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SAN DIEGO GAS & ELECTRIC

ENCINA POWER PLANT

COOLING WATER INTAKE SYSTEM DEMONSTRATION

SDGE

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ENCINA POWER PLANT

COOLING WATER INTAKE SYSTEM DEMONSTRATION
(IN ACCORDANCE WITH SECTION 316(b) FEDERAL WATER POLLUTION CONTROL ACT AMENDMENT OF 1972)

PREPARED FOR:

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN DIEGO REGION
SAN DIEGO, CALIFORNIA

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FISH REMOVAL BY INTAKE SCREENS (IMPINGEMENT STUDIES)

7.1 ABSTRACT AND SUMMARY

A 336 consecutive day study was conducted to describe and evaluate impingement of marine fishes, large invertebrates, and marine plants at the traveling screens and bar rack system of the Encina Power Plant cooling water intake. Detailed quantitative sampling and analysis to obtain biological and physical data were conducted twice daily during this period. The primary method of biological sampling was to obtain quantitative 12-hour accumulation samples during each day and night period, using nets placed in the trash collector baskets of all (three) traveling screen systems.

Results of the study included the following:

- Seventy-six species of fishes, 45 species of large invertebrates and seven species of marine grasses and algae were impinged.
- Marine plants were the largest component of material in the samples.
- The total amount of animal material impinged at the traveling screens during the 336 consecutive day period was 85,943 individuals weighing 1548 kg (3414 lb).

- 79,662 of the total individuals were fishes weighing a total of 1395 kg (3076 lb).
- During thermal treatments (seven for the year) 108,102 fish weighing 2422 kg (5341 lb) were removed.

Levels of impingement were lower at the Encina Power Plant compared to those reported for other coastal generating stations in southern California. Numbers impinged at Encina and other plants during a one year period, including thermal treatments, were:

- 187,764 fish weighing 3817 kg (8417 lb) at Encina Power Plant Units 1-5 with a maximum flow rate of 828 MGD.
- 260,917 fish weighing 19,553 kg (43,063 lb) at Redondo Beach Generating Station Units 7 and 8 with a maximum flow rate of approximately 673 MGD (7-1).
- 365,641 fish weighing 16,974 kg (37,423 lb) at San Onofre Nuclear Generating Station Unit 1 with a maximum flow rate of approximately 500 MGD (7-2).

The six highest ranking fish species by numbers impinged (83 percent of all fishes) are active, open water forms that occur in schools. In decreasing order of abundance, they are the queenfish, deepbody anchovy, topsmelt, California grunion, northern anchovy, and shiner surfperch.

Impingement of many fish species was relatively consistent throughout the year. Levels of impingement, however, showed considerable short- and long-term variation. There were no significant correlations between water temperature, salinity, cloud cover and ocean wave height and levels of impingement when these parameters were analyzed alone. It appears that impingement is influenced by a combination of factors. Primary causal factors involved appear to be high wind speeds, strong wave action and turbulence, rainfall and lowered salinity, and increased turbidity. For example, four of five storm periods (characterized by wind speeds $\geq$ 12 mph, rainfall, salinity $\leq$ 29.9 ppt, and wave heights >4 ft) had evident effects, the levels of impingement being significantly higher after onset of the storm than before it. Dredging operations throughout outer Agua Hedionda Lagoon also caused significantly higher impingement.

There was clear evidence that levels of impingement for fishes were significantly higher during darkness than during daylight. There also were significant correlations between levels of impingement and the flow rates of cooling water in the conveyance channels, impingement increasing fairly directly with increasing flow rates, assuming equal numbers of fish were present during the various flows. The peak impingement occurred in early spring during dredging operations. There were also seasonal peaks in summer and fall.

In general, there was little decomposition or physical damage for most fishes impinged, and a majority of these entered the screen well collector baskets alive. There appeared to be direct relationships between the degree of damage and both the fragility and size of fishes impinged. Delicate forms (e.g., anchovy species) experienced greatest damage during impingement.

Sex ratios of many critical species in the samples indicated that larger proportions of females than males were impinged during the 336 day period. In one case (the specklefin midshipmen) all of the females were in an advanced reproductive state. For most species considered, adult females in all stages of reproductive development occurred in the impingement samples.

Eelgrass and the giant kelp were the dominant marine plant species impinged at both the bar rack and traveling screen systems. Large rays and sharks were a small component of the bar rack samples. In general, highest levels of impingement for plants at the bar rack system occurred during and following storms. However, impingement of plants at the traveling screens generally was greater during the summer and fall.

Seven thermal treatments were sampled during the year. Seventy-three fish species and 34 invertebrates were collected at traveling screens during thermal treatments. Fourteen species were collected that were not taken during daily impingement samples. Over 90 percent of fish collected consisted of nine major species (deepbody anchovy, topsmelt, northern anchovy, shiner surfperch, California grunion, walleye surfperch, queenfish, round stingray, and giant kelpfish).

During thermal treatments for the year, 108,102 fish which weighed 2422 kg (5341 lb) were collected in addition to daily impingement samples. The greatest collections occurred in February and the least in December. Sampling indicates that certain larger fish live in the tunnels and are only impinged when killed during thermal treatments. The numbers of fish resident in the tunnels appears to be greatest in winter and lowest in summer. This could be due to fish seeking refuge in the lagoon during winter periods.

The results of this study were evaluated in relation to information from other research on behavior of fishes and factors affecting impingement. The primary factors involved appear to be water temperature, velocity of flow and other flow characteristics in the cooling water system, turbulence and salinity changes associated with storms, level of illumination, and the water depth and structural characteristics of the intake system.

7.2 HISTORICAL INFORMATION

Species lists and ecological information for fishes known or expected to occur in Agua Hedionda Lagoon and the inshore ocean area adjacent to the Encina Power Plant are given in Sections 6.2 and 6.3 of this report. Detailed information about fishes taken in these areas during monthly sampling by Woodward-Clyde Consultants is given in Section 6.5. Extensive data concerning benthic invertebrates and plants inhabiting Agua Hedionda Lagoon have been reported by Miller (1966), Bradshaw and Estberg (1973), and Bradshaw et al. (1976) (7-3, 7-4 and 7-5). These sources provide useful background information for the impingement study. They also provide a good indication of the fish, invertebrate, and plant species likely to be impinged in the cooling water system of the power plant.

The impingement study described in this report is the first detailed one conducted at the Encina Power Plant. Previously, regular monthly sampling was carried out at the plant by the San Diego Gas & Electric Company (SDG&E) during the five year period November, 1972 - February, 1978 to record the impingement of fishes and large crustaceans. These records provide useful historical information against which the results of the detailed study may be compared. They also were used in planning the methods used in this study.

Sampling was conducted by personnel of SDG&E at representative times on 1 to 4 days per month. As described in Section 16.2.3, material washed from the traveling screens passed through concrete troughs and a spout into large metal trash collecting baskets. Impingement samples for SDG&E monitoring study were obtained by placing a metal screen collecting device in place of the spout at the end of the trough. The collector was left in place for a known length of time (normally 8 hours) and the contents were then removed and examined.

A standard data form was used to record the information. These monitoring records are maintained by SDG&E. A sample of the data form is shown in Figure 7.2-1. Estimated number of individuals, estimated total weight, and estimated size range were recorded by month for each of 21 families of fishes and for lobsters and shrimp, as indicated in Figure 7.2-1. The estimated total weight of fish collected also was recorded.

The size of the sampling device employed by SDG&E was much smaller than that used in the detailed study and the methods of processing the samples were different. Despite these differences, the results from both approaches are generally comparable.

7.3 METHODOLOGY

Quantitative sampling and analysis of impinged fishes, large invertebrates and marine plants was conducted twice daily at the Encina Power Plant during the period February 4, 1979 through January 4, 1980. Preliminary sampling also was conducted during the period January 19 through February 3, 1979 to refine the methods used. Detailed descriptions for all methods of sampling and analysis employed in the impingement study are given in Appendix B, Section 16.2.3 of this report. Brief descriptions of these methods are provided here.

A morning sample at 0700 hr and an evening sample at 1900 hr were taken from large nylon nets suspended in the metal trash collector baskets associated with each of the three separate traveling screen systems of the Power Plant. The locations of these three traveling screen systems, designed as impingement stations 1, 4, and 5, are shown in Figure 7.3-1. Station 1 was located at the traveling screens of generating Units 1-3, station 4 at the screens of generating Unit 4, and station 5 at the screens of generating Unit 5. By sampling in this way, 12-hr accumulation samples were obtained continuously from each of three screenwell locations. The samples taken at 0700 hr represented impingement that occurred primarily during darkness, while those taken at 1900 hr represented impingement that occurred during daylight.

The entire contents of the net collector at each screenwell station location constituted the 12-hr accumulation sample.

Appropriate methods of subsampling were employed when the amounts of material and the numbers of individuals of a given animal species were large. These standard subsampling methods are described in Appendix Section 16.2.3. All data were recorded on standard forms, using a computer coding format.

In the laboratory, all fishes, large invertebrates, and marine plants were sorted from the whole sample or subsample prior to making identifications, counts and measurements. These organisms were identified to species or to the lowest possible taxonomic category, using keys and reference collections.

The aggregate weight of all animal and plant material combined and the aggregate weight of all marine plants were determined to the nearest 100 g. The rank order of abundance of each plant species by estimated volume and the numbers of individuals of each fish and motile invertebrate species were determined and recorded. The total body length of individual fishes was determined and recorded to the nearest 1 mm. The wet body weight of individual fishes was determined to the nearest 1 g after shaking loose water from the body. Total weight of all individuals combined was determined in the same manner. The qualitative body condition of individual fishes was determined, using standard codes for decomposition and physical damage as described in Appendix Section 16.2.3.

Once per month, fishes taken in one or more impingement samples at each station also were examined to determine their sex and reproductive condition. During periods when the amount of material impinged was small, samples from two to eight consecutive days were used to determine reproductive characteristics.

Individuals from the entire sample or series of samples were used in determining reproductive characteristics. All individuals were examined to determine the numbers of males and and females of each species present. All females were then examined by visual inspection of the ovary to determine reproductive condition. The characteristics and data codes used to indicate the sex of each individual and the reproductive condition of females are described in Appendix Section 16.2.3.

Fishes and marine plants that had accumulated in the trash collector trailers associated with the bar rack screening system also were examined at 0700 hr each day. The location of the bar rack system, designated as impingement station 9, is shown in Figure 7.3-1.

The contents of the trash collector trailers were examined qualitatively by searching through the material. The accumulated material consisted primarily of larger marine plants. The rank order of abundance of each marine plant species by estimated volume was recorded. Large fishes and other vertebrate animals were removed for identification and measurements of length and weight, using the same methods described for the traveling screen samples.

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Pertinent physical and meteorological data were obtained from measurements and observations made during each sampling period or from records provided by SDG&E. Detailed descriptions of these data and the methods used to obtain them are given in Appendix B, Section 16.2.3.

Meteorological and other physical data were taken near the bar rack system four times during each 24-hr period. These were wind speed (nearest 1 mph), weather conditions, cloud cover, wave height, air and water temperatures (nearest 0.5 C), and salinity (nearest 0.1 ppt).

Data concerning tidal height and stage at the time samples were taken and the highest and lowest tide levels during the preceeding 12-hr period were obtained from a sine curve tide chart. Continuous information concerning the number of circulating water pumps operating for each generating unit of the Power Plant and the flow rates of these pumps was obtained from records maintained by SDG&E at the Encina Power Plant. Total flow rates of seawater through each of the three traveling screen impingement stations at a given time were then determined from the number of circulating pumps in operation and the known flow rates of these pumps.

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7.4 SPECIES COMPOSITION AND OCCURRENCE OF IMPINGED FISHES AND INVERTEBRATES

The scientific and common names of all fishes and large invertebrate animals taken in impingement samples at stations 1, 4, 5, and 9 during the period February 4, 1979 - January 4, 1980 are given in Tables 7.4-1 and 7.4-2, respectively. Marine grasses and algae taken in these samples are considered separately in Section 7.11.

As shown in Table 7.4-1, the total number of fish species impinged during the 336-day period of sampling was 76. All of these species are known to occur either in Agua Hedionda Lagoon or in the coastal ocean area adjacent to the Encina Power Plant, as indicated by information considered in Sections 6.2 and 6.5 of this report.

Only one species, the longfin sanddab (Citharichthys xanthostigma), was unexpected in the impingement samples, because it occurs in relatively deep water (> 30 m). However, it was represented in the samples by only five individuals. Somewhat unexpected was the occurrence of the California flying fish (Cypselurus californicus), of which 31 individuals were taken during the 336-day sampling period. This pelagic species normally occurs in coastal ocean areas, but its presence in the impingement samples indicates clearly that it sometimes enters Agua Hedionda Lagoon.

As indicated in Table 7.4-2, the total number of large invertebrate species taken in the impingement samples was 45. Most

TABLE 7.4-1
SPECIES OF FISHES TAKEN IN IMPINGEMENT SAMPLES AT THE ENCINA POWER PLANT DURING THE PERIOD JANUARY 1979 - JANUARY 1980

Scientific Name	Common Name
Alloclinus holderi	Island kelpfish
Amphistichus argenteus	Barred surfperch
Anchoa compressa	Deepbody anchovy
Anchoa delicatissima	Slough anchovy
Anisotremus davidsonii	Sargo
Atherinops affinis	Topsmelt
Atherinopsis californiensis	Jacksmelt
Brachyistius frenatus	Kelp surfperch
Chromis punctipinnis	Blacksmith
Citharichthys stigmaeus	Speckled sanddab
Citharichthys xanthostigma	Longfin sanddab
Clupea harengus	Pacific herring
Cymatogaster aggregata	Shiner surfperch
Cymatogaster gracilis	Island surfperch
Cynoscion nobilis	White seabass
Cypselurus californicus	California flying fish
Damalichthys vacca	Pile surfperch
Decapterus hypodus	Mexican scad
Dorosoma petenense	Threadfin shad
Embiotoca jacksoni	Black surfperch
Engraulis mordax	Northern anchovy
Fundulus parvipinnis	California killifish
Genyonemus lineatus	White croaker
Gibbonsia metzi	Striped kelpfish
Girella nigricans	Opaleye
Gymnothorax mordax	Moray eel
Gymnura marmorata	California butterfly ray
Hermosilla azurea	Zebra perch
Heterodontus francisci	Horn shark

TABLE 7.4-1 (Continued)

Scientific Name	Common Name
Heterostichus rostratus	Giant kelpfish
Hyperprosopon argenteum	Walleye surfperch
Hypsoblennius gilberti	Rockpool blenny
Hypsoblennius jenkinsi	Mussel blenny
Hypsopsetta guttulata	Diamond turbot
Hypsypops rubicundus	Garibaldi
Leptocottus armatus	Staghorn sculpin
Leuresthes tenuis	California grunion
Medialuna californiensis	Halfmoon
Menticirrhus undulatus	California corbina
Micrometrus minimus	Dwarf surfperch
Mugil cephalus	Striped mullet
Mustelus californicus	Gray smoothhound
Myliobatis californica	Bat ray
Oligocottus rubellio	Rosy sculpin
Ophichthus zophochir	Yellow snake eel
Paralabrax clathratus	Kelp bass
Paralabrax maculatotasciatus	Spotted sand bass
Paralabrax nebulifer	Barred sand bass
Paralichthys californicus	California halibut
Peprilus simillimus	Pacific butterfish
Phanerodon furcatus	White surfperch
Platyrhinoidis triseriata	Thornback ray
Pleuronichthys ritteri	Spotted turbot
Porichthys notatus	Plainfin midshipman
Porichthys myriaster	Specklefin midshipman
Rhacochilus toxotes	Rubberlip surfperch
Rhinobatos productus	Shovelnose guitarfish
Roncador stearnsii	Spotfin croaker

TABLE 7.4-1 (Concluded)

Scientific Name	Common Name
Sarda chiliensis	Pacific bonito
Scomberomorus concolor	Monterey Spanish mackerel
Scorpaena guttata	Sculpin/spotted scorpionfish
Seriphus politus	Queenfish
Sphyraena argentea	California barracuda
Squatina californica	Pacific angel shark
Strongylura exilis	California needlefish
Symphurus atricauda	California tonguefish
Syngnathus californiensis	Kelp pipefish
Syngnathus leptorhynchus	Bay pipefish
Torpedo californica	Pacific electric ray
Trachurus symmetricus	Jack mackerel
Triakis semifasciata	Leopard shark
Umbrina roncador	Yellowfin croaker
Urolophus halleri	Round stingray
Xenistius californiensis	Salema
Xystreurys liolepis	Fantail sole

TABLE 7.4-2
SPECIES OF LARGE MARINE INVERTEBRATE ANIMALS TAKEN IN IMPINGEMENT SAMPLES AT THE ENCINA POWER PLANT DURING THE PERIOD JANUARY 1979 - JANUARY 1980

Scientific Name	Common Name
Aeolidia papillosa	Nudibranch
Aequipecten aequisulcatus	Speckled scallop
Aglaophenia sp.	Hydroid
Alpheus dentipes	Pistol shrimp
Anthopleura elegantissima	Aggregate sea anemone
Aplysia californica	California sea hare
Balanus tintinnabulum	Red and white barnacle
Callianassa californiensis	Ghost shrimp
Cancer antennarius	Common rock crab
Cancer anthonyi	Anthony's rock crab
Cancer jordani	Jordan's rock crab
Cancer productus	Red rock crab
Chlamys hastatus	Pacific spear scallop
Crangon nigromaculata	Black spotted shrimp
Diaulula sandiegenesis	San Diego sea slug
Hemigrapsus nudus	Purple shore crab
Hermissenda crassicornis	Nudibranch
Hinnites multirugosus	Rock scallop
Loligo opalescens	Squid
Lovenia cordiformis	Sea porcupine
Loxorhynchus crispatus	Masking crab
Lysmata californica	Striped shrimp
Lytechinus pictus	Painted urchin
Megathura crenulata	Giant keyhole limpet
Molpadia arenicola	Sweet potato cucumber
Mytilus edulis	Bay mussel
Navanax inermis	Striped sea slug
Octopus bimaculatus	Two-spotted octopus

TABLE 7.4-2 (Concluded)

Scientific Name	Common Name
Octopus bimaculoides	Mud flat octopus
Pachygrapsus crassipes	Striped shore crab
Panulirus interruptus	California spiny lobster
Pelagia panopyra	Purple-striped jellyfish
Pelia tumida	Dwarf crab
Penaeus californiensis	California brown shrimp
Pentidotea rescata	Kelp isopod
Pilumnus spinohirsutus	Hairy crab
Pisaster ochraceus	Ochre starfish
Podochela hemphilli	Spider crab
Pollicipes polymerus	Pacific goose barnacle
Polyorchis penicillatus	Hydromedusa
Portunus xantusi	Swimming crab
Pugettia producta	Kelp crab
Pyromaia tuberculata	Spider crab
Strongylocentrotus purpuratus	Purple sea urchin
Taliepus nuttalli	Southern kelp crab

smaller forms, particularly those living attached to impinged marine plants, were not identified or considered in processing the samples because of time limitations. All of the species listed in Table 7.4-2 are relatively common in the area near the Power Plant and might be expected to be carried into the cooling water system.

Most are benthic species that inhabit unconsolidated sediment or rocky habitats either in Agua Hedionda Lagoon or in the adjacent nearshore ocean area. Only two large pelagic invertebrate species occurred in the samples. They are the squid (Loligo opalescens) and the purple-striped jellyfish (Pelagia panopyra), both common forms in coastal areas of southern California.

The numerical ranking of each animal species taken in samples at traveling screen stations 1, 4, and 5 is given in Table 7.4-3. Total numbers of individuals of each species and all species combined taken during the 336-day sampling period also are shown for each traveling screen station, and for the three stations combined.

As indicated in Table 7.4-3, 85,957 animals were taken in the impingement samples at stations 1, 4, and 5 during the 336-day period, of which 79,662 (92.7 percent) were fishes and only 6,281 (7.3 percent) were invertebrates. The largest total number of fishes was impinged at station 4 (39,509; 49.6 percent of total), the next largest at station 5 (25,037; 31.4 percent), and the smallest number at station 1 (15,116; 19.0 percent). Among

TABLE 7.4-3
NUMERICAL RANKING OF ALL ANIMAL SPECIES IMPINGED AT ENCINA POWER PLANT TRAVELING SCREEN STATIONS DURING THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

RANK	COMMON NAME	SPECIES NAME	TOTAL NUMBERS IMPINGED STATION 1	STATION 4	STATION 5	TOTAL
1	QUEENFISH	SERIPHUS POLITUS	3733	9685	5263	18681
2	DEEPBODY ANCHOVY	ANCHOA COMPRESSA	2400	5148	5751	13299
3	TOPSMELT	ATHERINOPS AFFINIS	996	6443	3476	10915
4	CALIFORNIA GRUNION	LEURESTHES TENUIS	2044	5284	1255	8583
5	NORTHERN ANCHOVY	ENGRAULIS MORDAX	972	4874	1588	7434
6	SHINER SURFPERCH	CYMATOGASTER AGGREGATA	1248	2724	2573	6545
7	ANTHONY'S ROCK CRAB	CANCER ANTHONYI	1766	287	487	2540
8	WALLEYE SURFPERCH	HYPERPROSOPON ARGENTEUM	687	537	653	1877
9	SLOUGH ANCHOVY	ANCHOA DELICATISSIMA	463	1020	275	1758
10	WHITE SURFPERCH	PHANERODON FURCATUS	939	423	389	1751
11	ROUND STINGRAY	UROLOPHUS HALLERI	357	562	707	1526
12	CALIFORNIA HALIBUT	PARALICHTHYS CALIFORNICUS	179	406	630	1215
13	GIANT KELPFISH	HETEROSTICHUS ROSTRATUS	254	639	153	1046
14	SWIMMING CRAB	PORTUNUS XANTUSI	315	137	432	884
15	STRIPED SHORE CRAB	PACHYGRAPSUS CRASSIPES	240	182	444	866
16	SALEMA	XENISTIUS CALIFORNIENSIS	87	394	57	538
17	SQUID	LOLIGO OPALESCENS	146	293	83	522
18	DIAMOND TURBOT	HYPSOPSETTA GUTTULATA	31	91	338	460
19	CALIFORNIA BARRACUDA	SPHYRAENA ARGENTEA	116	273	44	433
20	PACIFIC GOOSE BARNACLE	POLLICIPES POLYMERUS	206	55	143	404
21	SPECKLEFIN MIDSHIPMAN	PORICHTHYS MYRIASTER	49	94	219	362
22	PACIFIC BUTTERFISH	PEPRILUS SIMILLIMUS	7	32	244	283
23	STAGHORN SCULPIN	LEPTOCOTTUS ARMATUS	61	67	117	245
24	BAT RAY	MYLIOBATUS CALIFORNICA	29	41	159	229
25	CALIFORNIA BUTTERFLY RAY	GYMNURA MARMORATA	42	39	139	220
26	PENAEID SHRIMP	PENAEUS CALIFORNIENSIS	22	13	170	205
27	BARRED SAND BASS	PARALABRAX NEBULIFER	37	78	74	189
28	THORNBACK RAY	PLATYRHINOIDIS TRISERIATA	34	42	99	175
29	SARGO	ANISOTREMUS DAVIDSONII	30	84	58	172
30	RED AND WHITE BARNACLE	BALANUS TINTINNABULUM	88	28	46	162
31	WHITE CROAKER	GENYONEMUS LINEATUS	42	34	77	153
32	CALIFORNIA TONGUEFISH	SYMPHURUS ATRICAUDA	34	54	52	140
33	CALIFORNIA CORBINA	MENTICIRRHUS UNDULATUS	26	41	50	117
34	KELP CRAB	PUGETTIA PRODUCTA	39	24	46	109
35	BAY PIPEFISH	SYNGNATHUS LEPTORHYNCHUS	23	65	19	107
36	BARRED SURFPERCH	AMPHISTICHUS ARGENTEUS	24	29	30	83
37	SPOTTED SAND BASS	PARALABRAX MACULATOFASCIATUS	5	28	40	73
37	PILE SURFPERCH	DAMALICHTHYS VACCA	19	24	30	73
37	STRIPED MULLET	MUGIL CEPHALUS	4	13	56	73
38	TWO-SPOTTED OCTOPUS	OCTOPUS BIMACULATUS	20	16	35	71
39	BAY MUSSEL	MYTILUS EDULIS	39	13	14	66
40	OPALEYE	GIRELLA NIGRICANS	7	6	51	64
41	ANCHOVY	ANCHOA SP.	5	8	47	60
42	YELLOWFIN CROAKER	UMBRINA RONCADOR	4	20	31	55
42	PAINTED URCHIN	LYTECHINUS PICTUS	34	13	8	55
43	STRIPED SEA SLUG	NAVANAX INERMIS	15	5	29	49
43	GHOST SHRIMP	CALLIANASSA CALIFORNIENSIS	24	25	0	49
44	PURPLE SHORE CRAB	HEMIGRAPSUS NUDUS	17	8	19	44
45	CALIFORNIA NEEDLEFISH	STRONGYLURA EXILIS	7	15	19	41
45	BLACK SURFPERCH	EMBIOTOCA JACKSONI	20	4	17	41

TABLE 7.4-3 (Continued)

RANK	COMMON NAME	SPECIES NAME	TOTAL NUMBERS IMPINGED STATION 1	STATION 4	STATION 5	TOTAL
46	JACKSMELT	ATHERINOPSIS CALIFORNIENSIS	0	23	17	40
47	SWEET POTATO CUCUMBER	MOLPADIA ARENICOLA	9	2	25	36
48	COMMON ROCK CRAB	CANCER ANTENNARIUS	14	8	13	35
49	KELP BASS	PARALABRAX CLATHRATUS	9	15	10	34
50	SPOTFIN CROAKER	RONCADOR STEARNSII	1	8	24	33
51	KELP PIPEFISH	SYNGNATHUS CALIFORNIENSIS	8	8	16	32
52	CALIFORNIA FLYING FISH	CYPSELURUS CALIFORNICUS	7	13	11	31
52	HYDROMEDUSA	POLYORCHIS PENICILLATUS	20	5	6	31
53	SPOTTED TURBOT	PLEURONICHTHYS RITTERI	6	5	19	30
54	THREADFIN SHAD	DOROSOMA PETENENSE	0	4	24	28
55	BLACK SPOTTED SHRIMP	CRANGON NIGROMACULATA	18	3	6	27
56	WHITE SEABASS	CYNOSCION NOBILIS	6	10	9	25
56	MUSSEL BLENNY	HYPSOBLENNIUS JENKINSI	10	9	6	25
57	GRAY SMOOTHHOUND	MUSTELUS CALIFORNICUS	1	5	16	22
58	PACIFIC ELECTRIC RAY	TORPEDO CALIFORNICA	4	6	11	21
59	BLACKSMITH	CHROMIS PUNCTIPINNIS	1	6	13	20
60	CALIFORNIA SEA HARE	APLYSIA CALIFORNICA	9	0	9	18
61	ROCKPOOL BLENNY	HYPSOBLENNIUS GILBERTI	5	6	6	17
62	SPECKLED SCALLOP	AEQUIPECTEN AEQUISULCATUS	8	6	2	16
62	HYDROID	AGLAOPHENIA (COLONY OF HYDROIDEA	4	2	10	16
62	PURPLE SEA URCHIN	STRONGYLOCENTROTUS PURPURATUS	12	1	3	16
63	NUDIBRANCH	HERMISSENDA CRASSICORNIS	15	0	0	15
64	CALIFORNIA KILLIFISH	FUNDULUS PARVIPINNIS	3	10	1	14
65	BASS	PARALABRAX SP.	0	9	4	13
66	HALFMOON	MEDIALUNA CALIFORNIENSIS	0	10	2	12
66	ISLAND SURFPERCH	CYMATOGASTER GRACILIS	2	9	1	12
67	SOUTHERN KELP CRAB	TALIEPUS NUTTALLI	4	2	5	11
68	PLAINFIN MIDSHIPMAN	PORICHTHYS NOTATUS	9	0	1	10
68	ISLAND KELPFISH	ALLOCLINUS HOLDERI	4	4	2	10
68	MONTEREY SPANISH MACKERAL	SCOMBEROMORUS CONCOLOR	0	0	10	10
68		BIRDS*	0	5	5	10
69	PACIFIC BONITO	SARDA CHILIENSIS	7	0	2	9
70	MORAY EEL	GYMNOTHORAX MORDAX	4	3	1	8
70	RUBBERLIP SURFPERCH	RHACOCHILUS TOXOTES	1	0	7	8
71	SHOVELNOSE GUITARFISH	RHINOBATOS PRODUCTUS	2	0	5	7
71	KELP SURFPERCH	BRACHYISTIUS FRENATUS	1	0	6	7
71	BAY BLENNY	HYPSOBLENNIUS GENTILIS	1	4	2	7
71		LARVAL FISH	2	0	5	7
72	FANTAIL SOLE	XYSTREURYS LIOLEPIS	0	5	1	6
73	LONGFIN SANDDAB	CITHARICHTHYS XANTHOSTIGMA	0	5	0	5
73	PACIFIC SPEAR SCALLOP	CHLAMYS HASTATUS	3	0	2	5
73	HAIRY CRAB	PILUMNUS SPINOHIRSUTUS	3	1	1	5
73	PURPLE-STRIPED JELLYFISH	PELAGIA PANOPYRA	2	0	3	5
74	LEOPARD SHARK	TRIAKIS SEMIFASCIATA	0	0	4	4
74	PACIFIC HERRING	CLUPEA HARENGUS	0	0	4	4
74	SCULPIN/SPOTTED SCORPIONFISH	SCORPAENA GUTTATA	0	3	1	4
74	DWARF SURFPERCH	MICROMETUS MINIMUS	1	0	3	4
74	SPECKLED SANDDAB	CITHARICHTHYS STIGMAEUS	3	0	1	4
75	HORN SHARK	HETERODONTUS FRANCISCI	0	0	3	3

TABLE 7.4-3 (Concluded)

RANK	COMMON NAME	SPECIES NAME	TOTAL NUMBERS IMPINGED STATION 1	STATION 4	STATION 5	TOTAL
75	YELLOW SNAKE EEL	OPHICHTHUS ZOPHOCHIR	0	0	3	3
75	JACK MACKERAL	TRACHURUS SYMMETRICUS	0	0	3	3
75	STRIPED KELPFISH	GIBBONSIA METZI	0	3	0	3
75	SPIDER CRAB	PYROMAIA TUBERCULATA	0	0	3	3
75	AGGREGATE SEA ANENOME	ANTHOPLEURA ELEGANTISSIMA	3	0	0	3
76	PACIFIC ANGEL SHARK	SQUATINA CALIFORNICA	0	1	1	2
76	MEXICAN SCAD	DECAPTERUS HYPODUS	0	2	0	2
76	ZEBRAPERCH	HERMOSILLA AZUREA	0	2	0	2
76	GARIBALDI	HYPSYPOPS RUBICUNDUS	0	0	2	2
76		SQUIRRELS*	0	0	2	2
76	GIANT KEYHOLE LIMPET	MEGATHURA CRENULATA	2	0	0	2
76	CALIFORNIA SPINY LOBSTER	PANULIRUS INTERRUPTUS	2	0	0	2
76	MASKING CRAB	LOXORHYNCHUS CRISPATUS	2	0	0	2
77	ROSY SCULPIN	OLIGOCOTTUS RUBELLIO	1	0	0	1
77		MICE*	1	0	0	1
77		RATS*	0	0	1	1
77	SAN DIEGO SEA SLUG	DIAULULA SANDIEGENESIS	1	0	0	1
77	NUDIBRANCH	AEOLIDIA PAPILLOSA	0	0	1	1
77	STRIPED SHRIMP	LYSMATA CALIFORNICA	1	0	0	1
77	PISTOL SHRIMP	ALPHEUS DENTIPES	0	0	1	1
77	SPIDER CRAB	PODOCHELA HEMPHILLI	1	0	0	1
77	RED ROCK CRAB	CANCER PRODUCTUS	1	0	0	1
77	OCHRE STARFISH	PISASTER OCHRACEUS	0	0	1	1
77	SEA PORCUPINE	LOVENIA CORDIFORMIS	0	0	1	1
77	BRITTLE STARS	OPHIUROIDEA	1	0	0	1
		TOTAL FISHES	15,116	39,509	25,037	79,662
		TOTAL INVERTEBRATES	3,104	1,129	2,048	6,281
		TOTAL TERRESTRIAL ANIMALS	1	5	8	14
		TOTAL ANIMALS	18,221	40,643	27,093	85,957

*Dead terrestrial animals impinged.

invertebrates, the largest total number was impinged at station 1 (3,104; 49.4 percent), the next largest at station 5 (2,048; 32.6 percent), and the smallest number at station 4 (1,129; 18.0 percent).

Based on the numerical rankings and numbers of individuals shown in Table 7.4-3, and on considerations described in Section 6.3, 22 species of fishes were treated as critical species for the impingement study. These include all of the 15 forms designated as critical species in Section 6.3 (Table 6.3-1). They are, in decreasing order of abundance in the samples:

Common Name	Species Name
Queenfish	*Seriphus politus*
Topsmelt	*Atherinops affinis*
Northern anchovy	*Engraulis mordax*
Walleye surfperch	*Hyperprosopon argenteum*
California halibut	*Paralichthys californicus*
Giant kelpfish	*Heterostichus rostratus*
Barred sand bass	*Paralabrax nebulifer*
California corbina	*Menticirrhus undulatus*
Barred surfperch	*Amphisticus argenteus*
Spotted sand bass	*Paralabrax maculatofasciatus*
Striped mullet	*Mugil cephalus*
Kelp bass	*Paralabrax clathratus*
White sea bass	*Cynoscion nobilis*

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California sheephead	Pimelometopon pulchrum
Pacific sanddab	Citharichthys sordidus
Hornyhead turbot	Pleuronichthys verticalis

Seven other fish species represented in the impingement samples by a total of more than 500 individuals during the 336-day sampling period (Table 7.4-3) were treated as additional critical species for purposes of the impingement study. They are, in decreasing order of abundance:

Common Name	Species Name
Deepbody anchovy	Anchoa compressa*
California grunion	Leuresthes tenuis*
Shiner surfperch	Cymatogaster aggregata*
Slough anchovy	Anchoa delicatissima*
White surfperch	Phanerodon furcatus
Round stingray	Urolophus halleri*
Salema	Xenistius californiensis

Five of these seven, indicated by asterisks, also were treated as critical species for the nekton studies, as described in Section 6.3 of this report.

Data for these 22 critically treated species of fishes have been considered in greater detail than those for the remaining 57 species. In some cases, however, as described in the following subsections concerning impingement, there were insufficient data to allow detailed treatment.

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Shown in Table 7.4-4 are the numerical rankings and percentages of occurrence for each of these 22 critical species. The values shown separately for each impingement station and for all stations combined are based on the total number of individuals of each species taken during the 336-day sampling period (Table 7.4-3), expressed as percentages of the total number of all fishes taken in that set of samples.

The data shown in Tables 7.4-3 and 7.4-4 indicate that the queenfish (Seriphus politus) had by far the highest level of impingement at the traveling screen stations (18,681 individuals; 23.4 percent of all fishes). The deepbody anchovy (Anchoa compressa) experienced the second highest level of impingement (13,299 individuals; 16.7 percent), the topsmelt (Atherinops affinis) the third highest level, and the California grunion (Leuresthes tenuis) the fourth highest level (8,583 individuals; 10.8 percent). Two species, the northern anchovy (Engraulis mordax) and the shiner surfperch (Cymatogaster aggregata) experienced the next highest levels of impingement that were essentially the same (9.3 and 9.2 percent, respectively).

All six of these highest ranking species are very abundant in the area near the Encina Power Plant, as described in Sections 6.2 and 6.5 of this report. Because of this, their relatively high levels of impingement are not surprising. Examination of impingement monitoring records obtained by SDG&E during the period 1972-1978 (see Section 7.3) indicated that, in general,

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TABLE 7.4-4
NUMERICAL RANKING AND PERCENTAGES OF OCCURRENCE IN IMPINGEMENT SAMPLES AT STATIONS 1, 4 AND 5 FOR CRITICALLY TREATED FISH SPECIES
ENCINA POWER PLANT - AUGUST 1, 1980

Rank	Common Name	Species Name	PERCENT OCCURRENCE Station 1	Station 4	Station 5	All Stations
1	Queenfish	*Seriphus politus* (C)	24.7	24.5	21.0	23.4
2	Deepbody anchovy	*Anchoa compressa* (AC)	15.9	13.0	23.0	16.7
3	Topsmelt	*Atherinops affinis* (C)	5.6	16.3	13.9	13.7
4	California grunion	*Leuresthes tenuis* (AC)	13.5	13.4	5.0	10.8
5	Northern anchovy	*Engraulis mordax* (C)	5.4	12.3	5.3	9.3
6	Shiner surfperch	*Cymatogaster aggregata* (AC)	9.3	5.9	10.3	9.2
8	Walleye surfperch	*Hyperprosopon argenteum* (C)	4.5	1.4	2.6	2.4
9	Slough anchovy	*Anchoa delicatissima* (AC)	3.1	2.6	1.1	2.2
10	White surfperch	*Phanerodon furcatus* (AC)	5.2	1.1	1.5	2.2
11	Round stingray	*Urolophus halleri* (AC)	2.4	1.5	2.8	2.0
12	California halibut	*Paralichthys californicus* (C)	1.2	1.0	2.5	1.5
13	Giant kelpfish	*Heterostichus rostratus* (C)	1.7	1.6	0.5	1.3
16	Salema	*Xenistius californiensis* (AC)	0.6	1.0	0.2	0.7
27	Barred sand bass	*Paralabrax nebulifer* (C)	0.2	0.2	0.3	0.2
33	California corbina	*Menticirrhus undulatus* (C)	0.2	0.1	0.2	0.2
36	Barred surfperch	*Amphistichus argenteus* (C)	0.2	0.1	0.1	0.1
36	Spotted sand bass	*Paralabrax maculatofasciatus* (C)	0.03	0.1	0.2	0.1
37	Striped mullet	*Mugil cephalus* (C)	0.03	0.03	0.2	0.1
49	Kelp bass	*Paralabrax clathratus* (C)	0.1	0.04	0.04	0.04
56	White seabass	*Cynoscion nobilis* (C)	0.04	0.03	0.04	0.03
	California sheephead	*Pimelometopon pulchrum* (C)	0	0	0	0
	Pacific sanddab	*Citharicthys sordidus* (C)	0	0	0	0
	Hornyhead turbot	*Pleuronichthys verticalis* (C)	0	0	0	0

these same groups of fishes also had the highest levels of impingement during the previous six-year period.

The six species ranking next highest in impingement had considerably lower, similar levels ranging from 1,877 individuals (2.4 percent of all fishes) for the walleye surfperch (Hyperprosopon argenteum) to 1,046 individuals (1.3 percent) for the giant kelpfish (Heterostichus rostratus). All of the remaining species had levels of impingement that represented less than 1.0 percent of the total number of all fishes impinged during the 336-day sampling period.

Among the 12 species exhibiting levels of impingement greater than 1.0 percent, only three are bottom fishes (Tables 7.4-3 and 7.4-4). They are the round stingray (Urolophus halleri), the California halibut (Paralichthys californicus), and the giant kelpfish (Heterostichus rostratus). The other nine species are all relatively active, open water forms. They are also the nine highest ranking species in terms of levels of impingement (Table 7.4-3).

Seven of the critical species had levels of impingement less than 0.2 percent ($\leq$ 189 individuals), as shown in Tables 7.4-3 and 7.4-4. These species are:

Common Name	Species Name
Barred sand bass	Paralabrax nebulifer
California corbina	Menticirrhus undulatus
Barred surfperch	Amphistichus argenteus
Spotted sand bass	Paralabrax maculatofasciatus

Striped mullet	*Mugil cephalus*
Kelp bass	*Paralabrax clathratus*
White sea bass	*Cynoscion nobilis*

No individuals of the three remaining critical species were taken in any of the impingement samples during the 336-day period of the study (Table 7.4-4). These species are:

Common Name	Species Name
California sheephead	*Pimelometopon pulchrum*
Pacific sanddab	*Citharichthys sordidus*
Hornyhead turbot	*Pleuronichthys verticalis*

Their absence from the impingement samples is not surprising, because they are unlikely to occur in the immediate vicinity of the Power Plant. Pacific sanddab normally occurs at depths greater than 30 m in the ocean. Because they were absent from all impingement samples, these three species were not considered in the following subsections concerning impingement.

As shown in Table 7.4-4, there was some variation in the percentage of individuals of a given species impinged by the three different traveling screen systems (stations 1, 4, and 5). However, in general, the levels were fairly consistent between the three stations. There appears to be no pattern to these variations shown in Table 7.4-4 and they are presumed to be the result of random processes.

As indicated in Table 7.4-3, four large invertebrate species ranked relatively high in levels of impingement, with more than

500 individuals of each occurring in all samples during the 336-day period of the study. Anthony's rock crab (Cancer anthonyi) had by far the highest level of impingement (1,877 individuals, 40.4 percent of all large invertebrates impinged). However, in relation to all invertebrate and fish species taken in the impingement samples, Anthony's rock crab ranked seventh at 2.2 percent. Most of the individuals impinged were juveniles or small adults. Anthony's rock crab is of very slight commercial importance in the San Diego area. Two smaller crabs, Portunus xantusi and Pachygrapsus crassipes, had approximately equal levels of impingement (14.1 and 13.8 percent, respectively). These two species, which have no commercial or sportfishing value, are very common in Agua Hedionda Lagoon. A fourth species, the squid Loligo opalescens, represented 9.3 percent of the invertebrates impinged, but only 0.5 percent of all invertebrates and fishes combined (numerical rank 17). This species supports a commercial fishery elsewhere in California.

Three other invertebrate species of value to man as food ranked much lower in their levels of impingement (Table 7.4-3). The California brown shrimp (Penaeus californiensis) ranked twenty-sixth, representing only 3.2 percent of all large invertebrates impinged. The common rock crab (Cancer antennarius) ranked forty-eighth, representing only 0.6 percent of all large invertebrates. The California spiny lobster (Panulirus interruptus) ranked seventy-sixth, with only two individuals (0.03 percent) impinged during the 336-day period of the study.

In general, these results suggest that invertebrates formed a very small part of the animal material impinged at the Encina Power Plant. Because of this, they were not included in the more detailed evaluation described in the following subsections concerning impingement.

The numerical ranking, total number, and size data for each fish species taken at the bar rack screening system (station 9) during the period February 4, 1979 - January 4, 1980 are shown in Table 7.4-5. No large invertebrates were observed in these samples.

Only 22 individuals of 6 fish species were observed in the bar rack samples (Table 7.4-5). Of these, the Pacific electric ray (Torpedo californica) was the only common form (16 individuals; 72.7 percent of the total). The next most common species observed was the bat ray (Myliobatis californica), of which two individuals were observed (9.1 percent). With the exception of one large spotfin croaker (Roncador stearnsi), all of the species observed were rays or sharks (elasmobranch fishes).

All individuals were quite large, with a size range of 380-1200 mm in total length and individual body weights up to 34.7 kg. Because of the wide spacing of the vertical bars in the bar rack screening system, impingement of fishes was, as expected, limited to very few individuals of large size.

Shown in Table 7.4-6 is the ranking by weight of each fish and invertebrate species taken in samples at traveling screen stations 1, 4, and 5. Total weights (g) for all individuals

TABLE 7.4-5

NUMERICAL RANKING OF LARGE FISH SPECIES IMPINGED AT THE BAR RACK SCREENING SYSTEM OF THE ENCINA POWER PLANT DURING THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

Rank	Common Name	Scientific Name	Number Observed	Total Length (mm) $\bar{x}$	Total Length (mm) Range	Weight (g) $\bar{x}$	Weight (g) Range
1	Pacific electric ray	*Torpedo californica*	16	1015	650-1200	10584	6600-34700
2	Bat ray	*Myliobatis californica*	2	812	805-820	2250	2000-2500
3	California butterfly ray	*Gymnura marmorata*	1	380		1754	
3	Thornback ray	*Platyrhinoidis triseriata*	1	510		735	
3	Spotfin croaker	*Roncador stearnsi*	1	708		3630	
3	Pacific angel shark	*Squatina californica*	1	1130		14500	

TOTAL - 22

TABLE 7.4-6

RANKING BY WEIGHT OF ALL FISH AND INVERTEBRATE SPECIES IMPINGED AT ENCINA POWER PLANT TRAVELING SCREEN STATIONS DURING THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

RANK	COMMON NAME	SCIENTIFIC NAME	TOTAL WEIGHT STATION 1	TOTAL WEIGHT STATION 4	TOTAL WEIGHT STATION 5	TOTAL
1	ROUND STINGRAY	UROLOPHUS HALLERI	40178	48384	97334	185896
2	PACIFIC ELECTRIC RAY	TORPEDO CALIFORNICA	15316	23470	87114	125900
3	TOPSMELT	ATHERINOPS AFFINIS	8587	44158	59595	112340
4	QUEENFISH	SERIPHUS POLITUS	13615	28646	49053	91314
5	SPECKLEFIN MIDSHIPMAN	PORICHTHYS MYRIASTER	7484	19694	51554	78732
6	CALIFORNIA BUTTERFLY RAY	GYMNURA MARMORATA	6164	9512	50448	66124
7	DEEPBODY ANCHOVY	ANCHOA COMPRESSA	14002	20506	29815	64323
8	CALIFORNIA HALIBUT	PARALICHTHYS CALIFORNICUS	5924	13694	37510	57128
9	DIAMOND TURBOT	HYPSOPSETTA GUTTULATA	3998	9812	42736	56546
10	BAT RAY	MYLIOBATUS CALIFORNICA	7352	9034	40042	56428
11	SHINER SURFPERCH	CYMATOGASTER AGGREGATA	9583	19516	24159	53258
12	WALLEYE SURFPERCH	HYPERPROSOPON ARGENTEUM	9860	14212	26333	50405
13	THORNBACK RAY	PLATYRHINOIDIS TRISERIATA	5284	8980	33886	48150
14	STRIPED MULLET	MUGIL CEPHALUS	2172	10904	31654	44730
15	TWO-SPOTTED OCTOPUS	OCTOPUS BIMACULATUS	10332	11298	19554	41184
16	ANTHONY'S ROCK CRAB	CANCER ANTHONYI	23542	4609	7057	35208
17	CALIFORNIA GRUNION	LEURESTHES TENUIS	7162	15922	10686	33770
18	CALIFORNIA SEA HARE	APLYSIA CALIFORNICA	10320	0	10460	20780
19	MORAY EEL	GYMNOTHORAX MORDAX	6400	170	13620	20190
20	OPALEYE	GIRELLA NIGRICANS	390	98	17522	18010
21	WHITE SURFPERCH	PHANERODON FURCATUS	6516	4525	5950	16991
22	SPOTFIN CROAKER	RONCADOR STEARNSII	2518	2516	11520	16554
23	BARRED SAND BASS	PARALABRAX NEBULIFER	3088	3314	8907	15309
24	GIANT KELPFISH	HETEROSTICHUS ROSTRATUS	2719	7376	4817	14912
25	NORTHERN ANCHOVY	ENGRAULIS MORDAX	2290	7280	5003	14573
26	PENAEID SHRIMP	PENAEUS CALIFORNIENSIS	1928	968	11376	14272
27	GRAY SMOOTHHOUND	MUSTELUS CALIFORNICUS	652	922	11710	13284
28	SQUID	LOLIGO OPALESCENS	3180	6791	2795	12766
29	SWIMMING CRAB	PORTUNUS XANTUSI	3576	1470	5982	11028
30	SPOTTED SAND BASS	PARALABRAX MACULATOFASCIATUS	1240	2496	7121	10857
31	CALIFORNIA CORBINA	MENTICIRRHUS UNDULATUS	136	1013	8114	9263
32	CALIFORNIA FLYING FISH	CYPSELURUS CALIFORNICUS	1444	2540	4034	8018
33	PACIFIC BUTTERFISH	PEPRILUS SIMILLIMUS	302	1305	6401	8008
34	CALIFORNIA NEEDLEFISH	STRONGYLURA EXILIS	1062	2164	4594	7820
35	JACKSMELT	ATHERINOPSIS CALIFORNIENSIS	0	3190	3786	6976
36	STRIPED SHORE CRAB	PACHYGRAPSUS CRASSIPES	2318	2170	1905	6393
37	WHITE CROAKER	GENYONEMUS LINEATUS	266	950	4845	6061
38	PILE SURFPERCH	DAMALICHTHYS VACCA	21	374	5504	5899
39	SARGO	ANISOTREMUS DAVIDSONII	188	2692	2276	5156
40	STAGHORN SCULPIN	LEPTOCOTTUS ARMATUS	1478	1562	2113	5153
41	CALIFORNIA BARRACUDA	SPHYRAENA ARGENTEA	1367	2178	690	4235
42	SLOUGH ANCHOVY	ANCHOA DELICATISSIMA	1548	1662	896	4106
43	BLACK SURFPERCH	EMBIOTOCA JACKSONI	792	820	1954	3566
44	YELLOW SNAKE EEL	OPHICHTHUS ZOPHOCHIR	0	0	2944	2944
45	SHOVELNOSE GUITARFISH	RHINOBATOS PRODUCTUS	1610	0	974	2584
46	PACIFIC BONITO	SARDA CHILIENSIS	1490	0	886	2376
47	SPOTTED TURBOT	PLEURONICHTHYS RITTERI	480	394	1432	2306
48	BLACKSMITH	CHROMIS PUNCTIPINNIS	48	248	1958	2254
49	SALEMA	XENISTIUS CALIFORNIENSIS	575	1047	622	2244
50	PLAINFIN MIDSHIPMAN	PORICHTHYS NOTATUS	2144	0	[illegible]	[illegible]

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TABLE 7.4-6 (Continued)

RANK	COMMON NAME	SCIENTIFIC NAME	TOTAL WEIGHT STATION 1	STATION 4	STATION 5	TOTAL
51	CALIFORNIA TONGUEFISH	SYMPHURUS ATRICAUDA	460	784	888	2132
52	RUBBERLIP SURFPERCH	RHACOCHILUS TOXOTES	10	0	1952	1962
53	SWEET POTATO CUCUMBER	MOLPADIA ARENICOLA	880	236	739	1855
54	BARRED SURFPERCH	AMPHISTICHUS ARGENTEUS	183	572	1098	1853
55	KELP CRAB	PUGETTIA PRODUCTA	600	360	838	1798
56	STRIPED SEA SLUG	NAVANAX INERMIS	734	92	884	1710
57	YELLOWFIN CROAKER	UMBRINA RONCADOR	24	264	1316	1604
58	PURPLE-STRIPED JELLYFISH	PELAGIA PANOPYRA	1288	0	96	1384
59	PAINTED URCHIN	LYTECHINUS PICTUS	905	230	190	1325
60	ZEBRAPERCH	HERMOSILLA AZUREA	0	1200	0	1200
61	BASS	PARALABRAX SP.	0	156	928	1084
62	LEOPARD SHARK	TRIAKIS SEMIFASCIATA	0	0	996	996
63	FANTAIL SOLE	XYSTREURYS LIOLEPIS	0	388	264	652
64	PURPLE SHORE CRAB	HEMIGRAPSUS NUDUS	222	92	294	608
65	COMMON ROCK CRAB	CANCER ANTENNARIUS	271	160	176	607
66	BAY PIPEFISH	SYNGNATHUS LEPTORHYNCHUS	302	194	108	604
67	MEXICAN SCAD	DECAPTERUS HYPODUS	0	556	0	556
68	CALIFORNIA SPINY LOBSTER	PANULIRUS INTERRUPTUS	506	0	0	506
69	KELP BASS	PARALABRAX CLATHRATUS	118	222	162	502
70	KELP PIPEFISH	SYNGNATHUS CALIFORNIENSIS	68	56	318	442
71	MONTEREY SPANISH MACKERAL	SCOMBEROMORUS CONCOLOR	0	0	416	416
72	CALIFORNIA KILLIFISH	FUNDULUS PARVIPINNIS	18	381	12	411
73	GARIBALDI	HYPSYPOPS RUBICUNDUS	0	0	400	400
74	THREADFIN SHAD	DOROSOMA PETENENSE	0	86	300	386
75	HYDROID	AGLAOPHENIA (COLONY OF HYDROIDEA)	64	38	272	374
76	ISLAND SURFPERCH	CYMATOGASTER GRACILIS	26	206	126	358
77	SOUTHERN KELP CRAB	TALIEPUS NUTTALLI	166	14	160	340
78	PACIFIC ANGEL SHARK	SQUATINA CALIFORNICA	0	130	164	294
79	SCULPIN/SPOTTED SCORPIONFISH	SCORPAENA GUTTATA	0	286	0	286
80	HYDROMEDUSA	POLYORCHIS PENICILLATUS	131	129	17	277
81	PURPLE SEA URCHIN	STRONGYLOCENTROTUS PURPURATUS	120	0	150	270
82	JACK MACKERAL	TRACHURUS SYMMETRICUS	0	0	244	244
83	MUSSEL BLENNY	HYPSOBLENNIUS JENKINSI	24	74	130	228
84	WHITE SEABASS	CYNOSCION NOBILIS	48	88	90	226
85	ISLAND KELPFISH	ALLOCLINUS HOLDERI	52	74	76	202
86	PACIFIC HERRING	CLUPEA HARENGUS	0	0	164	164
87	ROCKPOOL BLENNY	HYPSOBLENNIUS GILBERTI	72	44	34	150
88	ANCHOVY	ANCHOA SP.	24	6	96	126
89	GHOST SHRIMP	CALLIANASSA CALIFORNIENSIS	51	72	0	123
90	GIANT KEYHOLE LIMPET	MEGATHURA CRENULATA	122	0	0	122
91	DWARF SURFPERCH	MICROMETUS MINIMUS	12	0	108	120
92	KELP SURFPERCH	BRACHYISTIUS FRENATUS	6	0	112	118
93	BLACK SPOTTED SHRIMP	CRANGON NIGROMACULATA	76	10	30	116
94	STRIPED KELPFISH	GIBBONSIA METZI	0	104	0	104
95	SEA PORCUPINE	LOVENIA CORDIFORMIS	0	0	88	88
96	HAIRY CRAB	PILUMNUS SPINOHIRSUTUS	68	18	0	86
97	LONGFIN SANDDAB	CITHARICHTHYS XANTHOSTIGMA	0	82	0	82
97	HORN SHARK	HETERODONTUS FRANCISCI	0	0	74	74
98	SPECKLED SANDDAB	CITHARICHTHYS STIGMAEUS	48	0	26	74
99	HALFMOON	MEDIALUNA CALIFORNIENSIS	0	42	10	52

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TABLE 7.4-6 (Concluded)

RANK	COMMON NAME	SCIENTIFIC NAME	TOTAL WEIGHT STATION 1	STATION 4	STATION 5	TOTAL
100	RAY BLENNY	HYPSOBLENNIUS GENTILIS	24	10	6	40
101	SPIDER CRAB	PYROMAIA TUBERCULATA	0	0	32	32
102	ROSY SCULPIN	OLIGOCOTTUS RUBELLIO	26	0	0	26
103	RED ROCK CRAB	CANCER PRODUCTUS	18	0	0	18
104	AGGREGATE SEA ANEMONE	ANTHOPLEURA ELEGANTISSIMA	12	0	0	12
105	NUDIBRANCH	HERMISSENDA CRASSICORNIS	10	0	0	10
105	PISTOL SHRIMP	ALPHEUS DENTIPES	0	0	10	10
106	PACIFIC SPEAR SCALLOP	CHLAMYS HASTATUS	0	0	8	8
107	MASKING CRAB	LOXORHYNCHUS CRISPATUS	6	0	0	6
108	NUDIBRANCH	AEOLIDIA PAPILLOSA	0	0	4	4
108	OCHRE STARFISH	PISASTER OCHRACEUS	0	0	4	4
108	SAN DIEGO SEA SLUG	DIAULULA SANDIEGENSIS	4	0	0	4
108	SPECKLED SCALLOP	AEQUIPECTEN AEQUISULCATUS	2	2	0	4
108	SPIDER CRAB	PODOCHELA HEMPHILLI	4	0	0	4
108	STRIPED SHRIMP	LYSMATA CALIFORNICA	4	0	0	4
109	BRITTLE STARS	OPHIUROIDEA	2	0	0	2
		TOTAL WEIGHT OF FISHES (kg)	199.1	353.3	842.8	1395.2
		TOTAL WEIGHT OF INVERTEBRATES (kg)	61.4	28.7	63.1	153.2
		TOTAL WEIGHT OF ANIMALS (kg)	260.5	382.0	905.9	1548.4

of each species taken during the 336-day sampling period are shown for each traveling screen station and for the three stations combined. Also shown are total weights, rounded to the nearest 0.1 kg, for all fish species, all invertebrate species, and all animal material combined.

As indicated in Table 7.4-6, many of these rankings by weight differed considerably from those based on numbers of individuals impinged (Tables 7.4-3 and 7.4-4). The round stingray (Urolophus halleri) and the Pacific electric ray (Torpedo californica) ranked first and second based on total weights of animal material impinged. The total weight of round stingray impinged was 185.9 kg (410 lb) or 13.3 percent of all fishes by weight. The total weight of Pacific electric ray impinged was 125.9 kg (227.6 lb) or 9.0 percent of all fishes by weight. In contrast, they ranked only eleventh and fifty-eighth, respectively, based on numbers impinged. These and other large, heavy-bodied rays were prominent in the higher rankings based on weight, with the California butterfly ray (Myliobatis californica) among the first ten.

The topsmelt (Atherinops affinis) ranked third both in number and weight of individuals impinged (Tables 7.4-3 and 7.4-6). Its total weight of 112.3 kg (247.6 lb) represented 8.0 percent of all fishes by weight. The queenfish (Seriphus politus), which ranked first in numbers of individuals impinged, also has a high rank of fourth in terms of weight. Its total weight of 91.3 kg (201.3 lb) represented 6.5 percent of all fishes by weight. Among the other species ranked within the first ten on the basis of numbers impinged, only the deepbody anchovy (Anchoa compressa) also was ranked within that range on the basis of weight. It was ranked second by number impinged and seventh by weight. However, several of the other species ranked within the first ten by number impinged (Table 7.4-3) did fall within the first 20 ranks by weight (Table 7.4-6). They are the shiner surfperch (Cymatogaster aggregata) ranked eleventh by weight, the walleye surfperch (Hyperprosopon argenteum) ranked twelfth by weight, and the California grunion (Leuresthes tenuis) ranked seventeenth by weight.

The specklefin midshipman (Porichthys myriaster) also was a major component by weight (rank 5). Yet this species was ranked only twenty-first on the basis of numbers impinged. Two large invertebrate species ranked relatively high in terms of weight. They are the two-spotted octopus (Octopus bimaculatus) ranked fifteenth, and Anthony's rock crab (Cancer anthonyi) ranked sixteenth. In contrast, Anthony's rock crab was ranked seventh by number impinged and two-spotted octopus was ranked only thirty-eighth. Both species were periodically quite common in the study area, and their occurrence as major invertebrate components of the impingement samples is not surprising.

As indicated in Table 7.4-6, the total weight of all animal material impinged at the three traveling screen stations during sampling over the 336-day period was 1548.4 kg (3414 lb). Of this material, 1395.2 kg (3076 lb) consisted of fishes and 153.2

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kg (338 lb) of large invertebrates. Thus, fishes accounted for 90.1 percent of this material and invertebrates only 9.9 percent. The highest weight of animals was impinged at traveling screen station 5 (842.8 kg or 18,158 lb of fishes; 63.1 kg or 139 lb of invertebrates). The second highest weight of animals was impinged at station 4 (353.3 kg or 779 lb of fishes; 28.7 kg or 63 lb of invertebrates), and the lowest weight of animals was impinged at station 1 (199.1 kg or 439 lb of fishes; 61.4 kg or 135 lb of invertebrates).

These weights are somewhat lower than the true amounts impinged during the period February 4, 1979 - January 4, 1980, because sampling could not be completed on all days and because some badly damaged animals were not weighed. These data also exclude the weights of fishes removed during tunnel recirculation. However, they represent reasonably accurate estimates for total weights of material impinged.

7.5 VARIATIONS IN NUMBER AND BIOMASS OF FISHES IMPINGED IN RELATION TO ENVIRONMENTAL FACTORS

Short- and long-term fluctuations in numbers and biomass of fishes impinged during the 48-week study period are considered in this section, with emphasis on the critical species identified in Section 7.4. The possible influences of major environmental factors on impingement also are considered. These factors are water temperature, salinity, wave conditions, wind speed, storms and rainfall, cloud cover, and dredging operations in outer Agua Hedionda Lagoon. Possible effects on impingement of day vs. night conditions, tidal conditions, and flow rates in the cooling water system are considered separately in Sections 7.6, 7.7, and 7.8, respectively.

Plots of mean total number and mean total weight of all fishes impinged at traveling screen station 1 per 24-hr interval over the period February 4, 1979-January 4, 1980 are shown in Figures 7.5-1 and 7.5-2, respectively. These mean values are based on data taken during each 7-day sampling interval. Also shown on these same figures for comparison is a plot of mean water temperatures for each of the same 7-day periods. Plots of these impingement data for traveling screen station 4 are given in Figures 7.5-3 and 7.5-4 and for station 5 in Figures 7.5-5 and 7.5-6. Plots of the combined impingement data for all three stations are shown in Figures 7.5-7 and 7.5-8.

The mean impingement values for each weekly interval on which these plots were based are given in Table 7.5-1. Also

TABLE 7.5-1
MEAN TOTAL NUMBER AND WEIGHT (g) OF ALL FISHES IMPINGED AT ENCINA POWER PLANT TRAVELING SCREEN STATIONS PER 24-HOUR INTERVAL OVER THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

		STATION 1		STATION 4		STATION 5		ALL STATIONS	
TIME PERIOD	WEEK	Total Number	Total Weight	Total Number	Total Weight	Total Number	Total Weight	Total Number	Total Weight
Feb 4-10	1	46	522.0	293	2688.0	116	1786.0	455	4996.0
11-17	2	31	242.0	170	1107.0	90	1148.0	291	2497.0
18-24	3	72	788.0	519	5447.0	783	5759.0	1374	11994.0
Feb 25-Mar 3	4	91	914.0	160	2392.0	115	1603.0	366	4909.0
Mar 4-10	5	6	50.0	0	0.0	41	1123.0	47	1173.0
11-17	6	13	73.0	0	0.0	35	1157.0	48	1230.0
18-24	7	13	105.0	0	0.0	30	4583.0	43	4688.0
25-31	8	7	29.0	0	0.0	24	2232.0	31	2261.0
Apr 1- 7	9	5	174.0	0	0.0	271	9573.0	276	9747.0
8-14	10	3	91.0	0	0.0	21	1135.0	24	1226.0
15-21	11	2	47.0	0	0.0	18	1470.0	20	1517.0
22-28	12	8	110.0	0	0.0	50	1944.0	58	2054.0
Apr 29-May 5	13	14	185.0	0	0.0	11	2882.0	25	3067.0
May 6-12	14	97	521.0	0	0.0	0	0.0	97	521.0
13-19	15	33	219.0	0	0.0	0	0.0	33	219.0
20-26	16	67	820.0	0	0.0	0	0.0	67	820.0
May 27-Jun 2	17	52	478.0	0	0.0	0	0.0	52	478.0
Jun 3- 9	18	57	288.0	12	92.0	49	952.0	118	1332.0
10-16	19	91	798.0	42	224.0	61	948.0	194	1970.0
17-23	20	107	487.0	236	1943.0	148	3585.0	491	6015.0
24-30	21	51	274.0	320	927.0	145	2105.0	516	3306.0
Jul 1- 7	22	31	187.0	235	549.0	102	593.0	368	1329.0
8-14	23	30	59.0	323	716.0	258	1642.0	611	2417.0
15-21	24	31	274.0	77	426.0	58	752.0	166	1452.0
22-28	25	87	237.0	112	278.0	106	1052.0	305	1567.0
Jul 29-Aug 4	26	95	972.0	195	476.0	72	3193.0	362	4641.0
Aug 5-11	27	17	145.0	58	183.0	32	563.0	107	891.0
12-18	28	46	192.0	105	422.0	41	945.0	192	1559.0
19-25	29	108	425.0	380	1012.0	103	1040.0	591	2477.0
Aug 26-Sep 1	30	55	194.0	153	1381.0	53	267.0	261	1842.0
Sep 2- 8	31	54	113.0	216	703.0	73	739.0	343	1555.0
9-15	32	15	106.0	67	109.0	21	234.0	103	449.0
16-22	33	39	168.0	31	312.0	20	530.0	90	1010.0
23-29	34	57	463.0	42	365.0	90	932.0	189	1760.0
Sep 30-Oct 6	35	41	283.0	100	515.0	53	980.0	194	1778.0
Oct 7-13	36	33	2033.0	75	414.0	22	722.0	130	3169.0
14-20	37	34	110.0	94	257.0	28	501.0	156	868.0
21-27	38	79	471.0	223	909.0	68	760.0	370	2140.0
Oct 28-Nov 3	39	187	494.0	168	375.0	62	1114.0	417	1983.0
Nov 4-10	40	88	539.0	100	430.0	59	1164.0	247	2133.0
11-17	41	53	520.0	196	675.0	58	640.0	307	1835.0
18-24	42	210	711.0	394	1094.0	189	1353.0	793	3158.0
Nov 25-Dec 1	43	60	537.0	513	207.0	11	343.0	584	1087.0
Dec 2- 8	44	37	235.0	143	1032.0	49	1379.0	229	2646.0
9-15	45	13	152.0	60	544.0	24	866.0	97	1562.0
16-22	46	9	187.0	123	844.0	64	1146.0	196	2177.0
23-29	47	34	391.0	91	773.0	21	357.0	146	1521.0
Dec 30-Jan 4	48	8	112.0	33	1523.0	7	1204.0	48	2839.0
	48-WK MEAN	50.4	365.1	126.2	653.0	78.2	1437.0	254.8	2455.5

shown in Table 7.5-1 are the overall mean numbers and weights of all fishes impinged over the 48-week period of the study.

Plots of weekly mean temperature and salinity values for seawater entering the cooling water system of the Encina Power Plant during the 48-week period are shown in Figure 7.5-9. As indicated in Appendix Section 16.2.3, these measurements were made at the point where seawater enters the bar rack screening system. Weekly mean flow rates, temperature, and salinity values are given in Table 7.5-2.

Plots of weekly mean values for wave height of the ocean just offshore from the Encina Power Plant and of cloud cover are shown in Figure 7.5-10. Observations of wave height for the ocean were made at a point near where seawater enters Agua Hedionda Lagoon, the source of cooling water for the Power Plant. The presumption was that high waves at that point associated with storm conditions may cause some fishes to move into the lagoon seeking shelter and thus become more susceptible to impingement. Observations also were made of wave heights in Agua Hedionda Lagoon adjacent to the bar rack screening system. However, these wave heights were always less than one foot and for that reason were not considered to be a significant factor affecting impingement.

Shown in Table 7.5-3 are detailed data for total number and total weight of all fishes impinged at traveling screen stations 1, 4, and 5 during each 12-hr sampling interval over the period February 4, 1979-January 4, 1980. Also shown in this table are

TABLE 7.5-2
WEEKLY MEAN TEMPERATURES (°C), SALINITIES (‰) AND FLOW RATES (1000 gpm) OF SEAWATER ENTERING THE COOLING WATER SYSTEM OF THE ENCINA POWER PLANT DURING THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

TIME PERIOD	WEEK	TEMPERATURE (°C)	SALINITY (°/oo)	UNITS 1-3 Flow Rate (1000 gpm)	UNIT 4 Flow Rate (1000 gpm)	UNIT 5 Flow Rate (1000 gpm)	TOTAL PLANT Flow Rate (1000 gpm)
Feb 4-10	1	13.5	32.5	121	180	220	521
11-17	2	14.5	32.5	134	180	220	534
18-24	3	14.0	31.3	134	153	220	507
Feb 25-Mar 3	4	14.0	32.1	134	153	220	507
Mar 4-10	5	14.5	32.5	134	0	220	354
11-17	6	15.5	31.5	134	0	220	354
18-24	7	15.0	30.6	134	0	220	354
25-31	8	16.5	30.9	134	0	220	354
Apr 1- 7	9	17.0	31.8	134	0	220	354
8-14	10	17.0	31.7	129	0	220	349
15-21	11	17.0	31.9	121	0	220	341
22-28	12	16.0	32.7	127	0	188	315
Apr 29-May 5	13	17.0	32.4	108	0	220	328
May 6-12	14	16.0	31.1	134	0	0	134
13-19	15	16.5	32.2	134	0	0	134
20-26	16	18.0	32.0	134	13	0	147
May 27-Jun 2	17	19.0	32.3	134	0	0	134
Jun 3- 9	18	18.5	32.6	128	27	220	375
10-16	19	20.5	33.0	134	27	215	376
17-23	20	20.0	32.5	97	27	220	344
24-30	21	21.5	32.8	88	0	220	308
Jul 1- 7	22	20.5	32.6	76	0	220	296
8-14	23	21.0	32.7	82	27	220	329
15-21	24	19.5	32.4	134	153	220	507
22-28	25	21.0	32.4	114	180	220	514
Jul 29-Aug 4	26	20.0	32.3	134	180	220	534
Aug 5-11	27	22.5	32.5	134	180	220	534
12-18	28	22.0	32.5	127	180	220	527
19-25	29	20.5	32.4	133	180	188	501
Aug 26-Sep 1	30	21.0	32.2	134	180	188	502
Sep 2- 8	31	21.0	32.7	134	180	220	534
9-15	32	20.5	32.6	134	129	220	483
16-22	33	21.0	32.6	134	153	210	497
23-29	34	19.5	32.6	134	153	220	507
Sep 30-Oct 6	35	16.5	32.8	134	153	220	507
Oct 7-13	36	17.5	32.7	134	180	220	534
14-20	37	18.0	32.7	134	180	220	534
21-27	38	17.5	32.7	134	180	220	534
Oct 28-Nov 3	39	14.5	32.8	134	180	220	534
Nov 4-10	40	16.0	32.7	134	180	220	534
11-17	41	15.0	32.7	134	180	220	534
18-24	42	11.5	32.8	134	180	220	534
Nov 25-Dec 1	43	14.0	32.8	127	180	220	527
Dec 2- 8	44	14.0	32.8	134	180	220	534
9-15	45	14.5	33.0	134	171	220	525
16-22	46	15.0	32.8	134	180	220	534
23-29	47	14.0	32.6	134	13	220	367
Dec 30-Jan 4	48	12.5	32.7	134	171	220	525

TABLE 7.5-3
TOTAL NUMBERS AND WEIGHTS (g) OF ALL FISHES IMPINGED AT ENCINA POWER PLANT TRAVELING SCREEN STATIONS DURING EACH 12-HOUR SAMPLING INTERVAL OVER THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

DATE	TIME OF DAY	STATION 1 TOTAL NUMBER	1 TOTAL WEIGHT	4 TOTAL NUMBER	4 TOTAL WEIGHT	5 TOTAL NUMBER	5 TOTAL WEIGHT
790204	DAY	21	653	514	6426	14	221
	NIGHT	0	0	13	79	20	642
790205	DAY	5	53	35	1187	13	450
	NIGHT	36	1267	47	2303	317	3337
790206	DAY	0	0	130	1094	26	491
	NIGHT	0	0	73	768	29	697
790207	DAY	80	116	115	220	72	594
	NIGHT	52	558	0	0	9	130
790208	DAY	4	15	115	1142	42	692
	NIGHT	3	121	360	660	60	345
790209	DAY	5	2	210	3017	80	3526
	NIGHT	96	690	292	1109	60	370
790210	DAY	18	180	84	630	35	243
	NIGHT	0	0	63	181	36	764
790211	DAY	16	25	10	77	45	228
	NIGHT	8	446	235	636	20	734
790212	DAY	0	0	0	0	27	343
	NIGHT	30	227	285	405	36	690
790213	DAY	5	7	70	959	4	42
	NIGHT	8	54	224	1230	32	517
790214	DAY	15	11	16	64	8	61
	NIGHT	0	0	50	349	88	504
790215	DAY	5	149	1	12	12	640
	NIGHT	36	221	0	0	101	1185
790216	DAY	1	0	67	894	70	1799
	NIGHT	26	161	101	1945	50	247
790217	DAY	6	7	21	423	27	503
	NIGHT	60	383	108	754	42	570
790218	DAY	0	0	8	77	10	640
	NIGHT	24	211	180	672	21	374
790219	DAY	5	57	0	0	17	1123
	NIGHT Start of	54	1034	324	1619	36	641
790220	DAY ← Dredging	3	34	27	379	26	530
	NIGHT ▲	41	373	321	1467	56	823
790221	DAY	10	77	191	2673	90	3310
	NIGHT ●	47	235	178	680	22	307
790222	DAY ◇ ×	27	99	402	3254	1184	8005
	NIGHT ●	150	610	1269	10259	1716	8694
790223	DAY ×	16	581	157	7741	370	2878
	NIGHT	44	1133	291	6644	692	5486
790224	DAY	27	233	3	25	888	5804
	NIGHT TR ×	54	838	282	2637	355	1698
790225	DAY	6	14	152	562	0	0
790226	DAY ●	46	840	100	736	84	4198
	NIGHT	54	259	76	605	96	4068
790227	DAY	24	193	63	2286	52	839

TABLE 7.5-3 (Continued)

			STATION 1		4		5	
DATE	TIME OF DAY		TOTAL NUMBER	TOTAL WEIGHT	TOTAL NUMBER	TOTAL WEIGHT	TOTAL NUMBER	TOTAL WEIGHT
790228	DAY		51	882	72	2393	28	518
	NIGHT		57	566	162	1682	78	695
790301	DAY	▲	27	418	49	841	50	1068
	NIGHT	◇	51	665	59	509	0	0
790302	DAY	◇	40	667	63	1159	52	2067
	NIGHT		120	663	276	5019	78	1444
790303	DAY		15	53	0	0	252	3796
	NIGHT		78	1177	48	951	32	1636
790304	NIGHT		18	78	0	0	57	1674
790305	DAY		7	87	0	0	56	1299
790306	DAY		0	0	0	0	28	1043
	NIGHT		1	8	0	0	11	735
790307	DAY		1	3	0	0	28	376
	NIGHT		4	6	0	0	13	316
790308	DAY		1	9	0	0	14	632
	NIGHT		4	17	0	0	15	136
790309	DAY		1	3	0	0	16	600
	NIGHT		1	3	0	0	12	517
790310	DAY		0	0	0	0	24	216
	NIGHT		7	136	0	0	15	314
790311	DAY	◇	3	12	0	0	9	234
	NIGHT		9	31	0	0	9	210
790312	DAY	◇	2	8	0	0	7	122
	NIGHT	▲	2	6	0	0	8	83
790313	DAY		1	3	0	0	10	739
	NIGHT		12	100	0	0	30	624
790314	DAY		4	18	0	0	20	1367
	NIGHT		17	140	0	0	31	602
790315	DAY		5	17	0	0	14	178
	NIGHT	●	18	74	0	0	32	890
790316	DAY		5	21	0	0	10	614
	NIGHT	●	9	55	0	0	32	1242
790317	DAY	× ▲	0	0	0	0	23	941
	NIGHT	×	6	25	0	0	9	251
790318	DAY		2	4	0	0	10	728
	NIGHT	●	14	85	0	0	20	600
790319	DAY		0	0	0	0	1	56
	NIGHT	× ▲	5	23	0	0	12	9060
790320	DAY	× ▲	7	28	0	0	12	1103
	NIGHT	×	10	78	0	0	6	489
790321	DAY	◇	4	16	0	0	23	1503
	NIGHT	● ×	9	31	0	0	27	1166
790322	DAY		15	196	0	0	11	276
	NIGHT		1	0	0	0	15	896
790323	DAY		2	27	0	0	21	9133
	NIGHT		7	24	0	0	27	2052
790324	DAY		3	181	0	0	7	446
	NIGHT		9	41	0	0	18	576
790325	DAY		1	4	0	0	10	470
	NIGHT		7	24	0	0	16	481
790326	DAY		0	0	0	0	5	843
	NIGHT		8	50	0	0	9	262
790327	DAY	● ●	1	4	0	0	8	781
	NIGHT	● ◇ ▲	7	23	0	0	19	851
790328	DAY	× ▲	4	28	0	0	11	5529
	NIGHT	×	7	20	0	0	24	2536
790329	DAY		4	17	0	0	7	465
	NIGHT	●	4	11	0	0	19	452
790330	DAY	×	0	0	0	0	12	645
	NIGHT		3	11	0	0	15	570
790331	DAY	×	0	0	0	0	8	1594
	NIGHT	TR	4	14	0	0	7	147

TABLE 7.5-3 (Continued)

DATE	TIME OF DAY	STATION 1 TOTAL NUMBER	STATION 1 TOTAL WEIGHT	STATION 4 TOTAL NUMBER	STATION 4 TOTAL WEIGHT	STATION 5 TOTAL NUMBER	STATION 5 TOTAL WEIGHT
790401	DAY	22	89	0	0	220	7171
	NIGHT	0	0	0	0	1403	34888
790402	DAY	1	208	0	0	84	2692
	NIGHT	4	702	0	0	72	1475
790403	DAY	0	0	0	0	24	4454
	NIGHT	0	0	0	0	20	1034
790404	DAY	2	9	0	0	20	4970
	NIGHT	1	158	0	0	10	1535
790405	DAY	2	39	0	0	8	299
	NIGHT	1	4	0	0	10	881
790406	DAY	0	0	0	0	4	56
	NIGHT	0	0	0	0	6	193
790407	DAY	0	0	0	0	11	341
	NIGHT	2	9	0	0	3	19
790408	DAY	0	0	0	0	2	54
	NIGHT	0	0	0	0	16	506
790409	DAY	1	3	0	0	7	1455
	NIGHT ●	3	86	0	0	6	582
790410	DAY ● ◇	1	7	0	0	3	131
	NIGHT	0	0	0	0	6	218
790411	DAY ◇	2	12	0	0	12	677
	NIGHT	0	0	0	0	22	1880
790412	DAY	1	373	0	0	11	673
	NIGHT	2	10	0	0	13	370
790413	DAY	3	6	0	0	14	217
	NIGHT	3	53	0	0	14	662
790414	DAY	0	0	0	0	10	337
	NIGHT	2	19	0	0	11	186
790415	DAY ×	0	0	0	0	8	227
	NIGHT	1	3	0	0	7	85
790416	DAY	3	16	0	0	9	333
	NIGHT	6	65	0	0	17	791
790417	DAY	1	5	0	0	6	448
	NIGHT	1	14	0	0	8	367
790418	DAY ●	1	35	0	0	9	576
	NIGHT ●	1	3	0	0	8	434
790419	DAY	1	29	0	0	10	887
	NIGHT	0	0	0	0	8	350
790420	DAY	0	0	0	0	11	847
	NIGHT	1	0	0	0	5	649
790421	DAY	0	0	0	0	12	321
	NIGHT	1	162	0	0	11	3972
790422	DAY	0	0	0	0	20	875
	NIGHT	0	0	0	0	12	656
790423	DAY	2	9	0	0	23	321
	NIGHT ●	2	11	0	0	14	833
790424	DAY	1	90	0	0	23	705
	NIGHT ← Dredging Completed	7	126	0	0	53	2307
790425	NIGHT	7	57	0	0	41	1170
790426	DAY	13	207	0	0	65	1871
790427	DAY	0	0	0	0	8	510
	NIGHT ●	7	23	0	0	26	418
790428	DAY	3	13	0	0	0	0
	NIGHT	6	125	0	0	18	2002
790429	DAY	3	278	0	0	5	509
	NIGHT	13	119	0	0	0	0
790430	DAY	0	0	0	0	11	7854
	NIGHT	1	5	0	0	9	447
790501	DAY	0	0	0	0	8	332
	NIGHT ●	1	2	0	0	8	8903
790502	DAY	0	0	0	0	9	1144
	NIGHT	2	4	0	0	7	347

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TABLE 7.5-3 (Continued)

DATE	TIME OF DAY	STATION 1 TOTAL NUMBER	TOTAL WEIGHT	4 TOTAL NUMBER	TOTAL WEIGHT	5 TOTAL NUMBER	TOTAL WEIGHT
790503	DAY	1	28	0	0	4	106
	NIGHT	4	9	0	0	7	187
790504	DAY	7	162	0	0	0	0
	NIGHT	19	100	0	0	10	346
790505	DAY	6	219	0	0	0	0
	NIGHT	41	369	0	0	0	0
790506	DAY	7	60	0	0	0	0
	NIGHT	33	615	0	0	0	0
790507	DAY	17	294	0	0	0	0
	NIGHT	53	284	0	0	0	0
790508	DAY	8	132	0	0	0	0
	NIGHT	86	467	0	0	0	0
790509	DAY	41	164	0	0	0	0
	NIGHT	205	660	0	0	0	0
790510	DAY	14	138	0	0	0	0
	NIGHT	111	367	0	0	0	0
790511	DAY	13	114	0	0	0	0
	NIGHT	51	356	0	0	0	0
790512	DAY	7	181	0	0	0	0
	NIGHT	31	513	0	0	0	0
790513	DAY	8	115	0	0	0	0
	NIGHT	36	152	0	0	0	0
790514	DAY	5	103	0	0	0	0
	NIGHT	41	132	0	0	0	0
790515	DAY	3	358	0	0	0	0
	NIGHT	27	168	0	0	0	0
790516	DAY	1	2	0	0	0	0
	NIGHT	44	261	0	0	0	0
790517	DAY	4	10	0	0	0	0
	NIGHT	33	87	0	0	0	0
790518	DAY	1	2	0	0	0	0
	NIGHT	8	92	0	0	0	0
790519	DAY	1	3	0	0	0	0
	NIGHT	16	47	0	0	0	0
790521	DAY	8	347	0	0	0	0
	NIGHT	40	173	0	0	0	0
790522	DAY	13	50	0	0	0	0
	NIGHT	43	299	0	0	0	0
790523	DAY	22	1060	0	0	0	0
790524	DAY	49	345	0	0	0	0
	NIGHT	49	473	0	0	0	0
790525	DAY	25	560	0	0	0	0
	NIGHT	96	730	0	0	0	0
790526	DAY	1	7	0	0	0	0
	NIGHT	24	458	0	0	0	0
790527	DAY	5	49	0	0	0	0
	NIGHT	23	140	0	0	0	0
790528	DAY	8	17	0	0	0	0
	NIGHT	20	125	0	0	0	0
790529	DAY	6	242	0	0	0	0
	NIGHT	20	181	0	0	0	0
790530	DAY	10	23	0	0	0	0
	NIGHT	28	163	0	0	0	0
790531	DAY	36	494	0	0	0	0
	NIGHT	77	353	0	0	0	0
790601	DAY	17	62	0	0	0	0
	NIGHT	50	837	0	0	0	0
790602	DAY	5	154	0	0	0	0
	NIGHT	56	504	0	0	0	0
790603	DAY	2	0	0	0	0	0
	NIGHT	39	59	0	0	0	0
790604	DAY	3	16	0	0	5	149
	NIGHT	20	21	0	0	0	0
790605	DAY	4	11	4	14	6	122
	NIGHT	22	70	9	84	3	0

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TABLE 7.5-3 (Continued)

DATE	TIME OF DAY	STATION 1 TOTAL NUMBER	STATION 1 TOTAL WEIGHT	4 TOTAL NUMBER	4 TOTAL WEIGHT	5 TOTAL NUMBER	5 TOTAL WEIGHT
790606	DAY	9	22	0	0	17	538
	NIGHT	27	114	2	13	24	128
790607	NIGHT	53	203	1	2	51	761
790608	DAY	0	0	1	3	25	663
	NIGHT	35	266	1	4	38	893
790609	DAY	40	63	24	42	72	178
	NIGHT	117	1025	33	434	80	2759
790610	DAY	12	12	10	15	36	164
	NIGHT	10	49	120	235	5	40
790611	DAY	95	406	1	0	31	441
	NIGHT	52	892	8	47	81	624
790612	DAY	44	98	7	28	52	407
790613	DAY	39	267	11	82	33	469
790614	DAY	8	33	2	7	41	620
	NIGHT	35	585	13	253	25	1757
790615	DAY	46	126	18	126	32	245
	NIGHT	0	0	22	374	0	0
790616	DAY	29	108	15	57	15	739
	NIGHT TR	176	2212	25	117	17	182
790617	DAY	0	0	34	446	62	2635
	NIGHT	0	0	43	455	142	1779
790618	DAY	0	0	69	565	19	2060
	NIGHT	0	0	35	636	35	1138
790619	DAY	0	0	3	53	0	0
	NIGHT	0	0	7	109	62	2426
790620	DAY	0	0	29	134	0	0
	NIGHT	33	222	102	387	104	1541
790621	DAY	8	24	11	525	53	1590
	NIGHT	626	2330	614	5078	78	766
790622	DAY	1	2	55	373	56	1873
	NIGHT	34	237	325	3113	158	3019
790623	DAY	6	51	53	547	111	2549
	NIGHT	44	540	271	1178	155	3720
790624	DAY	1	6	54	348	52	1063
	NIGHT	1	2	0	0	68	2612
790625	DAY	1	5	46	151	74	606
	NIGHT	44	273	372	725	91	1925
790626	DAY	14	1121	90	523	79	1735
	NIGHT	20	66	232	1399	60	525
790627	DAY	16	76	74	884	84	589
	NIGHT	4	5	180	385	65	1711
790628	DAY	6	8	108	165	84	538
	NIGHT	9	111	228	572	98	1671
790629	DAY	0	0	202	436	80	874
	NIGHT	4	6	336	483	0	0
790630	DAY	128	140	0	0	33	187
	NIGHT	108	71	316	419	144	596
790701	DAY	2	7	94	231	16	92
	NIGHT	0	0	87	378	0	0
790702	DAY	54	49	60	73	16	56
	NIGHT	11	102	66	107	20	325
790703	DAY	5	4	95	167	48	178
	NIGHT	8	10	228	396	102	499
790704	DAY	4	163	48	40	48	469
	NIGHT	18	26	140	789	70	204
790705	DAY	8	6	48	81	36	583
	NIGHT	40	393	672	1199	45	201
790706	DAY	0	0	54	80	60	843
	NIGHT	8	18	52	290	62	385
790707	DAY	2	124	0	0	188	286
	NIGHT	54	410	3	11	5	27
790708	DAY	7	24	36	391	49	1329
	NIGHT	6	14	126	291	0	0

TABLE 7.5-3 (Continued)

DATE	TIME OF DAY	STATION 1 TOTAL NUMBER	1 TOTAL WEIGHT	4 TOTAL NUMBER	4 TOTAL WEIGHT	5 TOTAL NUMBER	5 TOTAL WEIGHT
790709	DAY	64	112	291	391	248	2184
	NIGHT	54	86	564	1209	828	1681
790710	DAY	8	11	60	132	64	2246
	NIGHT	0	0	328	628	112	434
790711	DAY	10	18	6	8	48	247
	NIGHT	12	10	575	1039	175	445
790712	DAY	0	0	12	18	8	45
	NIGHT	24	46	104	148	114	823
790713	DAY	0	0	32	70	12	19
	NIGHT	12	14	90	206	39	823
790714	DAY	2	4	14	54	32	429
	NIGHT	11	77	24	427	75	788
790715	DAY	15	14	21	511	27	68
	NIGHT	84	711	17	89	2	0
790716	DAY	0	0	49	62	16	129
	NIGHT	28	26	128	154	66	175
790717	DAY	0	0	6	5	18	22
	NIGHT	76	336	42	60	45	111
790718	DAY	2	15	15	17	13	1000
	NIGHT	7	568	162	614	45	605
790719	DAY	0	0	12	1208	20	665
790720	DAY	0	0	10	19	48	430
	NIGHT	1	0	74	243	6	358
790721	DAY	0	0	0	0	72	953
	NIGHT	2	245	0	0	100	748
790722	DAY	0	0	0	0	12	209
	NIGHT	1	5	0	0	29	595
790723	DAY	7	8	12	118	30	900
	NIGHT	30	35	25	25	70	582
790724	DAY	0	0	24	78	21	178
	NIGHT	16	18	95	203	78	1892
790725	DAY	54	156	0	0	24	428
	NIGHT	138	358	0	0	88	1043
790726	DAY	160	150	128	240	16	23
790727	DAY	8	361	30	224	30	38
	NIGHT	115	354	159	101	128	79
790728	DAY	15	34	248	127	192	55
	NIGHT TR	20	63	138	692	104	814
790729	DAY	7	31	8	26	0	0
	NIGHT	78	164	66	513	142	8210
790730	DAY	0	0	66	43	21	7
	NIGHT	159	3108	39	180	37	2720
790731	DAY	0	0	7	42	28	2264
	NIGHT	0	0	59	472	39	4629
790801	NIGHT	0	0	126	548	7	26
790802	DAY	3	2	173	223	66	337
790803	DAY	2	3	12	93	11	224
	NIGHT	95	699	30	62	16	537
790804	DAY	6	10	34	119	2	1
	NIGHT	220	1812	550	533	60	203
790805	DAY	0	0	2	1	0	0
	NIGHT	12	606	0	0	6	933
790806	DAY	0	0	6	6	20	211
	NIGHT	24	42	78	293	38	218
790807	DAY	0	0	11	29	22	330
	NIGHT	0	0	0	0	45	912
790808	DAY	0	0	42	62	5	412
	NIGHT	0	0	56	77	8	43
790809	DAY	2	10	13	279	7	163
	NIGHT	51	190	8	100	18	127
790810	DAY	0	0	0	0	6	181
	NIGHT	4	32	6	4	8	12

TABLE 7.5-3 (Continued)

DATE	TIME OF DAY	STATION 1 TOTAL NUMBER	1 TOTAL WEIGHT	4 TOTAL NUMBER	4 TOTAL WEIGHT	5 TOTAL NUMBER	5 TOTAL WEIGHT
790811	DAY	4	9	20	149	3	65
	NIGHT	22	126	165	283	40	336
790812	DAY	4	6	8	18	4	7
	NIGHT	6	14	12	248	20	557
790813	DAY ●	0	0	6	1	3	0
	NIGHT	9	12	22	83	15	196
790814	DAY	1	3	13	20	11	346
	NIGHT	40	119	78	1042	38	53
790815	DAY	2	6	35	71	10	225
	NIGHT	12	13	51	185	4	3
790816	DAY	2	4	36	29	12	251
	NIGHT	24	759	0	0	36	1952
790817	DAY	3	5	39	43	30	164
	NIGHT	105	240	390	562	42	1509
790818	DAY	2	5	42	193	14	609
	NIGHT	111	149	396	462	45	42
790819	NIGHT	12	14	116	1041	27	191
790821	DAY	33	59	65	426	26	374
	NIGHT	0	0	0	0	4	9
790822	DAY	28	594	0	0	76	349
	NIGHT	294	730	386	465	152	1008
790823	DAY	0	0	150	198	28	2381
	NIGHT	112	275	105	600	118	875
790824	DAY	4	27	38	65	17	249
	NIGHT	60	391	260	456	64	910
790825	DAY	4	24	800	1185	0	0
	NIGHT	48	226	168	1131	54	475
790826	DAY	2	13	42	905	0	0
	NIGHT	9	105	284	2121	0	0
790827	DAY	2	13	46	443	0	0
	NIGHT	31	78	10	2176	2	19
790828	DAY	0	0	0	0	1	11
	NIGHT	23	82	82	2159	15	71
790829	DAY ●	6	212	100	483	2	29
	NIGHT	28	58	114	230	11	116
790830	DAY ●	4	3	60	79	12	144
	NIGHT	151	351	0	0	46	404
790831	DAY	2	4	32	120	30	186
	NIGHT	28	24	54	273	99	638
790901	DAY	0	0	42	180	18	72
	NIGHT TR*	100	412	204	498	132	182
790902	DAY	14	16	36	110	52	502
	NIGHT	86	122	186	1208	303	830
790903	DAY	2	1	34	70	16	1832
	NIGHT	162	543	549	1688	0	0
790904	DAY	0	0	21	14	0	0
790905	DAY	2	2	5	3	10	235
	NIGHT	0	0	288	350	0	0
790906	DAY	0	0	8	15	12	140
	NIGHT	0	0	42	244	0	0
790907	DAY	5	2	10	53	4	0
	NIGHT	68	156	202	734	36	454
790908	DAY	0	0	5	13	0	0
	NIGHT TR	12	24	16	65	42	810
790909	DAY	14	135	0	0	3	21
790910	DAY	0	0	3	3	2	55
	NIGHT	32	26	138	117	24	54
790911	DAY	0	0	0	0	1	2
	NIGHT	0	0	14	50	8	38
790912	DAY	0	0	6	13	3	91
	NIGHT	0	0	86	137	29	148
790913	NIGHT	0	0	0	0	38	392

*Incomplete tunnel recirculation limited to 2 hrs.

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TABLE 7.5-3 (Continued)

		STATION 1		4		5	
DATE	TIME OF DAY	TOTAL NUMBER	TOTAL WEIGHT	TOTAL NUMBER	TOTAL WEIGHT	TOTAL NUMBER	TOTAL WEIGHT
790914	DAY	0	0	4	14	8	572
	NIGHT	15	256	76	301	7	18
790915	DAY	0	0	6	23	2	10
	NIGHT	30	217	70	115	0	0
790916	DAY	0	0	6	36	4	18
	NIGHT	11	57	0	0	3	303
790917	DAY	12	31	2	15	3	19
	NIGHT	0	0	11	48	0	0
790918	DAY	6	2	6	8	3	41
	NIGHT	0	0	37	613	18	797
790919	DAY	5	29	8	67	4	142
	NIGHT	0	0	58	201	30	190
790920	DAY	0	0	10	68	3	31
	NIGHT	228	730	22	491	18	85
790921	DAY	0	0	12	86	3	39
	NIGHT	1	0	37	500	30	1124
790922	DAY	1	292	2	7	17	717
	NIGHT	6	35	8	46	7	201
790923	DAY	1	2	48	257	32	418
	NIGHT	30	111	46	204	114	1958
790924	DAY	2	27	1	14	24	171
	NIGHT	52	72	12	669	33	212
790925	DAY	0	0	5	20	1	10
	NIGHT	0	0	24	35	120	266
790926	DAY	1	11	0	0	7	424
	NIGHT	85	1250	50	755	88	637
790927	DAY	1	13	4	16	20	507
	NIGHT	110	866	0	0	35	341
790928	DAY	2	9	5	13	12	619
	NIGHT	146	592	93	552	41	424
790929	DAY	5	64	0	0	6	129
	NIGHT	36	221	3	18	30	407
790930	DAY	0	0	0	0	8	212
	NIGHT	32	277	0	0	75	130
791001	DAY	4	18	6	42	32	100
	NIGHT	42	400	5	86	33	896
791002	DAY	0	0	100	119	5	40
	NIGHT	26	126	54	799	44	1581
791003	DAY	4	29	76	873	11	332
	NIGHT	36	290	69	378	27	64
791004	DAY	7	86	18	174	1	9
	NIGHT	60	418	231	497	54	734
791005	DAY	0	0	0	0	9	1185
	NIGHT	20	210	72	145	69	673
791006	DAY	0	0	0	0	25	30
	NIGHT	56	130	70	492	45	876
791007	DAY	4	35	36	255	25	423
	NIGHT	24	7553	0	0	24	354
791008	DAY	6	37	20	113	3	8
	NIGHT	16	40	81	641	21	291
791009	NIGHT	21	48	87	801	36	707
791010	DAY	2	10	5	41	1	20
	NIGHT	0	0	0	0	9	2169
791011	NIGHT	80	3361	40	409	0	0
791012	DAY	30	84	4	25	0	0
791013	DAY	1	13	18	109	0	0
	NIGHT TR	0	0	119	138	0	0
791014	DAY	9	29	15	126	12	35
791015	DAY	8	4	276	203	4	529
	NIGHT	0	0	0	0	24	28
791016	DAY	1	0	36	31	24	890
	NIGHT	75	119	0	0	34	764

000513

TABLE 7.5-3 (Continued)

DATE	TIME OF DAY	STATION 1 TOTAL NUMBER	1 TOTAL WEIGHT	4 TOTAL NUMBER	4 TOTAL WEIGHT	5 TOTAL NUMBER	5 TOTAL WEIGHT
791017	DAY	3	13	10	116	5	68
	NIGHT	42	96	92	401	14	33
791018	DAY	2	36	11	271	14	143
	NIGHT	4	14	27	102	0	0
791019	DAY	2	34	10	72	21	41
	NIGHT	30	350	26	160	18	243
791020	DAY	0	0	45	44	4	40
	NIGHT	5	21	64	145	11	442
791021	DAY	1	0	45	81	28	69
	NIGHT	180	201	20	205	24	43
791022	DAY	4	18	90	136	36	29
	NIGHT	0	0	117	400	20	66
791023	DAY	26	1485	29	2054	3	585
	NIGHT	144	416	56	496	0	0
791024	DAY	0	0	48	155	48	1216
791026	DAY	0	0	455	312	65	1128
791027	NIGHT	0	0	144	250	82	287
791028	DAY	78	424	187	604	35	2867
791029	DAY	0	0	15	18	0	0
	NIGHT	60	70	200	329	22	693
791031	DAY	0	0	120	105	0	0
791101	DAY	0	0	0	0	36	174
	NIGHT	192	390	49	284	0	0
791102	DAY	0	0	0	0	9	96
	NIGHT	164	359	105	348	80	220
791103	NIGHT	348	901	0	0	95	961
791105	DAY	40	70	75	261	60	375
791106	DAY	5	305	32	91	114	301
	NIGHT	55	341	30	207	0	0
791107	DAY	7	631	18	114	18	474
	NIGHT	31	182	74	487	36	4226
791108	DAY	40	284	0	0	32	154
791108	NIGHT	25	312	83	530	0	0
791109	DAY	31	205	44	92	6	113
	NIGHT	48	135	0	0	30	154
791110	DAY	0	0	36	54	8	116
	NIGHT	202	501	156	530	21	487
791111	DAY	8	37	792	1693	32	464
	NIGHT	82	1017	0	0	0	0
791112	DAY	1	25	36	106	6	49
	NIGHT	0	0	234	408	93	753
791113	DAY	12	10	12	15	18	887
	NIGHT	99	1301	182	1146	20	61
791114	DAY	0	0	0	0	8	175
	NIGHT	63	138	0	0	29	245
791115	DAY	0	0	0	0	10	25
	NIGHT	0	0	0	0	21	235
791116	DAY	26	182	18	395	72	749
	NIGHT	0	0	0	0	28	60
791117	DAY	1	89	25	67	25	109
	NIGHT	76	844	74	892	44	666
791118	DAY	5	11	80	380	75	327
	NIGHT	24	311	72	942	46	722
791119	DAY	0	0	30	222	28	196
	NIGHT	28	61	12	346	70	95
791120	DAY	0	0	0	0	18	153
	NIGHT	120	218	24	91	268	1430
791121	DAY	460	1972	52	231	24	213
	NIGHT	0	0	205	552	62	877
791122	NIGHT	626	1695	1533	2827	266	921
791123	DAY	0	0	246	854	170	1785
791124	DAY	0	0	112	117	16	434
	NIGHT TR	0	0	0	0	94	[illegible]

000514

TABLE 7.5-3 (Continued)

DATE	TIME OF DAY	STATION 1 TOTAL NUMBER	1 TOTAL WEIGHT	4 TOTAL NUMBER	4 TOTAL WEIGHT	5 TOTAL NUMBER	5 TOTAL WEIGHT
791125	DAY	40	204	64	394	0	0
791126	DAY	207	1103	74	384	0	0
	NIGHT	0	0	1743	2989	0	0
791127	DAY	0	0	8	13	7	135
	NIGHT	50	592	413	3153	0	0
791128	DAY	15	65	18	104	0	0
	NIGHT	0	0	763	4105	0	0
791129	DAY	6	27	22	169	15	21
	NIGHT	31	723	51	311	0	0
791130	DAY	0	0	30	548	26	1320
	NIGHT	40	777	38	253	6	152
791201	DAY	0	0	40	155	5	343
	NIGHT	0	0	68	901	12	259
791202	DAY	0	0	51	393	3	197
	NIGHT	0	0	48	222	18	1003
791203	DAY	45	478	87	1020	13	498
	NIGHT	0	0	32	576	10	5807
791204	DAY	0	0	40	206	8	489
	NIGHT	0	0	25	508	46	391
791205	DAY	1	34	9	26	28	105
	NIGHT	6	17	18	89	0	0
791206	DAY	39	247	174	433	14	191
	NIGHT	0	0	88	1049	23	282
791207	DAY	30	161	186	1079	14	93
	NIGHT	48	202	56	1128	32	221
791208	DAY	16	40	18	65	11	138
	NIGHT	77	469	172	731	24	235
791209	DAY	0	0	10	54	17	302
	NIGHT	0	0	39	352	30	1033
791210	DAY	5	99	30	100	10	111
	NIGHT	0	0	0	0	26	316
791211	DAY	0	0	5	48	6	152
	NIGHT	22	148	32	1087	0	0
791212	DAY	4	29	32	232	6	414
	NIGHT	4	11	0	0	7	107
791213	DAY	11	173	90	311	15	498
	NIGHT	21	272	0	0	0	0
791214	DAY	13	206	22	131	18	543
	NIGHT	0	0	60	758	13	811
791215	DAY	1	3	14	44	6	126
	NIGHT	9	126	77	692	15	1652
791216	DAY	2	3	10	29	6	170
	NIGHT	4	15	57	1215	12	382
791217	DAY	8	242	20	116	10	57
	NIGHT	0	0	54	319	17	243
791218	DAY	21	127	219	596	18	813
	NIGHT	0	0	180	426	94	1850
791219	DAY	11	266	0	0	29	1403
	NIGHT	0	0	0	0	20	90
791220	NIGHT	10	470	79	1331	94	994
791221	DAY	0	0	32	731	0	0
	NIGHT	0	0	90	303	40	279
791222	NIGHT	0	0	0	0	42	593
791224	DAY	4	69	30	83	7	128
791225	DAY	0	0	20	167	22	404
791226	DAY	24	258	90	804	24	200
	NIGHT	0	0	66	1109	0	0
791227	NIGHT	52	394	66	317	0	0
791228	DAY	2	28	8	189	5	171
	NIGHT	26	282	54	297	0	0
791229	DAY	4	185	11	77	8	224
	NIGHT TR	40	542	66	437	30	481
791230	DAY	0	0	16	26	0	0

TABLE 7.5-3 (Concluded)

		STATION 1		4		5	
DATE	TIME OF DAY	TOTAL NUMBER	TOTAL WEIGHT	TOTAL NUMBER	TOTAL WEIGHT	TOTAL NUMBER	TOTAL WEIGHT
791231	DAY	0	0	6	28	0	0
	NIGHT	11	39	0	0	0	0
800101	NIGHT	0	0	0	0	12	359
800102	DAY	6	12	30	454	0	0
	NIGHT	0	0	37	396	0	0
800103	NIGHT	8	63	0	0	0	0
800104	DAY	1	199	19	5607	8	4641
	NIGHT	10	193	40	343	10	419

LEGEND

TR - denotes times of tunnel recirculation

● - denotes wind speeds ≥ 12 mph

◇ - denotes ocean wave heights for ≥ 4 ft

x - denotes salinities ≤ 29.9 ‰

▲ - denotes light-heavy rain

the specific times of occurrence for physical conditions possibly related to impingement of fishes. These conditions are: wind speeds ≥12 mph (19 kph), ocean wave heights ≥4 ft (1.2 m), salinity values ≤29.9 ppt, associated conditions of light to heavy rainfall, and times of dredging operations in outer Agua Hedionda Lagoon. These physical data were obtained as described in Appendix B, Section 16.2.3. The specific times of tunnel recirculation or heat treatment of the cooling water system also are shown. Effects of tunnel recirculation are considered separately in Section 7.12. The format described above for biological and physical data in Table 7.5-3 allows their direct intercomparison, as described in the analyses of data that follow.

As indicated in Figures 7.5-1 through 7.5-8 and Tables 7.5-1 and 7.5-3, total numbers and biomass of fishes impinged varied considerably throughout the year and from week to week. For all traveling screen stations combined (Figures 7.5-7 and 7.5-8), the greatest number and weight of fishes impinged was in late February, 1979 during a period of winter storms, rainfall, and low salinity (Table 7.5-3 and Figure 7.5-9). This peak is most evident in the data for stations 4 and 5 (Figures 7.5-3 through 7.5-6). The highest peak in weight of fishes impinged occurred at station 5 in early April. As indicated in Table 7.5-2, generating Unit 4 was not in operation from early March through the end of May and generating Unit 5 also was out of service in May. This accounts in part for the lower levels of impingement during that period (Figures 7.5-1 through 7.5-8), as considered separately in Section 7.8. Peak levels of impingement at station 1 occurred in October and November (Figures 7.5-1 and 7.5-2) and for station 4 in November and early December (Figures 7.5-3 and 7.5-4). Levels of impingement were somewhat lower and variable during the summer and early fall months (Figures 7.5-7 and 7.5-8).

Parametric correlation analysis was used in an attempt to determine possible statistical relationships between four physical variables and the total number and weight of all fishes impinged at all stations combined during corresponding periods of time. Weekly mean values for the entire 336-day period of the study (Tables 7.5-1 and 7.5-2 and Figures 7.5-9 and 7.5-10) were used for these analyses. The possible correlations considered and the correlation coefficient determined for each were:

	Mean Total Number of Fishes Impinged	Mean total Weight of Fishes Impinged
Mean Temperature	-0.097	-0.227
Mean Salinity	-0.002	-0.190
Mean Ocean Wave Height	0.136	0.141
Mean Cloud Cover	0.097	-0.085

None of these correlations was significant (p values >0.05), as reflected also by the very low correlation coefficient values. Comparison of the impingement plots (Figures 7.5-1 through 7.5-8) with those for the physical data (Figures 7.5-9 and 7.5-10) tends to confirm that there were no evident relationships between these four physical variables and the mean number or weight of fishes impinged.

These results are not surprising, because the impingement data are quite variable and it also is very likely that impingement is influenced by a combination of factors, rather than one or two in isolation. For example, it might be argued that impingement was highest in the late fall, winter and early spring, when water temperatures were lowest (Figures 7.5-1 through 7.5-8). Yet this also was the period of increased cloud cover, storm conditions, intermittently reduced salinity, and dredging in Agua Hedionda Lagoon.

As a means of evaluating the effects of storm conditions on impingement, Mann-Whitney U tests were applied to data for total number and total weight of impinged fishes, shown in Table 7.5-3. Five distinct intervals of storm conditions during the period February 20-May 12, 1979 were selected, using the physical data noted in Table 7.5-3 as a guide. These five periods were characterized by wind speeds $\geq$12 mph (16 kph), rainfall, salinities $\leq$29.9 ppt in the lagoon, and, in four of the five cases, by ocean wave heights greater than 4 ft (1.2 m).

All data for a period of 4 to 7 days before the storm began were compared with all data from the same number of days after the onset of the storm. For example, in evaluating effects of the storm that began on February 20, 1979, data for the four days preceding that date were compared with those for the four-day period starting February 20. Values from each 12-hr sampling interval for total number and total weight of all fishes impinged were analyzed separately by station.

The Mann-Whitney U tests evaluated the null hypothesis that there was no difference in levels of impingement between the two consecutive time periods, against the one-way alternative hypothesis that the level of impingement during storm conditions was significantly greater than that just preceding the storm. The results of these Mann-Whitney U test comparisons were as follows (SIG indicates a significant difference at the level of significance shown; NS indicates difference not significant):

	Station 1		Station 4		Station 5	
Inclusive Dates	Number	Weight	Number	Weight	Number	Weight
2/16 - 2/24	SIG ($p< .10$)	SIG ($p< .05$)	SIG ($p< .05$)	SIG ($p< .05$)	SIG ($p< .05$)	SIG ($p< .05$)
3/8 - 3/22	SIG ($p< .10$)	NS	Unit Off		NS	SIG ($p< .05$)
3/23 - 3/30	NS	NS	Unit Off		NS	NS
4/5 - 4/13	SIG ($p< .05$)	SIG ($p< .05$)	Unit Off		SIG ($p< .05$)	NS
5/3 - 5/12	SIG ($p< .05$)	SIG ($p< .10$)	Unit Off		Unit Off	

The results show that in 13 of the 20 comparisons, the total number or weight of fishes impinged was significantly greater following the onset of storm conditions and reduced salinity than during the period just preceding the storm. In some of the remaining seven cases that did not show a statistically significant difference, there also was a tendency for the numbers and weights of fishes impinged to be higher following the onset of a storm than just before it (Table 7.5-3). This evidence indicates that the combination of conditions associated with storms during the winter and spring months often causes a significant increase in the number and biomass of fishes impinged at the traveling screens of the Encina Power Plant.

During the period February 20-April 25, 1979, maintenance dredging was done by SDG&E to remove accumulated sediment from the outer portion of Agua Hedionda Lagoon. The dredge was operated six days per week (Monday through Saturday) during this entire period. There was considerable disturbance of the sediment and turbidity levels were relatively high in the outer lagoon.

As indicated in Table 7.5-1 and Figures 7.5-1 through 7.5-8, the highest total numbers and weights of fishes for the 336-day period of the study were impinged at stations 4 and 5 during the week of February 18-24, and primarily after February 20 (Table 7.5-3). There also was a less pronounced but evident increase in the level of impingement at station 1 after dredging commenced.

This apparent effect of dredging was evaluated further by using a Mann-Whitney U test to compare weekly mean values for total number and weight of fishes impinged (Table 7.5-1) for the period February 18-April 28 with those for the succeeding period of April 29-June 23. The data for all traveling screen stations combined were used. The Mann-Whitney U test evaluated the null hypothesis that there was no difference in mean weekly levels of impingement during and following the dredging operations, against the one-way alternative hypothesis that mean weekly levels of impingement were significantly greater during the dredging operations than following them. The results of these statistical comparisons indicate that there was no significant difference ($p>0.05$) in mean number of fishes impinged during and after the dredging operations, while the mean weight of fishes was significantly greater ($p<0.05$) during dredging than following it.

In combination, the evidence described above indicates that dredging operations did have a significant effect in increasing the impingement of fishes. The same was true for motile invertebrate species inhabiting the unconsolidated sediment bottom of outer Agua Hedionda Lagoon. During the period of dredging several of these species, including particularly the crabs Portunus xantusi and Cancer spp. and the black spotted shrimp Crangon nigromaculata, were very abundant in the impingement samples.

Unfortunately, the period of dredging overlapped that of storm conditions during the winter and early spring. Because of this, it is difficult to separate the effects of these two confounding variables in evaluating the data.

Shown in Table 7.5-4 are the mean numbers of individuals of each critical species impinged per 24-hr sampling interval within each week during the period February 4, 1979-January 4, 1980. Corresponding mean weight data for these species are summarized in Table 7.5-5. The overall mean numbers and weights of each critical species impinged per 24-hr interval for the 336-day sampling period as a whole, based on that data in Tables 7.5-4 and 7.5-5, are given in Table 7.5-6. All of these values are

TABLE 7.5-4

WEEKLY MEAN NUMBERS OF CRITICALLY-TREATED FISH SPECIES IMPINGED AT THE ENCINA POWER PLANT PER 24-HR INTERVAL DURING THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

SPECIES NAME	WEEK 1 (Feb 4)	2 (Feb 11)	3 (Feb 18)	4 (Feb 25)	5 (Mar 4)	6 (Mar 11)	7 (Mar 18)	8 (Mar 25)
UROLOPHUS HALLERI	13.5	6.2	3.5	1.3	.9	.7	.9	.9
ENGRAULIS MORDAX	.2	.4	.9	1.0	.1	.1	.5	.2
ANCHOA COMPRESSA	15.6	24.4	160.7	38.3	1.7	7.8	6.6	3.8
ANCHOA DELICATISSIMA	2.0	6.4	12.9	2.8	3.3	4.6	4.1	2.2
LEURESTHES TENUIS	.8	.7	.0	.2	.0	.4	.4	.4
ATHERINOPS AFFINIS	100.5	44.0	136.4	46.6	3.8	3.5	1.6	2.1
PARALABRAX CLATHRATUS	.0	.0	.0	.0	.0	.0	.1	.0
PARALABRAX MACULATOFASCIATUS	.0	.0	.2	.3	.0	.0	.0	.0
PARALABRAX NEBULIFER	.0	.0	.8	.4	.1	.1	.1	.0
XENISTIUS CALIFORNIENSIS	5.4	.4	.0	.0	.1	.1	.1	.1
SERIPHUS POLITUS	8.0	2.9	31.0	11.6	5.8	2.4	2.0	1.3
MENTICIRRHUS UNDULATUS	.0	.0	.2	.0	.0	.0	.0	.0
AMPHISTICHUS ARGENTEUS	.0	.1	.0	.0	.1	.1	.0	.0
HYPERPROSOPON ARGENTEUM	.5	.6	15.2	2.9	.2	.3	.4	1.0
CYMATOGASTER AGGREGATA	3.0	1.0	63.0	7.8	1.4	.6	.7	.6
PHANERODON FURCATUS	.0	.0	1.7	.0	.1	.0	.1	.1
MUGIL CEPHALUS	.3	.0	.2	.3	.0	.1	.1	.1
PARALICHTHYS CALIFORNICUS	1.6	2.1	11.3	3.0	.8	.9	1.1	.3

SPECIES NAME	WEEK 9 (Apr 1)	10 (Apr 8)	11 (Apr 15)	12 (Apr 22)	13 (Apr 29)	14 (May 6)	15 (May 13)	16 (May 20)
UROLOPHUS HALLERI	2.2	1.0	.9	1.4	.6	.9	.4	1.1
ENGRAULIS MORDAX	.2	.1	.2	1.1	.0	.0	.1	.0
ANCHOA COMPRESSA	46.5	.6	.1	.4	.0	.1	.0	.0
ANCHOA DELICATISSIMA	.0	.1	.0	.1	.0	.0	.0	.0
LEURESTHES TENUIS	.6	.2	.4	2.2	.1	.1	.4	.3
ATHERINOPS AFFINIS	74.2	1.7	1.4	3.7	1.8	2.1	.9	1.6
PARALABRAX MACULATOFASCIATUS	.1	.0	.0	.0	.0	.1	.0	.1
PARALABRAX NEBULIFER	.4	.0	.1	.0	.0	.0	.0	.0
XENISTIUS CALIFORNIENSIS	.1	.1	.0	.1	.0	.0	.0	.0
SERIPHUS POLITUS	3.0	1.7	1.1	3.7	.5	1.6	1.3	1.0
MENTICIRRHUS UNDULATUS	.0	.1	.0	.4	.0	.0	.0	.0
AMPHISTICHUS ARGENTEUS	.0	.4	.0	.1	.0	2.9	.0	.1
HYPERPROSOPON ARGENTEUM	4.6	1.1	1.1	3.7	5.8	48.0	15.0	5.0
CYMATOGASTER AGGREGATA	.9	1.9	2.7	2.7	1.7	1.6	.9	2.0
PHANERODON FURCATUS	.1	.0	.0	.4	1.5	34.1	9.4	33.4
MUGIL CEPHALUS	.2	.1	.0	.1	.0	.0	.0	.1
PARALICHTHYS CALIFORNICUS	.1	.4	.0	.2	.1	.0	.0	.3

TABLE 7.5-4 (Continued)

SPECIES NAME	WEEK 17 (May 27)	18 (Jun 3)	19 (Jun 10)	20 (Jun 17)	21 (Jun 24)	22 (July 1)	23 (July 8)	24 (July 15)
UROLOPHUS HALLERI	1.0	.8	1.5	2.5	.9	.6	1.5	.3
ENGRAULIS MORDAX	.0	.2	.7	10.3	8.3	3.3	61.7	4.0
ANCHOA COMPRESSA	.4	7.9	11.9	43.5	44.0	24.6	30.5	13.1
ANCHOA DELICATISSIMA	.3	.2	.6	4.0	1.6	.6	.2	.0
LEURESTHES TENUIS	.1	.1	.2	2.8	7.3	1.5	4.0	.8
ATHERINOPS AFFINIS	1.3	4.1	4.4	7.1	9.9	4.8	11.5	4.5
PARALABRAX CLATHRATUS	.0	.0	.0	.1	.0	.0	.0	.0
PARALABRAX MACULATOFASCIATUS	.0	.0	.1	.2	.0	.0	.0	.0
PARALABRAX NEBULIFER	.0	.0	.1	.6	.4	.2	.2	.0
XENISTIUS CALIFORNIENSIS	.0	.0	.1	.2	.3	.0	.0	.0
SERIPHUS POLITUS	1.9	5.3	5.6	60.4	27.4	53.1	32.1	21.0
CYNOSCION NOBILIS	.0	.0	.0	.4	.0	.0	.0	.0
MENTICIRRHUS UNDULATUS	.0	.0	.0	.1	.0	.0	.0	.3
AMPHISTICHUS ARGENTEUS	.0	.1	.0	.0	.2	.0	.4	.0
HYPERPROSOPON ARGENTEUM	5.0	1.4	1.0	6.9	2.4	1.4	3.0	1.5
CYMATOGASTER AGGREGATA	3.6	8.8	16.9	26.8	51.4	21.5	39.7	6.4
PHANERODON FURCATUS	27.7	7.0	4.8	8.5	7.7	5.4	5.2	1.5
MUGIL CEPHALUS	.0	.9	.0	.1	.0	.0	.0	.0
PARALICHTHYS CALIFORNICUS	.0	.2	.5	3.0	1.4	1.7	3.8	1.9

SPECIES NAME	WEEK 25 (July 22)	26 (July 29)	27 (Aug 5)	28 (Aug 12)	29 (Aug 19)	30 (Aug 26)	31 (Sept 2)	32 (Sept 9)
UROLOPHUS HALLERI	.2	4.2	.4	.1	.4	.4	.4	.2
ENGRAULIS MORDAX	46.3	26.6	5.0	6.0	126.2	25.0	25.0	2.4
ANCHOA COMPRESSA	10.1	26.4	1.6	10.1	5.2	7.1	12.4	2.5
ANCHOA DELICATISSIMA	.0	3.3	.4	5.1	4.1	2.7	1.1	2.1
LEURESTHES TENUIS	.0	.3	.8	.4	6.0	2.4	13.7	1.7
ATHERINOPS AFFINIS	5.9	3.7	1.8	3.2	8.1	7.3	2.4	.2
PARALABRAX CLATHRATUS	.0	.0	.0	.0	.2	.0	.1	.0
PARALABRAX MACULATOFASCIATUS	.0	1.3	.0	.0	.2	.0	.0	.0
PARALABRAX NEBULIFER	.8	1.5	.4	.0	.0	.6	.6	.0
XENISTIUS CALIFORNIENSIS	.0	.2	.0	.0	.1	.1	.0	.0
SERIPHUS POLITUS	22.6	33.8	15.9	48.0	19.9	40.4	51.5	20.8
CYNOSCION NOBILIS	.0	.0	.0	.0	.0	.0	.0	.4
MENTICIRRHUS UNDULATUS	.0	.0	.0	.1	.0	.0	.0	.0
HYPERPROSOPON ARGENTEUM	.2	.2	.0	.6	.5	.2	.9	.0
CYMATOGASTER AGGREGATA	19.0	3.4	7.8	.4	.8	.5	1.7	.7
PHANERODON FURCATUS	1.6	1.8	.9	.4	.2	.0	.9	.0
MUGIL CEPHALUS	.0	.0	.0	.1	.0	.0	.2	.0
PARALICHTHYS CALIFORNICUS	3.1	1.2	1.0	2.7	2.9	.5	2.8	.4

TABLE 7.5-4 (Concluded)

SPECIES NAME	WEEK 33 (Sept 16)	34 (Sept 23)	35 (Sept 30)	36 (Oct 7)	37 (Oct 14)	38 (Oct 21)	39 (Oct 28)	40 (Nov 4)
UROLOPHUS HALLERI	.6	.7	1.1	.8	.4	.9	.3	.4
ENGRAULIS MORDAX	1.5	7.3	1.0	1.5	.8	3.3	8.1	1.4
ANCHOA COMPRESSA	.7	7.3	5.9	4.8	5.3	11.8	11.4	10.1
ANCHOA DELICATISSIMA	.7	2.9	1.5	1.1	1.0	13.3	.3	.9
LEURESTHES TENUIS	9.4	20.5	10.0	6.4	10.4	26.1	47.1	16.4
ATHERINOPS AFFINIS	.8	1.5	3.0	3.3	.5	4.1	4.8	2.9
PARALABRAX CLATHRATUS	.0	.0	.0	.0	.0	.0	.0	.2
PARALABRAX MACULATOFASCIATUS	.0	.0	.0	.0	.5	.0	.4	.0
PARALABRAX NEBULIFER	.0	.1	.2	.1	.3	.0	.3	.0
XENISTIUS CALIFORNIENSIS	.0	.0	.0	.0	.0	.0	.0	.8
SERIPHUS POLITUS	12.2	18.1	34.0	14.6	22.9	39.7	35.4	33.0
CYNOSCION NOBILIS	.0	.1	.1	.1	.0	.0	.0	.1
MENTICIRRHUS UNDULATUS	.1	.0	.6	.2	.1	1.3	.3	.1
AMPHISTICHUS ARGENTEUS	.0	.0	.1	.0	.0	.0	.3	.0
HYPERPROSOPON ARGENTEUM	.0	.2	.7	.2	.3	1.0	1.3	2.3
CYMATOGASTER AGGREGATA	.1	.5	.5	.6	.1	.3	.3	1.3
PHANERODON FURCATUS	.0	.0	.1	.0	.1	.0	.8	.2
MUGIL CEPHALUS	.0	.1	.0	.0	.0	.3	.3	.2
PARALICHTHYS CALIFORNICUS	1.8	.1	1.4	.0	.0	.9	1.1	.6

SPECIES NAME	WEEK 41 (Nov 11)	42 (Nov 18)	43 (Nov 25)	44 (Dec 2)	45 (Dec 9)	46 (Dec 16)	47 (Dec 23)	48 (Dec 30)
UROLOPHUS HALLERI	1.8	1.8	7.4	8.2	1.3	6.3	5.2	1.9
ENGRAULIS MORDAX	2.1	1.7	2.4	1.6	.8	.2	.6	1.7
ANCHOA COMPRESSA	21.5	8.9	31.1	2.5	3.4	3.4	3.5	2.6
ANCHOA DELICATISSIMA	2.2	1.4	2.6	.2	.1	2.9	.6	.4
LEURESTHES TENUIS	17.3	134.7	96.6	12.1	5.5	2.4	1.5	.9
ATHERINOPS AFFINIS	2.7	7.4	10.3	17.0	1.4	4.6	3.1	4.2
PARALABRAX CLATHRATUS	.1	.2	.4	.3	.0	.0	.2	.2
PARALABRAX MACULATOFASCIATUS	.3	.3	.0	.0	.0	.0	.0	.0
PARALABRAX NEBULIFER	.0	.4	.8	.5	.0	.0	.0	.0
XENISTIUS CALIFORNIENSIS	.6	4.1	6.5	2.1	1.7	.6	1.7	2.4
SERIPHUS POLITUS	57.0	69.7	33.2	24.5	11.7	35.4	5.3	3.2
CYNOSCION NOBILIS	.0	.0	.0	.1	.0	.0	.0	.0
MENTICIRRHUS UNDULATUS	.2	.7	.3	.2	.3	.8	.0	.0
AMPHISTICHUS ARGENTEUS	.0	.8	.3	.3	.0	.0	.0	.0
HYPERPROSOPON ARGENTEUM	3.2	3.9	1.8	.9	.1	.8	1.1	.3
CYMATOGASTER AGGREGATA	.1	1.3	5.1	4.7	3.6	.6	14.8	.9
PHANERODON FURCATUS	.6	.0	.4	.1	.0	.3	.0	.0
MUGIL CEPHALUS	.0	.2	.0	.1	.0	.1	.0	.0
PARALICHTHYS CALIFORNICUS	.0	.9	1.7	.8	1.1	1.5	.6	.5

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TABLE 7.5-5

WEEKLY MEAN WEIGHT (g) OF EACH CRITICALLY-TREATED SPECIES IMPINGED AT ENCINA POWER PLANT PER 24-HR SAMPLING INTERVAL DURING THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

SPECIES NAME	WEEK 1 (Feb 4)	2 (Feb 11)	3 (Feb 18)	4 (Feb 25)	5 (Mar 4)	6 (Mar 11)	7 (Mar 18)	8 (Mar 25)
UROLOPHUS HALLERI	1079.6	540.1	399.6	123.6	82.3	94.4	157.2	107.4
ENGRAULIS MORDAX	.9	1.0	5.5	9.4	.7	.4	2.2	1.0
ANCHOA COMPRESSA	197.0	198.8	1744.6	292.3	11.2	52.6	35.9	22.2
ANCHOA DELICATISSIMA	4.4	20.9	40.1	10.5	8.6	13.1	12.4	6.6
LEURESTHES TENUIS	4.1	2.8	.0	1.4	.0	2.3	2.7	3.9
ATHERINOPS AFFINIS	651.5	348.0	2123.8	688.4	85.3	80.4	39.6	54.7
PARALABRAX CLATHRATUS	.0	.0	.0	.0	.0	.0	.4	.0
PARALABRAX MACULATOFASCIATUS	.0	.0	.6	22.8	.0	.0	.0	.0
PARALABRAX NEBULIFER	.2	.0	5.1	16.3	.0	.3	1.8	.0
XENISTIUS CALIFORNIENSIS	14.4	1.0	.0	.0	2.1	.2	.4	.2
SERIPHUS POLITUS	128.4	38.2	1101.3	370.5	105.7	37.9	127.4	22.6
MENTICIRRHUS UNDULATUS	.0	.0	18.7	.0	.0	.0	.0	.0
AMPHISTICHUS ARGENTEUS	.0	11.6	5.5	.0	3.6	3.0	.0	.0
HYPERPROSOPON ARGENTEUM	21.3	28.5	777.9	176.3	4.0	14.6	12.9	62.4
CYMATOGASTER AGGREGATA	54.5	31.7	1691.3	244.0	46.9	19.3	31.4	13.4
PHANERODON FURCATUS	.0	.0	148.2	7.9	13.1	.0	29.8	13.1
MUGIL CEPHALUS	720.3	.0	117.1	193.3	.0	41.4	104.9	98.2
PARALICHTHYS CALIFORNICUS	96.2	151.8	971.2	853.9	31.4	45.9	40.5	7.9

SPECIES NAME	WEEK 9 (Apr 1)	10 (Apr 8)	11 (Apr 15)	12 (Apr 22)	13 (Apr 29)	14 (May 6)	15 (May 13)	16 (May 20)
UROLOPHUS HALLERI	721.8	109.0	66.7	92.0	49.1	82.7	66.6	58.7
ENGRAULIS MORDAX	1.6	1.3	1.8	10.1	.0	.0	.1	.0
ANCHOA COMPRESSA	410.6	6.1	1.8	2.4	.0	1.3	.0	.0
ANCHOA DELICATISSIMA	.0	.2	.0	.5	.0	.0	.0	.0
LEURESTHES TENUIS	3.4	2.1	5.4	27.6	.8	1.1	4.4	5.6
ATHERINOPS AFFINIS	1311.0	47.0	25.0	71.6	41.3	32.0	5.4	19.1
PARALABRAX MACULATOFASCIATUS	12.5	.0	.0	.0	.0	20.7	.0	64.6
PARALABRAX NEBULIFER	153.3	.0	11.6	.0	.0	.0	.0	.0
XENISTIUS CALIFORNIENSIS	.2	.2	.0	.2	.0	.0	.0	.0
SERIPHUS POLITUS	162.3	8.1	9.4	19.9	3.8	10.9	3.4	4.1
MENTICIRRHUS UNDULATUS	.0	.6	.0	59.6	.0	.0	.0	.0
AMPHISTICHUS ARGENTEUS	.0	6.0	.0	1.1	.0	8.3	.0	.4
HYPERPROSOPON ARGENTEUM	187.0	50.5	65.9	106.0	159.6	244.1	80.6	23.6
CYMATOGASTER AGGREGATA	24.8	53.4	95.9	63.2	28.3	25.4	9.3	12.9
PHANERODON FURCATUS	13.2	.0	.0	1.5	15.5	96.9	26.4	133.6
MUGIL CEPHALUS	86.5	42.2	.0	30.7	.0	.0	.0	136.0
PARALICHTHYS CALIFORNICUS	4.3	17.9	.0	58.4	4.0	.0	.0	1.4

TABLE 7.5-5 (Continued)

SPECIES NAME	WEEK 17 (May 27)	18 (Jun 3)	19 (Jun 10)	20 (Jun 17)	21 (Jun 24)	22 (July 1)	23 (July 8)	24 (July 15)
UROLOPHUS HALLERI	46.3	106.3	199.1	327.6	74.8	48.4	199.7	33.5
ENGRAULIS MORDAX	.0	1.5	3.6	68.2	18.9	11.8	237.1	13.8
ANCHOA COMPRESSA	11.9	41.1	71.1	258.8	261.4	175.0	206.0	102.0
ANCHOA DELICATISSIMA	1.0	.5	1.3	9.0	5.1	1.9	.7	.0
LEURESTHES TENUIS	1.7	1.5	4.5	35.9	73.7	20.1	36.6	8.3
ATHERINOPS AFFINIS	17.7	89.2	70.8	106.8	165.0	94.9	158.8	52.9
PARALABRAX CLATHRATUS	.0	.0	.0	.0	.0	.0	.0	.0
PARALABRAX MACULATOFASCIATUS	.0	.0	.6	13.6	.0	.0	.0	.0
PARALABRAX NEBULIFER	.0	.0	.7	14.8	137.6	31.7	1.4	.0
XENISTIUS CALIFORNIENSIS	.0	.0	.5	1.6	12.3	.0	.0	.0
SERIPHUS POLITUS	3.6	21.1	27.9	328.2	193.6	234.4	202.8	93.4
CYNOSCION NOBILIS	.0	.0	.0	1.9	.0	.0	.0	.0
MENTICIRRHUS UNDULATUS	.0	.0	.0	1.9	.0	.0	.0	151.4
AMPHISTICHUS ARGENTEUS	.0	.3	.0	.0	1.2	.0	8.9	.0
HYPERPROSOPON ARGENTEUM	53.3	14.3	39.7	36.6	38.2	24.0	44.0	26.3
CYMATOGASTER AGGREGATA	18.4	34.2	65.7	117.9	261.5	91.8	219.2	37.1
PHANERODON FURCATUS	117.4	32.1	22.7	64.5	56.0	48.7	190.0	32.3
MUGIL CEPHALUS	.0	4.3	.0	27.6	.0	.0	.0	.0
PARALICHTHYS CALIFORNICUS	.0	7.8	12.8	121.6	46.3	50.7	90.7	68.4

SPECIES NAME	WEEK 25 (July 22)	26 (July 29)	27 (Aug 5)	28 (Aug 12)	29 (Aug 19)	30 (Aug 26)	31 (Sept 2)	32 (Sept 9)
UROLOPHUS HALLERI	10.9	727.6	91.9	17.1	38.5	59.0	65.3	27.8
ENGRAULIS MORDAX	90.0	46.8	8.4	9.6	343.1	59.9	60.9	7.3
ANCHOA COMPRESSA	74.1	156.1	8.4	40.0	33.8	37.8	65.5	12.7
ANCHOA DELICATISSIMA	.0	10.8	.9	10.9	11.3	5.1	2.4	2.8
LEURESTHES TENUIS	.0	.8	8.3	2.9	49.4	17.8	115.6	17.3
ATHERINOPS AFFINIS	53.1	50.9	15.3	37.4	102.6	97.1	26.9	1.7
PARALABRAX CLATHRATUS	.0	.0	.0	.0	6.0	.0	4.0	.0
PARALABRAX MACULATOFASCIATUS	.0	246.3	.0	.0	212.4	.0	.0	.0
PARALABRAX NEBULIFER	5.5	258.1	64.8	.0	.0	64.0	93.3	.0
XENISTIUS CALIFORNIENSIS	.0	2.2	.0	4.3	9.4	4.0	.0	.0
SERIPHUS POLITUS	161.7	275.6	92.2	169.5	94.7	128.9	381.3	78.5
CYNOSCION NOBILIS	.0	.0	.0	.0	.0	.3	.0	2.2
MENTICIRRHUS UNDULATUS	.0	.0	.0	201.3	.0	.0	.0	.0
HYPERPROSOPON ARGENTEUM	1.4	8.2	.0	5.9	4.1	8.4	26.1	.0
CYMATOGASTER AGGREGATA	154.4	25.7	78.6	6.8	9.2	8.8	41.1	7.1
PHANERODON FURCATUS	19.7	26.8	12.3	1.1	2.5	.8	14.4	.0
MUGIL CEPHALUS	.0	.0	.0	37.2	.0	.0	.0	.0
PARALICHTHYS CALIFORNICUS	102.5	11.2	11.8	79.9	76.2	16.4	97.7	13.2

TABLE 7.5-5 (Concluded)

SPECIES NAME	WEEK 33 (Sept 16)	34 (Sept 23)	35 (Sept 30)	36 (Oct 7)	37 (Oct 14)	38 (Oct 21)	39 (Oct 28)	40 (Nov 4)
UROLOPHUS HALLERI	123.3	132.9	141.3	36.9	99.9	147.1	52.0	102.4
ENGRAULIS MORDAX	6.6	29.4	3.3	3.6	1.8	8.5	69.9	11.3
ANCHOA COMPRESSA	4.6	60.8	54.5	42.3	30.0	57.4	55.1	58.8
ANCHOA DELICATISSIMA	6.9	5.0	3.5	2.4	1.8	28.7	.6	2.3
LEURESTHES TENUIS	104.0	293.7	114.7	59.6	81.7	234.2	400.8	131.8
ATHERINOPS AFFINIS	10.7	16.0	29.0	29.5	11.4	35.3	47.9	52.3
PARALABRAX CLATHRATUS	.0	.0	.0	.0	.0	.0	.0	1.2
PARALABRAX MACULATOFASCIATUS	.0	.0	.0	.0	32.4	.0	4.1	.0
PARALABRAX NEBULIFER	.0	.3	.8	.3	12.3	.0	3.1	.0
XENISTIUS CALIFORNIENSIS	.0	.2	.1	.0	.0	.0	.0	2.6
SERIPHUS POLITUS	49.5	86.2	144.8	93.6	91.2	201.1	172.4	174.0
CYNOSCION NOBILIS	.0	1.0	3.1	1.2	.0	.0	.0	1.3
MENTICIRRHUS UNDULATUS	.7	.0	2.0	1.3	.2	2.6	.8	.3
AMPHISTICHUS ARGENTEUS	.0	.0	9.3	.0	.0	.0	4.7	.0
HYPERPROSOPON ARGENTEUM	.0	2.5	6.1	2.0	15.4	15.3	38.3	45.2
CYMATOGASTER AGGREGATA	1.6	6.3	9.2	7.4	1.0	4.5	2.8	18.3
PHANERODON FURCATUS	.0	.0	1.2	.0	5.8	.0	52.3	4.4
MUGIL CEPHALUS	25.5	12.6	.0	.0	.0	264.9	191.9	166.5
PARALICHTHYS CALIFORNICUS	35.3	6.7	49.8	.0	.8	22.5	94.4	37.6

SPECIES NAME	WEEK 41 (Nov 11)	42 (Nov 18)	43 (Nov 25)	44 (Dec 2)	45 (Dec 9)	46 (Dec 16)	47 (Dec 23)	48 (Dec 30)
UROLOPHUS HALLERI	332.5	353.2	606.7	601.8	88.4	533.7	299.4	73.5
ENGRAULIS MORDAX	12.2	7.1	17.6	10.8	3.7	1.9	3.3	7.6
ANCHOA COMPRESSA	66.6	57.7	94.6	12.8	14.9	21.0	27.3	17.6
ANCHOA DELICATISSIMA	4.6	2.9	3.6	.5	.1	6.7	.9	.7
LEURESTHES TENUIS	93.6	710.9	353.7	63.7	26.8	13.8	7.0	11.4
ATHERINOPS AFFINIS	33.3	114.8	59.1	118.4	14.3	41.8	36.1	31.4
PARALABRAX CLATHRATUS	.4	2.3	6.2	3.3	.0	.0	1.9	2.3
PARALABRAX MACULATOFASCIATUS	1.4	.5	.6	.0	.0	.0	.0	.0
PARALABRAX NEBULIFER	.0	2.5	25.3	3.0	.0	.0	.0	.0
XENISTIUS CALIFORNIENSIS	1.7	12.1	22.8	6.1	5.1	1.2	5.4	9.3
SERIPHUS POLITUS	277.9	302.2	114.6	179.7	63.3	180.4	28.4	25.1
CYNOSCION NOBILIS	.0	.0	.0	.6	.0	.0	.0	.0
MENTICIRRHUS UNDULATUS	2.1	5.2	1.3	1.7	62.1	5.3	.0	.0
AMPHISTICHUS ARGENTEUS	.0	14.0	5.9	5.2	.9	.0	.0	.0
HYPERPROSOPON ARGENTEUM	192.0	174.6	37.6	18.3	2.2	26.7	22.5	4.9
CYMATOGASTER AGGREGATA	1.4	17.4	92.2	87.9	63.8	12.7	280.8	8.0
PHANERODON FURCATUS	18.4	.0	7.4	.8	.0	6.8	.0	.0
MUGIL CEPHALUS	.0	222.5	.0	93.1	.0	178.4	.0	.0
PARALICHTHYS CALIFORNICUS	25.7	46.7	75.9	36.5	114.3	47.0	31.6	12.9

TABLE 7.5-6

OVERALL MEAN NUMBER AND WEIGHT OF CRITICALLY-TREATED SPECIES† IMPINGED AT ENCINA POWER PLANT PER 24-HR INTERVAL DURING THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

Rank	Common Name	Species Name	Mean Number	Mean Weight (g)
1	Queenfish	*Seriphus politus* (C)	20.5	142.2
2	Deepbody anchovy	*Anchoa compressa* (AC)	12.8	106.6
3	Topsmelt	*Atherinops affinis* (C)	12.0	155.3
4	California grunion	*Leuresthes tenuis* (AC)	10.2	65.9
5	Northern anchovy	*Engraulis mordax* (C)	8.2	25.3
6	Shiner surfperch	*Cymatogaster aggregata* (AC)	7.0	88.3
8	Walleye surfperch	*Hyperprosopon argenteum* (C)	3.1	61.5
9	Slough anchovy	*Anchoa delicatissima* (AC)	1.2	5.2
10	White surfperch	*Phanerodon furcatus* (AC)	3.3	25.8
11	Round stingray	*Urolophus halleri* (AC)	1.9	200.6
12	California halibut	*Paralichthys californicus* (C)	1.3	77.2
13	Giant kelpfish	*Heterostichus rostratus* (C)	0.8	6.8
16	Salema	*Xenistius californiensis* (AC)	0.6	2.5
27	Barred sand bass	*Paralabrax nebulifer* (C)	0.2	19.3
33	California corbina	*Menticirrhus undulatus* (C)	0.1	10.8
36	Barred surfperch	*Amphistichus argenteus* (C)	0.1	1.9
36	Spotted sand bass	*Paralabrax maculatofasciatus* (C)	0.1	13.2
37	Striped mullet	*Mugil cephalus* (C)	0.4	58.6
49	Kelp bass	*Paralabrax clathratus* (C)	0.04	0.6
56	White seabass	*Cynoscion nobilis* (C)	0.03	0.2
	California sheephead	*Pimelometopon pulchrum* (C)	0.0	0.0
	Pacific sanddab	*Citharicthys sordidus* (C)	0.0	0.0
	Hornyhead turbot	*Pleuronichthys verticalis* (C)	0.0	0.0

† Symbols (C) and (AC) are used to indicate critical and additionally-treated critical species.

averages based on data from the three traveling screen stations, not totals for all stations combined.

As indicated in Table 7.5-6, the queenfish (Seriphus politus) had the highest overall mean number of individuals impinged (20.5 per 24 hr). It had the third highest mean level of impingement by weight (142.2 g or 0.31 lb per 24 hr). The round stingray (Urolophus halleri) had the highest mean level of impingement by weight (200.6 g or 0.44 lb per 24 hr). The deepbody anchovy (Anchoa compressa) and the topsmelt (Atherinops affinis) were second and third in number of individuals impinged with 12.8 and 12.0 per 24 hr, respectively. Topsmelt had the second highest mean level of impingement by weight (155.3 g or 0.34 lb per 24 hr), while deepbody anchovy was fourth with 106.6 g (0.24 lb) per 24 hr. The California grunion (Leuresthes tenuis) was fourth in mean number of individuals impinged per 24-hr interval (10.2) and sixth in mean weight (65.9 g or 0.15 lb).

The weekly means for number and weight of individuals impinged shown in Tables 7.5-4 and 7.5-5, respectively, provide detailed information about short-term and seasonal variations in impingement of the critical species. Impingement of queenfish was continuous throughout the year. Highest mean numbers of individuals were impinged during the period mid-June through early September, when ambient water temperatures were highest (Figure 7.5-9), and again in November. Lowest mean numbers of queenfish were impinged during the period March-May, during a period of relatively low water temperatures. However, the largest mean weight of individuals impinged was during the week of February 18 (1101.3 g or 2.4 lb per 24 hr). Impingement of round stingray also was continuous and variable throughout the year (Tables 7.5-4 and 7.5-5). The largest mean number (13.5) and weight (1076.9 g or 2.4 lb) of individuals were impinged during the week of February 4, when water temperatures were low. The lowest mean numbers (0.1 to 0.4 individuals per 24 hr) were impinged during the period July-September, when ambient water temperatures were highest.

The highest mean numbers of deepbody anchovy (100.5 to 160.7 per 24 hr) were impinged in February, and the lowest mean numbers (0.4 per 24 hr) from mid-April through May (Table 7.5-4). The largest mean weight of individuals (1744.6 g or 3.9 lb per 24 hr) also was impinged in February (Table 7.5-5). Topsmelt also showed very definite peaks in mean number impinged (100.5 to 136.4 per 24 hr) during February, generally lower numbers throughout most of the rest of the year, and lowest mean numbers impinged during April and May. Mean weights of topsmelt showed a similar pattern.

Impingement of California grunion was relatively continuous throughout the year, with increasing numbers during September and October and a peak in mean number impinged during November (134.7 per 24 hr). Lowest mean numbers were impinged during the period February through June (Table 7.5-4). In general, mean weights of this species showed a similar pattern (Table 7.5-5). The northern anchovy (Engraulis mordax) also occurred in the impingement samples almost continuously throughout the year, with lowest mean numbers during the period September through early June. This was followed by variable but increasing mean numbers during June and July, with a peak of 126.2 per 24 hr in August. Mean weights of northern anchovy impinged showed a similar pattern.

Shiner surfperch had relatively high levels of impingement from late May through late July, with lower, variable levels throughout the rest of the year. However, the largest mean weight of shiner surfperch was impinged in February (1101.3 g or 2.4 lb per 24 hr). Both the walleye surfperch (Hyperprosopon argenteum) and the white surfperch (Phanerodon furcatus) had the largest mean numbers of individuals impinged in May, relatively large mean numbers during the early summer months, and much lower numbers during the remainder of the year (Table 7.5-4).

The California halibut (Paralichthys californicus) had the highest levels of impingement, in terms of both mean number and weight, during February (11.3 individuals per 24 hr; 971.2 g or 2.1 lb per 24 hr). Its levels of impingement were lower throughout the remainder of the year. Most of these individuals were small to large juveniles and small adults.

The short-term and seasonal patterns of impingement for most of the remaining critical species are much less clear (Tables 7.5-4 and 7.5-5). This is due in part to the fact that relatively few individuals were taken in the impingement samples.

None of these remaining species showed distinct short-term or seasonal patterns of impingement.

7.6 DAY VS NIGHT VARIATION

It is evident from examining the detailed data in Table 7.5-3 that, in general, total numbers and weights of fishes impinged seemed to be higher during the predominantly night time sampling period (1900 to 0700 hr) than during the preceding daytime period (0700 to 1900 hr). This was tested by applying a series of Wilcoxon paired-sample tests to the data for all three traveling screen stations combined. These data for numbers of individuals are shown in Table 7.6-1.

Separate tests were used to evaluate data for each week of sampling and for total number and total weight of all fishes impinged. The data for the 12-hr day and night periods of each date (Tables 7.5-3 and 7.6-1) were treated as pairs. The Wilcoxon paired-sample tests evaluated the null hypothesis that there was no difference in levels of impingement between the 12-hr day and night periods, against the one-way alternative hypothesis that levels of impingement were significantly higher at night than during the day.

The results of these tests for total number of fishes indicated that during 47 of the 48 weeks considered, impingement was significantly greater ($p<0.05$) at night than during the day. Similarly, the results for total weight of fishes indicated that during 44 of the 48 weeks considered, impingement also was significantly greater ($p<0.05$) at night than during the day.

The relationships described above are very strikingly evident in the comparative plots for numbers of individuals

TABLE 7.6-1
WEEKLY MEAN TOTAL NUMBER OF FISH IMPINGED PER 12-HR DAY AND NIGHT SAMPLING INTERVAL AT ENCINA POWER PLANT DURING THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

WEEK	DAY	NIGHT
1	80.9	92.1
2	22.4	77.0
3	182.2	293.2
4	64.5	84.3
5	14.7	13.2
6	8.1	16.0
7	8.4	12.9
8	5.1	10.6
9	78.4	109.4
10	4.8	7.0
11	5.1	5.4
12	14.4	16.1
13	4.9	10.2
14	15.3	81.4
15	3.3	29.3
16	16.9	50.4
17	12.4	39.1
18	14.1	32.9
19	28.4	45.3
20	35.6	159.9
21	64.7	125.3
22	44.3	89.0
23	47.8	163.6
24	20.2	52.1
25	56.2	77.1
26	29.7	107.7
27	8.6	34.6
28	13.2	72.8
29	105.8	123.8
30	21.1	74.9
31	13.9	153.2
32	3.5	43.6
33	5.3	32.8
34	9.3	60.4
35	18.0	52.5
36	11.9	46.5
37	25.6	33.3
38	67.5	87.4
39	53.3	139.5
40	35.4	65.9
41	64.8	80.4
42	101.2	230.0
43	33.9	292.3
44	41.4	45.2
45	16.6	25.9
46	29.7	56.6
47	18.5	50.0
48	12.3	18.3

shown in Figure 7.6-1. All of this evidence indicates clearly that the total number or weight of fishes impinged during the period 1900 to 0700 hr was usually greater than that impinged during the preceding daylight period of 0700 to 1900 hr. There are several possible explanations for this. Many fishes tend to be more quiescent during darkness. Visual cues used in swimming and avoidance behavior also would be reduced at that time. Because of this, some fishes may be more susceptible to being transported into the cooling water system during periods of darkness. Another possible explanation is that some fishes may move into the area near the Power Plant during the night to feed or to seek shelter. Some or all of these processes may be acting in combination to produce the effects observed.

7.7 VARIATION IN RELATION TO TIDAL CONDITIONS

Statistical evaluations were done to consider the possible effects of spring and neap tide conditions on levels of impingement for fishes. During minimum or neap tide periods, the oscillation of water above and below mean sea level is more compressed than during extreme or spring tidal periods, when high tide levels are lower and the low tide levels higher. The presumption was that these differences in tidal range might lead to differences in levels of impingement.

A series of Mann-Whitney U tests was applied to data for total number and weight of all fishes impinged (Tables 7.5-3 and 7.6-1) during the spring and neap tide periods of each monthly series of moon phases, using standard tide and moon phase tables as a basis for classification. Data from all three traveling screen stations combined were used in these tests.

The Mann-Whitney U tests evaluated the null hypothesis that there was no difference in levels of impingement between spring and neap tide conditions during a given series of moon phases, against the alternative hypothesis that there was a significant difference between them.

The results indicate that in only one of 46 test comparisons for number of fishes and in only two of 46 comparisons for weight of fishes were the differences significantly different between spring and neap tide periods ($p<0.05$). All of the remaining comparisons show no significant differences ($p<0.05$) in levels of impingement.

This evidence suggests that tidal conditions, as considered in this evaluation, had no evident effects on the total number or weight of fishes impinged. No attempt was made to evaluate effects of incoming and outgoing tidal flow on levels of impingement. This more detailed evaluation was not possible because both conditions of tidal flow occurred within a given 12-hr sampling interval.

7.8 RELATIONSHIP OF IMPINGEMENT TO FLOW RATES IN THE COOLING WATER SYSTEM

As described in Section 3.0 and Appendix Section 16.2.3 of this report, flow rates of seawater into the cooling water system of the Encina Power Plant and within different parts of the system vary, depending on the number of circulating pumps and generating units in operation. An attempt was made to evaluate the relationship between levels of impingement for fishes and different conditions of flow rate that occurred during the 48-week period of the study. This was done by analyzing data for each traveling screen station separately and for all stations combined.

The basic biological data on which these evaluations were based, total number and weight of all fishes impinged, are given in Tables 7.5-1 and 7.5-3. Mean flow rates of water moving past the three traveling screen stations associated with generating Units 1-3, 4, and 5 and mean total flow rates of water for all generating units combined are shown in Table 7.5-2 for each weekly interval during the period February 4, 1979 to January 4, 1980. The methods of determining flow rates are described in Appendix Section 16.2.3.

Plots of these weekly mean flow rate data are shown together in Figure 7.8-1 for comparison. The long period during March - July when Unit 4 was out of service or operating at a low level of flow, and the period during May when Unit 5 was out of service, are reflected in the plots. Variations in flow at each traveling screen station and for the cooling water system as a whole also are evident.

Weekly mean data for total numbers of fishes impinged at stations 1, 4, and 5 are shown in Figures 7.8-2, 7.8-3, and 7.8-4, respectively. Also shown in these figures are the corresponding plots of weekly mean flow rates. Plots of mean total numbers of all fishes impinged at the three stations combined and the combined flow rate for all generating units are shown in Figure 7.8-5.

Parametric correlation analysis was used in an attempt to determine possible statistical relationships between flow rates of the cooling water and the total number and weight of all fishes impinged during corresponding periods of time. Weekly mean values for the entire 48-week period of the study (Figures 7.8-2 through 7.8-5) were employed in these analyses.

The possible correlations considered and the correlation coefficient determined for each were as follows (SIG indicates significant correlation at the level shown):

	Station 1		Station 4		Station 5		All Stations Combined	
Flow Rate For:	Number of Fishes	Weight of Fishes	Number of Fishes	Weight of Fishes	Number of Fishes	Weight of Fishes	Number of Fishes	Weight of Fishes
All Units Combined	0.181	0.138	0.392 SIG ($p<.05$)	0.332 SIG ($p<.05$)	0.140	-0.012	0.315 SIG ($p<.05$)	0.156
Units 1-3	0.047	0.168						
Unit 4			0.428 SIG ($p<.05$)	0.349 SIG ($p<.05$)				
Unit 5					0.204	0.276 SIG ($p<.05$)		

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These results indicate that there were statistically significant positive correlations between total flow rate for all units combined and both total number and weight of all fishes impinged at station 4. There also were significant positive correlations between the flow rate of water passing to generating Unit 4 and the total number and weight of fishes impinged at station 4. The flow rate for all units combined showed a significant positive correlation with total number of fishes impinged at all traveling screen stations combined, but not with total weight of these fishes. The flow rate of water to generating Unit 5 showed a significant positive correlation with total weight of fishes impinged at station 5, but not with the total number of fishes.

These correlation analyses suggest that, in general, levels of impingement increased in relation to increasing flow rates of the cooling water. Effects of other factors and random variability probably tended to mask or alter this relationship in some cases. This appears to be the case for levels of impingement at station 1, as shown in Figure 7.8-2. Despite the fact that the flow rate of water past the traveling screens at this station was relatively constant, levels of impingement varied widely.

It is interesting to note that during March, April, and early May, when generating Unit 4 was not operating and total flow rates into the cooling water system of the Power Plant were reduced from approximately 500,000 gpm to 350,000 gpm (Figure 7.8-1, Table 7.5-2), impingement at stations 1 and 5 declined and generally tended to remain at low levels (Figures 7.8-2 and 7.8-4, Table 7.5-1). While by no means conclusive, this evidence suggests that such a reduction in flow rate of water entering the Power Plant from the lagoon tended to reduce impingement at stations 1 and 5, despite the fact that flow rates at the traveling screens for generating Units 1-3 and 5 remained relatively constant during the entire period (Figure 7.8-1, Table 7.5-2).

7.9 BODY CONDITION AND SIZE DISTRIBUTIONS OF FISHES IMPINGED

The degree of decomposition and the degree of physical damage found during examination of all of the impinged fishes were characterized on grading scales of 1 to 4, as shown in Table 7.9-1. The mean values of these two estimates of body condition are shown in Table 7.9-2 for the 19 critically treated species. Separate mean values are shown for each traveling screen station and for all stations combined. These means are based on all data obtained during the 48-week period of the study.

In general, there was little decomposition of the fishes impinged at the three traveling screen stations. Almost all of the critical species were assigned decomposition codes of 1 or 2. Also, in most cases there was relatively little physical damage to the fish. Together, these data indicate that most of the fishes impinged probably were alive at the time they reached the traveling screens and passed into the collector baskets. Direct observation of the fishes in the sampling nets confirmed this fact. A majority of those that had entered sampling nets and trash collectors recently appeared to be alive and in relatively good condition. Much of the observed decomposition probably occurred while the fish were held in the sampling nets over periods of several hours. On many occasions when the traveling screens had been operated shortly before the sampling net was removed, most of the fish were still alive in the net at the time the samples were collected. Routinely, these live fishes were placed in holding tanks at the Encina laboratory and were

TABLE 7.9-1
CODES USED FOR EVALUATING BODY CONDITION OF IMPINGED FISHES AT ENCINA POWER PLANT DURING 1979

DECOMPOSITION CODE

Characteristics/ Appearance	Code 1	Code 2	Code 3	Code 4
Skin	Normal luster, color clear and bright	Color dull, no apparent slime	Normal color and luster gone, some muscle structure visible	Gross discoloration, skin in abnormal stage of discoloration
Odor	Fresh: typical of freshly caught fish	Flat to slightly fishy odor	Slightly stale or rancid odor, but not sour, putrid	Sour, putrid (stinkers) or definite off odor
Degree of firmness	Firm, elastic	Firm, no elasticity	Soft	Very soft and mushy

PHYSICAL DAMAGE CODE

Characteristics/ Appearance	Code 1	Code 2	Code 3	Code 4
Eyes	Clear, bright and protruding	Sunken, cloudy-white or reddish	Sunken, dull-white, smashed, red	Missing
Physical damage	No mutilation or deformity	Slight deformities or mutilation, no splitting	Some splitting of body or shell, slightly broken or smashed	Badly split, smashed or mutilated, or with >20% of flesh exposed

TABLE 7.9-2
MEAN DECOMPOSITION AND DAMAGE CODES FOR ALL INDIVIDUALS OF CRITICALLY-TREATED SPECIES EXAMINED AT ENCINA POWER PLANT DURING 1979

	STATION					
	1		4		5	
SPECIES NAME	DECOMP	DAMAGE	DECOMP	DAMAGE	DECOMP	DAMAGE
UROLOPHUS HALLERI	1.57	1.29	1.16	1.36	1.76	1.70
ENGRAULIS MORDAX	1.43	2.32	1.61	2.16	1.92	2.66
ANCHOA COMPRESSA	1.31	1.80	1.35	1.76	1.71	2.37
ANCHOA DELICATISSIMA	1.25	1.83	1.28	1.81	1.33	2.03
LEURESTHES TENUIS	1.07	1.26	1.17	1.36	1.42	2.06
ATHERINOPS AFFINIS	1.45	1.54	1.30	1.39	1.73	1.96
PARALABRAX CLATHRATUS	1.00	1.00	1.00	1.00	1.50	1.50
PARALABRAX MACULATOFASCIATUS	1.75	1.60	2.00	1.75	3.85	3.39
PARALABRAX NEBULIFER	1.13	1.25	1.41	1.40	2.35	2.42
XENISTIUS CALIFORNIENSIS	1.24	1.23	1.07	1.18	1.31	1.36
SERIPHUS POLITUS	1.19	1.38	1.21	1.37	1.34	1.64
CYNOSCION NOBILIS	1.33	1.00	1.00	1.40	1.00	1.25
MENTICIRRHUS UNDULATUS	1.00	1.00	1.19	1.25	1.21	1.42
AMPHISTICHUS ARGENTEUS	1.00	1.08	1.09	1.27	1.21	1.58
HYPERPROSOPON ARGENTEUM	1.08	1.29	1.23	1.26	1.69	1.90
CYMATOGASTER AGGREGATA	1.40	1.48	1.26	1.28	1.54	1.62
PHANERODON FURCATUS	1.05	1.18	1.14	1.24	1.14	1.28
MUGIL CEPHALUS	1.33	1.67	1.00	1.50	1.15	1.53
PARALICHTHYS CALIFORNICUS	1.06	1.14	1.10	1.18	1.26	1.33

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released after being processed as part of the sample. These individuals appeared to be in good condition when released.

There was at least one exception to the generalization described above. For periods of up to several days after tunnel recirculation (heat treatment), the impinged fishes were noticeably more decomposed than at other times during the year. One critical species, the spotted sand bass (Paralabrax maculatofasciatus), was impinged in significant numbers only after periods of tunnel recirculation, and thus the mean values given in Table 7.9-2 for decomposition of this species are much higher than for other species. To some extent this also appeared to be true for the barred sand bass (Paralabrax nebulifer), at least at screenwell station 5.

The overall average decomposition and damage codes for the 19 critical species at the three stations were:

Station	Mean Decomposition Code	Mean Physical Damage Code
1	1.25	1.39
4	1.24	1.42
5	1.60	1.84

From these overall values it is apparent that screenwell stations 1 and 4 were approximately equal in the amount of physical damage experienced by impinged fishes. Damage at station 5 appeared to be slightly more severe.

Some differences in degree of physical damage also were observed among species. There appeared to be a fairly direct relationship between the amount of damage and the fragility or delicate morphological characteristics of the species. For example, all three of the anchovy species shown in Table 7.9-2 (Anchoa compressa, A. delicatissima and Engraulis mordax) were subject to much more damage than the two relatively more "firm-fleshed" atherinid species (Atherinops affinis and Leuresthes tenuis). Similar correlations can be seen for the sciaenids and other groups.

The data also were examined for possible relationships in size of fishes and physical damage that occurred during impingement. Size data for the critical species are summarized in Table 7.9-3. Disregarding the fragile anchovy species, a general trend appears to be evident in which the larger species of fishes seem to be slightly more damaged during impingement than smaller species. However, more extensive analyses of the data would be required to verify this relationship.

From Table 7.9-3 it is evident that a considerable size range of each species was impinged. For example, individuals of the strong swimming striped mullet (Mugil cephalus) varying from 67 to 630 mm in total length were impinged (mean = 303 mm). This may indicate that the impingement was not necessarily a function of swimming speed, strength or stamina. Once again, however, more detailed analysis of the data would be required to verify this observation. The mean lengths of several of the impinged species were represented in the samples primarily by smaller juvenile sizes. However, this could be attributed to the natural

TABLE 7.9-3
MEAN, STANDARD DEVIATION, AND RANGE OF TOTAL LENGTHS (mm) FOR EACH CRITICALLY-TREATED SPECIES MEASURED AT ENCINA POWER PLANT DURING 1979

SPECIES NAME	N	MEAN	STANDARD DEVIATION	MINIMUM LENGTH	MAXIMUM LENGTH
UROLOPHUS HALLERI	929	199.7	54.0	44	403
ENGRAULIS MORDAX	2056	86.0	25.4	16	170
ANCHOA COMPRESSA	4494	101.8	18.4	12	186
ANCHOA DELICATISSIMA	821	76.0	10.6	46	132
LEURESTHES TENUIS	2016	115.7	30.0	47	202
ATHERINOPS AFFINIS	3257	123.2	34.5	27	313
PARALABRAX CLATHRATUS	20	108.6	30.2	51	213
PARALABRAX MACULATOFASCIATUS	42	202.3	93.7	55	430
PARALABRAX NEBULIFER	82	150.3	86.9	45	422
XENISTIUS CALIFORNIENSIS	293	68.3	16.8	46	220
SERIPHUS POLITUS	6743	81.7	30.4	40	420
CYNOSCION NOBILIS	12	96.1	21.4	64	138
MENTICIRRHUS UNDULATUS	50	127.8	116.5	56	540
AMPHISTICHUS ARGENTEUS	54	92.8	37.9	25	196
HYPERPROSOPON ARGENTEUM	1085	98.1	45.5	40	240
CYMATOGASTER AGGREGATA	2399	88.6	28.0	7	260
PHANERODON FURCATUS	1063	79.2	26.0	53	357
MUGIL CEPHALUS	42	302.9	190.0	67	630
HETEROSTICHUS ROSTRATUS	525	118.7	40.7	17	310
PARALICHTHYS CALIFORNICUS	549	154.8	60.3	17	631

attraction of smaller fishes to bays and estuaries such as Agua Hedionda Lagoon, rather than a selectivity in the size of fishes impinged in the cooling water system of the Encina Power Plant.

7.10 SEX RATIOS AND REPRODUCTIVE CONDITION OF CRITICAL SPECIES

Using the methods described in Appendix B, Section 16.2.3, monthly samples of fishes were analyzed in detail in an attempt to determine the sex ratios and female reproductive condition for the 19 critically treated species. The dates for which regular 12-hr impingement samples were employed in these analyses were:

- February 4, 1979
- March 6-8 and 11-14
- April 9-12 and 15-17
- May 7-10 and 13-15
- June 13-16
- July 29-31
- August 27-30
- September 26-27
- November 6-8 and 27-29
- December 31
- January 2-3, 1980

Data obtained for each traveling screen station and for all the dates indicated within a given month were pooled. The results of these analyses are described in this subsection.

The monthly analyses provided data for only 11 of the 19 critically treated species. They are:

Common Name	Species Name
Queenfish	*Seriphus politus*
Topsmelt	*Atherinops affinis*

Northern anchovy	Engraulis mordax
Walleye surfperch	Hyperprosopon argenteum
California halibut	Paralichthys californicus
Deepbody anchovy	Anchoa compressa
California grunion	Leuresthes tenuis
Shiner surfperch	Cymatogaster aggregata
Slough anchovy	Anchoa delicatissima
Round stingray	Urolophus halleri
Salema	Xenistius californiensis

Adults of the other eight critical species did not occur in the samples used. One additional species, the specklefin midshipman (Porichthys myriaster), also was included because the individuals impinged had unusual reproductive characteristics.

Table 7.10-1 gives the number of males and females of each species and the resulting sex ratio (M/F). These data are shown separately by month. Values also are given for all months combined. Not shown in Table 7.10-1 are the numbers of immature individuals for which the sex could not be determined. In general, approximately 70 to 80 percent of the individuals examined in these samples were immature. As indicated in Table 7.10-1, the numbers of adult males and females of a species present in samples for a given month generally were small. Because of this, the sex ratio estimates for some species varied considerably from month to month. The data for round stingray and deepbody anchovy illustrate the problem. Sex ratios estimated for round stingray varied from 0.18 to 1.67 and those for deepbody

TABLE 7.10-1
MONTHLY NUMBERS OF MALES AND FEMALES AND SEX RATIOS OF CRITICALLY-TREATED SPECIES EXAMINED AT ENCINA POWER PLANT DURING 1979

SPECIES NAME	01 JANUARY 1980 NO. OF MALES	NO. OF FEMALES	RATIO (M/F)	02 FEBRUARY 1979 NO. OF MALES	NO. OF FEMALES	RATIO (M/F)	03 MARCH 1979 NO. OF MALES	NO. OF FEMALES	RATIO (M/F)
UROLOPHUS HALLERI	0	0	.00	14	20	.70	3	2	1.50
ENGRAULIS MORDAX	0	0	.00	0	0	.00	0	0	.00
ANCHOA COMPRESSA	2	2	1.00	0	0	.00	2	16	.13
ANCHOA DELICATISSIMA	0	0	.00	0	0	.00	5	17	.29
PORICHTHYS MYRIASTER	0	0	.00	0	0	.00	0	0	.00
LEUPESTHES TENUIS	0	0	.00	2	0	.00	0	0	.00
ATHERINOPS AFFINIS	2	4	.50	3	13	.23	2	13	.15
XENISTIUS CALIFORNIENSIS	0	0	.00	0	0	.00	0	0	.00
SERIPHUS POLITUS	0	0	.00	0	0	.00	0	0	.00
HYPERPROSOPON ARGENTEUM	0	0	.00	0	0	.00	0	0	.00
CYMATOGASTER AGGREGATA	0	0	.00	0	0	.00	0	0	.00
PARALICHTHYS CALIFORNICUS	0	0	.00	0	0	.00	3	1	3.00

SPECIES NAME	04 APRIL 1979 NO. OF MALES	NO. OF FEMALES	RATIO (M/F)	05 MAY 1979 NO. OF MALES	NO. OF FEMALES	RATIO (M/F)	06 JUNE 1979 NO. OF MALES	NO. OF FEMALES	RATIO (M/F)
UROLOPHUS HALLERI	4	4	1.00	1	4	.25	3	6	.50
ENGRAULIS MORDAX	0	0	.00	0	0	.00	0	0	.00
ANCHOA COMPRESSA	2	1	2.00	0	0	.00	13	23	.57
ANCHOA DELICATISSIMA	0	0	.00	0	0	.00	0	0	.00
PORICHTHYS MYRIASTER	0	0	.00	0	0	.00	1	5	.20
LEURESTHES TENUIS	1	3	.33	2	1	2.00	0	0	.00
ATHERINOPS AFFINIS	2	4	.50	2	0	.00	0	0	.00
XENISTIUS CALIFORNIENSIS	0	0	.00	0	0	.00	0	0	.00
SERIPHUS POLITUS	0	0	.00	0	0	.00	0	0	.00
HYPERPROSOPON ARGENTEUM	0	0	.00	0	0	.00	0	0	.00
CYMATOGASTER AGGREGATA	0	0	.00	0	0	.00	0	0	.00
PARALICHTHYS CALIFORNICUS	0	0	.00	0	0	.00	0	0	.00

TABLE 7.10-1 (Concluded)

SPECIES NAME	07 JULY 1979 NO. OF MALES	NO. OF FEMALES	RATIO (M/F)	08 AUGUST 1979 NO. OF MALES	NO. OF FEMALES	RATIO (M/F)	09 SEPTEMBER 1979 NO. OF MALES	NO. OF FEMALES	RATIO (M/F)
UROLOPHUS HALLERI	3	17	.18	0	0	.00	1	3	.33
ENGRAULIS MORDAX	0	0	.00	0	0	.00	0	0	.00
ANCHOA COMPRESSA	1	4	.25	4	20	.20	2	1	2.00
ANCHOA DELICATISSIMA	2	2	1.00	0	0	.00	0	0	.00
PORICHTHYS MYRIASTER	0	0	.00	2	5	.40	0	0	.00
LEURESTHES TENUIS	0	0	.00	0	0	.00	2	17	.12
ATHERINOPS AFFINIS	2	1	2.00	0	0	.00	0	0	.00
XENISTIUS CALIFORNIENSIS	0	0	.00	1	0	.00	0	0	.00
SERIPHUS POLITUS	0	0	.00	0	0	.00	0	0	.00
HYPERPROSOPON ARGENTEUM	0	0	.00	0	0	.00	0	0	.00
CYMATOGASTER AGGREGATA	0	0	.00	0	0	.00	0	0	.00
PARALICHTHYS CALIFORNICUS	0	0	.00	0	0	.00	0	0	.00

SPECIES NAME	11 NOVEMBER 1979 NO. OF MALES	NO. OF FEMALES	RATIO (M/F)	12 DECEMBER 1979 NO. OF MALES	NO. OF FEMALES	RATIO (M/F)	ALL MONTHS NO. OF MALES	NO. OF FEMALES	RATIO (M/F)
UROLOPHUS HALLERI	24	23	1.04	5	3	1.67	58	82	0.71
ENGRAULIS MORDAX	3	4	.75	0	0	.00	3	4	0.75
ANCHOA COMPRESSA	9	1	9.00	0	0	.00	35	68	0.51
ANCHOA DELICATISSIMA	1	1	1.00	0	0	.00	8	20	0.40
PORICHTHYS MYRIASTER	0	0	.00	0	0	.00	3	10	0.30
LEURESTHES TENUIS	1	5	.20	0	0	.00	6	26	0.23
ATHERINOPS AFFINIS	1	3	.33	0	0	.00	14	38	0.37
XENISTIUS CALIFORNIENSIS	0	0	.00	0	0	.00	1	0	0.00
SERIPHUS POLITUS	1	1	1.00	0	0	.00	1	1	1.00
HYPERPROSOPON ARGENTEUM	1	0	.00	0	0	.00	1	0	0.00
CYMATOGASTER AGGREGATA	2	0	.00	0	0	.00	2	0	0.00
PARALICHTHYS CALIFORNICUS	0	0	.00	0	0	.00	3	1	3.00

anchovy from 0.13 to 9.00 (Table 7.10-1). It appears very unlikely that these reflect true variations in sex ratio of the impinged individuals from month to month. Instead, it is more likely that the variations were due primarily to the small total numbers of adult males and females taken in the samples.

The data for all months combined show that deepbody anchovy and round stingray had sex ratios of 0.51 and 0.71, respectively. This indicates that, overall, the proportion of females impinged was greater than that of males. The same was true for slough anchovy, with an overall sex ratio of 0.40.

Some species showed more consistency in their sex ratios. The specklefin midshipman occurred in samples only during June, July, and August. In both instances, however, the numbers of females were much greater than the numbers of males, with sex ratios of 0.20 and 0.40 (Table 7.10-1). The sex ratio for both months combined was 0.30. With one exception in each case, the same was true for California grunion (sex ratios of 0.12 to 0.33) and topsmelt (sex ratios of 0.15 to 0.50). Sex ratios of these two species for all months combined were 0.23 and 0.37, respectively. California halibut were taken only in the samples for March. As indicated in Table 7.10-1, there were more males than females, giving a sex ratio of 3.00. Data for the remaining species were too limited to allow generalizations about their sex ratios (Table 7.10-1). Among the eight species for which adequate data were available, seven had overall sex ratios well below 1.00, indicating that the number of adult females impinged was greater than the number of males.

Table 7.10-2 summarizes data concerning the reproductive condition of females for 11 critical species of fishes. No adult females of the remaining eight critical species occurred in the reproductive samples. Data also are included for specklefin midshipman. The reproductive condition codes shown in Table 7.10-2 are the following:

Female Reproductive Condition Code		Criteria
1	Immature	Ovary small and completely undeveloped
2	Developing	Ovary small but with eggs visible
3	Ripe	Ovary large with eggs visible; eggs can be expelled by pressure on body wall
4	Spent	Ovary ragged in appearance

Additional reproductive condition codes used for embiotocid and elasmobranch fishes only:

5 Carrying young fishes - early stages of development

6 Carrying young fishes - late stages of development

These codes were assigned to individual females by dissecting and examining the ovaries and by determining the presence of young in embiotocids (surfperches) and elasmobranchs (rays). A detailed description of these methods is provided in Appendix Section 16.2.3. The values in Table 7.10-2 are the percentages

TABLE 7.10-2
PERCENTAGES OF FEMALES IN DIFFERENT STAGES OF REPRODUCTIVE CONDITION SHOWN BY MONTH FOR THE PERIOD FEBRUARY 1979 - JANUARY 1980
ENCINA POWER PLANT

MONTHLY REPRODUCTIVE CONDITION FOR SERIPHUS POLITUS

		REPRODUCTIVE CONDITION CODE					
		1	2	3	4	5	6
MONTH	N	%	%	%	%	%	%
02	1	.00	1.00	.00	.00	.00	.00
03	1	1.00	.00	.00	.00	.00	.00
04	1	1.00	.00	.00	.00	.00	.00
06	1	.00	1.00	.00	.00	.00	.00
07	4	.25	.50	.25	.00	.00	.00
09	1	.00	.00	.00	1.00	.00	.00
11	1	1.00	.00	.00	.00	.00	.00

MONTHLY REPRODUCTIVE CONDITION FOR ANCHOA COMPRESSA

		REPRODUCTIVE CONDITION CODE					
		1	2	3	4	5	6
MONTH	N	%	%	%	%	%	%
01	2	.50	.50	.00	.00	.00	.00
03	16	.25	.75	.00	.00	.00	.00
04	1	.00	1.00	.00	.00	.00	.00
06	24	.00	.54	.42	.04	.00	.00
07	4	.50	.50	.00	.00	.00	.00
08	20	.95	.05	.00	.00	.00	.00
09	1	1.00	.00	.00	.00	.00	.00
11	1	1.00	.00	.00	.00	.00	.00

MONTHLY REPRODUCTIVE CONDITION FOR ATHERINOPS AFFINIS

		REPRODUCTIVE CONDITION CODE					
		1	2	3	4	5	6
MONTH	N	%	%	%	%	%	%
01	4	.00	1.00	.00	.00	.00	.00
02	13	.00	.85	.15	.00	.00	.00
03	13	.08	.46	.46	.00	.00	.00
04	4	.00	.50	.50	.00	.00	.00
07	1	.00	1.00	.00	.00	.00	.00
08	1	1.00	.00	.00	.00	.00	.00
11	3	1.00	.00	.00	.00	.00	.00

TABLE 7.10-2 (Continued)

MONTHLY REPRODUCTIVE CONDITION FOR LEURESTHES TENUIS

		REPRODUCTIVE CONDITION CODE					
		1	2	3	4	5	6
MONTH	N	%	%	%	%	%	%
04	3	.00	.67	.33	.00	.00	.00
05	1	.00	.00	1.00	.00	.00	.00
06	2	.00	.00	1.00	.00	.00	.00
08	6	1.00	.00	.00	.00	.00	.00
09	17	.41	.29	.00	.29	.00	.00
11	5	.80	.20	.00	.00	.00	.00

MONTHLY REPRODUCTIVE CONDITION FOR ENGRAULIS MORDAX

		REPRODUCTIVE CONDITION CODE					
		1	2	3	4	5	6
MONTH	N	%	%	%	%	%	%
03	1	.00	1.00	.00	.00	.00	.00
04	1	.00	1.00	.00	.00	.00	.00
07	1	1.00	.00	.00	.00	.00	.00
08	1	1.00	.00	.00	.00	.00	.00
11	4	.75	.25	.00	.00	.00	.00

MONTHLY REPRODUCTIVE CONDITION FOR CYMATOGASTER AGGREGATA

		REPRODUCTIVE CONDITION CODE					
		1	2	3	4	5	6
MONTH	N	%	%	%	%	%	%
03	5	.00	.00	.00	.00	1.00	.00
04	15	.07	.20	.07	.13	.13	.40
05	1	.00	1.00	.00	.00	.00	.00
06	1	.00	.00	1.00	.00	.00	.00
08	1	1.00	.00	.00	.00	.00	.00

000557

TABLE 7.10-2 (Continued)

MONTHLY REPRODUCTIVE CONDITION FOR HYPERPROSOPON ARGENTEUM

		REPRODUCTIVE CONDITION CODE					
		1	2	3	4	5	6
MONTH	N	%	%	%	%	%	%
03	1	.00	.00	.00	.00	.00	1.00
04	5	.00	.40	.00	.40	.00	.20
05	5	.00	.80	.00	.00	.00	.20
06	2	.50	.00	.00	.50	.00	.00

MONTHLY REPRODUCTIVE CONDITION FOR ANCHOA DELICATISSIMA

		REPRODUCTIVE CONDITION CODE					
		1	2	3	4	5	6
MONTH	N	%	%	%	%	%	%
03	17	.06	.94	.00	.00	.00	.00
07	2	.00	1.00	.00	.00	.00	.00
11	1	.00	1.00	.00	.00	.00	.00

MONTHLY REPRODUCTIVE CONDITION FOR UROLOPHUS HALLERI

		REPRODUCTIVE CONDITION CODE					
		1	2	3	4	5	6
MONTH	N	%	%	%	%	%	%
01	1	1.00	.00	.00	.00	.00	.00
02	1	1.00	.00	.00	.00	.00	.00
03	2	1.00	.00	.00	.00	.00	.00
04	4	1.00	.00	.00	.00	.00	.00
05	4	1.00	.00	.00	.00	.00	.00
06	6	1.00	.00	.00	.00	.00	.00
07	10	1.00	.00	.00	.00	.00	.00
08	1	1.00	.00	.00	.00	.00	.00
09	3	.67	.00	.00	.00	.00	.33
11	22	1.00	.00	.00	.00	.00	.00
12	3	1.00	.00	.00	.00	.00	.00

TABLE 7.10-2 (Concluded)

MONTHLY REPRODUCTIVE CONDITION FOR PARALICHTHYS CALIFORNICUS

		REPRODUCTIVE CONDITION CODE					
		1	2	3	4	5	6
MONTH	N	%	%	%	%	%	%
03	1	1.00	.00	.00	.00	.00	.00

MONTHLY REPRODUCTIVE CONDITION FOR HETEROSTICHUS ROSTRATUS

		REPRODUCTIVE CONDITION CODE					
		1	2	3	4	5	6
MONTH	N	%	%	%	%	%	%
11	2	.00	.50	.50	.00	.00	.00

MONTHLY REPRODUCTIVE CONDITION FOR PORICHTHYS MYRIASTER

		REPRODUCTIVE CONDITION CODE					
		1	2	3	4	5	6
MONTH	N	%	%	%	%	%	%
06	5	.00	.40	.60	.00	.00	.00
07	2	.00	.00	1.00	.00	.00	.00
08	5	.00	.00	1.00	.00	.00	.00

of females in each of these different stages of reproductive condition, shown by month for the period February 1979 to January 1980.

The data for queenfish show a clear pattern of reproductive development, despite the fact that the number of females examined was relatively small. Only females with immature ovaries or those with developing eggs in the ovaries were encountered in the samples during the period from January to June. Females with developing and ripe ovaries occurred in the July samples, and a spent female was present in August.

For deepbody anchovy, both ripe and spent females were taken only during the June collections (Table 7.10-2). Females with immature ovaries were present during January, March, July through September, and November. Those with developing ovaries were noted during January, March, April, and June through August.

For topsmelt only females with immature ovaries were encountered in the August and November samples (Table 7.10-2). Only females with developing eggs occurred in January, and both developing and ripe females were encountered in the samples for February, March and April. For California grunion, only females with immature and developing ovaries occurred in samples during the period from August to November. Developing and ripe females were taken in April, and only ripe females were encountered in May and June.

Only females with immature or developing ovaries were taken in the monthly samples for both northern anchovy and slough anchovy. However, the numbers of individuals examined were very small (Table 7.10-2).

The two species of surfperches, shiner surfperch and walleye surfperch, showed fairly distinct patterns of reproductive activity. For shiner surfperch, only females with immature and developing ovaries were encountered in May and August. A ripe female occurred in June. Females carrying young were encountered in March and April. Both spent females and those carrying young in advanced stages of development occurred in the April samples. Female walleye surfperch carrying young in advanced stages of development were encountered in March, April and May. Spent females also occurred in April and June. Females of the round stingray had only immature ovaries in all samples except those for September. The latter contained one female carrying young in an advanced stage of development.

Only one immature female of California halibut was taken in the reproductive samples. Female giant kelpfish occurred only in the November samples. Females with both developing and ripe ovaries were present in this sample. Female specklefin midshipman occurred in impingement samples during June, July, and August. As indicated in Table 7.10-2, almost all of them (10 of 12) had ripe ovaries.

While these data are limited, they do indicate that for most of the 12 species considered, adult females in all stages of reproductive development are impinged. Possible exceptions are northern anchovy, slough anchovy, round stingray, and California halibut. However, too few individuals of all these species except round stingray were taken in the samples to evaluate this question adequately.

Relatively large numbers of female round stingray were taken (57). Yet the ovaries of all but one of these were immature. In the case of specklefin midshipman, on the other hand, 10 of the 12 adult females encountered were in ripe condition.

7.11 IMPINGEMENT OF MARINE PLANTS

In terms of volume, the largest component of biological material normally encountered in impingement samples at the Encina Power Plant consisted of marine algae and grasses. Most of this was large or small fragments of detrital plant material that had broken free from the bottom and entered the cooling water system in floating or drifting masses.

The species of vascular plants (marine grasses) and marine algae encountered in impingement samples at stations 1, 4, 5, and 9 during the study are listed in Table 7.11-1. Seven species were represented in these samples. Fragments of other species may have been present in very small amounts, but were not identified.

Very large accumulations of marine plant material were impinged and removed at the bar rack screening system (station 9), shown in Figure 7.3-1. All seven species listed in Table 7.11-1 were taken in the bar rack samples. The rankings for these, based on frequency of occurrence and estimated relative volume, are shown in Table 7.11-2. The two highest ranked species, eel grass (*Zostera marina*) and giant kelp (*Macrocystis pyrifera*), had essentially the same frequency of occurrence at station 9, but the volume of eel grass was generally greater in most samples. Eel grass is a very common species in Agua Hedionda Lagoon, forming extensive beds in shallow water as described in Section 6.0 of this report. Similarly, giant kelp is the dominant large marine alga in shallow ocean areas near the Power

TABLE 7.11-1
SPECIES OF MARINE GRASSES AND ALGAE TAKEN IN IMPINGEMENT SAMPLES AT THE ENCINA POWER PLANT DURING THE PERIOD JANUARY 1979 - JANUARY 1980

Scientific Name	Common Name
Vascular plants (marine grasses):	
Phyllospadix torreyi	Torrey's surf grass
Zostera marina	Eel grass
Algae:	
Codium fragile	Codium
Cystoseira setchelli	Bladder chain
Egregia menziesii	Feather boa
Macrocystis pyrifera	Giant kelp
Sargassum agardhianum	Sargassum

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TABLE 7.11-2
RANKING OF MARINE GRASS AND ALGAL SPECIES (BASED ON VOLUME) IMPINGED AT THE BAR RACK SCREENING SYSTEM OF ENCINA POWER PLANT DURING THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

			Frequency of Daily Occurrence at Each Rank					
Rank	Common Name	Scientific Name	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5-6	Total
1	Eel grass	*Zostera marina*	163	28	4	0	0	195
2	Giant kelp	*Macrocystis pyrifera*	34	155	5	0	0	194
3	Feather boa	*Egregia menziesii*	1	12	138	8	1	160
4	Sargassum	*Sargassum agardhianum*	0	0	13	99	6	118
5	Torrey's surf grass	*Phyllospadix torreyi*	0	0	13	13	59	85
6	Codium	*Codium fragile*	0	0	1	5	0	6
7	Bladder chain	*Cystoseira setchelli*	0	0	0	0	2	2

Plant. Because of this, their large volumes in the impingement samples are not surprising. The feather boa (Egregia menziesii) and sargassum (Sargassum agardhianum) also were relatively common in samples at station 9. Most of the plant material impinged on the bar rack screening system consisted of relatively large masses or fragments.

A plot showing variation in mean total volume of material impinged at station 9 per 24-hr interval for each month of the study appears in Figure 7.11-1. Almost all of this material consisted of marine plants. Levels of impingement were highest in February and lowest in May and June. In general, the highest levels of impingement occurred following storms. The reason for this presumably is that storm waves and surge dislodge and transport large amounts of plant material. In late October, the log boom at the ocean entrance to Agua Hedionda Lagoon broke. After this time, much larger volumes of plant material were impinged at the bar rack system and at the traveling screens. This increase in volume at station 9 is evident in Figure 7.11-1.

All seven plant species listed in Table 7.11-1 also occurred in the samples at traveling screen stations 1, 4, and 5. The rankings for these species, based on frequency of occurrence and estimated relative volume in all traveling screen samples combined, are shown in Table 7.11-3.

As in the bar rack samples, eel grass and giant kelp had essentially the same total frequency of occurrence, but the volume of first-ranked eel grass was greater in a majority of the

TABLE 7.11-3
RANKING OF MARINE GRASS AND ALGAL SPECIES IMPINGED AT ENCINA POWER PLANT TRAVELING SCREEN STATIONS DURING THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

			Frequency of Occurrence						
Rank	Common Name	Scientific Name	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	>Rank 5	Total
1	Eel grass	*Zostera marina*	1039	322	35	11	0	1	1408
2	Giant kelp	*Macrocystis pyrifera*	363	999	40	2	0	0	1404
3	Sargassum	*Sargassum agardhianum*	1	27	464	268	20	1	781
4	Feather boa	*Egregia menziesii*	5	41	368	171	13	1	599
5	Torrey's surf grass	*Phyllospadix torreyi*	4	15	222	144	148	23	556
6	Codium	*Codium fragile*	0	7	119	139	86	25	376
7	Bladder chain	*Cystoseira setchelli*	0	0	7	17	29	6	59

samples (Table 7.11-3). Sargassum ranked third, feather boa was fourth, Torrey's surf grass was fifth and codium was sixth in order of estimated volume. The seventh-ranked brown alga, bladder chain, occurred much less frequently in traveling screen samples and was generally represented by much smaller volumes of material than for the other species.

A plot showing mean total weight of all plant material impinged per 24-hr period for each week of the study is given in Figure 7.11-2. The weekly mean values on which this plot is based also are shown in Table 7.11-4. These weekly mean values were determined from the data obtained during each day of sampling at the three traveling screen stations. They represent the average value for the three stations, rather than the total for all stations combined.

As indicated in Table 7.11-4, the overall mean value for the 48-week period was 51.45 kg (113 lb) per day. Weekly mean values ranged from 20.57 kg (45 lb) per day in mid-May to 103.53 kg (228 lb) per day in early November (Figure 7.11-2; Table 7.11-4). A second peak of 93.83 kg (212 lb) per day occurred in late June.

TABLE 7.11-4
WEEKLY MEAN TOTAL WEIGHT OF ALL MARINE PLANT MATERIAL IMPINGED AT ENCINA POWER PLANT TRAVELING SCREEN STATIONS PER 24-HR INTERVAL DURING THE PERIOD FEBRUARY 4, 1979 - JANUARY 4, 1980

DATE	WEEK	MEAN WEIGHT (g) PER 24 HRS
Feb. 4	1	44571.4
Feb. 11	2	49314.3
Feb. 18	3	56628.6
Feb. 25	4	45714.3
Mar. 4	5	44342.9
Mar. 11	6	46028.6
Mar. 18	7	30685.7
Mar. 25	8	40371.4
Apr. 1	9	32202.9
Apr. 8	10	41571.4
Apr. 15	11	34171.4
Apr. 22	12	56285.7
Apr. 29	13	34314.3
May 6	14	23200.0
May 13	15	20571.4
May 20	16	20914.3
May 27	17	26657.1
Jun. 3	18	68914.3
Jun. 10	19	93828.6
Jun. 17	20	69771.4
Jun. 24	21	91828.6
Jul. 1	22	60342.9
Jul. 8	23	63200.0
Jul. 15	24	52314.3
Jul. 22	25	60542.9
Jul. 29	26	59228.6
Aug. 5	27	62000.0
Aug. 12	28	58085.7
Aug. 19	29	52066.7
Aug. 26	30	78514.3
Sept. 2	31	54114.3
Sept. 9	32	41657.1
Sept. 16	33	50571.4
Sept. 23	34	54857.1
Sept. 30	35	53950.0
Oct. 7	36	41028.6
Oct. 14	37	60085.7
Oct. 21	38	41166.7
Oct. 28	39	43800.0
Nov. 4	40	103533.3
Nov. 11	41	58171.4
Nov. 18	42	46714.3
Nov. 25	43	40457.1
Dec. 2	44	60514.3
Dec. 9	45	59171.4
Dec. 16	46	51971.4
Dec. 23	47	45966.7
Dec. 30	48	43500.0
48-WEEK MEAN		51446.0

7.12 TUNNEL RECIRCULATION

Tunnel recirculations (thermal treatments) were performed at approximately six-week intervals during the year to prevent fouling (see Section 3.1.5.10 for a description of procedures). Treatments were generally run on Saturday evenings during periods of lower power demand and during a high tide. Temperatures in the channels were raised to about 41 C (105 F) and held for approximately 2.5 hours. Depending upon ambient temperature, the time required to bring the temperature up to 41 C can take up to two hours. Cool down time to return to ambient can also take a similar time span, so that the complete operation can take up to six hours. Generally the treatment is completed by about 0500 or 0600 hr on Sunday morning. During this operation, organisms in residence in the intake channels between the trash rack and traveling screens (Figure 7.3-1) are killed.

Seven thermal treatments were conducted during 1979 (February, April, June, July, September, October, and December). All organisms impinged during thermal treatments were collected and a rank order listing of all species was compiled (Table 7.12-1). A total of 73 fish and 34 invertebrate species were obtained. Fourteen species occurred in the thermal treatment sampling that were not captured during daily impingement sampling (Table 7.12-2). Impingement samples coupled with thermal treatment and regular lagoon net collections resulted in a total of 96 different fish species from Agua Hedionda Lagoon (Table 7.12-3) during the year long study.

TABLE 7.12-1
RANK ORDER OF THERMAL TREATMENT SPECIES CAPTURED FROM JANUARY THROUGH DECEMBER, 1979 AT ENCINA POWER PLANT

SPECIES NAME	COMMON NAME	NUMBER CAUGHT	TOTAL WEIGHT	RANK
ANCHOA COMPRESSA	DEEPBODY ANCHOVY	23142	182179	1
ATHERINOPS AFFINIS	TOPSMELT	21788	166058	2
ENGRAULIS MORDAX	NORTHERN ANCHOVY	19567	93981	3
CYMATOGASTER AGGREGATA	SHINER SURFPERCH	12326	275549	4
LEURESTHES TENUIS	CALIFORNIA GRUNION	9671	81708	5
HYPERPROSOPON ARGENTEUM	WALLEYE SURFPERCH	8305	522797	6
SERIPHUS POLITUS	QUEENFISH	3485	96320	7
UROLOPHUS HALLERI	ROUND STINGRAY	1685	404237	8
HETEROSTICHUS ROSTRATUS	GIANT KELPFISH	1421	36212	9
ORDER DECAPODA		811	28577	10
GIRELLA NIGRICANS	OPALEYE	617	64921	11
PARALABRAX MACULATOFASCIATUS	SPOTTED SAND BASS	616	87360	12
PHANERODON FURCATUS	WHITE SURFPERCH	604	8609	13
PARALABRAX CLATHRATUS	KELP BASS	568	38505	14
PARALABRAX NEBULIFER	BARRED SAND BASS	518	26724	15
ANCHOA DELICATISSIMA	SLOUGH ANCHOVY	464	1405	16
BRACHYURANS	CRABS	376	3178	17
PORICHTHYS MYRIASTER	SPECKLEFIN MIDSHIPMAN	345	62191	18
PARALICHTHYS CALIFORNICUS	CALIFORNIA HALIBUT	329	52995	19
PACHYGRAPSUS CRASSIPES	SHORE CRAB	323	2555	20
UMBRINA RONCADOR	YELLOWFIN CROAKER	306	7423	21
FAMILY ATHERINIDAE		288	34225	22
HYPSOBLENNIUS JENKINSI	MUSSEL BLENNY	277	2100	23
HYPSOBLENNIUS GILBERTI	ROCKPOOL BLENNY	259	923	24
HYPSOPSETTA GUTTULATA	DIAMOND TURBOT	185	35897	25
AMPHISTICHUS ARGENTEUS	BARRED SURFPERCH	166	15946	26
XENISTIUS CALIFORNIENSIS	SALEMA	161	1389	27
CANCER ANTENNARIUS	COMMON ROCK CRAB	144	396	28
GENYONEMUS LINEATUS	WHITE CROAKER	125	6084	29
LOLIGO OPALESENS	SQUID	99	7446	30
EMBIOTOCA JACKSONI	BLACK SURFPERCH	89	8411	31
LEPTOCOTTUS ARMATUS	STAGHORN SCULPIN	82	2762	32
ANISOTREMUS DAVIDSONII	SARGO	79	5778	33
OCTOPUS		76	5038	34
SPHYRAENA ARGENTEA	CALIFORNIA BARRACUDA	75	1268	35
SQUID (TEUTHOIDEA)	SQUID	68	609	36
DOROSOMA PETENENSE	THREADFIN SHAD	59	245	37
HYPSOBLENNIUS SP.		58	535	38
MYLIOBATIS CALIFORNICA	BAT RAY	49	15806	39
CHEILOTREMA SATURNUM	BLACK CROAKER	46	881	40
CHROMIS PUNCTIPINNIS	BLACKSMITH	36	2227	41
DAMALICHTHYS VACCA	PILE SURFPERCH	32	5529	42
MENTICIRRHUS UNDULATUS	CALIFORNIA COBBINA	29	4634	43
CANCERIDAE	ROCK CRABS	28	22	44
GYMNURA MARMORATA	CALIFORNIA BUTTERFLY RAY	24	9998	45
SYNGNATHUS LEPTORRHYNCHUS	BAY PIPEFISH	24	82	45
ATHERINOPSIS CALIFORNIENSIS	JACKSMELT	21	4279	46
FUNDULUS PARVIPINNIS	CALIFORNIA KILLIFISH	21	95	46

TABLE 7.12-1 (Concluded)

SPECIES NAME	COMMON NAME	NUMBER CAUGHT	TOTAL WEIGHT	RANK
HERMOSILLA AZUREA	ZEBRAPERCH	21	778	46
PORTUNUS SP.	SWIMMING CRAB	18	0	47
PORTUNUS XANTUSII	SWIMMING CRAB	18	10	47
FAMILY PORTUNIDAE	SWIMMING CRAB	17	97	48
FAMILY PENAEIDAE	PENAEID SHRIMP	15	38	49
PEPRILUS SIMILLIMUS	PACIFIC BUTTERFISH	15	775	49
CYNOSCION NOBILIS	WHITE SEABASS	13	833	50
MAJIDAE	KELP CRAB	13	65	50
MEDIALUNA CALIFORNIENSIS	HALFMOON	10	150	51
MUGIL CEPHALUS	STRIPED MULLET	10	5593	51
RONCADOR STEARNSII	SPOTFIN CROAKER	10	11884	51
MICROMETRUS MINIMUS	DWARF SURFPERCH	8	80	52
PACHYGRAPSUS SP.	SHORE CRAB	8	0	52
PLATYRHINOIDIS TRISERIATA	THORNBACK	8	3896	52
BRACHYISTIUS FRENATUS	KELP SURFPERCH	7	362	53
CALLIANASSA	GHOST SHRIMP	7	0	53
HYPSOBLENNIUS GENTILIS	BAY BLENNY	7	22	53
MUSTELUS CALIFORNICUS	GRAY SMOOTHHOUND	7	2498	53
PENAEUS CALIFORNIENSIS	PENAEID SHRIMP	7	179	53
PANULIRUS INTERRUPTUS	SPINY LOBSTER	6	1061	54
SCOMBER JAPONICUS	PACIFIC MACKEREL	6	808	54
HYPSYPOPS RUBICUNDUS	GARIBALDI	5	1911	55
PUGETTIA PRODUCTUS	NORTHERN KELP CRAB	5	0	55
PLEURONICHTHYS VERTICALIS	HORNYHEAD TURBOT	3	492	56
SARDA CHILIENSIS	PACIFIC BONITO	3	1284	56
SQUALUS ACANTHIAS	SPINY DOGFISH	3	4050	56
STRONGYLURA EXILIS	CALIFORNIA NEEDLEFISH	3	510	56
CANCER ANTHONYI	ANTHONYS ROCK CRAB	2	0	57
GIBBONSIA ELEGANS	SPOTTED KELPFISH	2	18	57
GYMNOTHORAX MORDAX	CALIFORNIA MORAY	2	11050	57
MUSTELUS HENLEI	BROWN SMOOTHHOUND	2	1300	57
NEMERTEAN	RIBBON WORMS	2	0	57
OXYLEBIUS PICTUS	PAINTED GREENLING	2	20	57
PUGETTIA SP.	KELP CRAB	2	0	57
TALIPUS	KELP CRAB	2	0	57
APLYSIA SP.	SEA HARE	1	0	58
CANCER PRODUCTUS	COMMON ROCK CRAB	1	1	58
CANCER SP.		1	3705	58
CLINOCOTTUS ANALIS	WOOLY SCULPIN	1	20	58
EPIALTUS NUTALLII	KELP CRAB	1	70	58
GIBBONSIA METZI	STRIPED KELPFISH	1	5	58
GRAPSIDAE	SHORE CRABS	1	2	58
HALICHOERES SEMICINCTUS	ROCK WRASSE	1	90	58
HIPPOLYTE CALIFORNIENSIS	SHRIMP	1	0	58
ICTALURUS MELAS	BLACK BULLHEAD	1	68	58
IDOTEA RESECATA	KELP ISOPOD	1	1	58
NAVANAX INERMIS	STRIPED SEA SLUG	1	12	58
OPHICHTHUS ZOPHOCHIR	YELLOW SNAKE EEL	1	257	58
OXYJULIS CALIFORNICA	SENORITA	1	20	58
PARAXANTHIAS TAYLORI	LUMPY CRAB	1	0	58
SCOMBEROMORUS CONCOLOR	MONTEREY SPANISH MACKEREL	1	25	58
SCORPAENA GUTTATA	SCULPIN OR SPOTTED SCORPIONFISH	1	120	58
SEBASTES PAUCISPINIS	BOCACCIO	1	211	58
SEBASTES RASTRELLIGER	GRASS ROCKFISH	1	670	58
STRONGYLOCENTROTUS PURPURATUS	PURPLE URCHIN	1	0	58
SYMPHURUS ATRICAUDA	CALIFORNIA TONGUEFISH	1	25	58
TORPEDO CALIFORNICA	PACIFIC ELECTRIC RAY	1	4280	58
TRACHURUS SYMMETRICUS	JACK MACKEREL	1	0	58
TRIBE CARIDES	CARID SHRIMP	1	0	58
CIRRIPEDIA	BARNACLES	0	5120	59
KELP		0	137814	59
MYTILIDAE	ASSORTED MUSSELS	0	24031	59
TOTAL		110160	2642373	

000572

TABLE 7.12-2
FISH SPECIES COLLECTED DURING THERMAL TREATMENT
THAT WERE NOT COLLECTED DURING DAILY IMPINGEMENT SAMPLES
IN 1979 AT THE ENCINA POWER PLANT

SCIENTIFIC NAME	COMMON NAME
Cheilotrema saturnum	Black croaker
Hypsoblennius gentilis	Bay blenny
Scomber japonicus	Pacific mackerel
Pleuronichthys verticalis	Horneyhead turbot
Squalus acanthias	Spiny dogfish
Biggonsia elegans	Spotted kelpfish
Mustelus henlei	Brown smoothhound
Oxylebius pictus	Painted greenling
Clinocottus analis	Wooly sculpin
Halichoeres semicinctus	Rock wrasse
Ictalurus melas	Black bullhead
Oxyjulis californica	Señorita
Sebastes paucispinis	Bocaccio
Sebastes rastrelliger	Grass rockfish

TABLE 7.12-3
FISH SPECIES CAPTURED IN AGUA HEDIONDA LAGOON (TRAWLS, GILL NETS, SEINE, TRAVELING SCREENS, THERMAL TREATMENT) SAMPLES AT THE ENCINA POWER PLANT DURING 1979

SCIENTIFIC NAME	COMMON NAME
Alloclinus holderi	Island kelpfish
Amphistichus argenteus	Barred surfperch
Anchoa compressa	Deepbody anchovy
Anchoa delicatissima	Slough anchovy
Anisotremus davidsonii	Sargo
Atherinops affinis	Topsmelt
Atherinopsis californiensis	Jacksmelt
Brachyistius frenatus	Kelp surfperch
Cheilotrema saturnum	Black croaker
Chromis punctipinnis	Blacksmith
Citharichthys stigmaeus	Speckled sanddab
Citharichthys xanthostigma	Longfin sanddab
Clinocottus analis	Wooly sculpin
Clupea harengus	Pacific herring
Cymatogaster aggregata	Shiner surfperch
Cymatogaster gracilis	Island surfperch
Cynoscion nobilis	White seabass
Cypselurus californicus	California flying fish
Damalichthys vacca	Pile surfperch
Decapterus hypodus	Mexican shad
Dorosoma petenense	Threadfin shad
Embiotoca jacksoni	Black surfperch
Engraulis mordax	Northern anchovy
Fundulus parvipinnis	California killifish
Genyonemus lineatus	White croaker
Gibbonsia elegans	Spotted kelpfish
Gibbonsia metzi	Striped kelpfish
Gillichthys mirabilis	Longjaw mudsucker
Girella nigricans	Opaleye
Gobionellus longicaudus	Longtain goby
Gymnothorax mordax	Moray eel
Gymnura marmorata	California butterfly ray

TABLE 7.12-3 (Continued)

SCIENTIFIC NAME	COMMON NAME
Halichoreres semicinctus	Rock wrasse
Hermosilla azurea	Zebra perch
Heterodontus francisci	Horn shark
Heterostichus rostratus	Giant kelpfish
Hyperprosopon argenteum	Walleye surfperch
Hypsoblennius gentilis	Bay blenny
Hypsoblennius gilberti	Rockpool blenny
Hypsoblennius jenkinsi	Mussel blenny
Hypsopsetta guttulata	Diamon turbot
Hypsypops rubicundus	Garibaldi
Ictalurus melas	Black bullhead
Ilypnus gilberti	Cheekspot goby
Leptocottus armatus	Staghorn sculpin
Leuresthes tenuis	California grunion
Medialuna californiensis	Halfmoon
Menticirrhus undulatus	California corbina
Micrometrus minimus	Dwarf surfperch
Mugil cephalus	Striped mullet
Mustelus californicus	Gray smoothhound
Mustelus henlei	Brown smoothhound
Myliobatis californica	Bat ray
Oligocottus rubellio	Rosy sculpin
Ophichthus zophochir	Yellow snake eel
Oxyjulis californica	Señorita
Oxylebius pictus	Painted greenling
Paraclihus rostratus	Reef finspot
Paralabrax clathratus	Kelp bass
Paralabrax maculatofasciatus	Spotted bass
Paralabrax nebulifer	Barred sand bass
Paralichthys californicus	California halibut
Peprilus simillimus	Pacific butterfish
Phanerodon furcatus	White surfperch
Platyrhinoidis triseriata	Thornback ray
Pleuronichthys ritteri	Spotted turbot
Pleronichthys vertecalis	Horneyhead turbot
Porichthys notatus	Plainfin midshipman
Porichthys myriaster	Specklefin midshipman

000575

TABLE 7.12-3 (Concluded)

SCIENTIFIC NAME	COMMON NAME
Quietula y-cauda	Shadow goby
Rhacochilus toxotes	Rubberlip surfperch
Rhinobatos productus	Shovelnose guitarfish
Roncador stearnsi	Spotfin croaker
Sarda chiliensis	Pacific bonito
Scomber japonicus	Pacific mackerel
Scomberomorus concolor	Monterey Spanish mackerel
Scorpaena guttata	Sculpin/spotted scropionfish
Scorpaenichthys marmoratus	Cabezon
Sebastes paucispinis	Bocaccio
Sebastes rastrelliger	Grass rockfish
Seriphus politus	Queenfish
Sphyraena argentea	California barracuda
Squalus acanthias	Spiny dogfish
Squatina californica	Pacific angel shark
Strongylura exilis	California needlefish
Symphurus atricauda	California tonguefish
Syngnathus californiensis	Kelp pipefish
Syngnathus leptorhynchus	Bay pipefish
Torpedo californica	Pacific electric ray
Trachurus symmetricus	Jack mackerel
Triakis semifasciata	Leopard shark
Umbrina roncador	Yellowfin croaker
Urolophus halleri	Round stingray
Xenistius californiensis	Salema
Xystreurys liolepis	Fantail sole

000576

Generally, those species that ranked high in abundance during thermal treatment were the same species that ranked high in daily impingement samples. Over 90 percent of the fish collected during all thermal treatments were comprised of 9 major species (Table 7.12-1) which also comprised 88 percent of the total daily impingement catch. A total of 108,102 fish were killed during thermal treatments for the year. This, compared with 79,662 fish removed by daily impingement sampling for the year, indicates that significant numbers of fish reside in the intake tunnels without being impinged.

Several species (opaleye, spotted sand bass, kelp bass, barred sand bass, mussel blenny, and rockpool blenny) were taken in much higher numbers during thermal treatments than during daily impingement samples. The data suggest that these species are able to survive within the tunnels, with a low probability of being impinged. In the case of the two blennies, this may be due to their preference for a sedentary habit among encrusting growths and fouling organisms. Such a lifestyle would lead to a scarcity of encounters with the traveling screens.

As for the three species of bass, their demersal habits and swimming strength may account for the low daily impingement removals. Opaleye also hide in holes and crevices at times and are strong swimmers.

The total weight of fish collected during thermal treatments was 2,422.4 kg (5,341 lb) (63 percent of the total removed by both thermal treatment and daily impingement during 1979). The average weight (per fish) for all fish collected during thermal treatments was 22.4 g, which was 32 percent greater than the average weight of fish obtained from daily impingement samples (17 g).

Fish impingement during thermal treatments varied seasonally. Greatest abundances were taken during February and the least, during December (Tables 7.12-4 through 7.12-10). The greatest weight of organisms removed occurred in February and the smallest weight, in July. Average weight per organism varied during the year from 10.3 to 36.0 g. Smallest organisms were abundant in summer treatments (July - September) and the largest were more abundant in winter and spring.

Different traveling screens removed different amounts of organisms during periods of tunnel recirculation. Generally speaking, screen 5 (Unit 5) caught the most organisms (54 percent of total removal by thermal treatment). Screens 1 (Units 1, 2, and 3) and 4 (Unit 4) accounted for 30 and 16 percent, respectively, of the total number of organisms killed during thermal treatment. However, based on weight of organisms, screen 5 again ranked first (79 percent), screen 4 ranked second (12 percent), and screen 1 ranked last (9 percent). The data show that the greatest numbers and largest organisms were impinged in the longest intake tunnel (leading to screen 5), while a significant number of smaller species were impinged at screen 1, and a smaller number of larger organisms were impinged in the intermediate length tunnel of screen 4 (Table 7.12-11). No

TABLE 7.12-4
INVENTORY OF SPECIES REMOVED BY THERMAL TREATMENT
AT ENCINA POWER PLANT DURING FEBRUARY, 1979

SCIENTIFIC NAME	COMMON NAME	SCREEN TS1 NUMBER CAUGHT	WEIGHT	TS4 NUMBER CAUGHT	WEIGHT	TS5 NUMBER CAUGHT	WEIGHT	TOTAL CAUGHT	TOTAL WEIGHT
SQUALUS ACANTHIAS	SPINY DOGFISH					1	1500	1	1500
MUSTELUS CALIFORNICUS	GRAY SMOOTHHOUND					4	1694	4	1694
TORPEDO CALIFORNICA	PACIFIC ELECTRIC RAY	1	4280					1	4280
PLATYRHINOIDIS TRISERIATA	THORNBACK					1	252	1	252
UROLOPHUS HALLERI	ROUND STINGRAY	1	144			511	155444	512	155588
GYMNURA MARMORATA	CALIFORNIA BUTTERFLY RAY					3	1635	3	1635
GYMNOTHORAX MORDAX	CALIFORNIA MORAY					1	6100	1	6100
DOROSOMA PETENENSE	THREADFIN SHAD					47		47	0
ENGRAULIS MORDAX	NORTHERN ANCHOVY	9	52			1	20	10	72
ANCHOA COMPRESSA	DEEPBODY ANCHOVY	396	2030	266	1906	4528	32226	5190	36162
ANCHOA DELICATISSIMA	SLOUGH ANCHOVY	29	141			4	13	33	154
PORICHTHYS MYRIASTER	SPECKLEFIN MIDSHIPMAN	1	3					1	3
LEURESTHES TENUIS	CALIFORNIA GRUNION	8	24					8	24
ATHERINOPS AFFINIS	TOPSMELT	8401	41989	1299	15366	3098	38098	12798	95453
SYNGNATHUS LEPTORHYNCHUS	BAY PIPEFISH	3	11					3	11
SCORPAENA GUTTATA	SCULPIN OR SPOTTED SCORPIONFISH					1	120	1	120
SEBASTES RASTRELLIGER	GRASS ROCKFISH					1	670	1	670
SEBASTES PAUCISPINIS	BOCACCIO					1	211	1	211
LEPTOCOTTUS ARMATUS	STAGHORN SCULPIN					3	204	3	204
PARALABRAX CLATHRATUS	KELP BASS	2	7	1	38	208	12951	211	12996
PARALABRAX MACULATOFASCIATUS	SPOTTED SAND BASS			21	95	302	36240	323	36335
PARALABRAX NEBULIFER	BARRED SAND BASS	27	139	2	6			29	145
XENISTIUS CALIFORNIENSIS	SALEMA			20	120			20	120
ANISOTREMUS DAVIDSONII	SARGO			1	1500	1	180	2	1680
SERIPHUS POLITUS	QUEENFISH	18	77	21	929	351	3260	390	4266
UMBRINA RONCADOR	YELLOWFIN CROAKER					32	3159	32	3159
MENTICIRRHUS UNDULATUS	CALIFORNIA CORBINA					3	1559	3	1558
RONCADOR STEARNSII	SPOTFIN CROAKER					5	4552	5	4552
GIRELLA NIGRICANS	OPALEYE	4	20			66	26268	70	26288
HERMOSILLA AZUREA	ZEBRAPERCH					1	700	1	700
MEDIALUNA CALIFORNIENSIS	HALFMOON			9				9	0
EMBIOTOCA JACKSONI	BLACK SURFPERCH					4	897	4	897
AMPHISTICHUS ARGENTEUS	BARRED SURFPERCH					79	11050	79	11050
HYPERPROSOPON ARGENTEUM	WALLEYE SURFPERCH			31	2346	4308	344540	4339	346886
CYMATOGASTER AGGREGATA	SHINER SURFPERCH	2	45	3	29	3690	142794	3695	142868
BRACHYISTIUS FRENATUS	KELP SURFPERCH					3	162	3	162
DAMALICHTHYS VACCA	PILE SURFPERCH	19	76			6	2726	25	2802
PHANERODON FURCATUS	WHITE SURFPERCH					5	377	5	377
HYPSYPOPS RUBICUNDUS	GARIBALDI					2	961	2	961
SPHYRAENA ARGENTEA	CALIFORNIA BARRACUDA	1	21			1	62	2	83
OXYJULIS CALIFORNICA	SENORITA					1	20	1	20
HALICHOERES SEMICINCTUS	ROCK WRASSE					1	90	1	90
HYPSOBLENNIUS GILBERTI	ROCKPOOL BLENNY			142		6	137	148	137
HYPSOBLENNIUS JENKINSI	MUSSEL BLENNY	221	1989					221	1989

TABLE 7.12-4 (Concluded)

SCIENTIFIC NAME	COMMON NAME	SCREEN TS1 NUMBER CAUGHT	WEIGHT	TS4 NUMBER CAUGHT	WEIGHT	TS5 NUMBER CAUGHT	WEIGHT	TOTAL CAUGHT	TOTAL WEIGHT
HETEROSTICHUS ROSTRATUS	GIANT KELPFISH			1	26	68	6976	69	7002
SCOMBER JAPONICUS	PACIFIC MACKEREL					5	766	5	766
SCOMBEROMORUS CONCOLOR	MONTEREY SPANISH MACKEREL	1	25					1	25
PEPRILUS SIMILLIMUS	PACIFIC BUTTERFISH					9	645	9	645
PARALICHTHYS CALIFORNICUS	CALIFORNIA HALIBUT	1	24	3	141	93	28243	97	28408
HYPSOPSETTA GUTTULATA	DIAMOND TURBOT	1	4			96	19685	97	19689
OCTOPUS		2		1	180	4	1315	7	1495
CIRRIPEDIA	BARNACLES						130	0	130
FAMILY PENAEIDAE	PENAEID SHRIMP					3	38	3	38
TRIBE CARIDES	CARID SHRIMP	1						1	0
CALLIANASSA	GHOST SHRIMP	7						7	0
MAJIDAE	KELP CRAB			1		7	38	8	38
TALIPUS	KELP CRAB	2						2	0
PUGETTIA SP.	KELP CRAB	2						2	0
PUGETTIA PRODUCTUS	NORTHERN KELP CRAB	4						4	0
CANCER SP.		1						1	0
CANCER ANTENNARIUS	COMMON ROCK CRAB	9		3				12	0
CANCER ANTHONYI	ANTHONYS ROCK CRAB	2						2	0
FAMILY PORTUNIDAE	SWIMMING CRAB	2				15	97	17	97
PORTUNUS SP.	SWIMMING CRAB	9						9	0
PORTUNUS XANTUSII	SWIMMING CRAB	9		4				13	0
PARAXANTHIAS TAYLORI	LUMPY CRAB			1				1	0
PACHYGRAPSUS SP.	SHORE CRAB	8						8	0
NEMERTEAN	RIBBON WORMS	2						2	0
*TOTAL FEBRUARY		9206	51101	1830	226820	17580	888804	28616	962587

000580

TABLE 7.12-5
INVENTORY OF SPECIES REMOVED BY THERMAL TREATMENT
AT ENCINA POWER PLANT DURING APRIL, 1979

SCIENTIFIC NAME	COMMON NAME	SCREEN TS1 NUMBER CAUGHT	WEIGHT	TS4 NUMBER CAUGHT	WEIGHT	TS5 NUMBER CAUGHT	WEIGHT	TOTAL CAUGHT	TOTAL WEIGHT
SQUALUS ACANTHIAS	SPINY DOGFISH					2	2550	2	2550
MUSTELUS CALIFORNICUS	GRAY SMOOTHHOUND					1	364	1	364
MYLIOBATIS CALIFORNICA	BAT RAY					6	2225	6	2225
UROLOPHUS HALLERI	ROUND STINGRAY	1	652			242	88400	243	89052
GYMNURA MARMORATA	CALIFORNIA BUTTERFLY RAY					4	2350	4	2350
DOROSOMA PETENENSE	THREADFIN SHAD	1	76			11	169	12	245
ENGRAULIS MORDAX	NORTHERN ANCHOVY	1	4			11	104	12	108
ANCHOA COMPRESSA	DEEPBODY ANCHOVY	2005	7903			2523	24634	4528	32537
ANCHOA DELICATISSIMA	SLOUGH ANCHOVY					2	6	2	6
PORICHTHYS MYRIASTER	SPECKLEFIN MIDSHIPMAN					2	2050	2	2050
ICTALURUS MELAS	BLACK BULLHEAD	1	68					1	68
STRONGYLURA EXILIS	CALIFORNIA NEEDLEFISH					1	250	1	250
FUNDULUS PARVIPINNIS	CALIFORNIA KILLIFISH					2		2	0
LEURESTHES TENUIS	CALIFORNIA GRUNION					5	28	5	28
ATHERINOPSIS CALIFORNIENSIS	JACKSMELT					15	3009	15	3009
ATHERINOPS AFFINIS	TOPSMELT	3234	14529			2140	22432	5374	36961
SYNGNATHUS LEPTORHYNCHUS	BAY PIPEFISH	3	6					3	6
PARALABRAX CLATHRATUS	KELP BASS	1	69			27	902	28	971
PARALABRAX MACULATOFASCIATUS	SPOTTED SAND BASS	1	110			51	5950	52	6060
PARALABRAX NEBULIFER	BARRED SAND BASS	23	118			90	2800	113	2918
XENISTIUS CALIFORNIENSIS	SALEMA					1	4	1	4
ANISOTREMUS DAVIDSONII	SARGO					5	40	5	40
SERIPHUS POLITUS	QUEENFISH	3	19			38	2692	41	2711
UMBRINA RONCADOR	YELLOWFIN CROAKER					2	4	2	4
MENTICIRRHUS UNDULATUS	CALIFORNIA CORBINA					2	634	2	634
RONCADOR STEARNSII	SPOTFIN CROAKER	1	4082					1	4082
GIRELLA NIGRICANS	OPALEYE					27	8000	27	8000
AMPHISTICHUS ARGENTEUS	BARRED SURFPERCH					5	313	5	313
HYPERPROSOPON ARGENTEUM	WALLEYE SURFPERCH	4	260			851	67146	855	67406
CYMATOGASTER AGGREGATA	SHINER SURFPERCH					744	25597	744	25597
BRACHYISTIUS FRENATUS	KELP SURFPERCH					4	200	4	200
MICROMETRUS MINIMUS	DWARF SURFPERCH					8	80	8	80
DAMALICHTHYS VACCA	PILE SURFPERCH					1	440	1	440
PHANERODON FURCATUS	WHITE SURFPERCH	1	34			7	809	8	843
MUGIL CEPHALUS	STRIPED MULLET					2	767	2	767
HYPSOBLENNIUS GILBERTI	ROCKPOOL BLENNY	53	278					53	278
HETEROSTICHUS ROSTRATUS	GIANT KELPFISH	1	4			27	1696	28	1700
SCOMBER JAPONICUS	PACIFIC MACKEREL					1	42	1	42
PEPRILUS SIMILLIMUS	PACIFIC BUTTERFISH					6	130	6	130
PARALICHTHYS CALIFORNICUS	CALIFORNIA HALIBUT					20	1850	20	1850
PLEURONICHTHYS VERTICALIS	HORNYHEAD TURBOT					1	192	1	192
HYPSOPSETTA GUTTULATA	DIAMOND TURBOT					41	7400	41	7400
NAVANAX INERMIS	STRIPED SEA SLUG	1	12					1	12
APLYSIA SP.	SEA HARE					1		1	0

TABLE 7.12-5 (Concluded)

SCIENTIFIC NAME	COMMON NAME	SCREEN TS1 NUMBER CAUGHT	WEIGHT	TS4 NUMBER CAUGHT	WEIGHT	TS5 NUMBER CAUGHT	WEIGHT	TOTAL CAUGHT	TOTAL WEIGHT
OCTOPUS		6	42			4		10	42
CIRRIPEDIA	BARNACLES		4990					0	4990
IDOTEA RESECATA	KELP ISOPOD	1	1					1	1
PENAEUS CALIFORNIENSIS	PENAEID SHRIMP					2		2	0
HIPPOLYTE CALIFORNIENSIS	SHRIMP					1		1	0
BRACHYURANS	CRABS		1988					0	1988
MAJIDAE	KELP CRAB	4	27			1		5	27
PUGETTIA PRODUCTUS	NORTHERN KELP CRAB					1		1	0
CANCRIDAE	ROCK CRABS	5	22			23		28	22
CANCER PRODUCTUS	COMMON ROCK CRAB	1	1					1	1
PORTUNUS SP.	SWIMMING CRAB					9		9	0
PORTUNUS XANTUSII	SWIMMING CRAB	3	10			2		5	10
GRAPSIDAE	SHORE CRABS	1	2					1	2
PACHYGRAPSUS CRASSIPES	SHORE CRAB	1	5			2		3	5
KELP			30845				9100	0	39945
*TOTAL APRIL		5357	66157			6974	285359	12331	351516

000583

TABLE 7.12-6
INVENTORY OF SPECIES REMOVED BY THERMAL TREATMENT AT ENCINA POWER PLANT DURING JUNE, 1979

SCIENTIFIC NAME	COMMON NAME	SCREEN TS1 NUMBER CAUGHT	WEIGHT	TS4 NUMBER CAUGHT	WEIGHT	TS5 NUMBER CAUGHT	WEIGHT	TOTAL CAUGHT	TOTAL WEIGHT
MYLIOBATIS CALIFORNICA	BAT RAY			1	400			1	400
UROLOPHUS HALLERI	ROUND STINGRAY	14	2942			292	51200	306	54142
GYMNURA MARMORATA	CALIFORNIA BUTTERFLY RAY					3	1400	3	1400
ENGRAULIS MORDAX	NORTHERN ANCHOVY	2	8	2				4	8
ANCHOA COMPRESSA	DEEPBODY ANCHOVY	572	4219	1128	8187	249	1743	1949	14149
ANCHOA DELICATISSIMA	SLOUGH ANCHOVY	30	106					30	106
PORICHTHYS MYRIASTER	SPECKLEFIN MIDSHIPMAN	7	2813			252	37425	259	40238
FAMILY ATHERINIDAE						289	34225	288	34225
LEURESTHES TENUIS	CALIFORNIA GRUNION	16	23					16	23
ATHERINOPSIS CALIFORNIENSIS	JACKSMELT			1	150	2	350	3	500
ATHERINOPS AFFINIS	TOPSMELT	164	598	921	10867	425	6840	1510	18305
OXYLEBIUS PICTUS	PAINTED GREENLING	2	20					2	20
LEPTOCOTTUS ARMATUS	STAGHORN SCULPIN			5	25	22	400	27	425
PARALABRAX CLATHRATUS	KELP BASS	9	1742	17	4250	12	1314	38	7306
PARALABRAX MACULATOFASCIATUS	SPOTTED SAND BASS	33	1179	1	350	38	7900	72	9429
PARALABRAX NEBULIFER	BARRED SAND BASS	14	1008	3		73	1754	90	2762
XENISTIUS CALIFORNIENSIS	SALEMA			11				11	0
ANISOTREMUS DAVIDSONII	SARGO	2	20	2	400	1	1250	5	1670
SERIPHUS POLITUS	QUEENFISH	9	35	120	3875	246	10840	375	14750
UMBRINA RONCADOR	YELLOWFIN CROAKER			9				9	0
MENTICIRRHUS UNDULATUS	CALIFORNIA CORBINA					1	175	1	175
GENYONEMUS LINEATUS	WHITE CROAKER			45	3517	70	2120	115	5637
RONCADOR STEARNSII	SPOTFIN CROAKER					1	1000	1	1000
GIRELLA NIGRICANS	OPALEYE	10	546	4	850	71	7525	85	8921
EMBIOTOCA JACKSONI	BLACK SURFPERCH					12	634	12	634
AMPHISTICHUS ARGENTEUS	BARRED SURFPERCH					2	450	2	450
HYPERPROSOPON ARGENTEUM	WALLEYE SURFPERCH	26	2756	182	11612	586	36170	794	50538
CYMATOGASTER AGGREGATA	SHINER SURFPERCH	66	516	1613	9026	713	11525	2392	21067
DAMALICHTHYS VACCA	PILE SURFPERCH					1	675	1	675
PHANERODON FURCATUS	WHITE SURFPERCH			165	1576	80	2081	245	3657
HYPSYPOPS RUBICUNDUS	GARIBALDI					1	300	1	300
CHROMIS PUNCTIPINNIS	BLACKSMITH	2	117	1	200	5	400	8	717
MUGIL CEPHALUS	STRIPED MULLET					5	2630	5	2630
HYPSOBLENNIUS SP.						58	535	58	535
HYPSOBLENNIUS GILBERTI	ROCKPOOL BLENNY	52	457					52	457
HYPSOBLENNIUS JENKINSI	MUSSEL BLENNY			12				12	0
HETEROSTICHUS ROSTRATUS	GIANT KELPFISH	117	750	417	3130	134	2734	668	6614
PARALICHTHYS CALIFORNICUS	CALIFORNIA HALIBUT			1	100	43	2986	44	3086
PLEURONICHTHYS VERTICALIS	HORNYHEAD TURBOT			2	300			2	300
HYPSOPSETTA GUTTULATA	DIAMOND TURBOT					18	3424	18	3424
MYTILIDAE	ASSORTED MUSSELS		24031					.0	24031
OCTOPUS		1		1				2	0
ORDER DECAPODA			21938	490	6066			490	28004
FAMILY PENAEIDAE	PENAEID SHRIMP	12						12	0

TABLE 7.12-6 (Concluded)

SCIENTIFIC NAME	COMMON NAME	SCREEN TS1 NUMBER CAUGHT	WEIGHT	TS4 NUMBER CAUGHT	WEIGHT	TS5 NUMBER CAUGHT	WEIGHT	TOTAL CAUGHT	TOTAL WEIGHT
PENAEUS CALIFORNIENSIS	PENAEID SHRIMP					5	179	5	179
PANULIRUS INTERRUPTUS	SPINY LOBSTER	1	150			1	142	2	292
CANCER SP.							3705	0	3705
STRONGYLOCENTROTUS PURPURATUS	PURPLE URCHIN	1						1	0
KELP					8044			0	8044
*TOTAL JUNE		1162	65974	5154	72745	3710	236031	10026	374930

TABLE 7.12-7
INVENTORY OF SPECIES REMOVED BY THERMAL TREATMENT AT ENCINA POWER PLANT DURING JULY, 1979

SCIENTIFIC NAME	COMMON NAME	SCREEN TS1 NUMBER CAUGHT	WEIGHT	TS4 NUMBER CAUGHT	WEIGHT	TS5 NUMBER CAUGHT	WEIGHT	TOTAL CAUGHT	TOTAL WEIGHT
MUSTELUS HENLEI	BROWN SMOOTHHOUND					2	1300	2	1300
PLATYRHINOIDIS TRISERIA A	THORNBACK					1	1000	1	1000
MYLIOBATIS CALIFORNICA	BAT RAY					20	6590	20	6590
UROLOPHUS HALLERI	ROUND STINGRAY					150	22500	150	22500
GYMNURA MARMORATA	CALIFORNIA BUTTERFLY RAY					2	770	2	770
ENGRAULIS MORDAX	NORTHERN ANCHOVY	6164	10950	389	1042	15	50	6568	12042
ANCHOA COMPRESSA	DEEPBODY ANCHOVY	912	4871	859	5199	996	10215	2767	20285
ANCHOA DELICATISSIMA	SLOUGH ANCHOVY					18	142	18	142
PORICHTHYS MYRIASTER	SPECKLEFIN MIDSHIPMAN	1	200			36	7560	37	7760
LEURESTHES TENUIS	CALIFORNIA GRUNION	20	100	378	699	33	344	431	1143
ATHERINOPSIS CALIFORNIENSIS	JACKSMELT					1	300	1	300
ATHERINOPS AFFINIS	TOPSMELT	363	826	69	653	200	3843	632	5322
PARALABRAX CLATHRATUS	KELP BASS					29	2730	29	2730
PARALABRAX MACULATOFASCIATUS	SPOTTED SAND BASS					40	11206	40	11206
PARALABRAX NEBULIFER	BARRED SAND BASS			3	71	10	800	13	871
XENISTIUS CALIFORNIENSIS	SALEMA					11	432	11	432
SERIPHUS POLITUS	QUEENFISH	69	450	1	4	45	5617	115	6071
UMBRINA RONCADOR	YELLOWFIN CROAKER					45	1800	45	1800
MENTICIRRHUS UNDULATUS	CALIFORNIA CORBINA					3	440	3	440
GENYONEMUS LINEATUS	WHITE CROAKER			5	210			6	210
RONCAD STEARNSII	SPOTFIN CROAKER					1	160	1	160
GIRELLA NIGRICANS	OPALEYE	39	15[illegible]	17	40	1	345	57	542
EMBIOTOCA JACKSONI	BLACK SURFPERCH					13	950	13	950
HYPERPROSOPON ARGENTEUM	WALLEYE SURFPERCH			2	171	50	3610	52	3781
CYMATOGASTER AGGREGATA	SHINER SURFPERCH			15	78	131	1961	146	2039
DAMALICHTHYS VACCA	PILE SURFPERCH					3	1000	3	1000
CHROMIS PUNCTIPINNIS	BLACKSMITH					3	512	3	512
HYPSOBLENNIUS JENKINSI	MUSSEL BLENNY			40	97			40	97
HETEROSTICHUS ROSTRATUS	GIANT KELPFISH	177	1301	3	18	15	1357	195	2676
GIBBONSIA METZI	STRIPED KELPFISH	1	5					1	5
PARALICHTHYS CALIFORNICUS	CALIFORNIA HALIBUT					25	5482	25	5482
HYPSOPSETTA GUTTULATA	DIAMOND TURBOT					9	1396	9	1396
OCTOPUS						1	520	1	520
ORDER DECAPODA				321	573			321	573
PANULIRUS INTERRUPTUS	SPINY LOBSTER					1	200	1	200
CANCER ANTENNARIUS	COMMON ROCK CRAB	132	396					132	396
PACHYGRAPSUS CRASSIPES	SHORE CRAB	99	330					99	330
KELP							3800	0	3800
*TOTAL JULY		7977	19586	2103	8855	1910	98932	11990	127373

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TABLE 7.12-8
INVENTORY OF SPECIES REMOVED BY THERMAL TREATMENT AT ENCINA POWER PLANT DURING SEPTEMBER, 1979

SCIENTIFIC NAME	COMMON NAME	SCREEN TS1 NUMBER CAUGHT	WEIGHT	TS4 NUMBER CAUGHT	WEIGHT	TS5 NUMBER CAUGHT	WEIGHT	TOTAL CAUGHT	TOTAL WEIGHT
MUSTELUS CALIFORNICUS	GRAY SMOOTHHOUND					2	440	2	440
MYLIOBATIS CALIFORNICA	BAT RAY			5	1500	15	4600	20	6100
UROLOPHUS HALLERI	ROUND STINGRAY			3	1080	131	25900	134	26980
GYMNURA MARMORATA	CALIFORNIA BUTTERFLY RAY					5	875	5	875
GYMNOTHORAX MORDAX	CALIFORNIA MORAY					1	4950	1	4950
ENGRAULIS MORDAX	NORTHERN ANCHOVY	3421	9688	2645	7260	6380	62480	12446	79428
ANCHOA COMPRESSA	DEEPBODY ANCHOVY	387	1713	464	5035	4070	39930	4921	46678
ANCHOA DELICATISSIMA	SLOUGH ANCHOVY	89	279	137	371			226	650
PORICHTHYS MYRIASTER	SPECKLEFIN MIDSHIPMAN			1	220	43	11050	44	11270
STRONGYLURA EXILIS	CALIFORNIA NEEDLEFISH					1	80	1	80
LEURESTHES TENUIS	CALIFORNIA GRUNION	732	3857	1060	23977	1650	16170	3442	44004
ATHERINOPS AFFINIS	TOPSMELT	41	193	136	650			177	843
PARALABRAX CLATHRATUS	KELP BASS	2	115	8	708	30	3450	40	4273
PARALABRAX MACULATOFASCIATUS	SPOTTED SAND BASS			27	4903	59	14550	86	19453
PARALABRAX NEBULIFER	BARRED SAND BASS			78	4618	24	2350	102	6968
XENISTIUS CALIFORNIENSIS	SALEMA			1	20			1	20
ANISOTREMUS DAVIDSONII	SARGO			1	30			1	30
SERIPHUS POLITUS	QUEENFISH	117	528	363	8149	1444	45180	1924	53857
CYNOSCION NOBILIS	WHITE SEABASS			2	70			2	70
UMBRINA RONCADOR	YELLOWFIN CROAKER	14	83			4	310	18	393
MENTICIRRHUS UNDULATUS	CALIFORNIA CORBINA					1	160	1	160
GENYONEMUS LINEATUS	WHITE CROAKER			4	237			4	237
RONCADOR STEARNSII	SPOTFIN CROAKER			1	790			1	790
GIRELLA NIGRICANS	OPALEYE	2	208	16	2141	250	6700	268	9049
MEDIALUNA CALIFORNIENSIS	HALFMOON					1	150	1	150
EMBIOTOCA JACKSONI	BLACK SURFPERCH			1	60	1	70	2	130
HYPERPROSOPON ARGENTEUM	WALLEYE SURFPERCH			119	4569	945	11930	1064	16499
CYMATOGASTER AGGREGATA	SHINER SURFPERCH	14	124	103	2811	2090	20460	2207	23395
DAMALICHTHYS VACCA	PILE SURFPERCH			1	22			1	22
PHANERODON FURCATUS	WHITE SURFPERCH			1	12	332	3320	333	3332
HYPSYPOPS RUBICUNDUS	GARIBALDI					2	650	2	650
SPHYRAENA ARGENTEA	CALIFORNIA BARRACUDA	14	110					14	110
HYPSOBLENNIUS GENTILIS	BAY BLENNY	3	12					3	12
HYPSOBLENNIUS GILBERTI	ROCKPOOL BLENNY	2	11					2	11
HYPSOBLENNIUS JENKINSI	MUSSEL BLENNY	1	4					1	4
HETEROSTICHUS ROSTRATUS	GIANT KELPFISH	2	26	25	568	26	1250	53	1844
GIBBONSIA ELEGANS	SPOTTED KELPFISH	1	8					1	8
PARALICHTHYS CALIFORNICUS	CALIFORNIA HALIBUT	1	36	9	372	46	3500	56	3908
HYPSOPSETTA GUTTULATA	DIAMOND TURBOT	1	148			4	550	5	698
OCTOPUS		41	221	1	80	5	1000	47	1301
PANULIRUS INTERRUPTUS	SPINY LOBSTER					2	400	2	400
BRACHYURANS	CRABS	307	690					307	690
EPIALTUS NUTTALLII	KELP CRAB					1	70	1	70
PACHYGRAPSUS CRASSIPES	SHORE CRAB					221	2220	221	2220
KELP							26400	0	26400
*TOTAL SEPTMBER		5192	18054	5212	70253	17786	311145	28190	399432

TABLE 7.12-9
INVENTORY OF SPECIES REMOVED BY THERMAL TREATMENT AT ENCINA POWER PLANT DURING OCTOBER, 1979

SCIENTIFIC NAME	COMMON NAME	SCREEN TS1 NUMBER CAUGHT	WEIGHT	TS4 NUMBER CAUGHT	WEIGHT	TS5 NUMBER CAUGHT	WEIGHT	TOTAL CAUGHT	TOTAL WEIGHT
PLATYRHINOIDIS TRISERIATA	THORNBACK					4	2420	4	2420
MYLIOBATIS CALIFORNICA	BAT RAY					2	491	2	491
UROLOPHUS HALLERI	ROUND STINGRAY					115	25864	115	25864
GYMNURA MARMORATA	CALIFORNIA BUTTERFLY RAY			1	225	6	2743	7	2968
OPHICHTHUS ZOPHOCHIR	YELLOW SNAKE EEL	1	257					1	257
ENGRAULIS MORDAX	NORTHERN ANCHOVY	3	7			54	567	57	574
ANCHOA COMPRESSA	DEEPBODY ANCHOVY	462	1911	402	934	2681	27250	3545	30095
ANCHOA DELICATISSIMA	SLOUGH ANCHOVY	152	342					152	342
PORICHTHYS MYRIASTER	SPECKLEFIN MIDSHIPMAN					2	870	2	870
FUNDULUS PARVIPINNIS	CALIFORNIA KILLIFISH	19	95					19	95
LEURESTHES TENUIS	CALIFORNIA GRUNION	1919	14098	839	6988	2627	36242	5385	57328
ATHERINOPS AFFINIS	TOPSMELT	92	540			131	1545	223	2085
CLINOCOTTUS ANALIS	WOOLY SCULPIN			1	20			1	20
PARALABRAX CLATHRATUS	KELP BASS			9	474	83	5686	92	6160
PARALABRAX MACULATOFASCIATUS	SPOTTED SAND BASS			1	159	38	3818	39	3977
PARALABRAX NEBULIFER	BARRED SAND BASS			10	572	89	6144	99	6716
XENISTIUS CALIFORNIENSIS	SALEMA			2	17	11	327	13	344
ANISOTREMUS DAVIDSONII	SARGO			1	15	47	1922	48	1937
SERIPHUS POLITUS	QUEENFISH	23	149	135	2207	267	7441	425	9797
CYNOSCION NOBILIS	WHITE SEABASS					11	763	11	763
UMBRINA RONCADOR	YELLOWFIN CROAKER			1	50	33	186	34	236
MENTICIRRHUS UNDULATUS	CALIFORNIA CORBINA			1	404	3	726	4	1130
RONCADOR STEARNSII	SPOTFIN CROAKER					1	1300	1	1300
CHEILOTREMA SATURNUM	BLACK CROAKER			11	45	22	436	33	481
GIRELLA NIGRICANS	OPALEYE			11	1397	85	8304	96	9701
HERMOSILLA AZUREA	ZEBRAPERCH	19	76					19	76
EMBIOTOCA JACKSONI	BLACK SURFPERCH			1	60	5	490	6	550
HYPERPROSOPON ARGENTEUM	WALLEYE SURFPERCH			84	2360	107	3885	191	6245
CYMATOGASTER AGGREGATA	SHINER SURFPERCH			51	760	126	1712	177	2472
DAMALICHTHYS VACCA	PILE SURFPERCH					1	590	1	590
CHROMIS PUNCTIPINNIS	BLACKSMITH			1	51	22	752	23	803
MUGIL CEPHALUS	STRIPED MULLET					3	2196	3	2196
SPHYRAENA ARGENTEA	CALIFORNIA BARRACUDA			3	58	22	109	25	167
HYPSOBLENNIUS GENTILIS	BAY BLENNY			1				1	0
HYPSOBLENNIUS GILBERTI	ROCKPOOL BLENNY			1				1	0
HYPSOBLENNIUS JENKINSI	MUSSEL BLENNY			1				1	0
HETEROSTICHUS ROSTRATUS	GIANT KELPFISH			3	110	100	3621	103	3731
SARDA CHILIENSIS	PACIFIC BONITO					3	1284	3	1284
PARALICHTHYS CALIFORNICUS	CALIFORNIA HALIBUT			6	481	63	7900	69	8381
HYPSOPSETTA GUTTULATA	DIAMOND TURBOT					8	2175	8	2175
SQUID (TEUTHOIDEA)	SQUID					68	609	68	609
OCTOPUS						3	825	3	825
PANULIRUS INTERRUPTUS	SPINY LOBSTER			1	169			1	169
KELP			13300				46325	0	59625
*TOTAL OCTOBER		2690	30775	1578	17556	6843	207518	11111	197513

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TABLE 7.12-10
INVENTORY OF SPECIES REMOVED BY THERMAL TREATMENT AT ENCINA POWER PLANT DURING DECEMBER, 1979

SCIENTIFIC NAME	COMMON NAME	SCREEN TS1 NUMBER CAUGHT	WEIGHT	TS4 NUMBER CAUGHT	WEIGHT	TS5 NUMBER CAUGHT	WEIGHT	TOTAL CAUGHT	TOTAL WEIGHT
PLATYRHINOIDIS TRISERIATA	THORNBACK	1	224	1				2	224
UROLOPHUS HALLERI	ROUND STINGRAY	11	757	10	554	204	28800	225	30111
ENGRAULIS MORDAX	NORTHERN ANCHOVY	67	232	177	584	226	933	470	1749
ANCHOA COMPRESSA	DEEPBODY ANCHOVY	23	102	19	38	200	2133	242	2273
ANCHOA DELICATISSIMA	SLOUGH ANCHOVY			3	5			3	5
STRONGYLURA EXILIS	CALIFORNIA NEEDLEFISH					1	180	1	180
LEURESTHES TENUIS	CALIFORNIA GRUNION	28	112	143	715	213	800	384	1627
ATHERINOPSIS CALIFORNIENSIS	JACKSMELT					2	470	2	470
ATHERINOPS AFFINIS	TOPSMELT	299	1540	482	3149	293	2400	1074	7089
SYNGNATHUS LEPTORHYNCHUS	BAY PIPEFISH	2	1	16	64			18	65
LEPTOCOTTUS ARMATUS	STAGHORN SCULPIN			1		51	2133	52	2133
PARALABRAX CLATHRATUS	KELP BASS	7	27	60	692	63	3350	130	4069
PARALABRAX MACULATOFASCIATUS	SPOTTED SAND BASS					4	900	4	900
PARALABRAX NEBULIFER	BARRED SAND BASS	1	58	11	916	60	5370	72	6344
TRACHURUS SYMMETRICUS	JACK MACKEREL			1				1	0
XENISTIUS CALIFORNIENSIS	SALEMA	27	100	61	282	16	87	104	469
ANISOTREMUS DAVIDSONII	SARGO	1	4	2	300	15	117	18	421
SERIPHUS POLITUS	QUEENFISH	8	41	7	161	200	4666	215	4868
UMBRINA RONCADOR	YELLOWFIN CROAKER	3	13	3	85	160	1733	166	1831
MENTICIRRHUS UNDULATUS	CALIFORNIA CORBINA					15	537	15	537
CHEILOTREMA SATURNUM	BLACK CROAKER					13	400	13	400
GIRELLA NIGRICANS	OPALEYE					14	2420	14	2420
HERMOSILLA AZUREA	ZEBRAPERCH	1	2					1	2
EMBIOTOCA JACKSONI	BLACK SURFPERCH					52	5250	52	5250
AMPHISTICHUS ARGENTEUS	BARRED SURFPERCH					80	4133	80	4133
HYPERPROSOPON ARGENTEUM	WALLEYE SURFPERCH			77	2780	933	28662	1010	31442
CYMATOGASTER AGGREGATA	SHINER SURFPERCH	18	371	707	13080	2240	44560	2965	58111
PHANERODON FURCATUS	WHITE SURFPERCH					13	400	13	400
CHROMIS PUNCTIPINNIS	BLACKSMITH					2	195	2	195
SPHYRAENA ARGENTEA	CALIFORNIA BARRACUDA	1	10	8	195	25	703	34	908
HYPSOBLENNIUS GENTILIS	BAY BLENNY			3	10			3	10
HYPSOBLENNIUS GILBERTI	ROCKPOOL BLENNY	3	40					3	40
HYPSOBLENNIUS JENKINSI	MUSSEL BLENNY			2	10			2	10
HETEROSTICHUS ROSTRATUS	GIANT KELPFISH			12	381	293	12264	305	12645
GIBBONSIA ELEGANS	SPOTTED KELPFISH	1	10					1	10
SYMPHURUS ATRICAUDA	CALIFORNIA TONGUEFISH					1	25	1	25
PARALICHTHYS CALIFORNICUS	CALIFORNIA HALIBUT			3	270	15	1610	18	1880
HYPSOPSETTA GUTTULATA	DIAMOND TURBOT			1		6	1115	7	1115
LOLIGO OPALESCENS	SQUID	1	30	6	250	92	7166	99	7446
OCTOPUS		3	80			3	775	6	855
BRACHYURANS	CRABS	69	500					69	500
*TOTAL DECEMBER		575	4254	1816	24521	5505	164387	7896	193162
TOTAL		32156	255601	17693	319409	58382	2125569	108231	2700579

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TABLE 7.12-11
FISH, INVERTEBRATE, AND ALGAE COLLECTIONS AT TRAVELING SCREENS FOR ENCINA POWER PLANT, JANUARY - DECEMBER, 1979

	Screen 1 (Units 1-3)			Screen 4 (Unit 4)			Screen 5 (Unit 5)			
	Daily Impinged	Thermal Treatment	Yearly Total	Daily Impinged	Thermal Treatment	Yearly Total	Daily Impinged	Thermal Treatment	Yearly Total	All Screens Yearly Total
Fish										
Numbers	15,116	31,411	46,527	39,509	16,863	56,372	25,037	59,831	84,868	187,767
Weight (Kg)	199.1	156.3	355.4	353.3	201.4	554.7	842.8	2,088.5	2,931.3	3,841.4
Invertebrates										
Numbers	3,104	750	3,854	1,129	830	1,959	2,048	477	2,525	8,338
Weight (Kg)	61.4	55.5	116.9	28.7	7.3	36.0	63.1	18.0	81.1	244.0
Weight of Kelp, Algae (Kg)		44.1			8.0			85.6		137.8
TOTAL NUMBER (fish & invert.)			50,381			58,331			87,393	196,105
TOTAL WEIGHT (Kg) (fish & invert.)			472.3			590.7			3,012.5	4,075.4

traveling screen was consistently number one in terms of number of organisms captured during each thermal treatment. All three screens ranked number 1, 2, and 3 during various thermal treatments; however, screen 5 ranked number one more frequently than the others, screen 4 ranked second most frequently, and screen 1 ranked third most frequently. With regard to weight of organisms captured, screen 5 consistently ranked first.

The study shows that certain numbers of fish species inhabit the intake tunnel systems without being impinged. Some relatively large individuals apparently live in the tunnels and their numbers appear to be greatest in winter and lowest during summer. However, all these organisms are killed during thermal treatments. Following each treatment repopulation of the tunnels begins, as organisms move into the intake from Agua Hedionda Lagoon. A number of lagoon species do not appear to move into the Plant and thus are not subject to impingement or thermal treatment (Table 7.12-12).

The specific times when tunnel recirculation was conducted were given in Table 7.5-3. Examination of data in this table for total number and weight of fishes impinged indicates that sometimes there were residual effects of tunnel recirculation lasting for one or more days following the operation. During those periods, larger than usual numbers and total weights of fishes occurred in the samples, despite the fact that all material impinged during the 6-hr period of the tunnel recirculation itself was removed by sampling at that time.

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TABLE 7.12-12
FISH SPECIES COLLECTED IN AGUA HEDIONDA LAGOON
THAT WERE NOT COLLECTED AT THE TRAVELING SCREENS
AT ENCINA POWER PLANT DURING 1979

SCIENTIFIC NAME	COMMON NAME
Scorpaenichthys marmoratus	Cabezon
Paraclinus rostratus	Reef finspot
Gobionellus longicaudus	Longtail goby
Gillichthys mirabilis	Longjaw mudsucker
Ilypnus gilberti	Cheekspot goby
Quietula y-cauda	Shadow goby

This effect was evaluated statistically by comparing the levels of impingement for 48-hr periods just before and just after tunnel recirculation. The 12-hr period 1900-0700 hr, within which tunnel recirculation occurred, was omitted from consideration. The comparisons were made with a series of Mann-Whitney U tests on total number and weight of all fishes impinged for the three traveling screen stations combined. These tests evaluated the null hypothesis that there was no significant difference in levels of impingement before and after tunnel recirculation, against the one-way alternative hypothesis that the level of impingement was significantly greater after tunnel recirculation than before.

A comparison was not made for the tunnel recirculation of February 24-25, 1979, because of possible confounding effects associated with a storm and the start of dredging operations at that time (Table 7.5-3). The incomplete tunnel recirculation on September 1-2, 1979 also was not considered, because it lasted only two hours.

The results of the Mann-Whitney U tests were as follows (SIG indicates a significant difference at the level of significance shown; NS indicates difference not significant):

Dates of Tunnel Recirculation	Total Number of Fishes	Total Weight of Fishes
3/31-4/1	SIG ($p<.05$)	SIG ($p<.05$)
6/16-6/17	SIG ($p<.10$)	SIG ($p<.05$)

Dates of Tunnel Recirculation	Total Number of Fishes	Total Weight of Fishes
7/28-7/29	NS	NS
9/8-9/9	NS	NS
10/13-10/14	SIG ($p < .05$)	NS
11/24-11/25	NS	NS
12/29-12/30	NS	NS

For only three of the seven tunnel recirculations considered were levels of impingement significantly greater following recirculation than just before. It is clear from the statistical results and from examination of Table 7.5-3 that residual effects of impingement sometimes did occur following tunnel recirculation, but not in all cases.

7.13 DISCUSSION

The nature and extent of entrapment and impingement of fishes and invertebrates in cooling water systems of power plants is influenced by a number of physical and biological factors (7-6, 7-7, 7-8, 7-9, 7-10, 7-11, 7-12, 7-13, and 7-14). The primary physical factors involved appear to be water temperature, velocity of flow and other flow characteristics in the cooling water system, waves, surge, turbulence and salinity changes associated with storms, level of illumination, and the water depth and structural characteristics of the intake system. All of these factors contribute to impingement through their interactions with the species-specific and size-specific behavior and condition of fishes and invertebrates inhabiting the area adjacent to the intake, including the attraction of many species to man-made structures (7-15, 7-16, and 7-17). The detailed, two-year study of environmental factors affecting impingement of fishes at the Redondo Beach Generating Station in Redondo Beach, California (7-18), is particularly useful as a basis for comparing the results of this study at the Encina Power Plant.

Specific interpretations of results from this impingement study are considered in preceding subsections of the report. A more general interpretation of the important results is provided here.

The detailed, daily sampling programs conducted during the period February 4, 1979 - January 4, 1980 provided a very comprehensive set of data concerning impingement of fishes, large invertebrates, and marine plants in the cooling water system of the Encina Power Plant. The methods used were effective in obtaining accurate quantitative and qualitative data.

During the 336-day period of the study, 76 species of fishes, 45 species of large invertebrates, and 7 species of marine grasses and algae were impinged at the traveling screens and the bar rack screening system. All were species common in Agua Hedionda Lagoon or in adjacent ocean areas.

Johnson et al. (1976) (7-19) reported that 112 species of fishes were impinged in the cooling water system of generating Units 7 and 8 at the Redondo Beach Generating Station during the two-year period September 1974 - August 1976. In common with the Encina Power Plant, these units use cooling water drawn from an area inhabited by both bay and ocean species. However, the intake structure at the Redondo Generating Station is located near the head of the Redondo Submarine Canyon. As a result, the fish fauna and the marine biota in general are particularly rich in species composition (7-20 and 7-21). These characteristics probably explain in part the difference in number of species impinged at the two power plants.

The total amount of fish and invertebrate material impinged at the traveling screens of the Encina Power Plant during the 336-day period was 85,943 individuals, with a combined weight of approximately 1548.4 kg (3414 lb). Of these, 79,662 individuals were fishes weighing a total of 1395.2 kg (3076 lb). In contrast to this, Johnson et al. (1976) (7-22) reported that an estimated

260,917 fishes weighing 19,553.4 kg (43,063 lb) were impinged at the traveling screens for Units 7 and 8 of the Redondo Beach Generating Station during the 52-week (364-day) period September 1, 1974 - August 31, 1975. These figures included fishes impinged during tunnel recirculation.

Several differences between the two power plants probably account for the very different total levels of impingement observed. The cooling water systems supplying Units 7 and 8 of the Redondo Generating Station had a maximum flow rate of 468,000 gpm, in contrast to a maximum flow rate of 534,300 gpm for all Units of the Encina Power Plant (41,900-220,000 gpm per Unit). The cooling water passes through a relatively long conduit from 366 m (1200 ft) to the Redondo Beach Generating Station, while the cooling water conveyance channels of the Encina Power Plant (Figure 7.3-1) are shorter. The structures through which water enters the cooling water system are different at the two power plants and the velocity of flow into the intake structure is relatively high at the Redondo Beach Generating Station ($\bar{x}$ = 73.2 cm/sec or 2.4 ft/sec). In addition, the richer fish fauna in King Harbor and at the head of the Redondo Submarine Canyon probably contributed to the higher levels of impingement reported at Redondo Beach. In any case, the results obtained in this study indicate that the levels of impingement for fishes and invertebrates are relatively low at the Encina Power Plant compared to those for the Redondo Beach Generating Station and other large coastal power plants in southern California.

The queenfish (Seriphus politus) had by far the highest level of impingement at the Encina Power Plant in terms of number of individuals (18,681 individuals, 23.4 percent of all fishes). It also ranked fourth in weight (6.5 percent of all fishes). The deepbody anchovy (Anchoa compressa) had the second highest level of impingement (13,299 individuals; 16.7 percent of all fishes) and ranked seventh in weight. Next in order by number of individuals impinged were the topsmelt (Atherinops affinis), the California grunion (Leuresthes tenuis), the northern anchovy (Engraulis mordax), and the shiner surfperch (Cymatogaster aggregata), represented by from 9.2 to 13.7 percent of all fishes impinged. All six of these highest ranking species were common in the area near the Encina Power Plant during the study. All also are relatively active, open water forms. Because of these characteristics, it is not surprising that they form the large majority (83.1 percent) of all individuals impinged.

Generally similar results were reported for the Redondo Generating Station (7-23). In 1974-75, the highest ranking fishes in number impinged were northern anchovy (38 percent of all fishes), shiner surfperch (16 percent), and queenfish (16 percent).

The six species ranking next highest in impingement at the Encina Power Plant had considerably lower, similar levels ranging from 1877 individuals (2.4 percent of all fishes) for the walleye surfperch (Hyperprosopon argenteum) to 1046 individuals (1.3 percent) for the giant kelpfish (Heterostichus rostratus). All of the remaining species had levels of impingement that represented less than 1.0 percent of the total number of all fishes impinged. Two of these six, walleye surfperch and the white surfperch also were important components of impingement samples at Redondo Beach (7-24).

Among the 12 species exhibiting levels of impingement greater than 1.0 percent at the Encina Power Plant, only three are bottom fishes. They are the round stingray (*Urolophus halleri*), the California halibut (*Paralichthys californicus*) and the giant kelpfish (*Heterostichus rostratus*). In general, bottom fishes are less susceptible to impingement because they are heavy-bodied forms influenced very little by water flow more than 1 to 2 m above the bottom. The giant kelpfish normally remains close to the fronds and blades of the giant kelp (*Macrocystis pyrifera*). It probably is carried into the cooling water system with the large masses of giant kelp that have broken off from the kelp canopy.

Many of the rankings by weight differed considerably from those by number of individuals impinged. The round stingray (*Urolophus halleri*) and the Pacific electric ray (*Torpedo californica*) ranked first and second on the basis of weight (13.3 percent and 9.0 percent of all fishes), respectively. Other heavy-bodied rays within the first ten species on the basis of weight were the sixth ranked California butterfly ray (*Gymnura marmorata*) and the tenth ranked bat ray (*Myliobatis californica*). Johnson et al. (1976) (7-25) noted a similar large component of elasmobranch fishes in the biomass of impingement samples at the Redondo Beach Generating Station. They found that 33 percent of the impinged fishes by weight consisted of sharks and rays, and that during 1974-75 Pacific electric ray accounted for 9 percent of all fishes by weight.

The topsmelt (Atherinops affinis) ranked third in the impingement samples at the Encina Power Plant, both in number and weight of individuals, representing 8 percent of all fishes by weight. The queenfish (Seriphus politus) ranked fourth in weight. Thus, all three of these open water species ranked high in both numbers and weight of individuals impinged.

The rankings of fishes on the basis of weight are a useful component of the impingement study. Yet they are less important ecologically than the rankings based on number of individuals impinged. This is because most population processes of the species involved are more directly affected by the numbers of individuals in the population and variation in these numbers than they are by the total biomass of individuals. For this reason, selection of additional critical species was based on the numerical rankings and total numbers of individuals impinged, as described in subsection 7.4.

Both the numbers and weights of fishes and invertebrates varied considerably throughout the year and from day to day and week to week. Results of correlation analyses indicated that there were no significant correlations between weekly mean values of temperature, salinity, ocean wave height, or cloud cover on either the weekly mean total numbers or weights of fishes impinged. The lack of significant correlations may be a reflection of the fact that impingement is influenced by a combination of factors, rather than by one or two acting in isolation.

The seasonal pattern of changes in impingement for some critical species of fishes appeared to be related either directly or indirectly to water temperature. For example, the queenfish (Seriphus politus) had the highest levels of impingement during the period mid-June through early September, when ambient water temperatures were highest. Lowest mean numbers were impinged during the period March-May, when water temperatures were relatively low. In contrast, the largest numbers of round stingrays (Urolophus halleri) were impinged in February, when water temperatures were low, and the smallest numbers were impinged from July to September, the period of highest water temperatures. While this evidence does not show conclusively that water temperature is related to levels of impingement, it suggests that temperature probably is involved in the process for some species. This had been shown to be the case in other studies of impingement (7-26, 7-27, 7-28, 7-29, and 7-30).

Effects of five distinct storm periods on numbers and weights of fishes were evaluated statistically by comparing data for periods of 4 to 7 days before and after onset of storms. The storm periods were characterized by wind speeds $\geq$ 12 mph (16 kph), rainfall, salinities $\leq$ 29.9 ppt in the lagoon, and ocean wave heights $\geq$ 4 ft ((1.2 m). Four of the five storm periods had

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significant effects, with larger numbers or weights of fishes impinged during the storm conditions than just before.

The results do not allow specific assessment of the individual physical conditions involved, but only their combined effects. However, it is very likely that all of these physical conditions, and possibly the associated increase in turbidity as well, act in combination to cause increased impingement. Turbulent water conditions in the ocean adjacent to the entrance to Agua Hedionda Lagoon may affect impingement by causing fishes to seek shelter in the lagoon. Johnson et al. (1976) (7-31) and others (7-32, 7-33, 7-34, and 7-35) have observed similar effects in other studies.

Johnson et al. (1976) (7-36) reported that storms accompanied by high wind speeds caused turbulent water conditions around the intake structure of the Redondo Beach Generating Station. During six storms over the two-year period September 1974 - August 1976, in which wind speeds averaged greater than 17.3 mph (27.7 kph) for 24-hr periods, 208,052 fishes were impinged in 19 days. This represented 24 percent of all fishes impinged during the two-year period of their study. Two major storms alone accounted for 21 percent of all fishes impinged. They also found that the mean number of fishes impinged per day during storm periods ($\bar{x}$ = 8223) was significantly greater than during normal periods ($\bar{x}$ = 817).

The effects of storm conditions on the area around the intake structure of the Redondo Beach Generating Station undoubtedly are much greater than for the Encina Power Plant. At Redondo Beach the intake structure for Units 7 and 8 is located in an area directly exposed to wind, ocean swells, and turbulence, while at the Encina Power Plant water enters the system from the relatively sheltered outer part of Agua Hedionda Lagoon. Evidence of this is the fact that during storms, when ocean wave heights exceeded 4 ft (1.2 m), wave heights in outer Agua Hedionda Lagoon remained less than 1 ft (0.3 m). This difference presumably is one major reason why storm conditions had much less pronounced effects on levels of impingement at the Encina Power Plant.

Dredging operations to remove accumulated sediment from outer Agua Hedionda Lagoon during the period from February 20 to April 25, 1979, also caused increased impingement of fishes and invertebrates. This was true particularly for species living in the lagoon. Evidence from statistical comparisons between levels of impingement during and following the dredging operations support this conclusion. Unfortunately, the period of dredging overlapped that of storm conditions during the winter and early spring, so that it was difficult to separate the effects of these two confounding variables.

Most of the effects of dredging operations in increasing impingement are relatively obvious ones. Disturbance and removal of bottom sediment would cause displacement of benthic fishes and invertebrates into the water column, making them more vulnerable to impingement. High levels of turbidity in the lagoon caused by dredging would reduce light levels and visibility markedly, with a resulting increase in impingement of fishes. In addition, both benthic and open water fishes probably were attracted into the areas affected by dredging to feed on organisms displaced by disturbance of the sediment. The resulting higher densities of some species in the outer part of Agua Hedionda Lagoon probably contributed to the higher levels of impingement observed.

Evaluation of more detailed information about short-term and seasonal variations in impingement of fishes considered as critical species suggests that for most of them impingement was relatively continuous throughout the year. However, the numbers and weights of individuals for each species varied greatly from day to day, week to week, and seasonally. In some cases these variations appeared to be related directly or indirectly to effects of water temperature, storm conditions, dredging operations in outer Agua Hedionda Lagoon, and other environmental factors.

There is a very clear evidence that the numbers and weights of fishes impinged during the night and early morning period primarily of darkness (1900 to 0700 hr) were significantly greater in almost all cases than those during the day (0700 to 1900 hr). Diurnal effects of this kind on impingement have been reported for several freshwater cooling systems (7-37, 7-38, 7-39, and 7-40).

There are a number of probable reasons for this evident day-night difference in levels of impingement at the Encina Power Plant. Many fishes tend to be relatively quiescent and reduce their swimming activities during darkness. The visual cues used by most species of fishes in swimming and avoidance behavior also would be reduced at low levels of illumination. Because of these effects, some species would be more susceptible to being transported into the cooling water system and impinged during periods of darkness. Another possible effect is that some species may move into the area of Agua Hedionda Lagoon adjacent to the Encina Power Plant during darkness to feed or seek shelter. Higher densities of these individuals might then contribute to increased levels of impingement. Several of the species with high levels of impingement at the Encina Power Plant are active at night. These include the queenfish (*Seriphus politus*), the northern anchovy (*Engraulis mordax*), and the Pacific electric ray (*Torpedo californica*).

As in the case of evaluating effects of storm conditions, it is very difficult to consider each of these possible causal factors in isolation. Specific field and laboratory experiments would be required to do so.

Results of correlation analyses and evaluation of variations in impingement indicate that, in general, there was a direct relationship between increasing flow rates of cooling water and the impingement levels of fishes. Johnson et al. (1976) (7-41) reported a similar relationship for Units 7 and 8 of the Redondo Generating Station. They found that an average of twice as many fishes were impinged during periods when all four circulator pumps supplying these units were in operation (468,000 gpm; maximum intake velocity of 97.5 cm/sec or 3.2 ft/sec) than when only two pumps were operating. The numbers of fishes impinged were significantly different at these two levels of flow.

Swimming capabilities of fishes and their reactions to flow velocities at the point where cooling water enters the Power Plant are known to influence impingement. Schuler and Larsen (1975) (7-42) showed in laboratory tests using simulated intake structures that entrapment of fishes increases with increasing approach velocities of water at the intake. Johnson et al. (1976) (7-43) also reported the results of field and laboratory studies to evaluate the swimming capabilities and impingement of four species, the queenfish (Seriphus politus), the northern anchovy (Engraulis mordax), the shiner surfperch (Cymatogaster aggregata), and the white croaker (Genyonemus lineatus). Of these, only the northern anchovy showed significantly higher levels of entrapment and impingement with four, as opposed to two, circulator pumps of Units 7 and 8 in operation at the Redondo Generating Station. Results of their laboratory studies also showed that shiner surfperch and white croaker both have swimming capabilities greater than those required to escape from flow with approach velocities up to 97.5 cm/sec (3.2 ft/sec) at the point where cooling water enters the intake structure. Such velocities exceed those measured in the cooling water system of the Encina Power Plant. However, the specific swimming capabilities of most fish species impinged at the Encina Power Plant are not known.

Generating Unit 4 at the Encina Power Plant was out of service during March, April, and May and the total flow rates of cooling water into the plant were reduced from approximately 500,000 gpm to 350,000 gpm. During this time impingement at the traveling screens for the two units remaining in operation declined and generally remained at relatively low levels. While not conclusive, this evidence suggests that such a reduction in total flow rate of water entering the Power Plant from Agua Hedionda Lagoon tended to reduce impingement at the traveling screens of both units still in operation, despite the fact that the flow rates within the conveyance channels for these two units remained approximately the same. This possible effect could be evaluated further through comparisons of impingement levels at different total flow rates. The information obtained would be of practical value in determining the optimal flow characteristics of the cooling water system to maintain low levels of impingement.

In general, there was little decomposition or physical damage evident among most species of fishes in the impingement samples. However, following tunnel recirculation (heat treatment) the numbers of decomposed individuals increased, reflecting the fact that substantial numbers of dead fishes from the tunnel recirculation remained in the conveyance channels for periods of several days before they were impinged.

Observations during sampling indicated that when first washed into the sampling nets and trash collector units, most fishes were alive and in relatively good condition. Death and decomposition of most individuals appeared to be the result of exposure out of water in the trash collector baskets, rather than to impingement on the traveling screens. Live fishes removed from the sampling nets and held in tanks supplied with seawater recovered and appeared to be normal. These individuals were routinely released.

There appeared to be a fairly direct relationship between the amount of physical damage and the fragility or delicate morphological characteristics of a given species. For example, all three of the anchovy species were subject to much more damage than the two relatively more "firm-fleshed" atherinid species and other fishes. Aside from the anchovies, there also appeared to be a tendency for species with larger body size to sustain slightly more physical damage than those of smaller size.

The sex ratios of the round stingray (Urolophus halleri), the deepbody anchovy (Anchoa compressa), the slough anchovy (A. delicatissima), the topsmelt (Atherinops affinis), the California grunion (Leuresthes tenuis), and the specklefin midshipman (Porichthys myriaster) all reflected the fact that frequently larger numbers of adult females than males were impinged. The causes of this are not clear. However, in the case of the specklefin midshipman all of the females impinged were in advanced stages of reproductive development. Johnson et al. (1976) (7-44) reported similar observations on midshipman species, shiner surfperch, and other species that when impingement of females was greater than that for males, the females usually were in an advanced reproductive stage. This evidence suggests that reproductive condition of females in some species, including specklefin midshipman and shiner surfperch, influences their susceptibility to impingement. Blaxter (1969) (7-45), in a review concerning swimming performance of fishes, noted that reproductive condition can influence swimming capabilities. As Johnson et al. (1976) (7-46) have indicated, the orientation behavior of female fishes also may change when they are in an advanced reproductive state. It is difficult to assess the impact such differential impingement of females in reproductive condition would have on the natural populations. While the data obtained concerning reproductive condition are limited, they do indicate that for most of the 12 species considered, adult females in all stages of reproductive development occurred in the impingement samples.

The largest component of marine organisms in almost all impingement samples from the bar rack and traveling screen stations consisted of marine grasses and algae. Large rays and sharks accounted for a relatively small part of the material impinged at the bar rack screening system. Eel grass (Zostera marina) and the giant kelp (Macrocystis pyrifera) were the dominant species in terms of volume. In general, the highest levels of impingement at the bar rack system occurred during and following storms. The reason for this appears to be that surge and wave action associated with storm conditions dislodge and transport large amounts of plant material. However, impingement of plants at the traveling screens generally was greater during the summer and fall.

<u>References</u>

7-1 Johnson, R. L., P. Dorn, K. Muench, and M. Hood, An Evaluation of Fish Entrapment Associated with the Offshore Cooling Water Intake System at the Redondo Beach Steam Generating Station, Phase II, Southern California Edison Company - <u>77-RD-12</u>, 1976.

7-2 Marine Review Committee (MRC), Annual Report to the California Coastal Commission, August 1976-August 1977, Appendix I, Estimated Effects of SONGS Unit I on Marine Organisms: Technical Analysis and Results, <u>MRC DOC. 77-09, No. 2</u>, 1977.

7-3 Miller, J. N., <u>The Present and Past Molluscan Faunas and Environments of Four Southern California Coastal Lagoons</u>, Master's Thesis, University of California, San Diego, 1966.

7-4 Bradshaw, J. S. and G. N. Estberg, <u>An Ecological Study of the Subtidal Marine Life in Agua Hedionda Lagoon</u>, University of San Diego Environmental Studies Laboratory Technical Report, Prepared for San Diego Gas & Electric Company, San Diego, California, 1973.

7-5 Bradshaw, J., B. Browning, K. Smith, and J. Speth, The Natural Resources of Agua Hedionda Lagoon, U. S. Fish and Wildlife Service, <u>Coastal Wetland Series No. 16</u>, 1976.

7-6 Kerr, J. E., Studies of Fish Preservation at the Contra Costa Steam Plant of the Pacific Gas & Electric Company, State of California, The Resources Agency, The Department of Fish and Game - <u>Fish Bulletin 92</u>, Sacramento, CA. 1953.

7-7 Herald, E. S. and D. A. Simpson, "Fluctuations in Abundance of Certain Fishes in South San Francisco Bay as Indicated by Sampling at a Trash Screen," Calif. Fish and Game, Vol. 39(2), pp. 271-278, (1955).

7-8 Bainbridge, J. C., "The Problem of Excluding Fish from Water Intakes," Ann. Appl. Biol., Vol. 53, pp. 505-508, (1964).

7-9 Prentice, E. F. and F. J. Ossiander, Fish Diversion Systems and Biological Investigations of Horizontal Traveling Screen Model III, Proceedings of the Second Entrainment and Intake Screening Workshop, Baltimore, MD, December 1974, pp. 205-214.

7-10 Schuler, V. J., Experimental Studies in Guiding Marine Fishes of Southern California with Screens and Louvers, Proceedings of the Second Entrainment and Intake Screening Workshop, Baltimore, MD, December 1974, pp. 305-315.

7-11 Johnson, Dorn, Muench, and Hood, (7-1).

7-12 Jensen, L. D., (ed.), Proceedings of the Second Entrainment and Intake Screening Workshop, Electric Power Research Institute, "EPRI Publication No. 74-049-00-5," Palo Alto, CA, 347 pp., (1974).

7-13 Jensen, L. D. (ed.), Third National Workshop on Entrainment and Impingement: Section 316(b) - Research and Compliance, Ecological Analysts, Inc., Melville, New York, 425 pp. (1977).

7-14 Jensen, L. D. (ed.), Fourth National Workshop on Entrainment and Impingement, Ecological Analysts, Inc., Melville, New York, 424 pp., (1978).

7-15 Turner, C. H., E. E. Ebert, and R. R. Given, Man-made reef ecology, State of California, The Resources Agency, Department of Fish and Game - Fish Bulletin 146, Sacramento, CA, 1969.

7-16 Klima, E. F., and D. A. Wickham, "Attraction of Coastal Pelagic Fishes with Artificial Structures," Trans. Am. Fish. Soc., Vol. 100(1), pp. 86-99, (1971).

7-17 Johnson, Dorn, Muench, and Hood, (7-1).

7-18 Johnson, Dorn, Muench, and Hood, (7-1).

7-19 Johnson, Dorn, Muench, and Hood, (7-1).

7-20 Ford, R. F., D. G. Foreman, C. D. Kroll, and D. G. Watts, Ecological Effects of Thermal Effluent from a Coastal Electric Generating Station on Benthic Marine Invertebrates, Phase III, Southern California Edison Company - 78-RD-56, (1978).

7-21 Stephens, J. S., Effects of Thermal Effluent of Southern California Edison's Redondo Beach Steam Generating Station on the Warm Temperate Fish Fauna of King Harbor Marina, Annual Report for Phase III, Southern California Edison Company - 78-RD-47, (1978).

7-22 Johnson, Dorn, Muench, and Hood, (7-1).

7-23 Johnson, Dorn, Muench, and Hood, (7-1).

7-24 Johnson, Dorn, Muench, and Hood, (7-1).

7-25 Johnson, Dorn, Muench, and Hood, (7-1).

7-26 Jensen, (7-12).

7-27 Jensen, (7-13).

7-28 Jensen, (7-14).

7-29 Johnson, Dorn, Muench, and Hood, (7-1).

7-30 Lifton, W. S. and J. F. Storr, The Effect of Environmental Variables on Fish Impingement, Fourth National Workshop on Entrainment and Impingement, Ecological Analysts, Inc., Melville, New York, 424 pp., (1978).

7-31 Johnson, Dorn, Muench, and Hood, (7-1).

7-32 Jensen, (7-12).

7-33 Jensen, (7-13).

7-34 Jensen, (7-14).

7-35 Lifton and Storr, (7-30).

7-36 Johnson, Dorn, Muench, and Hood, (7-1).

7-37 Voightlander, C., Assessment of Impingement Impacts on TVA Reservoirs, Third National Workshop on Entrainment and Impingement: Section 316(b) - Research and Compliance, Ecological Analysts, Inc., Melville, New York, 425 pp., (1977).

7-38 Lifton and Storr, (7-30).

7-39 Jensen, (7-13).

7-40 Jensen, (7-14).

7-41 Johnson, Dorn, Muench, and Hood, (7-1).

7-42 Schuler, V. J. and L. E. Larson, "Improved Fish Protection at Intake Systems," J. Envir. Engin. Div., Am. Soc., Civil Engineer, Proc. Paper 11756, Vol. 101, pp. 897-910, (1975).

7-43 Johnson, Dorn, Muench, and Hood, (7-1).

7-44 Johnson, Dorn, Muench, and Hood, (7-1).

7-45 Blaxter, J. H. S., "Swimming Speeds of Fish," Food Agr. Organiz., U. N. Fish Rep., Vol. 62, pp. 62-100, (1969).

7-46 Johnson, Dorn, Muench, and Hood, (7-1).

PLANT Encina

DATE 3-6-74

FISH OBSERVATIONS

NORMAL OPERATION 7 hours observed on each date shown below

Month of February 1974

Type of Fish	Estimated Number of Fish	Estimate of Total Weight	Size Range Inches
ATHERINIDAE (SILVERSIDE FAMILY) JACKSMELT, TOPSMELT-ATHERINOPS SPP.	10	2 lb	3-7
BATRACHOIDIDAE (TOADFISH FAMILY) SLIM MIDSHIPMAN-PORICHTHYS MYRIASTER			
BELONIDAE (NEEDLEFISH FAMILY) CALIFORNIA NEEDLEFISH-STRONGYLURA EXILIS			
BOTHIDAE (LEFTEYED FLOUNDER FAMILY) CALIFORNIA HALIBUT-PARALICHTYS CALIFORNICUS			
CARANGIDAE (JACK FAMILY) PACIFIC JACK MACKEREL-TRACHURUS SYMMETRICUS			
CALIFORNIA YELLOWTAIL-SERIOLA DORSALIS			
CLUPEIDAE (HERRING FAMILY) PACIFIC SARDINE-SARDINOPS CAERULEA	5	1 lb	3-6
CYBIIDAE (SPANISH MACKEREL FAMILY) CALIFORNIA BONITO-SARDA LINEOLATA			
EMBIOTOCIDAE (SURFPERCH FAMILY) ALL SPECIES COMBINED	1	2 lb	15
ENGRAULIDAE (ANCHOVY FAMILY) NORTHERN ANCHOVY-ENGRAULIS MORDAX	6	0.5 lb	3-6
GIRELLIDAE (NIBBLER FAMILY) OPALEYE-GIRELLA NIGRICANS	1	0.5 lb	8
MUGILIDAE (MULLET FAMILY) STRIPED MULLET-MUGIL CEPHALUS	6	0.5 lb	2-3
OSMERIDAE (SMELT FAMILY) SURF SMELT-HYPOMESUS PRETIOSUS			
PLEURONECTIDAE (RIGHTEYED FLOUNDER FAMILY) SOLE, FLOUNDER, TURBOT	1	0.5 lb	9
SCIAENIDAE (CROAKER FAMILY) QUEENFISH-SERIPHUS POLITUS			
WHITE SEABASS-CYNOSCION NOBILIS			
SPOTFIN CROAKER-RONCADOR STEARNSI			
YELLOWFIN CROAKER-UMBRINA RONCADOR			
OTHER			
SCOMBRIDAE (MACKEREL FAMILY) PACIFIC MACKEREL-PNEUMATOPHORUS DIEGO			
SCORPAENIDAE (ROCKFISH FAMILY) SCULPIN-SCORPAENA GUTTATA			
SERRANIDAE (BASS FAMILY) KELP BASS-PARALABRAX CLATHRATUS			
SAND BASS-P. NEBULIFER			
SPOTTED BASS-P. MACULATOFASCIATUS	~~6~~	~~2 lb~~	~~4-6~~
SPHYRAENIDAE CALIFORNIA BARRACUDA-SPHYRAENA ARGENTEA			
DASYATIDAE (STINGRAY FAMILY)	4	4 lb	8-12
RAJIDAE (SKATE FAMILY)			
SHARKS			
CALIFORNIA SPINY LOBSTER-PANULIRUS INTERRUPTUS			
MYSIDAE (SHRIMP FAMILY)			
OTHER SPECIES	1	0.3 lb	6

Estimated total pounds of fish during observation 13.3 lb

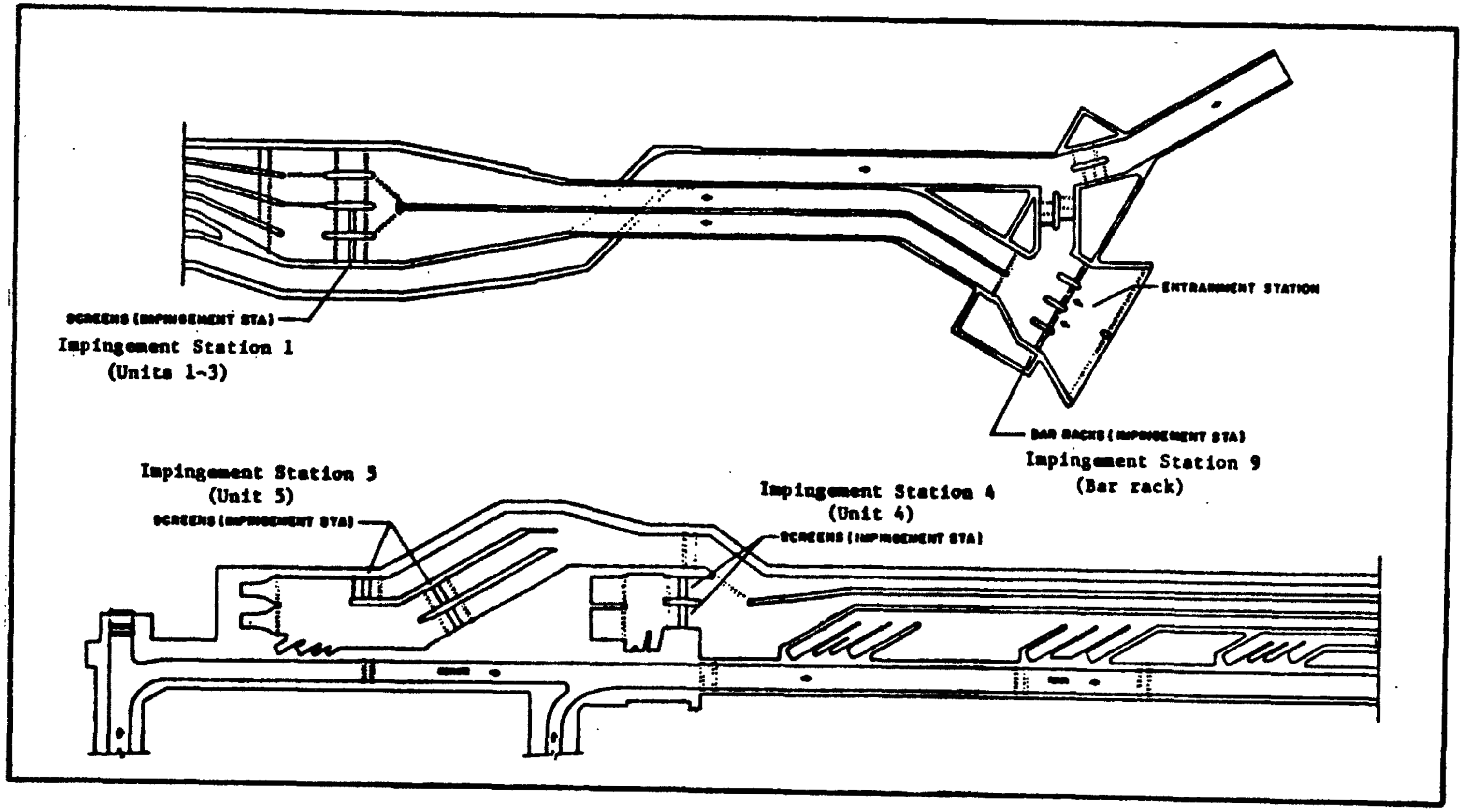
Remarks: (Include unusual events such as red tide, excessive rain, which has affected amount of fish observed

Circulating Water Tunnel Heat Treating Period, February 10, 1974

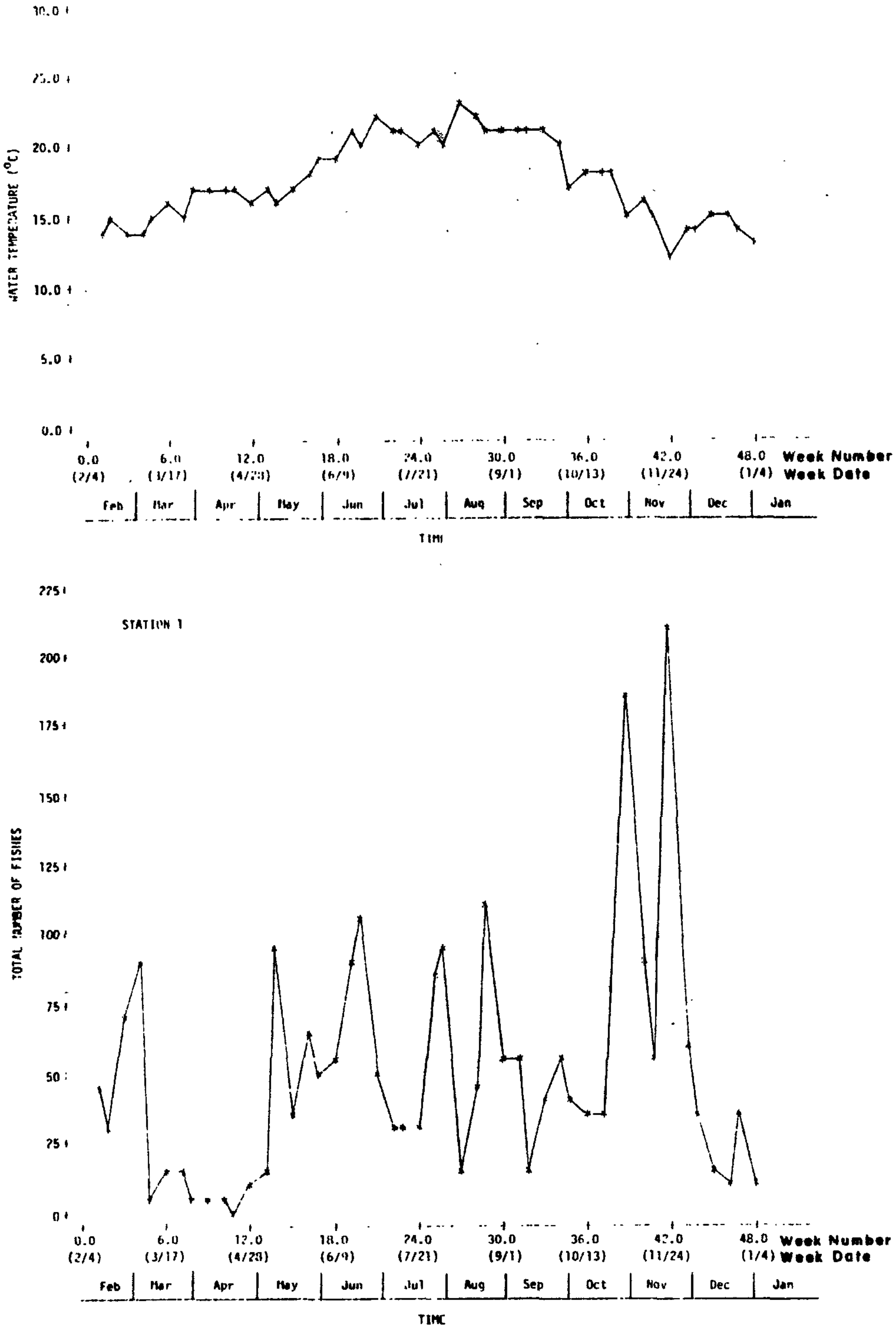
Company Representative

SAN DIEGO GAS & ELECTRIC COMPANY	
Standard form used by SDG&E in recording impingement data. Encina Power Plant - August 1, 1980	
PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.2-1

000615



SAN DIEGO GAS & ELECTRIC COMPANY	
Cooling water system of the Encina Power Plant showing the location of the four impingement sampling stations August 1, 1980	
PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.3-1



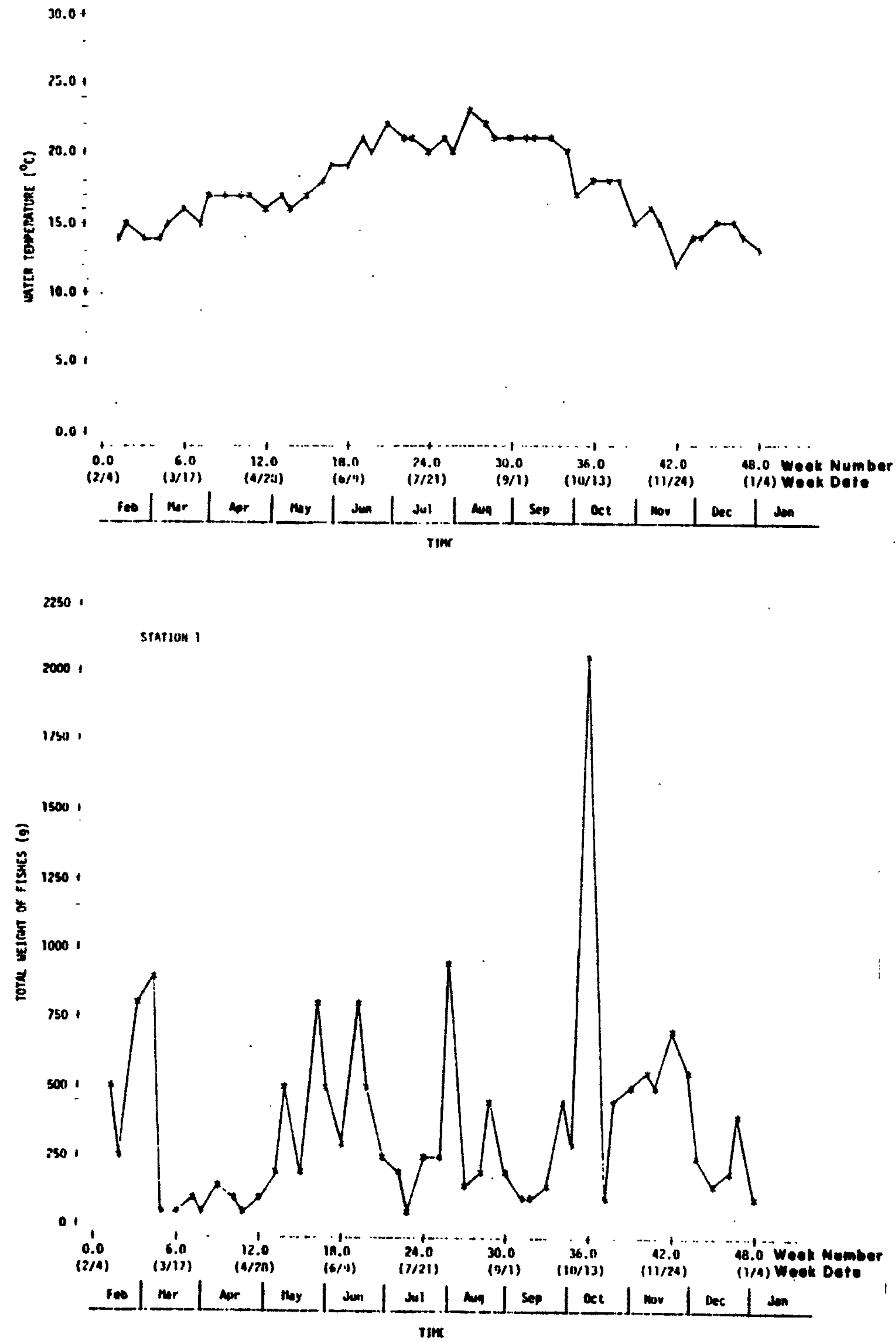
SAN DIEGO GAS & ELECTRIC COMPANY

Weekly mean total number of fishes impinged at station 1 per 24-hour interval from 2-4-79 to 1-4-80
Encina Power Plant - August 1, 1980

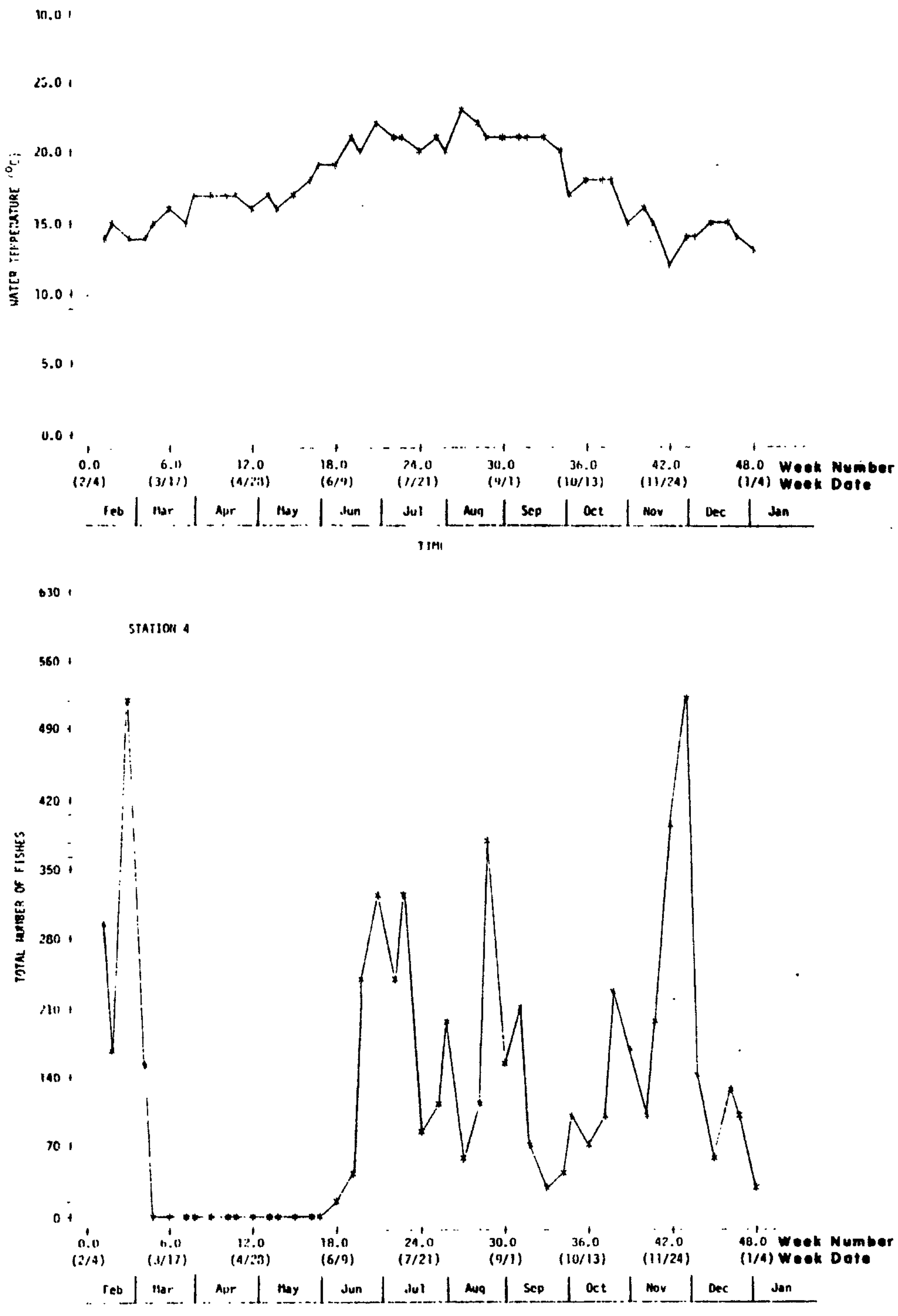
PREPARED BY:
WOODWARD-CLYDE CONSULTANTS

FIGURE NO.
7.5-1

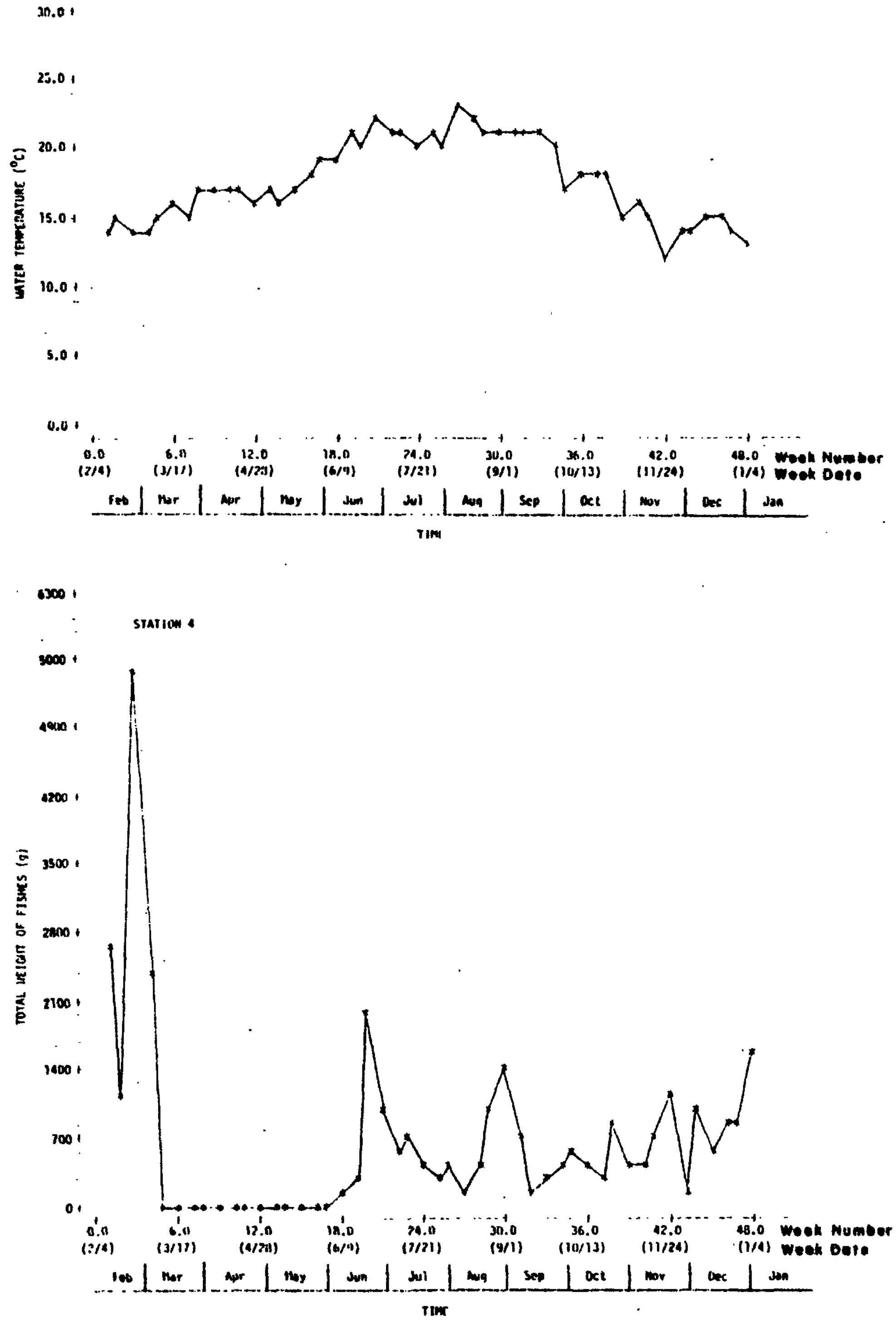
000617



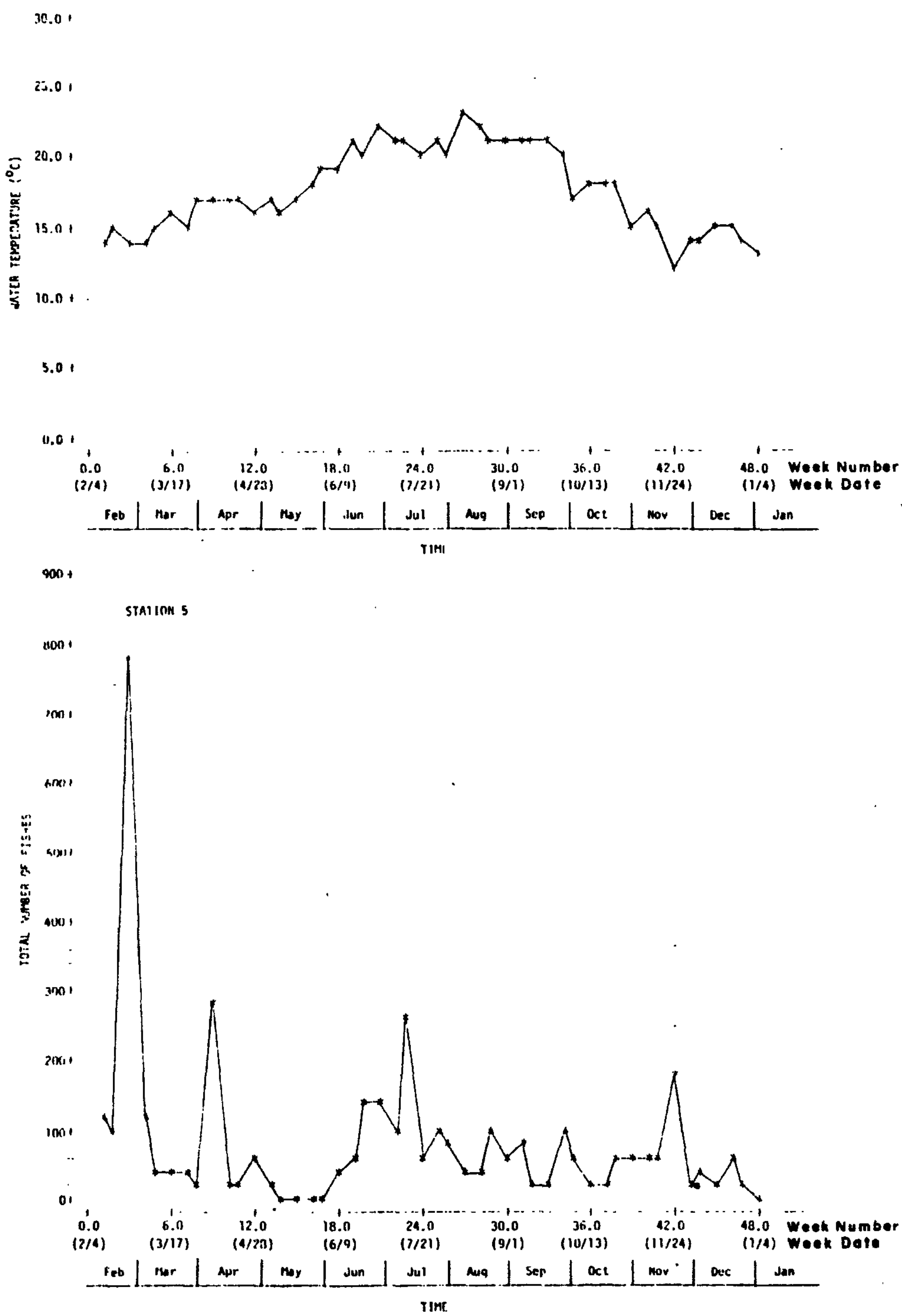
SAN DIEGO GAS & ELECTRIC COMPANY	
Weekly mean total weight of fishes impinged at station 1 per 24-hour interval from 2-4-79 to 1-4-80 Encina Power Plant - August 1, 1980	
PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.5-2



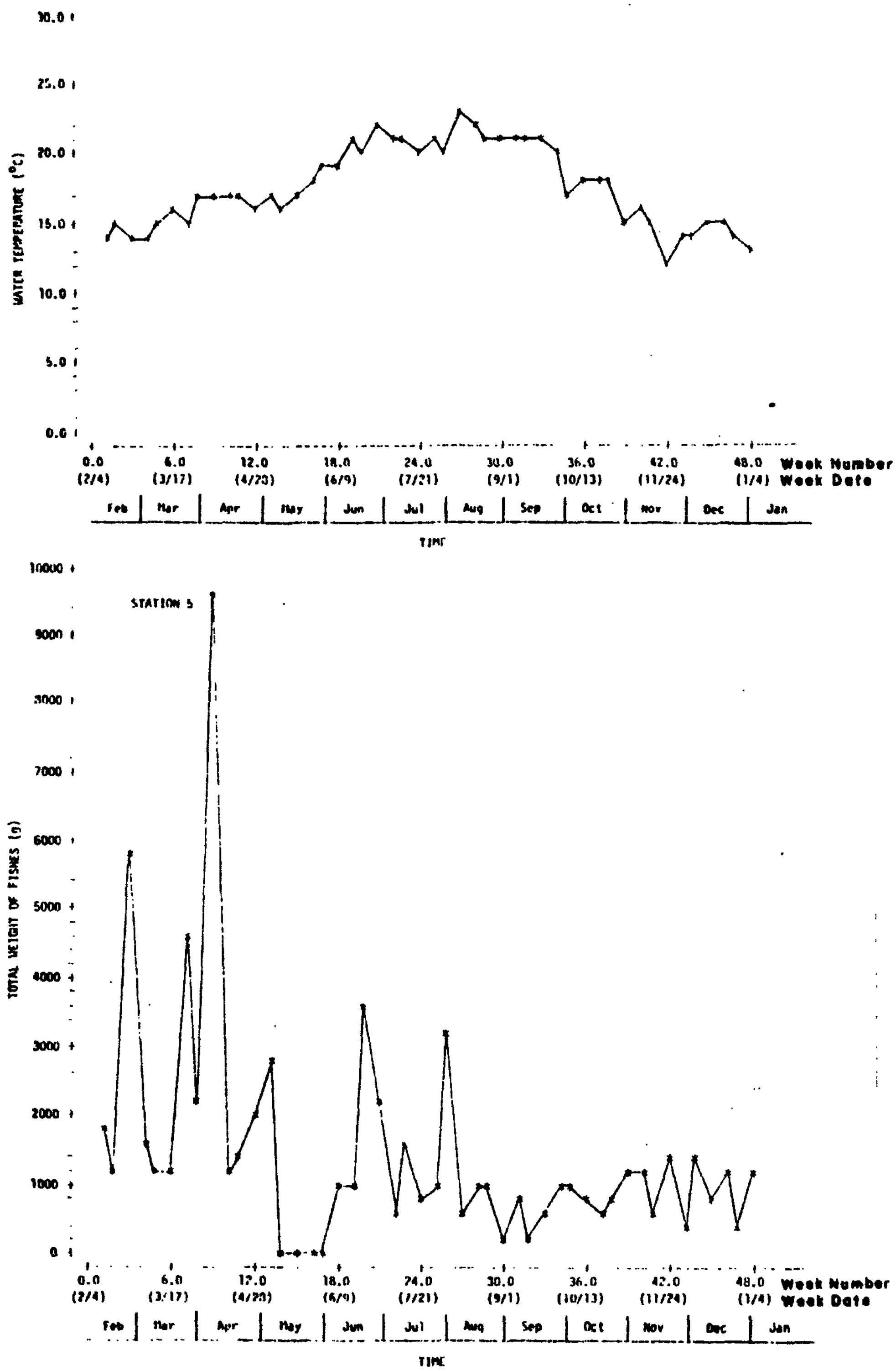
SAN DIEGO GAS & ELECTRIC COMPANY	
Weekly mean total number of all fishe impinged at station 4 per 24-hour interval from 2-4-79 to 1-4-80 Encina Power Plant - August 1, 1980	
PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.5-3



SAN DIEGO GAS & ELECTRIC COMPANY	
Weekly mean total weight of fishes impinged at station 4 per 24-hour interval from 2-4-79 to 1-4-80 Encina Power Plant - August 1, 1980	
PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.5-4



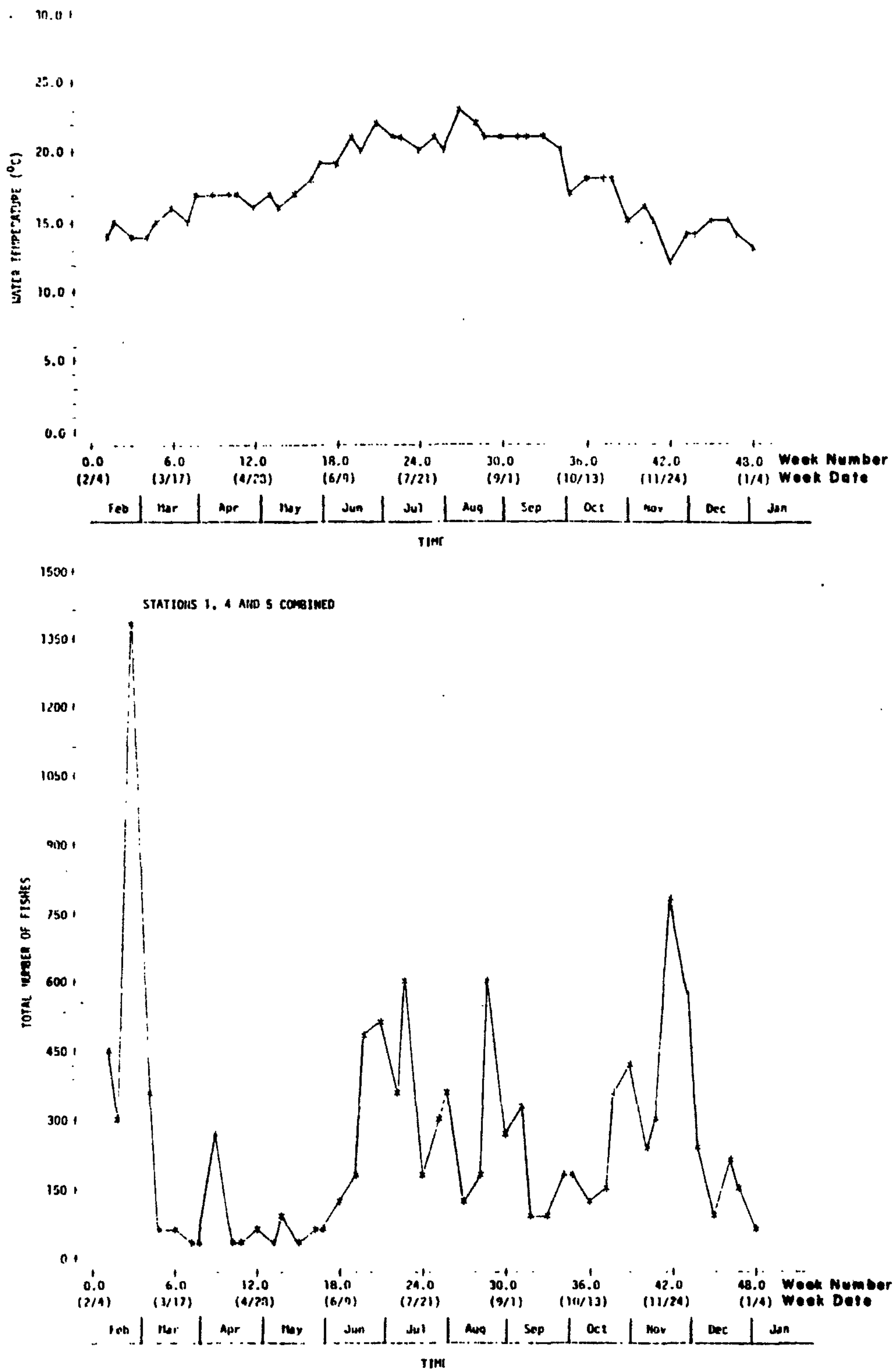
SAN DIEGO GAS & ELECTRIC COMPANY	
Weekly mean total number of all fishes impinged at station 5 per 24-hour interval from 2-4-79 to 1-4-80 Encina Power Plant - August 1, 1980	
PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.5-5



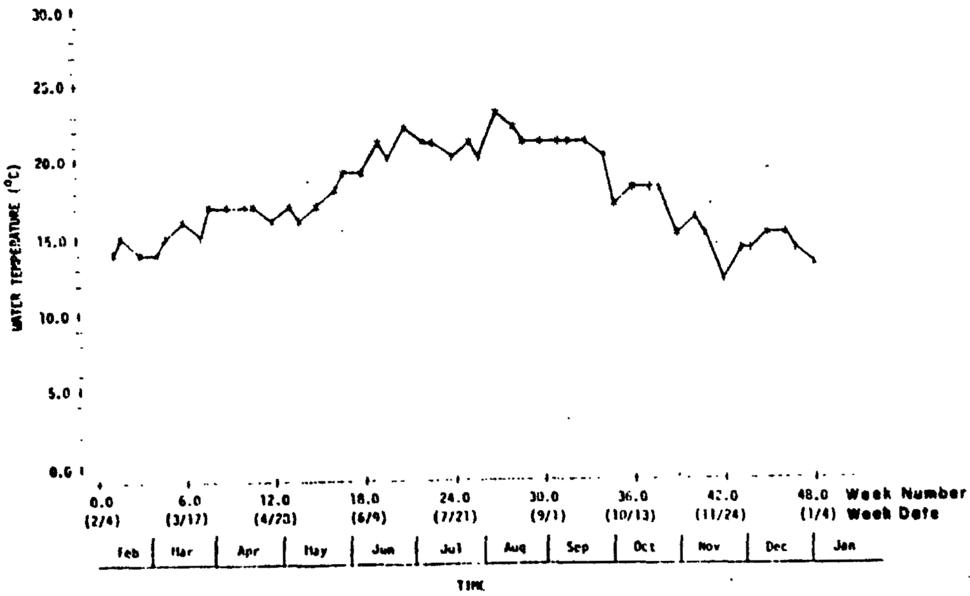
SAN DIEGO GAS & ELECTRIC COMPANY

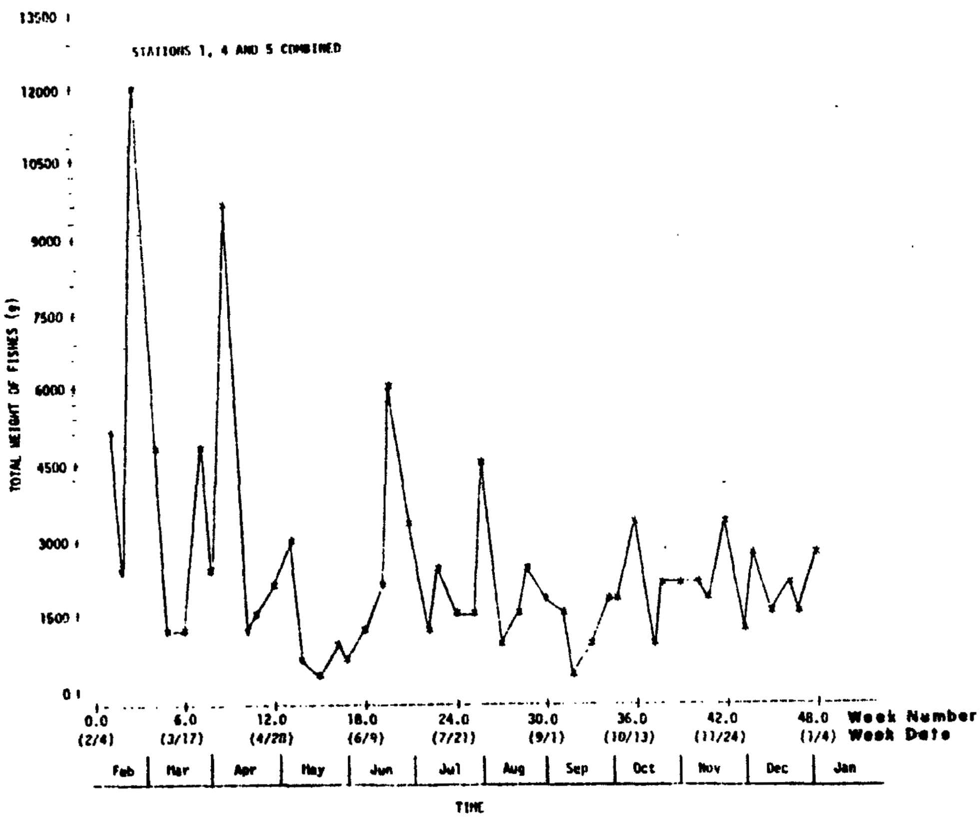
Weekly mean total weight of fishes impinged at station 5 per 24-hour interval from 2-4-79 to 1-4-80
Encina Power Plant - August 1, 1980

PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.5-6



SAN DIEGO GAS & ELECTRIC COMPANY	
Weekly mean total number of all fishes impinged at all stations per 24-hour interval from 2-4-79 to 1-4-80 Encina Power Plant - August 1, 1980	
PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.5-7



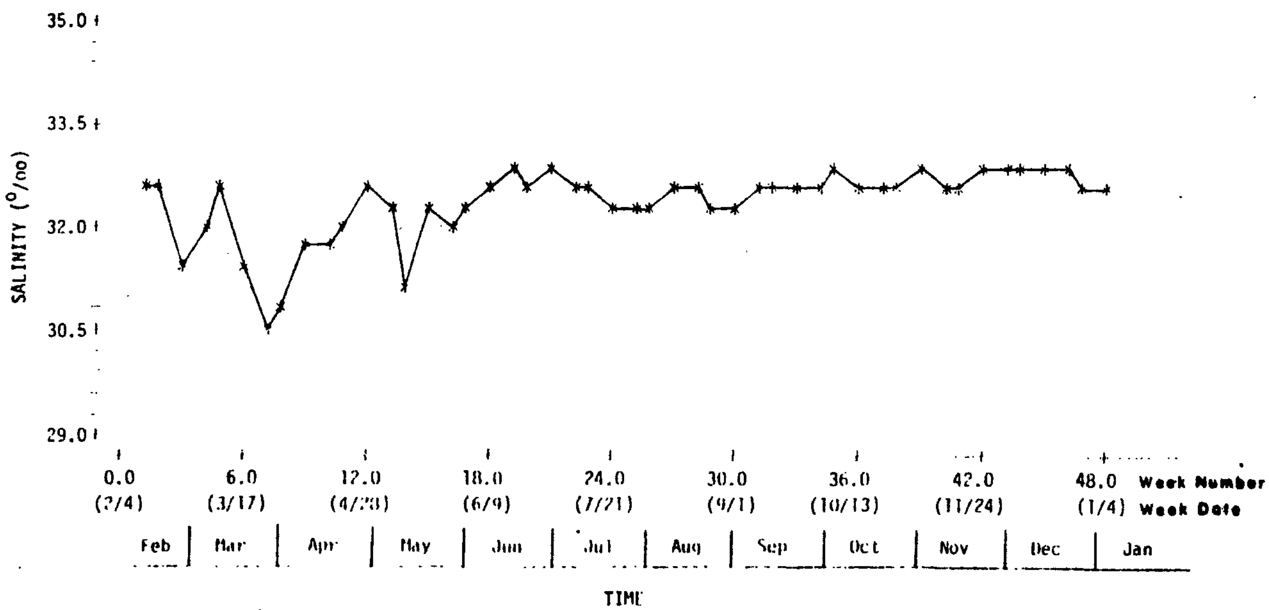


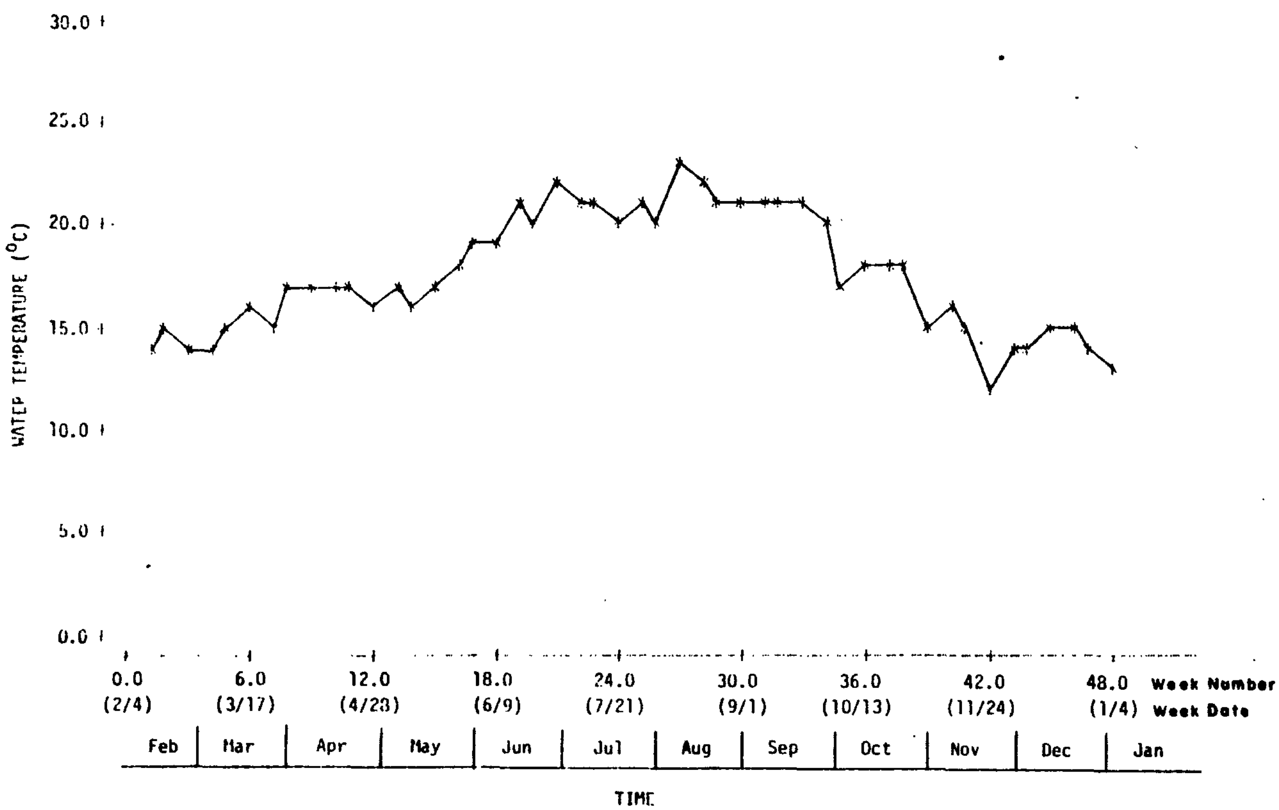
SAN DIEGO GAS & ELECTRIC COMPANY

Weekly mean total weight of all fishes impinged at all stations per 24-hour interval from 2-4-79 to 1-4-80
Encina Power Plant - August 1, 1980

PREPARED BY: WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 7.5-8



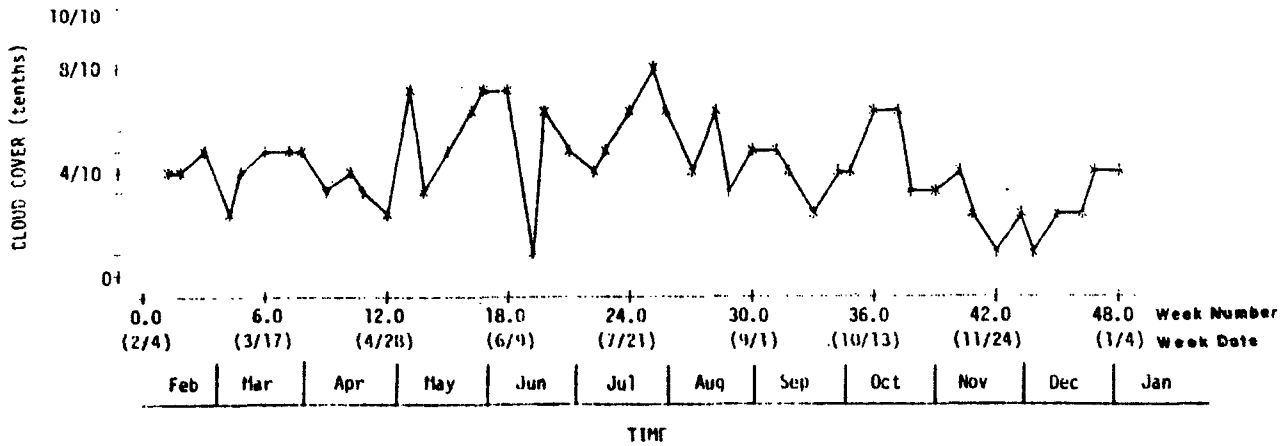


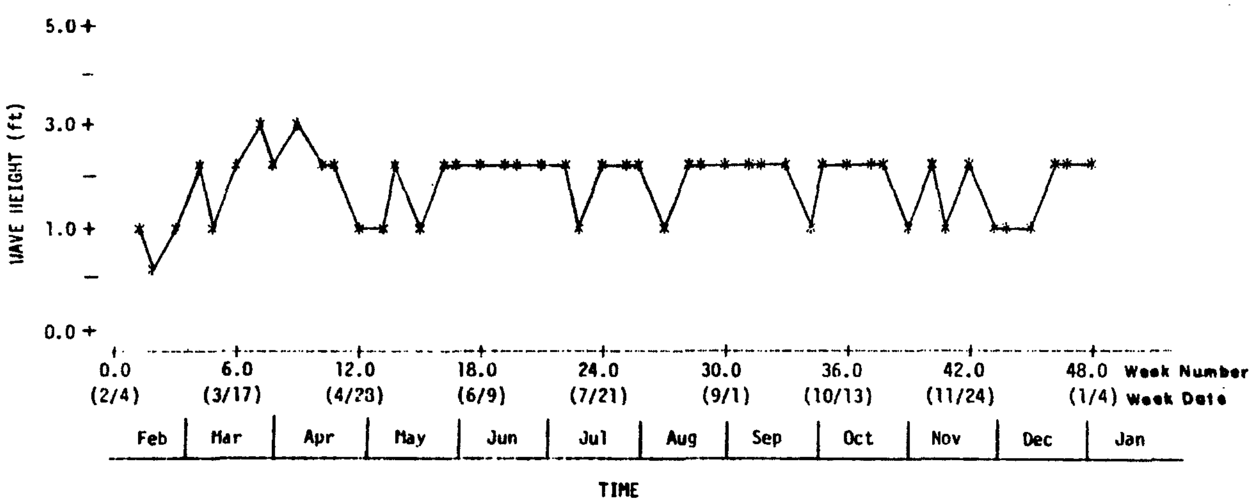
SAN DIEGO GAS & ELECTRIC COMPANY

Weekly mean values of temperature and salinity for seawater entering the cooling water intake from 2-4-79 to 1-4-8[0] Encina Power Plant - August 1, 1980

PREPARED BY: WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 7.5-9





SAN DIEGO GAS & ELECTRIC COMPANY	
Weekly mean values for wave height (ft) and cloud cover (units of 1/10 cover) from 2-4-79 to 1-4-80 Encina Power Plant - August 1, 1980	
PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.5-10

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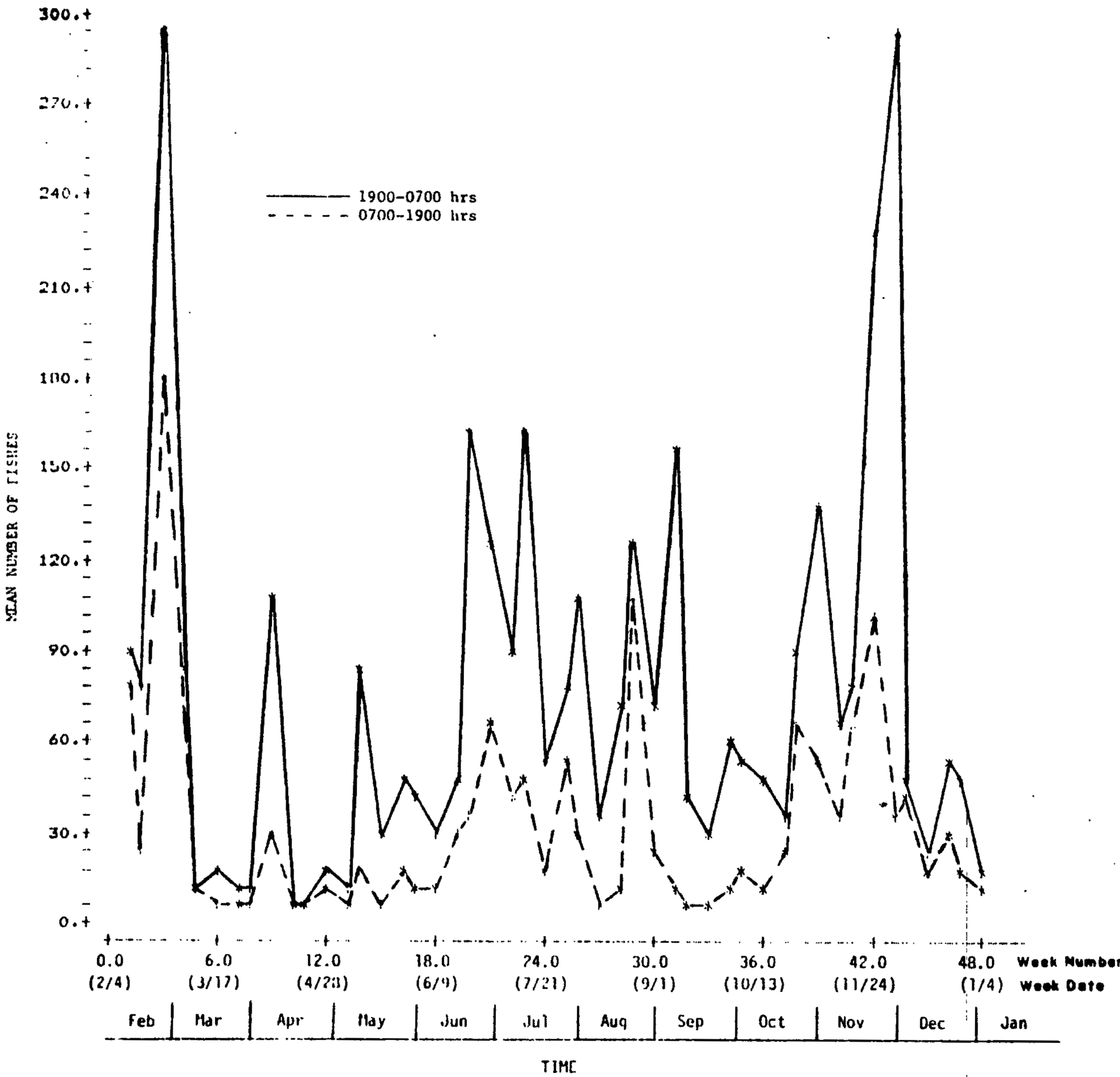
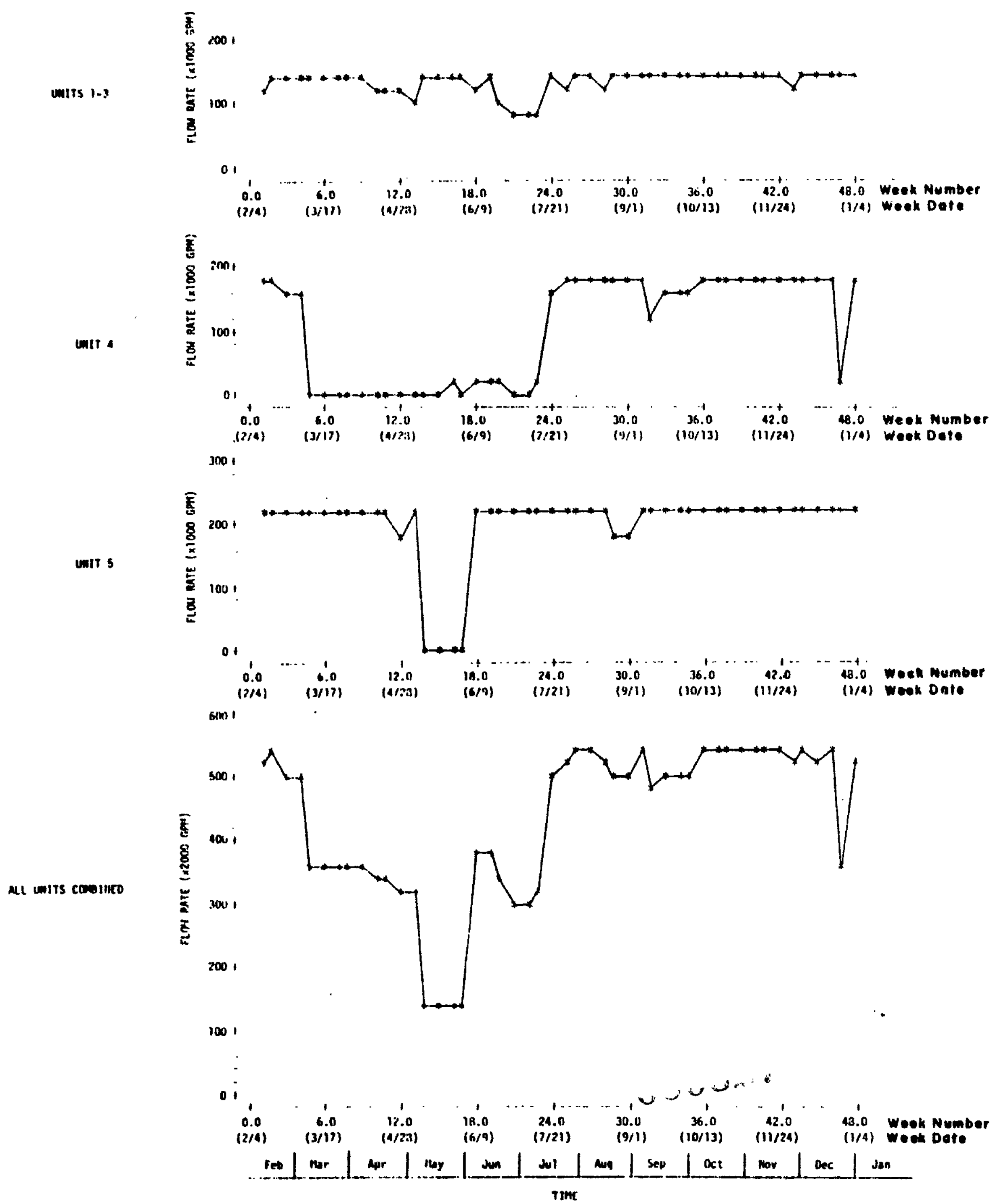
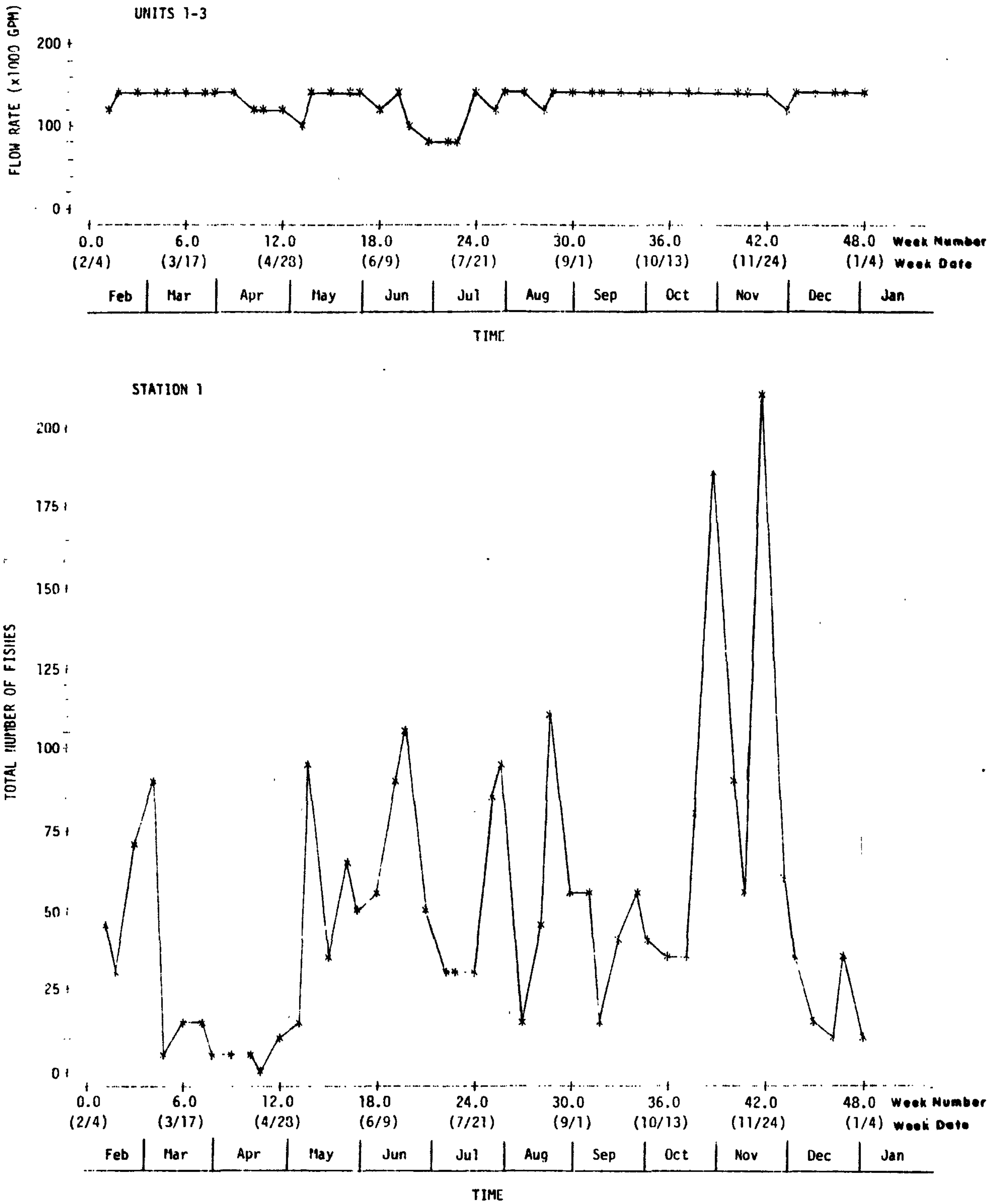


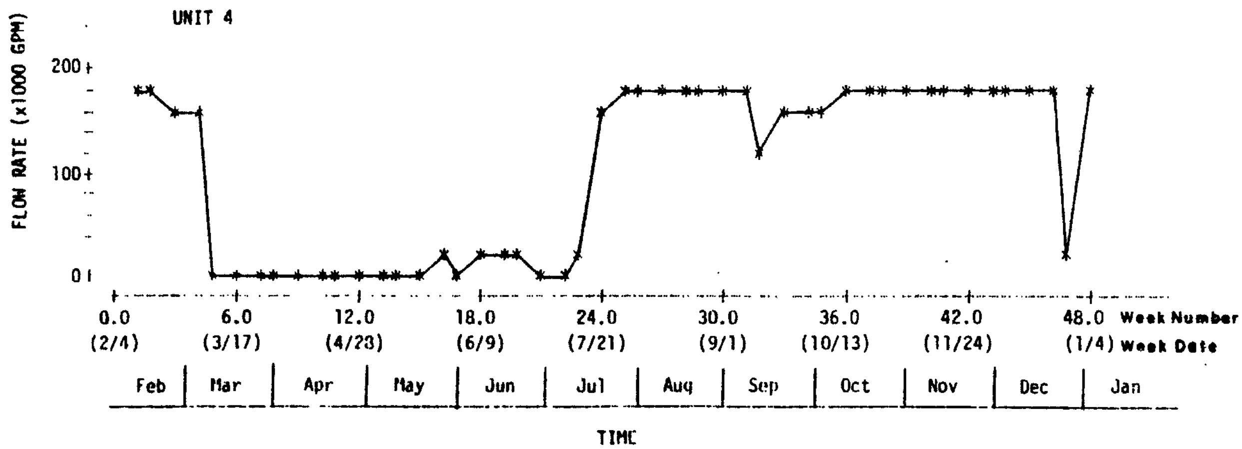
SAN DIEGO GAS & ELECTRIC COMPANY	
Comparisons of daytime and nighttime impingement for the period 2-4-79 to 1-4-80 Encina Power Plant - August 1, 1980	
PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.6-1

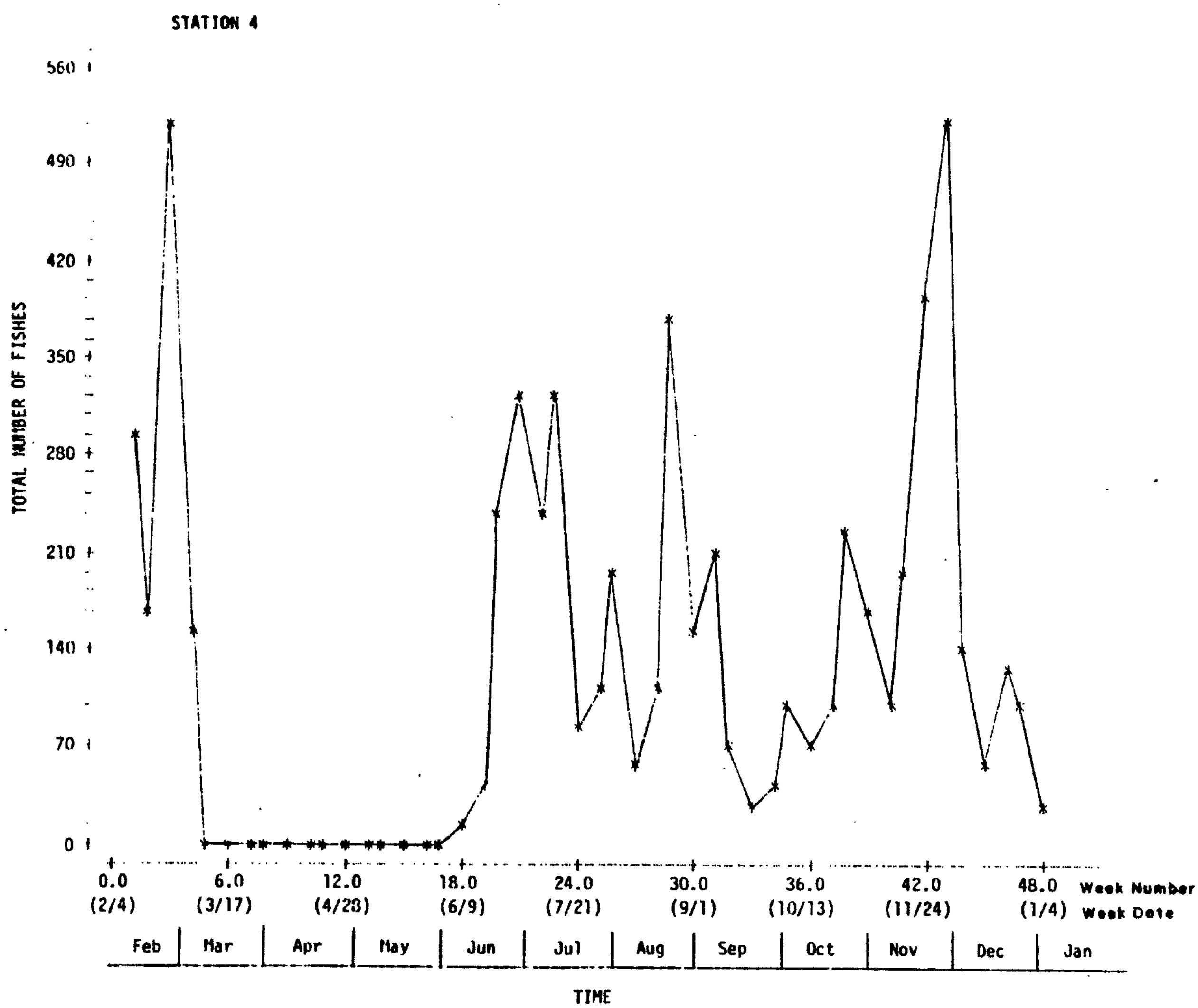


SAN DIEGO GAS & ELECTRIC COMPANY	
Weekly mean flow rates during the period 2-4-79 to 1-4-80 Encina Power Plant - August 1, 1980	
PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.8-1

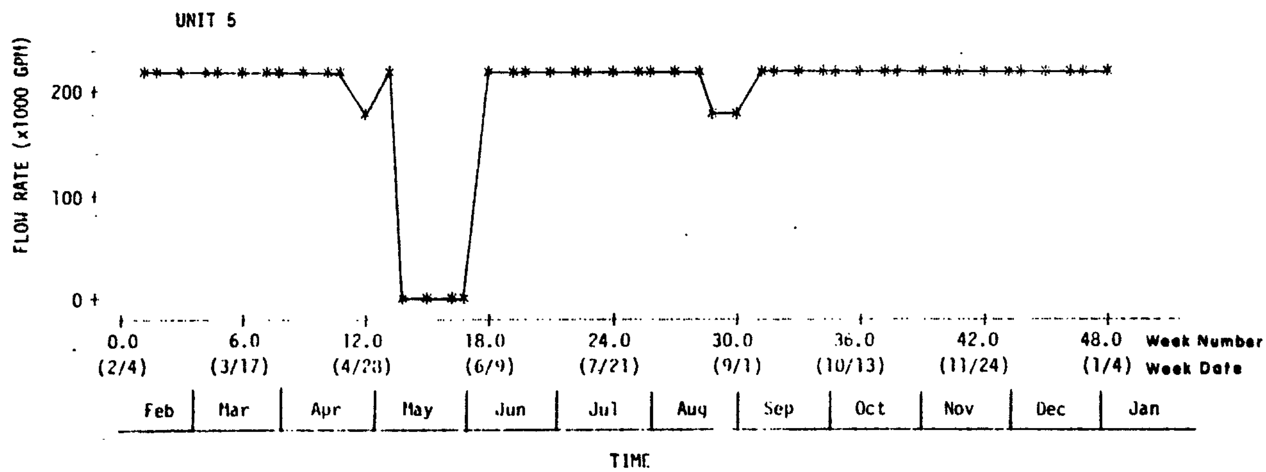


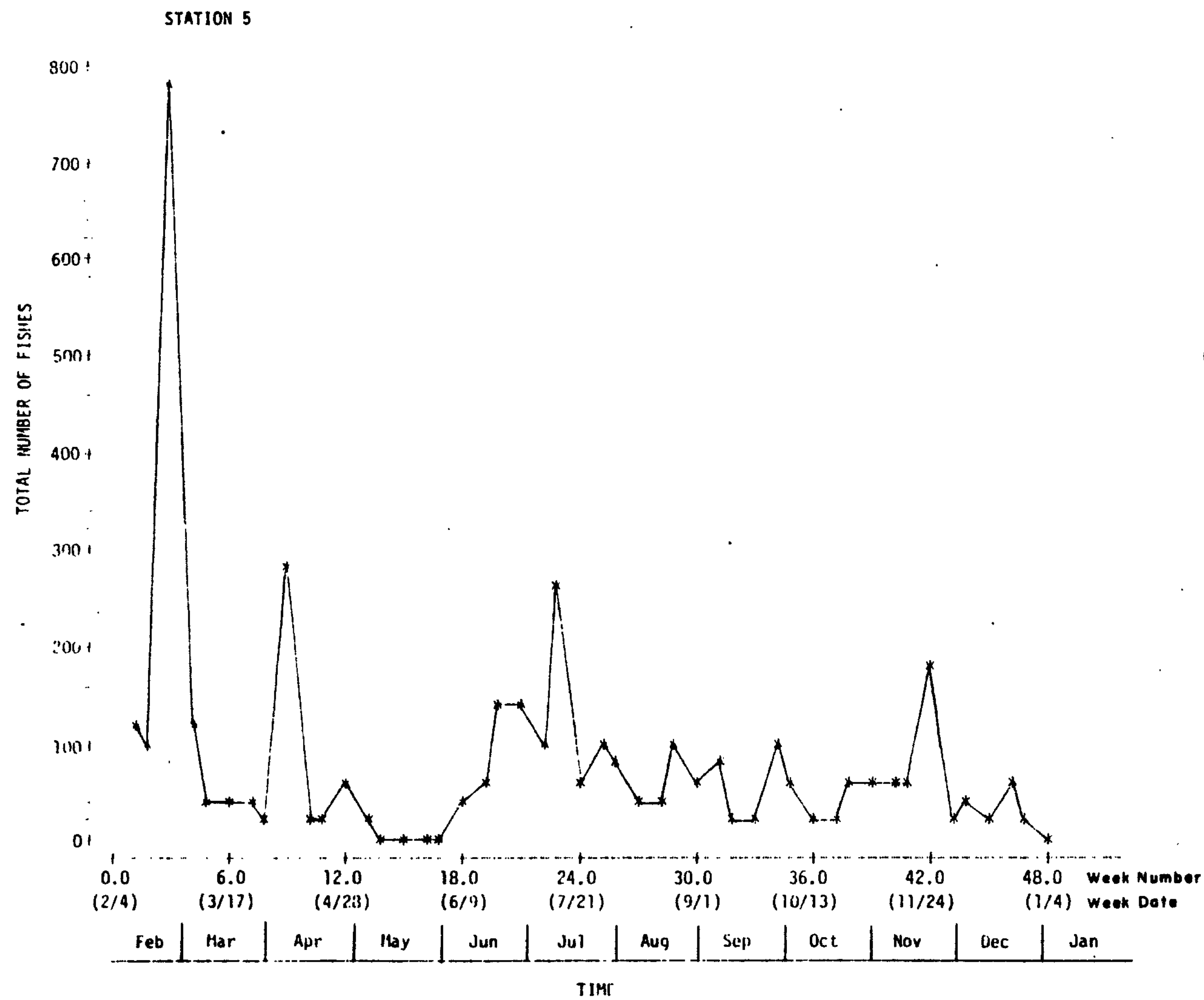
SAN DIEGO GAS & ELECTRIC COMPANY	
Comparisons of weekly mean flow rates and impingement at station 1 from 2-4-79 to 1-4-80 Encina Power Plant - August 1, 1980	
PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.8-2





SAN DIEGO GAS & ELECTRIC COMPANY	
Comparisons of weekly mean flow rates and impingement at station 4 from 2-4-79 to 1-4-80 Encina Power Plant - August 1, 1980	
PREPARED BY: WOODWARD-CLYDE CONSULTANTS	FIGURE NO. 7.8-3





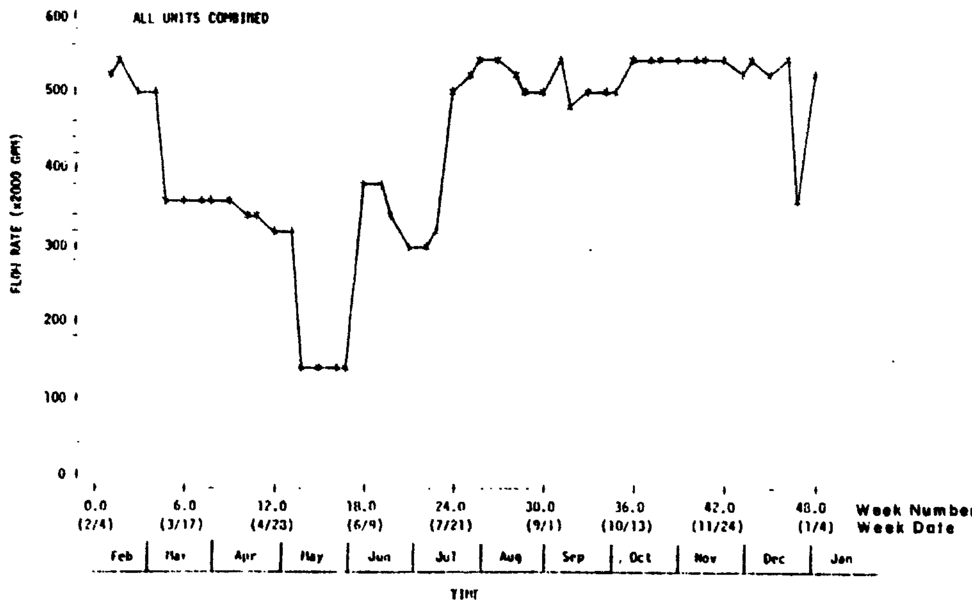
SAN DIEGO GAS & ELECTRIC COMPANY

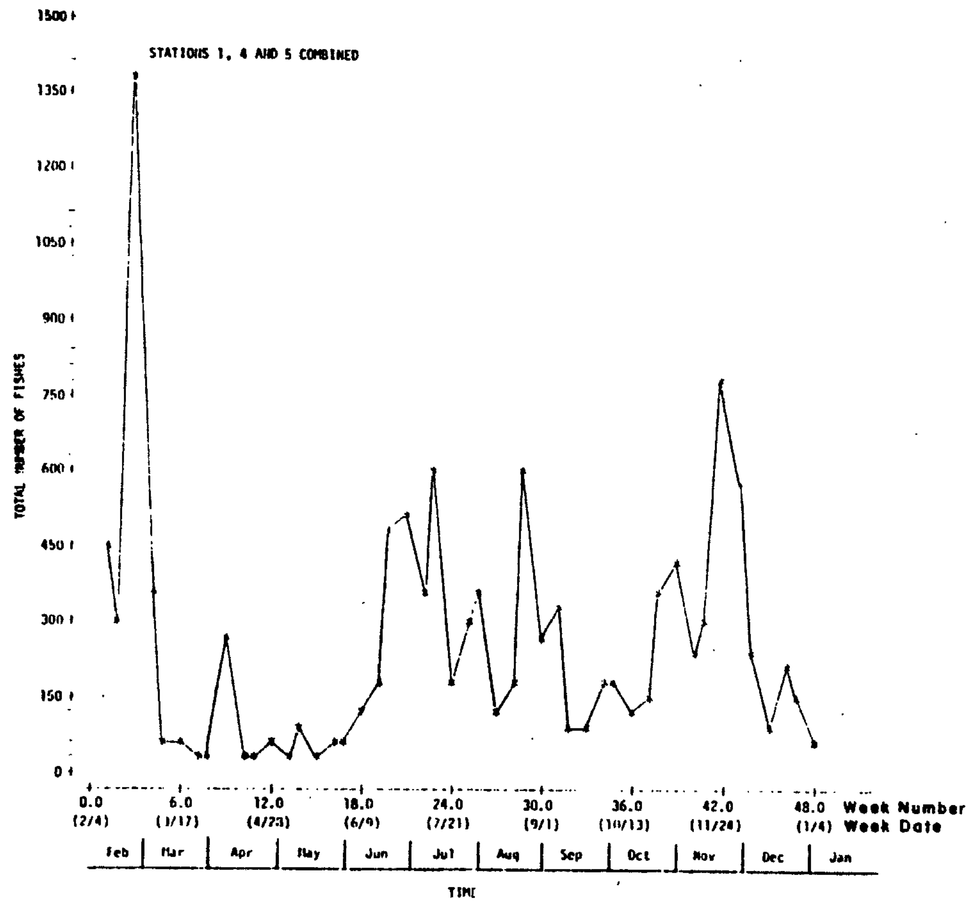
Comparisons of weekly mean flow rates and impingement at station 5 from 2-4-79 to 1-4-80

Encina Power Plant - August 1, 1980

PREPARED BY:
WOODWARD-CLYDE CONSULTANTS

FIGURE NO.
7.8-4





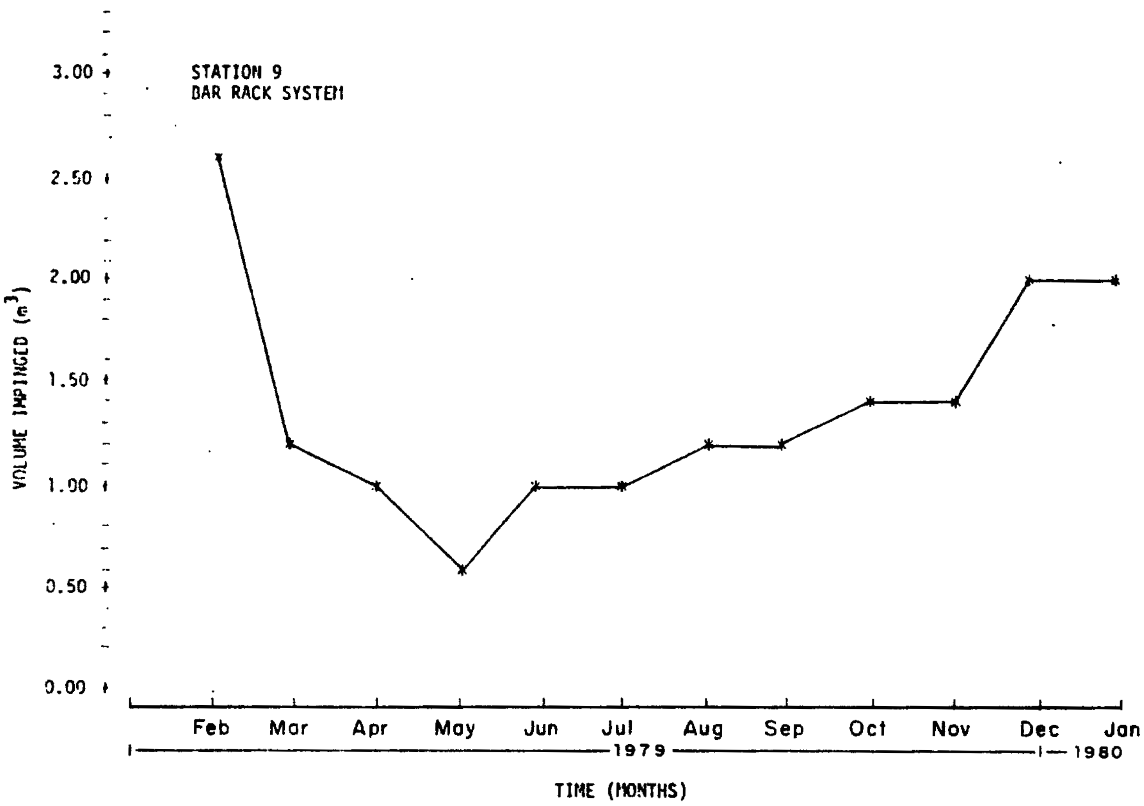
SAN DIEGO GAS & ELECTRIC COMPANY

Comparisons of weekly mean flow rates and total impingement from 2-4-79 to 1-4-80

Encina Power Plant - August 1, 1980

PREPARED BY: WOODWARD-CLYDE CONSULTANTS

FIGURE NO. 7.8-5



SAN DIEGO GAS & ELECTRIC COMPANY

Monthly mean volume of all material impinged at the bar rack per 24-hour interval from 2-4-79 to 1-4-80
Encina Power Plant - August 1, 1980

PREPARED BY:
WOODWARD-CLYDE CONSULTANTS

FIGURE NO.
7.11-1

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