CHAPTER 4

2000 IN-PLANT FISH ASSESSMENT

INTRODUCTION

This chapter reports on fish impingement at the San Onofre Nuclear Generating Station (SONGS) in compliance with National Pollutant Discharge Elimination System (NPDES) requirements. The term "impingement" refers to entrapped fish that are killed in the SONGS cooling system and are removed by traveling screens. This chapter summarizes in-plant fish collection data for the year 2000 at San Onofre Units 2 and 3. San Onofre Unit 1 was taken out of service in 1992 and did not operate in 2000. Since circulating water pumps were not in service in 2000, no fish impingement samples could be taken, nor are they required by the NPDES permit.

Also included in this chapter is a report on the operation and effectiveness of "Fish Chase" procedures carried out in 2000 as a means of increasing fish survival at SONGS. The "Fish Chase" is a procedure used at SONGS to remove as many fish as possible from the circulating water system before heat treatment procedures are begun to eliminate fouling organisms from the system[1].

Fish enter Units 2 and 3 of the generating station via seawater intakes supplying cooling water to the station. Most of the fish are guided through the intake screenwell to the fish return system and are returned to the ocean alive. Those remaining are impinged on the traveling screens and are deposited in containers for disposal. Estimates of the total number and weight of fish impinged during normal plant operation, including heat treatment, and analysis of size (age) and sex structure of select impinged species are presented in this report for Units 2 and 3 at SONGS.

[1] Information in this report regarding the Fish Chase procedure also meets requirements of Condition B of the coastal development permit for SONGS (permit no. 6-81-330-A, formerly 183-73 issued by the California Coastal Commission.

METHODS

The analytical approach for this section utilizes tabular summaries of the number of individuals and biomass of fish species impinged during normal operations and heat treatments. The total monthly normal operation catch is calculated by multiplying the number of fish sampled during one 24-hour period per calendar quarter by the amount of sea water sampled during the 24-hour sample divided by the total amount of sea water pumped during each month of the quarter. If a heat treatment occurs during the month, those fish are added to the monthly total. In other words:

$$\frac{i}{I} = \frac{f_s}{f_m}$$

$$I f_s = i f_m$$

$$I = i f_m / f_s$$

$$I_1 = i\,(f_s / f_m) + h_1 \qquad \frac{f_m}{f_s}$$

Where:

I_1 = Estimated total impingement for month 1.
i = Impinged fish in sample(s) during quarter.
f_s = Amount of sea water sampled during impingement sample.
f_m = Total amount of sea water pumped during month 1.
h_1 = Impinged fish in heat treatments during month 1.

After monthly impingement is calculated, the total annual impingement is determined by summing the months for 2000.

In 1999, a new NPDES permit was issued to the San Onofre Nuclear Generating Station that reduced the requirement for fish impingement monitoring from monthly sampling to quarterly sampling. This change went into effect in August 1999. For this reason, normal operation samples were taken in 2000 during each of the four calendar quarters (January-March; April-June; July-September; and October-December. Impingement for each month was calculated using the sample data for the quarter in which the month falls.

Length-frequency distributions of select species impinged in 2000 are constructed using samples of a maximum of 125 individuals for each normal operation and heat treatment sample. Fish were measured to the nearest millimeter. Sex ratios are estimated based on sub-samples of a maximum of 50 individuals per sample. Data are presented separately for each unit.

HEAT TREATMENT SAMPLES

Heat treatments at San Onofre involve recirculating approximately two-thirds of the normal discharge flow back through the condenser to achieve a temperature of 105°F (41°C) in the screenwell to control biofouling. The intake conduit is heat treated in this manner on an as-required schedule based upon a biofouling growth model (LCMR 1977) and operational requirements of the plant. During the heat treatment process, fish residing in the screenwell die due to the elevated temperatures. The dead fish are removed by screens and collected by biologists who separate them by species. They are then counted, weighed, and sub-samples are measured and their sex determined.

FISH CHASE

A "fish chase" procedure has been developed at SONGS to reduce the impact on fish populations by minimizing the number of fish killed during heat treatments.

Many fish accumulate in the cooling water system between heat treatments, often residing in habitat provided by gate slots and other structures within the system. Without the "fish chase" procedure, all fish residing in the circulating water system at the time of the heat treatment likely would be killed.

The fish chase is a procedure unique to SONGS. It was developed to allow live fish to move out of the circulating water system before beginning the heat treatment. This is accomplished by slowly manipulating cross-over gates in the vicinity of the screenwell, where most of the fish reside. This operation re-circulates effluent water so that the water is slowly warmed. The gate manipulations also create eddy currents that will dislodge fish that have congregated in areas of low flow. The elevated temperatures and new flow patterns are intended to agitate fish enough that they will seek new habitat and will find their way into the fish return elevator for release back to the ocean. The fish chase is monitored by a biologist to assure that the fish are not overly stressed by the procedure. Engineers, operators and biologists are continuing to improve on the effectiveness of the fish chase by experimenting with various combinations of temperature and gate changes.

NORMAL OPERATION

Normal plant operation samples of fish are collected according to the frequency required by the station's NPDES permit, except during periods when the units are not in service due to refueling or maintenance. These 24-hour samples are intended to be representative of the amount of fish that enter the plant during a "normal" day's operation. In 2000, samples were taken quarterly throughout the year at both Units 2 and 3.

FISH RETURN SYSTEM

At Units 2 and 3, fish are guided via vanes and louvers to the fish return chamber where an elevator raises them to the surface of the intake screenwell and releases them via a sluiceway back to the ocean. Previously reported studies (SCE, 1988; Love, *et al*, 1989) assessed the effectiveness and survivorship of the fish return system. In 1999, additional studies of the fish return system were conducted as part of a special study for the California Coastal Commission. No fish return samples were taken in 2000.

The fish return system is operated by equipment operators at least twice daily and operations are logged on daily status sheets (Form SO123-0-10) (M. J. Johnson, Personal Communications).

DATA ANALYSIS

Analysis of impingement catch involves (1) estimating the catch of fish for the year, (2) describing the length-frequency distributions of select species, and (3) describing sex ratios of select species. Weights, counts, length measurements and gender determination for all required species are provided in the 2000 Annual Data Report. This chapter of the Analysis Report presents catch data for the 15 most common species and length and sex data for species believed to be of particular interest to resource managers, assuming sufficient data exists for meaningful analysis.

The calculation used to determine the annual impingement catch in weight and numbers of fish during normal operation and heat treatment was described earlier in this section.

Fish released during the fish chase procedure are counted by biologists as the fish are raised in the fish return elevator. Biomass is determined by applying the values measured for fish taken in the subsequent heat treatment samples. That is, fish returned via the fish return system are assumed, on average, to weigh the same as fish taken in the following heat treatment.

Size structure and sex ratios of select species are examined using length-frequency histograms and sex ratio tables developed from data gathered during impingement sampling.

RESULTS AND DISCUSSION

SUMMARY OF PLANT OPERATIONS

The monthly operational status of each unit in 2000 is summarized in Table 4-1. The table shows the number of gallons of seawater pumped per month. The amount of power produced at the station is not necessarily related to the volume of seawater pumped. This is because circulating water pumps may have to be operated even when the station is not producing power and the pumps operate at only one speed whereas the plant may not always be run at maximum capacity.

Table 4-1. Monthly Circulating Water Flow.

Month	Unit 1 10^6 gallons	Unit 2 10^6 gallons	Unit 3 10^6 gallons
January	157.40	37,782.35	37,780.70
February	147.29	35,345.05	35,343.55
March	157.44	37,782.25	37,780.70
April	152.39	36,563.90	36,561.97
May	157.54	37,782.13	37,780.86
June	152.56	36,562.49	36,562.81
July	157.75	37,781.02	37,782.40
August	157.80	37,781.09	37,782.45
September	152.56	36,562.17	36,563.94
October	158.14	8,434.49	37,782.70
November	152.37	21,383.61	36,564.46
December	157.36	37,781.85	37,781.68
Total	1,860.58	401,542.38	446,068.23

ANNUAL IMPINGEMENT ESTIMATE

Unit 1

Fish impingement at Unit 1 is assumed to be zero since no circulating water pumps were operated in 2000. Flows resulting from operation of service water pumps are negligible (equivalent to about four days of operation for the entire year) and insufficient to create enough flow velocity to entrain or impinge fish.

Unit 2

The 2000 annual impingement estimate for Unit 2 is based on four quarterly normal operation impingement samples and seven heat treatment samples conducted during the year. Appendix A lists all normal operation and heat treatment samples collected at Unit 2 in 2000. Table 4-2 shows the estimated monthly abundance of the 15 most abundant fish species and all species combined in 2000. Table 4-3 presents the estimated monthly biomass of the top 15 fish species by weight in kilograms. Monthly abundance and biomass of all species occurring at SONGS Unit 2 in 2000 are presented in detail in Appendices B and C, respectively.

A total of 63 species of fish were counted and weighed at Unit 2 in 2000. When weighted by the total amount of seawater used by Unit 2 in 2000, the estimated fish impingement was 675,102 individuals weighing 10,033 kilograms. The top 15 species accounted for 99.4% of the total number and 98.2% of the total weight. Queenfish and northern anchovy were the most common species contributing 91% of the total in number of fish and 59.7% of the total weight. Spiney dogfish also contributed significantly to the total weight of fish impinged in 2000 with 17.5% of the total. Yellowfin croaker, which were prominent in 1999, were present in 2000, but in much lower numbers.

Unit 3

The 2000 annual impingement estimate for Unit 3 is based on four normal operation impingement samples and nine heat treatment samples conducted during the year. Table 4-4 shows the estimated monthly abundance of the 15 most abundant fish species and all species combined in 2000. Table 4-5 presents the estimated monthly biomass of the top 15 fish species by weight in kilograms. A list of all normal operation and fish return samples taken in 2000 are presented in Appendix A. Monthly abundance and biomass of <u>all</u> species occurring at SONGS Unit 3 in 2000 are presented in detail in Appendix D and E, respectively.

A total of 62 species of fish were counted and weighed at Unit 3 in 2000. When weighted by the total amount of seawater used by Unit 3 in 2000, the estimated fish impingement was 1,665,183 individuals weighing 18,617.8 kilograms. The top 15 species accounted for 99.7% of the total number and 98.5% of the total weight. Queenfish and white croaker were the most common species contributing 82.1% of the total in number of fish and 62% of the total weight. Spiney dogfish also contributed significantly to the total weight of fish impinged in 2000 with 15.2% of the total biomass. Similar to Unit 2, Yellowfin croaker were present in 2000, but in much lower numbers than were seen in 1999. Unit 3 had a much larger impingement rate compared to Unit 2.

Table 4-2. Estimated Monthly Count of Fish Impinged at Unit 2 in 2000

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
QUEENFISH	95,812	89,497	95,668	27,075	28,444	28,665	30,070	31,330	30,142	5,059	12,825	23,260	497,846
NORTHERN ANCHOVY	1,827	1,450	1,550	3,076	3,202	3,064	29,078	30,430	28,146	1,785	4,527	8,046	116,181
WHITE CROAKER	8	0	0	4,678	5,092	4,691	2,046	2,870	2,045	76	193	425	22,124
WHITE SEAPERCH	0	0	0	5,190	5,371	5,193	62	74	62	0	0	5	15,957
PACIFIC SARDINE	1,005	667	713	61	65	60	713	713	690	0	0	0	4,687
PIPEFISH	97	87	93	1,020	1,054	1,020	31	31	30	0	0	0	3,463
TOPSMELT	6	0	0	720	751	755	93	98	671	7	18	32	3,150
JACKSMELT	37	0	0	560	633	575	0	2	0	55	140	259	2,262
SARGO	0	0	0	0	1	667	0	208	265	7	18	69	1,234
PACIFIC BUTTERFISH	0	0	0	0	0	0	341	355	364	7	18	37	1,121
WALLEYE SURFPERCH	1	0	0	34	31	36	155	218	168	7	18	124	791
BLACK PERCH	0	0	0	210	228	224	0	18	15	0	0	2	697
SALEMA	3	0	0	0	0	17	0	520	43	7	18	56	663
SPINY DOGFISH	0	0	0	180	186	180	0	0	0	0	0	0	546
SHINER PERCH	2	0	0	61	63	69	31	179	85	0	0	10	500
Total of top 15 species	98,798	91,701	98,024	42,865	45,122	45,216	62,620	67,046	62,726	7,010	17,773	32,325	671,225
Total of all 63 species	99,049	91,904	98,241	43,462	45,732	45,820	62,837	67,444	63,237	7,031	17,826	32,521	675,102

Table 4-3. Estimated Monthly Weight (Kgs) of Fish Impinged at Unit 2 in 2000

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
QUEENFISH	315.2	292.9	313.0	658.8	699.1	701.1	651.2	690.9	660.6	30.7	77.8	141.2	5232.4
SPINY DOGFISH	0.0	0.0	0.0	578.7	598.0	578.7	0.0	0.0	0.0	0.0	0.0	0.0	1755.4
NORTHERN ANCHOVY	13.2	8.1	8.6	9.5	10.3	9.5	204.0	214.6	197.4	10.2	25.8	45.8	756.9
CALIFORNIA ELECTRIC RAY	173.6	162.4	173.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	509.6
CALIFORNIA BUTTERFLY RAY	12.7	11.9	12.7	139.5	144.2	139.5	0.0	0.0	0.0	0.0	0.0	0.0	460.5
SARGO	0.0	0.0	0.0	0.0	0.6	138.0	0.0	40.7	110.3	0.0	0.1	6.2	295.8
PACIFIC SARDINE	44.3	27.1	29.0	2.7	2.9	2.6	40.0	40.0	38.7	0.0	0.0	0.0	227.3
WHITE CROAKER	0.2	0.0	0.0	39.6	42.8	39.2	13.8	32.6	15.0	0.6	1.5	3.2	188.4
JACKSMELT	3.9	0.0	0.0	38.9	42.5	40.8	0.0	0.0	0.0	1.2	3.0	5.5	135.8
TOPSMELT	0.3	0.0	0.0	27.7	28.9	29.4	3.6	3.8	23.5	0.1	0.3	0.5	118.1
WHITE SEAPERCH	0.0	0.0	0.0	19.1	19.8	19.2	0.2	0.4	0.2	0.0	0.0	0.1	59.0
SALEMA	0.1	0.0	0.0	0.0	0.0	1.2	0.0	37.4	3.5	0.0	0.1	0.5	42.8
YELLOWFIN CROAKER	0.0	0.0	0.0	0.0	0.0	6.8	0.0	12.8	12.8	0.0	0.0	0.2	32.6
BAT RAY	0.0	0.0	0.0	7.2	7.4	7.2	0.0	0.0	0.0	0.0	0.0	0.0	21.8
GIANT SEABASS	0.0	0.0	0.0	19.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.2
Total of top 15 species	563.5	502.3	537.0	1540.9	1596.4	1713.1	912.7	1073.3	1062.0	42.8	108.4	203.3	9855.8

Table 4-4. Estimated Monthly Count of Fish Impinged at Unit 3 in 2000

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
QUEENFISH	121,757	114,222	121,757	36,586	36,980	38,760	60,723	58,794	54,205	107,256	104,068	107,719	962,829
WHITE CROAKER	0	97	0	13,161	13,050	12,915	122,806	122,603	118,657	434	433	550	404,707
NORTHERN ANCHOVY	4,123	39,936	4,123	5,721	5,828	5,670	40,318	40,718	39,049	1,240	1,250	1,264	189,237
WHITE SEAPERCH	0	1	0	12,599	13,019	12,604	3,110	3,124	3,000	0	0	0	47,457
PACIFIC BUTTERFISH	0	0	0	0	0	0	7,696	7,734	7,487	186	227	188	23,518
PACIFIC SARDINE	1,519	1,451	1,519	226	124	136	1,833	1,833	1,771	31	30	32	10,505
PIPEFISH	248	232	248	1,320	1,364	1,320	186	186	180	0	0	1	5,285
WALLEYE SURFPERCH	31	33	31	12	0	14	1,591	1,542	1,452	0	14	12	4,732
SHINER PERCH	0	7	0	6	0	7	1,062	1,028	968	0	9	2	3,089
JACKSMELT	496	500	496	405	279	374	1	0	8	31	35	37	2,662
SARGO	0	0	0	0	0	157	304	242	816	0	92	1	1,612
DEEP BODY ANCHOVY	0	0	0	0	0	0	0	38	38	465	584	467	1,592
YELLOWFIN CROAKER	0	0	0	7	0	5	246	348	543	0	26	5	1,180
TOPSMELT	0	0	0	260	248	302	35	87	70	31	30	32	1,095
SALEMA	0	1	0	26	0	70	574	168	85	0	11	54	989
Total of top 15 species	128,174	156,480	128,174	70,329	70,892	72,334	240,485	238,445	228,330	109,674	106,809	110,364	1,660,489
Total of all 62 species	128,236	156,579	128,236	71,308	71,760	73,235	240,624	238,762	228,603	109,891	107,343	110,608	1,665,183

Table 4-5. Estimated Monthly Weight (Kgs) of Fish Impinged at Unit 3 in 2000

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
QUEENFISH	527.0	496.9	527.0	786.9	794.4	872.5	1367.3	1286.4	1176.7	573.7	561.6	577.2	9547.6
SPINY DOGFISH	0.0	0.0	0.0	934.3	965.5	934.3	0.0	0.0	0.0	0.0	0.0	0.0	2834.1
WHITE CROAKER	0.0	3.1	0.0	94.3	91.0	94.7	570.9	568.0	550.4	4.1	4.2	5.0	1985.9
NORTHERN ANCHOVY	30.8	138.5	30.8	14.9	14.7	14.6	271.8	276.1	263.2	6.0	5.9	6.1	1073.4
WHITE SEAPERCH	0.0	0.1	0.0	47.5	49.0	47.5	199.7	200.1	193.2	0.0	0.0	0.0	737.1
PACIFIC SARDINE	49.9	49.4	49.9	10.8	5.8	6.3	104.6	104.7	101.1	0.9	0.9	1.0	485.5
SARGO	0.0	0.0	0.0	0.0	0.0	22.4	93.6	57.8	216.8	0.0	23.9	0.0	414.4
YELLOWFIN CROAKER	0.0	0.0	0.0	1.4	0.0	1.1	70.1	96.0	231.7	0.0	0.7	0.1	401.1
PACIFIC BUTTERFISH	0.0	0.0	0.0	0.0	0.0	0.0	109.0	109.4	106.1	2.1	3.4	2.2	332.3
SHINER PERCH	0.0	0.2	0.0	0.2	0.0	0.1	50.2	50.0	48.1	0.0	0.2	0.0	149.0
JACKSMELT	17.9	16.9	17.9	31.8	20.7	25.8	0.1	0.0	0.2	1.8	1.9	2.1	137.0
SPECKLEFIN MIDSHIPMAN	0.0	0.3	0.0	1.0	1.1	1.0	28.4	27.1	26.2	0.0	0.5	0.0	85.6
SALEMA	0.0	0.0	0.0	1.3	0.0	4.4	35.2	12.1	6.2	0.0	0.2	0.3	59.6
WALLEYE SURFPERCH	0.9	1.1	0.9	0.9	0.0	0.1	14.6	14.5	13.0	0.0	0.5	0.3	46.8
TOPSMELT	0.0	0.0	0.0	11.3	10.6	13.5	1.5	2.7	2.6	1.2	1.2	1.3	45.9
Total of top 15 species	626.5	706.4	626.5	1936.5	1952.8	2038.3	2916.9	2805.1	2935.5	589.9	605.1	595.6	18335.2
Total of all 62 species	634.6	716.3	634.6	1987.8	1985.3	2075.7	2935.9	2825.8	2949.2	613.5	638.2	621.1	18617.8

Heat Treatment Operations and "Fish Chase".

"Heat treatments" are conducted on an "as needed" basis at coastal generating stations to control the growth of fouling organisms such as mussels and barnacles. The timing of these operations is dependent on season, ocean temperature, and observed settlement and growth of fouling organisms. The operations typically occur about every six weeks. The water temperature within the station is elevated to a temperature that will be lethal to the fouling organisms within the plant. Since this temperature is also lethal to fish residing in the station, a special effort called a "fish chase" has been developed at San Onofre to cause fish to leave the station alive before the heat treatment begins. Table 4-6 summarizes the number and weight of fish returned to the ocean during the fish chase that occurs just prior to the heat treatment and the percent of those fish returned to the ocean compared to the number of fish killed during the heat treatment process at SONGS Units 2 and 3.

Table 4-6. Fish Chase Efficiency by Heat Treatment for Units 2 and 3

		Fish Chase		Heat Treatment		% Released	
Unit	Date	Number	Kilograms	Number	Kilograms	Number	Kilograms
Unit 2	02/20/00	197	7.195	808	29.402	19.6%	19.7%
Unit 2	04/03/00	543	31.82	501	35.195	52.0%	47.5%
Unit 2	05/19/00	1,317	35.8	1,339	37.236	49.6%	49.0%
Unit 2	06/25/00	1,231	59.5	2,860	213.518	30.1%	21.8%
Unit 2	08/05/00	2,341	353.257	4,607	175.495	33.7%	66.8%
Unit 2	09/30/00	1,425	442.129	2,427	197.261	37.0%	69.1%
Unit 2	12/09/00	685	17.082	1,025	16.785	40.1%	50.4%
Unit 3	02/06/00	46	0.62	36,615	122.657	0.1%	0.5%
Unit 3	04/17/00	594	14.196	1,190	44.096	33.3%	24.4%
Unit 3	04/21/00	311	8.062	673	22.389	31.6%	26.5%
Unit 3	06/02/00	1,543	124.25	3,789	154.319	28.9%	44.6%
Unit 3	07/08/00	4,400	572.768	8,219	432.211	34.9%	57.0%
Unit 3	08/19/00	11,911	1,894.45	6,356	319.102	65.2%	85.6%
Unit 3	09/23/00	1,904	629.307	3,692	523.348	34.0%	54.6%
Unit 3	11/18/00	440	92.7	995	44.491	30.7%	67.6%
Unit 3	12/23/00	3,770	35.04	720	7.603	84.0%	82.2%
Totals		32,658	4,318	75,816	2,375	30.1%	64.5%

In 2000, a total of 75,816 fish weighing 2,375 kgs were impinged during heat treatment operations at SONGS. At the same time, as a result of the "Fish Chase" procedure, 32,658 fish weighing 4,318 kgs were successfully released back to the ocean prior to the heat treatments. The percentage of fish released varied among the heat treatments, but averaged 30.1% by number of fish and 64.5% by biomass for the year. The percent of fish released varied from a low of 0.1% of the number of fish and 0.5% of biomass to a high of 84% of the fish and 82.2% of the biomass. The unusually low return on February 6, 2000 resulted when the biologist was delayed because of extended security clearance requirements and was unable to count all the fish that were returned alive to the ocean. However, the operator of the fish elevator reported making six successful releases from the fish return system prior to the arrival of the biologist. The return, therefore, was much greater than indicated by the data report. A summary of Fish Chase operations is presented in Table 4-7.

Table 4-7. Description of Fish Chase Operations in 2000

					Elevator					Heat Treatment		
Unit	Date	Start Time	Intake Temp.	Max FC Temp.	Operational Status	# of Dumps	Condition of fish	Number of Fish	Fish Biomass	Number of Fish	Fish Biomass	Comment
2	2/20/00	0729	59.4	85.9	Good	21	Good	197	7.195	808	29.402	No unusual events
2	4/3/00	1929	62	83.6	Good	17	Good	543	31.82	501	35.195	No unusual events
2	5/19/00	2042	59.5	83	Good	18	Good	1317	35.8	1339	37.236	No unusual events
2	6/25/00	1100	67.8	83	Curtailed	10	Good	1231	59.5	2860	213.518	Operator concern; chain stretching.
2	8/5/00	1116	61	87	Good	28	Good	2341	353.257	4607	175.495	No unusual events
2	9/30/00	0934	67	87	Good	14	Good	1425	442.129	2427	197.261	No unusual events
2	12/9/00	0357	59	87	Good	28	Good	685	17.082	1025	16.785	No unusual events
3	2/6/00	0734	57.8	83	Good	16	Good	46	0.62	36615	122.657	Bio delayed; First 6 dumps uncounted
3	4/17/00	1929	59.3	83	Postponed	9	Good	594	14.196	1190	44.096	Seal sighted; heat treat cancelled.
3	4/21/00	2043	60.7	84	Good	9	Good	311	8.062	673	22.389	No unusual events
3	6/2/00	1930	65	82	Good	13	Good	1543	124.25	3789	154.319	No unusual events
3	7/8/00	1207	66	87	Good	20	Good	4400	572.768	8219	432.211	Cal F&G, Nat. Park Service present
3	8/19/00	0935	70	85	Good	20	Good	11911	1894.445	6356	319.102	No unusual events
3	9/23/00	1306	70.6	87.8	Good	26	Good	1904	629.307	3692	523.348	No unusual events
3	11/18/00	1307	60	84	1 hr. Delay	19	Good	440	92.7	995	44.491	Turtle released alive prior to FC.
3	12/23/00	0402	59	83.1	Good	16	Good	3770	35.04	720	7.603	No unusual events

In Table 4-7 above, "Operational Status" provides information on the overall success of the fish chase procedure from an operational standpoint, i.e., whether it was completed as scheduled or not. "Condition of Fish" is a qualitative evaluation of how the fish appeared as they were released. A designation of "Good" means that less than 1% of the fish released appeared weakened or dead. The target temperature for a fish chase is usually 83°F. (28.3° C.) However, higher temperatures may be necessary to remove warm water species such as yellowfin croaker, sargo and zebra perch. In 2000, maximum temperatures ranged from 82° to 87.8° F.(27.8° to 31° C.). Graphs of temperature curves for each fish chase are presented in Appendix F. Table 4-8 presents a summary of fish released during the Fish Chase operations in 2000. The table provides the percent returned by numbers and biomass for the 15 most common species based on biomass. Appendix G provides the same information for all species taken at SONGS in 2000.

Table 4-8. Summary of Fish Released During Fish Chase Operations (Top 15 Species)

	Unit 2 Fish Chase		Unit 3 Fish Chase		Unit 2 Heat treat		Unit 3 Heat treat		% Returned	% Returned
Common Name	Number	Kgs	Number	Kgs	Number	Kgs	Number	Kgs	by Count	by Biomass
SARGO	1621	510.838	5422	1334.392	1179	295.432	1612	414.432	71.62%	72.22%
YELLOWFIN CROAKER	140	48.75	2189	697.715	102	32.637	1181	401.112	64.48%	63.25%
QUEENFISH	970	26.796	5,238	65.824	6056	155.823	17732	512.091	20.70%	12.18%
SALEMA	1698	126.484	7012	476.962	608	42.644	989	59.571	84.51%	85.51%
SPOTFIN CROAKER	75	38.83	932	488.385	6	2.518	32	15.672	96.36%	96.66%
NORTHERN ANCHOVY	2460	28.305	3232	31.739	1743	16.109	36749	115.932	12.88%	31.26%
ZEBRA PERCH	117	70.2	37	20.26	4	2.4	2	1.11	96.25%	96.26%
GIANT SEABASS			6	63.5	1	19.2			85.71%	76.78%
BARRED SAND BASS	163	34.543	110	24.77	58	11.754	63	11.409	69.29%	71.92%
WHITE CROAKER	196	5.76	291	5.966	1428	28.901	1528	28.34	14.14%	17.00%
BAT RAY	1	0.35	4	54.5					100.00%	100.00%
SHOVELNOSE GUITARFISH	2	6	7	29	1	4	2	7	75.00%	76.09%
JACKSMELT	3	0.73	45	3.538	180	12.981	295	18.49	9.18%	11.94%
KELP BASS	22	3.74	111	27.415	16	0.063	37	4.096	71.51%	88.22%
CALIFORNIA CORBINA	36	8.36	104	25.12	1	0.048	1	0.201	98.59%	99.26%
Totals for Top 15 species	7504	909.69	24740	3349.09	11383	624.51	60223	1589.46	31.05%	65.80%
Totals for all 72 species	7739	947	24919	3371	13567	705	62249	1670	30.11%	64.52%

Fish Return System Operation

The SONGS fish return system is normally operated twice per day by station operators. It is a routine part of station operations that is logged on daily status sheets (Form SO123-0-10) (M. J. Johnson, Personal Communication). A summary of exceptions to daily operability of the fish return system in 2000 is detailed in Table 4-8.

Prior to 1999, no quantitative biological data on the efficiency of the fish return system had been collected since 1994. However, eleven years of data were collected from 1984 through 1994, and a special study provided additional information in 1999. A summary of the return efficiency of the fish return system during those years is presented in Table 4-9. Return efficiency is the percent of fish returned to the ocean alive during normal operation compared to the number of fish impinged and does not include fish returned during the "fish chase". No fish return samples were taken in 2000.

Table 4-9. Operating status of the Fish Return System in 2000.

Unit	Total Hours FRS Out of Service in 2000	Reason FRS was Out of Service	% System Availability in 2000
2	32	Repairs	99.6
3	32	Repairs	99.6

Table 4-10. Fish Return Efficiency 1984-1994 and 1999

Year	Unit 2 Percent Returned	Unit 3 Percent Returned
1984	96.50	95.40
1985	88.30	60.10
1986	75.00	69.90
1987	65.00	67.80
1988	80.00	68.50
1989	41.60	58.40
1990	51.50	36.60
1991	75.40	66.30
1992	74.40	59.30
1993	83.00	78.00
1994	87.70	78.40
1999	72.40	68.22

LENGTH FREQUENCY ANALYSIS

Figures 4-1 through 4-4 present length-frequency distributions of queenfish, northern anchovy, white croaker and Pacific sardine collected in-plant at Units 2 and 3 during 2000. These species were selected either because of their predominance in the catch (e.g., queenfish and northern anchovy) or because of their interest to resource managers (e.g., Pacific sardine and white croaker). Length data for all other species is provided in the 2000 data report.

Fig. 4-1. Queenfish Length Distribution

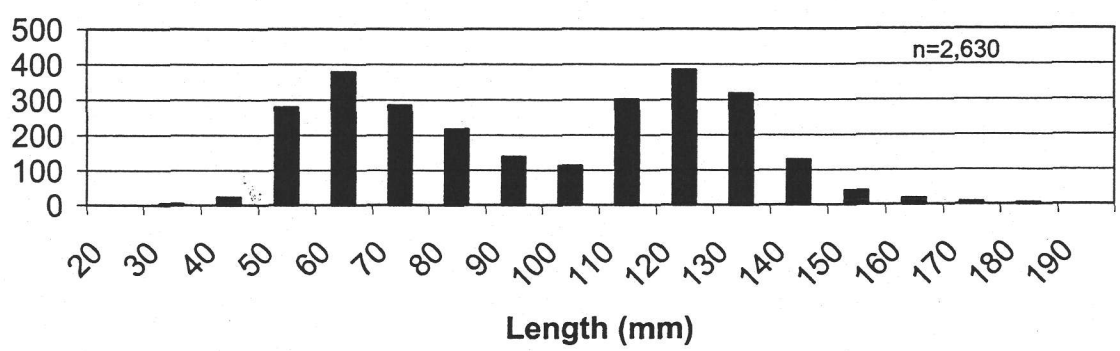


Fig. 4-2. Northern Anchovy Length Distribution

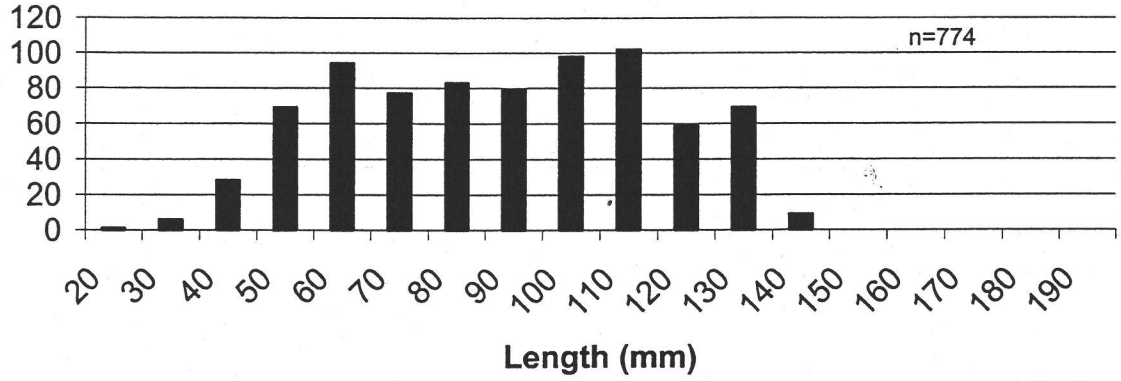


Fig. 4-3. White Croaker Length Distribution

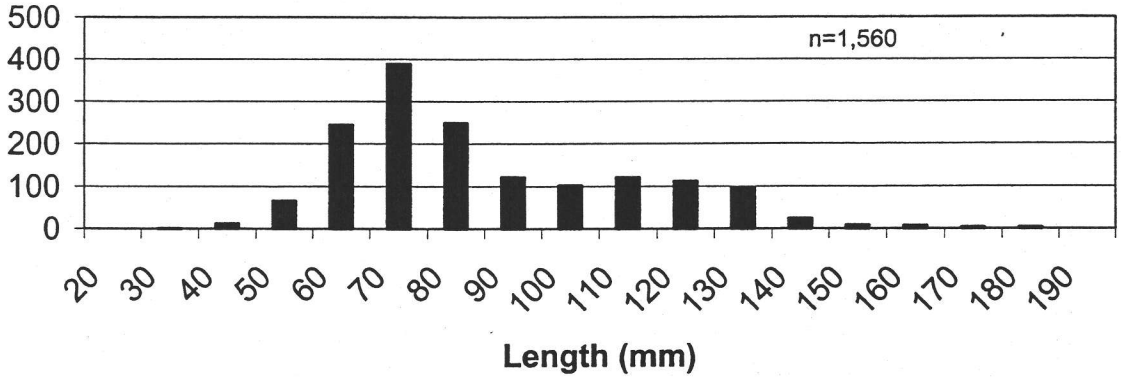
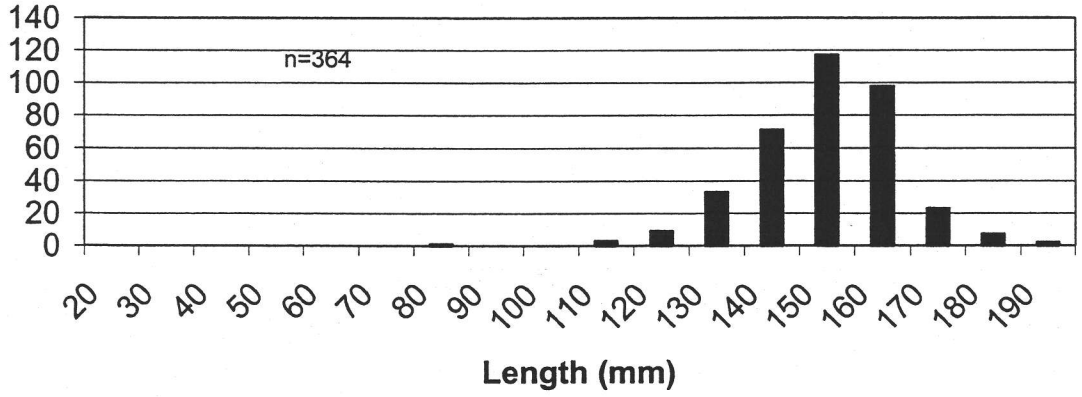


Fig. 4-4. Pacific Sardine Length Distribution



As in most years, queenfish and northern anchovy were numerous in 2000 and accounted for over 75% of the total catch at SONGS, by number.

Northern anchovy are small, short-lived fish typically found in schools near the surface during the day, then dispersing through the water column at night. It is probably during this dispersal at night that they are most likely to be entrained into generating station intakes. They rarely exceed four years in age and seven inches in length, although individuals as old as seven years and nine inches have been recorded. There is a great deal of regional variation in age composition and size at age with older, larger, fish found at relatively offshore and northerly locations. In warm years relatively old and large fish are found farther north than during cool years (Leet, et al, 1992). At SONGS in 2000, northern anchovy lengths ranged mostly from 30 to 140 mm throughout the year, with modal peaks at 60 and 100 mm. The smaller size class (around 50 mm) correlates to an age of 1.5 to 2.5 months (Sakagawa and Kimura 1976). The large number of northern anchovies seen at SONGS in 1999 did not continue into 2000. Though abundant, the northern anchovy biomass in 2000 was about 25% that of 1999. This may be a result of a decline in the presence of La Niña conditions in 2000.

Queenfish school in shallow water during the day, often in the shadow of reefs or kelp, then disperse and move offshore at night when they feed actively (Love, 1991). It is during these nocturnal migrations and dispersal in the water column that many of the queenfish are entrained into generating station intakes (Johnson, et al., 1976). The annual abundance of queenfish has fluctuated significantly from year to year with an apparent relationship with ENSO (El Niño/La Niña) events. Though abundance has remained generally strong during both warm and cool water periods, there were marked declines during the strong warm-water ENSO events of 1982-83, 1987 and 1997-98. In 1999, a cold water year, queenfish abundance was double that of 1998. In 2000, queenfish abundance was approximately equal to 1999. Queenfish lengths ranged from 30 to 180 mm. The length distribution was generally bi-modal, however the modality is obscured by growth of the fish during the year. The primary modes were at 60 and 120 mm representing mostly Age 0 and Age 1 individuals. Recruitment of young-of-the-year (YOY) appeared strong in 2000.

Pacific sardines continued to decline in number in 2000 when compared to 1998 and 1999. As in previous years, numbers continued to be higher at Unit 3 than at Unit 2, a phenomenon that is difficult to explain. In 2000, most of the sardines ranged from 110 to 200 mm, but, unlike 1999, hardly any smaller sardines (from 10 to 110 mm) were present.

Unlike queenfish, who's abundance has fluctuated from year to year but has not shown any long-term decline, white croaker abundance over the same period exhibited an overall downward trend, until 1999. In 1999, perhaps due to the colder water temperatures, white croaker abundances increased to nearly 10 times that of 1998. In 2000 the trend continued with numbers ten times greater than in.1999. White croaker often co-occur with queenfish (Love, 1991) and exhibit similar diurnal dispersal patterns. Seasonal abundance data from impingement sampling data support observations by Allen and DeMartini (1983) that white croaker may move offshore into deeper waters during winter months. In 2000, the white croaker length frequency distribution is bi-modal with modes at 70 and 110 mm. Lengths ranged from 40 to 180 mm, but few exceeded 130 mm in length.

SEX COMPOSITION

Sex ratios of fish impinged at Units 2 and 3 are summarized in Table 4-11. As observed in past years, females frequently outnumbered males for many of the species studied. This is especially true of the perches, northern anchovies, and queenfish. This may be due to increased vulnerability to impingement of gravid females, especially the embiotocids, that have impaired swimming ability. White croaker also had more females than males. In contrast, Pacific sardines were more commonly males than females. All these characteristics are consistent with data from previous years.

Table 4-11. Count by Sex of fish captured at SONGS Units 2 & 3 in 2000.

Common Name	Unit 2		Unit 3	
	Female	Male	Female	Male
BARRED SAND BASS	28	10	11	4
BAT RAY		1	1	
BLACK CROAKER	4	9	2	3
BLACK PERCH	34	22	7	2
CALIFORNIA BUTTERFLY RAY	1		1	1
CALIFORNIA CORBINA				1
CALIFORNIA ELECTRIC RAY			1	
CALIFORNIA HALIBUT	1	1		
CALIFORNIA SHEEPHEAD	2			
DEEP BODY ANCHOVY	6	5		
GRAY SMOOTHHOUND	1			
KELP BASS			1	2
NORTHERN ANCHOVY	126	101	114	80
PACIFIC BUTTERFISH	7	1		1
PACIFIC SARDINE	37	41	47	69
PILE PERCH	2		1	
QUEENFISH	264	128	305	105
ROCK WRASSE	7	7		
SARGO	87	103	64	86
SHINER PERCH	67	53	27	15
SPINY DOGFISH	6		6	3
SPOTFIN CROAKER	3	2	10	8
WALLEYE SURFPERCH	112	56	36	24
WHITE CROAKER	82	54	100	89
WHITE SEA BASS	1			
WHITE SEAPERCH	15		1	
YELLOWFIN CROAKER	45	52	55	60

TOTAL IMPINGEMENT

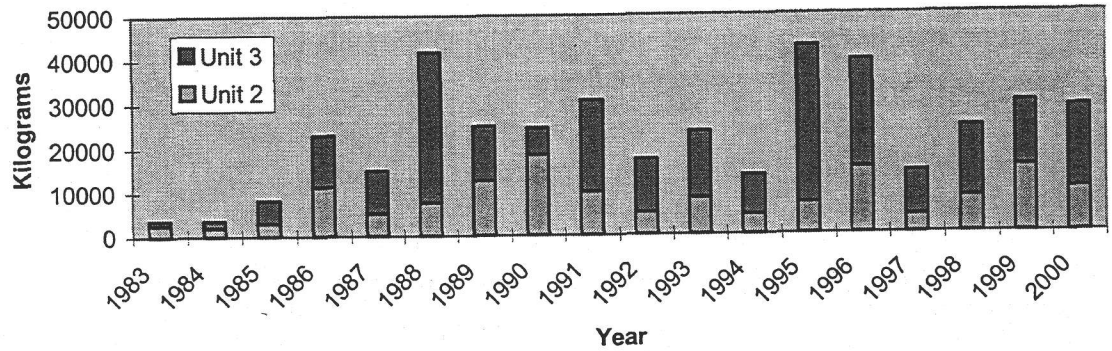
The total impingement fish loss for 2000 is the sum of the estimated annual impingement loss during normal operation and fish impinged during heat treatment. Estimated annual impingement for Unit 2 in 2000, for all species combined, was 675,102 fish weighing 10,033 kilograms. Annual impingement at Unit 3 was 1,665,183 fish weighing 18,618 kilograms (Table 4-12).

Table 4-12. Total number and weight of fish caught at San Onofre Units 2 & 3 in 2000.

Unit	Normal Operation Impingement Total	Heat Treatment Total	Total Fish Impingement
2 (Count)	661,535	13,567	675,102
2 (Kilograms)	9,328	705	10,033
3 (Count)	1,602,935	62,248	1,665,183
3 (Kilograms)	16,951	1,667	18,618

Compared to previous years of operation, 2000 impingement was 26% higher than the 18-year average of 22,719 kg recorded since Units 2 and 3 began operation, but was within the normal variation of samples in past years. Changes in impingement catch at SONGS are likely the result of large-scale climatological and oceanographic perturbations unrelated to operation of the generating station. The impingement data collected at SONGS is frequently used by resource managers as an indicator of natural fluctuations in near-shore fish populations.

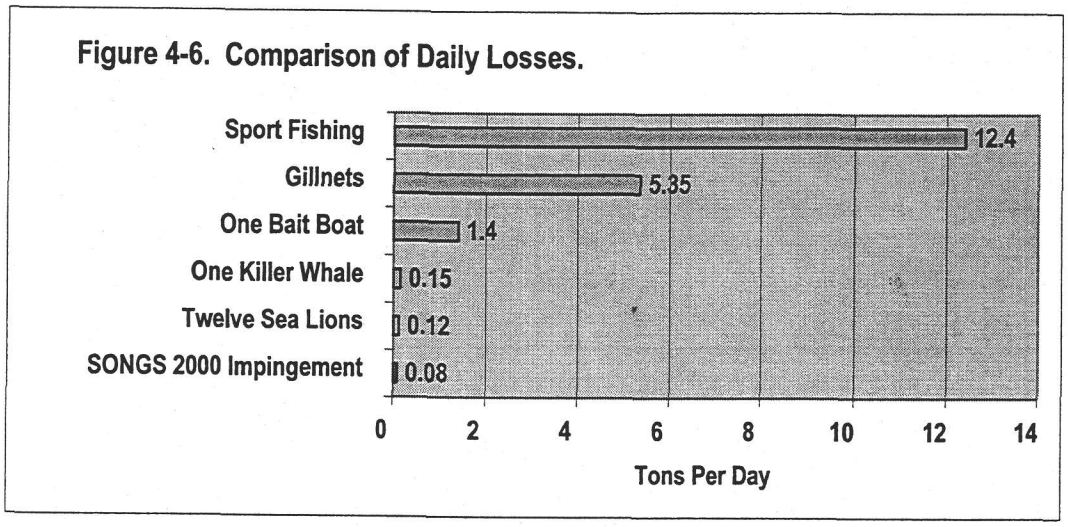
Fig. 4-5. SONGS Impingement 1983-2000



COMPARISON TO OTHER SOURCES OF FISH LOSS

This report provides an estimate of fish loss due to impingement resulting from the use of seawater as a source of cooling water for the San Onofre Nuclear Generating Station. In order to put these losses in perspective, it may be useful to compare the impingement losses with other losses routinely experienced by Southern California fish populations.

Figure 4-6 presents a variety of stresses on local fish populations and their relative magnitude in relation to SONGS impingement.



Data source: [1] 2000 Songs Annual Analysis Report; [2-3] "Marine Mammals of California" by A.E. Daugherty, 1979; [4] C. Cooney, Cal F&G, pers. com.; [5] Cal F&G/MMS computer data base; [6] U.S. Dept. of Commerce, Marine Rec. Fishery Statistics Survey, Pacific Coast 1981-1984 (within 3 miles of shore).

SUMMARY

IMPINGEMENT

Overall, the number and weight of fish impinged at San Onofre in 2000 was 26% higher than the 18-year average, but within the range of values recorded since Units 2 and 3 began operation. There is no indication that fish impingement at SONGS has significantly impacted the maintenance of a balanced, indigenous fish population in the receiving water, nor did it impair any beneficial uses dependent on the fisheries resources.

Unit 1

Fish impingement at Unit 1 is assumed to be zero since no circulating water pumps were operated in 2000. Flows resulting from operation of service water pumps are negligible (equivalent to less than 5 days of operation for the entire year) and insufficient to create enough flow velocity to entrain or impinge fish.

Unit 2

An estimated 675,102 individuals weighing a total of 10,033 kgs. were impinged by Unit 2 based on four quarterly samples of normal operation and seven heat treatment samples conducted during 2000. Northern anchovies and queenfish comprised 91% of the catch by number and 59.7% of the catch by weight.

Unit 3

An estimated 1,665,183 individuals weighing a total of 18,618 kg were impinged by Unit 3 based on four quarterly samples of normal operation and nine heat treatments in 2000. Northern anchovies and queenfish comprised 69.2% of the catch by number and 57% of the total weight.

FISH CHASE

A special procedure called a "fish chase" has been developed at San Onofre to cause fish to leave the circulating water system before heat treatments begin. In 2000, a total of 32,479 fish weighing 4,318 kgs. were successfully released back to the ocean prior to heat treatments.

1.4% – count
15% – weight

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APPENDIX A

List of Normal Operation and Fish Return Samples at SONGS Units 2 & 3.

Appendix A. Heat Treatment and Normal Operation Samples Taken at Units 2&3 During 2000.

Unit	Date	Sample Type	Number of Species	Number of Fish	Fish Biomass (Kgs.)
Unit 2	02/20/00	Heat Treatment	23	808	29.402
Unit 2	04/03/00	Heat Treatment	25	501	35.195
Unit 2	05/19/00	Heat Treatment	18	1,339	37.236
Unit 2	06/25/00	Heat Treatment	29	2,860	213.518
Unit 2	08/05/00	Heat Treatment	27	4,607	175.495
Unit 2	09/30/00	Heat Treatment	29	2,427	197.261
Unit 2	12/09/00	Heat Treatment	29	1,025	16.785
Unit 2	01/11/00	Normal Operation	8	3,169	17.353
Unit 2	05/23/00	Normal Operation	22	1,432	50.983
Unit 2	07/11/00	Normal Operation	15	2,027	30.008
Unit 2	12/19/00	Normal Operation	12	1,016	6.294
Unit 3	02/06/00	Heat Treatment	22	36,615	122.657
Unit 3	04/17/00	Heat Treatment	26	1,190	44.096
Unit 3	04/21/00	Heat Treatment	14	673	22.389
Unit 3	06/02/00	Heat Treatment	27	3,789	154.319
Unit 3	07/08/00	Heat Treatment	29	8,219	432.211
Unit 3	08/19/00	Heat Treatment	24	6,356	319.102
Unit 3	09/23/00	Heat Treatment	27	3,692	523.348
Unit 3	11/18/00	Heat Treatment	29	995	44.491
Unit 3	12/23/00	Heat Treatment	22	720	7.603
Unit 3	01/11/00	Normal Operation	8	4,137	20.472
Unit 3	05/23/00	Normal Operation	23	2,315	64.048
Unit 3	07/11/00	Normal Operation	12	7,497	80.861
Unit 3	12/19/00	Normal Operation	12	3,545	19.79

APPENDIX B.

Estimated Monthly Number of Fish Impinged at SONGS Unit 2 in 2000.

Appendix B. Estimated Monthly Number of Fish at SONGS Unit 2 in 2000

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
BARRACUDA	0	0	0	0	0	0	0	0	0	0	0	1	1
BARRED SAND BASS	7	0	0	12	0	11	0	12	8	0	0	8	58
BASKETWEAVE CUSK-EEL	2	0	0	91	93	90	62	62	60	0	0	0	460
BAT RAY	0	0	0	30	31	30	0	0	0	0	0	0	91
BLACK CROAKER	0	0	0	0	0	7	0	2	4	0	0	11	24
BLACK PERCH	0	0	0	210	228	224	0	18	15	0	0	2	697
BLACKSMITH	0	0	0	1	1	1	0	3	5	0	0	11	22
BOCACCIO	1	0	0	0	0	0	0	0	0	0	0	0	1
BROWN ROCKFISH	1	0	0	0	0	2	0	0	0	0	0	0	3
CABEZON	63	58	62	17	18	7	0	0	1	0	0	2	228
CALIFORNIA BUTTERFLY RAY	31	29	31	30	31	30	0	0	0	0	0	0	182
CALIFORNIA CORBINA	1	0	0	0	0	0	0	0	0	0	0	0	1
CALIFORNIA ELECTRIC RAY	31	29	31	0	0	0	0	0	0	0	0	0	91
CALIFORNIA FLYINGFISH	0	0	0	0	0	0	31	31	30	0	0	0	92
CALIFORNIA GRUNION	0	0	0	0	48	10	0	0	0	0	0	2	60
CALIFORNIA HALIBUT	1	0	0	1	0	0	0	0	1	0	0	0	3
CALIFORNIA LIZARDFISH	0	0	0	30	31	30	0	0	0	0	0	0	91
CALIFORNIA SCORPIONFISH	5	0	0	38	32	31	31	38	33	0	0	4	212
CALIFORNIA SHEEPHEAD	0	0	0	2	0	0	0	0	0	0	0	0	2
CHUB MACKEREL	0	0	0	0	0	0	0	0	0	7	18	31	55
DEEP BODY ANCHOVY	95	87	93	11	0	0	0	6	66	0	0	12	370
FINESCALE TRIGGERFISH	0	0	0	0	0	1	0	0	0	0	0	0	1
GIANT KELPFISH	0	0	0	3	8	6	0	8	9	0	0	3	37
GIANT SEABASS	0	0	0	1	0	0	0	0	0	0	0	0	1
GRASS ROCKFISH	0	0	0	0	0	0	0	0	2	0	0	0	2
GRAY SMOOTHHOUND	0	0	0	30	31	30	0	0	0	0	0	0	91
JACK MACKEREL	1	0	0	1	1	0	31	106	190	0	0	6	336
JACKSMELT	37	0	0	560	633	575	0	2	0	55	140	259	2262
KELP BASS	0	0	0	0	0	0	0	0	4	0	0	12	16
KELP PIPEFISH	0	0	0	2	0	0	0	0	0	0	0	3	5
NORTHERN ANCHOVY	1827	1450	1550	3076	3202	3064	29078	30430	28146	1785	4527	8046	116181
PACIFIC BUTTERFISH	0	0	0	0	0	0	341	355	364	7	18	37	1121
PACIFIC CUTLASSFISH	0	0	0	0	1	0	0	0	0	0	0	0	1
PACIFIC SARDINE	1005	667	713	61	65	60	713	713	690	0	0	0	4687
PILE PERCH	0	0	0	0	0	0	0	2	0	0	0	0	2
PIPEFISH	97	87	93	1020	1054	1020	31	31	30	0	0	0	3463
PLAINFIN MIDSHIPMAN	0	0	0	33	31	30	0	2	0	7	18	31	151
QUEENFISH	95812	89497	95668	27075	28444	28665	30070	31330	30142	5059	12825	23260	497846
ROCK WRASSE	1	0	0	0	0	4	0	8	5	0	0	0	18
ROCKFISH	0	0	0	1	0	0	0	0	0	0	0	0	1
ROCKPOOL BLENNY	7	0	0	5	5	3	0	0	4	7	18	47	95
RUBBERLIP SEAPERCH	0	0	0	90	93	90	0	0	0	0	0	0	273

Continued on next page

Appendix B. Estimated Monthly Number of Fish at SONGS Unit 2 in 2000

Continued from previous page

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
SALEMA	3	0	0	0	0	17	0	520	43	7	18	56	663
SARGO	0	0	0	0	1	667	0	208	265	7	18	69	1234
SENORITA	0	0	0	0	0	1	0	7	1	0	0	4	13
SHINER PERCH	2	0	0	61	63	69	31	179	85	0	0	10	500
SHOVELNOSE GUITARFISH	0	0	0	0	0	0	0	0	1	0	0	0	1
SPECKLED SANDDAB	0	0	0	66	62	61	0	0	0	0	0	0	189
SPECKLEFIN MIDSHIPMAN	0	0	0	0	0	3	62	62	60	0	0	0	187
SPINY DOGFISH	0	0	0	180	186	180	0	0	0	0	0	0	546
SPOTFIN CROAKER	0	0	0	3	0	1	0	1	1	0	0	0	6
SPOTTED KELPFISH	0	0	0	0	0	0	0	0	2	0	0	0	2
SPOTTED TURBOT	4	0	0	9	0	0	0	0	0	0	0	1	14
STRIPED KELPFISH	0	0	0	0	0	3	0	0	0	0	0	0	3
TOPSMELT	6	0	0	720	751	755	93	98	671	7	18	32	3150
WALLEYE SURFPERCH	1	0	0	34	31	36	155	218	168	7	18	124	791
WHITE CROAKER	8	0	0	4678	5092	4691	2046	2870	2045	76	193	425	22124
WHITE SEA BASS	0	0	0	0	0	1	0	3	0	0	0	0	4
WHITE SEAPERCH	0	0	0	5190	5371	5193	62	74	62	0	0	5	15957
WOOLY SCULPIN	0	0	0	0	0	0	0	0	0	0	0	1	1
YELLOW SNAKE EEL	0	0	0	90	93	90	0	0	0	0	0	0	273
YELLOWFIN CROAKER	0	0	0	0	0	31	0	41	24	0	0	6	102
ZEBRA PERCH	0	0	0	0	0	0	0	4	0	0	0	0	4
	99049	91904	98241	43462	45732	45820	62837	67444	63237	7031	17826	32521	675102

APPENDIX C.

Estimated Monthly Catch in Kilograms of Fish at SONGS Unit 2 in 2000.

Appendix C. Estimated Monthly Catch in Kilograms at SONGS Unit 2 in 2000

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
BARRACUDA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.016
BARRED SAND BASS	1.401	0.000	0.000	2.046	0.000	3.124	0.000	2.482	2.280	0.000	0.000	0.421	11.754
BASKETWEAVE CUSK-EEL	0.007	0.000	0.000	3.965	4.092	3.960	1.643	1.643	1.590	0.000	0.000	0.000	16.900
BAT RAY	0.000	0.000	0.000	7.200	7.440	7.200	0.000	0.000	0.000	0.000	0.000	0.000	21.840
BLACK CROAKER	0.000	0.000	0.000	0.000	0.000	0.747	0.000	0.371	0.725	0.000	0.000	0.816	2.659
BLACK PERCH	0.000	0.000	0.000	1.050	1.308	1.708	0.000	0.670	1.366	0.000	0.000	0.086	6.188
BLACKSMITH	0.000	0.000	0.000	0.062	0.063	0.070	0.000	0.276	0.045	0.000	0.000	0.074	0.590
BOCACCIO	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
BROWN ROCKFISH	0.040	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.140
CABEZON	0.406	0.377	0.403	0.682	1.239	0.297	0.000	0.000	0.288	0.000	0.000	0.227	3.919
CALIFORNIA BUTTERFLY RAY	12.710	11.890	12.710	139.504	144.152	139.498	0.000	0.000	0.000	0.000	0.000	0.000	460.465
CALIFORNIA CORBINA	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048
CALIFORNIA ELECTRIC RAY	173.604	162.405	173.603	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	509.612
CALIFORNIA FLYINGFISH	0.000	0.000	0.000	0.000	0.000	0.000	4.650	4.650	4.500	0.000	0.000	0.000	13.800
CALIFORNIA GRUNION	0.000	0.000	0.000	0.000	0.634	0.177	0.000	0.000	0.000	0.000	0.000	0.020	0.831
CALIFORNIA HALIBUT	0.209	0.000	0.000	0.131	0.000	0.000	0.000	0.000	0.700	0.000	0.000	0.000	1.040
CALIFORNIA LIZARDFISH	0.000	0.000	0.000	1.380	1.426	1.380	0.000	0.000	0.000	0.000	0.000	0.000	4.186
CALIFORNIA SCORPIONFISH	0.729	0.000	0.000	0.670	0.206	0.281	0.093	1.230	0.400	0.000	0.000	0.280	3.889
CALIFORNIA SHEEPHEAD	0.000	0.000	0.000	0.433	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.433
CHUB MACKEREL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.505	1.281	2.263	4.049
DEEP BODY ANCHOVY	0.550	0.493	0.527	0.163	0.000	0.000	0.000	0.106	1.100	0.000	0.000	0.146	3.085
FINESCALE TRIGGERFISH	0.000	0.000	0.000	0.000	0.000	1.900	0.000	0.000	0.000	0.000	0.000	0.000	1.900
GIANT KELPFISH	0.000	0.000	0.000	0.143	0.250	0.308	0.000	0.137	0.279	0.000	0.000	0.051	1.168
GIANT SEABASS	0.000	0.000	0.000	19.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	19.200
GRASS ROCKFISH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.188	0.000	0.000	0.000	0.188
GRAY SMOOTHHOUND	0.000	0.000	0.000	4.350	4.495	4.350	0.000	0.000	0.000	0.000	0.000	0.000	13.195
JACK MACKEREL	0.040	0.000	0.000	0.048	0.098	0.000	1.922	2.715	6.096	0.000	0.000	0.122	11.041
JACKSMELT	3.896	0.000	0.000	38.938	42.542	40.780	0.000	0.046	0.000	1.170	2.965	5.496	135.833
KELP BASS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.000	0.000	0.047	0.063
KELP PIPEFISH	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.008
NORTHERN ANCHOVY	13.224	8.062	8.618	9.534	10.286	9.495	203.980	214.620	197.447	10.159	25.756	45.763	756.946
PACIFIC BUTTERFISH	0.000	0.000	0.000	0.000	0.000	0.000	5.146	5.567	5.456	0.083	0.211	0.440	16.903
PACIFIC CUTLASSFISH	0.000	0.000	0.000	0.000	0.248	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.248
PACIFIC SARDINE	44.296	27.116	28.986	2.672	2.890	2.640	39.990	39.990	38.700	0.000	0.000	0.000	227.279
PILE PERCH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.044	0.000	0.000	0.000	0.000	0.044
PIPEFISH	0.066	0.058	0.062	1.320	1.364	1.320	0.124	0.124	0.120	0.000	0.000	0.000	4.558
PLAINFIN MIDSHIPMAN	0.000	0.000	0.000	0.993	0.837	0.810	0.000	0.893	0.000	0.021	0.053	0.093	3.699
QUEENFISH	315.170	292.851	313.044	658.805	699.079	701.100	651.154	690.911	660.572	30.678	77.777	141.224	5232.366
ROCK WRASSE	0.104	0.000	0.000	0.000	0.000	0.660	0.000	1.150	0.512	0.000	0.000	0.000	2.426
ROCKFISH	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
ROCKPOOL BLENNY	0.090	0.000	0.000	0.040	0.046	0.040	0.000	0.000	0.015	0.028	0.070	0.167	0.496
RUBBERLIP SEAPERCH	0.000	0.000	0.000	0.570	0.589	0.570	0.000	0.000	0.000	0.000	0.000	0.000	1.729
SALEMA	0.121	0.000	0.000	0.000	0.000	1.160	0.000	37.432	3.525	0.021	0.053	0.499	42.810

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
SARGO	0.000	0.000	0.000	0.000	0.589	137.950	0.000	40.700	110.250	0.048	0.123	6.160	295.820
SENORITA	0.000	0.000	0.000	0.000	0.000	0.034	0.000	0.170	0.038	0.000	0.000	0.013	0.255
SHINER PERCH	0.050	0.000	0.000	0.186	0.177	0.218	0.124	1.879	1.200	0.000	0.000	0.158	3.992
SHOVELNOSE GUITARFISH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.000	0.000	0.000	0.000	4.000
SPECKLED SANDDAB	0.000	0.000	0.000	0.457	0.465	0.458	0.000	0.000	0.000	0.000	0.000	0.000	1.380
SPECKLEFIN MIDSHIPMAN	0.000	0.000	0.000	0.000	0.000	1.414	2.263	2.263	2.190	0.000	0.000	0.000	8.130
SPINY DOGFISH	0.000	0.000	0.000	578.716	597.998	578.694	0.000	0.000	0.000	0.000	0.000	0.000	1755.407
SPOTFIN CROAKER	0.000	0.000	0.000	1.171	0.000	0.252	0.000	0.620	0.475	0.000	0.000	0.000	2.518
SPOTTED KELPFISH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.008
SPOTTED TURBOT	0.037	0.000	0.000	0.088	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.136
STRIPED KELPFISH	0.000	0.000	0.000	0.000	0.000	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.031
TOPSMELT	0.294	0.000	0.000	27.661	28.860	29.432	3.596	3.823	23.480	0.111	0.281	0.540	118.077
WALLEYE SURFPERCH	0.042	0.000	0.000	0.372	0.155	0.245	1.550	2.768	1.928	0.152	0.386	3.152	10.750
WHITE CROAKER	0.220	0.000	0.000	39.551	42.795	39.188	13.826	32.606	14.955	0.581	1.474	3.238	188.434
WHITE SEA BASS	0.000	0.000	0.000	0.000	0.000	2.000	0.000	0.246	0.000	0.000	0.000	0.000	2.246
WHITE SEAPERCH	0.000	0.000	0.000	19.141	19.809	19.172	0.186	0.373	0.237	0.000	0.000	0.132	59.050
WOOLY SCULPIN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003
YELLOW SNAKE EEL	0.000	0.000	0.000	3.480	3.596	3.480	0.000	0.000	0.000	0.000	0.000	0.000	10.556
YELLOWFIN CROAKER	0.000	0.000	0.000	0.000	0.000	6.750	0.000	12.838	12.816	0.000	0.000	0.233	32.637
ZEBRA PERCH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.400	0.000	0.000	0.000	0.000	2.400
	567.357	503.252	537.954	1564.727	1617.729	1742.991	930.247	1105.744	1097.497	43.557	110.429	211.897	10033.381

APPENDIX D.

Estimated Monthly Number of Fish Impinged at SONGS Unit 3 in 2000.

Appendix D. Estimated Monthly Number of Fish at SONGS Unit 3 in 2000

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
BARRACUDA	0	0	0	0	0	0	0	0	3	93	93	93	282
BARRED SAND BASS	0	5	0	6	0	4	3	14	20	0	9	2	63
BASKETWEAVE CUSK-EEL	0	1	0	37	31	31	0	0	0	0	0	0	100
BAT RAY	0	0	0	30	31	30	0	0	0	0	0	0	91
BLACK CROAKER	0	2	0	0	0	1	1	0	0	0	5	6	15
BLACK PERCH	0	0	0	97	93	98	5	0	0	0	5	4	302
BLACKSMITH	0	1	0	1	0	2	1	0	2	0	27	0	34
BOCACCIO	0	0	0	2	0	0	32	31	30	0	0	0	95
CABEZON	0	6	0	68	31	39	3	0	1	0	1	0	149
CALIFORNIA BUTTERFLY RAY	31	29	31	0	0	0	0	0	0	0	0	1	92
CALIFORNIA CORBINA	0	0	0	0	0	1	0	0	0	0	0	0	1
CALIFORNIA ELECTRIC RAY	0	0	0	1	0	0	0	0	0	0	0	0	1
CALIFORNIA GRUNION	0	0	0	0	0	4	0	0	13	62	60	62	201
CALIFORNIA HALIBUT	0	3	0	0	0	0	0	0	0	0	1	1	5
CALIFORNIA LIZARDFISH	0	0	0	30	31	30	0	0	0	0	0	0	91
CALIFORNIA SCORPIONFISH	0	4	0	3	0	3	0	0	0	0	4	1	15
CALIFORNIA SHEEPHEAD	0	0	0	0	0	0	0	2	0	0	0	0	2
CHUB MACKEREL	0	0	0	0	0	2	0	0	4	31	53	31	121
CREVICE KELPFISH	0	0	0	0	0	0	0	2	0	0	1	0	3
DEEP BODY ANCHOVY	0	0	0	0	0	0	0	38	38	465	584	467	1592
DWARF PERCH	0	0	0	0	0	0	0	2	0	0	0	0	2
ENGLISH SOLE	0	2	0	0	0	0	0	0	0	0	0	0	2
FINESCALE TRIGGERFISH	0	0	0	0	0	0	3	0	0	0	0	0	3
GIANT KELPFISH	31	31	31	31	31	33	4	2	4	0	2	1	201
HALFMOON	0	0	0	0	0	0	0	0	1	0	0	0	1
HORN SHARK	0	0	0	0	0	0	1	0	0	0	0	0	1
JACK MACKEREL	0	4	0	39	0	11	0	182	109	0	49	0	394
JACKSMELT	496	500	496	405	279	374	1	0	8	31	35	37	2662
KELP BASS	0	0	0	0	0	6	3	2	0	31	56	31	129
KELP PIPEFISH	0	0	0	3	0	0	0	0	0	0	0	0	3
MUSSEL BLENNY	0	0	0	0	0	5	0	0	0	0	0	0	5
NORTHERN ANCHOVY	4123	39936	4123	5721	5828	5670	40318	40718	39049	1240	1250	1264	189237
PACIFIC BUTTERFISH	0	0	0	0	0	0	7696	7734	7487	186	227	188	23518
PACIFIC CUTLASSFISH	0	0	0	30	31	30	0	0	0	0	0	0	91
PACIFIC SARDINE	1519	1451	1519	226	124	136	1833	1833	1771	31	30	32	10505
PILE PERCH	0	0	0	1	0	0	0	0	0	0	0	0	1
PIPEFISH	248	232	248	1320	1364	1320	186	186	180	0	0	1	5285
PLAINFIN MIDSHIPMAN	0	0	0	30	31	30	0	0	0	0	0	0	91
QUEENFISH	121757	114222	121757	36586	36980	38760	60723	58794	54205	107256	104068	107719	962829
ROCK WRASSE	0	0	0	0	0	0	1	2	2	0	0	0	5
ROCKPOOL BLENNY	0	8	0	71	62	60	0	0	6	0	157	11	375
RUBBERLIP SEAPERCH	0	0	0	30	31	30	0	0	0	0	0	0	91
SALEMA	0	1	0	26	0	70	574	168	85	0	11	54	989
SARGO	0	0	0	0	0	157	304	242	816	0	92	1	1612

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
SHINER PERCH	0	7	0	6	0	7	1062	1028	968	0	9	2	3089
SHOVELNOSE GUITARFISH	0	0	0	0	0	0	0	2	0	0	0	0	2
SPECKLED SANDDAB	0	0	0	60	62	60	0	0	0	0	0	0	182
SPECKLEFIN MIDSHIPMAN	0	1	0	61	62	61	65	62	60	0	1	0	373
SPINY DOGFISH	0	0	0	270	279	270	0	0	0	0	0	0	819
SPOTFIN CROAKER	0	0	0	5	0	0	12	4	10	0	1	0	32
SPOTTED KELPFISH	0	0	0	0	0	0	2	0	2	0	0	0	4
SPOTTED TURBOT	0	2	0	39	31	30	0	0	0	0	0	0	102
STRIPED KELPFISH	0	0	0	0	0	0	0	0	0	0	2	0	2
TOPSMELT	0	0	0	260	248	302	35	87	70	31	30	32	1095
VERMILIAN ROCKFISH	0	0	0	3	0	0	0	0	0	0	0	0	3
WALLEYE SURFPERCH	31	33	31	12	0	14	1591	1542	1452	0	14	12	4732
WHITE CROAKER	0	97	0	13161	13050	12915	122806	122603	118657	434	433	550	404707
WHITE SEA BASS	0	0	0	1	0	0	1	10	6	0	7	0	25
WHITE SEAPERCH	0	1	0	12599	13019	12604	3110	3124	3000	0	0	0	47457
YELLOW SNAKE EEL	0	0	0	30	31	30	0	0	0	0	0	0	91
YELLOWFIN CROAKER	0	0	0	7	0	5	246	348	543	0	26	5	1180
ZEBRA PERCH	0	0	0	0	0	0	2	0	0	0	0	0	2
	128236	156579	128236	71308	71760	73235	240624	238762	228603	109891	107343	110608	1665183

APPENDIX E.

Estimated Monthly Catch in Kilograms of Fish at SONGS Unit 3 in 2000.

Appendix E. Estimated Monthly Catch in Kilograms at SONGS Unit 3 in 2000

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
BARRACUDA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	2.852	2.829	2.852	8.633
BARRED SAND BASS	0.000	0.829	0.000	0.845	0.000	0.716	0.569	4.080	3.180	0.000	0.953	0.237	11.409
BASKETWEAVE CUSK-EEL	0.000	0.028	0.000	1.938	1.860	1.807	0.000	0.000	0.000	0.000	0.000	0.000	5.633
BAT RAY	0.000	0.000	0.000	6.779	7.005	6.780	0.000	0.000	0.000	0.000	0.000	0.000	20.565
BLACK CROAKER	0.000	0.354	0.000	0.000	0.000	0.052	0.108	0.000	0.000	0.000	0.287	0.320	1.121
BLACK PERCH	0.000	0.000	0.000	0.614	0.589	0.664	0.372	0.000	0.000	0.000	1.080	0.700	4.019
BLACKSMITH	0.000	0.005	0.000	0.032	0.000	0.117	0.055	0.000	0.034	0.000	0.102	0.000	0.345
BOCACCIO	0.000	0.000	0.000	0.006	0.000	0.000	0.364	0.341	0.330	0.000	0.000	0.000	1.041
CABEZON	0.000	0.030	0.000	7.571	6.510	6.564	0.926	0.000	0.096	0.000	0.118	0.000	21.814
CALIFORNIA BUTTERFLY RAY	7.408	6.930	7.408	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.344	22.091
CALIFORNIA CORBINA	0.000	0.000	0.000	0.000	0.000	0.201	0.000	0.000	0.000	0.000	0.000	0.000	0.201
CALIFORNIA ELECTRIC RAY	0.000	0.000	0.000	12.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.200
CALIFORNIA GRUNION	0.000	0.000	0.000	0.000	0.000	0.073	0.000	0.000	0.060	0.310	0.300	0.310	1.053
CALIFORNIA HALIBUT	0.000	0.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.478	0.002	0.813
CALIFORNIA LIZARDFISH	0.000	0.000	0.000	3.780	3.906	3.780	0.000	0.000	0.000	0.000	0.000	0.000	11.465
CALIFORNIA SCORPIONFISH	0.000	0.450	0.000	0.088	0.000	0.353	0.000	0.000	0.000	0.000	0.511	0.083	1.485
CALIFORNIA SHEEPHEAD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.738	0.000	0.000	0.000	0.000	0.738
CHUB MACKEREL	0.000	0.000	0.000	0.000	0.000	0.443	0.000	0.000	0.216	0.992	2.422	0.992	5.065
CREVICE KELPFISH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.009	0.000	0.015
DEEP BODY ANCHOVY	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.550	0.572	5.766	7.429	5.790	20.106
DWARF PERCH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000	0.010
ENGLISH SOLE	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008
FINESCALE TRIGGERFISH	0.000	0.000	0.000	0.000	0.000	0.000	5.360	0.000	0.000	0.000	0.000	0.000	5.360
GIANT KELPFISH	0.341	0.362	0.341	1.665	1.674	1.694	0.317	0.006	0.043	0.000	0.029	0.106	6.578
HALFMOON	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.030	0.000	0.000	0.000	0.030
HORN SHARK	0.000	0.000	0.000	0.000	0.000	0.000	2.165	0.000	0.000	0.000	0.000	0.000	2.165
JACK MACKEREL	0.000	0.130	0.000	2.181	0.000	0.915	0.000	3.310	3.527	0.000	1.032	0.000	11.095
JACKSMELT	17.885	16.950	17.885	31.750	20.706	25.839	0.082	0.000	0.188	1.767	1.875	2.092	137.020
KELP BASS	0.000	0.000	0.000	0.000	0.000	2.434	0.574	0.402	0.000	13.671	13.916	13.670	44.666
KELP PIPEFISH	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008
MUSSEL BLENNY	0.000	0.000	0.000	0.000	0.000	0.041	0.000	0.000	0.000	0.000	0.000	0.000	0.041
NORTHERN ANCHOVY	30.811	138.504	30.811	14.925	14.662	14.550	271.830	276.145	263.189	5.952	5.900	6.089	1,073.368
PACIFIC BUTTERFISH	0.000	0.000	0.000	0.000	0.000	0.000	109.041	109.448	106.064	2.139	3.434	2.171	332.297
PACIFIC CUTLASSFISH	0.000	0.000	0.000	5.580	5.766	5.580	0.000	0.000	0.000	0.000	0.000	0.000	16.925
PACIFIC SARDINE	49.906	49.412	49.906	10.839	5.766	6.300	104.642	104.744	101.106	0.930	0.900	1.010	485.460
PILE PERCH	0.000	0.000	0.000	0.383	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.383
PIPEFISH	0.341	0.319	0.341	2.250	2.325	2.250	0.279	0.279	0.270	0.000	0.000	0.001	8.654
PLAINFIN MIDSHIPMAN	0.000	0.000	0.000	0.420	0.434	0.420	0.000	0.000	0.000	0.000	0.000	0.000	1.274
QUEENFISH	526.954	496.922	526.954	786.904	794.410	872.458	1,367.274	1,286.431	1,176.702	573.728	561.647	577.218	9,547.602
ROCK WRASSE	0.000	0.000	0.000	0.000	0.000	0.000	0.122	0.154	0.272	0.000	0.000	0.000	0.548
ROCKPOOL BLENNY	0.000	0.064	0.000	0.619	0.527	0.510	0.000	0.000	0.018	0.000	0.255	0.040	2.033
RUBBERLIP SEAPERCH	0.000	0.000	0.000	0.360	0.372	0.360	0.000	0.000	0.000	0.000	0.000	0.000	1.092
SALEMA	0.000	0.004	0.000	1.287	0.000	4.400	35.150	12.080	6.200	0.000	0.180	0.270	59.571
SARGO	0.000	0.000	0.000	0.000	0.000	22.400	93.550	57.800	216.800	0.000	23.880	0.002	414.432
SHINER PERCH	0.000	0.189	0.000	0.224	0.000	0.073	50.163	50.026	48.080	0.000	0.174	0.028	148.957

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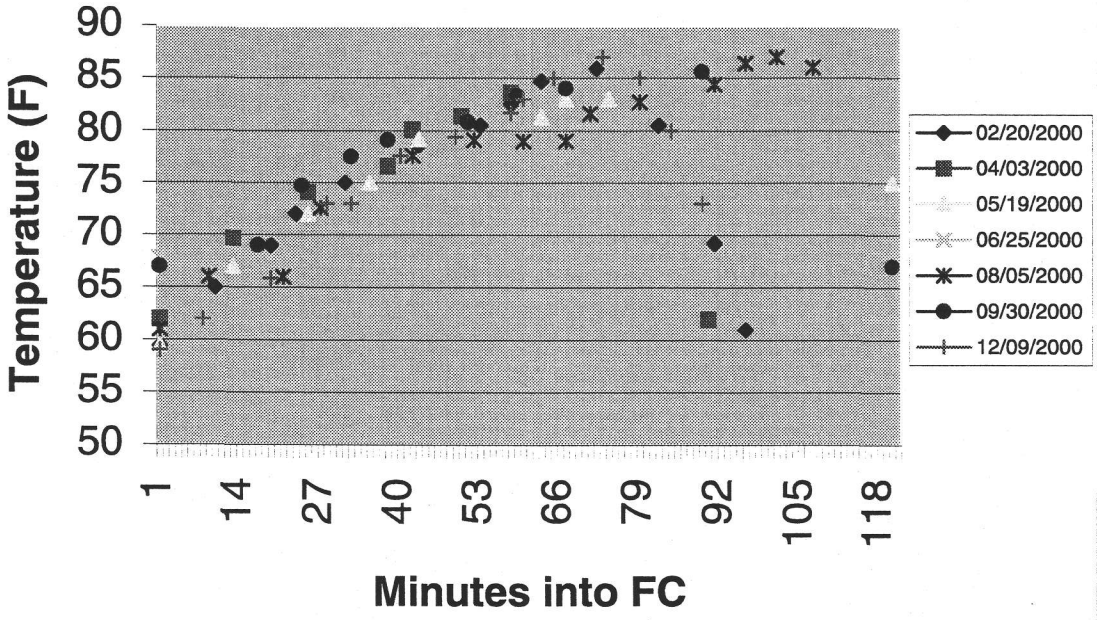
SHOVELNOSE GUITARFISH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.000	0.000	0.000	0.000	0.000	7.000
SPECKLED SANDDAB	0.000	0.000	0.000	0.420	0.434	0.420	0.000	0.000	0.000	0.000	0.000	0.000	1.274
SPECKLEFIN MIDSHIPMAN	0.000	0.300	0.000	1.022	1.054	1.027	28.366	27.094	26.220	0.000	0.507	0.000	85.590
SPINY DOGFISH	0.000	0.000	0.000	934.308	965.455	934.329	0.000	0.000	0.000	0.000	0.000	0.000	2,834.091
SPOTFIN CROAKER	0.000	0.000	0.000	2.100	0.000	0.000	6.060	2.494	4.466	0.000	0.552	0.000	15.672
SPOTTED KELPFISH	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.000	0.046	0.000	0.000	0.000	0.059
SPOTTED TURBOT	0.000	0.009	0.000	0.224	0.093	0.090	0.000	0.000	0.000	0.000	0.000	0.000	0.416
STRIPED KELPFISH	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.000	0.016
TOPSMELT	0.000	0.000	0.000	11.263	10.632	13.489	1.462	2.657	2.634	1.240	1.200	1.284	45.862
VERMILIAN ROCKFISH	0.000	0.000	0.000	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023
WALLEYE SURFPERCH	0.930	1.052	0.930	0.851	0.000	0.140	14.574	14.548	12.994	0.000	0.470	0.280	46.769
WHITE CROAKER	0.000	3.050	0.000	94.344	91.040	94.735	570.942	567.998	550.388	4.123	4.232	5.049	1,985.900
WHITE SEA BASS	0.000	0.000	0.000	0.095	0.000	0.000	0.598	1.324	0.460	0.000	0.717	0.000	3.194
WHITE SEAPERCH	0.000	0.065	0.000	47.456	49.038	47.496	199.744	200.119	193.201	0.000	0.000	0.000	737.120
YELLOW SNAKE EEL	0.000	0.000	0.000	1.050	1.085	1.050	0.000	0.000	0.000	0.000	0.000	0.000	3.185
YELLOWFIN CROAKER	0.000	0.000	0.000	1.370	0.000	1.105	70.075	96.000	231.700	0.000	0.746	0.116	401.112
ZEBRA PERCH	0.000	0.000	0.000	0.000	0.000	0.000	1.110	0.000	0.000	0.000	0.000	0.000	1.110
	634.577	716.299	634.577	1,987.773	1,985.342	2,075.654	2,935.888	2,825.782	2,949.186	613.468	638.179	621.055	18,617.780

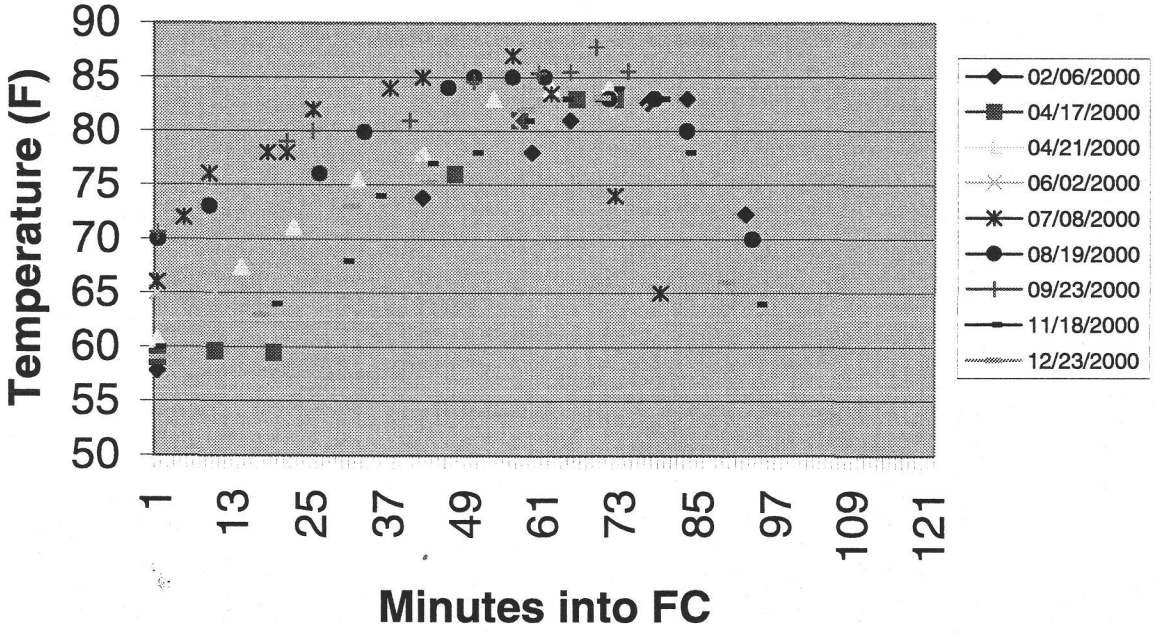
APPENDIX F.

Graphs of Temperature Curves for Fish Chases at SONGS Units 2 and 3 in 2000

Appendix F-1. Unit 2 Fish Chase Temperature Curves.



Appendix F-2. Unit 3 Fish Chase Temperature Curves.



APPENDIX G.

Summary of Fish Released During Fish Chase Operations (By Species)

Appendix G. Summary of Fish Released During Fish Chase Operations (By Species)

	Unit 2 Fish Chase		Unit 3 Fish Chase		Unit 2 Heat treat		Unit 3 Heat treat		% Returned	% Returned
Common Name	Number	Kgs	Number	Kgs	Number	Kgs	Number	Kgs	by Count	by Biomass
BARRACUDA					1	0.016	6	0.169	0.00%	0.00%
BARRED SAND BASS	163	34.543	110	24.77	58	11.754	63	11.409	69.29%	71.92%
BASKETWEAVE CUSK-EEL					3	0.012	9	0.173	0.00%	0.00%
BAT RAY	1	0.35	4	54.5					100.00%	100.00%
BLACK CROAKER	9	1.682	2	0.12	24	2.659	15	1.121	22.00%	32.28%
BLACK PERCH	65	5.383	10	1.188	60	3.003	29	2.293	45.73%	55.37%
BLACKSMITH	8	0.326			22	0.59	34	0.345	12.50%	25.85%
BOCACCIO					1	0.003	3	0.029	0.00%	0.00%
BROWN ROCKFISH	2	0.81			3	0.14			40.00%	85.26%
CABEZON	11	1.304	7	0.42	46	2.736	58	2.705	14.75%	24.06%
CALIFORNIA BUTTERFLY RAY							1	0.344	0.00%	0.00%
CALIFORNIA CORBINA	36	8.36	104	25.12	1	0.048	1	0.201	98.59%	99.26%
CALIFORNIA ELECTRIC RAY	1	0.4					1	12.2	50.00%	3.17%
CALIFORNIA GRUNION					60	0.831	17	0.133	0.00%	0.00%
CALIFORNIA HALIBUT	1	0.18			3	1.04	5	0.813	11.11%	8.85%
CALIFORNIA LIZARDFISH	1	0.17							100.00%	100.00%
CALIFORNIA SCORPIONFISH	42	4.817	17	2.151	29	3.431	15	1.485	57.28%	58.63%
CALIFORNIA SHEEPHEAD	1	0.25			2	0.433	2	0.738	20.00%	17.59%
CHUB MACKEREL			2	0.13			29	2.121	6.45%	5.78%
CREVICE KELPFISH							3	0.015	0.00%	0.00%
DEEP BODY ANCHOVY					97	1.538	212	2.995	0.00%	0.00%
DIAMOND TURBOT			2	0.35					100.00%	100.00%
DWARF PERCH							2	0.01	0.00%	0.00%
ENGLISH SOLE							2	0.008	0.00%	0.00%
FINESCALE TRIGGERFISH			1	2	1	1.9	3	5.36	20.00%	21.60%
GARIBALDI	1	0.33							100.00%	100.00%
GIANT KELPFISH	11	0.27	5	0.44	37	1.168	19	0.663	22.22%	27.94%
GIANT SEABASS			6	63.5	1	19.2			85.71%	76.78%
GRASS ROCKFISH					2	0.188			0.00%	0.00%
GRAY SMOOTHHOUND	2	3.25							100.00%	100.00%
HALFMOON			3	0.86			1	0.03	75.00%	96.63%
HORN SHARK	2	5					1	2.165	66.67%	69.78%
JACK MACKEREL	1	0.05			244	5.337	394	11.095	0.16%	0.30%
JACKSMELT	3	0.73	45	3.538	180	12.981	295	18.49	9.18%	11.94%
KELP BASS	22	3.74	111	27.415	16	0.063	37	4.096	71.51%	88.22%
KELP PIPEFISH					5	0.008	3	0.008	0.00%	0.00%
LEOPARD SHARK			1	0.3					100.00%	100.00%
MUSSEL BLENNY							5	0.041	0.00%	0.00%
NORTHERN ANCHOVY	2460	28.305	3232	31.739	1743	16.109	36749	115.932	12.88%	31.26%
PACIFIC BUTTERFISH	3	0.034	1	0.03	54	0.965	150	2.846	1.92%	1.65%
PACIFIC CUTLASSFISH					1	0.248			0.00%	0.00%
PACIFIC SARDINE	3	0.122	14	0.634	296	15.504	162	9.238	3.58%	2.96%
PILE PERCH					2	0.044	1	0.383	0.00%	0.00%

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Common Name	Unit 2 Fish Chase Number	Unit 2 Fish Chase Kgs	Unit 3 Fish Chase Number	Unit 3 Fish Chase Kgs	Unit 2 Heat treat Number	Unit 2 Heat treat Kgs	Unit 3 Heat treat Number	Unit 3 Heat treat Kgs	% Returned by Count	% Returned by Biomass
PIPEFISH					4	0.004	1	0.001	0.00%	0.00%
PLAINFIN MIDSHIPMAN			1	0.1	5	1.076			16.67%	8.50%
QUEENFISH	970	26.796	5,238.00	65.824	6056	155.823	17732	512.091	20.70%	12.18%
ROCK WRASSE	6	0.85	3	0.1	18	2.426	5	0.548	28.13%	24.21%
ROCKFISH	2	0.13			1	0.002			66.67%	98.48%
ROCKPOOL BLENNY					40	0.274	193	0.486	0.00%	0.00%
ROUND STINGRAY	3	1.2	1	0.1					100.00%	100.00%
SALEMA	1698	126.484	7012	476.962	608	42.644	989	59.571	84.51%	85.51%
SARGO	1621	510.838	5422	1334.392	1179	295.432	1612	414.432	71.62%	72.22%
SENORITA					13	0.255			0.00%	0.00%
SHINER PERCH			2	0.06	226	3.169	145	1.757	0.54%	1.20%
SHOVELNOSE GUITARFISH	2	6	7	29	1	4	2	7	75.00%	76.09%
SMOOTHHOUND	1	0.1							100.00%	100.00%
SPECKLED SANDDAB					7	0.015			0.00%	0.00%
SPECKLEFIN MIDSHIPMAN	12	5.17			3	1.414	7	2.088	54.55%	59.62%
SPOTFIN CROAKER	75	38.83	932	488.385	6	2.518	32	15.672	96.36%	96.66%
SPOTTED KELPFISH					2	0.008	4	0.059	0.00%	0.00%
SPOTTED TURBOT			1	0.2	14	0.136	11	0.143	3.85%	41.75%
STAGHORN SCULPIN			1	0.02					100.00%	100.00%
STRIPED KELPFISH					3	0.031	2	0.016	0.00%	0.00%
TOPSMELT	3	0.121	46	2.34	635	22.615	183	7.199	5.65%	7.63%
VERMILIAN ROCKFISH	1	0.01					3	0.023	25.00%	30.30%
WALLEYE SURFPERCH	32	0.85	26	0.67	185	4.475	225	5.031	12.39%	13.79%
WHITE CROAKER	196	5.76	291	5.966	1428	28.901	1528	28.34	14.14%	17.00%
WHITE SEA BASS	5	4.14	30	9.839	4	2.246	25	3.194	54.69%	71.99%
WHITE SEAPERCH	6	0.148	3	0.25	30	0.439	40	0.689	11.39%	26.08%
WOOLY SCULPIN					1	0.003			0.00%	0.00%
YELLOWFIN CROAKER	140	48.75	2189	697.715	102	32.637	1181	401.112	64.48%	63.25%
ZEBRA PERCH	117	70.2	37	20.26	4	2.4	2	1.11	96.25%	96.26%
Totals	7739	947	24919	3371	13567	705	62249	1670	30.11%	64.52%