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DIABLO CANYON POWER PLANT SITE ECOLOGICAL STUDY
QUARTERLY REPORT NO. 17

July 1 - September 30, 1977

by

Daniel W. Gotshall
and
Laurence L. Laurent

PACIFIC GAS AND ELECTRIC COMPANY
COOPERATIVE RESEARCH AGREEMENT 5-11-75

2) MARINE RESOURCES

3) Administrative Report No. 78-5

May 1978

DIABLO CANYON POWER PLANT SITE ECOLOGICAL STUDY^{1/}

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ABSTRACT

During the quarter a total of 38 random 30-m² and 152 random 1/4-m² subtidal stations were surveyed. Red abalone, *Haliotis rufescens*, densities remained very low. There was a continued decline in densities of giant red sea urchins, *Strongylocentrotus franciscanus*, in Diablo Cove as well as the North Control area. The annual shore census of bull kelp, *Nereocystis luetkeana*, revealed the lowest number of plants in the surface canopy in Diablo Cove since 1973. The subtidal station data supported this observation.

Sea otter, *Enhydra lutris*, observations were continued. A small group of otters continued to raft in the Cove east of Lion Rock. Some of these otters probably forage as far south as South Cove.

The survey of 11 random intertidal stations completed our Upwelling sampling effort.

^{1/} Marine Resources, Administrative Report No. 78-5, May 1978.

^{2/} Operations Research Branch, P.O. Box 98, Avila Beach, CA 93424.

This is the 17th 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:

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INTRODUCTION

During the latter part of the quarter the Project Leader and stenographer positions were transferred to the Diablo Canyon office. We believe this move will further increase the efficiency of our project by cutting down on travel expenses and increasing the number of mandays that can be devoted to our field work.

Almost all of our efforts this quarter were directed toward random subtidal surveys. As usual, most laboratory time was spent sorting and processing intertidal and subtidal algae samples. Whenever possible, counts were made of sea otters, *Enhydra lutris*, in Lion Rock, Diablo and South Coves. Surveys of random intertidal stations for the Upwelling period were completed.

This report is a summary of work performed during the quarter and does not constitute a Department of Fish and Game environmental impact report. Our quarterly reports are interim reports and usually do not contain completely analyzed data. Yearly analysis and comparison of data are presented in our annual reports.

METHODS

Subtidal Random Stations

Surveys of random 30-m² subtidal stations were conducted as before: 24 locations were selected in North Control and 24 in Diablo Cove (Figure 1).

North Control stations were selected from three depth strata: 12 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. Identifiable invertebrates 5 cm and larger, as well as four species of brown algae, were counted within each random 30-m² station. In Diablo Cove 16 stations were selected from depths of 2.1 to 7.6 m and 8 stations from depths of 7.9 to 18.3 m. These stations were equally divided between North and South

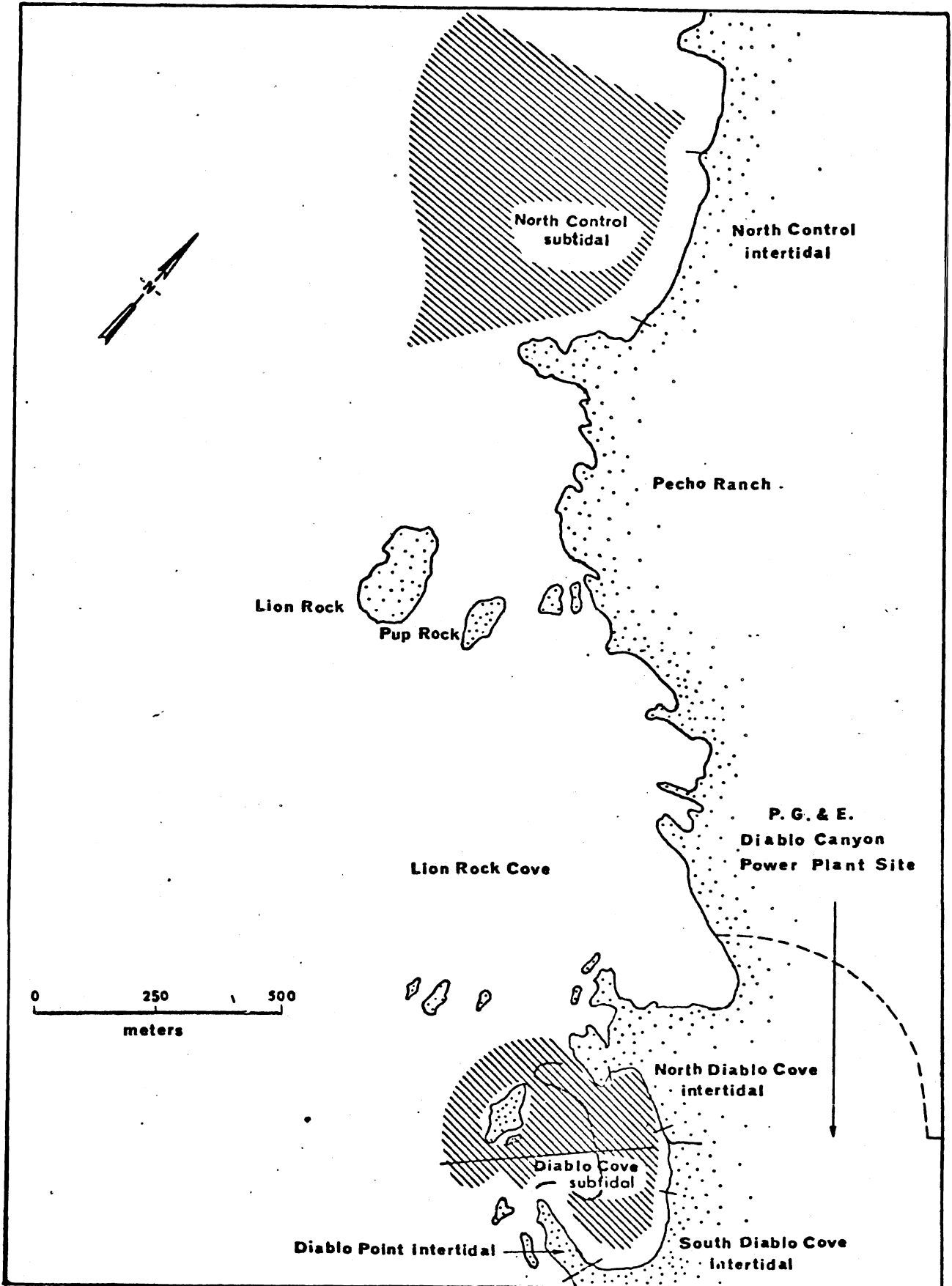


FIGURE 1. Location of random subtidal and intertidal areas -- Diablo Canyon Power Plant Site. (Dark lines in Diablo Cove designate deep and shallow strata and North Cove and South Cove strata.)

Diablo Cove.

In addition, we continued a study begun in 1975 which consists of counting all identifiable invertebrates within four $1/4\text{-m}^2$ quadrats randomly selected along a 30-m transect line. Transect lines were laid out from the boat's anchor either parallel to the shore or on a north magnetic bearing at previously surveyed random 30-m^2 stations. Counts of bull kelp were made one meter to either side of the transect line.

Intertidal Stations

Methods of conducting random intertidal surveys remained consistent with previous reports (Gotshall et al. 1974; Gotshall, Laurent and Wendell 1976; Gotshall, Laurent and Wendell 1977).

Bull Kelp

The annual shore census of bull kelp in the surface canopy within Diablo Cove was performed on September 27 and 28. This year the distribution of the kelp was distinct and once again sparse enough to permit counting of plants in separate "beds". In previous years, 1974 through 1976, the distribution was exceedingly even and the bull kelp was so abundant that censuses were conducted by counting within artificial demarcations or "wedges". In fact in 1975, the bull kelp was too dense to count reliably, and its abundance was estimated instead.

This year the census was again performed by two counters working independently. Ten power (10x) binoculars were used as spotting aids.

Sea Otters

Observations were made once again throughout the quarter for the presence and activity of sea otters. The observation area continued to be from Lion Rock on the north to South Cove on the south. Diablo Cove is between these

locations. Binoculars were used as spotting aids. There were a total of 15 observation days during the quarter.

NORTH CONTROL AND PERMANENT CONTROL STATIONS

Subtidal Activities

None of the permanent subtidal stations were surveyed during the quarter. In the North Control, 14 of the 24 random 30-m² stations and 56 of the 96 random 1/4-m² quadrats were completed.

Algae

Results

Laminaria dentigera density increased this year over last year (Table 1). *Pterygophora californica* increased density was even more impressive.

TABLE 1. Mean Number Per m² of Selected Invertebrates and Brown Algae at Random North Control Stations, 1976 and 1977.

	30-m ² Stations		1/4-m ² Stations
	1976	1977	1977
Red abalone	0.01	0.02	0.28
Giant red sea urchins	0.13	0.09	1.84
<i>Laminaria</i>	0.69	1.03	
<i>Pterygophora</i>	0.49	1.93	

Invertebrates

Results

A preliminary collation of the 30-m² station data yielded these highlights: densities of red abalones remained at low levels; giant red sea urchin numbers

continued to decline (Table 1). The decline of the latter is attributed to continued sea otter foraging.

Discussion

The substantially higher densities of abalones and urchins at $1/4\text{-m}^2$ are due to the fact that the divers are able to see more of the smaller juveniles at the $1/4\text{-m}^2$ stations, particularly after the red algae sample is removed from the quadrat.

Intertidal Activities

None of the permanent or random intertidal control stations were surveyed during the quarter. Sea otter observations were made in Lion Rock Cove and South Cove.

Sea Otters

Results

The maximum number of otters observed on a single day was six. For the most part, the otters stayed in the cove east of Lion Rock. Only one otter was seen in South Cove. It is possible that the otters in Lion Rock Cove were females as a pup was once again observed in the group.

DIABLO COVE

Subtidal Activities

All 24 of the 30-m^2 random subtidal stations and all 96 of the $1/4\text{-m}^2$ random subtidal stations were completed.

Algae

Results

Densities of *Laminaria* increased substantially at random 30-m^2 stations while *Pterygophora* densities decreased slightly (Table 2).

Invertebrates

Results

Red abalone densities remained at low levels while giant red sea urchin densities continued to decrease (Table 2). Most of the abalones and urchins observed at 1/4-m² quadrats were juveniles.

TABLE 2. Mean Numbers Per m² of Selected Invertebrates and Brown Algae at Diablo Cove Random Subtidal Stations, 1976 and 1977.

	30-m ² Stations		1/4-m ² Stations
	1976	1977	1977
Red abalone	0.02	0.01	0.20
Giant red sea urchins	0.26	0.10	0.84
<i>Laminaria</i>	2.59	5.28	
<i>Pterygophora</i>	5.63	4.34	

Intertidal Activities

Eleven random intertidal stations were surveyed during the quarter. The annual bull kelp census was conducted in September. Sea otter observations were continued, weather permitting.

Algae

Results

The two counts of bull kelp were reasonably close: 10,095 and 11,091 or about a 10% difference in numbers. There was also close observer agreement concerning location of individual kelp beds and their general configurations. As we have done in previous years, the counts for both the individual kelp beds

and total surface canopy were averaged (Figure 2). The total surface canopy population this year is estimated at 10,563 plants.

The bull kelp population in Diablo Cove this year, besides being the smallest since 1973, was also quite peripheral in nature. Most of the plants occurred in the shallow nearshore areas (3- to 6-m depths) while the central portion of the cove was relatively barren of bull kelp. The densest area of bull kelp was immediately seaward of the discharge structure in a very shallow area which earlier had been well scoured by cooling-water pump operation and, hence, was free from substrate competitors. In the central portions of the cove the juvenile bull kelp sporophytes of the 1977 year class had to compete with increasingly dense populations of *Laminaria dentigera* and *Pterygophora californica* for available space. Additionally, the dense subsurface canopies formed by *L. dentigera* and *P. californica* may have inhibited growth of young bull kelp plants by shading necessary levels of light from them.

Although bull kelp was generally sparse in the 6- to 12-m depths of mid-Diablo Cove, we observed many beds in deeper offshore areas (18- to 25-m depths) outside of Diablo Cove. These beds, many of which marked pinnacles previously unknown to us, were probably the result of an unusually long period of high water clarity in spring and summer months which allowed sufficient light penetration to greater depths. The increased amount of light, combined with an absence of dense stands of *Laminaria* and *Pterygophora*, enabled the juveniles to grow successfully in the deeper areas.

The subtidal surveys also indicate a diminished bull kelp population within Diablo Cove. A total of 48 counts from both 30-m² "macro" stations and 60-m² linear transects yielded an overall mean of 0.24 plants/m². This compared with a mean of 0.61 plants/m² in 1976. When the 1977 data were broken into both north and south components, the disparate distribution shown by the shore

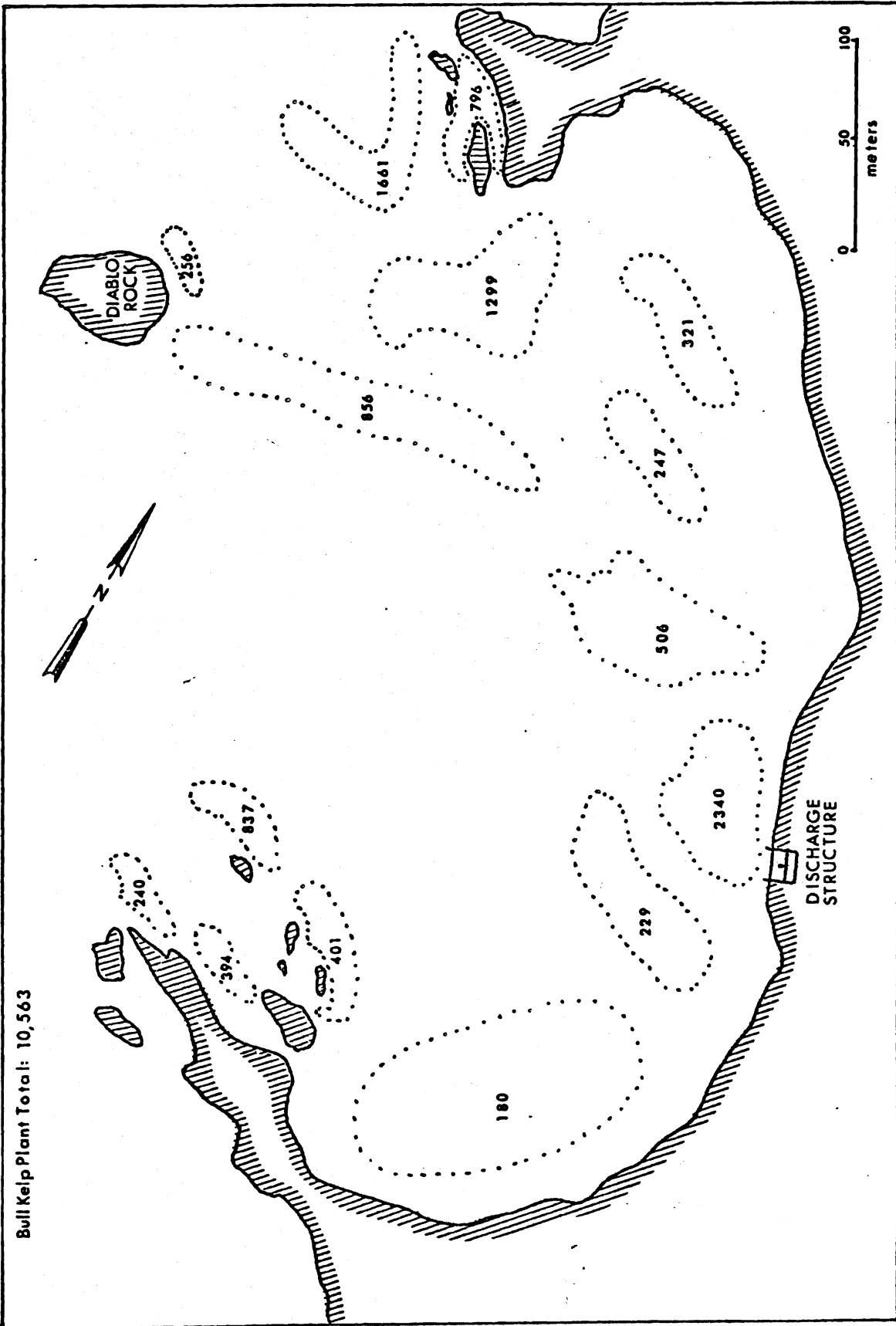


FIGURE 2. Counts of bull kelp, *Nereocystis luetkeana*, in Diablo Cove, 1977; Diablo Canyon Power Plant Site.

census was substantiated: there were 0.33 plants/m² in the northern portion of Diablo Cove and 0.15/m² in the southern portions, reflecting a relatively barren area in the south-central cove area.

Invertebrates

Results

Although subjectively the intertidal communities appear unchanged from previous Upwelling periods, no data are presented in this report. Analysis will be performed on all data collected to date during the remainder of the 1977/78 contract year.

Sea Otters

Results

No sea otters were observed in Diablo Cove during the quarter.

REFERENCES

- Gotshall, D.W., L.L. Laurent, E.E. Ebert, F.E. Wendell, and G.D. Farrens. 1974. Diablo Canyon Power Plant Site Ecological Study Annual Report: June 1, 1973 - June 30, 1974. Calif. Dept. Fish and Game, Mar. Resour. Adm. Rep., (74-10): 1-107.
- Gotshall, D.W., L.L. Laurent, and F.E. Wendell. 1976. Diablo Canyon Power Plant Site Ecological Study, Annual Report: July 1, 1974 - June 30, 1975 and Quarterly Report No. 8, April 1, 1975 - June 30, 1975. Calif. Dept. Fish and Game, Mar. Resour. Adm. Rep., (76-8): 1-112.
- Gotshall, D.W., L.L. Laurent, and F.E. Wendell. 1977. Diablo Canyon Power Plant Site Ecological Study Annual Report: July 1, 1975 - June 30, 1976 and Quarterly Report No. 12, April 1, 1976 - June 30, 1976. Calif. Dept. Fish and Game, Mar. Resour. Adm. Rep., (77-18): 1-125.

APPENDIX I

MAN-DAYS SPENT AT DIABLO CANYON POWER PLANT SITE

July 1 -- September 30, 1977

Intertidal Surveys:

July 1, 2, 3, 4

Participants: Gotshall, Laurent, Wendell, Kelly, Krenn

July 29, 30, 31, August 1

Participants: Laurent, Wendell, Kelly, Krenn

Subtidal Surveys:

July 5, 6, 7, 11, 26

Participants: Laurent, Wendell, Kelly

July 8, 13, 27

Participants: Wendell, Kelly

July 12

Participants: Gotshall, Wendell, Kelly

July 14, 25

Participants: Laurent, Wendell

July 15, 20

Participants: Gotshall, Laurent, Wendell

August 4, 5

Participants: Laurent, Wendell, Kelly

August 8, 9, 24

Participants: Wendell, Kelly

August 10

Participants: Gotshall, Wendell, Kelly

Subtidal Surveys (continued)

August 11

Participants: Gotshall, Kelly

August 12, 25, 26

Participants: Gotshall, Laurent, Wendell, Kelly

August 30

Participants: Laurent, Wendell

September 1

Participants: Laurent, Wendell

September 2, 6, 7, 8, 9, 21

Participants: Gotshall, Laurent, Wendell

September 19, 20

Participants: Gotshall, Laurent

September 22

Participants: Gotshall, Laurent, Wendell, Kelly

September 23

Participants: Laurent, Kelly

September 26, 27, 30

Participants: Wendell, Kelly

Total Man-Days During Quarter: 250

Total Man-Days at Site*: 221

Total Stations Surveyed: 201

Travel Time Man-Days: 5

Boat Time (Hours): 25.2

Laboratory Time Man-Days**: 24

* Total time spent at Diablo Canyon by all project personnel; includes both field time as well as laboratory time. Beginning with this report, all time off for vacations, sick leave, etc., will be excluded.

** Time spent at Monterey Office by Project Leader and seasonal aid.

Project Personnel:

Daniel W. Gotshall	Senior Marine Biologist, Project Leader
Laurence L. Laurent	Associate Marine Biologist
Fred E. Wendell	Assistant Marine Biologist
Sally A. Barker	Stenographer
James L. Kelly	Seasonal Aid
Sally J. Krenn	Seasonal Aid