F I N A L   R E P O R T

SCATTERGOOD GENERATING STATION

CLEAN WATER ACT
SECTION 316(b)
VELOCITY CAP EFFECTIVENESS STUDY

Prepared by

MBC *Applied Environmental Sciences*
Costa Mesa, California

Tenera Environmental, Inc.
San Luis Obispo, California

URS Corporation
Santa Ana, California

Prepared for

Los Angeles Department of Water and Power

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

LIST OF ACRONYMS

cm	centimeters
CDS	Comprehensive Demonstration Study
cfs	cubic feet per second
CWA	Clean Water Act
CWIS	cooling water intake structure(s)
dB	decibels
EPA	Environmental Protection Agency
ft	feet
gpm	gallons per minute
GPS	Global Positioning System
IM&E	Impingement Mortality and Entrainment
kg	kilograms
kHz	kilohertz
L	length
LADWP	Los Angeles Department of Water and Power
LARWQCB	Los Angeles Regional Water Quality Control Board
m	meters
mgd	million gallons per day
mi	miles
MLLW	Mean Lower Low Water
mm	millimeters
NPDES	National Pollutant Discharge Elimination System
PIC	Proposal for Information Collection
QA/QC	Quality Assurance/Quality Control
re:	reference
sec	seconds
SGS	Scattergood Generating Station
TS	Target Strength

1.0 EXECUTIVE SUMMARY

The purpose of the Scattergood Velocity Cap Effectiveness Study was to assess the effectiveness of the velocity cap at the Scattergood Generating Station (SGS) cooling water intake structure in reducing fish impingement. To determine effectiveness, impingement samples were collected during periods with the generating station operating in normal flow where cooling water is withdrawn from the intake structure with a velocity cap, and in reverse flow where cooling water is withdrawn from the discharge structure that does not have a velocity cap. The study was performed from October 2006 to early January 2007, and included both physical and biological sampling components. Impingement samples were collected four to five times per week during the study period and when heat treatments were used to clear fishes from the intake system to ensure that all organisms were included in the impingement data. Hydroacoustic surveys were conducted during day and night in both normal and reverse flow to determine if any significant differences in fish densities between the intake and discharge structures could be detected that might be contributing to any differences observed in impingement.

The overall effectiveness of the SGS velocity cap for all fishes determined from the impingement sampling was a 97.6 percent reduction in abundance and a 95.3 percent reduction in biomass. The statistical analyses detected a significant reduction in abundance, although no significant reduction was detected in biomass. This was most likely attributable to the impingement of high-biomass species, such as Pacific electric ray and thornback, during the final normal flow survey period.

A total of 650,141 fishes weighing 16,007 kg (35,290 lbs) and comprised of at least 64 separate species was impinged during the 85-day study including normal operation (with velocity cap) and reverse flow operation (without velocity cap).

Pacific sardine was by far the most abundant fish species, and accounted for approximately 94.2 percent of the abundance. No significant differences in fish densities were detected between the intake and discharge structures from the hydroacoustic data, indicating that differences in impingement between normal and reverse flow regimes were attributable to the presence or absence of the velocity cap and not the fish densities in the vicinity of the two structures.

The estimated effectiveness of the velocity cap in the current study met or exceeded estimates from prior investigations.

2.0 REPORT ORGANIZATION

Section 3.0–*Introduction* provides background and an overview of the 316(b) Phase II regulations, the SGS cooling water intake system and operations, as well as a review of the Scattergood Generating Station Study Plan for Testing the Effectiveness of the Intake Structure Velocity Cap (Study Plan). Section 4.0–*Methods* describes the field methods for changing intake flow direction, impingement sampling and sample processing, QA/QC procedures, hydroacoustic survey methods, and data analysis methods for impingement and hydroacoustic results. Section 5.0–*Results* summarizes the results of the impingement and hydroacoustic surveys, including statistical analyses. Section 6.0–*Assessment of Scattergood Velocity Cap Effectiveness* summarizes the calculated effectiveness of the SGS velocity cap in reducing impingement of fishes into the CWIS. Section 7.0–*Summary of Other Velocity Cap Effectiveness Studies* provides a background summary of velocity cap effectiveness studies at other power facilities. For completeness the attachments to this report contain the Study Plan, the Hydroacoustic Sampling Plan, copies of key correspondence with the Los Angeles Regional Water Quality Control Board (LARWQCB), and pertinent data collected during the study.

3.0 INTRODUCTION

The following section provides an overview of the 316(b) Phase II regulations, the SGS cooling water intake structure system and operations, and a review of the Study Plan.

3.1 BACKGROUND AND OVERVIEW

On July 9, 2004, the U.S. Environmental Protection Agency published the second phase of new regulations under Section 316(b) of the Clean Water Act (CWA) for cooling water intake structures (CWIS) that apply to existing facilities (Phase II facilities). The Phase II Final Rule went into effect on September 7, 2004, and applies to existing generating stations with CWIS that withdraw at least 50 million gallons per day (mgd) from rivers, streams, lakes, reservoirs, oceans, estuaries, or other waters of the United States. The cooling water system for the Los Angeles Department of Water and Power (LADWP) SGS in Los Angeles, California (Figure 3-1) withdraws a maximum of 495.4 mgd of ocean water for cooling purposes. All three generating units withdraw ocean water from a single intake that extends approximately 490 m (1,600 ft) offshore from the SGS in Santa Monica Bay. The maximum cooling water flow is 112.3 mgd per unit at Units 1&2, and 270.7 mgd at Unit 3.

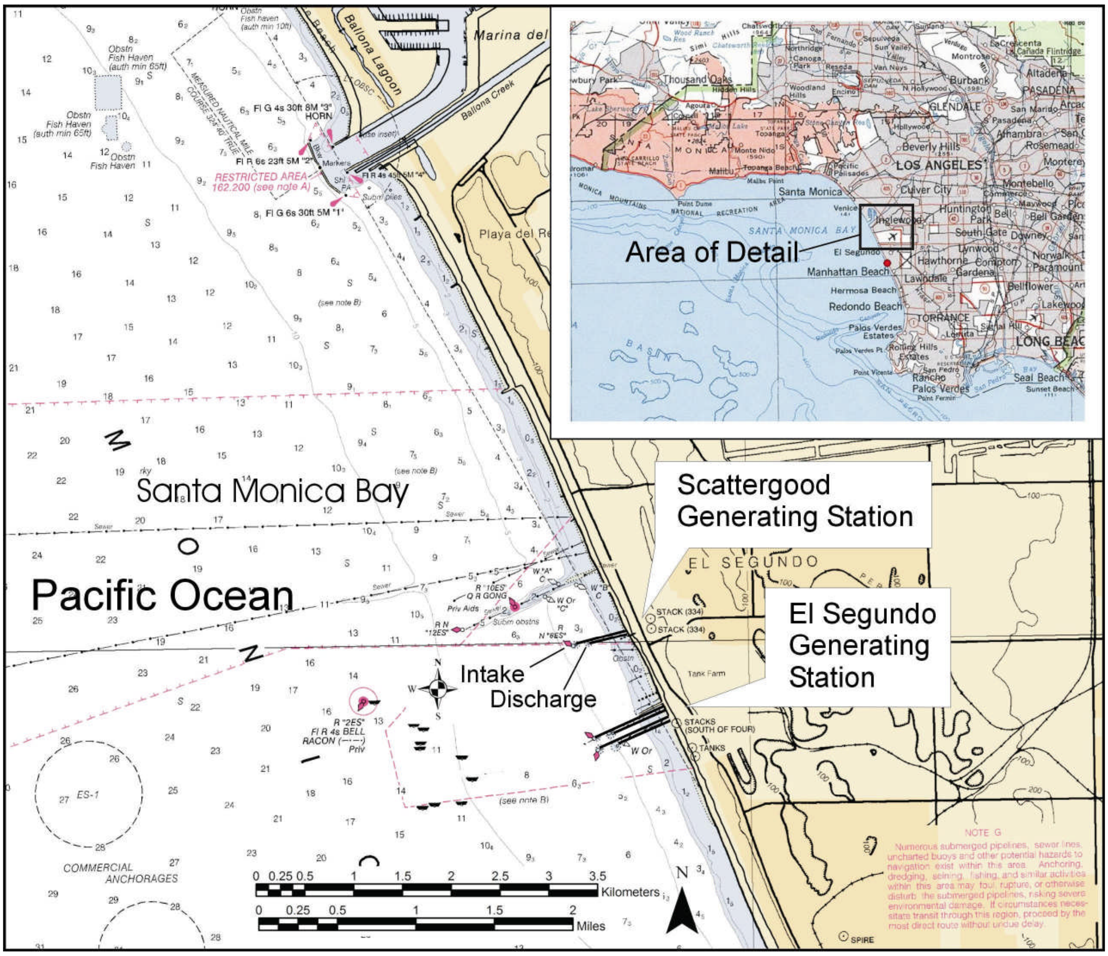


Figure 3-1. Location of the Scattergood Generating Station

SGS is classified as a Phase II existing facility, and is subject to the 316(b) Phase II final regulations. The Phase II regulations (40 CFR 9, 122-125) established national performance standards that required reducing impingement mortality by 80 to 95 percent and entrainment by 60 to 90 percent. With the implementation of the final regulations, EPA intended to minimize the adverse environmental impact of cooling water intake structures by reducing the number of aquatic organisms lost as result of water withdrawals associated with those intake structures. The Phase II regulations provided facilities with five compliance alternatives:

1. Demonstrate the facility has reduced flow commensurate with a closed-cycle recirculating system (applies to the impingement mortality and entrainment performance standards) or has reduced design intake velocity to less than 0.5 feet per second (only applies to the impingement mortality performance standard);

2. Demonstrate that existing design and construction technologies, operational measures, and/or restoration measures meet the performance standards;

3. Demonstrate that the facility has selected design and construction technologies, operational measures, and/or restoration measures that will, in combination with any existing technologies, operational measures, and/or restoration measures, meet the performance standards;

4. Demonstrate that the facility has installed and properly operates and maintains an approved technology;

5. Demonstrate that a site-specific determination of BTA is appropriate.

Pursuant to the Phase II Final Rule, LADWP submitted the SGS Proposal for Information Collection (PIC) to the LARWQCB in October 2005. The PIC included a detailed study plan for the SGS Impingement Mortality and Entrainment (IM&E) Characterization Study, as well as a study plan to quantify the effectiveness of the SGS velocity cap in reducing impingement mortality. The SGS study plan was revised and the Study Plan dated August 28, 2006, was submitted to the LARWQCB for review in September 2006 (Appendix E of the PIC and Attachment A-1 of this report). In October 2006, the LARWQCB indicated that, in general, the proposed Study Plan was adequate to evaluate the effectives of the velocity cap at SGS, and therefore, the study was initiated in October 2006. Hydroacoustic surveys of fish abundance were not included in the original Study Plan dated August 28, 2006 (Attachment A-1), but were incorporated into the study plan prior to the beginning of the surveys in order to address the LARWQCB's concern related to the potential for fish densities to be different at the intake and discharge structures (see Attachment A-3, Comment No. 2).

The other comment from the LARWQCB regarding the sampling plan (see Attachment A-3, Comment No. 1) pertained to measuring diel variation in impingement similar to the approach used in the 316(b) IM&E study. The IM&E sampling is divided into six-hour sampling blocks to allow the calculation of an impingement rate based on flow that is then used to extrapolate impingement over the periods between surveys. The purpose of the velocity cap sampling is to count all the organisms collected within the system during each period of reverse and normal flow, including organisms collected during the normal 316(b) impingement sampling. Therefore, diel sampling was not incorporated into the sampling.

3.1.1 Description of the Cooling Water Intake Structure (CWIS)

One CWIS at SGS serves all three units. The CWIS includes a single offshore intake pipe with velocity cap located approximately 488 m (1,600 ft) offshore (Table 3-1 and Figure 3-2). The ocean bottom surrounding the intake is at elevation[1] (El.) –8.8 m (-29.0 ft) (Figure 3-3). The top lip of the intake riser is at a depth of El.–3.4 m (-11.0 ft). The concrete pipe extends 4.0 m (13.0 ft) above the sea floor. A circular velocity cap was installed in 1974 to replace the cap from the original 1958 construction, which was severely damaged in a large storm. The concrete cap has a radius of 5.0 m (16.3 ft) with a 1.5-m (5-ft) opening between the bottom of the cap and the top of the intake riser. The velocity cap redirects the intake flow from a vertical direction to a horizontal direction. Water flows through the velocity cap, down a 5.3 m (17.5 ft) internal diameter vertical riser pipe, and into a 3.7 m (12.0 ft) internal diameter intake pipe that conveys the water to the onshore screen structure.

[1] All elevations refer to mean sea level.

Table 3-1. Specifications of the SGS Cooling Water Intake and Discharge Structures

	Intake	Discharge
Distance from shore	488 m (1,600 ft)	366 m (1,200 ft)
Riser height from bottom	3.2 m (10.5 ft)	3.4 m (11.1 ft)
Riser inside diameter	5.3 m (17.4 ft)	5.3 m (17.4 ft)
Approx. water depth (MLLW)	9.0 m (29.5 ft)	8.0 m (26.2 ft)
Depth below sea surface	5.3 m (17.4 ft)	4.6 m (15.1 ft)

Source: Pender (1975), IRC (1981)

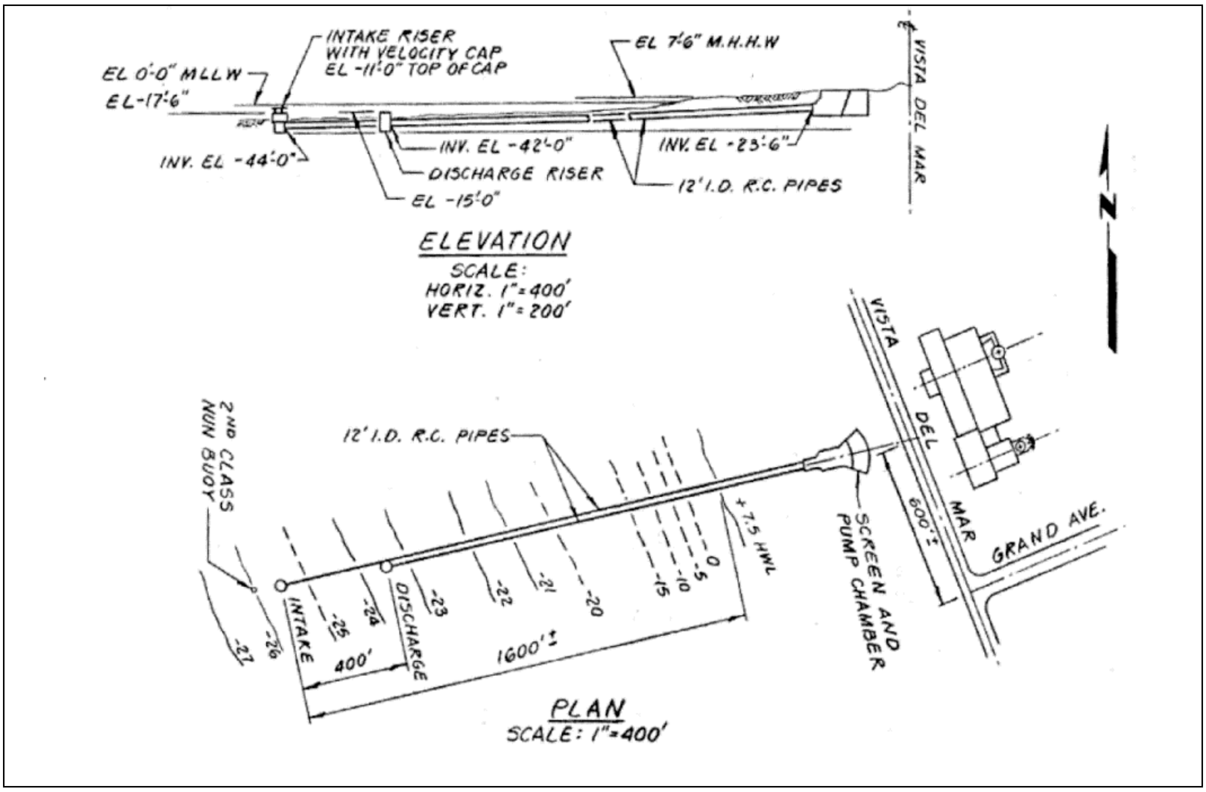


Figure 3-2. Configuration of the SGS Intake and Discharge Structures

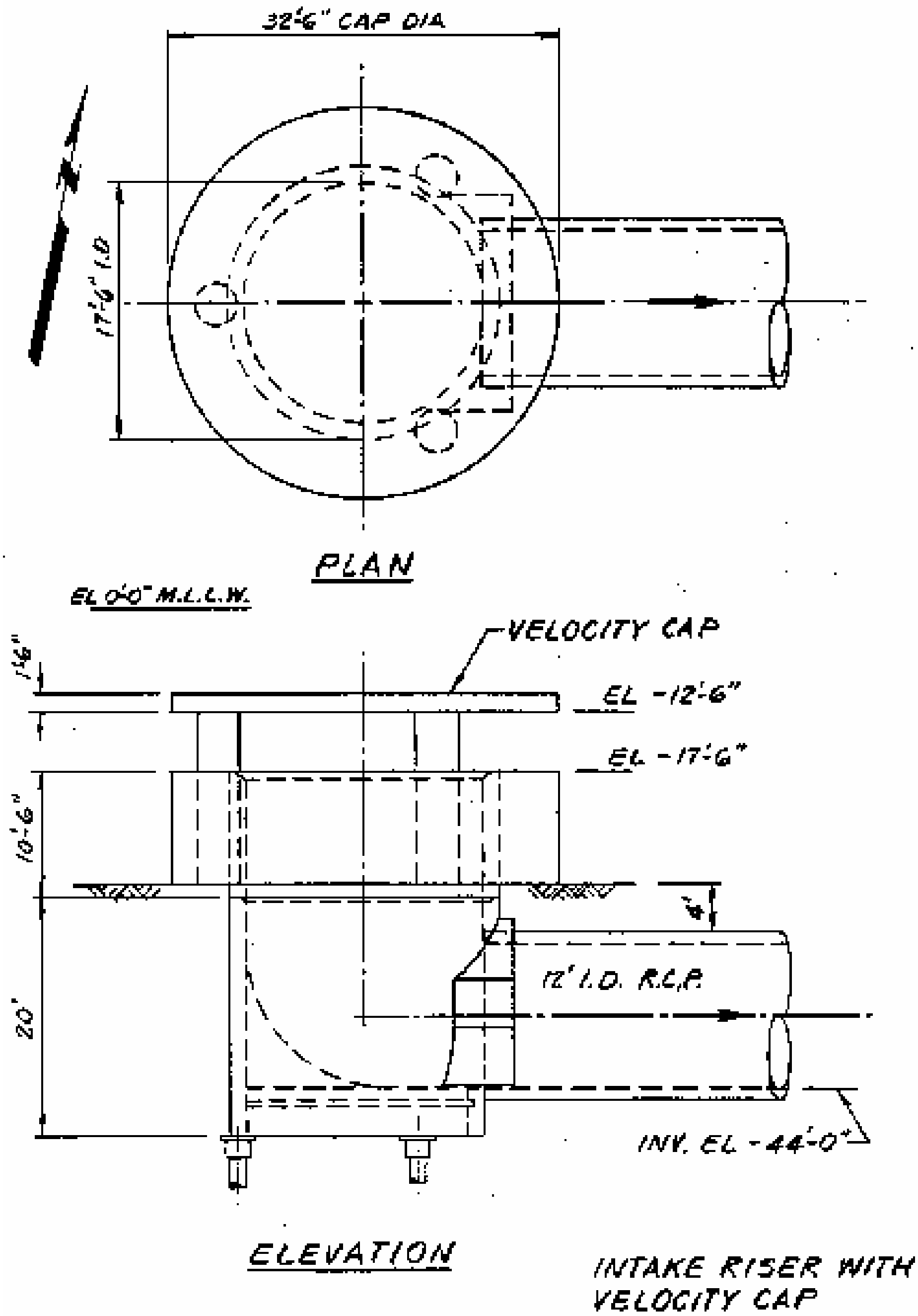


Figure 3-3. Plan (top) and Section (bottom) View of the SGS Velocity Cap Intake Structure

The cooling water intake pipe is connected to an inlet chamber configured in a 21 m (68.8 ft) long, 60° wide arc (Figures 3-4 and 3-5). The length of the intake pipe from the velocity cap to the inlet chamber is 640 m (2,100 ft) (Figure 3-2). Water entering the inlet chamber is redirected by guide vanes into the eight trash rack bays (Figure 3-4). These trash racks prevent large debris from reaching the traveling screens. Each trash rack bay is 1.8 m (6 ft) wide, with a bottom located at El.-7.2 m (-23.5 ft), and extends to

El. 3.7 m (12.0 ft). The trash racks are vertical 0.9-cm (3/8-inch) by 10-cm (4-inch) steel bars centered 13 cm (5 inches) apart.

Traveling water screens are positioned 9.1 m (30 ft) downstream of the trash rack (Figures 3-4 and 3-5). The screens are 1.8 m (6.0 ft) wide and have a bottom elevation of El. –7.2 m (–23.5 ft). The traveling screens have a rectangular 0.9-cm (3/8-inch) by 1.9-cm (3/4-inch) mesh pattern and are rotated and washed every eight hours. Each screen is washed by internal and external spray nozzles that spray debris from the descending screen panels into two troughs that lead to debris basket pits located on either side of the structure.

The circulating water pumps are located 7.6 m (25 ft) downstream of the traveling screens (Figures 3-4 and 3-5). Units 1 and 2 each have two circulating water pumps, while Unit 3 has four pumps. The Units 1 and 2 pumps are each rated at 147.6 m^3 per minute [39,000 gallons per minute (gpm) or 86.9 cubic feet per second (cfs)], while the four pumps for Unit 3 are each rated at 177.9 m^3 per minute (47,000 gpm or 104.7 cfs). The total circulating water flow for the SGS is 1,302 m^3 per minute (344,000 gpm or 766.5 cfs).

After passing through the condensers, warmed water is discharged into a 3.7 m (12 ft) internal diameter pipe that runs 366 m (1,200 ft) offshore parallel to the intake pipe. The discharged water exits through a 2.3 m (7.5 ft) diameter vertical riser located 122 m (400 ft) away from the intake velocity cap.

The cooling water is heat treated approximately once every 8 to 12 weeks to prevent condenser biofouling. This is done by recirculation of the cooling water through the system. The circulated water is maintained at a temperature of 46°C (115°F) for 1 hour and 40 minutes. Each cooling water pipeline is also injected with liquid chlorine in the form of sodium hypochlorite for 40 minutes per day per shift. Chlorine levels in the discharge water are kept within the limits of the NPDES permit.

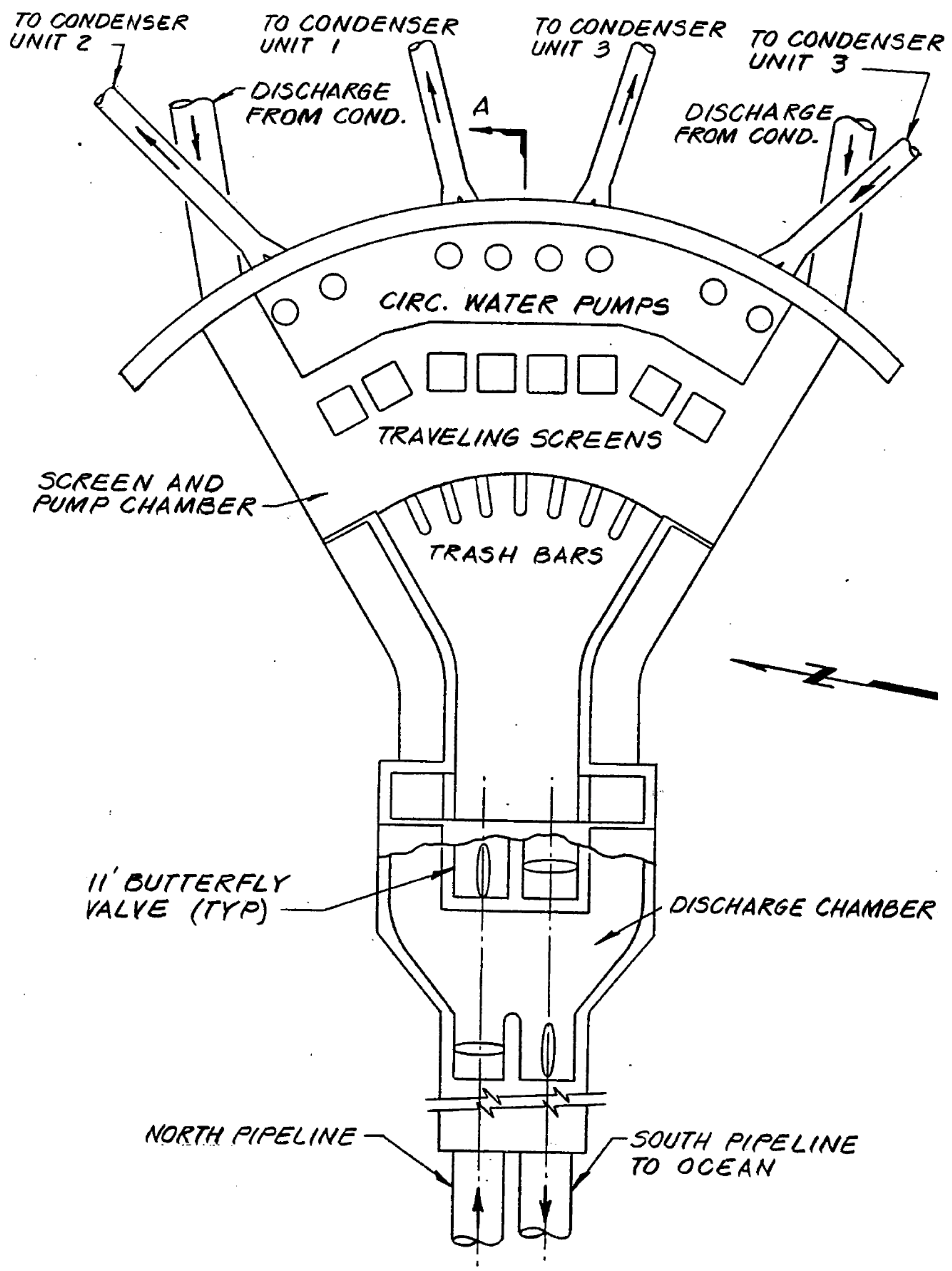


Figure 3-4. Plan View of the SGS Onshore CWIS

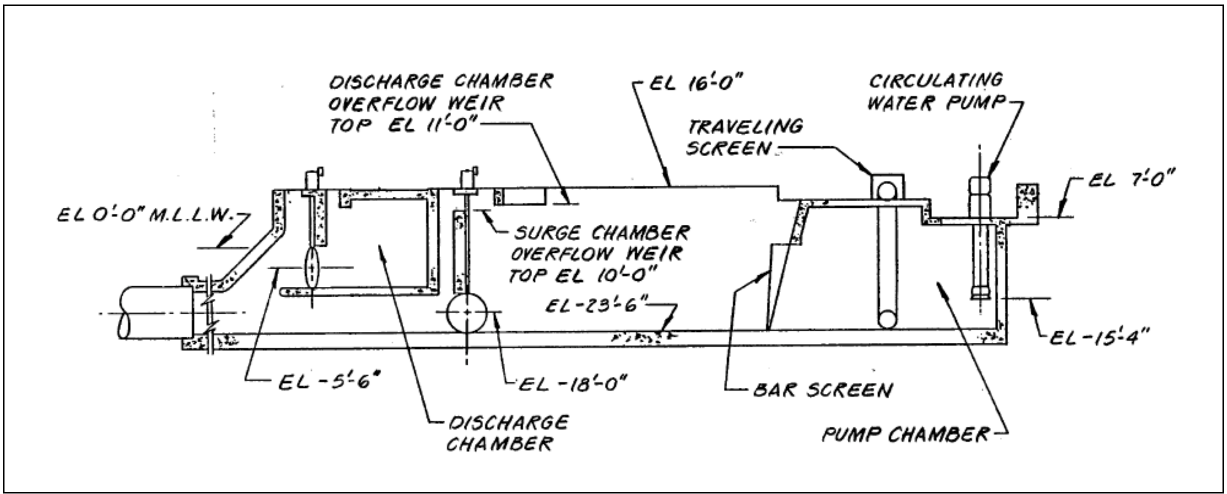


Figure 3-5. Section View of the SGS Onshore CWIS

3.2 VELOCITY CAP STUDY PLAN

The following section provides a review of the site-specific Study Plan designed to evaluate the performance of the SGS velocity cap.

3.2.1 Study Plan Overview

The study plan included impingement sampling during normal intake flow when cooling water is withdrawn from the intake structure with a velocity cap, and sampling during reverse intake flow when cooling water is withdrawn from the discharge structure without a velocity cap. Periods of normal intake flow (with the velocity cap) and reverse intake flow (without the velocity cap) would be alternated every two weeks over a 12-week period to provide six weeks of impingement data under normal flow that could be compared with data from six weeks of operation under reverse flow. In addition, the reverse intake flow data could be compared to normal impingement rates from samples collected weekly during the IM&E Characterization Study.

3.2.2 Study Plan Objectives

The objective of the study was to evaluate and document the effectiveness of the existing velocity cap in reducing fish and shellfish entrapment at SGS and to determine the level of performance in meeting the Clean Water Act Section 316(b) Phase II Final Rule performance standard for reducing impingement mortality.

3.2.3 Study Plan Description

The intake structure velocity cap study was proposed to be completed over a 12-week period with alternating two-week periods of normal and reverse intake flow. During normal intake flow, the intake structure with a velocity cap is used to withdraw cooling water from the source waterbody into the forebay, and during reverse intake flow, the discharge structure without a velocity cap is used to withdraw cooling water into the forebay. The plant cooling water flow was reversed approximately every two weeks to ensure that conditions between sampling periods were as similar as possible. Scheduling of surveys required coordination with the generating station personnel, and could be modified to facilitate operational constraints. The study consisted of weekly IM&E Characterization Study impingement surveys, velocity cap impingement surveys, and heat treatment impingement surveys which are discussed in Section 4.0 of this report.

Prior to each approximately two-week survey period, all fish species from within the forebay were removed by conducting heat treatments. Heat treatments were performed by controlling the opening and closing of the circulating water intake and discharge valves causing the water temperature in the forebay to increase. During and after this period, the traveling screens were run until all heat-treated fishes were removed from the forebay. Heat treatments were conducted between each of the survey periods to ensure that all of the organisms that may have entered the forebay during the previous sampling period were included in the estimate of total impingement. Once impingement on the circulating water screens subsided to near zero after each heat treatment, and the flow direction had been reversed, the next sampling period was initiated. The proposed sampling sequence for each of the sampling periods is presented in Table 3-2.

Table 3-2. Proposed Sampling Sequence

Week	Mon	Tue	Wed	Thur	Fri
1	HT	Weekly IM	VC Survey	VC Survey	
2		Weekly IM	VC Survey	VC Survey	
3	HT*	Weekly IM	VC Survey	VC Survey	
4		Weekly IM	VC Survey	VC Survey	
5	HT*	Weekly IM	VC Survey	VC Survey	
6		Weekly IM	VC Survey	VC Survey	
7	HT*	Weekly IM	VC Survey	VC Survey	
8		Weekly IM	VC Survey	VC Survey	
9	HT*	Weekly IM	VC Survey	VC Survey	
10		Weekly IM	VC Survey	VC Survey	
11	HT*	Weekly IM	VC Survey	VC Survey	
12		Weekly IM	VC Survey	VC Survey	
13	HT*				

Non-shaded days = normal flow direction, shaded days = reverse flow direction
* - Following heat treatment, flow direction is reversed
Weekly IM - Weekly impingement sampling
VC Survey - Velocity cap impingement sampling
HT – Heat treatment impingement sampling

The study design using alternating periods of normal and reverse flow was used to address the potential criticism that abundances of some juvenile fishes may change over the course of the 12-week study period. This criticism was addressed by splitting the sampling up into six two-week periods where periods with reverse flow would alternate with periods of normal flow. The two-week sampling periods reduced the likelihood that significant abundance changes would occur between periods. Any abundance changes could be evaluated by comparing consecutive two-week sampling periods. If a difference was detected, the data could be blocked to reduce variability; otherwise, the samples could be lumped into a single analysis.

Spatial differences in abundances near the normal intake and the reverse flow intake were assessed using hydroacoustic estimates of biomass. Hydroacoustic biomass data were collected during previous studies on velocity caps effectiveness at the Huntington Beach and Ormond Beach Generating Stations and used to calculate an index on the vulnerability to impingement (Thomas et al. 1980). In the present study, hydroacoustic estimates were used to detect potential differences in fish densities at the intake and discharge locations and determine if the differences contributed to entrapment under reverse and normal flow.

4.0 METHODS

The following section describes methods used to collect impingement and hydroacoustic data, as well data/statistical analysis methods.

4.1 FLOW DIRECTION

The Velocity Cap Effectiveness Study required the SGS to operate in two flow modes: normal flow where cooling water is withdrawn from the intake structure with a velocity cap, and reverse flow where cooling water is withdrawn from the discharge structure without a velocity cap. Normal flow direction is the normal mode of operation for the SGS. The transition from normal to reverse flow required the opening and closing of the circulating water intake and discharge valves within the SGS CWIS. The opening and closing of the intake and discharge valves resulted in the SGS withdrawing cooling water from the discharge structure (without the velocity cap), and discharging cooling water through the intake structure (Figure 4-1). Flow reversals were performed after the completion of heat treatments. Regardless of flow direction, all incoming cooling water was directed through the forebay, bar racks, and traveling screens.

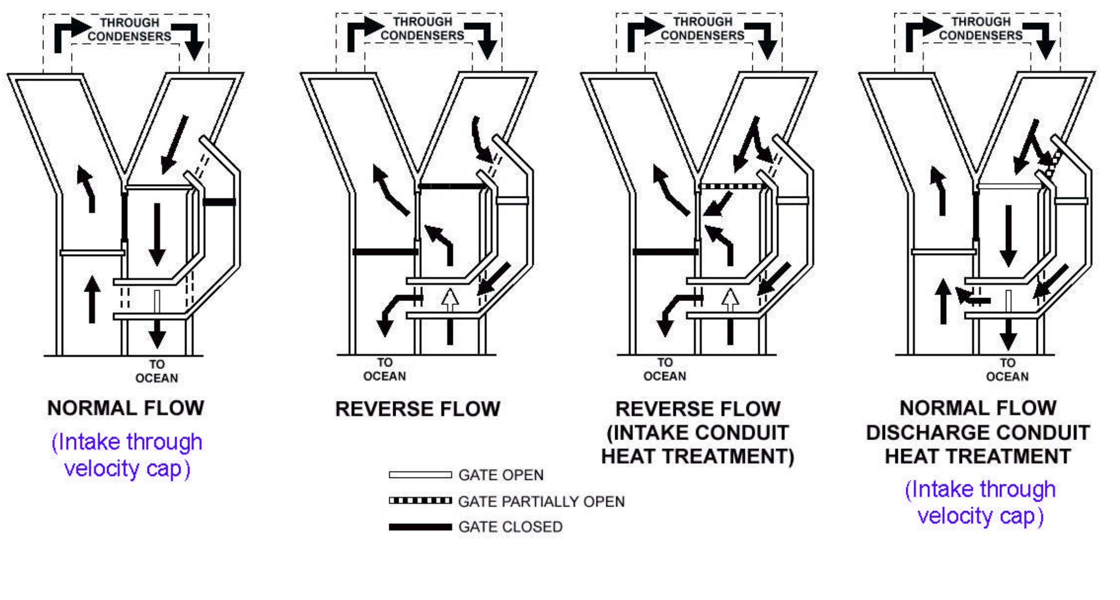


Figure 4-1. Diagram of Flow Regimes During the Velocity Cap Effectiveness Study

4.2 FIELD SAMPLING

The field studies included impingement sampling and hydroacoustic sampling. The impingement sampling was performed to quantify impingement rates during each of the survey periods, and consisted of weekly IM&E Characterization Study, velocity cap, and heat treatment impingement surveys. The hydroacoustic sampling was performed to detect any differences in fish densities between the intake and discharge structures.

4.2.1 Impingement Sampling

Impingement sampling consisted of three survey types:

- IM&E Characterization Study impingement surveys;
- Velocity cap impingement surveys; and
- Heat treatment impingement surveys.

In combination, the three types of impingement surveys resulted in the assessment of all impinged organisms at the SGS between October 10, 2006 and January 3, 2007. Surveys conducted during this period assessed all impinged organisms.

4.2.1.1 IM&E Characterization Study Impingement Surveys

The IM&E Characterization Study impingement sampling effort began in January 2006 and was completed in January 2007. It consisted of weekly 24-hour impingement survey periods with four 6-hour blocks within each survey.

4.2.1.2 Velocity Cap Study Impingement Surveys

The Velocity Cap Study impingement sampling effort began on October 11, 2006, and was completed on January 2, 2007. Each velocity cap impingement sampling survey consisted of a 24-hour survey period (without the four 6-hour sampling blocks), and was performed three to four times per week in addition to the IM&E Characterization Study impingement surveys.

4.2.1.3 Heat Treatment Impingement Surveys

Heat Treatment impingement sampling occurred during heat treatment procedures, which were performed at the beginning of the study, and at the completion of each sampling period at 11- to 23-day intervals prior to changing flow direction. The purpose of the heat treatment impingement sampling was to quantify all of the fishes and shellfishes that where entrapped inside the CWIS during each sampling period.

4.2.2 Impingement Sample Processing

During the Velocity Cap Study period, weekly IM&E Characterization Study impingement surveys continued as part of the IM&E Characterization Study. Weekly impingement samples were collected every six hours over a 24-hour period. During each sampling cycle, the traveling screens were rotated and cleaned and the impinged material was rinsed into collection baskets associated with each set of screens.

A log containing hourly observations of the operating status of the circulating water pumps (on and off) for the entire study period was obtained from the power plant operation staff that provided a record of the amount of cooling water pumped by the plant. Six to eleven Velocity Cap Study impingement samples were collected during each 11- to 23-day flow period. These samples were collected using the same procedures used for weekly IM&E Characterization Study impingement surveys except that a single sample was collected over an approximate 24-hour period. In order to quantify the fish drawn into the forebay during the study, Heat Treatment impingement sampling was also conducted prior to the beginning of the first sampling period and at the end of each approximate two-week sampling period during the study. Procedures for heat treatment sampling involve clearing and rinsing the traveling screens prior to the start of the heat treatment procedure. At the end of the heat treatment procedure, normal pump operation was resumed and the traveling screens rinsed until no more fish were collected on the screens. Weekly IM&E Characterization Study, Velocity Cap, and Heat Treatment impingement samples were processed using the following procedures, which are described in more detail on pages 15-16 of the Sampling Plan included in Appendix A of the SGS PIC.

All fishes and invertebrates were separated from the impinged debris and vegetation. All fishes, crabs, shrimps and prawns, and cephalopod mollusks were identified, counted, weighed, and measured using the following criteria:

Organism Group	Length Measurement Criteria
Fishes	Total body length for sharks, disc width for rays and skates, and standard length for fishes
Crabs	Maximum carapace width
California spiny lobster and shrimps	Carapace length, measured from the anterior margin of the carapace between the eyes to the posterior margin of the carapace
Octopus	Maximum “arm” spread, measured from the tip of one tentacle to the tip of the opposite tentacle
Market squid	Dorsal mantle length, measured from the edge of the mantle to the posterior end of the body

If a large number (more than 30) of any individual countable species was collected during a cycle, 30 randomly selected individuals of this species were individually weighed and measured and the remaining individuals were counted and batch-weighed. The sex of the countable organisms was determined to the extent possible without dissection. The condition of each countable organism was also assessed and recorded: “A” for alive, “D” for dead, and “M” for mutilated. Mutilated organisms were counted but not weighed or measured. All other invertebrates were identified and weighed. Debris, including vegetation, was separated out, categorized (e.g., fouling organisms, algae) and weighed.

There was one instance where fish that were likely killed during a heat treatment were impinged on the day following the heat treatment (November 9-10, 2006). These fish could be discerned from other recently impinged fish by their physical appearance (e.g. pale coloration and flaccid body). Unless otherwise noted in this report, no adjustments were made to the impingement data to account for delayed impingement.

4.2.3 Impingement Sampling QA/QC Program

Quality assurance/quality control (QA/QC) procedures used for the IM&E Characterization Study impingement surveys were also conducted on the velocity cap impingement surveys. The QA/QC procedures were developed to ensure that all of the organisms were removed from the debris and that the correct identification, enumeration, length and weight measurements of the organisms were recorded on the data sheets. A random sampling event was chosen for QA/QC re-sorting to verify that all the collected organisms were removed from the impinged material. If the count of any of individual taxon made during the QA/QC survey varied by more than 5 percent (or by one individual if the total number of individuals was less than 20) from the count recorded by the observer then the next three sampling cycles for that observer would be checked. A velocity cap impingement surveys was QA/QC reviewed on October 13, 2006. No significant deviation from the sampling protocol was observed. Although some target organisms were overlooked during sorting, the above criteria were met.

In addition, the following measures/procedures were employed to ensure field identifications and measurements, as well as data entry and analysis, were accurate:

- All field leaders were experienced with southern California nearshore fishes and invertebrates;
- All field personnel reviewed written procedures prior to field sampling;
- All field personnel reviewed a specialized taxonomic guide for the species most commonly impinged at SGS. The guide highlighted the distinguishing features of the commonly impinged species;
- All field data were verified by scientists upon return to the laboratory;
- Voucher specimens were returned to the laboratory for confirmation of identification;
- All field data were double-entered into a Microsoft Access database. The two sets of data were checked against each other to determine entry errors;
- Errors were corrected and data rechecked and verified as needed.

4.2.4 Hydroacoustic Sampling

The purpose of conducting hydroacoustic surveys at SGS was to determine if any differences in fish abundances could be detected between the intake and discharge structures during the two-week time periods when the impingement sampling was occurring. A consistent difference in abundance between locations could indicate that any differences in impingement between periods of normal and reverse flow were not entirely the result of the presence or absence of the velocity cap. There were four survey sets of normal and reverse flow collected (Table 4-1). An initial study plan planned for sampling 21 transects with three repetitions per survey, but during the first daytime survey period (October 22-23, 2006) it was determined that we would only be able to sample 14 transects per hour. As a result, the center five transects closest to the intake and discharge structures were not sampled in subsequent surveys to avoid collecting acoustic noise from spurious reflections due to the intake and discharge structures. The outer two transects furthest from the intake and discharge were also not sampled in subsequent surveys. The 14 transects that were included in the sampling were numbered 2-8 and 14-20 from north to south, based on the numbering of the original 21 transects. During each survey, three replicate samples of 14 transects were collected during daytime and three replicate samples of 14 transects were collected during night at both intake and discharge locations (Figure 4-2). It took approximately one hour to sample all 14 transects.

Table 4-1. Dates and Times (PST) of the SGS Hydroacoustic Surveys

Survey	Normal Flow Day	Normal Flow Night	Reverse Flow Day	Reverse Flow Night
1	Oct. 22, 2006 (0942-1342)	Oct. 22, 2006 (1924-2239)	Oct. 23, 2006 (1030-1303)	Oct. 23, 2006 (1822-2129)
2	Nov. 10, 2006 (0911-1149)	Nov. 9, 2006 (2114-0017)	Nov. 5, 2006 (1034-1334)	Nov. 5, 2006 (2126-0025)
			Nov. 8, 2006 (1139-1422)	
3	Nov. 19, 2006 (0936-1312)	Nov. 19, 2006 (2143-0103)	Nov. 21, 2006 (1018-1326)	Nov. 20, 2006 (2327-0238)
4	Dec. 13, 2006 (0904-1126)	Dec. 13, 2006 (1740-2011)	Dec. 3, 2006 (1412-1730)	Dec. 3, 2006 (2059-0025)

The 14 transects at both locations were 260.0 m (853.0 ft) long and spaced approximately 10.0 m (33.0 ft) apart. Backscatter data collected along each transect was used to estimate fish densities (Figure 4-2). Seven transects were grouped starting 28.5 m (93.5 ft) north of the intake and discharge structures, and the other seven were grouped starting 28.5 m (93.5 ft) south of the structures to avoid signals from the structures interfering with the water column backscatter. Each transect was divided into an offshore (intake) and onshore (discharge) section with lengths of approximately 130 m (427 ft) each.

The average depth of the transects in the offshore section was 8.9 m (29.0 ft) (re: MLLW) while the inshore transect depths averaged 8.0 m (26.0 ft) (re: MLLW) deep. The depths of transects north of the structures were shallower averaging 8.2 m (27.0 ft) compared to 8.7 m (29.0 ft) (re: MLLW) in the southern section. The bottom had low relief and was relatively free of structures. The maximum depth in the survey area was 10 m (33.0 ft) (re: MLLW).

Fish density was estimated from the pings recorded by a 199 kHz BioSonics scientific fisheries echosounder model DTX4000. Average density for offshore (intake) and inshore (discharge) transect sections was computed after dividing each transect into offshore and inshore sections.

A total of 701 transects was sampled and processed near the SGS intake and discharge structures (Attachment A-7). Of these, all but one transect captured both offshore and inshore components. One transect in the second survey under normal flow conditions only recorded the offshore portion.

The second and fourth hydroacoustic surveys were not performed on consecutive days. The second survey began in reverse flow on November 5, 2006 but normal flow could not be re-established until November 9, 2006. The daytime reverse flow sampling was repeated and completed on November 8, 2006 but a vessel malfunction prevented a repeat nighttime survey. Normal flow sampling for the second survey began at night on November 9, 2006 and concluded with daytime sampling the next day. Therefore, the second survey results contained a second daytime set of transects. The fourth survey began with reverse flow sampling on December 3, 2006. However, normal flow could not be re-established until December 11, 2006 and hydroacoustic sampling took place on December 13, 2006 for both day and night. Weather during the surveys was clear with swell heights less than 1.8 m (5.9 ft) and wind less than 18.5 kph (10.0 knots). Weather observations recorded at NOAA stations during times of the hydroacoustic surveys are shown in Table 4-2.

The theory of estimating fish biomass using acoustics is explained in a number of references including Johannesson and Mitson (1983) and MacLennon and Simmonds (1991). A BioSonics echosounder was used to collect the acoustic backscatter from the water column near the SGS intake and outfall. The echosounder’s 6.5 degree (half-power full beam width) transducer was mounted in a finned vehicle towed on the port side of a 7 m (23 ft) long vessel at 1.5-2 meters per second (mps) (5-6.5 fps). The transducer face was 1 m (3.2 ft) below the water surface and a data start range of 0.5 m (1.6 ft) was used to blank transmitter ringing from the collected data. Acoustic data were collected in each ping to a range of 20 m (66 ft) with a ping repetition rate of 10 per second. All receiver signals were digitized in the transducer using the BioSonics Visual Acquisition software and saved on a laptop computer for later analysis. Data were collected with low thresholds of a –90 dB and –110 dB during the first survey and subsequently at a very low threshold of –115 dB for the remaining surveys.

The hydroacoustic data was analyzed using echo integration, which relates the backscatter strength recorded by the echosounder to fish density by using a scalar called target strength that can be measured either in terms of individual fish or biomass. Acoustic data were analyzed using BioSonics Visual Analyzer software using a threshold of –75 dB. This threshold was chosen to integrate to somewhat below the level of the smallest individual fish expected in the survey. The size of the smallest individual of the most abundant 99.95% of fish in samples recorded at the intake structure (*Seriphus politus*) was 1.5 cm (0.6 inch). Barange et al. (1996) presented the following fish length, L (cm), to target strength, TS (dB), relationship from pelagic fish that justifies the use of a –75 dB threshold:

$$TS = 20 \log L - 76.$$

Table 4-2. Weather Observation during the SGS Hydroacoustic Surveys

Survey Period	Date/Time	Flow Condition	Wind (kph)	Wind (deg)	Air T (ºC)	H20 T (ºC)	Swell (m)	Wave Period (s)	Tide (cm)
1	10/22 0942-1342	Normal Day	17.4	266	22.0	17.9	1.1	16.1	426
1	10/22 1924-2239	Normal Night	6.9	100	21.1	18.5	1.2	16.6	359
1	10/23 1020-1303	Reverse Day	18.5	247	18.5	18.0	1.1	16.1	498
1	10/23 1822-2129	Reverse Night	9.7	178	18.5	18.5	1.1	15.7	211
2	11/5 1034-1334	Reverse Day	15.7	225	18.7	17.8	1.2	10.8	221
2	11/5 2126-0025	Reverse Night	2.8	105	18.2	18.0	1.1	11.5	375
2	11/8 1139-1422	Reverse Day	17.9	273	17.8	17.9	1.3	13.2	427
2	11/9 2114-0017	Normal Day	8.0	117	17.4	18.5	1.5	11.0	215
2	11/10 0911-1149	Normal Night	9.9	107	21.9	17.5	1.1	10.7	499
3	11/19 0936-1312	Normal Day	12.3	230	20.9	17.3	0.8	12.9	249
3	11/19-20 2143-0103	Normal Night	10.2	069	19.8	17.8	0.9	12.0	309
3	11/20-21 2327-0238	Reverse Night	8.3	108	18.9	17.9	0.6	13.1	273
3	11/21 1018-1326	Reverse Day	7.9	144	17.8	17.3	0.7	11.5	309
4	12/3 1412-1730	Reverse Day	15.6	016	16.7	15.0	0.8	12.0	-50
4	12/3 2059-0025	Reverse Night	15.2	038	16.3	15.4	0.9	11.6	293
4	12/13 0904-1126	Normal Day	2.3	270	15.4	15.3	1.5	13.8	214
4	12/13 1740-2011	Normal Night	10.5	270	14.1	15.3	1.8	13.2	244

Wind Speed and Direction from NOAA NCDC Station KLAX. Swell Height and Period from NOAA Buoy 46025.
Air and Water Temperature and Tide from NOAA Station SMOC1.

The present study relied on an assumption of –33 dB per kg in order to scale acoustic backscatter to fish density. Previous studies at cooling water intake systems (Thomas et al. 1980) using a 120 kHz nine-degree single-beam transducer assumed target strength of –33 dB per kg to scale integrated acoustic signals. However, at SGS the accuracy of the biomass estimate is only important as a relative measure because the purpose of the hydroacoustic survey was to detect differences in fish abundance between the intake and discharge structures.

Surface noise due to wind and the discharge, and near bottom noise were filtered from the acoustic densities by integrating each transect two times using the BioSonics Visual Analyzer with ping based output. Each transect was first processed by setting an end range 0.5 m (1.6 ft) above the tracked bottom. Then the bottom was set just below any surface noise, resulting in a second output. Fish biomass in each ping was calculated per unit surface area (FPUSA) by using the second output to subtract out surface noise. The density of fish in the two portions of each transect was calculated from the average of hydroacoustic measures of fish density in each ping, in kg/m^3, first dividing each ping's FPUSA by the depth (i.e. 0.5 m [1.6 ft] above bottom).

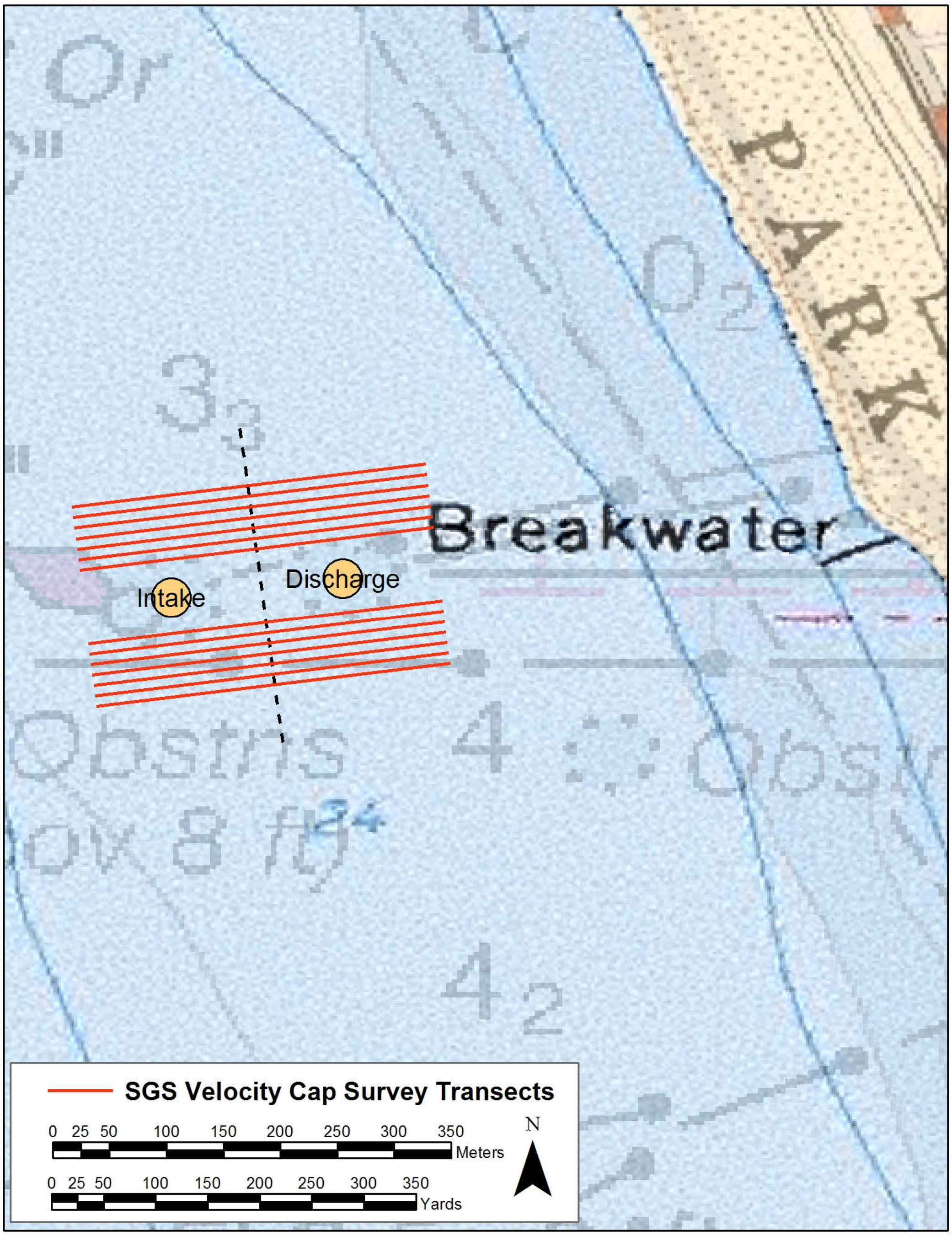


Figure 4-2. Hydroacoustic Survey Transects Near the SGS Intake and Discharge Structures

4.3 DATA ANALYSIS

4.3.1 Impingement Data

The sampling resulted in three periods of normal intake flow using the intake structure with a velocity cap to withdraw cooling water from the source waterbody into the forebay and two periods of reverse intake flow using the discharge structure without a velocity cap to withdraw cooling water into the forebay. The data from the study were analyzed using resampling techniques that do not make any assumptions regarding the underlying distributions of the data required by the parametric statistical analyses originally proposed for the study (Good 2006). The only assumption of resampling analysis is that the data represent independent samples drawn from the population of interest.

Resampling techniques refer to the use of the observed data to produce new hypothetical samples, the results of which can then be analyzed (Good 2006). These techniques have gained use and acceptance as the computer power required to rapidly randomize and resample data has increased. For the analyses used for impingement the sampled data from the two locations or sampling periods were used to calculate a t-test statistic expressing the difference between the two groups. The entire set of data from the two groups was then randomized and successive samples drawn from the data using the same sample sizes in the two original groups. A t-statistic was calculated for each permutation of the data (usually 1,000) generating a distribution that was used to test the value from the original groups. A t-statistic from the original data at the extreme of the distribution (>95% of the generated values) would indicate that the observed difference would only be expected to occur, on average, less than 5% of the time and therefore indicated that the difference was statistically significant. A value not at the extremes of the distribution would indicate that the value could occur randomly and would not be significant.

The data used in the resampling analysis were impingement rates for total fish abundance and biomass from all of the sampling periods. A t-statistic was calculated for the difference observed between impingement rates for the reverse and normal flow conditions. The tests were not complete permutations but used sampling without replacement and used a small number (1,000 permutations per test) of samples when compared with the total number of permutations possible based on the sample sizes of n_x and n_y, the total number of samples collected under the two flow regimes. The t-statistic was calculated as follows:

$$t = \frac{(\bar{x} - \bar{y})}{\sqrt{\frac{s_x^2}{n_x} + \frac{s_y^2}{n_y}}},$$

where:

$\bar{x}$ = mean of normal flow transect densities

$\bar{y}$ = mean of reverse flow transect densities

s = standard deviation

n = number of samples.

The t-statistic was calculated for each permutation of the data and the resulting “t” distribution was used to test if the test statistic from the two original sample means ($\bar{x}, \bar{y}$) exceeded 95 percent of the values in the distribution of t-statistics from the permutations. A t-statistic from the original samples that lay outside 95 percent of the values indicated a significant difference between impingement rates for the two flow conditions. In most areas of scientific research, the criterion for statistical significance is conventionally set at the 5% level. That is, an observed result is regarded as statistically significant—as something more than random chance—only if it had a 5% or smaller likelihood of occurring.

The percent reduction (effectiveness, or *E*) of the velocity cap based on density (number of fishes or biomass impinged per volume cooling water entrained) during paired (adjacent) survey periods was calculated as:

$$E = \frac{D_{ri} - D_{nj}}{D_{ri}}$$

where:

D_{ri} = density of fishes impinged in reverse flow (no velocity cap) during period i
D_{nj} = density of fishes impinged in normal flow (with velocity cap) during period j

The overall effectiveness (*E*) of the velocity cap based on density (number of fishes or biomass impinged per volume cooling water entrained) during the velocity cap study was calculated as:

$$E = \frac{D_r - D_n}{D_r}$$

where:

D_r = density of fishes impinged in reverse flow (no velocity cap)
D_n = density of fishes impinged in normal flow (with velocity cap)

4.3.2 Hydroacoustic Data

Survey factors that were considered in the analysis of hydroacoustic data were offshore or inshore section (near the intake or discharge locations), flow direction (normal or reverse) and diel period (day or night). During each survey, three samples of the 14 transects were attempted during daytime and three samples of the 14 transects were attempted during night at both intake and discharge locations. For analysis, we considered these samples to be independent because each sample of 14 transects required an hour’s time. During this time, we believed nearshore pelagic fish species could move freely in and out of the sampling area.

Two tests were made using the hydroacoustic data. First, a general test was used to determine if biomasses differed between the offshore and inshore portions of the transects using a bootstrap test (Efron and Tibshirani 1993). Then permutation tests were used to determine if any differences in fish abundances could be detected between the intake and discharge locations under normal and reverse flow using the same general resampling techniques used for the impingement data.

In the first test, the null hypothesis was that the difference between the offshore and inshore transect segments was zero. Rejecting the null hypothesis meant that fish biomass was different between offshore and inshore transect sections and might be contributing to the differences in fish abundance detected from the impingement sampling during normal and reverse flow. A bootstrap test (Efron and Tibshirani 1993) for comparing the difference between offshore and inshore transect segments was made by first computing the offshore-inshore difference in each transect and resampling these values which included periods of normal (n=329) and reverse flow (n=371) with replacement to see if zero in the resulting distribution exceeded 95 percent of the samples.

The second set of tests was used to detect differences in fish abundance between normal and reverse flow periods. The pool of data used in the analyses included the abundances from the inshore transects during reverse flow and the offshore transects during normal flow. These analyses were done using Monte Carlo permutation tests (Good 2006) using the t-statistic to test the equality of means. These paired tests were not complete permutations but used sampling without replacement and used a small number (10,000 permutations per test) of samples when compared with the total number of permutations possible based on the sample sizes from the normal and reverse flow periods. The t-statistic was calculated for each Monte Carlo sample and the resulting “t” distribution was used to test if the test statistic of the two original sample means exceeded 95 percent of the values in the distribution of t-statistics from the permutations.

5.0 RESULTS

5.1 SURVEY PERIODS

A total of five flow periods occurred during the study; three with the velocity cap (normal flow) and two without the velocity cap (reverse flow) (Table 5-1). The study ended prematurely at the direction of the LARWQCB. The survey period duration ranged between 11 and 23 days, and was primarily affected by operational limitations. As an example, a heat treatment scheduled for November 6, 2006 was aborted just after it started due to problems with the SGS generating unit; however, the heat treatment was successfully performed three days later.

Table 5-1. Velocity Cap Effectiveness Study Survey Periods

Survey Period	Flow Direction	Start Date	End Date	No. of Days	Total Volume m^3 (Gallons)	Mean Daily Flow Rate m^3/day (Gallons/day)
N_1	Normal	Oct. 10, 2006	Oct. 23, 2006	13.0	16,911,607 (4,468,059,974)	1,302,423 (344,100,283)
R_1	Reverse	Oct. 23, 2006	Nov. 9, 2006	17.2	22,263,200 (5,881,955,086)	1,296,885 (342,637,127)
N_2	Normal	Nov. 9, 2006	Nov. 20, 2006	10.8	13,739,444 (3,629,971,995)	1,267,525 (334,880,133)
R_2	Reverse	Nov. 20, 2006	Dec. 11, 2006	21.2	28,176,876 (7,444,352,972)	1,326,578 (350,481,797)
N_3	Normal	Dec. 11, 2006	Jan. 3, 2007	22.8	29,255,423 (7,729,305,945)	1,281,610 (338,601,419)
R_3	Reverse	*	*	*	*	*

** Study completed after third normal flow period per LARWQCB directive to cease the velocity cap study.*

Flow direction was switched from normal to reverse (or reverse to normal) immediately following heat treatments. One exception to this occurred during the second reverse flow period (R_2) where flow direction was not switched from normal to reverse until approximately 14 hours after completion of the heat treatment.

5.2 COOLING WATER FLOW DURING SURVEY PERIODS

The IM&E Characterization Study circulating water flow for the period of January 2006 through January 2007 is presented in Figure 5-1. Mean daily cooling water flow and total volumes during the Velocity Cap Effectiveness Study are presented in Table 5-1, and mean daily cooling water flow rates are depicted in Figure 5-2. Mean daily cooling water flow rates during normal flow periods (with the velocity cap) ranged between 1,267,524 m^3 per day (334,880,133 gallons per day) and 1,302,423 m^3 per day (344,100,283 gallons per day), while during the two reverse flow periods (without the velocity cap) mean daily flow rates were 1,296,885 m^3 per day (342,637,127 gallons per day) and 1,326,578 m^3 per day (350,481,797 gallons per day), respectively.

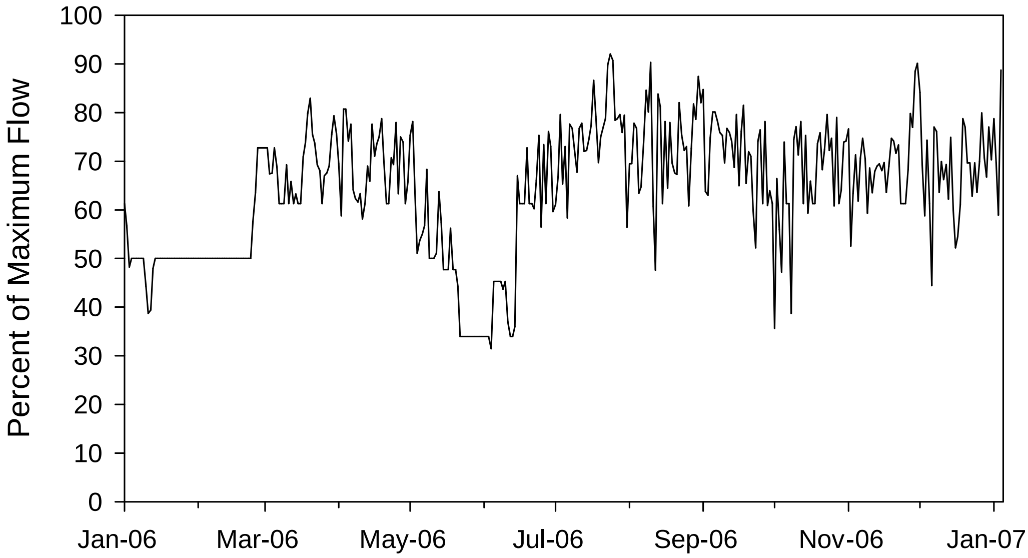


Figure 5-1. Mean Daily Cooling Water Flow (percent of maximum flow of 495.4 mgd) at the SGS, Jan. 2006 – Jan. 2007

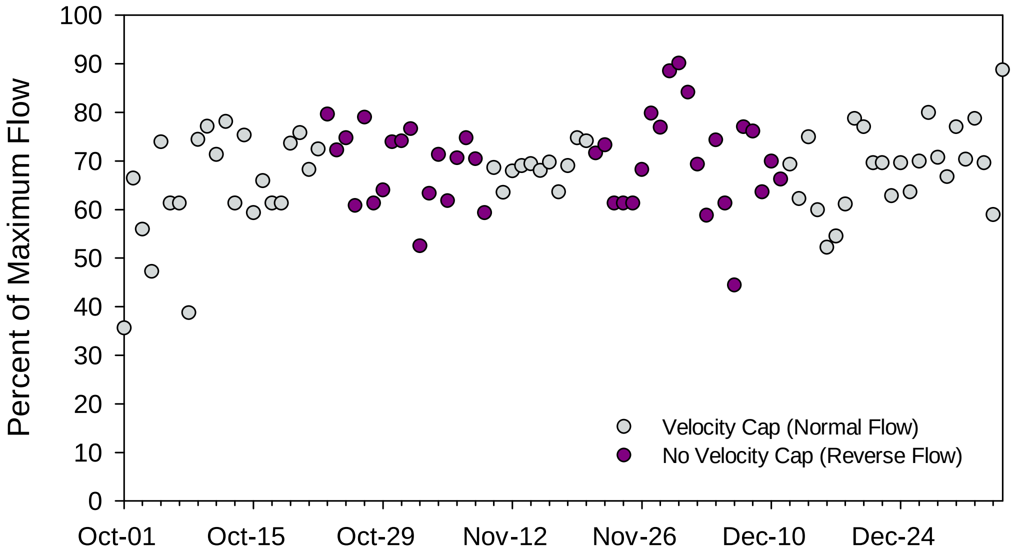


Figure 5-2. Mean Daily Cooling Water Flow (percent of maximum flow of 495.4 mgd) at the SGS during the Velocity Cap Effectiveness Study

5.3 IMPINGEMENT STUDIES

During the 85-day velocity cap study period, 62 impingement surveys were conducted including 13 weekly IM&E Characterization surveys, 43 velocity cap study surveys, and 6 heat treatment surveys. Fish impingement data are presented in this section and in Attachment A-8. Macroinvertebrate impingement data are presented in Attachment A-8.

5.3.1 24-Hour Sampling Period Impingement Results

A total of 118,097 fishes weighing a total of 2,839 kg (6,259 lbs.) and comprised of at least 59 separate species was impinged during the weekly IM&E Characterization and velocity cap study surveys (Tables 5-2 and 5-3). Approximately 95 percent of the abundance and 80 percent of the biomass was impinged in reverse flow (without the velocity cap). Pacific sardine (*Sardinops sagax*) was by far the most abundant species, comprising nearly 96 percent of the total abundance. Abundance and biomass peaked during the second reverse flow period in early December (Figure 5-3).

5.3.1.1 Normal Flow (with Velocity Cap) Results

Abundance during normal flow survey periods ranged from 43 individuals (from 11 species) during the first normal flow period with a total volume of 16,911,607 m^3 to 5,406 individuals (from 51 species) during the third normal flow period with a total volume of 29,255,423 m^3 (Table 5-2). During the second normal flow period, 655 fish (from 21 species) were impinged with a total flow volume of 13,739,444 m^3. The most abundant species were Pacific sardine, jacksmelt (*Atherinopsis californiensis*), and topsmelt (*Atherinops affinis*). Biomass during normal flow periods ranged from 18.9 kg (42 lbs) during the first normal flow period with a total volume of 16,911,607 m^3 to 415.1 kg (915 lbs) during the third normal flow period with a total volume of 29,255,423 m^3 (Table 5-3). During the second normal flow period, 131.1 kg (289 lbs) of fish were impinged with a total flow volume of 13,739,444 m^3. Species contributing most to biomass were Pacific electric ray (*Torpedo californica*), jacksmelt, and bat ray (*Myliobatis californica*).

5.3.1.2 Reverse Flow (without Velocity Cap) Results

A total of 31,175 fishes weighing 828.6 kg (1,827 lbs) from 24 species was impinged during the first reverse flow period with a total volume of 22,263,200 m^3 (Tables 5-2 and 5-3). During the second reverse flow period with a total volume of 28,176,876 m^3 a total of 80,818 fishes weighing 1,444.9 kg (3,185 lbs) from 39 species were impinged. Pacific sardine accounted for more than 99 percent of the total abundance and nearly 96 percent of the total biomass. Other species contributing most to biomass were bat ray (1.6 percent) and Pacific electric ray (1.3 percent).

Table 5-2. Fish Impingement Abundance by Species from IM&E Characterization Study and Velocity Cap Impingement Surveys

Taxon	Common Name	Survey Period					Total	Percent
		N_1	R_1	N_2	R_2	N_3		
Sardinops sagax	Pacific sardine	4	30,899	150	80,113	1,976	113,142	95.80
Atherinopsis californiensis	jacksmelt	2	2	50	68	1,132	1,254	1.06
Atherinops affinis	topsmelt	24	30	253	106	705	1,118	0.95
Seriphus politus	queenfish	-	92	4	96	676	868	0.73
Engraulis mordax	northern anchovy	-	26	1	8	369	404	0.34
Myliobatis californica	bat ray	4	55	54	54	19	186	0.16
Scomber japonicus	Pacific chub mackerel	-	16	6	135	25	182	0.15
Citharichthys stigmaeus	speckled sanddab	-	-	4	1	114	119	0.10
Atherinopsidae	unid silverside	-	-	113	-	-	113	0.10
Leuresthes tenuis	California grunion	-	4	1	105	2	112	0.09
Anchoa compressa	deepbody anchovy	-	1	-	44	59	104	0.09
Pleuronichthys ritteri	spotted turbot	-	13	-	10	34	57	0.05
Platyrhinoidis triseriata	thornback	1	2	2	7	35	47	0.04
Torpedo californica	Pacific electric ray	3	4	4	1	29	41	0.03
Xenistius californiensis	salema	1	12	-	15	9	37	0.03
Porichthys myriaster	specklefin midshipman	-	5	2	1	17	25	0.02
Peprilus simillimus	Pacific pompano	-	-	-	1	21	22	0.02
Pleuronichthys verticalis	hornyhead turbot	-	2	1	1	16	20	0.02
Syngnathus californiensis	kelp pipefish	-	-	-	-	20	20	0.02
Syngnathus sp	pipefish, unid.	-	-	-	4	13	17	0.01
Scorpaena guttata	California scorpionfish	-	-	-	2	14	16	0.01
Heterostichus rostratus	giant kelpfish	-	3	-	2	9	14	0.01
Anchoa delicatissima	slough anchovy	-	-	-	6	7	13	0.01
Paralichthys californicus	California halibut	-	1	1	-	11	13	0.01
Trachurus symmetricus	jack mackerel	-	-	1	4	7	12	0.01
Urobatis halleri	round stingray	-	1	1	2	7	11	0.01
Heterodontus francisci	horn shark	-	-	-	1	9	10	0.01
Menticirrhus undulatus	California corbina	-	-	3	1	5	9	0.01
Odontopyxis trispinosa	pygmy poacher	-	-	-	-	9	9	0.01
Hyperprosopon argenteum	walleye surfperch	-	-	-	2	5	7	0.01
Pleuronichthys guttulatus	diamond turbot	-	2	-	-	5	7	0.01
Cheilotrema saturnum	black croaker	-	-	-	6	-	6	0.01
Embiotoca jacksoni	black perch	-	-	-	4	2	6	0.01
Ophidion scrippsae	basketweave cusk-eel	-	-	-	2	4	6	0.01
Paralabrax nebulifer	barred sand bass	1	1	2	1	1	6	0.01
Umbrina roncador	yellowfin croaker	-	-	-	-	6	6	0.01
Chromis punctipinnis	blacksmith	1	-	-	3	1	5	0.00
Genyonemus lineatus	white croaker	-	-	-	-	5	5	0.00
Paralabrax clathratus	kelp bass	-	-	1	3	1	5	0.00
Sebastes paucispinis	bocaccio	-	-	-	-	5	5	0.00
Ophichthus zophochir	yellow snake eel	-	-	-	-	4	4	0.00
Scorpaenichthys marmoratus	cabezon	1	1	-	-	2	4	0.00
Anisotremus davidsonii	sargo	-	1	-	-	2	3	0.00
Parophrys vetulus	English sole	-	-	-	-	3	3	0.00
Phanerodon furcatus	white seaperch	1	-	-	2	-	3	0.00
Leptocottus armatus	Pacific staghorn sculpin	-	-	-	-	2	2	0.00
Rhacochilus toxotes	rubberlip seaperch	-	-	-	2	-	2	0.00

Table 5-2 (Cont.). Fish Impingement Abundance By Species From IM&E Characterization Study and Velocity Cap Impingement Surveys

		Survey Period						
Taxon	**Common Name**	N_1	R_1	N_2	R_2	N_3	**Total**	**Percent**
Medialuna californiensis	halfmoon	-	1	-	1	-	2	0.00
Symphurus atricaudus	California tonguefish	-	-	-	-	2	2	0.00
Amphistichus argenteus	barred surfperch	-	-	-	1	-	1	0.00
Dorosoma petenense	threadfin shad	-	-	-	-	1	1	0.00
Embiotocidae	surfperch, unid.	-	-	1	-	-	1	0.00
Gymnura marmorata	California butterfly ray	-	-	-	-	1	1	0.00
Hypsoblennius gilberti	rockpool blenny	-	-	-	-	1	1	0.00
Hypsoblennius jenkinsi	mussel blenny	-	-	-	-	1	1	0.00
Oxyjulis californica	senorita	-	-	-	-	1	1	0.00
Porichthys notatus	plainfin midshipman	-	-	-	-	1	1	0.00
Rhacochilus vacca	pile perch	-	-	-	1	-	1	0.00
Sphyraena argentea	Pacific barracuda	-	-	-	1	-	1	0.00
Syngnathus leptorhynchus	bay pipefish	-	-	-	1	-	1	0.00
Synodus lucioceps	California lizardfish	-	1	-	-	-	1	0.00
Triakis semifasciata	leopard shark	-	-	-	-	1	1	0.00
	Total Fishes	**43**	**31,175**	**655**	**80,818**	**5,406**	**118,097**	**100.00**
	Total Taxa	**11**	**24**	**21**	**39**	**51**	**62**	
	Period Volume (m^3)	**16,911,607**	**22,263,200**	**13,739,444**	**28,176,876**	**29,255,423**	**110,346,550**	

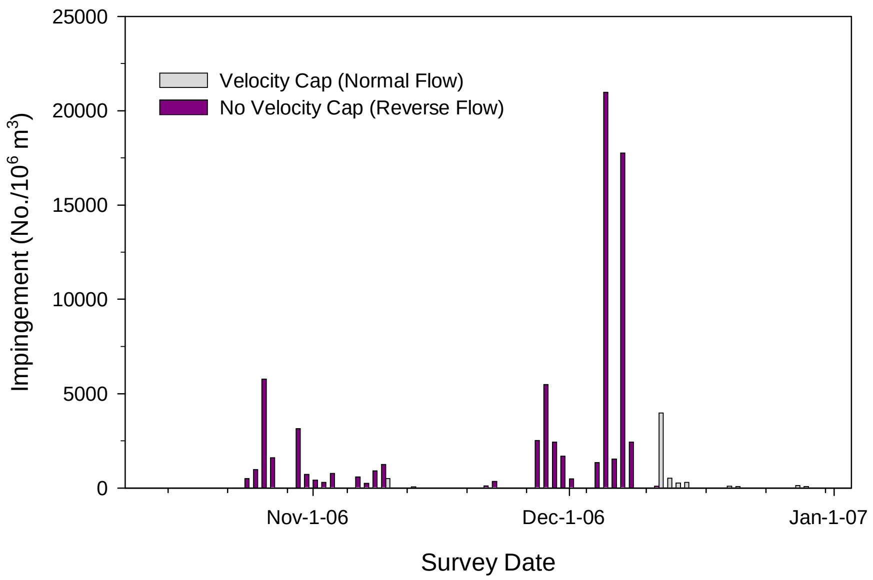
Table 5-3. Fish Impingement Biomass (kg) By Species from IM&E Characterization Study and Velocity Cap Impingement Surveys

Taxon	Common Name	Survey Period					Total	Percent
		N_1	R_1	N_2	R_2	N_3		
Sardinops sagax	Pacific sardine	0.161	778.266	10.114	1,395.811	37.140	2,221.492	78.26
Torpedo californica	Pacific electric ray	15.560	24.350	17.300	6.700	192.020	255.930	9.02
Myliobatis californica	bat ray	1.525	18.053	86.252	18.788	9.096	133.714	4.71
Atherinopsis californiensis	jacksmelt	0.087	0.242	4.665	3.932	112.178	121.104	4.27
Atherinops affinis	topsmelt	0.692	0.731	6.270	3.185	19.135	30.013	1.06
Platyrhinoidis triseriata	thornback	0.030	2.348	0.547	1.488	17.122	21.535	0.76
Scomber japonicus	Pacific chub mackerel	-	1.119	0.335	8.646	1.789	11.889	0.42
Triakis semifasciata	leopard shark	-	-	-	-	11.000	11.000	0.39
Seriphus politus	queenfish	-	0.211	0.015	0.466	4.242	4.934	0.17
Atherinopsidae	silverside, unid.	-	-	2.780	-	-	2.780	0.10
Urobatis halleri	round stingray	-	1.036	0.411	0.643	0.334	2.424	0.09
Porichthys myriaster	specklefin midshipman	-	0.696	0.943	0.002	0.352	1.993	0.07
Paralabrax nebulifer	barred sand bass	0.579	0.289	0.450	0.274	0.247	1.839	0.06
Menticirrhus undulatus	California corbina	-	-	0.706	0.043	0.560	1.309	0.05
Leuresthes tenuis	California grunion	-	0.026	0.004	1.177	0.044	1.251	0.04
Engraulis mordax	northern anchovy	-	0.098	0.007	0.023	1.073	1.201	0.04
Scorpaenichthys marmoratus	cabezon	0.228	0.565	-	-	0.192	0.985	0.03
Paralichthys californicus	California halibut	-	0.008	0.004	-	0.966	0.978	0.03
Cheilotrema saturnum	black croaker	-	-	-	0.825	-	0.825	0.03
Ophichthus zophochir	yellow snake eel	-	-	-	-	0.792	0.792	0.03
Umbrina roncador	yellowfin croaker	-	-	-	-	0.778	0.778	0.03
Pleuronichthys ritteri	spotted turbot	-	0.080	-	0.183	0.442	0.705	0.02
Peprilus simillimus	Pacific pompano	-	-	-	0.023	0.663	0.686	0.02
Pleuronichthys verticalis	hornyhead turbot	-	0.043	0.006	0.031	0.574	0.654	0.02
Genyonemus lineatus	white croaker	-	-	-	-	0.551	0.551	0.02
Anchoa compressa	deepbody anchovy	-	0.004	-	0.197	0.340	0.541	0.02
Trachurus symmetricus	jack mackerel	-	-	0.025	0.194	0.316	0.535	0.02
Rhacochilus vacca	pile perch	-	-	-	0.525	-	0.525	0.02
Medialuna californiensis	halfmoon	-	0.246	-	0.255	-	0.501	0.02
Pleuronichthys guttulatus	diamond turbot	-	0.004	-	-	0.484	0.488	0.02
Citharichthys stigmaeus	speckled sanddab	-	-	0.016	0.012	0.451	0.479	0.02
Scorpaena guttata	California scorpionfish	-	-	-	0.140	0.323	0.463	0.02
Embiotoca jacksoni	black perch	-	-	-	0.215	0.154	0.369	0.01
Xenistius californiensis	salema	0.006	0.022	-	0.158	0.157	0.343	0.01
Hyperprosopon argenteum	walleye surfperch	-	-	-	0.056	0.285	0.341	0.01
Paralabrax clathratus	kelp bass	-	-	0.102	0.210	0.004	0.316	0.01
Heterodontus francisci	horn shark	-	-	-	0.028	0.264	0.292	0.01
Ophidion scrippsae	basketweave cusk-eel	-	-	-	0.091	0.184	0.275	0.01
Chromis punctipinnis	blacksmith	0.048	-	-	0.146	0.052	0.246	0.01
Gymnura marmorata	California butterfly ray	-	-	-	-	0.184	0.184	0.01
Heterostichus rostratus	giant kelpfish	-	0.012	-	0.035	0.123	0.170	0.01
Rhacochilus toxotes	rubberlip seaperch	-	-	-	0.159	-	0.159	0.01
Embiotocidae	surfperch, unid.	-	-	0.156	-	-	0.156	0.01
Parophrys vetulus	English sole	-	-	-	-	0.142	0.142	0.01
Amphistichus argenteus	barred surfperch	-	-	-	0.115	-	0.115	0.00
Synodus lucioceps	California lizardfish	-	0.078	-	-	-	0.078	0.00
Phanerodon furcatus	white seaperch	0.019	-	-	0.051	-	0.070	0.00

Table 5-3 (Cont.). Fish Impingement Biomass (kg) By Species from IM&E Characterization Study and Velocity Cap Impingement Surveys

Taxon	Common Name	Survey Period					Total	Percent
		N_1	R_1	N_2	R_2	N_3		
Symphurus atricaudus	California tonguefish	-	-	-	-	0.070	0.070	0.00
Anchoa delicatissima	slough anchovy	-	-	-	0.028	0.029	0.057	0.00
Syngnathus californiensis	kelp pipefish	-	-	-	-	0.051	0.051	0.00
Oxyjulis californica	senorita	-	-	-	-	0.051	0.051	0.00
Anisotremus davidsonii	sargo	-	0.034	-	-	0.012	0.046	0.00
Leptocottus armatus	Pacific staghorn sculpin	-	-	-	-	0.035	0.035	0.00
Syngnathus sp	pipefish, unid.	-	-	-	0.011	0.020	0.031	0.00
Sphyraena argentea	Pacific barracuda	-	-	-	0.028	-	0.028	0.00
Sebastes paucispinis	bocaccio	-	-	-	-	0.020	0.020	0.00
Odontopyxis trispinosa	pygmy poacher	-	-	-	-	0.013	0.013	0.00
Dorosoma petenense	threadfin shad	-	-	-	-	0.013	0.013	0.00
Syngnathus leptorhynchus	bay pipefish	-	-	-	0.003	-	0.003	0.00
Hypsoblennius gilberti	rockpool blenny	-	-	-	-	0.002	0.002	0.00
Hypsoblennius jenkinsi	mussel blenny	-	-	-	-	0.002	0.002	0.00
Porichthys notatus	plainfin midshipman	-	-	-	-	0.001	0.001	0.00
	Total Biomass (kg)	**18.935**	**828.561**	**131.108**	**1,444.897**	**415.072**	**2,838.573**	**100.00**
	Total Taxa	**11**	**24**	**21**	**39**	**51**	**62**	
	Period Volume (m^3)	**16,911,607**	**22,263,200**	**13,739,444**	**28,176,876**	**29,255,423**	**110,346,550**	

a) Abundance



b) Biomass

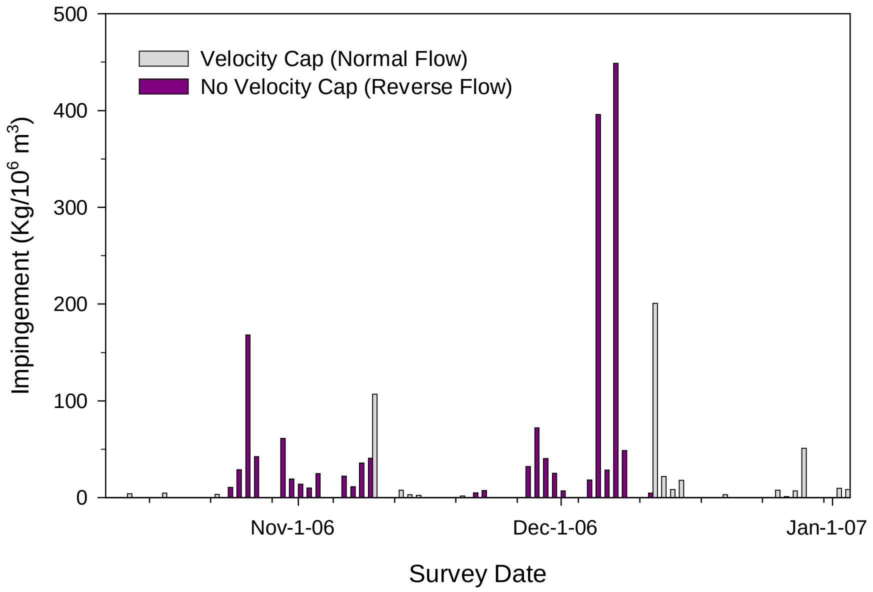


Figure 5-3. Fish Impingement Rate During 24-hr Velocity Cap and IM&E Characterization Study Impingement Surveys: a) Abundance (#/10^6 m^3) and b) Biomass (kg/10^6 m^3)

5.3.2 Heat Treatment Plus 24-Hour Sampling Period Impingement Results

A total of 650,141 fishes weighing a total of 16,007 kg (35,296 lbs.) and comprised of at least 64 separate species was impinged during the heat treatment, weekly IM&E Characterization, and velocity cap study surveys (Tables 5-4 and 5-5). Approximately 97 percent of the abundance and 95 percent of the biomass was impinged in reverse flow (without the velocity cap). Pacific sardine (*Sardinops sagax*) was by far the most abundant species, comprising nearly 94 percent of the total abundance. Impingement abundance was greater during the second reverse flow period than during the first; however, biomass was greater during the first reverse flow period (Figure 5-4).

There were generally more fish species collected during reverse flow periods than during normal flow periods (Table 5-6). However, there was an influx of species during the final normal flow period. Species richness during the third normal flow period was 1.7 to 2.9 times higher than the number of species collected during the first and second normal flow periods.

5.3.2.1 Normal Flow (with Velocity Cap) Results

Abundance during the normal flow survey periods ranged from 1,050 individuals (from 35 taxa) during the second normal flow period with a total volume of 13,739,444 m^3 to 16,218 individuals (from 61 taxa) during the third normal flow period with a total volume of 29,255,423 m^3 (Table 5-4). During the first normal flow period, 1,054 fish (from 21 taxa) were impinged with a total volume of 16,911,607 m^3. The most abundant species were queenfish (*Seriphus politus*), Pacific sardine, and northern anchovy (*Engraulis mordax*). Biomass during normal flow periods ranged from 52.4 kg (115 lbs) during the first normal flow period to 651.6 kg (1,436 lbs) during the third normal flow period (Table 5-5). During the second normal flow period, a total of 141.9 kg (313 lbs) of fish was impinged with a total volume of 13,739,444 m^3. Species contributing most to biomass were Pacific electric ray, queenfish, and jacksmelt.

5.3.2.2 Reverse Flow (without Velocity Cap) Results

A total of 220,065 fishes weighing 7,428.4 kg (16,376 lbs) from 41 species was impinged during the first reverse flow period with a total volume of 22,263,200 m^3 (Tables 5-4 and 5-5). During the second reverse flow period a total of 411,754 fishes weighing 7,733.0 kg (17,048 lbs) from 47 species were impinged with a total volume of 28,176,876 m^3. Pacific sardine accounted for more than 96 percent of the total abundance and over 91 percent of the total biomass. Other species contributing most to biomass were jacksmelt (3.7 percent) and topsmelt (2.4 percent).

5.3.2.3 Statistical Comparison of Results

Impingement rates under the two flow regimes (normal and reverse) were analyzed by generating a t-statistic from the two original groups of data and comparing that value with t-statistics generated using 1,000 iterations of the data. A significant difference in fish abundance (number impinged per 1,000,000 m^3) was detected between flow regimes with the calculated t-statistic of –3.35 exceeding > 99.9% of the generated values ($p < 0.001$). No significant difference in fish biomass (kg impinged per 1,000,000 m^3) was detected between flow regimes with the calculated t-statistic of 0.84 exceeding 78% of the generated values ($p = 0.78$).

Table 5-4. Fish Impingement Abundance by Species and Survey Period (IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys)

Taxon	Common Name	Survey Period					Total	Percent
		N_1	R_1	N_2	R_2	N_3		
Sardinops sagax	Pacific sardine	611	218,342	184	391,224	2,165	612,526	94.21
Atherinops affinis	topsmelt	72	343	348	12,937	891	14,591	2.24
Seriphus politus	queenfish	121	418	140	716	8,841	10,236	1.57
Atherinopsis californiensis	jacksmelt	2	165	52	5,084	1,381	6,684	1.03
Engraulis mordax	northern anchovy	81	74	8	132	1,591	1,886	0.29
Scomber japonicus	Pacific chub mackerel	2	140	26	735	32	935	0.14
Anchoa compressa	deepbody anchovy	-	8	2	170	249	429	0.07
Xenistius californiensis	salema	107	106	46	83	73	415	0.06
Myliobatis californica	bat ray	6	215	55	109	24	409	0.06
Peprilus simillimus	Pacific pompano	-	-	-	19	219	238	0.04
Genyonemus lineatus	white croaker	-	-	1	33	108	142	0.02
Citharichthys stigmaeus	speckled sanddab	-	3	5	12	114	134	0.02
Leuresthes tenuis	California grunion	-	6	1	113	5	125	0.02
Pleuronichthys ritteri	spotted turbot	-	47	1	34	42	124	0.02
Atherinopsidae	silverside	-	-	113	-	-	113	0.02
Hyperprosopon argenteum	walleye surfperch	-	3	-	57	42	102	0.02
Trachurus symmetricus	jack mackerel	1	10	1	70	20	102	0.02
Platyrhinoidis triseriata	thornback	1	2	2	17	43	65	0.01
Umbrina roncador	yellowfin croaker	-	-	-	28	30	58	0.01
Cheilotrema saturnum	black croaker	10	5	9	9	19	52	0.01
Phanerodon furcatus	white seaperch	3	32	2	8	7	52	0.01
Paralabrax clathratus	kelp bass	3	12	9	10	12	46	0.01
Paralabrax nebulifer	barred sand bass	6	6	9	13	12	46	0.01
Cymatogaster aggregata	shiner perch	-	42	2	-	1	45	0.01
Atractoscion nobilis	white seabass	-	3	-	24	15	42	0.01
Torpedo californica	Pacific electric ray	4	4	4	1	29	42	0.01
Scorpaena guttata	California scorpionfish	3	5	-	5	27	40	0.01
Embiotoca jacksoni	black perch	15	7	5	7	4	38	0.01
Urobatis halleri	round stingray	1	11	1	3	17	33	0.01
Menticirrhus undulatus	California corbina	-	2	3	12	13	30	0.00
Anisotremus davidsonii	sargo	-	4	3	12	9	28	0.00
Heterostichus rostratus	giant kelpfish	-	8	1	7	11	27	0.00
Porichthys myriaster	specklefin midshipman	-	5	2	1	17	25	0.00
Rhacochilus toxotes	rubberlip seaperch	1	5	3	6	9	24	0.00
Sphyraena argentea	Pacific barracuda	-	2	-	20	1	23	0.00
Syngnathus sp	pipefish	-	-	-	10	13	23	0.00
Paralichthys californicus	California halibut	-	4	2	5	11	22	0.00
Pleuronichthys verticalis	hornyhead turbot	-	2	1	1	17	21	0.00
Syngnathus californiensis	kelp pipefish	-	-	-	-	20	20	0.00
Rhacochilus vacca	pile perch	-	10	6	1	2	19	0.00
Scorpaenichthys marmoratus	cabezon	2	4	1	3	8	18	0.00
Chromis punctipinnis	blacksmith	2	-	1	6	5	14	0.00
Anchoa delicatissima	slough anchovy	-	-	-	6	7	13	0.00
Heterodontus francisci	horn shark	-	2	-	1	10	13	0.00
Odontopyxis trispinosa	pygmy poacher	-	-	-	-	9	9	0.00
Pleuronichthys guttulatus	diamond turbot	-	2	-	-	5	7	0.00
Ophidion scrippsae	basketweave cusk-eel	-	-	-	2	4	6	0.00

Table 5-4 (Cont.). Fish Impingement Abundance by Species and Survey Period (IM&E Characterization Study, Velocity Cap, and Heat Treatment Surveys)

Taxon	Common Name	Survey Period N_1	R_1	N_2	R_2	N_3	Total	Percent
Hypsoblennius gilberti	rockpool blenny	-	-	-	-	5	5	0.00
Ophichthus zophochir	yellow snake eel	-	-	-	1	4	5	0.00
Sebastes paucispinis	bocaccio	-	-	-	-	5	5	0.00
Leptocottus armatus	Pacific staghorn sculpin	-	-	-	-	4	4	0.00
Sebastes auriculatus	brown rockfish	-	2	-	2	-	4	0.00
Hypsoblennius jenkinsi	mussel blenny	-	-	-	-	3	3	0.00
Medialuna californiensis	halfmoon	-	1	-	2	-	3	0.00
Oxyjulis californica	señorita	-	2	-	-	1	3	0.00
Parophrys vetulus	English sole	-	-	-	-	3	3	0.00
Amphistichus argenteus	barred surfperch	-	-	-	2	-	2	0.00
Symphurus atricaudus	California tonguefish	-	-	-	-	2	2	0.00
Dorosoma petenense	threadfin shad	-	-	-	-	1	1	0.00
Embiotocidae	surfperch	-	-	1	-	-	1	0.00
Gibbonsia elegans	spotted kelpfish	-	-	-	-	1	1	0.00
Gymnura marmorata	California butterfly ray	-	-	-	-	1	1	0.00
Oxylebius pictus	painted greenling	-	-	-	-	1	1	0.00
Porichthys notatus	plainfin midshipman	-	-	-	-	1	1	0.00
Rathbunella alleni	stripefin ronquil	-	-	-	-	1	1	0.00
Syngnathus leptorhynchus	bay pipefish	-	-	-	1	-	1	0.00
Synodus lucioceps	California lizardfish	-	1	-	-	-	1	0.00
	Total Fishes	**1,054**	**220,065**	**1,050**	**411,754**	**16,218**	**650,141**	**100.00**
	Total Taxa	**21**	**41**	**35**	**47**	**61**	**67**	
	Period Volume (m^3)	**16,911,607**	**22,263,200**	**13,739,444**	**28,176,876**	**29,255,423**	**110,346,550**	

Table 5-5. Fish Impingement Biomass (kg) by Species and Survey Period (IM&E Characterization Study, Velocity Cap, and Heat Treatment Surveys)

Taxon	Common Name	Survey Period					Total	Percent
		N_1	R_1	N_2	R_2	N_3		
Sardinops sagax	Pacific sardine	16.568	7,184.146	10.993	6,667.255	42.991	13,921.953	86.97
Atherinopsis californiensis	jacksmelt	0.087	19.609	4.960	543.209	136.962	704.827	4.40
Atherinops affinis	topsmelt	2.199	10.624	9.002	357.641	25.155	404.621	2.53
Myliobatis californica	bat ray	2.689	153.298	86.484	53.394	13.100	308.965	1.93
Torpedo californica	Pacific electric ray	24.160	24.350	17.300	6.700	192.020	264.530	1.65
Seriphus politus	queenfish	0.576	2.575	0.784	15.194	151.660	170.789	1.07
Scomber japonicus	Pacific chub mackerel	0.197	11.012	1.768	50.697	2.321	65.995	0.41
Platyrhinoidis triseriata	thornback	0.030	2.348	0.547	5.155	22.530	30.610	0.19
Genyonemus lineatus	white croaker	-	-	0.075	2.021	11.707	13.803	0.09
Urobatis halleri	round stingray	1.095	5.559	0.411	1.056	4.100	12.221	0.08
Triakis semifasciata	leopard shark	-	-	-	-	11.000	11.000	0.07
Peprilus simillimus	Pacific pompano	-	-	-	0.684	6.860	7.544	0.05
Paralabrax nebulifer	barred sand bass	1.390	0.999	2.244	1.310	1.404	7.347	0.05
Engraulis mordax	northern anchovy	0.323	0.368	0.040	0.412	5.406	6.549	0.04
Hyperprosopon argenteum	walleye surfperch	-	0.114	-	3.213	2.412	5.739	0.04
Heterodontus francisci	horn shark	-	3.739	-	0.028	1.706	5.473	0.03
Trachurus symmetricus	jack mackerel	0.024	0.325	0.025	4.082	0.753	5.209	0.03
Menticirrhus undulatus	California corbina	-	0.488	0.706	1.900	1.447	4.541	0.03
Cheilotrema saturnum	black croaker	0.407	0.461	0.375	0.892	1.272	3.407	0.02
Umbrina roncador	yellowfin croaker	-	-	-	1.550	1.853	3.403	0.02
Rhacochilus toxotes	rubberlip seaperch	0.050	0.360	0.218	0.415	2.148	3.191	0.02
Scorpaenichthys marmoratus	cabezon	0.350	1.124	0.156	0.072	1.303	3.005	0.02
Embiotoca jacksoni	black perch	0.707	0.809	0.275	0.507	0.592	2.890	0.02
Xenistius californiensis	salema	0.248	0.420	0.136	1.594	0.420	2.818	0.02
Atherinopsidae	silverside	-	-	2.780	-	-	2.780	0.02
Paralichthys californicus	California halibut	-	0.073	0.031	1.657	0.966	2.727	0.02
Paralabrax clathratus	kelp bass	0.278	0.109	0.787	0.695	0.825	2.694	0.02
Anchoa compressa	deepbody anchovy	-	0.033	0.009	1.131	1.493	2.666	0.02
Phanerodon furcatus	white seaperch	0.044	1.394	0.058	0.592	0.577	2.665	0.02
Atractoscion nobilis	white seabass	-	0.087	-	1.321	1.140	2.548	0.02
Scorpaena guttata	California scorpionfish	0.943	0.286	-	0.804	0.492	2.525	0.02
Pleuronichthys ritteri	spotted turbot	-	0.350	0.034	1.523	0.536	2.443	0.02
Sebastes auriculatus	brown rockfish	-	0.702	-	1.591	-	2.293	0.01
Porichthys myriaster	specklefin midshipman	-	0.696	0.943	0.002	0.352	1.993	0.01
Rhacochilus vacca	pile perch	-	0.665	0.460	0.525	0.127	1.777	0.01
Leuresthes tenuis	California grunion	-	0.034	0.004	1.323	0.114	1.475	0.01
Sphyraena argentea	Pacific barracuda	-	0.092	-	1.248	0.045	1.385	0.01
Ophichthus zophochir	yellow snake eel	-	-	-	0.136	0.792	0.928	0.01
Pleuronichthys verticalis	hornyhead turbot	-	0.043	0.006	0.031	0.658	0.738	0.00
Medialuna californiensis	halfmoon	-	0.246	-	0.483	-	0.729	0.00
Cymatogaster aggregata	shiner perch	-	0.656	0.023	-	0.015	0.694	0.00
Citharichthys stigmaeus	speckled sanddab	-	0.019	0.045	0.125	0.451	0.640	0.00
Chromis punctipinnis	blacksmith	0.049	-	0.055	0.251	0.197	0.552	0.00
Pleuronichthys guttulatus	diamond turbot	-	0.004	-	-	0.484	0.488	0.00
Heterostichus rostratus	giant kelpfish	-	0.048	0.004	0.180	0.147	0.379	0.00
Ophidion scrippsae	basketweave cusk-eel	-	-	-	0.091	0.184	0.275	0.00
Anisotremus davidsonii	sargo	-	0.061	0.024	0.106	0.078	0.269	0.00

Table 5-5 (Cont.). Fish Impingement Biomass (kg) By Species and Survey Period (IM&E Characterization Study, Velocity Cap, and Heat Treatment Surveys)

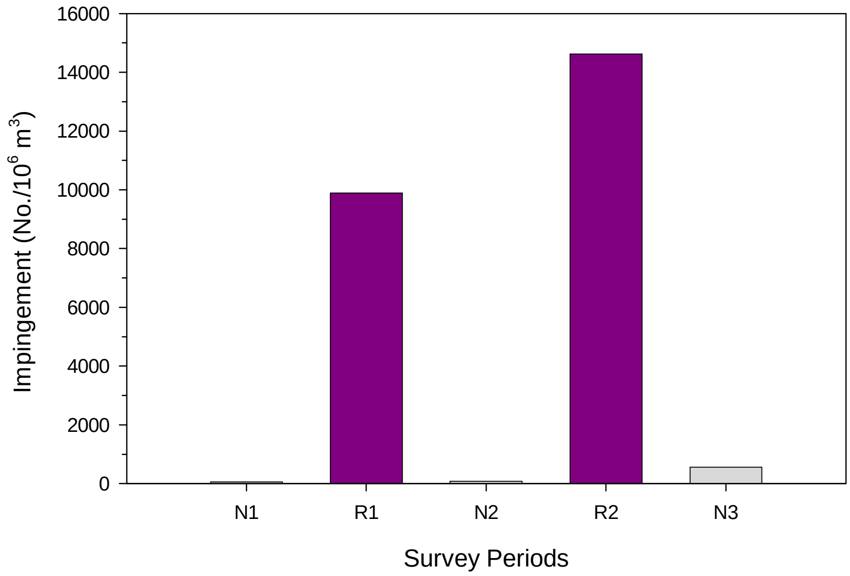
Taxon	Common Name	Survey Period					Total	Percent
		N_1	R_1	N_2	R_2	N_3		
Gymnura marmorata	California butterfly ray	-	-	-	-	0.184	0.184	0.00
Amphistichus argenteus	barred surfperch	-	-	-	0.161	-	0.161	0.00
Embiotocidae	surfperch	-	-	0.156	-	-	0.156	0.00
Parophrys vetulus	English sole	-	-	-	-	0.142	0.142	0.00
Leptocottus armatus	Pacific staghorn sculpin	-	-	-	-	0.093	0.093	0.00
Oxyjulis californica	señorita	-	0.039	-	-	0.051	0.090	0.00
Synodus lucioceps	California lizardfish	-	0.078	-	-	-	0.078	0.00
Symphurus atricaudus	California tonguefish	-	-	-	-	0.070	0.070	0.00
Syngnathus sp	pipefish	-	-	-	0.038	0.020	0.058	0.00
Anchoa delicatissima	slough anchovy	-	-	-	0.028	0.029	0.057	0.00
Syngnathus californiensis	kelp pipefish	-	-	-	-	0.051	0.051	0.00
Hypsoblennius gilberti	rockpool blenny	-	-	-	-	0.042	0.042	0.00
Oxylebius pictus	painted greenling	-	-	-	-	0.021	0.021	0.00
Sebastes paucispinis	bocaccio	-	-	-	-	0.020	0.020	0.00
Odontopyxis trispinosa	pygmy poacher	-	-	-	-	0.013	0.013	0.00
Dorosoma petenense	threadfin shad	-	-	-	-	0.013	0.013	0.00
Hypsoblennius jenkinsi	mussel blenny	-	-	-	-	0.009	0.009	0.00
Gibbonsia elegans	spotted kelpfish	-	-	-	-	0.007	0.007	0.00
Rathbunella alleni	stripefin ronquil	-	-	-	-	0.003	0.003	0.00
Syngnathus leptorhynchus	bay pipefish	-	-	-	0.003	-	0.003	0.00
	Total Biomass (kg)	**52.414**	**7,428.447**	**141.918**	**7,733.026**	**651.564**	**16,007.369**	**100.00**
	Total Taxa	**21**	**41**	**35**	**47**	**61**	**67**	
	Period Volume (m^3)	**16,911,607**	**22,263,200**	**13,739,444**	**28,176,876**	**29,255,423**	**110,346,550**	

Table 5-6. Differences in Number of Fish Species Impinged Between Survey Periods

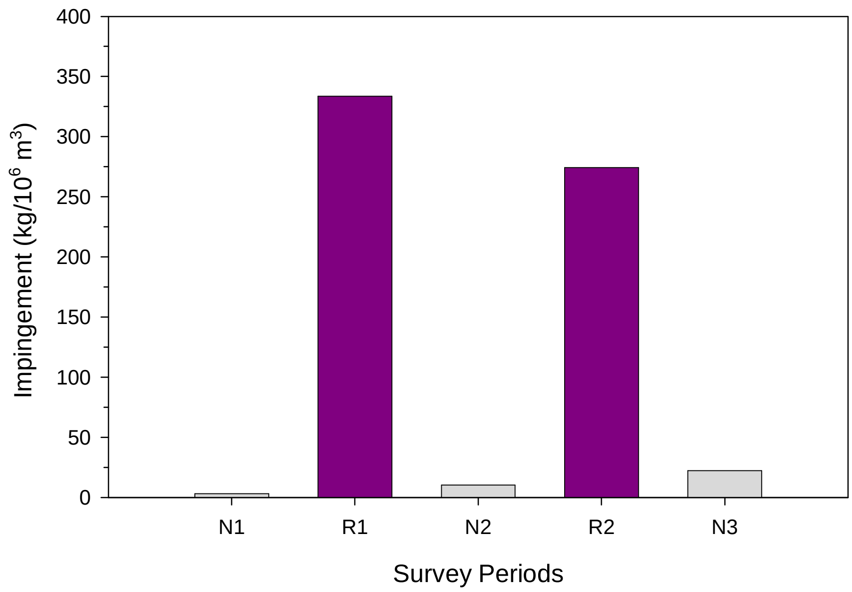
	Survey Period					
	N_1	R_1	N_2	R_2	N_3	R_3
Species not in prior period	-	20	2	14	17	*
Species not in subsequent period	1	10	1	4	-	*

Study completed after third normal flow period per LARWQCB directive to cease the velocity cap study.
Taxonomic groups not identifiable to species excluded from comparisons.

a) Abundance



b) Biomass



N = normal flow (with velocity cap), R = reverse flow (without the velocity cap).

Figure 5-4. Fish Impingement Rate for the IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys during Each of the Flow Periods: a) Abundance (#/10^6 m^3) and b) Biomass (kg/10^6 m^3)

5.3.3 Results for Abundant Species

The following section presents a detail evaluation of the four most abundant fish species collected during the Velocity Cap Effectiveness Study at SGS.

5.3.3.1 Pacific Sardine

Adult Range:
Indo-Pacific:
southern Africa to
eastern Pacific

Adult Habitat:
Pelagic, marine,
0-200 m depth

The genus *Sardinops* occurs in coastal areas of warm temperature zones of nearly all ocean basins. Pacific sardine range from Kamchatka, Russia to Guaymas, Mexico, Peru, and Chile (Miller and Lea 1972; Eschmeyer et al. 1983). Similar lineages occur off Africa, Australia, and Japan. Pacific sardine is one of five species of herrings (Family Clupeidae) that could occur in the waters off the SGS.

Pacific sardine is epipelagic, occurring in loosely aggregated schools (Wolf et al. 2001). Spawning occurs year-round in the upper 50 m (164 ft) of the water column, with seasonal peaks occurring from April to August between Point Conception, California and Magdalena Bay, Baja California. Adults are believed to spawn two to three times per season (Fitch and Lavenberg 1971). The primary spawning area for the principal northern subpopulation (ranging from northern Baja to Alaska) is between San Francisco and San Diego, California, and out to about 241 km (150 miles) offshore, though they are known to spawn as far offshore as 563 km (350 miles) offshore. Butler et al. (1993) estimated fecundity at 146,754 eggs to 2,156,600 eggs per two- and ten-year-old females, respectively, with longevity estimated at 13 years. Eggs and larvae occur near the sea surface, and eggs require about three days to hatch at 15°C (59°F).

Sardines are filter feeding and prey on planktonic crustaceans, fish larvae, and phytoplankton (Wolf et al. 2001). The average non-feeding swim speed of Pacific sardine is about 0.78 body lengths per second (BL/sec), while particulate feeding sardines exhibit swim speeds of 1.0 to 2.0 BL/sec; this equaled maximum speeds of 26 to 51 cm/sec (10.2 to 20.1 in./sec) (van der Lingen 1995). Pacific sardines are about 115 mm (4.5 in.) after one year, 173 mm (6.8 in.) after two years, 200 mm (7.9 in.) after three years, and 215 mm (8.5 in.) after four years (Hart 1973). They make northward migrations early in summer and return southward again in fall, with migrations becoming further with each year of life. Natural adult mortality (M) has been estimated as 0.4/year (MacCall 1979).

Pacific sardine supported the largest fishery in the Western Hemisphere during the 1930s and 1940s. However, the fishery collapsed in the 1940s and 1950s, leading to the establishment of the California Cooperative Oceanic Fisheries Investigations (CalCOFI) program in 1947, originally named the

Cooperative Sardine Research Program. Extreme natural variability and susceptibility to recruitment overfishing are characteristic of clupeoid stocks, including Pacific sardine (Hill et al. 2006). Regimes of high abundance of sardines (*S. sagax* and *S. pilchardus*) have alternated with regimes of high abundance of anchovy (*Engraulis* spp) in each of the five regions of the world where these taxa co-occur (Lluch-Belda et al. 1992). Both sardine and anchovy populations tend to vary over periods of roughly 60 years, although sardine have varied more than anchovy. Sardine population recoveries lasted an average of 30 years (Baumgartner et al. 1992). The Pacific sardine population began increasing at an average rate of 27 percent per year in the early 1980s, and recent estimates indicate the total biomass of Age-1 and older sardines is greater than one million metric tons (Hill et al. 2006; SWFSC 2007).

Sardine landed in the U.S. fishery are mostly frozen and sold overseas as bait and aquaculture feed, with smaller amounts canned or sold for human consumption and animal food (Hill et al. 2006). Commercial landings of Pacific sardine in 2006 in Santa Monica Bay catch blocks totaled 3,591,016 kg (9,134,600 lbs.) at a value of $426,626 (CDFG 2007). Los Angeles area landings (between Dana Point and Santa Monica) for 2005 totaled 24,143,616 kg (53,236,674 lbs.) at a value of $2,344,817 (CDFG 2006).

Sampling Results

A total of 612,526 Pacific sardines weighing 13,922 kg (30,693 lbs) was impinged during the three-month study (Tables 5-4 and 5-5). Pacific sardine was by far the most abundant fish collected during the study, accounting for 94.2 percent of total fish abundance and 87.0 percent of total fish biomass. Abundance was highest during the second reverse flow period, while biomass was highest during the first reverse flow period (Table 5-7, Figures 5-5 and 5-6). Abundance and biomass were both lowest during the second normal flow period. No sardines were impinged alive; 96 percent were dead and 4 percent were mutilated. Most sardines were between the 90- and 160-mm (3.5- and 6.3-inch) size classes, with an average size of 129 mm (5.1 in.) SL (Figure 5-7). Length frequency distribution indicated most sardines impinged were in their first or second year. The calculated effectiveness of the velocity cap in reducing impingement of Pacific sardine was greater than 99 percent (Table 5-8).

Table 5-7. Impingement of Pacific Sardine in the IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys during the Velocity Cap Effectiveness Study

Survey Period	Impingement Rate	
	No. per 1,000,000 m^3	Biomass (kg) per 1,000,000 m^3
N_1	36	1.0
R_1	9,807	322.7
N_2	13	0.8
R_2	13,885	236.6
N_3	74	1.5
R_3	*	*

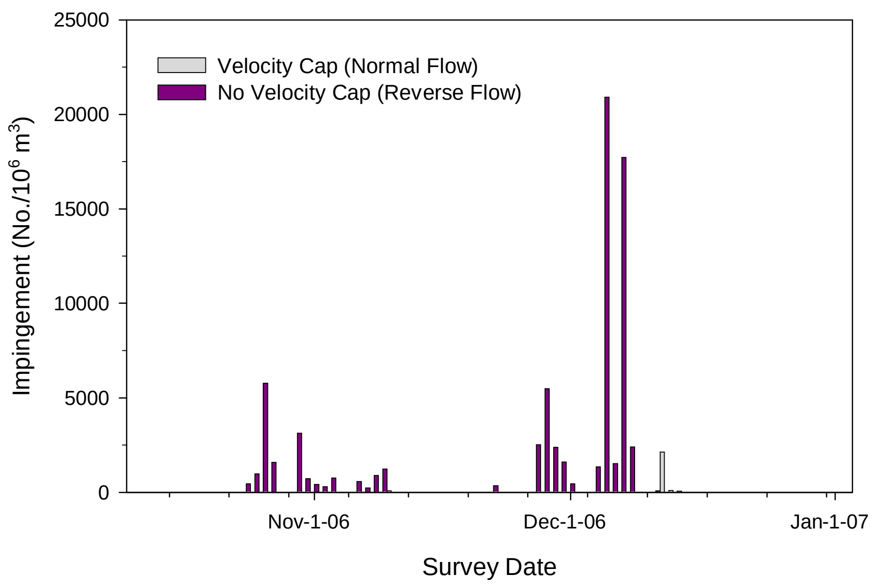
** Study completed after third normal flow period per LARWQCB directive to cease the velocity cap study.*

Table 5-8. Calculated Percent Effectiveness of the SGS Velocity Cap on Pacific Sardine

Survey Period Comparison	Calculated Percent Effectiveness (%)	
	Based on Abundance	Based on Biomass
R_1:N_1	99.63	99.70
R_1:N_2	99.86	99.75
R_2:N_2	99.90	99.66
R_2:N_3	99.47	99.38
R_3:N_3	*	*
Total	**99.59**	**99.57**

** Study completed after third normal flow period per LARWQCB directive to cease the velocity cap study.*

a) Abundance



b) Biomass

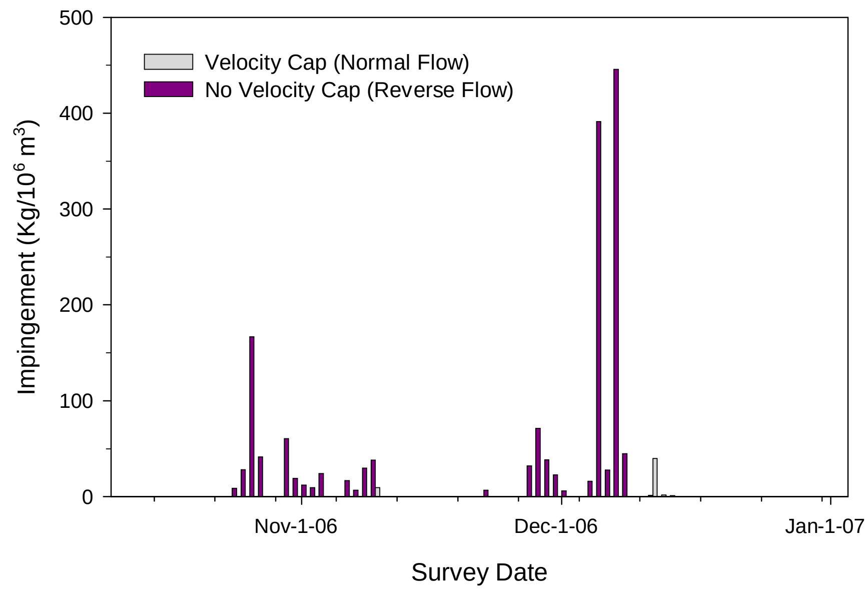
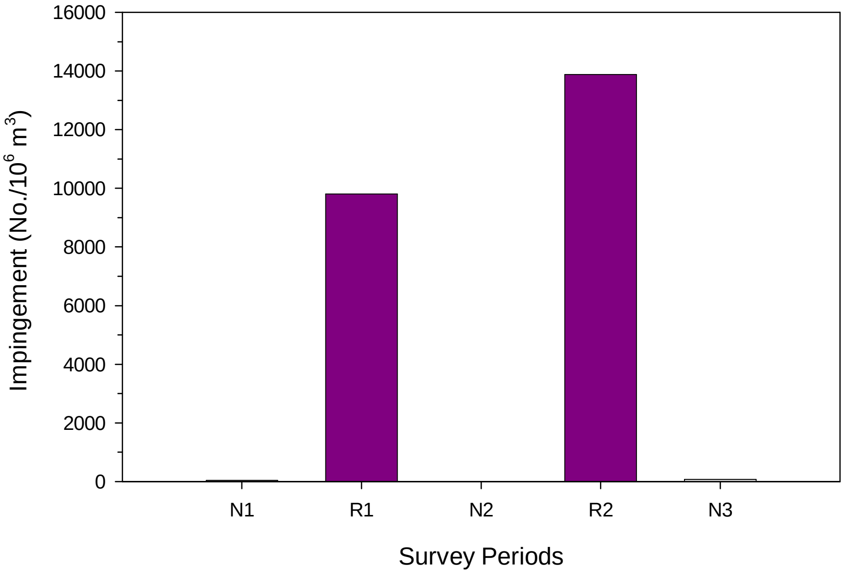
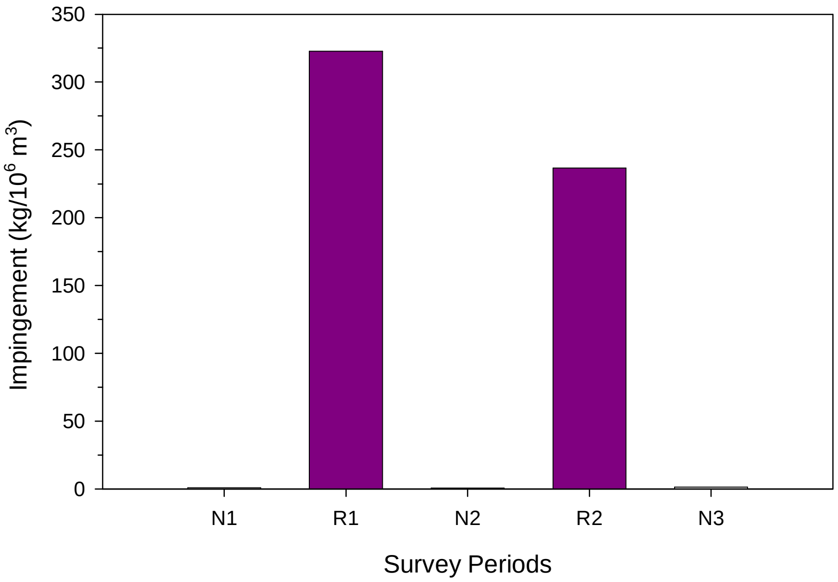


Figure 5-5. Pacific Sardine Impingement Rate During 24-hr Velocity Cap and IM&E Characterization Study Impingement Surveys: a) Abundance (#/10^6 m^3) and b) Biomass (kg/10^6 m^3)

a) Abundance



b) Biomass



N = normal flow (with velocity cap), R = reverse flow (without the velocity cap).

Figure 5-6. Pacific Sardine Impingement Rate for the IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys during Each of the Flow Periods: a) Abundance (#/10^6 m^3) and b) Biomass (kg/10^6 m^3)

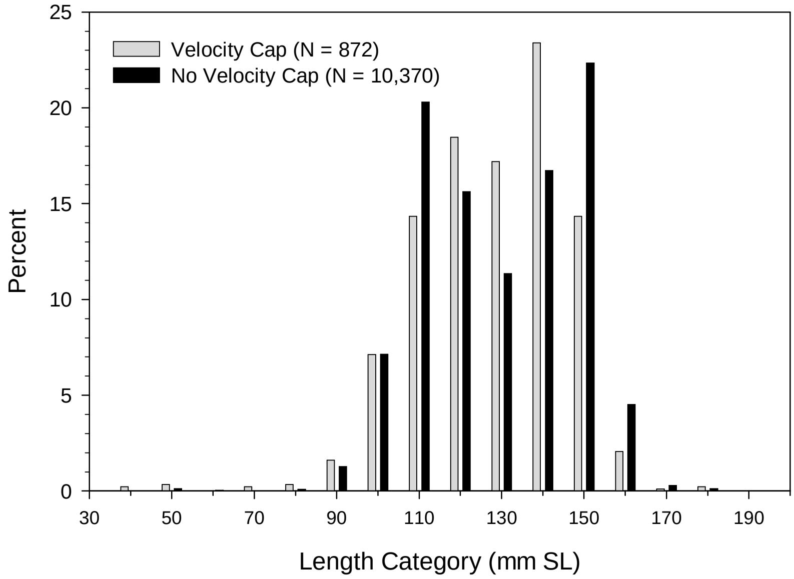


Figure 5-7. Length Frequency Distribution of Pacific Sardine from Impingement Samples

5.3.3.2 Topsmelt

Adult Range:
British Columbia, Canada to Baja California and Gulf of California

Adult Habitat:
Pelagic, brackish, marine

Three species of silversides (Family Atherinopsidae) occur in the waters off southern California: topsmelt (*Atherinops affinis*), jacksmelt (*Atherinopsis californiensis*), and California grunion (*Leuresthes tenuis*). Topsmelt ranges from Sooke Harbor, Vancouver Island, British Columbia to the Gulf of California (Miller and Lea 1972). All three species are common in Santa Monica Bay (MBC 2006).

Topsmelt occur in sandy beach areas, kelp beds, harbors, and estuaries (Gregory 2001). In Upper Newport Bay, they comprised 76 percent of the total catch in bimonthly sampling using six gear types (Horn and Allen 1985). They usually form loose schools at or near the sea surface (Fitch and Lavenberg 1973). Spawning is related to changes in water temperature (Middaugh et al. 1990), and in Newport Bay occurred between February and June, peaking in May and June (Love 1996). Females deposit eggs on marine plants and other floating objects where fertilization occurs (Love 1996). Fecundity is a function of female body size, with 110- to 120-mm (4.3- to 4.7-in.) long individuals spawning about 200 eggs per season, and fish larger than 160 mm (6.3 in.) spawning 1,000 eggs per season (Fronk 1969).

They reach 64 to 102 mm (2.5 to 4 in.) during their first year, 114 to 152 mm (4.5 to 6.0 in.) during their second year, and grow proportionally less each year (Gregory 2001). Maximum size is about 355 mm (14 in.). Some topsmelt spawn at age two, and most at age three. Topsmelt feed primarily within three to five meters (9.8 to 16.4 ft) of the sea surface over shallow rocky areas or kelp beds (Fitch and Lavenberg 1973). Adults feed on plant material, planktonic crustaceans, polychaetes, and insect larvae (Horn and Allen 1985).

Topsmelt are caught by recreational anglers from shore and from piers (Gregory 2001). Commercially caught silversides are marketed fresh for human consumption or bait. Commercial landings of topsmelt in 2006 in Santa Monica Bay catch blocks totaled 0.9 kg (2 lbs.) at a value of $20 (CDFG 2007). No landings were reported for Los Angeles area ports (CDFG 2006).

Sampling Results

A total of 14,591 topsmelt weighing nearly 405 kg (893 lbs) was impinged during the three-month study (Tables 5-4 and 5-5). Topsmelt was the second most abundant species in impingement samples, accounting for 2.2 percent of total fish abundance and 2.5 percent of total fish biomass. Both abundance and biomass were highest during the second reverse flow period (Table 5-9, Figures 5-8 and 5-9). Abundance and biomass were both lowest during the first normal flow period. Highest impingement during weekly IM&E and velocity cap surveys occurred between December 12 and 14, 2006 in normal flow (Figure 5-8). Of the individuals measured, 96.4 percent were dead, 2.2 percent were mutilated, and 1.4 percent was alive. Topsmelt ranged from 64 to 286 mm (2.5 to 11.3 in.) SL, averaging 135 mm (5.3 in.) (Figure 5-10), indicating most topsmelt impinged were in their first or second year. The calculated effectiveness of the velocity cap in reducing impingement of topsmelt was 92 percent (Table 5-10).

Table 5-9. Impingement of Topsmelt in the IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys during Velocity Cap Effectiveness Study

	Impingement Rate	
Survey Period	**No. per 1,000,000 m^3**	**Biomass (kg) per 1,000,000 m^3**
N_1	4	0.13
R_1	15	0.48
N_2	25	0.66
R_2	459	12.69
N_3	30	0.86
R_3	*	*

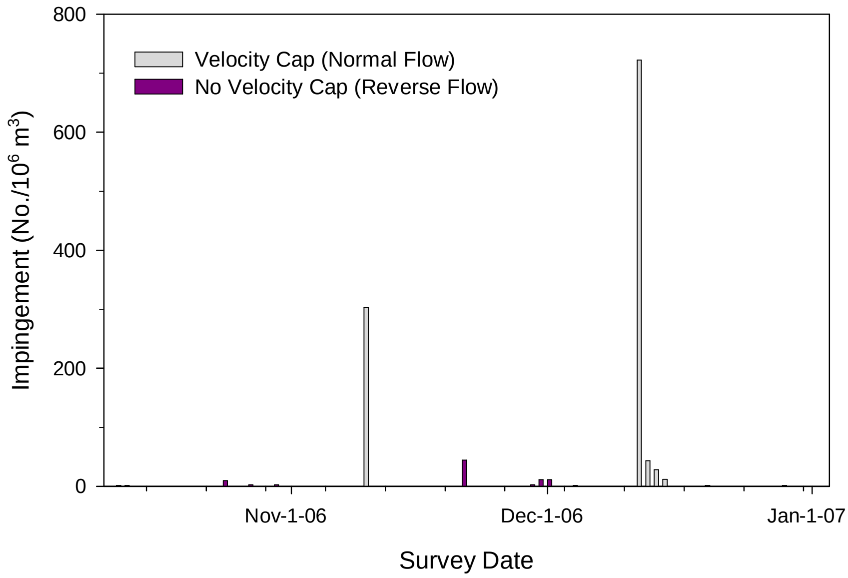
** Study completed after third normal flow period per LARWQCB directive to cease the velocity cap study.*

Table 5-10. Calculated Percent Effectiveness of the SGS Velocity Cap on Topsmelt

	Impingement Rate	
Survey Period Comparison	**No. per 1,000,000 m^3**	**Biomass (kg) per 1,000,000 m^3**
R_1:N_1	72.37	72.57
R_1:N_2	-	-
R_2:N_2	94.48	94.84
R_2:N_3	93.37	93.23
R_3:N_3	*	*
Total	**91.69**	**91.69**

Study completed after third normal flow period per LARWQCB directive to cease the velocity cap study. Hyphen indicates higher abundance or biomass during normal flow period.

a) Abundance



b) Biomass

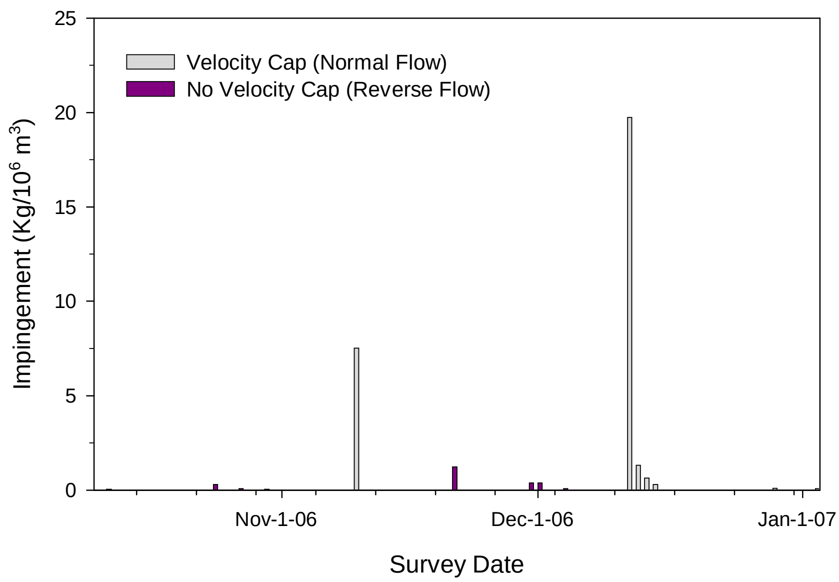
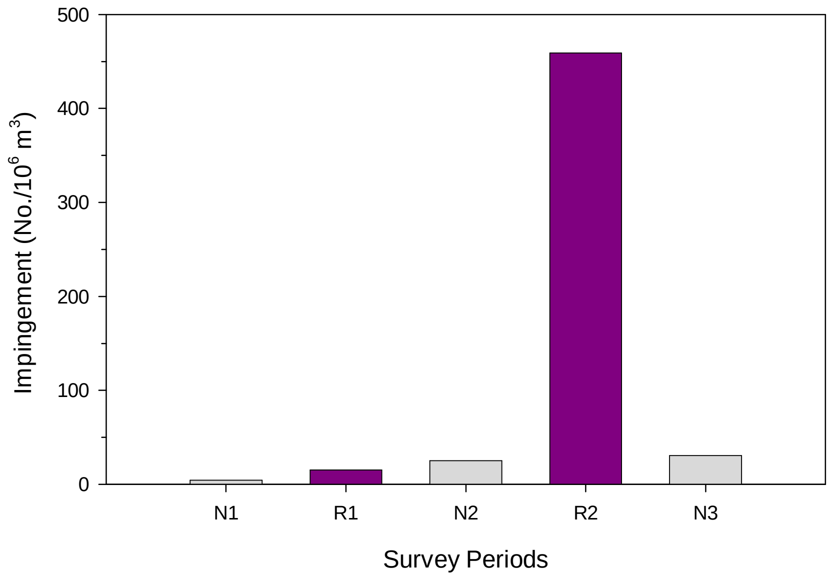
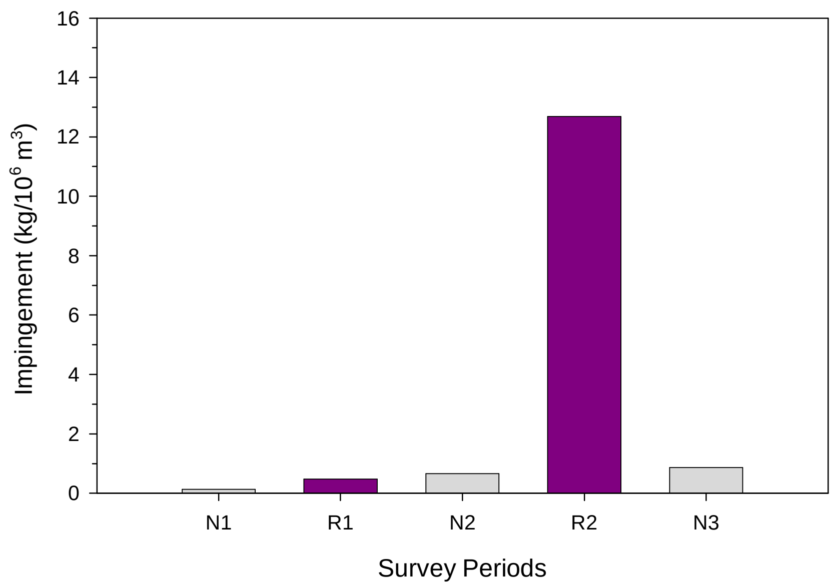


Figure 5-8. Topsmelt Impingement Rate during 24-hr Velocity Cap and IM&E Characterization Surveys: a) Abundance (#/10^6 m^3) and b) Biomass (kg/10^6 m^3)

a) Abundance



b) Biomass



N = normal flow (with velocity cap), R = reverse flow (without the velocity cap).

Figure 5-9. Topsmelt Impingement Rate for the IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys during Each of the Flow Periods: a) Abundance (#/10^6 m^3) and b) Biomass (kg/10^6 m^3)

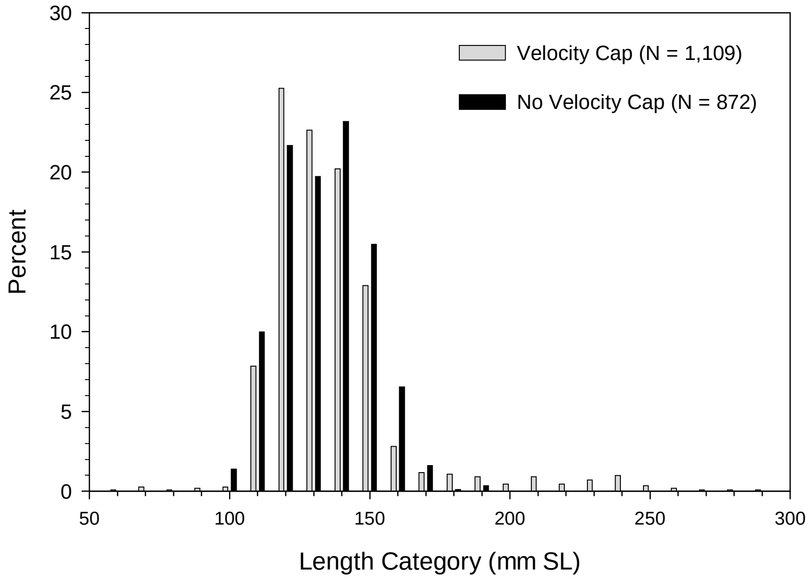


Figure 5-10. Length Frequency Distribution of Topsmelt from Impingement Samples

5.3.3.3 Queenfish

Adult Range:
Yaquina Bay, Oregon to southern Baja California

Adult Habitat:
Demersal, marine, 0-70 m depth

Queenfish (*Seriphus politus*) range from west of Uncle Sam Bank, Baja California, north to Yaquina Bay, Oregon (Miller and Lea 1972). Queenfish are common in southern California, but rare north of Monterey. They are one of eight species of croaker or ‘drums’ (Family Sciaenidae) found off California. Of those eight species, all but shortfin corvina (*Cynoscion parvipinnis*) have been collected in impingement samples at the SGS since 1990 (MBC 2006). Shortfin corvina has never occurred in Santa Monica Bay, and presently occurs as far north as San Diego Bay (Tenera 2004).

The reported depth range of queenfish is from the surface to depths of about 37 m (120 ft) (Miller and Lea 1972); however, in southern California, Allen (1982) found queenfish over soft bottoms between 10 and 70 m (33 and 230 ft), with highest abundance occurring at 10 m (33 ft). During the day, queenfish hover in dense, somewhat inactive schools close to shore, but disperse to feed in midwater after sunset (Hobson and Chess 1976). They are active throughout the night, and feeds several meters off the seafloor in small schools or as lone individuals.

Queenfish is a summer spawner. Goldberg (1976) found queenfish to enter spawning condition in April and spawn into August, while DeMartini and Fountain (1981) recorded spawning in queenfish between March and August. Spawning is asynchronous among females, but there are monthly peaks in intensity during the waxing (first quarter) of the moon (DeMartini and Fountain 1981). They also stated that mature queenfish spawn every 7.4 days on average, regardless of size. Duration of the spawning season is a function of female body size, ranging from three months (April–June) in recruit spawners to six months (March–August) in repeat spawners (>135 mm [5.3 in.] SL). Based on the spawning frequency and number of months of spawning, these two groups of spawners can produce about 12 and 24 batches of eggs during their respective spawning seasons (DeMartini and Fountain 1981).

Goldberg (1976) found no sexually mature females less than 148 mm (5.8 in.) SL in Santa Monica Bay. This differs from the findings of DeMartini and Fountain (1981) off San Onofre. They found females sexually mature at 100–105 mm (3.9–4.1 in.) SL at slightly greater than age-1. Batch fecundities in queenfish off San Onofre ranged from 5,000 eggs in a 105-mm female to about 90,000 eggs in a 250-mm fish. The average-sized female in that study (140 mm [5.5 in], 42 g [93 lbs]) had a potential batch fecundity of 12,000–13,000 eggs. Murdoch (1989a) estimated the average batch fecundity to be 12,700 for queenfish collected over a five-year period. Based on a female spawning frequency of 7.4 days, a 105 mm (4.1 in.) female that spawns for three months (April–June) can produce about 60,000 eggs/year, while a 250 mm (9.8 in.) female that spawns for six months (March through August) can produce nearly 2.3 million eggs/year (DeMartini and Fountain 1981).

Queenfish mature at 105 mm (4.1 in.) (DeMartini and Fountain 1981) to 127 mm (5 in.) (Love 1996), during their first spring or second summer. Maximum reported size is 305 mm (12 in.) (Miller and Lea 1972). Immature individuals grow at a rate of about 2.5 mm (0.1 in.)/day, while early adults grow about 1.8 mm (0.07 in.)/day (Murdoch et al. 1989b). Mortality estimates are unavailable for this species.

Queenfish feed mainly on crustaceans, including amphipods, copepods, and mysids, along with polychaetes and fishes (Quast 1968, Hobson and Chess 1976, Hobson et al. 1981, Feder et al. 1974). There were no reported commercial landings of queenfish in 2006 in Santa Monica Bay catch blocks (CDFG 2007), or from Los Angeles area landings in 2005 (CDFG 2006).

Sampling Results

A total of 10,236 queenfish weighing 171 kg (377 lbs) was impinged during the three-month study (Tables 5-4 and 5-5). Queenfish was the third most abundant species in impingement samples, accounting for 1.6 percent of total fish abundance and 1.1 percent of total fish biomass. Both abundance and biomass were highest during the third normal flow period (Table 5-11, Figures 5-11 and 5-12). Abundance and biomass were both lowest during the first normal flow period. Highest impingement during weekly IM&E and velocity cap surveys occurred between December 13 and 15, 2006 in normal flow (Figure 5-11). Of the individuals measured, 98 percent were dead and 2 percent were mutilated. Impinged queenfish ranged from 15 to 175 mm (0.6 to 6.9 in.) SL, averaging 79 mm (3.1 in.) (Figure 5-13). Length frequency analysis suggest two age classes were impinged during both flow regimes, likely corresponding to fish in their first and second years. During the first three survey periods, the velocity cap was 46 to 89 percent effective in reducing impingement of queenfish (Table 5-12).

Table 5-11. Impingement of Queenfish in the IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys during Velocity Cap Effectiveness Study

	Impingement Rate	
Survey Period	**No. per 1,000,000 m^3**	**Biomass (kg) per 1,000,000 m^3**
N_1	7	0.03
R_1	19	0.12
N_2	10	0.06
R_2	25	0.54
N_3	301	5.18
R_3	*	*

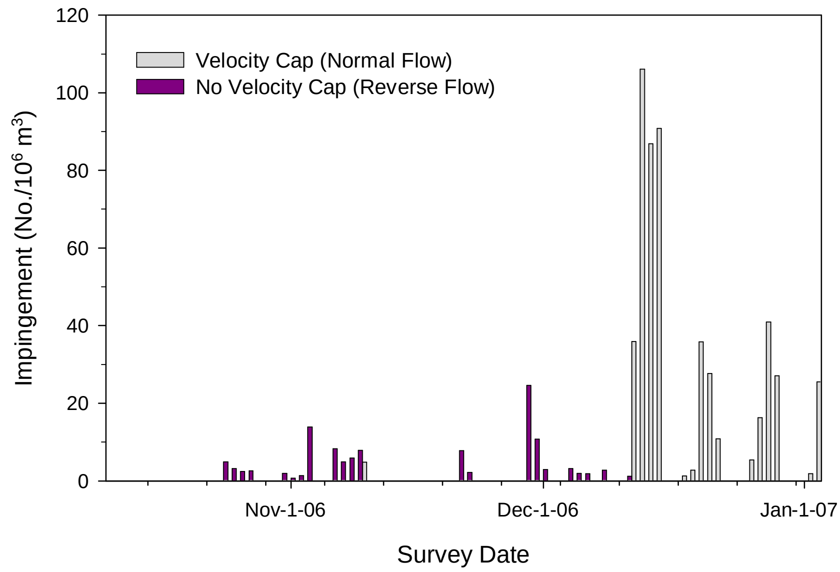
** Study completed after third normal flow period per LARWQCB directive to cease the velocity cap study.*

Table 5-12. Calculated Percent Effectiveness of the SGS Velocity Cap on Queenfish

	Impingement Rate	
Survey Period Comparison	**No. per 1,000,000 m^3**	**Biomass (kg) per 1,000,000 m^3**
R_1:N_1	61.89	70.55
R_1:N_2	45.73	50.66
R_2:N_2	59.90	89.42
R_2:N_3	-	-
R_3:N_3	*	*
Total	**-**	**-**

Study completed after third normal flow period per LARWQCB directive to cease the velocity cap study. Hyphen indicates higher abundance or biomass during normal flow period.

a) Abundance



b) Biomass

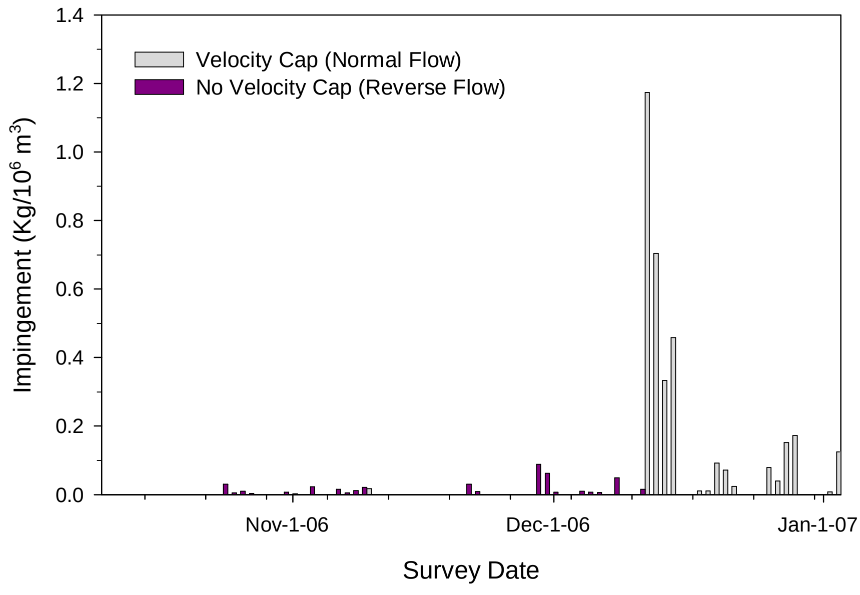
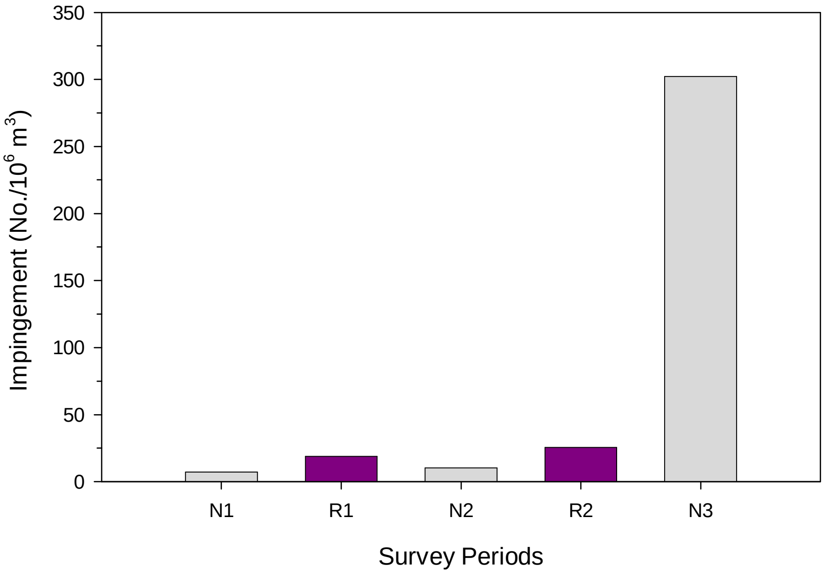
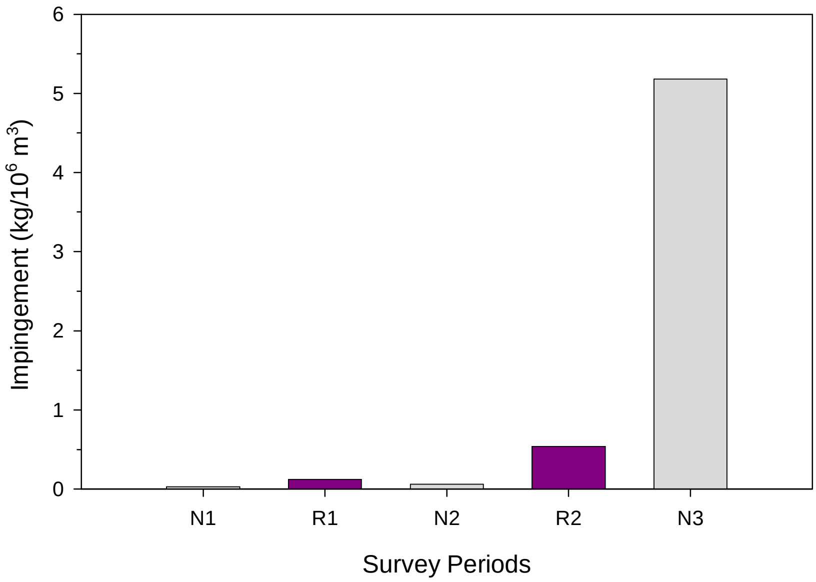


Figure 5-11. Queenfish Impingement Rate During 24-hr Velocity Cap and IM&E Characterization Surveys: a) Abundance (#/10^6 m^3) and b) Biomass (kg/10^6 m^3)

a) Abundance



b) Biomass



N = normal flow (with velocity cap), R = reverse flow (without the velocity cap).

Figure 5-12. Queenfish Impingement Rate for the IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys During Each of the Flow Periods: a) Abundance (#/10^6 m^3) and b) Biomass (kg/10^6 m^3)

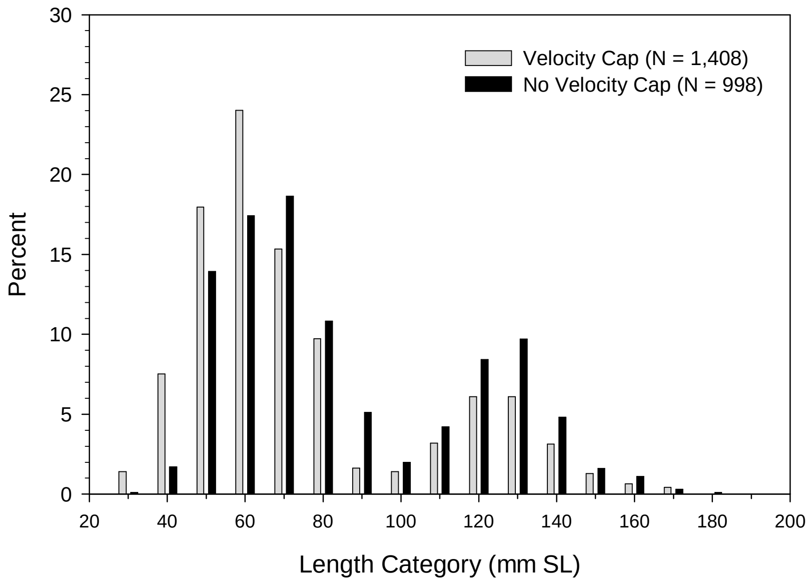


Figure 5-13. Length Frequency Distribution of Queenfish from Impingement Samples

5.3.3.4 Jacksmelt

Adult Range:
Yaquina, Oregon to Santa Maria Bay, Baja California

Adult Habitat:
Pelagic, brackish, marine

Three species of silversides (Family Atherinopsidae) occur in the waters off southern California: topsmelt (*Atherinops affinis*), jacksmelt (*Atherinopsis californiensis*), and California grunion (*Leuresthes tenuis*). Topsmelt was discussed in section 5.3.3.2. Jacksmelt ranges from Yaquina, Oregon to Santa Maria Bay, Baja California (Miller and Lea 1972). All three species commonly occur in Santa Monica Bay (MBC 2006).

Jacksmelt occur over much of the nearshore areas of California, and are usually found in bays and within a few miles of shore (Gregory 2001). Juveniles and adults are surface-oriented pelagic schooling fishes (Allen and DeMartini 193). Jacksmelt form denser and larger schools than topsmelt, although the two species often school together.

Spawning occurs in winter (October to April), and egg masses are attached to aquatic plants (eelgrass and algae) and flotsam by long filaments. Fecundity has been estimated at over 2,000 eggs per female (Emmett et al. 1991). They reach 114 to 127 mm (4.5 to 5 in.) during their first year, and up to 203 mm (8 in.) during their second year (Gregory 2001). Maximum size is about 560 mm (22 in.). Jacksmelt mature at about two to three years. Adults feed on plankton and small fishes (Horn and Allen 1985).

Jacksmelt are caught recreationally, but a parasitic nematode often infests the flesh, thus reducing their commercial and recreational value (Emmett et al. 1991). Commercial landings of jacksmelt in 2006 in Santa Monica Bay catch blocks totaled 45 kg (100 lbs.) at a value of $75 (CDFG 2007). Los Angeles area landings (between Dana Point and Santa Monica) for 2005 totaled 1,541 kg (3,399 lbs.) at a value of $1,777 (CDFG 2006).

Sampling Results

A total of 6,684 jacksmelt weighing nearly 705 kg (1,554 lbs) was impinged during the three-month study (Tables 5-4 and 5-5). Jacksmelt was the fourth most abundant species in impingement samples, accounting for 1.0 percent of total fish abundance and 4.4 percent of total fish biomass. Both abundance and biomass were highest during the second reverse flow period (Table 5-13, Figures 5-14 and 5-15). Abundance and biomass were both lowest during the first normal flow period. Highest impingement during weekly IM&E and velocity cap surveys occurred in mid-December in normal flow (Figure 5-14). Of the individuals measured, 58 percent were alive, 41 percent were dead, and 1 percent was mutilated. Impinged jacksmelt ranged from 68 to 315 mm (2.7 to 12.4 in.) SL, averaging 205 mm (8.1 in.) (Figure 5-16), which corresponds to fish in their second year. The calculated effectiveness of the velocity cap in reducing impingement of topsmelt was 77–79 percent (Table 5-14).

Table 5-13. Impingement of Jacksmelt in the IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys during Velocity Cap Effectiveness Study

	Impingement Rate	
Survey Period	**No. per 1,000,000 m^3**	**Biomass (kg) per 1,000,000 m^3**
N_1	0.12	0.01
R_1	7.41	0.88
N_2	3.78	0.36
R_2	180.43	19.28
N_3	47.20	4.68
R_3	*	*

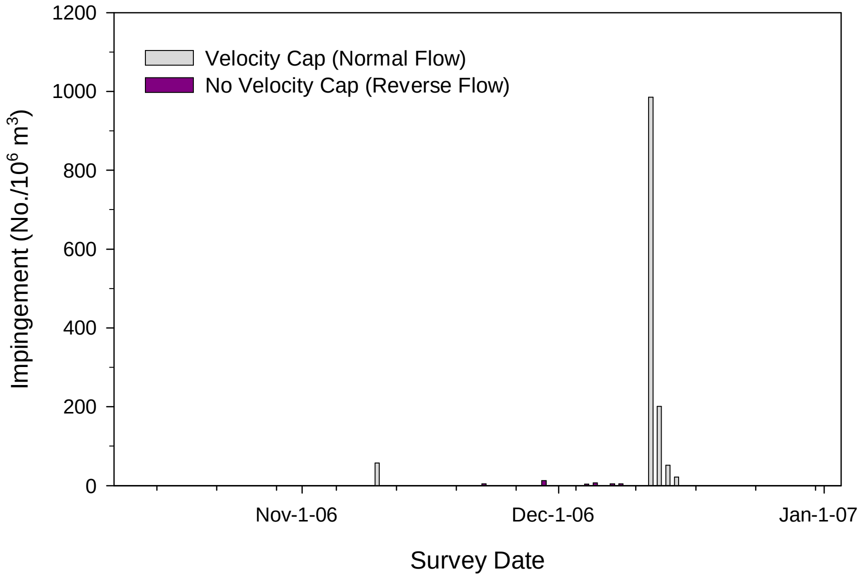
** Study completed after third normal flow period per LARWQCB to cease the velocity cap study.*

Table 5-14. Calculated Percent Effectiveness of the SGS Velocity Cap on Jacksmelt

	Impingement Rate	
Survey Period Comparison	**No. per 1,000,000 m^3**	**Biomass (kg) per 1,000,000 m^3**
R_1:N_1	98.40	99.42
R_1:N_2	48.93	59.01
R_2:N_2	97.90	98.13
R_2:N_3	73.84	75.72
R_3:N_3	*	*
Total	**76.98**	**78.76**

** Study completed after third normal flow period per LARWQCB to cease the velocity cap study.*

a) Abundance



b) Biomass

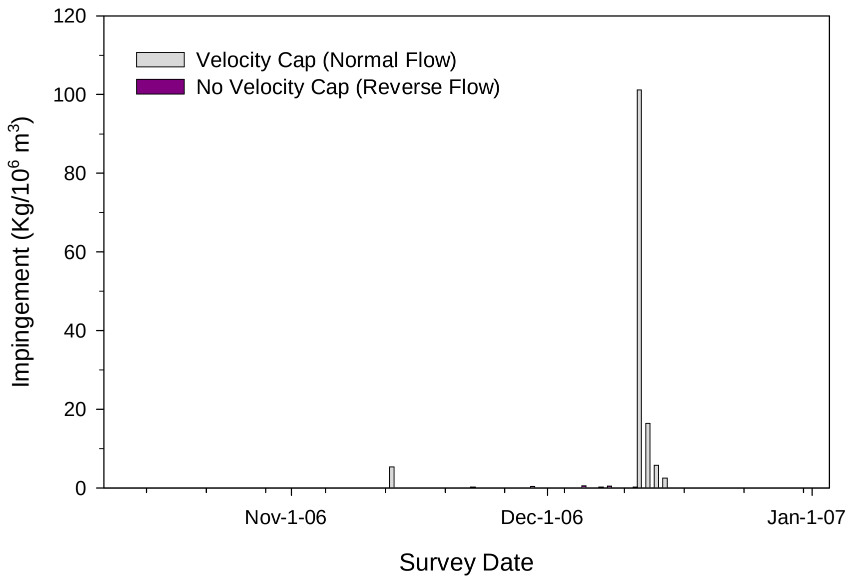
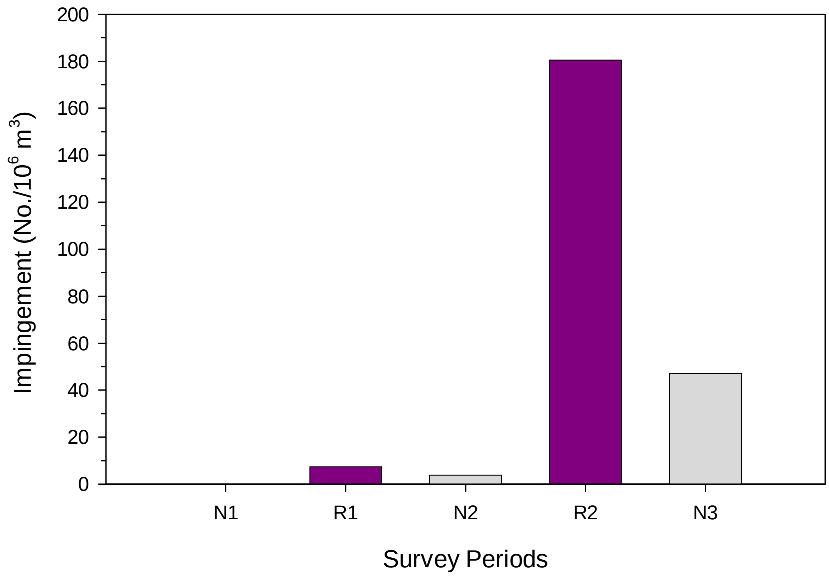
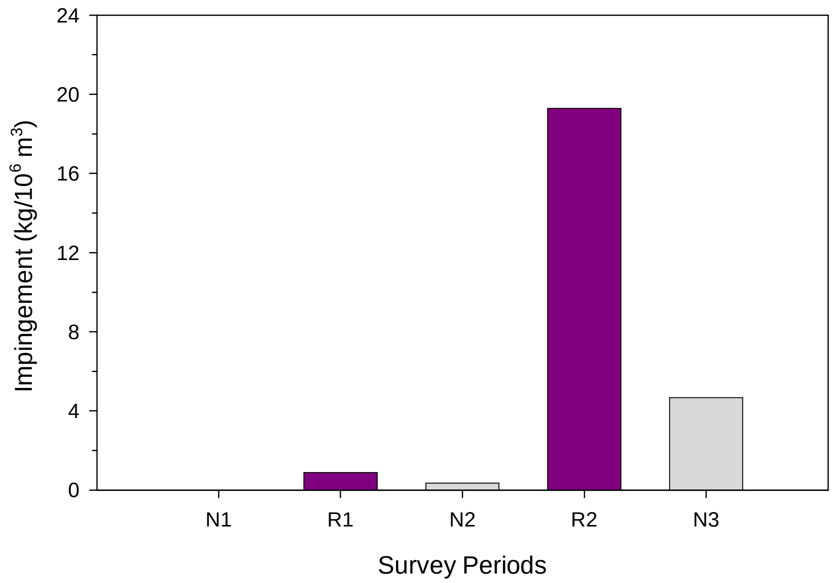


Figure 5-14. Jacksmelt Impingement Rate During 24-hr Velocity Cap and IM&E Characterization surveys: a) Abundance (#/10^6 m^3) and b) Biomass (kg/10^6 m^3)

a) Abundance



b) Biomass



N = normal flow (with velocity cap), R = reverse flow (without the velocity cap).

Figure 5-15. Jacksmelt Impingement Rate for the IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys during each of the Flow Periods: a) Abundance (#/10^6 m^3) and b) Biomass (kg/10^6 m^3)

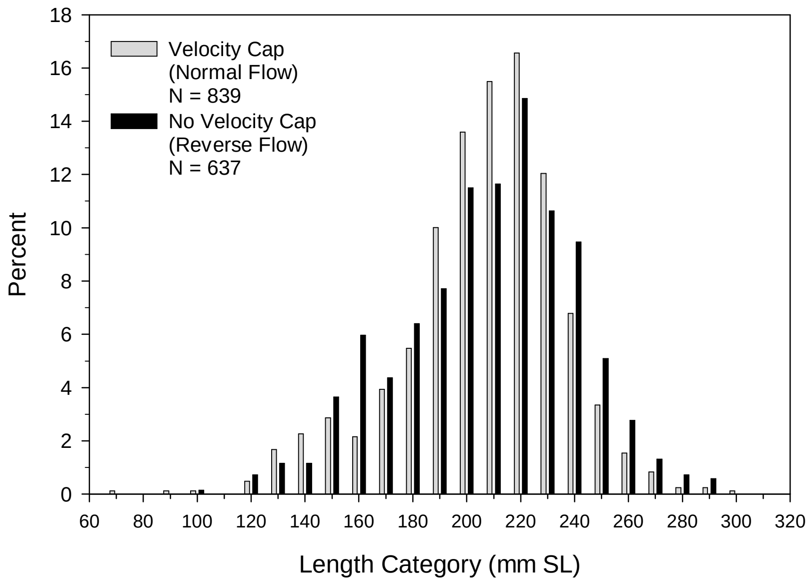


Figure 5-16. Length Frequency Distribution of Jacksmelt from Impingement Samples

5.4 HYDROACOUSTIC SAMPLING RESULTS

Estimates of fish density in numbers per cubic meter from a total of 701 transects collected from period October 22, 2006 to December 13, 2006 near the SGS intake and discharge structures offshore are presented in Attachment A-7. To illustrate one part of the fish density estimation procedure, Figures 5-17, 5-18, and 5-19 show typical fish echoes and the removal limits of surface and bottom noise in a comparison of two, nighttime transects made in approximately the same location but in normal and reverse flow conditions. First, the water column backscatter was separated from the bottom. Then any surface noise was removed from the water column.

Figure 5-20 shows all fish density estimates collected near the SGS intake and discharge offshore structures from hydroacoustic sampling. Overall, the mean density in the offshore portion of all transects was 0.0116 kg/m^3 while the inshore portion averaged 0.0152 kg/m^3. Table 5-15 shows mean fish densities estimated in hydroacoustic surveys, by day and night in normal and reverse intake flow conditions and inshore and offshore portions. Figure 5-21 shows the densities by transect during day and night. Data are for 14 transects from a possible 21 near the SGS intake and discharge. The outer transects 1 and 21 were not surveyed due to time constraints; inner transects (9-13) near structures were not surveyed to avoid noise from intake and discharge structures. The result in the next section compares the offshore with the inshore fish densities using all but one, per transect, differences.

These fish density differences between offshore and inshore transect sections are shown in Figure 5-20 by a frequency histogram using 70 of the 71 transects sampled during the study. One of the 71 transects was omitted because the inshore portion was not collected. The majority of differences were found near 0. A bootstrapped estimate of the distribution of these density estimates indicated that a value of 0 fell at approximately 90% in the cumulative distribution or p=0.2, indicating that, overall, one cannot say the inshore estimates were different than the offshore ones.

The results in the following section contrast just the inshore portion in reverse flow and the offshore portion in normal flow.

Top left and lower left panels are nighttime transects from November 20, 2006 (Survey 3 normal flow) showing bottom tracking to filter surface (top left) and near bottom (bottom left) noise from water column pelagic fish echoes. Top right and lower right panels are the same transect a day later in reverse flow. Individual fish as well as a shoal can be seen. The hard blue bottom return visible at left 1/3 in both surveys is an offshore pipeline, south of the intake structures.

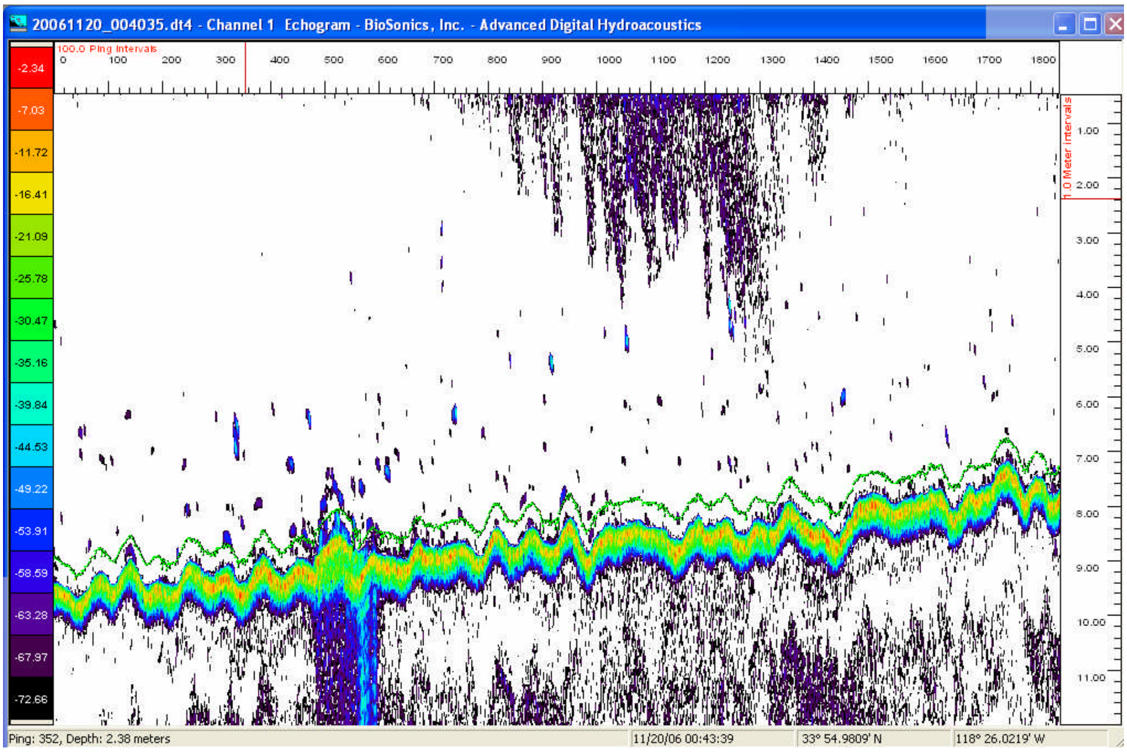


Figure 5-17. Example of Hydroacoustic Data and Processing: Bottom Tracking

Data from Survey 3, normal flow, November 20, 2006 night. Vertical depth (m) scale is at right; color acoustic intensity scale (dB) is at left. Horizontal scale shows ping number (5 Hz pingrate). Bottom tracking is shown by green line. Individual fish can be seen in the water column above the bottom with noise appearing at the surface midway thru the transect. The hard blue bottom return visible at left 1/3 is an offshore pipeline, south of the intake structures.

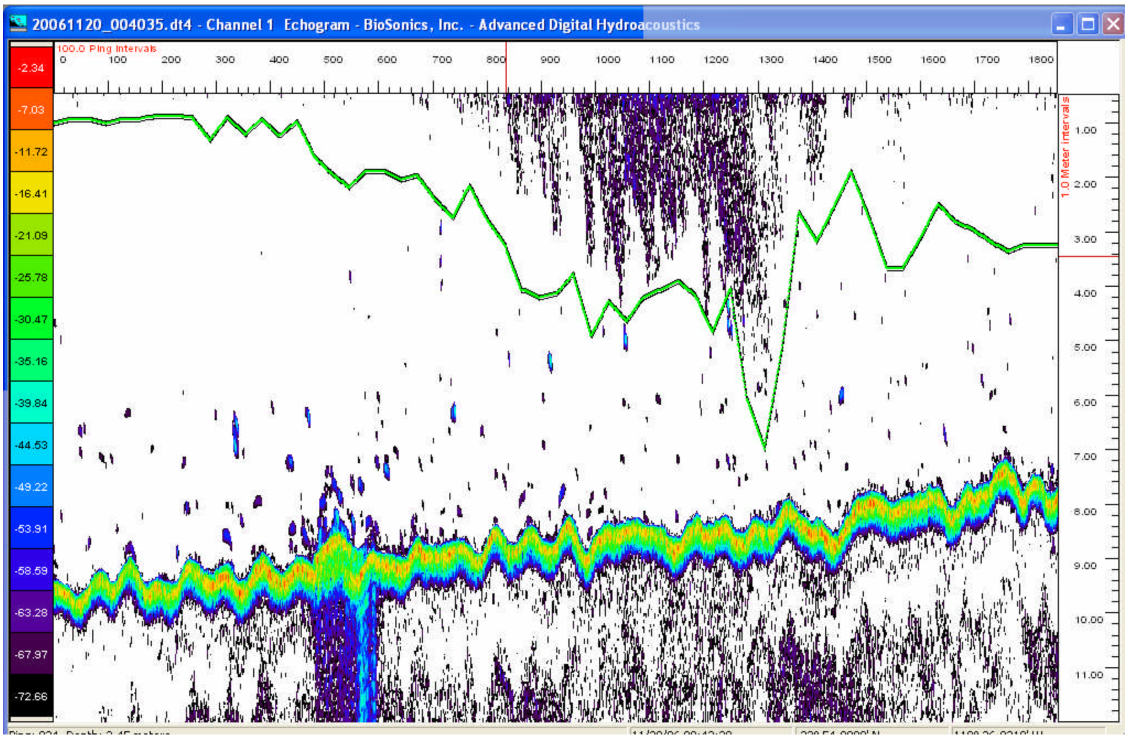


Figure 5-18. Example of Hydroacoustic Data and Processing: Pelagic Tracking

Data from Survey 3, normal flow, November 20, 2006 night. Pelagic tracking to filter surface (top left) noise from water column pelagic fish echoes.. Vertical depth (m) scale is at right; color acoustic intensity scale (dB) is at left. Horizontal scale shows ping number (5 Hz ping rate). Surface noise tracking is shown by green line.

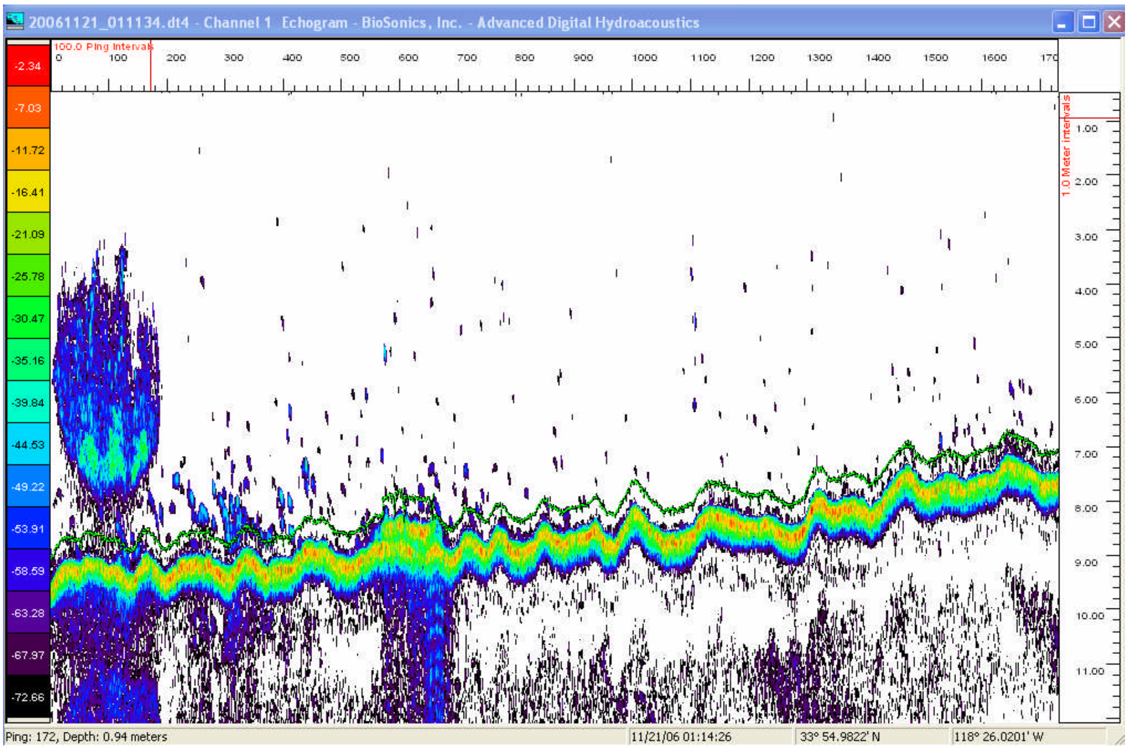


Figure 5-19. Example of Hydroacoustic Data and Processing: Bottom Tracking

Data from Survey 3, reverse flow, November 20, 2006 night. Vertical depth (m) scale is at right; color acoustic intensity scale (dB) is at left. Horizontal scale shows ping number (5 Hz pingrate). Bottom tracking is shown by green line. Individual fish can be seen above the bottom while a shoal appears at left. The hard blue bottom return visible at left 1/3 in both surveys is an offshore pipeline, south of the intake structures. No surface noise is evident.

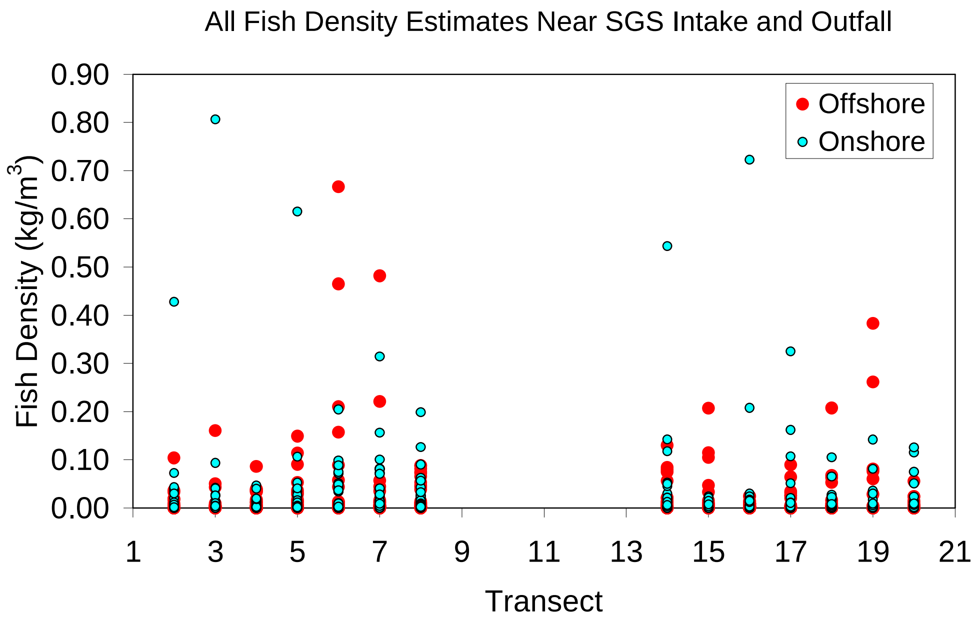


Figure 5-20. Hydroacoustic Fish Density Estimates for Each Transect for All Sample Replicates (day and night)

Transect estimates were grouped into offshore and inshore components for analysis by reverse (no velocity cap) and normal (velocity cap) intake conditions. Data are for 14 transects (from a possible 21) near the SGS intake and discharge for the period October 22, 2006 to December 13, 2006. Outer transects 1 and 21 were not surveyed due to time constraints; inner transects near 11 were not surveyed to avoid noise from intake and discharge structures.

5.4.1 Normal and Reverse Flow Results

Transect estimates were grouped into offshore and inshore components for analysis by normal (velocity cap) and reverse (no velocity cap) intake conditions (Figure 5-22). Table 5-15 shows the four surveys means of transect densities segregated by offshore and inshore, normal and reverse flow, and day and night. A comparison of densities averaged over surveys and using offshore versus inshore transect portions in normal (offshore) and reverse (inshore) flow were 0.02076 kg/m^3 (normal, day) versus 0.01232 kg/m^3 (reverse, day) and 0.00173 kg/m^3 (normal, night) versus 0.00488 kg/m^3 (reverse, night). Per transect estimates are reported in Attachment A-7.

Table 5-15. Hydroacoustic Estimates of Fish Biomass (kg/m^3) near the SGS Intake and Outfall

	Normal				Reverse			
	Day Offshore	**Day Inshore**	**Night Offshore**	**Night Inshore**	**Day Offshore**	**Day Inshore**	**Night Offshore**	**Night Inshore**
Survey 1								
Mean	0.01558	0.03342	0.00095	0.00844	0.04217	0.02260	0.00637	0.00079
St. Dev.	0.03292	0.11550	0.00134	0.01338	0.11101	0.08364	0.01657	0.00133
N	41	41	42	42	42	42	42	42
Survey 2								
Mean	0.02953	0.06603	0.00074	0.03043	0.01096	0.01583	0.00637	0.00497
St. Dev.	0.07864	0.17547	0.00095	0.05215	0.02645	0.05205	0.02007	0.01990
N	36	36	42	41	79	79	42	42
Survey 3								
Mean	0.02512	0.02336	0.00030	0.00528	0.01971	0.00815	0.00735	0.01323
St. Dev.	0.07682	0.03598	0.00040	0.01875	0.07299	0.02010	0.02559	0.03553
N	42	42	42	42	42	42	42	42
Survey 4								
Mean	0.01280	0.00818	0.00491	0.00657	0.00442	0.00270	0.00061	0.00051
St. Dev.	0.04233	0.03081	0.00392	0.00588	0.01866	0.00850	0.00132	0.00133
N	42	42	42	42	41	41	42	42
Average of Means	**0.02076**	**0.03275**	**0.00173**	**0.01268**	**0.01931**	**0.01232**	**0.00517**	**0.00488**

* Biomasses are survey mean estimates in offshore and inshore transect portions, by day and night, and in normal and reverse flow conditions. Standard deviations and number of transects (N) are shown.

** October 22, 2006 thru December 13, 2006 data.

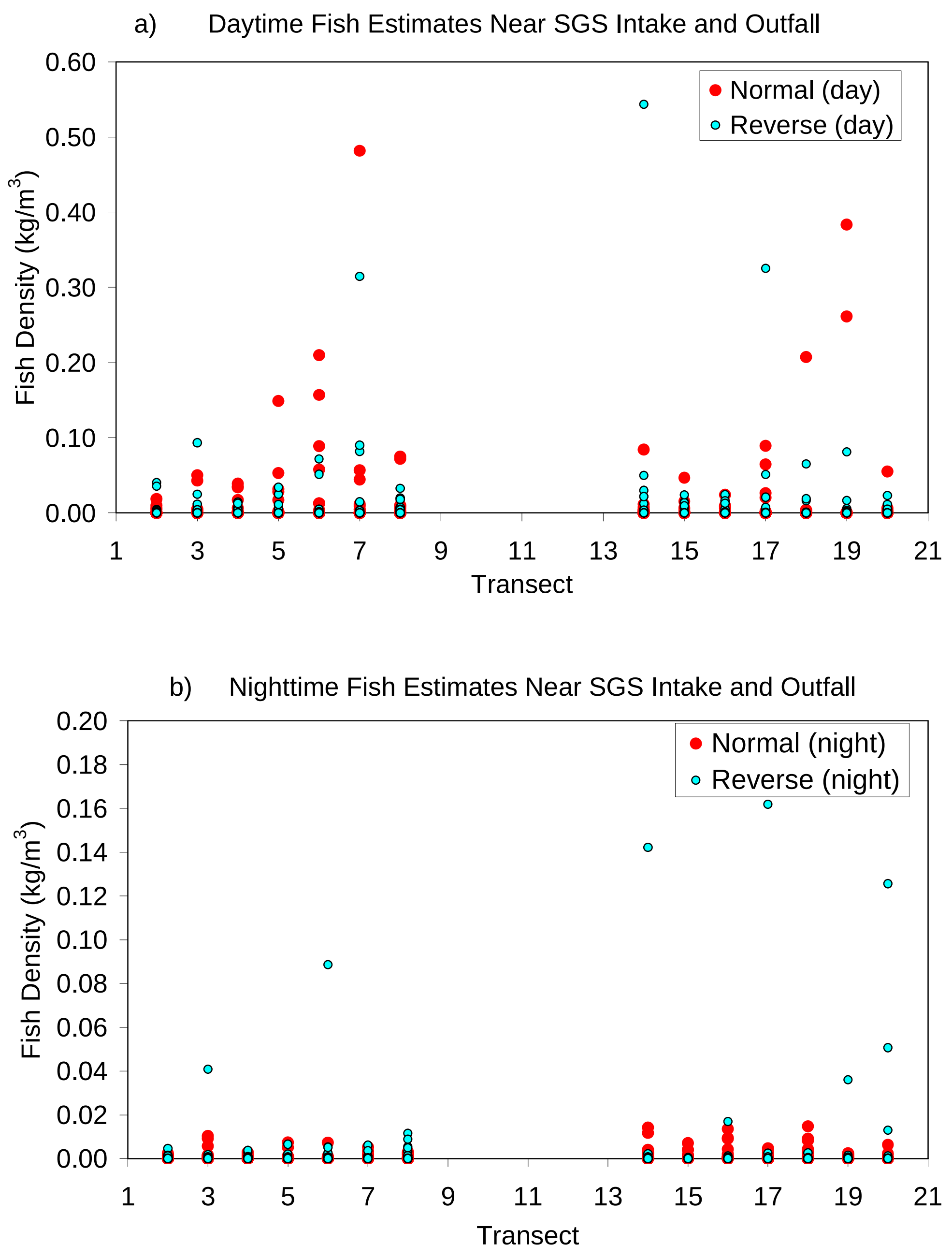


Figure 5-21. Hydroacoustic Fish Density Estimates Grouped into Normal Flow (with velocity cap) and Reverse Flow (without velocity cap)

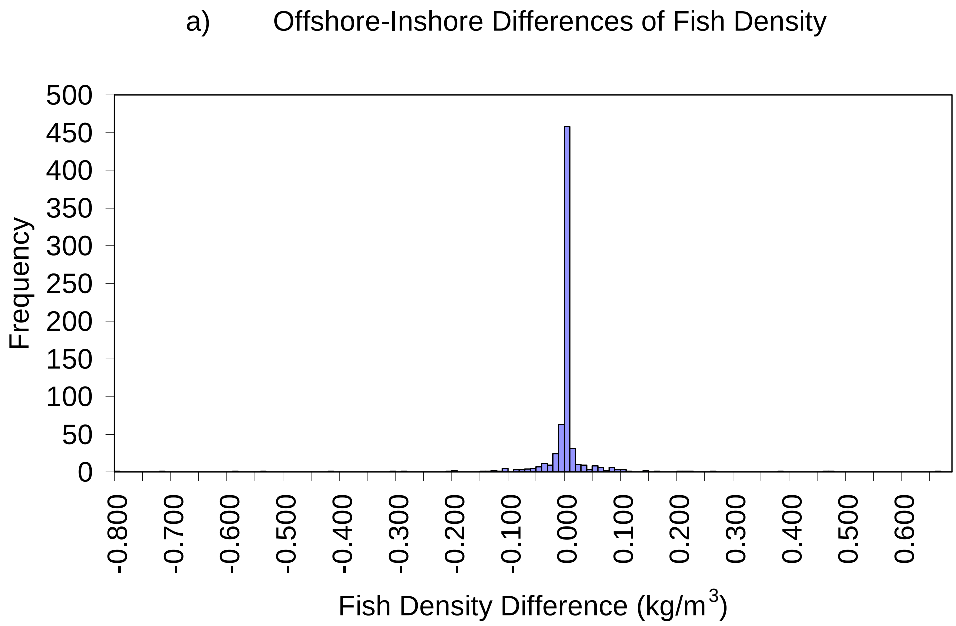
Daytime estimates are shown in top panel (a) with nighttime estimates below (b). Data are for 14 transects (from a possible 21) near the SGS intake and discharge for the period October 22, 2006 to December 13, 2006. Outer transects 1 and 21 were not surveyed due to time constraints; inner transects near 11 were not surveyed to avoid noise from intake and discharge structures.

5.4.2 Statistical Comparison of Results

Two comparisons of normal versus reverse flow mean fish densities were made, one for daytime and the other for nighttime. Table 5-16 presents the mean fish densities (kg/m^3) and t-statistics associated with the two comparisons. Figures 5-23 and 5-24 present the t-statistic distributions resulting from 10,000 Monte Carlo permutations of day and night densities, respectively. In both cases no significant difference was detected. However, the chance of rejecting a true null hypothesis was greater in nighttime samples. That is, there was more chance of saying there is no difference in the night fish density distributions in the two intake conditions when there actually was a difference. In addition, night distributions in the reverse flow were three times normal flow densities. During day, higher densities occurred in the normal flow condition. Overall, during normal intake flow conditions, fish densities averaged 0.0109 kg/m^3 while during reverse flow average fish densities were 0.0093 kg/m^3. A permutation test using all data indicated no significant difference could be seen between reverse and normal flow in the fish densities (Figure 5-25). The t-statistic for this comparison of fish densities in normal and reverse flow conditions was 0.4912 with a p-value of 0.624.

Table 5-16. Mean Fish Densities (kg/m^3) and t-Statistics of Data Used in Monte Carlo Permutation Tests

	Day		Night		All	
	Normal	**Reverse**	**Normal**	**Reverse**	**Normal**	**Reverse**
Mean	0.02046	0.01301	0.00173	0.00488	0.01090	0.00933
Standard Deviation	0.06034	0.05097	0.00281	0.02084	0.04322	0.04042
N	161	204	168	168	329	372
t-statistic	1.25122		-1.94127		0.49215	
p	0.212		-0.0524		0.624	



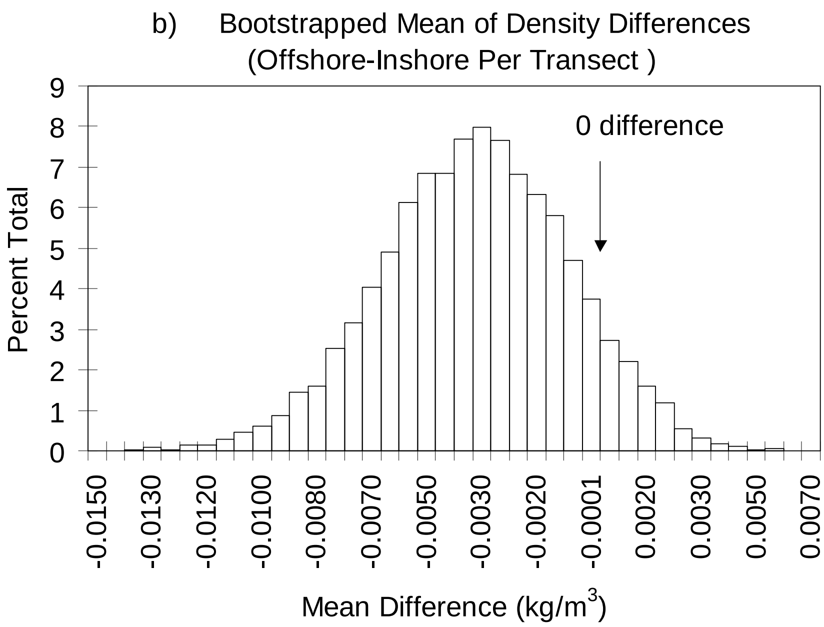


Figure 5-22. Distribution of (a) 700 per Transect Offshore-Inshore Differences of Fish Density

Graph (b) is the distribution of 10,000 bootstrapped mean estimates from the survey population above, with 0 indicated, p=0.2, showing no significant difference could be detected.

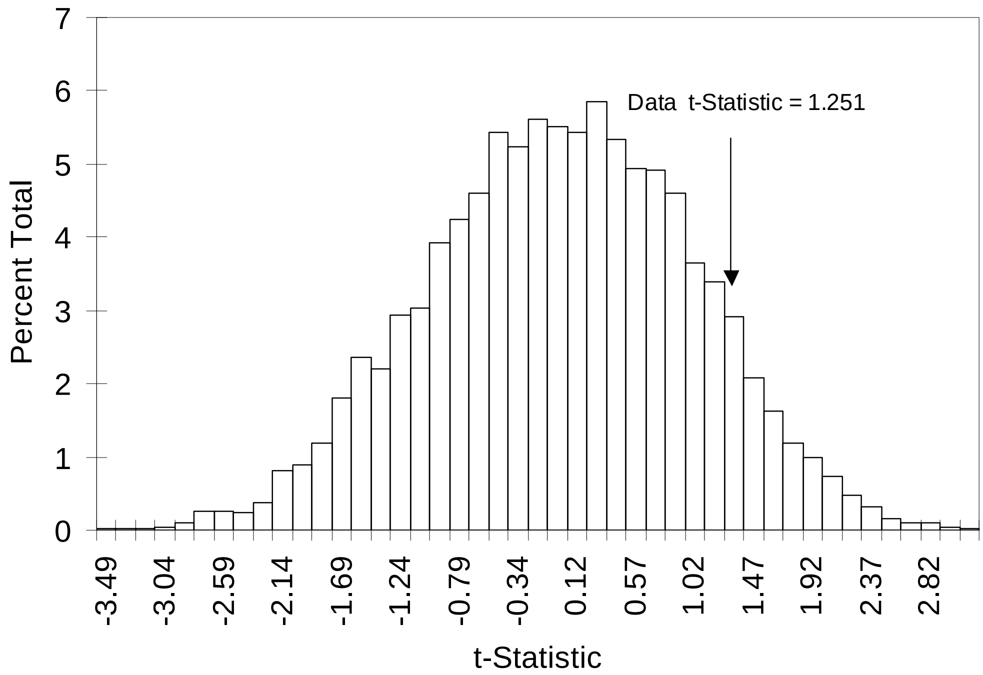


Figure 5-23. Distribution of t-Statistics of Daytime Fish Densities Estimated by Monte Carlo Permutation Resampling

**The daytime t-statistic was 1.251 indicating p=0.2 or no significant difference between normal flow fish densities and reverse flow fish densities during daytime.*

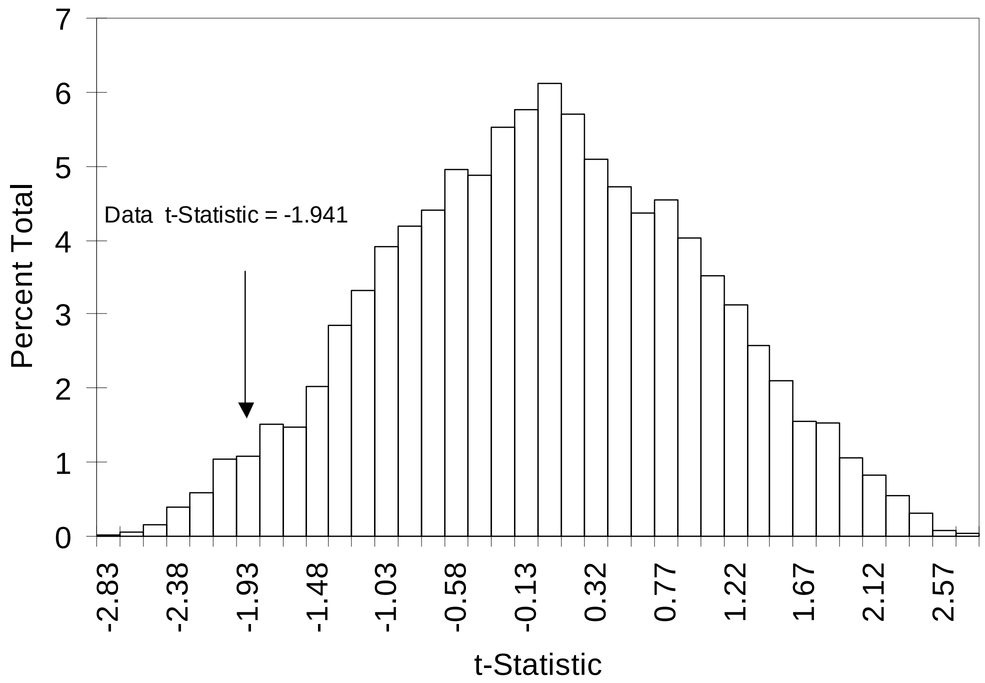


Figure 5-24. Distribution of t-Statistics of Nighttime Fish Densities Estimated by Monte Carlo Permutation Resampling

**The nighttime t-statistic was -1.941 with a p-value of 0.052 or no significant difference detected used between normal flow fish densities and reverse flow fish densities during nighttime.*

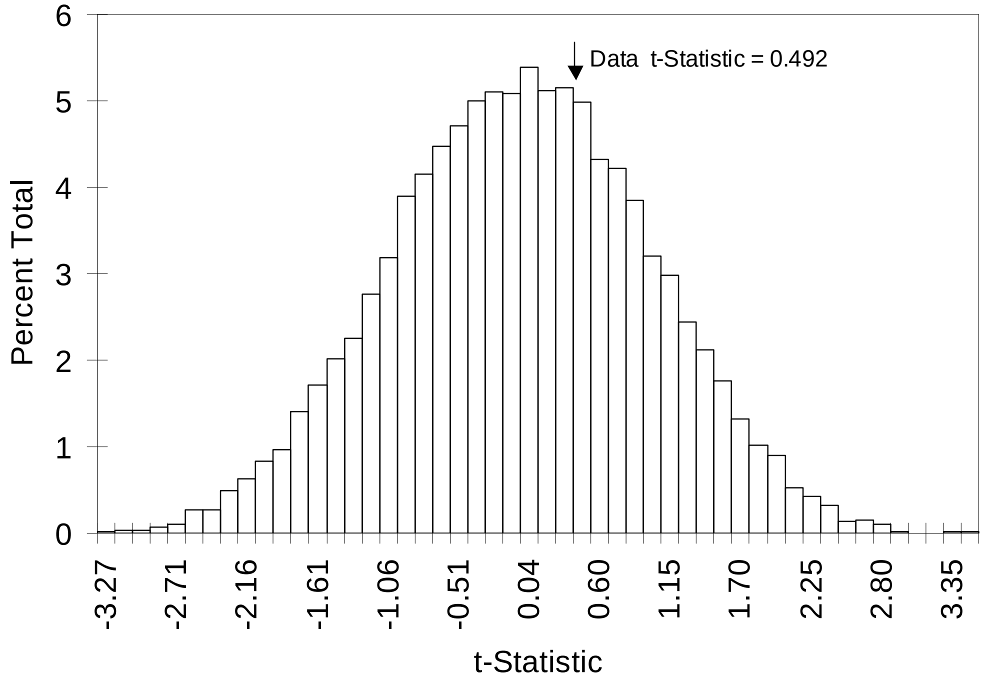


Figure 5-25. Distribution of t-Statistics of Fish Densities Estimated by Monte Carlo Permutation Resampling

**The t-statistic was 0.492 with a p-value of 0.624 or no significant difference detected between normal flow fish densities and reverse flow fish densities during both day and night.*

6.0 ASSESSMENT OF SCATTERGOOD VELOCITY CAP EFFECTIVENESS

A total of 650,141 fish weighing 16,007 kg (35,296 lbs) was impinged during the Scattergood Velocity Cap Effectiveness Study (Table 6-1). There was one instance where fish that were likely killed during a heat treatment (November 9, 2006) were impinged on the day following the heat treatment (November 10, 2006). These fish could be discerned from recently impinged fish by their physical appearance (e.g. pale coloration and flaccid body). A total of 421 fishes weighing 88.9 kg (196 lbs) were impinged on November 10, 2006, and it was obvious they were killed during the heat treatment the previous day. Reasons for delayed impingement are unknown, but the fish were probably in a 'quiet area' or eddy current in the forebay, as there were only five of eight circulating water pumps in operation during that time period. Estimates of velocity cap effectiveness without adjustments for delayed impingement are presented in Table 6-2, and estimates taking into account delayed impingement are presented in Table 6-3.

The calculated effectiveness of the SGS velocity cap on all fishes as determined by impingement rate was 97.56 percent based on abundance and 95.30 percent based on biomass (Table 6-2). Analysis of impingement rate takes into account differences in flow between survey periods. The t-statistic and associated *p*-value for abundance was statistically significant; however, the results for biomass were not statistically significant. A possible explanation for the disparity between the two is the impingement of relatively low numbers of high-biomass species, such as Pacific electric ray and thornback, during the third normal flow period.

Table 6-1. Impingement Results for All Fishes in the IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys during Velocity Cap Effectiveness Study

	Without Delayed Impingement		**With Delayed Impingement**	
	Abundance	**Biomass (kg)**	**Abundance**	**Biomass (kg)**
N_1	1,054	52.414	1,054	52.414
R_1	220,065	7,428.447	220,486	7,517.348
N_2	1,050	141.918	629	53.017
R_2	411,754	7,733.026	411,754	7,733.026
N_3	16,218	651.564	16,218	651.564
R_3	*	*		
Total	**650,141**	**16,007.369**	**650,141**	**16,007.369**

** Study completed after third normal flow period per LARWQCB directive to cease the velocity cap study.*

Table 6-2. Calculated Percent Effectiveness of the SGS Velocity Cap on All Fishes in the IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys during Velocity Cap Effectiveness Study (Not Including Delayed Impingement)

	Calculated Percent Effectiveness (%)	
Survey Period Comparison	**Based on Abundance**	**Based on Biomass**
R_1:N_1	99.37	99.07
R_1:N_2	99.23	96.90
R_2:N_2	99.48	96.24
R_2:N_3	96.21	91.88
R_3:N_3	*	*
Total	**97.56**	**95.30**
t	**-3.35**	**0.84**
p	**<0.001**	**0.78**

** Study completed after third normal flow period per LARWQCB directive to cease the velocity cap study.*

Table 6-3. Calculated Percent Effectiveness of the SGS Velocity Cap on All Fishes in the IM&E Characterization Study, Velocity Cap, and Heat Treatment Impingement Surveys during Velocity Cap Effectiveness Study (Including Delayed Impingement)

	Impingement Rate	
Survey Period Comparison	**No. per 1,000,000 m^3**	**Biomass (kg) per 1,000,000 m^3**
R_1:N_1	99.37	99.07
R_1:N_2	99.54	98.84
R_2:N_2	99.69	98.59
R_2:N_3	96.21	91.88
R_3:N_3	*	*
Total	**97.61**	**95.80**

** Study completed after third normal flow period per LARWQCB directive to cease the velocity cap study. (With adjustments to account for delayed impingement)*

The percent effectiveness was higher than calculated in prior studies (see Section 7.0), and this was probably due, in large part, to the current presence of Pacific sardine in the source waters. Pacific sardine was not abundant off southern California in the 1970s and early 1980s, a period which marked the end of a cool water regime and a transition to warm water conditions (Moser et al. 2001; Horn and Stephens 2006). During a two-year impingement study (1978–1980) at eight coastal generating stations in southern California, over 4.5 million fish were impinged (Herbinson 1981). However, only eight Pacific sardine were recorded during the study. No Pacific sardine were impinged at Scattergood in 1979 during the

316(b) demonstration (IRC 1981). Abundance of Pacific sardine off southern California has increased since the 1990s, making them more susceptible to impingement than in previous studies. Topsmelt and jacksmelt may also be more abundant today than they were 30 to 50 years ago. Abundance of these two species during three heat treatments at the SGS in 1978-1979 represented less than 0.8 percent of the total impingement abundance (IRC 1981). Numbers of topsmelt and jacksmelt in heat treatment impingement samples at the SGS has varied substantially since 1990, but there appears to be a trend of increasing abundance (MBC 2006).

A total of 19 taxa that were collected in previous impingement studies at the SGS in 2006 were not impinged during the Scattergood Velocity Cap Effectiveness Study. However, as indicated in Table 6-4, these species were impinged in relatively low abundance (0.1 percent of the total) in the impingement studies prior to the Scattergood Velocity Cap Effectiveness Study. Additionally, the 33 most abundant species in impingement samples from studies during period from 1990 through September 2006, which comprised 99.6 percent of abundance during that 17-year period (MBC 2006), were all impinged during the three-month velocity cap study.

Table 6-4. Additional Species Impinged Prior to Velocity Cap Effectiveness Study

Taxon	Common Name	Number Impinged	Percent of Total Abundance
Halichoeres semicinctus	rock wrasse	24	0.037
Brachyistius frenatus	kelp perch	15	0.023
Chilara taylori	spotted cusk-eel	13	0.020
Girella nigricans	opaleye	4	0.006
Micrometrus minimus	dwarf perch	3	0.005
Sebastes rastrelliger	grass rockfish	3	0.005
Artedius corallinus	coralline sculpin	2	0.003
Semicossyphus pulcher	California sheephead	2	0.003
11 other taxa	11 other taxa	1 each	0.002 each
	Totals:	**77**	**0.119**

The LARWQCB also raised a concern over the possibility of fish being able to swim out of the cooling water system once they are entrained. IRC (1981) reported a maximum velocity through the intake conduit of 207 cm/sec (81 in./sec). Since flow during the velocity cap study was generally between 50 and 80 percent of maximum (Figure 5-2), then conduit velocities would be 104 to 166 cm/sec (41 to 65 in./sec). Swim speeds of Pacific sardine can reach two body lengths per second. The average size of impinged sardines was 129 mm (5.1 in.); therefore, they would be expected to reach swim speeds of about 26 cm/sec (10.2 in./sec), well below velocities in the conduit. Swim speeds of many common fishes are unknown. Dorn et al. (1979) examined the swimming performance of nine southern California fish species, six of which were impinged during the current study: shiner perch, walleye surfperch, white seaperch, black perch, blacksmith, and white croaker. Maximum continuous swim speeds ranged from 42 to 61 cm/sec (16.5 to 24 in./sec) for the nine species tested. Burst swim speed, measured for one second after electrocution, ranged from 94 cm/sec (37.0 in./sec) (blacksmith) to 137 cm/sec (53.9 in./sec) (white croaker). Based on the available data, it is a reasonable assumption that fishes are not exiting the cooling water system once entrained.

Evaluations of the effectiveness of the velocity cap indicate some species-specific patterns. Schooling, surface-feeding species, such as Pacific sardine, were more susceptible to vertical (reverse) flows. Vertical stratification within the water column and sensitivity to flow and disturbance are two parameters that may have affected the entrapment rates of these species. Rheotaxis has been commonly observed in marine fishes surrounding offshore cooling water intake structures (Helvey and Dorn 1981), but these observations were always in relation to normal, horizontal flow patterns rather than the vertical flow patterns.

Pacific sardine has been classified as a coastal pelagic species (Allen and Pondella 2006), which commonly forms dense schools (Helfman et al. 1997). Additionally, clupeiforms (anchovies, sardines, herring, etc.) have highly derived connections between their gas bladder and ears, thereby making them more attune to low-frequency vibrations, such as the tail beat of a neighbor within a tightly grouped school (Helfman et al. 1997). While Pacific sardines may be more receptive to their environment, as is required to maintain dense schools, this sensitivity may be only attributable to horizontal flow. Vertical flow, such as the flow into the intake without a velocity cap, creates an environment that the mechanoreception structures of nearshore marine fish may be ill suited to detect. Furthermore, Pacific sardines typically occupy the midwater habitat (Allen 1985), leaving them more susceptible to vertical intake flows. The significant increase in impingement rates during reverse flow periods further support this notion.

Since 1990, an average of 17,869 Pacific sardine (unadjusted for cooling water flow) has been impinged annually (MBC unpublished data), or roughly 2 percent of the total unadjusted abundance impinged during the reverse flow periods of the Scattergood Velocity Cap Effectiveness study. The previous annual maximum impingement was 146,723 individuals impinged in 2004 (heat treatment only), or 24 percent of the Scattergood Velocity Cap Effectiveness study. Based on these data, operation of the cooling water system without a velocity cap resulted in a 50-fold increase in impingement of Pacific sardine, on average, or at best a four-fold increase over the next highest annual abundance.

Data from the current study suggests that species with greater affinity for midwater and surface waters, such as Pacific sardine, were more susceptible to vertical intake flows that are created without a velocity cap. These species, such as Pacific sardine, often form large pelagic schools, which can enable excessively high entrapment rates when they are entrained in the cooling water intake current of an uncapped intake structure, as was observed during the current study. While additional factors may affect the impingement of both species types, namely the density of the source population in the vicinity of the intake point, the variation in schooling behavior allows for greater impingement losses without the use of a velocity cap. In general, a higher proportion of larger individuals was impinged during periods without the velocity cap in the present study.

7.0 SUMMARY OF OTHER VELOCITY CAP EFFECTIVENESS STUDIES

The following section summarizes historical velocity cap effectiveness studies, all of which were performed in southern California.

7.1 SCATTERGOOD VELOCITY CAP EFFECTIVENESS

A velocity cap was installed on the intake riser at the SGS in 1958 (not as part of the original design of the cooling water intake system, but as a modification to the intake structure). The velocity cap suffered damage during large storms, and in June 1970, LADWP decided to remove the damaged structure and replace it. Until the velocity cap was removed on August 5, 1970, the SGS operated in reverse configuration (i.e., withdrawing cooling water from the normal discharge conduit, and discharging through the normal intake). While operating in this configuration, impingement mortality was particularly high. The California Department of Fish and Game requested that LADWP not replace the velocity cap immediately, but try to estimate its effectiveness as a fish protection device by comparing impingement before and after its replacement (Pender 1975).

The new velocity cap that was installed in October 1974 was designed slightly different than the previous velocity cap. The design changes took into account (1) the susceptibility of the prior design to storm damage, (2) the operational requirements of a new unit at SGS (Unit 3), and (3) studies performed by Southern California Edison to determine optimum flow requirement for reducing impingement. The intake riser was fitted with a "riser lip" so the outer circumference of the velocity cap was the same as that of the riser. This design minimizes vertical flow components in the intake zone of influence.

Comparisons between periods were confounded by variations in plant operations and cooling water flows due to power demand and outages. That is, the SGS operated under different conditions during the various periods. Based on all of the data recorded by Pender (1975), the effectiveness of the velocity caps at the SGS based on fish impingement biomass (standardized to cooling water flow between heat treatment procedures) was about 83 percent.

7.2 EL SEGUNDO VELOCITY CAP EFFECTIVENESS

Weight (1958) evaluated the effectiveness of the velocity cap at Units 1&2 at El Segundo Generating Station (ESGS), approximately one kilometer downcoast from the SGS. The intake terminus at Units 1&2 differs from that at SGS primarily in that (1) it is slightly further from shore (796 m [2,611 ft] compared with 488 m [1,600 ft]), (2) it is rectangular as opposed to circular, and (3) maximum flow rate is less than one-half that at the SGS (207 mgd compared with 495 mgd). However, depth of withdrawal is essentially the same.

The impingement periods analyzed by Weight (1958) were July 1956 to June 1957 (pre-velocity cap installation) and July 1957 to June 1958 (velocity cap in place). Fish impingement biomass during the two periods was 246,940 kg (544,409 lbs) and 13,563 kg (29,901 lbs), respectively, equivalent to a reduction in impingement of 94.5 percent.

7.3 HUNTINGTON BEACH VELOCITY CAP EFFECTIVENESS

The Huntington Beach Generating Station (HBGS) Velocity Cap Effectiveness Study was carried out by a team of researchers from the University of Washington College of Fisheries. This study may be the most comprehensive evaluation of velocity cap effectiveness ever conducted. This study collected impingement and source water data on individual species and the results were reported in several University of Washington technical reports (see Section 8.0). The results were also published in an IEEE journal (Thomas and Johnson 1980). The hydroacoustic methods used as one of the approaches for sampling the source water fish populations were presented at a Scientific Committee on Oceanic Research (SCOR) meeting in 1980 (Thorne 1980).

The study consisted of a series of field trials at four different power plants over one year, with the majority of the trials at HBGS. The seven trials at HBGS resulted in 123 hourly estimates of impingement and source water fish abundances with 70 observations at full flow with the velocity cap in place. This was the control condition and was used to compare impingement and source water abundances under several other plant operating conditions. Source water abundances of fishes were estimated using hydroacoustic sampling that was supplemented with net sampling to verify the composition of the acoustic targets. Gill nets were also positioned at different depths in the water column to determine the vertical distribution of the different species. Data were collected with the plant under full operation in reverse flow (without velocity cap).

The study had several unique features that improved the ability to measure the effectiveness of the velocity cap. First, unlike the 1950s study at the ESGS, test conditions were evaluated for a few hours or days and then changed to evaluate another set of test conditions. This insured that fish composition and source water abundances didn’t change dramatically between tests. Secondly, the intake tunnels were cleared of fishes between observations by injecting chlorine at the upstream end of the screenwell in concentrations that forced the fishes towards the traveling screens. This insured a complete count of fish entrapment during each trial. In addition, several trials of each test condition were conducted over the course of the study to ensure that seasonal differences in ocean conditions and fish composition were taken into account. Finally, the entrapment data were combined with estimates of source water fish populations in the vicinity of the intakes to calculate estimates of entrapment vulnerability. The source water population estimates were made using net and hydroacoustic sampling. This enabled the effects of the velocity cap to be evaluated independently of offshore population abundances. The statistical technique for adjusting the entrapment rates was to calculate the ratio of entrapment to fish densities in the source water in the vicinity of the intake (*E/B*). This ratio was used to estimate the relative vulnerability of fishes to entrapment by the intake.

The use of the vulnerability ratio (*E/B*) in assessing differences among treatments had additional benefits that increased the statistical power to determine if there was a significant decrease in the vulnerability of fishes to impingement in the control condition with the velocity cap. The ratio of vulnerability resulted in a measure that adjusted the impingement data for the abundances of fishes in the source water during each observation to insure that any differences in impingement were the results of the presence or absence of the velocity cap and not source water abundances. This decreased the variation among observations within a treatment, which contributed to the ability to detect differences among treatments. The use of the *E/B* ratio and the large number of replicates of each treatment increased the statistical power of the study to detect any differences due to the velocity cap.

The final report presents results both for total impingement of all fish species combined (Table 7-1) and three individual fishes: queenfish, white croaker, and northern anchovy. There were also large numbers of silversides collected, but they were mostly collected in the source water sampling, and were only collected from impingement sampling during reverse operations in the absence of the velocity cap. Although not analyzed in the report due to the absence of normal operations data for comparison, the results for silversides are a good example of the effectiveness of the velocity cap. Results showed that silversides were primarily distributed in the surface layers where they were less likely to be pulled into the system during normal operations with the velocity cap. In the absence of the velocity cap the intake draws water vertically from surface layers resulting in greater impingement of silversides.

Table 7-1. Entrapment Densities for Total Fishes at the HBGS

Year	Velocity Cap Present	Time	Entrapment Density (kg/hr)	Effectiveness
1979	No	Day/Night 18-hr	20.45	
1979	Yes	Day/Night 18-hr	1.97	90%
1979	No	Night	32.93	
1979	Yes	Night	15.53	53%
			Average:	**72%**
1980	No	Day	47.2	
1980	Yes	Day	0.65	99%
1980	No	Night	52.99	
1980	Yes	Night	6.78	87%
			Average:	**93%**
			Overall:	**82%**

*Data from 1979 and 1980 Velocity Cap Studies (from Thomas et al. 1980, Table 3, p. 18).

The vulnerability ratios from the study present a more accurate measure of the true effectiveness of the velocity cap (Figure 7-1). As is clear from Figure 7-1 the difference in vulnerability for Treatment 2 (full flow without the velocity cap) and Treatment 3 (full flow without the velocity cap) was highly significant which was verified by analyzing the data with a one-tailed Mann-Whitney U-Test ($p < 0.0001$). Although these results clearly demonstrate the effectiveness of the velocity cap, the estimated efficiency is conservative since data from silversides were not included in the analysis.

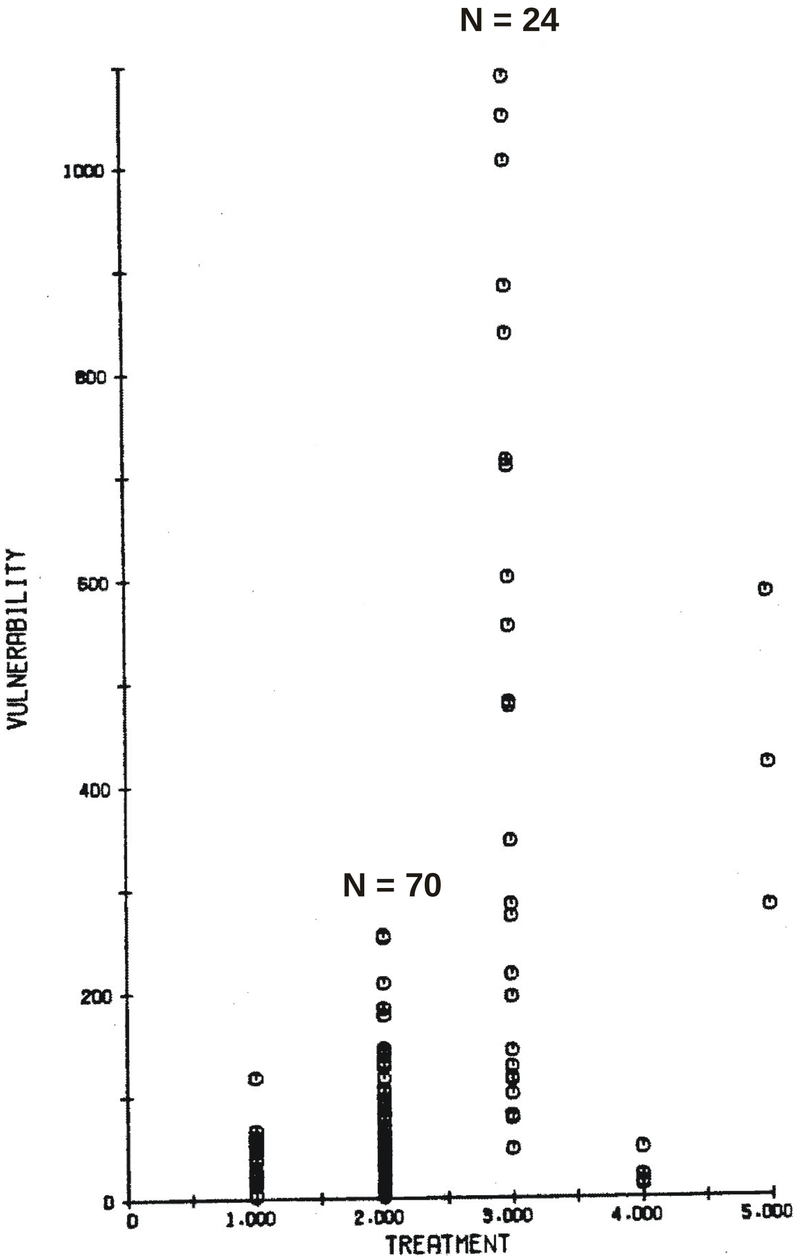


Figure 7-1. Huntington Beach Study Vulnerability (*E/B* x 10^4) for All Species Combined by Treatment

** Plant Operational Mode: 1 = reduced-flow with-cap; 2 = full-flow with-cap; 3 = full-flow without-cap; 4 = reduced-flow without-cap; and 5 = tunnel swapping, i.e., the transition period between reversed and normal flow directions.*

*** The data were collected at Huntington Beach in 1979 and 1980 (from Thomas et al. 1980 Figure 6 p.14).*

7.4 ORMOND BEACH VELOCITY CAP EFFECTIVENESS

The Ormond Beach Generating Station (OBGS) Velocity Cap Effectiveness Study was carried out concurrently with the HBGS study (Section 7.3) by a team of researchers from the University of Washington College of Fisheries (Thomas et al. 1980). The study consisted of 35 hourly estimates of entrapment (compared with 123 at HBGS), comprised of 24 estimates of control and 11 estimates with no velocity cap in place. Entrapment vulnerability indices corroborated those from HBGS, with the difference in vulnerability between velocity cap and no velocity cap determined to be statistically significant (one-tailed Mann Whitney U-Test, p=0.0083). Overall, reductions in fish entrapment rates due to the velocity cap were 61 percent (nighttime) and 87 percent (daytime). Data were treated “differently in data reduction because of an unusually high relative abundance of mackerel schools (*Scomber japonicus* and *Trachurus symmetricus*) in the study area”, which could have obscured species-specific trends of “key” fishes in lower abundance, which were the focus of the study. Offshore data from these mackerel schools were removed from the analysis when determining velocity cap effectiveness, similar to the approach used for silversides at HBGS. Therefore, velocity cap effectiveness at the OBGS is likely much higher than that presented by Thomas et al. (1980).

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Attachment A-1

Scattergood Generating Station Study Plan for Testing the Effectiveness of the Intake Structure Velocity Cap

APPENDIX E

STUDY PLAN FOR TESTING THE EFFECTIVENESS OF THE INTAKE STRUCTURE VELOCITY CAP

SCATTERGOOD GENERATING STATION

STUDY PLAN FOR TESTING THE EFFECTIVENESS OF THE INTAKE STRUCTURE VELOCITY CAP

August 28, 2006

Prepared for:

Los Angeles Department of Water and Power
Los Angeles, California

Prepared by:

Tenera Environmental
San Luis Obispo, California

MBC *Applied Environmental Sciences*
Costa Mesa, California

URS Corporation
Santa Ana, California

TABLE OF CONTENTS

1.0 PURPOSE OF STUDY

The intake structure velocity cap study plan proposes to evaluate the effectiveness of the velocity cap in reducing fish entrapment at the Scattergood Generating Station (SGS) and to determine the level of performance in meeting the requirements of the Clean Water Act Section 316(b) Phase II Final Rule performance standards. The performance of the existing velocity cap will be evaluated with a site-specific field study to confirm published results from studies conducted at other power plants in southern California and to validate the Los Angeles Department of Water and Power's (LADWP) historical data.

The study plan involves conducting impingement sampling during normal intake flow using the intake structure with a velocity cap to withdraw cooling water from the source waterbody into the forebay, and reverse intake flow using the discharge structure without a velocity cap to withdraw cooling water into the forebay. Periods of normal intake flow (with the velocity cap) and reverse intake flow (without the velocity cap) would be alternated every two weeks over a 12-week period to provide a total of six weeks of normal intake flow impingement sampling data that will be compared with six weeks of reverse intake flow impingement sampling data. In addition, the reverse intake flow data can be compared to normal impingement rates from samples being collected weekly during the Impingement Mortality and Entrainment (IM&E) Characterization Study.

2.0 SCOPE OF WORK

The intake structure velocity cap study will be completed over a 12-week period with alternating 2-week periods of normal and reverse intake flow. During normal intake flow, the intake structure with a velocity cap is used to withdraw cooling water from the source waterbody into the forebay, and during reverse intake flow the discharge structure without a velocity cap is used to withdraw cooling water into the forebay. Scheduling of surveys will be coordinated with the generating station personnel, and may be modified to facilitate operational constraints.

The study design using alternating 2-week periods of normal and reverse flow was used to address the potential criticism that abundances of some juvenile fishes may change over the course of the 12-week study period. This criticism is addressed by splitting the sampling up into the six 2-week periods where reverse flow would occur for two weeks followed by two weeks of normal flow, followed by two weeks of reverse flow, and so forth. There is very little likelihood of significant abundance changes occurring over a 2-week period. Any abundance changes will be evaluated by comparing consecutive 2-week sampling periods. If there is a difference, the data can be blocked to reduce variability, otherwise the samples could be lumped into a single analysis. Both approaches result in an increase in the statistical power to detect a difference in impingement between normal and reverse flow conditions. This would also address potential changes in species composition that may occur during the course of the study.

The study will be conducted with all the circulating water pumps operating at full capacity during the 12-week study period and with minimal flow variation to the extent possible considering the operational constraints of the facility. Large changes in flow during the study period will affect impingement rates and increase the variation among samples. This will make it more difficult to statistically detect a difference between normal and reverse flow conditions. Statistically, varying flow conditions will be addressed by using flow as a covariate in the statistical analysis, but there are two problems with this approach. First, the number of samples necessary to establish a relationship between the covariate and dependent variable is much larger than the proposed sample sizes. Second, we will only be recording impingement over a 24-hour sampling period for most of the sampling and variations in flow through the day could dramatically affect impingement rates. For these reasons, the study will be conducted with all the circulating water pumps operating at full capacity and with minimal flow variation.

The study will consist of three different survey types:

- Heat treatment impingement surveys – Heat treatments will be performed at the beginning of the study and at two week intervals (preceding flow reversals) to remove all entrapped fish from the forebay;

- Weekly impingement surveys – These surveys are currently being conducted as part of the IM&E Characterization Study, and consist of 24-hour surveys with four 6-hour sampling blocks within each survey;
- Velocity cap impingement surveys – These supplemental surveys will be conducted twice per week in addition to the weekly impingement surveys. The velocity cap impingement surveys will consist of one 24-hour sampling period.

Methods for the heat treatment and weekly impingement surveys are detailed on pages 15 and 16 of the Scattergood Generating Station Summary of Existing Physical and Biological Information and Impingement Mortality and Entrainment Characterization Study Sampling Plan (Sampling Plan) included in Appendix A of the Proposal for Information Collection (PIC). The supplemental velocity cap impingement surveys will employ similar methods to the weekly impingement surveys, except instead of rotating and rinsing the traveling screens at approximate 6-hour intervals following an initial rotation/washing, the traveling screens will only be operated once after approximately 24 hours.

Prior to each 2-week survey period, it will be required to remove all fish species from within the forebay by conducting heat treatments. A heat treatment is done by first manipulating the intake gates and then raising the water temperature in the forebay. During and after this period, the traveling screens are run until all heat-treated fishes are removed from the forebay. Heat treatments will subsequently be performed at 2-week intervals to ensure that all of the organisms that may have entered the forebay during the prior 2-week period are included in the sample. The organisms collected during the heat treatment will be processed using the impingement procedures as described in Section 3.0 – Impingement Sample Processing. Once impingement on the circulating water screens has subsided to near zero after each heat treatment, and the flow direction is reversed, the next 2-week sampling period will commence. The sampling sequence for each 2-week period is as follows:

1. Conduct heat treatment to clear system
2. Begin 1st 2-week sampling period with reverse flow
3. Conduct heat treatment to clear system
4. Begin 2nd 2-week sampling period with normal flow
5. Conduct heat treatment to clear system
6. Begin 3rd 2-week sampling period with reverse flow
7. Conduct heat treatment to clear system
8. Begin 4th 2-week sampling period with normal flow
9. Conduct heat treatment to clear system
10. Begin 5th 2-week sampling period with reverse flow
11. Conduct heat treatment to clear system
12. Begin 6th 2-week sampling period with normal flow
13. Conduct heat treatment to clear system

The following is a sample schedule based on the proposed sampling intervals, but may vary due to facility operating constraints:

Week	Mon	Tue	Wed	Thur	Fri
1	HT	Weekly IM	VC Survey	VC Survey	
2		Weekly IM	VC Survey	VC Survey	
3	HT*	Weekly IM	VC Survey	VC Survey	
4		Weekly IM	VC Survey	VC Survey	
5	HT*	Weekly IM	VC Survey	VC Survey	
6		Weekly IM	VC Survey	VC Survey	
7	HT*	Weekly IM	VC Survey	VC Survey	
8		Weekly IM	VC Survey	VC Survey	
9	HT*	Weekly IM	VC Survey	VC Survey	
10		Weekly IM	VC Survey	VC Survey	
11	HT*	Weekly IM	VC Survey	VC Survey	
12		Weekly IM	VC Survey	VC Survey	
13	HT*				

Non-shaded days = normal flow direction, shaded days = reverse flow direction

* - Following heat treatment, flow direction is reversed

Weekly IM - Weekly impingement sampling

VC Survey - Velocity cap impingement sampling

3.0 IMPINGEMENT SAMPLE PROCESSING

During the 12-week study period, weekly impingement sampling will continue to be conducted as part of the IM&E Characterization Study. Weekly impingement samples are collected every six hours over a 24-hour period. During each sampling cycle, the traveling screens are rotated and cleaned and the impinged material is rinsed into collection baskets associated with each set of screens. A log containing hourly observations of the operating status of the circulating water pumps (on and off) for the entire study period is obtained from the power plant operation staff that provides a record of the amount of cooling water pumped by the plant. Four other velocity cap impingement samples will be collected during each 2-week study period. These samples will be collected using the same procedures used for normal impingement sampling except that a single sample will be collected over a 24-hour period. In order to quantify the fish drawn into the forebay during the study, heat treatment impingement sampling will also be conducted prior to the beginning of the first 2-week sampling period and at the end of each 2-week sampling period during the study. Procedures for heat treatment sampling involve clearing and rinsing the traveling screens prior to the start of the heat treatment procedure. At the end of the heat treatment procedure normal pump operation will be resumed and the traveling screens rinsed until no more fish are collected on the screens. Weekly, velocity cap, and heat treatment impingement samples will be processed using the following procedures, which are described in more detail on pages 15-16 of the Sampling Plan included in Appendix A of the PIC.

All fishes and invertebrates are separated from the impinged debris and vegetation. All fishes, crabs, shrimps and prawns, and cephalopod mollusks are identified, counted, weighed, and measured using the following criteria:

Organism Group	Length Measuring Criteria
Fishes	Total body length for sharks, disc width for skates and rays and standard lengths for bony fishes
Crabs	Maximum carapace width
Spiny lobster and Shrimps	Carapace length, measured from the anterior margin of carapace between the eyes to the posterior margin of the carapace
Octopus	Maximum “arm” spread, measured from the tip of one tentacle to the tip of the opposite tentacle
Squid	Dorsal mantle length, measured from the edge of the mantle to the posterior end of the body

If a large number (more than 30) of any individual countable species is collected during a cycle, 30 randomly selected individuals of this species are individually weighed and measured and the remaining individuals are counted and batch-weighed. The sex of the countable organisms is determined to the extent possible without dissection. The condition of each countable organism is also recorded: "A" for alive; "D" for dead; and "M" for mutilated. Mutilated organisms are counted but not weighed or measured. All other invertebrates are identified and weighed. Debris, including vegetation, is separated out, categorized (e.g., fouling organisms, algae) and weighed.

4.0 IMPINGEMENT SAMPLING QA/QC PROGRAM

The same quality assurance/quality control (QA/QC) procedures used for the weekly impingement sampling described on page 17 of the Sampling Plan included in Appendix A of the PIC will be continued during the velocity cap study period. The QA/QC procedures will help ensure that all of the organisms are removed from the debris and that the correct identification, enumeration, length and weight measurements of the organisms are recorded on the data sheet. Random sampling events will be chosen for QA/QC re-sorting to verify that all the collected organisms were removed from the impinged material. QA/QC surveys will be done at least twice during the study and more frequently if necessary. If the count of any of individual taxon made during the QA/QC survey varies by more than 5 percent (or one individual if the total number of individuals is less than 20) from the count recorded by the observer then the next three sampling cycles for that observer will be checked. The sampling procedures will be reviewed with all personnel prior to the start of the study. The same QA/QC procedures used for data verification of weekly impingement survey data will be used during the velocity cap surveys. These QA/QC measures include: (1) review of all field data by the project manager, (2) verification of all field data by a qualified scientist, (3) duplicate data entry to identify potential entry errors, and (4) final data verification.

5.0 DATA ANALYSIS

The sampling design will result in three 2-week periods of normal intake flow using the intake structure with a velocity cap to withdraw cooling water from the source waterbody into the forebay and three 2-week periods of reverse intake flow using the discharge structure without a velocity cap to withdraw cooling water into the forebay. Within each 2-week period there will be six 24-hour weekly/velocity cap impingement data sets and one heat treatment impingement data set. The data will be analyzed using analysis of variance after appropriate tests of assumptions and necessary data transformations. The impingement data will initially be analyzed using a block design. Each block will include consecutive 2-week periods with and without velocity cap treatments. This analysis will identify any differences among blocks that might be due to changes in species composition over time. If no differences are detected among blocks the individual samples from the time blocks will be combined and the data analyzed using a simple t-test between the two treatments. If the block differences are significant, the data will be analyzed using analysis of variance to control for the variation among time blocks. The data from the heat treatment samples will be analyzed separately using a two-sample t-test. Statistical analysis will be done on total fish abundance, biomass, and for individual species that are in high abundance. The analyses will be used to determine if the difference in impingement with and without the velocity cap is statistically significant. If the difference is significant, an estimate of the difference and confidence intervals for the estimate will be calculated. This difference will be used in adjusting impingement measured during the current year-long study to baseline levels that would be expected to occur in the absence of the velocity cap. The statistical analyses will be supplemented with graphical summaries of the results.

Attachment A-2

Hydroacoustic Sampling Plan

TENERA Environmental

Date: October 11, 2006

To: Ms. Susan Damron, Ms. Katherine Rubin, and Mr. Rafael Garrett - LADWP

From: Dr. John Hedgepeth

Re: Hydroacoustic sampling for SGS Velocity Cap Study

The purpose of conducting hydroacoustic surveys at the Scattergood Generating Station (SGS) will be to determine if any differences in fish abundances can be detected between the intake and outfall during the time period when the outfall is alternately used as an intake every two weeks.

Hydroacoustic surveys at the SGS intake (500 m offshore 4-5 fathoms) and outfall (400 m offshore 3-4 fathoms) will be made to compare the densities of fishes in the area using backscatter data. Survey factors will be location (intake or discharge), flow direction (normal or reverse) and diel period (day or night). We will collect samples over 10 days, selected at the date of changing flow directions so that one day will before the changeover and one day after the changeover according to the schedule shown below. On each day, 3 samples will be collected during daytime and three during night at both intake and outfall locations giving a total of 120 samples. To determine if a significant difference can be detected between the intake and discharge locations the data will analyzed using analysis of variance.

Schedule of Hydroacoustic Sampling Dates

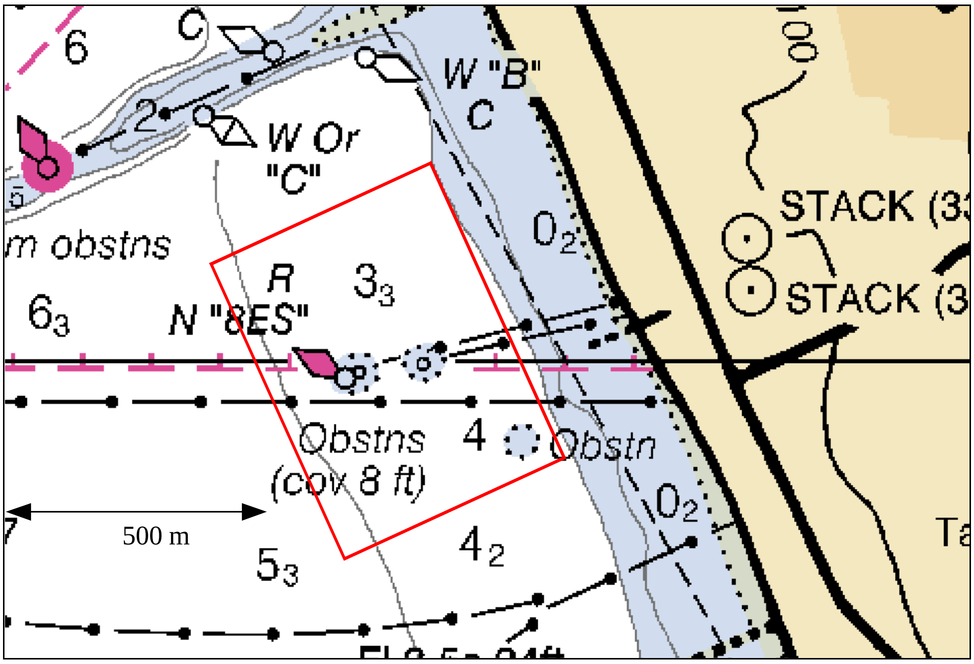
October		November		December	
Reverse	Normal	Reverse	Normal	Reverse	Normal
X	X X	X X	X X	X X	X

A 200 kHz BioSonics scientific fisheries echosounder will collect the acoustic backscatter from the water column near the SGS intake and outfall. The data will be collected from a boat with the echosounder mounted just below the water surface using parallel spaced transects of approximately 200 m long and 10 m apart. Surveys will occur in proximity of the intake and outfall (see figure) starting within 100 m of each.

Within survey block variance will be estimated using transect estimates. This design anticipates that the maximum variance will be in the onshore-offshore direction so that the alongshore variance will be minimized. Sample ping rate of the echosounder will be 5-10 per second and boat speed will be 1.5-2 meters per second. Concurrent differential GPS positions will be recorded every second enabling alternative geospatial estimates of variability.

Previous studies at cooling water intake systems (Thomas et al. 1980) used a 120 kHz nine-degree single-beam transducer and assumed target strength to scale integrated acoustic signals. Indices of abundance will be made with more sophisticated equipment than were available in the previous studies. In the previous studies, vulnerabilities were estimated as a ratio using a combination of screen sampling, acoustic gear, lampara seines and gillnets without direct measures of acoustic sizes of fish. We propose to calculate field abundance indices using a digital 200 kHz echosounder with six-degree transducer (full beamwidth at half power) that will record the entire water column at 2 cm vertical intervals. The processing software can estimate fish density by echo integration or by echo counting methods when densities are lower. In the proposed studies, better near-to-bottom fish density estimation will result from a combination of the narrower six-degree beamwidth and processing software with better bottom tracking.

Each hydroacoustic survey will require a boat, skipper and echosounder operator. Data will be post-processed using BioSonics Visual Analyzer. Total project cost is estimated as $66,300.



Scattergood Generating Station offshore intake and outfall (in red rectangle).

Attachment A-3

Comments on Study Plan
from Los Angeles Regional Water Quality Control Board

California Regional Water Quality Control Board

Los Angeles Region

Recipient of the 2001 *Environmental Leadership Award* from Keep California Beautiful

Linda S. Adams
Agency Secretary

320 W. 4th Street, Suite 200, Los Angeles, California 90013
Phone (213) 576-6600 FAX (213) 576-6640 - Internet Address: http://www.waterboards.ca.gov/losangeles

Arnold Schwarzenegger
Governor

Post-It™ brand fax transmittal memo 7671	# of pages ▸ 3
To Katherine Rubin	From David Hung
Co. LADWP	Co. LARWQCB
Dept.	Phone # 213/576-6664
Fax # 213-367-3297	Fax #

October 4, 2006

Ms. Susan Damron
City of Los Angeles Department of Water and Powe.
111 N. Hope Street, Room 1213
Los Angeles, California 90012

Dear Ms. Damron:

LOS ANGELES DEPARTMENT OF WATER AND POWER, SCATTERGOOD GENERATING STATION, LOS ANGELES, CA. (NPDES NO. CA0000370, CI NO. 1886) – REVIEW OF SCATTERGOOD GENERATING STATION, STUDY PLAN FOR TESTING THE EFFECTIVENESS OF THE INTAKE STRUCTURE VELOCITY CAP

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) staff have reviewed the *Scattergood Generating Station Study Plan for Testing the Effectiveness of the Intake Structure Velocity Cap,* prepared for The City of Los Angeles Department of Water and Power (LADWP) by Tenera Environmental, Inc., MBC Applied Environmental Sciences, and URS Corporation. This study plan was submitted as Appendix E of the previously submitted *Clean Water Act Section 316 (b) Proposal for Information Collection (PIC) for Scattergood Generating Station*. This Study Plan was designed to evaluate the effectiveness of the existing velocity cap at reducing impingement and was prepared in response to comments received by the LADWP on the PIC submitted in 2005.

Overall, this study plan is adequate to evaluate the efficiency of the existing velocity cap in reducing impingement at this facility. However, our review has identified two concerns with the Study Plan as presented.

COMMENT #1 – SAMPLING FREQUENCY. The supplemental velocity cap studies will be conducted during the same time period as weekly impingement surveys, but slightly different methods will be used to collect the samples. In the weekly impingement surveys, the traveling screens will be held stationary for intervals of approximately 6 hours, which allows them to collect fish and shellfish before rotating them and collecting the impingement sample. This protocol will result in four six-hour impingement samples collected over a 24-hour period. By contrast, the velocity cap samples will be collected by holding the traveling screens stationary for 24-hours before collecting the impingement samples. Such a protocol will prevent quantification of diel variation (which is required to be quantified in the Impingement Mortality and Entrainment [IM&E] Surveys) and likely degrade the quality of specimens collected for identification. Further, this difference in sampling methods may make it more difficult to directly compare impingement rates measured under the two different sampling protocols. No rationale is provided for why impingement samples for the velocity cap study are to be collected in a different manner than those for the IM&E studies.

RECOMMENDATION #1. Given that these studies are to be conducted during the same time period and are measuring the same endpoint (i.e., impingement), and unless there are other logistical obstacles, the velocity cap study impingement samples should compare directly to those collected under the IM&E surveys.

COMMENT #2 – SPATIAL VARIATIONS. The intake tunnel (with the velocity cap) and the discharge tunnel (reverse intake) are at different distances from the shoreline and different water depths at the point of water intake. The Discharger did not consider associated variations in fish and shellfish species and variations in population densities. The statistical analysis proposed by the Discharger did not include a correction for this variation or any extrapolation based on IM&E data to be collected.

RECOMMENDATION #2. The data analysis should consider spatial variations between the normal intake and the reverse intake points and associated variations in fish and shellfish species and variations in population densities. The Discharger should include a correction for these variations that is based on the IM&E data to be collected.

If you have any questions, please contact Dr. Tony Rizk at (213) 576-6756.

Sincerely,

Jonathan S. Bishop
Executive Officer

MAILING LIST

U. S. Environmental Protection Agency, Region 9, Permit Branch (WTR-5)
Ms. Nancy Yoshikawa, U. S. Environmental Protection Agency, Region 9
Ms. Robyn Stuber, U. S. Environmental Protection Agency, Region 9
U.S. Army Corps of Engineers
Mr. Bob Hoffman, NOAA National Marine Fisheries Service
Department of Interior, U. S. Fish and Wildlife Service
Mr. Philip Isorena, State Water Resources Control Board, Division of Water Quality
Mr. Dominic Gregorio, State Water Resources Control Board, Division of Water Quality
Mr. Marc S. Pryor, California Energy Commission
Mr. Rick York, California Energy Commission
Mr. Tom Luster, California Coastal Commission
Mr. William Paznokas, California Department of Fish & Game, Region 5
Mr. Thomas Napoli, California Department of Fish & Game
Mr. Guangyu Wang, Santa Monica Bay Restoration Commission
Department of Health Services, Sanitary Engineering Section
California State Parks and Recreation
South Coast Air Quality Management District
Water Replenishment District of Southern California
Los Angeles County, Department of Public Works, Waste Management Division
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Ms. Heather L. Hoecherl, Heal the Bay
Dr. Mark Gold, Heal the Bay
Mr. Dana Palmer, Santa Monica Baykeeper
Mr. David Beckman, Natural Resources Defense Council
Mr. Daniel Cooper, Lawyers for Clean Water
Environment Now
Mr. Tim Hemig, El Segundo Power LLC
Mr. Steve Maghy, AES Southland LLC
Ms. Julie Babcock, Reliant Energy
Mr. Tim Havey, TetraTech
Mr. Shane Beck, MBC Applied Environmental Sciences
Mr. Scott Seipel, Shaw Environmental & Infrastructure, Inc.
Mr. John Steinbeck, Tenera Environmental

Attachment A-4

Letter from LADWP to Los Angeles Regional Water Quality Control Board

December 1, 2006

Mr. Jonathan Bishop
Executive Officer
Regional Water Quality Control Board
Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90012

Dear Mr. Bishop

Subject: LADWP's Velocity Cap Study Preliminary Results to Date and Request to Cease Study

The purpose of this letter is to inform the Los Angeles Regional Water Quality Control Board (Regional Board) of the results to date of LADWP's velocity cap study and to determine whether continuation of the study as outlined in the study scope of work submitted to the Regional Board on Friday September 1, 2006 is still necessary.

<u>Velocity Cap Study Background</u>

The purpose of the velocity cap study is to evaluate the effectiveness of the velocity cap in reducing fish impingement mortality at the Scattergood Generating Station (SGS). To determine the effectiveness of the velocity cap, impingement is quantified during normal flow for a two week period using the existing intake (with velocity cap) and then quantified during reverse flow for another two week period using the existing discharge as the cooling water intake (without velocity cap). The flow patterns are alternated six times over a 12 week period. Since the discharge structure is similar in design to the intake, but lacks a velocity cap, an estimation of the benefit of the velocity cap can be determined. In addition, there is very little separation between the intake and discharge pipes; therefore, it is LADWP's belief that the habitat types are identical for both locations. To be sure, LADWP is conducting hydro-acoustical surveys at both the intake and discharge to confirm that the fish population numbers are similar at both locations. The effectiveness of the velocity cap will then be determined by mathematically computing the ratio of impinged fish with and without the velocity cap. As set forth in the study scope reviewed by Regional Board staff, a statistical analysis will be done on total fish abundance, biomass, and for individual species that are in high abundance. The analysis will be used to determine if the difference in impingement with and without the velocity cap is statistically significant.

Historical Velocity Cap Studies

Preliminary draft data from LADWP's current velocity cap study indicates an effectiveness of at least 95 percent. This compares well with current and historical velocity cap studies in the southern California region which have shown the velocity cap to be at least 80 to 90% effective. In the 1970s, the velocity cap was damaged at SGS due to storms and the plant operated in a reverse mode while a new velocity cap was installed. The fish impingement data collected during this period showed an effectiveness of at least 86%. Other studies done in southern California, such as the Huntington Beach Generating Station Study conducted by the University of Washington Fisheries Research Institute (July 1979 and 1980), showed a velocity cap effectiveness of 72% and 93%, respectively. A velocity cap study conducted at the El Segundo Generating Station for Units 1 and 2, July 1956 to June 1958, showed a 95% effectiveness. EPA, in its Technical Development Document for the Final Section 316(b) Phase II Existing Facilities Final Rule (2004), notes that "efficiencies of velocity caps on West Coast offshore intakes have exceeded 90 percent (ASCE)". Based on this information and the results of previous studies, LADWP feels confident that the current study is on track to confirm the historical velocity cap impingement mortality reduction effectiveness.

Current Study Status

LADWP's current velocity cap study is in week eight of its 12 week study. December 4th concludes the second reverse flow mode with a return to normal flow operation. Thus far, the most abundant species being impinged is the Pacific sardine. An estimated 216,000 Pacific sardine (*Sardinops sagax*) weighing approximately 7,200 kg (16,000 lbs) were estimated to be impinged during a 17-day reverse flow period, or approximately 940 lbs per day. For comparison, the annual Los Angeles area commercial landings in 2005 totaled 53, 236, 674 lbs, or approximately 146,000 lbs per day (http://www.dfg.ca.gov/mrd/landings05). The reverse flow impingement of sardines is therefore equivalent to <1% of the daily average commercial catch in the Los Angeles area.

The current observed percent effectiveness does not appear to be related to any study variances, such as temporal (seasonal) or spatial. The preliminary results of the hydro-acoustical surveys indicate that there are no differences in the fish population abundance between the intake and discharge locations. With regard to seasonal variances, the preliminary results from the SGS velocity cap study indicate high representation of species normally impinged at SGS. For example:

- Of the species impinged during the velocity cap study (October – November 2006), 91% were also impinged during the 316(b) impingement mortality surveys from January – June 2006. That is to say, that the fish observed in impingement surveys are essentially the same fish seen in the velocity cap study.

- The species that comprise 99.9% of the abundance in the velocity cap study period, namely sardines, were also impinged during January – June 2006. Thus, sardines are present in the source water year round.
- The same 22 fish species comprising 94% of the historic (1990-2005) impingement abundance at SGS have all been impinged during the initial phases of the velocity cap study.

While there is inter-annual variation in the number of species impinged at SGS, the core group of species that comprises the bulk of the impingement abundance has remained relatively stable over time. Preliminary results indicate that the fishes normally impinged at SGS are well represented in the velocity cap study, and results from the study can be successfully used to determine effectiveness of the velocity cap.

To date, LADWP's study has showed that 1,011 fish were impinged during the first normal flow mode, compared to 212,000 fish impinged during the first flow reversal, showing a 99.5% effectiveness. During the second normal flow period, 1,050 fish were impinged. The second reverse flow period is concluding, and preliminary data suggests the daily impingement rate is about twice that from the first reverse flow period, indicating similar effectiveness results. Since the second reverse preliminary results are similar to the first, and the two normal flow impingement regimes were both substantially lower than the reverse flow regimes, the results are showing consistency. Therefore, LADWP believes it will be able to demonstrate statistical soundness with the data collected October through November 2006, and supplement this with historical local and statewide results to adequately defend the calculated effectiveness number. The negative effects of the study are that a large number of fish are being impinged in the reverse mode.

LADWP has found that in reverse flow, without the velocity cap, a significant number of additional fish are being brought into the intake compared to normal flow with the velocity cap. While concluding the velocity cap study as proposed would make the statistical soundness of the data analysis more robust, LADWP believes that the data collected to date strongly mirrors the regional southern California historical data and that any temporal (seasonal) or spatial variability is not a factor. Continuing the velocity cap study as outlined in the study is not necessary and would unnecessarily cause undesirable environmental consequences to marine fishes. Therefore, LADWP respectfully request permission to discontinue the velocity cap study at the conclusion of the next two week regular operation (i.e., not implementing the last reverse flow).

The federal 316(b) Rule provides that after reviewing the Comprehensive Design Study (CDS), including information compiled for the velocity cap effectiveness study (e.g., the data, statistics and analysis), if the Regional Board believes there is insufficient data or analyses to support LADWP's conclusion, additional studies could be required.

In order to avert performing the last reverse flow study segment, LADWP needs the Regional Board's written response granting permission to discontinue the study by close of business on December 15, 2006. If you have any further questions regarding this letter, please contact Ms. Susan Damron or myself at 213-367-0279 or 213-367-0436, respectively.

Sincerely,

Katherine Rubin

Ms. Katherine Rubin
Interim Manager of Wastewater Quality Compliance

KR: bdc

c: Ms. Deborah Smith – LARWQCB
Mr. David Hung – LARWQCB
Mr. Tony Rizk – LARWQCB
Mr. Mike Lyons – LARWQCB
Ms. Shirley Pearson – URS
Ms. Barbara Klos – URS
Mr. Dave Bailey – EPRI Solutions
Mr. Shane Beck – MBC
Mr. John Steinbeck – Tenera
Ms. Susan Damron – LADWP
Ms. Katherine Rubin - LADWP

Attachment A-5

Letter from Los Angeles Regional Water Quality Control Board to LADWP Requiring Early Termination of the Study

California Regional Water Quality Control Board
Los Angeles Region

Recipient of the 2001 *Environmental Leadership Award* from Keep California Beautiful

Linda S. Adams
Agency Secretary

320 W. 4th Street, Suite 200, Los Angeles, California 90013
Phone (213) 576-6600 FAX (213) 576-6640 - Internet Address: http://www.waterboards.ca.gov/losangeles

Arnold Schwarzenegger
Governor

December 15, 2006

Ms. Susan Damron
City of Los Angeles Department of Water and Power
111 N. Hope Street, Room 1213
Los Angeles, California 90012

Dear Ms. Damron:

LOS ANGELES DEPARTMENT OF WATER AND POWER, SCATTERGOOD GENERATING STATION, LOS ANGELES, CA. (NPDES NO. CA0000370, CI NO. 1886) – LADWP VELOCITY CAP STUDY REQUEST TO CEASE STUDY

As part of the studies required for the implementation of the United State Environmental Protection Agency (USEPA) 316(b) Phase II Rule, the City of Los Angeles Department of Water and Power (LADWP) developed the *Scattergood Generating Station Study Plan for Testing the Effectiveness of the Intake Structure Velocity Cap*, prepared by Tenera Environmental, Inc., MBC Applied Environmental Sciences, and URS Corporation. LADWP submitted the study plan to the California Los Angeles Regional Water Quality Control Board, Los Angeles Region (Regional Board) on September 5, 2006. Regional Board staff provided comments on this study plan on October 4, 2006.

LADWP commenced the study on October 10, 2006. LADWP operated the plant in the normal flow configuration (velocity cap) for 2 weeks, followed by operation of the plant in a reverse flow configuration (no velocity cap) for 2 weeks. LADWP performed heat treatment at the start of the study and at the end of each 2-week test period. This procedure was to be repeated three (3) times. LADWP opined that data collected would constitute a statistically significant data set to quantify the reduction in impingement due to the velocity cap.

On Tuesday, November 28, 2006, the LADWP contacted the Regional Board staff by telephone which led to a meeting on November 29, 2006. At that meeting, LADWP submitted to the Regional Board staff interim (preliminary) test results that showed that at the end of the first (1^{st}) normal flow test period (weeks 1 and 2), the fish killed during heat treatment were approximately 1000, with a combined weight of 34 kg. However, at the end of the first (1^{st}) reverse flow test period (weeks 3 and 4), the number of fish killed during the heat treatment was in excess of 200,000, with a combined weight of approximately 7,000 kg. The number of fish killed during the second (2^{nd}) normal flow test period (weeks 5 and 6) yielded results similar to the first (1^{st}) normal flow test period. LADWP commenced the second (2^{nd}) reverse flow test period (weeks 7 and 8) on November 21, 2006.

At that meeting, eight (8) days into the second (2^{nd}) reverse flow test period, LADWP requested authorization to terminate the study early, i.e., at the end of the ongoing second (2^{nd}) reverse flow test period. LADWP opined that the high number of fish killed during the heat treatment at the end of the first (1^{st}) reverse flow test period demonstrates the high efficiency rate of the velocity cap. Further, LADWP expressed serious concern about the large number of fish being killed and did not want to further impact the region fisheries with additional heat treatments and associated large fish kills. Following that meeting, LADWP submitted a letter on December 1, 2006 which formalized this information and their request to the Regional Board.

The Regional Board staff, in concurrence with LADWP, is extremely concerned about the significant quantity of fish killed from the heat treatment at the end of the first (1^{st}), and presumably the second (2^{nd}) reverse flow test period. On December 11, 2006, the Regional Board verbally conveyed to LADWP that the operation of the plant in the reverse flow configuration cannot continue and directed LADWP to cease that mode of plant operation.

This letter reiterates the Regional Board verbal directive to LADWP to cease the reverse flow study immediately. LADWP is directed to document the adverse impact to the fisheries that have resulted from this study and to develop appropriate mitigation measures.

In reference to the efficacy of the velocity cap, the data collected to date must be thoroughly reviewed and analyzed prior to determining the reduction in impingement. To illustrate, the Regional Board staff are concerned about LADWP reliance on the data from heat treatment, a destructive technology, to fully justify velocity cap performance. Daily impingement data may be a better indicator of the rate of fish impingement. With the current tunnel configuration for these tests, there is no mechanism to allow captured fish to escape before heat treatment. This overestimates the fish that would normally be impinged if the captured fish can escape. Further, in this study, LADWP heat treated the intake tunnel at the onset of the normal flow (velocity cap) test period. This has removed the fish that would likely collect on the screens on a daily basis and under normal conditions. The subsequent two (2) weeks fish "stocking" period in the intake tunnel may not be long enough to recover the intake tunnel fish population density and fish impingement rate under normal operating conditions. Any subsequent heat treatment of the intake forebay and tunnel during this study would further deplete the fish "stocked" in the intake tunnel and bias the data.

In summary, although the Regional Board staff recognizes that the velocity cap significantly reduces fish impingement, until the data have been fully analyzed, it cannot be determined if LADWP has quantified the efficacy of the velocity cap in terms of percent reduction of impingement. It also raises questions about whether fish release methodologies need to be implemented along with the velocity cap. Upon submittal of the results to date from the study, the Regional Board will schedule a meeting with LADWP and other local scientists to evaluate both the impacts of this study as well as whether additional studies need to be done.

LADWP may continue monitoring fish impingement in the normal flow configuration (velocity cap) and collect additional data, as appropriate. However, the operation of the plant using the reverse flow configuration must cease immediately.

If it is determined that future studies are needed to quantify the efficiency of the velocity cap as well as meet other objectives in compliance with the Regional Board and the USEPA requirements, LADWP must explore study plans that use less destructive test procedures and have shorter time frames. Future study plans must incorporate a detailed assessment of risks involved and appropriate mitigation measures.

If you have any questions, please contact Dr. Tony Rizk at (213) 576-6756.

Sincerely,

Jonathan S. Bishop
Executive Officer

MAILING LIST

U. S. Environmental Protection Agency, Region 9, Permit Branch (WTR-5)
Ms. Nancy Yoshikawa, U. S. Environmental Protection Agency, Region 9
Ms. Robyn Stuber, U. S. Environmental Protection Agency, Region 9
U.S. Army Corps of Engineers
Mr. Bob Hoffman, NOAA National Marine Fisheries Service
Department of Interior, U. S. Fish and Wildlife Service
Mr. Philip Isorena, State Water Resources Control Board, Division of Water Quality
Mr. Dominic Gregorio, State Water Resources Control Board, Division of Water Quality
Mr. Marc S. Pryor, California Energy Commission
Mr. Rick York, California Energy Commission
Mr. Tom Luster, California Coastal Commission
Mr. William Paznokas, California Department of Fish & Game, Region 5
Mr. Thomas Napoli, California Department of Fish & Game
Ms. Shelly Luce, Santa Monica Bay Restoration Commission
Department of Health Services, Sanitary Engineering Section
California State Parks and Recreation
South Coast Air Quality Management District
Water Replenishment District of Southern California
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Mr. Steve Maghy, AES Southland LLC
Ms. Julie Babcock, Reliant Energy
Mr. Tim Havey, TetraTech
Mr. Shane Beck, MBC Applied Environmental Sciences
Mr. Scott Seipel, Shaw Environmental & Infrastructure, Inc.
Mr. John Steinbeck, Tenera Environmental

Attachment A-6

Cooling Water Flow Volumes during the Velocity Cap Study

Cooling Water Flow Volumes at SGS during IM&E Characterization Study and Velocity Cap Impingement Surveys.

Sample Processing Date	Survey Flow Volume (gallons)	Survey Flow Volume (cubic meters)
10/12/06	345,595,000	1,308,077
10/13/06	344,599,000	1,304,307
10/16/06	393,360,000	1,488,868
10/17/06	962,511,000	3,643,104
10/19/06	350,876,000	1,328,066
10/20/06	310,521,000	1,175,322
10/23/06	295,580,000	1,118,770
10/24/06	379,740,000	1,437,316
10/26/06	339,563,000	1,285,246
10/27/06	326,604,000	1,236,196
10/30/06	307,960,000	1,165,629
10/31/06	1,014,656,000	3,840,473
11/02/06	401,129,000	1,518,273
11/03/06	362,022,000	1,370,253
11/06/06	381,858,000	1,445,333
11/07/06	266,970,000	1,010,481
11/09/06	953,563,000	3,609,236
11/10/06	219,698,000	831,557
11/13/06	961,362,000	3,638,755
11/14/06	371,661,000	1,406,737
11/15/06	345,119,000	1,306,275
11/16/06	308,231,000	1,166,654
11/17/06	332,320,000	1,257,831
11/20/06	1,065,153,000	4,031,604
11/21/06	340,071,000	1,287,169
11/22/06	360,488,000	1,364,447
11/27/06	1,529,519,000	5,789,229
11/28/06	496,500,000	1,879,253
11/29/06	376,451,000	1,424,867
11/30/06	464,925,000	1,759,741
12/01/06	452,499,000	1,712,709
12/04/06	996,217,000	3,770,681
12/05/06	274,147,000	1,037,646
12/06/07	289,259,000	1,094,845
12/07/06	234,140,000	886,220
12/08/06	382,867,000	1,449,152
12/11/06	851,236,000	3,221,928
12/12/07	220,520,000	834,668
12/13/07	298,919,000	1,131,408
12/14/06	225,135,000	852,136
12/15/06	445,010,000	1,684,363
12/18/06	837,614,000	3,170,369
12/19/06	289,646,000	1,096,310
12/20/07	397,806,000	1,505,696
12/21/06	372,625,000	1,410,386
12/22/06	341,910,000	1,294,129
12/26/06	1,313,782,000	4,972,665
12/27/06	356,958,000	1,351,086
12/28/06	374,468,000	1,417,361
12/29/06	351,214,000	1,329,345
01/02/07	1,466,586,000	5,551,028
01/03/07	331,336,000	1,254,107

Cooling Water Flow Volumes at SGS during Heat Treatment Survey Periods.

Heat Treatment Date	Survey Flow Volume (gallons)	Survey Flow Volume (cubic meters)
10/23/06	4,468,060,000	16,911,607
11/9/06	5,881,955,000	22,263,200
11/20/06	3,629,972,000	13,739,444
12/4/06	5,112,734,060	19,351,698
12/11/06	2,331,619,000	8,825,178
1/3/07	7,729,306,000	29,255,423

Attachment A-7

Hydroacoustic Data Collected During the Velocity Cap Study

Fish densities near the SGS intake and discharge structures measured using hydroacoustics.

Date	Time	Survey #	Day=1 Night= 2	Normal=1 Reverse= 2	Rep#	Offshore Density (kg/m3)	Onshore Density (kg/m3)	Offshore Ping #	Inshore Ping #	Transect #
10/22/2006	9:42:25	1	1	1	1	6.42E-07	1.52E-03	665	320	2
10/22/2006	9:47:10	1	1	1	1	1.74E-06	5.76E-06	1075	791	3
10/22/2006	9:50:51	1	1	1	1	1.72E-02	1.25E-02	1294	736	4
10/22/2006	9:55:18	1	1	1	1	1.28E-05	2.60E-04	1121	1016	5
10/22/2006	9:59:25	1	1	1	1	3.19E-05	6.29E-04	1223	798	6
10/22/2006	10:04:10	1	1	1	1	9.56E-06	1.15E-03	1016	1145	7
10/22/2006	10:08:37	1	1	1	1	9.88E-03	3.69E-03	1141	922	8
10/22/2006	10:35:47	1	1	1	1	1.15E-02	1.17E-01	971	1005	14
10/22/2006	10:40:06	1	1	1	1	4.67E-02	5.39E-04	752	1231	15
10/22/2006	10:44:08	1	1	1	1	7.41E-05	1.94E-04	823	1013	16
10/22/2006	10:48:12	1	1	1	1	6.46E-02	8.13E-06	744	1293	17
10/22/2006	10:52:21	1	1	1	1	9.42E-07	4.87E-04	814	1119	18
10/22/2006	10:56:40	1	1	1	1	5.61E-05	9.15E-05	696	1437	19
10/22/2006	11:00:48	1	1	1	1	8.66E-07	4.28E-05	794	1142	20
10/22/2006	11:24:13	1	1	1	2	4.29E-06	1.57E-04	1552	767	2
10/22/2006	11:28:56	1	1	1	2	8.92E-06	2.19E-03	1249	939	3
10/22/2006	11:33:23	1	1	1	2	9.85E-06	4.75E-04	1366	834	4
10/22/2006	11:37:52	1	1	1	2	2.61E-07	2.27E-03	1192	1271	5
10/22/2006	11:42:38	1	1	1	2	1.57E-01	9.83E-02	1257	904	6
10/22/2006	11:47:03	1	1	1	2	4.45E-02	3.93E-02	1172	1383	7
10/22/2006	11:52:20	1	1	1	2	2.92E-05	7.37E-03	1339	1029	8
10/22/2006	11:57:38	1	1	1	2	1.31E-06	1.75E-04	931	1577	14
10/22/2006	12:02:25	1	1	1	2	1.05E-07	4.14E-03	1038	1088	15
10/22/2006	12:07:08	1	1	1	2	6.11E-03	7.23E-01	841	1542	16
10/22/2006	12:11:46	1	1	1	2	2.03E-02	4.62E-05	1010	1142	17
10/22/2006	12:16:40	1	1	1	2	6.90E-07	2.21E-06	777	1580	18
10/22/2006	12:21:41	1	1	1	2	5.31E-07	9.85E-06	952	1655	19
10/22/2006	12:26:20	1	1	1	2	2.81E-03	3.11E-03	763	1643	20
10/22/2006	12:40:44	1	1	1	3	6.32E-03	9.26E-05	1449	783	2
10/22/2006	12:45:29	1	1	1	3	0.00E+00	2.72E-02	1321	1054	3
10/22/2006	12:49:57	1	1	1	3	1.70E-06	1.05E-04	1349	814	4
10/22/2006	12:57:40	1	1	1	3	1.70E-02	2.68E-03	1320	1330	5
10/22/2006	13:02:49	1	1	1	3	8.88E-02	8.67E-02	1279	938	6
10/22/2006	13:07:26	1	1	1	3	5.67E-02	1.00E-01	1159	1448	7
10/22/2006	13:13:25	1	1	1	3	2.65E-05	1.80E-02	1155	1289	14
10/22/2006	13:18:58	1	1	1	3	1.24E-04	5.51E-05	1011	1727	15
10/22/2006	13:24:05	1	1	1	3	4.08E-06	1.15E-04	970	1189	16
10/22/2006	13:28:37	1	1	1	3	8.92E-02	1.44E-03	867	1667	17
10/22/2006	13:33:10	1	1	1	3	2.66E-07	1.40E-06	889	1125	18
10/22/2006	13:37:28	1	1	1	3	1.08E-07	1.75E-05	804	1838	19
10/22/2006	13:42:11	1	1	1	3	9.08E-07	1.15E-01	797	1137	20
10/22/2006	19:24:01	1	2	1	1	1.69E-03	3.60E-03	1538	844	2
10/22/2006	19:28:59	1	2	1	1	1.55E-03	3.22E-03	1101	988	3
10/22/2006	19:33:07	1	2	1	1	1.76E-03	1.66E-02	1237	828	4
10/22/2006	19:37:51	1	2	1	1	8.49E-04	9.75E-03	954	1182	5
10/22/2006	19:42:18	1	2	1	1	3.54E-04	4.66E-02	1245	925	6
10/22/2006	19:46:56	1	2	1	1	7.45E-04	4.08E-02	997	1207	7
10/22/2006	19:51:33	1	2	1	1	2.97E-03	5.89E-02	1120	1008	8
10/22/2006	19:56:57	1	2	1	1	2.50E-04	6.95E-05	1091	1134	14
10/22/2006	20:02:51	1	2	1	1	1.13E-04	6.46E-04	1058	986	15
10/22/2006	20:07:00	1	2	1	1	2.08E-03	2.45E-04	1075	1151	16
10/22/2006	20:11:22	1	2	1	1	1.38E-03	1.30E-03	869	1044	17
10/22/2006	20:15:45	1	2	1	1	7.23E-04	1.87E-03	967	1214	18
10/22/2006	20:20:00	1	2	1	1	6.39E-04	1.03E-04	1164	1070	19
10/22/2006	20:24:15	1	2	1	1	3.59E-04	4.05E-05	924	1271	20
10/22/2006	20:34:01	1	2	1	2	1.32E-03	1.36E-03	995	1019	2
10/22/2006	20:37:56	1	2	1	2	3.38E-04	2.97E-03	1225	949	3
10/22/2006	20:42:21	1	2	1	2	2.57E-04	3.95E-03	969	1072	4
10/22/2006	20:46:22	1	2	1	2	9.54E-04	2.03E-03	1285	942	5
10/22/2006	20:51:03	1	2	1	2	5.17E-05	5.71E-03	1094	1178	6
10/22/2006	20:55:18	1	2	1	2	1.81E-03	6.18E-03	1330	985	7
10/22/2006	21:00:03	1	2	1	2	3.27E-04	1.18E-02	1033	1298	8
10/22/2006	21:04:49	1	2	1	2	2.11E-03	4.57E-04	1287	997	14

Fish densities near the SGS intake and discharge structures (continued).

Date	Time	Survey #	Day=1 Night= 2	Normal=1 Reverse= 2	Rep#	Offshore Density (kg/m3)	Inshore Density (kg/m3)	Offshore Ping #	Inshore Ping #	Transect #
10/22/2006	21:09:42	1	2	1	2	9.07E-04	6.74E-04	1021	1305	15
10/22/2006	21:14:10	1	2	1	2	3.41E-04	2.77E-03	1146	1067	16
10/22/2006	21:19:04	1	2	1	2	2.83E-05	1.24E-03	1068	1233	17
10/22/2006	21:23:28	1	2	1	2	5.55E-05	2.14E-04	1182	1063	18
10/22/2006	21:27:55	1	2	1	2	3.93E-04	3.69E-04	963	1179	19
10/22/2006	21:32:12	1	2	1	2	2.12E-04	8.71E-05	1211	1101	20
10/22/2006	21:38:36	1	2	1	3	2.69E-05	2.53E-04	1169	1037	2
10/22/2006	21:42:42	1	2	1	3	5.74E-04	1.17E-03	1356	946	3
10/22/2006	21:47:20	1	2	1	3	8.63E-04	2.30E-03	1091	1187	4
10/22/2006	21:51:51	1	2	1	3	7.95E-04	9.62E-03	1351	1059	5
10/22/2006	21:56:31	1	2	1	3	3.98E-04	5.78E-03	1114	1258	6
10/22/2006	22:01:16	1	2	1	3	9.04E-04	1.50E-02	1316	965	7
10/22/2006	22:05:53	1	2	1	3	1.71E-03	6.93E-03	1084	1331	8
10/22/2006	22:11:29	1	2	1	3	3.15E-04	1.60E-02	1316	1115	14
10/22/2006	22:16:36	1	2	1	3	1.76E-04	4.77E-03	1012	1384	15
10/22/2006	22:21:15	1	2	1	3	2.78E-04	2.97E-02	1262	1043	16
10/22/2006	22:25:52	1	2	1	3	3.09E-04	7.59E-03	948	1253	17
10/22/2006	22:30:19	1	2	1	3	8.21E-03	2.71E-02	1161	1068	18
10/22/2006	22:34:57	1	2	1	3	2.82E-04	1.21E-04	1006	1206	19
10/22/2006	22:39:14	1	2	1	3	6.03E-04	4.46E-03	1119	1203	20
10/23/2006	10:30:31	1	1	2	1	3.00E-05	7.96E-04	983	1154	2
10/23/2006	10:34:31	1	1	2	1	3.18E-04	9.64E-04	961	692	3
10/23/2006	10:38:04	1	1	2	1	2.48E-04	2.78E-04	953	989	4
10/23/2006	10:42:00	1	1	2	1	1.30E-02	2.27E-04	937	685	5
10/23/2006	10:45:42	1	1	2	1	6.67E-01	1.82E-03	848	988	6
10/23/2006	10:49:21	1	1	2	1	1.54E-02	2.29E-03	852	732	7
10/23/2006	10:52:56	1	1	2	1	4.38E-02	6.13E-03	835	970	8
10/23/2006	10:57:03	1	1	2	1	8.34E-03	5.43E-01	841	735	14
10/23/2006	11:00:31	1	1	2	1	2.07E-01	6.69E-03	822	1128	15
10/23/2006	11:04:18	1	1	2	1	1.51E-04	1.05E-03	926	765	16
10/23/2006	11:08:17	1	1	2	1	2.26E-05	5.65E-03	790	1023	17
10/23/2006	11:11:53	1	1	2	1	3.08E-06	8.67E-06	948	793	18
10/23/2006	11:15:34	1	1	2	1	2.84E-02	2.93E-03	805	1000	19
10/23/2006	11:19:06	1	1	2	1	7.52E-05	5.38E-03	964	801	20
10/23/2006	11:24:25	1	1	2	2	2.08E-03	1.47E-04	855	768	2
10/23/2006	11:27:29	1	1	2	2	1.15E-03	1.14E-02	925	707	3
10/23/2006	11:30:43	1	1	2	2	8.61E-02	4.17E-03	870	911	4
10/23/2006	11:34:05	1	1	2	2	1.14E-01	1.00E-02	956	709	5
10/23/2006	11:37:30	1	1	2	2	7.70E-03	7.16E-02	874	940	6
10/23/2006	11:41:03	1	1	2	2	2.21E-01	4.55E-04	874	735	7
10/23/2006	11:44:23	1	1	2	2	8.78E-02	2.51E-03	918	982	8
10/23/2006	11:48:09	1	1	2	2	2.08E-02	2.16E-02	872	763	14
10/23/2006	11:51:28	1	1	2	2	4.90E-04	1.21E-02	840	1077	15
10/23/2006	11:55:05	1	1	2	2	2.17E-03	4.84E-03	826	759	16
10/23/2006	11:58:35	1	1	2	2	1.57E-05	5.11E-02	854	1096	17
10/23/2006	12:02:17	1	1	2	2	4.99E-06	3.37E-04	778	768	18
10/23/2006	12:05:43	1	1	2	2	3.29E-07	4.87E-04	859	1111	19
10/23/2006	12:09:25	1	1	2	2	1.68E-07	1.14E-02	902	822	20
10/23/2006	12:14:16	1	1	2	3	3.62E-02	4.04E-02	912	934	2
10/23/2006	12:17:48	1	1	2	3	5.14E-03	4.15E-03	947	723	3
10/23/2006	12:21:35	1	1	2	3	3.74E-02	2.99E-03	939	962	4
10/23/2006	12:25:07	1	1	2	3	1.36E-02	2.84E-03	962	745	5
10/23/2006	12:28:45	1	1	2	3	6.91E-03	4.86E-03	928	1068	6
10/23/2006	12:32:32	1	1	2	3	6.83E-04	2.01E-03	990	745	7
10/23/2006	12:36:32	1	1	2	3	8.72E-02	5.98E-03	958	1000	8
10/23/2006	12:40:40	1	1	2	3	2.11E-02	2.98E-02	850	815	14
10/23/2006	12:44:17	1	1	2	3	3.30E-02	1.47E-02	880	1148	15
10/23/2006	12:48:09	1	1	2	3	1.26E-04	2.41E-02	826	790	16
10/23/2006	12:51:53	1	1	2	3	2.24E-05	2.07E-02	925	1112	17
10/23/2006	12:55:44	1	1	2	3	3.81E-05	5.31E-04	853	836	18
10/23/2006	12:59:17	1	1	2	3	2.24E-03	1.65E-02	954	1269	19
10/23/2006	13:03:24	1	1	2	3	9.12E-04	1.12E-05	923	847	20
10/23/2006	18:22:30	1	2	2	1	1.99E-03	4.62E-03	1052	1011	2
10/23/2006	18:26:26	1	2	2	1	3.32E-03	1.05E-03	1002	784	3

Fish densities near the SGS intake and discharge structures (continued).

Date	Time	Survey #	Day=1 Night= 2	Normal=1 Reverse= 2	Rep#	Offshore Density (kg/m3)	Inshore Density (kg/m3)	Offshore Ping #	Inshore Ping #	Transect #
10/23/2006	18:30:30	1	2	2	1	2.85E-03	2.74E-03	1067	1115	4
10/23/2006	18:34:39	1	2	2	1	4.70E-03	6.56E-03	1014	772	5
10/23/2006	18:38:43	1	2	2	1	3.01E-03	1.73E-03	1258	1201	6
10/23/2006	18:43:24	1	2	2	1	5.58E-03	8.85E-05	1125	844	7
10/23/2006	18:47:39	1	2	2	1	4.71E-02	2.91E-04	1221	1262	8
10/23/2006	18:52:40	1	2	2	1	1.40E-04	2.57E-05	1071	951	14
10/23/2006	18:57:15	1	2	2	1	2.14E-04	2.94E-04	1061	1253	15
10/23/2006	19:01:49	1	2	2	1	1.28E-04	1.34E-04	1039	1017	16
10/23/2006	19:06:09	1	2	2	1	1.55E-04	2.79E-04	1096	1283	17
10/23/2006	19:10:43	1	2	2	1	4.46E-04	2.07E-04	996	1004	18
10/23/2006	19:15:08	1	2	2	1	2.23E-05	1.42E-03	1053	1167	19
10/23/2006	19:19:21	1	2	2	1	3.05E-05	1.28E-04	1096	967	20
10/23/2006	19:24:38	1	2	2	2	1.26E-03	3.76E-04	1148	1080	2
10/23/2006	19:28:49	1	2	2	2	6.41E-04	1.91E-04	1179	837	3
10/23/2006	19:33:01	1	2	2	2	2.20E-03	1.06E-03	1169	1120	4
10/23/2006	19:37:18	1	2	2	2	4.80E-03	7.50E-04	1075	830	5
10/23/2006	19:41:33	1	2	2	2	2.86E-03	5.47E-05	1135	1302	6
10/23/2006	19:45:58	1	2	2	2	5.96E-03	2.40E-04	1005	848	7
10/23/2006	19:50:06	1	2	2	2	8.11E-02	3.30E-03	1122	1359	8
10/23/2006	19:55:23	1	2	2	2	1.42E-03	1.76E-05	1048	921	14
10/23/2006	19:59:40	1	2	2	2	2.00E-03	1.08E-04	1031	1322	15
10/23/2006	20:04:03	1	2	2	2	5.21E-04	8.43E-05	1107	960	16
10/23/2006	20:08:34	1	2	2	2	7.49E-05	3.07E-04	1070	1249	17
10/23/2006	20:12:55	1	2	2	2	4.38E-04	1.51E-04	1174	987	18
10/23/2006	20:17:28	1	2	2	2	2.12E-04	7.00E-04	1073	1358	19
10/23/2006	20:22:01	1	2	2	2	1.24E-03	1.65E-04	1062	1020	20
10/23/2006	20:27:39	1	2	2	3	1.90E-03	4.31E-04	1172	1188	2
10/23/2006	20:32:15	1	2	2	3	5.72E-04	3.17E-05	1191	895	3
10/23/2006	20:36:58	1	2	2	3	6.82E-04	1.24E-03	1192	1181	4
10/23/2006	20:41:37	1	2	2	3	4.96E-04	1.51E-03	1126	901	5
10/23/2006	20:46:24	1	2	2	3	7.88E-04	3.17E-04	1215	1241	6
10/23/2006	20:53:19	1	2	2	3	3.53E-02	4.78E-04	1168	892	7
10/23/2006	20:57:52	1	2	2	3	5.25E-02	1.35E-03	1141	1097	8
10/23/2006	21:02:49	1	2	2	3	3.65E-04	3.84E-05	1108	1007	14
10/23/2006	21:07:19	1	2	2	3	1.25E-04	3.97E-04	1056	1131	15
10/23/2006	21:11:35	1	2	2	3	6.68E-05	8.49E-05	1079	1001	16
10/23/2006	21:16:08	1	2	2	3	5.65E-05	1.56E-05	1054	1206	17
10/23/2006	21:20:23	1	2	2	3	1.30E-05	1.38E-05	1052	967	18
10/23/2006	21:24:44	1	2	2	3	8.83E-06	4.08E-05	1000	1209	19
10/23/2006	21:28:54	1	2	2	3	1.44E-04	1.67E-05	1088	1089	20
11/5/2006	10:34:38	2	1	2	1	9.33E-07	2.32E-04	1154	1125	2
11/5/2006	10:39:13	2	1	2	1	9.21E-05	7.98E-05	1225	969	3
11/5/2006	10:44:00	2	1	2	1	9.42E-04	1.56E-03	1139	1078	4
11/5/2006	10:48:54	2	1	2	1	1.36E-05	1.08E-04	1055	1030	5
11/5/2006	10:53:26	2	1	2	1	2.71E-03	7.16E-04	1133	1159	6
11/5/2006	10:58:08	2	1	2	1	1.06E-03	2.87E-04	1091	973	7
11/5/2006	11:02:58	2	1	2	1	4.24E-03	1.37E-04	1095	1146	8
11/5/2006	11:08:17	2	1	2	1	3.41E-04	4.52E-03	1025	950	14
11/5/2006	11:13:04	2	1	2	1	1.19E-03	7.92E-05	1186	1197	15
11/5/2006	11:17:54	2	1	2	1	1.02E-04	5.98E-04	980	952	16
11/5/2006	11:22:18	2	1	2	1	4.17E-04	2.31E-03	1090	1302	17
11/5/2006	11:27:18	2	1	2	1	5.06E-04	8.92E-04	964	964	18
11/5/2006	11:31:53	2	1	2	1	1.03E-04	5.77E-03	947	1070	19
11/5/2006	11:35:50	2	1	2	1	2.03E-05	1.39E-04	983	907	20
11/5/2006	11:41:44	2	1	2	2	2.91E-03	1.78E-05	1113	1101	2
11/5/2006	11:45:47	2	1	2	2	1.11E-06	2.79E-05	1047	885	3
11/5/2006	11:50:02	2	1	2	2	5.54E-06	1.03E-04	934	1009	4
11/5/2006	11:53:48	2	1	2	2	1.85E-06	8.35E-04	847	727	5
11/5/2006	11:57:11	2	1	2	2	2.70E-04	1.14E-03	875	913	6
11/5/2006	12:00:43	2	1	2	2	1.23E-04	7.76E-05	1103	888	7
11/5/2006	12:05:10	2	1	2	2	8.60E-06	2.68E-03	1066	1291	8
11/5/2006	12:10:09	2	1	2	2	4.81E-05	1.49E-03	848	858	14
11/5/2006	12:14:04	2	1	2	2	8.88E-03	1.80E-03	874	1104	15
11/5/2006	12:17:52	2	1	2	2	2.12E-03	5.40E-04	810	748	16

Fish densities near the SGS intake and discharge structures (continued).

Date	Time	Survey #	Day=1 Night= 2	Normal=1 Reverse= 2	Rep#	Offshore Density (kg/m3)	Inshore Density (kg/m3)	Offshore Ping #	Inshore Ping #	Transect #
11/5/2006	12:22:01	2	1	2	2	1.42E-03	1.48E-04	963	1229	17
11/5/2006	12:26:10	2	1	2	2	8.73E-05	3.53E-05	806	841	18
11/5/2006	12:30:28	2	1	2	2	2.35E-05	5.84E-04	894	1046	19
11/5/2006	12:34:28	2	1	2	2	9.22E-04	3.17E-05	843	787	20
11/5/2006	12:40:57	2	1	2	3	1.94E-02	6.91E-05	1037	884	2
11/5/2006	12:44:50	2	1	2	3	3.26E-05	7.32E-04	1018	827	3
11/5/2006	12:49:16	2	1	2	3	4.63E-06	9.97E-05	1044	1119	4
11/5/2006	12:53:36	2	1	2	3	2.77E-05	2.47E-02	1088	837	5
11/5/2006	12:58:16	2	1	2	3	2.59E-04	3.42E-05	970	1106	6
11/5/2006	13:02:31	2	1	2	3	1.20E-04	8.17E-02	938	805	7
11/5/2006	13:06:53	2	1	2	3	6.53E-04	1.96E-02	915	1017	8
11/5/2006	13:11:14	2	1	2	3	3.41E-05	1.23E-02	859	822	14
11/5/2006	13:15:05	2	1	2	3	1.07E-04	1.36E-02	833	1007	15
11/5/2006	13:18:47	2	1	2	3	3.77E-04	1.84E-05	919	877	16
11/5/2006	13:22:52	2	1	2	3	3.67E-05	3.95E-04	902	1139	17
11/5/2006	13:26:48	2	1	2	3	1.62E-05	3.33E-05	904	989	18
11/5/2006	13:31:02	2	1	2	3	2.67E-03	8.10E-02	950	1047	19
11/5/2006	13:34:46	2	1	2	3	1.04E-05	1.97E-03	897	1014	20
11/5/2006	21:26:26	2	2	2	1	5.57E-05	9.55E-05	978	1068	20
11/5/2006	21:31:39	2	2	2	1	2.84E-04	8.27E-05	1161	880	19
11/5/2006	21:35:43	2	2	2	1	1.33E-04	8.25E-05	809	1115	18
11/5/2006	21:40:08	2	2	2	1	8.45E-05	3.01E-04	844	785	17
11/5/2006	21:43:48	2	2	2	1	1.19E-04	3.11E-04	907	1127	16
11/5/2006	21:48:19	2	2	2	1	2.77E-04	6.47E-05	964	841	15
11/5/2006	21:52:12	2	2	2	1	4.15E-04	1.78E-04	1020	1391	14
11/5/2006	21:58:32	2	2	2	1	1.09E-02	2.62E-04	1047	772	8
11/5/2006	22:02:16	2	2	2	1	1.12E-03	7.88E-04	1113	1181	7
11/5/2006	22:07:20	2	2	2	1	6.48E-04	5.17E-04	982	896	6
11/5/2006	22:11:20	2	2	2	1	1.89E-04	1.18E-03	1108	1195	5
11/5/2006	22:16:13	2	2	2	1	1.97E-04	7.39E-04	1090	826	4
11/5/2006	22:20:15	2	2	2	1	1.27E-04	1.30E-04	1112	1151	3
11/5/2006	22:25:14	2	2	2	1	1.40E-04	1.97E-04	1107	830	2
11/5/2006	22:35:33	2	2	2	2	4.93E-04	5.02E-05	818	780	20
11/5/2006	22:39:00	2	2	2	2	1.92E-04	4.91E-05	845	1034	19
11/5/2006	22:43:15	2	2	2	2	1.68E-04	2.39E-04	861	817	18
11/5/2006	22:46:42	2	2	2	2	4.56E-04	1.77E-04	868	971	17
11/5/2006	22:51:17	2	2	2	2	1.58E-03	1.06E-03	929	864	16
11/5/2006	22:54:55	2	2	2	2	1.15E-01	3.54E-04	910	1046	15
11/5/2006	22:59:36	2	2	2	2	5.63E-02	2.21E-03	917	849	14
11/5/2006	23:03:43	2	2	2	2	6.69E-03	1.19E-03	923	1001	8
11/5/2006	23:08:22	2	2	2	2	4.08E-03	1.12E-03	932	788	7
11/5/2006	23:11:59	2	2	2	2	3.39E-04	2.77E-04	908	950	6
11/5/2006	23:16:25	2	2	2	2	8.25E-04	7.08E-04	1081	812	5
11/5/2006	23:20:08	2	2	2	2	5.37E-04	7.05E-04	888	916	4
11/5/2006	23:24:41	2	2	2	2	3.20E-04	1.84E-03	1067	733	3
11/5/2006	23:28:19	2	2	2	2	4.18E-04	8.26E-04	791	871	2
11/5/2006	23:33:13	2	2	2	3	1.07E-02	1.26E-01	1052	926	20
11/5/2006	23:37:10	2	2	2	3	1.62E-03	3.60E-02	983	1139	19
11/5/2006	23:41:52	2	2	2	3	7.89E-04	2.68E-03	926	856	18
11/5/2006	23:45:32	2	2	2	3	1.20E-03	2.40E-03	882	984	17
11/5/2006	23:49:47	2	2	2	3	3.16E-03	1.24E-03	868	883	16
11/5/2006	23:53:20	2	2	2	3	2.30E-03	3.31E-04	838	1008	15
11/5/2006	23:57:34	2	2	2	3	5.18E-03	7.63E-04	936	832	14
11/6/2006	0:01:39	2	2	2	3	3.86E-02	1.16E-02	928	873	8
11/6/2006	0:05:44	2	2	2	3	4.45E-04	9.40E-04	960	809	7
11/6/2006	0:09:26	2	2	2	3	2.60E-04	5.33E-03	927	926	6
11/6/2006	0:13:49	2	2	2	3	2.24E-04	1.01E-03	964	775	5
11/6/2006	0:17:36	2	2	2	3	2.23E-04	3.75E-03	883	884	4
11/6/2006	0:21:45	2	2	2	3	2.06E-04	4.59E-04	984	782	3
11/6/2006	0:25:32	2	2	2	3	7.02E-04	1.17E-03	891	863	2
11/8/2006	11:39:46	2	1	2	1	1.05E-03	7.54E-04	1084	1150	7
11/8/2006	11:44:29	2	1	2	1	7.81E-03	1.54E-04	1069	882	8
11/8/2006	11:50:54	2	1	2	1	1.71E-04	2.33E-03	1036	1206	14

Fish densities near the SGS intake and discharge structures (continued).

Date	Time	Survey #	Day=1 Night= 2	Normal=1 Reverse= 2	Rep#	Offshore Density (kg/m3)	Inshore Density (kg/m3)	Offshore Ping #	Inshore Ping #	Transect #
11/8/2006	11:56:00	2	1	2	1	2.00E-04	1.48E-03	819	806	15
11/8/2006	11:59:57	2	1	2	1	2.50E-04	9.90E-04	918	1210	16
11/8/2006	12:04:09	2	1	2	1	2.54E-04	3.68E-04	855	834	17
11/8/2006	12:07:48	2	1	2	1	3.61E-05	8.72E-04	843	1011	18
11/8/2006	12:11:31	2	1	2	1	3.14E-04	3.57E-05	856	860	19
11/8/2006	12:15:27	2	1	2	1	1.52E-04	3.81E-03	914	1066	20
11/8/2006	12:22:34	2	1	2	2	3.27E-02	4.50E-03	955	706	2
11/8/2006	12:26:30	2	1	2	2	1.60E-01	2.06E-03	884	880	3
11/8/2006	12:30:28	2	1	2	2	1.19E-02	7.52E-04	983	730	4
11/8/2006	12:34:44	2	1	2	2	1.64E-04	5.18E-03	927	989	5
11/8/2006	12:39:07	2	1	2	2	2.31E-03	1.35E-03	910	798	6
11/8/2006	12:43:32	2	1	2	2	4.99E-03	3.14E-01	926	851	7
11/8/2006	12:47:34	2	1	2	2	3.19E-03	2.78E-03	963	774	8
11/8/2006	12:53:57	2	1	2	2	7.92E-02	3.37E-04	834	981	14
11/8/2006	12:58:05	2	1	2	2	9.80E-04	1.56E-04	926	901	15
11/8/2006	13:02:40	2	1	2	2	2.30E-03	1.40E-03	904	1066	16
11/8/2006	13:06:46	2	1	2	2	3.40E-02	3.25E-01	877	797	17
11/8/2006	13:10:34	2	1	2	2	5.29E-02	6.51E-02	939	1066	18
11/8/2006	13:14:26	2	1	2	2	8.09E-02	2.52E-04	869	856	19
11/8/2006	13:18:11	2	1	2	2	2.34E-02	2.73E-03	929	1188	20
11/8/2006	13:25:52	2	1	2	3	6.03E-05	3.57E-02	1118	771	2
11/8/2006	13:30:12	2	1	2	3	3.01E-04	2.47E-02	957	1094	3
11/8/2006	13:34:10	2	1	2	3	3.18E-03	1.44E-02	1003	769	4
11/8/2006	13:40:07	2	1	2	3	3.58E-02	3.40E-02	1027	1041	5
11/8/2006	13:44:07	2	1	2	3	4.33E-02	5.12E-02	891	806	6
11/8/2006	13:48:12	2	1	2	3	3.33E-04	1.46E-02	1015	1111	7
11/8/2006	13:52:47	2	1	2	3	1.32E-02	1.79E-02	1107	885	8
11/8/2006	13:57:45	2	1	2	3	7.48E-02	2.16E-02	982	1188	14
11/8/2006	14:02:04	2	1	2	3	7.06E-05	2.39E-02	987	899	15
11/8/2006	14:06:38	2	1	2	3	2.17E-05	4.22E-05	1002	1135	16
11/8/2006	14:10:57	2	1	2	3	3.06E-05	3.99E-03	968	889	17
11/8/2006	14:15:02	2	1	2	3	6.74E-02	2.41E-05	794	1028	18
11/8/2006	14:18:39	2	1	2	3	7.57E-02	3.25E-03	838	881	19
11/8/2006	14:22:39	2	1	2	3	4.38E-06	5.16E-03	900	1006	20
11/9/2006	21:14:02	2	2	1	1	1.09E-04	8.05E-03	1136	823	2
11/9/2006	21:18:11	2	2	1	1	1.42E-04	3.22E-03	859	913	3
11/9/2006	21:22:01	2	2	1	1	7.75E-04	9.01E-03	1073	784	4
11/9/2006	21:26:09	2	2	1	1	1.17E-04	2.49E-02	886	1008	5
11/9/2006	21:30:18	2	2	1	1	3.79E-04	9.54E-03	1024	841	6
11/9/2006	21:34:29	2	2	1	1	1.89E-03	1.56E-01	861	1095	7
11/9/2006	21:38:30	2	2	1	1	5.81E-04	2.70E-02	1088	848	8
11/9/2006	21:44:20	2	2	1	1	2.53E-03	3.66E-03	906	1172	14
11/9/2006	21:48:07	2	2	1	1	3.82E-04		1053	0	15
11/9/2006	21:52:48	2	2	1	1	1.05E-03	2.08E-01	1157	1175	16
11/9/2006	21:57:32	2	2	1	1	1.35E-04	2.08E-03	1042	934	17
11/9/2006	22:01:56	2	2	1	1	2.74E-03	5.73E-04	920	1152	18
11/9/2006	22:06:31	2	2	1	1	1.54E-04	1.55E-04	1104	978	19
11/9/2006	22:10:57	2	2	1	1	2.34E-04	7.59E-04	908	1137	20
11/9/2006	22:18:21	2	2	1	2	1.32E-04	4.29E-02	1055	809	2
11/9/2006	22:22:24	2	2	1	2	4.77E-04	4.16E-02	950	979	3
11/9/2006	22:25:56	2	2	1	2	1.23E-04	1.38E-02	1052	796	4
11/9/2006	22:29:58	2	2	1	2	1.18E-04	2.70E-02	1019	1111	5
11/9/2006	22:34:01	2	2	1	2	6.50E-04	3.92E-02	1103	913	6
11/9/2006	22:38:24	2	2	1	2	1.77E-04	8.04E-02	1028	1126	7
11/9/2006	22:42:26	2	2	1	2	4.77E-04	4.26E-02	1152	919	8
11/9/2006	22:47:25	2	2	1	2	8.26E-04	2.25E-04	958	1150	14
11/9/2006	22:51:30	2	2	1	2	1.53E-03	9.93E-04	1067	968	15
11/9/2006	22:55:56	2	2	1	2	3.78E-04	1.37E-03	940	1212	16
11/9/2006	23:00:11	2	2	1	2	2.58E-04	1.01E-04	1042	936	17
11/9/2006	23:04:21	2	2	1	2	3.33E-04	4.02E-04	953	1263	18
11/9/2006	23:08:39	2	2	1	2	3.43E-04	1.74E-04	1022	963	19
11/9/2006	23:13:04	2	2	1	2	3.93E-04	9.17E-05	987	1203	20
11/9/2006	23:20:07	2	2	1	3	1.77E-04	2.00E-02	1136	865	2

Fish densities near the SGS intake and discharge structures (continued).

Date	Time	Survey #	Day=1 Night= 2	Normal=1 Reverse= 2	Rep#	Offshore Density (kg/m3)	Inshore Density (kg/m3)	Offshore Ping #	Inshore Ping #	Transect #
11/9/2006	23:24:16	2	2	1	3	1.40E-04	1.46E-02	945	1078	3
11/9/2006	23:28:34	2	2	1	3	5.33E-04	1.60E-02	1166	837	4
11/9/2006	23:33:12	2	2	1	3	2.24E-04	1.06E-01	959	1084	5
11/9/2006	23:37:32	2	2	1	3	4.85E-04	2.05E-01	1067	849	6
11/9/2006	23:41:38	2	2	1	3	3.02E-04	7.28E-02	876	978	7
11/9/2006	23:46:01	2	2	1	3	3.51E-04	6.24E-02	1116	835	8
11/9/2006	23:50:49	2	2	1	3	4.05E-03	5.44E-04	812	1077	14
11/9/2006	23:55:10	2	2	1	3	3.97E-03	4.87E-04	1140	856	15
11/9/2006	23:59:57	2	2	1	3	5.07E-04	3.74E-03	803	1023	16
11/10/2006	0:04:27	2	2	1	3	4.85E-04	5.64E-04	979	919	17
11/10/2006	0:08:52	2	2	1	3	1.00E-03	8.56E-04	796	1085	18
11/10/2006	0:13:08	2	2	1	3	9.06E-04	4.73E-04	1011	981	19
11/10/2006	0:17:18	2	2	1	3	6.22E-04	2.80E-04	835	1057	20
11/10/2006	9:11:48	2	1	1	1	7.48E-02	1.71E-02	1033	892	8
11/10/2006	9:16:40	2	1	1	1	1.40E-04	4.52E-02	815	992	14
11/10/2006	9:20:58	2	1	1	1	3.08E-04	2.10E-02	992	844	15
11/10/2006	9:25:08	2	1	1	1	1.75E-05	1.34E-04	875	1007	16
11/10/2006	9:29:27	2	1	1	1	1.43E-04	4.25E-05	924	845	17
11/10/2006	9:33:26	2	1	1	1	3.21E-03	1.43E-03	835	1072	18
11/10/2006	9:37:29	2	1	1	1	1.10E-05	2.96E-02	948	848	19
11/10/2006	9:41:50	2	1	1	1	6.09E-03	4.47E-03	863	1014	20
11/10/2006	9:47:54	2	1	1	2	6.82E-04	1.13E-02	938	778	2
11/10/2006	9:51:51	2	1	1	2	4.41E-03	2.48E-03	955	1039	3
11/10/2006	9:55:44	2	1	1	2	2.19E-04	9.48E-03	1075	811	4
11/10/2006	9:59:53	2	1	1	2	2.80E-02	6.15E-01	947	1081	5
11/10/2006	10:04:05	2	1	1	2	2.10E-01	7.43E-02	1074	864	6
11/10/2006	10:08:31	2	1	1	2	9.09E-03	8.07E-02	905	1109	7
11/10/2006	10:12:48	2	1	1	2	2.56E-03	2.50E-02	1065	854	8
11/10/2006	10:17:51	2	1	1	2	1.16E-05	1.80E-02	914	1089	14
11/10/2006	10:21:48	2	1	1	2	6.79E-03	2.29E-04	1023	911	15
11/10/2006	10:26:24	2	1	1	2	8.47E-03	1.55E-02	958	1154	16
11/10/2006	10:30:43	2	1	1	2	3.21E-05	1.16E-02	1005	930	17
11/10/2006	10:35:25	2	1	1	2	1.83E-05	1.08E-03	938	1225	18
11/10/2006	10:39:37	2	1	1	2	9.86E-04	1.29E-03	996	953	19
11/10/2006	10:44:19	2	1	1	2	4.61E-04	3.01E-04	969	1157	20
11/10/2006	10:53:57	2	1	1	3	4.35E-03	4.28E-01	981	805	2
11/10/2006	10:57:57	2	1	1	3	1.81E-03	8.07E-01	941	1002	3
11/10/2006	11:02:04	2	1	1	3	1.15E-04	6.46E-03	1106	1648	4
11/10/2006	11:06:45	2	1	1	3	3.82E-05	5.22E-02	920	1116	5
11/10/2006	11:11:05	2	1	1	3	3.45E-03	3.37E-02	1073	865	6
11/10/2006	11:15:36	2	1	1	3	1.17E-02	2.40E-02	915	1140	7
11/10/2006	11:20:00	2	1	1	3	9.12E-03	2.37E-02	1032	915	8
11/10/2006	11:25:26	2	1	1	3	8.41E-02	3.21E-03	838	1130	14
11/10/2006	11:29:32	2	1	1	3	1.22E-03	3.06E-03	897	819	15
11/10/2006	11:33:41	2	1	1	3	2.39E-06	3.11E-03	835	983	16
11/10/2006	11:37:28	2	1	1	3	4.15E-04	1.82E-03	926	889	17
11/10/2006	11:41:36	2	1	1	3	2.07E-01	2.79E-04	827	1038	18
11/10/2006	11:45:24	2	1	1	3	3.83E-01	1.93E-04	937	875	19
11/10/2006	11:49:38	2	1	1	3	9.41E-05	5.51E-03	877	1072	20
11/19/2006	9:36:38	3	1	1	1	9.79E-03	7.21E-02	1221	799	2
11/19/2006	9:44:29	3	1	1	1	1.49E-01	4.05E-03	922	1007	5
11/19/2006	9:48:15	3	1	1	1	4.82E-01	1.40E-02	972	789	7
11/19/2006	9:53:03	3	1	1	1	7.26E-03	1.04E-02	852	1133	14
11/19/2006	9:57:01	3	1	1	1	2.63E-02	7.19E-05	889	898	17
11/19/2006	10:01:43	3	1	1	1	6.04E-05	2.58E-05	870	1049	20
11/19/2006	10:07:48	3	1	1	1	4.28E-02	4.30E-03	933	791	3
11/19/2006	10:12:17	3	1	1	1	1.26E-02	3.43E-03	958	997	6
11/19/2006	10:16:40	3	1	1	1	3.28E-05	6.53E-04	905	926	15
11/19/2006	10:21:20	3	1	1	1	5.94E-08	7.13E-05	871	1083	18
11/19/2006	10:27:10	3	1	1	1	3.51E-02	4.67E-02	932	784	4
11/19/2006	10:31:34	3	1	1	1	4.39E-04	2.93E-03	1013	1109	8
11/19/2006	10:35:53	3	1	1	1	5.07E-04	2.11E-04	1034	866	16
11/19/2006	10:40:47	3	1	1	1	1.01E-04	1.42E-01	945	1030	19
11/19/2006	10:56:25	3	1	1	2	1.86E-02	7.13E-04	1174	906	2

Fish densities near the SGS intake and discharge structures (continued).

Date	Time	Survey #	Day=1 Night= 2	Normal=1 Reverse= 2	Rep#	Offshore Density (kg/m3)	Inshore Density (kg/m3)	Offshore Ping #	Inshore Ping #	Transect #
11/19/2006	11:01:31	3	1	1	2	2.27E-03	4.04E-02	1211	1127	5
11/19/2006	11:06:04	3	1	1	2	4.66E-03	1.54E-02	1053	969	7
11/19/2006	11:11:23	3	1	1	2	2.67E-03	5.26E-02	960	1078	14
11/19/2006	11:15:34	3	1	1	2	4.25E-06	1.12E-04	975	937	17
11/19/2006	11:20:20	3	1	1	2	1.02E-06	7.47E-02	1062	1082	20
11/19/2006	11:26:49	3	1	1	2	5.27E-03	1.30E-02	1087	821	3
11/19/2006	11:31:23	3	1	1	2	1.25E-02	4.85E-02	1090	1101	6
11/19/2006	11:36:11	3	1	1	2	1.52E-02	6.09E-06	938	926	15
11/19/2006	11:40:49	3	1	1	2	3.47E-05	1.05E-01	1063	1126	18
11/19/2006	11:46:52	3	1	1	2	3.89E-02	2.87E-03	934	772	4
11/19/2006	11:51:36	3	1	1	2	5.30E-04	7.09E-02	980	1093	8
11/19/2006	11:56:26	3	1	1	2	2.41E-02	2.71E-04	928	927	16
11/19/2006	12:00:51	3	1	1	2	6.92E-06	1.83E-04	975	1225	19
11/19/2006	12:07:43	3	1	1	3	4.62E-04	2.97E-03	1050	836	2
11/19/2006	12:12:17	3	1	1	3	3.16E-02	1.60E-02	1037	1075	5
11/19/2006	12:16:31	3	1	1	3	9.85E-04	1.26E-01	1053	877	7
11/19/2006	12:21:35	3	1	1	3	5.61E-05	4.19E-04	965	1132	14
11/19/2006	12:25:42	3	1	1	3	6.29E-06	3.75E-05	1063	977	17
11/19/2006	12:30:35	3	1	1	3	5.50E-02	5.79E-03	976	1168	20
11/19/2006	12:37:01	3	1	1	3	3.72E-03	5.41E-03	1022	883	3
11/19/2006	12:41:49	3	1	1	3	5.76E-02	3.65E-02	1105	1117	6
11/19/2006	12:46:59	3	1	1	3	4.06E-06	3.47E-05	1073	967	15
11/19/2006	12:51:43	3	1	1	3	4.07E-03	5.64E-03	1007	1114	18
11/19/2006	12:57:21	3	1	1	3	2.05E-03	4.00E-02	1180	851	4
11/19/2006	13:02:37	3	1	1	3	2.93E-05	8.42E-03	1057	1182	8
11/19/2006	13:07:38	3	1	1	3	9.57E-03	4.68E-03	1101	994	16
11/19/2006	13:12:56	3	1	1	3	1.57E-05	2.51E-05	965	946	19
11/19/2006	21:43:40	3	2	1	1	4.28E-05	3.00E-02	1283	829	2
11/19/2006	21:48:17	3	2	1	1	7.10E-05	8.89E-04	983	998	5
11/19/2006	21:52:07	3	2	1	1	1.52E-04	5.62E-02	1405	946	7
11/19/2006	21:57:46	3	2	1	1	7.34E-04	4.56E-03	902	1196	14
11/19/2006	22:02:06	3	2	1	1	3.98E-04	1.07E-01	1132	1012	17
11/19/2006	22:06:49	3	2	1	1	7.12E-05	3.84E-03	1009	1188	20
11/19/2006	22:12:58	3	2	1	1	2.95E-05	2.08E-05	1079	815	3
11/19/2006	22:17:18	3	2	1	1	5.81E-05	2.98E-04	1017	990	6
11/19/2006	22:21:45	3	2	1	1	1.00E-03	1.22E-03	1132	897	15
11/19/2006	22:26:29	3	2	1	1	2.95E-04	6.52E-04	825	1065	18
11/19/2006	22:32:11	3	2	1	1	5.15E-05	1.06E-03	1335	923	4
11/19/2006	22:37:12	3	2	1	1	3.81E-05	1.55E-03	1027	1108	8
11/19/2006	22:41:59	3	2	1	1	3.36E-04	3.78E-04	1143	973	16
11/19/2006	22:46:47	3	2	1	1	8.95E-05	7.75E-04	936	1158	19
11/19/2006	22:53:53	3	2	1	2	4.51E-05	6.35E-05	1120	898	2
11/19/2006	22:58:28	3	2	1	2	8.65E-05	1.82E-04	911	1010	5
11/19/2006	23:02:26	3	2	1	2	3.68E-05	4.52E-04	1027	880	7
11/19/2006	23:07:39	3	2	1	2	1.30E-04	1.56E-04	935	1055	14
11/19/2006	23:11:44	3	2	1	2	9.30E-04	5.16E-04	997	935	17
11/19/2006	23:16:21	3	2	1	2	7.94E-05	5.96E-04	971	1071	20
11/19/2006	23:22:39	3	2	1	2	5.69E-05	4.66E-05	1088	854	3
11/19/2006	23:27:28	3	2	1	2	3.39E-05	2.36E-04	936	1013	6
11/19/2006	23:32:17	3	2	1	2	7.19E-04	7.79E-04	1000	930	15
11/19/2006	23:37:03	3	2	1	2	4.61E-04	2.87E-04	917	1113	18
11/19/2006	23:42:40	3	2	1	2	7.92E-04	2.44E-05	1124	874	4
11/19/2006	23:47:45	3	2	1	2	1.26E-04	2.61E-04	916	1014	8
11/19/2006	23:52:13	3	2	1	2	6.91E-04	7.58E-04	1038	955	16
11/19/2006	23:57:00	3	2	1	2	7.84E-05	1.11E-04	967	1085	19
11/20/2006	0:03:33	3	2	1	3	3.21E-05	2.18E-04	1169	864	2
11/20/2006	0:08:01	3	2	1	3	3.11E-05	2.79E-05	972	1002	5
11/20/2006	0:12:02	3	2	1	3	1.15E-04	1.21E-03	1155	902	7
11/20/2006	0:17:07	3	2	1	3	3.14E-04	4.45E-05	951	1162	14
11/20/2006	0:21:20	3	2	1	3	8.01E-05	1.55E-03	1053	928	17
11/20/2006	0:25:47	3	2	1	3	4.89E-05	7.57E-04	983	1182	20
11/20/2006	0:32:20	3	2	1	3	1.52E-03	4.35E-05	1025	758	3
11/20/2006	0:36:18	3	2	1	3	1.81E-04	2.63E-05	881	895	6
11/20/2006	0:40:35	3	2	1	3	1.69E-03	1.81E-03	968	891	15

Fish densities near the SGS intake and discharge structures (continued).

Date	Time	Survey #	Day=1 Night= 2	Normal=1 Reverse= 2	Rep#	Offshore Density (kg/m3)	Inshore Density (kg/m3)	Offshore Ping #	Inshore Ping #	Transect #
11/20/2006	0:44:55	3	2	1	3	1.60E-04	1.99E-04	820	1095	18
11/20/2006	0:50:42	3	2	1	3	2.07E-05	7.50E-05	1011	810	4
11/20/2006	0:54:53	3	2	1	3	2.98E-05	1.73E-03	889	1034	8
11/20/2006	0:59:32	3	2	1	3	5.72E-04	7.79E-04	885	913	16
11/20/2006	1:03:33	3	2	1	3	2.58E-04	3.74E-04	872	1081	19
11/20/2006	23:27:14	3	2	2	1	4.31E-05	1.41E-03	1376	939	2
11/20/2006	23:32:08	3	2	2	1	6.73E-05	2.04E-03	995	1133	5
11/20/2006	23:36:22	3	2	2	1	2.94E-05	8.27E-04	1036	814	7
11/20/2006	23:40:51	3	2	2	1	1.30E-01	1.42E-01	925	1094	14
11/20/2006	23:44:54	3	2	2	1	3.06E-02	1.62E-01	958	899	17
11/20/2006	23:49:21	3	2	2	1	9.83E-05	5.06E-02	912	1050	20
11/20/2006	23:55:07	3	2	2	1	4.83E-05	4.08E-02	1069	827	3
11/20/2006	23:59:17	3	2	2	1	3.41E-05	8.86E-02	970	987	6
11/21/2006	0:04:17	3	2	2	1	7.54E-03	1.80E-04	884	885	15
11/21/2006	0:08:32	3	2	2	1	1.01E-04	2.38E-04	926	1194	18
11/21/2006	0:14:39	3	2	2	1	3.35E-05	3.17E-04	1110	864	4
11/21/2006	0:19:08	3	2	2	1	4.25E-05	1.34E-03	994	1019	8
11/21/2006	0:24:20	3	2	2	1	1.35E-03	1.69E-02	1015	932	16
11/21/2006	0:28:51	3	2	2	1	4.35E-05	4.08E-04	935	1244	19
11/21/2006	0:35:22	3	2	2	2	9.06E-05	5.71E-05	1091	790	2
11/21/2006	0:39:48	3	2	2	2	5.35E-05	4.83E-05	937	897	5
11/21/2006	0:43:34	3	2	2	2	6.63E-05	6.08E-03	892	779	7
11/21/2006	0:48:18	3	2	2	2	2.75E-03	6.67E-04	932	1076	14
11/21/2006	0:52:21	3	2	2	2	1.19E-03	3.29E-04	889	853	17
11/21/2006	0:56:24	3	2	2	2	5.36E-05	1.30E-04	915	1098	20
11/21/2006	1:03:03	3	2	2	2	9.92E-05	7.31E-04	952	801	3
11/21/2006	1:07:15	3	2	2	2	5.20E-05	2.63E-03	924	948	6
11/21/2006	1:11:34	3	2	2	2	1.05E-01	1.06E-04	875	861	15
11/21/2006	1:15:54	3	2	2	2	1.63E-02	8.51E-05	874	1068	18
11/21/2006	1:21:07	3	2	2	2	5.08E-05	1.43E-04	993	829	4
11/21/2006	1:25:26	3	2	2	2	1.02E-04	5.49E-03	944	960	8
11/21/2006	1:29:55	3	2	2	2	7.23E-04	2.95E-04	918	875	16
11/21/2006	1:34:19	3	2	2	2	6.08E-04	7.59E-05	940	1086	19
11/21/2006	1:39:58	3	2	2	3	6.92E-05	1.21E-03	1028	837	2
11/21/2006	1:44:17	3	2	2	3	4.24E-05	7.59E-04	887	952	5
11/21/2006	1:47:54	3	2	2	3	4.07E-04	3.57E-03	950	794	7
11/21/2006	1:52:33	3	2	2	3	5.79E-03	1.38E-04	917	1035	14
11/21/2006	1:56:34	3	2	2	3	5.85E-04	2.57E-04	941	830	17
11/21/2006	2:00:34	3	2	2	3	1.45E-04	1.30E-02	909	1175	20
11/21/2006	2:06:23	3	2	2	3	8.37E-05	7.41E-04	1019	853	3
11/21/2006	2:10:30	3	2	2	3	3.46E-04	5.10E-03	950	951	6
11/21/2006	2:15:15	3	2	2	3	2.16E-03	1.73E-04	1064	843	15
11/21/2006	2:19:39	3	2	2	3	2.52E-04	1.69E-04	891	1110	18
11/21/2006	2:25:00	3	2	2	3	1.25E-04	9.07E-04	1023	823	4
11/21/2006	2:29:27	3	2	2	3	1.78E-04	4.84E-03	954	1019	8
11/21/2006	2:33:57	3	2	2	3	1.34E-03	1.44E-04	1063	896	16
11/21/2006	2:38:45	3	2	2	3	3.98E-04	6.44E-05	920	1109	19
11/21/2006	10:18:58	3	1	2	1	1.65E-02	3.32E-03	1018	694	2
11/21/2006	10:23:05	3	1	2	1	5.09E-07	4.89E-05	911	1185	5
11/21/2006	10:27:04	3	1	2	1	7.02E-04	8.99E-02	918	916	7
11/21/2006	10:32:22	3	1	2	1	6.19E-05	3.48E-05	972	1243	14
11/21/2006	10:36:59	3	1	2	1	1.14E-06	7.06E-07	1016	986	17
11/21/2006	10:41:44	3	1	2	1	5.34E-03	1.39E-06	984	1166	20
11/21/2006	10:47:52	3	1	2	1	2.63E-05	4.00E-03	1010	826	3
11/21/2006	10:52:06	3	1	2	1	1.02E-06	1.67E-03	1022	1033	6
11/21/2006	10:56:29	3	1	2	1	6.63E-05	4.43E-07	928	867	15
11/21/2006	11:00:48	3	1	2	1	1.86E-04	1.63E-02	840	1052	18
11/21/2006	11:05:44	3	1	2	1	1.14E-02	7.32E-03	957	711	4
11/21/2006	11:09:59	3	1	2	1	1.11E-02	3.29E-03	880	970	7
11/21/2006	11:14:40	3	1	2	1	2.09E-08	4.57E-05	687	820	16
11/21/2006	11:18:30	3	1	2	1	6.01E-02	7.10E-04	918	1013	19
11/21/2006	11:24:05	3	1	2	2	1.53E-05	1.51E-03	961	723	2
11/21/2006	11:28:28	3	1	2	2	1.29E-02	1.14E-02	998	950	5

Fish densities near the SGS intake and discharge structures (continued).

Date	Time	Survey #	Day=1 Night= 2	Normal=1 Reverse= 2	Rep#	Offshore Density (kg/m3)	Inshore Density (kg/m3)	Offshore Ping #	Inshore Ping #	Transect #
11/21/2006	11:32:12	3	1	2	2	1.06E-05	7.21E-03	857	739	8
11/21/2006	11:36:57	3	1	2	2	1.13E-05	7.37E-07	915	1013	14
11/21/2006	11:40:49	3	1	2	2	3.15E-08	7.55E-03	814	806	17
11/21/2006	11:45:19	3	1	2	2	1.47E-02	4.67E-06	969	1036	20
11/21/2006	11:50:46	3	1	2	2	1.36E-03	9.33E-02	920	767	3
11/21/2006	11:55:17	3	1	2	2	4.65E-01	9.95E-05	1057	994	6
11/21/2006	12:00:03	3	1	2	2	6.77E-06	8.00E-04	857	832	15
11/21/2006	12:04:42	3	1	2	2	1.25E-05	3.55E-05	936	1047	18
11/21/2006	12:10:03	3	1	2	2	2.17E-04	3.44E-03	976	763	4
11/21/2006	12:14:15	3	1	2	2	1.38E-02	2.51E-03	1063	1127	7
11/21/2006	12:19:08	3	1	2	2	3.87E-05	1.60E-02	871	954	16
11/21/2006	12:23:42	3	1	2	2	4.01E-04	4.86E-06	1069	1070	19
11/21/2006	12:29:04	3	1	2	3	3.70E-04	6.77E-04	1024	764	2
11/21/2006	12:33:24	3	1	2	3	9.03E-02	8.20E-05	989	1015	5
11/21/2006	12:37:37	3	1	2	3	6.57E-02	3.24E-02	934	680	8
11/21/2006	12:43:56	3	1	2	3	2.35E-04	1.73E-07	1050	1168	14
11/21/2006	12:48:05	3	1	2	3	2.52E-02	1.45E-05	734	726	17
11/21/2006	12:52:03	3	1	2	3	2.35E-02	2.32E-02	843	942	20
11/21/2006	12:57:02	3	1	2	3	4.32E-05	2.44E-04	909	788	3
11/21/2006	13:00:54	3	1	2	3	3.28E-04	2.96E-07	995	894	6
11/21/2006	13:05:31	3	1	2	3	8.53E-04	9.34E-03	802	733	15
11/21/2006	13:09:30	3	1	2	3	4.30E-04	9.44E-04	801	940	18
11/21/2006	13:14:15	3	1	2	3	3.83E-04	1.73E-06	887	695	4
11/21/2006	13:18:02	3	1	2	3	1.60E-03	4.86E-03	958	984	8
11/21/2006	13:22:18	3	1	2	3	4.05E-04	5.21E-07	824	730	16
11/21/2006	13:26:30	3	1	2	3	4.50E-03	1.57E-04	859	1015	19
12/3/2006	14:12:11	4	1	2	1	2.32E-07	3.36E-07	1237	1498	2
12/3/2006	14:17:24	4	1	2	1	1.11E-06	5.87E-07	1239	1170	5
12/3/2006	14:22:09	4	1	2	1	3.22E-05	2.99E-07	1058	855	8
12/3/2006	14:26:41	4	1	2	1	6.06E-06	4.96E-02	1147	1181	14
12/3/2006	14:35:02	4	1	2	1	2.06E-07	6.40E-05	763	869	17
12/3/2006	14:38:49	4	1	2	1	1.12E-05	1.32E-06	1050	1160	20
12/3/2006	14:45:56	4	1	2	1	1.39E-06	1.25E-06	1033	822	3
12/3/2006	14:50:13	4	1	2	1	1.14E-05	4.62E-04	1081	1316	6
12/3/2006	14:57:23	4	1	2	1	1.80E-05	3.84E-05	934	913	15
12/3/2006	15:01:52	4	1	2	1	6.39E-06	1.87E-02	939	1173	18
12/3/2006	15:07:51	4	1	2	1	2.21E-05	1.26E-02	983	735	4
12/3/2006	15:11:58	4	1	2	1	2.02E-05	8.09E-07	1117	1137	7
12/3/2006	15:17:01	4	1	2	1	1.08E-03	1.29E-02	975	942	16
12/3/2006	15:21:12	4	1	2	2	1.64E-06	5.22E-06	1055	1032	19
12/3/2006	15:32:31	4	1	2	2	6.54E-07	1.11E-07	938	1213	5
12/3/2006	15:36:34	4	1	2	2	1.01E-06	1.72E-06	874	717	8
12/3/2006	15:41:06	4	1	2	2	3.46E-06	1.21E-06	822	981	14
12/3/2006	15:44:33	4	1	2	2	9.48E-09	1.10E-06	888	941	17
12/3/2006	15:48:58	4	1	2	2	0.00E+00	7.06E-07	868	972	20
12/3/2006	15:54:16	4	1	2	2	1.08E-04	4.99E-06	996	755	3
12/3/2006	15:58:36	4	1	2	2	2.24E-06	0.00E+00	873	1036	7
12/3/2006	16:02:58	4	1	2	2	2.89E-05	4.85E-07	753	857	15
12/3/2006	16:06:50	4	1	2	2	6.29E-02	2.79E-06	761	1088	18
12/3/2006	16:11:45	4	1	2	2	9.17E-06	6.97E-05	952	873	4
12/3/2006	16:16:20	4	1	2	2	1.19E-06	8.57E-07	900	988	6
12/3/2006	16:20:39	4	1	2	2	1.61E-06	6.32E-04	795	882	16
12/3/2006	16:24:47	4	1	2	3	9.86E-08	7.26E-05	825	969	19
12/3/2006	16:30:38	4	1	2	3	1.04E-01	6.07E-07	863	661	2
12/3/2006	16:42:04	4	1	2	3	7.92E-05	4.38E-07	903	1045	5
12/3/2006	16:46:18	4	1	2	3	3.09E-06	4.19E-03	802	702	8
12/3/2006	16:49:50	4	1	2	3	2.37E-04	3.71E-03	852	901	14
12/3/2006	16:53:23	4	1	2	3	4.91E-03	6.41E-04	793	753	17
12/3/2006	16:57:04	4	1	2	3	6.44E-05	6.45E-06	824	999	20
12/3/2006	17:02:15	4	1	2	3	2.81E-04	4.46E-06	880	734	3
12/3/2006	17:05:48	4	1	2	3	1.27E-04	1.39E-03	828	787	6
12/3/2006	17:09:48	4	1	2	3	4.63E-04	2.08E-05	798	1148	15
12/3/2006	17:13:54	4	1	2	3	2.10E-03	1.07E-05	801	980	18

Fish densities near the SGS intake and discharge structures (continued).

Date	Time	Survey #	Day=1 Night= 2	Normal=1 Reverse= 2	Rep#	Offshore Density (kg/m3)	Inshore Density (kg/m3)	Offshore Ping #	Inshore Ping #	Transect #
12/3/2006	17:18:44	4	1	2	3	6.58E-04	1.58E-05	854	694	4
12/3/2006	17:22:19	4	1	2	3	1.59E-03	2.66E-03	874	987	7
12/3/2006	17:27:03	4	1	2	3	6.61E-04	1.04E-03	829	707	16
12/3/2006	17:30:37	4	1	2	3	1.97E-03	1.71E-03	810	962	19
12/3/2006	20:59:08	4	2	2	1	1.51E-04	1.08E-04	1020	770	2
12/3/2006	21:03:27	4	2	2	1	1.30E-04	4.72E-04	900	955	5
12/3/2006	21:07:19	4	2	2	1	1.37E-04	8.56E-05	938	716	8
12/3/2006	21:11:47	4	2	2	1	1.49E-03	2.04E-04	849	1051	14
12/3/2006	21:15:54	4	2	2	1	2.37E-04	1.39E-04	841	815	17
12/3/2006	21:19:51	4	2	2	1	1.40E-04	1.20E-03	930	1041	20
12/3/2006	21:25:25	4	2	2	1	6.59E-05	1.25E-04	1037	748	3
12/3/2006	21:29:59	4	2	2	1	6.52E-05	7.42E-04	950	1032	6
12/3/2006	21:34:34	4	2	2	1	2.30E-03	4.93E-04	870	832	15
12/3/2006	21:38:55	4	2	2	1	2.62E-04	2.09E-04	865	1091	18
12/3/2006	21:44:07	4	2	2	1	9.81E-05	5.98E-04	1043	760	4
12/3/2006	21:48:28	4	2	2	1	3.08E-04	3.02E-04	925	1013	7
12/3/2006	21:52:41	4	2	2	1	3.04E-03	2.99E-04	825	824	16
12/3/2006	21:56:47	4	2	2	1	2.80E-04	5.79E-04	809	1091	19
12/3/2006	22:02:53	4	2	2	2	8.85E-05	1.11E-04	1070	1016	2
12/3/2006	22:07:17	4	2	2	2	2.54E-04	2.25E-04	883	968	5
12/3/2006	22:11:10	4	2	2	2	2.20E-04	8.83E-03	920	1035	8
12/3/2006	22:14:58	4	2	2	2	1.25E-03	1.97E-04	870	1039	14
12/3/2006	22:18:53	4	2	2	2	1.27E-03	2.65E-04	911	869	17
12/3/2006	22:22:53	4	2	2	2	1.62E-04	1.17E-04	874	1068	20
12/3/2006	22:35:35	4	2	2	2	7.63E-05	2.76E-04	1030	841	3
12/3/2006	22:41:12	4	2	2	2	7.87E-05	5.81E-05	943	241	6
12/3/2006	22:44:35	4	2	2	2	1.44E-03	3.44E-04	1086	877	15
12/3/2006	22:48:48	4	2	2	2	8.49E-04	1.38E-04	898	1058	18
12/3/2006	22:54:52	4	2	2	2	8.67E-05	1.58E-04	1034	814	4
12/3/2006	22:59:10	4	2	2	2	1.67E-04	2.61E-04	954	1004	7
12/3/2006	23:04:07	4	2	2	2	1.26E-04	5.81E-04	1006	868	16
12/3/2006	23:08:27	4	2	2	2	1.20E-04	1.77E-04	931	1082	19
12/3/2006	23:14:07	4	2	2	3	4.68E-04	1.89E-04	1067	723	2
12/3/2006	23:18:01	4	2	2	3	6.59E-05	2.50E-04	787	887	5
12/3/2006	23:21:33	4	2	2	3	1.19E-04	1.34E-04	868	693	8
12/3/2006	23:25:35	4	2	2	3	2.78E-04	5.28E-04	817	913	14
12/3/2006	23:29:13	4	2	2	3	2.02E-04	8.32E-04	833	888	17
12/3/2006	23:33:29	4	2	2	3	4.49E-04	2.52E-04	915	1172	20
12/3/2006	23:53:58	4	2	2	3	2.03E-04	1.47E-04	1216	882	3
12/3/2006	23:58:39	4	2	2	3	2.11E-04	2.89E-04	915	949	6
12/4/2006	0:03:05	4	2	2	3	8.16E-05	2.70E-04	994	976	15
12/4/2006	0:07:34	4	2	2	3	1.90E-04	4.48E-04	835	1003	18
12/4/2006	0:12:57	4	2	2	3	1.72E-04	1.72E-04	1041	766	4
12/4/2006	0:17:16	4	2	2	3	2.72E-04	3.24E-04	826	914	7
12/4/2006	0:21:23	4	2	2	3	7.93E-03	1.24E-04	900	850	16
12/4/2006	0:25:50	4	2	2	3	1.54E-04	3.05E-04	878	1048	19
12/13/2006	9:04:01	4	1	1	1	1.97E-04	1.69E-05	1193	447	20
12/13/2006	9:07:16	4	1	1	1	1.26E-03	2.11E-03	815	618	17
12/13/2006	9:10:41	4	1	1	1	3.92E-03	8.31E-05	919	493	14
12/13/2006	9:13:56	4	1	1	1	9.41E-04	1.99E-01	818	640	8
12/13/2006	9:17:41	4	1	1	1	1.28E-03	5.50E-05	911	414	5
12/13/2006	9:20:24	4	1	1	1	1.19E-04	2.11E-04	833	582	2
12/13/2006	9:24:37	4	1	1	1	2.61E-01	4.80E-04	1017	558	19
12/13/2006	9:27:48	4	1	1	1	3.69E-04	4.85E-05	870	577	16
12/13/2006	9:31:53	4	1	1	1	4.46E-03	1.85E-04	1030	551	7
12/13/2006	9:35:17	4	1	1	1	1.56E-03	1.91E-03	1002	851	4
12/13/2006	9:40:21	4	1	1	1	3.00E-03	1.88E-04	780	555	18
12/13/2006	9:43:09	4	1	1	1	1.43E-03	2.80E-04	932	779	15
12/13/2006	9:47:20	4	1	1	1	1.26E-02	2.54E-04	951	549	6
12/13/2006	9:51:02	4	1	1	1	2.47E-05	2.57E-02	969	508	3
12/13/2006	9:55:49	4	1	1	2	2.80E-04	9.96E-06	745	429	20
12/13/2006	9:58:13	4	1	1	2	2.36E-04	1.01E-03	667	430	17
12/13/2006	10:01:16	4	1	1	2	3.97E-03	1.69E-04	718	460	14

Fish densities near the SGS intake and discharge structures (continued).

Date	Time	Survey #	Day=1 Night= 2	Normal=1 Reverse= 2	Rep#	Offshore Density (kg/m3)	Inshore Density (kg/m3)	Offshore Ping #	Inshore Ping #	Transect #
12/13/2006	10:03:48	4	1	1	2	7.19E-02	7.04E-03	726	483	8
12/13/2006	10:07:08	4	1	1	2	6.01E-05	2.98E-04	1017	312	5
12/13/2006	10:09:47	4	1	1	2	3.30E-05	6.28E-04	904	358	2
12/13/2006	10:13:47	4	1	1	2	1.17E-04	4.45E-05	924	559	19
12/13/2006	10:16:50	4	1	1	2	1.54E-03	7.57E-04	818	511	16
12/13/2006	10:20:17	4	1	1	2	1.24E-04	1.35E-02	901	367	7
12/13/2006	10:22:55	4	1	1	2	6.33E-03	1.73E-02	852	392	4
12/13/2006	10:26:27	4	1	1	2	1.64E-04	2.88E-03	766	441	18
12/13/2006	10:28:55	4	1	1	2	2.96E-03	4.16E-04	735	474	15
12/13/2006	10:32:15	4	1	1	2	1.67E-04	1.47E-04	960	420	6
12/13/2006	10:35:01	4	1	1	2	8.48E-04	9.67E-03	901	504	3
12/13/2006	10:39:23	4	1	1	3	9.38E-06	7.03E-05	728	516	20
12/13/2006	10:42:02	4	1	1	3	2.01E-03	2.11E-03	901	729	17
12/13/2006	10:46:14	4	1	1	3	2.67E-03	2.15E-02	856	592	14
12/13/2006	10:49:40	4	1	1	3	6.39E-03	2.07E-03	910	741	8
12/13/2006	10:53:32	4	1	1	3	5.30E-02	1.44E-03	1095	507	5
12/13/2006	10:56:44	4	1	1	3	2.70E-05	6.56E-03	977	761	2
12/13/2006	11:01:12	4	1	1	3	4.93E-04	6.69E-04	879	624	19
12/13/2006	11:04:21	4	1	1	3	5.28E-04	3.03E-04	898	738	16
12/13/2006	11:08:28	4	1	1	3	5.12E-05	2.47E-04	951	558	7
12/13/2006	11:11:37	4	1	1	3	3.38E-02	6.33E-04	931	709	4
12/13/2006	11:15:45	4	1	1	3	1.60E-03	2.27E-02	967	592	18
12/13/2006	11:19:00	4	1	1	3	5.32E-03	2.17E-04	899	640	15
12/13/2006	11:23:00	4	1	1	3	2.20E-04	4.67E-04	1020	578	6
12/13/2006	11:26:12	4	1	1	3	5.01E-02	6.07E-04	979	659	3
12/13/2006	17:40:04	4	2	1	1	1.84E-03	9.43E-04	982	570	20
12/13/2006	17:43:06	4	2	1	1	2.69E-03	2.76E-03	786	605	17
12/13/2006	17:46:58	4	2	1	1	2.88E-03	3.40E-03	927	411	14
12/13/2006	17:49:49	4	2	1	1	2.67E-03	6.63E-03	899	617	8
12/13/2006	17:53:32	4	2	1	1	1.14E-03	4.74E-03	927	354	5
12/13/2006	17:56:09	4	2	1	1	1.06E-03	4.67E-04	851	394	3
12/13/2006	18:00:09	4	2	1	1	1.68E-03	9.43E-04	825	355	19
12/13/2006	18:02:31	4	2	1	1	4.22E-03	2.46E-03	711	458	16
12/13/2006	18:06:20	4	2	1	1	5.96E-04	4.17E-03	807	369	7
12/13/2006	18:08:47	4	2	1	1	9.66E-04	1.72E-03	777	324	4
12/13/2006	18:12:23	4	2	1	1	4.31E-03	5.16E-03	783	343	18
12/13/2006	18:14:40	4	2	1	1	4.00E-03	3.67E-03	741	408	15
12/13/2006	18:17:41	4	2	1	1	9.37E-04	9.10E-03	802	263	6
12/13/2006	18:19:50	4	2	1	2	1.32E-03	2.92E-04	796	326	3
12/13/2006	18:39:18	4	2	1	2	2.27E-03	6.22E-03	999	610	20
12/13/2006	18:42:31	4	2	1	2	4.68E-03	1.09E-02	843	781	17
12/13/2006	18:46:33	4	2	1	2	1.42E-02	1.22E-02	937	434	14
12/13/2006	18:49:44	4	2	1	2	1.03E-02	3.63E-03	792	587	3
12/13/2006	18:53:20	4	2	1	2	5.11E-03	2.25E-03	955	762	5
12/13/2006	18:56:34	4	2	1	2	1.33E-03	7.33E-04	860	813	2
12/13/2006	19:01:21	4	2	1	2	1.90E-03	5.63E-03	1006	526	19
12/13/2006	19:04:27	4	2	1	2	9.01E-03	1.21E-02	938	685	16
12/13/2006	19:08:36	4	2	1	2	3.37E-03	2.77E-02	1121	488	7
12/13/2006	19:11:56	4	2	1	2	2.78E-03	1.81E-02	959	445	4
12/13/2006	19:15:39	4	2	1	2	1.47E-02	5.79E-03	942	499	18
12/13/2006	19:18:48	4	2	1	2	7.03E-03	1.48E-02	851	611	15
12/13/2006	19:22:47	4	2	1	2	9.49E-04	1.25E-03	1144	465	6
12/13/2006	19:25:54	4	2	1	2	9.15E-03	4.80E-03	950	579	3
12/13/2006	19:30:18	4	2	1	3	6.27E-03	8.76E-03	853	471	20
12/13/2006	19:32:49	4	2	1	3	3.69E-03	1.05E-02	782	572	17
12/13/2006	19:36:04	4	2	1	3	1.17E-02	5.79E-03	1006	367	14
12/13/2006	19:39:14	4	2	1	3	2.01E-03	2.34E-03	844	501	8
12/13/2006	19:42:22	4	2	1	3	7.37E-03	1.12E-03	899	464	5
12/13/2006	19:45:07	4	2	1	3	2.35E-03	1.57E-03	854	480	2
12/13/2006	19:49:00	4	2	1	3	2.44E-03	8.99E-03	923	441	19
12/13/2006	19:52:02	4	2	1	3	1.36E-02	1.48E-02	810	557	16
12/13/2006	19:55:35	4	2	1	3	5.25E-03	8.69E-03	1001	437	7
12/13/2006	19:58:31	4	2	1	3	5.73E-03	3.85E-03	1002	425	3

Fish densities near the SGS intake and discharge structures (continued).

Date	Time	Survey #	Day=1 Night= 2	Normal=1 Reverse= 2	Rep#	Offshore Density (kg/m3)	Inshore Density (kg/m3)	Offshore Ping #	Inshore Ping #	Transect #
12/13/2006	20:02:21	4	2	1	3	9.08E-03	8.03E-03	798	436	18
12/13/2006	20:05:02	4	2	1	3	9.40E-03	7.46E-03	731	426	16
12/13/2006	20:08:32	4	2	1	3	7.31E-03	2.08E-03	859	432	6
12/13/2006	20:11:07	4	2	1	3	2.78E-03	1.91E-02	807	543	4

Attachment A-8

Impingement Data Collected During the Velocity Cap Study

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC1**	Velocity Cap Imp. Survey
Date:	**October 12, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinops affinis	topsmelt	2	0.061
	Atherinopsis californiensis	jacksmelt	1	0.052
	Xenistius californiensis	salema	1	0.006
			4	0.119

Shellfish No shellfish

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC2**	Velocity Cap Imp. Survey		
Date:	**October 13, 2006**	Normal Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinops affinis	topsmelt	2	0.028
	Torpedo californica	Pacific electric ray	1	5.960
			3	5.988
Shellfish	*Panulirus interruptus*	California spiny lobster	1	0.243
	Portunus xantusii	Xantus swimming crab	3	0.009
			4	0.252
Non-Shellfish	*Dendronotus*	dendronotid nudibranch unid	1	0.002
			1	0.002

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC3**	Velocity Cap Imp. Survey		
Date:	**October 16, 2006**	Normal Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinops affinis	topsmelt	1	0.027
	Myliobatis californica	bat ray	1	0.603
	Sardinops sagax	Pacific sardine	1	0.019
			3	0.649
Shellfish	*Pachygrapsus crassipes*	striped shore crab	1	0.004
	Panulirus interruptus	California spiny lobster	2	0.851
	Portunus xantusii	Xantus swimming crab	2	0.053
			5	0.908

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC4**	Velocity Cap Imp. Survey
Date:	**October 17, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Scorpaenichthys marmoratus	cabezon	1	0.228
	Torpedo californica	Pacific electric ray	1	6.050
			2	6.278
Shellfish	*Cancer amphioetus*	bigtooth rock crab	1	0.001
	Oct. bimaculatus/bimaculoides	California two-spot octopus	1	0.094
	Portunus xantusii	Xantus swimming crab	1	0.002
			3	0.097

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC5**	Velocity Cap Imp. Survey
Date:	**October 19, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Platyrhinoidis triseriata	thornback	1	0.030
			1	0.030
Shellfish	*Portunus xantusii*	Xantus swimming crab	2	0.040
			2	0.040

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC6**	Velocity Cap Imp. Survey
Date:	**October 20, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	No fish			
Shellfish	*Pachygrapsus crassipes*	striped shore crab	1	0.001
	Portunus xantusii	Xantus swimming crab	1	0.026
			2	0.027

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC7**	Velocity Cap Imp. Survey		
Date:	**October 23, 2006**	Normal Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Chromis punctipinnis	blacksmith	1	0.048
	Myliobatis californica	bat ray	3	0.922
	Torpedo californica	Pacific electric ray	1	3.550
			5	4.52
Shellfish	*Oct. bimaculatus/bimaculoides*	California two-spot octopus	1	0.201
	Portunus xantusii	Xantus swimming crab	1	0.003
			2	0.204

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC8**	Velocity Cap Imp. Survey		
Date:	**October 24, 2006**	Reverse Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anisotremus davidsonii	sargo	1	0.034
	Atherinops affinis	topsmelt	14	0.420
	Engraulis mordax	northern anchovy	24	0.089
	Medialuna californiensis	halfmoon	1	0.246
	Myliobatis californica	bat ray	1	0.192
	Paralabrax nebulifer	barred sand bass	1	0.289
	Sardinops sagax	Pacific sardine	661	12.474
	Scorpaenichthys marmoratus	cabezon	1	0.565
	Seriphus politus	queenfish	7	0.043
	Urobatis halleri	round stingray	1	1.036
	Xenistius californiensis	salema	11	0.019
			723	15.407
Shellfish	*Cancer antennarius*	Pacific rock crab	2	0.002
	Cancer anthonyi	yellow crab	8	0.010
	Cancer gracilis	graceful crab	1	0.002
	Cancer jordani	hairy rock crab	5	0.005
	Portunus xantusii	Xantus swimming crab	1	0.002
	Pugettia producta	northern kelp crab	6	0.040
			23	0.061
Non-Shellfish	*Lytechinus pictus*	white sea urchin	1	0.001
			1	0.001

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC9**	Velocity Cap Imp. Survey		
Date:	**October 26, 2006**	Reverse Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinops affinis	topsmelt	1	0.025
	Myliobatis californica	bat ray	3	1.753
	Pleuronichthys ritteri	spotted turbot	1	0.005
	Sardinops sagax	Pacific sardine	7128	206.008
	Scomber japonicus	Pacific chub mackerel	1	0.063
	Seriphus politus	queenfish	3	0.012
			7137	207.866
Shellfish	*Cancer anthonyi*	yellow crab	2	0.011
	Cancer jordani	hairy rock crab	1	0.001
	Panulirus interruptus	California spiny lobster	1	2.688
			4	2.700
Non-Shellfish	Ophiuroidea	brittle star, unid.	1	0.001
			1	0.001

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC10**	Velocity Cap Imp. Survey
Date:	**October 27, 2006**	Reverse Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinops affinis	topsmelt	3	0.081
	Heterostichus rostratus	giant kelpfish	2	0.010
	Myliobatis californica	bat ray	3	1.026
	Pleuronichthys guttulatus	diamond turbot	2	0.004
	Porichthys myriaster	specklefin midshipman	1	0.003
	Sardinops sagax	Pacific sardine	1859	48.241
	Scomber japonicus	Pacific chub mackerel	2	0.085
	Seriphus politus	queenfish	3	0.005
			1875	49.455
Shellfish	*Cancer anthonyi*	yellow crab	1	0.001
	Cancer jordani	hairy rock crab	1	0.001
	Portunus xantusii	Xantus swimming crab	2	0.025
			4	0.027

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC11**	Velocity Cap Imp. Survey
Date:	**October 30, 2006**	Reverse Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinops affinis	topsmelt	10	0.160
	Myliobatis californica	bat ray	6	1.657
	Sardinops sagax	Pacific sardine	12020	232.74
			12036	234.557
Shellfish	*Cancer jordani*	hairy rock crab	3	0.003
			3	0.003

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC12**	Velocity Cap Imp. Survey		
Date:	**October 31, 2006**	Reverse Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinopsidae eggs	atherinopsid eggs	-	0.004
	Myliobatis californica	bat ray	1	0.402
	Sardinops sagax	Pacific sardine	1090	28.995
	Seriphus politus	queenfish	3	0.010
			1094	29.411
Shellfish	*Pachygrapsus crassipes*	striped shore crab	1	0.001
			1	0.001

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC13**	Velocity Cap Imp. Survey
Date:	**November 2, 2006**	Reverse Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Myliobatis californica	bat ray	4	1.069
	Sardinops sagax	Pacific sardine	431	13.444
	Scomber japonicus	Pacific chub mackerel	1	0.165
	Seriphus politus	queenfish	2	0.003
			438	14.681
Shellfish	*Cancer anthonyi*	yellow crab	2	0.009
			2	0.009

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC14**	Velocity Cap Imp. Survey		
Date:	**November 3, 2006**	Reverse Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinops affinis	topsmelt	1	0.017
	Atherinopsis californiensis	jacksmelt	1	0.137
	Engraulis mordax	northern anchovy	1	0.005
	Myliobatis californica	bat ray	2	0.485
	Sardinops sagax	Pacific sardine	764	24.253
	Scomber japonicus	Pacific chub mackerel	1	0.066
	Seriphus politus	queenfish	14	0.023
			784	24.986
Shellfish	*Cancer antennarius*	Pacific rock crab	1	0.003
	Cancer anthonyi	yellow crab	2	0.002
	Cancer jordani	hairy rock crab	3	0.005
	Oct. bimaculatus/bimaculoides	California two-spot octopus	1	0.138
	Portunus xantusii	Xantus swimming crab	2	0.005
			9	0.153
Non-Shellfish	*Navanax inermis*	California aglaja	1	0.001
			1	0.001

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC15**	Velocity Cap Imp. Survey		
Date:	**November 6, 2006**	Reverse Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	1	0.004
	Atherinopsis californiensis	jacksmelt	1	0.105
	Leuresthes tenuis	California grunion	2	0.012
	Myliobatis californica	bat ray	18	5.684
	Pleuronichthys verticalis	hornyhead turbot	1	0.021
	Porichthys myriaster	specklefin midshipman	2	0.243
	Sardinops sagax	Pacific sardine	2056	61.335
	Scomber japonicus	Pacific chub mackerel	4	0.248
	Seriphus politus	queenfish	30	0.055
	Synodus lucioceps	California lizardfish	1	0.078
	Torpedo californica	Pacific electric ray	2	12.25
	Xenistius californiensis	salema	1	0.003
			2119	80.038
Shellfish	*Panulirus interruptus*	California spiny lobster	1	0.810
	Portunus xantusii	Xantus swimming crab	8	0.049
			9	0.859

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC16**	Velocity Cap Imp. Survey
Date:	**November 7, 2006**	Reverse Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Leuresthes tenuis	California grunion	1	0.007
	Myliobatis californica	bat ray	3	1.142
	Platyrhinoidis triseriata	thornback	1	0.348
	Pleuronichthys ritteri	spotted turbot	1	0.007
	Sardinops sagax	Pacific sardine	330	9.510
	Scomber japonicus	Pacific chub mackerel	2	0.191
	Seriphus politus	queenfish	7	0.007
	Torpedo californica	Pacific electric ray	1	5.000
			346	16.212
Shellfish	*Cancer anthonyi*	yellow crab	4	0.004
	Portunus xantusii	Xantus swimming crab	4	0.059
			8	0.063

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC17**	Velocity Cap Imp. Survey		
Date:	**November 9, 2006**	Reverse Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Engraulis mordax	northern anchovy	1	0.004
	Leuresthes tenuis	California grunion	1	0.007
	Myliobatis californica	bat ray	8	2.999
	Paralichthys californicus	California halibut	1	0.008
	Pleuronichthys ritteri	spotted turbot	5	0.035
	Sardinops sagax	Pacific sardine	1553	48.323
	Scomber japonicus	Pacific chub mackerel	3	0.198
	Seriphus politus	queenfish	10	0.027
			1582	51.601
Shellfish	*Cancer antennarius*	Pacific rock crab	1	0.484
	Cancer anthonyi	yellow crab	1	0.004
	Panulirus interruptus	California spiny lobster	1	0.284
	Portunus xantusii	Xantus swimming crab	12	0.222
			15	0.994

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC18**	Velocity Cap Imp. Survey
Date:	**November 10, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinops affinis	topsmelt	252	6.253
	Atherinopsis californiensis	jacksmelt	48	4.459
	Engraulis mordax	northern anchovy	1	0.007
	Leuresthes tenuis	California grunion	1	0.004
	Menticirrhus undulatus	California corbina	3	0.706
	Myliobatis californica	bat ray	48	64.727
	Paralabrax nebulifer	barred sand bass	2	0.450
	Paralichthys californicus	California halibut	1	0.004
	Sardinops sagax	Pacific sardine	54	7.822
	Scomber japonicus	Pacific chub mackerel	4	0.218
	Seriphus politus	queenfish	4	0.015
	Torpedo californica	Pacific electric ray	1	3.800
	Trachurus symmetricus	jack mackerel	1	0.025
	Urobatis halleri	round stingray	1	0.411
			421	88.901
Shellfish	*Cancer antennarius*	Pacific rock crab	1	0.003
	Oct. bimaculatus/bimaculoides	California two-spot octopus	1	0.610
	Pachygrapsus crassipes	striped shore crab	2	0.009
	Panulirus interruptus	California spiny lobster	1	0.461
	Portunus xantusii	Xantus swimming crab	2	0.045
	Pugettia producta	northern kelp crab	1	0.073
			8	1.201

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC19**	Velocity Cap Imp. Survey
Date:	**November 13, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinopsidae	silverside, unid.	113	2.780
	Citharichthys stigmaeus	speckled sanddab	4	0.016
	Embiotocidae	surfperch, unid.	1	0.156
	Myliobatis californica	bat ray	5	18.925
	Paralabrax clathratus	kelp bass	1	0.102
	Pleuronichthys verticalis	hornyhead turbot	1	0.006
	Porichthys myriaster	specklefin midshipman	1	0.275
	Sardinops sagax	Pacific sardine	94	2.216
	Torpedo californica	Pacific electric ray	1	3.100
			221	27.576
Shellfish	*Pachycheles rudis*	thick claw porcelain crab	8	0.008
	Panulirus interruptus	California spiny lobster	2	3.287
	Portunus xantusii	Xantus swimming crab	13	0.089
			23	3.384

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC20**	Velocity Cap Imp. Survey		
Date:	**November 15, 2006**	Normal Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinopsis californiensis	jacksmelt	1	0.087
	Sardinops sagax	Pacific sardine	1	0.036
	Torpedo californica	Pacific electric ray	1	4.400
			3	4.523
Shellfish	*Pachygrapsus crassipes*	striped shore crab	1	0.012
	Panulirus interruptus	California spiny lobster	1	0.623
	Portunus xantusii	Xantus swimming crab	2	0.006
			4	0.641

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC21**	Velocity Cap Imp. Survey		
Date:	**November 16, 2006**	Normal Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Platyrhinoidis triseriata	thornback	1	0.109
	Porichthys myriaster	specklefin midshipman	1	0.668
			2	0.777
Shellfish	*Portunus xantusii*	Xantus swimming crab	2	0.010
			2	0.010

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC22**	Velocity Cap Imp. Survey		
Date:	**November 17, 2006**	Normal Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	No fish			
Shellfish	*Portunus xantusii*	Xantus swimming crab	1	0.002
			1	0.002

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC23**	Velocity Cap Imp. Survey
Date:	**November 20, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinops affinis	topsmelt	1	0.017
	Atherinopsis californiensis	jacksmelt	1	0.119
	Sardinops sagax	Pacific sardine	1	0.040
	Scomber japonicus	Pacific chub mackerel	1	0.039
	Torpedo californica	Pacific electric ray	1	6.000
			5	6.215
Shellfish	*Panulirus interruptus*	California spiny lobster	1	0.259
			1	0.259

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC24**	Velocity Cap Imp. Survey		
Date:	**November 21,2006**	Reverse Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Amphistichus argenteus	barred surfperch	1	0.115
	Atherinops affinis	topsmelt	57	1.584
	Atherinopsis californiensis	jacksmelt	2	0.191
	Cheilotrema saturnum	black croaker	5	0.801
	Embiotoca jacksoni	black perch	2	0.105
	Engraulis mordax	northern anchovy	2	0.007
	Heterostichus rostratus	giant kelpfish	1	0.022
	Medialuna californiensis	halfmoon	1	0.255
	Paralabrax clathratus	kelp bass	3	0.210
	Paralabrax nebulifer	barred sand bass	1	0.274
	Phanerodon furcatus	white seaperch	2	0.051
	Pleuronichthys verticalis	hornyhead turbot	1	0.031
	Rhacochilus toxotes	rubberlip seaperch	2	0.159
	Rhacochilus vacca	pile perch	1	0.525
	Sardinops sagax	Pacific sardine	23	0.497
	Scomber japonicus	Pacific chub mackerel	17	1.180
	Scorpaena guttata	California scorpionfish	2	0.140
	Seriphus politus	queenfish	10	0.038
	Trachurus symmetricus	jack mackerel	1	0.092
	Xenistius californiensis	salema	10	0.037
			144	6.314
Shellfish	*Cancer antennarius*	Pacific rock crab	4	0.011
	Cancer jordani	hairy rock crab	1	0.001
	Lophopanopeus bellus	blackclaw crestleg crab	1	0.001
	Lysmata californica	red rock shrimp	1	0.001
	Oct. bimaculatus/bimaculoides	California two-spot octopus	3	1.94
	Portunus xantusii	Xantus swimming crab	7	0.049
			17	2.003
Non-Shellfish	*Strongylocentrotus purpuratus*	purple sea urchin	3	0.005
			3	0.005

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC25**	Velocity Cap Imp. Survey		
Date:	**November 27, 2006**	Reverse Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Sardinops sagax	Pacific sardine	14551	185.091
	Scomber japonicus	Pacific chub mackerel	2	0.200
			14553	185.291
Shellfish	*Pugettia producta*	northern kelp crab	1	0.005
			1	0.005

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC26**	Velocity Cap Imp. Survey		
Date:	**November 28, 2006**	Reverse Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	1	0.004
	Atherinopsis californiensis	jacksmelt	3	0.220
	Chromis punctipinnis	blacksmith	1	0.064
	Citharichthys stigmaeus	speckled sanddab	1	0.012
	Leuresthes tenuis	California grunion	8	0.124
	Myliobatis californica	bat ray	6	1.335
	Pleuronichthys ritteri	spotted turbot	2	0.008
	Sardinops sagax	Pacific sardine	10285	134.035
	Scomber japonicus	Pacific chub mackerel	1	0.045
			10308	135.847
Shellfish	*Cancer anthonyi*	yellow crab	1	0.005
	Pachygrapsus crassipes	striped shore crab	1	0.005
	Panulirus interruptus	California spiny lobster	1	0.178
	Portunus xantusii	Xantus swimming crab	2	0.011
			5	0.199

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC27**	Velocity Cap Imp. Survey
Date:	**November 30, 2006**	Reverse Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	15	0.069
	Atherinops affinis	topsmelt	20	0.668
	Engraulis mordax	northern anchovy	1	0.002
	Heterodontus francisci	horn shark	1	0.028
	Leuresthes tenuis	California grunion	67	0.607
	Myliobatis californica	bat ray	9	2.514
	Ophidion scrippsae	basketweave cusk-eel	1	0.068
	Pleuronichthys ritteri	spotted turbot	2	0.020
	Sardinops sagax	Pacific sardine	2814	40.046
	Scomber japonicus	Pacific chub mackerel	2	0.089
	Seriphus politus	queenfish	19	0.109
			2951	44.22
Shellfish	*Loligo opalescens*	California market squid	1	0.029
	Portunus xantusii	Xantus swimming crab	2	0.009
			3	0.038

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC28**	Velocity Cap Imp. Survey
Date:	**December 1, 2006**	Reverse Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	5	0.032
	Atherinops affinis	topsmelt	19	0.651
	Engraulis mordax	northern anchovy	1	0.003
	Leuresthes tenuis	California grunion	19	0.233
	Myliobatis californica	bat ray	3	0.837
	Pleuronichthys ritteri	spotted turbot	1	0.007
	Sardinops sagax	Pacific sardine	765	10.288
	Scomber japonicus	Pacific chub mackerel	3	0.173
	Seriphus politus	queenfish	5	0.012
			821	12.236
Shellfish	*Cancer anthonyi*	yellow crab	1	0.004
	Crangon nigromaculata	blackspotted bay shrimp	1	0.001
	Loligo opalescens	California market squid	1	0.028
	Pachygrapsus crassipes	striped shore crab	1	0.002
	Panulirus interruptus	California spiny lobster	1	0.598
	Portunus xantusii	Xantus swimming crab	7	0.103
			12	0.736

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey: **VC29** Velocity Cap Imp. Survey
Date: **December 4, 2006** Reverse Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	10	0.033
	Atherinops affinis	topsmelt	6	0.248
	Atherinopsis californiensis	jacksmelt	14	0.629
	Leuresthes tenuis	California grunion	5	0.074
	Platyrhinoidis triseriata	thornback	1	0.024
	Sardinops sagax	Pacific sardine	5042	60.708
	Scomber japonicus	Pacific chub mackerel	3	0.147
	Seriphus politus	queenfish	12	0.036
	Syngnathus	pipefish, unid.	1	0.001
	Torpedo californica	Pacific electric ray	1	6.700
			5095	68.600
Shellfish	*Cancer anthonyi*	yellow crab	1	0.001
	Cancer jordani	hairy rock crab	1	0.001
	Portunus xantusii	Xantus swimming crab	2	0.010
			4	0.012

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC30**	Velocity Cap Imp. Survey
Date:	**December 5, 2006**	Reverse Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinopsis californiensis	jacksmelt	7	0.549
	Engraulis mordax	northern anchovy	1	0.003
	Myliobatis californica	bat ray	2	0.681
	Platyrhinoidis triseriata	thornback	2	0.019
	Sardinops sagax	Pacific sardine	21700	406.022
	Scomber japonicus	Pacific chub mackerel	50	3.341
	Seriphus politus	queenfish	2	0.007
	Trachurus symmetricus	jack mackerel	1	0.029
	Xenistius californiensis	salema	1	0.040
			21766	410.691

Shellfish No shellfish

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC31**	Velocity Cap Imp. Survey
Date:	**December 7, 2006**	Reverse Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	2	0.011
	Atherinopsis californiensis	jacksmelt	4	0.203
	Hyperprosopon argenteum	walleye surfperch	1	0.028
	Myliobatis californica	bat ray	2	0.529
	Sardinops sagax	Pacific sardine	15701	395.032
	Scomber japonicus	Pacific chub mackerel	26	1.869
	Trachurus symmetricus	jack mackerel	1	0.034
	Xenistius californiensis	salema	1	0.009
			15738	397.715
Shellfish	No shellfish			
Non-Shellfish	*Pisaster ochraceus*	ochre star	1	0.022
			1	0.022

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC32**	Velocity Cap Imp. Survey		
Date:	**December 8, 2006**	Reverse Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	2	0.008
	Atherinopsis californiensis	jacksmelt	7	0.602
	Chromis punctipinnis	blacksmith	1	0.079
	Hyperprosopon argenteum	walleye surfperch	1	0.028
	Leuresthes tenuis	California grunion	3	0.060
	Menticirrhus undulatus	California corbina	1	0.043
	Myliobatis californica	bat ray	10	3.016
	Peprilus simillimus	Pacific pompano	1	0.023
	Platyrhinoidis triseriata	thornback	2	0.411
	Porichthys myriaster	specklefin midshipman	1	0.002
	Sardinops sagax	Pacific sardine	3480	64.918
	Scomber japonicus	Pacific chub mackerel	26	1.264
	Seriphus politus	queenfish	4	0.071
	Trachurus symmetricus	jack mackerel	1	0.039
	Xenistius californiensis	salema	2	0.068
			3542	70.632
Shellfish	*Cancer antennarius*	Pacific rock crab	1	0.009
	Cancer jordani	hairy rock crab	1	0.001
			2	0.010

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC33**	Velocity Cap Imp. Survey		
Date:	**December 11, 2006**	Reverse Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	5	0.013
	Atherinopsis californiensis	jacksmelt	6	0.674
	Chromis punctipinnis	blacksmith	1	0.003
	Engraulis mordax	northern anchovy	2	0.004
	Leuresthes tenuis	California grunion	3	0.079
	Myliobatis californica	bat ray	18	8.072
	Ophidion scrippsae	basketweave cusk-eel	1	0.023
	Platyrhinoidis triseriata	thornback	1	1.025
	Pleuronichthys ritteri	spotted turbot	1	0.115
	Sardinops sagax	Pacific sardine	238	4.215
	Seriphus politus	queenfish	4	0.048
	Syngnathus sp	pipefish, unid.	1	0.004
	Urobatis halleri	round stingray	2	0.643
			283	14.918
Shellfish	*Blepharipoda occidentalis*	spiny mole crab	15	0.368
	Cancer antennarius	Pacific rock crab	1	0.001
	Cancer productus	red rock crab	1	0.003
	Crangon nigromaculata	blackspotted bay shrimp	1	0.001
	Loligo opalescens	California market squid	1	0.011
	Lysmata californica	red rock shrimp	1	0.002
	Pachygrapsus crassipes	striped shore crab	1	0.017
	Portunus xantusii	Xantus swimming crab	6	0.045
			27	0.448

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC34**	Velocity Cap Imp. Survey		
Date:	**December 12, 2006**	Normal Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	8	0.053
	Atherinops affinis	topsmelt	603	16.479
	Atherinopsis californiensis	jacksmelt	822	84.432
	Citharichthys stigmaeus	speckled sanddab	4	0.022
	Embiotoca jacksoni	black perch	2	0.154
	Engraulis mordax	northern anchovy	5	0.017
	Genyonemus lineatus	white croaker	5	0.551
	Heterodontus francisci	horn shark	1	0.035
	Hyperprosopon argenteum	walleye surfperch	4	0.262
	Menticirrhus undulatus	California corbina	2	0.342
	Myliobatis californica	bat ray	4	2.100
	Peprilus simillimus	Pacific pompano	1	0.054
	Platyrhinoidis triseriata	thornback	2	1.147
	Pleuronichthys ritteri	spotted turbot	2	0.091
	Pleuronichthys verticalis	hornyhead turbot	1	0.126
	Porichthys myriaster	specklefin midshipman	1	0.006
	Sardinops sagax	Pacific sardine	1776	33.198
	Scomber japonicus	Pacific chub mackerel	22	1.662
	Scorpaena guttata	California scorpionfish	1	0.001
	Seriphus politus	queenfish	30	0.98
	Torpedo californica	Pacific electric ray	3	13.65
	Trachurus symmetricus	jack mackerel	4	0.234
	Triakis semifasciata	leopard shark	1	11.00
	Umbrina roncador	yellowfin croaker	5	0.766
	Xenistius californiensis	salema	3	0.136
			3312	167.498
Shellfish	*Blepharipoda occidentalis*	spiny mole crab	3	0.058
	Cancer anthonyi	yellow crab	1	0.004
	Crangon nigromaculata	blackspotted bay shrimp	1	0.001
	Oct. bimaculatus/bimaculoides	California two-spot octopus	1	0.521
	Pachygrapsus crassipes	striped shore crab	1	0.003
	Portunus xantusii	Xantus swimming crab	2	0.011
			9	0.598

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC35**	Velocity Cap Imp. Survey
Date:	**December 14, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	1	0.005
	Anisotremus davidsonii	sargo	1	0.005
	Atherinops affinis	topsmelt	24	0.539
	Atherinopsis californiensis	jacksmelt	44	4.896
	Citharichthys stigmaeus	speckled sanddab	3	0.027
	Engraulis mordax	northern anchovy	20	0.064
	Leuresthes tenuis	California grunion	1	0.019
	Menticirrhus undulatus	California corbina	1	0.002
	Ophichthus zophochir	yellow snake eel	1	0.202
	Pleuronichthys guttulatus	diamond turbot	1	0.119
	Pleuronichthys ritteri	spotted turbot	1	0.009
	Sardinops sagax	Pacific sardine	50	0.878
	Scomber japonicus	Pacific chub mackerel	1	0.040
	Seriphus politus	queenfish	74	0.284
	Syngnathus californiensis	kelp pipefish	1	0.007
	Trachurus symmetricus	jack mackerel	1	0.032
	Umbrina roncador	yellowfin croaker	1	0.012
	Xenistius californiensis	salema	1	0.008
			227	7.148
Shellfish	*Cancer antennarius*	Pacific rock crab	2	0.002
	Crangon nigromaculata	blackspotted bay shrimp	2	0.003
	Portunus xantusii	Xantus swimming crab	14	0.103
			18	0.108

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC36**	Velocity Cap Imp. Survey
Date:	**December 15, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa delicatissima	slough anchovy	3	0.012
	Atherinops affinis	topsmelt	20	0.495
	Atherinopsis californiensis	jacksmelt	37	4.146
	Chromis punctipinnis	blacksmith	1	0.052
	Citharichthys stigmaeus	speckled sanddab	41	0.112
	Engraulis mordax	northern anchovy	152	0.431
	Heterodontus francisci	horn shark	2	0.062
	Heterostichus rostratus	giant kelpfish	1	0.007
	Myliobatis californica	bat ray	1	0.279
	Odontopyxis trispinosa	pygmy poacher	1	0.002
	Ophichthus zophochir	yellow snake eel	1	0.328
	Paralichthys californicus	California halibut	1	0.014
	Parophrys vetulus	English sole	2	0.032
	Peprilus simillimus	Pacific pompano	2	0.057
	Platyrhinoidis triseriata	thornback	10	3.919
	Pleuronichthys guttulatus	diamond turbot	4	0.365
	Pleuronichthys ritteri	spotted turbot	4	0.134
	Porichthys myriaster	specklefin midshipman	13	0.049
	Porichthys notatus	plainfin midshipman	1	0.001
	Sardinops sagax	Pacific sardine	30	0.615
	Scomber japonicus	Pacific chub mackerel	2	0.087
	Scorpaena guttata	California scorpionfish	3	0.007
	Seriphus politus	queenfish	153	0.771
	Symphurus atricaudus	California tonguefish	1	0.037
	Syngnathus californiensis	kelp pipefish	3	0.010
	Torpedo californica	Pacific electric ray	2	18.000
	Trachurus symmetricus	jack mackerel	1	0.028
	Urobatis halleri	round stingray	2	0.058
	Xenistius californiensis	salema	2	0.005
			496	30.115
Shellfish	*Cancer anthonyi*	yellow crab	1	0.006
	Cancer gracilis	graceful crab	1	0.002
	Cancer jordani	hairy rock crab	1	0.001
	Crangon nigromaculata	blackspotted bay shrimp	18	0.023
	Heptacarpus palpator	intertidal coastal shrimp	1	0.001
	Loligo opalescens	California market squid	1	0.023
	Lysmata californica	red rock shrimp	1	0.002
	Octopus rubescens	East Pacific red octopus	2	0.148
	Portunus xantusii	Xantus swimming crab	55	0.391
			81	0.597

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC37**	Velocity Cap Imp. Survey
Date:	**December 18, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Citharichthys stigmaeus	speckled sanddab	1	0.002
	Engraulis mordax	northern anchovy	3	0.008
	Parophrys vetulus	English sole	1	0.110
	Sardinops sagax	Pacific sardine	4	0.074
	Seriphus politus	queenfish	4	0.035
	Syngnathus californiensis	kelp pipefish	2	0.007
			15	0.236
Shellfish	*Cancer antennarius*	Pacific rock crab	1	0.007
	Panulirus interruptus	California spiny lobster	1	0.500
	Portunus xantusii	Xantus swimming crab	3	0.029
			5	0.536

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC38**	Velocity Cap Imp. Survey		
Date:	**December 19, 2006**	Normal Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Engraulis mordax	northern anchovy	2	0.006
	Peprilus simillimus	Pacific pompano	1	0.025
	Pleuronichthys ritteri	spotted turbot	1	0.007
	Pleuronichthys verticalis	hornyhead turbot	1	0.046
	Sardinops sagax	Pacific sardine	4	0.079
	Seriphus politus	queenfish	3	0.012
			12	0.175
Shellfish	*Cancer antennarius*	Pacific rock crab	1	0.004
	Portunus xantusii	Xantus swimming crab	5	0.027
			6	0.031

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC39**	Velocity Cap Imp. Survey
Date:	**December 21,2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	4	0.016
	Citharichthys stigmaeus	speckled sanddab	4	0.012
	Engraulis mordax	northern anchovy	48	0.122
	Ophichthus zophochir	yellow snake eel	1	0.128
	Paralichthys californicus	California halibut	1	0.050
	Peprilus simillimus	Pacific pompano	1	0.056
	Pleuronichthys ritteri	spotted turbot	5	0.052
	Sardinops sagax	Pacific sardine	4	0.059
	Seriphus politus	queenfish	39	0.101
	Syngnathus californiensis	kelp pipefish	2	0.004
	Xenistius californiensis	salema	1	0.003
			110	0.603
Shellfish	*Cancer antennarius*	Pacific rock crab	2	0.014
	Crangon nigromaculata	blackspotted bay shrimp	1	0.004
	Portunus xantusii	Xantus swimming crab	21	0.152
			24	0.17

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC40**	Velocity Cap Imp. Survey		
Date:	**December 22, 2006**	Normal Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	1	0.003
	Citharichthys stigmaeus	speckled sanddab	1	0.019
	Engraulis mordax	northern anchovy	8	0.008
	Heterodontus francisci	horn shark	1	0.023
	Platyrhinoidis triseriata	thornback	1	0.381
	Pleuronichthys ritteri	spotted turbot	3	0.014
	Sardinops sagax	Pacific sardine	2	0.040
	Scorpaenichthys marmoratus	cabezon	1	0.031
	Seriphus politus	queenfish	14	0.031
			32	0.55
Shellfish	*Cancer anthonyi*	yellow crab	3	0.003
	Cancer gracilis	graceful crab	1	0.001
	Cancer jordani	hairy rock crab	1	0.001
	Oct. bimaculatus/bimaculoides	California two-spot octopus	1	0.28
	Portunus xantusii	Xantus swimming crab	14	0.061
			20	0.346

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC41**	Velocity Cap Imp. Survey		
Date:	**December 26, 2006**	Normal Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	4	0.026
	Anisotremus davidsonii	sargo	1	0.007
	Atherinops affinis	topsmelt	5	0.081
	Atherinopsis californiensis	jacksmelt	1	0.110
	Citharichthys stigmaeus	speckled sanddab	4	0.018
	Dorosoma petenense	threadfin shad	1	0.013
	Engraulis mordax	northern anchovy	8	0.043
	Heterostichus rostratus	giant kelpfish	1	0.037
	Hyperprosopon argenteum	walleye surfperch	1	0.023
	Leptocottus armatus	Pacific staghorn sculpin	1	0.025
	Myliobatis californica	bat ray	3	1.669
	Ophichthus zophochir	yellow snake eel	1	0.134
	Paralichthys californicus	California halibut	1	0.019
	Peprilus simillimus	Pacific pompano	8	0.263
	Platyrhinoidis triseriata	thornback	7	2.471
	Pleuronichthys verticalis	hornyhead turbot	3	0.060
	Sardinops sagax	Pacific sardine	5	0.097
	Scorpaena guttata	California scorpionfish	3	0.210
	Seriphus politus	queenfish	27	0.392
	Torpedo californica	Pacific electric ray	7	31.600
			92	37.298
Shellfish	*Cancer anthonyi*	yellow crab	4	0.017
	Cancer gracilis	graceful crab	1	0.001
	Crangon nigromaculata	blackspotted bay shrimp	1	0.002
	Panulirus interruptus	California spiny lobster	1	0.279
	Portunus xantusii	Xantus swimming crab	15	0.064
			22	0.363
Non-Shellfish	*Caudina arenicola*	sweet potato sea cucumber	1	0.006
			1	0.006

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC42**	Velocity Cap Imp. Survey		
Date:	**December 28, 2006**	Normal Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	14	0.114
	Citharichthys stigmaeus	speckled sanddab	38	0.166
	Engraulis mordax	northern anchovy	19	0.095
	Heterodontus francisci	horn shark	2	0.050
	Heterostichus rostratus	giant kelpfish	2	0.024
	Hypsoblennius jenkinsi	mussel blenny	1	0.002
	Leuresthes tenuis	California grunion	1	0.025
	Menticirrhus undulatus	California corbina	1	0.012
	Myliobatis californica	bat ray	2	0.791
	Odontopyxis trispinosa	pygmy poacher	6	0.008
	Oxyjulis californica	senorita	1	0.051
	Paralichthys californicus	California halibut	2	0.32
	Peprilus simillimus	Pacific pompano	1	0.028
	Platyrhinoidis triseriata	thornback	3	1.532
	Pleuronichthys ritteri	spotted turbot	5	0.075
	Pleuronichthys verticalis	hornyhead turbot	3	0.138
	Porichthys myriaster	specklefin midshipman	2	0.234
	Seriphus politus	queenfish	58	0.216
	Symphurus atricaudus	California tonguefish	1	0.033
	Syngnathus californiensis	kelp pipefish	10	0.013
	Torpedo californica	Pacific electric ray	1	5.850
	Urobatis halleri	round stingray	1	0.017
			174	9.794
Shellfish	*Blepharipoda occidentalis*	spiny mole crab	1	0.004
	Cancer antennarius	Pacific rock crab	1	0.004
	Cancer anthonyi	yellow crab	5	0.013
	Cancer jordani	hairy rock crab	1	0.004
	Crangon nigromaculata	blackspotted bay shrimp	103	0.139
	Oct. bimaculatus/bimaculoides	California two-spot octopus	1	0.157
	Portunus xantusii	Xantus swimming crab	10	0.088
			122	0.409
Non-Shellfish	*Caudina arenicola*	sweet potato sea cucumber	1	0.016
			1	0.016

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC43**	Velocity Cap Imp. Survey
Date:	**December 29, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	22	0.095
	Atherinops affinis	topsmelt	2	0.039
	Citharichthys stigmaeus	speckled sanddab	7	0.052
	Engraulis mordax	northern anchovy	11	0.040
	Gymnura marmorata	California butterfly ray	1	0.184
	Heterodontus francisci	horn shark	2	0.068
	Heterostichus rostratus	giant kelpfish	1	0.011
	Leptocottus armatus	Pacific staghorn sculpin	1	0.010
	Myliobatis californica	bat ray	2	0.657
	Ophidion scrippsae	basketweave cusk-eel	3	0.129
	Paralabrax clathratus	kelp bass	1	0.004
	Platyrhinoidis triseriata	thornback	2	1.031
	Pleuronichthys ritteri	spotted turbot	1	0.010
	Pleuronichthys verticalis	hornyhead turbot	1	0.059
	Seriphus politus	queenfish	36	0.230
	Syngnathus	pipefish unid	1	0.001
	Torpedo californica	Pacific electric ray	9	64.900
	Urobatis halleri	round stingray	2	0.206
	Xenistius californiensis	salema	1	0.003
			106	67.729
Shellfish	*Cancer antennarius*	Pacific rock crab	2	0.113
	Cancer anthonyi	yellow crab	5	0.013
	Cancer productus	red rock crab	1	0.001
	Crangon nigromaculata	blackspotted bay shrimp	13	0.027
	Lysmata californica	red rock shrimp	1	0.001
	Oct. bimaculatus/bimaculoides	California two-spot octopus	1	0.138
	Portunus xantusii	Xantus swimming crab	12	0.106
	Pugettia producta	northern kelp crab	3	0.008
			38	0.407

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VC44**	Velocity Cap Imp. Survey
Date:	**January 1, 2007**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Engraulis mordax	northern anchovy	2	0.005
	Heterostichus rostratus	giant kelpfish	1	0.014
	Myliobatis californica	bat ray	4	2.127
	Platyrhinoidis triseriata	thornback	2	1.445
	Pleuronichthys ritteri	spotted turbot	2	0.011
	Sardinops sagax	Pacific sardine	1	0.010
	Seriphus politus	queenfish	10	0.045
	Syngnathus californiensis	kelp pipefish	2	0.010
	Torpedo californica	Pacific electric ray	6	48.920
	Urobatis halleri	round stingray	1	0.025
			31	52.612
Shellfish	*Cancer antennarius*	Pacific rock crab	1	0.005
	Cancer anthonyi	yellow crab	8	0.029
	Cancer jordani	hairy rock crab	2	0.01
	Pachycheles rudis	thick claw porcelain crab	1	0.002
	Portunus xantusii	Xantus swimming crab	2	0.018
			14	0.064

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI40**	IM&E Charac. Study Survey		
Start Date:	**October 10, 2006**	Normal Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	*Atherinops affinis*	topsmelt	1	0.018
	Phanerodon furcatus	white seaperch	1	0.019
			2	0.037
Unit 2	*Atherinops affinis*	topsmelt	3	0.062
			3	0.062
Unit 3	*Atherinops affinis*	topsmelt	15	0.496
	Atherinopsis californiensis	jacksmelt	1	0.035
	Sardinops sagax	Pacific sardine	3	0.142
			19	0.673
Shellfish				
Unit 1	*Pachygrapsus crassipes*	striped shore crab	1	0.001
			1	0.001
Unit 2	No Shellfish			
Unit 3	*Panulirus interruptus*	California spiny lobster	1	1.650
			1	1.650

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI41**	IM&E Charac. Study Survey
Start Date:	**October 17, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	No Fish			
Unit 2	*Paralabrax nebulifer*	barred sand bass	1	0.579
			1	0.579
Unit 3	No Fish			
Shellfish				
Unit 1	*Portunus xantusii*	Xantus swimming crab	1	0.018
			1	0.018
Unit 2	*Portunus xantusii*	Xantus swimming crab	1	0.002
			1	0.002
Unit 3	*Lysmata californica*	red rock shrimp	1	0.001
			1	0.001

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI42**	IM&E Charac. Study Survey		
Start Date:	**October 24, 2006**	Reverse Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	*Sardinops sagax*	Pacific sardine	373	9.513
	Scomber japonicus	Pacific chub mackerel	1	0.068
	Seriphus politus	queenfish	1	0.001
			375	9.582
Unit 2	*Heterostichus rostratus*	giant kelpfish	1	0.002
	Myliobatis californica	bat ray	1	0.368
	Pleuronichthys ritteri	spotted turbot	1	0.003
	Pleuronichthys verticalis	hornyhead turbot	1	0.022
	Sardinops sagax	Pacific sardine	401	14.287
	Seriphus politus	queenfish	2	0.004
			407	14.686
Unit 3	*Myliobatis californica*	bat ray	1	0.213
	Pleuronichthys ritteri	spotted turbot	1	0.005
	Sardinops sagax	Pacific sardine	465	12.444
	Seriphus politus	queenfish	1	0.001
			468	12.663
Shellfish				
Unit 1	No Shellfish			
Unit 2	*Pugettia producta*	northern kelp crab	1	0.002
			1	0.002
Unit 3	*Cancer antennarius*	Pacific rock crab	4	0.005
	Cancer anthonyi	yellow crab	7	0.004
	Cancer gracilis	graceful crab	1	0.069
	Podochela hemphill	hemphill kelp crab	1	0.001
			13	0.079

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI43**	IM&E Charac. Study Survey		
Start Date:	**October 31, 2006**	Reverse Flow Direction		

Fish	**Taxon**	**Common Name**	**Survey Totals** **Abundance**	**Biomass (kg)**
Unit 1	*Atherinops affinis*	topsmelt	1	0.028
	Sardinops sagax	Pacific sardine	162	4.741
			163	4.769
Unit 2	*Platyrhinoidis triseriata*	thornback	1	2
	Sardinops sagax	Pacific sardine	251	7.482
	Seriphus politus	queenfish	1	0.004
			253	9.486
Unit 3	*Myliobatis californica*	bat ray	1	0.293
	Sardinops sagax	Pacific sardine	147	4.463
	Scomber japonicus	Pacific chub mackerel	1	0.035
			149	4.791
Shellfish				
Unit 1	No Shellfish			
Unit 2	*Portunus xantusii*	Xantus swimming crab	1	0.005
			1	0.005
Unit 3	*Portunus xantusii*	Xantus swimming crab	1	0.009
			1	0.009

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI44**	IM&E Charac. Study Survey
Start Date:	**November 7, 2006**	Reverse Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	*Myliobatis californica*	bat ray	1	0.205
	Sardinops sagax	Pacific sardine	156	5.379
	Seriphus politus	queenfish	2	0.004
			159	5.588
Unit 2	*Myliobatis californica*	bat ray	2	0.565
	Pleuronichthys ritteri	spotted turbot	4	0.025
	Porichthys myriaster	specklefin midshipman	1	0.214
	Sardinops sagax	Pacific sardine	643	21.63
	Seriphus politus	queenfish	3	0.006
	Torpedo californica	Pacific electric ray	1	7.100
			654	29.54
Unit 3	*Porichthys myriaster*	specklefin midshipman	1	0.236
	Sardinops sagax	Pacific sardine	409	13.004
	Seriphus politus	queenfish	3	0.006
			413	13.246
Shellfish				
Unit 1	No Shellfish			
Unit 2	*Pachygrapsus crassipes*	striped shore crab	1	0.002
	Portunus xantusii	Xantus swimming crab	4	0.061
			5	0.063
Unit 3	*Cancer jordani*	hairy rock crab	1	0.001
	Portunus xantusii	Xantus swimming crab	2	0.014
			3	0.015

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI45**	IM&E Charac. Study Survey	
Start Date:	**November 14, 2006**	Normal Flow Direction	

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	*Scomber japonicus*	Pacific chub mackerel	1	0.078
			1	0.078
Unit 2	No Fish			
Unit 3	*Myliobatis californica*	bat ray	1	2.6
	Platyrhinoidis triseriata	thornback	1	0.438
			2	3.038
Shellfish				
Unit 1	*Portunus xantusii*	Xantus swimming crab	1	0.003
			1	0.003
Unit 2	*Lophopanopeus bellus*	blackclaw crestleg crab	1	0.002
	Portunus xantusii	Xantus swimming crab	1	0.017
			2	0.019
Unit 3	No Shellfish			

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI46**	IM&E Charac. Study Survey		
Start Date:	**November 21, 2006**	Reverse Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	*Sardinops sagax*	Pacific sardine	80	1.535
			80	1.535
Unit 2	*Embiotoca jacksoni*	black perch	1	0.059
	Heterostichus rostratus	giant kelpfish	1	0.013
	Sardinops sagax	Pacific sardine	183	3.840
	Seriphus politus	queenfish	1	0.005
	Syngnathus sp	pipefish, unid.	1	0.002
			187	3.919
Unit 3	*Atherinopsis californiensis*	jacksmelt	6	0.304
	Cheilotrema saturnum	black croaker	1	0.024
	Embiotoca jacksoni	black perch	1	0.051
	Sardinops sagax	Pacific sardine	204	3.988
	Scomber japonicus	Pacific chub mackerel	1	0.056
	Seriphus politus	queenfish	2	0.007
			215	4.430
Shellfish				
Unit 1	No Shellfish			
Unit 2	No Shellfish			
Unit 3	*Cancer anthonyi*	yellow crab	3	0.004
	Portunus xantusii	Xantus swimming crab	1	0.006
			4	0.010

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI47**	IM&E Charac. Study Survey
Start Date:	**November 28, 2006**	Reverse Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	*Anchoa compressa*	deepbody anchovy	2	0.014
	Atherinops affinis	topsmelt	3	0.023
	Atherinopsis californiensis	jacksmelt	5	0.145
	Engraulis mordax	northern anchovy	1	0.004
	Pleuronichthys ritteri	spotted turbot	1	0.014
	Sardinops sagax	Pacific sardine	398	6.176
	Seriphus politus	queenfish	13	0.067
			423	6.443
Unit 2	*Anchoa compressa*	deepbody anchovy	1	0.005
	Anchoa delicatissima	slough anchovy	3	0.012
	Atherinopsis californiensis	jacksmelt	11	0.324
	Myliobatis californica	bat ray	3	1.278
	Pleuronichthys ritteri	spotted turbot	2	0.018
	Sardinops sagax	Pacific sardine	2536	42.151
	Scomber japonicus	Pacific chub mackerel	1	0.077
	Seriphus politus	queenfish	14	0.036
	Syngnathus sp	pipefish, unid.	1	0.004
			2572	43.905
Unit 3	*Anchoa compressa*	deepbody anchovy	1	0.008
	Anchoa delicatissima	slough anchovy	2	0.011
	Atherinops affinis	topsmelt	1	0.011
	Atherinopsis californiensis	jacksmelt	2	0.043
	Pleuronichthys ritteri	spotted turbot	1	0.001
	Sardinops sagax	Pacific sardine	448	6.71
	Scomber japonicus	Pacific chub mackerel	2	0.126
	Seriphus politus	queenfish	8	0.023
	Sphyraena argentea	Pacific barracuda	1	0.028
	Syngnathus leptorhynchus	bay pipefish	1	0.003
			467	6.964

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI47 (Cont.)**	IM&E Charac. Study Survey
Start Date:	**November 28, 2006**	Reverse Flow Direction

			Survey Totals	
Shellfish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	*Portunus xantusii*	Xantus swimming crab	5	0.036
			5	0.036
Unit 2	*Farfantepenaeus californiensis*	yellowleg shrimp	1	0.022
	Panulirus interruptus	California spiny lobster	1	0.230
	Portunus xantusii	Xantus swimming crab	3	0.012
			5	0.264
Unit 3	*Portunus xantusii*	Xantus swimming crab	1	0.007
	Pyromaia tuberculata	tuberculate pear crab	1	0.001
			2	0.008
Non-Shellfish				
Unit 2	*Polyorchis penicillatus*	red jellyfish	1	0.003
			1	0.003

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI48**	IM&E Charac. Study Survey		
Start Date:	**December 5, 2006**	Reverse Flow Direction		

Fish	**Taxon**	**Common Name**	**Survey Totals** **Abundance**	**Biomass (kg)**
Unit 1	*Sardinops sagax*	Pacific sardine	173	2.49
	Seriphus politus	queenfish	1	0.003
			174	2.493
Unit 2	*Anchoa delicatissima*	slough anchovy	1	0.005
	Atherinopsis californiensis	jacksmelt	1	0.048
	Myliobatis californica	bat ray	1	0.526
	Platyrhinoidis triseriata	thornback	1	0.009
	Sardinops sagax	Pacific sardine	1285	23.942
	Scomber japonicus	Pacific chub mackerel	1	0.079
	Seriphus politus	queenfish	1	0.004
	Xenistius californiensis	salema	1	0.004
			1292	24.617
Unit 3	*Sardinops sagax*	Pacific sardine	207	4.127
			207	4.127
Shellfish				
Unit 1	No Shellfish			
Unit 2	*Portunus xantusii*	Xantus swimming crab	1	0.003
			1	0.003
Unit 3	No Shellfish			

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI49**	IM&E Charac. Study Survey		
Start Date:	**December 12, 2006**	Normal Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	*Anchoa compressa*	deepbody anchovy	1	0.004
	Anchoa delicatissima	slough anchovy	1	0.004
	Atherinops affinis	topsmelt	9	0.561
	Atherinopsis californiensis	jacksmelt	13	1.257
	Engraulis mordax	northern anchovy	1	0.003
	Hypsoblennius gilberti	rockpool blenny	1	0.002
	Sardinops sagax	Pacific sardine	24	0.5
	Seriphus politus	queenfish	3	0.012
			53	2.343
Unit 2	*Anchoa compressa*	deepbody anchovy	1	0.006
	Atherinopsis californiensis	jacksmelt	37	2.75
	Engraulis mordax	northern anchovy	5	0.013
	Odontopyxis trispinosa	pygmy poacher	1	0.002
	Sardinops sagax	Pacific sardine	44	0.841
	Scorpaena guttata	California scorpionfish	1	0.001
	Seriphus politus	queenfish	3	0.006
			92	3.619
Unit 3	*Anchoa compressa*	deepbody anchovy	3	0.018
	Atherinops affinis	topsmelt	40	0.923
	Atherinopsis californiensis	jacksmelt	178	14.587
	Engraulis mordax	northern anchovy	42	0.11
	Heterostichus rostratus	giant kelpfish	1	0.012
	Myliobatis californica	bat ray	1	0.618
	Paralichthys californicus	California halibut	5	0.525
	Peprilus simillimus	Pacific pompano	5	0.125
	Platyrhinoidis triseriata	thornback	1	0.33
	Pleuronichthys ritteri	spotted turbot	8	0.026
	Pleuronichthys verticalis	hornyhead turbot	5	0.13
	Porichthys myriaster	specklefin midshipman	1	0.063
	Sardinops sagax	Pacific sardine	28	0.693
	Scorpaena guttata	California scorpionfish	2	0.003

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI49 (Cont.)**	IM&E Charac. Study Survey
Start Date:	**December 12, 2006**	Normal Flow Direction

Shellfish	**Taxon**	**Common Name**	**Survey Totals Abundance**	**Survey Totals Biomass (kg)**
Unit 1	*Portunus xantusii*	Xantus swimming crab	4	0.02
			4	0.02
Unit 2	*Cancer anthonyi*	yellow crab	2	0.003
	O. bimaculatus/bimaculoides	California two-spot octopus	1	0.039
	Pachygrapsus crassipes	striped shore crab	1	0.001
	Portunus xantusii	Xantus swimming crab	2	0.009
			6	0.052
Unit 3	*Lepidopa californica*	California mole crab	1	0.002
	O. bimaculatus/bimaculoides	California two-spot octopus	1	0.028
	Portunus xantusii	Xantus swimming crab	34	0.194
	Pugettia producta	northern kelp crab	1	0.001
			37	0.225

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI50**	IM&E Charac. Study Survey
Start Date:	**December 19, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	*Engraulis mordax*	northern anchovy	2	0.006
	Platyrhinoidis triseriata	thornback	1	0.447
	Seriphus politus	queenfish	9	0.024
			12	0.477
Unit 2	*Citharichthys stigmaeus*	speckled sanddab	1	0.001
	Engraulis mordax	northern anchovy	3	0.008
	Seriphus politus	queenfish	2	0.006
			6	0.015
Unit 3	*Anchoa delicatissima*	slough anchovy	1	0.003
	Atherinops affinis	topsmelt	2	0.018
	Citharichthys stigmaeus	speckled sanddab	10	0.02
	Engraulis mordax	northern anchovy	32	0.076
	Heterodontus francisci	horn shark	1	0.026
	Heterostichus rostratus	giant kelpfish	1	0.016
	Odontopyxis trispinosa	pygmy poacher	1	0.001
	Paralabrax nebulifer	barred sand bass	1	0.247
	Peprilus simillimus	Pacific pompano	2	0.055
	Platyrhinoidis triseriata	thornback	4	3.285
	Pleuronichthys ritteri	spotted turbot	1	0.002
	Pleuronichthys verticalis	hornyhead turbot	2	0.015
	Sardinops sagax	Pacific sardine	4	0.056
	Scorpaena guttata	California scorpionfish	3	0.099
	Seriphus politus	queenfish	43	0.108
	Syngnathus sp	pipefish, unid.	2	0.004
	Trachurus symmetricus	jack mackerel	1	0.022
	Urobatis halleri	round stingray	1	0.028
	Xenistius californiensis	salema	1	0.002
			113	4.083

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI50 (Cont.)**	IM&E Charac. Study Survey
Start Date:	**December 19, 2006**	Normal Flow Direction

			Survey Totals	
Shellfish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	*Crangon nigromaculata*	blackspotted bay shrimp	2	0.003
	Portunus xantusii	Xantus swimming crab	4	0.065
			6	0.068
Unit 2	*Blepharipoda occidentalis*	spiny mole crab	1	0.011
	Cancer antennarius	Pacific rock crab	1	0.067
	Portunus xantusii	Xantus swimming crab	14	0.077
			16	0.155
Unit 3	*Cancer anthonyi*	yellow crab	3	0.002
	Crangon nigromaculata	blackspotted bay shrimp	3	0.005
	Loligo opalescens	California market squid	1	0.033
	Panulirus interruptus	California spiny lobster	1	0.798
	Portunus xantusii	Xantus swimming crab	35	0.162
			43	1.000

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI51**	IM&E Charac. Study Survey		
Start Date:	**December 26, 2006**	Normal Flow Direction		
			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	*Myliobatis californica*	bat ray	1	0.262
	Pleuronichthys ritteri	spotted turbot	1	0.011
	Scorpaenichthys marmoratus	cabezon	1	0.161
	Seriphus politus	queenfish	2	0.004
			5	0.438
Unit 2	*Myliobatis californica*	bat ray	1	0.593
	Scorpaena guttata	California scorpionfish	1	0.002
	Seriphus politus	queenfish	1	0.002
			3	0.597
Unit 3	*Anchoa delicatissima*	slough anchovy	1	0.005
	Engraulis mordax	northern anchovy	5	0.015
	Ophidion scrippsae	basketweave cusk-eel	1	0.055
	Paralichthys californicus	California halibut	1	0.038
	Platyrhinoidis triseriata	thornback	1	0.34
	Seriphus politus	queenfish	19	0.048
			28	0.501
Shellfish				
Unit 1	*Cancer anthonyi*	yellow crab	1	0.002
	Heptacarpus palpator	intertidal coastal shrimp	1	0.001
	Portunus xantusii	Xantus swimming crab	1	0.003
			3	0.006
Unit 2	*Cancer anthonyi*	yellow crab	1	0.002
	Pachygrapsus crassipes	striped shore crab	1	0.001
	Portunus xantusii	Xantus swimming crab	1	0.004
			3	0.007
Unit 3	*Cancer anthonyi*	yellow crab	4	0.006
	Cancer gracilis	graceful crab	1	0.082
	Portunus xantusii	Xantus swimming crab	2	0.028
			7	0.116
Non-Shellfish				
Unit 3	*Polyorchis penicillatus*	red jellyfish	1	0.001
			1	0.001

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**SGSFI52**	IM&E Charac. Study Survey		
Start Date:	**January 2, 2007**	Normal Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
Unit 1	*Seriphus politus*	queenfish	1	0.005
			1	0.005
Unit 2	*Seriphus politus*	queenfish	1	0.004
	Torpedo californica	Pacific electric ray	1	9.100
			2	9.104
Unit 3	*Engraulis mordax*	northern anchovy	1	0.003
	Heterostichus rostratus	giant kelpfish	1	0.002
	Platyrhinoidis triseriata	thornback	1	0.794
	Seriphus politus	queenfish	29	0.146
	Anchoa delicatissima	slough anchovy	1	0.005
	Menticirrhus undulatus	California corbina	1	0.204
			34	1.154
Shellfish				
Unit 1	No Shellfish			
Unit 2	*Cancer anthonyi*	yellow crab	1	0.006
			1	0.006
Unit 3	*Cancer anthonyi*	yellow crab	4	0.008
	Portunus xantusii	Xantus swimming crab	2	0.030
	Panulirus interruptus	California spiny lobster	1	0.056
	Heptacarpus palpator	intertidal coastal shrimp	2	0.001
			9	0.095
Non-Shellfish				
Unit 3	*Hermissenda crassicornis*	hermissenda	4	0.001
	Dendronotus frondosus	leafy dendronotid	51	0.012
			55	0.013

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VCHT1**	Heat Treatment IM Survey
Date:	**October 23, 2006**	Normal Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Atherinops affinis	topsmelt	48	1.507
	Cheilotrema saturnum	black croaker	10	0.407
	Chromis punctipinnis	blacksmith	1	0.001
	Embiotoca jacksoni	black perch	15	0.707
	Engraulis mordax	northern anchovy	81	0.323
	Myliobatis californica	bat ray	2	1.164
	Paralabrax clathratus	kelp bass	3	0.278
	Paralabrax nebulifer	barred sand bass	5	0.811
	Phanerodon furcatus	white seaperch	2	0.025
	Rhacochilus toxotes	rubberlip seaperch	1	0.050
	Sardinops sagax	Pacific sardine	607	16.407
	Scomber japonicus	Pacific chub mackerel	2	0.197
	Scorpaena guttata	California scorpionfish	3	0.943
	Scorpaenichthys marmoratus	cabezon	1	0.122
	Seriphus politus	queenfish	121	0.576
	Torpedo californica	Pacific electric ray	1	8.600
	Trachurus symmetricus	jack mackerel	1	0.024
	Urobatis halleri	round stingray	1	1.095
	Xenistius californiensis	salema	106	0.242
			1011	33.479
Shellfish	*Heptacarpus palpator*	intertidal coastal shrimp	2	0.002
	Lysmata californica	red rock shrimp	2	0.002
	Oct. bimaculatus/bimaculoides	California two-spot octopus	4	1.201
	Panulirus interruptus	California spiny lobster	8	4.556
	Portunus xantusii	Xantus swimming crab	3	0.047
			19	5.808

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VCHT2**	Heat Treatment IM Survey		
Date:	**November 9, 2006**	Reverse Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	7	0.029
	Anisotremus davidsonii	sargo	3	0.027
	Atherinops affinis	topsmelt	313	9.893
	Atherinopsis californiensis	jacksmelt	163	19.367
	Atractoscion nobilis	white seabass	3	0.087
	Cheilotrema saturnum	black croaker	5	0.461
	Citharichthys stigmaeus	speckled sanddab	3	0.019
	Cymatogaster aggregata	shiner perch	42	0.656
	Embiotoca jacksoni	black perch	7	0.809
	Engraulis mordax	northern anchovy	48	0.270
	Heterodontus francisci	horn shark	2	3.739
	Heterostichus rostratus	giant kelpfish	5	0.036
	Hyperprosopon argenteum	walleye surfperch	3	0.114
	Leuresthes tenuis	California grunion	2	0.008
	Menticirrhus undulatus	California corbina	2	0.488
	Myliobatis californica	bat ray	160	135.245
	Oxyjulis californica	senorita	2	0.039
	Paralabrax clathratus	kelp bass	12	0.109
	Paralabrax nebulifer	barred sand bass	5	0.710
	Paralichthys californicus	California halibut	3	0.065
	Phanerodon furcatus	white seaperch	32	1.394
	Pleuronichthys ritteri	spotted turbot	34	0.270
	Rhacochilus toxotes	rubberlip seaperch	5	0.360
	Rhacochilus vacca	pile perch	10	0.665
	Sardinops sagax	Pacific sardine	187443	6405.88
	Scomber japonicus	Pacific chub mackerel	124	9.893
	Scorpaena guttata	California scorpionfish	5	0.286
	Scorpaenichthys marmoratus	cabezon	3	0.559
	Sebastes auriculatus	brown rockfish	2	0.702
	Seriphus politus	queenfish	326	2.364
	Sphyraena argentea	Pacific barracuda	2	0.092
	Trachurus symmetricus	jack mackerel	10	0.325
	Urobatis halleri	round stingray	10	4.523
	Xenistius californiensis	salema	94	0.398
			188890	6599.882
Shellfish	*Cancer antennarius*	Pacific rock crab	2	0.236
	Cancer anthonyi	yellow crab	3	0.010
	Oct. bimaculatus/bimaculoides	California two-spot octopus	7	1.875
	Panulirus interruptus	California spiny lobster	37	14.926
	Portunus xantusii	Xantus swimming crab	10	0.161
	Pugettia producta	northern kelp crab	7	0.042
			66	17.25

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VCHT3**	Heat Treatment IM Survey		
Date:	**November 20, 2006**	Normal Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	2	0.009
	Anisotremus davidsonii	sargo	3	0.024
	Atherinops affinis	topsmelt	95	2.732
	Atherinopsis californiensis	jacksmelt	2	0.295
	Cheilotrema saturnum	black croaker	9	0.375
	Chromis punctipinnis	blacksmith	1	0.055
	Citharichthys stigmaeus	speckled sanddab	1	0.029
	Cymatogaster aggregata	shiner perch	2	0.023
	Embiotoca jacksoni	black perch	5	0.275
	Engraulis mordax	northern anchovy	7	0.033
	Genyonemus lineatus	white croaker	1	0.075
	Heterostichus rostratus	giant kelpfish	1	0.004
	Myliobatis californica	bat ray	1	0.232
	Paralabrax clathratus	kelp bass	8	0.685
	Paralabrax nebulifer	barred sand bass	7	1.794
	Paralichthys californicus	California halibut	1	0.027
	Phanerodon furcatus	white seaperch	2	0.058
	Pleuronichthys ritteri	spotted turbot	1	0.034
	Rhacochilus toxotes	rubberlip seaperch	3	0.218
	Rhacochilus vacca	pile perch	6	0.460
	Sardinops sagax	Pacific sardine	34	0.879
	Scomber japonicus	Pacific chub mackerel	20	1.433
	Scorpaenichthys marmoratus	cabezon	1	0.156
	Seriphus politus	queenfish	136	0.769
	Xenistius californiensis	salema	46	0.136
			395	10.810
Shellfish	*Lysmata californica*	red rock shrimp	1	0.002
	Oct. bimaculatus/bimaculoides	California two-spot octopus	3	1.861
	Panulirus interruptus	California spiny lobster	1	0.354
			5	2.217
Non-Shellfish	*Pisaster brevispinus*	short-spined sea star	1	0.021
			1	0.021

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VCHT4**	Heat Treatment IM Survey		
Date:	**December 4, 2006**	Reverse Flow Direction		

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Anchoa compressa	deepbody anchovy	7	0.035
	Atherinops affinis	topsmelt	2	0.056
	Atherinopsis californiensis	jacksmelt	81	7.677
	Atractoscion nobilis	white seabass	16	0.565
	Cheilotrema saturnum	black croaker	3	0.067
	Chromis punctipinnis	blacksmith	3	0.105
	Embiotoca jacksoni	black perch	3	0.292
	Engraulis mordax	northern anchovy	19	0.065
	Heterostichus rostratus	giant kelpfish	4	0.127
	Hyperprosopon argenteum	walleye surfperch	23	0.980
	Myliobatis californica	bat ray	31	15.44
	Paralabrax clathratus	kelp bass	7	0.485
	Paralabrax nebulifer	barred sand bass	3	0.225
	Phanerodon furcatus	white seaperch	5	0.515
	Platyrhinoidis triseriata	thornback	9	2.749
	Pleuronichthys ritteri	spotted turbot	7	0.081
	Rhacochilus toxotes	rubberlip seaperch	3	0.190
	Sardinops sagax	Pacific sardine	269358	4385.444
	Scomber japonicus	Pacific chub mackerel	388	24.482
	Scorpaenichthys marmoratus	cabezon	3	0.072
	Sebastes auriculatus	brown rockfish	2	1.591
	Seriphus politus	queenfish	352	2.909
	Sphyraena argentea	Pacific barracuda	8	0.403
	Trachurus symmetricus	jack mackerel	21	0.872
	Umbrina roncador	yellowfin croaker	13	0.736
	Xenistius californiensis	salema	44	0.940
			270415	4447.103
Shellfish	*Cancer anthonyi*	yellow crab	1	0.019
	Oct. bimaculatus/bimaculoides	California two-spot octopus	4	1.603
	Pachygrapsus crassipes	striped shore crab	1	0.008
	Panulirus interruptus	California spiny lobster	7	2.812
	Portunus xantusii	Xantus swimming crab	4	0.047
			17	4.489

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VCHT5**	Heat Treatment IM Survey
Date:	**December 11, 2006**	Reverse Flow Direction

			Survey Totals	
Fish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Amphistichus argenteus	barred surfperch	1	0.046
	Anchoa compressa	deepbody anchovy	119	0.899
	Anisotremus davidsonii	sargo	12	0.106
	Atherinops affinis	topsmelt	12829	354.400
	Atherinopsis californiensis	jacksmelt	4935	531.600
	Atractoscion nobilis	white seabass	8	0.756
	Citharichthys stigmaeus	speckled sanddab	11	0.113
	Engraulis mordax	northern anchovy	105	0.324
	Genyonemus lineatus	white croaker	33	2.021
	Heterostichus rostratus	giant kelpfish	1	0.018
	Hyperprosopon argenteum	walleye surfperch	32	2.177
	Leuresthes tenuis	California grunion	8	0.146
	Medialuna californiensis	halfmoon	1	0.228
	Menticirrhus undulatus	California corbina	11	1.857
	Myliobatis californica	bat ray	24	19.166
	Ophichthus zophochir	yellow snake eel	1	0.136
	Paralabrax nebulifer	barred sand bass	9	0.811
	Paralichthys californicus	California halibut	5	1.657
	Peprilus simillimus	Pacific pompano	18	0.661
	Phanerodon furcatus	white seaperch	1	0.026
	Platyrhinoidis triseriata	thornback	1	0.918
	Pleuronichthys ritteri	spotted turbot	17	1.259
	Rhacochilus toxotes	rubberlip seaperch	1	0.066
	Sardinops sagax	Pacific sardine	41753	886.000
	Scomber japonicus	Pacific chub mackerel	212	17.569
	Scorpaena guttata	California scorpionfish	3	0.664
	Seriphus politus	queenfish	268	11.819
	Sphyraena argentea	Pacific barracuda	11	0.817
	Syngnathus sp	pipefish, unid.	6	0.027
	Trachurus symmetricus	jack mackerel	45	3.016
	Umbrina roncador	yellowfin croaker	15	0.814
	Urobatis halleri	round stingray	1	0.413
	Xenistius californiensis	salema	24	0.496
			60521	1841.026
Shellfish	*Cancer anthonyi*	yellow crab	5	0.034
	Farfantepenaeus californiensis	yellowleg shrimp	2	0.078
	Oct. bimaculatus/bimaculoides	California two-spot octopus	5	1.426
	Panulirus interruptus	California spiny lobster	8	2.481
	Portunus xantusii	Xantus swimming crab	7	0.066
			27	4.085

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey: **VCHT6** Heat Treatment IM Survey
Date: **January 3, 2006** Normal Flow Direction

Fish	Taxon	Common Name	Survey Totals Abundance	Survey Totals Biomass (kg)
	Anchoa compressa	deepbody anchovy	190	1.153
	Anisotremus davidsonii	sargo	7	0.066
	Atherinops affinis	topsmelt	186	6.02
	Atherinopsis californiensis	jacksmelt	249	24.784
	Atractoscion nobilis	white seabass	15	1.14
	Cheilotrema saturnum	black croaker	19	1.272
	Chromis punctipinnis	blacksmith	4	0.145
	Cymatogaster aggregata	shiner perch	1	0.015
	Embiotoca jacksoni	black perch	2	0.438
	Engraulis mordax	northern anchovy	1222	4.333
	Genyonemus lineatus	white croaker	103	11.156
	Gibbonsia elegans	spotted kelpfish	1	0.007
	Heterodontus francisci	horn shark	1	1.442
	Heterostichus rostratus	giant kelpfish	2	0.024
	Hyperprosopon argenteum	walleye surfperch	37	2.127
	Hypsoblennius gilberti	rockpool blenny	4	0.04
	Hypsoblennius jenkinsi	mussel blenny	2	0.007
	Leptocottus armatus	Pacific staghorn sculpin	2	0.058
	Leuresthes tenuis	California grunion	3	0.07
	Menticirrhus undulatus	California corbina	8	0.887
	Myliobatis californica	bat ray	5	4.004
	Oxylebius pictus	painted greenling	1	0.021
	Paralabrax clathratus	kelp bass	11	0.821
	Paralabrax nebulifer	barred sand bass	11	1.157
	Peprilus simillimus	Pacific pompano	198	6.197
	Phanerodon furcatus	white seaperch	7	0.577
	Platyrhinoidis triseriata	thornback	8	5.408
	Pleuronichthys ritteri	spotted turbot	8	0.094
	Pleuronichthys verticalis	hornyhead turbot	1	0.084
	Rathbunella alleni	stripefin ronquil	1	0.003
	Rhacochilus toxotes	rubberlip seaperch	9	2.148
	Rhacochilus vacca	pile perch	2	0.127
	Sardinops sagax	Pacific sardine	189	5.851
	Scomber japonicus	Pacific chub mackerel	7	0.532
	Scorpaena guttata	California scorpionfish	13	0.169
	Scorpaenichthys marmoratus	cabezon	6	1.111
	Seriphus politus	queenfish	8165	147.418
	Sphyraena argentea	Pacific barracuda	1	0.045
	Trachurus symmetricus	jack mackerel	13	0.437
	Umbrina roncador	yellowfin croaker	24	1.075
	Urobatis halleri	round stingray	10	3.766
	Xenistius californiensis	salema	64	0.263
			10812	236.492

Scattergood Generating Station – Velocity Cap Study Impingement Data

Survey:	**VCHT6 (Cont.)**	Heat Treatment IM Survey
Date:	**January 3, 2006**	Normal Flow Direction

			Survey Totals	
Shellfish	**Taxon**	**Common Name**	**Abundance**	**Biomass (kg)**
	Cancer antennarius	Pacific rock crab	4	0.028
	Cancer anthonyi	yellow crab	8	0.045
	Cancer gracilis	graceful crab	2	0.005
	Cancer jordani	hairy rock crab	2	0.008
	Heptacarpus palpator	intertidal coastal shrimp	2	0.002
	Lysmata californica	red rock shrimp	13	0.024
	Oct. bimaculatus/bimaculoides	California two-spot octopus	9	3.064
	Panulirus interruptus	California spiny lobster	14	4.233
	Portunus xantusii	Xantus swimming crab	15	0.081
	Pugettia producta	northern kelp crab	4	0.022
			73	7.512
Non-Shellfish	*Navanax inermis*	California aglaja	6	0.024
			6	0.024

Length Frequency Distribution of Pacific Sardine at SGS during the Velocity Cap Effectiveness Study

	Number of Individuals Measured		
Length Midpoint (mm SL)	**Velocity Cap (Normal Flow)**	**No Velocity Cap (Reverse Flow)**	**Total**
30	0	1	1
40	2	3	5
50	3	12	15
60	0	4	4
70	2	0	2
80	3	8	11
90	14	132	146
100	62	740	802
110	125	2105	2230
120	161	1620	1781
130	150	1176	1326
140	204	1735	1939
150	125	2317	2442
160	18	469	487
170	1	29	30
180	2	12	14
190	0	3	3
200	0	4	4
Total	872	10370	11242

Length Frequency Distribution of Topsmelt at SGS during the Velocity Cap Effectiveness Study

	Number of Individuals Measured		
Length Midpoint (mm SL)	**Velocity Cap (Normal Flow)**	**No Velocity Cap (Reverse Flow)**	**Total**
60	1	0	1
70	3	0	3
80	1	0	1
90	2	0	2
100	3	12	15
110	87	87	174
120	280	189	469
130	251	172	423
140	224	202	426
150	143	135	278
160	31	57	88
170	13	14	27
180	12	1	13
190	10	3	13
200	5	0	5
210	10	0	10
220	5	0	5
230	8	0	8
240	11	0	11
250	4	0	4
260	2	0	2
270	1	0	1
280	1	0	1
290	1	0	1
Total	1109	872	1981

Length Frequency Distribution of Jacksmelt at SGS during the Velocity Cap Effectiveness Study

	Number of Individuals Measured		
Length Midpoint (mm SL)	**Velocity Cap (Normal Flow)**	**No Velocity Cap (Reverse Flow)**	**Total**
70	1	0	1
80	0	0	0
90	1	0	1
100	1	1	2
110	0	0	0
120	4	5	9
130	14	8	22
140	19	8	27
150	24	25	49
160	18	41	59
170	33	30	63
180	46	44	90
190	84	53	137
200	114	79	193
210	130	80	210
220	139	102	241
230	101	73	174
240	57	65	122
250	28	35	63
260	13	19	32
270	7	9	16
280	2	5	7
290	2	4	6
300	1	0	1
310	0	0	0
320	0	1	1
Total	839	687	1526

Length Frequency Distribution of Queenfish at SGS during the Velocity Cap Effectiveness Study

Length Midpoint (mm SL)	Number of Individuals Measured		
	Velocity Cap (Normal Flow)	No Velocity Cap (Reverse Flow)	Total
20	1	0	1
30	20	1	21
40	106	17	123
50	253	139	392
60	338	174	512
70	216	186	402
80	137	108	245
90	23	51	74
100	20	20	40
110	45	42	87
120	86	84	170
130	86	97	183
140	44	48	92
150	18	16	34
160	9	11	20
170	6	3	9
180	0	1	1
Total	1408	998	2406

Impingement Rates during 24-hr Velocity Cap and IM&E Impingement Surveys

Date	Flow Direction	*All Fishes* No./10⁶ m³	*All Fishes* Kg/10⁶ m³	*Pacific sardine* No./10⁶ m³	*Pacific sardine* Kg/10⁶ m³	*Topsmelt* No./10⁶ m³	*Topsmelt* Kg/10⁶ m³
10/12/2006	Normal	3.067	0.091	0.000	0.000	1.533	0.047
10/13/2006	Normal	2.015	4.022	0.000	0.000	1.343	0.019
10/16/2006	Normal	0.823	0.178	0.274	0.005	0.274	0.007
10/17/2006	Normal	1.506	4.727	0.000	0.000	0.000	0.000
10/18/2006	Normal	0.851	0.493	0.000	0.000	0.000	0.000
10/19/2006	Normal	0.894	0.027	0.000	0.000	0.000	0.000
10/20/2006	Normal	0.000	0.000	0.000	0.000	0.000	0.000
10/23/2006	Normal	3.633	3.285	0.000	0.000	0.000	0.000
10/24/2006	Reverse	503.021	10.719	459.885	8.679	9.740	0.292
10/25/2006	Reverse	972.576	28.735	964.018	28.200	0.000	0.000
10/26/2006	Reverse	5773.356	168.150	5766.075	166.647	0.809	0.020
10/27/2006	Reverse	1608.574	42.428	1594.848	41.386	2.574	0.069
10/30/2006	Reverse	3133.989	61.075	3129.823	60.602	2.604	0.042
10/31/2006	Reverse	720.555	19.371	717.921	19.097	0.000	0.000
11/1/2006	Reverse	412.333	13.900	408.684	12.177	0.730	0.020
11/2/2006	Reverse	303.044	10.158	298.201	9.302	0.000	0.000
11/3/2006	Reverse	775.868	24.727	756.075	24.001	0.990	0.017
11/6/2006	Reverse	587.105	22.176	569.650	16.994	0.000	0.000
11/7/2006	Reverse	242.443	11.360	231.232	6.664	0.000	0.000
11/8/2006	Reverse	910.226	35.915	896.862	29.707	0.000	0.000
11/9/2006	Reverse	1251.413	40.818	1228.473	38.225	0.000	0.000
11/10/2006	Normal	506.279	106.909	64.938	9.406	303.046	7.520
11/13/2006	Normal	60.735	7.578	25.833	0.609	0.000	0.000
11/14/2006	Normal	2.133	3.215	0.711	0.026	0.000	0.000
11/15/2006	Normal	2.297	2.385	0.000	0.000	0.000	0.000
11/16/2006	Normal	1.714	0.666	0.000	0.000	0.000	0.000
11/17/2006	Normal	0.000	0.000	0.000	0.000	0.000	0.000
11/20/2006	Normal	1.240	1.542	0.248	0.010	0.248	0.004
11/21/2006	Reverse	111.873	4.905	17.869	0.386	44.283	1.231
11/22/2006	Reverse	353.257	7.244	342.263	6.862	0.000	0.000
11/27/2006	Reverse	2513.806	32.006	2513.461	31.972	0.000	0.000
11/28/2006	Reverse	5485.160	72.288	5472.921	71.324	0.000	0.000
11/29/2006	Reverse	2429.700	40.223	2373.555	38.626	2.807	0.024
11/30/2006	Reverse	1676.951	25.129	1599.099	22.757	11.365	0.380
12/1/2006	Reverse	479.358	7.144	446.661	6.007	11.094	0.380
12/4/2006	Reverse	1351.215	18.193	1337.159	16.100	1.591	0.066
12/5/2006	Reverse	20976.317	395.791	20912.712	391.291	0.000	0.000
12/6/2006	Reverse	1528.070	28.531	1520.763	27.912	0.000	0.000
12/7/2006	Reverse	17758.572	448.777	17716.822	445.749	0.000	0.000
12/8/2006	Reverse	2444.189	48.740	2401.405	44.797	0.000	0.000
12/11/2006	Reverse	87.836	4.630	73.869	1.308	0.000	0.000
12/12/2006	Normal	3968.044	200.676	2127.792	39.774	722.443	19.743
12/13/2006	Normal	525.009	22.042	84.850	1.798	43.309	1.312
12/14/2006	Normal	266.389	8.388	58.676	1.030	28.165	0.633
12/15/2006	Normal	294.473	17.879	17.811	0.365	11.874	0.294

Date	Flow Direction	All Fishes No./10^6 m^3	All Fishes Kg/10^6 m^3	Pacific sardine No./10^6 m^3	Pacific sardine Kg/10^6 m^3	Topsmelt No./10^6 m^3	Topsmelt Kg/10^6 m^3
12/18/2006	Normal	4.731	0.074	1.262	0.023	0.000	0.000
12/19/2006	Normal	10.946	0.160	3.649	0.072	0.000	0.000
12/20/2006	Normal	87.003	3.038	2.657	0.037	1.328	0.012
12/21/2006	Normal	77.993	0.428	2.836	0.042	0.000	0.000
12/22/2006	Normal	24.727	0.425	1.545	0.031	0.000	0.000
12/26/2006	Normal	18.501	7.501	1.005	0.020	1.005	0.016
12/27/2006	Normal	26.645	1.137	0.000	0.000	0.000	0.000
12/28/2006	Normal	122.763	6.910	0.000	0.000	0.000	0.000
12/29/2006	Normal	79.739	50.949	0.000	0.000	1.505	0.029
1/2/2007	Normal	5.585	9.478	0.180	0.002	0.000	0.000
1/3/2007	Normal	30.300	8.185	0.000	0.000	0.000	0.000

Impingement Rates during 24-hr Velocity Cap and IM&E Impingement Surveys

		Queenfish		*Jacksmelt*	
Date	Flow Direction	No./10^6 m^3	Kg/10^6 m^3	No./10^6 m^3	Kg/10^6 m^3
10/12/2006	Normal	0.000	0.000	0.767	0.040
10/13/2006	Normal	0.000	0.000	0.000	0.000
10/16/2006	Normal	0.000	0.000	0.000	0.000
10/17/2006	Normal	0.000	0.000	0.000	0.000
10/18/2006	Normal	0.000	0.000	0.000	0.000
10/19/2006	Normal	0.000	0.000	0.000	0.000
10/20/2006	Normal	0.000	0.000	0.000	0.000
10/23/2006	Normal	0.000	0.000	0.000	0.000
10/24/2006	Reverse	4.870	0.030	0.000	0.000
10/25/2006	Reverse	3.112	0.005	0.000	0.000
10/26/2006	Reverse	2.427	0.010	0.000	0.000
10/27/2006	Reverse	2.574	0.004	0.000	0.000
10/30/2006	Reverse	0.000	0.000	0.000	0.000
10/31/2006	Reverse	1.976	0.007	0.000	0.000
11/1/2006	Reverse	0.730	0.003	0.000	0.000
11/2/2006	Reverse	1.384	0.002	0.000	0.000
11/3/2006	Reverse	13.855	0.023	0.990	0.136
11/6/2006	Reverse	8.312	0.015	0.277	0.029
11/7/2006	Reverse	4.905	0.005	0.000	0.000
11/8/2006	Reverse	5.939	0.012	0.000	0.000
11/9/2006	Reverse	7.910	0.021	0.000	0.000
11/10/2006	Normal	4.810	0.018	57.723	5.362
11/13/2006	Normal	0.000	0.000	0.000	0.000
11/14/2006	Normal	0.000	0.000	0.711	0.062
11/15/2006	Normal	0.000	0.000	0.000	0.000
11/16/2006	Normal	0.000	0.000	0.000	0.000
11/17/2006	Normal	0.000	0.000	0.000	0.000
11/20/2006	Normal	0.000	0.000	0.248	0.030
11/21/2006	Reverse	7.769	0.030	1.554	0.148
11/22/2006	Reverse	2.199	0.009	4.397	0.223
11/27/2006	Reverse	0.000	0.000	0.000	0.000
11/28/2006	Reverse	0.000	0.000	1.596	0.117
11/29/2006	Reverse	24.564	0.088	12.633	0.359
11/30/2006	Reverse	10.797	0.062	0.000	0.000
12/1/2006	Reverse	2.919	0.007	0.000	0.000
12/4/2006	Reverse	3.182	0.010	3.713	0.167
12/5/2006	Reverse	1.927	0.007	6.746	0.529
12/6/2006	Reverse	1.827	0.006	0.913	0.044
12/7/2006	Reverse	0.000	0.000	4.514	0.229
12/8/2006	Reverse	2.760	0.049	4.830	0.415
12/11/2006	Reverse	1.241	0.015	1.862	0.209
12/12/2006	Normal	35.942	1.174	984.822	101.156
12/13/2006	Normal	106.062	0.704	201.519	16.395
12/14/2006	Normal	86.841	0.333	51.635	5.746
12/15/2006	Normal	90.836	0.458	21.967	2.461
12/18/2006	Normal	1.262	0.011	0.000	0.000

		Queenfish		*Jacksmelt*	
Date	**Flow Direction**	**No./10^6 m^3**	**Kg/10^6 m^3**	**No./10^6 m^3**	**Kg/10^6 m^3**
12/19/2006	Normal	2.736	0.011	0.000	0.000
12/20/2006	Normal	35.864	0.092	0.000	0.000
12/21/2006	Normal	27.652	0.072	0.000	0.000
12/22/2006	Normal	10.818	0.024	0.000	0.000
12/26/2006	Normal	5.430	0.079	0.201	0.022
12/27/2006	Normal	16.283	0.040	0.000	0.000
12/28/2006	Normal	40.921	0.152	0.000	0.000
12/29/2006	Normal	27.081	0.173	0.000	0.000
1/2/2007	Normal	1.801	0.008	0.000	0.000
1/3/2007	Normal	25.516	0.125	0.000	0.000

Impingement Rates during Each of the Flow Periods

		All Fishes		*Pacific sardine*		*Topsmelt*	
Period	**End Date**	**No./10^6 m^3**	**Kg/10^6 m^3**	**No./10^6 m^3**	**Kg/10^6 m^3**	**No./10^6 m^3**	**Kg/10^6 m^3**
N_1	10/23/2006	62.324	3.099	36.129	0.980	4.257	0.130
R_1	11/9/2006	9884.698	333.665	9807.305	322.692	15.407	0.477
N_2	11/20/2006	76.422	10.329	13.392	0.800	25.329	0.655
R_2	12/11/2006	14613.188	274.446	13884.577	236.622	459.135	12.693
N_3	1/3/2007	554.359	22.272	74.003	1.470	30.456	0.860

		Queenfish		*Jacksmelt*	
Period	**End Date**	**No./10^6 m^3**	**Kg/10^6 m^3**	**No./10^6 m^3**	**Kg/10^6 m^3**
N_1	10/23/2006	7.155	0.034	0.118	0.005
R_1	11/9/2006	18.775	0.116	7.411	0.881
N_2	11/20/2006	10.190	0.057	3.785	0.361
R_2	12/11/2006	25.411	0.539	180.432	19.279
N_3	1/3/2007	302.200	5.184	47.205	4.680

Macroinvertebrate Abundance By Species and Survey Period
(IM&E Characterization Study, Velocity Cap, and Heat Treatment Surveys)

Taxon	Common Name	Survey Period					Total	Percent
		N_1	R_1	N_2	R_2	N_3		
Portunus xantusii	Xantus swimming crab	17	22	267	47	48	401	38.12
Crangon nigromaculata	blackspotted bay shrimp	-	-	144	-	2	146	13.88
Panulirus interruptus	California spiny lobster	20	6	18	40	18	102	9.70
Cancer anthonyi	yellow crab	-	-	51	30	12	93	8.84
Dendronotus frondosus	leafy dendronotid	-	-	54	-	-	54	5.13
Octopus bimaculatus/bimaculoides	California two-spot octopus	6	4	15	8	12	45	4.28
Cancer antennarius	Pacific rock crab	2	1	15	10	6	34	3.23
Cancer jordani	hairy rock crab	-	-	7	14	3	24	2.28
Pugettia producta	northern kelp crab	-	1	8	14	1	24	2.28
Lysmata californica	red rock shrimp	5	1	15	-	2	23	2.19
Blepharipoda occidentalis	spiny mole crab	-	-	5	-	15	20	1.90
Pachygrapsus crassipes	striped shore crab	4	3	3	2	4	16	1.52
Pachycheles rudis	thick claw porcelain crab	-	8	1	-	-	9	0.86
Cancer gracilis	graceful crab	-	-	6	2	-	8	0.76
Heptacarpus palpator	intertidal coastal shrimp	2	-	6	-	-	8	0.76
Hermissenda crassicornis	hermissenda	-	-	7	-	-	7	0.67
Navanax inermis	California aglaja	-	-	6	1	-	7	0.67
Loligo opalescens	California market squid	-	-	2	-	3	5	0.48
Farfantepenaeus californiensis	yellowleg shrimp	-	-	-	-	3	3	0.29
Polyorchis penicillatus	red jellyfish	-	-	2	-	1	3	0.29
Strongylocentrotus purpuratus	purple sea urchin	-	-	-	-	3	3	0.29
Cancer productus	red rock crab	-	-	1	-	1	2	0.19
Caudina arenicola	sweet potatoe sea cucumber	-	-	2	-	-	2	0.19
Lophopanopeus bellus	blackclaw crestleg crab	-	1	-	-	1	2	0.19
Octopus rubescens	East Pacific red octopus	-	-	2	-	-	2	0.19
Cancer amphioetus	bigtooth rock crab	1	-	-	-	-	1	0.10
Dendraster excentricus	Pacific sand dollar	-	-	1	-	-	1	0.10

Taxon	Common Name	Survey Period					Total	Percent
		N_1	R_1	N_2	R_2	N_3		
Dendronotus sp	dendronotid nudibranch	1	-	-	-	-	1	0.10
Lepidopa californica	California mole crab	-	-	1	-	-	1	0.10
Lytechinus pictus	white sea urchin	-	-	-	1	-	1	0.10
Pisaster brevispinus	short-spined sea star	-	1	-	-	-	1	0.10
Pisaster ochraceus	ochre star	-	-	-	-	1	1	0.10
Podochela hemphill	hemphill kelp crab	-	-	-	1	-	1	0.10
Pyromaia tuberculata	tuberculate pear crab	-	-	-	-	1	1	0.10
	Total Macroinvertebrates	**58**	**48**	**639**	**170**	**137**	**1,052**	**100.00**
	Total Taxa	**9**	**10**	**24**	**12**	**19**	**34**	
	Period Volume (m^3)	**16,911,607**	**22,263,200**	**13,739,444**	**28,176,876**	**29,255,423**	**110,346,550**	

Macroinvertebrate Biomass (kg) By Species and Survey Period
(IM&E Characterization Study, Velocity Cap, and Heat Treatment Surveys)

		Survey Period						
Taxon	**Common Name**	N_1	R_1	N_2	R_2	N_3	**Total**	**Percent**
Panulirus interruptus	California spiny lobster	14.387	4.984	5.866	18.708	6.299	50.244	70.23
Octopus bimaculatus/bimaculoides	California two-spot octopus	1.496	2.471	4.227	2.013	4.969	15.176	21.21
Portunus xantusii	Xantus swimming crab	0.245	0.172	1.723	0.612	0.404	3.156	4.41
Cancer antennarius	Pacific rock crab	0.006	0.003	0.244	0.730	0.021	1.004	1.40
Blepharipoda occidentalis	spiny mole crab	-	-	0.073	-	0.368	0.441	0.62
Cancer anthonyi	yellow crab	-	-	0.159	0.055	0.067	0.281	0.39
Crangon nigromaculata	blackspotted bay shrimp	-	-	0.207	-	0.002	0.209	0.29
Pugettia producta	northern kelp crab	-	0.073	0.031	0.084	0.005	0.193	0.27
Cancer gracilis	graceful crab	-	-	0.091	0.071	-	0.162	0.23
Octopus rubescens	East Pacific red octopus	-	-	0.148	-	-	0.148	0.21
Loligo opalescens	California market squid	-	-	0.056	-	0.068	0.124	0.17
Farfantepenaeus californiensis	yellowleg shrimp	-	-	-	-	0.100	0.100	0.14
Pachygrapsus crassipes	striped shore crab	0.007	0.021	0.005	0.003	0.032	0.068	0.10
Cancer jordani	hairy rock crab	-	-	0.024	0.016	0.003	0.043	0.06
Lysmata californica	red rock shrimp	0.005	0.002	0.027	-	0.003	0.037	0.05
Navanax inermis	California aglaja	-	-	0.024	0.001	-	0.025	0.03
Caudina arenicola	sweet potatoe sea cucumber	-	-	0.022	-	-	0.022	0.03
Pisaster ochraceus	ochre star	-	-	-	-	0.022	0.022	0.03
Pisaster brevispinus	short-spined sea star	-	0.021	-	-	-	0.021	0.03
Dendronotus frondosus	leafy dendronotid	-	-	0.013	-	-	0.013	0.02
Pachycheles rudis	thick claw porcelain crab	-	0.008	0.002	-	-	0.010	0.01
Dendraster excentricus	Pacific sand dollar	-	-	0.008	-	-	0.008	0.01
Polyorchis penicillatus	red jellyfish	-	-	0.005	-	0.003	0.008	0.01
Heptacarpus palpator	intertidal coastal shrimp	0.002	-	0.005	-	-	0.007	0.01
Strongylocentrotus purpuratus	purple sea urchin	-	-	-	-	0.005	0.005	0.01
Cancer productus	red rock crab	-	-	0.001	-	0.003	0.004	0.01
Lophopanopeus bellus	blackclaw crestleg crab	-	0.002	-	-	0.001	0.003	0.00

Taxon	Common Name	Survey Period N_1	R_1	N_2	R_2	N_3	Total	Percent
Dendronotus sp	dendronotid nudibranch	0.002	-	-	-	-	0.002	0.00
Hermissenda crassicornis	hermissenda	-	-	0.002	-	-	0.002	0.00
Lepidopa californica	California mole crab	-	-	0.002	-	-	0.002	0.00
Cancer amphioetus	bigtooth rock crab	0.001	-	-	-	-	0.001	0.00
Lytechinus pictus	white sea urchin	-	-	-	0.001	-	0.001	0.00
Podochela hemphill	hemphill kelp crab	-	-	-	0.001	-	0.001	0.00
Pyromaia tuberculata	tuberculate pear crab	-	-	-	-	0.001	0.001	0.00
	Total Biomass (kg)	**16.151**	**7.757**	**12.965**	**22.295**	**12.376**	**71.544**	**100.00**
	Total Taxa	**9**	**10**	**24**	**12**	**19**	**34**	
	Period Volume(m^3)	**16,911,607**	**22,263,200**	**13,739,444**	**28,176,876**	**29,255,423**	**110,346,550**	