Diablo Canyon License Renewal Feasibility Study

Environmental Report Technical Data Report

ESSENTIAL FISH HABITAT IN THE VICINITY OF DCPP

Revision 0

August 31, 2009

Summary of Information

This technical report will address the following items:

1. Definition of Essential Fish Habitat (EFH) as stated in the Magnuson-Stevens Fishery Conservation and Management Act.
2. Description of EFH elements in the vicinity of DCPP – pre-operation and present.
3. Summary of DCPP impacts on EFH with references to the detailed accounts available in the DCPP monitoring reports.

Regulatory Background

In 1976, the Magnuson Fishery Conservation and Management Act (Magnuson Act) established a management system to more effectively utilize the marine fishery resources of the United States. It established eight Regional Fishery Management Councils (Councils), consisting of representatives with expertise in marine or anadromous fisheries from the constituent states. In order to develop fishery management plans (FMPs) for the conservation and management of fishery resources, Councils use input from the Secretary of Commerce (Secretary), the public, and panel of experts. The Pacific Fishery Management Council (PFMC) is responsible for managing certain groundfish, coastal pelagic species, highly migratory species, and salmon from 3–200 miles off Washington, Oregon, and California. As amended in 1986, the Magnuson Act required Councils to evaluate the effects of habitat loss or degradation on their fishery stocks and take actions to mitigate such damage. In 1996, this responsibility was expanded to ensure additional habitat protection.

Within California, in particular, coastal marine resources in state waters (within 3 miles of the shoreline) are managed by regulations implemented by the Department of Fish and Game under the Natural Resources Agency. In addition, the California Coastal Commission regulates coastal development and uses through the Coastal Act of 1976 that broadly protects marine habitat and water quality, which may also come under review for the California Environmental Quality Act. Regulations involving discharges into waters of the state are administered by the Regional Water Quality Control Boards.

Essential fish habitat (EFH) is defined in the Magnuson-Stevens Fishery Conservation and Management Act as "...those waters and substrate necessary for spawning, breeding, feeding or growth to maturity"[1]. For the purpose of interpreting the definition of EFH, the term "waters" includes aquatic areas historically used by fish. Where appropriate this can include such environs as open waters, wetlands, estuarine, and riverine habitats. The term "substrate" includes sediment, hard bottom, structures underlying the waters, and the biological communities associated with the substrate. "necessary" means the habitat is required to support a sustainable

[1] Magnuson-Stevens Act, 16 U.S.C. 1801 et seq.

fishery and a healthy ecosystem; and "spawning, breeding, feeding or growth to maturity" covers a species' full life cycle.

In accordance with these definitions and descriptions, EFH would include a variety of elements found within, but not exclusive to, the coastal waters surrounding DCPP including the waters of Diablo Cove and the Intake Cove where the effects of the Plant are most pronounced. The variety of substrates within these waters ranges from flat bottom areas covered with fine silt, sand, or shell fragments to high-relief areas comprised of large boulders and upthrust bedrock. Many areas are also covered with rocky cobble and gravel, and the varied substrates extend from the continuously submerged subtidal areas up through the intertidal shoreline. Manmade structures or components make up a portion of the substrate and include the intake and discharge structures, and the two large breakwaters that enclose the Intake Cove. Associated with the wide variety of substrates is an equally varied marine flora that grows upon it and constitutes part of the EFH. The subtidal and intertidal flora includes beds of giant kelp (*Macrocystis pyrifera*) and bull kelp (*Nereocystis luetkeana*), a wide variety of smaller, understory algal species, and surf grass beds. Different combinations of substrate and flora provide habitat for an equally varied collection of fish species. For example, several species of rockfishes (*Sebastes* spp.) can be found swimming in the midwater, beneath the kelp canopy, while gobies and sculpins utilize the rocky substrate below and shelter beneath smaller species of red and brown algae.

DCPP Construction and Operation Affecting EFH

Diablo Canyon Power Plant (DCPP) is situated on the central California coast (35°12'N, 120°51'W) approximately 90 km (56 mi) north of Point Conception. Construction of DCPP Units 1&2 in the 1970s, and operation of both units since 1985, have altered the habitat in the immediate vicinity of the Plant. Initially, the construction of the intake and discharge structures altered short segments of shoreline by replacing the natural bedrock, boulder, and cobble substrate with reinforced concrete structures. Two breakwaters designed to protect the intake structure from wave action also enclosed a portion of open coastal shoreline shifting the habitat from one characterized by high energy water movement to one that is normally quiescent. As plant and animal species eventually colonized these artificial structures, they, in turn, became habitat. With a variety of attached algal species and encrusting invertebrates, the breakwaters assumed the role of high relief rocky substrate with an assemblage of fish species utilizing their surface and interior as they would a naturally occurring rock formation.

Operation of DCPP has also had impacts on the inshore habitat, almost exclusively in Diablo Cove, in the vicinity of DCPP. These impacts are related to the flow of cooling water pumped from the Intake Cove, through the Plant, and out the discharge structure located on the shoreline of Diablo Cove. With all of its circulating water pumps in operation, approximately 2.5 billion gallons of seawater is pumped through the system each day. The water temperature at the point of discharge is approximately 11°C (20°F) warmer than ambient intake temperatures, which vary seasonally from approximately 10.0–14.0°C (50.0–59.0°F). Both the temperature and volume of the discharge plume can directly affect EFH in the immediate vicinity of the Plant.

The marine environment in the vicinity of DCPP has been the object of intense environmental monitoring since the mid-1970s. These studies were initiated during the construction of the Plant and have continued, uninterrupted, through more than 20 years of plant operation. Various analysis reports have been consistent in their conclusions that biological effects of the discharge were mainly confined to Diablo Cove and diminished with both depth and distance from the point of discharge. A bibliography of various studies at DCPP that have addressed environmental impacts on EFH and other aspects of the marine environment in the vicinity of the plant are listed in **Appendix A**.

Habitat Areas of Particular Concern (HAPC)

EFH guidelines identify habitat areas of particular concern (HAPC) as types or areas of habitat that are identified based on one or more of the following considerations:

- The importance of the ecological function provided by the habitat.
- The extent to which the habitat is sensitive to human-induced environmental degradation.
- Whether, and to what extent, development activities are or will be stressing the habitat type.
- The rarity of the habitat type.

Three of the HAPC identified in the federal regulations are directly influenced by DCPP. They include rocky reefs, canopy kelp, and seagrass. The following descriptions include an overview of these habitat types and how they have been affected by power plant operation.

Rocky Reefs

Rocky habitats are generally categorized as either nearshore or offshore in reference to the proximity of the habitat to the coastline. Rocky habitat may be composed of bedrock, boulders, or smaller rocks, such as cobble and gravel. Hard substrates are one of the least abundant benthic habitats, yet they are among the most important habitats for groundfish. The rocky reefs HAPC includes those waters, substrates and other biogenic features associated with hard substrate (bedrock, boulders, cobble, gravel, etc.) to mean higher high water.

As mentioned earlier, construction of the breakwaters, intake, and discharge structures at DCPP affected the quantity and quality of rocky reef substrates in the Intake Cove and Diablo (Discharge) Cove. The net result, however, was that despite early disruption of habitat during the construction phase, subsequent re-colonization by native marine species of kelp, other algae, and invertebrates provided stable rock habitat that has supported indigenous nearshore fish assemblages. The habitat supported sport and commercial nearshore fisheries until it was protected from fishing by a security exclusion zone around DCPP in 2001.

Canopy Kelps

Of the habitats associated with the rocky substrate on the continental shelf, kelp forests are of primary importance to the ecosystem and serve as important groundfish habitat. Kelp forest communities are found relatively close to shore along the open coast. These subtidal communities provide vertically-structured habitat throughout the water column: a canopy of tangled blades from the surface to a depth of ten feet, a midwater, stipe region, and the holdfast region at the seafloor. Kelp stands provide nurseries, feeding grounds, and shelter to a variety of fish species and their prey. Giant kelp communities are highly productive relative to other habitats, including wetlands, shallow and deep sand bottoms, and rock-bottom artificial reefs. The net primary production of seaweeds in a kelp forest is available to consumers as living tissue on attached plants, as drift in the form of whole plants or detached pieces, and as dissolved organic matter exuded by attached and drifting plants[2].

Kelp canopies are widespread along the 18 km (11 mile) coastline in the vicinity of Diablo Canyon, reaching maximum extent in fall months and occupying most rock reefs shallower than approximately 10 m (33 ft) (**Figure 1**). Coastal aerial photographs spanning a 30-year period (1969–1998) were analyzed to determine potential effects of the DCPP discharge on kelp surface canopies in Diablo Cove and adjoining nearshore areas north of Diablo Cove[3]. This study area represented a segment of about 2 km (1.2 mi) of the greater Diablo Canyon coastline. Both bull kelp (*Nereocystis luetkeana*) and giant kelp (*Macrocystis pyrifera*) occurred in the study area. Areas contacted by the discharge were tested for long-term changes relative to controls using a before-after-control-impact (BACI) statistical model.

Bull kelp declined significantly in Diablo Cove after power plant start-up due to its inability to grow and reproduce in the warm water. It remained, however, at low levels of abundance in some of the marginal areas of the cove where cooler offshore water was entrained by the discharge circulation. Test results were inconclusive for bull kelp declines outside of Diablo Cove, possibly due to the mixed canopy composed of bull kelp and giant kelp.

Giant kelp was more tolerant of the warmer conditions, and the combined coverage of bull kelp and giant kelp (total kelp cover) for the study area increased from about 3.0 ha (7.5 ac) to about 4.0 ha (9.9 ac) between the pre-operation and operation study periods. However, this absolute increase actually represented a statistically significant decline relative to control areas where total kelp cover increased by larger amounts over time. The differing rates of increase could have been related to natural variation associated with the mixed canopies, substrate availability, competition, and power plant effects.

[2] Foster, M.S. and D. R. Schiel. 1985. The ecology of giant kelp forests in California: a community profile. U.S. Fish Wildl. Serv. Biol. Rep. 85(7.2).

[3] Tenera Environmental. 2000. Effects of the DCPP Discharge on Surface Canopy Kelps as Determined by Analysis of Aerial Photographs. Doc. E9-039.2. Prepared for Pacific Gas and Electric Company, San Francisco, CA.

The estimate of the annual average amount of bull kelp canopy lost in Diablo Cove during plant operation was 0.2 ha (0.4 ac) (**Table 1**). A replacement canopy of giant kelp increased in Diablo Cove starting in the early 1990s from near-zero abundance to an annual average of about 0.5 ha (1.3 ac). Giant kelp was greatest in abundance in 1998 (1.3 ha; 3.2 ac). The shift confirmed earlier predictions that bull kelp would decline near the discharge while giant kelp would increase.

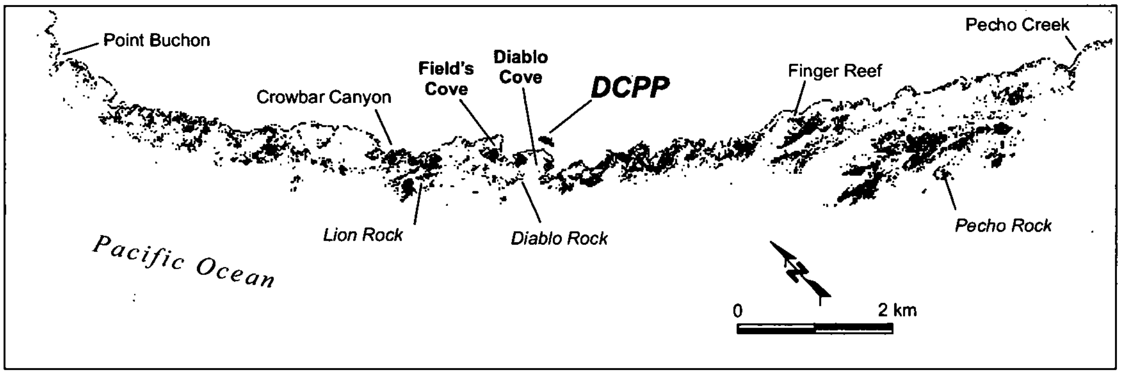

Figure 1. Distribution of surface canopy kelp based on GIS mapping of a 1998 aerial survey (Tenera 2000a). Giant kelp was most common north of DCPP whereas bull kelp was most common south of DCPP.

Table 1. Area estimates of bull kelp replaced by giant kelp in Diablo Cove based on GIS analysis.

Pre-Operation Bull Kelp		**Operation** Giant Kelp	
1981	<0.1 ha (<0.1 ac)	1991	0.2 ha (0.5 ac)
1982	0.1 ha (0.2 ac)	1997	<0.1 ha (<0.1 ac)
1983	0.4 ha (0.9 ac)	1998	1.3 ha (3.2 ac)
mean	**0.2 ha (0.4 ac)**	**mean**	**0.5 ha (1.3 ac)**

The increased abundance of giant kelp habitat in Diablo Cove after plant start-up coincided with increased abundances of some kelp-associated fish species, such as kelp bass, and provided shelter for some juvenile rockfish species (e.g., kelp, gopher, black-and-yellow) that use kelp habitat for successful settlement in the nearshore zone[4]. The increased diversity and numbers of midwater fishes during operation, and the continued increases of benthic fishes in north Diablo Cove may also have been related to the added structural complexity provided by giant kelp.

[4] Tenera Environmental, Inc. 1997. Thermal effects monitoring program, analysis report: Chapter 1 - Changes in the marine environment resulting from the Diablo Canyon Power Plant discharge. Doc. E7-204.7. Prepared for Pacific Gas and Electric Company, San Francisco, CA.

Seagrasses

Two important seagrass species found on the West Coast of the U.S. are eelgrass (*Zostera* spp.) and surfgrass (*Phyllospadix* spp.). These grasses are vascular plants, not seaweeds, forming dense beds of leafy shoots year-round in the lower intertidal and subtidal areas. Eelgrass is found on soft-bottom substrates in intertidal and shallow subtidal areas of estuaries and occasionally in other nearshore areas, such as the Channel Islands. Surfgrass occurs on hard-bottom substrates along higher energy coastlines. Studies have shown seagrass beds to be among the areas of highest primary productivity in the world.

Analysis of long-term monitoring data showed that the DCPP thermal discharge caused surfgrass to become less abundant in Diablo Cove after plant start-up. Based on earlier observations prior to power plant start-up, surfgrass once formed a nearly continuous band around the shoreline of Diablo Cove, covering an estimated area of about 2 hectares (5 acres). Severe storm waves in winter 1982/83, before power plant start up, subsequently reduced surfgrass cover in Diablo Cove to about 0.4 hectare (1 acre). Surveys in summer/fall 1997 showed that surfgrass cover in Diablo Cove was about 0.1 hectare (0.25 acre) (**Figure 2**)[5]. Based on these qualitative estimates, the operation of the DCPP discharge reduced the cover of surfgrass in Diablo Cove by about 0.3 hectare (0.75 acre). Lack of recovery to pre-storm abundances represented a potential loss of approximately 1.9 hectares (4.75 acres) of surfgrass in Diablo Cove. Areas in Diablo Cove that lacked surfgrass were generally suitable for its establishment in terms of substratum composition and depth, but the areas were covered with algae instead. The specific causes for the declines and the lack of recovery are unexplained. Healthy patches of surfgrass remained in certain portions of north and south Diablo Cove long after plant start-up despite chronic exposure to warmer water temperature regimes.

North of Diablo Cove, intertidal surfgrass increased in Field's Cove after the 1982/83 storms and during power plant operation, but the increase was not as large as at control stations. Statistical analysis detected the change as a significant decline in intertidal surfgrass abundance in Field's Cove, relative to control populations. There was no baseline information for determining potential discharge effects to subtidal surfgrass in Field's Cove. Although the potential exists for effects, since portions of Field's Cove are contacted by the DCPP discharge, the summer/fall 1997 surveys noted that the subtidal surfgrass in Field's Cove appeared to be similar in abundance to the other areas north and south of Diablo Cove.

[5] Tenera Environmental, Inc. 1998. Surfgrass (*Phyllospadix*) in the vicinity of the Diablo Canyon Power Plant discharge. Doc. E7-225.4. Prepared for Pacific Gas and Electric Company, San Francisco, CA.

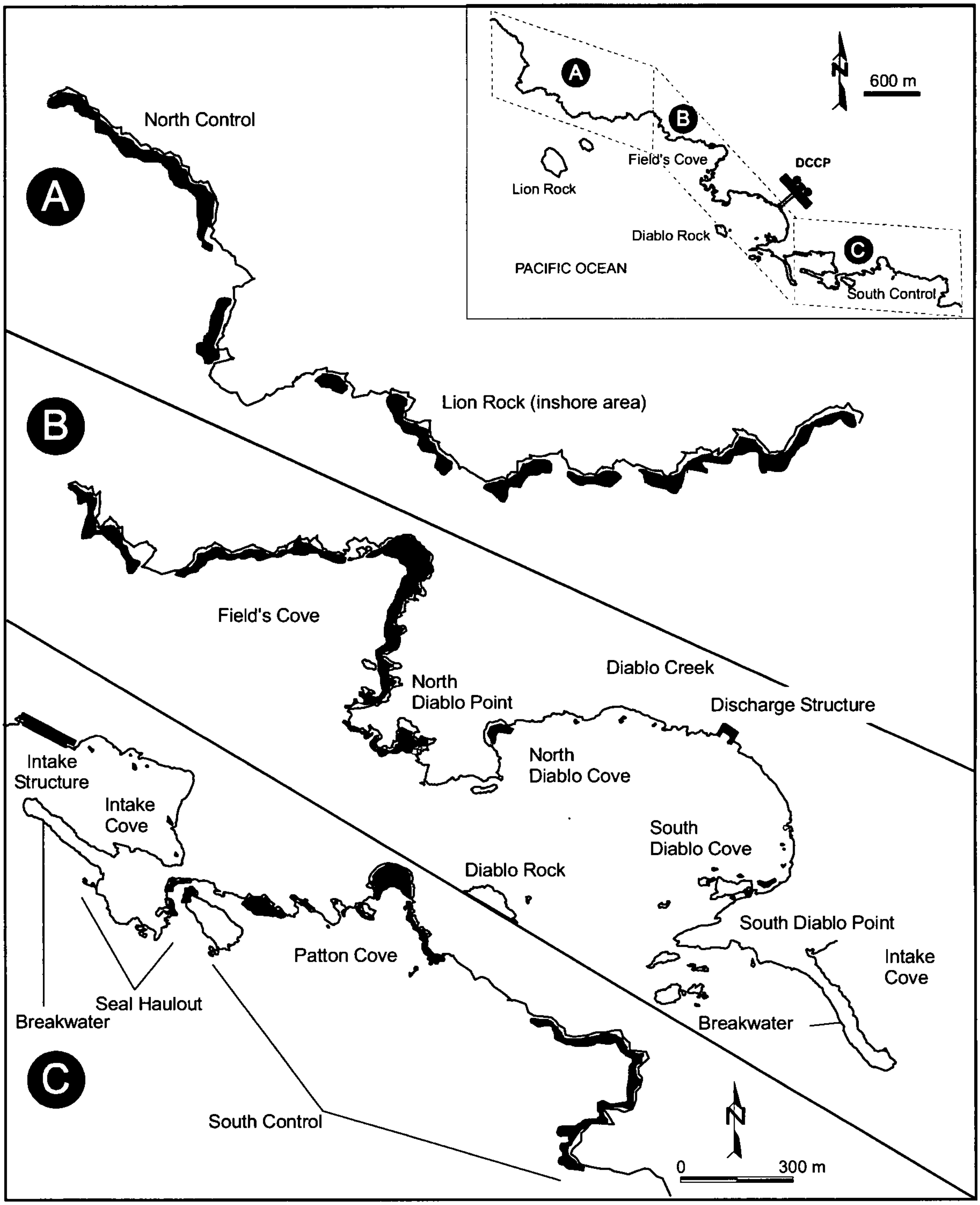
A
B
600 m
Field's Cove
DCCP
Lion Rock
Diablo Rock
C
PACIFIC OCEAN
South Control
North Control
A
Lion Rock (inshore area)
B
Field's Cove
Diablo Creek
North
Diablo Point
Discharge Structure
North
Diablo Cove
Intake
Structure
Intake
Cove
South
Diablo Cove
Diablo Rock
South Diablo Point
Intake
Cove
Patton Cove
Seal Haulout
Breakwater
Breakwater
C
South Control
0
300 m

Figure 2. Map of the Diablo Canyon coastline and distribution of surfgrass (dark shading) from North Control to South Control based on the 1997 summer/fall surveys. Shoreline areas outside Diablo Cove that lacked surfgrass were generally too steep to provide adequate habitat.

Species Identified in Fishery Management Plans

The NMFS develops fishery management plans (FMP)[6,7] for certain species within the designations of "coastal pelagic species" or "groundfish" for which EFH is specified. The following tables (**Tables 2** and **3**) present a list of the species with an indication on their occurrence in the vicinity of DCPP. The species that are noted may occur in any of several life stages, from larvae to adults, and may include presence at depths or distances beyond the direct influence of the DCPP intake and discharge.

Table 2. Species managed under the PFMC Pacific Coast Coastal Pelagics Fishery Management Plan.

Common name	***Scientific name***	**Present along Diablo Canyon shoreline vicinity***
Pacific saury	*Cololabis saira*	
Northern anchovy (central subpopulation)	*Engraulis mordax*	X
Northern anchovy (northern subpopulation)	*Engraulis mordax*	
Market squid	*Loligo opalescens*	X
Pacific bonito	*Sarda chiliensis*	X
Pacific herring	*Clupea harengus*	X
Pacific sardine	*Sardinops sagax*	X
Pacific (chub or blue) mackerel	*Scomber japonicus*	X
Jack (Spanish) mackerel	*Trachurus symmetricus*	X

[6] Pacific Fishery Management Council. 2008. Pacific coast groundfish fishery management plan for the California, Oregon, and Washington groundfish fishery as amended through Amendment 19. July 2008.

[7] Pacific Fishery Management Council. 1998. The coastal pelagic species fishery management plan. December 1998.

Table 3. Species managed under the PFMC Pacific Coast Groundfish Fishery Management Plan.

Common name	***Scientific name***	**Present along Diablo Canyon shoreline vicinity***
SHARKS AND SKATES		
Big skate	*Raja binoculata*	X
California skate	*R. inornata*	
Leopard shark	*Triakis semifasciata*	X
Longnose skate	*R. rhina*	
Soupfin shark	*Galeorhinus zyopterus*	X
Spiny dogfish	*Squalus acanthias*	
RATFISH		
Ratfish	*Hydrolagus colliei*	X
MORIDS		
Finescale codling	*Antimora microlepis*	
GRENADIERS		
Pacific rattail	*Coryphaenoides acrolepis*	
ROUNDFISH		
Cabezon	*Scorpaenichthys marmoratus*	X
Kelp greenling	*Hexagrammos decagrammus*	X
Lingcod	*Ophiodon elongatus*	X
Pacific cod	*Gadus macrocephalus*	
Pacific whiting (hake)	*Merluccius productus*	
Sablefish	*Anoplopoma fimbria*	
ROCKFISH		
Aurora rockfish	*Sebastes aurora*	
Bank rockfish	*S. rufus*	
Black rockfish	*S. melanops*	X
Black and yellow rockfish	*S. chrysomelas*	X
Blackgill rockfish	*S. melanostomus*	
Blue rockfish	*S. mystinus*	X
Bocaccio	*S. paucispinis*	X
Bronzespotted rockfish	*S. gilli*	
Brown rockfish	*S. auriculatus*	X
Calico rockfish	*S. dallii*	X
California scorpionfish	*Scorpaena gutatta*	
Canary rockfish	*Sebastes pinniger*	X
Chameleon rockfish	*S. phillipsi*	
Chilipepper	*S. goodei*	X
China rockfish	*S. nebulosus*	X
Copper rockfish	*S. caurinus*	X
Cowcod	*S. levis*	
Darkblotched rockfish	*S. crameri*	
Dusky rockfish	*S. ciliatus*	
Dwarf-red rockfish	*S. rufinanus*	
Flag rockfish	*S. rubrivinctus*	
Freckled rockfish	*S lentiginosus*	
Gopher rockfish	*S. carnatus*	X
Grass rockfish	*S. rastrelliger*	X

Greenblotched rockfish	*S. rosenblatti*	
Greenspotted rockfish	*S. chlorostictus*	
Greenstriped rockfish	*S. elongatus*	X
Halfbanded rockfish	*S. semicinctus*	X
Harlequin rockfish	*S. variegatus*	
Honeycomb rockfish	*S. umbrosus*	
Kelp rockfish	*S. atrovirens*	X
Longspine thornyhead	*Sebastolobus altivelis*	
Mexican rockfish	*Sebastes macdonaldi*	
Olive rockfish	*S. serranoides*	X
Pink rockfish	*S. eos*	
Pinkrose rockfish	*S. simulator*	
Pygmy rockfish	*S. wilsoni*	
Pacific ocean perch	*S. alutus*	
Quillback rockfish	*S. maliger*	
Redbanded rockfish	*S. babcocki*	
Redstripe rockfish	*S. proriger*	
Rosethorn rockfish	*S. helvomaculatus*	
Rosy rockfish	*S. rosaceus*	X
Rougheye rockfish	*S. aleutianus*	
Sharpchin rockfish	*S. zacentrus*	
Shortbelly rockfish	*S. jordani*	X
Shortraker rockfish	*S. borealis*	
Shortspine thornyhead	*Sebastolobus alascanus*	
Silvergray rockfish	*Sebastes brevispinis*	
Speckled rockfish	*S. ovalis*	
Splitnose rockfish	*S. diploproa*	
Squarespot rockfish	*S. hopkinsi*	X
Starry rockfish	*S. constellatus*	X
Stripetail rockfish	*S. saxicola*	X
Swordspine rockfish	*S. ensifer*	
Tiger rockfish	*S. nigrocinctus*	
Treefish	*S. serriceps*	X
Vermilion rockfish	*S. miniatus*	X
Widow rockfish	*S. entomelas*	X
Yelloweye rockfish	*S. ruberimus*	
Yellowmouth rockfish	*S. reedi*	
Yellowtail rockfish	*S. flavidus*	X
FLATFISH		
Arrowtooth flounder (turbot)	*Atheresthes stomias*	
Butter sole	*Isopsetta isolepis*	X
Curlfin sole	*Pleuronichthys decurrens*	X
Dover sole	*Microstomus pacificus*	X
English sole	*Parophrys vetulus*	X
Flathead sole	*Hippoglossoides elassodon*	
Pacific sanddab	*Citharichthys sordidus*	X
Petrale sole	*Eopsetta jordani*	
Rex sole	*Glyptocephalus zachirus*	
Rock sole	*Lepidopsetta bilineata*	X
Sand sole	*Psettichthys melanostictus*	X

Starry flounder	*Platichthys stellatus*	**X**

Appendix A: Partial Listing of DCPP Marine Environmental Documents

Changes to the local marine environment that have occurred due to the operation of DCPP have been documented in detailed reports, many of which have been prepared as part of the annual monitoring and reporting requirements of the NPDES discharge permits administered by the Regional Water Quality Control Board. These documents include, but are not limited to, the following:

Blecha, J.B., J.R. Steinbeck, and D.C. Sommerville. 1992. Aspects of the biology of black abalone, *Haliotis cracherodii*, near Diablo Canyon, central California. pp. 225-236 *in* S.A. Shepherd, J.J. Tegner, and S.A. Guzman del Proo (eds.), Abalone of the world: biology, fisheries and culture. Blackwell Scientific Publications Ltd., Oxford.

Burge, R.T. and S.A. Schultz. 1973. The marine environment in the vicinity of Diablo Cove with special reference to abalone and bony fishes. Calif. Dept. Fish Game, Mar. Res. Tech. Rpt. No. 19.

Ebert, E.E. 1966. An evaluation of marine resources in the Diablo Canyon area, May 2-4, 1966. MRO Ref. No. 66-10. Calif. Dept. Fish Game, Special Study.

Findikaki, I.T. 1986. Statistical analysis and comparative evaluation of field and hydraulic model water temperature data in the vicinity of the Diablo Canyon thermal outfall. Submitted to Bechtel Inc., San Francisco, CA. Prepared for Pacific Gas and Electric Company, Dept. Engr. Research, San Ramon, CA. February 1986.

Gotshall D.W., J.R.R. Ally, D.L. Vaughn, B.B. Hatfield, and P. Law. 1986. Pre-operational baseline studies of selected nearshore marine biota at the Diablo Canyon Power Plant site: 1979-1982. Calif. Dept. Fish Game, Mar. Res. Tech. Rep. No. 50.

Gotshall, D.W., L.L. Laurent, S.L. Owen, J. Grant, and P. Law. 1984. A quantitative ecological study of selected nearshore marine plants and animals at the Diablo Canyon Power Plant site: a pre-operational baseline: 1973-1978. Calif. Dept. Fish Game, Mar. Res. Tech. Rep. No. 48.

Icanberry, J.W., J.W. Warrick, and D.W. Rice, Jr. 1978. Seasonal larval fish abundance in waters off Diablo Canyon, California. Trans. Amer. Fish. Soc. 107:225-234.

Leighton, J.P. 1988. Estimation of the dilution factor for the Diablo Canyon Power Plant thermal discharge plume. Technical and Ecological Services, Report No. 028.282-88.2, Pacific Gas and Electric Company, Technical and Ecological Services, San Ramon, CA. February 1988.

Martin, M., M. Stephenson, D. Smith, J. Linfield, G. Ichikawa, J. Goetzel, J. Bennett, S. Eastman, and M. Manera. 1985. Diablo Canyon Nuclear Power Plant outfall monitoring report. State Mussel Watch Progr. Prelimin. Data Rpt. 1984-1985. Calif. Dept. Fish Game. 19 pp.

North, W.J. 1969. An evaluation of the marine flora and fauna in the vicinity of Diablo Cove, California. Marine Advisors, La Jolla, CA. p. 1097-1128.

North, W.J. and E. Anderson. 1973. Anticipated biological effects from heated effluents at Diablo Cove. Dept. Eng. Res., Pacific Gas and Electric Company, San Francisco, CA. May 1973.

North, W.J. and E. Anderson. 1973. Anticipated biological effects from heated effluents at Diablo Cove. Dept. Eng. Res., Pacific Gas and Electric Company, San Francisco, CA.

North, W.J., E.K. Anderson, and F.A. Chapman. 1989. Wheeler J. North ecological studies at Diablo Canyon Power Plant. Final Report, 1967-1987. Pacific Gas and Electric Company, San Francisco, CA.

PG&E. 1971. Environmental report, units 1 and 2, Diablo Canyon site. AEC dockets 50-275, 50-323. July 1971; PG&E, environmental report supplement no. 2 (1972).

PG&E. 1978. Pacific Gas and Electric Company 316(a) Demonstration Program Field Biology Preoperational Phase Database Summary, Vols. 1 and 2. Prepared by Lockheed Center for Marine Research, Carlsbad, CA. for Kaiser Engineers, Inc. April 1978.

PG&E. 1982. Compendium of Thermal Effects Laboratory Studies Volumes 1, 2, and 3. Diablo Canyon Power Plant. Prepared by TERA Corp., Berkeley, CA for Pacific Gas & Electric Co., San Francisco, CA.

PG&E. 1985. Environmental evaluation of heat treatment thermal discharges. Diablo Canyon Power Plant. Prepared by TERA Corp., Berkeley, CA. July 1985.

PG&E. 1988. Cooling water intake structure 316(b) demonstration. Diablo Canyon Power Plant. Pacific Gas and Electric Company, San Francisco, CA. Prepared by TERA Corp., Berkeley, CA. April 1988.

PG&E. 1988. Thermal Effects Monitoring Program. Final Report. Pacific Gas and Electric Company, San Francisco, CA.

PG&E. 1989. Diablo Canyon Power Plant. Marine Environmental Monitoring Program. 1988 Annual Report. Pacific Gas and Electric Company, San Francisco, CA. DCl-89-119. April 1989.

Resio, D.T. 1982. Report on wave climatology for Diablo Canyon, California. Oceanweather, Inc. June 1982. 97 pp.

Ryan, P. J., N. Ismail, R. C. H. Lou, S. W. Tu, and R. L. Wiegel. 1987. Hydraulic model verification tests for units 1 and 2 Diablo Canyon Power Plant. Pacific Gas and Electric Company, Dept. Engr. Research, San Ramon, CA. Report 420-DC-87.15. April. 1987.

Safaie, B. 1986. Study of nearshore current in the vicinity of Diablo Canyon, California. Prepared for Pacific Gas and Electric Company, Dept. Engr. Research, San Ramon, CA. June 1986.

Setran, A.C. and D.W. Behrens. 1993. Transitional ecological requirements for early juveniles of two sympatric stichaeid fishes, *Cebidichthys violaceus* and *Xiphister mucosus*. Envir. Biol. Fishes 37:381-395.

Steinbeck, J. R., D. R. Schiel, and M. S. Foster. 2005. Detecting long-term change in complex communities: a case study from the rocky intertidal zone. Ecological Applications 15:1813-1832.

Tenera Environmental, Inc. (in prep.). Diablo Canyon Power Plant Receiving Water Monitoring Program: 1995 - 2008 Analysis Report. Prepared for Pacific Gas & Electric Company, San Francisco, CA.

Tenera Environmental, Inc. 1997. Diablo Canyon Power Plant Thermal Effects Monitoring Program Analysis Report. Chapter 1. Changes in the marine environment resulting from the Diablo Canyon Power Plant thermal discharge. Prepared for Pacific Gas and Electric Company, San Francisco, CA.

Tenera Environmental, Inc. 1998. Diablo Canyon Power Plant Thermal Effects Monitoring Program Analysis Report. Chapter 2 - Assessment of Thermal Effects. Prepared for Pacific Gas & Electric Company, San Francisco, CA.

Tenera Environmental, Inc. 1998. Surfgrass (*Phyllospadix*) in the Vicinity of the Diablo Canyon Power Plant Discharge. E7-225.4. Prepared for Pacific Gas and Electric Company, San Francisco, CA.

Tenera Environmental, Inc. 1999. Effects of the DCPP discharge on surface canopy kelps as determined by analysis of aerial photographs. Prepared for Pacific Gas & Electric Company, San Francisco, CA.

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