WETLANDS MITIGATION CREDIT FOR POTENTIAL IMPINGEMENT, AS WELL AS FOR POTENTIAL ENTRAINMENT

The March 27, 2009 Regional Board Staff Report states that the March 9, 2009 Minimization Plan "does not specify the mitigation proposed for impacts due [to] impingement in addition to those already required by the CCC for entrainment." In fact, the March 9 Minimization Plan is clear that the proposed wetlands described in Chapter 6 of the Plan provide the mitigation for impingement. The Staff Report, however, refrains from making a determination as to whether the proposed mitigation "adequately compensates" for potential impingement losses apparently because staff are concerned that the mitigation credit associated with the wetlands already is allocated fully to mitigate for potential entrainment losses from the CDP. The concern apparently is that relying on the same wetlands to mitigate for both the effects of impingement and entrainment results in the double counting of mitigation credit. Such is not the case.

I. EXECUTIVE SUMMARY

The approach proposed in the March 9 Minimization Plan does not result in any double counting. The mitigation approach is to construct or restore up to 55.4 acres of estuarine wetlands. These kinds of wetlands are known to provide a wide variety of ecological functions. They provide important spawning and nursery grounds that support large larval populations, thereby compensating for potential entrainment from the Carlsbad Desalination Plant's (the "CDP") intake of seawater from the Agua Hedionda Lagoon (the "Lagoon"). They also provide food and refuge for fish, whether those fish are present because they matured from locally produced larvae, or migrated into the wetlands from other nearshore or wetlands populations. By supporting populations of fish in addition to the species for which entrainment mitigation is provided, the proposed wetlands have the potential to provide substantial mitigation for impingement, in addition to entrainment.

The key to whether the proposed wetlands can provide impingement mitigation relates to differences between the species that are impinged, versus those that are entrained. The basic principle is that wetlands required to compensate for entrainment of one species are available to compensate for impingement of a wholly different species assuming, of course, that the wetlands will produce the impinged species.

As applied to the CDP, it turns out that entrainment mitigation was driven by three fish taxa—gobies, blennies, and garibaldi. In fact, 49 of the proposed 55.4 acres of the proposed wetlands will be designed to compensate for the potential entrainment at the CDP of these three fish taxa. Fortuitously, these three taxa rarely are impinged. Rather, other fish predominate potential impingement at the CDP. Because these other fish are expected to be present in substantial quantities in the planned wetlands, the 49 acres of wetlands can mitigate for their potential impingement losses at the CDP.

The other 6.4 acres of the planned wetlands will be designed to compensate for the potential entrainment at the CDP of five ocean-going species—white croaker, northern anchovy, California halibut, queenfish, and spotfin croaker. These fish were detected in relatively small numbers in the 2004-2005 entrainment data upon which the analysis relies. The 6.4 acres of planned wetlands are expected to produce many fish other than these five ocean-going species. The expected production of these other fish in 6.4 acres is available to compensate for their potential impingement at the CDP.

We the undersigned have cross-checked each other's work and have considered whether we each are claiming credit for the same benefits of the proposed wetlands. We are confident that such is not the case, and that the proposed plan is based on sound ecological and biological accounting. The ecological functions of the proposed wetlands are sufficient, and sufficiently distinct, to provide for mitigation of both entrainment and impingement. Our conclusions may be summarized as follows:

- No Prior Singular Dedication: The commitment to create or restore up to 55.4 acres of wetlands did not result in the dedications of those wetlands to a singular biological function—compensation for entrained larvae. In fact, wetlands provide robust ecosystems that can serve multiple purposes such as compensating for impinged fish as well as entrained species.

- Impingement Credit in the 49 Acres: The entrainment mitigation uses up the portion of biological production related to gobies, blennies, and garibaldi. This mitigation commitment rules out counting towards impingement mitigation the presence of these three species in these acres. Many other fish, however, including many that are impinged (e.g., topsmelt), are expected to be produced or otherwise inhabit the 49 acres. The presence of juvenile and adult stages of these fish is available to serve as impingement credit. Included among such fish are the five previously identified ocean-going species since these 49 acres provide no entrainment mitigation for them.

- Impingement Credit in the 6.4 Acres: These wetlands were required to compensate for entrainment of larvae of the five above-listed ocean-going species. This rules out counting towards impingement mitigation the presence of these five species in these acres. Many other fish, however, including many that are impinged, are expected to occur in the 6.4 acres. Juvenile and adult stages of such fish are available to serve as impingement credit. Included in such impingement credit are blennies, gobies and garibaldi since these 6.4 acres are not earmarked to provide entrainment mitigation for them.

- Adequacy of Impingement Mitigation: Estimates based on anticipated productivity values demonstrate that the proposed wetlands will produce ample fish biomass to offset potential CDP impingement. We based our calculations on a very conservative assumption of 4.7 kilograms per day ("kg/day") of impingement, corresponding to 1,715.5 kg/year. About 11.5 acres of intertidal mudflats and subtidal habitat are very likely to produce this much fish biomass of impinged species, as demonstrated by Mr. Nordby, and not including any goby, blenny, or garibaldi production in the 49 acres. 11.5 acres represents about 20 percent of the overall planned acreage. As is clear, the reality is that the proposed wetland will over-mitigate for impingement, and probably to a very substantial degree.

- Conservative Nature of Proposed Mitigation: It bears emphasis that the proposed mitigation is based on a number of conservative assumptions and a conservative scenario, providing the highest level of confidence as to the adequacy of the proposal. Key points in this regard are as follows:

  1. Stand-Alone Operations Used as a Conservative Basis: We understand that the RWQCB is authorizing only CDP operations while the EPS also continues to operate, at least intermittently. Our analysis, however, assumes that the CDP is operating independently of the EPS and ascribes to the CDP full mitigation responsibility for all entrainment and impingement associated with 304 million gallons per days ("MGD") of flow (i.e., the feedstock needs of the CDP). In reality, the EPS will continue to provide the CDP with a substantial percentage of its feedstock needs, and the EPS is responsible—not the CDP—for entrainment and impingement associated with meeting its cooling water needs. In this regard, our evaluation is very conservative.

  2. Potential Impingement Likely Lower Than 4.7 Kg/Day: Our calculations based on the long-established relationship between flow and impingement suggest that actual impingement at the CDP is likely to be on the order of 1.5 to 2.2 kg/day. The 1980 study of impingement at the EPS established a "direct" and "significant" relationship between flow and impingement at the EPS. The 2004-2005 study is consistent with these earlier findings. Yet, we assumed a value of 4.7 kg/day after receiving substantial feedback from RWQCB staff that it wished us to explore various calculation methods. We do not want to be misunderstood that we embrace calculation methods that reject the flow-impingement relationship, or require the use of outlier data as if those events will re-occur with frequency. Our use of 4.7 kg/day value is very conservative and likely unrealistically overstates impingement.

  3. No Compensatory Mortality Assumed: Dr. Raimondi expressed concern that our approach might be assuming compensatory mortality. Such is not the case. If we had assumed compensatory mortality, the mitigation acreage would have been much less than 55.4 acres. Compensatory mortality is the theory that natural systems can respond to larval losses without experiencing any loss at the juvenile and adult population stages. We actually assumed *proportional* loss across all life stages. That is why the 49 acres for goby, blenny and garibaldi larval mitigation is not also available to mitigate for impingement of juvenile and adult forms of these species. With this explained, we also wish to point out that most ecologists, including the undersigned, believe in compensatory mortality. In fact, without it, Agua Hedionda Lagoon would be depauperate—not the rich environment present there today. The assumption in our mitigation estimates, which ignore *compensatory* mechanisms, and assume *proportional* loss, is conservative.

4. Compensation Provided for *All* Potential Entrainment and Impingement – Staff acknowledge that there were no threatened or endangered species detected in the 2004-2005 field program. It also is the case that not all species detected in the field program have commercial and/or recreational value. Yet, our approach compensates regardless of the value, or lack thereof, of any species. Our approach introduces yet another level of conservatism into the proposed mitigation.

The remainder of this document describes in some further detail our assessment of the specious double-counting claim.

II. THE PROPOSED WETLANDS WILL PRODUCE MANY ECOLOGICAL BENEFITS

The proposed wetlands were based on scientific methods to ensure that they provide an environment capable of compensating for the potential entrainment losses from the CDP. These methods do not rule out the potential for the wetlands to compensate for other losses, such as those due to potential impingement. As described below, wetlands provide a wide variety of benefits, promoting and serving a wide range of ecological functions. It is plain that not all of these benefits have been earmarked for entrainment mitigation.

A. Estuarine Wetlands Contain Salt Marshes, Which Generate Primary Productivity

The proposed wetlands restoration project will produce tidal estuarine habitats, which are among the most productive areas on earth.[1] These estuaries typically consist of various habitats, including: (a) shallow subtidal habitat[2]; (b) intertidal mudflats; and (c) intertidal salt marshes, which depending on elevation, are alternately inundated and exposed by the tide.

The intertidal salt marsh is the major engine of an estuary's high productivity. The salt marsh supports vascular plants and algae that produce biomass from sunlight through photosynthesis. This biomass provides energy to many of the organisms in the vicinity of the marshes. An increase in a salt marsh's vegetative biomass over a given time period is referred to as the marsh's "primary productivity." This productivity eventually transfers to higher order consumers, such as invertebrates, fish and birds. In order to estimate the food that is available to higher order consumers, ecologists measure the primary productivity of salt marshes.

To assess the primary productivity of vascular plants, replicate plots of vegetation are harvested over time (e.g., one growing season). They are then sorted by species, dried in an oven and weighed.[3] These data provide an annual curve for biomass plus estimates of yearly

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[1] Larry G. Allen, *Seasonal Abundance, Composition, and Productivity of the Littoral Fish Assemblage in Upper Newport Bay, California*, 80 Fishery Bull. 769 (1982).

[2] In southern California, shallow subtidal habitats are usually two meters deep or less.

[3] Dry weight is used in biomass estimates because different plant species contain different amounts of water in their tissues and comparisons of wet weight would overestimate the relative productivity of plants that contain more water. For example, cordgrass, a

production. Primary productivity of benthic algal communities is measured indirectly by measuring differences in oxygen concentration in light and dark plexiglass or glass chambers. These results are mathematically converted to grams DW/m2/year.[4]

B. Wetlands Also Deliver High Secondary Productivity

The biomass of the vascular plants and algae decompose and pass along the food web to fish and invertebrates. A "food web" is a pattern of relationships among organisms that eat and are eaten in the ecosystem. Some algae may be grazed directly by both fish and invertebrates. The fish and invertebrates convert these foods into body mass, or growth, a process known as secondary productivity. This new biomass represents the secondary productivity.

Measurements of the efficiency of transferring primary productivity into secondary productivity are complex and highly variable. One conservative estimate is that approximately 10% of primary productivity is transferred at each step of the food web.[5] Thus, if there are 1,500 g DW/m^2/year of primary productivity available, approximately 150 g DW/m^2/year of secondary productivity could be assimilated in a one-step food web where the plants (primary producers) are directly grazed on by herbivores. Approximately 15 g DW/m^2/year would then be available for biomass production in a two-step food chain, and so on.

Secondary productivity estimates of fishes in southern California estuaries are among the highest recorded.[6] Short food chains that transfer the high primary productivity of the salt marsh to higher order consumers are often cited as one of the mechanisms responsible for these high secondary productivity estimates. This is known as "telescoping" the food chain in the terminology of Odum.[7] Just as a telescope brings distant images closer, the wetlands bring the end product of the food chain—i.e., assimilation and growth—closer in space and time to the primary productivity that underlies it. In his study of fish productivity in the Upper Newport Bay

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vascular, or "rooted", plant which dominates the low marsh of southern California estuaries, has a relatively low water content compared to pickleweed, a succulent plant that dominates the mid and upper marsh elevations. Drying the plant tissues allows a more accurate comparison of the relative contribution of each to the overall productivity.

[4] Joy Zedler et al., *Primary Productivity in a Southern California Estuary*, *in* Coastal Zone '78; Symposium on Technical, Env'l, Socioeconomic & Regulatory Aspects of Coastal Zone Mgtm. 652 (ASCE, 1978).

[5] *See* Boesch, Donald F. and Turner, R. Eugene, *Dependence of Fishery Species on Salt Marshes: The Role of Food and Refuge*, 7 Estuaries and Coasts 463 (1984) (*citing* L. R. Pomeroy, *Secondary Production Mechanisms of Continental Shelf Communities*, quoted *in* Ecological Processes in Coastal and Marine Systems 163-86 (R. J. Livingston, ed., 1979).

[6] *See* Larry G. Allen, *supra*, at 786 (suggesting that the high productivity of the saltmarsh is efficiently transferred to these organisms).

[7] W. E. Odum, *Utilization of the Direct Grazing and Plant Detritus Food Chains by the Striped Mullet Mugil Cephalus¸ in* MARINE FOOD CHAINS 222-40 (J. H. Steele ed., 1970).

(discussed in Section IV, *supra*), Allen notes that "[t]here is little doubt that this assemblage represents an example of 'food chain telescoping' as described by Odum (1970)."

A salt marsh's primary productivity transfers to other organisms in addition to fish. Benthic invertebrates, such as bivalves, filter detritus and algae and convert it to biomass. Epibenthic invertebrates, such as snails and shrimp, graze on algae and detritus. Birds exploit numerous foods that are the products of the salt marsh primary productivity. While some of these trophic relationships are undoubtedly more complex than the telescoped food chains alluded to by Odum, the basis for all of them is the salt marsh.

Odum describes the productivity of these systems as follows:

> "[S]ilversides, killifish, and flounders… and other species…move back and forth with the tides, feeding on benthos of the intertidal zone when it is covered with water. Likewise, shorebirds move back and forth on the intertidal zone hunting for food when it is uncovered. It is remarkable that anything is left after these alternate attacks from land and sea!"[8]

Nevertheless Teal explains, "things are 'left' to support the continual trophic need of the estuary because healthy tidal marshes produce enormous quantities of food and possess the habitat, structure, and functional linkages to make that food readily available on an ongoing basis to consumer organisms like invertebrates, fish and birds using the estuary and nearby coastal oceans."[9]

C. Estuarine Wetlands Support Larval Production

Estuarine wetland ecosystems are important spawning and nursery grounds for fish. These systems are especially important to what are commonly referred to as "estuarine dependent" fishes—i.e., those species that spend their entire life cycle within the estuary. Other fishes that exploit the estuarine environment include "marine transient" species. Marine transient species may use the estuary during a phase of the life cycle, but they eventually migrate out of the estuary to the nearshore and offshore environments.

Among estuarine dependent fishes, adults and juveniles are distributed within the estuary according to their preferred position in the water column, the abundance of their food source, substrate preferences and other habitat preferences. Some fish are strong swimmers and live in the water column of the shallow waters; these are referred to as "pelagic" species. Others prefer the bottom; these bottom dwellers are known as "demersal fishes."

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[8] John M. Teal, PSE&G Renewal Application, *Attachment G-2, Salem Generating Station, Permit No. NJ00056222*, at 12 (March 4, 1999) (*citing* Eugene P. Odum, Fundamentals of Ecology (1953)).

[9] John M. Teal, supra, at 12 (*citing* John Teal & Mildred Teal, Life and Death of a Salt March (1969)).

The habitat preferences of the adults determine their spawning areas. Pelagic species typically have floating eggs that contain oil globules for buoyancy. Demersal fishes may or may not have floating eggs and some may attach their eggs to the substrate.

As stated, estuarine dependent fishes complete their life cycles within the estuary and their preferred spawning grounds are determined by the habitat preferences of the adults. For all estuarine dependent species, whether pelagic or demersal, retention of the eggs and larvae within the estuary is critical to successful reproduction. Eggs and larvae that are transported via the tides to the nearshore habitat do not survive to become adults. Some estuarine species have developed different mechanisms to ensure retention of eggs and larvae. For example, Brothers (1975) suggested that gobies time their spawning to coincide with spring tides (tides of less amplitude) to reduce tidal translocation to the nearshore habitat. Topsmelt attach their eggs to floating mats of macroalgae while gobies attach their eggs to the side of their burrows. Despite these measures, the larvae may still be exported to the nearshore by tides. Commonly, estuarine species produce vast numbers of eggs and larvae in order that some are retained and mature.

Gobies (Family Gobidae) are an example of a demersal estuarine dependent taxa. Several species of goby live their entire lives within the estuary, including the three species that comprise the CIQ goby complex.[10] These gobies live in burrows in the mud and attach their eggs to the sides of these burrows. Upon hatching, their larvae release into the waters of the estuary, grow and metamorphose into adults. Although natural mortality is high, estimated at greater than 99%, those that survive and mature continue the reproductive cycle.

Gobies very rarely survive outside of the estuarine environment. Tidal translocation to the nearshore environment is one of the main causes of mortality.[11] Goby larvae typically dominate the larval assemblage of southern California bays and estuaries with densities as high as $63/m^3$ reported during one reproductive pulse at Tijuana Estuary.[12]

D. <u>Estuarine Wetlands Produce and Support Postlarval Fish</u>

Postlarval fishes are described in "year classes" with the most recent recruitment from larval form into the adult/juvenile population referred to as "young-of-the-year", or the year one age class. It is these young-of-the-year fish that appear to benefit most from the estuarine environment. Such benefits include: (a) trophic support resulting in high growth rates, (b)

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[10] The "CIQ goby complex" includes three different gobiied taxa*: Clevelandia ios, Ilypnus gilberti, Quietula y-cauda*.

[11] Edward B. Brothers, The Comparative Ecology and Behavior of Three Sympatric California Gobies (1975)(Ph.D Dissertation, University of California San Diego) (cited by Joy B. Zedler et al., The Ecology of Tijuana Estuary: a National Estuarine Research Reserve 55-56 (NOAA Office of Coastal Res. Mgtm. Div. 1992)).

[12] Christopher S. Nordby, The Comparative Ecology of Ichthyoplankton Within Tijuana Estuary and in the Adjacent Nearshore Waters 79 (Nov. 29, 1982) (unpublished M.S. Thesis, San Diego State University) (on file with author).

increased survivorship due to lowered mortality, and (c) a suitable physio-chemical environment for development of young fishes.[13]

1. Estuarine wetlands support high growth rates.

Trophic support involves the transfer of primary productivity to secondary producers. As discussed above, primary productivity from the salt marsh transfers along the food web to higher order consumers, thereby resulting in high growth rates.

2. Estuarine wetlands provide protection, which increases rates of fish survivorship.

Boesh and Turner explain:

> "Implicit in the concept of salt marsh systems as nurseries for economically important fishes and invertebrates is that the shallow waters associated with the marsh provide protection for critical life history stages. In this manner marsh habitats may provide a refuge from predators which would otherwise decimate juvenile populations and lower potential yield to the fishery. A corollary hypothesis is that the shallow water-wetland interfaces provide habitat and refuge from predators for prey species and their ultimate availability to the predators."[14]

In southern California estuaries, larval and post larval topsmelt have been associated with the same floating mats of macroalgae to which their eggs are attached, an apparent refuge from predators.[15] Boesh and Turner[16] cite experimental evidence that shrimp may avoid predation by killifish by hiding among the leaves of artificial grass that provide cover.

3. Estuarine wetlands provide physio-chemical environments that support fish development.

The "physio-chemical environment" conducive to the development of young fish is a complex concept, but relates in part to higher water temperatures and nutrient availability. The shallow waters of estuaries are typically warmer than those of the near shore environment, especially during the winter.[17] The warmer water allows for a higher assimilation of food into growth, as less metabolic energy is required for maintaining body temperature. Because growth rates are faster in warmer, nutrient rich estuarine waters, fish spend less time in the smaller life

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[13] Linda A. Deegan and Jeffrey E. Hughes, *Salt March Ecosystems Support of Marine Transient Species, in* CONCEPTS AND CONTROVERSIES OF MARINE TRANSIENT SPECIES 333 (Michael P. Weinstein & Daniel A. Kreeger eds., 2000).

[14] Boesch and Turner, *supra*, at 465.

[15] Nordby, *supra*, at 47.

[16] Boesch and Turner, *supra*, at 465.

[17] Deegan and Hughes, *supra*, at 333-65.

stages with the associated higher mortality rates (e.g., predation). The availability of nutrients is the direct result of primary productivity and trophic support discussed above.

In addition to the goby, estuarine dependent fish species whose young-of-the-year derive these benefits include topsmelt, California killifish, longjaw mudsucker, diamond turbot and staghorn sculpin. These species contribute to the high productivity estimates of fishes referenced later in this discussion.

An estuary's physio-chemical environment also supports marine transient fish species in a variety of ways. For example, the California halibut typically spends the first year or two in the warm, protected waters of the estuary before migrating offshore. The striped mullet, on the other hand, spawns offshore but otherwise spends the majority of its life in the estuary. Other marine transient fish, such as the deepbody anchovy, may enter the estuarine environment on a high tide to forage or spawn, and exit the system shortly thereafter. All of these estuarine dependent and marine transient species are referred to collectively as the estuarine fish assemblage. The species of this assemblage contribute to the total fish biomass in the estuarine system.

III. THE PROPOSED WETLANDS WILL MITIGATE FOR POTENTIAL ENTRAINMENT BY PROVIDING HABITAT FOR ENTRAINED SPECIES

The Empirical Transport Model ("ETM") and the Area of Production Foregone ("APF") method were used to estimate the wetlands acreage reasonably capable of compensating for entrainment losses that may occur at the CDP.[18] These techniques use species-specific information to drive mitigation calculations. In this case, the APF calculations were based primarily on the proportional mortality values of the three most commonly entrained lagoon species: the goby, blenny and garibaldi.[19] Mitigation acreage was also added to provide out-of-kind mitigation for five ocean-going species—smaller numbers of which were entrained.

A. <u>ETM Calculations Are Based on the Proportional Mortality Values for the Most Commonly Entrained Species</u>

The ETM applies species-specific entrainment estimates to calculate mitigation acreage requirements.[20] When applying the model, scientists focus on those fish populations that are at

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[18] As explained in Minimization Plan Chapter 5, the ETM calculates what is known as the Area of Production Foregone ("APF")—i.e., the mitigation acreage required to offset entrainment losses. APF = Proportional Mortality (Pm) x Source Water Body (SWB).

[19] These three lagoon species also had the highest proportional mortality values. *See* Minimization Plan, Chapter 5, Table 5-7, p. 5-15.

[20] *See, e.g.*, Recommended Revised Condition Compliance Findings (approved December 10, 2008), p. 12 of 19 (explaining that the restoration site is expressly designed "to replace the numbers and types of species identified in the [entrainment] study as subject to entrainment.").

risk of entrainment. The resulting APF is driven by proportional mortality[21] values "for each of the main species subject to entrainment."[22]

The APF is calculated by multiplying the proportional mortality values for the most commonly entrained species by the size of the source water body (i.e., the area of water in which the most commonly entrained species are at risk of being entrained). The resulting APF value provides an estimate of the average area of habitat expected to add back the larvae of those species that were lost to entrainment.[23] Because the ETM is a species-specific model, it first requires identification of those species that are most commonly entrained.

B. <u>Gobies, Blennies and Garibaldi Are the Most Commonly Entrained Lagoon Species; the Intake Also Entrains Open Ocean Species to a Limited Extent</u>

The 2004-2005 Tenera data show that entrainment at the EPS intake consists overwhelmingly of three lagoon fish species—gobies,[24] blennies, and garibaldi. Goby and blenny larvae alone account for nearly 95 percent of the larvae entrained at EPS.[25]

Tenera found that the EPS intake also entrains to a limited extent the larvae of several open ocean species.[26] Specifically, less than 5% of the larvae entrained at EPS are white croaker, northern anchovy, California halibut, queenfish, and spotfin croaker.[27]

C. <u>Dr. Raimondi and the Coastal Commission Determined that 49 Acres of Estuarine Wetlands Will Provide In-Kind Mitigation for the Gobies, Blennies, and Garibaldi</u>

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[21] Proportional mortality compares the portion of a population at risk of entrainment to the portion of that population actually entrained. See, e.g., Recommended Revised Condition Compliance Findings (approved December 10, 2008), p. 10 of 19.

[22] See id. at 10.

[23] Recommended Revised Condition Compliance Findings (approved December 10, 2008), p. 10 of 19.

[24] The EPS intake actually entrains the larvae of three different gobiied taxa (i.e., *Clevelandia ios*, *Ilypnus gilberti*, *Quietula y-cauda*, i.e., the CIQ Complex). The three species in the CIQ complex have been combined for analysis in the present study because it is not possible to distinguish between them at the small sizes typically collected in the plankton tows. *See* Impingement Mortality and Entrainment Characterization Study, Effects on the Biological Resources of Agua Hedionda Lagoon and the Nearshore Environment at 3-28 (Tenera Env't. 2008).

[25] *See* Impingement Study, *supra*, Table S-1, at S-6.

[26] Open ocean species might also be referred to as "nearshore" species. These species primarily inhabit non-lagoon environments and their distributions extend over large geographic ranges. *See id.* at S-8.

[27] *See id.* at S-6.

The restoration site is expressly designed "to replace the numbers and types of species identified in the study as subject to entrainment."[28] In other words, the restoration site produces "in-kind" mitigation for the most commonly entrained lagoon species.

The concept of in-kind mitigation is straightforward: for all of the larvae of a given species that are entrained by the intake, the restoration site is large enough, and incorporates the essential design features, to produce a similar number of larvae for that species. For instance, if an intake entrains 100 goby larvae in a given year, the restoration site will offset that loss by providing habitat capable of producing about 100 goby larvae.

The Marine Life Mitigation Plan ("MLMP") requires Poseidon to create or restore up to 49 acres of estuarine habitat to provide in-kind mitigation for the three most commonly entrained lagoon species. Based on Dr. Raimondi's analysis, this mitigation acreage is sufficient to offset the potential CDP entrainment of goby, blenny and/or garibaldi larvae.

Lagoon Species	Proportional Mortality
Gobies	21.6%
Blennies	8.6%
Garibaldi	6.5%
Average	12.2%

APF (Lagoon Species) = Pm x SWB
APF (Lagoon Species) = 12.2% x 304 acres
APF (Lagoon Species) = 37.1 acres @ 50% confidence level
APF (Lagoon Species) = 49 acres @ 80% confidence level

D. Dr. Raimondi and the Coastal Commission Determined that 6.4 Acres of Estuarine Wetlands Will Provide Mitigation for the Most Commonly Entrained Open Ocean Species

The MLMP requires Poseidon to create or restore 6.4 acres of estuarine wetland to provide out-of-kind mitigation for the entrained open ocean species. The MLMP is based on the understanding that this additional acreage will fully offset the potential CDP entrainment of open-ocean species. In light of the difficulty of creating new open-ocean habitat, and also the desirability of providing additional coastal wetlands, Dr. Raimondi determined that the area of the open-ocean for which production was foregone should be replaced with out-of-kind coastal wetlands. Based on his methodologies, Dr. Raimondi concluded that these 6.4 acres will provide habitat and service in sufficient quantities to mitigate for the most commonly entrained open-ocean larvae.

Open Ocean Species	Proportional Mortality
White Croaker	0.1%
Northern Anchovy	0.14%
California Halibut	0.17%

[28] Recommended Revised Condition Compliance Findings, *supra, at* 12.

Queenfish	0.37%
Spotfin Croaker	0.63%
Average	0.29%

APF (Open Ocean Species) = Pm x SWB
APF (Open Ocean Species) = 0.29% x 22,000 acres x 1/10[29]
APF (Open Ocean Species) = 6.4 acres @ 80% confidence level

IV. FISH PRODUCTION IN THE PROPOSED WETLANDS THAT IS NOT EARMARKED FOR ENTRAINMENT MITIGATION IS AVAILABLE FOR IMPINGEMENT MITIGATION

A. 49 Acres of Fish Biomass Other than Gobies, Blennies, and Garibaldi Is Available for Impingement Mitigation; Similarly, 6.4 Acres of Fish Biomass Other than the Five Open-Ocean Species Is Available for Impingement Mitigation

It would be incorrect to assume that the planned wetlands will produce only larvae and other life stages for the species subject to the ETM/APF calculations. General ecological principles and scientific understanding indicate that the benefits of the wetlands will be broader than that.[30] In addition to producing the larvae of entrained species, the mitigation wetlands will be capable of sustaining many other forms of life as well. These other life forms will include diverse assemblages of plants, birds, invertebrates, mammals, as well as fish.[31]

The issue explored by the undersigned Mr. Nordby is whether these benefits can be expected to compensate for potential impingement. Relying on previous studies of fish productivity in coastal southern California wetlands, Mr. Nordby concluded that such benefit is very likely to be present. The key to this evaluation is to determine whether and to what extent:

- Fish other than gobies, blennies and garibaldi and other entrained lagoon species will be produced and supported in 49 acres of the wetlands.
- Fish other than the most commonly entrained open-ocean species (i.e., white croaker, northern anchovy, California halibut, queenfish and spotfin croaker) will be produced and supported in 6.4 acres of the wetlands.

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[29] Based on the assumption that "successfully restored wetland habitat would be ten times more productive than a similar area of nearshore ocean waters," the Coastal Commission adjusted the out-of-kind mitigation acreage requirement by a factor of 10. *See* Recommended Revised Condition Compliance Findings (approved December 10, 2008), p. 14 of 19.

[30] *See, e.g.,* Section II, *supra*.

[31] The MLMP's biological performance standards anticipate some of these benefits and—via rigorous monitoring and enforcement provisions—ensure that the mitigation site will consist of specific biological attributes (e.g., species densities, vegetation cover, etc.).

B. Prior Studies Suggest that the Proposed Wetlands Will Produce at Least 150 kg WW/year of Fish Biomass

Fish production estimates from Allen (1980) provide a reasonable basis upon which to estimate the productivity of the intertidal mudflats and subtidal habitats that will be included in the planned mitigation wetlands. Allen surveyed the littoral zone of the Upper Newport Bay, reporting fish productivity values for a variety of species. These values are considered reasonable proxies for those portions of the planned wetlands that will consist of intertidal mudflats and subtidal habitats. It is expected that at least 40 percent, or 22 acres, of the planned wetlands will be of this kind. While the balance of the planned wetlands also will be productive, we do not have a quantitative assessment of this productivity, rendering our analysis conservative in this respect. Allen estimated fish production of about 150 kg WW/acre/year for the kinds of intertidal mudflats and subtidal habitats to be included in the planned wetlands.[32]

C. Allen's Productivity Estimate Is Conservative

According to Allen, his study calculated a productivity value that was "undoubtedly an underestimate"[33] for at least two principal reasons. First, "the largest species of the system, adult *Mugil cephalus* [i.e., striped mullet] [] was not represented in the production estimates due to inadequate sampling."[34] Second, density estimates for some species of littoral fishes are particularly difficult to obtain. Allen noted that these "difficult to obtain…species include small, burrow-inhabiting fishes of the family *Goibiidae* [i.e., gobies] and other small benthic fishes…which escape under a seine or through the mesh of various nets."[35] While the six bag seines that Allen employed "were very effective (99%) at capturing *A. affinis*,"[36] these bag seines had a "low efficiency" for capturing the gobiid (*Clevelandia ios*).

In addition, Allen used small square enclosures with an anesthetic with the intent of sampling small burrow inhabiting fishes, especially gobies. Despite this additional sampling, this led to a "large under-estimate" of gobiid density.[37] This is further underscored by the Supplemental Fish Studies in Aqua Hedionda Lagoon, 2005[38] where both density and total biomass of gobies were substantially greater than the results from Allen. Using block nets and

[32] *I.e.*, 9.35 g DW/m^2/yr = 37.4 g WW/m^2/yr = 151.4 kg WW/acre/yr.

[33] Larry G. Allen, *supra*, at 786.

[34] *Id*.

[35] *Id.* at 785.

[36] *Id*.

[37] *Id*.

[38] Cabrillo Power I LLC, Encina Power Station: Clean Water Act Section 316(b) Impingement Mortality and Entrainment Characterization Study: Effects on the Biological Resources of Agua Hedionda Lagoon and the Nearshore Ocean Environment, Appendix C, January 2008, Tenera Environmental Lafayette, CA at C-1

repeated beach seine hauls, Nordby and Zedler also reported large numbers of goby collected describing arrow goby as numerically dominant.[39]

The fact that Allen under-sampled gobies and other difficult-to-catch species is important because it informs the conclusions that he reached. Specifically, Allen's productivity value does not reflect the productivity of all fishes in Upper Newport Bay. For instance, although gobies exist in the surveyed area,[40] they were not captured in the bag seines. Instead, his value represents an estimate of the productivity of only those fish that Allen caught. In this respect, Allen's productivity estimate is an underestimate and conservative.

D. Species Other Than Gobies, Blennies and Garibaldi Account for More than 99 Percent of Allen's Overall Productivity Estimate

In Table 2 of his report (reproduced below), Allen lists the number and weight of each species that he caught during his one-year sampling period (January 1978 to January 1979). His productivity number is based exclusively on the 32 species listed in the table:

Species	Common Name	No.	Weight (g)	% No.	% Weight
Atherinops affinis	Topsmelt	42591	82665	76.66%	79.86%
Fundulus parvipinnis	California killifish	6722	7920.5	12.10%	7.65%
Gambusia affinis	Mosquitofish	3077	1066.1	5.54%	1.03%
Clevelandia ios	Arrow goby	1334	312.7	2.40%	0.30%
Anchoa compressa	Deep body anchovy	684	7474.1	1.23%	7.22%
Cymatogaster aggregata	Shiner perch	223	690.6	0.40%	0.67%
Gillichthys mirabilis	Longjaw mudsucker	203	426.3	0.37%	0.41%
Anchoa delicatissima	Slough anchovy	195	471	0.35%	0.46%
Mugil cephalus	Striped mullet	132	1206.9	0.24%	1.17%
Engraulis mordax	Northern anchovy	113	155.2	0.20%	0.15%
Leuresthes tenuis	California grunion	88	60.1	0.16%	0.06%
Quietula y-cauda	Shadow goby	53	25.1	0.10%	0.02%

[39] Christopher S. Nordby and Joy B. Zedler, *Responses of Fish and Macrobenthic Assemblages to Hydrologic Disturbances in Tijuana Estuary and Los Penasquitos Lagoon, California*, 14 Estuaries 80, 85 (1991).

[40] Although difficult to catch, it is likely that gobies exist in Upper Newport Bay. First, Allen caught gobies during the sampling period (i.e., Shadow goby, Cheekspot goby, and Yellowfin goby). Second, Upper Newport Bay is similar to Agua Hedionda Lagoon. Because AHL supports a large goby population, it is likely that Upper Newport Bay does as well. Nordby and Zedler's work supports this point.

Species	Common Name	No.	Weight (g)	% No.	% Weight
Ilypnus gilberti	Cheekspot goby	38	8.1	0.07%	0.01%
Lepomis cyanellus	Green sunfish	32	54.5	0.06%	0.05%
Syngnathus auliscus	Barred pipefish	20	16.1	0.04%	0.02%
Hypsopsetta guttulata	Diamond turbot	19	36.1	0.03%	0.03%
Lepomis macrochirus	Bluegill	8	34.4	0.01%	0.03%
Syngnathus leptorhynchus	Bay pipefish	8	13	0.01%	0.01%
Leptocottus armatus	Pacific staghorn sculpin	4	7.3	0.01%	0.01%
Acanthogobius flavimanus	Yellowfin goby	3	4.5	0.01%	0.00%
Paralichthys californicus	California halibut	2	5.4	0.00%	0.01%
Pimephales promelas	Flathead minnow	2	0.2	0.00%	0.00%
Cynoscion nobilis	White seabass	1	6.6	0.00%	0.01%
Girella nigricans	Opaleye	1	0.4	0.00%	0.00%
Morone saxatilis	Striped bass	1	317.1	0.00%	0.31%
Mustelus californicus	Grey smoothhound shark	1	58	0.00%	0.06%
Porichthys myriaster	Specklefin midshipman	1	0.1	0.00%	0.00%
Seriphus politus	Queen croaker	1	0.3	0.00%	0.00%
Sphyraena argentea	Pacific barracuda	1	4.2	0.00%	0.00%
Symphurus atricauda	California tonguefish	1	0.2	0.00%	0.00%
Umbrina roncador	Yellowfin croaker	1	44.2	0.00%	0.04%
Urolophus halleri	Round stringray	1	430	0.00%	0.42%
Totals		55,561	103,514.3		

The last column in the table above, entitled "% Weight" is calculated for each species by dividing the total dry weight value recorded for that species during the entire year-long sampling period by the total dry weight recorded for all species (last row, column 3). This value represents the percentage of the biomass productivity value (i.e, 150 kg/acre/year) that is attributable to the listed species. For instance, Allen notes that the topsmelt greatly predominated in biomass (79.9%) and accounts for approximately 80% of the total production.

1. <u>The most commonly entrained lagoon species combine to account for only 0.33 percent of the total biomass productivity</u>.

While the goby constitutes fully 61% of the larvae entrained at EPS, it contributes only 0.33% to the total biomass production observed by Allen.[41] Neither the blenny nor the garibaldi were reported in Allen's study.

2. <u>The most commonly entrained open ocean species combine to account for only 7.83 percent of the total biomass productivity</u>.

Three different anchovy taxa collectively contribute 7.83% to the total biomass production reported by Allen, while the California halibut contributes a mere 0.01%. The white croaker, queenfish, and spotfin croaker were not reported in Allen's study.

Allen's overall productivity estimate is comprised principally of species, the biomass of which can be used to offset potential CDP impingement. It is reasonable to assume that the proposed wetlands will include intertidal mudflats and subtidal habitats capable of productivity values and species diversity comparable to Upper Newport Bay. Thus, these intertidal mudflats and subtidal habitats likely will produce similar quantities of fish biomass (i.e., 150 kg/acre/year). The biomass from these species is largely available to offset potential CDP impingement.

E. The Restoration Wetlands Will Produce Enough Fish Biomass from Fish Not Already Counted Toward Entrainment Mitigation to Offset Potential CDP Impingement

On March 18, 2009, the undersigned Mr. Chris Nordby submitted a statement to the Regional Board in which he concluded that, "Poseidon's mitigation project will offset fully the CDP's estimated stand-alone impingement."[42] To reach this conclusion, Mr. Nordby compared various estimates of potential CDP impingement with Allen's conservative productivity value (150 kg DW/year).

Assuming impingement of 4.7 kg/day of fish biomass—a conservative, and perhaps unrealistically high, estimate as described in Chapter 5 of the Minimization Plan and Attachments 5 and 9 thereto—11.5 acres of intertidal mudflats and subtidal habitats capable of productivity and species diversity comparable to Upper Newport Bay will provide full impingement mitigation.[43] The MLMP provides, as a minimum standard, that the wetland restoration site(s) must restore "extensive intertidal and subtidal areas."[44] Poseidon intends to create or restore at least 11.5 acres of such habitat, among the 55.4 acres proposed in the Minimization Plan and MLMP. Assuming, conservatively, that the CDP will result in the impingement of 1715.5 kg/year of fish biomass (i.e., 4.7 kg/day), full mitigation will be assured

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[42] *See* Minimization Plan Attachment 7, "Mitigation Computation Based on Impingement Assessment," (March, 18, 2009), at p. 1.

[43] Mr. Nordby assumed that 100% of Allen's productivity estimate could be applied to offset the CDP's impingement. Since gobies account for 0.33% of Allen's productivity estimate and Poseidon cannot claim impingement mitigation credit for this productivity in the 49 acres. Since anchovies and halibut account for 7.83% of the productivity value, Poseidon cannot claim impingement credit for this productivity in the 6.4 acres. As a result, Nordby's estimates were adjusted slightly to reflect the fact that only 99.67% of the productivity estimate can be used to offset the CDP's impingement in the 49 acres while 92.18% of the estimate can be used to offset the CDP's impingement in the 6.4 acres. These minor differences produce essentially the same acreage estimate that Mr. Nordby identified in Attachment 7. At 4.7 kg/day, the mitigation obligation increases from 11.3 to 11.5 acres.

[44] *See* MLMP § 3.1(b).

if the proposed wetlands produce 1715.5 kg/year of fish biomass from species not already counted toward entrainment mitigation. Poseidon will have mitigated for impingement, and likely will have substantially over-mitigated, as long as 21 percent of the 55.4 acres consists of intertidal mudflats and subtidal habitats (i.e., 11.5 acres of 55.4 acres).

F. Gobies, Blennies and Garibaldi Are Rarely Impinged

It is important to note that the most commonly entrained lagoon species are almost never impinged. This is true notwithstanding their apparent abundance in AHL, as reflected by their relative abundance in the entrainment samples.

During the 2004/2005 field program, Tenera collected only 14 blennies, and only 3 gobies from the intake screens (together only 0.07% of the total number impinged). These values are consistent with Allen's observations in Upper Newport Bay, suggesting that while the species exist in both locales, they are not easily caught or impinged.

V. ATTESTATION

I declare that to the best of my knowledge that the foregoing information is true and correct, and, if called upon to testify thereto, I would testify competently.

Dr. David L. Mayer, Ph.D.

President/Principal Scientist

Tenera Environmental

Mr. Chris Nordby

President/Principal Biologist

Nordby Biological Consulting