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The Resources Agency
DEPARTMENT OF FISH AND GAME

DIABLO CANYON POWER PLANT SITE ECOLOGICAL STUDY
QUARTERLY REPORT NO. 11
JANUARY 1 - MARCH 31, 1976

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by

Daniel W. Gotshall
Laurence L. Laurent
and
Fred E. Wendell

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

MARINE RESOURCES
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ABSTRACT

Permanent subtidal stations 6, 11 and 16 were surveyed. Appreciable increases in densities of one species of brown algae and five species of macroinvertebrates were noted at station 6.

Winter surveys of random and permanent intertidal stations were completed. There was little or no change in black and red abalone, *Haliotis cracherodii* and *H. rufescens*, densities at the various random study areas. There was a noticeable increase in black abalone numbers at permanent station 2A located in North Diablo Cove. Three new permanent stations were established and counts of abalone completed.

Approximately 100 sea otters, *Enhydra lutris*, have moved from the Point Buchon area to the area around Pecho Rock.

We fished at 13 random stations in Diablo Cove and five stations in North Cove and North Control to determine the catch rate of common sport fishes.

A good percentage of the 1975 bull kelp, *Nereocystis luetkeana*, population weathered the winter storms. We calculated an approximate 18% over-wintering survival rate.

Daily observations of foam in Diablo Cove continued; large amounts of piled-up foam have been observed during low tides in the South Diablo intertidal during periods of northwesterly winds. On a recent reconnaissance dive in Intake Cove, fish numbers appeared to be on the increase and visibility appeared to be improving.

^{1/} Marine Resources, Administrative Report No. 76-10,
August 1976.

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INTRODUCTION

It should be noted that our quarterly reports are interim reports and usually do not contain completely analyzed data. Yearly analyses of data and data comparisons are presented in our annual reports.

Most of our field time during this quarter was devoted to completing winter surveys of the random and permanent intertidal stations. The project boat "Sebastes" underwent annual overhaul that included installation of new stainless steel fuel tanks, and repair of the hull damaged by encounters with the dredge in Intake Cove.

Our field work also included daily recorded observations of the foam in Diablo Cove created by the discharge, relocating and surveying of permanent subtidal stations, and sportfish catch-per-unit-of-effort studies.

OPERATIONS

Permanent Subtidal Station Surveys

Methods

The permanent subtidal stations continued to require extensive maintenance. Stations 6, 7, 9, 11, and 12 lost their surface buoys during winter storms; thus far we have relocated and rebuoyed stations 6, 7, 9, and 11 (Figure 1).

Results

Winter surveys were completed for stations 6, 11, and 16. At station 6 there was a marked increase in the density of *Pterygophora californica*, *Pisaster giganteus*, *Parastichopus parvimensis*, *Parastichopus californico*, *Dendrodoris fulva*, and *Mitra idae*. The swell shark, *Cephaloscyllium ventriosum*, observed at station 6 in November was absent. The most interesting animal observed was a gold colored wolf eel, *Anarrhichthys ocellatus*. This color phase is considered relatively rare.

Counts of *Cucumaria miniata* increased substantially at station 11 but this may be due to better underwater visibility during this survey. *Orthasterias koehleri* numbers were lower (six as compared to 14 in November) while *Mitra idae*, which was not observed in November, yielded a total of seven animals. Little or no change was noted for the remainder of the invertebrates; however, we did observe nine species of fish, compared to six species in November.

Densities of algae and invertebrates at station 16 remained about the same as recorded in November, except that the two red abalone, *Haliotis rufescens*, observed in November could not be located.

INTERTIDAL SURVEYS

Methods

During this quarter, 15 random intertidal stations were surveyed bringing the total number of such stations surveyed for the 1975-76 Davidson period to 30. Abalone counts along the permanent intertidal stations 1, 2, and 3 were finished for this period and an additional three permanent stations, located north, south, and within Diablo Cove, were established and surveyed in areas of high black abalone density (Figure 1). These stations were situated parallel to the shoreline rather than perpendicular as the older permanent transects had been. Data for invertebrates and algae from quadrats of the random stations for this period will be detailed in the 1976 annual report, but data for the abalone count from both random and permanent transects will be reported here.

Results

A total of 49 transects was surveyed for abalone during this Davidson

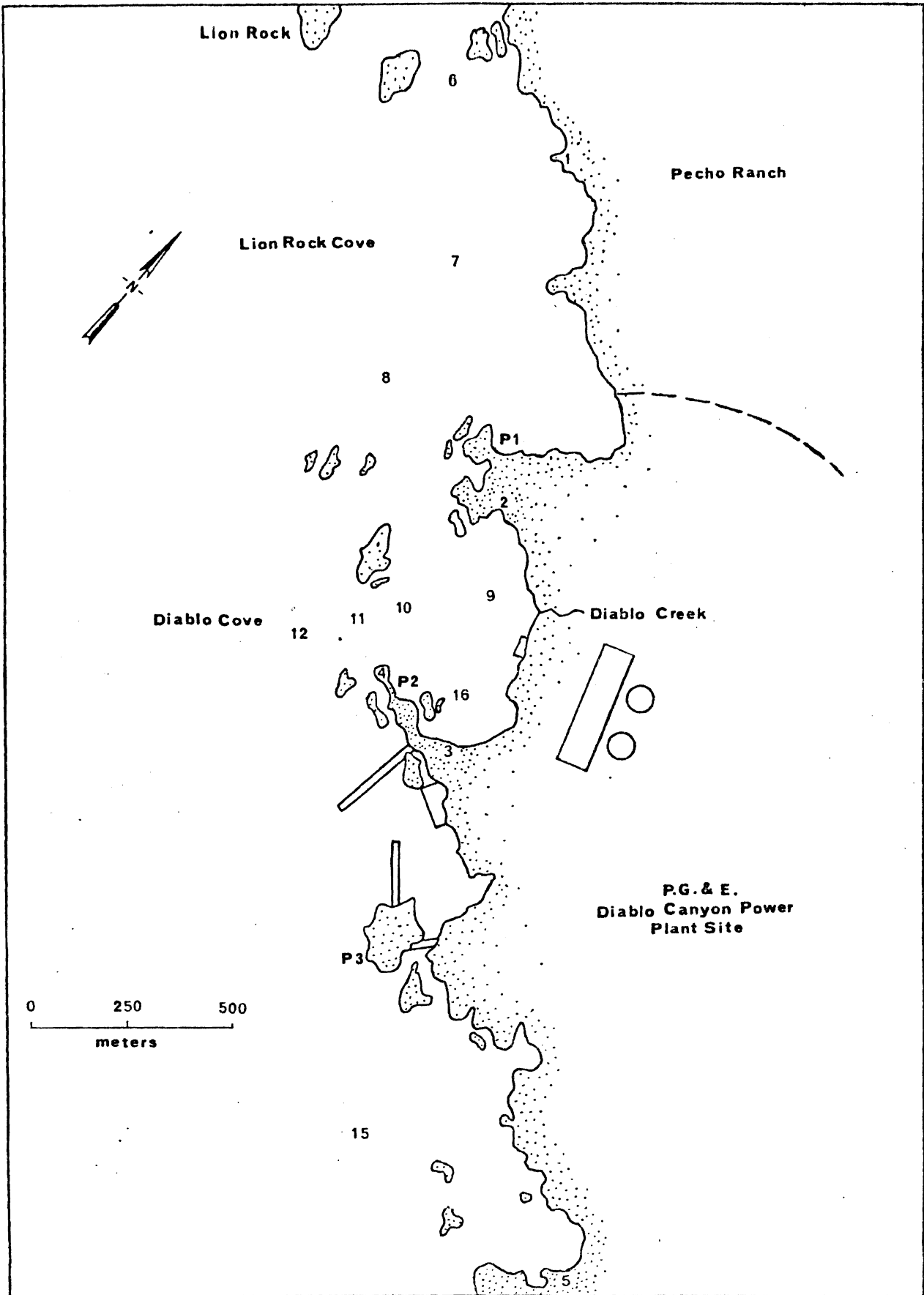


FIGURE 1. Locations of permanent subtidal and intertidal stations - **Diablo** Canyon power plant site.

period (November through March) at the random intertidal stations. Twenty-seven of these transects were run parallel to the shoreline and 22 were run perpendicular to the shoreline. Four permanent stations were also surveyed. Black abalone and red abalone numbers varied greatly between survey areas (Table 1). There was, however, no apparent change at each survey area from past surveys except for counts of black abalone along perpendicular transects in the North Control. This apparent decline in the North Control may be due to continued sporadic foraging of sea otters in this area. The Student-Newman-Keuls procedure for analysis of variance is being used to measure differences between mean abalone density estimates at each study area for each oceanographic period. This analysis, when completed, will make future comparisons of mean densities less subjective.

TABLE 1. Mean number per square meter of black abalone, *Haliotis cracherodii*, and red abalone, *Haliotis rufescens*, found along transects during the 1974-75 and 1975-76 Davidson period.

Area	Parallel				Perpendicular	
	<i>Haliotis cracherodii</i>		<i>Haliotis rufescens</i>		<i>Haliotis cracherodii</i>	
	1974-75	1975-76	1974-75	1975-76	1974-75	1975-76
NDCI	1.38(8)	1.28(7)	0.10	0.16	2.13(12)	2.39(8)
SDCI	0.01(9)	0.02(8)	0.10	0.06	0.24(13)	0.27(8)
DPI	0.98(3)	0.96(2)	0.00	0.06	-	-
NCI	0.55(9)	0.68(10)	0.02	0.05	1.02(7)	0.36(6)

() Sample size

The permanent intertidal transects 1A and B, 2A and B, and 3A and B were surveyed this quarter (Table 2). Transect 2A yielded a higher count of black

abalone on this survey than on any prior survey. The estimated density was 5.42 black abalone/m² compared to a high of 4.45/m² in 1971. This increase may be due to movements of black abalone into the transect area from surrounding areas and (or) sampling error. Transect 2B, 1A, and B and 2A and B showed little change. As previously mentioned, three newly established permanent transects were located in areas of high black abalone densities. The transect in South Field's Cove, P1, had 4.14 black abalone/m² and 0.06 red abalone/m². Transect P2, situated between Diablo Point and South Diablo Cove, had 5.97 black abalone/m² and no red abalone. The third newly constructed permanent transect, P3, is located on a flat bench adjacent to the Intake Cove breakwater referred to formally as the "Harbor Seal Haul-Out Area". This area had 1.34 black abalone/m² and no red abalone.

TABLE 2. Mean number per square meter of black abalone, *Haliotis cracherodii*, and red abalone, *Haliotis rufescens*, from permanent transects surveyed between November 1975 and April 1976.

Area	<i>Haliotis cracherodii</i>	<i>Haliotis rufescens</i>
1A	9.50	0
1B	8.59	0
2A	5.42	0.10
2B	1.76	0.14
3A	0.53	0
3B	0.67	0
P1	4.14	0.06
P2	5.97	0
P3	1.34	0

Sea Otter

Methods

While we have no formal program to monitor sea otter numbers, we have followed their movements and activity through incidental sightings and by personal communication with Suzanne Benech who performs sea otter counts under a contract with PG&E in the area between Point Buchon and the vicinity of Pecho Rock.

Results

Until the beginning of this quarter, a population of about 150 individuals were located for the most part north of Diablo Cove between Point Buchon and our North Control area. In early February, however, most of this area's population, about 107 otters, abruptly moved south in the vicinity of Pecho Rock, completely by-passing the Diablo Cove area. This late-winter move south follows a pattern we have observed in previous years.

In late March, we watched a group of sea otters in the area of Flowing Well Creek, south of Pecho Rock, during a late afternoon feeding period (from 1445 to 1645 hours). During the 1.5-hr period we observed approximately 25 sea otters (not all of them were feeding) consume 15 items: 10 abalone, eight of them positively red abalone; two crabs (*Pugettia producta*); and three unidentifiable items. Their foraging was very near shore in shallow depths near wash rocks and exposed reefs, and in very occluded water. The lack of visibility did not seem to interfere with their hunting. As indicated in previous studies, abalone apparently continues to be the sea otters' preferred food in newly-colonized areas.

SPORTFISH CATCH-PER-UNIT-OF-EFFORT

Methods

As time and weather permitted, we continued to occupy fishing stations at the random and permanent subtidal stations. One or two rods were fished for 30 min at each station. Some of the fish captured were retained for food habit studies: gopher, black and yellow, and grass rockfish (*Sebastes carnatus*, *S. chrysomelas*, and *S. rastrelliger*, respectively).

Results

In Diablo Cove we occupied 13 fishing stations. The catch from these stations included two blue rockfish, *Sebastes mystinus*, five gopher rockfish, one black and yellow rockfish, two black rockfish, *S. melanops*, one grass rockfish, one kelp greenling, *Hexagrammos decagrammus*, and one cabezon, *Scorpaenichthys marmoratus*. The catch per hour was 1.3 fish. Five stations in North Cove and the North Control yielded a catch rate of 2.7 fish per hour. The catch was composed of one blue rockfish, seven gopher rockfish, one black and yellow rockfish, one kelp greenling, one cabezon, and one copper rockfish, *S. caurinus*.

DIABLO COVE *NEREOCYSTIS* POPULATION

Methods

Since 1970, annual counts have been made from shore of the Diablo Cove surface canopy of bull kelp, *Nereocystis luetkeana*. The shore census had been conducted near the end of September or the beginning of October when the canopy generally reaches peak density. This is also the period before the high seas of early winter storms begin to thin the bull kelp population.

The 1975 surface canopy was, however, too dense to make a shore count possible. In the absence of the census, we derived an estimate of the

total number of surface plants (Gotshall, et al. 1976). The estimate we derived was 33,000 plants.

Most of these plants were removed by the winter seas, but a high number of them survived into March. Because the canopy was greatly thinned, we performed a shore census in late March to determine the over-winter survival rate.

Results

Our March count showed approximately 5800 *Nereocystis* plants of the 1975 Diablo Cove population survived the winter. Assuming our peak canopy estimate of 33,000 plants is accurate, then about 18% of the population survived into the beginning of this spring. This is a very high percentage because previous studies (Foreman 1970; Earl Ebert, Calif. Dept. Fish and Game Pers. Commun.), indicate that from 1 to 5% of all first year *Nereocystis* plants survive winter storms. This survival rate, coupled with a reproduction rate that has nearly doubled the annual numbers during the last 3 years, indicate extremely favorable growing conditions for bull kelp in Diablo Cove. Judging by the numbers of 15-to 30-cm (6- to 12-inch) juveniles we already have observed in the Diablo Cove subtidal in February and March of this year, 1976 promises to be another year of abundance for *Nereocystis luetkeana*.

Another series of high seas in late March further thinned the 1975 bull kelp population within Diablo Cove by an estimated 80%. Following the storms, most of the upper intertidal region of South Diablo Cove was covered by mats of tangled stipes of bull kelp.

FOAM OBSERVATIONS

Methods

As reported in the last quarterly, our observations and photograph-taking of foam conditions in Diablo Cove are continuing on a regular basis.

Results

On several occasions during the quarter, under a similar set of weather conditions, foam produced by turbulence of the cooling water system discharge became as thick as 15 to 20 cm (6 to 8 inches) and covered an appreciable part of southern Diablo Cove. It appears that this unfortunate situation exists when the sea state is calm to moderate, the winds are calm, and the tidal stage is at flood or slack. Under more extreme weather conditions, the foam does not appear to build up as well possibly because surface tension required for foam accretion is disrupted by further turbulence.

The surface of Diablo Cove is not the only area affected by foam. Under moderate conditions, but with a 5 to 15 knot northwest wind blowing, we have observed foam piling up in the South Diablo Cove intertidal to depths of about 0.3 m (1 ft) and covering approximately 600 m². This situation may occur only a small percentage of the time and, although unsightly, may have little or no deleterious effect on intertidal organisms, but additional monitoring and (or) laboratory studies will have to be undertaken to determine this.

The cooling system pumps were turned off in February and will remain off for an undetermined period of time.

INTAKE COVE

Results

We made another reconnaissance dive in the mid-portion of Intake Cove in early March. Underwater visibility was about 6 m (20 ft), superb for this area. Due to the visibility, and perhaps to improving conditions as well, we observed higher numbers of fish than on earlier occasions, particularly adult blue rockfish. Invertebrate composition remained unchanged with *Patiria miniata*, the bat star, still the dominant macro invertebrate. Foliose benthic red algae are still common only in the shallow regions of the breakwater tribars, probably because this is the only area inside the Cove which receives adequate flushing of sediment (because of the breakwater's porosity) to allow for spore survival and successful growth. Pea kelp, *Macrocystis integrifolia*, continues to increase within the Cove and now forms an extensive canopy in the region of the Intake structure. Although the upper layers of silt on the Cove bottom are still easily disturbed, it was our impression that compaction of the sediments is occurring. If this is so, with time, more and more of the silt will be removed from the dynamic cycle of disturbance-caused turbidity and the Cove will return to a healthier, although not original, condition.

LABORATORY ACTIVITIES

As before, much of our lab effort is directed at processing our algae samples. We also began to work on our invertebrate collections and added several new species to our list. Also during this quarter, with the aid of the Department's statistical section in Menlo Park, we initiated preparation of our data for storage and analysis in the RAMIS system. We hope to begin data analysis by the end of the second quarter of this year.

REFERENCES

- Foreman, R.E. 1970. Physiology, ecology and development of the brown alga, *Nereocystis luetkeana* (Mertens) Paul R. Ph.D. dissertation, Univ. of Calif., Berkeley. 114 p.
- Gotshall, Daniel W., Laurence L. Laurent, and Fed E. Wendell. 1976. Diablo Canyon Power Plant Site Ecological Study, Quarterly Report No. 10, October 1 - December 31, 1975. Marine Resources Administrative Report 76 - 8: 1-10.

APPENDIX I

MAN-DAYS SPENT AT DIABLO CANYON POWER PLANT SITE

January 1 - March 31, 1976

Intertidal surveys:

January 13-17

Participants: Laurent, Wendell,

January 27-30

Participants: Laurent, Wendell, Dykzeul,

February 13-14

Participants: Laurent, Wendell,

March 13-14

Participants: Laurent, Wendell

Subtidal surveys:

March 9

Participants: Laurent, Wendell

March 16-17

Participants: Laurent, Wendell,

Sportfish catch-per-unit-of-effort study:

February 10-11

Participants: Laurent, Wendell,

February 13-14

Participants: Laurent, Wendell, Gotshall

February 15, 16, 26, 27, March 8, 9, 10

Participants: Laurent, Wendell,

March 16-17

Participants:	Laurent, Wendell, Gotshall, Oakes
Total man-days during quarter	272
Total man-days at site*	200
Total stations surveyed	40
Travel time man-days	5
Boat time (hours)	11.7
Laboratory time man-days**	78

*Total time spent at Diablo Canyon by all project personnel,
includes both field time as well as laboratory time.

**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
Lois E. Sloan	Stenographer
Jane E. Dykzeul	Seasonal Aid
Franklin R. Oak	Seasonal Aid
Terrie Tiffany	Seasonal Aid