Environmental
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Technical Memorandum

Marine Life Mortality Comparison between Proposed Screening Location and Lagoon Shoreline Location

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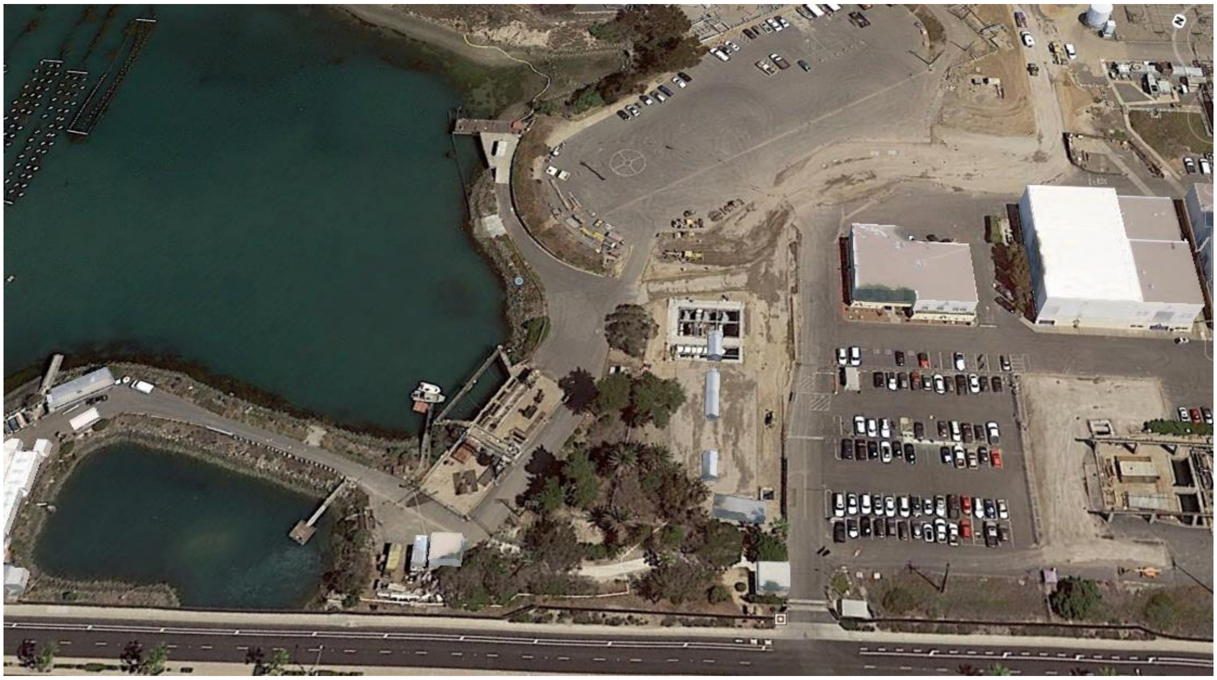

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Introduction

Poseidon Water (Poseidon) has developed a conceptual design for the New Screening/Fish-friendly Pumping Structure that will be implemented when the Carlsbad Desalination Plant (CDP) enters long-term, stand-alone operation after the Encina Power Station's (EPS) once-through cooling system goes offline. At that point, the CDP will become subject to the provisions of Chapter III.M of the Water Quality Control Plan, Ocean Waters of California (Ocean Plan Amendment [OPA]). The long-term, stand-alone CDP's New Screening/Fish-friendly Pumping Structure will use 1-mm modified (referring to the presence of fish protection features) traveling water screens (TWS) located between the existing EPS intake tunnels and the CDP's existing Intake Pump Station (IPS).

During November 2 and December 15 meetings, the State Water Resources Control Board and San Diego Regional Water Quality Control Boards (Boards) asked for additional information to aide in determining the intake configuration that would result in the least intake and mortality of all forms or marine life. In particular, the Boards requested that Poseidon compare the mortality expected with the TWS in the proposed location (onshore) to the mortality expected if the TWS were located at the shoreline of the Agua Hedionda lagoon. Previously, the Boards stated that "Entrapment of marine life may occur in the intake tunnel, if organisms pass through the trash racks at the onset of the tunnel but cannot swim back through them". Therefore, the objective of this technical memorandum (memo) is to compare the intake and mortality of all forms of marine life expected with the TWS in each location.

Existing Regulatory Guidance

Clean Water Act Section 316(b)

The Staff Report/Substitute Environmental Documentation (SED) incorporated, by reference, guidance developed by the U.S. Environmental Protection Agency (EPA). This EPA information was noted as offering helpful guidance with respect to configuration of screening systems to reduce or avoid impingement and entrainment. Substantial research and compliance data have been generated since the original implementation of 316(b) in the U.S. Most recently, in 2014, the EPA released a final Rule implementing section 316(b) of the Clean Water Act (EPA 2014). This Rule was based on years of previous research on impingement, entrainment, and effective cooling water intake structure design. As such, a brief review of key parts of the Rule is provided below as it is germane to the intake impacts being considered at the CDP.

The existing 316(b) Rule offers useful guidance on how existing cooling water intake structures can comply with the impingement mortality standard. Among the seven impingement mortality compliance alternatives allowed, one is by demonstrating that the through-screen velocity (TSV) does not exceed 0.5 ft/sec. This compliance alternative is described in the 2014 Rule (EPA 2014, pg 48325) as follows:

> *EPA has clarified that compliance with a 0.5 fps intake velocity achieves the IM standards. EPA's record shows an intake velocity of 0.5 fps or lower provides similar or greater reductions in impingement, and therefore impingement mortality, than modified traveling screens—the technology forming the basis for the numeric impingement mortality performance standard that is the goal for all facilities. There are two ways to demonstrate compliance using intake velocity. First, an intake with a maximum design intake velocity less than or equal to 0.5 fps is pre-approved BTA for impingement mortality and does not require further monitoring. Alternatively, under a streamlined option, the facility may demonstrate to the Director that the facility meets the velocity requirement through monitoring of the actual intake velocity. Screen velocity can be monitored by direct measurement or by calculation using the volumetric actual intake flow and source water surface elevation.*

Regarding entrapment, the EPA did not include any requirements in the final 2014 Rule. The following was offered by EPA for justification (EPA 2014, pg 48355):

> *EPA agrees that specific entrapment requirements are not necessary and requirements for facilities to deploy technologies to avoid entrapment have been deleted from the final rule. However, a facility that entraps fish must count the entrapped organisms as impingement mortality.*

Since neither the SED nor the OPA offer guidance on the issue of entrapment, it is germane to refer to how the EPA defines entrapment. Entrapment is defined in the final 316(b) Rule (EPA 2014, pg 48431) as follows:

> *Entrapment means the condition where impingeable fish and shellfish lack the means to escape the cooling water intake. Entrapment includes but is not limited to: Organisms caught in the bucket of a traveling screen and unable to reach a fish return; organisms caught in the forebay of a cooling water intake system without any*

> *means of being returned to the source waterbody without experiencing mortality; or cooling water intake systems where the velocities in the intake pipes or in any channels leading to the forebay prevent organisms from being able to return to the source waterbody through the intake pipe or channel.*

Provision of a fish return system (FRS) in the intake system design at the CDP therefore provides a means of egress for collected organisms to return to the Lagoon.

Comparison of Intake Designs

Conceptual Designs

Figure 1 and Figure 2 below depict the general layout of the proposed onshore and Lagoon shoreline locations for the TWS, respectively.

Figure 1. General layout of the CDP with onshore location of the New Screening/Fish-friendly Pumping Structure.

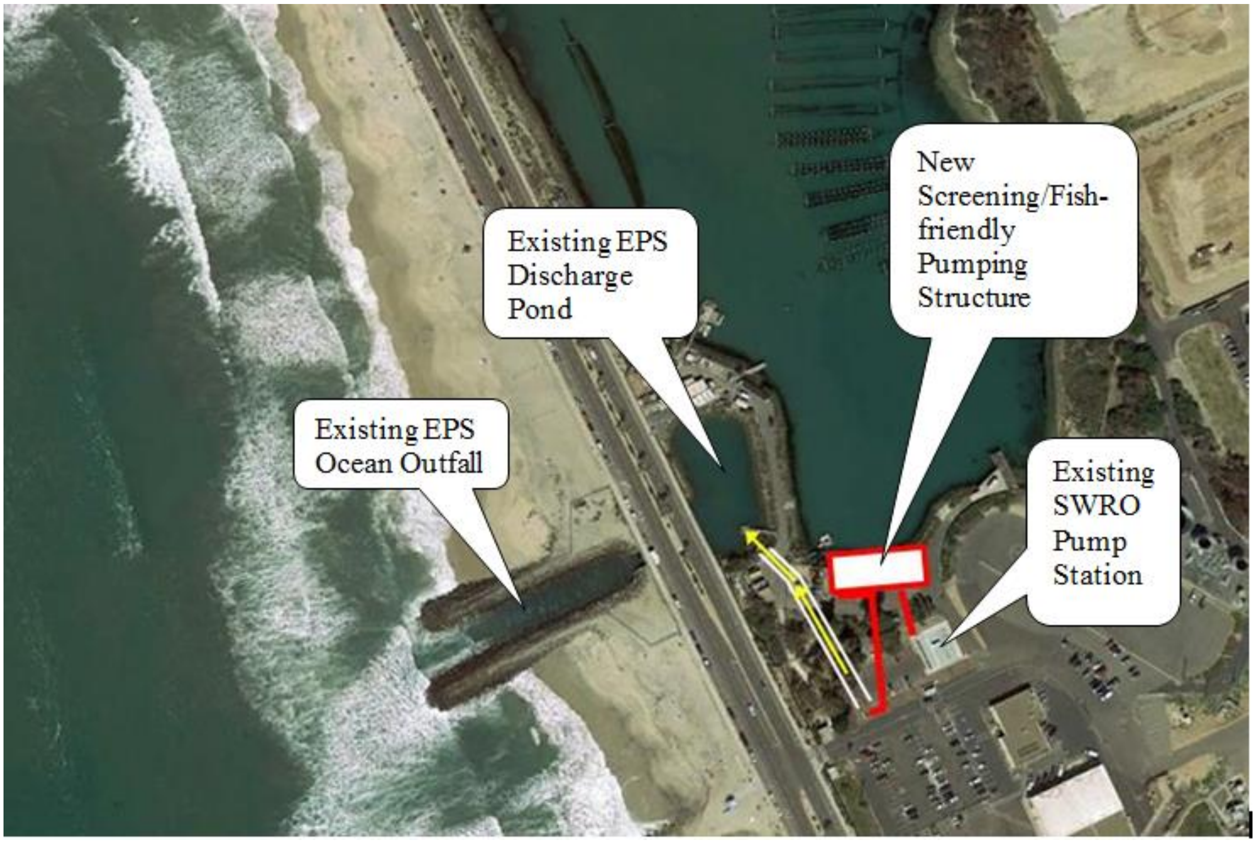

Figure 2. General layout of the CDP with Lagoon shoreline location of the New Screening/Fish-friendly Pumping Structure.

Comparison Method

Operational Impacts - Collection and Return

The first step in evaluating potential mortality associated with different intake configurations is to determine how to parse the ambient organisms into groups. In general, marine organisms can be parsed into those that would be entrained ("entrainables") and those that would be impinged ("impingeables"). Relative to the 316(b) Rule, the EPA categorizes only organisms that would be retained by a 9.5-mm mesh as impingeables. The following excerpt (EPA 2014, pg 48377) expands on this:

> *Because EPA wants to ensure that a facility's monitoring plan is consistent with the technical basis for today's requirements, EPA is requiring facilities to monitor impingement mortality using a sample that has been passed through a sieve or net with no more than 0.56 inches maximum opening, so that only organisms that do not pass through this mesh size are counted. In doing so, facilities would retain (and therefore count) only organisms that would have been impinged on a 3⁄8" mesh*

> *screen, which was the technological basis used for developing the impingement mortality performance standard. Facilities could similarly apply a "hypothetical net" in that they could elect to count only organisms that would not have passed through a net with mesh openings less than 0.56 inches. For example, a facility that uses a fine-mesh screen of 0.5 mm or diverts the flow directly to a sampling bay will need to count only organisms that remain if the flow passed through a net, screen, or debris basket fitted with 3⁄8-inch mesh spacing.*

Eggs and Larvae

Poseidon has assumed that all larval fish will experience 100% mortality. Furthermore, the location of the modified TWS will not change the fact that passive life stages will be entrained and lost; rather, this potential impact is common to both designs. The 100% mortality assumed for the proposed TWS location onshore is the same for the TWS location at the Lagoon shoreline. The 0.5 ft/sec TSV criterion is immaterial since these organisms cannot mount a directional response to the flow velocity. Therefore, for egg and larval stages, there is no difference between intake and mortality of all forms of marine life when considering the location of the TWS.

Juveniles and Adults

When considering organisms that are not passive (i.e., those with a swimming ability), there is a conceptual difference in the potential for mortality between locations. The fates for juvenile and adult fish could vary based on the location of the TWS. Of these larger organisms that could interact with the TWS, impingement, in the typical sense, is a low risk. Since both intake locations would be designed for the same TSV of 0.5 ft/sec or less, impingement on the screen face itself should be very low. As noted in section 8.3.4 of the SED:

> *…the through-screen velocity should not exceed 0.5 ft/sec as it have been demonstrated to protect most small fish and is an appropriate value to preclude most impingement of adult fish.*

The principal difference between locating the TWS on the Lagoon shoreline versus at the proposed onshore location is that the onshore location presents the opportunity for organisms to be exposed to transport through a FRS. Put differently, based on the definition of impingement provided in the SED (see above), at a through-screen velocity of 0.5 ft/sec, most impingement should be precluded. At that velocity, it is likely that the only organisms to be truly impinged against the screen face and collected in a FRS are those that are physiologically compromised. It is more likely that fish that are collected and returned via a FRS have entered the screen's fish bucket volitionally.

By comparison, the Lagoon shoreline location would not require a FRS; rather the Boards have indicated that the passive exclusion of organisms at the withdrawal point would be achieved with the low through-screen velocity.

For juveniles and adults, therefore, the onshore TWS location will have to account for survival of organisms during transport through a FRS; the Lagoon shoreline location will not. An evaluation of the differences in intake and mortality of all forms of marine life therefore requires that we review existing information on the survival of juveniles and adults through a FRS.

Summary of Available Data

Various data sources are available for use in estimating the magnitude and composition of organisms that will likely be transported through a FRS at the stand-alone CDP. These data and reports are described below in greater detail.

Tenera. 2008. Clean Water Act Section 316(b) Impingement Mortality and Entrainment Characterization Study. Effects on the Biological Resources of Agua Hedionda Lagoon and the Nearshore Ocean Environment. Prepared for Cabrillo Power LLC, Encina Power Station.

This report details an impingement and entrainment characterization study conducted originally for compliance with the U.S. Environmental Protection Agency's (EPA) 316(b) regulations. It provides an evaluation of annual impingement and entrainment at the EPS. The maximum flow rate for the EPS with all units in operation is 864 MGD.

The species that are expected to potentially be collected by the TWS and transported by the FRS are those that were previously collected in the impingement sampling conducted at the EPS (Tenera 2008). Table 1 below presents the composition of the dominant species collected in impingement sampling at the EPS in 2004-2005. The species/taxa listed accounted for 96.9% of the total collected during impingement sampling.

Table 1. Dominant species collected in impingement sampling conducted at the Encina Power Station based on the cooling water flows (Tenera 2008).

Species Name	Common Name	Number	% of Total Collected
Atherinops affinis	Topsmelt	5,252	27.0%
Cymatogaster aggregata	Shiner Surfperch	2,827	14.5%
Anchoa compressa	Deepbody Anchovy	2,081	10.7%
Seriphus politus	Queenfish	1,306	6.7%
Xenistius (Haemulon) californiensis	Salema	1,061	5.5%
Anchoa delicatissima	Slough Anchovy	1,056	5.4%
Atherinopsidae	Silverside	999	5.1%
Hyperprosopon argenteum	Walleye Surfperch	606	3.1%
Engraulis mordax	Northern Anchovy	537	2.8%
Leuresthes tenuis	California Grunion	489	2.5%
Heterostichus rostratus	Giant Kelpfish	344	1.8%
Paralabrax maculatofasciatus	Spotted Sand Bass	303	1.6%
Sardinops sagax	Pacific Sardine	268	1.4%
Roncador stearnsii	Spotfin Croaker	184	0.9%
Paralabrax nebulifer	Barred Sand Bass	151	0.8%
Gymnura marmorata	California Butterfly Ray	147	0.8%
Phanerodon furcatus	White Surfperch	144	0.7%
Strongylura exilis	California Needlefish	135	0.7%
Paralabrax clathratus	Kelp Bass	111	0.6%
Porichthys myriaster	Specklefin Midshipman	103	0.5%
unidentified chub	unidentified chub	96	0.5%
Paralichthys californicus	California Halibut	95	0.5%
Anisotremus davidsoni	Sargo	94	0.5%
Urolophus halleri	Round Stingray	79	0.4%
Atractoscion nobilis	White Seabass	76	0.4%
Hypsopsetta (Plueronichthys) guttulata	Diamond Turbot	67	0.3%
Micrometrus minimus	Dwarf Surfperch	57	0.3%
Syngnathus spp.	Pipefishes	55	0.3%
Atherinopsis californiensis	Jacksmelt	54	0.3%
Myliobatis californica	Bat Ray	54	0.3%
Total		**18,831**	**96.9%**

Poseidon. 2009. Attachment 5 – Estimation of the Potential for Impingement Should the CDP Operate in Stand-Alone Mode. Flow, Entrainment, and Impingement Minimization Plan. Carlsbad Desalination Project, San Diego Regional Water Quality Control Board, Region 9, San Diego Region, Oder No. R-9-2006-0065, NPDES No. CA109223.

Attachment 5 to the 2009 Flow, Entrainment, and Impingement Minimization Plan provides an analysis of methods for estimating impingement-related mortalities at the CDP under stand-alone operation. Using a weighted-average, flow-proportioned approach, an estimate of the potential impingement is generated. There are two important notes about this prorated impingement estimate for the CDP:

1. These data include anomalous events that are typically eliminated from other such studies as outliers. During these anomalous events, many freshwater fish were collected in the samples. The collection of freshwater fish at the seawater intake clearly indicates that this is an anomalous event.
2. The nature of impingement at the EPS design flows (higher through-screen velocity) is markedly different from the concept of impingement at the CDP flow (through-screen velocity less than or equal to 0.5 ft/sec). The 0.5-ft/sec velocity was selected to "*to preclude most impingement of adult fish*"

Baseline

Building upon the approach in Attachment 5, data were parsed into flow-related and non flow-related groups. To group taxa-specific, flow-related data together, the original sampling data were reviewed and compiled for the two anomalous sampling events (Jan 12 and Feb 23). No proportional reduction was applied to these non flow-related data (i.e., if 200 fish were impinged during the 2004-2005 sampling at the EPS with a mean flow of 657 MGD, then it was projected that 200 fish would also be impinged at the CDP with a mean flow of 299 MGD). A proportional reduction based on flow rate (299 MGD/657 MGD = 0.455) was applied to the other flow-related data.

Freshwater fish were removed from the analysis since they would not survive in the marine environment of the Lagoon regardless of the screening location. Due to osmotic shock, dead or moribund freshwater fish would be collected on the screens in the same manner as debris. Note that the rest of the data from the anomalously high sampling events were still included in the analysis as described above.

Fish Return Survival

The next step is to apply a survival rate to the organisms transported through the FRS. In the absence of fish return survival data for the dominant taxa, existing scientific literature (EPRI 2010) and best professional judgment must be used to determine survival.

EPRI (2010) conducted laboratory research to determine the survival of organisms through a FRS. Study variables included fish size/age, velocity of water in the FRS, discharge height above the water surface, and various FRS design variables including overall length, drops, and bends in the FRS. The focus of the study was on larvae and early juvenile freshwater fish species. The results indicated that after about 11.0 mm in length, survival increased dramatically to between 70 and 100%. These data constitute the most complete to date on the survival of fish through a FRS.

Love et al. (1989) conducted an investigation to assess survival of organisms through the FRS at the San Onofre Nuclear Generating Station (SONGS). The study objectives were to quantify collection efficiency and survival of organisms through the system. The survival component of this investigation included assessments of both immediate and extended survival (96 hours) and organisms experienced the full collection and return process. Experimental fish were confined to a submerged holding net at the offshore terminus of the FRS and held for 96 hours to assess survival. Observations were made at 24-hr intervals to assess survival. Table 2 summarizes FRS survival from the SONGS study.

Table 2. Percent survival of species in 96-hr holding experiments at San Onofre Nuclear Generating Station (from Love et al. 1989).

		Unit 2		Unit 3		Reference	
Species Name	**Common name**	**Percent Survival**	**n**	**Percent Survival**	**n**	**Percent Survival**	**n**
Anchoa compressa	Deepbody Anchovy	50.0	2	-	-	-	-
Anchoa delicatissima	Slough Anchovy	0.0	95	-	-	-	-
Anisotremus davidsonii	Sargo	100.0	2	-	-	100	3
Atherinopsis californiensis	Jacksmelt	100.0	2	-	-	-	-
Atractoscion nobilis	White Seabass	100.0	1	100.0	1	-	-
Chromis punctipinnis	Blacksmith	100.0	1	100.0	1	-	-
Cymatogaster aggregata	Shiner Surfperch	100.0	1	-	-	100	4
Damalichthys (Rhacochilus) vacca	Pile Surfperch	-	-	100.0	4	-	-

Species Name	Common name	Unit 2 Percent Survival	n	Unit 3 Percent Survival	n	Reference Percent Survival	n
Engraulis mordax	Northern Anchovy	94.3	930	97.9	4630	14.8	108
Genyonemus lineatus	White Croaker	49.5	95	25.0	40	100.0	10
Herosilla azurea	Zebra Perch	100.0	3	-	-	-	-
Heterostichus rostratus	Giant Kelpfish	100.0	1	100.0	1	-	-
Hyperprosopon argenteum	Walleye Surfperch	100.0	19	100.0	12	100.0	1
Medialuna californiensis	Halfmoon	100.0	1	-	-	-	-
Meticirrhus undulatus	California Corbina	-	-	100.0	1	100	2
Paralabrax clathratus	Kelp Bass	100.0	1	-	-	100	3
Paralabrax nebulifer	Barred Sand Bass	100.0	1	-	-	100	4
Peprilus simillimus	Pacific Butterfish	-	-	100.0	1	-	-
Phanerodon furcatus	White Surfperch	100.0	5	94.7	19	100.0	8
Sebastes paucispinis	Bocaccio Rockfish	-	-	100.0	1	-	-
Seriphus politus	Queenfish	31.6	753	54.1	846	78.8	170
Umbrina roncador	Yellowfin Croaker	100.0	58	97.0	133	100.0	15
Xenistius (Haemulon) californiensis	Salema	100.0	21	100.0	38	-	-

Although the FRS at SONGS differs in design from that proposed at the CDP, the data are useful for determining the likely survival of southern CA marine fish species through a collection and return process. FRS survival rates were applied to the species that overlapped with those expected at the CDP to calculate survival

Where species-specific data were unavailable, the midpoint of survival demonstrated in the EPRI (2010) study were used. Where species-specific data were available from the SONGS study (Love et al. 1989), these data were used to estimate survival for the same species present at the CDP.

Fish Swimming Capacity

In addition to the means of egress provided by the FRS, there is potential for a subset of the fish to escape from the intake system through the same path they followed in. The EPS intake tunnels were designed for a facility drawing full cooling water flows. At design capacity, the EPS is permitted to withdraw 857 million gallons per day (MGD) of cooling water through the intake tunnels (Tenera 2005). Based on the dimensions of the tunnels, the mean velocity at the maximum design flow would be approximately 7.5 ft/sec. When the EPS goes offline and the CDP enters long-term, stand-alone operation, the total intake flow will decrease to 299 MGD. This represents a 65 percent reduction in flow and, therefore, a 65 percent reduction in velocity. The mean tunnel velocity will be approximately 2.6 ft/sec under long-term, stand-alone operation. At this velocity, the potential for fish to escape the intake flow will improve relative to the EPS operation. In addition, the maximum distance a fish would need to travel to exit the intake tunnels would be approximately 200 ft.

To evaluate the potential for fish to escape from the existing tunnels, a literature search was conducted to quantify fish swim speeds based both in terms of absolute swimming speed and speed relative to body length (a more common measurement). The generalized swim speeds were then applied to organisms that were collected in the 2004-2005 EPS impingement sampling study (Tenera 2008). Length frequency distributions for the dominant taxa were used to estimate the absolute swim speeds that organisms may be capable of to determine whether escape from the mean velocity in the tunnels was physiologically possible.

Table 3 presents the full stepwise approach used in calculating the mortality associated with the preferred onshore screening location.

Table 3. Summary of calculation methods used to derive the estimate of mortality associated with the preferred onshore screening location.

Sequence	Step
1	Chris Nordby weighted average, flow-proportioned estimate - 4.7 kg/day
2	Reduce normal sampling events by the proportional flow (299 MGD/657 MGD)
3	Do not adjust outlier sampling events (Jan 12 and Feb 23)
4	Sum the flow proportioned normal events and unadjusted outlier events to get new baseline
5	Remove all freshwater fish from dataset
6	Reduce remaining fish by the number that are expected to have swimming capacity to escape via tunnel - based on fish length frequencies and expected swim speeds
7	Apply species-specific (where applicable) fish return survival estimate or otherwise apply 85% survival estimate to all remaining fish
8	Subtract (escaped fish + fish surviving fish return system) from total to get mortalities

Construction-Related Impacts

Permanent Habitat Loss

Construction of a TWS intake on the Lagoon shoreline will create impacts to habitat for species making use of the shoreline as habitat. Among the species using this habitat are Garibaldi (*Hypsypops rubicundus*). Garibaldi is the state fish of CA, affording this species protection under CA Department of Fish and Game fishery regulations (Tenera 2008). Garibaldi utilize the rocky riprap in the southern end of the Lagoon where females spawn demersal adhesive eggs that attach to the rocky substrate. Relevant studies were reviewed to assess the potential impact of removing habitat on Garibaldi. The studies reviewed included the following:

- M-Rep Consulting 2007. Comparison of Garibaldi (*Hysypops rubicundis*) populations in Agua Hedionda Lagoon, CA and in Mission Bay, CA
- Tenera 2008. Clean Water Act Section 316(b) Impingement Mortality and Entrainment Characterization Study. Effects on the Biological Resources of Agua Hedionda Lagoon and the Nearshore Ocean Environment.
- DeMartini et al. 1994. Growth and production estimates for biomass-dominant fishes on a southern California artificial reef.

In addition to the species-specific impact on Garibaldi, a greater impact may result from the loss of productivity associated with that lost intertidal and subtidal habitat. To that end, relevant studies were reviewed to determine the magnitude of the potential loss in productivity associated with each shoreline alternative. The studies reviewed included the following:

- Claisse et al. 2014. Biological productivity of fish associated with offshore oil and gas structures on the Pacific OCS.
- DeMartini et al. 1994. Growth and production estimates for biomass-dominant fishes on a southern California artificial reef.
- Johnson et al. 1994. Fish production and habitat utilization on a southern California artificial reef.

Figure 3 depicts the four potential conceptual designs for the shoreline intake system. The footprint of each design was estimated along the Lagoon shoreline using conceptual designs in Computer-Aided Design (CAD) files.

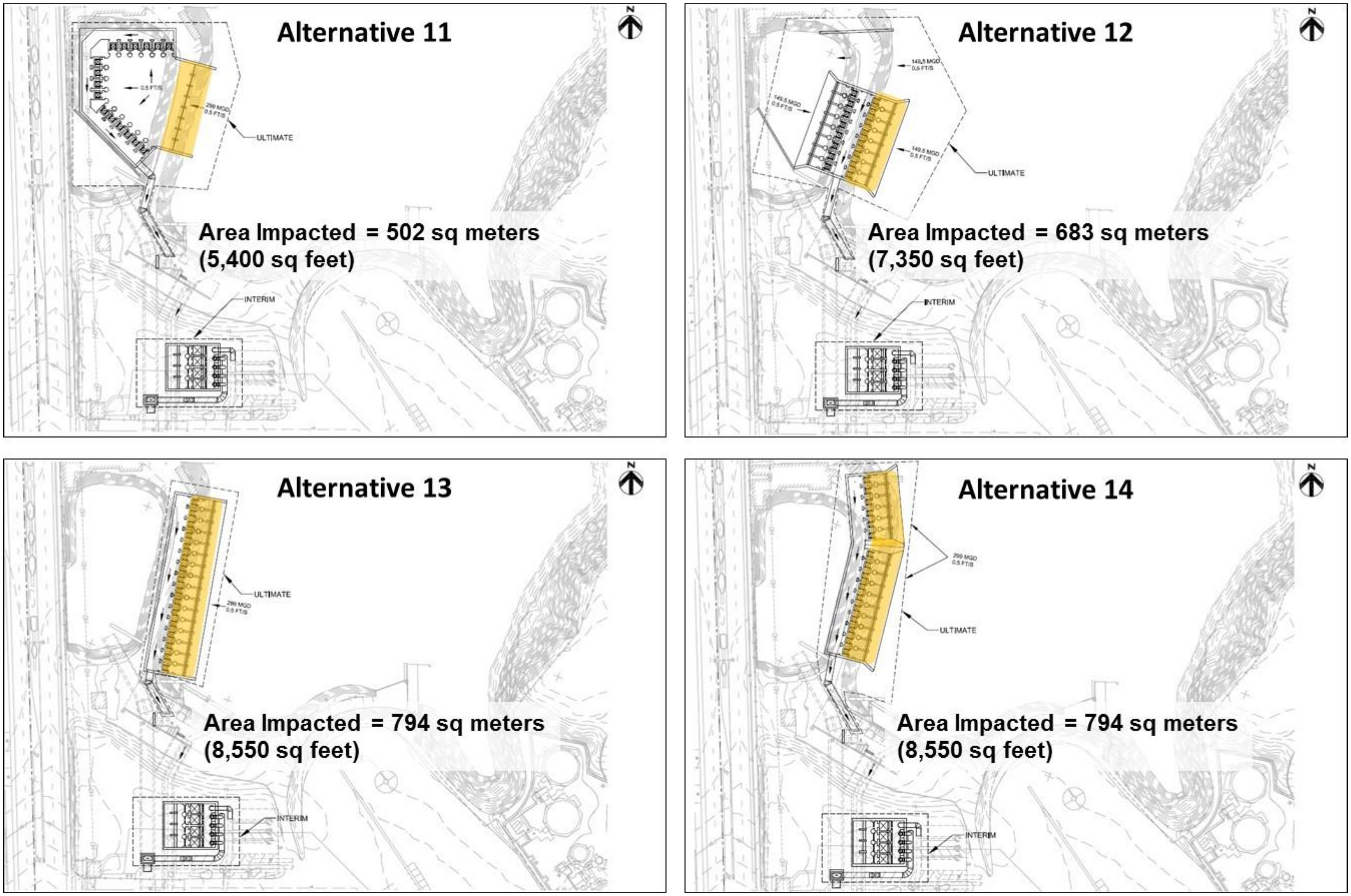

Figure 3. Estimated footprints (in orange boxes) for the four conceptual designs for the Lagoon shoreline intake system for the CDP.

Results and Discussion

Operational Impacts – Impingement and Return

Fish Return Survival

Survival of organisms through the FRS is expected to be high based on previous work by Love et al. (1989) and EPRI (2010). Where species-specific data were available from the SONGS study for southern California species, they were used to estimate survival. For other species, 85% survival was used as it represented the midpoint of the range of survival for fish greater than 11 mm in length (substantially smaller than those collected at the EPS in 2004-2005).

The estimates are based on the calculation steps described above which take into account the prorated impingement expected at the CDP based on the reduced intake flow rate (from 657 MGD to 299 MGD), the potential survival of organisms transported through the FRS, and the capacity for some fish to escape through the tunnels back to the Lagoon (described below).

Fish Swimming Capacity

Numerous studies have sought to quantify fish swim speeds, with the most recent treatise on this subject (Videler and Wardle 1991) compiling all available published fish swim speed data. This review paper summarized swim speed data for 27 species of fish of various sizes. Among the generalized conclusions, the authors state that, on average, the burst swimming speed for the species reviewed was 10 body length (BL)/sec. Using this relative swim speed, the absolute swim speeds of the organisms that were collected in the 2004-2005 EPS impingement sampling study (Tenera 2008) were estimated. Since absolute swim speeds vary with fish length, length frequency distributions for dominant taxa were used to estimate the absolute swim speeds for discrete size classes. Burst swim speeds were reduced to sustained swim speeds by assuming that sustained swim speed was 10% of the burst swim speed calculated based on body lengths. This is a conservative assumption applied to the calculation to account for the fact that escape from the tunnel would require a sustained effort against the mean 2.6 ft/sec velocity in the tunnel.

Table 4 presents the results of the swim speed analysis.

Table 4. Estimates of number of fish able to potentially escape from mean tunnel velocity of 2.6 ft/sec.

								Number of fish able to swim 3.0 ft/sec		
Taxon	**Length Range (mm)**	**Mean Length (cm)**	**Total weight (g)**	**Mean weight (g)**	**Total # Collected**	**Length (cm) at which individual can exceed 3.0 ft/sec[1]**	**Proportion exceeding 3.0 ft/sec based on burst swim speed[2]**	**Based on burst swim speed[3]**	**Based on sustained swim speed[3]**	**Weight (g) of fish able to escape from tunnels[4]**
Anchovies	19-169	76	15,587	4.2	3,686	9.5	0.269	992	99	416
Silversides	18-325	84	48,167	7.6	6,305	9.0	0.633	3,991	399	3,033
Shiner Surfperch	11-228	70	28,374	10	2,828	9.0	0.416	1,176	118	1,176
Queenfish	22-499	74	7,516	5.8	1,306	11.3	0.181	236	24	137
Walleye Surfperch	20-225	113	23,983	39.6	606	9.0	0.860	521	52	2,064
Sand Basses	28-358	81	6,825	12.1	565	9.0	0.579	327	33	396
Pacific Sardine	35-242	85	1,480	5.5	268	9.0	0.740	198	20	109
Spotfin Croaker	33-555	103	11,354	61.7	184	11.3	0.380	70	7	431
White Seabass	36-441	224	12,167	160.1	76	11.3	0.953	72	7	1,160
									Total	**8,923**

[1] Based on burst swim speed of 10 body lengths/sec (Videler and Wardle 1991).

[2] Based on length frequency distributions from the 2004-2005 impingement sampling at the Encina Power Station (Tenera 2008)

[3] Based on best professional judgment that sustained swim speed which would be required to mount a sustained escape from the tunnels is 10% of burst speed

[4] Based on mean weight of each taxon from the 2004-2005 impingement sampling at the Encina Power Station (Tenera 2008)

Table 5 presents the estimated mortality of organisms associated with the preferred onshore screening location. The estimated mortality is based on the assumptions described above regarding projected survival through the FRS and the capacity for some fish to escape through the existing tunnels back to the Lagoon. The projected mortality of fish from the onshore TWS location is 0.497 kg of fish/day or 181 kg of fish/yr. Attachment 5 to the 2009 Flow, Entrainment, and Impingement Minimization Plan calculated a weighted-average, flow-proportioned estimate of 4.7 kg of fish/day or 1,716 kg of fish /yr. As stated previously in a Response to Comment file provided by Chris Nordby and Dave Mayer, the estimate of 4.7 kg/day is very conservative and likely overestimates the impingement that will occur at the CDP since outlier data were included in the calculation.

By comparison, the Lagoon shoreline location is assumed to have no operational-related mortality impacts associated with it. However, it is logical to assume that a shoreline intake without a return system will incur some mortality to organisms in the Lagoon. Since the screen panels would have to be equipped with at least minimal lips for debris management purposes (i.e., to collect and dispose of debris), fish will invariably be collected as well. Although this is not a quantifiable impact, it is important to note in the context of this analysis.

Table 5. Estimate of total mortality expected the proposed onshore screening location for the CDP by taxa.

			Total 2004-2005		Total reductions flow and non flow events		Reduced by number that can escape based on swim speed		Number surviving fish return system (85% Survival or SONGS)[1]		Total Mortalities	
Species Name	**Common Name**	**CDP/EPS Flow**	**#**	**Wght (g)**	**#**	**Wght (g)**	**#**	**Weight (g)**	**#**	**Wght (g)**	**#**	**Wght (g)**
Atherinops affinis	Topsmelt	0.455	5,252	42,561	3,946	34,779	3,547	31,730	3,015	26,971	532	4,760
Cymatogaster aggregata	Shiner Surfperch	0.455	2,827	28,374	1,454	16,939	1,336	15,758	1,336	15,758		
Anchoa compressa	Deepbody Anchovy	0.455	2,081	11,627	1,235	8,198	1,136	7,779	568	3,890	568	3,890
Seriphus politus	Queenfish	0.455	1,306	7,516	653	4,066	629	3,930	534	3,340	94	589
Xenistius (Haemulon) californiensis	Salema	0.455	1,061	2,390	498	1,113	498	1,113	423	946	75	167
Anchoa delicatissima	Slough Anchovy	0.455	1,056	3,144	963	2,917	963	2,917	963	2,917		
Atherinopsidae	Silverside	0.455	999	4,454	455	2,027	455	2,027	386	1,723	68	304
Hyperprosopon argenteum	Walleye Surfperch	0.455	606	23,983	546	22,341	494	20,279	494	20,279		
Engraulis mordax	Northern Anchovy	0.455	537	786	249	372	249	372	242	362	7	10
Leuresthes tenuis	California Grunion	0.455	489	2,280	223	1,038	223	1,038	189	882	33	156
Heterostichus rostratus	Giant Kelpfish	0.455	344	2,612	159	1,255	159	1,255	159	1,255		
Paralabrax maculatofasciatus	Spotted Sand Bass	0.455	303	4,604	284	3,684	251	3,289	214	2,796	38	493
Sardinops sagax	Pacific Sardine	0.455	268	1,480	137	872	117	763	100	648	18	114
Roncador stearnsii	Spotfin Croaker	0.455	184	11,354	92	8,181	85	7,750	72	6,587	13	1,162
Paralabrax nebulifer	Barred Sand Bass	0.455	151	1,541	122	1,042	122	1,042	122	1,042		
Gymnura marmorata	California Butterfly Ray	0.455	147	61,019	67	27,770	67	27,770	57	23,604	10	4,165
Phanerodon furcatus	White Surfperch	0.455	144	4,686	88	3,885	88	3,885	84	3,722	4	163
Strongylura exilis	California Needlefish	0.455	135	6,025	62	2,791	62	2,791	53	2,372	9	419
Paralabrax clathratus	Kelp Bass	0.455	111	680	95	320	95	320	95	320		
Porichthys myriaster	Specklefin Midshipman	0.455	103	28,189	47	13,116	47	13,116	40	11,148	7	1,967

			Total 2004-2005		Total reductions flow and non flow events		Reduced by number that can escape based on swim speed		Number surviving fish return system (85% Survival or SONGS)[1]		Total Mortalities	
Species Name	**Common Name**	**CDP/EPS Flow**	**#**	**Wght (g)**	**#**	**Wght (g)**	**#**	**Weight (g)**	**#**	**Wght (g)**	**#**	**Wght (g)**
Paralichthys californicus	California Halibut	0.455	95	1,729	62	1,220	62	1,220	52	1,037	9	183
Anisotremus davidsoni	Sargo	0.455	94	1,662	60	1,248	60	1,248	60	1,248		
Urolophus halleri	Round Stingray	0.455	79	20,589	36	9,370	36	9,370	31	7,965	5	1,406
Atractoscion nobilis	White Seabass	0.455	76	12,167	43	7,510	36	6,351	36	6,351		
Hypsopsetta (Plueronichthys) guttulata	Diamond Turbot	0.455	67	10,764	42	6,580	42	6,580	36	5,593	6	987
Micrometrus minimus	Dwarf Surfperch	0.455	57	562	52	523	52	523	44	444	8	78
Syngnathus spp.	Pipefishes	0.455	55	161	26	73	26	73	22	62	4	11
Atherinopsis californiensis	Jacksmelt	0.455	54	1,152	25	524	25	524	25	524		
Myliobatis californica	Bat Ray	0.455	54	25,864	25	11,771	25	11,771	21	10,005	4	1,766
Menticirrhus undulatus	California Corbina	0.455	43	1,906	41	1,739	41	1,739	41	1,739		
Amphistichus argenteus	Barred Surfperch	0.455	43	1,306	37	1,271	37	1,271	31	1,081	6	191
Fundulus parvipinnis	California Killifish	0.455	43	299	41	291	41	291	35	247	6	44
unidentified fish	damaged	0.455	37	1,130	18	548	18	548	16	466	3	82
Leptocottus unid.	Pacific Staghorn Sculpin	0.455	32	280	15	127	15	127	12	108	2	19
Sphyraena argentea	California Barracuda	0.455	29	397	15	280	15	280	13	238	2	42
Umbrina roncador	Yellowfin Croaker	0.455	28	573	17	478	17	478	11	309	6	169
Ophichthus zophochir	Yellow Snake Eel	0.455	18	5,349	8	2,434	8	2,434	7	2,069	1	365
Citharichthys stigmaeus	Speckled Sanddab	0.455	17	62	10	33	10	33	8	28	1	5
Brachyistius frenatus	Kelp Surfperch	0.455	16	182	7	83	7	83	6	70	1	12
Cheilotrema saturnum	Black Croaker	0.455	15	103	7	47	7	47	6	40	1	7
Embiotoca jacksoni	Black Surfperch	0.455	14	1,240	7	766	7	766	6	651	1	115
Genyonemus lineatus	White Croaker	0.455	12	171	6	78	6	78	3	33	3	45

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Platyrhinoidis triseriata	Thornback	0.455	12	6,231	5	2,836	5	2,836	5	2,410	1	425
Chromis punctipinnis	Blacksmith	0.455	10	396	6	198	6	198	6	198		
unidentified fish		0.455	10	811	5	369	5	369	4	314	1	55
Porichthys notatus	Plainfin Midshipman	0.455	9	1,792	4	816	4	816	3	693	1	122
Hermosilla azurea	Zebra Perch	0.455	9	1,097	6	514	6	514	6	514		
Trachurus symmetricus	Jack Mackerel	0.455	7	7	3	3	3	3	3	3	0	0
Hypsoblennius gentilis	Bay Blenny	0.455	7	37	4	20	4	20	3	17	1	3
Heterostichus spp.	Kelpfish	0.455	7	48	3	22	3	22	3	19	0	3
Engraulidae	anchovies	0.455	6	3	3	1	3	1	2	1	0	0
Anchoa spp.	anchovy	0.455	6	27	3	12	3	12	2	10	0	2
Peprilus simillimus	Pacific Butterfish	0.455	5	91	2	41	2	41	2	41		
Rhacochilus vacca	Pile Surfperch	0.455	4	915	2	504	2	504	2	504		
Sebastes atrovirens	Kelp Rockfish	0.455	4	40	2	18	2	18	2	15	0	3
Pleuronichthys verticalis	Hornyhead Turbot	0.455	4	190	2	86	2	86	2	73	0	13
Pleuronectiformes unid.	flatfishes	0.455	4	62	2	28	2	28	2	24	0	4
Syngnathus leptorhynchus	Bay Pipefish	0.455	3	9	1	4	1	4	1	3	0	1
Hypsoblennius gilberti	Rockpool Blenny	0.455	3	16	2	10	2	10	2	9	0	2
Mustelus californicus	Gray Smoothhound	0.455	3	1,850	1	842	1	842	1	716	0	126
Cheilopogon pinnatibarbatus	Smallhead Flyingfish	0.455	3	604	1	275	1	275	1	234	0	41
Girella nigricans	Opaleye	0.455	2	346	1	157	1	157	1	134	0	24
Rhinobatos productus	Shovelnose Guitarfish	0.455	4	6,661	2	3,031	2	3,031	2	2,577	0	455
Acanthogobius flavimanus	Yellowfin Goby	0.455	2	55	1	25	1	25	1	21	0	4
Scomber japonicus	Pacific Mackerel	0.455	2	10	1	5	1	5	1	4	0	1

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Hypsoblennius spp.	blennies	0.455	2	11	1	5	1	5	1	4	0	1
Hypsoblennius jenkinsi	Mussel Blenny	0.455	2	17	1	8	1	8	1	7	0	1
Paralabrax spp.	Sand Bass	0.455	2	2	1	1	1	1	1	1	0	0
Scorpaena guttata	California Scorpionfish	0.455	2	76	1	55	1	55	1	47	0	8
Hyporhamphus rosae	California Halfbeak	0.455	2	23	1	10	1	10	1	9	0	2
Symphurus atricaudus	California Tonguefish	0.455	2	15	1	7	1	7	1	6	0	1
Sarda chiliensis	Pacific Bonito	0.455	2	1,010	1	460	1	460	1	391	0	69
Albula vulpes	Bonefish	0.455	2	1,192	2	1,192	2	1,192	2	1,013	0	179
Sciaenidae unid.	croaker	0.455	2	3	1	1	1	1	1	1	0	0
Oxylebius pictus	Painted Greenling	0.455	1	5	0	2	0	2	0	2	0	0
Lyopsetta exilis	Slender Sole	0.455	1	26	0	12	0	12	0	10	0	2
Citharichthys sordidus	Pacific Sanddab	0.455	1	1	1	1	1	1	1	1	0	0
Gibbonsia montereyensis	Crevice Kelpfish	0.455	1	8	0	4	0	4	0	3	0	1
Pleuronichthys ritteri	Spotted Turbot	0.455	1	7	1	3	1	3	1	3	0	1
Gillichthys mirabilis	Longjaw Mudsucker	0.455	1	34	0	15	0	15	0	13	0	2
Dorosoma petenense	Threadfin Shad	0.455	1	3	0	1	0	1	0	1	0	0
Porichthys spp.	midshipman	0.455	1	200	0	91	0	91	0	77	0	14
Cynoscion parvipinnis	Shortfin Corvina	0.455	1	900	1	900	1	900	1	765	0	135
Mugil cephalus	Striped Mullet	0.455	1	3	0	1	0	1	0	1	0	0
Paraclinus integripinnis	Reef Finspot	0.455	1	4	0	2	0	2	0	2	0	0
Hyperprosopon spp.	surfperch	0.455	1	115	0	52	0	52	0	44	0	8
Citharichthys spp.	sanddabs	0.455	0	0								
Triakis semifasciata	Leopard Shark	0.455	0	0								

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Medialuna californiensis	Halfmoon	0.455	0	0								
Torpedo californica	Pacific Electric Ray	0.455	1	3,750	0	1,707	0	1,707	0	1,451	0	256
Scorpaenidae	scorpionfishes	0.455	0	0								
Halichoeres semicinctus	Rock Wrasse	0.455	0	0								
Hypsypops rubicundus	Garibaldi	0.455	0	0								
Seriola lalandi	Yellowtail Jack	0.455	0	0								
Dasyatis dipterura	Diamond Stingray	0.455	0	0								
Heterodontus francisci	Horn Shark	0.455	0	0		-						
Zoarcidae	eelpouts	0.455	0	0								
TOTALS			**19,239**	**365,656**	**12,051**	**218,050**	**11,292**	**209,108**	**9,737**	**183,257**	**1,555**	**25,851**
												497

[1] Species-specific FRS survival data from Love et al. 1989.

Construction-Related Impacts

Permanent Habitat Loss

Two separate surveys were conducted to estimate the density of Garibaldi juveniles and adults in the Lagoon. The first such study was conducted in 2005 (Tenera 2008). Comparing 2004-2005 entrainment sampling results in which Garibaldi larvae were prominent (fourth in overall entrainment abundance) to earlier entrainment sampling in 1979 when Garibaldi larvae were rare, Tenera concluded that "*it is evident that the local population has increased considerably and now utilizes the artificial substrate in the lagoon for spawning to a much greater degree than previously. Some of the increase may reflect the long-term protected status of the species from sport or commercial collections in California*."

A more recent survey was conducted in 2007 (M-Rep Consulting 2007) to estimate the density of Garibaldi in the rocky riprap habitat near the EPS intake structure. The dive surveys were conducted in the rock riprap areas adjacent to (immediately east and west of) the EPS intake structure. Divers swam a 103-m long transect and counted all Garibaldi observed within 1 meter of either side of the transect line. The mean density of Garibaldi in the Lagoon area surveyed was 19.1 fish/100m^2. Removal of the shoreline riprap for the alternative intake structures being considered (Figure 3) would result in the displacement of adult Garibaldi as well as a permanent loss of high quality Garibaldi nesting habitat.

Greater than the impact to just Garibaldi, is the potential impact to productivity associated with this habitat. Johnson et al. (1994) conducted a study to evaluate, among other things, the productivity of fish at the Torrey Pines Artificial Reef (TPAR). The TPAR is situated approximately 5 km north of La Jolla 0.5 km (1,640 ft) offshore at a depth of 14 m (46 ft). The reef substrate (large quarry rock between 0.5 and 2 m in diameter and surrounding sand bottom) is similar to the shoreline habitat that would be impacted at the CDP if a shoreline intake were to be constructed. The study developed quantitative estimates of fish production during a 7-month period for the boulder and sand habitat that comprised the TPAR. Fish productivity was estimated using somatic growth via a mark recapture design and through visual diver surveys of standing stock. Surveys were conducted in manner to capture the presence of both cryptic and obvious fishes.

Productivity based on somatic growth of fishes for the TPAR was estimated to be 66.5 g WW/m^2/yr (Claisse et al. 2014). Table 6 summarizes the loss in fish productivity associated with the four conceptual design alternatives. Depending on the alternative design considered, the impact ranges from 33 to 53 kg of fish biomass lost per year.

Table 6. Estimated lost fish biomass per year for the proposed onshore screening location for the CDP.

Intake alternative	Footpint area (ft^2)	Footprint area (m^2)	Productivy (WWg/m^2/yr)[1]	Lost fish biomass (WWg/yr)	Lost fish biomass (WWkg/yr)
1	5,400	502	66.5	33,361	33.36
2	7,350	683	66.5	45,409	45.41
3	8,550	794	66.5	52,822	52.82
4	8,550	794	66.5	52,822	52.82

[1] Productivity estimate from Johnson et al. 1994

Conclusions

Operational Impacts – Impingement and Return

The incremental increase in marine life mortality associated with an onshore TWS intake location is approximately 0.497 kg of fish/day based on the expected survival of organisms transported through the FRS and based on the ability of some of the fish being able to swim against the tunnel velocity. Taking into consideration the survival estimated in the analysis above, the total mortality projected is 0.497 kg/day or 181 kg of fish/year based on taxa-specific survival estimates gleaned from previous research and best professional judgment.

Construction-Related Impacts

A review of the available literature indicates that the riprap shoreline is both valuable habitat to both the state-protected Garibaldi and a very productive habitat contributing to the health of the marine environment in Agua Hedionda Lagoon. Taking into account the productivity of the habitat that would have to be removed to construct a shoreline intake indicates that the equivalent of between 33 and 53 kg of fish/year would be lost. Using the mean footprint (693 m^2) of the four alternatives presented in this analysis, the mean fish biomass that would potentially be lost is 46 kg/year.

Compared to the projected losses at the onshore intake location of 181 kg/year, the incremental increase in impact resulting from the onshore location is approximately 135 kg/year (181 – 46 = 135).

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