoculars are used in spotting the otters. Records are kept on numbers observed and their activity.

### NORTH CONTROL AND PERMANENT CONTROL STATIONS

#### Subtidal Activities

We were able to locate and survey two of the four permanent control stations, nos. 6 and 15 (Figure 2). We also completed two fish species counts at permanent station 15 during the quarter.

#### Algae

#### Results

No algae samples were taken during this quarter. Laboratory analysis of previous samples continued. Algae data from previously sorted samples were prepared for computer analysis.

#### Invertebrates

#### Results

Densities of giant red sea urchins, *Strongylocentrotus franciscanus*, at

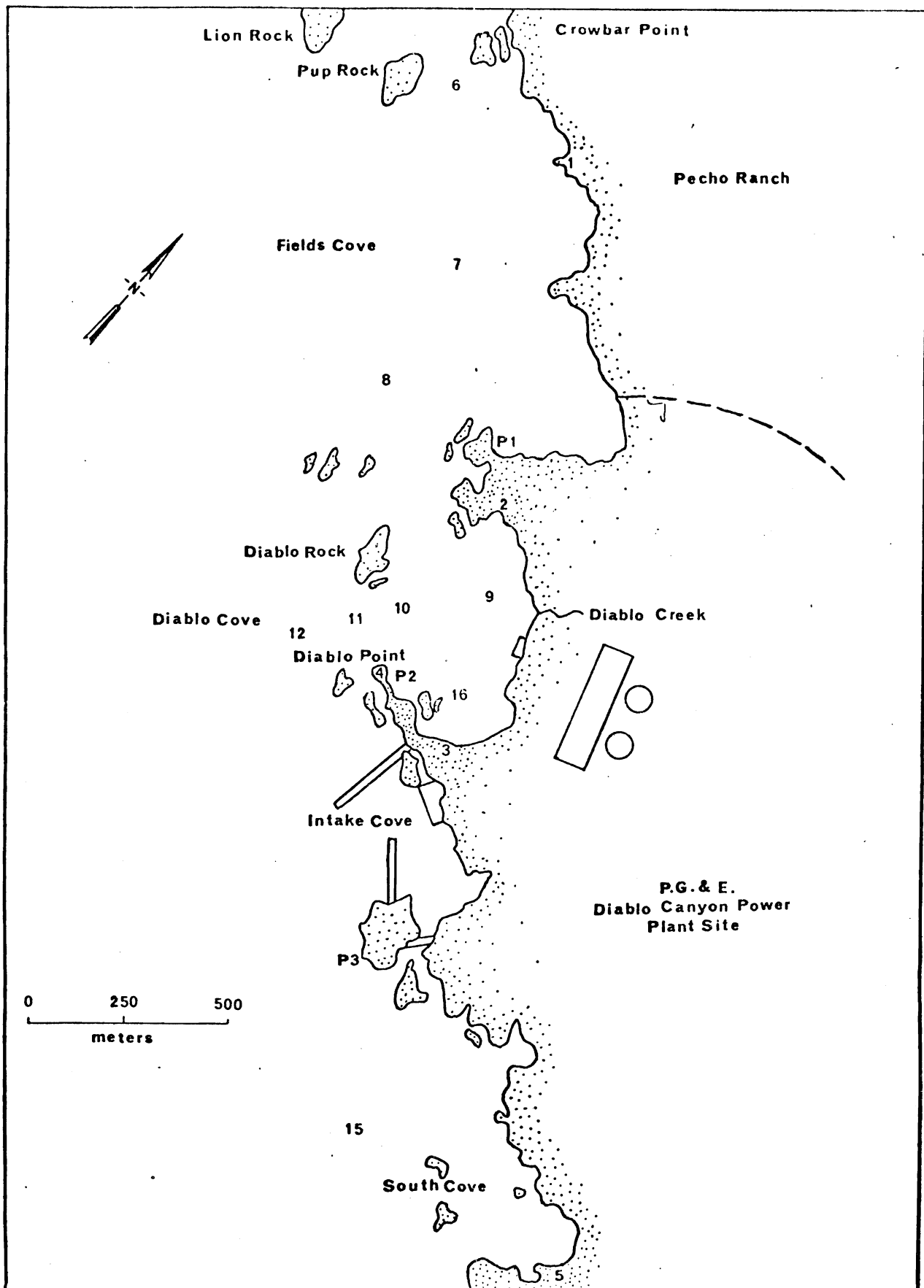


FIGURE 2. Locations of permanent subtidal and intertidal stations -- Diablo Canyon Power Plant Site. Stations 1, 2, 3, P1, P2, P3, are intertidal; stations 6, 7, 8, 9, 10, 11, 12, 15, 16 are subtidal; stations 4, 5, 13, and 14 are abandoned.



station 15 in South Cove continued to decline: in November 1977 we counted 69 and in June we observed only 14, a decrease of 80%.

#### Discussion

We believe the sharp decline of giant red sea urchins at station 15 is due almost entirely to foraging by sea otters.

#### Fish

#### Results

Adult blue rockfish, *Sebastes mystinus*, were the most frequently observed species during both species counts of station 15. We did not observe any young-of-the-year blue rockfish. Kelp greenling, *Hexagrammos decagrammus*, were the second most frequently observed species.

#### Discussion

During our diving surveys this quarter, the lack of young-of-the-year rockfish was very apparent. In the past years we usually began seeing large numbers of incoming year class rockfishes, particularly blue rockfish, by mid-May. The very late Upwelling season may have affected the survival and/or growth rate of the pelagic rockfish larvae. The lack of juvenile rockfish has also been noted in the Monterey area (Bob Lea, C.D.F.&G., pers. commun.).

#### Intertidal Activities

All three northern permanent stations (1A, 1B, and P1) and P3, south of Diablo Cove (Figure 2), were surveyed for black abalone, *Haliotis cracherodii*, and red abalone, *H. rufescens*, during this quarter.

#### Invertebrates

#### Results

Abalone numbers at two of the stations, 1A and P1, are roughly comparable to previous surveys. The counts for black abalone (414) at

station 1B showed a sharp decrease from previous surveys. As in the past, no red abalone appeared on either 1A or 1B, neither did they occur at station P1 where the average numbers of red abalone for previous surveys had been slightly less than two.

Control station P3, to the south of Diablo Cove, showed no change in black abalone numbers compared to previous surveys. However, a red abalone was found here for the first time--possibly tumbled to this high location by winter storm waves.

#### Discussion

The previous three surveys at 1B have yielded, chronologically, black abalone counts of 490, 472, and 549. The 414 black abalone from this survey represent about 80% of the average of these three counts. Several possibilities could account for this apparent decrease. First is counting error due to visual occlusion by dense springtime algal cover. Second is an actual drop in numbers due to emigration or mortality. Emigration is a possibility since juvenile abalone comprised a substantial percentage of the total population during the last 2 years and many of these could have moved to less crowded territory. Mortality could have occurred in a number of ways: predation by shore birds or sea stars (especially on the smaller abalone), competition for space by pervasive encrusting animals (such as *Phragmatopoma californica* which has become dominant at this station in the last 6 months), or by injury (or non-attachment) resulting from removal of the abalone for measurement during the previous survey (the first and only time we've measured abalone at this station).

#### Sea Otters

#### Results

There were 39 observation days in this quarter. Sea otter activity

increased in both the North Cove (237 sightings) and South Cove (89 sightings) control areas when compared to last quarter. The highest daily incidence of otters in control areas was during the 13 observation days in April when 10.1 otters per day were seen. During the 11 observation days in May, 8.6 otters per day were sighted and only 5.6 per day were counted during June. On May 1, 20 otters were counted in control areas, the largest single-day count so far obtained.

From the middle of April to the middle of June, several otters began foraging in the intake cove during the day and rafting inside the west breakwater during the evening. On 2 days, a small raft of seven to eight otters was observed in the intake cove during the very early morning. All otters left the area when daily plant site activity started.

#### Discussion

Otters sighted in North Cove control areas were almost exclusively female, either alone or with pups. Some of the young are large enough to be considered yearlings, or sub-adults. North Cove appears to be a rafting area for females. It is approximately 3 miles north of the main male raft.

The increase in otter sightings in control areas during this quarter reflects annual trends in sea otter movements. The spring peak has been followed by a decline during summer months.

#### NORTH DIABLO COVE

#### Subtidal Activities

#### Algae

#### Results

One random station, no. 128, was sampled during this quarter. Four algae samples were taken and are being processed.

## Invertebrates

### Results

The usual invertebrate species were observed at random station no. 128, with the orange cup coral, *Balanophyllia elegans*, present in all four quadrats. *Homalopoma luridum*, *Acmaea mitra*, and *Tonicella lineata* were present in three of the four quadrats.

### Intertidal Activities

## Invertebrates

### Results

Both permanent stations in this section of the Cove, 2A and 2B (Figure 2), showed an approximate 25% decrease in black abalone numbers compared to the previous survey. At station 2A the count decreased from 291 to 212 and at 2B it decreased from 107 to 75. Red abalone also decreased at the two stations: from an average at 2A of nearly six to one, and from an average of almost eight to two at 2B.

### Discussion

The numbers of abalone, both black and red, at station 2A have always shown a high variability and these recent figures may not represent a significant departure from the overall average. However, station 2B has generally had consistent numbers of both abalone species and has had the highest numbers of red abalone of all the stations and this recent survey seems to demonstrate a significant decrease. The most obvious possibility for this decline, apart from possible sea otter foraging, is the violent shifting of boulder habitat in this area by the powerful storm waves of this past winter. Many large boulders appeared to have moved laterally and several were overturned. Again, further surveys will be needed to substantiate this apparent decline.

SOUTH DIABLO COVE

Subtidal Activities

All six permanent stations were surveyed during the quarter. In addition, fish species counts were conducted at stations 1 and 12 (Figure 2).

Algae

Results

No subtidal algal samples were taken this quarter. Laboratory analysis of previous samples continued. Data from previously sorted samples were prepared for computer analysis.

Invertebrates

Results

Red abalone appeared more frequently during this survey, they were observed at stations 16, 9, and 10. Giant red sea urchin densities remained low.

Discussion

The observed increase in red abalone probably is due to animals moving out of deep crevices where our divers previously could not see them or moving into the study area from other areas.

Fish

Results

We made three separate fish species counts at permanent station No. 1; kelp greenling had the highest mean frequency of occurrence, followed by blue rockfish. Gopher rockfish, *Sebastes carnatus*, were the third most frequently observed species. At station 12, blue rockfish, gopher rockfish, and kelp greenling were observed during all six time intervals.

Discussion

A few juvenile (incoming year class) rockfish were observed in Diablo Cove but not the large aggregations we have observed during previous surveys.

Intertidal Activities

Invertebrates

Results

Black abalone along permanent stations 3A and 3B showed different trends: at 3A they increased from 18 animals of the previous survey to 44 and at 3B they decreased from 94 to 54. Red abalone did not vary greatly from previous survey averages: at 3A there were none and at 3B there were two.

Discussion

Although abalone numbers at 3B indicate a sharp decrease from the previous survey, they are near the overall average for the station ( $\bar{x}$  = 62.5). The number of black abalone at 3A represents an increase, but the count is only nine greater than the previous high count.

Sea Otters

Results

During this quarter, only 15 sea otters were sighted in Diablo Cove. Eight sightings were in April, three in May, and four in June. All otters observed in Diablo Cove were foraging or eating. No animals were observed rafting in that area.

Evidence of recent sea otter predation, in the form of freshly broken shells and tests, was noted on several dives in Diablo Cove.

Discussion

Diablo Cove offers good habitat for foraging and sheltered areas

for rafting; however, for some reason otters do not seem to raft there possibly because of construction activity at the site.

## FINAL REPORT DATA ANALYSIS

### Activities

We continued to transfer data collected through 1977 onto computer forms. Most of the data remaining to be established in the computer file consist of intertidal and subtidal algal biomass data.

Philip Law and the project leader met several times to go over subtidal invertebrate data analysis. Mr. Law ran several analyses of key species, including comparisons of North Control with Diablo Cove, seasonal comparisons, and between-year comparisons. He used parametric analyses with transformed and untransformed data, as well as non-parametric tests.

From the results of these analyses, Mr. Law had decided that the Kruskal-Wallis test, a non-parametric analysis of variance, is the most appropriate and most powerful method to detect significant differences in our data comparisons.

REFERENCES

- Jones, Robert S. and M. John Thompson, 1978. Comparison of Florida Reef Fish Assemblages Using a Rapid Visual Technique. Bull. of Marine Science 28(1): 159-172.



APPENDIX I

MAN-DAYS SPENT AT DIABLO CANYON POWER PLANT SITE

April 1 - June 30, 1978

<u>Intertidal Surveys:</u>	May 24, 25 and 26
Participants:	Gotshall, Laurent, Grant, Bowker, Wiley
	June 23
Participants:	Laurent and Grant
<u>Subtidal Surveys:</u>	May 8, 26
Participants:	Gotshall, Laurent, Grant
	May 9
Participants:	Gotshall, Grant
	May 10
Participants:	Gotshall, Laurent
	June 15, 16, 28
Participants:	Gotshall, Laurent
	June 21, 22, 27, 29, 30
Participants:	Laurent, Gotshall, Grant
	June 23, 26
Participants:	Gotshall, Grant

Total Man-Days During Quarter: 330

Total Man-Days at Site\*: 304

Total Stations Surveyed: 10

Travel Time Man-Days†: 30

\* Excludes time off for vacation, sick leave, etc., but includes both laboratory as well as field time.

† Includes all trips away from site.

Boat Time (Hours):

13

PROJECT PERSONNEL:

Daniel W. Gotshall	Senior Marine Biologist, Project Leader
Laurence L. Laurent	Associate Marine Biologist
John J. Grant	Assistant Marine Biologist
Sally A. Barker	Stenographer
Rosemary C. Bowker	Graduate Student Assistant
Steven W. Wiley	Graduate Student Assistant