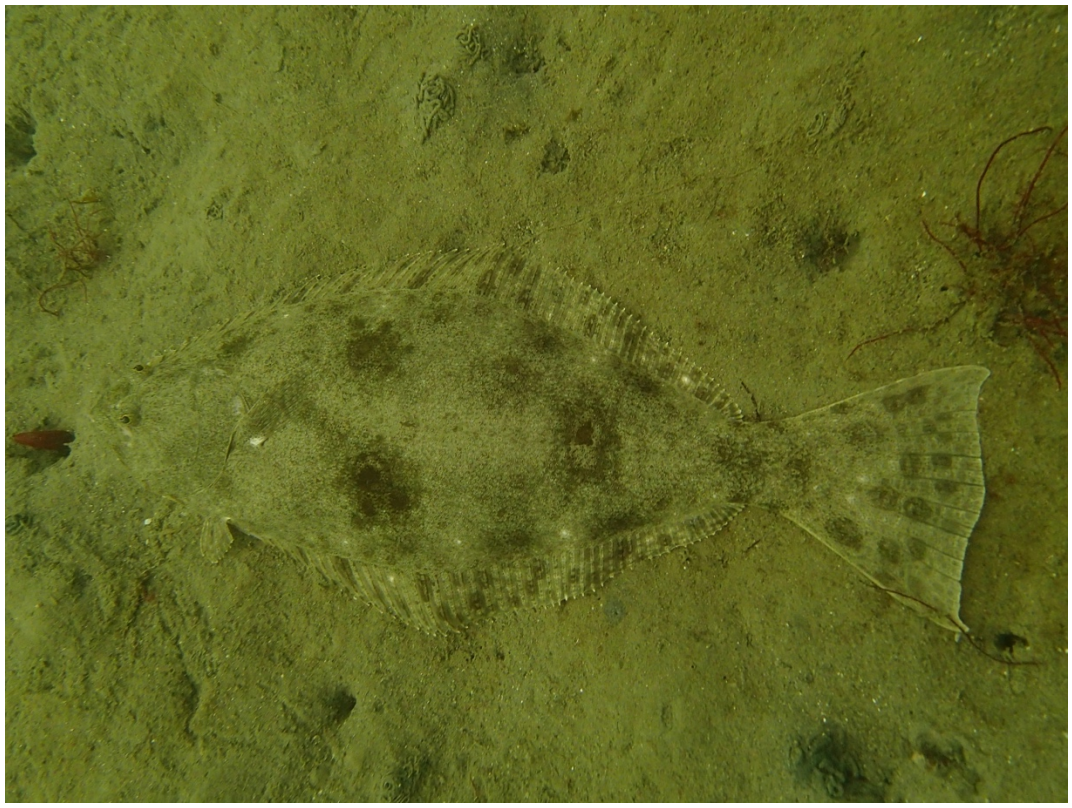
Huntington Beach Desalination Plant

INTAKE SITE DETERMINATION: MULTIPLE LINES OF EVIDENCE ANALYSIS



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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).

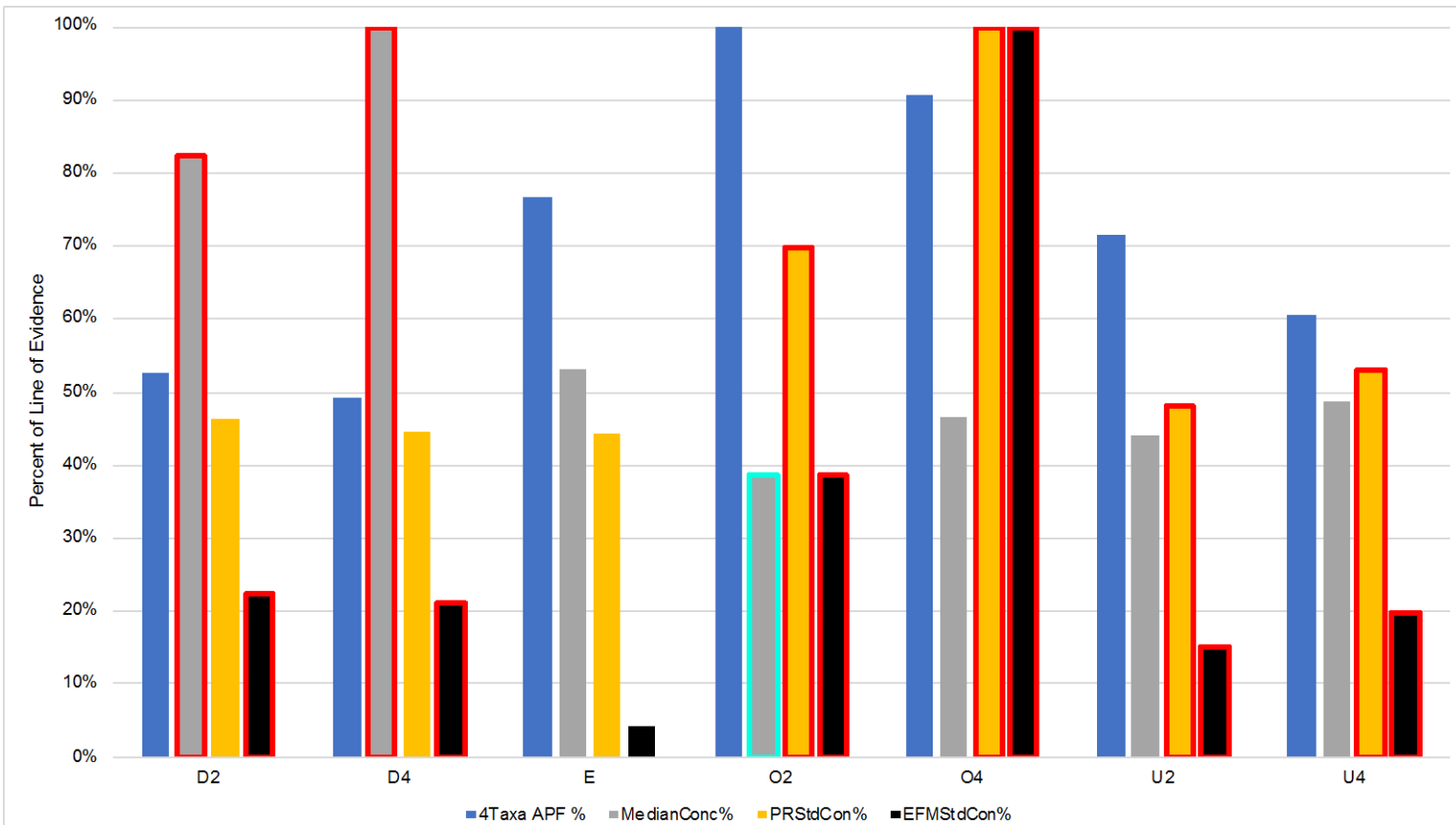

Figure ES- 1. Percent of the maximum value for each line of evidence examined by station. Red outlined bars represent values that were significantly higher than the corresponding value at proposed intake site E. The green outlined bar was significantly less than the corresponding value at proposed intake 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.

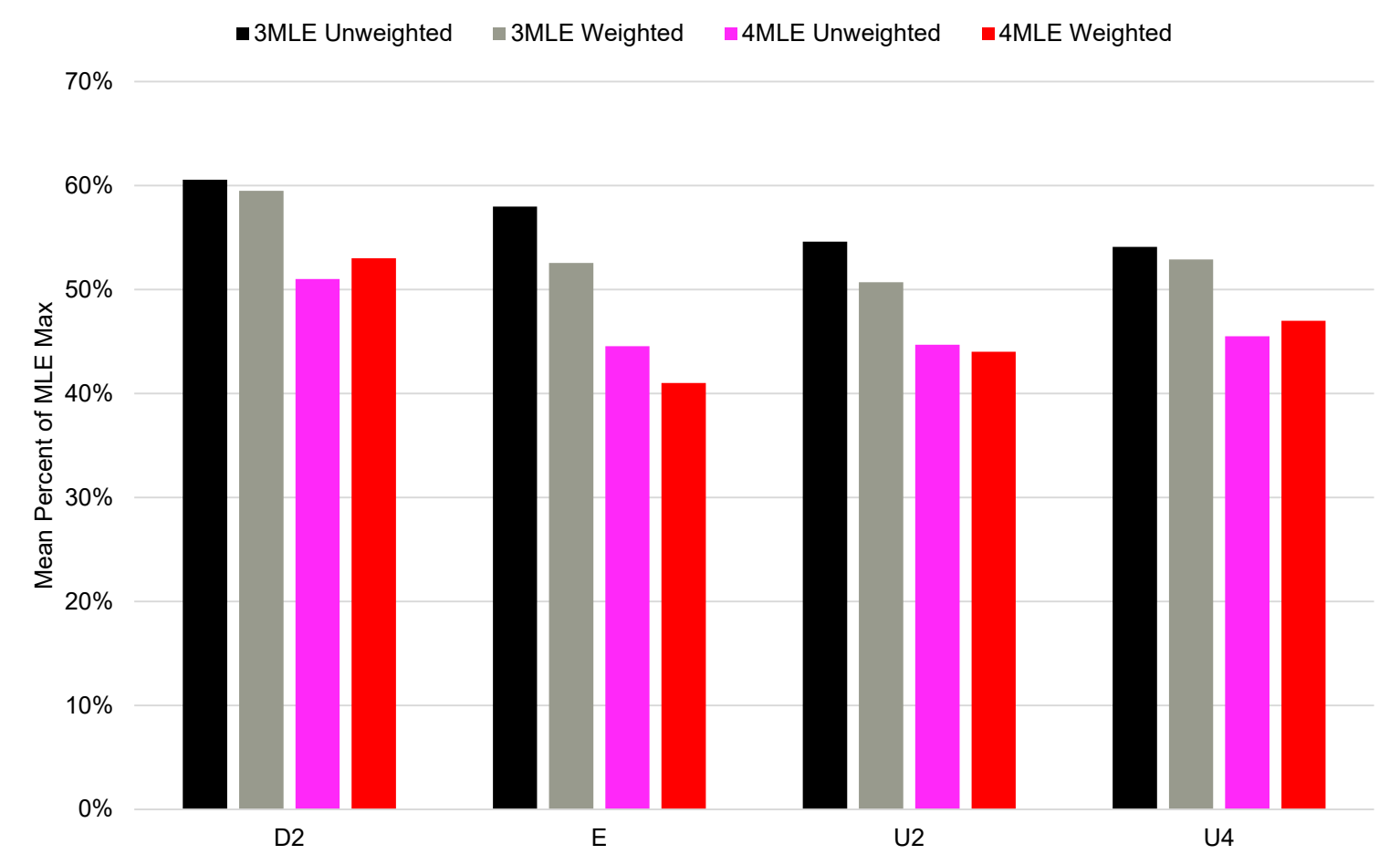

Figure ES- 2. Summary analysis of multiple lines of evidence (MLE). Each bar represents an average of the three or four MLEs both unweighted and weighted.

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 ith survey
E_i =	Estimated number of larvae entrained during the ith survey
$SSWD_i$ =	Estimated mean larval density in the sampled source water during the ith 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 ith 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).

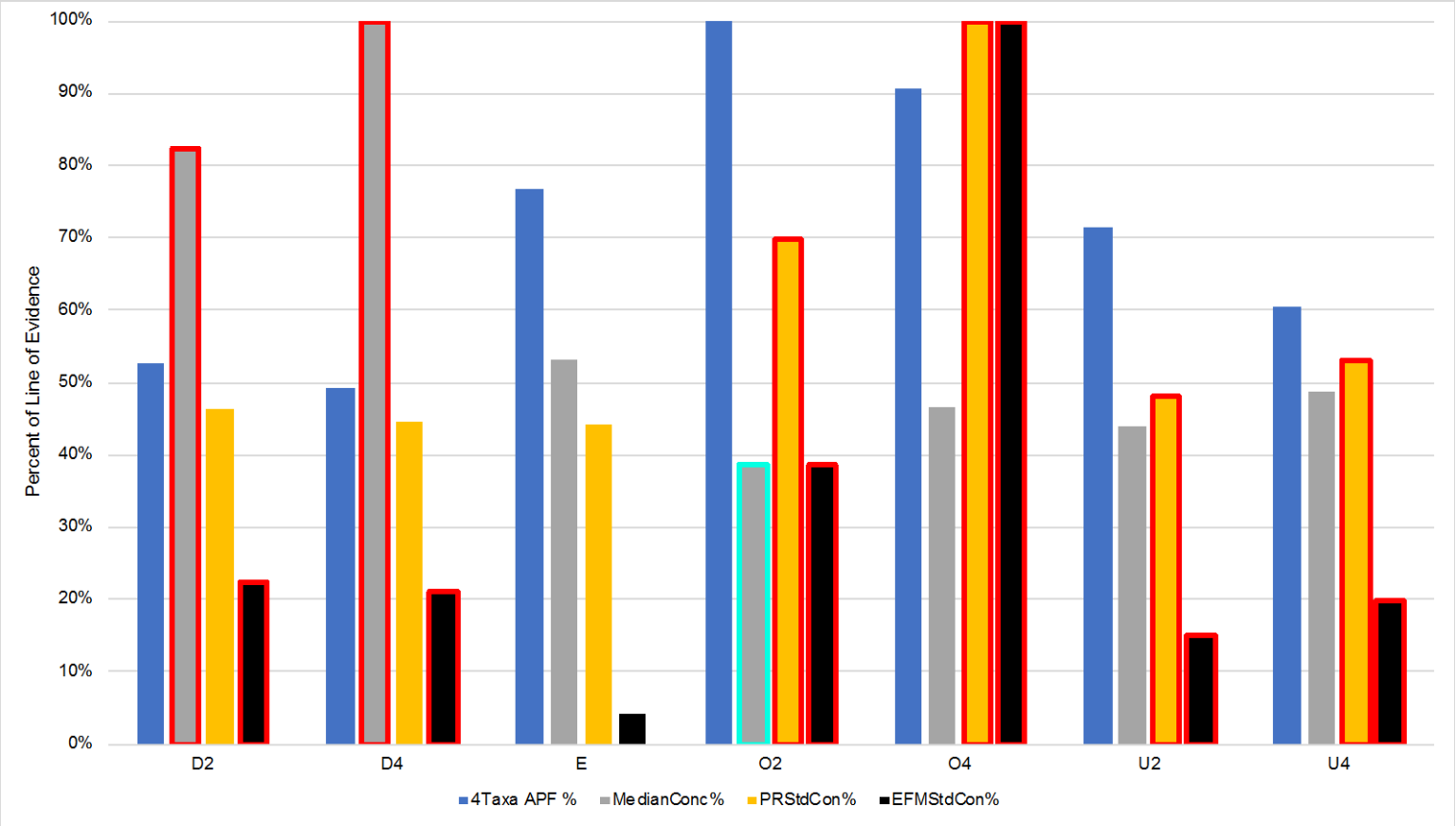

Figure 2. Percent of the maximum value for each line of evidence examined by station. Red outlined bars represent values that were significantly higher than the corresponding value at proposed intake site E. The teal outlined bar was significantly less than the corresponding value at proposed intake 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.

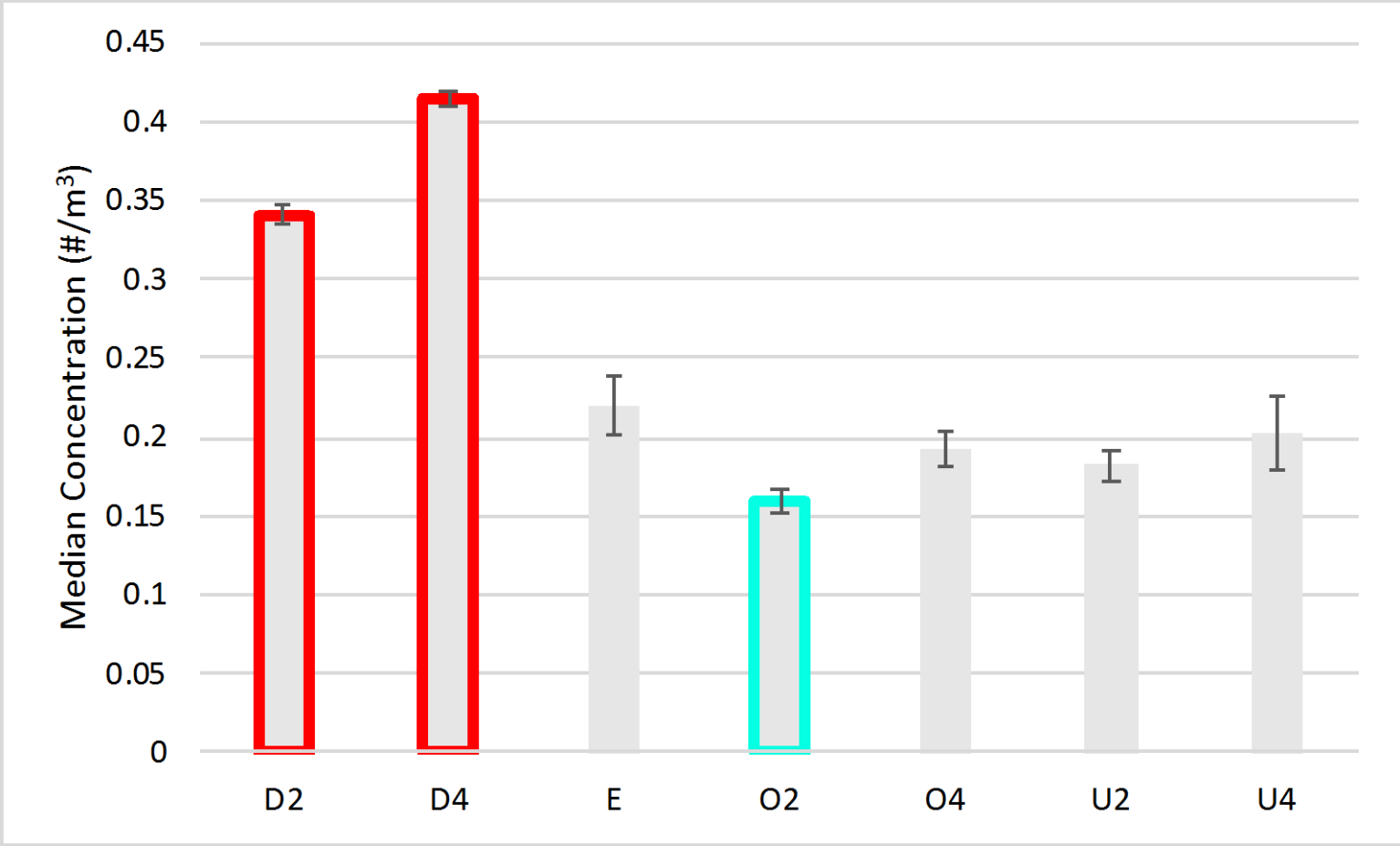

Figure 3. Median concentration (plus standard error) of all identified and counted larvae by potential intake site. The red and teal borders designate significant difference between the site-specific concentrations and those at proposed intake site E.

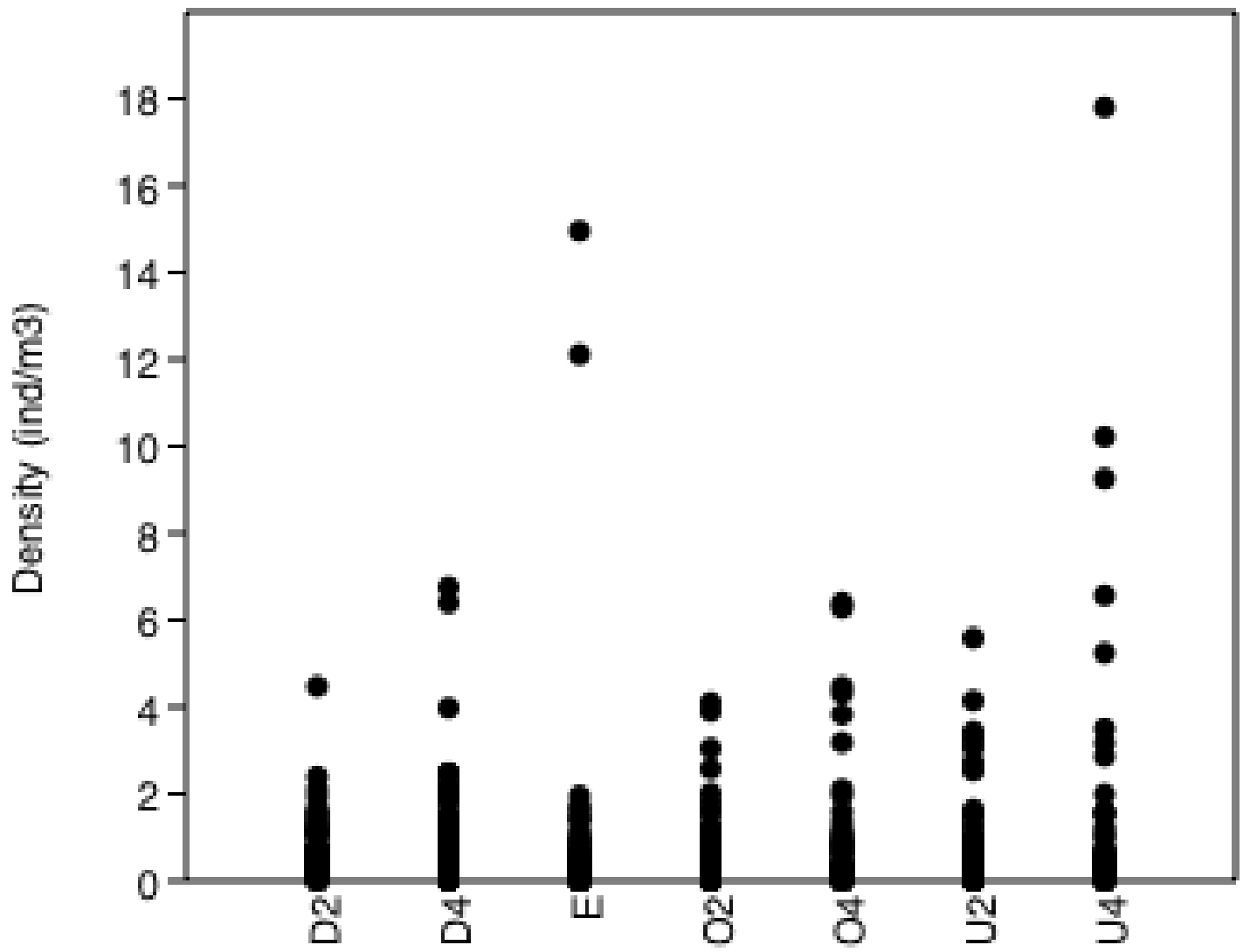

Figure 4. Total larval concentration per net (n=96) for each potential intake site.

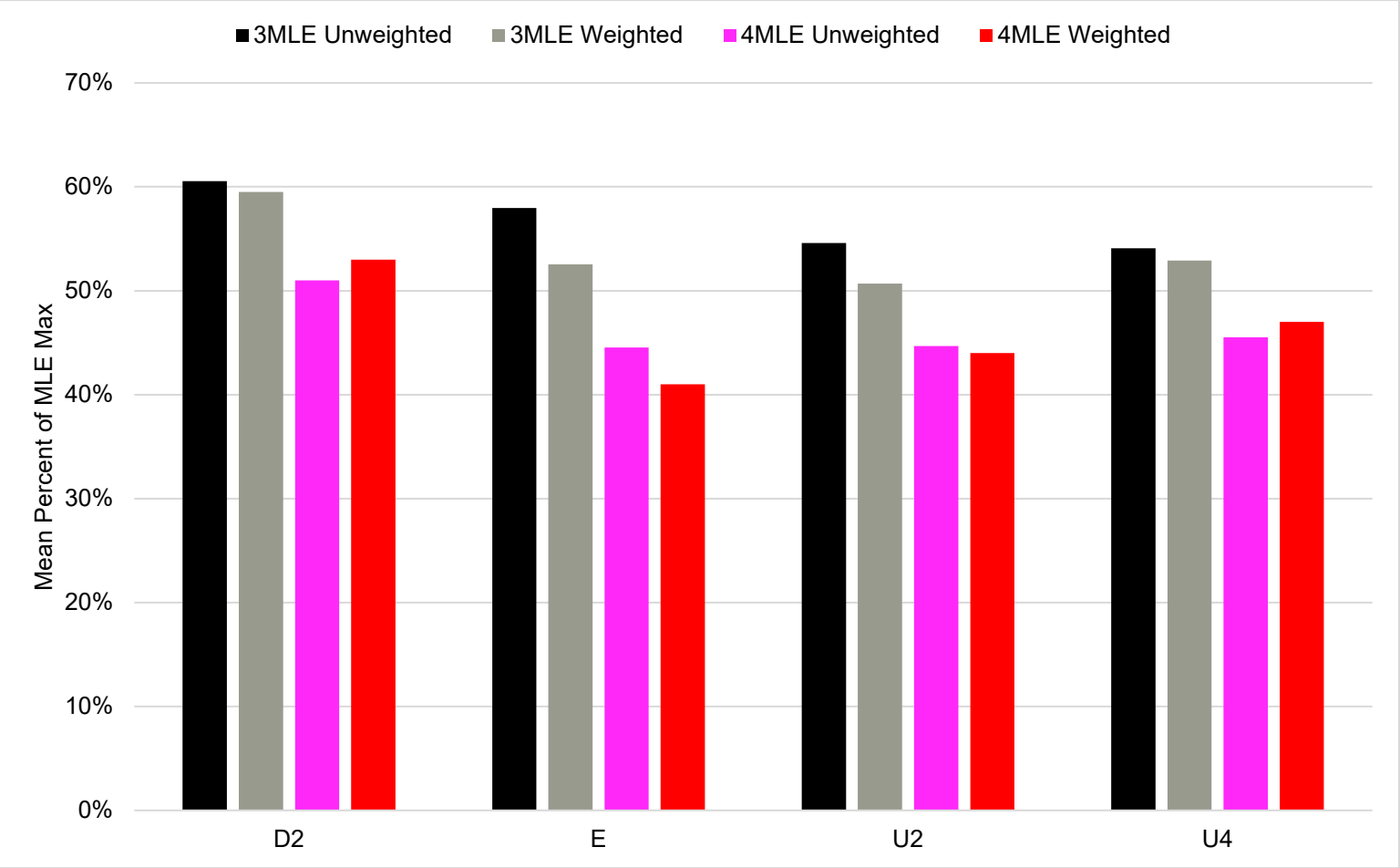

Figure 5. Summary analysis of multiple lines of evidence (MLE). Each bar represents an average of the three or four MLEs both unweighted and weighted.