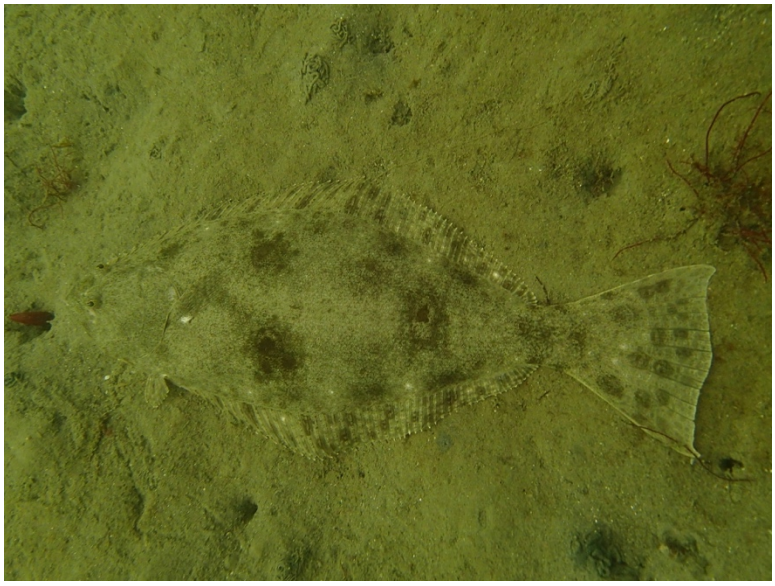
# HUNTINGTON BEACH DESALINATION PLANT

## 1-MM SCREENED SEAWATER INTAKE SITE DETERMINATION SUMMARY REPORT



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| Prepared For | POSEIDON WATER<br>HUNTINGTON BEACH DESALINATION PLANT |
| Prepared By | MILLER MARINE SCIENCE & CONSULTING, INC<br>AND<br>TWB ENVIRONMENTAL RESEARCH AND CONSULTING, INC |
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## ATTACHMENTS

Attachment 1: Steinbeck, J. and E. Miller. 2015. Comparison of ichthyoplankton data collected at the HBGS intake for two 12-month periods: July 2014-June 2015 and September 2004-August 2004. Prepared for Poseidon Water. Appendix Q of Report of Waste Discharge for NPDES CA8000403.

Attachment 2: Miller Marine Science & Consulting, Inc. 2018. Huntington Beach Desalination Plant intake site determination: multiple lines of evidence analysis. Prepared for Poseidon Water.

Attacment 3: Attachment 3 – MBC and Tenera 2005 Entrainment Estimate Methods and Table of Estimated entrainment totals for each taxon entrained among the three potential intake sites.

Attachment 4: Rasmussen, L. 2018. Technical Memorandum: San Pedro Bay nearshore and shelf currents. Prepared for Poseidon Water.

Attachment 5: Dudek. 2019. D2 and U2 – Alternative 1mm screened seawater intake feasibility analysis according to the OPA and CEQA.

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# EXECUTIVE SUMMARY

The purpose of this report is to compile the findings and conclusions of Poseidon's various prior analyses into one report examining the estimated entrainment impacts at the proposed 1-mm screened seawater intake site in comparison to six (6) alternative intake sites offshore of the proposed Huntington Beach Desalination Project (HBDP). The area where the proposed intake would be placed is encompassed by homogeneous sandy, soft-bottom where there is nothing to suggest that any one of the three investigated intake sites would have conditions materially different than another; they are functionally indistinguishable from each other. This report also addresses the intake siting requirements in the California Ocean Plan Amendment (OPA).

The series of analyses includes those that have been previously provided in technical reports, but also new, additional analyses developed in response to recent conversations with Dr. Raimondi and the agency staffs related to Dr. Raimondi's Neutral Third-Party Review ("NTPR") of the alternative intake sites.

The culmination of the 6-month NTPR process was two reports from Dr. Raimondi utilizing Multiple Lines of Evidence (MLE) concluding that four (4) of the six (6) alternative intake sites were ecologically inferior. Of the remaining two (2) alternatives sites, identified as entrainment sampling stations D2 and U2, Dr. Raimondi's report concludes that the proposed intake site E ranks best based on the Standardized Larval Concentration ("SLC") line of evidence and third when the Mean Larval Concentration ("MLC") and SLC are equally weighted and merged into one line of evidence. When statistical significance testing is applied, as recommended by Dr. Raimondi throughout the NTPR process, there is no ecological difference between stations E, D2 and U2 and therefore no scientifically justifiable rationale for re-locating the site of the proposed 1-mm screened seawater intake. Lacking any statistical differences among the three remaining sites, there is no scientific confidence that an intake at any of the three would result in less actual entrainment over the operational life of the HBDP.

During collaborative reviews of Dr. Raimondi's draft final report, agency staff proposed examining entrainment estimates at each site to determine which would be the least impactful over the operational life of the project. In this report, Poseidon provides this analysis with a focus on taxon-specific impacts in accordance with Section III.M.2.b.(3) and (4) of the OPA because the NTPR process neither directly examined taxon-specific impacts nor provided evidence identifying an available site that was superior to the proposed intake site at station E.

This analysis confirmed mole crab dominated the overall entrainment, especially at proposed intake site E where more than 50% of all entrainment was mole crab. Excluding mole crab, as was done during the initial California Energy Commission's[1] evaluation of entrainment impacts at the Huntington Beach Generating Station using these same data, entrainment at proposed intake site E was superior to alternative intake site D2 by over 15 million larvae and ranked

[1] Mole crab (also known as sand crab *Emerita analoga*) were a target taxon of the CEC data analysis but were excluded from final formal ETM and APF modeling due to the lack of late stage megalops stage larvae. Nearly all mole crab larvae were stage 1 zoea, or the first post-hatch stage, and lacked verifiable life history information needed for the ETM.

second (by less than 6 million larvae) in total entrainment to alternative intake site U2 (Table ES-1). These data suggest that basing an intake location on total entrainment estimates would benefit mole crab to the detriment of the remaining taxa, including taxa that support fisheries, are depressed due to anthropogenic factors, or are protected from harvest through a harvest moratorium enacted under California regulations.

Furthermore, identified taxon-specific entrainment at proposed intake site E was highest for only eighteen (18) taxa, the least of all three intake sites. Six (6) of the eighteen (18) taxa are fished. Alternative intake site U2 posed the greatest threat with peak entrainment for thirty-three (33) taxa, including sixteen (16) fished taxa (Table ES-1). At alternative intake site D2, entrainment peaked for twenty-three (23) taxa including nine (9) fished taxa.

Entrainment of taxa supporting a fishery peaked at alternative intake site U2 where almost 2.4 million more larvae of the fished category were entrained than were at proposed intake site E. Approximately 1.3 million fewer larvae were entrained at alternative intake site D2 than at proposed intake site E. Larvae from taxa whose standing stock populations were depressed or protected by a harvest moratorium were both entrained in numbers up to 1.5 million more at either alternative intake site than at proposed intake site E.

During the July 19, 2018 NTPR conference call, Dr. Raimondi recommended adding an analysis of the larval concentration data where all taxa were treated equally. He noted this could be accomplished by standardizing each taxon's site-specific concentration by the taxon's concentration across all sampling sites. In his draft final report, Dr. Raimondi noted that there are two disparate approaches being proposed, the SLC and MLC. One approach (MLC) is based on just the total concentration of larvae, irrelevant of taxon, that would assess how many larvae are lost but would not capture the potential impacts to the overall community and its ecological structure. The second approach (SLC) is described in Dr. Raimondi's draft final report as follows: "*The reason for this is to provide an evaluation of risk, in the absences of a sufficient ETM/APF assessment. It is a recognition that rare species, which minimally contribute to MLC, may actually be more at risk to ongoing or new sources of mortality than are common species which drive MLC estimates.*" For example, large losses of an abundant taxon are much less of an impact than a smaller loss of an already depressed population. Losses of a few protected taxon's larvae posed much greater risk to population viability than losses of several hundred larvae of a taxon with a robust and healthy population that is neither fished nor stressed from any other known anthropogenic factor. Examining the data so all taxa counted equally regardless of their total abundance would better measure ecological risk. Setting all taxa on an equal measurement scale acknowledged that some taxa are less abundant in the environment, either naturally (such as high-level predators) or as a result of anthropogenic factors. Dr. Raimondi introduced the standardized larval concentration method into the analysis based on the need to incorporate ecological risk into the assessment.

These data confirm that moving the proposed intake site based on total entrainment irrespective of taxon-specific entrainment would protect mole crab at the expense of most other taxa and the environment. Mole crab populations are considered very healthy and robust throughout southern California.

**Table ES-1. Number of larvae entrained more or less than would be entrained at Intake Site E for each category of taxa entrained.**

| Category | # of Larvae Entrained In Comparison to Site E | | | |
|---|---|---|---|---|
| | Site U2 | | Site D2 | |
| Total Non-Mole Crab Larvae Entrained | -5,829,230 | Less Than E | 15,078,885 | More Than E |
| Highest Taxon-Specific Entrainment | 15 | More Than E | 5 | More Than E |
| Fished Larvae Entrained | 2,367,150 | More Than E | -1,276,766 | Less Than E |
| Depressed Stock Larvae Entrained | 439,715 | More Than E | 1,546,985 | More Than E |
| Harvest Moratorium Larvae Entrained | 386,757 | More Than E | 68,815 | More Than E |

Beyond the numerical analyses used to determine the potential intake and mortality of all forms of marine life, section III.M.2.b. of the OPA requires the project applicant to address seven criteria to answer the question of whether the best available intake site has been identified for the proposed project. Perhaps the most critical among the siting criteria are those that address the location of the intake relative to MPAs, sensitive habitats, and sensitive species.

OPA section III M.2.B states, *"To the extent feasible, surface intakes shall be sited so as to maximize the distance from a MPA or SWQPA."* Potential intake site U2 is indisputably the closest to the nearest MPAs in Bolsa Chica Wetlands and should be eliminated from further consideration. Similarly, siting an intake at D2 would increase the risk to sensitive species (e.g., Giant Sea Bass) and is positioned directly offshore the mouth to the Huntington Beach Wetlands.

The RWB's administrative record is replete with ecological evidence that the proposed 1-mm screened intake site E is environmentally superior compared to the alternative intake sites for minimizing the intake and mortality of all forms of marine life. Further feasibility analysis is unnecessary; however, Poseidon is providing a feasibility analysis (Attachment 5) at the request of the RWB that examines the considerations of building a new intake at alternative sites D2 and U2.

When considering the feasibility of constructing a new intake at alternative intake sites D2 or U2, the long-term environmental and social impacts associated with the major construction effort far outweigh any perceived environmental benefit. Evaluation of the five feasibility criteria (i.e., schedule, technical, environmental, social and economic) reveal that implementing an intake at alternative intake sites U2 or D2 would result in a substantially longer implementation schedule (between 11 and 13 years to develop, permit, construct, and commission), a substantially greater social impact (e.g., beach closures and associated economic impacts on tourism), a substantially greater cost ($510M in additional costs), and a substantially greater technical construction challenge – all without any scientifically justifiable environmental benefit.

In conclusion, as Table ES – 2 illustrates, utilizing NTPR Dr. Raimondi's MLE guidance and following the overall guidance of the OPA in reference to site selection, there is no ecologically significant difference among proposed intake site E and alternative intake sites D2 and U2; alternative intake sites D2 and U2 fail the OPA test as they are not the "maximum distance feasible" from an MPA or SWQPA; and intake sites at D2 or U2 would cause greater ecological damage due to impacts to fished (meaning targeted and of value to recreational and/or

commercial fishing) and protected species compared to proposed intake site E; all three intake sites have the same sandy, soft-bottom habitat that is indistinguishable; and finally, moving the intake from the currently permitted and proposed site would fail CWC section 13142.5(b) and the OPA's 5-criteria feasibility test.

**Table ES-2. Comparison of site parameters relative to the intake site analysis.**

| Question | Site U2 | Site E | Site D2 |
|---|---|---|---|
| Statistically significant less entrainment impact than other candidate sites? | No | No | No |
| Least number of taxa with maximum entrainment occurring at the site? | No | Yes | No |
| Least entrainment of taxa with peer-reviewed report documenting the standing stock is depressed? | No | Yes | No |
| Least entrainment of taxa protected under a harvest moratorium? | No | Yes | No |
| At maximum distance away from an MPA, sensitive species nursery habitat, estuary, or other sensitive habitat? | No | Yes | No |
| Positioned on soft/sandy-bottom habitat? | Yes | Yes | Yes |
| Will require temporary/permanent habitat disturbance to install wedgewire screens? | Yes | Yes | Yes |
| Will not require temporary/permanent habitat disturbance to connect intake structure to onshore desalination plant? | No | Yes | No |
| Best intake site available to minimize environmental impacts when all factors are considered. | No | Yes | No |

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# I. ENTRAINMENT IMPACT ANALYSIS

Since April 2016, Poseidon Water Surfside (Poseidon) has worked collaboratively with staff representing the Santa Ana Regional Water Quality Control Board (RWB), State Water Resources Control Board (SWB), and the California Coastal Commission (CCC) to assess if the currently permitted and proposed Huntington Beach Desalination Plant (HBDP) intake site is the best available site to minimize the intake and mortality of all forms of marine life.

In March 2018, RWB staff informed Poseidon that the information in the application's administrative record effectively concluded that there were no other feasible sites along the coast of Orange County for the proposed HBDP that would minimize the intake and mortality of all forms of marine life. However, based on a larval entrainment analysis prepared by the California Coastal Commission staff, the RWB requested that Poseidon evaluate moving the proposed 1-mm screened seawater intake an additional 0.9 miles offshore of the proposed HBDP. Later, the alternative screened intake site evaluation was expanded to include six (6) alternative sites within a 19.8 square mile grid offshore of the proposed HBDP. The RWB then hired Dr. Peter Raimondi as a NTPR to evaluate the best available site for a 1-mm screened ocean intake to minimize the intake and mortality of all forms of marine life for the proposed HBDP.

Prior analyses demonstrated the Huntington Beach site had the lowest entrainment of all sites in southern California where entrainment data was available (Figure 1) and that entrainment effects at the proposed intake site will be ecologically insignificant[2].

Numerous HBDP entrainment reports have been prepared and relied upon by local and state agencies under the requirements of the California Environmental Quality Act ("CEQA") including the City of Huntington Beach in 2006 and 2010 and State Lands Commission in 2010 and 2017, and separately by the RWB as part of its 2012 amendment and renewal of the HBDP's National Pollutant Discharge Elimination System (NPDES) permit (Order Number R8-2012-0007) and California Water Code section 13142.5(b) compliance determination. These studies concluded:

- The HBDP is projected to entrain less than three (3) larvae with every thousand (1,000) gallons of seawater withdrawn at Site E;
- Larval entrainment losses at Site E are projected to affect only a small fraction of the larvae (0.02−0.33%) of the source water populations of approximately 115 billion individual larval fish at risk to entrainment that occur within the HBDP's source water;
- No state or federal threatened or endangered species were collected during the entrainment sampling;

[2] State Lands Commission Final Supplemental Environmental Impact Report Page 4-58 and 4-59 certified October 19, 2017 concludes the HBDP *"would not substantially reduce populations of any affected species or affect the ability of any affected species to sustain their populations. This impact would be less than significant … No mitigation measures are required."*

- The proposed intake (Site E) is not within a Marine Protected Area (MPA) or an Area of Special Biological Significance (ASBS);
- Impacts on marine organisms due to the potential entrainment resulting from the project are relatively small, and would not substantially reduce populations of affected species, or affect the ability of the affected species to sustain their populations.

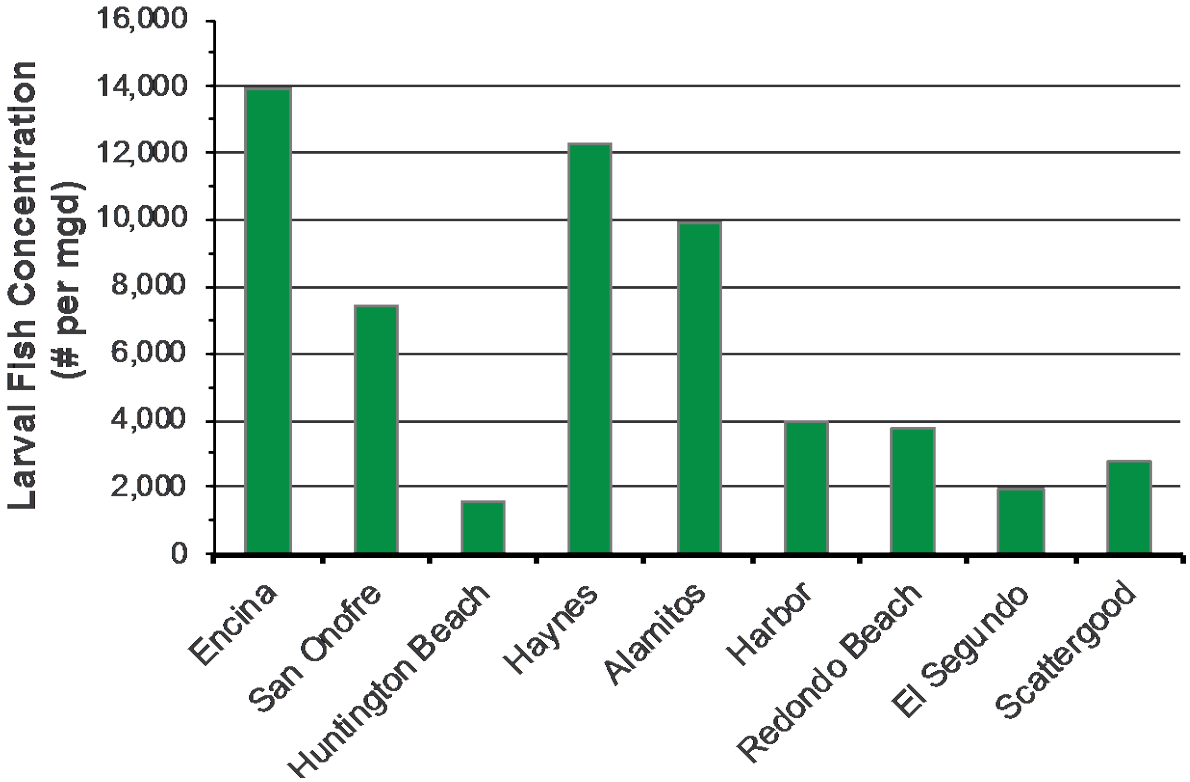


**Figure 1. Entrainment estimates by once-through cooled power plants (Steinbeck, July 2008) in Final Substitute Environmental Document for Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling, May 4 2010.**

Furthermore, based on comments provided by the CCC staff, the State Lands Commission's 2017 FSEIR evaluated the environmental benefits of moving the 1-mm screened intake 0.9 miles farther offshore. The 2017 FSEIR concluded:

> *Extending the existing pipeline would result in substantial construction-related impacts, including impacts to marine biological resources and ocean water quality from seafloor disturbance, short-term increases in construction emissions, and impacts related to presence of marine vessel traffic and construction equipment … This alternative would meet most project objectives and is potentially technically feasible, but would result in a substantial increase in construction-related impacts and would not reduce operational impacts. Therefore, this alternative was eliminated from further consideration."*

Despite the determination by various permitting agencies that the HBDP will have insignificant marine life impacts based on CEQA standards, CWC section 13142.5(b) and the Ocean Plan Amendment (OPA) require the best available site, design, technology and mitigation measures

feasible to minimize the intake and mortality of all forms of marine life. Consequently, agency staff have required an evaluation of whether moving the proposed screened seawater intake to another site within a 19.8 square mile grid offshore of the proposed HBDP would result in measurably lower levels of entrainment of all forms of marine life.

Starting in July 2018, Poseidon Water and regulatory agency staff have worked jointly with Dr. Peter Raimondi as part of a Neutral Third-Party Review (NTPR) to evaluate the best available site for a 1-mm screened ocean intake to minimize the intake and mortality of all forms of marine life for the proposed HBDP. The parties determined that this analysis requires Multiple Lines of Evidence (MLE) as the OPA provides various guidance under section III.M.2.b but does not prescribe a single analytical approach. This MLE approach was undertaken to weave together the disparate methods of comparing the entrainment impact of each intake site considered to ensure the goals of the OPA are preserved, i.e., minimize the environmental impacts of the operation of a seawater desalination plant. While some lines of evidence were mutually agreed upon, others with a direct nexus to the OPA (e.g., such as distance to sensitive habitats [e.g., MPAs], under pressure from other anthropogenic sources, and habitat homogeneity) were not included in the MLE analysis review by Dr. Raimondi during the NTPR.

During the NTPR process Dr. Raimondi opined on the importance of examining environmental risk rather than a simple numerical difference. Evaluating risk is consistent with OPA guidance on the appropriate application of ETM/APF, an analysis method which focuses on an evaluation of the broader ecosystem risk rather than abundance of the species entrained. The APF, per Dr. Raimondi, was developed to calculate and express risk in a readily understood metric (area of habitat). Nevertheless, the value of the ETM/APF in its original use was to evaluate the risk to the local aquatic ecological community posed by entrainment at a designated facility's water intake structure. The ETM incorporates this risk by standardizing the entrainment estimate as a function of the overall source population abundance susceptible to entrainment. This allows regulators to evaluate project risks not based on numbers presented out of context (e.g., billions of larvae entrained without reference to how many larvae were in the population at the time of entrainment) but on what proportion of the population is at risk of entrainment mortality. During the NTPR process, Dr. Raimondi provided examples illustrating why a large entrainment estimate from a population with a large and healthy population presents a much smaller risk than does a moderate or small entrainment estimate to population with a naturally low, or depressed by anthropogenic actions, population level.

After evaluating the potential entrainment impacts resulting from operations at the proposed intake site and each alternative site, the feasibility of building a new intake at one of the alternative sites requires additional analyses. An alternative intake site would require new construction of the offshore intake structure and pipelines under the beach to convey the water to the plant located inland of the Pacific Coast Highway within the AES Huntington Beach, L.L.C. property. Therefore, selection of an alternative intake needs to take into consideration schedule, technical, environmental, social, and economic feasibility criteria associated with the construction and operation of the new intake.

## Data Source

Marine life data produced during the 2003-04 plankton study reported in MBC and Tenera (2005) has been utilized throughout the entrainment evaluation of the HBDP. Near-weekly sampling occurred at the proposed intake site (Station E) and monthly sampling was conducted at six source water stations initially used to contextualize the larval concentrations at the proposed intake site (Figure 2). For this intake site evaluation, only those monthly sampling events where all seven stations were sampled within the same 24-hr period were used to minimize the effect of temporal variation in the plankton community that would arise if Station E only sampling events were included. The 2003-04 plankton study was developed and executed under the guidance and oversight of a team of stakeholders and scientists jointly empaneled by the California Energy Commission and AES Huntington Beach, LLC. It included many of the same scientists that participated in the various expert review panels the SWB used during the OPA development. These scientists included Drs. Michael Foster and Gregg Cailliet of Moss Landing Marine Laboratories and Dr. Peter Raimondi of the University of California, Santa Cruz. Through their involvement, one of the most comprehensive and robust entrainment characterization studies was conducted that served as a model for studies that followed for other once-through-cooled power plants in compliance with study requirements under the then applicable United States Environmental Protection Agency's implementation of Clean Water Act Section 316(b).

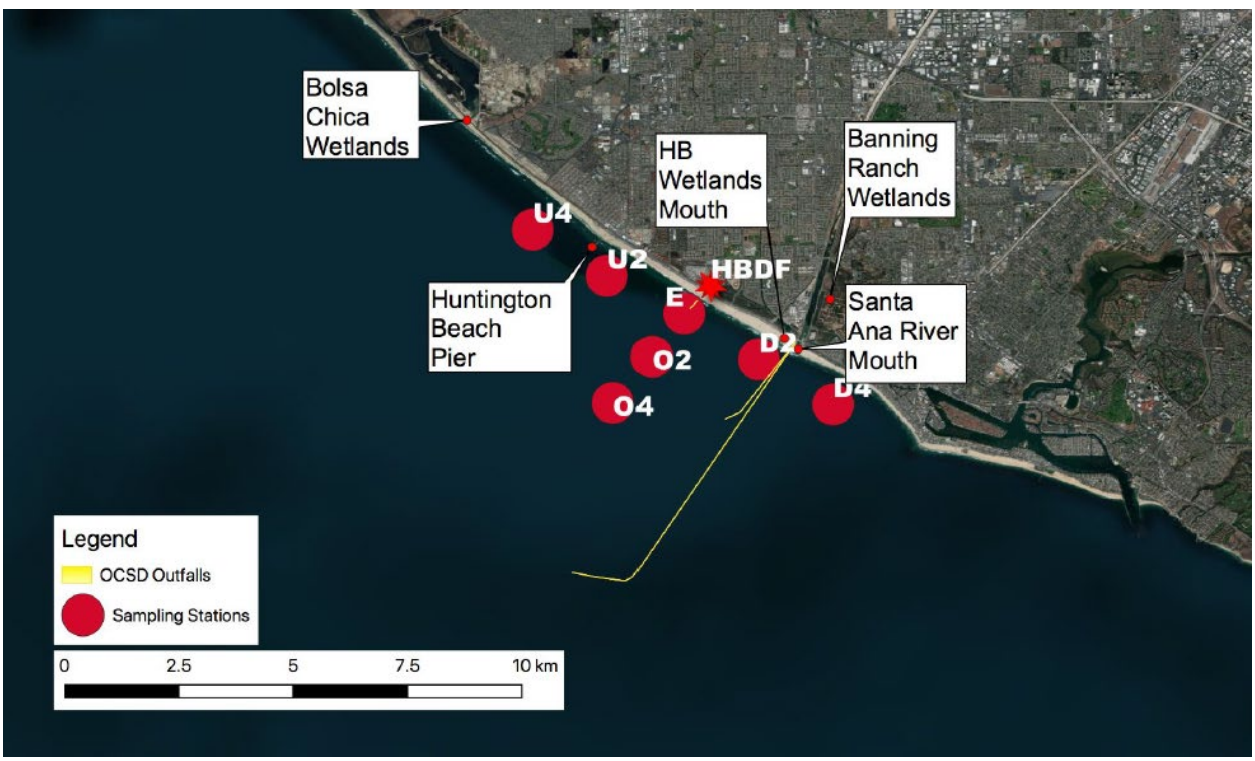


**Figure 2. Sites sampled during the 2003-04 plankton field sampling by MBC and Tenera (2005). Sensitive habitats and landmarks relevant to the analysis are also indicated.**

A confirmatory study in 2014-15 sampling plankton near the proposed intake site found a community and overall mean concentration of fish larvae commensurate with that recorded during the 2003-04 study (Steinbeck and Miller 2015; Attachment 1). These results and similarities between the two sampling efforts indicated no material change was expected in the community

and reinforced the continued use of the 2003-04 study data as representative of the likely plankton community potentially entrained by the HBDP.

# Multiple Lines of Evidence Analysis

## Previously Submitted Quantitative Multiple Lines of Evidence Analysis

A detailed summary of the MLE is provided in MMSC (2018; Attachment 2) and is consistent with the NTPR final draft reports provided by Dr. Raimondi on November 27, 2018.

Three MLE were initially agreed upon by Poseidon and the regulatory agency staff, but additional analyses are required per the OPA instructions for site selection. Consistent with standard scientific practice, statistical testing was done to confirm the differences between sites were due to true differences in the measured parameter, such as mean larval concentration, rather than random chance. The NTPR recommended against traditional inferential statistics, but rather recommended following the statistical procedures he developed for use in the California Coastal Commission-required monitoring for the Wheeler North Artificial Reef built by The Southern California Edison Co. as mitigation for impacts by the San Onofre Nuclear Generating Station (Reed et al. 2018). Therefore, those mutually agreed upon MLE are presented here, and the OPA-required additional lines of evidence are also presented below.

An initial screening was done to exclude any station that showed the highest impacts based on any one of the MLE; therefore, Stations O2, O4, and D4 were excluded from further consideration. Subsequent conversations with Dr. Raimondi and agency staff during the NTPR process excluded U4 from further consideration. The MMSC conclusions were:

1. Application of the ETM/APF was unsupported in this instance as the needed data is not collected when studies are completed in accordance with the OPA, and associated administrative record, sampling guidance
2. MMSC proposed using the median larval concentration instead of the mean larval concentration (MLC) as the median is less sensitive to outliers and the skewed data distributions common to ecological field data (Sokal and Rohlf 1995). The median (and mean) was highly sensitive to the distribution of the top two or three abundant larval taxa, but insensitive to the remaining taxa. The MLC by site was, in ascending order, U2, E, and D2. Statistical significance testing determined the median concentration at Site D2 was significantly higher than at the remaining sites. Using the mean larval concentration, as Dr. Raimondi did, the three candidate sites ranked in ascending order of mean concentration as U2, D2, and E.
3. A standardized larval concentration (SLC) was incorporated, as suggested by Dr. Raimondi, as a measure to give all taxa equal weight in the analysis. Unlike the MLC, the SLC placed the concentration of each taxon at a given station into the context of its concentration across all stations. This was similar to part of the ETM where the estimated entrainment is contextualized as a proportion of the total source population for that taxon in the sampling area, or proportional entrainment ($P_e$). The proposed intake site (E) had the lowest SLC of all stations analyzed in both methods of calculating the SLC. Using the method proposed by MMSC, the SLC at the proposed intake site was significantly less

than the corresponding SLC at each other site. No significant difference was detected between proposed site E and either site U2 or D2 based on the NTPR's recommended SLC method.

Outside of the three MLE mutually agreed upon, MMSC (2018) conducted new additional analyses to evaluate which species would be most impacted by entrainment at each intake site. Included in this analysis was each of the analyzed taxon's status as a fished taxon or consideration to benefit from MPA protections. Of the three final candidate sites, Site E had the least impact on taxa that were either fished or considered likely to benefit from MPA protections (Table 1).

**Table 1. Twenty-five most abundant larval taxa occurring in the 2003-04 plankton sampling program. The taxon-specific abundances were ranked across the seven sites to represent where the taxon was most to least abundant. Fished represents if the taxon was considered to support a recreational or commercial fishery (or both) as well as if the California Department of Fish and Game South Coast Marine Protected Area Science Advisory Team considered the taxon likely to benefit from MPA protection. Fished and MPA designations based on Appendices C-1 and D in http://www.dfg.ca.gov/marine/pdfs/rpsc/body_part2.pdf. Red text denotes those taxa were considered both fished and likely to benefit from MPA protection.**

| Taxa | D2 | E | U2 | Fished (App D.) | MPA (Table C-1) |
|---|---|---|---|---|---|
| *Emerita analoga* (zoea) | 4 | 6 | 5 | NO | YES |
| *Gobiidae* unid. | 6 | 5 | 3 | NO | NO |
| *Engraulis mordax* | 2 | 6 | 7 | YES | NO |
| *Seriphus politus* | 5 | 4 | 1 | YES[1] | NO |
| *Genyonemus lineatus* | 1 | 2 | 3 | YES | NO |
| *Sciaenidae* unid. | 3 | 1 | 4 | YES | NA |
| *Hypsoblennius* spp. | 3 | 2 | 4 | NO | NO |
| *Paralichthys californicus* | 3 | 2 | 5 | YES | NO |
| *Paralabrax* spp. | **4** | **2** | **3** | YES | YES |
| *Paralabrax clathratus* | **3** | **2** | **5** | YES | YES |
| *Atherinopsis californiensis* | 3 | 5 | 7 | YES | NO |
| larvae, unidentified yolksac | 3 | 2 | 4 | NA | NA |
| *Sardinops sagax* | 1 | 3 | 4 | YES | NO |
| *Sphyraena argentea* | 5 | 1 | 4 | YES | NO |
| *Chromis punctipinnis* | **1** | **1** | **1** | YES | YES |
| Engraulidae | 7 | 5 | 1 | NA | NA |
| *Hypsopsetta guttulata* | 5 | 1 | 7 | YES | NO |
| *Citharichthys stigmaeus* | 3 | 4 | 2 | YES | NO |
| *Cancer gracilis* (megalops) | 1 | 5 | 6 | YES | NO |
| *Cancer anthonyi* (megalops) | **5** | **6** | **7** | YES | YES |
| *Cancer antennarius* (megalops) | **1** | **2** | **6** | YES | YES |
| *Lepidogobius lepidus* | 4 | 2 | 3 | NO | NO |
| larval fish fragment | 2 | 5 | 6 | NA | NA |
| *Leuresthes tenuis* | 7 | 4 | 5 | NO | YES |
| *Pleuronichthys ritteri* | 3 | 1 | 4 | YES | NO |
| Remaining Taxa - Sum | 3 | 1 | 2 | | |
| Number of Taxa ID'd | 51 | 54 | 58 | | |
| Sum of Ranks | 88 | 80 | 109 | | |

## New OPA Sections III.M.2.b.(3) and (4) Lines of Evidence Analyzed

Recent meetings with agency staffs indicated evaluating estimated entrainment totals may be of interest in their decision-making process. In response, Poseidon investigated taxon-specific impacts in accordance with Section III.M.2.b.(3) and (4) of the California Ocean Plan. The estimated annual entrainment was calculated for each taxon using the same methods described in MBC and Tenera (2005) included in Attachment 3 with a table of the HBDP estimated results. Briefly, these estimates were calculated by summing each of the 12 survey-specific entrainment estimates. Each taxon was assigned to the potential intake site where it would be most impacted by entrainment based on where its highest entrainment estimate was calculated. Using this same dataset, each taxon was categorized for its status as fished or not fished, documented depressed standing stock or not, managed under a Fishery Management Plan (State or Federal) or not, and protected by a harvest moratorium or not (Table 2).

Seventy-seven taxa were documented amongst the catches from at least one of the three candidate[3] sites evaluated. Taxa taken exclusively at one of the other four sites not amongst the final candidate sites were excluded from this analysis. Of the identified taxa, the mole crab (*Emerita analoga*) accounted for 37% of the total entrainment. The estimated entrainment at each site including all 77 taxa ranged from 84 million larvae at Site U2 to 119 million larvae at Site E. If mole crab is removed, the distribution changes to 52 million larvae at Site U2 to 73 million larvae at Site D2, with 58 million at Site E. At an estimated 61 million individuals entrained, mole crab accounts for more than 50% of all entrainment at Site E. Put another way, more mole crab are entrained at Site E than all of the remaining 76 taxa combined. Less than 32 million mole crab would be entrained at either remaining site. Therefore, to be consistent with explicit and implied intent of the OPA Section III.M.2.b., a more detailed accounting of taxon-specific impacts was warranted. Taxon-specific analyses included only those taxa identified to at least the taxonomic family level. Generic, unidentified “larval fish” categories were excluded from the taxon-specific analysis.

First, the number of taxa that would be more severely impacted by entrainment through an intake located at each site ranged from 33 (including a tie for Northern Anchovy) at Site U2 to 18 (including a tie for Northern Anchovy) at Site E (Table 2). Twenty-three taxa would be most severely impacted by entrainment through an intake at Site D2. Of the taxa likely to suffer the largest impact at each site, 16 were fished (commercial or recreational) at Site U2, followed by nine at Site D2, and six at Site E. Garibaldi (*Hypsypops rubicundus*) was the only protected taxon taken during the 12 surveys, and those exclusively occurred at Sites U2 and D2, but none were caught at Site E during the 12 surveys. Pacific Sardine (*Sardinops sagax*) was also included as a moratorium taxon as the fishery is presently closed due to standing stock concerns as of December 21, 2018: *A precautionary measure is built into sardine management to stop directed fishing when the population falls below 150,000 metric tons. The latest population estimate is below that level, and managers have closed the fishery* (NOAA 2018). Pacific Sardine were predominantly caught at Site U2, with a smaller number occurring at Site E and none at Site D2.

[3] Candidate and potential are used interchangeably throughout this document with each having the same meaning as the other.

**Table 2. Distribution of the identified taxa entrained at one of the three candidate sites. Each taxon is listed under the site where its estimated entrainment was the highest. Taxonomy was not updated from MBC and Tenera (2005) to maintain easy comparability with the original report and dataset.**

| U2 | E | D2 |
|---|---|---|
| ***Engraulis mordax* (tie)** | *Emerita analoga* (zoea) | Gobiidae unid. (CIQ Goby) |
| ***Genyonemus lineatus*** | ***Engraulis mordax* (tie)** | ***Seriphus politus*** |
| **Sciaenidae unid.** | Atherinopsidae | ***Leuresthes tenuis*** |
| *Hypsoblennius* spp. | *Ilypnus gilberti* | **Engraulidae** |
| *Atherinopsis californiensis* | Syngnathidae unid. | ***Paralabrax* spp.** |
| ***Cancer anthonyi* (megalops)** | *Citharichthys stigmaeus* | *Gillichthys mirabilis* |
| ***Paralichthys californicus*** | *Gibbonsia* spp. | *Cheilotrema saturnum* |
| *Hypsopsetta guttulata* | Paralichthyidae unid. | ***Sphyraena argentea*** |
| ***Cancer gracilis* (megalops)** | Myctophidae unid. | *Leptocottus armatus* |
| ***Cancer antennarius* (megalops)** | Pleuronectidae unid. | *Lepidogobius lepidus* |
| ***Roncador stearnsi*** | *Clevelandia ios* | *Hypsypops rubicundus* |
| ***Paralabrax clathratus*** | ***Cancer productus* (megalops)** | *Pleuronichthys ritteri* |
| ***Sardinops sagax*** | *Triphoturus mexicanus* | *Acanthogobius flavimanus* |
| *Pleuronichthys* spp. | ***Cancer* spp. (megalops)** | Ophidiidae unid. |
| Labrisomidae unid. | ***Cancer* spp.** | *Ruscarius creaseri* |
| Haemulidae | Agonidae unid. | ***Atractoscion nobilis*** |
| *Pleuronichthys verticalis* | ***Sebastes* spp. V_De** | ***Merluccius productus*** |
| *Gobiesox* spp. | ***Sebastes* spp. VD** | *Syngnathus leptorhynchus* |
| ***Citharichthys* spp.** | | *Artedius lateralis* |
| *Oxyjulis californica* | | ***Umbrina roncador*** |
| *Hypsoblennius jenkinsi* | | *Oxylebius pictus* |
| *Xystreurys liolepis* | | *Artedius* spp. |
| ***Sebastes* spp. V** | | **Scombridae unid.** |
| ***Cancer oregonsis* (zoea V)** | | |
| *Xenistius califoriensis* | | |
| *Gobiesocidae unid.* | | |
| *Typhlogobius californiensis* | | |
| *Stenobrachius leucopsarus* | | |
| *Icelinus* spp. | | |
| ***Citharichthys sordidus*** | | |
| ***Sebastes* spp. V_D** | | |

| | | |
|---|---|---|
| ***Panulirus interruptus* (puerulus stage)** | | |
| *Ophidion scrippsae* | | |
| 16 Fished | 6 Fished | 9 Fished |
| **Boldface** = fished taxon | | |

Using these entrainment estimates, estimated entrainment by site for each category listed (fished, depressed standing stock, and under a harvest moratorium) was calculated (Table 3). The most fished taxa would be entrained at Site U2. Taxa without clear status as fished or not fished were excluded from the totals. Impacts to taxa with documented depressed standing stocks peaked at Site D2 with the least at Site E. Taxa with no information on their standing stock status were categorized as NA. Entrainment of taxa protected by a harvest moratorium peaked at Site U2 with the least at Site E.

**Table 3. Estimated annual entrainment (number of larvae) from each category by intake site. Taxa not clearly defined under each category were excluded from the analysis.**

| Fished | U2 | E | D2 |
|---|---|---|---|
| Yes | 28,625,169 | 26,258,019 | 24,981,253 |
| No | 51,706,730 | 89,977,297 | 58,180,124 |
| | | | |
| **Depressed Standing Stock** | **U2** | **E** | **D2** |
| Yes | 9,578,282 | 9,138,567 | 10,685,552 |
| NA | 63,970,401 | 102,369,551 | 65,501,553 |
| | | | |
| **Harvest Moratorium** | **U2** | **E** | **D2** |
| Yes | 517,472 | 130,715 | 199,530 |
| No | 83,423,020 | 118,694,355 | 87,378,336 |

## Nearshore Coastal Oceanographic Patterns

Rasmussen (2018; Attachment 4) reviewed the wealth of available oceanographic information for the Huntington Beach, California area compiled over years of monitoring the Orange County Sanitation District's outfalls. This review resulted in several conclusions relevant to the siting of the HBDP surface water intake structure. The broad scale circulation is determined by the southward flowing California Current branching off south of Pt. Conception and turning shoreward around the Channel Islands, joining the California Undercurrent in a turn northward over the middle of the San Pedro Shelf. The currents over the San Pedro shelf are significantly correlated in the alongshore direction, with correlation length scales of 25-30 km, and are extremely correlated over the scale of the proposed intake sites (<10 km). Little difference would be expected in current behavior between sites over that distance along the coast. Ocean currents over the San Pedro shelf are not well correlated in the cross-shelf direction. Inner shelf currents can be in the opposite direction from the mid-shelf, and slow rapidly with depth. Outer shelf currents are more vertically homogenous through mid-depths but are similarly weak near the bottom. The primary difference here between shallower and deeper sites is the presence of a moderately strong flow at mid-depths (approximately 12-15 m above bottom) at the deeper sites

(e.g., Site O4). Different forcing mechanisms over the mid-outer shelf and inner shelf essentially decouple currents over the two areas. The result is higher average surface current velocity in the shallower region where sites D4, D2, E, U2, U4 and O2 are located. Site O4 is near the inner-middle shelf transition and may have somewhat slower surface currents.

# II. REGULATORY GUIDANCE – OCEAN PLAN AMENDMENT

In support of Poseidon's application for a NPDES Permit renewal (submitted March 15, 2016), a total of over 120 technical documents were submitted. Those documents provide technical information intended to support a Water Code determination for the proposed HBDP in accordance with Ocean Plan chapter III.M. In particular, the question of the best intake site was comprehensively evaluated by agency staff as well as the independent reviewer selected for the NTPR process (per section III.M.2.a.(1)). The objective of the intense evaluation was to identify the best site for the proposed screened surface intake. As outlined in the OPA, selecting the best site (defined as *the general onshore and offshore location of a new or expanded facility*) requires analysis of a number of factors described in section III.M.2.b. The section below provides a response to each factor described in this "site" section of the OPA that focuses on the biological considerations that can affect the intake and mortality of all forms of marine life.

## III.M.2.b.(3) – Avoid Sensitive habitats and Sensitive Species

Multiple submittals were provided relative to the feasibility of placing the intake in a location that avoids impacts to sensitive habitats and sensitive species. Compliance with this section of the OPA is discussed below in two sections: sensitive habitats and sensitive species.

### Sensitive Habitats

Sensitive habitats are defined in the OPA as: *kelp beds, rocky substrate, surfgrass beds, eelgrass beds, oyster beds, spawning grounds for state or federally managed species, market squid nurseries, or other habitats in need of special protection as determined by the Water Boards*. Sensitive habitats in the vicinity of the proposed HBDP intake include:

- Bolsa Chica Wetlands which includes two areas designated as MPAs which include many of the habitats (e.g., eelgrass beds) defined as sensitive in the OPA:
    1. Bolsa Bay State Marine Conservation Area
    2. Bolsa Chica Basin State Marine Conservation Area
- Upper Newport Bay State Marine Conservation Area (MPA)
- Huntington Beach Wetlands
- Santa Ana River mouth
- Hard/rocky substrate associated with the Huntington Beach Pier and Orange County Sanitation District's (OCSD) rip rap armoring on the outfall structures
- Nursery grounds for depressed species

After multiple meetings with agency staff, agreement was reached on December 18, 2018 that the potential intake sites under consideration would be limited to U2, E, and D2. Given this narrowing of the potential intake sites, consideration must be given to the location of each of these sites relative to sensitive habitats listed above.

#### MPAS

Relative to the mouth of the Bolsa Chica Wetlands (two Bolsa Chica MPAs), potential intake site U2 is the closest (approximately 3.1 miles). By comparison, potential intake site E is approximately 4.4 miles from the mouth of the Bolsa Chica Wetlands. Given the OPA instruction to "*avoid sensitive habitats*" and the OPA requirement (at III.M.2.b.(7)) that "*surface intakes shall be sited so as to maximize the distance from a MPA*", potential intake site U2 is indisputably worse than potential intake sites E and D2 (Figure 3).

Relative to the mouth of the Upper Newport Bay Wetlands MPA, potential intake site D2 is the closest (approximately 5.8 miles). By comparison, potential intake site E is approximately 7.0 miles from the mouth of the Newport Bay Wetlands MPA. Given the OPA instruction to "*avoid sensitive habitats*" and the OPA requirement (at III.M.2.b.(7)) that "*surface intakes shall be sited so as to maximize the distance from a MPA*", potential intake site D2 is indisputably worse than potential intake sites E and U2.

#### NON-MPA SENSITIVE HABITATS

Other sensitive habitats not associated with an MPA exist in the vicinity of the potential intake sites being considered; the most important of which are the nursery grounds for Giant Sea Bass (*Stereolepis gigas*) and artificial rocky substrate associated with nearby OCSD outfall rip rap armoring[4]. Therefore, potential intake site D2 is indisputably worse than potential intake sites E and U2 due to its proximity to the head of the Newport Submarine Canyon where Giant Sea Bass juveniles aggregate.

Relative to the mouth of the Huntington Beach Wetlands, potential intake site D2 is the closest (0.0 miles). By comparison potential intake site E is approximately 1.2 miles from the mouth of the Huntington Beach Wetlands. Given the OPA instruction to "*avoid sensitive habitats*", potential intake site D2 is indisputably worse than potential intake sites E and U2 (Figure 3).

## Sensitive Species

Sensitive species are not defined in the OPA, but, according to the SED, they are: *organisms that can only survive within a narrow range of environmental conditions, are sensitive to anthropogenic stresses, or are in need of special protection*. As recommended in the SED, Poseidon consulted the California Natural Diversity Database and the California Department of Fish and Wildlife's list of "special animals" (*the species most at risk or most in need of conservation efforts*, per the SED) to identify the sensitive marine species in the vicinity of the potential intake locations. Giant Sea Bass stand out as a sensitive species that garners attention.

[4] The armoring around the Huntington Beach Generating Station intake at Site E is excluded from this analysis as the HBDP intake riser will have similar rip rap armoring regardless of which of the three sites is selected.

**Figure 3. Location of the three candidate intake sites in the final evaluation, the two mouths of wetland complexes, the Orange County Sanitation District (OCSD) ocean outfalls, and the location of Giant Sea Bass observations in the Huntington Beach and Newport area. The "32" showing on the Giant Sea Bass Sightings symbol reflects their density at the site, or 32 Giant Sea Bass young-of-the-year/hectare reported in Benseman and Allen (2018).**

### GIANT SEA BASS

Giant Sea Bass occur in the vicinity of the potential intake sites under consideration and are in need of special protection. Giant Sea Bass are internationally recognized as critically endangered by the International Union for the Conservation of Nature (IUCN) and are protected by the State of California via a moratorium prohibiting both targeted commercial[5] and recreational fishing. Nursery grounds for young-of-the-year Giant Sea Bass were recently identified near the head of the submarine canyon off Newport Beach (Benseman and Allen 2018). Based on the location of the nursery area, potential intake site D2 would be likely to result in the greatest intake and mortality of this sensitive species.

[5] Commercial gill net fishers are allowed to land one Giant Sea Bass daily as incidental catch.

# III.M.2.b.(4) – Direct and Indirect Effects of Construction and Operation, Individually and in Combination with Potential Anthropogenic Effects

Poseidon has analyzed and summarized the direct and indirect effects on all forms of marine life associated with construction and operation of a screened ocean intake at the potential intake sites being considered.

## Construction Impacts

Impacts associated with construction of an intake at potential site U2 or D2 are clearly greater than at proposed intake site E as heavy onshore and offshore construction would be required to install pipelines to convey water to the onshore HBDP facility. Comparatively, no new intake pipelines would need to be constructed to implement an intake at potential site E as all the existing HBGS infrastructure is already in place and would simply be repurposed for the proposed HBDP.

## Operational Impacts

Impacts associated with the operation of an intake at the three potential intake sites being considered are evaluated in Chapter I above with a particular focus on the *potential anthropogenic effects on all forms of marine life resulting from other past, present, and reasonably foreseeable future activities*. Previous analyses of potential entrainment impacts were focused on risk-based approaches (ETM/APF). Using a risk-based analysis framework was also suggested as the preferred approach of the Neutral Third-Party Reviewer Dr. Peter Raimondi. During the NTPR process, additional efforts were expended to assess measures of taxon-specific entrainment risk (i.e., standardized larval concentration). During more recent engagement with agency staff and Dr. Raimondi, the effort to assess taxon-specific risk was grossly simplified to a simple accounting of annual entrainment at each of the three potential intake sites being considered.

Poseidon has therefore estimated simple annual entrainment for each of the three remaining potential intake sites being considered. However, to assess the required "*direct and indirect effects…individually and in combination with potential anthropogenic effects*" we have also put these estimates into context. We have subsequently determined at which intake site each taxon would be impacted the most. Those taxa were then categorized according to their status relative to anthropogenic effects (whether it is fished commercially or recreationally, whether it is a protected species, and whether it is a depressed taxon).

Of the 77 taxa collected at the three potential intake sites, 33 taxa would be more severely impacted at U2, 23 would be more severely impacted at D2, and 18 taxa would be more severely impacted at E. Furthermore, more than half of the individuals entrained at E were mole crab, a species at very low risk of a population-level impact due to their abundance (Dugan et al. 2015). The most fished taxa would be entrained at potential intake site U2. Impacts to taxa with documented depressed standing stocks peaked at potential intake site D2 with the least at potential intake site E. Entrainment of taxa protected by a harvest moratorium (Garibaldi and Pacific Sardine) peaked at potential intake site U2 with the least at potential intake site E.

Based on the analysis required at III.M.2.b.(4) of the OPA, when taking into account direct and indirect impacts and the status (relative to the past, present, and reasonably foreseeable future

activities within the area) of the taxa likely to be impacted at each of the potential intake sites, intake site E is the best available intake site.

## III.M.2.b.(5) – Oceanographic, Geologic, Hydrogeologic, and Seafloor Topographic Conditions

Given the proximity of the three potential intake sites (2.4 miles apart) and the homogeneity of the conditions at each, it is not reasonable to expect any differences in the oceanographic, geologic, hydrogeologic, and seafloor topographic conditions at the three potential intake sites under consideration. In fact, these conditions are extremely homogenous in the offshore area that encompasses the three potential intake sites (U2, E, and D2). Each condition listed in this section of the OPA is addressed briefly below.

The oceanographic conditions that govern the currents at each of the potential intake sites suggest little difference would be expected in current behavior between sites over this distance along the coast (Rasmussen 2018).

The geologic and hydrogeologic conditions were thoroughly characterized in the ISTAP process (see NPDES Renewal Application Appendices F, G, QQQQ and CCCCC). The seafloor in the area is predominantly homogeneous sandy soft-bottom, except for the artificial armoring done to protect the OCSD outfalls. Annual sediment characterizations of the area stretching up and downcoast one mile from the Huntington Beach Generating Station intake structure consistently finds predominantly sand (>90% of all sediments), silt, and clay with little to no gravel (MBC 2016). Additional sampling offshore the San Gabriel River mouth to the northwest and around the OCSD outfall to the southeast documented similar sediment compositions confirming the area is predominantly sandy bottom habitat (MBC 2015 and OCSD 2016).

Based on a review of the information that has been submitted to the record, there is nothing to suggest that any one of the three remaining potential intake sites would have different oceanographic, geologic, hydrogeologic, or seafloor topographic conditions than another; they are functionally indistinguishable. Therefore, any differences in the intake and mortality of all forms of marine life are likely the result of natural inherent variation in plankton.

## III.M.2.b.(7) – Avoid Infrastructure in MPA or SWQPA and Maximize Intake Distance from a MPA or SWQPA

The section above which responds directly to III.M.2.b.(3) provides information on how the intake can be sited to prevent impacts to sensitive habitats and sensitive species. The section includes a discussion explicitly addressing the distance of the potential intake sites from MPAs. None of the potential intake sites are located within a MPA or SWQPA. The closest MPA to any of the potential intake sites are the two MPAs that are part of Bolsa Chica Wetland (Bolsa Bay State Marine Conservation Area and Bolsa Chica Basin State Marine Conservation Area). Since this section of the OPA states that "*surface intakes shall be sited so as to maximize the distance from a MPA or SWQPA*", potential intake site U2 is indisputably the worst since it is the closest to these MPAs (Figure 4).

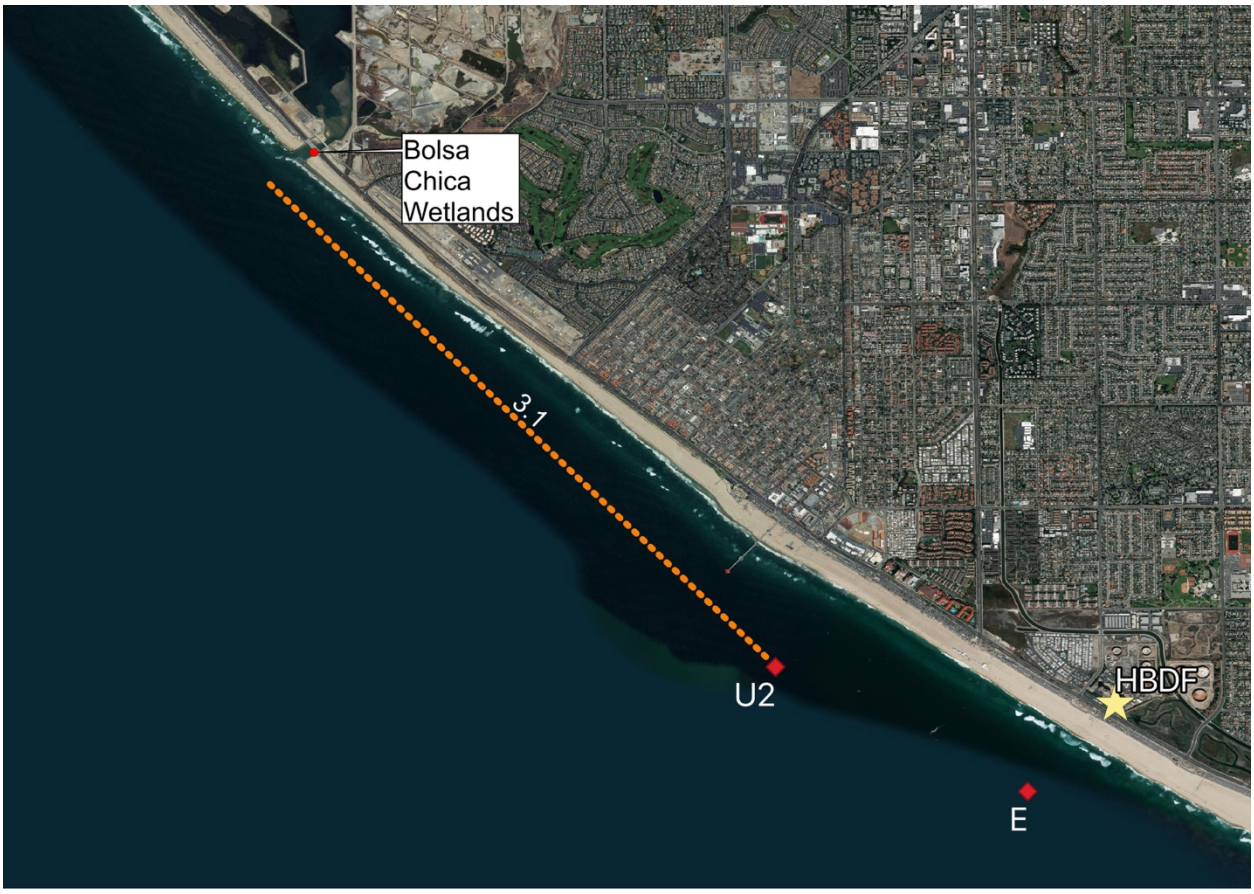


**Figure 4. Distance (3.1 miles) between potential intake site U2 and the closest MPAs: Bolsa Bay State Marine Conservation Area and Bolsa Chica Basin State Marine Conservation Area.**

# III. FEASIBILITY CONSIDERATIONS

Section M.2.a.(2) of the OPA states that the regional water board shall conduct a Water Code section 13142.5(b) analysis for new seawater desalination facilities by taking into account the feasibility of each alternative for the site, design, technology, and mitigation. Feasible is defined as "*capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors*." A full feasibility analysis for each potential intake site is included in Attachment 5 and summarized here.

Implementing a screened intake at potential intake sites D2 or U2 would be *technically infeasible* due to site constraints since the air burst system would have to be located on the beach (subject to sea level rise) since the HBDP site is too far from site D2 to accommodate an effective air burst system. Implementing an intake at D2 or U2 would be *economically infeasible*, as it would add $510M in total construction costs as compared to the proposed intake site E, increasing the project construction costs by approximately one-half without any quantifiable environmental benefit to justify the added costs. Implementing an intake at D2 or U2 would take between 11 and 13 years to complete (relative to 4.5 years for proposed site E), and therefore *cannot be completed in a reasonable timeframe*. Implementing an intake at D2 or U2 would be *socially*

*infeasible* due to impacts to major tourist-generating events (e.g., Great Pacific Airshow and the U.S. Open of Surfing), beach closures, and recreational impacts.

Finally, implementing an intake at U2 is *environmentally infeasible* as it conflicts with the specific direction in the OPA that screened intakes shall be located a maximum distance feasible from MPAs. Implementing an intake at D2 is *environmentally infeasible* as it would put the intake adjacent to the mouth of the restored Huntington Beach wetlands complex and pose the maximum risk to sensitive species (Giant Sea Bass) that have been documented to occur in that area. Potential intake sites U2 and D2 were found to have the lowest entrainment counts using a simplistic annual entrainment estimate by site but disregarding statistical significance and species-specific impacts that captures the risk to all forms of marine life contemplated by the OPA. For both alternative intake sites (D2 and U2), other environmental concerns would include exceedance of the daily SCAQMD construction threshold for oxides of nitrogen (NOx); negative impacts to aesthetics in a visually-sensitive area; potential for hazardous offshore work conditions associated with the trestle structure; and exposure of sensitive receptors to construction noise for significantly longer than an intake at proposed site E.

Based on a consideration of the five feasibility criteria, implementing an intake at potential intake site U2 or D2 is constrained: substantially longer implementation schedules (up to 10 years to develop, permit, construct, and commission), substantially greater social impacts (e.g., beach closures and associated economic impacts on tourism), substantially greater cost implications, and substantially greater technical construction challenges. Therefore, taking into account the five feasibility factors (schedule, economic, environmental, social, and technological), proposed intake site E is the most superior site for the 1-mm screened seawater intake.

**Table 4. Feasibility summary for alternative intake site U2 and D2 as compared to proposed intake site E.**

| Feasibility Category | Intake Site U2 | Intake Site D2 |
|---|---|---|
| Technical Feasibility | Significant onshore constraints - aboveground airburst system would be located in an area effected by sea level rise. | Significant onshore constraints - aboveground airburst system would be located in an area effected by sea level rise. |
| Economic Feasibility | Implementation would result in an additional $510M in total life cycle costs | Implementation would result in an additional $510M in total life cycle costs |
| Environmental Feasibility | | |
| Biological Resources | Permanent loss of a small amount of benthic habitat equivalent to 0.088 acres would occur. Potential intake site U2 is indisputably the closest to the nearest MPAs in Bolsa Chica Wetlands and should be eliminated from further consideration. | Permanent loss of a small amount of benthic habitat equivalent to 0.088 acres would occur. Siting an intake at D2 would pose the maximum risk to sensitive species (Giant Sea Bass) that have been documented to occur in that area. D2 is located adjacent to the opening of the restored Huntington Beach Wetlands Complex |

| | | |
|---|---|---|
| Air Quality | Construction of the alternative intake system would contribute further to the exceedance of the SCAQMD construction threshold for NOx. | Construction of the alternative intake system would contribute further to the exceedance of the SCAQMD construction threshold for NOx. |
| Energy and GHG Emissions | Operation would result in additional electricity demand and GHG emissions; however, no significant impact would occur. | Operation would result in additional electricity demand and GHG emissions; however, no significant impact would occur. |
| Land Use | Significant impacts associated with the temporary loss of recreational land use access and usage would occur. | Significant impacts associated with the temporary loss of recreational land use access and usage would occur. |
| Aesthetics | Significant temporary visual impacts would occur. | Significant temporary visual impacts would occur. |
| Hazards | Potential hazards associated with offshore construction would occur; however, this would not result in a significant impact. | Potential hazards associated with offshore construction would occur; however, this would not result in a significant impact. |
| Noise | Significant temporary noise and vibration impacts would occur. | Significant temporary noise and vibration impacts would occur. |
| Transportation | Additional construction traffic would occur; however, this would not result in a significant impact. | Additional construction traffic would occur; however, this would not result in a significant impact. |
| Social Feasibility | | |
| Commercial and Recreational Fishing | Impacts would occur during up to 8-year construction period. | Impacts would occur during up to 8-year construction period. |
| Recreation and Access | Impacts would occur during up to 8-year construction period. | Impacts would occur during up to 8-year construction period. |

# IV. SUMMARY AND CONCLUSIONS

The detailed site assessment presented above combines material presented in prior reports (submitted to the administrative record as appendices to the NPDES Renewal Application) and original analyses unique to this report. Throughout this report, the goal was to evaluate which intake site (represented by the sampling locations used by MBC and Tenera (2005)) would result in the least environmental impact per the criteria listed in OPA Section M.2.b (Table 5). It is important to note that an offshore surface intake suitable for use by the HBDP after adding 1-mm cylindrical wedgewire screens exists at Site E and has been the intake site included in all prior regulatory approvals including NPDES and CEQA. The best site available analyses included the MLE agreed upon with the regulatory agency staff but was expanded herein to include a deeper investigation of taxon-specific impacts at each site. In addition, this report explicitly addresses the requirements of the OPA which states that the applicant must evaluate seven parameters (per III.M.2.b) to determine the best available site. Among those OPA requirements are the directives

to maximize the distance between the intake site and MPAs, sensitive habitats, and sensitive species.

The MLE approach concluded that applying the ETM/APF to the existing data was inappropriate and failed to provide a reliable result. Therefore, the ETM/APF was eliminated as an alternative site evaluation tool. Differences were detected in the mean larval concentration (MLC) among potential intake sites. Of the final three candidate intake sites (U2, E, and D2), Site U2 had the lowest 50% confidence interval MLC followed by Sites D2 and E. These differences, however, were not statistically significant using the method recommended by during the NTPR process Dr. Raimondi. The significance testing method recommended by Dr. Raimondi was the California Coastal Commission's contract scientist's method used for assessing the performance of the San Onofre Nuclear Generating Station mitigation projects. Using the standardized larval concentration method (SLC) which was recommended by Dr. Raimondi as a means to better assess the overall risk to the environment, entrainment at Site E had substantially lower impacts than the remaining sites. As with the MLC, no statistically significant differences were detected among any of the three sites' SLC using the same California Coastal Commission assessment method. The result of the MLE analysis did not identify an alternative intake site as clearly superior to the proposed intake site at station E.

**Table 5. Comparison of site parameters relative to the intake site analysis.**

| Question | Site U2 | Site E | Site D2 |
|---|---|---|---|
| Statistically significant less entrainment impact than other candidate sites? | No | No | No |
| Least number of taxa with maximum entrainment occurring at the site? | No | Yes | No |
| Least entrainment of taxa with peer-reviewed report documenting the standing stock is depressed? | No | Yes | No |
| Least entrainment of taxa protected under a harvest moratorium? | No | Yes | No |
| At maximum distance away from an MPA, sensitive species nursery habitat, estuary, or other sensitive habitat? | No | Yes | No |
| Positioned on soft/sandy-bottom habitat? | Yes | Yes | Yes |
| Will require temporary/permanent habitat disturbance to install wedgewire screens? | Yes | Yes | Yes |
| Will not require temporary/permanent habitat disturbance to connect intake structure to onshore desalination plant? | No | Yes | No |

Without clear guidance from the MLE that there is site superior to the proposed intake at station E, additional analyses were included by Poseidon to confirm the best available site for the HBDP

surface water intake structure. Continuing with the evaluation of the entrainment analysis, all of the taxa documented at each of the three candidate intake sites (U2, E, and D2) were included in an overall evaluation to determine which site's entrainment poses the greatest risk to the overall community, including any special status or fished taxa. Conventional methods were used to estimate the annual entrainment of each taxon. Total entrainment of all taxa was highest at Site E, but this was reflective of mole crab entrainment which accounted for more than one-half of all entrainment, the highest of any site. Dugan et al. (2015) found mole crab ubiquitous and abundant at all 12 sites surveyed to support MPA baseline establishment, including no difference between beaches inside and outside the MPAs. At 10 of 12 beaches surveyed, the mole crab density exceeded 10,000/$m^2$. Therefore, the need to protect mole crab, with its documented distribution and healthy stock size in the presence of an existing once-through cooled power plant, needs to be balanced with the potential impacts to other, less abundant taxa. Less than 6 million non-mole crab larvae would be put at risk, annually, of entrainment overall by retaining the HBDP intake at Site E versus moving the intake to Site D2. An intake at Site E would protect fifteen (15) million non-mole crab larvae in comparison to Site U2. This cumulative analysis, however, fails to capture the complete story of the potential entrainment impacts to the coastal resources of southern California.

The intake site where the maximum entrainment for each taxon was identified and considered to be the site where that taxon would suffer the greatest impact. Through this analysis, entrainment at Site U2 was found to more severely impact nearly twice as many taxa as entrainment at Site E would impact. An intake at Site D2 would pose the second greatest threat to the community by most severely impacting five more taxa than would be impacted at Site E. Furthermore, sixteen (16) fished taxa would be severely impacted at Site U2, ten (10) more than would be impacted at Site E and seven more than Site D2. An intake at Site E, in comparison to the two alternative intake sites, would minimize the overall entrainment impact on the community as a whole and specifically on fished taxa.

Beyond the numerical analyses used to determine the potential intake and mortality of all forms of marine life, section III.M.2.b. of the OPA requires the project applicant to address seven criteria to answer the question of whether the best available intake site has been identified for the proposed project. Perhaps the most critical among the siting criteria are those that address the location of the intake relative to MPAs, sensitive habitats, and sensitive species. Alternative intake site U2 is indisputably the closest to the nearest MPAs in Bolsa Chica Wetlands and should be eliminated from further consideration. Similarly, siting an intake at D2 would increase the risk to sensitive species (Giant Sea Bass) and place the intake directly offshore the mouth of the Huntington Beach Wetlands. Considering the homogeneity of the sandy, soft-bottom habitat in the offshore area near Huntington Beach, there is nothing to suggest that any one of the alternative intake sites would have conditions different than proposed intake site at station E; they are functionally indistinguishable. Given this, it is much more likely that any numerical differences in larval abundances are the result of natural inherent variation in plankton rather than differences in habitat.

Lastly, when considering the feasibility of constructing a new intake at potential intake sites D2 or U2, the long-term environmental and social impacts associated with the major construction effort far outweigh any material environmental benefit. Evaluation of the five feasibility criteria reveal

that implementing an intake at potential intake site U2 or D2 would result in a substantially longer implementation schedule (between 11 and 13 years to develop, permit, construct, and commission), a substantially greater social impact (e.g., beach closures and associated economic impacts on tourism), a substantially greater cost ($510M in additional costs), and a substantially greater technical construction challenge – all without any scientifically justifiable environmental benefit.

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# ATTACHMENT 1: STEINBECK, J. AND E. MILLER. 2015. COMPARISON OF ICHTHYOPLANKTON DATA COLLECTED AT THE HBGS INTAKE FOR TWO 12-MONTH PERIODS: JULY 2014-JUNE 2015 AND SEPTEMBER 2004-AUGUST 2004. PREPARED FOR POSEIDON WATER. APPENDIX Q OF REPORT OF WASTE DISCHARGE FOR NPDES CA8000403.

POSEIDON WATER

# *Appendix Q - Entrainment Data Summary*
# *November 6, 2015*

***Renewal of NPDES CA8000403***
***Huntington Beach Desalination Project***

TENERA Environmental

# TECHNICAL MEMORANDUM

November 6, 2015

To: Mr. Scott Maloni, Poseidon Water

From: John Steinbeck, Tenera Environmental and Eric Miller, MBC Applied Environmental Sciences

Subject: Comparison of ichthyoplankton data collected at the HBGS intake for two 12-month periods: July 2014–June 2015 and September 2004–August 2004

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## Introduction

This memorandum provides a detailed summary and comparison of the larval fish (ichthyoplankton) communities characterized during two studies in the vicinity of Huntington Beach Generating Station (HBGS) open water intake. One study was conducted from July 2014–June 2015 (2014–15 Study), and the other study was conducted from September 2003–August 2004 as a California Energy Commission Condition of Certification for the retooling and restart of Units 3 and 4 (MBC and Tenera 2005) (2003–04 Study). The sampling for both studies was designed to collect data on ichthyoplankton concentrations in close proximity to the intake as a measure of ichthyoplankton during operation of the seawater intake.

The purpose of the 2014–15 Study was to determine if the data from the 2003–04 Study were representative of the current ichthyoplankton community. The data from the 2003–04 Study have previously been used by permitting agencies to analyze the potential effects of the proposed Huntington Beach Desalination Facility's (HBDF) seawater intake on ichthyoplankton populations,

The comparisons of the two studies in this report were evaluated relevant to the use of the data in an Empirical Transport Model (ETM) based assessment of the effects of the proposed HBDF intake on larval fish and shellfish. The results from ETM can be used to estimate the Area of Production Forgone (APF) for purposes of mitigation. The APF is an estimate of the habitat area necessary to complete compensate for the entrainment losses to a species without any consideration of other factors contributing to the regulation of the population. The ETM was the primary approach used in assessing the effects of the existing HBGS and proposed HBDF intake and use of ETM and APF are required in the State Water Board's Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling and the recent desalination amendment to the California Ocean Plan.

## Methods

Sampling for both studies was conducted offshore (within 100 m) of the HBGS intake structure. Sampling for the 2003–04 Study was conducted two to four times per month (weather dependent) and sampling for the 2014–15 Study was conducted approximately monthly. The sampling equipment and procedures were consistent with established best practices for sampling ichthyoplankton using midwater, oblique bongo net tows as pioneered by the California Cooperative Oceanic Fisheries Investigations (CalCOFI). The CalCOFI program was jointly conducted by the National Marine Fisheries Service, Scripps Institution of Oceanography, and the California Department of Fish and Wildlife (McClatchie 2014). These same methods have been repeatedly used in nearly all entrainment characterizations completed for power plants using submerged offshore seawater intake structures in California. The 2003–04 Study used a wheeled bongo frame fitted with two 0.6-m (2.0 ft) diameter plankton nets constructed of 333-µm (0. 13 in.) mesh to sample the water column from 13 cm (5.1 in.) off the bottom up to the surface. The sampling for the 2014–15 Study used a bongo frame with two 0.71 m (2.3 ft) diameter openings, each equipped with a 335-µm (0.13 in.) mesh plankton net to sample the water column from within 1 m (3.3 ft) of the bottom to the surface. All nets were equipped with a calibrated flowmeter, to record the volume of water filtered.

In both studies, the data for some of the species were combined into taxonomic groups (taxa[1]) because of the difficulty in identifying the earliest life stages of some of the species. Also, to facilitate the comparison between the data from the two studies, the data were combined for some of the taxa due to differences in the levels of taxonomic identification between the two studies.

Comparisons between the two studies were done using estimates of total larval concentration and total annual entrainment based on those concentrations. The annual entrainment estimates were calculated using estimates of larval concentration from each survey that were then extrapolated over the periods between surveys. If all of the survey periods were of equal length, the annual entrainment could be calculated using the average concentration from all the surveys and the total flow for the entire year. As shown in **Table 1**, the twelve surveys during the 2014–15 Study were not equally spaced, and the weight given to each survey in the annual entrainment estimate was based on the number of days in each survey period. The survey periods for the 2003–04 Study varied from weekly to biweekly.

[1] "taxa" refers to a taxonomically distinct group of species, which as larvae cannot be separated into species. The singular form of "taxa" is "taxon".

**Table 1.** Dates and days in survey periods for sampling done at the HBGS intake during the 2014–15 Study.

| Survey | Date | Days in Survey Period |
|---|---|---|
| PHBD01 | 30-Jul-14 | 41 |
| PHBD02 | 3-Sep-14 | 28 |
| PHBD03 | 24-Sep-14 | 25 |
| PHBD04 | 23-Oct-14 | 31 |
| PHBD05 | 25-Nov-14 | 33 |
| PHBD06 | 29-Dec-14 | 29 |
| PHBD07 | 22-Jan-15 | 25 |
| PHBD08 | 17-Feb-15 | 24 |
| PHBD09 | 10-Mar-205 | 35 |
| PHBD10 | 28-Apr-15 | 39 |
| PHBD11 | 28-May-15 | 24 |
| PHBD12 | 15-Jun-15 | 31 |

The differences in the sampling frequency between the two studies affect the ability to directly compare the results. This is one of the reasons that the approach used for the comparison in this technical memo is largely qualitative. A detailed quantitative comparison is not necessary because the numeric differences in abundance for individual taxa between years are much less important than the differences in the total number and type of taxa. There are two reasons why the differences between years for individual taxa are less important than the differences in the total number and type of taxa.

The first reason why differences in abundance for individual taxa are not important is because of the large changes in abundances of fish larvae which occur naturally from year to year. This is shown by data from one of the best long-term databases on nearshore ichthyoplankton abundance in California, which is collected just north of the HBGS in King Harbor, Redondo Beach (Pondella et al. 2012). The results from the King Harbor study show a declining trend in abundance over decades, but also show that changes in larval abundance can be very large among years (**Figure 1**). Therefore, differences in larval abundance between years are expected.

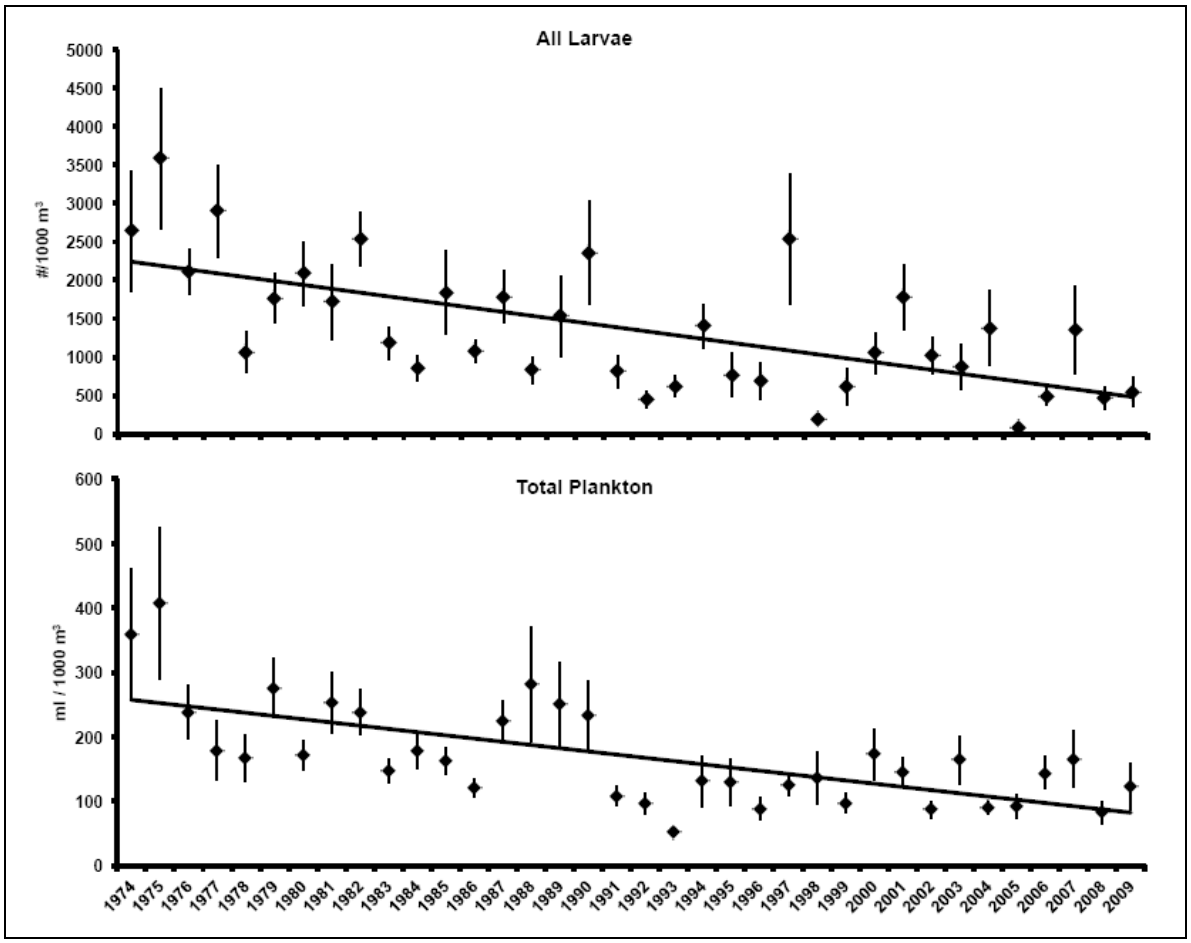


**Figure 1.** Average (± one std. error) total larval fish concentration (# per 1,000 $m^3$) and plankton volume (ml per 1,000 $m^3$) from 1974–2009 from sampling in King Harbor, Redondo Beach. Figure from Pondella et al. (2012).

The second reason why differences in abundance for individual taxa between 2003–04 and 2014–15 are less important than the differences in the total number and type of taxa is due to the ETM model used in the impact assessment. The results of the ETM are estimates of the proportional loss to the source water population due to entrainment. This proportion (or percentage) should be very similar from year to year, regardless of the changes in the abundances of ichthyoplankton, as long as other parameters such as the intake volume and coastal currents remain constant. In fact, one of the reasons for selecting the ETM as the preferred assessment approach in California is the recognition that the variation in the estimates of proportional loss between years should be much less than the variation in abundances. Unlike the ETM, assessment approaches that rely on absolute estimates of entrainment would likely require multiple years of data to provide reliable estimates on the effects of an ocean intake.

Although, the comparison between the results of the two studies is largely qualitative because the actual numeric differences between the taxa for the two studies should have minimal effects on the ETM estimates calculated using the data from the 2003–04 Study, a quantitative comparison of the results is still provided to determine if any differences in community composition occurred between the two studies. A large change in the composition of the species collected during the two studies would affect the ETM as the results are dependent on the taxa included in the analysis.

The following analyses were used to assess changes in the community structure between study periods. These analyses included study-specific species abundance distribution analysis and index of community importance (ICI; Stephens and Zerba 1981). The species abundance distribution was calculated for the 15 most common taxa captured during the 2014–15 Study. Data from the 2003–04 Study for these same taxa were used, when present. For each taxon, the percentage of each survey's (monthly in 2014–15 and nearly weekly in 2003–04) total density accounted for by each taxon was calculated. The mean percentage across all surveys was also calculated. Differences between the two studies were tested using a Kruskall-Wallis non-parametric analysis of variance where the taxa- and survey-specific percentages were used as replicates for each study. The ICI was derived by the equation: Ascending Rank ICI = (Descending Abundance Rank) + (Descending Frequency of Occurrence Rank). The ICI importance incorporates both a measure of abundance and frequency of occurrence to minimize the effect of anomalous collections. For example, a taxon with a high ICI rank would be among the five most abundant taxa **and** occur in all sampling events. The index results in a rank for each species that can be compared across years to assess changes in the community structure. Seventeen species were selected based on either their mean rank across the two studies and/or their high abundance in one of the two studies. A Mann-Whitney Rank Sum test was used to compare the two studies using the taxon-specific ranks as replicates.

## Results and Discussion

A summary of the data on the larval fish taxa groups collected during the two studies is presented in **Table 2**. The data from the two studies for that time period are presented in **Attachments A** and **B**. A total of 52 taxa groups were collected during the 2003–04 Study compared with a total of 33 taxa groups during the 2014–15 Study.[2] Twenty-two taxa groups collected during the 2003–04 Study were not collected during the 2014–15 Study and three taxa groups collected during the 2014–15 Study were not collected during the 2003–04 Study.

[2] Total numbers of taxa excludes the category of unidentified larval fishes.

**Table 2**. Average concentrations (number per 1,000 $m^3$) of ichthyoplankton from sampling conducted off HBGS from July 2014–June 2015, and from entrainment sampling at Huntington Beach Generating Station (HBGS) from September 2003–August 2004.

| Taxon | Common Name | Annual Average 2003-2004 | Annual Average 2014-2015 |
|---|---|---|---|
| Engraulidae | anchovies | 74.46 | 165.71 |
| *Sardinops sagax* | Pacific sardine | 0.25 | 84.89 |
| CIQ goby complex | gobies | 151.56 | 39.52 |
| *Genyonemus lineatus* | white croaker | 28.14 | 34.26 |
| larval fish unid. | larval fishes | 11.66 | 16.86 |
| *Seriphus politus* | queenfish | 18.17 | 16.29 |
| *Hypsoblennius* spp. | blennies | 10.28 | 15.43 |
| *Pleuronichthys guttulatus* | diamond turbot | 5.28 | 12.64 |
| Atherinopsidae | silverside | 5.98 | 10.48 |
| *Paralichthys californicus* | California halibut | 6.40 | 5.20 |
| *Chromis punctipinnis* | blacksmith | - | 4.62 |
| *Pleuronichthys ritteri* | spotted turbot | 0.75 | 4.13 |
| *Diaphus theta* | California headlightfish | 0.63 | 2.24 |
| *Triphoturus mexicanus* | Mexican lampfish | 0.51 | 2.00 |
| *Pleuronichthys* spp. | flounders | - | 1.73 |
| *Atractoscion nobilis* | white seabass | 0.29 | 1.43 |
| Labrisomidae unid. | labrisomid kelpfishes | 0.18 | 1.42 |
| *Roncador stearnsi* | spotfin croaker | 53.07 | 1.29 |
| *Typhlogobius californiensis* | blind goby | 0.06 | 0.74 |
| *Citharichthys* spp. | sanddabs | 2.15 | 0.65 |
| *Myctophidae unid.* | lanternfishes | 0.39 | 0.65 |
| *Menticirrhus undulatus* | California corbina | 2.33 | 0.49 |
| Paralichthyidae unid. | lefteye flounders & sanddabs | 0.12 | 0.44 |
| *Paralabrax* spp. | sand bass | 2.93 | 0.35 |
| Pleuronectoidei | flatfishes | 1.07 | 0.33 |
| Syngnathidae | pipefishes | 0.91 | 0.33 |
| *Gillichthys mirabilis* | longjaw mudsucker | 1.29 | 0.30 |
| *Haemulon califoriensis* | salema | 7.70 | 0.20 |
| *Rhinogobiops nicholsi* | blackeye goby | 0.06 | 0.19 |
| Sciaenidae unid. | croaker | 14.73 | 0.19 |
| *Gibbonsia* spp. | clinid kelpfishes | 0.55 | 0.18 |
| *Scomber japonicus* | Pacific mackerel | 0.10 | 0.18 |
| *Sphyraena argentea* | California barracuda | 0.79 | 0.18 |
| *Paraclinus integripinnis* | reef finspot | - | 0.16 |
| *Cheilotrema saturnum* | black croaker | 5.41 | - |
| *Hypsypops rubicundus* | garibaldi | 2.44 | - |
| *Oxyjulis californica* | senorita | 1.66 | - |
| *Umbrina roncador* | yellowfin croaker | 1.63 | - |

*table continued*

**Table 2** (continued). Average concentrations (number per 1,000 m3) of ichthyoplankton from sampling conducted off HBGS from July 2014–June 2015, and from entrainment sampling at Huntington Beach Generating Station (HBGS) from September 2003–August 2004.

| Taxon | Common Name | Annual Average 2003-2004 | Annual Average 2014-2015 |
|---|---|---|---|
| *Lepidogobius lepidus* | bay goby | 1.16 | - |
| *Leptocottus armatus* | Pacific staghorn sculpin | 0.97 | - |
| *Acanthogobius flavimanus* | yellowfin goby | 0.88 | - |
| Haemulidae | grunts | 0.28 | - |
| *Stenobrachius leucopsarus* | northern lampfish | 0.21 | - |
| *Pleuronichthys verticalis* | hornyhead turbot | 0.17 | - |
| *Peprilus simillimus* | Pacific butterfish | 0.14 | - |
| *Medialuna californiensis* | halfmoon | 0.13 | - |
| *Semicossyphus pulcher* | California sheephead | 0.13 | - |
| Scorpaenidae | rockfishes | 0.09 | - |
| *Symphurus atricaudus* | California tonguefish | 0.07 | - |
| *Strongylura exilis* | California needlefish | 0.07 | - |
| *Oxylebius pictus* | painted greenling | 0.07 | - |
| *Halichoeres semicinctus* | rock wrasse | 0.06 | - |
| *Merluccius productus* | Pacific hake | 0.06 | - |
| *Ruscarius creaseri* | rouchcheek sculpin | 0.05 | - |
| *Agonidae unid.* | poachers | 0.05 | - |
| Cottidae unid. | sculpins | 0.05 | - |
| **Totals** | | **418.56** | **425.70** |
| **Number of Taxa** | | **52** | **33** |

Although there were fewer taxa groups collected during the 2014–15 Study, the total annual average concentration of all fish larvae for the two studies were approximately equal (419 per 1,000 $m^3$ in 2003–04 and 426 per 1,000 $m^3$ in 2014–15 **- Table 2**). The large concentrations of anchovy (Engraulidae) and Pacific sardine (*Sardinops sagax*) larvae collected during the 2014–15 Study compensated for the fewer taxa collected when compared to the 2003–04 Study and the large concentration of gobies collected during the previous sampling. Despite the differences in these three larval taxa, many of the taxa in highest abundance were the same in both studies.

The concentrations of white croaker (*Genyonemus lineatus*), queenfish (*Seriphus politus*), blennies (*Hypsoblennius* spp.), and California halibut (*Paralichthys californicus*) were very similar between the two studies. These taxa were included in the previous intake assessments for both the HBGS and HBDF due to their high abundance and the importance of the adults of these taxa in the nearshore fish communities in the areas around the intake.

Notable differences in the data between the two studies are the larger numbers of gobies and spotfin croakers (*Roncador stearnsi*) collected during the 2003–04 Study, and the absence of salema (*Haemulon californiensis*) and black croaker (*Cheilotrema saturnum*) larvae from the 2014–15 Study data. The two croakers and salema were among the most abundant taxa taken during the 2003–04 Study, but their occurrence was largely limited to August 2004 collections. Minimal larval data exists for spotfin croaker, salema, and black croaker, but adult and juvenile data was available to shed light on their interannual variation. Juvenile and adult spotfin croaker and salema were episodic visitors to the greater Los Angeles-Orange County area in recent decades (Miller et al. 2011, Miller et al. 2014). Both species have larval durations of approximately 30 days (Moser 1996). Therefore, the presence of adult populations in the area likely resulted in above-average larval production than those years with minimal adult abundances in the area. Life history studies on both species indicate a high likelihood of spawning in the southern California area (Miller et al. 2009, Miller et al. 2014). Juvenile/adult abundances of both species were well above-average in 2004–05 (Miller et al. 2011, Miller et al. 2014), corresponding with the high larval densities in the 2003–04 Study. Due to their southern distribution, most hypotheses suggest both salema and spotfin croaker juvenile/adult abundances increase in southern California during warm water years, such as El Niño years (Miller et al. 2011, Miller et al. 2014). Recent data, however, has not substantiated these theories as both species occur in elevated abundances during years of both average and above average water temperatures. Research on their long-term abundance trends suggests neither species should be considered representative of the "normal" fish community that can be expected near the Huntington Beach intake in any given year.

Black croaker juvenile/adult abundances in the Southern California Bight have declined over recent decades (Miller et al. 2011). Their rank abundance in the 2003–04 Study was an artifact of one survey in late August 2004 when per net densities ranged from 17.8 to 672.3 individuals/1000 $m^3$. Black croaker only occurred in four surveys during the 2003–04 Study (September 2003, April 2004, and two in August 2004), but only three individuals were taken outside of August 2004 versus 69 individuals taken in August 2004.

In contrast to the results for salema and black croaker, which were only collected during the 2003–2004 Study, blacksmith (*Chromis punctipinnis*) larvae were only collected during the 2014–15 Study and were not collected in any of the surveys during the 2003–04 Study. As adults, blacksmith are usually associated with hard substrate or other habitats that provide vertical structure such as kelp beds or artificial habitats such as oil platforms. Therefore, the larvae could have come from multiple sources such as the habitat around the LA-Long Beach Harbor Complex (Harbor Complex), offshore oil platforms, or even the rock armoring around the HBGS intake and discharge structures. In contrast to blacksmith, larvae from other rocky habitat-associated fishes such as black croaker, garibaldi, California sheephead, and rock wrasses were only collected during the 2003–04 Study. These differences are likely associated with the reduced sampling effort

during the 2014–15 Study. Since there is no large expanse of rocky habitat (natural or man-made) in the vicinity of the HBGS intake, except for the rock armoring around the intake and discharge structures, the occurrence of these larvae near the intake may be episodic and was not captured with the reduced sampling effort.

The species abundance distributions derived from each study highlight the fact that most species made similar contributions to the sampled community in each study (**Figure 2**). The relative abundance of select taxa changed with northern anchovy exhibiting the most pronounced increase in relative contribution between the two studies. Overall, no significant difference was detected between the two communities (KW, n=150, U=10976, p=0.69), even with northern anchovy and Pacific sardine included in the analysis.

The ICI in each study reaffirmed this as minimal change in importance occurred for most taxa (**Figure 3**). When a change did occur, it was not consistently negative or positive. For instance, white croaker (*Genyonemus lineatus*) increased in community importance, while queenfish (*Seriphus politus*) decreased in importance. No significant difference was detected between the two studies rank index of community importance (MW, U=115.5, n = 17, p=0.325).

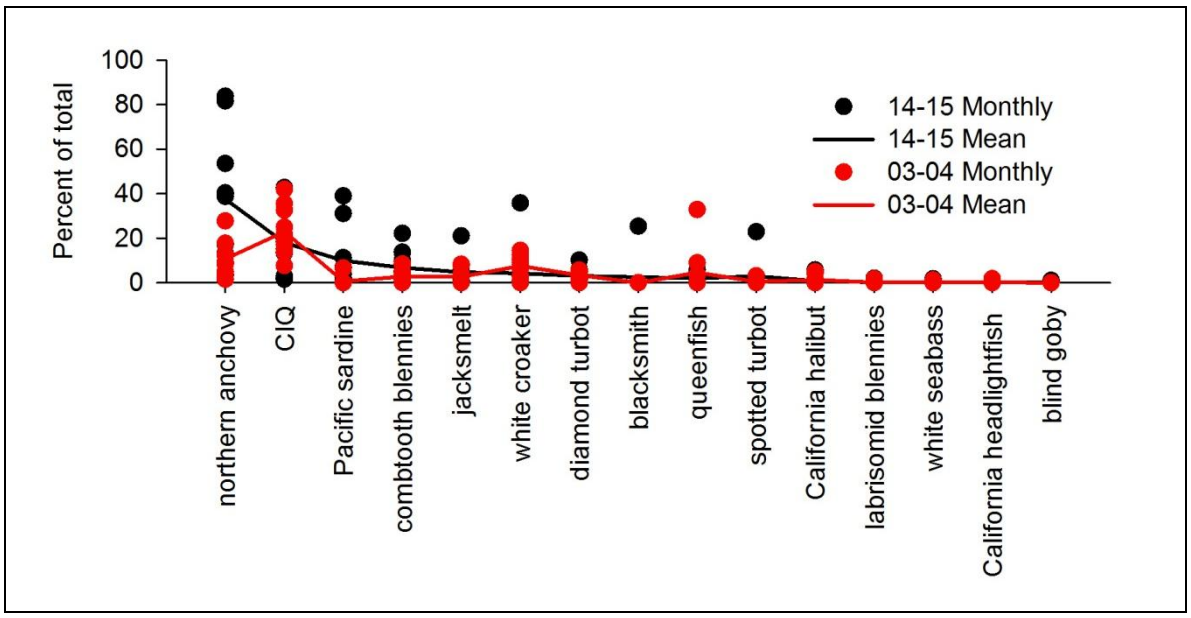


**Figure 2.** Species abundance distribution of fish larvae collected near the intake by survey for the 2003–04 (03–04) Study and the 2014–15 (14–15) Study. Dots represent the survey-specific percent of the total density represented by each taxon. The lines represent the taxon's mean percent of the total density across all surveys from each study.

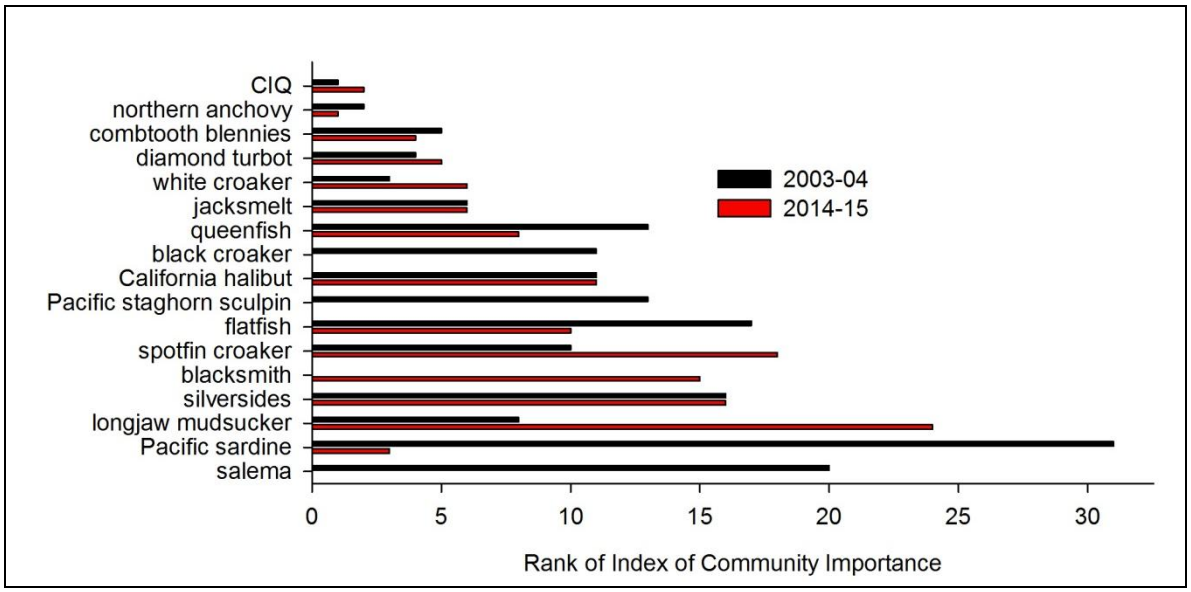


**Figure 3.** Rank of index of community importance by taxa for the 2003–04 and 2014–15 Studies of fish larvae near the intake.

Although the total annual average concentrations from the two studies were very similar, the estimated annual entrainment based on the data from the 2014–15 Study using a daily intake flow of 106 MGD (65.8 million larvae) in **Table 3** was lower than the estimate based on the 2003–04 data (73.7 million larvae). Despite the higher annual average concentration of larvae during the 2014–15 Study, there were several surveys with very low larval abundances, especially during the summer and fall periods (Appendix A: **Tables A1, A2, A4, A5,** and **A6**). The entrainment estimates were different because the estimate of annual entrainment incorporates both larval concentration and the numbers of days in each survey period, which varied among surveys (Table 1). Therefore, the time periods associated with the surveys with low larval abundances offset the three surveys with high abundances (January 2015 – **Table A7**, March 2015 – **Table A9**, and April 2015 – **Table A10**) resulting in the lower entrainment estimate.

The fish larvae collected during sampling in 2014–15 do not include any species that are listed as threatened or endangered at the state or federal level. The fish larvae collected also includes only five taxa, combtooth blennies (*Hypsoblennius* spp.), blacksmith, labrisomid kelpfishes, clinid kelpfishes (*Gibbonsia* spp.), and sea bass (*Paralabrax* spp.), that as adults are associated with nearshore rocky reef habitat. This is the dominant habitat in the nearshore Marine Protected Areas (MPA) located to the north and south of the intake sampling location. Although the MPAs at Crystal Cove and Laguna Beach, are closer to the intake location than the Harbor Complex, the prevailing downcoast currents off Huntington Beach (MBC and Tenera 2005) would indicate that the source of these larvae is most likely the Harbor Complex, which is not designated as a MPA. The jetties

and rock armoring around the Harbor Complex provide habitat for these fishes that is similar to the shallow, rocky reef areas in the MPAs.

**Table 3.** Estimated annual entrainment for larval fishes based on data from sampling conducted off HBGS from July 2014–June 2015 using a daily intake flow of 106 MGD.

| Taxon | Common Name | Sample Count | Total Annual Entrainment | Percent of Total Estimated Entrainment | Total Entrainment Std. Err. |
|---|---|---|---|---|---|
| *Engraulis mordax* | northern anchovy | 993 | 26,077,092 | 39.64 | 2,927,684 |
| *Sardinops sagax* | Pacific sardine | 513 | 14,298,109 | 21.73 | 1,581,845 |
| CIQ goby complex | gobies | 239 | 5,438,003 | 8.27 | 547,590 |
| *Genyonemus lineatus* | white croaker | 219 | 4,325,653 | 6.58 | 813,832 |
| unidentified larval fish | unidentified larval fish | 99 | 2,748,074 | 4.18 | 132,173 |
| *Seriphus politus* | queenfish | 92 | 2,667,473 | 4.05 | 426,478 |
| *Hypsoblennius* spp. | combtooth blennies | 90 | 2,333,342 | 3.55 | 198,356 |
| Atherinopsidae | Silversides | 61 | 1,725,883 | 2.62 | 166,100 |
| *Pleuronichthys guttulatus* | diamond turbot | 78 | 1,642,484 | 2.50 | 66,972 |
| *Chromis punctipinnis* | Blacksmith | 26 | 878,544 | 1.34 | 173,488 |
| *Paralichthys californicus* | California halibut | 33 | 636,661 | 0.97 | 42,269 |
| *Pleuronichthys ritteri* | spotted turbot | 26 | 533,118 | 0.81 | 47,510 |
| *Diaphus theta* | California headlightfish | 14 | 353,310 | 0.54 | 55,657 |
| *Triphoturus mexicanus* | Mexican lampfish | 13 | 317,426 | 0.48 | 50,730 |
| Labrisomidae | labrisomid blennies | 9 | 267,121 | 0.41 | 44,291 |
| *Atractoscion nobilis* | white seabass | 9 | 264,367 | 0.40 | 52,982 |
| *Pleuronichthys* spp. | turbots | 11 | 261,877 | 0.40 | 42,935 |
| *Roncador stearnsii* | spotfin croaker | 8 | 200,998 | 0.31 | 13,380 |
| *Typhlogobius californiensis* | blind goby | 4 | 139,124 | 0.21 | 31,505 |
| Myctophidae | lanternfishes | 4 | 92,575 | 0.14 | 9,031 |
| *Citharichthys stigmaeus* | speckled sanddab | 4 | 78,623 | 0.12 | 22,238 |
| *Menticirrhus undulatus* | California corbina | 3 | 65,850 | 0.10 | 4,753 |
| *Paralabrax* spp. | sea basses | 2 | 55,281 | 0.08 | 9,626 |
| Paralichthyidae | lefteye flounders & sanddabs | 3 | 53,446 | 0.08 | 15,117 |
| Pleuronectoidei | flatfishes | 2 | 41,987 | 0.06 | 8,135 |
| Syngnathidae | pipefishes | 2 | 39,311 | 0.06 | 11,119 |
| *Rhinogobiops nicholsi* | blackeye goby | 1 | 35,770 | 0.05 | 8,100 |
| Sciaenidae | croakers | 1 | 35,770 | 0.05 | 8,100 |
| *Gillichthys mirabilis* | longjaw mudsucker | 2 | 35,519 | 0.05 | 10,046 |
| *Sphyraena argentea* | Pacific barracuda | 1 | 34,925 | 0.05 | 7,714 |
| *Scomber japonicus* | Pacific mackerel | 1 | 33,205 | 0.05 | 7,519 |
| *Xystreurys liolepis* | fantail sole | 1 | 33,016 | 0.05 | 7,892 |
| *Paraclinus integripinnis* | reef finspot | 1 | 20,909 | 0.03 | 5,588 |
| *Gibbonsia* spp. | kelpfishes | 1 | 20,845 | 0.03 | 6,017 |
| **Totals** | | **2,566** | **65,785,691** | | |

## Conclusions

The results of the 2014–15 Study indicate that the current assessment based on data from the 2003–04 Study is representative of nearshore larval fish populations in the vicinity of the HBGS intake. Perhaps the most significant result of these analyses was that the core group of common resident species was equally represented in both studies suggesting the entrainment impacts to species in any given year can be accurately assessed using the 2003–04 data. Although there were differences in the numbers of taxa collected from the two studies, the differences largely reflected the greater sampling effort in the 2003–04 Study. The abundant larvae that were collected in both studies were northern anchovies, croakers, and flatfishes which are fishes characteristic of the sandy coastal habitat in the vicinity of the intake. Other taxa that were abundant in both studies included gobies and blennies which are likely transported out of the wetland habitat in the vicinity of the HBGS intake. These taxa formed the basis for the existing assessment completed for the HBDF intake and would be the most appropriate taxa to determine the effects of the intake because they are representative of the habitats in the vicinity of the intake and were in high abundance during both studies.

The results also verify the low probability that the intake would impact fish populations in rocky reef areas in any of the Marine Protected Areas (MPA) that are located to the north and south of the proposed intake location. The nearest MPA to the south is Crystal Cove which is 12.9 km (8.0 mi) distant, and the nearest MPA to the north is Abalone Cove, which is 38.3 km (24 mi). Larvae from fishes associated with rocky reef habitat in the MPAs were generally in very low abundance. It is important to recognize that the more likely source of these larvae is the rock jetties and other hard substrate around the Harbor Complex. Although more of these rocky habitat-associated larvae were collected during the 2003–04 Study, this was likely due to the increased sampling effort as the larvae for these taxa were in generally low abundance.

The difference in the estimates of annual entrainment of fish larvae from the two studies would not be expected to result in material changes in the ETM estimates of entrainment effects for individual taxa from the estimates based on the 2003–04 data. Large changes in the results of the assessment would not be expected because the estimates of impact are based on the relative proportion of the intake and source water abundances for individual taxa, which are less affected by natural changes in larval abundance between years. Most importantly, the results indicate that approximately the same taxa would form the basis of any assessment. The calculation of the average APF for the HBDF will likely be based on a select group of taxa. The analysis of the taxonomic composition from the two studies indicates that the taxonomic composition were similar for the two studies.

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## Attachment A: Data from 2014 Ichthyoplankton Sampling

**Table A1**. Total counts and average concentrations (Avg. Conc. - # per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for proposed Poseidon Water Huntington Beach Desalination Project on July 30, 2014. Two samples were collected during each day and night cycle.

| | | DAY | | NIGHT | | SURVEY | |
|---|---|---|---|---|---|---|---|
| **Taxon** | **Common Name** | **Count** | **Avg. Conc.** | **Count** | **Avg. Conc.** | **Total Count** | **Avg. Conc.** |
| **Entrainable Larval Fishes** | | | | | | | |
| *Chromis punctipinnis* | blacksmith | - | - | 22 | 94.43 | 22 | 47.21 |
| CIQ goby complex | gobies | 12 | 51.37 | 5 | 21.43 | 17 | 36.40 |
| *Engraulis mordax* | northern anchovy | 1 | 3.90 | 14 | 60.15 | 15 | 32.03 |
| *Hypsoblennius* spp. | combtooth blennies | 1 | 3.90 | 11 | 47.11 | 12 | 25.51 |
| larvae, yolksac | yolksac larvae | 2 | 7.80 | 5 | 21.43 | 7 | 14.62 |
| *Sardinops sagax* | Pacific sardine | 2 | 8.45 | 4 | 17.14 | 6 | 12.80 |
| *Seriphus politus* | queenfish | - | - | 5 | 21.48 | 5 | 10.74 |
| *Triphoturus mexicanus* | Mexican lampfish | - | - | 3 | 12.74 | 3 | 6.37 |
| *Roncador stearnsii* | spotfin croaker | 1 | 4.55 | 1 | 4.30 | 2 | 4.42 |
| larval fish - damaged | damaged larval fishes | - | - | 1 | 4.30 | 1 | 2.15 |
| *Leuresthes tenuis* | California grunion | - | - | 1 | 4.30 | 1 | 2.15 |
| *Pleuronichthys ritteri* | spotted turbot | - | - | 1 | 4.30 | 1 | 2.15 |
| *Paralabrax* spp. | sea basses | - | - | 1 | 4.25 | 1 | 2.12 |
| *Sphyraena argentea* | Pacific barracuda | - | - | 1 | 4.25 | 1 | 2.12 |
| | **Total Entrainable Larval Fishes:** | **19** | | **75** | | **94** | |
| **Targeted Invertebrates** | | | | | | | |
| No targeted invertebrates | | - | - | - | - | - | - |
| | **Total Targeted Invertebrates:** | **0** | | **0** | | **0** | |
| | **Total Survey Counts:** | **19** | | **75** | | **94** | |

**Table A2**. Total counts and average concentrations (Avg. Conc. - # per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for proposed Poseidon Water Huntington Beach Desalination Project on September 3, 2014. Two samples were collected during each day and night cycle.

| | | DAY | | NIGHT | | SURVEY | |
|---|---|---|---|---|---|---|---|
| **Taxon** | **Common Name** | **Count** | **Mean Conc.** | **Mean Conc.** | **Mean Conc.** | **Total Count** | **Mean Conc.** |
| **Entrainable Larval Fishes** | | | | | | | |
| larvae, yolksac | yolksac larvae | 7 | 24.78 | 6 | 26.26 | 13 | 25.52 |
| *Pleuronichthys ritteri* | spotted turbot | 5 | 16.70 | 2 | 8.56 | 7 | 12.63 |
| *Hypsoblennius* spp. | combtooth blennies | 1 | 3.09 | 5 | 21.39 | 6 | 12.24 |
| CIQ goby complex | gobies | 2 | 6.17 | 2 | 8.56 | 4 | 7.36 |
| *Menticirrhus undulatus* | California corbina | 2 | 7.44 | 1 | 4.28 | 3 | 5.86 |
| *Pleuronichthys* spp. | turbots | 3 | 9.26 | - | - | 3 | 4.63 |
| *Roncador stearnsii* | spotfin croaker | 2 | 6.17 | - | - | 2 | 3.09 |
| *Sardinops sagax* | Pacific sardine | - | - | 1 | 4.28 | 1 | 2.14 |
| *Seriphus politus* | queenfish | - | - | 1 | 4.28 | 1 | 2.14 |
| *Engraulis mordax* | northern anchovy | 1 | 3.72 | - | - | 1 | 1.86 |
| *Paraclinus integripinnis* | reef finspot | 1 | 3.72 | - | - | 1 | 1.86 |
| *Triphoturus mexicanus* | Mexican lampfish | 1 | 3.09 | - | - | 1 | 1.54 |
| | **Total Entrainable Larval Fishes:** | **25** | | **18** | | **43** | |
| **Targeted Invertebrates** | | | | | | | |
| *Metacarcin. anthonyi* (meg.) | yellow crab megalops | - | - | 1 | 4.28 | 1 | 2.14 |
| | **Total Targeted Invertebrates:** | **0** | | **1** | | **1** | |
| | **Total Survey Counts:** | **25** | | **19** | | **44** | |

**Table A3**. Total counts and average concentrations (Avg. Conc. - # per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for proposed Poseidon Water Huntington Beach Desalination Project on September 24, 2014. Two samples were collected during each day and night cycle.

| | | DAY | | NIGHT | | SURVEY | |
|---|---|---|---|---|---|---|---|
| **Taxon** | **Common Name** | **Count** | **Mean Conc.** | **Mean Conc.** | **Mean Conc.** | **Total Count** | **Mean Conc.** |
| **Entrainable Larval Fishes** | | | | | | | |
| *Engraulis mordax* | northern anchovy | 19 | 73.13 | 145 | 540.14 | 164 | 306.64 |
| *Hypsoblennius* spp. | combtooth blennies | 2 | 7.94 | 8 | 29.78 | 10 | 18.86 |
| *Sardinops sagax* | Pacific sardine | 1 | 3.97 | 6 | 23.97 | 7 | 13.97 |
| *Pleuronichthys guttulatus* | diamond turbot | 3 | 11.66 | 2 | 7.35 | 5 | 9.50 |
| CIQ goby complex | gobies | - | - | 3 | 11.02 | 3 | 5.51 |
| *Diaphus theta* | California headlight fish | - | - | 2 | 7.73 | 2 | 3.87 |
| larvae, yolksac | yolksac larvae | - | - | 2 | 7.73 | 2 | 3.87 |
| *Paralabrax* spp. | sea basses | - | - | 1 | 4.06 | 1 | 2.03 |
| *Pleuronichthys ritteri* | spotted turbot | 1 | 3.97 | - | - | 1 | 1.99 |
| *Triphoturus mexicanus* | Mexican lampfish | 1 | 3.97 | - | - | 1 | 1.99 |
| Myctophidae | lanternfishes | - | - | 1 | 3.67 | 1 | 1.84 |
| | **Total Entrainable Larval Fishes:** | **27** | | **170** | | **197** | |
| **Targeted Invertebrates** | | | | | | | |
| *Metacarcin. anthonyi* (meg.) | yellow crab megalops | - | - | 1 | 4.06 | 1 | 2.03 |
| | **Total Targeted Invertebrates:** | **0** | | **1** | | **1** | |
| | **Total Survey Counts:** | **27** | | **171** | | **198** | |

**Table A4**. Total counts and average concentrations (Avg. Conc. - # per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for proposed Poseidon Water Huntington Beach Desalination Project on October 23, 2014. Two samples were collected during each day and night cycle.

| | | DAY | | NIGHT | | SURVEY | |
|---|---|---|---|---|---|---|---|
| **Taxon** | **Common Name** | **Count** | **Mean Conc.** | **Count** | **Mean Conc.** | **Total Count** | **Mean Conc.** |
| **Entrainable Larval Fishes** | | | | | | | |
| *Engraulis mordax* | northern anchovy | - | - | 54 | 221.06 | 54 | 110.53 |
| CIQ goby complex | gobies | 1 | 4.44 | 10 | 41.49 | 11 | 22.96 |
| *Sardinops sagax* | Pacific sardine | - | - | 1 | 4.02 | 1 | 2.01 |
| | **Total Entrainable Larval Fishes:** | **1** | | **65** | | **66** | |
| **Targeted Invertebrates** | | | | | | | |
| No targeted invertebrates | | - | - | - | - | - | - |
| | **Total Targeted Invertebrates:** | **0** | | **0** | | **0** | |
| | **Total Survey Counts:** | **1** | | **65** | | **66** | |

**Table A5**. Total counts and average concentrations (Avg. Conc. - # per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for proposed Poseidon Water Huntington Beach Desalination Project on November 25, 2014. Two samples were collected during each day and night cycle.

| | | DAY | | NIGHT | | SURVEY | |
|---|---|---|---|---|---|---|---|
| **Taxon** | **Common Name** | **Count** | **Mean Conc.** | **Count** | **Mean Conc.** | **Total Count** | **Mean Conc.** |
| **Entrainable Larval Fishes** | | | | | | | |
| *Engraulis mordax* | northern anchovy | 4 | 15.68 | 16 | 66.84 | 20 | 41.26 |
| *Atherinopsis californiensis* | jacksmelt | 4 | 15.16 | 7 | 29.65 | 11 | 22.40 |
| larvae, yolksac | yolksac larvae | 5 | 20.52 | 1 | 4.15 | 6 | 12.33 |
| *Pleuronichthys* spp. | turbots | 6 | 24.31 | - | - | 6 | 12.15 |
| *Hypsoblennius* spp. | combtooth blennies | 2 | 8.10 | 3 | 12.90 | 5 | 10.50 |
| *Pleuronich. guttulatus* | diamond turbot | - | - | 3 | 12.60 | 3 | 6.30 |
| Atherinopsidae | silversides | 3 | 11.37 | - | - | 3 | 5.68 |
| CIQ goby complex | gobies | 1 | 4.31 | - | - | 1 | 2.16 |
| *Pleuronichthys ritteri* | spotted turbot | 1 | 4.31 | - | - | 1 | 2.16 |
| larval fish - damaged | damaged larval fishes | - | - | 1 | 4.15 | 1 | 2.07 |
| *Sardinops sagax* | Pacific sardine | - | - | 1 | 4.15 | 1 | 2.07 |
| | **Total Entrainable Larval Fishes:** | **26** | | **32** | | **58** | |
| **Targeted Invertebrates** | | | | | | | |
| No targeted invertebrates | | - | - | - | - | - | - |
| | **Total Targeted Invertebrates:** | **0** | | **0** | | **0** | |
| | **Total Survey Counts:** | **26** | | **32** | | **58** | |

**Table A6**. Total counts and average concentrations (Avg. Conc. - # per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for proposed Poseidon Water Huntington Beach Desalination Project on December 29, 2014. Two samples were collected during each day and night cycle.

| | | DAY | | NIGHT | | SURVEY | |
|---|---|---|---|---|---|---|---|
| **Taxon** | **Common Name** | **Count** | **Mean Conc.** | **Mean Conc.** | **Mean Conc.** | **Total Count** | **Mean Conc.** |
| **Entrainable Larval Fishes** | | | | | | | |
| ClQ goby complex | gobies | 6 | 24.85 | 20 | 71.08 | 26 | 47.97 |
| *Atherinopsis californiensis* | jacksmelt | 5 | 20.71 | 1 | 3.65 | 6 | 12.18 |
| *Pleuronichthys guttulatus* | diamond turbot | 2 | 8.28 | 2 | 7.31 | 4 | 7.79 |
| *Hypsoblennius* spp. | combtooth blennies | 1 | 4.14 | 1 | 3.65 | 2 | 3.90 |
| *Engraulis mordax* | northern anchovy | - | - | 2 | 6.91 | 2 | 3.45 |
| larvae, yolksac | yolksac larvae | - | - | 2 | 6.91 | 2 | 3.45 |
| Atherinopsidae | silversides | 1 | 3.68 | - | - | 1 | 1.84 |
| *Paralichthys californicus* | California halibut | - | - | 1 | 3.65 | 1 | 1.83 |
| Pleuronectoidei | flatfishes | - | - | 1 | 3.45 | 1 | 1.73 |
| | **Total Entrainable Larval Fishes:** | **15** | | **30** | | **45** | |
| **Targeted Invertebrates** | | | | | | | |
| No targeted invertebrates | | - | - | - | - | **-** | **-** |
| | **Total Targeted Invertebrates:** | **0** | | **0** | | **0** | |
| | **Total Survey Counts:** | **15** | | **30** | | **45** | |

**Table A7**. Total counts and average concentrations (Avg. Conc. - # per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for proposed Poseidon Water Huntington Beach Desalination Project on January 22, 2015. Two samples were collected during each day and night cycle.

| | | DAY | | NIGHT | | SURVEY | |
|---|---|---|---|---|---|---|---|
| **Taxon** | **Common Name** | **Count** | **Mean Conc.** | **Count** | **Mean Conc.** | **Total Count** | **Mean Conc.** |
| **Entrainable Larval Fishes** | | | | | | | |
| *Genyonemus lineatus* | white croaker | 21 | 83.52 | 176 | 651.91 | 197 | 367.71 |
| CIQ goby complex | gobies | 3 | 11.47 | 96 | 364.11 | 99 | 187.79 |
| *Engraulis mordax* | northern anchovy | 3 | 12.28 | 68 | 254.38 | 71 | 133.33 |
| *Sardinops sagax* | Pacific sardine | 15 | 57.34 | 46 | 172.71 | 61 | 115.02 |
| *Pleuronichthys guttulatus* | diamond turbot | 22 | 87.88 | 32 | 119.35 | 54 | 103.62 |
| *Paralichthys californicus* | California halibut | 11 | 43.94 | 20 | 73.08 | 31 | 58.51 |
| *Pleuronichthys ritteri* | spotted turbot | 4 | 15.02 | 12 | 46.27 | 16 | 30.64 |
| larvae, yolksac | yolksac larvae | 8 | 32.47 | 2 | 7.84 | 10 | 20.16 |
| *Citharichthys stigmaeus* | speckled sanddab | - | - | 4 | 15.68 | 4 | 7.84 |
| Paralichthyidae | lefteye flound./sandabs | 3 | 10.66 | - | - | 3 | 5.33 |
| *Atherinopsis californiensis* | jacksmelt | - | - | 2 | 7.84 | 2 | 3.92 |
| Syngnathidae | pipefishes | - | - | 2 | 7.84 | 2 | 3.92 |
| *Gillichthys mirabilis* | longjaw mudsucker | - | - | 2 | 7.08 | 2 | 3.54 |
| *Hypsoblennius* spp. | combtooth blennies | 1 | 4.36 | - | - | 1 | 2.18 |
| Pleuronectoidei | flatfishes | 1 | 4.36 | - | - | 1 | 2.18 |
| *Pleuronichthys* spp. | turbots | 1 | 3.55 | - | - | 1 | 1.78 |
| | **Total Entrainable Larval Fishes:** | **93** | | **462** | | **555** | |
| **Targeted Invertebrates** | | | | | | | |
| *Metacarcin. anthonyi* (meg.) | yellow crab megalops | - | - | 6 | 22.00 | 6 | 11.00 |
| *Romal. anten./Meta. gracil.* (meg.) | cancer crabs megalops | - | - | 4 | 14.92 | 4 | 7.46 |
| | **Total Targeted Invertebrates:** | **0** | | **10** | | **10** | |
| | **Total Survey Counts:** | **93** | | **472** | | **565** | |

**Table A8**. Total counts and average concentrations (Avg. Conc. - # per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for proposed Poseidon Water Huntington Beach Desalination Project on February 17, 2015. Two samples were collected during each day and night cycle.

| | | DAY | | NIGHT | | SURVEY | |
|---|---|---|---|---|---|---|---|
| **Taxon** | **Common Name** | **Count** | **Mean Conc.** | **Count** | **Mean Conc.** | **Total Count** | **Mean Conc.** |
| **Entrainable Larval Fishes** | | | | | | | |
| ClQ goby complex | gobies | 2 | 8.86 | 30 | 131.29 | 32 | 70.07 |
| *Engraulis mordax* | northern anchovy | 1 | 4.33 | 29 | 126.62 | 30 | 65.47 |
| *Hypsoblennius* spp. | combtooth blennies | 1 | 4.53 | 6 | 26.17 | 7 | 15.35 |
| *Atherinopsis californiensis* | jacksmelt | - | - | 3 | 13.15 | 3 | 6.57 |
| *Genyonemus lineatus* | white croaker | - | - | 2 | 8.77 | 2 | 4.38 |
| *Gibbonsia* spp. | kelpfishes | 1 | 4.33 | - | - | 1 | 2.16 |
| | **Total Entrainable Larval Fishes:** | **5** | | **70** | | **75** | |
| **Targeted Invertebrates** | | | | | | | |
| No targeted invertebrates | | - | - | - | - | - | - |
| | **Total Targeted Invertebrates:** | **0** | | **0** | | **0** | |
| | **Total Survey Counts:** | **5** | | **70** | | **75** | |

**Table A9**. Total counts and average concentrations (Avg. Conc. - # per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for proposed Poseidon Water Huntington Beach Desalination Project on March 10, 2015. Two samples were collected during each day and night cycle.

| | | DAY | | NIGHT | | SURVEY | |
|---|---|---|---|---|---|---|---|
| **Taxon** | **Common Name** | **Count** | **Mean Conc.** | **Count** | **Mean Conc.** | **Total Count** | **Mean Conc.** |
| **Entrainable Larval Fishes** | | | | | | | |
| *Engraulis mordax* | northern anchovy | 8 | 34.31 | 419 | 1,692.2 | 427 | 863.27 |
| *Sardinops sagax* | Pacific sardine | 21 | 88.50 | 228 | 911.29 | 249 | 499.90 |
| *Seriphus politus* | queenfish | 4 | 16.97 | 64 | 268.77 | 68 | 142.87 |
| CIQ goby complex | gobies | 6 | 24.69 | 9 | 37.72 | 15 | 31.21 |
| *Pleuronichthys guttulatus* | diamond turbot | 2 | 8.86 | 9 | 35.43 | 11 | 22.15 |
| larval fish - damaged | damaged larval fishes | - | - | 9 | 35.43 | 9 | 17.71 |
| *Atherinopsis californiensis* | jacksmelt | 2 | 8.86 | 4 | 18.81 | 6 | 13.84 |
| *Genyonemus lineatus* | white croaker | - | - | -4 | 18.81 | 4 | 9.40 |
| *Hypsoblennius* spp. | combtooth blennies | - | - | 2 | 7.11 | 2 | 3.55 |
| *Atractoscion nobilis* | white seabass | - | - | 1 | 4.70 | 1 | 2.35 |
| *Xystreurys liolepis* | fantail sole | - | - | 1 | 4.70 | 1 | 2.35 |
| *Pleuronichthys* spp. | turbots | 1 | 4.43 | - | - | 1 | 2.22 |
| *Paralichthys californicus* | California halibut | 1 | 4.05 | - | - | 1 | 2.03 |
| | **Total Entrainable Larval Fishes:** | **45** | | **750** | | **795** | |
| **Targeted Invertebrates** | | | | | | | |
| No targeted invertebrates | | - | - | - | - | - | - |
| | **Total Targeted Invertebrates:** | **0** | | **0** | | **0** | |
| | **Total Survey Counts:** | **45** | | **750** | | **795** | |

**Table A10.** Total counts and average concentrations (Avg. Conc. - # per 1,000 m3) for larval fishes and target invertebrates from sampling done at intake location for proposed Poseidon Water Huntington Beach Desalination Project on April 28, 2015. Two samples were collected during each day and night cycle.

| | | DAY | | NIGHT | | SURVEY | |
|---|---|---|---|---|---|---|---|
| **Taxon** | **Common Name** | **Count** | **Mean Conc.** | **Count.** | **Mean Conc.** | **Total Count** | **Mean Conc.** |
| **Entrainable Larval Fishes** | | | | | | | |
| *Engraulis mordax* | northern anchovy | 61 | 267.72 | 112 | 443.92 | 173 | 355.82 |
| *Sardinops sagax* | Pacific sardine | 30 | 131.90 | 144 | 556.19 | 174 | 344.05 |
| larvae, yolksac | yolksac larvae | 16 | 70.85 | 24 | 94.70 | 40 | 82.77 |
| *Atherinopsis californiensis* | jacksmelt | 2 | 8.82 | 20 | 82.91 | 22 | 45.86 |
| *Genyonemus lineatus* | white croaker | - | - | 16 | 59.14 | 16 | 29.57 |
| CIQ goby complex | gobies | 1 | 4.24 | 12 | 47.35 | 13 | 25.80 |
| Labrisomidae | labrisomid blennies | 1 | 4.57 | 8 | 29.57 | 9 | 17.07 |
| *Hypsoblennius* spp. | combtooth blennies | 3 | 13.06 | 4 | 17.78 | 7 | 15.42 |
| *Atractoscion nobilis* | white seabass | - | - | 8 | 29.57 | 8 | 14.78 |
| *Seriphus politus* | queenfish | 1 | 4.24 | 4 | 17.78 | 5 | 11.01 |
| *Diaphus theta* | California headlight | - | - | 4 | 17.78 | 4 | 8.89 |
| *Typhlogobius californiensis* | blind goby | - | - | 4 | 17.78 | 4 | 8.89 |
| *Rhinogobiops nicholsi* | blackeye goby | 1 | 4.57 | - | - | 1 | 2.29 |
| Sciaenidae | croakers | 1 | 4.57 | - | - | 1 | 2.29 |
| *Scomber japonicus* | Pacific mackerel | 1 | 4.24 | - | - | 1 | 2.12 |
| | **Total Entrainable Larval Fishes:** | **118** | | **360** | | **478** | |
| **Targeted Invertebrates** | | | | | | | |
| *Romal. anten./Meta. gracil.* (meg.) | cancer crabs | - | - | 20 | 76.92 | 20 | 38.46 |
| | **Total Targeted Invertebrates:** | **-** | | **20** | | **20** | |
| | **Total Survey Counts:** | **118** | | **380** | | **498** | |

**Table A11**. Total counts and average concentrations (Avg. Conc. - # per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for proposed Poseidon Water Huntington Beach Desalination Project on May 28, 2015. Two samples were collected during each day and night cycle.

| | | DAY | | NIGHT | | SURVEY | |
|---|---|---|---|---|---|---|---|
| **Taxon** | **Common Name** | **Count** | **Mean Conc.** | **Mean Conc.** | **Mean Conc.** | **Total Count** | **Mean Conc.** |
| **Entrainable Larval Fishes** | | | | | | | |
| *Engraulis mordax* | northern anchovy | 6 | 26.33 | 10 | 44.34 | **16** | **35.33** |
| *Seriphus politus* | queenfish | 3 | 13.62 | 8 | 35.47 | **11** | **24.55** |
| larvae, yolksac | yolksac larvae | 6 | 26.33 | 2 | 8.87 | **8** | **17.60** |
| CIQ goby complex | gobies | 1 | 4.69 | 4 | 17.88 | **5** | **11.29** |
| *Hypsoblennius* spp. | combtooth blennies | - | - | 4 | 17.74 | **4** | **8.87** |
| *Sardinops sagax* | Pacific sardine | 1 | 4.69 | 2 | 8.87 | **3** | **6.78** |
| *Pleuronichthys guttulatus* | diamond turbot | 1 | 4.69 | - | - | **1** | **2.35** |
| *Roncador stearnsii* | spotfin croaker | 1 | 4.24 | - | - | **1** | **2.12** |
| | **Total Entrainable Larval Fishes:** | **19** | | **30** | | **49** | |
| **Targeted Invertebrates** | | | | | | | |
| *Romal. anten./Meta. gracil.* (meg.) | cancer crabs megalops | - | - | 18 | 80.54 | 18 | 40.27 |
| | **Total Targeted Invertebrates:** | **0** | | **18** | | **18** | |
| | **Total Survey Counts:** | **19** | | **48** | | **67** | |

**Table A12**. Total counts and average concentrations (Avg. Conc. - # per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for proposed Poseidon Water Huntington Beach Desalination Project on June 15, 2015. Two samples were collected during each day and night cycle.

| | | DAY | | NIGHT | | SURVEY | |
|---|---|---|---|---|---|---|---|
| **Taxon** | **Common Name** | **Count** | **Mean Conc.** | **Mean Conc.** | **Mean Conc.** | **Total Count** | **Mean Conc.** |
| **Entrainable Larval Fishes** | | | | | | | |
| *Hypsoblennius* spp. | combtooth blennies | 4 | 14.34 | 30 | 123.33 | 34 | 68.84 |
| *Engraulis mordax* | northern anchovy | 6 | 21.43 | 14 | 57.63 | 20 | 39.53 |
| CIQ goby complex | gobies | 3 | 10.56 | 10 | 40.82 | 13 | 25.69 |
| *Sardinops sagax* | Pacific sardine | 2 | 7.25 | 8 | 32.52 | 10 | 19.89 |
| *Diaphus theta* | California headlight | 8 | 28.20 | - | - | 8 | 14.10 |
| *Triphoturus mexicanus* | Mexican lampfish | 8 | 28.20 | - | - | 8 | 14.10 |
| *Atherinopsis californiensis* | jacksmelt | 4 | 14.34 | 2 | 8.29 | 6 | 11.32 |
| *Chromis punctipinnis* | blacksmith | - | - | 4 | 16.37 | 4 | 8.19 |
| Myctophidae | lanternfishes | 1 | 3.63 | 2 | 8.29 | 3 | 5.96 |
| *Roncador stearnsii* | spotfin croaker | 1 | 3.46 | 2 | 8.29 | 3 | 5.88 |
| *Seriphus politus* | queenfish | - | - | 2 | 8.29 | 2 | 4.15 |
| | **Total Entrainable Larval Fishes:** | **37** | | **74** | | **111** | |
| **Targeted Invertebrates** | | | | | | | |
| *Metacar. anthonyi* (meg.) | yellow crab megalops | - | - | 12 | 48.90 | 12 | 24.45 |
| *Romal. anten./Meta. gracil.* (meg.) | cancer crabs megalops | - | - | 6 | 24.67 | 6 | 12.33 |
| | **Total Targeted Invertebrates:** | **0** | | **18** | | **18** | |
| | **Total Survey Counts:** | **37** | | **92** | | **129** | |

# Attachment B: Data from 2003–2004 Huntington Beach Generating Station Ichthyoplankton Sampling used in Comparison

**Table B1**. Average concentrations (# per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for Huntington Beach Generating Station from September 18, 2003 and November 10, 2003. Concentrations represent averages from two samples collected approximately every six hours over a 24-hour period.

| Taxon | Common Name | 09/18/03 | 09/29/03 | 10/13/03 | 10/20/03 | 11/03/03 | 11/10/03 |
|---|---|---|---|---|---|---|---|
| Gobiidae unid. | gobies | 267.76 | 214.61 | 234.90 | 106.41 | 88.02 | 2.58 |
| Engraulidae | anchovies | 72.34 | 82.59 | 77.58 | 76.06 | 13.26 | 31.09 |
| *Roncador stearnsi* | spotfin croaker | - | - | - | - | - | - |
| *Genyonemus lineatus* | white croaker | 17.05 | 19.39 | 11.21 | 15.99 | 3.02 | 5.21 |
| *Seriphus politus* | queenfish | - | - | - | - | - | - |
| Sciaenidae unid. | croakers | 3.22 | - | - | - | - | - |
| *Hypsoblennius* spp. | combtooth blennies | - | 2.23 | - | - | 27.65 | 28.05 |
| larvae, unidentified yolksac | yolksac larvae | - | - | - | - | - | - |
| *Xenistius califoriensis* | salema | - | - | - | - | - | - |
| *Paralichthys californicus* | California halibut | - | 2.00 | - | - | - | 5.48 |
| Atherinopsidae | silversides | - | - | - | - | - | - |
| *Cheilotrema saturnum* | black croaker | 2.40 | - | - | - | - | - |
| *Hypsopsetta guttulata* | diamond turbot | - | - | 5.36 | 4.99 | 10.95 | 3.07 |
| *Paralabrax* spp. | sea basses | - | - | - | - | - | - |
| *Hypsypops rubicundus* | garibaldi | - | - | - | - | - | - |
| larval/post-larval fish unid. | larval fishes | - | - | - | - | - | - |
| *Menticirrhus undulatus* | California corbina | - | - | - | - | - | - |
| *Citharichthys* spp. | sanddabs | 3.22 | - | - | - | - | 2.63 |
| *Oxyjulis californica* | senorita | - | - | - | - | - | - |
| *Umbrina roncador* | yellowfin croaker | - | - | - | - | - | - |
| *Gillichthys mirabilis* | longjaw mudsucker | - | - | 5.06 | - | - | - |
| *Lepidogobius lepidus* | bay goby | - | - | - | - | - | - |
| Pleuronectidae unid. | righteye flounders | - | - | - | - | 2.99 | 2.85 |
| *Leptocottus armatus* | Pacific staghorn sculpin | - | - | - | - | - | - |
| *Syngnathus* spp. | pipefishes | - | - | - | - | - | - |
| *Acanthogobius flavimanus* | yellowfin goby | - | - | - | - | - | - |
| *Sphyraena argentea* | Pacific barracuda | - | - | - | - | - | - |
| *Pleuronichthys ritteri* | spotted turbot | - | - | - | - | - | - |
| *Diaphus theta* | California headlight fish | - | - | - | - | - | - |
| *Gibbonsia* spp. | kelpfishes | - | - | - | - | - | - |
| *Triphoturus mexicanus* | Mexican lampfish | - | - | - | - | - | 2.85 |
| Myctophidae unid. | lanternfishes | 3.22 | - | - | - | - | - |
| *Atractoscion nobilis* | white seabass | - | - | - | - | - | - |
| Haemulidae | grunts | - | - | - | - | - | - |
| *Sardinops sagax* | Pacific sardine | - | - | - | - | - | - |
| *Stenobrachius leucopsarus* | northern lampfish | - | - | - | - | - | - |
| Labrisomidae unid. | labrisomid blennies | - | - | - | - | - | - |
| *Pleuronichthys verticalis* | hornyhead turbot | - | - | - | - | - | - |
| *Peprilus simillimus* | Pacific butterfish | - | - | - | - | - | - |
| *Medialuna californiensis* | halfmoon | - | - | - | - | - | - |
| *Semicossyphus pulcher* | California sheephead | - | - | - | - | - | - |
| Paralichthyidae unid. | lefteye flounders & sanddabs | - | - | 2.94 | - | - | - |
| *Scomber japonicus* | Pacific mackerel | - | - | - | - | - | - |
| Scorpaenidae | scorpion fishes | - | - | - | - | - | - |
| *Symphurus atricauda* | California tonguefish | - | - | - | - | - | - |
| *Strongylura exilis* | California needlefish | - | - | - | - | - | - |
| *Oxylebius pictus* | painted greenling | - | - | - | - | - | - |
| *Halichoeres semicinctus* | rock wrasse | - | - | - | - | - | - |
| *Typhlogobius californiensis* | blind goby | - | - | - | - | - | - |
| larval fish - damaged | damaged larval fishes | - | - | - | - | - | - |
| *Merluccius productus* | Pacific hake | - | - | - | - | - | - |
| *Coryphopterus nicholsi* | blackeye goby | - | - | - | - | - | - |
| *Ruscarius creaseri* | roughcheek sculpin | - | - | - | - | - | - |
| Agonidae unid. | poachers | - | - | - | - | - | - |
| Pleuronectiformes unid. | flatfishes | - | - | - | - | - | - |
| Cottidae unid. | sculpins | - | - | - | - | - | - |
| | **Total Larval Fishes:** | **369.21** | **320.82** | **337.05** | **203.45** | **145.89** | **83.80** |

**Table B2**. Average concentrations (# per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for Huntington Beach Generating Station from November 17, 2003 and December 22, 2003. Concentrations represent averages from two samples collected approximately every six hours over a 24-hour period.

| Taxon | Common Name | 11/17/03 | 11/24/03 | 12/01/03 | 12/08/03 | 12/15/13 | 12/22/03 |
|---|---|---|---|---|---|---|---|
| Gobiidae unid. | gobies | 186.58 | 69.75 | 132.52 | 26.76 | 245.89 | 132.73 |
| Engraulidae | anchovies | 25.71 | 5.07 | 7.85 | 23.99 | 179.98 | 11.38 |
| *Roncador stearnsi* | spotfin croaker | - | - | - | - | - | - |
| *Genyonemus lineatus* | white croaker | 37.70 | 43.39 | 12.94 | 26.81 | 83.63 | 8.53 |
| *Seriphus politus* | queenfish | - | - | - | - | - | - |
| Sciaenidae unid. | croakers | - | - | - | - | - | - |
| *Hypsoblennius* spp. | combtooth blennies | - | 5.03 | 5.26 | 5.12 | 2.66 | 3.06 |
| larvae, unidentified yolksac | yolksac larvae | - | - | - | - | - | - |
| *Xenistius califoriensis* | salema | - | - | - | - | - | - |
| *Paralichthys californicus* | California halibut | - | - | - | - | - | - |
| Atherinopsidae | silversides | - | - | 3.23 | 2.85 | 2.66 | 2.75 |
| *Cheilotrema saturnum* | black croaker | - | - | - | - | - | - |
| *Hypsopsetta guttulata* | diamond turbot | 2.29 | 8.52 | 5.71 | - | - | 5.55 |
| *Paralabrax* spp. | sea basses | - | - | - | - | - | - |
| *Hypsypops rubicundus* | garibaldi | - | - | - | - | - | - |
| larval/post-larval fish unid. | larval fishes | - | - | 2.64 | - | - | - |
| *Menticirrhus undulatus* | California corbina | - | - | - | - | - | - |
| *Citharichthys* spp. | sanddabs | - | - | - | - | - | - |
| *Oxyjulis californica* | senorita | - | - | - | - | - | - |
| *Umbrina roncador* | yellowfin croaker | - | - | - | - | - | - |
| *Gillichthys mirabilis* | longjaw mudsucker | 2.29 | - | 3.23 | 2.72 | 8.87 | 2.84 |
| *Lepidogobius lepidus* | bay goby | - | - | - | - | 19.87 | - |
| Pleuronectidae unid. | righteye flounders | 2.34 | - | - | - | - | - |
| *Leptocottus armatus* | Pacific staghorn sculpin | - | 2.44 | - | 5.12 | 5.75 | - |
| *Syngnathus* spp. | pipefishes | - | - | - | - | - | - |
| *Acanthogobius flavimanus* | yellowfin goby | - | - | - | - | 21.98 | - |
| *Sphyraena argentea* | Pacific barracuda | - | - | - | - | - | - |
| *Pleuronichthys ritteri* | spotted turbot | - | - | - | - | - | - |
| *Diaphus theta* | California headlight fish | - | - | - | - | - | - |
| *Gibbonsia* spp. | kelpfishes | - | - | - | - | - | - |
| *Triphoturus mexicanus* | Mexican lampfish | - | - | - | - | - | - |
| Myctophidae unid. | lanternfishes | - | - | - | - | - | - |
| *Atractoscion nobilis* | white seabass | - | - | - | - | - | - |
| Haemulidae | grunts | - | - | - | - | - | - |
| *Sardinops sagax* | Pacific sardine | - | - | - | - | - | - |
| *Stenobrachius leucopsarus* | northern lampfish | - | - | - | - | - | - |
| Labrisomidae unid. | labrisomid blennies | - | - | - | - | - | - |
| *Pleuronichthys verticalis* | hornyhead turbot | - | - | - | - | - | - |
| *Peprilus simillimus* | Pacific butterfish | - | - | - | - | - | - |
| *Medialuna californiensis* | halfmoon | - | - | - | - | - | - |
| *Semicossyphus pulcher* | California sheephead | - | - | - | - | - | - |
| Paralichthyidae unid. | lefteye flounders & sanddabs | - | - | - | - | - | - |
| *Scomber japonicus* | Pacific mackerel | - | - | - | - | - | - |
| Scorpaenidae | scorpion fishes | - | - | - | - | - | - |
| *Symphurus atricauda* | California tonguefish | - | - | - | - | - | - |
| *Strongylura exilis* | California needlefish | - | - | - | - | - | - |
| *Oxylebius pictus* | painted greenling | - | - | - | - | - | - |
| *Halichoeres semicinctus* | rock wrasse | - | - | - | - | - | - |
| *Typhlogobius californiensis* | blind goby | - | - | - | - | - | - |
| larval fish - damaged | damaged larval fishes | - | - | - | - | - | - |
| *Merluccius productus* | Pacific hake | - | - | - | - | - | - |
| *Coryphopterus nicholsi* | blackeye goby | - | - | - | - | - | - |
| *Ruscarius creaseri* | roughcheek sculpin | - | - | - | - | - | - |
| Agonidae unid. | poachers | - | - | - | - | - | - |
| Pleuronectiformes unid. | flatfishes | - | - | - | - | - | - |
| Cottidae unid. | sculpins | 2.16 | - | - | - | - | - |
| | **Total Larval Fishes:** | **259.07** | **134.21** | **173.38** | **93.38** | **571.29** | **166.84** |

**Table B3**. Average concentrations (# per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for Huntington Beach Generating Station from December 29, 2003 and February 2, 2004. Concentrations represent averages from two samples collected approximately every six hours over a 24-hour period.

| Taxon | Common Name | 12/29/03 | 01/05/04 | 01/12/04 | 01/19/04 | 01/26/04 | 02/02/04 |
|---|---|---|---|---|---|---|---|
| Gobiidae unid. | gobies | 116.10 | 91.74 | 106.93 | 78.48 | 215.05 | 13.59 |
| Engraulidae | anchovies | 28.28 | 11.16 | 5.59 | 13.91 | 2.47 | - |
| *Roncador stearnsi* | spotfin croaker | - | - | - | - | - | - |
| *Genyonemus lineatus* | white croaker | 2.39 | 20.88 | 61.63 | 94.40 | 28.26 | - |
| *Seriphus politus* | queenfish | - | - | - | - | - | - |
| Sciaenidae unid. | croakers | 2.48 | 2.94 | 11.28 | - | - | - |
| *Hypsoblennius* spp. | combtooth blennies | - | 2.83 | - | - | - | - |
| larvae, unidentified yolksac | yolksac larvae | - | - | - | - | - | - |
| *Xenistius califoriensis* | salema | - | - | - | - | - | - |
| *Paralichthys californicus* | California halibut | - | - | - | - | - | - |
| Atherinopsidae | silversides | 2.57 | 2.92 | 2.80 | 25.42 | 2.24 | 13.59 |
| *Cheilotrema saturnum* | black croaker | - | - | - | - | - | - |
| *Hypsopsetta guttulata* | diamond turbot | 9.87 | 2.84 | - | 2.84 | 8.06 | 2.57 |
| *Paralabrax* spp. | sea basses | - | - | - | - | - | - |
| *Hypsypops rubicundus* | garibaldi | - | - | - | - | - | - |
| larval/post-larval fish unid. | larval fishes | - | - | - | 2.84 | - | - |
| *Menticirrhus undulatus* | California corbina | - | - | - | - | - | - |
| *Citharichthys* spp. | sanddabs | - | - | - | 11.63 | - | - |
| *Oxyjulis californica* | senorita | - | - | - | - | - | - |
| *Umbrina roncador* | yellowfin croaker | - | - | - | - | - | - |
| *Gillichthys mirabilis* | longjaw mudsucker | - | - | - | 2.79 | - | - |
| *Lepidogobius lepidus* | bay goby | - | 2.95 | 5.59 | 5.85 | - | - |
| Pleuronectidae unid. | righteye flounders | - | - | - | - | - | - |
| *Leptocottus armatus* | Pacific staghorn sculpin | 2.50 | - | 11.48 | 6.13 | - | - |
| *Syngnathus* spp. | pipefishes | - | - | - | - | - | - |
| *Acanthogobius flavimanus* | yellowfin goby | - | - | - | - | 12.36 | - |
| *Sphyraena argentea* | Pacific barracuda | - | - | - | - | - | - |
| *Pleuronichthys ritteri* | spotted turbot | - | - | - | 3.07 | - | - |
| *Diaphus theta* | California headlight fish | - | - | - | - | - | - |
| *Gibbonsia* spp. | kelpfishes | - | - | - | 2.79 | - | - |
| *Triphoturus mexicanus* | Mexican lampfish | - | - | - | - | - | - |
| Myctophidae unid. | lanternfishes | - | - | - | - | - | - |
| *Atractoscion nobilis* | white seabass | - | - | - | - | - | - |
| Haemulidae | grunts | - | - | - | - | - | - |
| *Sardinops sagax* | Pacific sardine | - | - | - | - | - | - |
| *Stenobrachius leucopsarus* | northern lampfish | 2.50 | - | - | - | - | - |
| Labrisomidae unid. | labrisomid blennies | - | - | - | - | - | - |
| *Pleuronichthys verticalis* | hornyhead turbot | - | - | - | - | - | - |
| *Peprilus simillimus* | Pacific butterfish | - | - | - | - | - | - |
| *Medialuna californiensis* | halfmoon | - | - | - | - | - | - |
| *Semicossyphus pulcher* | California sheephead | - | - | - | - | - | - |
| Paralichthyidae unid. | lefteye flounders & sanddabs | - | - | - | - | - | - |
| *Scomber japonicus* | Pacific mackerel | - | - | - | - | - | - |
| Scorpaenidae | scorpion fishes | - | - | - | - | - | - |
| *Symphurus atricauda* | California tonguefish | - | - | - | - | - | - |
| *Strongylura exilis* | California needlefish | - | - | - | - | - | - |
| *Oxylebius pictus* | painted greenling | - | - | 3.00 | - | - | - |
| *Halichoeres semicinctus* | rock wrasse | - | - | - | - | - | - |
| *Typhlogobius californiensis* | blind goby | - | - | - | - | - | - |
| larval fish - damaged | damaged larval fishes | - | - | - | - | - | - |
| *Merluccius productus* | Pacific hake | - | - | - | - | - | - |
| *Coryphopterus nicholsi* | blackeye goby | - | - | - | - | - | - |
| *Ruscarius creaseri* | roughcheek sculpin | - | - | - | - | - | - |
| Agonidae unid. | poachers | - | - | - | - | - | - |
| Pleuronectiformes unid. | flatfishes | - | - | - | - | - | - |
| Cottidae unid. | sculpins | - | - | - | - | - | - |
| | **Total Larval Fishes:** | **166.69** | **138.26** | **208.30** | **250.14** | **268.44** | **29.75** |

**Table B4**. Average concentrations (# per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for Huntington Beach Generating Station from February 9, 2004 and March 15, 2004. Concentrations represent averages from two samples collected approximately every six hours over a 24-hour period.

| Taxon | Common Name | 02/09/04 | 02/17/04 | 02/23/04 | 03/03/04 | 03/08/04 | 03/15/04 |
|---|---|---|---|---|---|---|---|
| Gobiidae unid. | gobies | 41.86 | 18.60 | 282.22 | 11.99 | 137.12 | 247.38 |
| Engraulidae | anchovies | 2.56 | 5.40 | - | - | 33.56 | 35.04 |
| *Roncador stearnsi* | spotfin croaker | - | - | - | - | - | - |
| *Genyonemus lineatus* | white croaker | 15.55 | 7.16 | - | 11.99 | 13.97 | 5.25 |
| *Seriphus politus* | queenfish | - | - | - | - | - | - |
| Sciaenidae unid. | croakers | - | - | - | - | - | - |
| *Hypsoblennius* spp. | combtooth blennies | 2.63 | 2.41 | - | - | - | - |
| larvae, unidentified yolksac | yolksac larvae | - | - | - | - | - | - |
| *Xenistius califoriensis* | salema | - | - | - | - | - | - |
| *Paralichthys californicus* | California halibut | - | - | - | - | - | - |
| Atherinopsidae | silversides | 2.53 | 8.39 | 9.63 | - | 3.03 | 9.07 |
| *Cheilotrema saturnum* | black croaker | - | - | - | - | - | - |
| *Hypsopsetta guttulata* | diamond turbot | - | 5.10 | - | - | 3.18 | - |
| *Paralabrax* spp. | sea basses | - | - | - | - | - | - |
| *Hypsypops rubicundus* | garibaldi | - | - | - | - | - | - |
| larval/post-larval fish unid. | larval fishes | - | - | 2.45 | - | - | - |
| *Menticirrhus undulatus* | California corbina | - | - | - | - | - | - |
| *Citharichthys* spp. | sanddabs | - | - | - | 11.99 | - | - |
| *Oxyjulis californica* | senorita | - | - | - | - | - | - |
| *Umbrina roncador* | yellowfin croaker | - | - | - | - | - | - |
| *Gillichthys mirabilis* | longjaw mudsucker | 2.56 | 2.69 | 2.81 | - | 3.03 | - |
| *Lepidogobius lepidus* | bay goby | 2.89 | 5.33 | - | - | - | - |
| Pleuronectidae unid. | righteye flounders | - | - | - | - | - | - |
| *Leptocottus armatus* | Pacific staghorn sculpin | 2.56 | 2.41 | 4.49 | - | - | - |
| *Syngnathus* spp. | pipefishes | - | - | - | - | - | - |
| *Acanthogobius flavimanus* | yellowfin goby | - | 2.27 | 2.00 | - | - | - |
| *Sphyraena argentea* | Pacific barracuda | - | - | - | - | - | - |
| *Pleuronichthys ritteri* | spotted turbot | - | - | - | - | - | - |
| *Diaphus theta* | California headlight fish | - | - | - | - | - | - |
| *Gibbonsia* spp. | kelpfishes | - | - | 8.72 | - | - | - |
| *Triphoturus mexicanus* | Mexican lampfish | - | - | - | - | - | - |
| Myctophidae unid. | lanternfishes | - | - | - | - | - | - |
| *Atractoscion nobilis* | white seabass | - | - | - | - | - | - |
| Haemulidae | grunts | - | - | - | - | - | - |
| *Sardinops sagax* | Pacific sardine | - | - | - | - | - | - |
| *Stenobrachius leucopsarus* | northern lampfish | - | - | - | - | - | - |
| Labrisomidae unid. | labrisomid blennies | - | - | - | - | - | - |
| *Pleuronichthys verticalis* | hornyhead turbot | - | - | - | - | - | - |
| *Peprilus simillimus* | Pacific butterfish | - | - | - | - | - | - |
| *Medialuna californiensis* | halfmoon | - | - | - | - | - | - |
| *Semicossyphus pulcher* | California sheephead | - | - | - | - | - | - |
| Paralichthyidae unid. | lefteye flounders & sanddabs | - | - | - | - | - | - |
| *Scomber japonicus* | Pacific mackerel | - | - | - | - | - | - |
| Scorpaenidae | scorpion fishes | - | - | - | - | - | - |
| *Symphurus atricauda* | California tonguefish | - | - | - | - | - | - |
| *Strongylura exilis* | California needlefish | - | - | - | - | - | - |
| *Oxylebius pictus* | painted greenling | - | - | - | - | - | - |
| *Halichoeres semicinctus* | rock wrasse | - | - | - | - | - | - |
| *Typhlogobius californiensis* | blind goby | - | - | - | - | - | - |
| larval fish - damaged | damaged larval fishes | - | - | - | - | - | - |
| *Merluccius productus* | Pacific hake | 2.53 | - | - | - | - | - |
| *Coryphopterus nicholsi* | blackeye goby | - | - | - | - | - | - |
| *Ruscarius creaseri* | roughcheek sculpin | - | - | - | - | - | - |
| Agonidae unid. | poachers | - | - | - | - | - | - |
| Pleuronectiformes unid. | flatfishes | - | - | - | - | - | - |
| Cottidae unid. | sculpins | - | - | - | - | - | - |
| | **Total Larval Fishes:** | **75.65** | **59.76** | **312.32** | **35.98** | **193.89** | **296.74** |

**Table B5**. Average concentrations (# per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for Huntington Beach Generating Station from March 22, 2004 and May 3, 2004. Concentrations represent averages from two samples collected approximately every six hours over a 24-hour period.

| Taxon | Common Name | 03/22/04 | 04/05/04 | 04/12/04 | 04/19/04 | 04/23/04 | 05/03/04 |
|---|---|---|---|---|---|---|---|
| Gobiidae unid. | gobies | 134.29 | 77.76 | 34.37 | 161.94 | 3.02 | 368.00 |
| Engraulidae | anchovies | 68.90 | 36.09 | 44.42 | 87.84 | 51.74 | 189.17 |
| *Roncador stearnsi* | spotfin croaker | - | - | - | - | - | 4.79 |
| *Genyonemus lineatus* | white croaker | 54.03 | 2.57 | 83.13 | 97.60 | 55.98 | 137.91 |
| *Seriphus politus* | queenfish | - | - | - | - | - | - |
| Sciaenidae unid. | croakers | - | - | 4.55 | 3.24 | 8.09 | 9.97 |
| *Hypsoblennius* spp. | combtooth blennies | - | - | 2.19 | 10.40 | 7.51 | - |
| larvae, unidentified yolksac | yolksac larvae | - | 4.52 | - | - | 6.97 | 8.56 |
| *Xenistius califoriensis* | salema | - | - | - | - | - | - |
| *Paralichthys californicus* | California halibut | - | - | 2.32 | 3.72 | 33.13 | 7.64 |
| Atherinopsidae | silversides | 19.76 | 2.52 | 2.43 | 10.51 | - | 74.91 |
| *Cheilotrema saturnum* | black croaker | - | - | - | - | 7.11 | - |
| *Hypsopsetta guttulata* | diamond turbot | 2.74 | 2.52 | 11.78 | 6.48 | 3.52 | - |
| *Paralabrax* spp. | sea basses | - | - | - | - | - | - |
| *Hypsypops rubicundus* | garibaldi | - | - | - | - | - | - |
| larval/post-larval fish unid. | larval fishes | - | 2.69 | - | 3.24 | - | - |
| *Menticirrhus undulatus* | California corbina | - | - | - | - | - | - |
| *Citharichthys* spp. | sanddabs | - | 4.17 | - | - | 7.04 | 3.05 |
| *Oxyjulis californica* | senorita | - | 2.44 | - | - | - | - |
| *Umbrina roncador* | yellowfin croaker | - | - | - | - | - | - |
| *Gillichthys mirabilis* | longjaw mudsucker | 3.27 | 2.52 | - | 3.13 | - | 5.04 |
| *Lepidogobius lepidus* | bay goby | - | - | 2.32 | - | - | 2.58 |
| Pleuronectidae unid. | righteye flounders | - | - | 2.32 | - | - | 4.93 |
| *Leptocottus armatus* | Pacific staghorn sculpin | - | - | - | - | - | - |
| *Syngnathus* spp. | pipefishes | - | - | - | - | - | - |
| *Acanthogobius flavimanus* | yellowfin goby | - | - | - | - | - | - |
| *Sphyraena argentea* | Pacific barracuda | - | - | - | - | - | - |
| *Pleuronichthys ritteri* | spotted turbot | - | - | - | - | - | - |
| *Diaphus theta* | California headlight fish | - | - | - | - | - | - |
| *Gibbonsia* spp. | kelpfishes | - | - | - | - | - | 10.43 |
| *Triphoturus mexicanus* | Mexican lampfish | - | - | - | - | - | - |
| Myctophidae unid. | lanternfishes | - | - | - | - | - | - |
| *Atractoscion nobilis* | white seabass | - | - | - | - | - | - |
| Haemulidae | grunts | - | - | - | - | - | - |
| *Sardinops sagax* | Pacific sardine | - | - | - | - | - | - |
| *Stenobrachius leucopsarus* | northern lampfish | - | - | - | 3.13 | - | - |
| Labrisomidae unid. | labrisomid blennies | - | - | - | - | - | - |
| *Pleuronichthys verticalis* | hornyhead turbot | - | - | - | - | - | - |
| *Peprilus simillimus* | Pacific butterfish | - | - | - | - | - | - |
| *Medialuna californiensis* | halfmoon | - | - | - | - | - | - |
| *Semicossyphus pulcher* | California sheephead | - | - | - | - | - | - |
| Paralichthyidae unid. | lefteye flounders & sanddabs | - | - | - | - | - | 2.47 |
| *Scomber japonicus* | Pacific mackerel | - | - | - | - | - | - |
| Scorpaenidae | scorpion fishes | - | - | - | - | - | - |
| *Symphurus atricauda* | California tonguefish | - | - | - | - | - | - |
| *Strongylura exilis* | California needlefish | - | - | - | - | - | - |
| *Oxylebius pictus* | painted greenling | - | - | - | - | - | - |
| *Halichoeres semicinctus* | rock wrasse | - | - | - | - | - | - |
| *Typhlogobius californiensis* | blind goby | - | - | - | - | - | - |
| larval fish - damaged | damaged larval fishes | - | - | - | - | - | - |
| *Merluccius productus* | Pacific hake | - | - | - | - | - | - |
| *Coryphopterus nicholsi* | blackeye goby | - | - | - | - | - | - |
| *Ruscarius creaseri* | roughcheek sculpin | - | - | - | - | - | - |
| Agonidae unid. | poachers | - | - | - | - | - | - |
| Pleuronectiformes unid. | flatfishes | - | - | 2.25 | - | - | - |
| Cottidae unid. | sculpins | - | - | - | - | - | - |
| | **Total Larval Fishes:** | **282.99** | **137.81** | **192.07** | **391.23** | **184.11** | **829.45** |

**Table B6**. Average concentrations (# per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for Huntington Beach Generating Station from May 7, 2004 and June 14, 2004. Concentrations represent averages from two samples collected approximately every six hours over a 24-hour period.

| Taxon | Common Name | 05/07/04 | 05/17/04 | 05/24/04 | 06/01/04 | 06/07/04 | 06/14/04 |
|---|---|---|---|---|---|---|---|
| Gobiidae unid. | gobies | 191.60 | 93.47 | 50.64 | 74.14 | 23.70 | 92.05 |
| Engraulidae | anchovies | 69.89 | 69.35 | 179.35 | 371.70 | 10.66 | 167.95 |
| *Roncador stearnsi* | spotfin croaker | - | 18.27 | 26.74 | - | - | 59.14 |
| *Genyonemus lineatus* | white croaker | 117.64 | 71.74 | 39.17 | 17.50 | 2.30 | 2.49 |
| *Seriphus politus* | queenfish | - | 31.08 | 4.55 | - | - | 24.38 |
| Sciaenidae unid. | croakers | - | 46.73 | 64.09 | 1.98 | - | 205.00 |
| *Hypsoblennius* spp. | combtooth blennies | 15.22 | 25.48 | 17.89 | 6.85 | 15.82 | 30.14 |
| larvae, unidentified yolksac | yolksac larvae | - | 6.09 | 9.16 | - | 5.14 | 224.33 |
| *Xenistius califoriensis* | salema | - | - | - | - | - | - |
| *Paralichthys californicus* | California halibut | - | 2.97 | 4.96 | 3.95 | - | 125.84 |
| Atherinopsidae | silversides | 6.88 | - | 5.10 | 18.87 | - | - |
| *Cheilotrema saturnum* | black croaker | - | 20.16 | 2.27 | - | - | 8.05 |
| *Hypsopsetta guttulata* | diamond turbot | 7.08 | 8.36 | - | - | - | - |
| *Paralabrax* spp. | sea basses | - | 5.58 | - | - | - | 31.16 |
| *Hypsypops rubicundus* | garibaldi | - | - | - | - | - | 15.71 |
| larval/post-larval fish unid. | larval fishes | - | 2.31 | - | 6.88 | - | 29.17 |
| *Menticirrhus undulatus* | California corbina | - | - | - | - | - | 4.98 |
| *Citharichthys* spp. | sanddabs | - | 9.04 | 2.65 | - | - | - |
| *Oxyjulis californica* | senorita | - | 4.85 | 2.28 | - | - | - |
| *Umbrina roncador* | yellowfin croaker | - | - | 2.65 | - | - | 64.52 |
| *Gillichthys mirabilis* | longjaw mudsucker | - | - | - | - | - | - |
| *Lepidogobius lepidus* | bay goby | 3.54 | - | - | - | - | - |
| Pleuronectidae unid. | righteye flounders | - | - | 8.18 | - | - | - |
| *Leptocottus armatus* | Pacific staghorn sculpin | - | - | - | - | - | - |
| *Syngnathus* spp. | pipefishes | - | - | - | 34.41 | 2.84 | - |
| *Acanthogobius flavimanus* | yellowfin goby | - | - | - | - | - | - |
| *Sphyraena argentea* | Pacific barracuda | - | - | - | - | - | - |
| *Pleuronichthys ritteri* | spotted turbot | - | 2.97 | - | - | - | 17.52 |
| *Diaphus theta* | California headlight fish | - | - | - | - | - | - |
| *Gibbonsia* spp. | kelpfishes | - | - | - | - | - | - |
| *Triphoturus mexicanus* | Mexican lampfish | - | 3.04 | - | - | - | - |
| Myctophidae unid. | lanternfishes | - | - | - | - | - | - |
| *Atractoscion nobilis* | white seabass | - | - | - | - | - | 4.76 |
| Haemulidae | grunts | - | - | - | - | - | - |
| *Sardinops sagax* | Pacific sardine | - | - | - | - | - | - |
| *Stenobrachius leucopsarus* | northern lampfish | 3.54 | - | - | - | - | - |
| Labrisomidae unid. | labrisomid blennies | - | - | - | - | - | - |
| *Pleuronichthys verticalis* | hornyhead turbot | - | - | - | - | - | - |
| *Peprilus simillimus* | Pacific butterfish | - | - | - | - | - | 3.86 |
| *Medialuna californiensis* | halfmoon | - | - | - | - | - | - |
| *Semicossyphus pulcher* | California sheephead | - | - | - | - | - | - |
| Paralichthyidae unid. | lefteye flounders & sanddabs | - | - | - | - | - | - |
| *Scomber japonicus* | Pacific mackerel | - | - | 2.28 | - | - | - |
| Scorpaenidae | scorpion fishes | - | - | - | - | - | 3.76 |
| *Symphurus atricauda* | California tonguefish | - | - | - | - | - | 3.15 |
| *Strongylura exilis* | California needlefish | - | - | - | - | 3.03 | - |
| *Oxylebius pictus* | painted greenling | - | - | - | - | - | - |
| *Halichoeres semicinctus* | rock wrasse | - | - | - | - | - | - |
| *Typhlogobius californiensis* | blind goby | - | - | - | - | - | 2.75 |
| larval fish - damaged | damaged larval fishes | - | - | - | - | - | - |
| *Merluccius productus* | Pacific hake | - | - | - | - | - | - |
| *Coryphopterus nicholsi* | blackeye goby | - | - | - | - | 2.47 | - |
| *Ruscarius creaseri* | roughcheek sculpin | - | - | - | - | 2.29 | - |
| Agonidae unid. | poachers | - | - | - | 2.29 | - | - |
| Pleuronectiformes unid. | flatfishes | - | - | - | - | - | - |
| Cottidae unid. | sculpins | - | - | - | - | - | - |
| | **Total Larval Fishes:** | **415.39** | **421.49** | **421.96** | **538.57** | **68.25** | **1,120.71** |

**Table B7**. Average concentrations (# per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for Huntington Beach Generating Station from June 21, 2004 and July 26, 2004. Concentrations represent averages from two samples collected approximately every six hours over a 24-hour period.

| Taxon | Common Name | 06/21/04 | 06/28/04 | 07/06/04 | 07/12/04 | 07/19/04 | 07/26/04 |
|---|---|---|---|---|---|---|---|
| Gobiidae unid. | gobies | 139.91 | 120.87 | 490.06 | 428.65 | 298.95 | 197.87 |
| Engraulidae | anchovies | 231.82 | 245.92 | 42.44 | 192.32 | 119.36 | 241.03 |
| *Roncador stearnsi* | spotfin croaker | - | 4.53 | 406.74 | - | - | 8.19 |
| *Genyonemus lineatus* | white croaker | 4.61 | - | 2.90 | - | - | - |
| *Seriphus politus* | queenfish | - | 8.06 | 5.82 | 74.07 | 28.93 | 18.74 |
| Sciaenidae unid. | croakers | 7.37 | 67.72 | 74.88 | - | 34.64 | 16.38 |
| *Hypsoblennius* spp. | combtooth blennies | 7.66 | 104.70 | 22.32 | 12.15 | 40.15 | 8.56 |
| larvae, unidentified yolksac | yolksac larvae | - | 102.20 | - | 5.24 | - | 7.80 |
| *Xenistius californiensis* | salema | - | - | - | - | - | 2.50 |
| *Paralichthys californicus* | California halibut | 2.20 | 10.13 | 3.48 | 8.02 | 2.53 | 21.40 |
| Atherinopsidae | silversides | 2.24 | 9.00 | 8.45 | - | 3.22 | - |
| *Cheilotrema saturnum* | black croaker | - | 7.23 | 9.01 | - | - | 18.48 |
| *Hypsopsetta guttulata* | diamond turbot | - | - | 5.11 | - | 2.53 | - |
| *Paralabrax* spp. | sea basses | - | 24.16 | 2.11 | - | - | 37.86 |
| *Hypsypops rubicundus* | garibaldi | - | 82.89 | - | - | - | 8.64 |
| larval/post-larval fish unid. | larval fishes | 25.64 | 15.17 | - | - | - | 11.11 |
| *Menticirrhus undulatus* | California corbina | - | 27.39 | 2.21 | - | - | - |
| *Citharichthys* spp. | sanddabs | - | 10.13 | 2.59 | - | - | 23.45 |
| *Oxyjulis californica* | senorita | - | 55.35 | - | - | - | 8.13 |
| *Umbrina roncador* | yellowfin croaker | 2.24 | 2.26 | - | - | - | - |
| *Gillichthys mirabilis* | longjaw mudsucker | - | - | - | - | - | - |
| *Lepidogobius lepidus* | bay goby | - | - | - | - | - | - |
| Pleuronectidae unid. | righteye flounders | - | - | - | - | 2.53 | 8.56 |
| *Leptocottus armatus* | Pacific staghorn sculpin | - | - | - | - | - | - |
| *Syngnathus* spp. | pipefishes | - | - | - | - | - | - |
| *Acanthogobius flavimanus* | yellowfin goby | - | - | - | - | - | - |
| *Sphyraena argentea* | Pacific barracuda | - | 3.19 | - | - | - | 15.63 |
| *Pleuronichthys ritteri* | spotted turbot | - | - | - | - | 2.90 | 2.55 |
| *Diaphus theta* | California headlight fish | - | - | 22.52 | - | - | 5.32 |
| *Gibbonsia* spp. | kelpfishes | - | 2.26 | - | - | - | - |
| *Triphoturus mexicanus* | Mexican lampfish | - | - | 5.64 | - | - | 8.04 |
| Myctophidae unid. | lanternfishes | - | - | 5.78 | - | - | 2.74 |
| *Atractoscion nobilis* | white seabass | - | - | - | - | - | 5.99 |
| Haemulidae | grunts | - | - | - | - | - | 2.82 |
| *Sardinops sagax* | Pacific sardine | - | - | - | - | - | - |
| *Stenobrachius leucopsarus* | northern lampfish | - | - | - | - | - | - |
| Labrisomidae unid. | labrisomid blennies | - | 5.01 | - | - | - | - |
| *Pleuronichthys verticalis* | hornyhead turbot | - | - | - | - | - | - |
| *Peprilus simillimus* | Pacific butterfish | - | - | - | - | - | 2.50 |
| *Medialuna californiensis* | halfmoon | - | 5.79 | - | - | - | - |
| *Semicossyphus pulcher* | California sheephead | - | 3.19 | - | - | - | 2.50 |
| Paralichthyidae unid. | lefteye flounders & sanddabs | - | - | - | - | - | - |
| *Scomber japonicus* | Pacific mackerel | - | 2.26 | - | - | - | - |
| Scorpaenidae | scorpion fishes | - | - | - | - | - | - |
| *Symphurus atricauda* | California tonguefish | - | - | - | - | - | - |
| *Strongylura exilis* | California needlefish | - | - | - | - | - | - |
| *Oxylebius pictus* | painted greenling | - | - | - | - | - | - |
| *Halichoeres semicinctus* | rock wrasse | - | - | - | - | - | 2.82 |
| *Typhlogobius californiensis* | blind goby | - | - | - | - | - | - |
| larval fish - damaged | damaged larval fishes | - | - | - | - | - | - |
| *Merluccius productus* | Pacific hake | - | - | - | - | - | - |
| *Coryphopterus nicholsi* | blackeye goby | - | - | - | - | - | - |
| *Ruscarius creaseri* | roughcheek sculpin | - | - | - | - | - | - |
| Agonidae unid. | poachers | - | - | - | - | - | - |
| Pleuronectiformes unid. | flatfishes | - | - | - | - | - | - |
| Cottidae unid. | sculpins | - | - | - | - | - | - |
| | **Total Larval Fishes:** | **423.69** | **919.41** | **1,112.06** | **720.45** | **535.74** | **689.61** |

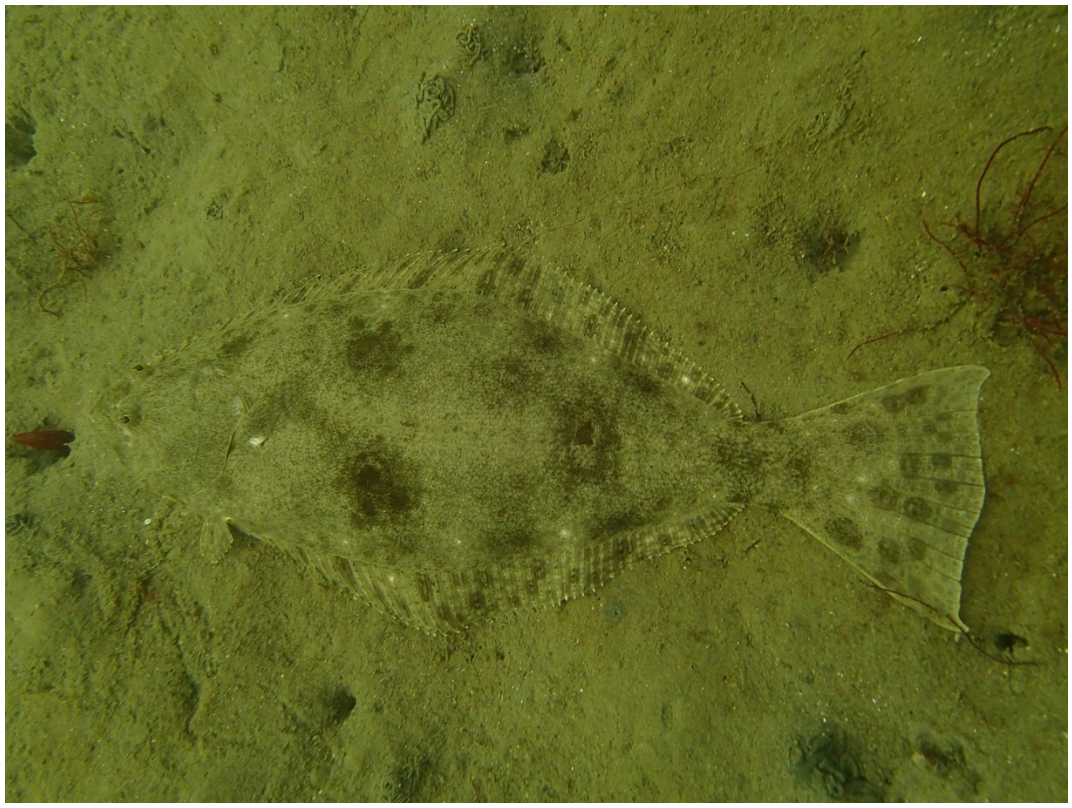
**Table B8**. Average concentrations (# per 1,000 $m^3$) for larval fishes and target invertebrates from sampling done at intake location for Huntington Beach Generating Station from August 24, 2004 and August 31, 2004. Concentrations represent averages from two samples collected approximately every six hours over a 24-hour period.

| Taxon | Common Name | 08/24/04 | 08/31/04 |
|---|---|---|---|
| Gobiidae unid. | gobies | 287.02 | 330.92 |
| Engraulidae | anchovies | 46.74 | 64.91 |
| *Roncador stearnsi* | spotfin croaker | 1,803.93 | 2.73 |
| *Genyonemus lineatus* | white croaker | - | 2.38 |
| *Seriphus politus* | queenfish | 281.28 | 322.39 |
| Sciaenidae unid. | croakers | 56.19 | 27.52 |
| *Hypsoblennius* spp. | combtooth blennies | 28.43 | 9.75 |
| larvae, unidentified yolksac | yolksac larvae | 19.40 | 6.69 |
| *Xenistius califoriensis* | salema | 336.09 | - |
| *Paralichthys californicus* | California halibut | 35.90 | 5.96 |
| Atherinopsidae | silversides | - | 5.74 |
| *Cheilotrema saturnum* | black croaker | 161.27 | 1.99 |
| *Hypsopsetta guttulata* | diamond turbot | 101.10 | - |
| *Paralabrax* spp. | sea basses | 9.70 | 18.44 |
| *Hypsypops rubicundus* | garibaldi | - | - |
| larval/post-larval fish unid. | larval fishes | - | - |
| *Menticirrhus undulatus* | California corbina | 67.88 | - |
| *Citharichthys* spp. | sanddabs | - | 3.07 |
| *Oxyjulis californica* | senorita | - | - |
| *Umbrina roncador* | yellowfin croaker | - | - |
| *Gillichthys mirabilis* | longjaw mudsucker | - | 3.91 |
| *Lepidogobius lepidus* | bay goby | - | - |
| Pleuronectidae unid. | righteye flounders | 8.16 | 1.99 |
| *Leptocottus armatus* | Pacific staghorn sculpin | - | - |
| *Syngnathus* spp. | pipefishes | 2.64 | - |
| *Acanthogobius flavimanus* | yellowfin goby | - | - |
| *Sphyraena argentea* | Pacific barracuda | 15.93 | - |
| *Pleuronichthys ritteri* | spotted turbot | 2.21 | 1.99 |
| *Diaphus theta* | California headlight fish | - | - |
| *Gibbonsia* spp. | kelpfishes | - | - |
| *Triphoturus mexicanus* | Mexican lampfish | 2.67 | - |
| Myctophidae unid. | lanternfishes | 2.67 | 2.71 |
| *Atractoscion nobilis* | white seabass | 2.21 | - |
| Haemulidae | grunts | 6.63 | 2.71 |
| *Sardinops sagax* | Pacific sardine | - | 10.86 |
| *Stenobrachius leucopsarus* | northern lampfish | - | - |
| Labrisomidae unid. | labrisomid blennies | - | 2.71 |
| *Pleuronichthys verticalis* | hornyhead turbot | 4.38 | 3.07 |
| *Peprilus simillimus* | Pacific butterfish | - | - |
| *Medialuna californiensis* | halfmoon | - | - |
| *Semicossyphus pulcher* | California sheephead | - | - |
| Paralichthyidae unid. | lefteye flounders & sanddabs | - | - |
| *Scomber japonicus* | Pacific mackerel | - | - |
| Scorpaenidae | scorpion fishes | - | - |
| *Symphurus atricauda* | California tonguefish | - | - |
| *Strongylura exilis* | California needlefish | - | - |
| *Oxylebius pictus* | painted greenling | - | - |
| *Halichoeres semicinctus* | rock wrasse | - | - |
| *Typhlogobius californiensis* | blind goby | - | - |
| larval fish - damaged | damaged larval fishes | - | 2.71 |
| *Merluccius productus* | Pacific hake | - | - |
| *Coryphopterus nicholsi* | blackeye goby | - | - |
| *Ruscarius creaseri* | roughcheek sculpin | - | - |
| Agonidae unid. | poachers | - | - |
| Pleuronectiformes unid. | flatfishes | - | - |
| Cottidae unid. | sculpins | - | - |
| | **Total Larval Fishes:** | **3,282.43** | **835.15** |

# ATTACHMENT 2: MILLER MARINE SCIENCE & CONSULTING, INC. 2018. HUNTINGTON BEACH DESALINATION PLANT INTAKE SITE DETERMINATION: MULTIPLE LINES OF EVIDENCE ANALYSIS. PREPARED FOR POSEIDON WATER.

# Huntington Beach Desalination Plant

## INTAKE SITE DETERMINATION: MULTIPLE LINES OF EVIDENCE ANALYSIS



| | |
|---|---|
| Prepared For | POSEIDON WATER<br>HUNTINGTON BEACH DESALINATION PLANT |
| Prepared By | ERIC MILLER AND DR. LARRY ALLEN<br>MILLER MARINE SCIENCE & CONSULTING, INC<br>ALISO VIEJO, CA |
| Date | OCTOBER 12, 2018 |
| Application Appendix Number | FFFFF |

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# EXECUTIVE SUMMARY

Extensive engagement since April 2016 among Poseidon Water and their consultants and the staff representing the Santa Ana Regional Water Quality Control Board, California State Water Resources Control Board, and the California Coastal Commission resulted in multiple detailed analyses of existing data to determine which site sampled during the 2003-04 entrainment study offshore Huntington Beach, California represented the site likely to result in the least intake and mortality of all forms of marine life (see National Pollutant Discharge Elimination System Permit Application Appendices XXXX, YYYY, ZZZZ1, ZZZZ2, AAAAA, DDDDD and EEEEE). Initially, per agency staff's direction, the Empirical Transport Model/Area of Production Forgone ("ETM/APF") analysis was exclusively used for the comparison; however, guidance provided during the interagency consultation process from the Regional Board's Neutral Third Party Reviewer Dr. Peter Raimondi has indicated the ETM/APF is likely deficient as a single line of evidence due to the lack of a robust larval length data at sites other than proposed intake site E.

In response to the critique of using the ETM/APF for this purpose, the raw mean (or median) larval concentration and standardized mean larval concentration were added as quantitative lines of evidence. No statistical analysis was recommended to compare the ETM/APF results, but a floating alpha approach was recommended by Dr. Raimondi to statistically determine which differences in the concentration analyses constituted a significant vs. an insignificant difference. The floating alpha method was previously developed by Dr. Raimondi for the California Coastal Commission's oversight of the San Onofre Nuclear Generating Station mitigation projects' performance. It relies on calculating an effect size, or standardized difference between the median (or mean for normally distributed data) values between two sites. The effect size serves as the critical p-value to determine if the results of a one-tailed t-test are significant. The Poseidon Water Team also added a qualitative analysis of the habitat, regulatory review of entrainment impacts to taxa stressed by other anthropogenic activities such as fishing, and proximity to sensitive habitats, marine protected areas, or protected species nursery areas. When examined in aggregate, the multiple lines of evidence (MLE) are to justify the identification of the best intake site based on ecological and regulatory factors alone.

Per Dr. Raimondi's guidance, the results of the most recent quantitative analyses presented to agency staff during the September 27, 2018, meeting (Appendix EEEEE) and updated in this final report (Appendix FFFFF) identified no scientifically-defensible ecological benefit achieved by moving the intake site from the currently proposed site E to any of the six alternative sites evaluated. Furthermore, the addition of both significance testing, as recommended by Dr. Raimondi, and the regulatory (i.e., qualitative) analyses required by the OPA in conjunction with the quantitative analyses definitively conclude that the proposed intake site E is ecologically superior to the six alternative sites evaluated.

For simplicity, an initial screening of all the MLE results was completed to identify the most ecologically impactful potential intake sites and remove them from further consideration (Figure ES-1). This eliminated potential intake sites D4, O2, and O4 from further consideration as each ranked among the most harmful in at least one of the three core MLE. Of the remaining four potential intake sites, the lowest APF was calculated for D2, the lowest median raw concentration was observed at U2 (but not significantly different from E or U4), and the lowest standardized concentration occurred at E (significantly lower than U2 and U4). An additional applicant-proposed standardized concentration analytical method reaffirmed the results of the standardized concentration method outlined by Dr. Raimondi that there are significantly lower concentrations at E than at the two remaining potential intake sites.

Averaged across the MLE, both weighted and unweighted, indicated potential intake site D2 was likely to have a higher impact on the surrounding marine environment than would occur at the remaining three potential intake sites (Figure ES-2). Differences in the mean MLEs for the remaining three potential intake sites were inconclusive. There was,

however, significantly higher standardized concentrations at potential intake sites U2 and U4 than at proposed intake site E detected in the results of both Dr. Raimondi's proposed standardized concentration analysis method and Poseidon's proposed standardized concentration analysis method. This was the only clearly differentiating quantitative result among the three remaining potential intake sites (E, U2, and U4).

Potential intake sites U2 and U4 are also substantially closer to the two marine protected areas in Bolsa Chica than proposed intake site E. The Ocean Plan Amendment clearly states the intake site should be located *to maximize the distance from a MPA* (marine protected area).

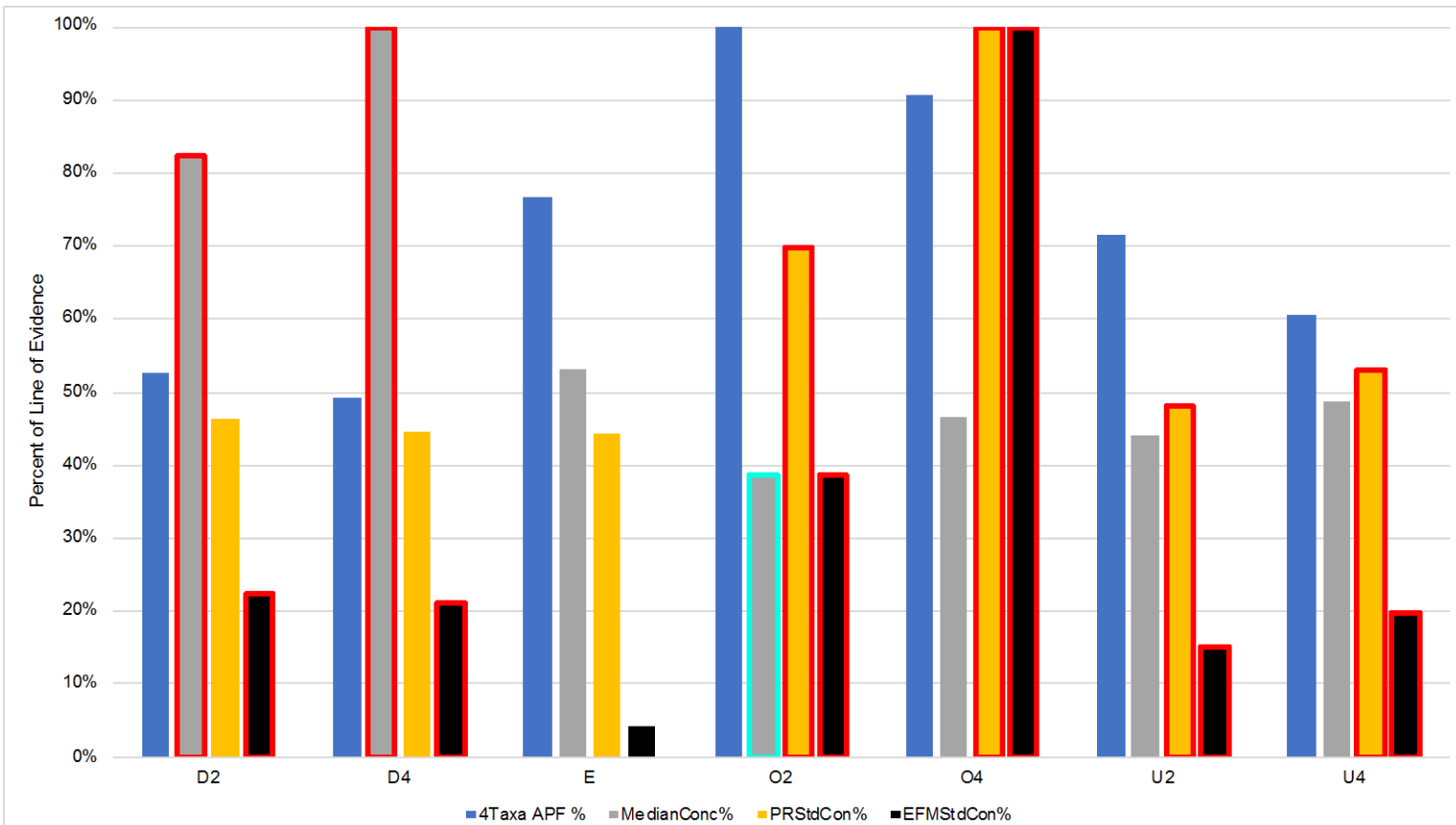


**Figure ES- 1. Percent of the maximum value for each line of evidence examined by station. Red outlined bars represent values that were significantly higher than the corresponding value at proposed intake site E. The green outlined bar was significantly less than the corresponding value at proposed intake site E. 4TaxaAPF% = APF using the common four taxa at six of the seven sites. MedianConc% = the median concentration of all identified and counted larvae. PRStdConc% = the mean standardized concentration of all identified taxa calculated using the Neutral Third-Party Reviewer's recommended method. EFMStdConc% = the mean standardized concentration of all identified taxa calculated using Eric Miller's method.**

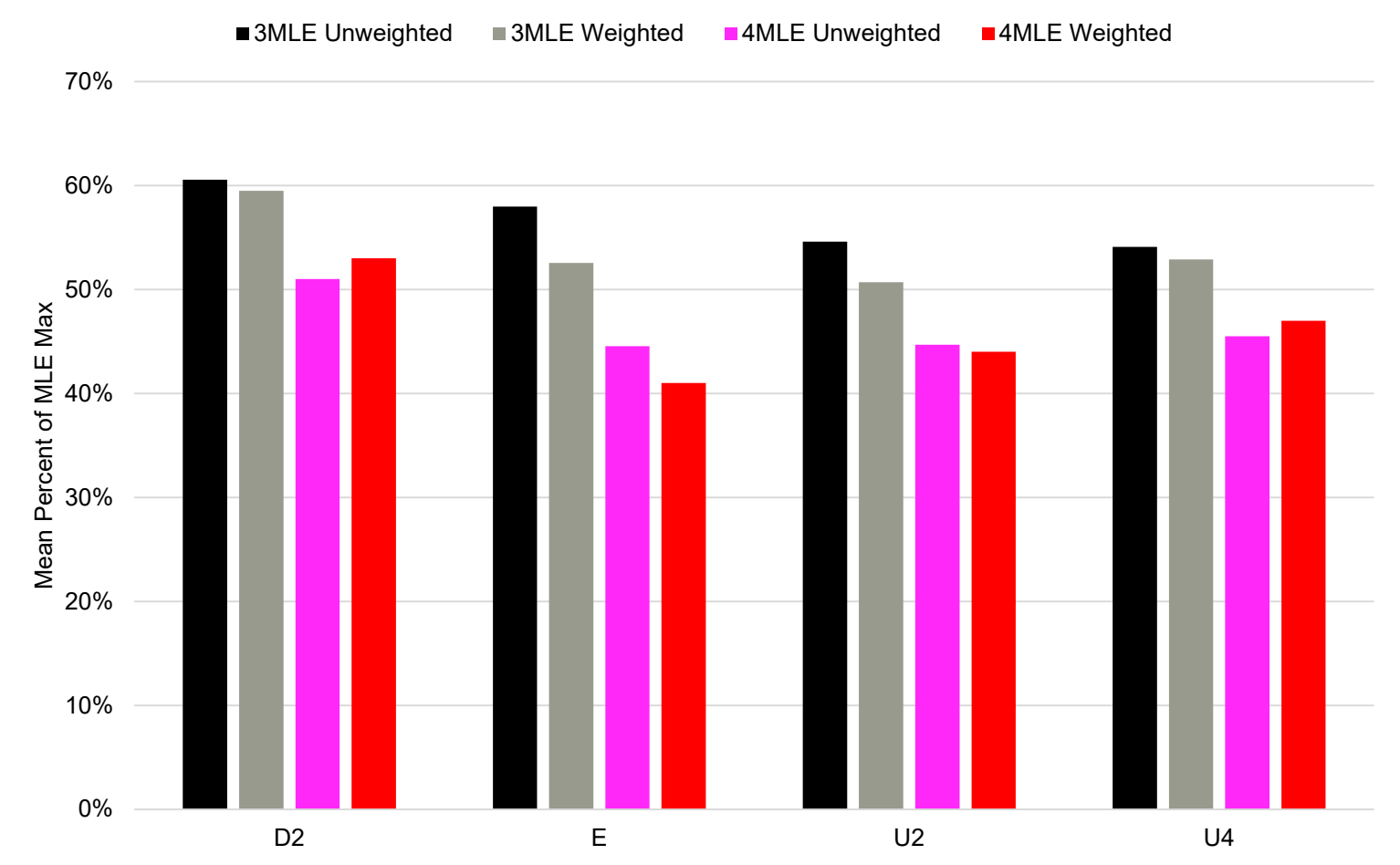


**Figure ES- 2. Summary analysis of multiple lines of evidence (MLE). Each bar represents an average of the three or four MLEs both unweighted and weighted.**

# PURPOSE

Starting in July 2018, Poseidon Water and regulatory agency staff have jointly worked with Dr. Peter Raimondi as part of a Neutral Third-Party Review (NTPR) to evaluate the best available site for a 1-mm screened ocean intake to minimize the intake and mortality of all forms of marine life for the proposed Huntington Beach Desalination Plant (HBDP). The parties have determined that this analysis will benefit from consideration of Multiple Lines of Evidence (MLE) as the Ocean Plan Amendment (OPA) provides various guidance under section M.2.b but does not prescribe a single analytical approach. This MLE approach was undertaken to weave together the disparate methods of comparing the potential environmental impact of each intake site considered to ensure the goals of the OPA are preserved, i.e., minimize the environmental impacts of the operation of a seawater desalination plant. Therefore, the following analysis includes lines of evidence that examine not only the numerical abundance of plankton, but also lines of evidence that examine risk to the entrained species from the operation of the seawater intake. In this context, Dr. Raimondi has defined risk as the measurement of the impact to the taxon's population to the extent possible. This is an important distinction between the MLE as not all species have the same source population abundances and thus each taxon's population has a different ability to absorb entrainment losses.

During meetings between April and September 2018, Dr. Raimondi opined on the importance of examining environmental risk rather than a simple numerical difference. Evaluating risk is consistent with OPA guidance on the appropriate application of ETM/APF, an analysis method which focuses on an evaluation of the broader ecosystem risk rather than abundance of the species entrained. The APF, per Dr. Raimondi, was developed to calculate and express risk in a readily understood metric (area of habitat). Nevertheless, the value of the ETM/APF in its original use was to evaluate the risk to the local aquatic ecological community posed by entrainment at a designated facility's water intake structure. The ETM incorporates this risk by standardizing the entrainment estimate as a function of the overall source population abundance susceptible to entrainment. Data concerns limited the utility of the ETM at all potential intake sites under consideration for the HBDP and therefore provided the genesis for examining the larval concentration data that was uniformly collected at all sampling stations. To incorporate risk into the larval concentration analysis, Dr. Raimondi recommended using standardized larval concentrations. Using standardized larval concentrations places the concentrations of each taxon on an equal plane with all the others. While not quite the same as standardizing to the source population abundance as would occur with the ETM, it does provide a more accurate assessment of the relative ecological risk of the intake location than simply counting the total number of marine organisms potentially susceptible to entrainment. Absent consideration of the proportion of the total population of each taxon that is potentially at risk, those taxa that are naturally more abundant will invariably have a more significant influence on the spatial pattern of raw concentration than those taxa that are naturally less abundant. Such an approach would protect those abundant taxa potentially at the expense of the rest of the taxa that are potentially at risk, which conflicts with the broader ecosystem protection goals of the OPA.

As an illustration of this concern, at the meeting on August 30, 2018, Dr. Raimondi used a hypothetical example to explain why the ecosystem risk analysis is a better metric for intake siting determinations than the total concentrations of species potentially at risk. In this example, the species at risk are the CIQ Goby and Tidewater Goby (*Eucyclogobius newberryi*). Tidewater Goby is a Federally-listed Endangered Species, while the three species in the CIQ Goby complex are not protected and relatively abundant. The hypothetical entrainment of 1000 CIQ goby and 100 Tidewater Goby (combined entrainment of 1100 fish) would be environmentally superior to the hypothetical entrainment of 500 CIQ Goby and 200 Tidewater Goby (combined entrainment of 700 fish) because a fewer number of the endangered Tidewater Goby are at risk of entrainment. The risk to the environment resulting from the entrainment of a greater number of CIQ Goby is less of a concern because of the healthy populations of this species group. The standardized concentration (discussed later) provides a way to evaluate the available data in a manner that appropriately weighs the ecological risk across the entrained community, rather than simply adding up total entrained organisms without any consideration of loss of those organisms to the communities they represent.

# MULTIPLE LINES OF EVIDENCE CONSIDERED AND THEIR APPLICABILITY TO OCEAN PLAN AMENDMENT COMPLIANCE

The MLE approach was pursued after agreement amongst the State and Regional Water Board Staff and California Coastal Commission Staff (Agency Staff), Dr. Raimondi, and Poseidon Water and its consultants (Poseidon Team) that no single metric satisfied the collective goal of identifying the best intake site as described in the OPA Section M.2.b. (biological considerations only):

- *(3) Analyze the feasibility of placing intake, discharge, and other facility infrastructure in a location that avoid impacts to sensitive habitats* and sensitive species.*
- *(4) Analyze the direct and indirect effects on all forms of marine life* resulting from facility construction and operation, individually and in combination with potential anthropogenic effects on all forms of marine life* resulting from other past, present, and reasonably foreseeable future activities within the area affected by the facility.*
- *(5) Analyze oceanographic, geologic, hydrogeologic, and seafloor topographic conditions at the site, so that the siting of a facility, including the intakes and discharges, minimizes the intake and mortality of all forms of marine life.**
- *(7) Ensure that the intake and discharge structures are not located within a MPA or SWQPA* with the exception of intake structures that do not have marine life mortality associated with the construction, operation, and maintenance of the intake structures (e.g. slant wells). Discharges shall be sited at a sufficient distance from a MPA or SWQPA* so that the salinity* within the boundaries of a MPA or SWQPA* does not exceed natural background salinity.* To the extent feasible,* surface intakes shall be sited so as to maximize the distance from a MPA or SWQPA.**

Discussions between the Agency Staff, Dr. Raimondi, and the Poseidon Team identified five quantitative and qualitative/regulatory lines of evidence:

Quantitative Lines of Evidence

1. ETM/APF using sampling station-specific criteria where available
    a. Addresses Section M.2.b.(4)
2. Mean concentration including all identified and enumerated taxa
    a. Addresses Section M.2.b.(4)
3. Standardized mean concentration including all identified and enumerated taxa
    a. Addresses Section M.2.b.(4)

Qualitative/Regulatory Lines of Evidence

4. Sampling station distance to sensitive habitats
    a. Addresses Sections M.2.b.(3) and M.2.b.(7)
5. Habitat Homogeneity
    a. Addresses Section M.2.b.(5)

# METHODS AND MAPPING OF SUPPORTING EXCEL FILE

## Methods

**Empirical Transport Model/Area of Production Forgone (ETM/APF)** – In consultation with Dr. Raimondi, the ETM was modified slightly from that reported in Appendix E of the OPA's Substitute Environmental Document (SWRCB 2015) to more accurately model for the contribution of estuarine taxa entrained at the submerged offshore intake structure. Prior studies of this location excluded estuarine taxa from consideration in the final APF (Davis et al. 2006). Coastal taxa were modeled using the standard ETM as described

in Appendix E of the OPA's Substitute Environmental Document, but the estuarine taxa were modeled using the derived ETM first proposed in Tenera (2006) where the traditional $P_e$ term is modified and $P_s$ term is removed:

$$P_M = 1 - f_i\left(1 - \left(\frac{E_i}{(SSWDi\ x\ TSWBV) + (Diest\ x\ TEWBV)}\right)\right)^d$$

Where

| | |
|---|---|
| $P_M$ = | Proportional Mortality |
| $f_i$ = | Proportion of the total annual source water population present during the $i^{th}$ survey |
| $E_i$ = | Estimated number of larvae entrained during the $i^{th}$ survey |
| $SSWD_i$ = | Estimated mean larval density in the sampled source water during the $i^{th}$ survey |
| TSWBV = | Total source water body volume derived as the alongshore displacement represented by the larval age (d) x the current speed (km/d) x 4.45 km (for the HBDP analysis) x mean depth of sampled source water body. |
| $D_{iest}$ = | Estimated larval density in the estuaries during the $i^{th}$ survey |
| TEWBV = | Total estuarine source water body volume from the estuaries used in the analysis |
| d = | number of days that the larvae are exposed to entrainment |

The area estuaries were not sampled during the 2003-04 Huntington Beach Generating Station field sampling program. Therefore, estuarine taxa larval concentrations reported from Agua Hedionda Lagoon (AHL; Tenera 2008) and Alamitos Bay (AB; MBC and Tenera 2007) were used to estimate the concentrations in the estuarine habitat in the Huntington Beach area. Source water populations in the area estuaries were estimated based on the two estuarine taxa concentration data sources after matching the sampling months between the estuarine data source and the 2003-04 field sampling program, e.g., January sampling results in AHL used for January larval concentrations caught during the 2003-04 field sampling program. Tenera (2006) captured an overall inventory of the habitat areas from the National Wetland Inventory (NWI) of the United States Fish and Wildlife Service in each of the area estuaries, but recommended these areas be reviewed to ensure they represented adult estuarine fish spawning habitat. The acreage of suitable estuarine fish adult spawning habitat was revised by Dr. Larry Allen to a total of 2,278.63 acres (Table 1). Both estuarine larval concentration data sources reported data as number/$m^3$ which was converted to number/$m^2$ of water surface by multiplying the reported concentration by the mean water depth of the sampling stations in each estuary. Month-specific mean depths were available in Tenera (2008) and were used (mean = 2.7 m). Only the expected depths for each station sampled in Alamitos Bay were available in MBC and Tenera (2007), the mean of which (4 m) was used in this analysis. These newly derived estuarine larval concentrations (number/$m^2$ of water surface) were used to estimate the total source water population in the estuaries for each estuarine taxa used in the ETM/APF analysis. Separate ETM/APF analyses were completed using each estuarine data source.

A series of ETM/APF analyses were completed to support both the intake site comparison and to estimate the mitigation acreage required to offset the intake entrainment losses. Potential intake sites were represented by the seven stations sampled during the 2003-04 field sampling program (Figure 1). The need for independent calculations, one for site comparison and another for mitigation calculation, reflected the limitations of the ETM/APF analysis for intake site comparison described below. Ideally, a suite of taxa representing the majority of all entrained larvae as well as various habitats and life histories common to the area that could be producing entrainable larvae are used in the analysis. Sufficient site-specific data are required to support ETM; these data were lacking for sites other than proposed intake site E.

The ETM/APF was calculated for each potential intake site independently using site-specific parameters. This included site-specific larval entrainment for each of the 12 monthly surveys derived by multiplying the month's mean concentration by the estimated water intake volume (106 million gallons per day or 401,253.64 $m^3$) proposed for the HBDP. In addition to site-specific entrainment estimates, site-specific estimates of the number of days larvae were susceptible to entrainment were needed. At nearly all potential intake sites, site-specific larval length measurements were only available for a subset of taxa, including: Northern Anchovy (*Engraulis mordax* plus Engraulidae), White Croaker (*Genyonemus lineatus*), CIQ Goby (*Clevelandia ios, Ilypnus gilberti,* and *Quietula y-cauda*), and Diamond Turbot (*Pleuronichthys guttulatus*). Despite a larger suite of taxa available for analysis at proposed intake site E, the intake site

comparison was restricted to these four taxa at all sites after consulting with Dr. Raimondi and Agency Staff. The estimated growth rate for each taxon was taken from Tenera (2010) for most taxa, from Midddaugh et al. (1990) for Jacksmelt (*Atherinopsis californiensis*), and from Rees (1959) for the *Emerita* growth rate.

In addition to larval length measurement limitations, no measured ocean current data from the 2003-04 field sampling program was available due to the failure of the current meter deployed at the time. Prior analyses of the collected plankton data utilized ocean current measurements made by the Orange County Sanitation District in the area during 1999-00 and 2007-08. During each measurement period, a different current measurement instrument was used and was positioned at a different location during each deployment. In an effort to overcome some of these data anomalies, Dr. Raimondi recommended using a ROMS modeling effort to estimate the ocean current speed at each potential intake site considered. This was complicated by the lack of coverage along the coast where five of the seven potential intake sites were located. Furthermore, only an annual mean current displacement was derived from the ROMS modeling for 2003 and 2004, independent of each other. The shortcomings of each ocean current data set were acknowledged and the decision was made to utilize all three (1999-00, 2007-08, and ROMS). A weighted average of the ROMS current displacements was calculated to reflect the fact that four months were sampled in 2003 and the remaining eight months were sampled in 2004. An annual mean current displacement was calculated from 12 consecutive months of measurements from the 1999-00 and 2007-08 ocean current data sets. These three ocean current displacement estimates were used to calculate the total alongshore source water body distance that is used in both the ETM and APF. The site-specific measured ocean current displacements could not be derived, rather one value was used for all intake site models.

In total, six APFs were calculated for each potential intake site. For each ocean current displacement, an APF was calculated based on each estuarine larval concentration data source (AHL and AB). The MLE analysis used the ROMS derived APFs and the mean APF, by estuarine larval concentration data source, of the two measured ocean current displacements. This reduced the overall number of APFs to four per potential intake site: two ROMS-based and two current meter-based.

A set of mitigation APFs were calculated for proposed intake site E as this was the lone site where larval lengths of a sufficient number of taxa were measured. APFs derived from 12 and 10 taxa are presented to reflect both the available data and precedent (Tenera 2006; Davis et al. 2006) for analysis at the site. A 1% reduction in overall APF was taken in recognition of the use of a 1-mm mesh screened intake in compliance with the OPA. In recognition of the productivity differences between open coast, sandy-bottom habitat and estuarine habitats (proposed mitigation), the APF for open coast taxa was scaled as 10 acres of impacted habitat mitigated by 1 acre of estuarine habitat as allowed by the OPA.

**Median Larval Concentration** – The median larval concentration, and standard error, was calculated by potential intake site for all taxa identified and enumerated during the sample processing. Each net was included individually in the analysis to ensure the full range of values and variation was reflected in the median, thus resulting in n=96 per site. The median was used, rather than the mean, as the data were not normally distributed and contained several data points that were considered outliers.

Use of the median larval concentration is new to this project analysis as of this report's writing, wherein the mean larval concentration has been used to this point during conversations between Agency Staff and the Poseidon Team. For consistency with the existing administrative record, the mean larval concentration was also calculated and presented herein, but not subjected to statistical analysis due to the non-normality of the data.

**Standardized Mean Larval Concentration** – To counteract the effects of the few inordinately abundant taxa (e.g., CIQ Goby and *Emerita*), the standardized mean larval concentration was examined. Using the standardized concentrations converted all values to the number of standard deviations above or below the taxon's mean across all potential intake sites. This allowed each taxon to contribute equally to the analysis, rather than be overwhelmed by the abundant taxa. Species are naturally more or less abundant based on their ecology and life histories, with some capable of achieving very large numbers, i.e., Northern Anchovy, while others, such as California Halibut, would naturally reach a population maximum at orders of magnitude less than, for example, Northern Anchovy. More direct evidence could be the differences between species that are not impacted by human activities and those that are such as the CIQ Goby and Tidewater Goby discussion presented earlier. The standardized mean larval concentration better accounts for risk to the population potentially entrained, as recommended by Dr. Raimondi.

Data standardization in this analysis incorporated calculating the z-score for each taxon by station. The z-score is:

$$Z = \frac{Value - Mean}{Standard\ Deviation}$$

Dr. Raimondi recommended one method of calculating the standardized mean larval concentration, while Eric Miller of Miller Marine Science & Consulting, Inc. proposed a second (EFM). Both methods were used and presented in this report, but Dr. Raimondi's method was considered one of the three core MLE and the EFM method a supplementary (applicant-proposed) line of evidence. Dr. Raimondi's method called for summing the total concentration for each identified taxon by intake site then calculating the taxon's mean concentration and standard deviation across the seven intake sites. From these three data points (intake site value, mean, and standard deviation) the z-score was calculated. The average z-scores across all 96 taxa recorded during the 2003-04 survey for each potential intake site were calculated and used in the final MLE.

The EFM method standardized across the results from each individual net due to concern that summing the concentrations did not accurately represent the variation and impact of random large catches. Therefore, the EFM method calculated the mean and standard deviation for each taxon across all nets that were processed for each monthly sampling event. Then the taxon-specific value for each of the nets was standardized against the mean and standard deviation derived for the year. The mean standard deviation was calculated from each individual standardized score for each taxon, by potential intake site. The grand mean of these taxon-specific standardized values for each intake site was calculated and used in the MLE.

**Significance Testing** – Significance testing was used to compare the site-specific concentrations and test for significant differences using the floating alpha method described in Reed et al. (2018). The median larval concentration analysis followed Reed et al. (2018) directly where the original 96 values per potential intake site were resampled (with replacement) to generate a new data set with n=10,000. The potential intake site-specific medians were calculated from the new data set. The effect size was calculated as the difference between the alternative intake site and the preferred intake site (E) medians divided by the preferred intake site E median.

$$Effect\ Size = \frac{Alternative\ Intake\ Site - Intake\ Site\ E}{Intake\ Site\ E}$$

The floating alpha method uses the effect size calculated between two sites as the critical p-value. A one-sample, one-sided t-test is used to compare the same two sites for which the effect size was calculated. Serial correlation was detected between the 96 values by potential intake site; therefore, the 12 monthly median raw concentrations by potential intake site were used in the t-test. The p-value resulting from the t-test is compared against the effect size. A p-value less than the effect size was considered a significant difference. For the standardized concentration analyses, no resampling was done. The median calculated from the 96 taxa-specific standardized concentrations per potential intake site was used to calculate both the effect size and the p-value using the t-test.

**Initial Screening** – The results of the preceding analyses were used to conduct an initial screening of the potential intake sites. Those sites achieving ≥ 90% of any MLE maximum were excluded from further consideration. Achieving ≥ 90% of an MLE maximum indicates that in at least one line of evidence, the potential intake site in question posed a substantially greater risk to all forms of marine life than the remaining potential intake sites that scored < 90% of the MLE maximum.

**Summarizing MLE Results** – To summarize the results of the MLE, the average percent of MLE-specific maximums were calculated. An average was calculated for the three core MLE (APF, Median Larval Concentration, and Dr. Raimondi Standardized Concentration) and a four MLE approach (three core MLE plus EFM Standardized Concentration). Furthermore, in recognition of the reduced efficacy and accuracy of the APFs based on the four taxa at each potential intake site, a second set of MLE means was calculated after weighting each MLE. Concerns over the veracity of the four-taxa APFs resulted in a reduced weight with each APF percent of maximum counting only as one-half its value in the summary for both the three and four MLE summations.

**Qualitative/Regulatory Analyses** – Additional qualitative/regulatory (QR) analyses were completed to assess the MLE at those potential intake sites advanced as candidates after the initial screening. The OPA contains narrative specifications such as maximizing the intake site's distance from a Marine Protected Area (MPA) or State Water Quality Protection Area (SWQPA). Each potential intake site was also examined to determine potential differences in the habitats surrounding the potential intake site including the site's proximity to sensitive habitats such as wetlands, protected species nursery sites, and other high value marine habitat (e.g., rocky reef, kelp forest, depressed species spawning grounds). An additional QR analysis categorized each of the 25 most abundant taxa based

on their fishery status and consideration as a taxon likely to benefit from MPA protection as determined by the California Department of Fish and Game (now Wildlife) South Coast Region MPA Science Advisory Team.

## Mapping to the Excel File

All of the data and analyses used in deriving the MLE are provided in the accompanying MS-Excel file (Review-10918MLE APF All Stations Analysis).

**Tab MLE Summary** – Summarizes the results from the evaluation of the lines of evidence described above. The values are presented as the percent of the MLE maximum for each potential intake site. Columns O through R summarize the MLEs for each potential intake site and their relation to the proposed intake site (Station E). Below that is the listing of potential intake sites that were excluded and for which MLE the site reached $\geq$ 90% of the MLE maximum. Each MLE is developed through the following tabs.

**APF Tabs** – The next 11 tabs with labels beginning with "APF" in the tab name document the development of the ETM/APF analyses. These begin with a summary of the resulting APFs, including the measured current results for each estuarine concentration data source that were averaged into one APF for each estuarine concentration data source. The ETM parameters used for each ocean current measurement analysis are represented on the "APF-ETM Parameters" tab, while the water volumes associated with each grid cell in the offshore sampling area are represented on the "APF-SWAgridvolumes" tab. Where applicable, additional instructions or notes are inserted to identify the tables' calculation methods and mechanics. The estimated source water population size for the two estuarine taxa included in the analysis were calculated for each intake site and ocean current value used are presented on the "APF-EstSWPCalc" tab. The next seven tabs present the ETM/APF calculation for each potential intake site. On each tab moving from left to right, each ocean current estimate-specific ETM/APF analysis is presented independently. For each, the source water population estimate for the estuarine taxa is updated as was the $P_s$ and APF source water area. The percent of maximum was calculated to be entered in the MLE summary table.

**Concentration Tab** – The next tab "Conc-AllSp" presents the total median and mean concentrations of all identified and counted taxa (summed across taxa before analyzing) at each potential intake site. Columns A through K contain the raw concentration for each potential intake site by individual net. Columns P through V contain the resampling results where the original data set was resampled with replacement to create a new data set of 10,000 records per potential intake site. Potential intake sites other than E were compared to E using the floating alpha method described above to determine if significant differences existed between the site-specific sampling results. Cells X1 through AE15 contain the descriptive statistics (mean, median, standard error, etc.) of the resampled data set. Cells X17 through AE22 contain the floating alpha significance analysis (ES – effect size, t-test for 12 monthly values, t-test-es difference) and the conclusions of independence testing (Durbin-Watson) for the full 96 original data points per potential intake site and the 12 monthly sum concentrations. The t-test is sensitive to data independence (autocorrelation), therefore the independence testing concluded the 12 monthly sum concentrations should be used to minimize the inclusion of autocorrelated data. The percent of maximum was calculated to be entered in the MLE summary table.

**Standardized Concentration Tabs** – Both approaches to the standardized concentration were presented. The first being on the "PR Std Con" tab that presents the approach proposed by Dr. Raimondi. The second analysis proposed by Eric Miller of Miller Marine Science & Consulting, Inc. is presented on the next four tabs beginning with "EFM". The EFM method required more tabs to account for the more detailed methods used. Both methods were analyzed for significant differences between the potential intake site results using the floating alpha method except no resampling was used. The standardized concentration analysis is presented on the five tabs beginning with Std Conc. All steps of the analysis are shown from the raw concentration through the final data set to highlight the analytical mechanics used to derive the final values. Mean concentrations at each potential intake site other than E were compared to E using the floating alpha method described above to determine if significant differences existed between the station-specific sampling results.

**Taxon Tabs** – The final three tabs focus on annual raw mean concentration, and the degree to which this parameter would result in the protection of *Emerita* at the potential detriment of the remaining taxa. This qualitative analysis categorized each of the 25 most abundant taxa based on their fishery status and consideration as a taxon likely to benefit from MPA protection as determined by the

California Department of Fish and Game (now Wildlife) South Coast Region MPA Science Advisory Team. The taxa are ranked in ascending order with higher ranks for those potential intake sites with higher concentrations of each taxon.

# RESULTS

**ETM/APF** – The ETM/APF did not substantially differ based on the estuarine larval concentration data source or ocean current data source (Table 2). Variations in ocean current displacement among the three values were used in their respective ETM/APF models to calculate the total source water body. While faster currents (larger annual displacement distance) result in a larger total source water body estimate (assuming a single d value) used as the APF source water area, the larger total source water body results in a smaller $P_s$ value. The opposing effect of these two variables cancels the difference in current speed out when compared with other ETM/APF results using different current speeds.

The grand mean APF across all the analyses, by potential intake site, ranged from 138 acres to 281 acres. Standardizing each potential intake site to the maximum resulted in a range of 49% to 100% (Figure 2). Two potential intake sites had APFs $\geq$ 90% of the maximum and were excluded from further consideration: Stations O2 and O4. Of the remaining potential intake sites, the APF at Station D4 was 49% of the maximum, while the APF for Station E was 77%. All other values fell within these bounds. No significance testing was applied to the ETM/APF analysis.

**Median Concentration** – The next line of evidence considered was the annual raw median concentration of all taxa combined at each station. This line of evidence is in conflict with the broader ecosystem protection goals of Section M.2.b.(4). of the OPA, which states:

> *(4) Analyze the direct and indirect effects on all forms of marine life* resulting from facility construction and operation, individually and in combination with potential anthropogenic effects on all forms of marine life* resulting from other past, present, and reasonably foreseeable future activities within the area affected by the facility.*

One interpretation of this provision of the OPA was to mean the best intake site is one that will minimize the overall ecological impact risk to the marine community, not just the lowest raw concentration of plankton identified and counted during sampling.

Comprehensive ecosystem protection goals provided the basis for the 2003-04 entrainment study used in this analysis. The sampling and analysis plan required the identification and counting of all larval fishes and a select group of invertebrates. This list of taxa, developed in consultation with a technical working group comprised of regulatory agency staff, project consultants, and third-party scientific experts, was specifically designed to appropriately weigh the ecological risk across the broader marine community potentially at risk of entrainment.

The median (and mean) raw concentration was calculated for each potential intake site in accordance with Agency Staff's request. Since this analysis was subject to significance testing, the resampled data set (n=10,000) was examined. The median concentration ranged from 0.16 larvae/$m^3$ to 0.41 larvae/$m^3$ (Figure 3). Significance testing determined the concentrations at potential intake sites D2 and D4 were significantly higher than at proposed intake site E. This same analysis concluded the concentration at potential intake site O2 was significantly less than at proposed intake site E. No significant difference was detected between the proposed intake site E median concentration (0.22 larvae/$m^3$) and the remaining potential intake site-specific concentrations. The median concentration at potential intake site D4 was the maximum (100%) and therefore excluded from further consideration (Figure 2).

To be consistent with prior analyses and presentation among the Agency Staff and Poseidon Team, the mean concentration was also calculated from the resampled data set. Mean concentrations ranged from 0.44 larvae/$m^3$ at potential intake site O2 to 0.92 larvae/$m^3$ at potential intake site U4. The median was considered a better measure of central tendency for this data set due to the presence of outliers (Figure 4) and the non-normality of the distribution indicated by significant ($p<0.01$) results of the Shapiro-Wilks test for each potential intake site's resampled concentrations.

**Standardized Mean Concentration** – While not ecologically uncommon, the abundance distribution of the taxa indicated a select few taxa dominated the total catch that would be reflected in the median concentration. *Emerita* accounted for 27% of all individuals. The combination of CIQ gobies and *Emerita* represented 52% of the total plankton catch despite the identification of 96 taxa. Such

dominance by a small number of taxa undermines the value of the raw concentration analysis when entrainment impacts are framed in the reference of risk to the environment. As noted previously, not all taxa are naturally as abundant as others. Furthermore, the raw concentration analysis fails to meet key requirements of Section M.2.b.(4)., specifically to account for entrainment impacts in combination with potential anthropogenic effects on all forms of marine life. The earlier example of CIQ Goby and Tidewater Goby entrainment demonstrates the nature of the Section M.2.b.(4). concerns.

The standardized mean concentration analysis evaluates ecological risk differences among the potential intake sites by standardizing the concentrations for each taxon's site-specific concentration across all the nets processed during that sampling event. In essence, this places the site-specific concentration in the context of the overall concentration across the area minimizing the differences in natural abundance patterns among sampled taxa.

Two methods were used to calculate the standardized mean concentration, one recommended by Dr. Raimondi (PR in the figure legend) and one by Eric Miller (EFM in the figure legend). The overall pattern of each was similar, but with different magnitudes to the differences among potential intake sites. Dr. Raimondi's approach indicated the mean standardized concentration was lowest at proposed intake site E and highest at potential intake site O4. The standardized concentrations of all 96 identified taxa was significantly higher at four potential intake sites in comparison to E. These were potential intake sites O2, O4, U2, and U4. No significant difference was detected between the standardized concentrations at potential intake sites D2 and D4. The EFM method identified a similar pattern as Dr. Raimondi's method, but with greater differences that resulted in all six of the potential intake sites having significantly higher standardized concentrations than occurred at proposed intake site E. The standardized mean concentration at potential intake site O4 was the maximum value for this MLE (100%) and was therefore excluded from further analysis.

**Initial Screening** – As noted in each of the preceding MLE sections, potential intake sites O2, O4, and D4 were excluded from further consideration due to their achieving $\geq$ 90% of the MLE maximum in one or more MLE. This left E, D2, U2, and U4 as potential intake sites considered for further analysis.

**Summarizing MLE Results** – For the four potential intake sites remaining, the overall MLE results were summarized and combined to evaluate the sum total of the analysis. In this analysis, the percent of maximum values were averaged across both the core three MLE and the four MLE, separately. An attempt was also made to weigh the different MLEs. Given the concern over relative accuracy and representativeness of the ETM/APF analysis based on four taxa, those percentages were given one-half weight (50%), while all the others were counted at 100%.

Across all four ways to look at the summary, potential intake site D2 came out as the most impactful of the four potential intake sites evaluated (Figure 5). The MLE summary was highest at potential intake site D2 regardless of which of the four analytical ways were used. The raw mean of the core three MLE was 4% higher at proposed intake site E than at U4 (the lowest value). After weighting the ETM/APF results, the mean MLE was the same at potential intake sites E and U4, but 2% higher than at U2. The addition of the EFM Standardized Concentration brought the proposed intake site E MLE down to even or less than what resulted at potential intake sites U2 and U4. This difference was magnified after weighting the ETM/APF analysis with proposed intake site E having the lowest summary MLE percentage (41%).

**Qualitative/Regulatory Analysis** – Spatial considerations such as distance to sensitive habitats, including nursery grounds for protected species, are included in Table 3 and presented in Figure 1. These considerations are germane to addressing Section M.2.b. of the OPA. Table 3 notes which taxa support a fishery (commercial and/or recreational) and if the Marine Protected Area South Coast Region Science Advisory Team considered the taxon likely to benefit from MPA protection. The two MPAs in Bolsa Chica are nearest potential intake sites U4 and U2, with both situated less than 3.5 miles from the mouth of Bolsa Chica. Proposed intake site E is approximately 4.4 miles downcoast of the mouth of Bolsa Chica. The next nearest MPA is the Upper Newport Bay State Marine Conservation Area at the head of Newport Bay where San Diego Creek empties into the bay. The entrance to Newport Bay is approximately 6.9 miles downcoast from proposed intake site E. From the bay entrance, it is approximately another 4.5 miles on the water to reach the MPA. Therefore, the Upper Newport Bay State Marine Conservation Area is approximately 11.5 miles away from proposed intake site E by boat.

In addition to the distance to sensitive habitats or fishery/MPA status, the location of Giant Sea Bass (*Stereolepis gigas*) nursery grounds are noted in Figure 1. Benseman and Allen (2018) and Allen et al. (in press) surveyed the Southern California Bight, including

offshore Huntington Beach and Newport, for the presence of recently settled Giant Sea Bass. No individuals were found offshore of Huntington Beach, but significantly higher densities were observed along the Newport coast. This was especially true near the Newport Pier located approximately 1.2 miles downcoast of potential intake site D4. Their study throughout the Southern California Bight found that beaches inshore of the heads of submarine canyons were preferred nursery grounds for Giant Sea Bass. Densities of these individuals declined sharply with distance along the coast from the canyon head. As noted in Appendix F1 of SLC (2017), Giant Sea Bass is protected in California and is illegal to take except for limited incidental take by commercial gill net.

The habitat in the area is predominantly homogeneous sandy soft-bottom. Annual sediment characterizations of the area stretching up and downcoast one mile from the Huntington Beach Generating Station intake structure consistently finds predominantly sand (>90% of all sediments), silt, and clay with little to no gravel (MBC 2016). Rocky reef habitat in the area is limited to anthropogenic structures including the Huntington Beach Generating Station intake and discharge structures and surrounding armor rock, the Huntington Beach Pier, and the Orange County Sanitation District outfalls. No kelp forests exist in the five miles surrounding the Huntington Beach area.

# CONCLUSIONS OF THE MLE ANALYSIS

The preceding analysis assumed each of the seven sampling stations used by MBC and Tenera (2005) could be potential intake sites for the HBDP. Using the plankton data collected during that field study, the entrainment likely to occur at each potential intake site was characterized. While Agency Staff initially identified the ETM/APF as the metric to compare the potential intake sites, all stakeholders agreed with Dr. Raimondi that the ETM/APF could not be the sole metric used for this purpose. Specifically, larval fish lengths were not recorded for a representative suite of taxa at each potential intake site as would be expected from the study design. The attempt to use the ETM/APF as a tool to compare potential intake sites therefore results in APF estimates that are unreliable - an artifact of using the ETM/APF for an unintended purpose rather than a reflection on the quality of the data. It is an unprecedented application of the model and would have vastly different data requirements than those outlined in Appendix E.

Lacking this information at the source water sampling stations used by MBC and Tenera (2005), the ETM/APF could not be applied in the manner in which it was originally envisioned. The larval length data is critical for the calculation of three parameters of the total ETM/APF approach: days exposed to entrainment (d), total source water area (TSWB or APF source water area), and $P_s$. The absence of these three parameters invalidates any attempt to model the entrainment impact risk to the environment using the ETM/APF. Larval length information was available for four common taxa at six of the seven potential intake sites, three taxa at the remaining one. In an attempt to compare the potential intake sites using the ETM/APF with similar inputs, only the four common taxa were included in the analysis despite the presence of 12 taxa available at proposed intake site E.

Taken in total, four candidate intake sites advanced past the initial screening. Of these four, potential intake site D2 had the highest potential impact across all four MLE summaries and was likewise excluded from further consideration. There was little difference between the three remaining potential intake sites with regards to MLE summary percentages. The standardized concentration, however, confirmed that proposed intake site E had significantly lower standardized concentrations than were found at either proposed intake site U2 or U4. Furthermore, both of the U sites were located, at a minimum, approximately one mile closer to two MPAs, both within the Bolsa Chica basin. The MLE, through a detailed and holistic examination, identified no scientifically-defensible ecological benefit achieved by moving the intake site from the currently proposed site E to a new location.

# MITIGATION AREA

Considering the preceding conclusion that the proposed intake site E is the best location for the HBDP intake, the following mitigation acreage estimates were derived. At the latest analysis, 12 taxa were found to have sufficient information and bearing on the entrainment impacts associated with an intake operating at intake site E. During the prior analysis for the California Energy Commission (CEC) using these same data, only eight taxa considered “coastal” taxa were included in the APF calculation. At that time, both CIQ gobies and Northern Anchovy were excluded from the CEC analysis (Davis et al. 2006). Due to the lack of any demonstrative differences in ETM/APF results between the estuarine source waters or ocean current data, the mitigation acreage ETM/APF was calculated using the Alamitos Bay estuarine source water concentrations and the 1999-00 ocean current data. A mitigation APF was derived using the techniques described for the site comparison detailed above. For the mitigation APF, the two habitat groups (estuarine and open

coast/sandy bottom) were separated and an APF to the 95% confidence interval calculated for each. Two taxa lists were used for the APF, one using the full 12 taxa recently used and a second with 10 taxa (remove Jacksmelt and *Emerita*). A 1% reduction was applied to each to account for the 1-mm screened intake credit allowed under the OPA. Lastly, a 10:1 (impacted:restored) scaling was applied to be consistent with Dr. Raimondi's comments. The resulting APFs are 22.69 acres for the 12-taxa version and 25.38 acres for the 10-taxa version.

# INTAKE SITE SELECTION ANALYTICAL RECORD

As of October 2018, the lengthy intake site selection process has not been detailed in a single record. Rather, the record consists of only a series of submittals in response to requests and revisions. The process of identifying the best intake site for the HBDP so as to minimize the impacts to all forms of marine life began in April 2016 with HDR (2016) examining the pattern in ichthyoplankton concentrations with increasing distance offshore into deeper waters. At the time, Agency Staff questioned if moving the intake from its current location where it supports the Huntington Beach Generating Station's cooling water intake to a point farther offshore in deeper water where Agency Staff assumed the ichthyoplankton concentrations decreased in relation to the shallower current site. Initially, raw ichthyoplankton concentrations were analyzed but no reliable difference was found between the potential intake sites E, O2, and O4. This was reaffirmed with a single day's sampling effort where no difference in the ichthyoplankton densities was observed, although a significant difference in total plankton volumetric biomass was detected as it increased with increasing distance offshore (MBC 2017).

Beginning in May 2017, Agency Staff asked the Poseidon Team to calculate an APF for each of the sites sampled during the 2003-04 sampling program summarized in MBC and Tenera (2005). In addition to calculating an APF for each site, Agency Staff asked the Poseidon Team to examine the available data to add taxa to the analysis, if possible. In response, HDR (2017a) was submitted and represented the first-ever attempt to expand the use of the ETM/APF analysis beyond its previously limited application of quantifying the impact of a water intake at a known site (the use prescribed in Appendix E of the OPA) to a tool to compare potential intake sites. At this time, a novel competing analysis was submitted by California Coastal Commission Staff (CCC 2017) which was reviewed by the Poseidon Team (HDR 2017b) and dramatic differences in results and conclusions between the two reports were identified. Some of these discrepancies were attributed to methodological differences between the two reports; though, the greatest discrepancies were attributed to the data sources used. While the Poseidon Team relied on the original raw data (that were also provided to the CCC via email on Mach 16, 2017), the CCC (2017) report relied on summarized data from the appendices included in MBC and Tenera (2007), a report modified from MBC and Tenera (2005) for compliance with the United States Environmental Protection Agency newly promulgated rules to enforce Section 316(b) of the United States Clean Water Act.

In April 2018, a workshop was convened in Sacramento between Agency Staff and the Poseidon Team to discuss the ETM/APF analysis, data sources, and analytical mechanics. This meeting fortunately occurred shortly after Agency Staff benefited from a technical workshop on the ETM/APF provided by Dr. Raimondi. During this meeting, consensus was achieved on multiple items, such as using the National Wetland Inventory as the data source identifying estuarine habitat to be used in the analysis. Additional questions were raised with regards to taxa habitat classifications, inclusion or exclusion of select taxa, and general mechanics of the ETM/APF. Up to this point, the Poseidon Team had relied primarily on the MBC and Tenera (2005) and Tenera (2006) precedent as these reports were prepared under the oversight of a technical working group comprised of CCC staff, California Department of Fish and Game staff, AES Huntington Beach staff and consultants, and appointed technical advisors Drs. Raimondi, Cailliet, and Foster. The technical advisor's role was to oversee the scientific elements to ensure the studies achieved acceptable scientific rigor. Agency Staff requested the Poseidon Team conduct a sensitivity analysis of following the precedent decisions in Tenera (2006) and Davis et al. (2006) as well as reclassifying some taxa, adding select abundant taxa, and removing some taxa not present in the monthly sampling results from all seven potential intake sites. Additional analyses were preformed adding the adult CIQ Goby spawning habitat in the Port of Long Beach as identified by the NWI to the estuarine source water habitat.

The sensitivity analysis was completed and presented at a meeting in July 2018 between Agency Staff and the Poseidon Team. This was the first such meeting attended by the newly contracted Neutral Third Party Reviewer, Dr. Raimondi. After reviewing the material presented by the Poseidon Team, Dr. Raimondi alerted all parties to concerns he had that had not been previously identified by Agency Staff or the Poseidon Team. The ETM equation as documented in the OPA Substitute Environmental Document Appendix E (SWRCB 2015) was inconsistent with what was done previously for the Huntington Beach area by Tenera (2006) for estuarine taxa. Dr. Raimondi

recommended the modified ETM used by Tenera (2006) also be used in the current analysis. Eric Miller of Miller Marine Science & Consulting, Inc. transcribed the equation and circulated to the group for review and approval, which Dr. Raimondi gave. This modified ETM equation (provided above in the Methods section) was used in all subsequent analyses of the estuarine taxa.

In addition to the estuarine ETM equation, Dr. Raimondi was concerned about the ETM/APFs calculated which thus far used one estimate of the days susceptible to entrainment for each taxon at all seven potential intake sites. Dr. Raimondi highlighted the fact that this nullifies one of the key factors of the ETM and that a correct application of the ETM in this first-ever application of the ETM/APF for comparing potential intake sites would calculate a site-specific estimated number of days susceptible to entrainment for each taxon. His chief question was whether any data was available at the potential intake sites since the focus of MBC and Tenera (2005) was on proposed intake site E. Data did exist, but only for select group of four taxa. This group of taxa, however, accounted for less than 90% of the total plankton abundance caught at each potential intake site. Therefore, the precision and applicability of the resulting ETM/APFs using only the four taxa was considered likely unreliable. Dr. Raimondi also advised that utilizing only four species for deriving the APF for the purpose of calculating compensatory mitigation was scientifically inappropriate and inconsistent with regulatory precedent.

In recognition of this concern, the concept of using MLE to inform the best intake site decision was formed. To this point, Dr. Raimondi recommended the use of standardized larval concentrations and calculating a floating alpha to use for significance testing. The standardized larval concentration method was recommended as it would reduce the effect of the dominant taxa that accounted for the majority of mean larval concentration. In Dr. Raimondi's opinion, using the standardized larval concentration would better measure risk, the ultimate goal of the ETM/APF, than using the raw larval concentration.

In August 2018, the Poseidon Team presented its results of the MLE analysis to the Agency Staff and Dr. Raimondi. The results were discussed and refinements/revisions recommended. The ETM/APF results of the CCC staff and the Poseidon Team remained substantially different, but some key missteps in the CCC analysis were pointed out so they could be remedied in the next revision. The revised results were presented by the Poseidon Team and CCC (independently) during a September 2018 meeting where additional scrutiny was given. The ETM/APF results derived by the CCC and the Poseidon Team were closer, but still differed substantially. Errors were identified in the CCC analysis that significantly contributed to the differences in the results. The Poseidon Team was tasked with taking the lead to address questions Dr. Raimondi had over:

1. The correct estuarine source water acreage,
2. The correct ROMS current displacement given sampling covered unequal portions of two years.

Additional revisions were recommended by Dr. Raimondi to bring the analyses more into line with what he had recommended, such as basing the floating alpha effect size on differences between the medians of resampled plankton concentration data sets rather than using Cohen's d.

This report represents the culmination of the preceding meetings, revisions, and conversations. Some values and conclusions herein differ from those previously presented due to the revisions effected in this report.

1. Only three potential intake sites were excluded during the initial screening rather than the four excluded during the September 2018 presentation. This is because using the median raw larval concentration differed from the results using the mean raw larval concentration. As a result, potential intake site U4 changed from having the highest mean larval concentration to having an average concentration. The raw larval concentration was the line of evidence excluding potential intake site U4 in the September analysis.
2. The ETM/APF results changed due to multiple calculation process changes recommended by Dr. Raimondi. The ROMS-based analysis results changed between the September presentation and this report due to transitioning from using the 2004 estimate to a weighted average of the 2003 and 2004 ROMS current estimate at each potential intake site. The revised estuarine source water area also caused a change in the estuarine source water population abundance relevant to the two estuarine taxa analyzed. This acreage changed also impacted the APF source water area used. Lastly, a new $f_i$ parameter was calculated for each taxon inclusive of the changes to the estuarine source water population abundances.

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# TABLES

**Table 1. Estimated adult CIQ goby and Diamond Turbot spawning habitat in the three local wetlands (as of 2003-04) derived from the National Wetland Inventory (https://www.fws.gov/wetlands/).**

| Bay | Description | Area ($m^2$) | Hectares | Acres | CIQ Goby or Diamond Turbot Habitat |
|---|---|---|---|---|---|
| Anaheim/HB Wetlands | Estuarine - Intertidal Flooded - subtidal | 536,095 | 53.61 | 132.47 | Yes |
| Anaheim/HB Wetlands | Estuarine - Open water - Subtidal | 2,207,754 | 220.78 | 545.54 | Yes |
| SantaAnaRiver/TalbertMarsh | Estuarine - Intertidal Flooded - subtidal | 39,957 | 4 | 9.87 | Yes |
| SantaAnaRiver/TalbertMarsh | Estuarine - Open water - Subtidal | 485,630 | 48.56 | 120 | Yes |
| Newport Bay | Estuarine - Intertidal Emergent - Flooded Subtidal | 1,234,755 | 123.48 | 305.11 | Yes |
| Newport Bay | Estuarine - Intertidal Flooded - subtidal | 280,950 | 28.1 | 69.42 | Yes |
| Newport Bay | Estuarine - Open water - Subtidal | 4,436,274 | 443.63 | 1096.22 | Yes |
| **Sum of CIQ Goby/Diamond Turbot habitat for the ETM/APF analysis** | | **9,221,415.00** | **922.16** | **2,278.63** | |

**Table 2. Area of production forgone (acres) for each potential intake site based on site specific ocean current estimates (ROMS) and measured currents (Regional Current) using estuarine larval concentration data collected in Agua Hedionda Lagoon (AHL) and Alamitos Bay.**

| Potential Intake Site | Number of Taxa In Analysis | ROMS | | Regional Current (99-00 & 07-08) | | |
|---|---|---|---|---|---|---|
| | | AHL | Alamitos Bay | AHL | Alamitos Bay | Grand Mean |
| | | APF | APF | APF | APF | |
| D2 | 4 | 148.55 | 148.33 | 147.37 | 147.28 | 148 |
| D4 | 4 | 137.66 | 137.63 | 138.08 | 138.06 | 138 |
| E | 4 | 215.95 | 215.98 | 214.255 | 214.24 | 215 |
| O2 | 4 | 280.82 | 280.78 | 280.275 | 280.25 | 281 |
| O4 | 3 | 254.3 | 254.3 | 254.345 | 254.345 | 254 |
| U2 | 4 | 200.12 | 200.09 | 201.66 | 201.58 | 201 |
| U4 | 4 | 168.84 | 168.82 | 169.82 | 169.74 | 169 |

**Table 3. Twenty-five most abundant larval taxa occurring in the 2003-04 plankton sampling program. The taxon-specific abundances were ranked across the seven sites to represent where the taxon was most to least abundant. Fished represents if the taxon was considered to support a recreational or commercial fishery (or both) as well as if the California Department of Fish and Game South Coast Marine Protected Area Science Advisory Team considered the taxon likely to benefit from MPA protection. Fished and MPA designations based on Appendices C-1 and D in http://www.dfg.ca.gov/marine/pdfs/rpsc/body_part2.pdf.**

| Taxa | O4 | O2 | D2 | D4 | U2 | E | U4 | Fished (App D.) | MPA (Table C-1) |
|---|---|---|---|---|---|---|---|---|---|
| *Emerita analoga (zoea)* | 1 | 2 | 4 | 3 | 5 | 6 | 7 | NO | YES |
| *Gobiidae* unid. | 1 | 2 | 6 | 7 | 3 | 5 | 4 | NO | NO |
| *Engraulis mordax* | 4 | 3 | 2 | 1 | 7 | 6 | 5 | YES | NO |
| *Seriphus politus* | 2 | 3 | 5 | 7 | 1 | 4 | 6 | YES[1] | NO |
| *Genyonemus lineatus* | 6 | 7 | 1 | 4 | 3 | 2 | 5 | YES | NO |
| *Sciaenidae* unid. | 7 | 6 | 3 | 2 | 4 | 1 | 5 | YES | NA |
| *Hypsoblennius* spp. | 7 | 5 | 3 | 1 | 4 | 2 | 6 | NO | NO |
| *Paralichthys californicus* | 7 | 6 | 3 | 1 | 5 | 2 | 4 | YES | NO |
| *Paralabrax* spp. | **7** | **6** | **4** | **1** | **3** | **2** | **5** | YES | YES |
| *Paralabrax clathratus* | **7** | **6** | **3** | **1** | **5** | **2** | **4** | YES | YES |
| *Atherinopsis californiensis* | 1 | 2 | 3 | 6 | 7 | 5 | 4 | YES | NO |
| larvae, unidentified yolksac | 6 | 7 | 3 | 1 | 4 | 2 | 5 | NA | NA |
| *Sardinops sagax* | 7 | 6 | 1 | 1 | 4 | 3 | 5 | YES | NO |
| *Sphyraena argentea* | 7 | 6 | 5 | 2 | 4 | 1 | 3 | YES | NO |
| *Chromis punctipinnis* | **7** | **6** | **1** | **1** | **1** | **1** | **5** | YES | YES |
| Engraulidae | 6 | 2 | 7 | 4 | 1 | 5 | 3 | NA | NA |
| *Hypsopsetta guttulata* | 3 | 4 | 5 | 2 | 7 | 1 | 6 | YES | NO |
| *Citharichthys stigmaeus* | 7 | 6 | 3 | 1 | 2 | 4 | 5 | YES | NO |
| *Cancer gracilis* (megalops) | 4 | 7 | 1 | 2 | 6 | 5 | 3 | YES | NO |
| *Cancer anthonyi* (megalops) | **3** | **4** | **5** | **2** | **7** | **6** | **1** | YES | YES |
| *Cancer antennarius* (megalops) | **5** | **7** | **1** | **3** | **6** | **2** | **4** | YES | YES |
| *Lepidogobius lepidus* | 6 | 7 | 4 | 5 | 3 | 2 | 1 | NO | NO |
| larval fish fragment | 7 | 4 | 2 | 1 | 6 | 5 | 3 | NA | NA |
| *Leuresthes tenuis* | 1 | 3 | 7 | 2 | 5 | 4 | 6 | NO | YES |
| *Pleuronichthys ritteri* | 7 | 6 | 3 | 2 | 4 | 1 | 5 | YES | NO |
| Remaining Taxa - Sum | 7 | 6 | 3 | 4 | 2 | 1 | 5 | | |
| Number of Taxa ID'd | 77 | 74 | 51 | 52 | 58 | 54 | 55 | | |
| Sum of Ranks | 133 | 129 | 88 | 67 | 109 | 80 | 115 | | |
| Sum of ranks = lowest sum is the station where each taxon is least abundant | | | | | | | | | |
| [1] = Queenfish commercial landings were frequently commingled with White Croaker (Miller et al. 2009) | | | | | | | | | |

# FIGURES

**Figure 1. Location of the seven sampling stations evaluated, the two mouths of wetland complexes, the Orange County Sanitation District (OCSD) ocean outfalls, and the location of Giant Sea Bass observations in the Huntington Beach and Newport area. The "32" showing on the Giant Sea Bass Sightings symbol reflects their density at the site, or 32 Giant Sea Bass young-of-the-year/hectare reported in Benseman and Allen (2018).**

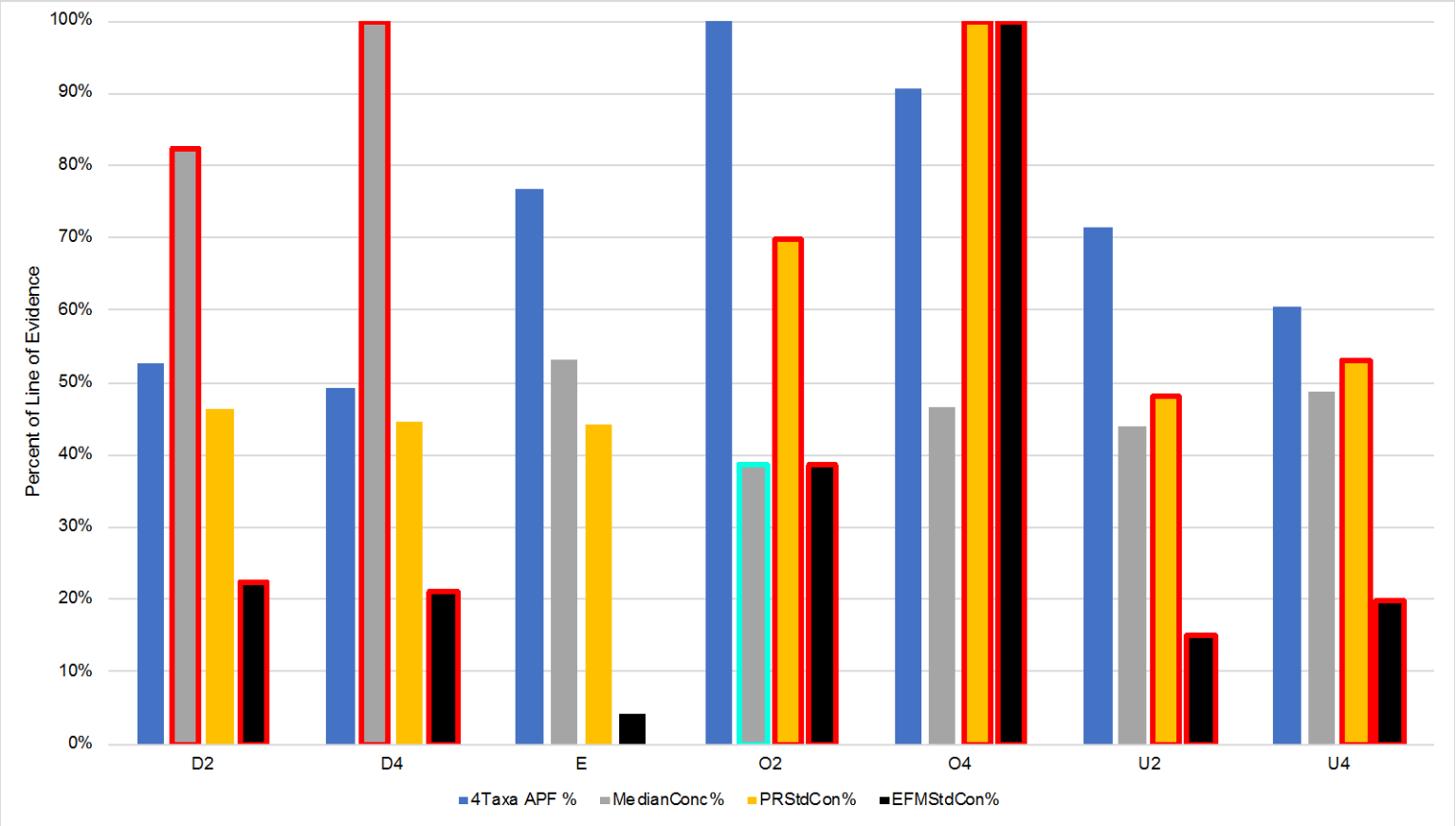


**Figure 2. Percent of the maximum value for each line of evidence examined by station. Red outlined bars represent values that were significantly higher than the corresponding value at proposed intake site E. The teal outlined bar was significantly less than the corresponding value at proposed intake site E. 4TaxaAPF% = APF using the common four taxa at six of the seven sites. MedianConc% = the median concentration of all identified and counted larvae. PRStdConc% = the mean standardized concentration of all identified taxa calculated using Dr. Peter Raimondi's recommended method. EFMStdConc% = the mean standardized concentration of all identified taxa calculated using Eric Miller's method.**

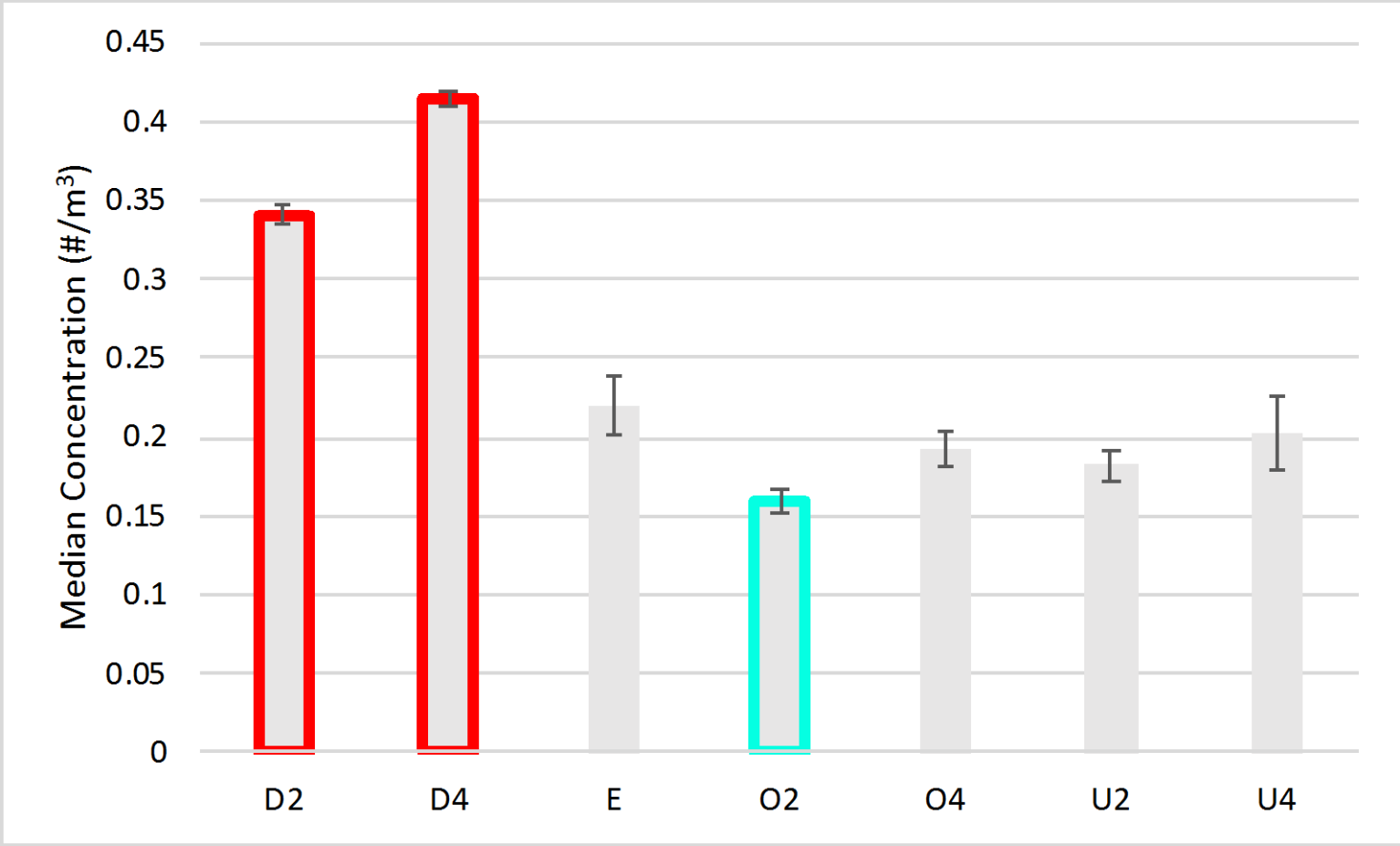


**Figure 3. Median concentration (plus standard error) of all identified and counted larvae by potential intake site. The red and teal borders designate significant difference between the site-specific concentrations and those at proposed intake site E.**

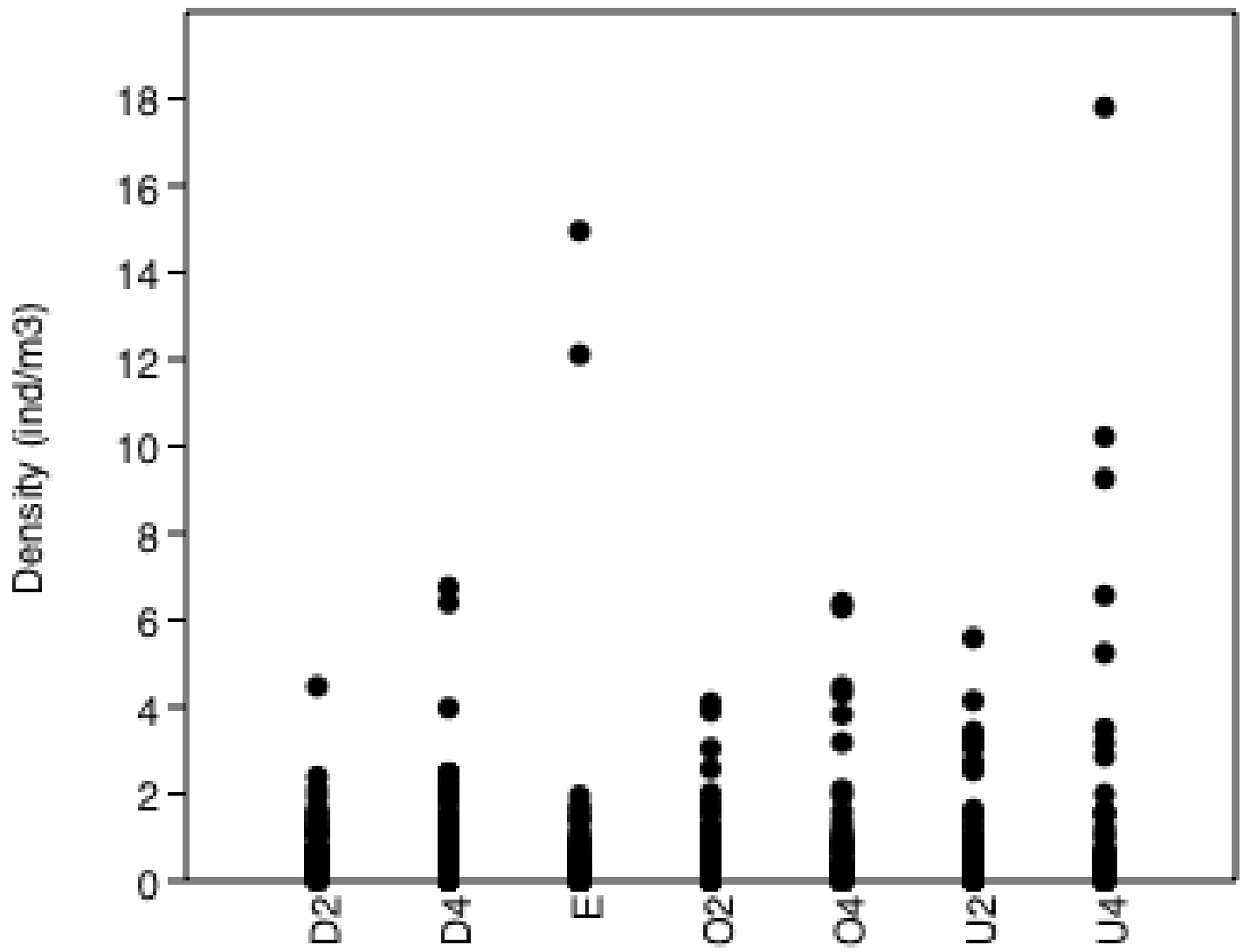


**Figure 4. Total larval concentration per net (n=96) for each potential intake site.**

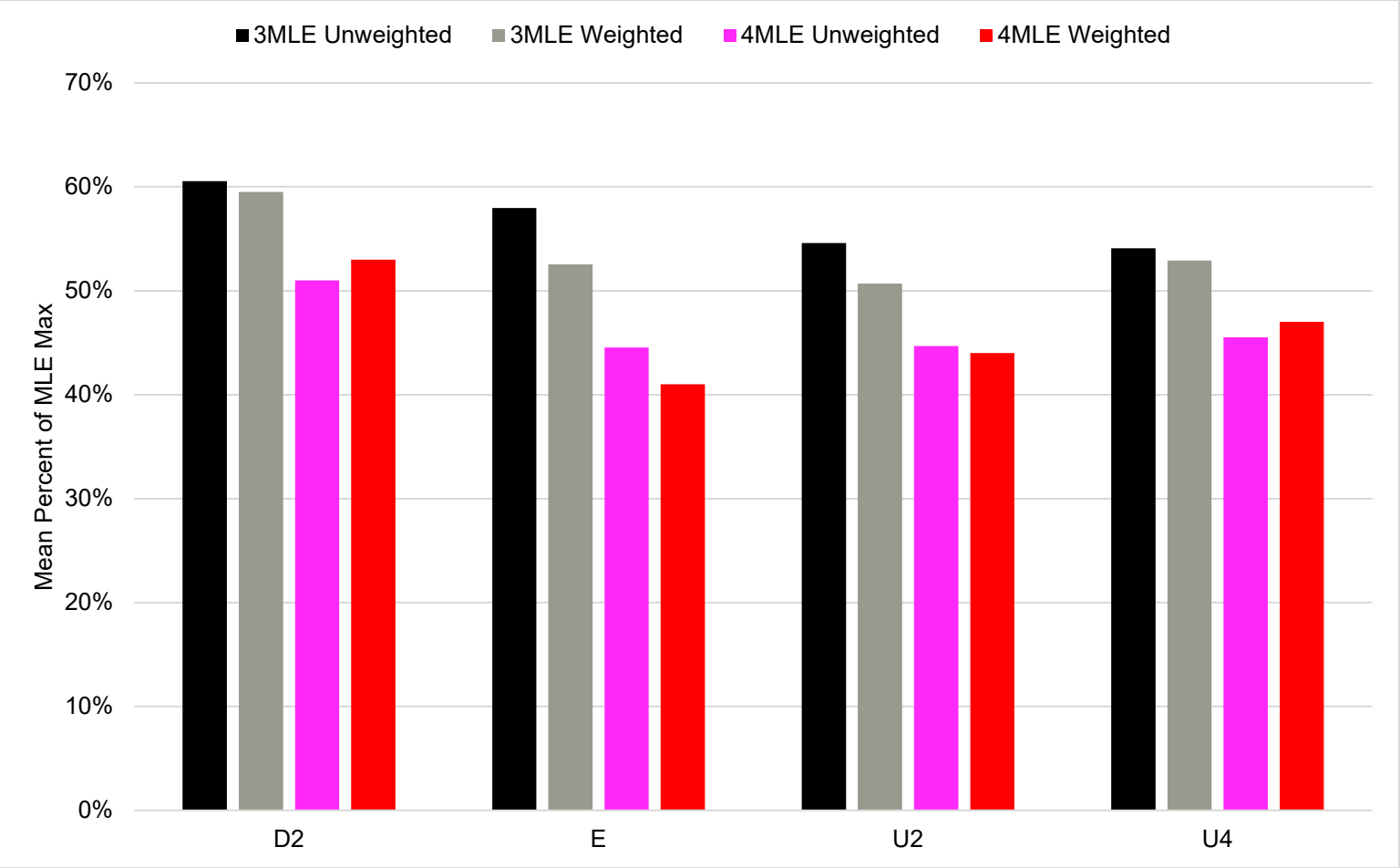


**Figure 5. Summary analysis of multiple lines of evidence (MLE). Each bar represents an average of the three or four MLEs both unweighted and weighted.**

# ATTACMENT 3: ATTACHMENT 3 – MBC AND TENERA 2005 ENTRAINMENT ESTIMATE METHODS AND TABLE OF ESTIMATED ENTRAINMENT TOTALS FOR EACH TAXON ENTRAINED AMONG THE THREE POTENTIAL INTAKE SITES.

# Appendix F1
# Estimating Total Entrainment

The following sections describe calculations used for assessing entrainment effects at the Huntington Beach Generating Station (HBGS). The equations are presented in a general form that is applicable to sample designs that may have differing numbers of stations, sampling periods, or replicates. The present design for the HBGS entrainment study will sample one station with two replicates four times per sample day. As described below, there will be one sampling day per monthly sampling period. While summation signs over stations are presented in the equations they will be summing over an *n* of one in the actual calculations and therefore will drop out of the formulas.

A general form can be written for summing entrainment over stations at an intake or entrainment site using cycles within a day and days within time periods. Let

$i$ = period $(i = 1, \ldots, N)$;

$j$ = day within period $(j = 1, \ldots, N_i)$;

$k$ = cycle within day $(k = 1, \ldots, N_{ij})$;

$l$ = station $(l = 1, \ldots, N_{ijk})$;

$m$ = volume at station within cycle $(m = 1, \ldots, N_{ijkl})$.

The total larval entrainment at an intake source can be expressed as

$$E_T = \sum_{i=1}^{N} \sum_{j=1}^{N_i} \sum_{k=1}^{N_{ij}} \sum_{l=1}^{N_{ijk}} \rho_{ijkl} V_{ijkl} \tag{A1}$$

where

$\rho_{ijkl}$ = density of larvae at the *l*th station within the *k*th cycle on the *j*th day in the *i*th time period;

$V_{ijkl}$ = volume of water passing the at the *l*th station within the *k*th cycle on the *j*th day in the *i*th time period.

This summation assumes that stations represent the total intake volume of the power plant. It also assumes that the larval density in the volume of water passing a station is constant over time and space over any cycle. An estimate of the total larval entrainment can be made by taking $n_{ijkl}$ samples of the $N_{ijkl}$ volumes passing a station as

$$\hat{E}_T = \sum_{i=1}^{N}\sum_{j=1}^{N_i}\sum_{k=1}^{N_{ij}}\sum_{l=1}^{N_{ijk}}\frac{V_{ijkl}}{n_{ijkl}}\sum_{m=1}^{n_{ijkl}}\rho_{ijklm} \tag{A2}$$

If we also assume that entrainment volume is constant and the same at all stations then

$$\hat{E}_T = \sum_{i=1}^{N}V_{ijkl}\sum_{j=1}^{N_i}\sum_{k=1}^{N_{ij}}\sum_{l=1}^{N_{ijk}}\frac{1}{n_{ijkl}}\sum_{m=1}^{n_{ijkl}}\rho_{ijklm} \tag{A3}$$

Strata will be defined as the stations and cycles with constant $N_{ij}$ and $N_{ijk}$. In addition, we sample $n_i$ days of the $N_i$ possible during a period so that

$$\begin{aligned}\hat{E}_T &= \sum_{i=1}^{N}N_iN_{ij}N_{ijk}V_{ijkl}\frac{1}{n_i}\sum_{j=1}^{n_i}\sum_{k=1}^{N_{ij}}\sum_{l=1}^{N_{ijk}}\left(\frac{1}{N_{ij}N_{ijk}n_{ijkl}}\right)\sum_{m=1}^{n_{ijkl}}\rho_{ijklm} \\ &= \sum_{i=1}^{N}V_i\frac{1}{n_i}\sum_{j=1}^{n_i}\sum_{k=1}^{N_{ij}}\sum_{l=1}^{N_{ijk}}\left(\frac{1}{N_{ij}N_{ijk}n_{ijkl}}\right)\sum_{m=1}^{n_{ijkl}}\rho_{ijklm}\end{aligned} \tag{A4}$$

where

$$V_i = \sum_{j=1}^{N_i}\sum_{l=1}^{N_{ij}}\sum_{k=1}^{N_{ijk}}V_{ijkl} \text{ or } N_iN_{ij}N_{ijk}V_{ijkl} \text{ since } V_{ijkl} \text{ is constant.}$$

If only one day per period is sampled Equation A4 can be expressed as

$$\begin{aligned}\hat{E}_T &= \sum_{i=1}^{N}V_i\sum_{k=1}^{N_{ij}}\sum_{l=1}^{N_{ijk}}\left(\frac{1}{N_{ij}N_{ijk}n_{ijkl}}\right)\sum_{m=1}^{n_{ijkl}}\rho_{ijklm} \\ &= \sum_{i=1}^{N}V_i\sum_{k=1}^{N_{ij}}\sum_{l=1}^{N_{ijk}}\left(\frac{1}{N_{ij}N_{ijk}}\right)\hat{\rho}_{ijkl}\end{aligned} \tag{A5}$$

with estimated variance

$$\widehat{Var}\left(\hat{E}_T\right)=\sum_{i=1}^{N}V_i^2\sum_{k=1}^{N_{ij}}\sum_{l=1}^{N_{ijk}}\left(\frac{1}{N_{ij}N_{ijk}}\right)^2\left(1-\frac{n_{ijkl}}{N_{ijkl}}\right)\frac{\widehat{Var}\left(\rho_{ijkl}\right)}{n_{ijkl}} \tag{A6}$$

where

$$\widehat{Var}\left(\rho_{ijkl}\right)=\frac{\sum_{m=1}^{n_{ijkl}}\left(\rho_{ijklm}-\hat{\bar{\rho}}_{ijkl}\right)^2}{\left(n_{ijkl}-1\right)};$$

$$\hat{\bar{\rho}}_{ijkl}=\frac{\sum_{m=1}^{n_{ijkl}}\rho_{ijklm}}{n_{ijkl}}.$$

Estimates of $E_T$ based on Equation A5 will be used in *FH* and *AEL* calculations to estimate annual effects of entrainment on fishes and invertebrates. Equation A6 will underestimate the true variance because it does not include within-period variance. In practice, we ignore the finite population correction, $\left(1-\frac{n_{ijkl}}{N_{ijkl}}\right)$ because $N_{ijkl}$ is large. Estimators similar to Equation A5 and Equation A6 are used for calculating survey period estimates of intake and source populations for use in ETM calculations.

| Taxon | D2 | E | U2 | Total | % of Total | Fished[1] Y/N | Depressed Standing Stock Y/N | FMP[2] Y/N | Mortarium[3] Y/N |
|---|---|---|---|---|---|---|---|---|---|
| Emerita analoga (zoea) | 14,313,968 | 60,640,057 | 31,584,709 | 106,538,734 | 37% | N | N | NA | NA |
| Gobiidae unid. (CIQ Goby) | 38,573,721 | 25,787,469 | 13,205,032 | 77,566,222 | 27% | N | N | NA | NA |
| Engraulis mordax | 10,561,416 | 14,325,488 | 15,255,478 | 40,142,382 | 14% | Y | N | Y | NA |
| Seriphus politus | 7,026,299 | 5,218,256 | 4,045,247 | 16,289,802 | 6% | Y | Y[4] | NA | NA |
| Genyonemus lineatus | 2,148,248 | 3,145,153 | 3,312,506 | 8,605,907 | 3% | Y | Y[4] | NA | NA |
| Sciaenidae unid. | 1,610,166 | 545,102 | 1,996,477 | 4,151,745 | 1% | NA | NA | NA | NA |
| Hypsoblennius spp. | 1,410,009 | 850,918 | 1,686,277 | 3,947,204 | 1% | N | N | NA | NA |
| Atherinopsis californiensis | 642,439 | 765,619 | 2,238,905 | 3,646,963 | 1% | N | N | Y | NA |
| Cancer anthonyi (megalops) | 692,430 | 1,143,728 | 1,159,467 | 2,995,625 | 1% | Y | NA | NA | NA |
| Leuresthes tenuis | 2,010,499 | 154,063 | 192,661 | 2,357,223 | 1% | Y | NA | NA | NA |
| Paralichthys californicus | 570,827 | 422,517 | 1,074,003 | 2,067,347 | 1% | Y | Y[5] | NA | NA |
| Engraulidae | 1,472,336 | 439,404 | 74,119 | 1,985,859 | 1% | NA | NA | NA | NA |
| Hypsopsetta guttulata | 756,147 | 193,037 | 907,116 | 1,856,300 | 1% | N | NA | NA | NA |
| Cancer gracilis (megalops) | 180,549 | 588,835 | 945,684 | 1,715,068 | 1% | Y | NA | NA | NA |
| Cancer antennarius (megalops) | 296,055 | 365,582 | 749,547 | 1,411,184 | 0% | Y | NA | NA | NA |
| larval fish fragment | 248,969 | 350,416 | 542,603 | 1,141,988 | 0% | NA | NA | NA | NA |
| larvae, unidentified yolksac | 354,874 | 325,666 | 427,987 | 1,108,527 | 0% | NA | NA | NA | NA |
| Atherinopsidae | 394,800 | 449,547 | 192,415 | 1,036,762 | 0% | N | NA | Y | NA |
| Roncador stearnsi | 337,022 | 88,631 | 420,995 | 846,648 | 0% | Y | NA | NA | NA |
| Paralabrax spp. | 388,538 | 93,494 | 344,814 | 826,846 | 0% | Y | Y[6] | NA | NA |
| Gillichthys mirabilis | 397,697 | 285,335 | 124,935 | 807,967 | 0% | N | NA | NA | NA |
| Ilypnus gilberti | 171,050 | 348,372 | 120,187 | 639,609 | 0% | N | NA | NA | NA |
| Paralabrax clathratus | 177,834 | 128,432 | 319,498 | 625,764 | 0% | Y | Y[6] | NA | NA |
| larval/post-larval fish unid. | 302,327 | 126,872 | 187,980 | 617,179 | 0% | NA | NA | NA | NA |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cheilotrema saturnum | 387,195 | 47,947 | 179,020 | 614,162 | 0% | N | NA | NA | NA |
| Sardinops sagax | 0 | 130,715 | 354,329 | 485,044 | 0% | Y | Y[7] | Y | Y |
| Syngnathidae unid. | 0 | 483,220 | 0 | 483,220 | 0% | NA | NA | NA | NA |
| Sphyraena argentea | 281,916 | 0 | 127,885 | 409,801 | 0% | Y | NA | NA | NA |
| Leptocottus armatus | 218,325 | 89,360 | 91,678 | 399,363 | 0% | NA | NA | NA | NA |
| Lepidogobius lepidus | 177,550 | 103,802 | 115,778 | 397,130 | 0% | NA | NA | NA | NA |
| Hypsypops rubicundus | 199,530 | 0 | 163,143 | 362,673 | 0% | N | NA | NA | Y |
| Citharichthys stigmaeus | 81,889 | 151,616 | 67,945 | 301,450 | 0% | Y | NA | Y | NA |
| Pleuronichthys spp. | 50,987 | 57,401 | 177,571 | 285,959 | 0% | N | NA | NA | NA |
| Pleuronichthys ritteri | 133,638 | 23,897 | 122,522 | 280,057 | 0% | N | NA | NA | NA |
| Gibbonsia spp. | 82,629 | 121,419 | 57,269 | 261,317 | 0% | N | NA | NA | NA |
| Labrisomidae unid. | 30,496 | 32,679 | 197,870 | 261,045 | 0% | N | NA | NA | NA |
| Acanthogobius flavimanus | 156,189 | 0 | 0 | 156,189 | 0% | N | NA | NA | NA |
| Haemulidae | 0 | 32,679 | 116,342 | 149,021 | 0% | NA | NA | NA | NA |
| Paralichthyidae unid. | 31,942 | 60,554 | 55,629 | 148,125 | 0% | NA | NA | NA | NA |
| Pleuronichthys verticalis | 0 | 36,918 | 98,530 | 135,448 | 0% | N | NA | NA | NA |
| Gobiesox spp. | 29,328 | 48,231 | 49,678 | 127,237 | 0% | N | NA | NA | NA |
| Citharichthys spp. | 0 | 29,499 | 93,204 | 122,703 | 0% | Y | NA | Y | NA |
| Ophidiidae unid. | 97,265 | 0 | 25,039 | 122,304 | 0% | N | NA | NA | NA |
| Oxyjulis californica | 33,593 | 27,381 | 56,809 | 117,783 | 0% | N | NA | NA | NA |
| Ruscarius creaseri | 116,679 | 0 | 0 | 116,679 | 0% | N | NA | NA | NA |
| Hypsoblennius jenkinsi | 30,483 | 23,897 | 59,780 | 114,160 | 0% | N | NA | NA | NA |
| Xystreurys liolepis | 0 | 0 | 103,503 | 103,503 | 0% | N | NA | NA | NA |
| Myctophidae unid. | 0 | 64,985 | 29,001 | 93,986 | 0% | N | NA | NA | NA |
| Sebastes spp. V | 0 | 29,499 | 62,946 | 92,445 | 0% | Y | NA | Y | NA |
| Atractoscion nobilis (Sciaenidae) | 91,890 | 0 | 0 | 91,890 | 0% | Y | Y[8] | Y | NA |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Merluccius productus | 59,408 | 31,438 | 0 | 90,846 | 0% | Y | NA | Y | NA |
| Pleuronectidae unid. | 0 | 55,931 | 29,401 | 85,332 | 0% | N | NA | NA | NA |
| Clevelandia ios | 0 | 52,008 | 30,997 | 83,005 | 0% | N | NA | NA | NA |
| Cancer productus (megalops) | 0 | 70,090 | 0 | 70,090 | 0% | Y | NA | NA | NA |
| Cancer oregonsis (zoea V) | 0 | 0 | 68,457 | 68,457 | 0% | N | NA | NA | NA |
| Xenistius califoriensis | 0 | 0 | 61,744 | 61,744 | 0% | N | NA | NA | NA |
| Triphoturus mexicanus | 27,030 | 32,034 | 0 | 59,064 | 0% | N | NA | NA | NA |
| Cancer spp. (megalops) | 21,980 | 28,684 | 0 | 50,664 | 0% | Y | NA | NA | NA |
| Cancer spp. | 0 | 48,231 | 0 | 48,231 | 0% | Y | NA | NA | NA |
| Syngnathus leptorhynchus | 46,445 | 0 | 0 | 46,445 | 0% | N | NA | NA | NA |
| Gobiesocidae unid. | 0 | 0 | 42,569 | 42,569 | 0% | N | NA | NA | NA |
| Artedius lateralis | 39,397 | 0 | 0 | 39,397 | 0% | N | NA | NA | NA |
| Umbrina roncador | 35,243 | 0 | 0 | 35,243 | 0% | Y | NA | NA | NA |
| larval fish - damaged | 0 | 32,679 | 0 | 32,679 | 0% | NA | NA | NA | NA |
| Typhlogobius californiensis | 0 | 0 | 32,217 | 32,217 | 0% | N | NA | NA | NA |
| Agonidae unid. | 0 | 32,215 | 0 | 32,215 | 0% | N | NA | NA | NA |
| Sebastes spp. V_De | 0 | 32,034 | 0 | 32,034 | 0% | Y | NA | Y | NA |
| Sebastes spp. VD | 0 | 32,034 | 0 | 32,034 | 0% | Y | NA | Y | NA |
| Stenobrachius leucopsarus | 0 | 0 | 31,243 | 31,243 | 0% | N | NA | NA | NA |
| Icelinus spp. | 0 | 0 | 30,791 | 30,791 | 0% | N | NA | NA | NA |
| Oxylebius pictus | 29,705 | 0 | 0 | 29,705 | 0% | N | NA | NA | NA |
| Artedius spp. | 29,704 | 0 | 0 | 29,704 | 0% | N | NA | NA | NA |
| Citharichthys sordidus | 0 | 0 | 29,401 | 29,401 | 0% | Y | NA | Y | NA |
| Sebastes spp. V_D | 0 | 0 | 29,401 | 29,401 | 0% | Y | NA | Y | NA |
| Panulirus interruptus (puerulus stage) | 0 | 0 | 23,554 | 23,554 | 0% | Y | NA | Y | NA |
| Scombridae unid. | 19,210 | 0 | 0 | 19,210 | 0% | Y | NA | Y | NA |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Ophidion scrippsae | 0 | 0 | 16,604 | 16,604 | 0% | Y | NA | Y | NA |
| Total | 87,577,866 | 118,825,070 | 83,940,492 | 290,343,428 | | | | | |
| Total w/o Emerita | 73,263,898 | 58,185,013 | 52,355,783 | 183,804,694 | | | | | |

Table References

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2 – https://www.wildlife.ca.gov/Conservation/Marine/Lobster-FMP, https://www.wildlife.ca.gov/Conservation/Marine/WSFMP, https://www.pcouncil.org/groundfish/fishery-management-plan/, https://www.pcouncil.org/coastal-pelagic-species/background-information/

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# ATTACHMENT 4: RASMUSSEN, L. 2018. TECHNICAL MEMORANDUM: SAN PEDRO BAY NEARSHORE AND SHELF CURRENTS. PREPARED FOR POSEIDON WATER.

# Technical Memorandum

Date: 29 August 2018
Prepared For: Mr. Scott Maloni, Poseidon Water
Prepared By: Dr. Linda Rasmussen, Miller Marine Science & Consulting
**Subject: San Pedro Bay Nearshore and Shelf Currents**

The circulation in the central Southern California Bight (SCB) has been extensively studied, due to the presence of sewage treatment plant outfalls and its location adjacent to major metropolitan areas. This memorandum summarizes published studies of observations and modeling on the San Pedro shelf and nearshore zone that may be relevant to assessing any functional differences between proposed seawater intake sites near Huntington Beach.

## GENERAL SCB CIRCULATION: TEMPORAL & SPATIAL VARIABILITY

Mean circulation patterns on the central SCB are detailed in reports prepared for the Los Angeles and Orange County sanitation boards (LACSB and OCSB) as well as in related academic analyses (e.g., SAIC 2003; Hamilton 2007; Noble et al., 2009). These studies employed numerous moored current meters and ADCP's over the San Pedro Shelf in 2001-2003 and 2006. Large scale flow offshore of the Bight islands has generally been described as south-southeastward, part of the easternmost California Current (Fig. 1). As the Bight opens up past Pt. Conception, a branch of this current turns eastward toward the coast, joining up with the northwestward flowing California Countercurrent to form a broad gyre circulation within the Bight.

More detailed depth-specific data show a somewhat more complicated pattern however. Mean mooring data exhibits a shift in direction with depth, with bottom currents often perpendicular to the direction of surface currents, and a 180° shift in direction on the inner shelf from northwestward to southeastward (Fig. 2, mean 4-year summer currents at surface, mid-depth, bottom, and depth-averaged).

Year to year, mooring data of the summer surface currents show the most variability (Fig. 3A) These are more susceptible to wind forcing due to the presence of a strong thermocline trapping energy near the surface. Subsurface currents show far less variability (Fig. 3B), and the mean multi-year flow pattern on the mid-outer shelf follows the direction of the California Countercurrent parallel to the bathymetric contours of the shelfbreak.

Year to year, depth-averaged mean current patterns are described in a summary review of Huntington Beach research and monitoring as "reasonably stable with time" such that "one could determine a regional pattern for these current fields in the central SCB even though measurements at the various locations were obtained at different times" (Nobel et al. 2009).

## CURRENT VARIABILITY IN ALONG-SHORE AND CROSS-SHORE DIRECTIONS

In the central SCB the Continental Shelf extends from shore to the 50-100 m isobath, with the shelfbreak dropping off to the Continental Slope more steeply and closer to shore along the Palos Verdes headland. Off Huntington Beach, the shelf is wide and gently sloping out to 100 m depth. Within the shelf, several zones are commonly distinguished due to characteristics that affect physical and biological processes (Kumar et al., 2015; Lentz & Fewings 2012; Austin & Lentz 2002). While these are not rigidly delineated, the **inner shelf** is typically defined as starting just outside the surfzone (around 5 m depth) to approximately 15 m. The distinguishing characteristic here is that the depth is so shallow that currents in entire water column are subject to frictional boundary effects from both the bottom and the surface. (Surface boundary effects include wind forcing of currents, while bottom friction slows currents to zero with depth. On the inner shelf, given similar winds, the result is that currents are generally slower than in deeper water.) The **mid-shelf** occupies the zone approximately between the 15-50 m isobaths where it becomes deep enough that surface and bottom boundary layers are distinct from one another, and the **outer shelf** would encompass 50-100 m depths. Mid-outer shelf currents in the upper water column are thus “free” of the slowing effect of bottom friction. Within the inner shelf some further distinguish a **nearshore** zone (less than 10 m depth) where influence of the surfzone is more prevalent.

In the context of seawater intake locations, stations D4, D2, E, U2 and U4 are well within the inner shelf (and nearshore) zones, while stations O2 and O4 are near the inner-mid shelf boundary.

In the central Southern California Bight most flow variability is in the dominant northwest-to-southeast moving currents, which have the highest velocity. The major differences are seen as one moves in the cross-shelf direction away from shore, perpendicular to the coast from the nearshore to outer shelf. Mooring and modeled data (Hamilton et al., 2006; Kumar et al., 2015) show a large drop in coherence between current patterns on the outer-mid shelf and the inner shelf.

In the alongshore direction (moving parallel to shore) coherence length scales are reported to be greater than the length of the San Pedro Basin (Hickey et al., 2003). Significant correlation between current meters in the bight has been observed at distances up to 25 km apart in the alongshore direction; at smaller scales of 8 km or less the correlation is extremely high at roughly 90% (Winant 1983). Data from OCSD moorings in 2004 indicated alongshore currents were coherent 11 km downcoast from the main transect and up to 20 km upcoast (where there is no intervening canyon and narrowing of the shelf).

Cross-shelf currents running perpendicular to the coast are typically much weaker compared to the dominant alongshore component, so are usually observed only as slight onshore or offshore drifts in the main current direction.

Currents also vary with depth, in both speed and direction (as seen in Fig. 2 and Fig. 3). At depths within 4-5 m of the bottom, velocity slows to 10-30% of its surface value (Table 1). Also, because bottom currents are so weak, even small fluctuations can result in a change in current direction. Bottom current characteristics are the same at both nearshore and mid-shelf locations, however in deeper waters over the mid-shelf, higher current velocity extends into mid-depths before attenuating near the bottom.

The average time scale of variability in central SCB currents is around one week. On the mid-shelf (30 m isobath) Hickey et al. (2003) report peaks at periods of 4-10 days. On the inner shelf near Huntington Beach average periods of 7-9 days are observed at all depths, although the mechanism behind the variability differs (see below).

## COMPLEXITY & DECOUPLING OF INNER SHELF PROCESSES

The drop in correlation of alongshore currents between outer and inner shelf is believed to be largely driven by a shift in forcing mechanisms (e.g., currents driven by local winds vs. remote winds or large-scale oceanic pressure gradients). EOF (empirical orthogonal function) analysis is a statistical method for distinguishing spatial patterns within data collected simultaneously at different locations and is often used to interpret an array of current meter measurements. Such analysis shows that mid-outer shelf currents are driven primarily by cross-shelf pressure gradients induced by large-scale coastally-trapped waves (Kelvin waves) propagating poleward along the west coast of North America. On the inner shelf the currents instead are strongly responsive to local wind stress (Noble et al., 2015; Hamilton et al., 2006).

The different forcing mechanisms mean that currents in the two regions are essentially decoupled from one another (Fig. 4). Currents on the mid-outer shelf are characterized by more vertical homogeneity (less vertical shear) and bathymetry-following current direction. On the inner shelf, wind forcing can produce surprisingly swift surface currents (50-80 cm/s with light wind speed) when conditions are strongly stratified in summer. These currents are independent of bathymetric steering and decrease rapidly with depth, approaching zero below 15 m (Fig. 5).

The wind driven currents are also responsible for shallow-water upwelling when winds are from the NNW. This upwelling draws bottom water from only as far away as the inner shelf, further distinguishing current patterns between the mid-outer and inner shelf regions.

Currents in this area are also highly correlated in the alongshore direction, as seen in a comparison of moorings 5 km apart at Huntington Beach (Fig. 6). However in the cross-shelf direction, there is decreased coherence between adjacent moorings, just as seen with currents further offshore. Differences in simultaneous currents at moorings on the 15m and 35m isobaths are shown in Fig. 7. Note the frequently changing current direction as well as current magnitude. The major shift between inner and mid-shelf surface currents, when present, is observed between the 20 and 25 m isobaths, where site O4 is located (Fig.8).

## MODELING INNER SHELF CURRENTS

A coupled ROMS-SWAN model (Regional Ocean Modeling System - Simulating Waves Nearshore) is perhaps the best example of the challenges for modeling inner shelf currents (Kumar et al., 2015). Tracer studies indicated that both nearshore and mid-shelf processes were involved in cross-shelf exchange, so this particular configuration was developed in order to take advantage of ROMS skill over the mid-outer shelf and SWAN skill with the nearshore boundary. The authors explain, “A coupled wave and circulation model with wind, wave, tide, and buoyancy forcing and sufficient resolution is required to accurately simulate inner-shelf and surfzone processes. Therefore, prior to studying cross-shelf exchange, a model must be concurrently applied from the midshelf to the surfzone and tested against field measurements.”

The model results compared favorably to data from the 2006 OCSD cross- and along-shelf mooring arrays near the outfall. Light and variable winds over the inner shelf are also problematic in driving models such as this because larger scale wind products lack sufficient resolution and have poor performance capturing conditions at the land-sea boundary. The ROMS-SWAN model took advantage of weather buoy winds from near the OCSD outfall.

**SUMMARY**

From the abundance of data measured over the course of OCSD outfall and other studies, a picture of circulation patterns on the San Pedro Shelf emerges with the following characteristics.

- Broad scale circulation is determined by the southward flowing California Current branching off south of Pt. Conception and turning shoreward around the Channel Islands, joining the California Undercurrent in a turn northward over the middle of the San Pedro Shelf.
- Currents over the San Pedro shelf are significantly correlated in the alongshore direction, with correlation length scales of 25-30 km, and are extremely correlated over the scale of the proposed intake sites (< 10 km). Little difference would be expected in current behavior between sites over that distance along the coast.
- Currents over the San Pedro shelf are not well correlated in the cross-shelf direction. Inner shelf currents can be in the opposite direction from the mid-shelf, and slow rapidly with depth. Outer shelf currents are more vertically homogenous through mid-depths but are similarly weak near the bottom. The primary difference here between shallower and deeper sites is the presence of a moderately strong flow at mid-depths (approximately 12-15 m above bottom) at the deeper sites.
- Different forcing mechanisms over the mid-outer shelf and inner shelf essentially decouple currents over the two areas. The result is higher average surface current velocity in the shallower region where sites D4, D2, E, U2, U4 and O2 are located. Site O4 is near the inner-middle shelf transition and may have somewhat slower surface currents. Deep and near-bottom currents as well as the average period of current variability are similar in the two regions however.
- Modeling nearshore currents (< 20m water depth) requires coupling with higher resolution models that include inner shelf physics and wind data reflective of nearshore land-sea interaction.

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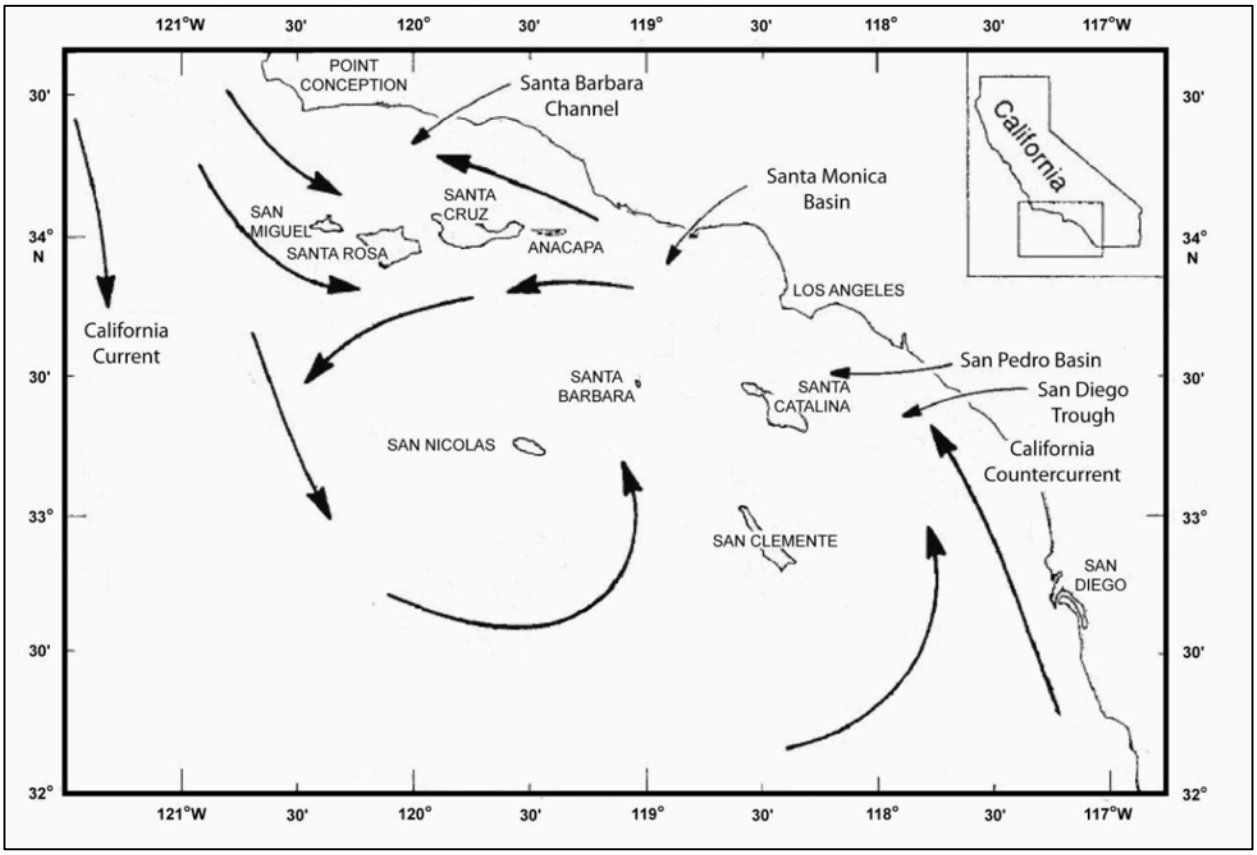



Figure 1. The large scale mid-outer shelf, depth-averaged circulation patterns in the SCB (From Howard et al., 2012; adapted from Hickey, 1992).

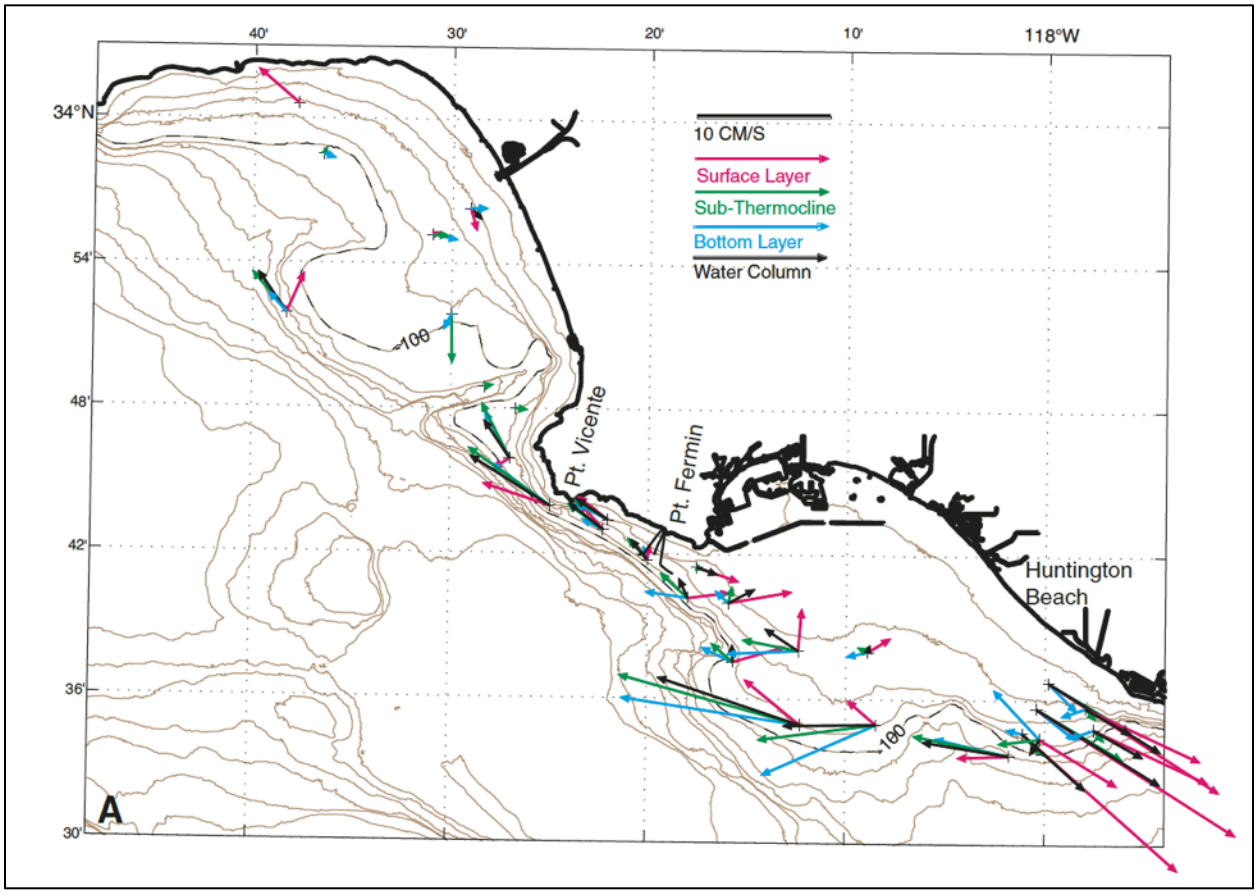



Figure 2. Mean flow patterns averaged over 4 successive summer seasons. Red, green, and blue vectors represent mean surface, mid-depth and bottom flows, while black arrows represent the depth-averaged flow. (From Noble et al., 2009)

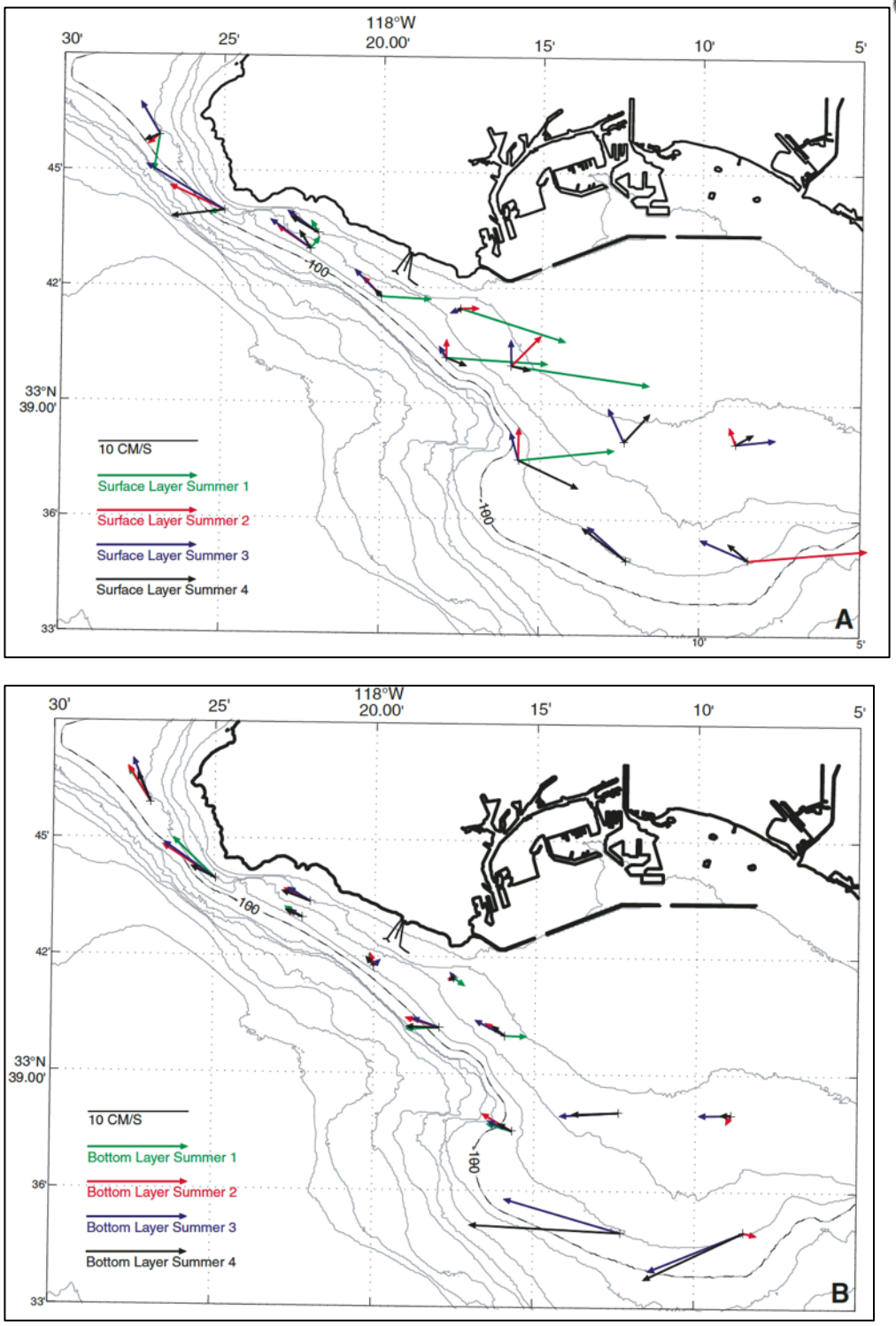



Figure 3. Mean flow patterns for (A) surface and (B) near-bed currents on the Palos Verdes and San Pedro shelves for four successive summer seasons. The flow patterns for subthermocline mean currents are similar to those near the bed. Bathymetric contour units are shown in meters. (Noble et al., 2009)

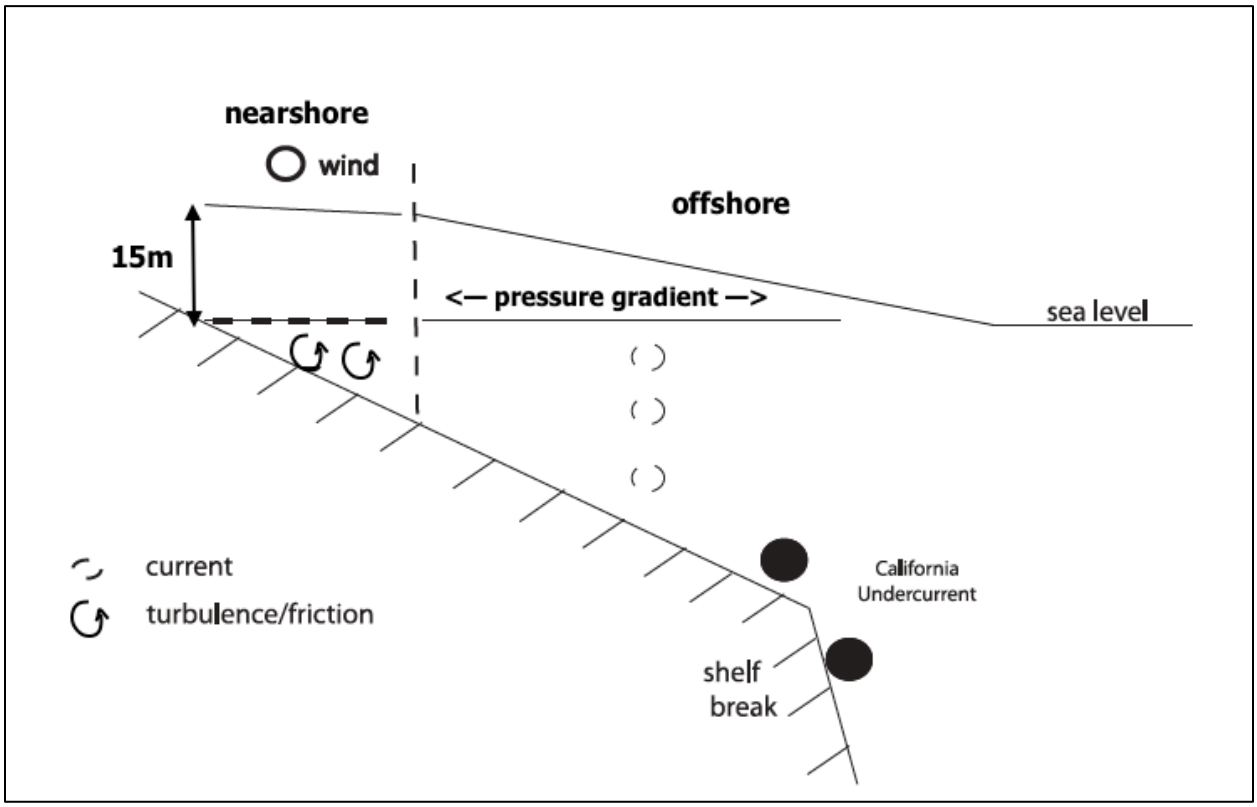
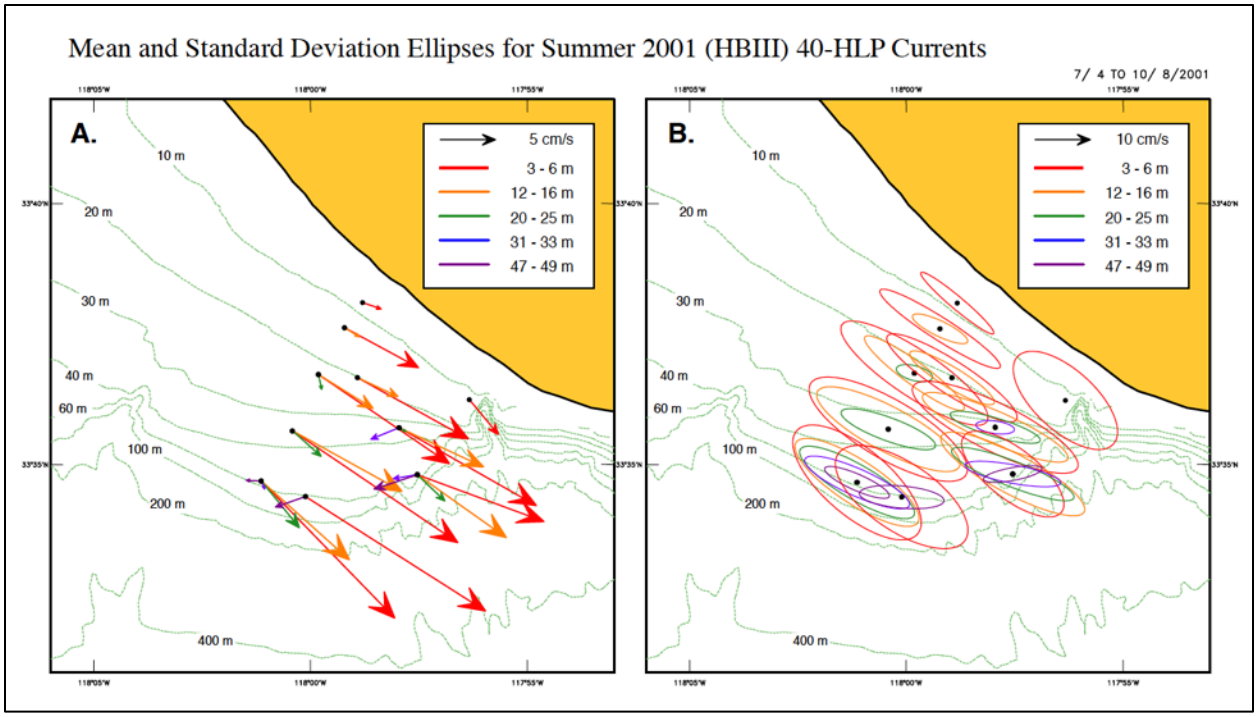



Figure 4. Spatial structure for the uncoupled forcing of nearshore currents (wind stress) and offshore currents (pressure gradients and the California Undercurrent). Here nearshore is defined as water depth < 20m. (After Noble et al. 2015)



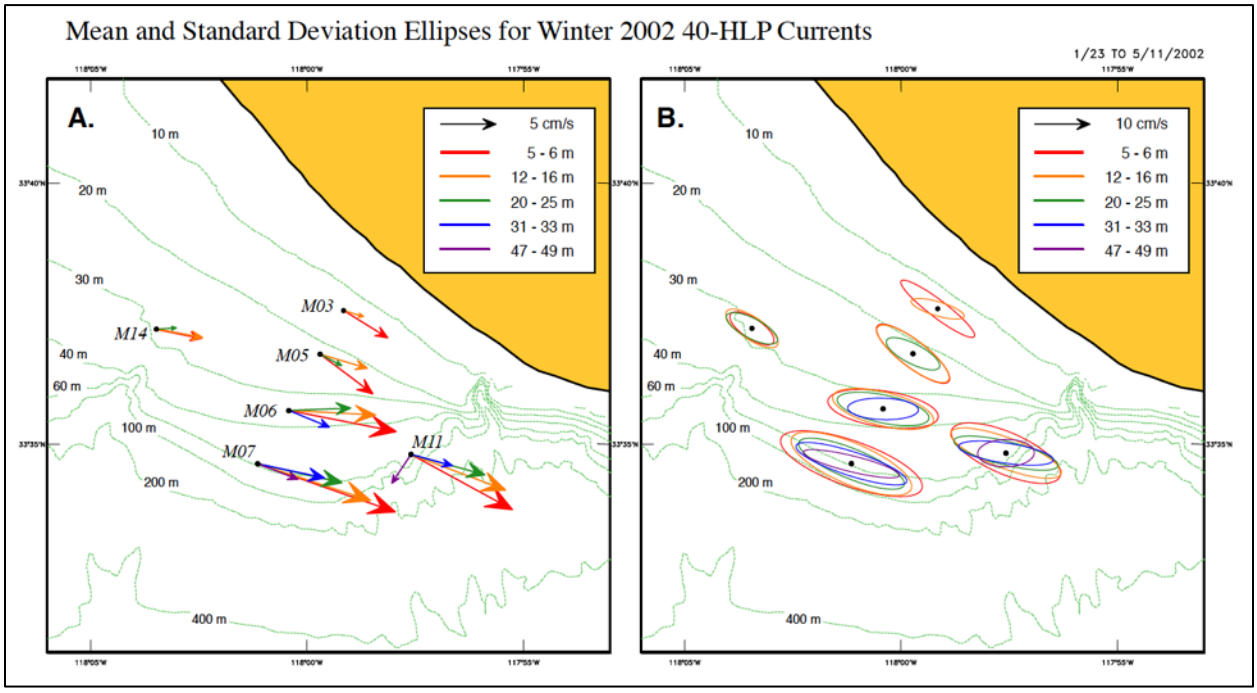




Figure 5. Mean currents during summer (July-Oct) and winter (Jan-May) at San Pedro shelf moorings. Colors indicate current depth. (From Hamilton 2007)

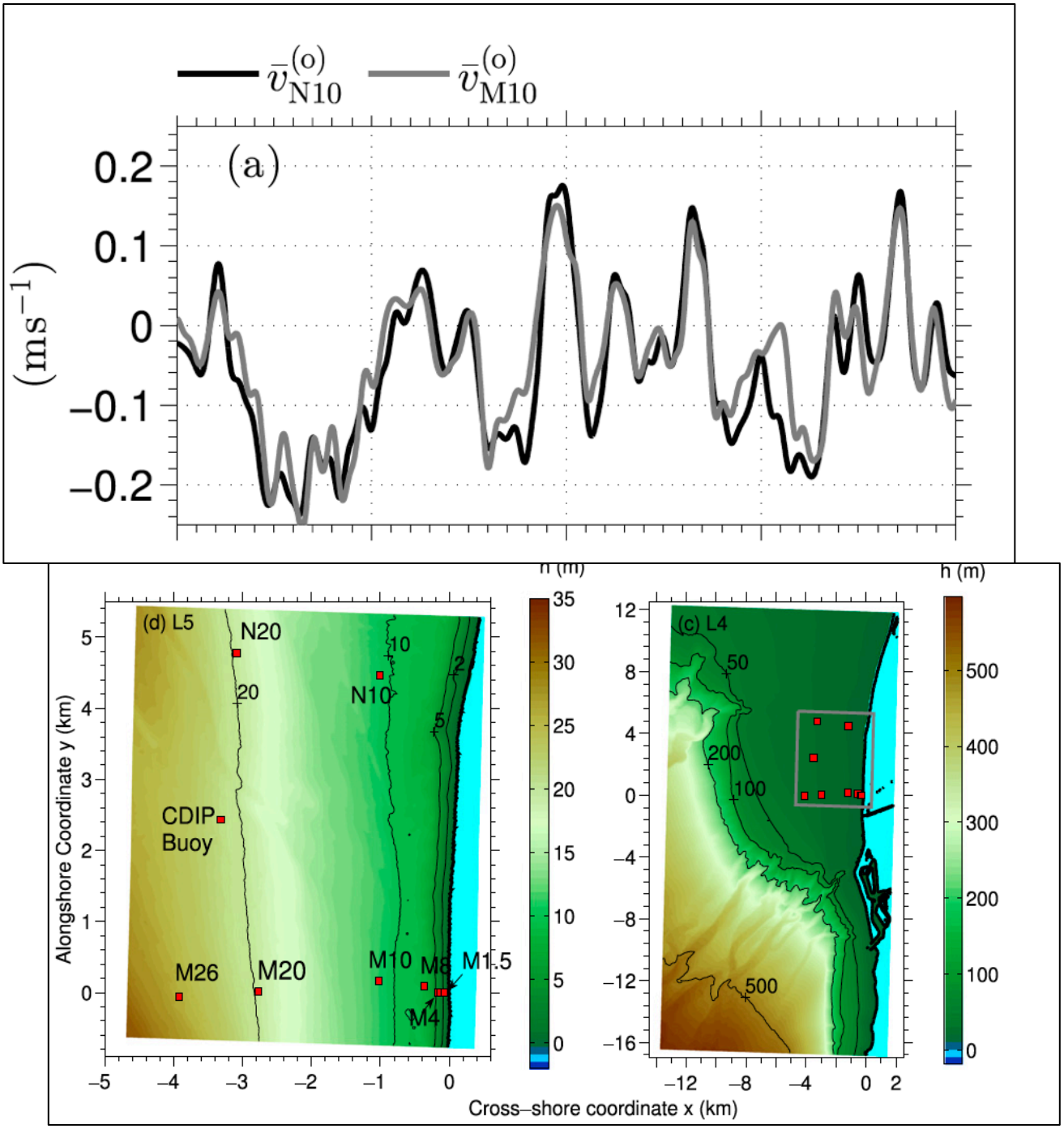



Figure 6. Observed depth-averaged, subtidal, alongshore current at moorings N10 (black) and M10 (gray) vs time. Moorings are at 10 m depth and approximately 5 km apart. (From Kumar et al. 2015)

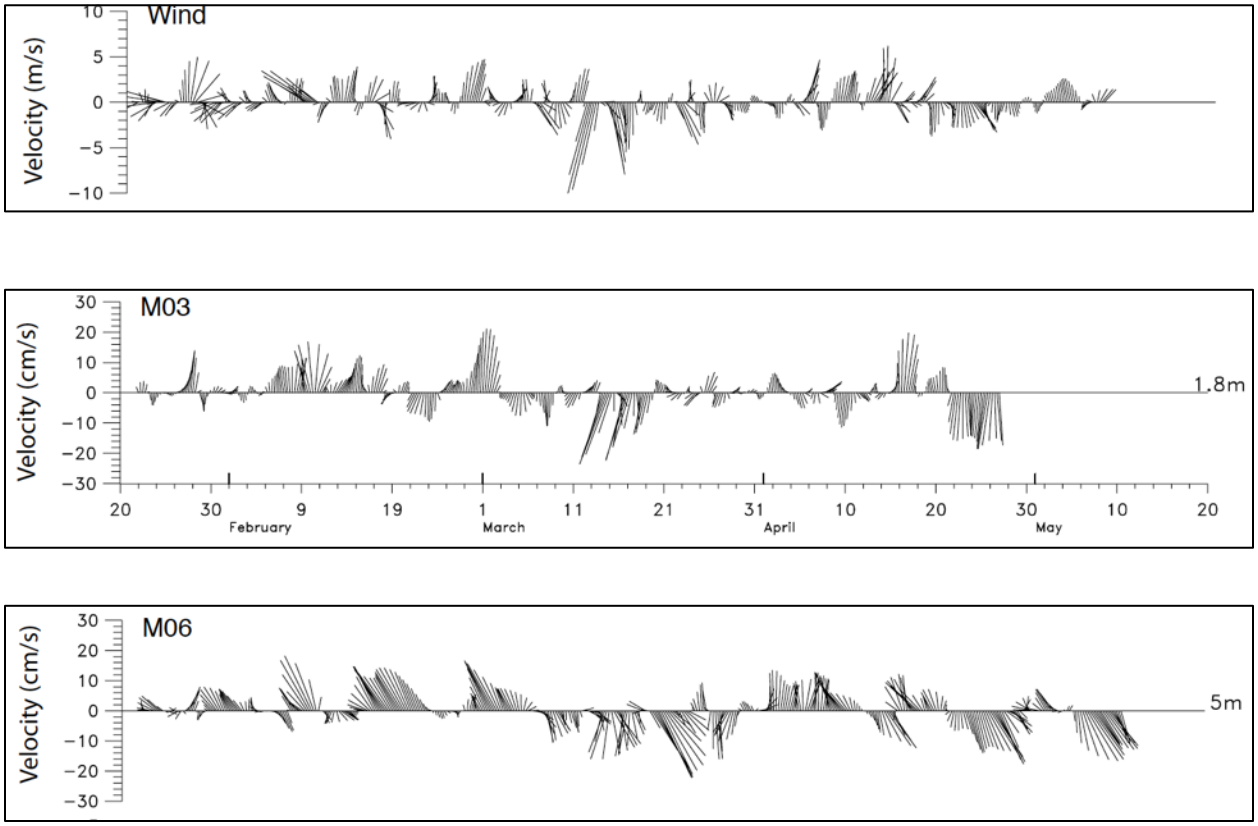



Figure 7. Near-surface current velocity at moorings M03 (15 m isobath, current speed at 1.8 m depth) and M06 (35 m isobath, current speed at 5 m depth) and corresponding wind vectors. (From Hamilton 2007)

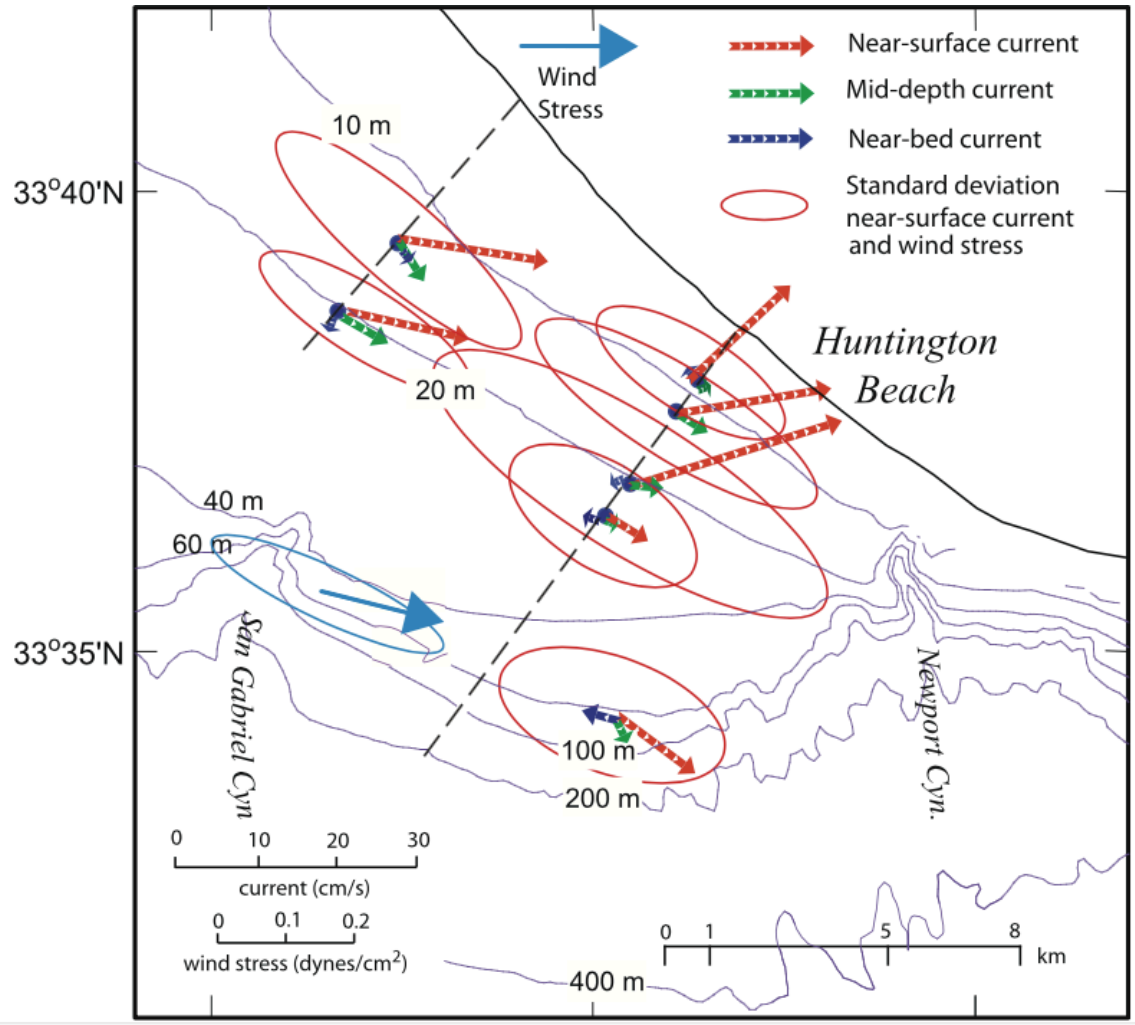



Figure 8. The mean near-surface, mid-depth and near-bed currents and mean wind stress amplitudes off Huntington Beach. The standard deviation of near-surface currents and wind stress is also depicted. The standard deviation of mid-depth and near-bed currents (not shown) is usually larger than the mean current. (From Noble et al., 2015)

| Water Depth | Inner shelf current velocity | Mid shelf current velocity |
|---|---|---|
| 5 m | 15-20 cm/s | 15-18 cm/s |
| 10 m | 4-6 cm/s | 10-18 cm/s |
| 25 m | – | 2-4 cm/s |

**Table 1.** Average current velocity offshore of Huntington Beach over the inner shelf (10-15 m depths) and mid-shelf (20-25 m depths) for surface, mid-depth (mid-shelf only) and bottom. (From data in Nobel et al., 2009)

# ATTACHMENT 5: DUDEK. 2019. D2 AND U2 – ALTERNATIVE 1MM SCREENED SEAWATER INTAKE FEASIBILITY ANALYSIS ACCORDING TO THE OPA AND CEQA.