CATEGORY 1

REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR:9608080239 DOC.DATE: 96/05/31 NOTARIZED: NO DOCKET #
FACIL:50-275 Diablo Canyon Nuclear Power Plant, Unit 1, Pacific Ga 05000275
50-323 Diablo Canyon Nuclear Power Plant, Unit 2, Pacific Ga 05000323
AUTH.NAME AUTHOR AFFILIATION
* Pacific Gas & Electric Co.
RECIP.NAME RECIPIENT AFFILIATION

BRIGGS,R. California, State of

SUBJECT: "Ecological Monitoring Program,Status Rept,Winter 1995 & Spring 1996 Surveys." W/960726 ltr.

DISTRIBUTION CODE: IE25D COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 45
TITLE: Environmental Monitoring Rept (per Tech Specs)

NOTES:

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
	PD4-2 LA	3	3	PD4-2 PD	1	1
	BLOOM,S	1	1			
INTERNAL:	ACRS	1	1	FILE CENTER 01	1	1
	NRR/DRPM/PERB	1	1	RGN4 FILE	1	1
EXTERNAL:	NRC PDR	1	1			

NOTE TO ALL "RIDS" RECIPIENTS:
PLEASE HELP US TO REDUCE WASTE! CONTACT THE DOCUMENT CONTROL DESK, ROOM OWFN 5D-5(EXT. 415-2083) TO ELIMINATE YOUR NAME FROM DISTRIBUTION LISTS FOR DOCUMENTS YOU DON'T NEED!

TOTAL NUMBER OF COPIES REQUIRED: LTTR 10 ENCL 10

CATEGORY 1 DOCUMENT

Pacific Gas and Electric Company

Diablo Canyon Power Plant
P.O. Box 56
Avila Beach, CA 93424
805/545-6000

Robert P. Powers
Vice President–Diablo Canyon
Operations and Plant Manager

July 26, 1996

PG&E Letter DCL-96-544

Mr. Roger Briggs, Executive Officer
California Regional Water Quality Control Board
Central Coast Region
81 Higuera Street, Suite 200
San Luis Obispo, CA 93401-5414

Dear Mr. Briggs:

Ecological Monitoring Program Semi-Annual Summary Report
Diablo Canyon Power Plant - NPDES No. CA0003751

In accordance with Order 90-09, NPDES No. CA0003751, enclosed is the Diablo Canyon Power Plant Semi-Annual Ecological Monitoring Program Report for the 1995 Winter and 1996 Spring Surveys. (Enclosure 1).

I certify under penalty of the law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. The results of the ecological monitoring presented are the observed results of measurements and observations required by the monitoring program, and is neither an assertion of the adequacy of any instrument reading or analytical result, nor an endorsement of the appropriateness of any analytical or measurement procedure. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations.

If you have any questions, please contact Drew Squyres of my staff at (805) 545-4439.

Sincerely,

J E Molden for

Robert P. Powers

96-544/DAS/kmo/654

1/1
Ltr

cc: Chief, Environmental Services Division
California Department of Fish and Game
Resources Building
1416 Ninth Street
Sacramento, CA 95814

Regional Administrator, Region 9
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105
Attention: Carey Houk (W-5-3)

Regional Administrator
U.S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Dr., Suite 400
Arlington, TX 76011-8064

Director
U.S. Nuclear Regulatory Commission
Region IV, Field Office
1450 Maria Lane, Suite 210
Walnut Creek, CA 94596-5368

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Chief, Marine Resources Division
California Department of Fish and Game
Resources Building
1416 Ninth Street
Sacramento, CA 95814

Enclosures

96-544/DAS/kmo/654

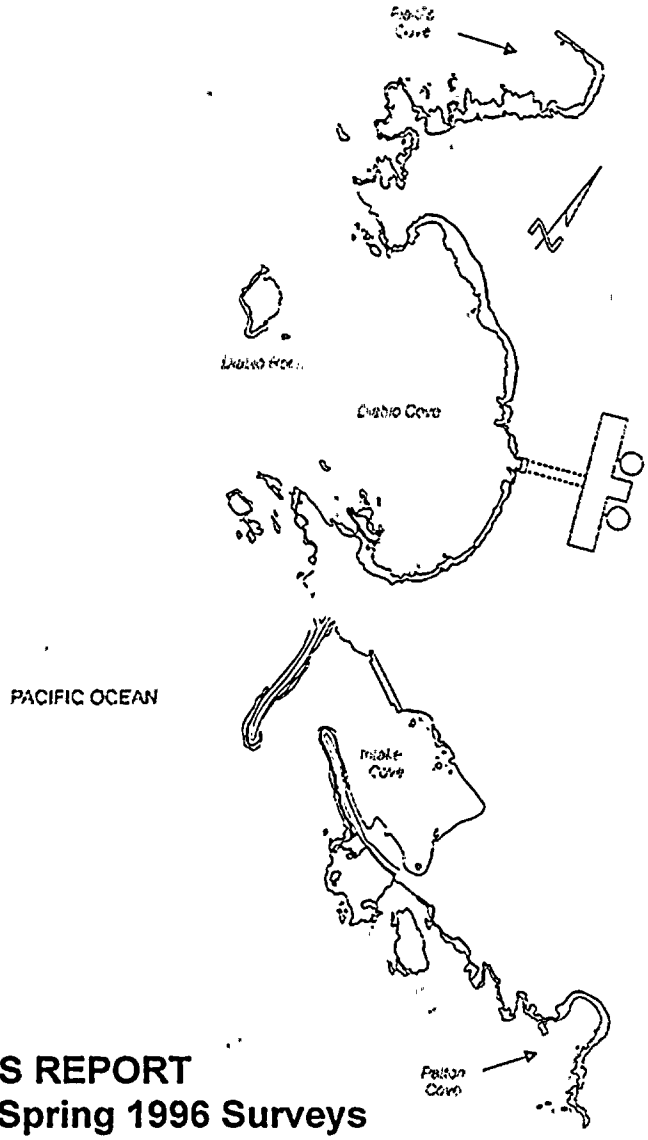
PG&E Letter DCL-96-544

ENCLOSURE 1

SEMI-ANNUAL SUMMARY REPORT ON THE DIABLO CANYON POWER PLANT ECOLOGICAL MONITORING PROGRAM 1995 WINTER AND 1996 SPRING SURVEYS

(NPDES NO. CA0003751)

Ecological Monitoring Program



STATUS REPORT
Winter 1995 and Spring 1996 Surveys

DIABLO CANYON POWER PLANT
PACIFIC GAS & ELECTRIC COMPANY

PG&E

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

THIS PAGE INTENTIONALLY
LEFT BLANK

1.0 INTRODUCTION

The 1995 Status Report for the Environmental Monitoring Program (EMP) at Diablo Canyon Power Plant (DCPP) has been prepared in accordance with the Monitoring and Reporting Program adopted on February 10, 1995 for Central Coast Regional Water Quality Control Board (CCRWQCB) Order Number 90-09 and National Pollutant Discharge Elimination System (NPDES) Permit No. CA 0003751. The NPDES permit was issued on May 11, 1990, to Pacific Gas and Electric Company (PG&E), owner and operator of DCPP.

1.1 Purpose

The purpose of the EMP is to detect impacts to the marine environment resulting from power plant operations. The Monitoring and Reporting (M&R) Program in DCPP's NPDES permit requires submittal of two EMP status reports each year to the CCRWQCB; one following completion of studies conducted in "summer/fall" (June-October) and the other following completion of studies conducted in "winter/spring" (November-May). The purpose of the status reports is to summarize results of completed studies, and to report on any substantive changes in environmental conditions from historical trends. Previous EMP and Thermal Effects Monitoring Program (TEMP) findings provide a historical basis for assessing changes and trends.

1.2 Project Status

The TEMP was conducted from 1976 through June 1995 to determine impacts of the power plant's thermal discharges on the receiving waters and shoreline of Diablo Cove and surrounding areas. A final assessment report on the TEMP studies is being prepared for submittal in 1997. On February 10, 1995, the CCRWQCB adopted a revised Monitoring and Reporting Program for DCPP. Item 1 of the revised program is the Ecological Monitoring Program (EMP). Sampling methods and location of stations for the EMP studies were selected to provide continuity with the TEMP. The EMP study plan was implemented on July 1, 1995.

1.3 Reporting

This progress report presents data collected from the EMP study tasks for the winter 1995-spring 1996 study period (November 1, 1995 through May 31, 1996) (Table 1-1). The

temperature data presented, however, includes recordings taken in fall 1995 of the previous reporting period, as they were unavailable for earlier reporting. Intertidal biological data are from horizontal band transect sampling (all stations) and vertical band transect sampling (Field's Cove station only). Subtidal data are from benthic station sampling only. No subtidal fish, kelp assessment, or red and black abalone surveys were scheduled during this reporting period, in accordance with the EMP study plan.

The sections of this report briefly describe sampling methods and data collected for the sampling period. Analytical and quantitative comparisons of data with historical trends are beyond the scope of the present report. However, qualitative comparisons to findings noted in previous EMP and TEMP reports are discussed when any notable changes were observed during the reporting period.

1.4 Summary of Results

Intertidal water temperatures were warmest at Station 10+2 located nearest the discharge. Coolest temperatures were recorded at Stations 2+2, 3+2, and 19+2, situated beyond the influence of the thermal plume. Warmest subtidal temperatures in Diablo Cove were recorded at stations located at depths of -11ft MLLW and shallower. Overall, Station 6-11 at Diablo Rock was the warmest subtidal station in Diablo Cove, followed by stations in north Diablo Cove and south Diablo Cove.

The seventh refueling outage for DCPP Units 1 and 2 occurred during the reporting period. Additional power plant outages and changes in circulating pump operations during the period interrupted the normal pattern of the thermal discharge. Although elevated water temperatures were recorded in Diablo Cove, at Diablo Point, and in Field's Cove when Units 1 and 2 were operational, temperatures in these areas were closer to ambient during outages and shutdowns.

In winter 1995/96, the EMP Diablo Cove intertidal stations were characterized by having lower abundances of perennial, and higher abundances of annual algal species than non-Diablo Cove stations. Relatively high purple sea urchin densities occurred in both Field's Cove and Diablo Cove. Several areas in north and south Diablo Cove remained high in abundances of

invertebrate grazers and barnacles in comparison to areas sampled outside the cove. Intertidal fishes were sampled on two occasions only in Field's Cove, in conformance with the EMP study plan. Species composition appeared similar to previous surveys, but black prickleback, a species common in previous surveys in Field's Cove was absent.

Subtidally, warm water indicator species (e.g. the gastropods, *Norrisia norrisia* and *Megathura crenulata*) occurred specifically in Diablo Cove. Several subsurface kelp plants (*Pterygophora* and *Laminaria*) were observed in the south Diablo Cove stations where thermal plume-related reductions in these species had previously occurred. Their occurrence may be related to cooler temperatures resulting from power plant outages during the period. Although not surveyed during the period, dense stands of giant kelp (that had developed over the past several years in Diablo Cove) persisted through winter 1996.

Table 1-1

Winter 1995 - Spring 1996 Surveys and Task Reporting

	Task	Survey Schedule	Stations [a]	Data in Present Report
Intertidal Studies	Temperature	Continuous	2, 6, 8, 9, 10, 12, 19	Sep 1995 - May 1996 [b]
	Horizontal Band Transect Stations	1 Winter and 1 Summer	1, 8, 9, 10, 12, 19	Survey 104
		2 Winter and 2 Summer	4, 5, 6	Surveys 103 and 104
	Vertical Band Transect Stations	2 Winter and 2 Summer	C	Surveys 63 and 64
		1 Summer	L, H	-
	Black Abalone Diablo Cove-Wide Transects	1 Summer	(10) 100m Transects	-
	Black Abalone Fixed 10-Meter Transects	1 Summer	(10) 10m Transects	-
Subtidal Studies	Temperature	Continuous	1-10, 6-11, 9-10, 9-15, 11-10, 11-15, 19-10, 22-10	Oct 1995 - May 1996 [c]
	Benthic Stations	1 Winter and 1 Summer	6-11, 9-10, 9-15, 10-15, 12-10, 19-10	Survey 96
		2 Winter and 2 Summer	22-10, 22-30	Surveys 95 and 96
	Fish Assessment	1 Summer and 1 Fall	4, 5, 6, 7, 8, 9, 10, 12, 13, 14	-
	Red Abalone Random Stations	1 Summer and 1 Fall	20 stations in Diablo Cove and 10 stations outside the cove	-
	Habitat Forming Kelp Survey	1 Fall	Cove-wide	-

[a] Station maps depicted in Figures 2-1, 3-1, 3-2, and 4-1

[b] Fall 1995 data included for North Reference Station 2+2 and Patton Cove Station 19+2, since data were not available for previous reporting

[c] Fall 1995 data included for Field's Cove Station 22-10 and Intake Cove Station 32-32, since data were not available for previous reporting

2.0 PHYSICAL MONITORING STUDIES

2.1 Water Temperature

Battery operated field temperature recording instruments are placed inside metal canisters at permanent +2ft mean lower low water (MLLW) intertidal stations and at permanent subtidal stations (Figure 2-1). The elevation or depth of each station is indicated by the number following the station number. Instruments among stations synchronously log temperature every 20 minutes. Temperature resolution is 0.01°C, with an accuracy of 0.02°C. Instruments are exchanged with serviced, calibrated units approximately every 60 days. Temperature data are transferred on to computer media for storage and analysis. Intertidal Stations 3+2 and 14+2 and subtidal Stations 1-10, 5-25, and 32-32 serve as back-up temperature recording stations.

Intertidal temperature units record air temperatures when tidal levels recede below the +2ft MLLW elevation. Recordings taken during air exposure periods are partitioned from the records to avoid including them in the intertidal water temperature database. Air and water temperature data are analytically distinguished from one another by concurrent tidal height (water depth) recordings taken by subtidal instruments.

Weekly mean intertidal water temperatures (week ending dates for the period September 1995 through May 1996) are presented by station in Table 2-1. (September-October 1995 data for several stations were not available for previous reporting, as the instruments had not been retrieved from the field.) Table 2-1 shows that the warmest intertidal water temperatures were recorded in Diablo Cove. Water temperatures were warmest at Station 10+2 located nearest the discharge. Temperatures at Stations 8+2 and 9+2 in north Diablo Cove were warmer than at Station 12+2 in south Diablo Cove. The coolest seawater temperatures were recorded at Stations 2+2, 3+2, and 19+2, located outside the thermal plume.

Temperature data for Station 19+2 is used as the ambient water temperature condition for comparison with other stations. Weekly mean temperatures among the Diablo Cove intertidal stations ranged between 2.9°C and 4.4°C above ambient. Instantaneous temperature recordings occasionally exceeded 10°C above ambient at those stations. Temperatures warmer

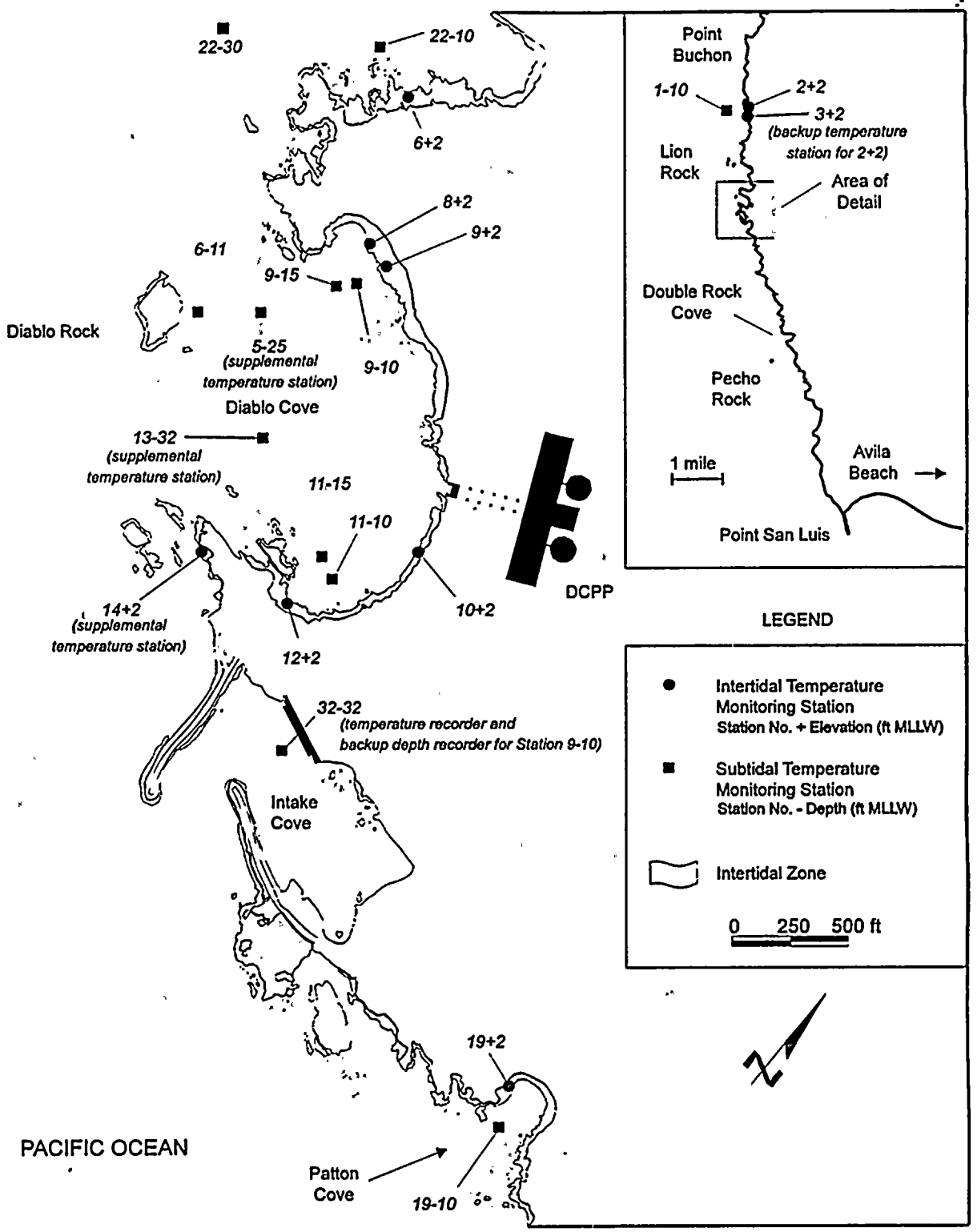


Figure 2-1

EMP Intertidal and Subtidal Seawater Temperature Monitoring Stations

Table 2-1

Weekly Mean Intertidal Seawater Temperatures
(Week Ending Dates: September 30, 1995 - May 31, 1996)

Week Ending Date

Area	Station	1995 Sep 30	Oct 7	Oct 14	Oct 21	Oct 28	Nov 4	Nov 11	Nov 18	Nov 25	Dec 2	Dec 9	Dec 16	Dec 23	Dec 30	1996 Jan 6	Jan 13	Jan 20	Jan 27	Feb 3	Feb 10	Feb 17	Feb 24	Mar 2	Mar 9	Mar 16	Mar 23	Mar 30	Apr 6	Apr 13	Apr 20	Apr 27	May 4	May 11	May 18	May 25	May 31
North	2+2	13.0	13.5	14.8	15.3	14.2	15.0	14.8	14.8	14.7	14.0	13.5	14.0	13.4	13.7	13.2	13.6	13.0	11.5	12.0	12.5	13.5	13.4	12.0	12.8	13.1	12.8	11.7	12.0	11.4	11.4	11.0	12.1	11.9	*	*	*
Reference	3+2	13.0	13.5	14.9	15.2	14.2	14.9	14.8	14.7	14.6	14.0	13.4	14.0	13.4	13.6	13.2	13.5	12.9	11.4	11.9	12.4	13.4	13.3	12.0	12.8	13.1	12.7	11.8	11.9	11.3	11.3	10.9	12.0	11.8	*	*	*
Field's Cove	6+2	13.1	13.9	15.5	15.8	14.8	15.6	15.6	15.5	15.1	14.5	14.6	14.3	13.8	14.0	14.0	14.6	13.6	12.5	12.7	12.9	14.4	14.2	13.1	13.6	13.3	13.2	12.4	12.6	11.4	11.2	10.7	12.4	12.1	13.0	11.5	11.5
North	8+2	15.0	15.9	19.5	19.2	17.9	19.4	18.8	17.6	16.2	15.7	17.1	15.0	14.9	15.4	16.3	17.3	15.9	14.9	15.4	14.5	17.4	16.2	15.7	16.2	14.6	14.9	15.3	15.6	13.4	12.3	11.8	15.6	13.7	16.5	12.6	14.5
Diablo Cove	9+2	15.2	15.8	19.5	19.1	18.1	19.3	18.7	17.7	16.2	15.7	17.1	15.2	14.9	15.5	16.3	17.4	16.1	15.1	15.5	14.7	17.6	16.4	15.9	16.4	15.2	15.1	15.8	15.7	13.8	12.6	12.7	15.6	13.6	16.6	12.6	14.6
South	10+2	15.7	15.9	19.2	18.7	18.2	18.5	18.1	18.5	18.8	17.0	16.7	16.9	18.0	20.4	18.4	17.9	18.6	16.3	16.0	19.5	18.3	18.9	16.4	17.4	17.6	17.9	15.5	16.0	15.7	15.8	16.0	16.3	15	14.8	13.6	14.7
Diablo Cove	12+2	14.7	15.3	18.4	18.1	17.7	18.2	17.8	17.9	17.0	16.2	16.2	15.2	15.8	16.6	16.3	16.6	16.4	14.7	14.4	15.1	16.5	16.4	15.2	15.8	15.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Diablo Point	14+2	14.0	14.2	16.7	16.5	16.0	16.3	16.7	16.8	16.3	16.1	15.9	15.0	15.0	15.3	15.4	16.1	15.3	14.2	13.6	13.7	14.9	15.5	14.4	14.5	14.7	14.6	13.7	13.6	12.6	12.4	12.0	12.6	12.4	12.6	12.2	12.7
Patton Cove	19+2	12.9	13.5	14.9	15.0	14.2	14.7	14.8	14.8	14.6	13.9	13.3	14.0	13.5	13.6	13.2	13.5	12.8	11.4	11.7	12.3	13.2	13.3	12.0	12.5	12.7	12.7	11.2	11.7	11.0	11.1	10.2	11.6	11.1	12.2	11.1	10.7

nd = no data

* Data not yet retrieved from the field unit

than ambient were also recorded at Station 14+2 on Diablo Point (south headland of Diablo Cove) and at Station 6+2 in Field's Cove, north of Diablo Cove.

Table 2-2 presents weekly mean temperatures for the subtidal stations (week ending dates from October 1995 through May 1996). October 1995 data are included as they were unavailable for reporting in the previous EMP status report.

Ambient temperature stations (Stations 1-10 and 19-10), located beyond the influence of the thermal plume differed by an average of about 0.2°C. Data from Station 19-10 is used in this report for comparing ambient subtidal temperatures to water temperatures at other stations potentially influenced by the thermal plume.

Table 2-2 shows that the warmest subtidal temperatures in Diablo Cove were recorded at stations located at depths of -11ft MLLW and shallower. Overall, Station 6-11 at Diablo Rock was the warmest subtidal station, followed by stations in north Diablo Cove and then south Diablo Cove. The average increase over ambient among stations ranged from less than 0.1° at Station 13-32 in the Diablo Cove south channel to 4.1°C at Station 6-11 at Diablo Rock. The maximum, instantaneous temperature difference from ambient was 10.4°C, recorded at Station 11-10 in south Diablo Cove. Station 22-10 in Field's Cove also recorded temperatures warmer than ambient. Temperatures both slightly warmer and slig y cooler than ambient were recorded at all the stations, in particular at those situated in deeper water in Diablo Cove (Stations 5-25 and 13-32). These fluctuations may have been caused by the entrainment of deep, offshore cold water into Diablo Cove by the advective force of the surface plume as it exits the cove.

During the present reporting period, the operation of the power plant was interrupted by two refueling outages and other short-term shutdowns. The seventh scheduled refueling outage of Unit 1 began in September 1995, and was completed when the unit was brought up to full power at the end of November 1995. In December, kelp debris loading caused both units to be shut-down for several days. In March 1996, power plant operation was again briefly interrupted (transformer replacement). The seventh scheduled refueling outage of Unit 2 began in April 1996 and ended in May 1996. When units and circulating pumps were off-line there was less

Table 2-2

Weekly Mean Subtidal Seawater Temperatures
(Week Ending Dates: October 14, 1995 - May 31, 1996)

		Week Ending Date																																		
		1995													1996																						
		Oct 14	Oct 21	Oct 28	Nov 4	Nov 11	Nov 18	Nov 25	Dec 2	Dec 9	Dec 16	Dec 23	Dec 30	Jan 6	Jan 13	Jan 20	Jan 27	Feb 3	Feb 10	Feb 17	Feb 24	Mar 2	Mar 9	Mar 16	Mar 23	Mar 30	Apr 6	Apr 13	Apr 20	Apr 27	May 4	May 11	May 18	May 25	May 31
Area	Station																																			
North Reference	1-10	15.2	15.0	14.2	14.9	14.8	14.7	14.7	14.0	13.5	14.0	13.5	13.7	13.2	13.6	13.0	11.4	11.9	12.4	13.5	13.3	12.1	12.9	13.1	12.7	11.9	12.0	11.3	11.3	10.8	11.8	11.3	12.5	11.3	11.0
Field's Cove	22-10	15.5	15.5	14.8	15.6	15.6	15.5	15.1	14.6	14.6	14.3	13.9	14.0	14.1	14.7	13.7	12.4	12.8	12.8	14.4	14.1	13.3	13.7	13.5	13.3	12.8	12.6	11.4	11.1	10.7	12.2	11.6	12.8	11.2	11.5
Diablo Rock Diablo Cove	6-11	17.8	17.2	16.9	17.9	17.5	17.8	18.3	17.2	18.2	16.0	17.5	20.0	19.2	19.5	19.1	17.1	18.0	18.2	19.8	19.2	18.2	19.1	17.8	17.8	17.4	17.3	13.0	12.8	12.0	14.2	12.5	15.9	12.8	15.7
North Channel Diablo Cove	5-25	16.0	15.2	14.6	14.9	15.0	15.9	16.2	15.4	14.4	14.8	15.4	15.9	15.0	15.4	14.9	13.1	13.4	14.4	15.4	15.3	14.0	14.4	14.3	14.7	12.6	12.6	11.3	11.4	10.8	11.3	10.8	12.4	11.1	11.6
North Diablo Cove	9-10	19.0	18.8	18.3	18.6	18.1	17.7	16.4	15.8	17.2	15.5	15.7	16.2	16.8	17.8	16.9	15.3	16.3	15.6	18.3	17.1	16.5	17.0	15.8	15.6	16.2	15.8	14.4	13.9	13.7	14.7	13.2	16.1	13.2	14.5
	9-15	18.3	18.0	17.3	17.7	17.2	17.3	16.2	15.8	17.0	15.3	15.4	15.8	16.6	17.7	16.5	14.9	15.9	15.0	18.1	16.5	16.3	16.7	15.5	15.5	16.0	15.5	13.5	12.7	12.7	13.7	12.6	15.5	12.6	14.0
South Diablo Cove	11-10	18.1	17.0	16.7	16.2	16.2	17.2	17.9	16.6	16.1	15.4	16.9	17.8	17.2	17.1	17.5	15.5	15.1	16.3	17.2	17.4	15.8	16.0	16.9	17.1	15.2	15.1	14.6	14.4	14.5	13.1	12.4	13.6	12.5	13.6
	11-15	17.0	15.7	15.4	15.0	15.1	16.1	17.0	15.8	14.4	15.3	16.4	17.7	16.1	16.0	16.4	14.2	14.1	16.2	15.8	16.6	14.5	15.4	15.8	16.0	12.9	13.7	13.1	13.8	13.4	12.0	11.1	13.1	12.4	12.9
South Channel Diablo Cove	13-32	15.1	14.3	14.0	14.3	14.3	14.4	15.1	13.8	12.9	14.6	14.4	15.1	13.7	13.5	13.3	11.6	12.1	13.6	13.1	14.0	12.1	12.8	13.1	12.6	10.9	11.3	11.0	11.9	10.7	10.8	10.4	11.5	11.1	10.3
Patton Cove	19-10	15.2	14.8	14.3	14.8	14.9	14.8	14.7	14.0	13.4	13.9	13.6	13.5	13.2	13.6	13.0	11.5	11.8	12.4	13.4	13.4	12.2	12.8	12.9	12.7	11.4	11.7	11.0	11.1	10.2	11.5	10.8	12.1	10.9	10.6
Intake Cove	32-32	14.4	14.0	13.6	14.1	14.2	14.3	14.4	13.4	12.9	13.9	13.5	13.5	13.1	13.4	12.8	11.3	11.7	12.2	13.1	13.2	12.0	12.3	12.6	12.3	11.0	11.2	10.5	10.7	9.8	10.7	10.3	11.4	10.3	10.1

difference between ambient water temperatures and temperatures in Diablo Cove. This change was most evident at Station 6-11 located at Diablo Rock.

3.0 INTERTIDAL BIOLOGICAL STUDIES

3.1 HORIZONTAL BAND TRANSECTS

This study samples intertidal algae and invertebrates at fixed stations, each consisting of two permanent 30m band transects oriented parallel to the shoreline; one at the +1ft MLLW tide level and one at the +3ft MLLW tide level (Figure 3-1). Each transect is composed of 10 fixed, $1m^2$ quadrat sampling areas. Each transect level is designated as the station number followed by elevation mark (e.g., the +3ft transect of Station 12 is designated as "12+3"). Stations in Field's Cove are sampled twice in summer and twice in winter. Remaining stations are sampled once in summer and once in winter. This section summarizes algal and invertebrate sampling results obtained from the horizontal band transects for Survey 103 (first winter survey for the Field's Cove stations) and Survey 104 (winter sampling of all stations).

In each quadrat, algal species are sampled for percentage cover. Overstory species are sampled first, then moved aside to expose understory species for coverage determinations. Species found in trace quantities are noted as being present. Total algal coverage (all species combined) is often greater than 100 percent due to layering of species.

Invertebrates are sampled by two methods in the same 10 quadrats sampled for algae. Invertebrate species data are recorded as numbers of individuals, presence occurrences, or coverage values, depending on which species are sampled. In five quadrats ("count" or "*Tegula*" quadrats), all individuals of select species are counted regardless of size. In the other five ("standard quadrats"), individuals greater than one inch (greatest dimension) are counted, while the remaining species are recorded as presence data. For all 10 quadrats, black abalone (*Haliotis cracherodii*) are counted, and encrusting invertebrates such as bryozoans, tunicates, and sponges are recorded based on coverage.

Algae

Tables 3-1 and 3-2 summarize the results of Surveys 103 and 104 conducted from November 1995 to January 1996. Species are presented in descending rank order according to theirpooled abundances across stations. Several general patterns are evident: Most species were observed at stations both inside and outside Diablo Cove. Species richness (numbers of

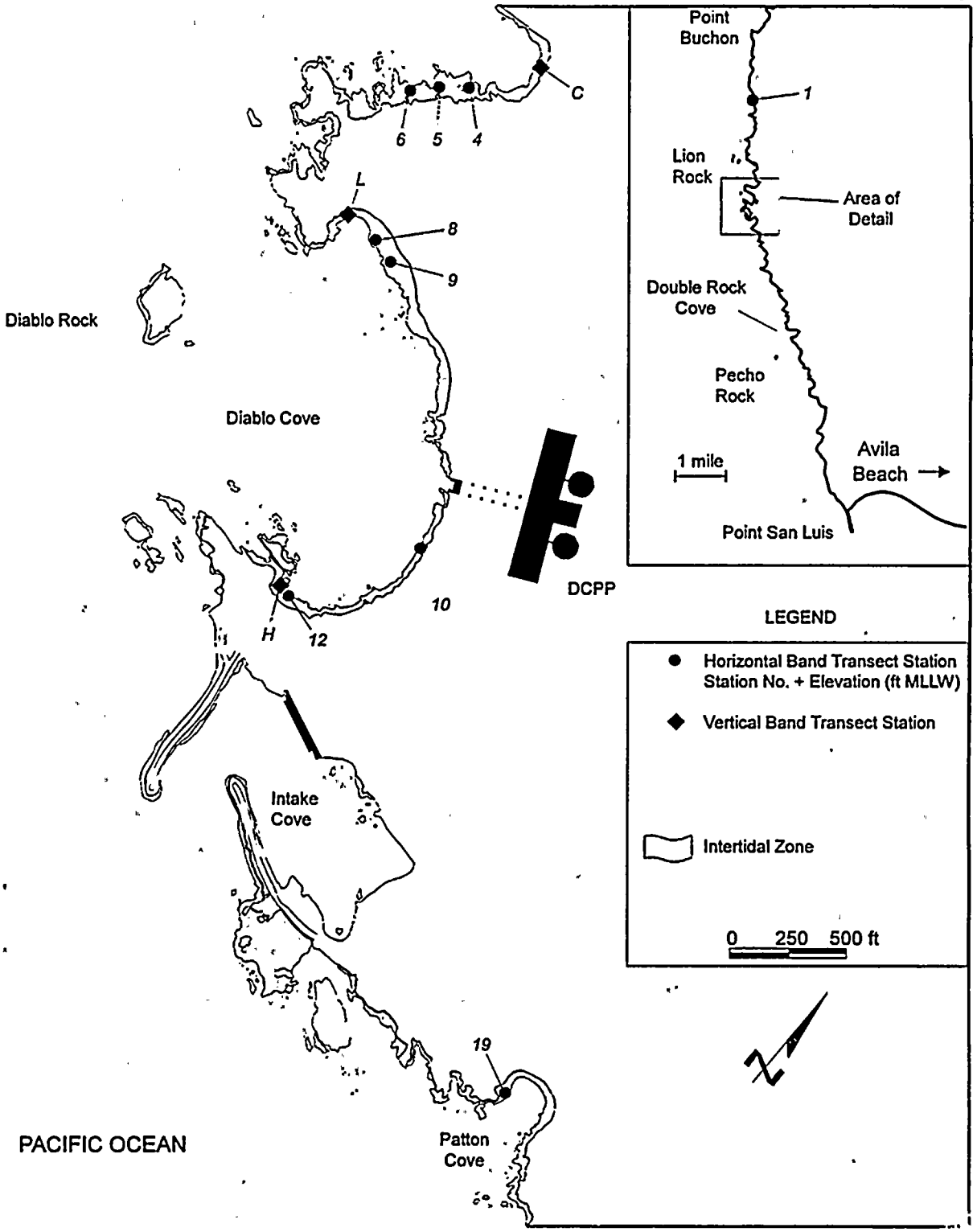


Figure 3-1

EMP Intertidal Horizontal and Vertical Band Transect Station Locations

Table 3-1

Summary of Intertidal Algal Abundances at the EMP +1ft MLLW Horizontal Band Transect Stations for Surveys 103 and 104 - IBT Method

Abundance = Mean percent cover per m^2 (N=10 per station)

Area	Field's Cove						North Reference	South Diablo Cove		North Diablo Cove		Patton Cove
Station	4+1	5+1	6+1	4+1	5+1	6+1	1+1	8+1	9+1	10+1	12+1	19+1
Survey	103	103	103	104	104	104	104	104	104	104	104	104
Month/Year	11/95	11/95	12/95	1/96	1/96	1/96	1/96	1/96	1/96	1/96	1/96	1/96
non-coralline crust	29.6	25.1	27.1	26.6	27.3	27.0	10.8	22.7	29.9	11.6	31.1	12.5
Gastroclonium coulteri	14.0	9.0	19.1	13.5	6.9	18.6	12.9	21.6	1.5	7.8	4.9	11.6
Phyllospadix spp.	10.1	10.1	10.3	7.4	8.5	8.8	27.6	10.8	-	-	-	4.4
coralline crust	11.6	8.6	5.3	10.4	9.5	8.1	6.3	5.5	13.9	0.6	1.2	16.1
Gigartina canaliculata	5.6	3.1	7.8	6.5	3.7	6.2	10.5	10.2	1.5	8.5	1.0	22.0
Iridaea splendens	5.6	3.5	16.3	5.3	3.1	16.4	14.0	-	-	-	-	21.1
Gelidium coulteri	9.5	16.9	6.2	4.4	3.7	3.9	6.4	<.1	2.3	0.2	0.3	<.1
Corallina vancouveriensis	7.4	9.9	2.6	10.0	13.4	3.7	1.5	0.2	2.4	0.1	-	1.9
Cryptopleura spp.	10.7	9.2	4.9	6.9	6.6	3.4	1.7	1.9	-	3.0	-	1.3
Egregia menziesii	19.9	7.9	4.9	11.0	3.5	1.9	-	-	-	-	-	<.1
filamentous red algae - complex	<.1	0.2	0.2	0.1	<.1	<.1	0.9	17.4	3.1	27.0	-	<.1
Calliarthron/Bossiella spp.	2.9	7.4	5.3	5.8	6.6	6.1	1.6	1.7	5.8	<.1	-	3.7
Mastocarpus papillatus	2.2	1.9	2.7	2.4	1.0	1.6	3.7	2.2	0.7	<.1	16.0	0.7
Endocladia muricata	5.3	8.4	1.1	5.7	9.2	1.1	0.8	0.6	0.2	-	0.1	<.1
Prionitis spp.	1.1	2.6	1.2	1.4	2.6	2.0	1.1	4.4	0.8	1.5	-	1.8
Rhodoglossum affine	1.5	0.6	0.7	1.5	0.4	0.8	7.9	3.5	0.5	1.5	0.3	<.1
Gigartina agardhii	0.9	0.6	3.9	0.8	0.7	3.8	0.8	-	-	-	-	0.9
Ulva/Enteromorpha spp.	3.4	<.1	0.2	1.1	-	<.1	<.1	0.6	5.7	0.6	<.1	0.4
juvenile articulated coralline algae	0.6	0.7	0.9	1.6	1.0	1.0	0.3	0.8	2.1	<.1	<.1	<.1
Pterosiphonia dendroidea	-	-	-	-	-	-	1.0	2.9	<.1	1.3	0.3	<.1
Gelidium pusillum	0.2	0.1	0.3	0.5	0.1	0.3	0.2	0.1	<.1	<.1	1.5	<.1
Gigartina leptorhynchos	<.1	<.1	1.1	0.2	<.1	0.4	0.3	0.4	-	<.1	0.4	<.1
Laurencia spp.	1.0	0.3	<.1	0.3	0.1	<.1	0.2	0.6	-	<.1	-	0.2
Codium setchellii	-	-	-	-	-	-	1.9	-	-	-	-	-
Iridaea heterocarpa	0.3	<.1	0.1	<.1	<.1	0.9	<.1	<.1	-	<.1	<.1	<.1
Neoagardhiella gaudichaudii	0.1	<.1	0.1	0.3	<.1	0.2	<.1	0.3	-	-	-	0.1
Cryptosiphonia woodii	0.1	0.2	0.1	0.1	0.3	0.2	-	-	-	-	<.1	-
Gigartina corymbifera/exasperata	<.1	<.1	-	0.1	<.1	-	-	-	-	-	-	0.6
Corallina officinalis	0.1	<.1	-	-	0.5	-	<.1	-	-	-	-	<.1
Chondria decipiens	-	-	-	-	-	-	-	-	-	0.4	<.1	-
Derbesia marina	-	-	-	-	-	-	-	<.1	0.3	<.1	-	-
Gigartina harveyana/spinosa	-	-	-	-	-	-	-	0.2	-	0.1	-	-
Laminaria setchellii	-	0.1	-	-	0.1	-	-	-	-	-	-	-
Smithora naiadum	0.1	-	<.1	-	-	<.1	-	-	-	-	-	-
Botryoglossum/Hymenena spp.	<.1	0.1	-	-	-	-	-	-	-	-	-	-
Codium fragile	-	-	-	-	-	-	-	-	0.1	-	-	-
Cladophora spp.	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	-	-	<.1	<.1
Callithamnion/Pleonosporium spp.	<.1	<.1	-	<.1	-	-	-	-	<.1	-	-	<.1
Porphyra spp.	<.1	<.1	<.1	<.1	-	<.1	<.1	-	-	-	-	-
Melobesia mediocris	<.1	<.1	<.1	-	-	<.1	<.1	-	-	-	-	-
Callithamnion pikeanum	-	-	<.1	-	-	<.1	<.1	-	-	-	-	<.1
Halymenia/Schizymenia spp.	-	-	<.1	-	-	-	<.1	-	-	<.1	-	-
Microcladia borealis	-	<.1	-	-	-	-	-	-	-	-	-	-
Colpomenia spp.	-	-	-	-	-	-	-	<.1	<.1	-	-	-
Bryopsis spp.	-	-	-	-	-	-	<.1	<.1	<.1	-	-	-
Callophyllis spp.	<.1	-	-	<.1	-	-	-	-	-	-	-	-
Gelidium robustum	-	-	-	-	<.1	-	-	-	-	-	-	-
Microcladia coulteri	<.1	-	-	-	-	-	-	-	-	-	-	-
red blades (juv.)	-	-	-	-	-	-	-	-	-	<.1	-	-
Antithamnion/Platythamnion spp.- complex	-	-	-	-	-	-	-	<.1	-	-	-	-

Table 3-2

Summary of Intertidal Algal Abundances at the EMP +3ft MLLW Horizontal Band Transect Stations for Surveys 103 and 104 - IBT Method

Abundance = Mean percent cover per m^2 (N=10 per station)

Area	Field's Cove						North Reference	South Diablo Cove		North Diablo Cove		Patton Cove
Station	4+3	5+3	6+3	4+3	5+3	6+3	1+3	8+3	9+3	10+2	12+3	19+3
Survey	103	103	103	104	104	104	104	104	104	104	104	104
Month/Year	12/95	11/95	12/95	1/96	1/96	1/96	1/96	1/96	1/96	1/96	1/96	1/96
non-coralline crust	30.0	18.5	32.0	28.7	18.5	23.1	21.2	14.4	24.7	44.0	23.0	28.6
Endocladia muricata	35.4	36.2	26.7	37.4	38.5	30.7	25.3	17.3	9.9	-	2.1	11.5
Mastocarpus papillatus	12.4	45.2	35.4	11.5	5.0	25.8	11.7	2.0	1.0	0.9	9.2	12.9
coralline crust	3.2	0.3	3.3	2.2	0.2	2.4	9.6	1.9	5.2	1.9	<.1	10.8
Iridaea splendens	2.6	1.6	5.3	1.9	0.8	6.3	16.9	-	-	-	-	2.4
Pelvetia fastigiata	0.3	3.1	2.0	0.6	1.7	1.7	7.8	-	-	-	-	6.9
Gelidium coulteri	4.2	0.4	4.2	2.8	0.1	1.0	1.1	1.3	0.2	2.4	<.1	<.1
Gastroclonium coulteri	-	-	-	<.1	-	-	-	0.1	-	9.1	-	-
Corallina vancouveriensis	0.4	<.1	1.3	0.8	<.1	1.2	1.2	0.5	<.1	<.1	<.1	2.7
Gelidium pusillum	<.1	<.1	1.0	0.5	<.1	0.6	1.9	0.4	0.5	<.1	0.2	0.3
Cryptopleura spp.	-	-	-	<.1	<.1	-	0.3	-	-	4.5	<.1	0.3
Gigartina agardhii	-	-	0.1	-	-	0.2	1.6	-	-	0.1	-	2.2
filamentous red algae - complex	-	<.1	-	-	-	-	-	<.1	<.1	4.0	-	-
Phyllospadix spp.	2.3	-	-	1.2	-	-	0.5	-	-	-	-	<.1
Rhodoglossum affine	0.1	<.1	0.7	<.1	<.1	0.6	1.5	0.3	0.3	0.2	-	0.1
Pterosiphonia dendroidea	-	-	-	-	-	-	-	-	-	3.5	-	-
Calliarthron/Bossiella spp.	1.3	<.1	0.2	0.8	<.1	0.6	<.1	<.1	0.1	<.1	-	<.1
Prionitis spp.	0.1	<.1	0.1	<.1	<.1	<.1	0.2	-	0.3	1.9	-	-
Gigartina canaliculata	<.1	<.1	<.1	<.1	<.1	<.1	0.2	<.1	<.1	2.1	-	0.2
Codium setchellii	-	-	-	-	-	-	2.2	-	-	-	-	-
Fucus gardneri	-	0.5	-	-	0.6	-	-	-	-	-	-	0.4
Iridaea heterocarpa	0.1	<.1	0.2	<.1	<.1	0.3	0.3	-	-	-	-	0.1
juvenile articulated coralline algae	<.1	<.1	-	0.2	<.1	<.1	<.1	0.3	0.3	<.1	-	<.1
Cryptosiphonia woodii	0.2	0.1	0.1	<.1	<.1	0.1	-	-	-	-	-	-
Hesperophycus harveyanus	-	0.6	-	-	-	-	-	-	-	-	-	-
Cladophora spp.	<.1	0.3	<.1	<.1	0.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Gigartina leptorhynchos	<.1	<.1	<.1	<.1	<.1	0.1	<.1	<.1	-	<.1	-	<.1
Analipus japonicus	-	-	-	-	-	-	0.4	-	-	-	-	-
Porphyra spp.	<.1	0.2	-	-	<.1	-	-	-	-	-	-	<.1
Laurencia spp.	0.1	-	-	-	-	-	-	-	-	<.1	-	-
Ulva/Enteromorpha spp.	-	<.1	-	-	-	-	-	-	<.1	<.1	-	<.1
Halymenia/Schizymenia spp.	-	-	-	-	-	-	-	-	-	<.1	-	-
Fucaceae unid.	-	-	-	<.1	-	-	-	-	-	-	-	-

species) and the coverage of several species were greatest among stations outside Diablo Cove. For example, *Iridaea splendens*, a perennial red alga, was abundant only at stations outside Diablo Cove. The red alga *Gigartina agardhii* was also more commonly found at stations outside the cove. *Endocladia muricata* (nail brush seaweed), a common high intertidal alga, occurred in low abundances at stations inside Diablo Cove and Patton Cove, compared to other locations. *Pelvetia fastigiata* and *Fucus gardneri* (rockweed kelps), which are typical components of high intertidal communities, were low in abundance or absent at Diablo Cove stations. *Egregia menziesii* (feather boa kelp) was observed only at stations outside Diablo Cove. In contrast, the ephemeral filamentous red algae complex (*Polysiphonia* spp., *Centroceras clavulatum*, and *Ceramium* spp.) was more abundant at Diablo Cove stations.

In general, the species composition of Diablo Cove's algal community has shifted from predominantly perennial species, which declined in abundance after power plant start-up, to more annual, short-lived algal cover during power plant operation.[1] This pattern continued through winter 1995/96 (Surveys 103 and 104). Similar changes have not been observed at study sites outside Diablo Cove where the composition and abundance of the same species has generally persisted after plant operation. Thermal effects-related changes at stations in Field's Cove and at Diablo Point located outside Diablo Cove have been observed and discussed in TEMP annual reports.

Invertebrates

Tables 3-3 and 3-4 summarize abundances of intertidal invertebrates in the five "count" quadrats of each +1ft and +3ft MLLW horizontal band transect sampled during Surveys 103 and 104. The tables list species that were counted and those that were enumerated as percent coverage, in descending rank order according to pooled abundances across stations. The most abundant species among all stations, *Tegula funebralis* (black turban snail), was conspicuously absent at the +1ft MLLW transect of Station 9 in north Diablo Cove. At the +3ft MLLW transect of Station 9, it was present in low numbers compared to all other +3ft MLLW transects. The limpets *Collisella scabra, C. limatula*, *Notoacmea scutum*, and *Fissurella volcano* were generally found in greatest abundance at stations in north Diablo Cove. As grazers on thin algal films, limpets may have increased in response to prior reductions in foliose algal cover and

[1] PG&E 1994. Thermal Effects Monitoring Program. Diablo Canyon Power Plant. 1993 Annual Report. March 1994.

Table 3-3

Summary of Intertidal Invertebrate Abundances at the EMP +1ft MLLW Horizontal Band Transect "Count Quadrats" for Surveys 103 and 104 - IBT Method

Area	Field's Cove						South North Reference	North Diablo Cove		Diablo Cove		Patton Cove
Station	4+1	5+1	6+1	4+1	5+1	6+1	1+1	8+1	9+1	10+1	12+1	19+1
Survey	103	103	103	104	104	104	104	104	104	104	104	104
Month/Year	11/95	11/95	12/95	1/96	1/96	1/96	1/96	1/96	1/96	1/96	1/96	1/96
a) Counts: Mean no. individuals per m^2 (N=5 per value)												
Tegula funebralis	0.4	95.2	56.8	4.8	110.4	57.6	53.8	14.8	-	82.0	277.6	45.2
Tetraclita (squamosa) rubescens	6.4	3.2	36.2	27.8	25.4	25.2	0.4	100.0	164.6	94.8	32.6	235.6
Pagurus spp.	6.2	16.0	27.0	10.6	37.4	20.4	22.8	9.8	5.4	5.0	67.8	17.6
Strongylocentrotus purpuratus	1.6	27.0	52.2	1.4	22.0	45.4	-	14.4	41.0	-	1.2	-
Collisella scabra	-	3.6	0.2	-	5.4	1.4	-	96.4	20.4	5.2	0.2	1.0
Anthopleura elegantissima	11.2	19.4	13.0	8.2	33.2	8.8	1.0	4.6	5.0	3.8	8.2	1.8
Tegula brunnea	15.6	4.2	14.4	9.2	5.8	4.8	6.8	4.2	0.4	-	-	3.4
Fissurella volcano	0.2	2.0	3.2	2.4	1.0	1.6	0.6	12.2	41.4	2.4	0.4	0.4
Notoacmea scutum	0.2	0.2	2.0	0.2	0.6	0.4	0.2	6.8	11.2	0.4	2.2	1.6
Collisella limatula	-	0.8	1.4	1.4	0.8	-	-	1.4	6.6	3.0	5.4	1.0
Nuttallina californica	3.6	5.2	-	3.6	2.4	0.6	-	0.4	-	-	-	0.2
Pachygrapsus crassipes	1.4	1.4	1.0	3.0	1.0	1.0	-	1.0	5.8	-	-	-
Collisella pelta	1.4	0.8	-	2.4	0.2	-	-	1.2	1.6	2.2	0.4	2.6
Serpulorbis squamigerus	-	1.0	4.6	0.8	1.2	1.0	-	-	-	0.6	-	-
Serpulidae unid.	1.2	0.2	1.2	2.4	0.6	0.2	<.1	1.0	1.2	-	-	0.2
Ocenebra spp.	0.4	0.6	0.4	1.4	0.2	0.4	1.4	0.4	0.2	-	0.6	0.4
Eplactis prolifera	0.2	0.4	0.6	1.4	0.4	0.4	0.2	1.0	0.2	-	-	-
Leptasterias spp.	0.4	1.2	0.8	0.8	0.4	0.6	0.4	-	-	-	-	0.2
Nemertea unid.	0.4	0.8	0.8	0.2	1.4	-	0.4	-	0.2	-	-	0.2
Haliotis spp.	0.2	-	0.6	1.0	-	0.4	-	0.2	0.6	-	-	-
Pugettia spp.	<.1	0.2	-	0.6	0.6	0.4	0.2	-	-	-	0.2	<.1
Pisaster ochraceus	-	-	-	0.2	-	0.2	-	0.2	0.8	-	0.4	-
Acmaea mitra	<.1	0.4	0.6	0.2	0.2	-	<.1	<.1	-	-	<.1	0.2
Lottia gigantea	-	-	-	-	-	-	-	0.6	0.8	-	-	-
Diopatra ornata	-	-	-	-	-	-	-	0.2	-	-	0.4	-
Littorina spp.	-	<.1	-	-	0.4	-	-	-	-	-	<.1	<.1
Cyanoplax spp.	-	-	-	-	-	-	-	0.4	<.1	-	-	-
Diodora spp.	-	-	-	0.2	-	-	-	-	0.2	-	-	<.1
Balanus spp.	-	-	-	-	-	-	-	-	-	0.4	-	-
Strongylocentrotus franciscanus	-	-	-	-	-	-	-	-	-	-	0.4	-
Calliostoma ligatum	-	-	-	-	0.2	-	-	-	-	-	-	<.1
Mopalia spp.	-	-	-	-	-	-	-	-	-	-	-	0.2
Lepidozona spp.	<.1	-	-	-	-	0.2	-	-	-	-	-	-
Anthopleura artemisia	-	-	-	-	-	-	-	-	-	-	-	0.2
Acanthina spp.	-	-	-	-	-	-	-	-	-	-	0.2	-
Octopus spp.	-	-	-	-	-	-	-	-	-	-	0.2	-
Patiria (Asterina) miniata	-	-	-	-	-	-	-	-	-	-	0.2	-
Idotea spp.	0.2	-	-	-	-	-	-	-	-	-	-	-
Diaulula sandiegensis	-	-	-	-	-	-	0.2	-	-	-	-	-
Mitra idae	-	-	-	0.2	-	-	-	-	-	-	-	-
Fusinus luteopictus	-	-	-	-	0.2	-	-	-	-	-	-	-
Pseudomelatoma torosa	0.2	-	-	-	-	-	-	-	-	-	-	-
Acmaeidae unid.	<.1	<.1	<.1	-	<.1	<.1	-	<.1	<.1	<.1	<.1	<.1
Mitrella spp.	<.1	<.1	<.1	<.1	-	<.1	<.1	<.1	-	<.1	<.1	<.1
Lacuna spp.	<.1	<.1	<.1	<.1	<.1	<.1	-	<.1	-	-	<.1	<.1
Collisella asmi	-	<.1	<.1	-	<.1	<.1	-	-	-	<.1	-	<.1
Crepidula spp.	<.1	-	<.1	-	-	-	<.1	-	-	-	-	<.1
Notoacmea paleacea	<.1	-	-	<.1	-	-	<.1	-	-	-	-	<.1
Notoacmea insessa	<.1	-	<.1	<.1	<.1	<.1	-	-	-	-	-	-
Lissothuria nutriens	-	<.1	<.1	-	<.1	-	<.1	-	<.1	-	-	-
Ischnochitonidae	-	<.1	<.1	<.1	-	-	<.1	-	-	-	<.1	-
Pisaster/Henricia juv.	<.1	-	-	-	-	-	<.1	-	-	-	-	-
Sipuncula unid.	-	<.1	<.1	-	-	-	-	-	-	-	-	-
Corynactis californica	-	-	-	-	-	-	-	-	-	-	-	<.1
Epitonium/Opalia spp.	<.1	-	-	-	-	-	-	-	-	<.1	-	-
Nereidae unid.	-	<.1	-	-	-	-	-	-	-	-	-	-

CONTINUED ON NEXT PAGE

Table 3-3
(continued)

Summary of Intertidal Invertebrate Abundances at the EMP +1ft MLLW Horizontal Band Transect "Count Quadrats" for Surveys 103 and 104 - IBT Method

Area	Field's Cove						South North Reference	North Diablo Cove		Diablo Cove		Patton Cove
Station	4+1	5+1	6+1	4+1	5+1	6+1	1+1	8+1	9+1	10+1	12+1	19+1
Survey	103	103	103	104	104	104	104	104	104	104	104	104
Month/Year	11/95	11/95	12/95	1/96	1/96	1/96	1/96	1/96	1/96	1/96	1/96	1/96
a) Counts: Mean no. individuals per m^2 (N=5 per value)												
Homalopoma spp.	-	-	-	-	<.1	-	-	-	-	-	-	<.1
Bittium spp.	-	-	-	<.1	-	-	<.1	-	-	-	-	-
Pelecypoda unid. boring	-	<.1	-	-	-	-	-	-	-	-	<.1	-
Tricolia spp.	-	-	<.1	-	-	-	<.1	-	-	-	-	-
Chaetopteridae	-	-	<.1	-	-	-	-	-	-	-	-	<.1
Tonicella lineata	-	-	-	<.1	-	-	-	-	-	-	-	-
Majidae	-	-	-	-	-	-	-	-	-	-	<.1	-
Amphissa spp.	-	-	-	-	<.1	-	-	-	-	-	-	-
b Cover: Mean percent cover per m^2 (N=5 per value)												
Pista spp.	1.0	<.1	1.9	1.9	<.1	0.6	6.3	<.1	<.1	34.6	<.1	-
Chthamalus fissus	-	<.1	<.1	<.1	<.1	<.1	<.1	3.8	<.1	4.4	0.7	<.1
Phragmatopoma californica	<.1	<.1	<.1	<.1	<.1	<.1	<.1	0.1	0.1	-	<.1	0.7
Spirorbidae	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	0.1
colonial/social tunicates, unid.	<.1	<.1	<.1	<.1	<.1	-	<.1	<.1	-	-	-	<.1
Porifera unid. encrusting	-	<.1	-	<.1	<.1	<.1	<.1	<.1	-	-	-	<.1
Bryozoa, encrusting	<.1	<.1	<.1	<.1	<.1	-	<.1	-	-	-	-	<.1
Salmacina tribranchiata	-	-	-	-	-	-	<.1	-	-	-	-	-

Table 3-4

Summary of Intertidal Invertebrate Abundances at the EMP +3ft MLLW Horizontal Band Transect "Count Quadrats" for Surveys 103 and 104 - IBT Method

Area	Field's Cove						South North Reference	North Diablo Cove		Diablo Cove		Patton Cove
Station	4+3	5+3	6+3	4+3	5+3	6+3	1+3	8+3	9+3	10+2	12+3	19+3
Survey	103	103	103	104	104	104	104	104	104	104	104	104
Month/Year	12/95	11/95	12/95	1/96	1/96	1/96	1/96	1/96	1/96	1/96	1/96	1/96
a) Counts: Mean no. individuals per m^2 (N=5 per value)												
Tegula funebralis	168.8	112.2	224.8	313.4	124.6	154.8	221.0	170.0	39.8	306.2	192.2	158.4
Anthopleura elegantissima	157.6	59.2	19.4	173.2	60.8	9.0	3.6	48.6	0.4	35.0	79.2	3.6
Collisella scabra	8.2	23.8	5.2	3.8	15.2	1.0	-	118.4	116.6	0.8	35.2	8.6
Pagurus spp.	56.4	10.0	26.2	104.0	11.0	18.4	40.0	6.2	7.8	1.4	23.4	7.4
Tetraclita (squamosa) rubscens	2.8	-	-	0.4	-	-	-	0.4	60.4	109.8	-	16.0
Collisella digitalis	-	-	-	-	-	-	-	16.4	25.2	-	0.4	0.6
Collisella limatula	0.6	2.6	0.8	2.6	1.0	-	0.4	15.4	3.4	4.2	1.6	4.6
Notoacmea scutum	4.8	0.8	0.2	0.6	3.6	0.6	0.8	0.8	9.8	0.4	3.0	5.0
Strongylocentrotus purpuratus	-	-	0.2	0.4	0.2	-	0.2	-	17.8	1.0	0.4	0.2
Collisella pelta	0.6	4.4	1.0	1.0	0.2	1.2	-	0.4	0.4	2.2	0.4	4.2
Ocenebra spp.	1.6	1.2	0.4	1.6	1.6	0.8	0.2	1.0	1.4	0.4	1.2	0.8
Fissurella volcano	0.2	-	-	-	-	-	-	0.2	8.6	2.6	-	-
Pachygrapsus crassipes	1.6	1.0	0.4	0.4	1.0	0.2	0.8	0.4	1.8	-	1.0	0.2
Pollicipes polymerus	-	-	-	-	0.4	-	2.4	-	-	-	4.8	-
Acanthina spp.	0.8	1.2	-	1.4	0.6	-	0.2	1.2	-	0.4	1.4	-
Cyanoplax spp.	0.4	1.2	0.6	0.2	0.4	-	-	0.2	0.6	-	0.2	-
Lottia gigantea	-	-	-	-	-	-	-	-	3.0	-	-	-
Nuttallina californica	-	-	0.4	0.2	-	-	0.4	0.6	0.4	0.2	-	-
Tegula brunnea	-	-	-	-	-	-	-	-	1.6	-	-	-
Mopalia spp.	-	-	-	0.4	-	0.2	0.6	-	-	-	0.2	-
Haliotis spp.	-	0.6	-	-	-	-	-	-	0.6	-	-	-
Serpulorbis squamigerus	-	-	-	-	-	-	-	-	0.2	0.8	-	-
Pisaster ochraceus	0.4	-	-	-	-	0.2	-	-	-	0.2	0.2	-
Nemertea unid.	-	0.2	-	0.2	-	-	-	0.2	-	-	-	0.2
Hemigrapsus nudus	0.4	-	-	-	-	-	-	-	-	-	-	0.4
Serpulidae unid.	<.1	<.1	<.1	0.2	-	-	-	-	0.2	-	-	<.1
Mytilus californianus	-	-	-	-	-	-	0.4	-	<.1	<.1	-	-
Leptasterias spp.	-	-	-	-	-	-	0.4	-	-	-	-	-
Collisella asmi	<.1	<.1	<.1	<.1	<.1	<.1	0.2	<.1	-	<.1	<.1	<.1
Anthopleura xanthogrammica	-	-	-	-	-	-	-	-	-	-	-	0.2
Acmaea mitra	-	-	-	-	-	-	-	-	-	-	0.2	-
Calliostoma ligatum	-	-	-	-	-	-	0.2	-	-	-	-	-
Patiria (Asterina) miniata	-	-	-	-	-	-	-	-	-	-	0.2	-
Strongylocentrotus franciscanus	-	-	-	-	-	-	-	-	-	-	0.2	-
Pseudomelatoma torosa	-	-	-	-	-	-	-	-	-	-	-	0.2
Cryptochiton stelleri	-	-	-	-	-	-	-	-	-	-	0.2	-
Pugettia spp.	-	-	-	-	-	0.2	-	-	-	-	-	-
Amphissa spp.	-	-	-	-	0.2	-	-	-	-	-	-	-
Acmaeidae unid.	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Littorina spp.	-	<.1	<.1	<.1	<.1	-	-	<.1	<.1	-	<.1	<.1
Crepidula spp.	<.1	-	-	-	-	-	<.1	-	-	-	-	<.1
Lacuna spp.	<.1	-	-	-	-	<.1	<.1	-	-	-	<.1	-
Ischnochitonidae	-	-	<.1	<.1	-	-	-	<.1	-	-	-	-
Mytilidae	-	-	-	-	-	-	-	<.1	<.1	-	-	<.1
Bittium spp.	<.1	-	-	<.1	-	-	-	-	-	-	-	-
Heptacarpus spp.	<.1	-	-	<.1	-	-	-	-	-	-	-	-
Lissothuria nutriens	-	-	-	-	-	-	<.1	-	<.1	-	-	-
Mitrella spp.	<.1	-	-	-	-	-	-	-	-	-	-	-
Epitonium/Opalia spp.	-	-	-	-	-	-	-	-	-	<.1	-	-
Idotea spp.	-	-	-	-	-	-	-	-	-	-	-	<.1
Homalopoma spp.	-	-	-	-	-	-	-	-	-	-	-	<.1
Sipuncula unid.	-	-	-	<.1	-	-	-	-	-	-	-	-
Grapsidae (juv.)	-	-	-	-	-	-	-	-	-	-	-	<.1

CONTINUED ON NEXT PAGE

Table 3-4
(continued)

Summary of Intertidal Invertebrate Abundances
at the EMP +3ft MLLW Horizontal Band Transect "Count Quadrats"
for Surveys 103 and 104 - IBT Method

Area	Field's Cove						South North Reference	North Diablo Cove		Diablo Cove		Patton Cove
Station	4+3	5+3	6+3	4+3	5+3	6+3	1+3	8+3	9+3	10+2	12+3	19+3
Survey	103	103	103	104	104	104	104	104	104	104	104	104
Month/Year	12/95	11/95	12/95	1/96	1/96	1/96	1/96	1/96	1/96	1/96	1/96	1/96
b Cover: Mean percent cover per m^2 (N=5 per value)												
Chthamalus fissus	0.4	<.1	0.6	0.8	<.1	<.1	<.1	13.5	16.5	1.4	3.1	1.0
Pista spp.	-	-	-	-	-	-	<.1	-	<.1	2.6	-	-
Phragmatopoma californica	<.1	<.1	0.3	<.1	<.1	0.3	<.1	0.3	<.1	<.1	<.1	<.1
Spirorbidae	<.1	<.1	<.1	<.1	-	-	<.1	-	<.1	<.1	<.1	<.1
Haliclona spp.	-	-	<.1	<.1	-	-	-	-	-	-	-	-
Bryozoa encrusting, unid.	-	-	-	-	-	-	-	-	-	<.1	-	-

increases in crustose algal forms. The barnacles *Tetraclita* (*squamosa*) *rubescens* and *Chthamalus fissus* were also seen in greatest abundance at Diablo Cove stations. However, *Tetraclita* was also abundant at Station 19+1 in Patton Cove. *Strongylocentrotus purpuratus* (purple sea urchin) continued to be observed in greatest abundance in north Diablo Cove and in Field's Cove. The relatively high numbers of urchins in Field's Cove may be related to the increased urchin densities in north Diablo Cove, which have resulted in the formation "urchin barrens" (areas grazed of algal cover).[2] *Pista* spp., a sedentary tube worm, continued to occur in dense aggregations at Station 10 near the discharge. Abundance of this species was considerably less at other EMP stations. The tables also indicate that in Field's Cove, where stations were sampled twice in winter 1995/96, the abundance of several species differed by as much as four-fold between the two winter surveys. These differences show the short-term variation that can occur in species abundances.

3.2 VERTICAL BAND TRANSECTS

Figure 3-1 shows locations of the three EMP vertical band transect stations. Each station is composed of three fixed transects aligned perpendicular to the shoreline according to permanent markers. Each transect originates in the high intertidal zone (about +3ft MLLW tide level) near the cliff base and terminates at the shoreline at approximately -0.5ft MLLW. The sample area along each transect is composed of 12 fixed $1m^2$ quadrat sampling sites.

For each quadrat, the presence of algal species and substrate types is recorded. For the invertebrates, two data sets are generated per quadrat: one of animals found on the surface of rocks ("surface" invertebrate data set), and the other being of animals found underneath cobbles and in cracks and crevices ("under-rock" invertebate data set). Observers search for intertidal fish within algae, under rocks and cobbles, and in tidepools, and capture them using dip nets. Species' occurrences per quadrat and total length (TL) measurements of each fish to the nearest mm are recorded. Results from this study are used to monitor species' occurrences at the stations and to follow changes in distributions relative to tidal elevation. Vertical distribution patterns among stations were not analyzed for this report.

[2] PG&E 1994. Thermal Effects Monitoring Program. Diablo Canyon Power Plant. 1993 Annual Report. March 1994.

In the EMP study design, Stations L and H in Diablo Cove are sampled once per year (summer), while Station C in Field's Cove is sampled four times yearly (twice in summer and twice in winter). Results presented below are for Station C sampled twice in winter 1995/96 (Surveys 63 and 64).

Algae

In general, the most common algal species found at Station C were present in similar numbers of quadrats during both surveys (Table 3-5). Although *Bossiella* spp., an articulated coralline algae, declined in occurrence, the occurrence of juvenile articulated coralline algae increased between the two surveys. It is possible that the shifts reflect an artifact of taxonomic distinction between these two taxa during the two field survey efforts. *Iridaea heterocarpa* and *I. splendens* (foliose algae) increased in frequency of occurrence, as did *Gelidium pusillum*, a small branched alga. *Ulva* spp. (sea lettuce), an annual, short-lived species, declined in occurrence. Less common species also exhibited increases and decreases in occurrence, although the shifts involved smaller changes.

Invertebrates

Table 3-6 shows results for invertebrates sampled at Station C for Surveys 63 and 64 (species occurrence in both the "surface" and "under-rock" quadrat data sets was treated as a single quadrat occurrence). In general, similar numbers of species were observed each survey. Each species also occurred in relatively the same number of quadrats between the two surveys. The limpet *Collisella pelta* however, occurred in approximately half the number of quadrats in the second survey. In contrast, the purple urchin *Strongylocentrotus purpuratus* and the barnacle *Tetraclita squamosa* occurred in appreciably greater numbers of quadrats during the second winter survey. The increase in *Strongylocentrotus* is consistent with a general increase in this species at horizontal band transects in Field's Cove.[3]

Fish

Two intertidal fish surveys were conducted at Field's Cove in winter 1995/96 (Table 3-7). No Diablo Cove stations were surveyed during this period in accordance with the EMP study plan. A greater number of individual fish and fish taxa were found during the February survey,

[3] PG&E 1994. Thermal Effects Monitoring Program. Diablo Canyon Power Plant. 1993 Annual Report. March 1994.

Table 3-5

Percent Frequency of Occurrences of Intertidal Algae at the EMP Vertical Band Transect Station C in Field's Cove for Surveys 63 and 64

Area	Field's Cove	
Station	**C**	**C**
Survey	63	64
Month/Year	12/95	1/96
Total $1m^2$ Quadrats Sampled	36	36
non-coralline crust	100.0	88.9
coralline crust	88.9	91.7
Mastocarpus papillatus	86.1	86.1
Cladophora graminea	86.1	83.3
Gelidium coulteri	77.8	69.4
Gigartina leptorhynchos	72.2	72.2
Endocladia muricata	61.1	75.0
Cryptosiphonia woodii	61.1	75.0
juvenile articulated coralline algae	44.4	75.0
Corallina vancouveriensis	55.6	61.1
Gelidium pusillum	25.0	69.4
Iridaea heterocarpa	13.9	72.2
Gastroclonium coulteri	38.9	30.6
Rhodoglossum affine	33.3	33.3
Cryptopleura violacea	27.8	36.1
Phyllospadix spp.	27.8	30.6
Bossiella spp.	55.6	-
Gigartina canaliculata	19.4	19.4
Ulva spp.	22.2	2.8
Laurencia spectabilis	11.1	13.9
Prionitis lanceolata	2.8	8.3
Neoagardhiella gaudichaudii	8.3	2.8
Iridaea splendens	-	11.1
Spongomorpha coalita	5.6	5.6
Porphyra perforata	8.3	-
Gigartina agardhii	5.6	-
Corallina officinalis	2.8	-
Microcladia coulteri	2.8	-
Botryoglossum farlowianum	-	2.8
Ceramium spp.	-	2.8
Farlowia mollis	-	2.8
Gelidium spp.	-	2.8

Table 3-6

Percent Frequency of Occurrences of Intertidal Invertebrates at the EMP Vertical Band Transect Station C in Field's Cove for Surveys 63 and 64

(data sets of invertebrates under and on top of rocks combined)

Area	Field's Cove	
Station	**C**	**C**
Survey	63	64
Month/Year	12/95	1/96
Total $1m^2$ Quadrats Sampled	36	36
Tegula funebralis	100.0	97.2
Anthopleura elegantissima	100.0	94.4
Pagurus spp.	100.0	88.9
Collisella scabra	72.2	58.3
Collisella limatula	80.6	47.2
Chthamalus spp.	50.0	75.0
Notoacmea scutum	55.6	63.9
Phragmatopoma californica	52.8	55.6
Tegula brunnea	44.4	61.1
Collisella pelta	66.7	27.8
Acmaeidae unid.	52.8	41.7
Collisella asmi	41.7	44.4
Spirorbidae unid.	47.2	38.9
Acanthina punctulata	44.4	38.9
Ocenebra circumtexta	44.4	36.1
Pista elongata	30.6	47.2
Petrolisthes cinctipes	38.9	38.9
Cirolana harfordi	27.8	38.9
Lacuna spp.	44.4	22.2
Tunicata unid.	41.7	25.0
Littorina scutulata	33.3	30.6
Ischnochitonoidae unid.	38.9	13.9
Leptasterias hexactis	30.6	19.4
Mitrella carinata	22.2	25.0
Porifera encrusting	19.4	25.0
Hemigrapsus nudus	22.2	19.4
Epiactis prolifera	19.4	19.4
Notoplana rupicola	22.2	16.7
Pugettia producta	13.9	22.2
Strongylocentrotus purpuratus	8.3	25.0
Tetraclita (squamosa) rubescens	2.8	27.8
Fissurella volcano	16.7	13.9
Lophopanopeus leucomanus	11.1	13.9
Hemigrapsus oregonensis	11.1	13.9
Lissothuria nutriens	8.3	16.7
Cancer antennarius	8.3	13.9
Stenoplax heathiana	11.1	11.1
Pisaster ochraceus	8.3	13.9

CONTINUED ON NEXT PAGE

Table 3-6
(continued)

Percent Frequency of Occurrences of Intertidal Invertebrates at the EMP Vertical Band Transect Station C in Field's Cove for Surveys 63 and 64

(data sets of invertebrates under and on top of rocks combined)

Area	Field's Cove	
Station	**C**	**C**
Survey	63	64
Month/Year	11/95	1/96
Total $1m^2$ Quadrats Sampled	36	36
Epitonium spp./*Opalia* spp.	11.1	11.1
Heptacarpus pictus	16.7	2.8
Pachygrapsus crassipes	5.6	13.9
Bryozoa encrusting	16.7	2.8
Crepidula adunca	16.7	-
Cyanoplax spp.	16.7	-
Nereidae unid.	11.1	2.8
Ocenebra interfossa	-	13.9
Notoacmea paleacea	11.1	2.8
Acmaea mitra	8.3	2.8
Amphiodia occidentalis	-	11.1
Crepidula spp.	-	11.1
Cyanoplax dentiens	5.6	2.8
Mopalia lignosa	2.8	5.6
Collisella digitalis	8.3	-
Ocenebra foveolata	8.3	-
Tricolia pulloides	-	8.3
Heptacarpus spp.	-	8.3
Idotea urotoma	5.6	-
Homalopoma baculum	5.6	-
Phidiana pugnax	5.6	-
Grapsidae unid.	5.6	-
Nereis grubei	5.6	-
Bittium spp.	-	5.6
Anthopleura xanthogrammica	-	2.8
Cancer productus	2.8	-
Pugettia richii	2.8	-
Mopalia muscosa	2.8	-
Serpulorbis squamigerus	2.8	-
Phascolosoma agassizii	2.8	-
Diaulula sandiegensis	2.8	-
Cyanoplax hartwegii	-	2.8
Octopus spp.	-	2.8
Anisodoris nobilis	-	2.8
Cancer spp.	-	2.8
Polychaeta unid.	2.8	-
Serpulidae unid.	2.8	-
Ophiuroidea unid.	-	2.8

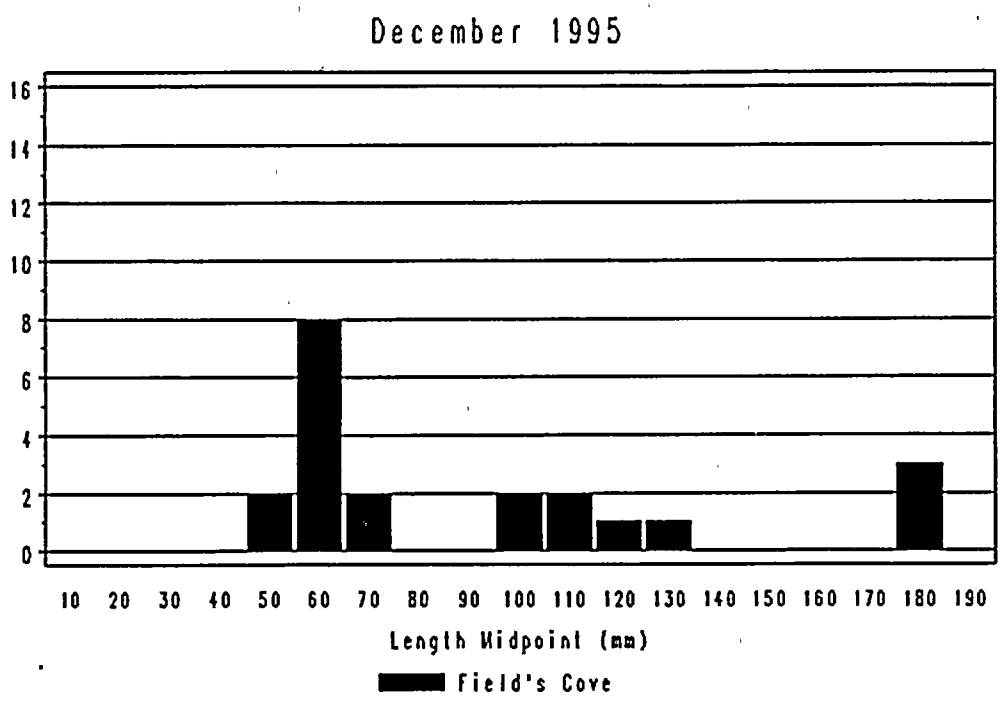
Table 3-7

Summary of Intertidal Fish Abundances at the
EMP Vertical Band Transect Station C in Field's Cove
for Surveys 63 and 64

	Survey	63		64	
	Date	12/95		1/96	
	Total 1m^2 Quadrats Sampled	36		36	
		Total Fish	Mean # Fish / m^2	Total Fish	Mean # Fish / m^2
Xiphister mucosus		21	0.6	34	0.9
Stichaeidae/Pholididae		7	0.2	10	0.3
Gobiesox maeandricus		6	0.2	9	0.3
Anoplarchus purpurescens		3	<.1	10	0.3
Oligocottus snyderi		3	<.1	2	<.1
Cebidichthys violaceus		2	<.1	3	<.1
Anoplarchus spp./*C. violaceus*		1	<.1	2	<.1
Gibbonsia spp.		-	-	2	<.1
Cottidae (juv.)		-	-	2	<.1
Oligocottus spp.		-	-	1	<.1

compared with the December survey, although the species composition and total abundances were generally similar between surveys. *Xiphister mucosus* (rock prickleback) was the most abundant species in both surveys, with a mean abundance ranging from 0.6 to 0.9 fish/m^2. A size frequency histogram for *X. mucosus* is presented in Figure 3-2. Median sizes were generally in the 60-70 mm total length (TL) size classes.

Taxa listed as Stichaeidae/Pholididae, second in abundance during both surveys, were generally pricklebacks and/or gunnels smaller than 30mm TL, which could not be positively identified to the species level in the field. Some of these may have been newly recruited *X. mucosus.* Absent from both surveys was *X. atropurpureus* (black prickleback), a common species which has been seen during many previous surveys in Field's Cove.



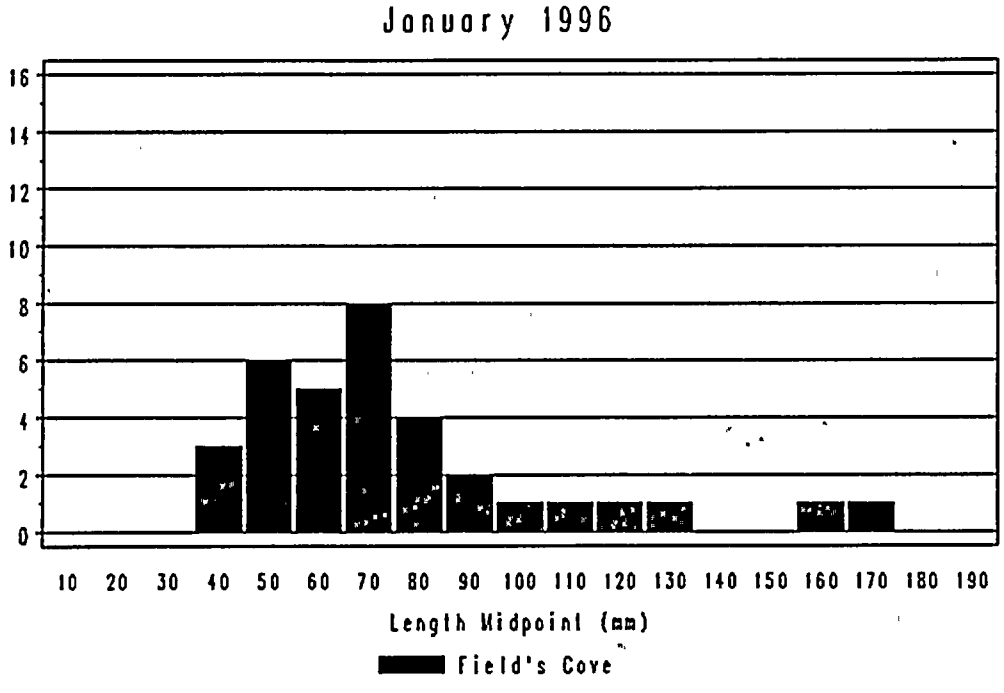


Figure 3-2

Summary of Length Frequency Data for Rock Pricklebacks, *Xiphister mucosus*, at the Vertical Band Transect Station C in Field's Cove During Winter 1995/96

THIS PAGE INTENTIONALLY
LEFT BLANK

4.0 SUBTIDAL BIOLOGICAL STUDIES

4.1 BENTHIC STATIONS

Subtidal benthic station sampling determines the abundance of algae and invertebrates within fixed 28m^2 stations located within and outside Diablo Cove (Figure 4-1). The depth of each station is indicated by a second number. (e.g. Station 10-15 is situated at a depth of 15ft MLLW.) Each station is subdivided into four 7m^2 arc-quadrants. Within each quadrant, several sampling methods are employed: subtidal random-line point contact sampling for algal cover (SLC method); arc-quadrant sampling for kelp and select macro-invertebrate counts (SAQ method); and counts and cover sampling of all invertebrates found in fixed 0.25m^2 quadrats (SFQ method).

In SLC sampling, 200 random point locations are sampled per station. At each point, species intercepting a vertical line passing through the point are recorded. Coverage of each species is determined by its percentage of contacts from the 50 random point samples. Species present on the station but not contacted by sampling points are entered on the data sheet for inclusion in species lists.

In SAQ sampling, counts are obtained for all kelp species and select macro-invertebrates larger than one inch (greatest dimension). Also, counts of all individuals, regardless of size, are obtained for the invertebrates *Tonicella lineata*, *Acmaea mitra*, *Tegula brunnea*, *T. montereyi*, and *Calliostoma ligatum*, within permanent one-third sections (2.37m^2) of each 7m^2 quadrant within a station.

In SFQ sampling, four fixed 0.25m^2 quadrat are sampled at each station for invertebrates of all sizes. This effort includes identifying and enumerating smaller and more cryptic forms not sampled by the SAQ sampling method. Data from the SFQ sampling method include counts of individual organisms for discrete invertebrate forms and coverage area (number of square inches of cover) for encrusting forms.

In the EMP study plan, Stations 22-10 and 22-30 in Field's Cove are sampled four times annually. Two sampling surveys are scheduled for winter and two surveys for summer, although

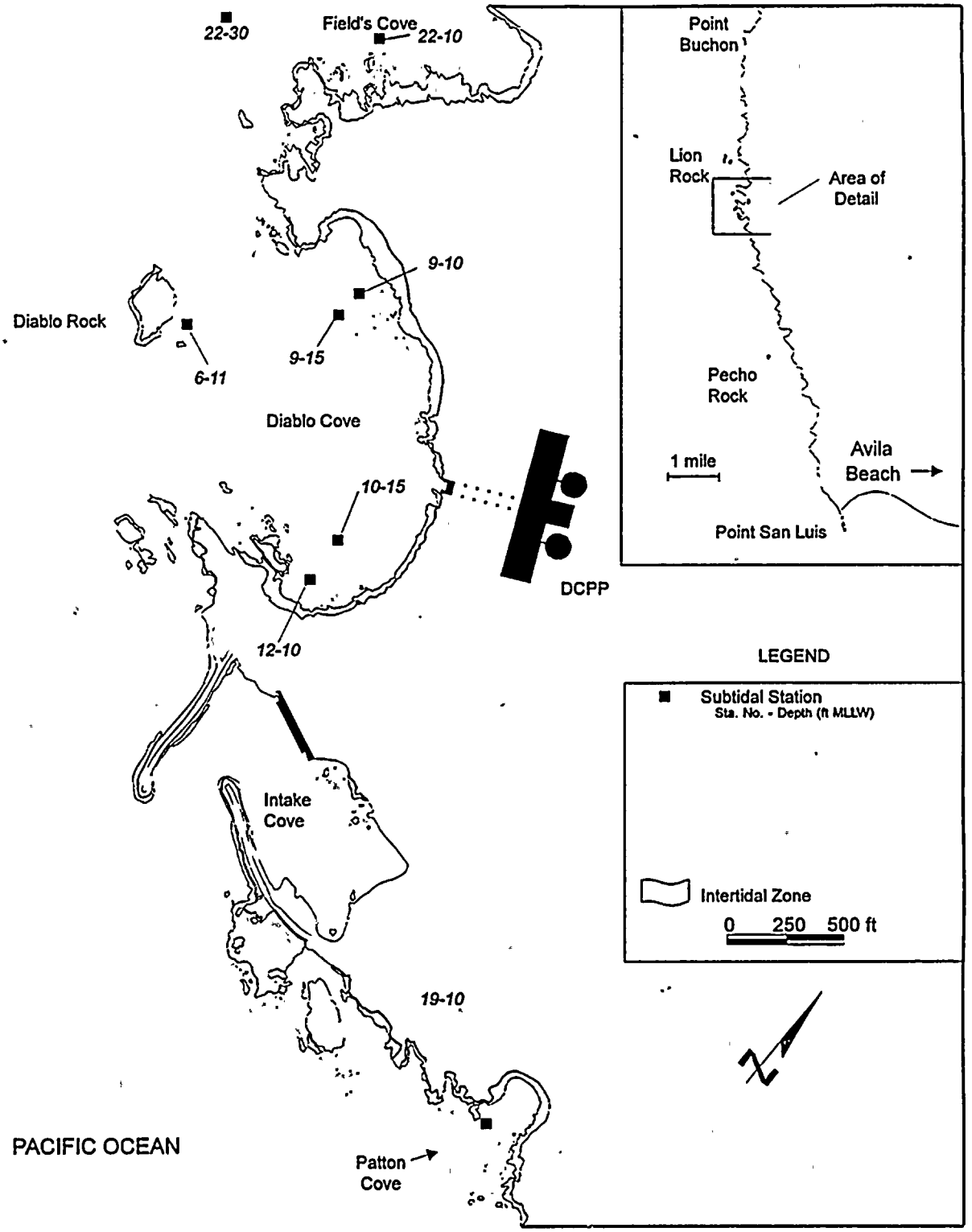


Figure 4-1

EMP Subtidal Benthic Stations

actual sampling dates may shift to the earlier or later season depending on sea conditions. Other stations are sampled twice annually (winter and summer). Results presented in this section are from Station 22-10 (Field's Cove) sampled in Survey 95 and from all stations sampled in Survey 96. Station 22-30 (Field's Cove) was not sampled during either survey due to poor diving conditions.

Algae

Table 4-1 shows the algal monitoring results for subtidal benthic Surveys 95 and 96. The distribution of species abundances across stations suggests that warmer water conditions in Diablo Cove are favorable for some species and not favorable for others. The perennial, foliose red alga *Botryoglossum farlowianum*, which was once abundant at Diablo Cove 10ft stations, was low in abundance at those stations during Surveys 95 and 96, but was still abundant at stations sampled outside Diablo Cove. In contrast, the annual, foliose red alga, *Cryptopleura* spp., was more abundant at most stations in Diablo Cove than outside Diablo Cove. The fleshy red algae complex *Farlowia/Pikea* spp. and the foliose red alga *Rhodymenia* spp. were most abundant at Station 6-11, the EMP station with the warmest water temperatures. Occurrences of chained diatoms (Chrysophyta), filamentous red algal complex, and the foliose red alga *Nienburgia andersoniana* were more common at Diablo Cove stations.

Bull kelp, *Nereocystis luetkeana*, a warm-water sensitive species, was not recorded at Diablo Cove stations, but giant kelp, *Macrocystis* spp., a more temperature tolerant species, was found at all of the Diablo Cove stations, except Station 6-11, the station exposed to the warmest temperatures. The subsurface kelps, *Laminaria setchellii* and *Pterygophora californica*, were generally more abundant at stations outside Diablo Cove. Before power plant start-up, these two species were abundant both inside and outside the cove. A decline in these two species in shallow-water areas of Diablo Cove since power plant start-up, has resulted in large differences in kelp densities between Diablo Cove and non-Diablo Cove stations. During some surveys, *Pterygophora* and *Laminaria* were not recorded at stations in Diablo Cove. During the winter 1995 to spring 1996 sampling period (Surveys 95 and 96), however, several *Pterygophora* and *Laminaria* plants were observed at Diablo Cove stations where earlier, no plants had been observed. These observations may be related to cooler water temperatures resulting from the power plant refueling outages that took place during the sampling period.

Table 4-1

Summary of Subtidal Algal Abundances at the EMP Benthic Sampling Stations for Surveys 95 and 96

Area	Field's Cove		Diablo Rock Diablo Cove	North Diablo Cove		South Diablo Cove		Patton Cove
Station	22-10	22-10	6-11	9-10	9-15	10-15	12-10	19-10
Survey	95	96	96	96	96	96	96	96
Month/Year	11/95	4/96	1/96	3/96	3/96	4/96	3/96	4/96
a: Understory mean percent cover per $7m^2$ (N=4 per station)								
coralline crust	37.0	55.5	26.0	45.5	58.0	52.0	31.5	46.5
Calliarthron/Bossiella spp.	55.5	56.0	3.0	11.0	47.0	39.0	21.0	43.0
Botryoglossum/Hymenena spp.	30.5	19.5	-	-	0.5	1.0	-	15.5
Gigartina corymbifera/exasperata	23.0	26.5	3.0	5.0	3.5	3.5	7.0	31.5
Cryptopleura spp.	0.5	-	3.5	46.5	27.5	0.5	54.5	0.5
Rhodymenia spp.	5.0	14.5	22.0	5.0	5.5	10.5	6.0	22.0
Prionitis spp.	10.5	10.0	0.5	5.0	8.5	2.5	14.0	0.5
Desmarestia ligulata v. ligulata	5.0	0.5	-	-	-	<.1	-	-
Farlowia/Pikea spp.- complex	1.0	6.0	50.0	12.0	12.0	5.0	6.5	2.0
Iridaea splendens	3.5	3.5	-	-	-	-	-	4.5
Cystoseira osmundacea	-	-	<.1	<.1	1.5	2.5	3.0	6.5
non-coralline crust	5.0	1.5	2.0	3.5	-	2.0	0.5	1.0
Laurencia spp.	0.5	0.5	<.1	1.5	3.5	-	<.1	2.5
Pterygophora californica	-	-	-	-	-	0.5	-	2.5
Callophyllis spp.	<.1	1.0	-	<.1	1.0	-	-	1.5
Ulva/Enteromorpha spp.	<.1	<.1	-	<.1	<.1	-	<.1	1.5
Corallina officinalis	<.1	<.1	-	1.0	-	<.1	1.0	<.1
Microcladia coulteri	<.1	1.5	-	-	-	-	-	1.0
Gelidium robustum	0.5	<.1	16.5	12.0	5.0	1.0	1.0	2.0
Laminaria dentigera	<.1	0.5	-	-	<.1	0.5	-	4.0
Polyneura latissima	-	-	-	-	-	-	-	3.5
Gigartina harveyana/spinosa	-	-	-	2.5	-	-	7.0	-
filamentous red algae - complex	-	-	13.0	5.5	-	0.5	-	-
Dictyoneurum californicum	-	<.1	-	-	-	-	-	-
Chrysophyta unid.	-	2.0	7.5	12.0	6.5	12.0	1.0	-
Halymenia/Schizymenia spp.	<.1	4.5	-	-	-	-	-	2.0
Neoagardhiella gaudichaudii	<.1	0.5	-	<.1	-	-	<.1	0.5
Nienburgia andersoniana	-	-	-	4.5	1.0	-	9.5	-
Gymnogongrus linearis	<.1	2.0	-	-	0.5	1.5	-	0.5
Macrocystis spp. (holdfast/sporophylls)	-	-	-	2.0	3.0	6.0	2.0	-
Callophyllis flabellulata	<.1	0.5	-	-	<.1	<.1	<.1	0.5
Prionitis australis	<.1	0.5	-	-	-	-	-	-
Rhodoglossum roseum	<.1	<.1	<.1	<.1	-	-	<.1	<.1
Erythrophyllum delesserioides	<.1	<.1	-	-	-	-	-	-
Gastroclonium coulteri	-	-	<.1	0.5	0.5	-	-	1.0
Pterosiphonia dendroidea	-	-	-	0.5	4.5	1.5	4.5	-
Gelidium spp.	-	-	-	-	-	<.1	3.0	-
Neoptilota densa	<.1	0.5	-	-	-	-	-	<.1
Laminariales (juv)	-	<.1	-	-	<.1	0.5	-	<.1
Dictyota binghamiae	-	-	-	0.5	-	-	-	-
Antithamnion/Platythamnion spp.	-	-	-	-	-	3.5	-	-
Nereocystis luetkeana (holdfast)	1.0	0.5	-	-	-	-	-	<.1
Callophyllis firma	-	<.1	-	-	-	-	-	-
Gymnogongrus leptophyllus	-	-	-	-	-	-	<.1	-
Pikea robusta	0.5	-	-	-	-	-	-	-
Pseudogloiophloea confusa	-	-	-	-	-	-	<.1	-
Colpomenia spp.	-	-	-	<.1	-	-	-	-
Halicystis ovalis	-	<.1	-	-	-	<.1	-	<.1
Delesseria decipiens	-	-	-	-	-	-	-	0.5
Sargassum muticum	-	-	-	<.1	-	-	-	-
b: Kelp plant counts per $7m^2$ (N=4 per station)								
Laminaria setchellii	13.0	28.8	-	-	0.5	3.8	0.3	44.8
Pterygophora californica	4.3	-	-	-	-	21.5	0.3	12.3
Cystoseira osmundacea	-	-	0.3	4.5	8.8	7.0	10.5	6.8
Macrocystis spp.	-	-	-	3.0	4.3	11.3	5.8	-
Laminariales (juv)	3.8	-	-	-	0.5	12.8	-	-
Nereocystis luetkeana	0.8	2.8	-	-	-	-	-	-

Historically, *Macrocystis* spp. occurred in low abundance in Diablo Cove. Strong recruitment, beginning in 1991, resulted in the formation of *Macrocystis* forests in Diablo Cove. Expansion of the population has resulted in dense *Macrocystis* on some EMP sampling stations. Some changes in understory algal species composition and abundance may be due to the interaction of canopy shading by *Macrocystis* and warm temperatures.

Invertebrates

Tables 4-2 and 4-3 present the subtidal arc-quadrant (SAQ) and subtidal fixed quadrat (SFQ) sampling results for the winter 1995 to spring 1996 sampling period (Surveys 95 and 96). The data are from Station 22-10 in Field's Cove (sampled twice), and stations in Diablo and Patton Coves (each sampled once). For the combined SAQ and SFQ data sets, a total of 102 invertebrate taxa and 2,665 individuals were sampled during Surveys 95 and 95. Three species (*Anthopleura elegantissima*, anemone; *Mitrella* spp., gastropod; and *Pisaster giganteus*, sea star) were noted at all stations for both surveys by either the SAQ or SFQ sampling method. In Diablo Cove, more species were found at ~15ft than at ~10ft stations. Species numbers (species richness) at the Diablo Cove ~15ft stations were similar to numbers sampled at the ~10ft non-Diablo Cove stations.

Tegula brunnea (brown turban snail) was most abundant at the two EMP stations sampled outside Diablo Cove. It occurred in relatively low densities in Diablo Cove stations or was not found at all. Prior to plant operation, *Tegula* was among the most common and abundant motile invertebrate species sampled at all benthic stations[1]. The *Tegula* sampled during recent surveys at Diablo Cove stations were smaller individuals, and were generally found in cryptic, under-rock habitats. In contrast, the *Tegula* sampled at Field's and Patton Cove stations were larger individuals found in the open. Also, few large, whole, empty *Tegula* shells were found in Diablo Cove, which suggests that larger individuals may be preyed upon by sheepshead and bat rays. This lack of *Tegula* shell resources may explain the reduced numbers of *Pagurus* spp. (hermit crabs) in Diablo Cove relative to Field's and Patton Coves.

Several other species, which were formerly common on all EMP stations, were present only at the Field's and Patton Cove stations. These include the anemone *Epiactis prolifera*, the gastropods

[1] PG&E 1994. Thermal Effects Monitoring Program. Diablo Canyon Power Plant. 1993 Annual Report. March 1994

Table 4-2

Summary of Subtidal Invertebrate Abundances at the EMP Benthic Sampling Stations for Surveys 95 and 96 - SAQ Method

Abundance = Mean no. individuals per $7m^2$ (N=4 per station)

Area	Field's Cove		Diablo Rock Diablo Cove	North Diablo Cove		South Diablo Cove		Patton Cove
Station	22-10	22-10	6-11	9-10	9-15	10-15	12-10	19-10
Survey	95	96	96	96	96	96	96	96
Month/Year	11/95	4/96	1/96	3/96	3/96	4/96	3/96	4/96
*Tegula brunnea**	24.0	6.8	-	-	3.0	3.0	0.8	9.0
Anthopleura elegantissima	0.5	0.5	16.8	3.5	5.8	11.5	0.8	7.0
*Acmaea mitra**	8.3	6.0	-	9.8	3.0	2.3	1.5	4.5
Diopatra ornata	-	-	0.3	-	-	26.0	0.5	4.0
Patiria (Asterina) miniata	2.8	11.0	0.3	-	-	1.5	-	6.5
*Tonicella lineata**	6.0	4.5	-	-	0.8	-	-	8.3
Serpulidae unid.	-	1.0	15.5	2.3	-	0.3	0.5	-
Strongylocentrotus purpuratus	-	-	3.5	9.3	2.0	3.8	-	-
Pagurus spp.	13.8	1.8	-	-	-	-	0.3	0.5
Pisaster giganteus	0.8	0.5	0.3	2.5	0.8	2.3	0.8	0.8
Cryptochiton stelleri	0.3	0.3	0.8	-	-	4.3	-	-
Mitra idae	-	0.3	-	-	0.3	1.3	0.8	-
*Calliostoma ligatum**	-	-	-	-	-	-	-	2.3
Serpulorbis squamigerus	-	0.8	-	-	-	-	1.0	-
Tethya aurantia	-	-	-	-	1.5	0.3	-	-
Eudistylia polymorpha	-	-	1.8	-	-	-	-	-
Strongylocentrotus franciscanus	-	-	0.3	0.8	-	-	-	-
Styela spp.	-	-	0.3	-	0.3	0.5	-	-
Norrisia norrisia	-	-	-	-	-	1.0	-	-
Anthozoa unid.	-	-	-	-	0.8	-	-	-
Doriopsilla albopunctata	-	-	-	0.3	0.3	0.3	-	-
Phidiana pugnax	-	0.3	-	0.3	-	-	0.3	-
Ophioplocus spp.	-	0.3	-	-	0.3	0.3	-	-
Anthopleura artemisia	-	-	-	-	-	0.5	-	-
Mopalia spp.	-	-	-	-	-	-	-	0.5
Astraea gibberosa	-	0.3	-	-	-	0.3	-	-
Anisodoris nobilis	-	-	-	0.5	-	-	-	-
Kelletia kelletii	-	-	-	-	0.3	0.3	-	-
Megathura crenulata	-	-	0.5	-	-	-	-	-
Anthopleura xanthogrammica	-	-	0.3	-	-	-	-	-
Diodora spp.	-	-	-	0.3	-	-	-	-
Octopus spp.	-	-	-	-	-	0.3	-	-
Sabellidae	-	-	-	-	-	0.3	-	-
Pisaster ochraceus	-	-	-	-	-	-	-	0.3
Pycnopodia helianthoides	0.3	-	-	-	-	-	-	-
Loxorhynchus spp.	-	-	-	-	-	-	0.3	-
Parastichopus spp.	-	-	-	-	0.3	-	-	-
Pisaster brevispinus	-	-	-	-	-	0.3	-	-
Cucumaria spp.	-	-	-	-	-	0.3	-	-
Cryptolithodes sitchensis	-	0.3	-	-	-	-	-	-
Paraxanthias taylori	-	-	0.3	-	-	-	-	-
Triopha catalinae	-	-	-	-	-	0.3	-	-

* Species counted in 1/3 of arc-quadrant and data multiplied by 3

Table 4-3

Summary of Subtidal Invertebrate Abundances at the EMP Benthic Sampling Stations for Surveys 95 and 96 - SFQ Method

Abundance = Mean no. individuals per $7m^2$ (N=4 per station)

Area	Field's Cove		Diablo Rock Diablo Cove	North Diablo Cove		South Diablo Cove		Patton Cove
Station	22-10	22-10	6-11	9-10	9-15	10-15	12-10	19-10
Survey	95	96	96	96	96	96	96	96
Month/Year	11/95	4/96	1/96	3/96	3/96	4/96	3/96	4/96
a: Counts of individuals: Mean no. individuals per m^2 (N=4 per station)								
Phragmatopoma californica	4.5	2.5	-	7.0	40.0	0.5	3.3	8.3
Pelecypoda unid. boring	6.8	5.0	1.0	1.8	13.3	5.8	2.0	0.8
Balanus spp.	4.5	-	-	-	-	-	-	15.0
Pista spp.	-	0.8	-	1.3	2.8	4.3	5.8	-
Balanus/Tetraclita spp.	-	2.8	-	-	8.5	-	0.3	3.3
Tegula brunnea	6.5	1.0	-	0.5	-	-	-	5.3
Homalopoma spp.	5.5	2.3	-	-	-	-	-	5.3
Pagurus spp.	3.0	3.3	-	-	0.5	0.8	1.3	3.8
Mitrella spp.	4.0	0.8	4.3	1.0	0.3	0.3	0.3	0.3
Acmaea mitra	2.5	1.3	0.8	1.5	1.5	1.0	-	2.3
Tetraclita (squamosa) rubescens	1.3	-	-	9.3	-	-	-	-
Serpulidae unid.	1.5	1.0	1.8	1.3	2.3	-	-	2.3
Collisella ochracea	0.3	2.8	2.0	1.5	0.8	-	0.3	1.8
Balanophyllia elegans	-	-	-	-	-	9.0	-	0.3
Dendropoma spp.	2.3	-	-	-	1.3	-	-	2.8
Strongylocentrotus purpuratus	0.3	-	-	0.8	2.3	1.8	0.3	-
Amphissa spp.	2.8	0.5	0.5	-	0.5	-	-	1.0
Pugettia spp.	2.0	0.3	0.3	0.5	0.3	1.0	-	0.5
Ophiothrix spp.	0.3	-	-	2.3	1.0	-	0.3	0.3
Chaetopteridae	1.3	1.0	0.5	-	1.0	0.3	-	-
Sabellidae	1.5	-	-	-	-	1.3	-	-
Leptasterias spp.	2.0	-	-	-	-	-	-	0.8
Anthopleura elegantissima	-	-	-	0.5	0.3	1.3	-	0.5
Tonicella lineata	0.3	1.0	-	0.3	0.3	-	-	0.8
Fissurella volcano	1.0	0.8	0.3	0.3	-	-	-	-
Leucandra heathi	2.3	-	-	-	-	-	-	-
Patiria (Asterina) miniata	0.5	0.8	-	-	-	-	-	0.8
Ischnochitonidae	-	-	-	0.3	1.3	-	0.5	-
Strongylocentrotus spp.	-	0.8	0.5	0.3	-	-	0.5	-
Sipuncula unid.	1.5	-	-	-	-	0.3	-	0.3
Serpulorbis squamigerus	1.5	-	-	-	0.3	-	-	-
Diopatra ornata	-	-	-	-	-	1.0	0.8	-
Fusinus luteopictus	0.8	0.8	-	-	-	-	-	-
Ophiuroidea unid.	-	-	1.5	-	-	-	-	-
Anthozoa unid.	0.5	0.3	0.3	-	0.3	-	-	-
Calliostoma ligatum	0.8	0.3	-	-	-	-	-	0.3
Henricia leviuscula	1.0	-	-	-	-	0.3	-	-
Lacuna spp.	-	-	1.0	-	0.3	-	-	-
Mopalia spp.	-	0.3	-	-	-	-	-	0.8
Astraea gibberosa	-	-	-	-	0.5	0.5	-	-
Halcampa decemtentacula	0.3	0.3	-	-	-	-	0.3	0.3
Mitra idae	-	0.3	-	-	-	0.5	0.3	-
Ocenebra spp.	0.3	0.3	-	-	-	0.3	-	0.3
Epiactis prolifera	-	0.3	-	-	-	-	-	0.5
Acmaeidae unid.	-	-	0.8	-	-	-	-	-
Leucilla nuttingi	-	0.8	-	-	-	-	-	-
Pisaster giganteus	-	0.3	-	0.3	-	0.3	-	-
Boltenia villosa	-	-	-	-	0.3	-	0.3	-
Cucumaria spp.	-	0.3	-	-	-	0.3	-	-
Cryptolithodes sitchensis	-	-	0.3	-	-	-	-	0.3
Mimulus foliatus	-	-	-	-	-	0.3	-	0.3
Tricolia spp.	-	-	0.5	-	-	-	-	-
Ophioplocus spp.	-	-	-	-	0.3	0.3	-	-
Anthopleura artemisia	-	-	-	-	-	0.3	-	-
Tealia spp.	-	-	-	-	-	-	-	0.3

CONTINUED ON NEXT PAGE

Table 4-3
(continued)

Summary of Subtidal Invertebrate Abundances at the EMP Benthic Sampling Stations for Surveys 95 and 96 - SFQ Method

Abundance = Mean no. individuals per $7m^2$ (N=4 per station)

Area	Field's Cove		Diablo Rock Diablo Cove	North Diablo Cove		South Diablo Cove		Patton Cove
Station	**22-10**	**22-10**	**6-11**	**9-10**	**9-15**	**10-15**	**12-10**	**19-10**
Survey	95	96	96	96	96	96	96	96
Month/Year	11/95	4/96	1/96	3/96	3/96	4/96	3/96	4/96
a: Counts of individuals: Mean no. individuals per m^2 (N=4 per station)								
Diodora spp.	0.3	-	-	-	-	-	-	-
Pododesmus cepio	-	-	-	-	0.3	-	-	-
Tegula montereyi	-	-	0.3	-	-	-	-	-
Cancer antennarius	-	-	-	-	-	-	-	0.3
Anisodoris nobilis	-	-	-	0.3	-	-	-	-
Doriopsilla albopunctata	-	-	-	-	0.3	-	-	-
Cryptochiton stelleri	-	-	0.3	-	-	-	-	-
Pisaster/Henricia juv.	-	-	-	-	-	-	-	0.3
Platyhelminthes unid.	-	-	-	-	0.3	-	-	-
Aeolidia papillosa	-	-	-	0.3	-	-	-	-
Cnemidocarpa finmarkiensis	-	-	-	-	-	0.3	-	-
Lepidozona spp.	-	-	-	-	-	-	-	0.3
Haliotis spp.	-	-	-	-	0.3	-	-	-
Eupentacta quinquesemita	0.3	-	-	-	-	-	-	-
Nornisia nornsii	-	-	-	-	-	0.3	-	-
Clavularia spp.	-	<.1	-	-	-	-	-	-
a: Cover: Mean no. square inches per m^2 (N=4 per station)								
Porifera encrusting unid.	3.3	2.0	0.8	0.8	0.5	-	-	1.0
Bryozoa encrusting unid.	1.3	0.3	0.5	0.5	4.3	0.5	<.1	0.3
colonial/social tunicates unid.	1.8	2.3	-	0.5	0.3	1.0	0.3	<.1
Hydroida	-	-	3.0	-	-	-	-	-
Hymenamphiastra cyanocrypta	<.1	0.3	-	-	2.0	0.3	-	-
Eurystomella bilabiata	1.5	0.8	-	-	-	-	-	-
(Tri) Didemnum spp.	0.8	0.5	-	<.1	0.3	0.5	<.1	-
Salmacina tribranchiata	0.8	0.3	-	0.3	0.3	-	-	-
Bryozoan epiphytic	-	-	1.3	-	-	-	-	-
Spirorbidae	0.3	<.1	-	<.1	<.1	<.1	0.3	0.3
Bryozoa foliose unid.	0.3	-	<.1	-	-	-	-	-
Haliclona spp.	-	-	0.3	-	-	-	-	-
Dodecaceria fewkesi	-	-	-	-	<.1	-	-	-
A.S.S. Hydroids	-	-	<.1	-	-	-	-	-
Bryozoa erect unid.	-	<.1	-	-	-	<.1	-	-

Homalopoma spp, *Calliostoma ligatum*, and *Fusinus luteopictus*, and the sea stars *Leptasterias* spp. and *Pycnopodia helianthoides*.

Patiria (Asterina) miniata (bat star) and *Tonicella lineata* (chiton) also tended to be more abundant at stations sampled outside Diablo Cove. *Diopatra ornata* (tube worm) was most abundant at Station 10-15 in south Diablo Cove. Its higher density there may be related to the more sandy habitat at Station 10-15. The occurrence of *Strongylocentrotus purpuratus* and *S. franciscanus* (purple and red sea urchins) at Diablo Cove stations, may be related to an "urchin barrens" expansion which began in 1992. However, ancillary observations during 1996 indicate reduction in urchin densities may be occurring, especially in the shallow subtidal and intertidal areas near the mouth of Diablo Creek and upcoast approximately 100m. The highest abundance of *Phragmatopoma californica* (tube worm) was recorded at Station 9-15 in north Diablo Cove.

The anemone *Anthopleura elegantissima* has been increasing in abundance at Diablo Cove stations over the past several years[2]. The greatest abundance among stations was recorded at Stations 6-11 and 10-15 in Diablo Cove. Since power plant start-up, qualitative observations have indicated that *Anthopleura* has been the most abundant benthic invertebrate in the area directly in front of the discharge structure.

The occurrences of several uncommon species indicate a shift in species composition since power plant start-up. Several species which were either rare or absent in the study area prior to about 1990, have been observed more frequently in Diablo Cove in recent years[3]. In general, these have been southern California species, including *Megathura crenulata* (giant keyhole limpet), *Norrisia norrisii* (Norris' top-shell), and Kellets whelk (*Kelletia kelletii*). *Aplysia californica* and *A. vaccaria* (sea hares), which were common in Diablo Cove during the previous reporting period[4], were not found at any EMP benthic station sampled during the present reporting period.

[2] PG&E 1994. Thermal Effects Monitoring Program. Diablo Canyon Power Plant. 1993 Annual Report. March 1994
[3] ibid.
[4] PG&E 1995. Environmental Monitoring Program. Diablo Canyon Power Plant. Winter-Fall 1995 Status Report. February 1995.

THIS PAGE INTENTIONALLY

LEFT BLANK