APPENDIX B

2018 Monitoring Plan for the SONGS' Reef Mitigation Project

MONITORING PLAN FOR THE SONGS' REEF MITIGATION PROJECT

Prepared for the staff of the California Coastal Commission by:

Daniel Reed

Stephen Schroeter

Mark Page

and

Mark Steele

In consultation with

Richard Ambrose, Peter Raimondi, and Russell Schmitt

Updated April 2017

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EXECUTIVE SUMMARY

The California Coastal Commission (CCC) requires Southern California Edison (SCE) and its partners to select a site and construct an artificial reef as partial mitigation for the resource losses at the San Onofre Kelp Bed (SOK) caused by the operation of San Onofre Nuclear Generating Station (SONGS) Units 2 and 3. The reef is to be located in the vicinity of SONGS with the goal of replacing a minimum of 150 acres (= 60.7 hectares) of kelp forest community. Mitigation for losses of kelp bed resources through the construction of an artificial reef will be done in two phases; a five year experimental phase followed by a mitigation phase having a duration equivalent to the operating life of SONGS Units 2 and 3. The primary objective of the experimental phase is to determine the substrate types and configurations that best provide adequate conditions for establishing and sustaining giant kelp and other reef-associated biota during the mitigation phase. Data collection on the experimental phase was completed in December 2004 and the CCC concurred with the Executive Director's determination for the type and percent cover of hard substrate on October 12, 2005. Construction of the mitigation phase of the SONGS artificial reef requirement began on June 9, 2008 and was completed 94 days later on September 11, 2008,

Monitoring by independent contract scientists working for the CCC will be done during the mitigation phase to: (1) determine whether the performance standards established for the mitigation reef are met, (2) determine, if necessary, the reasons why any performance standard has not been met, and (3) develop recommendations for appropriate remedial measures. The SONGS coastal development permit requires the CCC's contract scientists to develop a monitoring plan for the mitigation reef that describes the sampling methodology, analytical techniques and methods for measuring performance of the mitigation reef relative to the performance standards identified in the SONGS coastal development permit. This document serves as that monitoring plan. It contains: (1) a description of the process used to evaluate condition compliance, including a list of the performance standards by which the mitigation reef will be judged and the general approach that will be used to judge the overall success of the mitigation project, (2) descriptions of the specific sampling methods and analyses that will be used to evaluate each of the performance standards, (3) an explanation of how project data will be managed and archived for future use, and (4) a description of how the results from the monitoring program will be disseminated to the CCC, the applicant, and all other interested parties.

This monitoring plan is based in part on SCE's Final Construction Report for the Wheeler North Reef at San Clemente, California (Coastal Environments 2008), which was approved by the Executive Director of CCC on January 27, 2009. This is a living document that will be modified as needed to ensure and maintain rigorous monitoring and evaluation of Condition C in the most cost-effective manner possible. A chronology of changes to the monitoring plan are provided in Appendix 4 of this document.

1.0 INTRODUCTION

Through its 1991 and 1997 coastal permit actions, the California Coastal Commission (CCC) amended Southern California Edison Company's (SCE) coastal development permit for the San Onofre Nuclear Generating Station (SONGS) Units 2 and 3 (permit no. 6-81-330, formerly 183-73, hereafter SONGS permit) to include permit condition C, which requires SCE and its partners to select a site and construct an artificial reef as partial mitigation for the resource losses at the San Onofre kelp bed caused by SONGS's operations[1]. The reef is to be located in the vicinity of SONGS with the goal of replacing a minimum of 150 acres (= 60.7 hectares) of kelp forest community. Condition D of the SONGS permit adopted by the CCC establishes the administrative structure to fund the independent monitoring and technical oversight of the artificial reef mitigation project. Specifically, Condition D: (1) enables the CCC to retain contract scientists and technical staff to assist them in carrying out its oversight and monitoring functions, (2) provides for a scientific advisory panel to advise the CCC on the design, implementation, monitoring, and remediation of the SONGS mitigation projects, (3) assigns financial responsibility for the CCC's oversight and monitoring functions to the permittee and sets forth associated administrative guidelines, and (4) provides for periodic public review of the performance of the SONGS mitigation projects.

Mitigation for SONGS induced losses of kelp bed resources through the construction of an artificial reef is being done in two phases, a five year experimental phase (completed in December 2004) followed by a longer mitigation phase (beginning in September 2008) that has a minimum duration equivalent to the operating life of SONGS Units 2 and 3 including the decommissioning period to the extent there are continuing discharges. Condition

[1] The amount of kelp forest habitat lost due to SONGS operations was estimated at 179 acres. To fully mitigate this loss the CCC required SCE and its partners to build an artificial reef that replaced 150 acres of kelp forest habitat and to establish an interest-bearing account in the amount of $3.6 million for a mariculture/fish hatchery program operated by the State of California through the Ocean Resource Enhancement and Hatchery Program (OREHP). The purpose of this fund was to compensate for losses to the kelp bed community at SONGS that are not mitigated by the 150 acre artificial reef.

C requires construction of an artificial reef that consists of an experimental reef and a larger mitigation reef. The experimental reef must be a minimum of 16.8 acres (= 6.8 hectares) and the mitigation reef (when combined with the experimental reef) must be of sufficient size to sustain 150 acres (= 60.7 hectares) of medium to high density kelp forest community. The purpose of the experimental reef was to determine which combinations of substrate type and substrate coverage will most likely achieve the performance standards specified in the permit. The design of the mitigation reef was based on the results of the experimental reef (Reed et al. 2005).

The CCC approved the coastal development permit for the experimental reef on July 15, 1999 (CDP #E-97-10). The final plan approved by the CCC was for an experimental artificial reef located off San Clemente, California that tested eight different reef designs that varied in substrate composition (quarry rock or recycled concrete), substrate coverage (targeted 17%, 34%, and 67%), and presence of transplanted kelp. All eight reef designs were represented as individual 40m x 40m modules that were replicated in seven areas (i.e., blocks) for a total of 56 artificial reef modules totaling 22.4 acres (= 9.1 hectares). The Army Corps of Engineers issued its permit on August 13, 1999, and SCE completed construction of the experimental reef on September 30, 1999.

Five years of post-construction monitoring were completed in December 2004. Results from the five-year experimental phase of the artificial reef mitigation project were quite promising in that all six artificial reef designs and all seven locations (i.e., blocks) tested showed similar tendencies to meet several of the performance standards established for the mitigation reef (Reed et al. 2005). It was concluded from these findings that a low relief concrete rubble or quarry rock reef constructed off the coast of San Clemente, California had a good chance of providing adequate in-kind compensation for the loss of kelp forest biota caused by the operation of SONGS Units 2 and 3. These findings formed the basis of the CCC Executive Director’s determination that: (1) the mitigation reef shall be built of quarry rock or rubble concrete having dimensions and specific gravities that are within the range of the rock and concrete boulders used to construct the SONGS experimental artificial reef, and (2) the percent of the bottom covered by quarry rock or rubble concrete on the mitigation reef shall average at least 42%, but no more than 86%. The CCC concurred with the Executive Director’s determination for the type and percent cover of hard substrate on October 12, 2005.

On April 17, 2006 the California State Lands Commission acting on a request from SCE adopted a resolution declaring that the SONGS Mitigation Reef be named in honor of Dr. Wheeler North. SCE submitted a preliminary design plan for the Wheeler North Reef to the Executive Director of the CCC on May 12, 2006. The proposed design created a 128 acre, low-profile, single-layer reef (< 1 m in

height) of Catalina quarry rock distributed on the sea floor in quantities similar to those of the lowest substrate coverage used in the experimental phase of Condition C. The design consisted of 11 polygons that varied in area from 2.4 to 37.5 acres, which when combined with the 56 experiment modules totaled 150 acres of artificial reef. Four contingency polygons (totaling 22.4 acres) were designed to serve as potential alternative reef construction areas. The construction period was estimated at 100 working days.

On August 8, 2006, the Commission concurred with the Executive Director's determination that the Preliminary Design Plan for the Wheeler North Reef met the requirements of the SONGS permit. SCE submitted a final mitigation plan to the CCC in the form of a coastal development permit application in October 2007. The final plan and coastal development permit application for the construction of the Wheeler North Reef was approved by the CCC on February 6, 2008.

Construction of the Wheeler North Reef was completed in 94 days on September 11, 2008. Approximately 126,000 tons of boulder-sized quarry material were deposited in 18 polygons that collectively covered 152 acres (= 61.5 hectares) of sea floor as determined using multi-beam sonar. The sonar records were imported into Golden Software's Surfer v9.2 and areas were estimated with a horizontal grid size of 0.25 meters with an isobath interval of 0.5 meters. When added to the experimental reef a total of 177 acres (= 71.5 hectares) of mitigation reef were constructed. SCE submitted a final construction report detailing the as-built specifications of the Wheeler North Reef to the CCC on September 4, 2008 (Coastal Environments 2008). The Executive Director of the CCC found the Wheeler North Reef to be in compliance with Condition C and on January 27, 2009 issued a Notice of Acceptance of SCE's final construction report. In his notice of Acceptance the Executive Director found that the average cover of quarry rock on the Phase 2 reef was slightly below the 42% minimum requirement specified in SCE's Coastal Development Permit. To address this inadequacy the Executive Director of the CCC accepted a scenario in which 16 of the 18 polygons of the Phase 2 reef comprising 130 acres (hereafter referred to as primary polygons) were combined with the 25 acres of the Phase 1 reef (as determined in 2009, Elwany et al. 2009) to fulfill SCE's permit requirement that they construct a minimum of 150 acres of reef with an average of at least 42% cover. The 22 acres in the remaining two polygons (hereafter referred to as contingency polygons) will be included in evaluations assessing compliance of the biological performance standards that pertain to giant kelp and fish standing stock, which are described below (section 2.1).

Performance standards for reef substrate, giant kelp, fish, and benthos specified in Condition C are used to evaluate the success of the Wheeler North Reef in meeting the intended goal of replacing the kelp forest resources damaged or lost

by SONGS operations. Monitoring independent of the permittee shall be done in accordance with Condition D to: (1) determine whether the performance standards established for Condition C are met, (2) determine, if necessary, the reasons why any performance standard has not been met, and (3) develop recommendations for appropriate remedial measures.

The SONGS coastal development permit requires the CCC's contract scientists to develop a monitoring plan for the mitigation reef that describes the sampling methodology, and analytical techniques and methods for measuring the performance of the mitigation reef relative to the performance standards identified in Condition C. This document serves as that monitoring plan for the Wheeler North Reef (hereafter used to refer to the 177acre reef comprising the experimental modules of the Phase 1 Reef and the primary and contingency polygons constructed during Phase 2).

2.0 EVALUATION OF CONDITION COMPLIANCE

The specific requirements for attaining compliance with Condition C are discussed in various sections throughout the SONGS permit and are summarized in Appendix 1. Condition C identifies physical and biological standards that specify how the mitigation reef should perform and the timing and level of monitoring that is needed to evaluate its performance. The performance standards fall into two categories: (1) absolute standards, which require that the variable of interest attain or exceed a predetermined value that is linked to estimated losses in the San Onofre kelp forest caused by SONGS operations, and (2) relative standards, which require that the value of the variable of interest be similar to that measured on natural reference reefs. Among other things these performance standards require the Wheeler North Reef to support at least 150 acres of medium to high density kelp, 28 tons of fish, and assemblages of algae, invertebrates and fishes that are similar to nearby natural reference reefs.

The evaluation of each absolute performance standard in any given year is based on the greater value obtained from either: (1) data collected at the Wheeler North Reef that year, or (2) a four-year running average calculated from data collected at the Wheeler North Reef for that year and the previous three years. A running average recognizes that short-term fluctuations in kelp forest biota are the norm, and it is used to allow credit for excess reef biota in good years to compensate for occasional years when values for the biota are slightly below that of the absolute standards. All absolute standards must be met in a year in order for that year to count towards compliance with Condition C, regardless of whether a single-year or a running average is used to evaluate the standards.

The evaluation of each relative performance standard is based solely on a four-year running average calculated from data collected at the Wheeler North Reef for that year and the previous three years. An either /or criterion (i.e., using data from either a single year or a running average) is not appropriate in this case because the desired goal for the relative standards is not to achieve a specified value that is linked to estimated losses at the San Onofre kelp forest, but rather to evaluate whether the abundances and numbers of species of kelp forest biota at the Wheeler North Reef are similar to that of the reference reefs. This is best accomplished using a short-term (4-year) running average that accounts for natural variation in time. Natural kelp forests vary greatly in their species composition and abundance and it is likely, that the reference reefs will not consistently meet all the relative standards in a given year. Therefore to avoid requiring the Wheeler North Reef to perform better than the reference reefs the Wheeler North Reef is required to meet at least as many of the relative standards as the lowest performing reference site (which by definition is an acceptable measure of comparison; see section 2.2 below) in a given year for that year to count towards compliance with Condition C.

In this section of the monitoring plan we provide: (1) a list of the performance standards for the mitigation reef as stated in the SONGS permit, (2) an explanation of the process used to select the reference reefs that will be used as a measure of comparison in assessing the relative performance standards, (3) a description of the method of similarity that will be used to assess whether the performance standards have been met, and (4) a schedule for the monitoring period.

2.1 Performance standards

The following performance standards listed in the SONGS permit (no.6-81-330) will be used to measure the success of the mitigation reef and to determine whether remediation is necessary. Performance standards for (a) Substrate, (b) Kelp bed, c) Fish standing stock, and (d) Benthos pertaining to undesirable and invasive species are absolute standards; the remaining performance standards pertaining to (c) Fish and (d) Benthos are relative standards.

a. Substrate

1. The mitigation reef shall be constructed of rock, concrete, or a combination of these materials.

2. The total area of the mitigation reef (including the experimental reef modules) shall be no less than 150 acres.

3. At least 42% but no more than 86% of the mitigation reef area shall be covered by exposed hard substrate

4. At least 90 percent of the exposed hard substrate must remain available for attachment by reef biota. The permittee shall be required to add sufficient hard substrate to the mitigation reef to replace lost or unsuitable hard substrate, if at any time the Executive Director determines that more than 10 percent of the hard substrate within the reef has become covered by sediment, or has become unsuitable for growth of attached biota due to scouring, and there is no sign of recovery within three years. The Commission scientists in accordance with Condition D shall initiate surveys to monitor the amount and distribution of exposed hard substrate. These surveys shall begin immediately after construction is complete and continue for at least ten years.

b. Kelp bed

The artificial reef(s) shall sustain 150 acres of medium-to-high density giant kelp.

For purposes of this condition, medium-to-high density giant kelp is defined as more than four adult *Macrocystis pyrifera* plants per 100 m^2 of sea floor, as determined by down-looking sonar surveys or equivalent monitoring techniques in accordance with Condition D. If the average area of medium to high density giant kelp falls below 150 acres, then the reason for this failure shall be determined by independent monitoring overseen by CCC scientists. The permittee shall implement any remedial measures deemed necessary by the Executive Director.

The permittee's remediation requirement shall include the funding of independent studies that are necessary to determine the reasons for lack of kelp coverage as well as feasible corrective action, as determined by the Executive Director. If the failure is due to insufficient hard substrate, the corrective action shall entail the permittee adding hard substrate to the reef.

If sufficient hard substrate appears to be available but kelp recruitment is low, then corrective action could include the permittee funding independent studies of kelp recruitment that are designed to determine the best method of establishing kelp on the reef. The Executive Director shall determine whether such studies are necessary.

The method determined by the Executive Director most likely to be a successful and reliable corrective action for low kelp abundance shall be implemented by the permittee until kelp coverage meets this performance standard; however, kelp establishment or augmentation methods shall not be required for more than a total of five years. If oceanographic conditions

are unfavorable to kelp during part of this period, the Executive Director may defer the effort to establish kelp.

c. Fish

The standing stock of fish at the mitigation reef shall be at least 28 tons and the following performance standards shall hold

1. The resident fish assemblage shall have a total density and number of species similar to natural reefs within the region.
2. Fish reproductive rates shall be similar to natural reefs within the region.
3. The total density and number of species of young-of-year fish (fish less than 1 year old) shall be similar to natural reefs within the region.
4. Fish production shall be similar to natural reefs within the region.

d. Benthos

1. The benthic community (both algae and macroinvertebrates) shall have coverage or density and number of species similar to natural reefs within the region.
2. The benthic community shall provide food-chain support for fish similar to natural reefs within the region.
3. The important functions of the reef shall not be impaired by undesirable or invasive benthic species (e.g., sea urchins or *Cryptoarachnidium*).

2.2 Reference Reefs

Requiring that the value of a resource be similar to that on natural reefs is based on the rationale that to be successful, the mitigation reef must provide the same types and amounts of resources that occur on natural reefs. Resources on natural reefs, however, vary tremendously in space and time. Differences in physical characteristics of a reef (e.g., depth and topography) can cause plant and animal assemblages to differ greatly among reefs while seasonal and inter-annual differences in oceanographic conditions can cause the biological assemblages within reefs to fluctuate greatly over time. Ideally, the biological assemblages on a successful artificial reef should fluctuate in a manner similar to those on the natural reefs used for reference. One way to help ensure this is to select reference reefs that are close to and physically similar to the design of the Wheeler North Reef. The premise here is that nearby reefs with similar physical characteristics should support similar biota, which should fluctuate similarly over time. Thus, in addition to proximity other criteria used to select the reference reefs included that they: (1) not be influenced by the operation of SONGS, (2) be

located at a depth similar to the Wheeler North Reef, (3) be primarily low relief, preferably consisting of cobble or boulders, and (4) have a history of sustaining giant kelp at medium to high densities. The criterion that the reference reefs have a history of supporting persistent stands of giant kelp is important because communities on reefs without giant kelp can differ dramatically from those with kelp. Based on these criteria, San Mateo kelp bed (located adjacent to the southern end of the proposed Wheeler North Reef) and Barn kelp bed (located approximately 12 km south of San Mateo kelp bed) were chosen as reference reefs for evaluating the performance of the Wheeler North Reef.

Temporal variability, especially of the sort associated with changes in oceanographic conditions, can be accounted for more easily by sampling the Wheeler North Reef, San Mateo and Barn concurrently. Concurrent monitoring of the mitigation and reference reefs increases the likelihood that regional changes in oceanographic conditions affecting the Wheeler North Reef are reflected in the performance criteria, since nearby San Mateo and Barn will be subjected to similar regional changes in oceanographic conditions.

2.3 Determination of similarity

A requirement of the SONGS permit is that many of the response variables used to assess the relative performance standards of the Wheeler North Reef (hereafter referred to as “relative performance variables”) be “similar” to those at nearby natural reference reefs. Evaluating whether the performance of Wheeler North Reef is similar to that at the San Mateo and Barn reference reefs requires that the mean (or in some cases the median) value for a given relative performance variable at Wheeler North Reef not be significantly lower than the mean (or median) value at the lower performing of the two reference reefs. We use a one sample, one tailed approach for all comparisons. Significance is determined using an approach that utilizes both a formal probability value (i.e. p-value) and an effect size. This is generally done by means of a t-test except in the case of the performance standards pertaining to fish reproductive rates and food chain support for fish. For these two standards significance is determined by a resampling procedure in which the effect size is calculated as the proportional difference in the medians of the resampled distributions of the Wheeler North Reef and the lower performing reference reef, and the p-value is the percentile in the distribution of the lower performing reference reef that is equal to the median value of the Wheeler North Reef.

The performance at Wheeler North Reef with respect to a given relative performance standard is considered to be worse than the lower of the two reference reefs if the p-value for the comparison is ≤ to the proportional effect size (i.e., the proportional difference between the Wheeler North Reef and the lower performing reference reef). The only exception to this rule is when both the p-value and the proportional effect size are greater than 0.5, in which case

assessment for the period is considered inconclusive and additional studies will be done (see ***3.2 Methods for assessing the performance standards*** for details). As an example, if the proportional effect size for a given variable was 0.25 (i.e., the mean value at Wheeler North Reef was 75% of the mean value at the lower of the two reference reefs), then a t-test yielding a p-value ≤ 0.25 would indicate the Wheeler North Reef did not meet the performance standard, whereas p-values > 0.25 would indicate that it did meet the performance standard. The rationale for using the lower of the two reference reefs is that both reference reefs are considered to be acceptable measures of comparison for Wheeler North Reef. Hence, if Wheeler North Reef is performing at least as well as one of the reference reefs, it would be judged successful. The scaling of the p-value (α) to the effect size recognizes sampling error when estimating mean values and balances the probability of a Type I error (falsely concluding that Wheeler North Reef is not similar to the reference reefs when it is t) with the probability of a Type II error (falsely concluding that the Wheeler North Reef is similar to the reference reefs when it is not).

To insure that the Wheeler North Reef is not held to a higher standard than the reference reefs the above procedure is also applied to San Mateo and Barn to evaluate whether they would have met the relative performance standards. This is done by treating San Mateo (or Barn) as the mitigation reef and using the Wheeler North Reef and Barn (or San Mateo) as the two reference reefs. The Wheeler North Reef is considered similar to the reference reefs if the number of relative standards met by the Wheeler North Reef is equal to or greater than the number of relative standards met by either San Mateo or Barn.

The above approach ensures that the assessment of similarity is consistent with the SONGS permit requirement that the performance standards be met without the unreasonable requirement that Wheeler North Reef outperform San Mateo and Barn for every performance standard. Importantly, this approach deals realistically with the inherent variability of nature in a manner that best serves the interests of the public and SCE.

2.4 Monitoring period

Conditions C and D of the SONGS permit describe the monitoring requirements for the Wheeler North Reef which we summarize below. Additional documentation for this summary is provided in Appendix 1.

Fully implemented monitoring of the performance of the Wheeler North Reef (Stage 1 monitoring in Appendix 1) ensued after completion of its construction and will continue until success is achieved. Success of the Wheeler North Reef requires that :(1) all performance standards be met within 10 years after construction is completed, and (2) that all the performance standards have been met each year for three consecutive years. Hence, fully implemented monitoring

will last a minimum of 10 years. All years that the Wheeler North Reef is in compliance will count towards the compliance period. The level of sampling effort may be reduced if analyses of the data indicate that compliance of the performance standards can be adequately assessed using less sampling effort. Remediation may be required if the performance standards are not met within ten years and if three consecutive years of compliance has not occurred within 12 years. The Executive Director could prolong this stage of monitoring or reinstate it if necessary following any degradation of the Wheeler North Reef (resulting in a period of non-compliance) or remediation. Monitoring can be reduced to annual site inspections (Stage 2 monitoring in Appendix 1), which will serve to identify noncompliance with the performance standards, when the Wheeler North Reef has been in compliance with permit standards for at least three consecutive years, and evaluated for at least ten years post-construction.

If the Wheeler North Reef is considered unsuccessful within 12 years post-construction, then (at the discretion of the Executive Director) SCE shall fund an independent study to collect information needed to determine what remediation is required. SCE shall be required to implement any remedial measures determined necessary by the Executive Director in consultation with state and federal resource agencies and shall provide funds for independent monitoring that evaluates the success of the required remediation. Remediation monitoring may be different from the compliance monitoring required by the SONGS permit.

If the Wheeler North Reef is in a period of reduced monitoring and falls out of compliance for a period of two consecutive years, then full monitoring may be re-established for those standards that are out of compliance to determine whether non-compliance is an artifact resulting from a reduction in monitoring effort. If resumption of full monitoring leads to the conclusion that the reduction in monitoring was responsible for non-compliance, then monitoring will remain at the full levels for the duration of the project or until the Executive Director concludes that reduced monitoring could be reinstituted. CCC staff scientists will be responsible for designing and implementing the reduced monitoring program. If resumption of full monitoring leads to the conclusion that non-compliance is due to poor performance of the Wheeler North Reef, then SCE shall be responsible for implementing any remedial measures deemed necessary by the Executive Director including remediation monitoring

3.0 SAMPLING METHODS AND DATA COLLECTION

3.1 General Sampling Design

The goal of the general sampling design is to provide a cost efficient framework for collecting data that is suitable for accurately determining whether the Wheeler North Reef has met the SONGS' performance standards. To achieve this goal,

the sampling design incorporates the following features: (1) spatially distributed sampling to increase accuracy in the characterization of each reef, (2) a method for adaptively altering sampling effort based on the analysis of data collected during previous years, and (3) a strategy for dealing with the potential loss of sampling units at the reference reefs caused by unforeseen events.

3.1.1 Spatial distribution of sampling effort

Initially eighty two sampling locations, each defined by a fixed 50m x 20m area, were established at the Wheeler North Reef in the primary polygons, and at San Mateo and Barn in areas that are known to support persistent kelp; Figures 1a-c). An additional 10 sampling locations were established in the two contingency polygons on Wheeler North Reef. Sampling of the three reefs is done concurrently. Each sampling area is identified by unique differential GPS coordinates that mark the “zero end” of a 50m transect and a compass heading along which divers lay out a 50m measuring tape. A 20m wide swath centered along the 50m transect defines the sample area at each sampling location. Different sized sampling units (e.g., 0.5m^2, 1m^2, 20m^2, and 100m^2) within this sampling area are used to evaluate different performance variables (Figure 2;). This combined level of effort (246 transects spread across three reefs + 10 transects in the 2 contingency polygons on Wheeler North Reef) is similar to that used during the first year of the experimental phase of the SONGS artificial reef project (n = 242 transects). As was done in the experimental phase of the SONGS reef mitigation project, monitoring data are analyzed annually to determine whether sampling effort can be reduced or must be increased in order to accurately evaluate the performance standards.

The transects on each reef are arranged in pairs with the two transects in each pair spaced 25m apart (Figures 1a -c). The lone exception to this are the single transects located on 12 of the Phase 1 modules of Wheeler North Reef. The 10 transects in the two contingency polygons on Wheeler North Reef are similarly arranged in 5 pairs. Pairing of transects is done to increase sampling efficiency. Maps of kelp persistence and hard substrate were used to strategically distribute the 41 transect pairs at San Mateo and Barn across areas of reef known to support giant kelp. Transects at Wheeler North Reef were allocated to the polygons and the existing experimental reef modules in proportion to their area (Table 1).

3.1.2 Strategy for dealing with unusual events.

An issue that may occur during the course of monitoring the SONGS reef mitigation project is the loss of reef habitat and/or biota at sampling locations on the reference reefs due to unusual or unforeseen events. Such events would render the reference sites to be an inappropriate comparison for judging the performance of the Wheeler North Reef. An example of such an unusual event was the catastrophic loss of kelp forest biota at Barn during the impact

assessment phase of the SONGS mitigation project (Bence et al. 1989). The loss of hard substrate due to a rapid influx of sediment caused by the construction of the Interstate-5 freeway was implicated as the cause for the loss of kelp forest resources at Barn during the 1980s (Bence et al. 1989; Kuhn and Shepard, 1984). Because the loss of reef habitat at Barn was substantial, it was deemed to be an inappropriate reference site for measuring SONGS's impacts. Consequently, data from Barn were excluded from the analyses of SONGS impacts.

If such unusual events occur at San Mateo and Barn during the monitoring period of the Wheeler North Reef, then the following strategy will be employed:

1. If >50% of the reef habitat at any of the sampling locations on the reference reefs (i.e. the 50m x 20m area defined by a transect) is lost or damaged due to human activities, then that sampling location will be replaced with one that is suitable for use as a reference using the same criteria for transect placement as described above (*3.1.1 Spatial distribution of sampling effort)*.
2. If the amount of suitable reef habitat at San Mateo and Barn declines to less than that of the Wheeler North Reef, then it will be replaced with a different reference reef that contains as least as much area of suitable reef habitat as the Wheeler North Reef.

3.2 Methods for assessing the performance standards

The level of certainty in determining whether the Wheeler North Reef meets the performance standards is directly related to sampling effort. Data collected during the experimental Phase 1 of the reef mitigation were used to determine the level of sampling that would likely be needed to detect a 20% deviation from the relative performance standards (i.e., the effect size which is calculated as the proportional difference between the mean values for the Wheeler North Reef and that of the lowest performing reference reef) with 80% power (i.e., the statistical power is calculated as 1- Type II error), using a Type I error (α) = 0.2. Once data have been collected and an effect size for a given relative performance standard is determined, a critical α needs to be assigned in order to evaluate whether the performance standard has been met for the year. The monitoring philosophy adopted for this project is to balance the risk associated with falsely concluding that the performance standard was not met (Type I error = α) with the risk associated with falsely concluding that the standard was met (Type II error =β). The approach used to assign a value to α involves linking it to the effect size. This is done because the importance of correctly determining that the Wheeler North Reef failed to meet a relative performance standard increases with the magnitude of the difference between Wheeler North Reef and the lowest performing reference reef (i.e., the effect size). If the effect size is small, then it is necessary to apply a correspondingly small value of α in order to be certain that the difference between Wheeler North Reef and the reference reefs is in fact real. Assigning a critical value of α that is too large in this case runs the risk of falsely

concluding that the Wheeler North Reef met the performance standard when it did not (Type I error). By contrast if the effect size for a relative performance standard is large, then assigning a critical value of α that is too small runs the risk of falsely concluding that the Wheeler North Reef did not meet the performance standard when it did (Type II error). Thus linking the critical value of α to the effect size reduces the probability of committing a Type I error when the effect size is small, and a Type II error when the effect size is large.

The following rules will be used when assessing whether the Wheeler North Reef meets a given relative performance standards (refer to Figure 3):

1) If $\alpha \leq$ effect size for any α ranging from 0.000 to 0.500, then the Wheeler North Reef will be considered to have not met that performance standard (i.e. it is different from the reference sites) for the period of assessment (α and effect size rounded to three significant figures).
2) If $\alpha >$ effect size for any effect size ranging from 0.000 to 0.500, then the Wheeler North Reef will be considered to have met that performance standard (i.e., it is similar to at least one of the reference sites) for the period of assessment (α and effect size rounded to three significant figures).
3) If the effect size is > 0.500 and α is >0.500 then assessment for the period will be considered inconclusive (α and effect size rounded to three significant figures) and the following steps will be taken:
    a. The sampling design may be revised to increase the statistical power to an expected value of at least 80%. Whether this effort is necessary will be based on the history of the performance of the Wheeler North Reef with respect to the performance standard. For example, if the analyses were conclusive in previous periods, then a single inconclusive analysis would not be sufficient to invoke a revision of the sampling design.
    b. If needed, the revised sampling design will be implemented the following year.
    c. If in the following year the standard is met, then the standard will be considered to have been met the previous year as well. If in the following year the standard is not met, then the standard will be considered to not have been met the previous year as well.
    d. This process will continue until the standard can be assessed, unless the Commission changes the standard set forth in SONGS permit condition C.
4) Monitoring data will be evaluated annually to determine if changes need to be made to the sampling program to bring it closer to the design objective of detecting a 20% deviation from the performance standards (i.e., the effect size) with an 80% probability (i.e., the statistical power) using a type I error (α) = 0.2.

Listed below are the approaches that are used to evaluate the performance standards used to judge whether Condition C is in compliance with the SONGS permit. The general sampling methods follow those used during the experimental phase (Reed et al. 2005), with some modifications.

1. THE MITIGATION REEF SHALL BE CONSTRUCTED OF ROCK, CONCRETE, OR A COMBINATION OF THESE MATERIALS.

Approach: SCE's final design plan for the Wheeler North Reef listed quarried rock as the exclusive building material. University of California Santa Barbara (UCSB) scientists working for the CCC conducted diver surveys and reviewed SCE's final construction report for the Wheeler North Reef (Coastal Environments 2008) and determined that the material used to construct the Wheeler North Reef conformed to that described in the final design plan. Hence SCE met this performance standard.

2. THE TOTAL AREA OF THE MITIGATION REEF (INCLUDING THE EXPERIMENTAL REEF MODULES) SHALL BE NO LESS THAN 150 ACRES.

Approach: Multi-beam sonar surveys of the Phase 2 portion of Wheeler North Reef were done in 2008 by contractors working under a cooperative agreement with SCE and the CCC immediately after construction of the Wheeler North Reef (hereafter referred to as the as-built sonar survey). Data from the as-built sonar survey were compared to results obtained from the pre-construction multi-beam survey done in 2005 to determine whether the Wheeler North Reef constitutes 150 acres of artificial reef habitat. Analyses of data obtained from these surveys were presented in the final construction report of the Wheeler North Reef (Coastal Environments 2008). UCSB scientists working for the CCC reviewed these data and analyses and determined that the Phase 2 mitigation reef consisted of 152 acre low-profile (<1 m in height) single-layer quarry rock reef arranged in 18 polygons. Because multibeam surveys of the Phase 1 portion of Wheeler North Reef were not done in 2008 bathymetry data of the Phase 1 Reef collected in 2009 were used to estimate the total as-buit area of Wheeler North Reef (i.e., Phase 1 + Phase 2) in 2008. Thus the 177 acres of mitigation reef (25 acres from the Phase 1 as determined from data collected from the 2009 multi-beam sonar survey + 152 acres from Phase 2 as determined from data collected from the 2008 as–built multi-beam survey) met this performance standard.

3. AT LEAST 42 % BUT NO MORE THAN 86% OF THE MITIGATION REEF AREA SHALL BE COVERED BY EXPOSED HARD SUBSTRATE

Approach*:* The percent cover of hard substrate on the Wheeler North Reef was measured by UCSB scientists in summer 2008. Five 1m^2 quadrats were uniformly placed along each of the 50m long fixed transects, which were distributed across the polygons and experimental reef modules in proportion to the polygon (or

experimental reef module) area (see ***3.1 General Sampling Design*** for details). Percent cover was estimated using a uniform grid of 20 points placed within the $1m^2$ quadrats using the same technique employed during the experimental phase of the artificial reef mitigation project. In brief, the observer sighted an imaginary line through each of the points that was perpendicular to the bottom and recorded the substrate type intercepted by the line extending below the point. Substrates were classified as natural or artificial and categorized as bedrock (continuous rocky reef), mudstone, large boulder (largest diameter ≥ 100 cm), medium boulder (≥ 50cm and <100cm), small boulder (≥ 26cm and <50cm), cobble (≥ 7cm and ≤ 25cm), pebble (≥ 2mm and < 7cm), sand (< 2mm), and shell hash. The categories of exposed hard substrate used to assess this standard included only quarry rock in the form of cobble, small, medium and large boulders. Hard substrates covered with a thin layer of silt or sand were noted as being silted (silted artificial substrates are considered available for the attachment of reef biota for the purpose of evaluating performance standard 4 below). UCSB scientists estimated the mean percent cover of hard substrate averaged across all Phase 2 primary polygons and Phase 1 modules was 42.3 % demonstrating that the as-built condition of the Wheeler North Reef met this standard.

4. AT LEAST 90 PERCENT OF THE EXPOSED HARD SUBSTRATE MUST REMAIN AVAILABLE FOR ATTACHMENT BY REEF BIOTA

Approach*:* The total area of the exposed hard substrate (*S*) that is available for the attachment of reef biota during any given year *t* is determined as:
$S_t = A_t P_t$,

where A_t is the total area of the footprint of the Wheeler North Reef in year ,*t* and P_t is the proportion of the Wheeler North Reef covered by hard substrate in year *t*.. A_t is determined from backscatter in the most recent multibeam sonar survey using a horizontal grid size of 0.25 meters with an isobath interval of 0.5 meters as described in Elwany et al. 2009. P_t is determined from data collected in diver surveys. The proportion of area covered by hard substrate in the as-built condition in 2008 immediately after construction ($S_0 = A_0 P_0$) that is remaining at time *t* can be expressed as S_t/S_0 The value of S_t/S_0 based on the current year or a four-year running average of the current year and the preceding three years (whichever is larger) must be ≥ 0.9 for the Wheeler North Reef to be in compliance with this standard.

The reef footprint area used to evaluate this standard includes the Phase 1 modules and the Phase 2 primary polygons, which collectively met the construction criteria of ≥ 42% cover of rock. The area of the Phase 2 primary polygons in the as-built survey done immediately after construction in 2008 was 130.31 acres (Elwany et al. 2009). Because the footprint area of the Phase 1 modules was not measured during the 2008 as-built survey, their footprint area measured in 2009 (25 acres) is used as their footprint area in 2008. Hence the

initial footprint area of the Wheeler North Reef that is used to evaluate this performance standard (A_o) is 155 acres. The mean percent cover of rock of this initial footprint area in 2008 (P_0) was 45.6%.

5. THE ARTIFICIAL REEF(S) SHALL SUSTAIN 150 ACRES OF MEDIUM-TO-HIGH DENSITY GIANT KELP.

Approach: The abundance of giant kelp *Macrocystis pyrifera* is monitored by divers once per year in the summer in five replicate 10m x 2m plots arranged at 10m intervals along each of the replicate 50m transects at Wheeler North Reef (Figure 2). For the purpose of this performance standard, medium-to-high density giant kelp is defined as more than four adult plants per $100m^2$ of ocean bottom and adult giant kelp plants are defined as having eight or more fronds. The summed total of adult plants in the five 10m x 2m plots provides an estimate of the number of adult plants per $100m^2$ at each transect. The proportion of transects with a density > 4 adult plants per $100m^2$ is used as an estimate of the proportional area of the artificial reef occupied by medium to high density giant kelp. The total area A_k at Wheeler North Reef occupied by medium to high density giant kelp in a given year is determined as:

$$A_k = (N_k/N_r)*A_r$$

Where A_r is the area of Wheeler North Reef based on the most recent sonar survey, N_k = number of transects at Wheeler North Reef with >4 plants per $100m^2$, and N_r is the total number of transects sampled at Wheeler North Reef (n = 92). Unlike the standard for hard substrate, the data used to evaluate the performance standard for giant kelp are collected over the entire Wheeler North Reef (Phase 1 modules + Phase 2 primary polygons + Phase 2 contingency polygons). The reason for this is that the requirement for sustaining 150 acres of giant kelp is not tied to a specific coverage of hard substrate.

The value of A_k is calculated each year of the monitoring period and used to determine whether Wheeler North Reef has met this performance standard. If for a given year the value of A_k is ≥ 150 acres, then the Wheeler North Reef will be considered to have met this performance standard for that year. Because the abundance of giant kelp fluctuates naturally from year to year the Wheeler North Reef will also be considered to have met this performance standard for a given year if the mean value of A_k averaged over that year plus the three preceding years ≥ 150 acres.

6. THE STANDING STOCK OF FISH AT THE MITIGATION REEF SHALL BE AT LEAST 28 TONS

Approach: The standing stock of fish on the Wheeler North Reef is estimated using data on total fish density, individual lengths, and relationships between fish length and mass. Data on fish density and length are recorded on the bottom along replicate fixed transects at the Wheeler North Reef in summer to early

autumn of each year. Divers count, identify to species and estimate the total length (to the nearest cm) of each fish observed in a 3m wide x 1.5m high x 50m long volume centered above a measuring tape placed along the bottom of each replicate 50 m transect. For aggregating species such as the blacksmith (*Chromis punctipinnis*) and salema (*Xenistius californiensis*), the number and mean length of individuals in a group are estimated. Cryptic fishes (e.g. cottids, gobies, blennies) are recorded in a 2m wide swath centered along the transect as divers return after completing the sampling of less cryptic fish and in the five $1m^2$ quadrats used to sample invertebrates and algae. These data are augmented with data from additional surveys of fish lengths if more information is needed to accurately characterize the population size structures.

Length data are used to assign each fish to one of three life stages (juvenile, subadult, and adult) using data from the literature (e.g. Love 2011) or best professional judgment by reef fish experts (e.g., Milton Love UCSB and Mark Steele CSUN). The biomass of each species within a transect is calculated by multiplying the number of fish in each life-stage by the average weight of the life stage and summing over all life stages Fish weights are estimated from fish lengths using species-specific length- weight regressions obtained either from the literature (Gnose, 1967; Quast, 1968a, 1968b; Mahan, 1985; Wildermuth, 1983; Stepien, 1986; DeMartini et al., 1994, Love 2011) or from data collected as part of this project. The biomass densities of all species encountered on a transect are summed to produce an estimate of the total biomass of fish within each transect in units of g wet weight m^{-2}. This value is averaged across all transects, converted to US tons per acre, and multiplied by the total reef area (in acres) to obtain an estimate of the standing stock of bottom-dwelling fish at the Wheeler North Reef.

The sampling methods and calculations for determining fish standing stock described above are the same as those used by the Marine Review Committee (MRC, 1989) when they determined that SONGS operations caused a 28 ton reduction in the standing stock of bottom-dwelling kelp bed fish).

The Wheeler North Reef is considered to have met this performance standard if its standing stock of bottom-dwelling fish in a given year ≥28 tons, or its mean fish standing stock of bottom-dwelling fish averaged over that year plus the three preceding years ≥ 28 tons.

7. THE RESIDENT FISH ASSEMBLAGE SHALL HAVE A TOTAL DENSITY SIMILAR TO NATURAL REEFS WITHIN THE REGION.

Approach: Data on the density and lengths of resident fishes in the San Mateo and Barn kelp beds are collected using the same methods described for the Wheeler North Reef above (see approach for performance standard 6). Briefly, all species of resident fish are sampled on the bottom at each of the replicate 3m wide x 1.5m high x 50m long transects at Wheeler North Reef, San Mateo and

Barn and in the cryptic fish transects and quadrats to obtain the number of resident fish on each transect. Resident fish are defined here as reef associated species > 1 year old. Data on fish length are used to classify each individual fish counted as a resident or young-of-year (< 1 year old) based on published size classes and/or knowledge of local experts. The total density of resident fish for each reef (Wheeler North Reef, San Mateo, and Barn) is calculated as the mean density of resident fish on the bottom averaged over the replicate transects. The four-year running average of the density of resident fishes at the Wheeler North Reef must be similar to that at the reference reefs (as per the methods described Section 2.3 above) for the Wheeler North Reef to meet this performance standard for any given year.

8. THE YOUNG-OF-YEAR FISH ASSEMBLAGE SHALL HAVE A TOTAL DENSITY SIMILAR TO NATURAL REEFS WITHIN THE REGION.

Approach: Data on the density of young-of-year fish (defined as reef associated fish that are < 1 year old) at the Wheeler North Reef and reference reefs are collected during the same surveys done for resident fish. Additional surveys are done if determined necessary for evaluating this performance standard. The approach used for determining whether the density of young-of-year fish on the Wheeler North Reef is similar to that on the reference reefs is the same as that used for evaluating the performance standard pertaining to the density of resident reef fish. The four-year running average of the density of young-of-year fish at the Wheeler North Reef must be similar to that at the reference reefs (as per the methods described Section 2.3 above) for the Wheeler North Reef to meet this performance standard for any given year.

9. THE TOTAL NUMBER OF SPECIES OF RESIDENT AND YOUNG-OF-YEAR FISH SHALL BE SIMILAR TO NATURAL REEFS WITHIN THE REGION.

Species richness (number of species) of resident and young-of-year fish at the Wheeler North Reef and reference reefs are assessed as the mean number of species observed per transect during the same surveys used to estimate resident and young-of-year fish density. The four-year running average of the mean number of species of resident and young-of-year fish combined at the Wheeler North Reef must be similar to that at the reference reefs (as per the methods described Section 2.3 above) for the Wheeler North Reef to meet this performance standard for any given year.

10. FISH REPRODUCTIVE RATES SHALL BE SIMILAR TO NATURAL REEFS WITHIN THE REGION.

Approach: Data on per capita egg production of a select group of targeted reef fish species are used to determine whether fish reproductive rates at the Wheeler North Reef are similar to those at San Mateo and Barn for similar sized

individuals. Reproduction rates are assessed for selected target species that represent different feeding guilds of reef fishes in southern California and are sufficiently abundant to facilitate collection (Table 2).

Data on per capita egg production (i.e., number of eggs in a clutch) and the proportion of individuals likely to have spawned within 24 hours of collection (as determined by the hydrated status of the eggs) are collected monthly at Wheeler North Reef, San Mateo, and Barn during summer through autumn and used to evaluate this standard. A resampling approach is used to statistically determine whether the Wheeler North Reef met this performance standard for a given year (Appendix 2). This provides a method to estimate the variance and provides a basis for the calculation of a p-value. Because larger individuals tend to produce more eggs, the production of eggs is scaled to the body length and used to obtain a standardized measure of fecundity for each species at each reef.

For each reef, a species-specific estimate of standardized fecundity is combined with a species- specific estimate of the proportion of individuals spawning to obtain a four-year running average of the Fecundity Index that is averaged across all target species in a manner that weights each species and year equally (Appendix 2). The four-year running average of the Fecundity Index for each reef for a given year is calculated as the median of the resampled distribution of the four-year running average for that year. In order for fish reproductive rates at Wheeler North Reef to be considered similar to that at natural reference reefs the four-year running average of its Fecundity Index (based on the current year and the previous three years) must not be significantly lower than that of the reference reef with the lower four-year running average Fecundity Index as per the methods described in Section 2.3.

11. FISH PRODUCTION SHALL BE SIMILAR TO NATURAL REEFS WITHIN THE REGION.

Approach: Estimating fish production on a reef is a difficult and potentially expensive task because it requires knowledge (or scientifically defensible assumptions) of the abundance and size structure of the fish standing stock, coupled with size-specific rates of growth, mortality, reproduction, emigration and immigration. For this reason a great deal of thought has gone into developing a precise and cost-effective way to evaluate this performance standard. The method selected for estimating fish production involves the use of information already being collected on fish abundance and size structure (for performance standards 6, 7, and 9), fish reproductive rates (standard 8), combined with estimates of somatic growth rates obtained from additional otolith studies. Importantly, this method of calculating fish production assumes no net migration (i.e., the immigration of fish to a reef is assumed to be equal to the emigration of fish from a reef). Details of the method are presented in Appendix 3.

Production is estimated for five target species that represent the major feeding guilds of fishes in southern California kelp forests and are common to the study region (Table 2). The annual production calculated for each of the targeted species is averaged to obtain an overall mean and standard error for each of the three reefs (Wheeler North Reef, San Mateo and Barn). The four-year running average of fish production at the Wheeler North Reef must be similar to that at the reference reefs (as per the methods described Section 2.3) for the Wheeler North Reef to meet this performance standard for any given year.

12. THE BENTHIC COMMUNITY (BOTH ALGAE AND MACROINVERTEBRATES) SHALL HAVE COVERAGE OR DENSITY AND NUMBER OF SPECIES SIMILAR TO NATURAL REEFS WITHIN THE REGION.

Approach: The benthic communities at Wheeler North Reef, San Mateo, and Barn are sampled annually in the summer in the areas defined by the replicate 50m x 20m transects at each reef (see ***3.1 General Sampling Design*** for details). Several different sampling methods are used to determine density and percent cover of benthic invertebrates, and understory algae. Abundances of sessile invertebrates and understory algae that are either difficult to distinguish as individuals (e.g. colonial tunicates, foliose red algae) or lay flat on the bottom (e.g., the brown alga *Desmarestia ligulata*) are measured as percent cover in five replicate $1m^2$ quadrats located at 10m intervals along each of the eighty-two 50m transects. Percent cover is estimated using a uniform point contact method that consists of noting the identity and relative vertical position of all organisms under 20 uniformly placed points within each quadrat, giving a total of 100 points per transect. Using this method the total percent cover of all species combined can exceed 100%; however, the maximum percent cover possible for any single species cannot exceed 100%. Large solitary mobile invertebrates (e.g. sea stars, sea urchins, and lobsters) and large solitary understory algae (e.g. palm kelp, *Pterygophora californica*) are counted in the five replicate 10m x 2m plots located at 10m intervals along each 50m transect. Smaller solitary mobile invertebrates (nudibranchs, bivalves, etc.) and algae (small size classes of all kelps) that are numerous and/or time consuming to count in a $1m^2$ area are counted in a $0.5m^2$ area created by dividing the $1m^2$ quadrats in half using a bungee cord stretched across the frame of the quadrat. Percent cover data and count data are both used to determine the mean number of species of understory algae and benthic invertebrates per transect at each reef.

The following components of the benthic community are evaluated separately to determine whether this performance standard is met: (1) the percent cover of algae, (2) the number of species of algae, (3) the percent cover of sessile invertebrates, (4) the density of mobile invertebrates, and (5) the combined number of species of sessile and mobile invertebrates. The four-year running averages of each of these five components of the benthic community at the

Wheeler North Reef must be similar to those at the reference reefs (as per the methods described in Section 2.3) in order for the Wheeler North Reef to meet this performance standard for any given year.

12. THE BENTHIC COMMUNITY SHALL PROVIDE FOOD-CHAIN SUPPORT FOR FISH SIMILAR TO NATURAL REEFS WITHIN THE REGION.

Approach: Several different approaches could be taken to evaluate the contribution of the benthic community to food-chain support of reef fishes, but the most direct and cost efficient of these approaches involves sampling gut contents in reef fishes that feed on the bottom and are collected for other purposes. Such is the case for the black surfperch and the California sheephead. Both species feed almost exclusively on benthic prey and individuals of these species are collected for purposes of evaluating the performance standards pertaining to fish reproductive rates and fish production. Once collected, black surfperch and sheephead specimens are placed on ice and transported to the laboratory where they are either immediately dissected and processed or frozen for processing at a later date. Sample processing for both species involves removing the entire tubular digestive tracts and weighing the contents, either before or after preservation by fixation in 10% formaldehyde and storage in 70% ethanol. These measurements are used to calculate an index of food chain support (FCS) that is based on the mass of the gut contents relative to the body mass of the fish

$$FCS = g / (b-(r+g))$$

Where g = gut content mass, b = body mass, and r = gonad mass.

Because the number of specimens of each species collected inevitably varies between species and among reefs the FCS values must be standardized to ensure each species and reef are weighted equally. To accomplish this standardization, FCS values for each species and reef in a given year are resampled with replacement 100 times (100 being the targeted sample size) and this process is iterated 1000 times. The mean for each iteration is calculated to produce a dataset of 1000 FCS values for each species x reef combination for a given year. For each species and year, we calculate the mean and standard deviation of the FCS values averaged over all 3000 iterations (= 1000 values for 3 reefs). We use these means and standard deviations to calculate the z-scores for each combination of year x species x iteration number for each reef yielding 1000 z-scores for each species x year x reef combination. We then average the z scores of the two species for each of the 1000 year x reef combinations to produce a data set of 1000 standardized FCS values for each reef in any given year.

The four-year running average of the standardized FCS index for each reef is calculated using a four-year mean of each iteration based on the current year and the previous three years producing 1000 values of the four-year average of the standardized FCS index for each reef. The four-year mean of the standardized FCS index for each reef is calculated from the resampled distribution of these these 1000 values. The four-year running average of the standardized FCS index at Wheeler North Reef must be similar to that at the reference reefs (as per the methods described in Section 2.3) in order for the Wheeler North Reef to meet this performance standard for any given year.

13. THE IMPORTANT FUNCTIONS OF THE REEF SHALL NOT BE IMPAIRED BY UNDESIRABLE OR INVASIVE BENTHIC SPECIES (E.G., SEA URCHINS OR Cryptoarachnidium).

Approach: Reefs in southern California provide many important ecological functions that pertain to the production of food and the provision of habitat for reef associated species. Undesirable or invasive species have the potential to impair these functions and thus prevent the Wheeler North Reef from attaining its mitigation goal of compensating for the loss of marine resources caused by SONGS operations. Undesirable or invasive reef species may include introduced or non-native taxa such as the green seaweed *Caulerpa taxifolia,* which escaped from the aquarium trade to invade many marine habitats worldwide including some in southern California, and the brown seaweed *Sargassum horneri,* which was accidentally introduced from Asia and has become increasingly abundant at some reefs off southern California. Undesirable or invasive reef species may also include native species when they attain very high abundances. This is the case when dense aggregations of sessile invertebrates such as sea fans monopolize space and exclude other species, or when high densities of sea urchins over graze the bottom and create large deforested areas commonly called sea urchin barrens. Data on the abundance of undesirable and invasive species are collected as part of monitoring done to evaluate the biological performance standards pertaining to the benthic community.

Examples of key ecological functions provided by shallow reefs of southern California include the provision of nursery habitat for fishes, the production of invertebrate prey sufficient to support populations of predatory reef fish, and primary productivity by macroalgae. The first of these two functions are monitored for the purpose of evaluating the performance standards pertaining to the density and number of species of young-of-year fishes and benthic food chain support and thus incur no added cost to evaluate. By contrast, measuring primary productivity by reef macroalgae is very time consuming and is not required for evaluating the performance of Wheeler North Reef. However, more easily measured estimates of frond density can be used to accurately predict net primary productivity by giant kelp (Reed et al. 2009), which constitutes the vast majority of algal biomass on reefs in California (Graham et al. 2007). Data of kelp frond

density are routinely measured for the purpose of evaluating the performance standard pertaining to giant kelp.

The evaluation of this performance standard involves a two-step approach. First, the performance of Wheeler North Reef with respect to giant kelp, young-of-year fish and benthic food chain support is used to determine whether the important functions of Wheeler North Reef are impaired. Second, data of the abundance of sea urchins, sea fans and other undesirable or invasive species are used to evaluate whether any impairment in these reef functions result from increases in the abundance of invasive or undesirable species.

4.0 DATA MANAGEMENT

Data management protocols will follow those developed during the experimental phase of the reef mitigation project and are outlined below.

4.1 Daily Field and Data Transfer Procedures

Data management and quality assurance procedures for the artificial reef monitoring begin in the field. Upon completion of each dive, data sheets are checked for completeness and legibility and total counts are tallied for each species. After these field checks are completed, the data sheets are filed into a field binder for transport back to the laboratory. Upon arrival at the laboratory, data sheets are checked into a survey log that contains entries for the observer, date, and survey location. The log is used to verify that all data assignments for a day have been completed, and all field data have been accounted for.

Data consistency is also verified during the check-in procedure, and any anomalies are brought to the attention of the field supervisor. Senior staff members examine the data sheets for possible misidentification of species, missing data values, and invalid counts. The field supervisor decides how to rectify any errors and implements corrective action to avoid repeating mistakes in the field. Such actions have included retaking data, and providing additional field training for investigators.

4.2 Data Entry and Quality Assurance

All SONGS Mitigation Monitoring data are entered and stored in electronic databases based on Structured Query Language (SQL). The project's data entry procedures have been designed to facilitate rapid data entry while continuing to ensure the quality and integrity of the data as they are transformed from physical to electronic form.

The vast majority of monitoring data are entered using custom designed web forms. These web forms provide an intuitive, graphical user interface to the project's databases. Each form mimics the exact layout of the data sheets taken into the field, which allows the individual entering the data to electronically

transcribe a sheet without replicating key variable entries, or manipulating columns, rows, or formats. Such tasks are processed on the project's internal web server, which translates the form data into the appropriate format for storage on the project's data servers. In some cases, these forms can reduce the amount of data a user is required to enter by over 100 fields for a single data sheet, which translates to significant time savings.

This entry system also allows the implementation of a multi-tiered checking system. Data entered using the web forms are verified in three distinct phases before any information is considered suitable for the final databases on which all analyses are done.

1. First, database structure (i.e. foreign key constraints) restricts the values that can be entered into a data table (e.g. the observer entry cell contains only valid entries for observer's names).
2. Second, a JavaScript program is incorporated into each web form used to enter data. These programs include a number of checks (e.g. recognizing invalid data lengths, out of range values, and incorrect formats). Failure of one of these checks prevents the form from being submitted, and alerts the user of the error. The system requires errors to be corrected for a form to be successfully submitted.
3. Finally, a third filter occurs on the project's internal web server. After a form is successfully submitted, the web server will check that each data row does not violate any constraint built into the database. If any line of the form fails these tests, the entire form will be rejected until the invalid entry is corrected.

This three phase checking system has greatly reduced the time required for post-entry data checking procedures by eliminating the most common data entry errors. This system has also substantially reduced the number of data checking programs previously required to find these problems, in some cases by as much as 75%.

Three final steps convert the electronically checked databases into the final databases. First, pairs of investigators manually check each data line of the database tables against the field data sheets for correct values. Second, following the manual check, a series of programs are run on the data to check for consistent values between database tables. For example, sampling dates for a given location are checked against the dates recorded into the sampling log. Any inconsistencies are rectified. Once these checks are complete, the data are transferred to a "live" database that contains all fully checked and verified data. Data from the live database are merged onto a template that populates the data for zero value observations. The templates also contain all pertinent metadata (variable descriptions and sampling methods), which are checked thoroughly prior to posting. At this stage, databases are considered to be in their final form and suitable for analysis.

4.3 Data Storage and Preservation

After the physical data are entered and checked, each data sheet is scanned and converted into a PDF file for electronic storage. The material sheets are then filed in binders by survey type and year, and then added to the monitoring data library located at UCSB's SONGS mitigation office and laboratory in Carlsbad, CA. The PDF data sheets are similarly filed in an electronic library located on the project's data servers.

The project employs a highly redundant, multi-server system to ensure maximum data integrity, preservation, and uptime. The system consists of a central data server, and multiple mirror and backup servers located at UCSB's Carlsbad office, and at the Marine Science Institute on UCSB's main campus in Santa Barbara, CA.

The central server at UCSB's Carlsbad office acts as the primary management point for all project-related data and files. These files fall into three distinct classes, which are used to determine both the method and format of automated backup and preservation. These are 1) regular documents (backed up every four hours in native format), 2) SQL database files (backed up in real time to two mirror servers using native format, and once a week to the Marine Science Institute's server on UCSB's main campus in comma delimited text), and 3) statistical and database program files (backed up every four hours in native format, and once a week to server on main campus in native format).

Daily backups are written to a redundant disk array, while weekly backups are written to disk and removable media (tape, DVD). All valid users for the system can access daily backups of regular documents and statistical or database program files, however, the restoration of SQL database files must be done by a system administrator.

5.0 DISSEMINATION OF RESULTS

The following procedures are followed to ensure efficient and effective communication with SCE, state and federal resource agencies and the general public: (1) CCC contract scientists communicate with SCE and state and federal agencies as needed via phone, email, and face-to face meetings to discuss results and any potential changes in monitoring design, (2) status reports are prepared and submitted to the CCC for public viewing on an annual basis, (3) all monitoring data are made available upon request as soon as they have been verified, (4) CCC contract scientists maintain a public website that provides information on the history, current status, and other relevant information pertaining to the monitoring of the SONGS reef mitigation project, and (5) as per Condition D of the SONGS operating permit, duly noticed annual public workshops are convened to review the overall status of the project, identify problems and make recommendations for solving them, and review activities planned for the following year. .

6.0 REFERENCES

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Table 1. Distribution of monitoring transects on the Wheeler North Reef based on acreage provided in SCE's Final Construction Report for the Wheeler North Reef (Coastal Environments. 2008). *Area of Experimental Reef Modules determined by sonar surveys conducted in 2009.

Primary Polygons	Area (acres)	Number of Transects
1	13.83	6
2	38.88	20
3	6.61	4
4	14.05	8
6	4.24	2
7	6.80	4
8	7.64	4
9	2.52	2
10	3.89	2
11	3.48	2
12	1.35	2
13	2.85	2
14	2.12	2
15	5.54	2
16	11.19	6
17	5.32	2
Contingency Polygons		
5	9.48	4
7a	12.2	6
Experimental Reef Modules	24.79*	12
Total	177	92

Table 2. Reef fishes used as target species for estimating reproductive rates and fish production.

Common Name	Scientific Name	Mode of Reproduction	Primary Diet
kelp bass	*Paralabrax clathratus*	egg layer (broadcast)	Midwater and benthic fish and invertebrates
señorita	*Oxyjulis californica*	egg layer (broadcast)	Zooplankton & small benthic invertebrates
sheephead	*Semicossyphus pulcher*	egg layer (broadcast)	Hard-shelled benthic invertebrates
blacksmith	*Chromis punctipinnis*	egg layer (demersal)	Zooplankton
black surfperch	*Embiotica jacksoni*	live bearer	Small benthic invertebrates

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Figure 1a. Map of Wheeler North Reef showing the location of the 92 fixed transects where monitoring of the performance standards is done. Transects are in pairs and are shown as white lines in the primary reef polygons and as black lines in the contingency reef polygons and experimental reef modules. The primary and contingency reef polygons are identified by the numbers shown within them and correspond to the identification numbers shown in Table 1. Depth contours are in meters.


San Clemente Pier
N
Meters
0
500
1,000
1,500
Experimental reef modules
Primary reef polygons
Contingency reef polygons

Figure 1b. Map of the reef at San Mateo showing the location of the 82 fixed transects where monitoring of the performance standards is done. Transects are in pairs and are shown as white lines in the black shaded areas, which denote hard substrate. Depth contours are in meters.

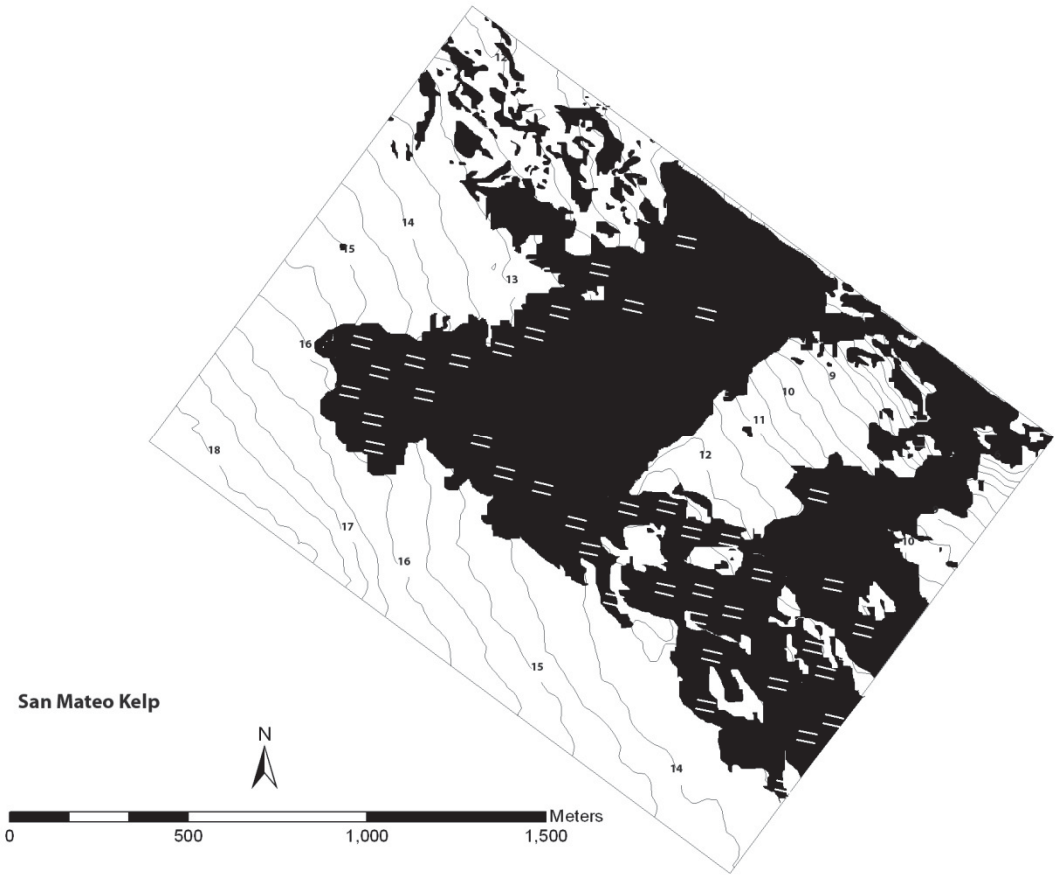


Figure 1c. Map of the reef at Barn showing the location of the 82 fixed transects where monitoring of the performance standards is done. Transects are in pairs and are shown as white lines in the black shaded areas, which denote hard substrate. Depth contours are in meters.

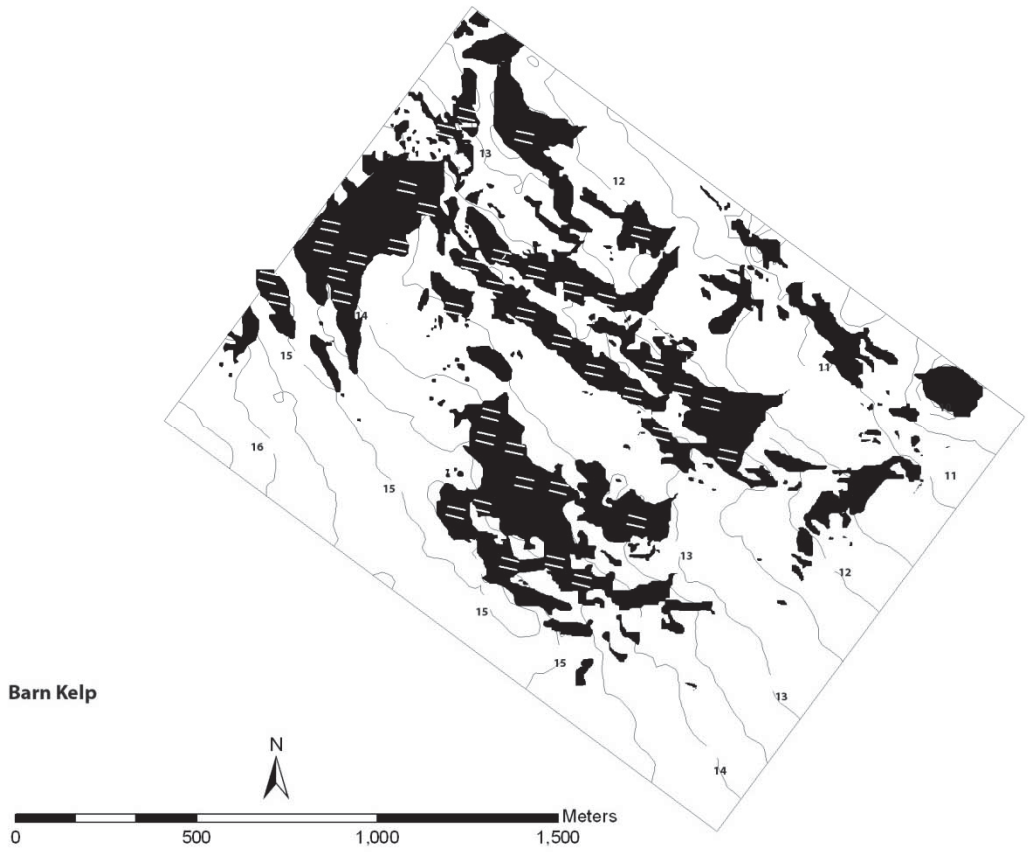


Figure 2. Schematic showing the different sized sampling areas that are used at each of the fixed monitoring stations; including a large 50m x 2m band transect (delineated by dashed lines; five smaller 10m x 2m band transects perpendicular to the main transect and evenly spaced along it; five evenly spaced 1m x 1m quadrats (shaded squares and inset) containing 20 evenly spaced point contact locations and divided into two 0.5 m^2 quadrats.

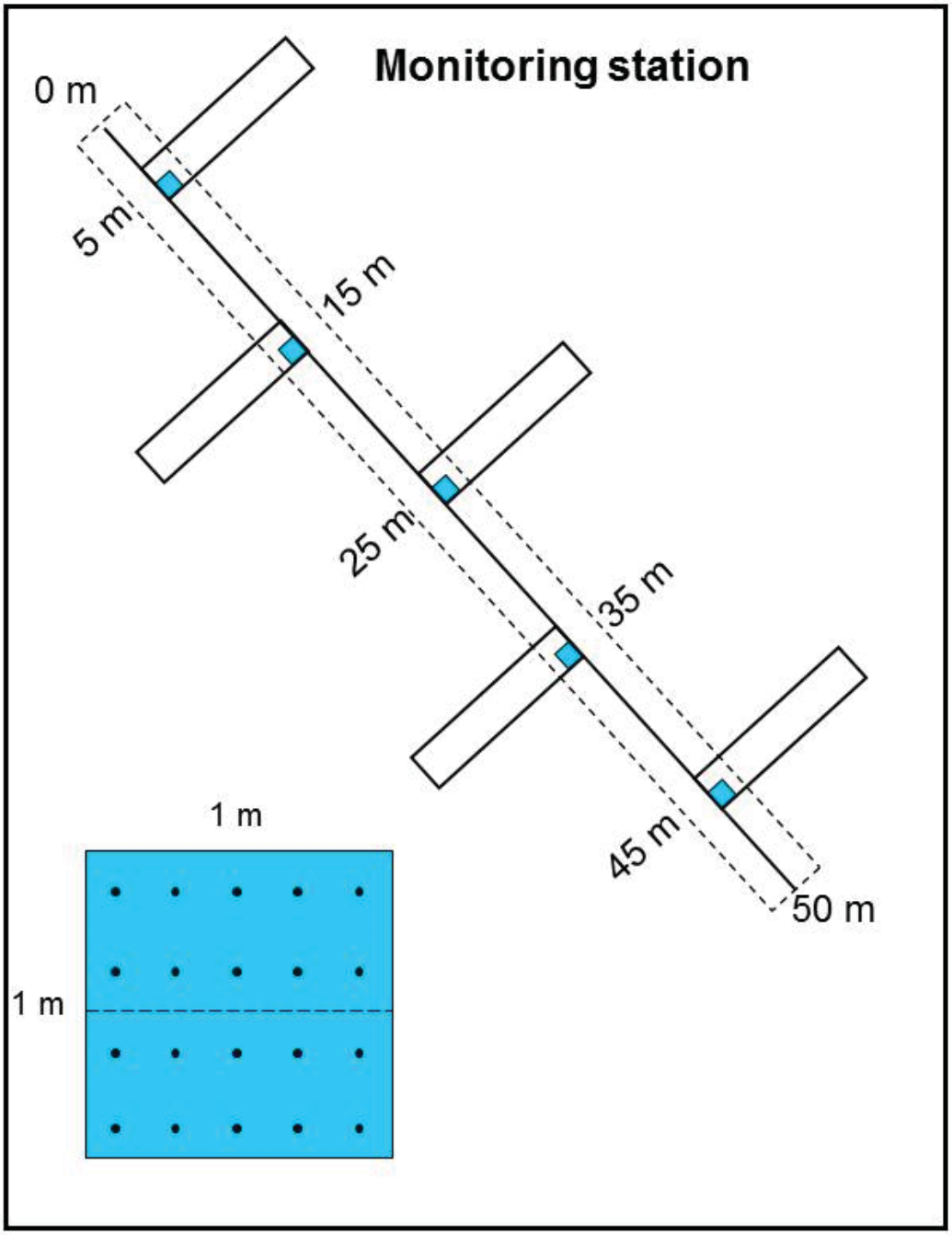
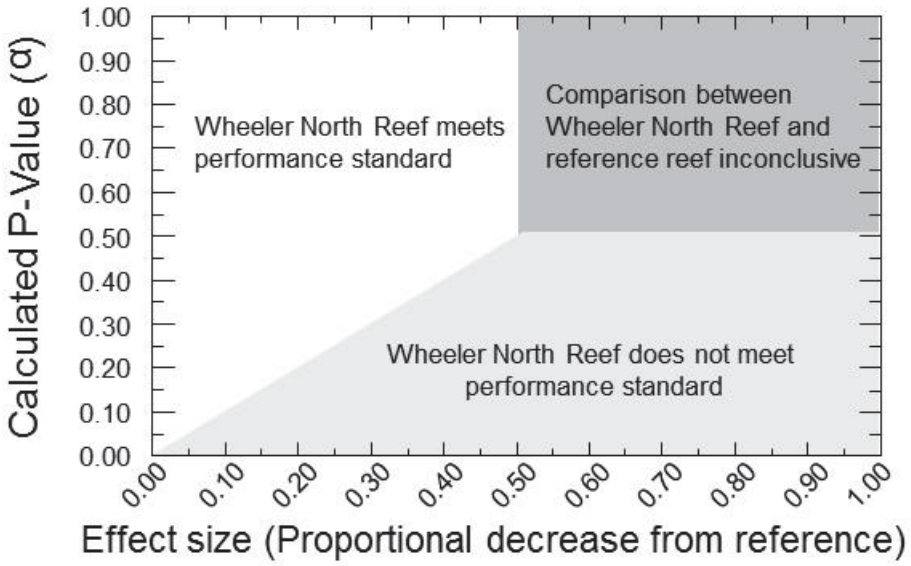


Figure 3. The relationship between effect size and α, and how it is used to determine whether the Wheeler North Reef meets a given relative performance standard.



Appendix 1

The Definition of Compliance in the Context of the SONGS Mitigation Projects

Prepared for the staff of the California Coastal Commission by:
Richard Ambrose

Mark Page

Peter Raimondi

Daniel Reed

Russell Schmitt

Stephen Schroeter

January 2013

EXECUTIVE SUMMARY

The California Coastal Commission (CCC) has required Southern California Edison (SCE) and its partners to construct mitigation projects that provide adequate compensation for the loss of marine resources resulting from the operation of SONGS Units 2 and 3. The CCC is responsible for determining whether these projects are successful. One issue that resides at the core of this determination is the level and duration of performance by the mitigation projects that is needed to achieve compliance with specific conditions of the SONGS coastal development permit. We address this issue below.

The conditions of the SONGS coastal development permit (6-81-330-A) were amended in 1991 to mitigate the adverse impacts of the operation of SONGS Units 2 and 3 on the marine environment. The conditions that were amended to the permit require SCE and its partners to (1) create or substantially restore a minimum of 150 acres of southern California wetlands (Condition A), (2) install fish barrier devices at the power plant (Condition B), and (3) construct an artificial reef large enough to sustain 150 acres of medium to high density kelp bed community (Condition C). A fourth condition (Condition D) requires SCE to fund the Commission's oversight of the mitigation and independent monitoring functions identified in and required by Conditions A, B, and C. Physical and biological standards are identified in conditions A and C that specify how the wetland and reef mitigation projects should perform and the timing and level of monitoring that is needed to evaluate their performance. The specific requirements for attaining compliance of these conditions are discussed in various sections throughout the permit. The purpose of this document is to provide SCE with clear and consistent interpretations of key terms in the SONGS coastal development permit, which provide the basis for assessing compliance of SONGS wetland and reef mitigation projects. We identify the specific sections in the permit that provide support for our interpretations, and provide schedules for the different levels of monitoring that are required to determine whether the wetland and reef mitigation projects are in compliance with Conditions A and C.

INTRODUCTION

The SONGS coastal development permit (6-81-330-A) requires SCE to create or substantially restore a minimum of 150 acres of southern California wetlands (Condition A), and to construct an artificial reef large enough to sustain 150 acres of medium to high density kelp bed community (Condition C). Physical and biological standards are identified in these conditions that specify how the wetland and reef mitigation projects should perform and the timing and level of monitoring that is needed to evaluate their performance is discussed. The purpose of this document is to provide consistent interpretations of key terms in the SONGS coastal development permit (6-81-330-A), which provide the basis for assessing compliance of SONGS wetland and reef mitigation projects. The specific sections

in the SONGS permit that provide support for our interpretations are indicated by numerical superscripts in the text and are referenced below (see p. 6 of Appendix 1, **Permit language supporting CCC staff's interpretations on SONGS project compliance**).

DEFINITIONS

Monitoring Period: Post-construction monitoring will ensue upon completion of the reef construction and wetland restoration[1, 2]. The duration of such monitoring will last for a period not less than the full operating life of SONGS (defined below) plus years monitored without the project attaining compliance with permit standards[2, 3].

Compliance: The condition in which the performance standards are met.

*Compliance Perio*d: The number of years that a mitigation project is in compliance. The mitigation requirements will be fulfilled when the compliance period equals the total years of operation of SONGS Units 2 & 3, including decommissioning period to the extent that there is continuing entrainment or impingement or discharge of cooling water[3,4].

MONITORING EFFORT

Mitigation Reef (see Figure A1)

1) *Stage 1: Fully implemented monitoring*: Independent monitoring designed and conducted by CCC staff scientists will be done to evaluate the performance of the mitigation reef[5]. The sampling methodology, analytical techniques, and methods for measuring performance of the mitigation reef relative to the performance standards shall be described in the monitoring plan prepared for the mitigation reef[6]. Monitoring will ensue upon completion of the reef construction[2]. The performance standards must be met within 10 years[7,8]. The project will be considered successful when the performance standards have been met each year for three consecutive years[9]. Hence, fully implemented monitoring will last a minimum of 10 years. All years that the project is in compliance will count towards the compliance period. The level of sampling effort may be reduced during this stage of monitoring if analyses of the data indicate that compliance of the performance standards can be adequately assessed using less sampling effort. Remediation may be required if the performance standards are not met within ten years and if three consecutive years of compliance has not occurred within 12 years [10, 11]. Note that the Executive Director could prolong this stage of monitoring or reinstate it if necessary following degradation of the artificial reef (resulting in a period of non-compliance) or remediation[12].

2) *Stage 2: Annual site inspections:* Monitoring can be reduced to annual site inspections[13,14], which will serve to identify noncompliance with the performance standards, when:

a. The project has been in compliance with permit standards for at least three consecutive years, and
b. The project has been evaluated for at least ten years post-construction.

The schedule for monitoring the mitigation reef project is shown in Figure A1.

Restored Wetland (see Figure A2)

1) *Stage 1: Fully implemented monitoring:* Independent monitoring designed and conducted by CCC staff scientists will be done to evaluate the performance of the wetland restoration project[5]. A description of the monitoring can be found in the wetland monitoring plan and details of the monitoring effort will be set forth in a work plan[15]. Monitoring will ensue upon completion of wetland construction[16]. Within 4 years of construction, the total densities and number of species of fish, macro-invertebrates and birds shall be similar to the densities and number of species in similar habitats in the reference wetlands[17]. The performance standards must be met within 10 years, which is the same amount of time required for the mitigation reef to meet the performance standards[7,8]. The wetland restoration project will be considered successful when the performance standards have been met for each of three consecutive years[9]. All years that the project is in compliance will count towards the compliance period. Remediation may be required if the performance standards are not met within ten years and if three successive years of compliance has not occurred within 12 years[18]. Note that the Executive Director could prolong this stage of monitoring or reinstate it if necessary following remediation or degradation of the wetland (resulting in a period of non-compliance)[12].

2) *Stage 2: Scaled back monitoring:* Upon determination that the project has been in compliance for three consecutive years, a scaled back stage of monitoring will ensue[14]. The scaled back monitoring program will be designed and implemented by CCC staff scientists[5]. Reduction in effort will be based on analyses of data collected during the period in which the project was in compliance. Staff scientists will examine these data to determine the minimum effort that would have been necessary to assess compliance during the period. All monitoring, whether it is fully implemented or scaled back, must be sufficient for assessing compliance of the performance standards.

The schedule for monitoring the wetland restoration project is shown in Figure A2.

REMEDIATION

If the mitigation reef or restored wetland is not considered successful within 12 years post-construction or if the restored wetland has not met the biological community standard by year 4, then (at the discretion of the Executive Director):

1) The permittee shall fund an independent study to collect information needed to determine what remediation is required[19].
2) The permittee shall be required to implement any remedial measures determined necessary by the Executive Director in consultation with state and federal resource agencies and will provide funds for independent monitoring that evaluates the success of the required remediation[10,11,19]. Remediation monitoring may be different from the compliance monitoring required by the permit.

If the mitigation reef or restored wetland is in a period of reduced monitoring and if it falls out of compliance for a period of two consecutive years, then to determine if non-compliance is an artifact resulting from a reduction in monitoring effort, full monitoring (Stage1) may be re-established for those standards that are out of compliance. If resumption of full monitoring leads to the conclusion that the reduction in monitoring was responsible for non-compliance, then monitoring will remain at the full levels for the duration of the study or until the Executive Director concludes that reduced monitoring could be reinstituted[12]. CCC staff scientists will be responsible for designing and implementing the reduced monitoring program[5].

If resumption of full monitoring leads to the conclusion that non-compliance is due to poor performance of the mitigation project then:

1) The permittee shall be required to fund an independent study to collect the information necessary to determine what remediation is needed [19]
2) The permittee shall be required to implement any remedial measures determined necessary by the Executive Director in consultation with state and federal resource agencies and will provide funds for independent monitoring that evaluates the success of the required remediation[10,11,19]. Remediation monitoring may be different from the compliance monitoring required by the permit.

Permit (No. 6-81-330-A) language supporting CCC staff's interpretations on SONGS project compliance

1. (III.A.3.4). Upon completion of construction of the wetland, monitoring shall be conducted to measure the success of the wetland in achieving stated restoration goals (as specified in restoration plan) and in achieving performance standards, specified below.

2. (III.B. 2.4). Following completion of construction the mitigation reef shall be monitored for a period equivalent to the operating life of SONGS.

3. (III.A.3.0). Monitoring, management (including maintenance), and remediation shall be conducted over the "full operating life" of SONGS Units 2 and 3**.** Full operating life" as defined in this permit includes past and future years of operation of SONGS units 2 and 3 including the decommissioning period to the extent there are continuing discharges. The number of past operating years at the time the wetland is ultimately constructed, shall be added to the number of future operating years and decommission period, to determine the length of the monitoring, management and remediation requirement.

4. (III.B 2.4). The permittee shall insure that the performance standards and goals set forth in this condition will be met for at least the length of time equivalent to the full operating life of SONGS Units 2 and 3…."Full operating life" as defined in this permit includes past and future years of operation of SONGS Units 2 and 3, including the decommissioning period to the extent there are continuing discharges.

5. (III.C.1.0). Personnel with appropriate scientific or technical training and skills will, under the direction of the Executive Director, oversee the mitigation and monitoring functions identified and required by conditions II-A through C. The Executive Director will retain approximately two scientists and one administrative support staff to perform this function.

This technical staff will oversee the preconstruction and post-construction site assessments, mitigation project design and implementation (conducted by permittee), and monitoring activities (including plan preparation); the field work will be done by contractors under the Executive Director's direction. The contractors will be responsible for collecting the data, analyzing and interpreting it, and reporting to the Executive Director.

6. (III.B.2.4. A monitoring plan for the mitigation reef shall be developed by the Commission staff scientists pursuant to Condition D. The monitoring plan shall be completed within six months of approval of a coastal development permit for the mitigation reef proposed in a final plan developed pursuant to this condition.

The monitoring plan shall provide an overall framework to guide the monitoring work. The monitoring plan shall describe the sampling methodology, analytical techniques, and methods for measuring performance of the mitigation reef relative to the performance standards identified below.

7. (III.B.2.4). The independent monitoring program for the mitigation reef shall be designed to assess whether the performance standards have been met. If these standards are met after ten years following the completion of construction, then monitoring can be reduced to annual site inspections.

8. (III.B.2.4). If the standards listed above are not met within ten years after reef construction, then the permittee shall undertake those remedial actions the Executive Director deems appropriate and feasible.

9. (III.C.3.0). The mitigation projects will be successful when all performance standards have been met each year for a three-year period. The Executive Director shall report to the Commission upon determining that all of the performance standards have been met for three years and that the project is deemed successful.

10. (III.B.2.4). The permittee shall undertake necessary remedial actions based on the monitoring results and annual site inspections for the full operating life of the SONGS Units 2 and 3.

11. (III.B.2.4). If the standards listed above are not met within ten years after reef construction, then the permittee shall undertake those remedial actions the Executive Director deems appropriate and feasible.

12. (III.C.3.0). If subsequent monitoring shows that a standard is no longer being met, monitoring may be increased to previous levels, as determined necessary by the Executive Director.

13. (III.B.2.4). The independent monitoring program for the mitigation reef shall be designed to assess whether the performance standards have been met. If these standards are met after ten years following the completion of construction, then monitoring can be reduced to annual site inspections.

14. (III.C.3.0). If the Commission determines that the performance standards have been met and the project is successful, the monitoring program will be scaled down, as recommended by the Executive Director and approved by the Commission. A public review shall thereafter occur every five years, or sooner if called for by the Executive Director.

15. (III.A.3.1). A monitoring and management plan will be developed in consultation with the permittee and appropriate wildlife agencies, concurrently with the preparation of the restoration plan, to provide an overall framework to guide the monitoring work. It will include an overall description of the studies to be conducted over the course of the monitoring program and a description of management tasks that are anticipated, such as trash removal. Details of the monitoring studies and management tasks will be set forth in a work program.

16. (III.A.3.4). Upon completion of construction of the wetland, monitoring shall be conducted to measure the success of the wetland in achieving stated restoration goals (as specified in restoration plan) and in achieving performance standards.

17. (III.A.3.4.b.1). *Biological Communities.* Within 4 years of construction, the total densities and number of species of fish, macroinvertebrates and birds shall be similar to the densities and number of species in similar habitats in the reference wetlands.

18. (III.A.3.4). The permittee shall be fully responsible for any failure to meet these goals and standards during the full operational years of SONGS Units 2 and 3. Upon determining that the goals or standards are not achieved, the Executive Director shall prescribe remedial measures, after consultation with the permittee, which shall be immediately implemented by the permittee with Commission staff direction. If the permittee does not agree that remediation is necessary, the matter may be set for hearing and disposition by the Commission.

19. (III.B.2.4). Executive Director may also use any other information available to determine whether the performance standards are being met. If information from the annual site inspections or other sources suggests the performance standards are not being met, then the permittee shall be required to fund an independent study to collect the information necessary to determine what remediation is needed. The Executive Director shall determine the required remedial actions based on information from the independent study. The permittee shall be required to implement any remedial measures determined necessary by the Executive Director in consultation with state and federal resource agencies, as well as provide funds for independent monitoring that evaluates the success of the required remediation. As described under the funding option (Condition D) of this permit, the cost of remediation shall not be limited if the permittee elects to implement the mitigation reef.

Figure A1. Idealized monitoring schedule for the mitigation reef showing the minimum time periods for the two stages of monitoring: (1) Fully implemented monitoring and (2) annual site inspection. The actual time periods for each stage may be longer, depending on the performance of the project.

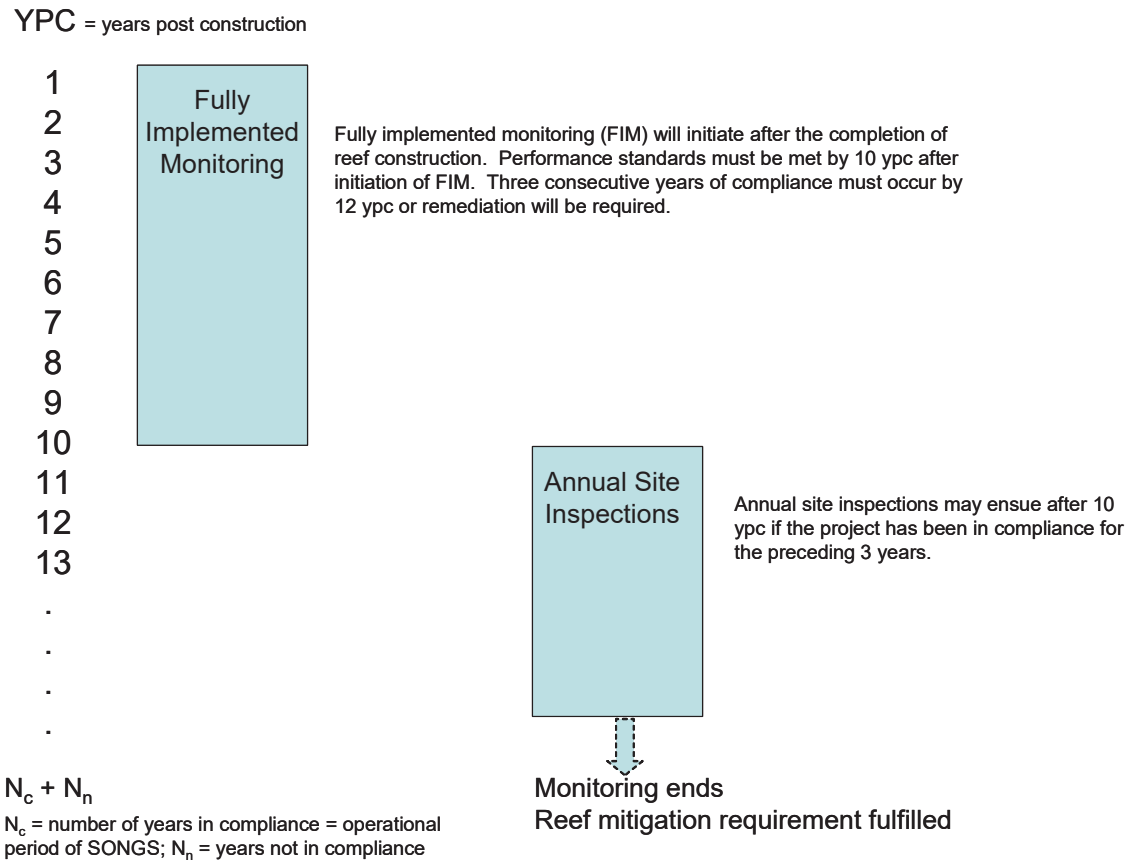
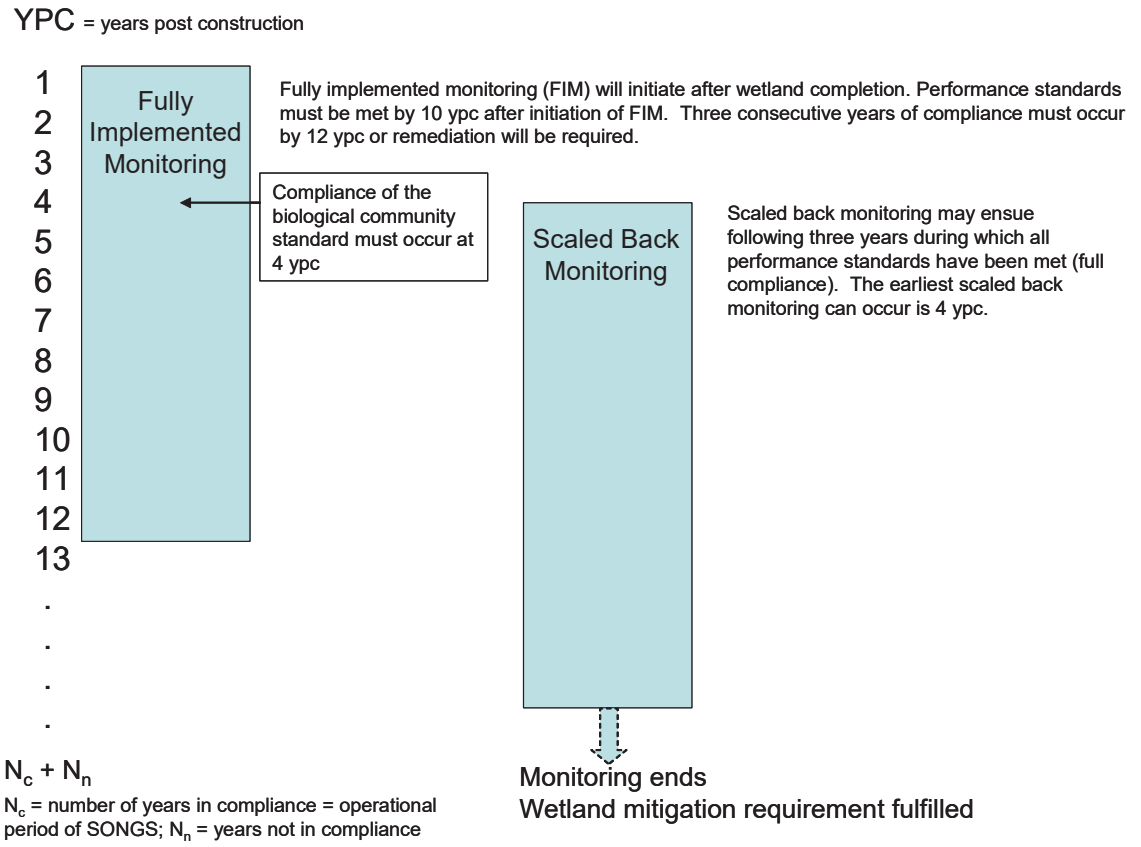


Figure A2. Idealized monitoring schedule for the wetland restoration project showing the minimum time periods for the two phases of monitoring: (1) Fully implemented monitoring and (2) scaled back monitoring. The actual time periods for each phase may be longer, depending on the performance of the project.



APPENDIX 2

METHODS FOR ESTIMATING FISH REPRODUCTIVE RATES

General Methods

Individuals of four targeted species (blacksmith, *Chromis punctipinnus;* sheephead, *Semicossyphus pulcher;*, senorita, *Oxyjulis californicus;* and kelp bass, *Paralabrax clathratus*), are collected monthly throughout their reproductive period (May to September) at Wheeler North Reef, San Mateo and Barn via spear and hook and line for the purpose of estimating fish reproductive rates. Like all common egg-laying species at the study sites, the four species targeted for assessing reproductive rates are batch spawners, that is, they spawn multiple batches of eggs throughout a single spawning season.

On the day that a batch of eggs is spawned, the eggs are first hydrated within the ovaries and then ovulated. Hydrated ova appear only within several hours of spawning and are recognized by their relatively large size and translucent appearance. We aim to capture at least 50 females with hydrated eggs in their ovaries from each reef for each year sampled. In the field, the body cavity of each specimen is opened and the sex and stage of development of the ovaries of females is noted. Ovaries are classified based on macroscopic examination as immature/inactive (no obvious oocytes); mature (obvious oocytes but none hydrated); and ripe (hydrated oocytes present). Specimens are kept on ice until they can be processed in the laboratory (no more than 24 h).

In the laboratory, each fish is weighed to the nearest 0.1 gram, and measured for total length and standard length. Sagittal otoliths are removed from each specimen for age and growth analysis needed for evaluating the performance standard pertaining to Fish Production. Ovaries from female fish are removed, blotted dry, weighed to the nearest 0.1 g. Ovary-free body weight is determined by subtracting the ovary weight from the body weight. Ovaries are preserved in 10% formalin for fecundity analysis in the laboratory.

Batch fecundity is estimated using hydrated eggs. It is usually impractical to count all of the hydrated ova within the ovaries of a female, so batch fecundity is estimated from subsamples, and the number of hydrated eggs in these subsamples is extrapolated to the entire ovary pair. The number of hydrated ova in each subsample is counted using a dissecting microscope and the number of hydrated ova is extrapolated to the entire ovary.

Fecundity Index for Egg-laying fish

The Fecundity Index for egg-laying fish is calculated for each reef as the product of batch fecundity and the proportion of individuals that produced eggs. A resampling approach is used to obtain an estimate of the variance of these two variables, which is needed to statistically determine whether the Wheeler North Reef has met this performance standard in a given year.

Estimating Batch Fecundity

Larger fish tend to produce more eggs. Therefore, the production of eggs is scaled to body length to obtain a standardized measure of fecundity that takes into account differences in size within a species. Standardization for each species is achieved by dividing the length and fecundity of an individual by the mean length or mean fecundity averaged across all individuals of that species collected at all three reefs. These standardized measurements are used to develop species-specific regression models for each reef in a given year using standardized fecundity as the dependent variable and standardized length as the independent variable. Data used in each regression model are resampled 1000 times using a bootstrap approach (i.e., resampling with replacement) yielding 1000 regression equations. The integrated area under each regression function provides a species-specific estimate of batch fecundity (F_b) across all sizes for a given reef and year.

Estimating the proportion of individuals that produced eggs

The number of individuals of each species that are sampled in a given year (N) and the proportion of them that produced eggs (p) are used in a binomial model to generate 1000 estimates of the number of reproductive individuals in each iteration (k). The proportion of individuals that produced eggs in a given iteration (P_k) is calculated as:

$$P_k = \binom{N}{k} p^k q^{1-k}$$

where q = 1-p.

Calculation of Fecundity Index

The 1000 estimates of F_b generated for each species, reef and year are merged with the 1000 estimates of P_k for each species, reef and year. The product of these two variables yields 1000 estimates of population fecundity (F_p) for each species at each reef for a given year. Values of F_p are then standardized to ensure that each species is weighted equally. This is done by dividing each species-specific value of F_p by the median of the resampled distribution of F_p for that species to produce 1000 cases of standardized fecundity (F_s) for each species at each reef for a given year. Values of F_s are averaged across all target species for which there are data to obtain 1000 estimates of reef fecundity (F_r) for each reef in a given year. The annual estimates of F_r for current year and the preceding three years are averaged by case to produce 1000 estimates of the four-year running average of F_r for a given year. The four-year running average of the Fecundity Index for each reef for a given year is calculated as the median of the resampled distribution of the four-year running average of F_r for that year.

An implicit assumption of using the Fecundity Index to evaluate whether fish reproductive rates at Wheeler North Reef is similar to that at natural reference reefs is that the frequency of spawning for a given species does not vary significantly among the three reefs.

APPENDIX 3

METHODS FOR ESTIMATING FISH PRODUCTION

This document describes the approach that is used to estimate annual production of fish tissue using data on length, density, somatic growth rates, and production of reproductive tissues for a select group of target species. The result is an estimate of production per unit area of reef for each species. The approach is conceptually similar to that used by DeMartini et al. (1994), but differs in the details of the production model and some of methods used to estimate key parameters. This approach to estimating tissue production includes production of both somatic and reproductive tissues. Hence, total production of tissue biomass for a given species is:

$$P_{TOTAL} = P_{St} + P_{Rt}$$

where P_{St} is production of soma and P_{Rr} is production of gonadal tissue over some time period t.

P_{St} is estimated as:

$$P_{S_t} = \sum_{i=1}^{n} (\overline{N}_{i_t} \bullet g_{i_t})$$

where $\overline{N}_{it}$ = mean population density of size class *i,during period t,* and g_{it} is the average growth increment (mass) of individuals in size class *i* over time period t.

P_{Rt} is estimated as:

$$P_{Rt} = P_{Ft} + P_{Mt}$$

where P_{Ft} is production of eggs by females in all size classes and P_{Mt} is production of milt (sperm and semen) by males in all size classes over time period t.

P_{Ft} is estimated as:

$$P_{F_t} = \sum_{i=1}^{n} (\overline{N}_{F,i_t} \bullet E_i \bullet w_e)$$

where $N_{F,it}$ = density of females in size class *I during period t;* E_i =mean number of eggs produced by a female in size class *i*; and w_e is the average weight of an egg.

P_M is estimated as:

$$P_{M_t} = \sum_{i=1}^{n} (\overline{N}_{M,i_t} \bullet E_i \bullet w_e \bullet r_i)$$

where $N_{M,it}$ = density of males in cohort *i during time t*; and r_i is the ratio of testes weight to ovary weight for males and females in cohort *i*. Thus, milt production, which is not readily measured, is estimated based on the ratio of testes to ovary size.

Parameter estimation

The equations above include several parameters that are estimatedusing data collected from the three field sites.

N_{it} — The density of individuals in a size class during time t is determined from field surveys of fish density and size structure.

N_{Ft} and N_{Mt} — The density of females and males in each size class during period t is estimated from total densities in field surveys and sex ratios determined from the work on reproductive output.

g_{it} — cohort specific growth increments over period t are estimated for the year preceding capture by back-calculation from otoliths of fishes collected for the work on reproduction and supplemented with collections of juveniles. In brief, somatic growth is estimated from otolith growth for species where clear increments are present and a tight relationship between otolith size and body size exists.

E_i — Per capita egg production is estimated as the product of the batch fecundity and the number reproductive bouts per year.

w_e — Egg weight is estimated from the largest 20% of yolked (but not hydrated) eggs in a large, random selection of ovaries of each species. Egg weight is calculated as egg volume in cc (using measured radius and assuming spherical shape) times a specific gravity of 1.

r_i — Ratio of testes to ovary weights is calculated for each size class from samples collected for the reproduction standard. Only mature, reproductively active fish are used in estimating this ratio; and only females with mature but non-hydrated eggs are used.

APPENDIX 4

CHRONOLOGY OF CHANGES TO THE MONITORING PLAN FOR SONGS' REEF MITIGATION

All changes to the monitoring plan for reef mitigation become effective the date they are implemented and do not affect the assessment of reef performance in previous years

Changes made in February 2013 revision.

1. Changes with respect to how the absolute performance standards are evaluated.

Previous approach: For a given year, each absolute standard is evaluated using data collected at the Wheeler North Reef (WNR) for that year.

New approach: For a given year, the evaluation of each absolute standard will be based on the greater value obtained from either: (1) data collected at WNR that year, or (2) a four-year running average calculated from data collected at WNR for that year and the previous three years.

Rationale for change: Short–term fluctuations in the physical and biological attributes of a kelp forest community are a common feature of natural reefs unaffected by SONGS operations. Assessing the absolute standards using either the current year's value or a four-year running average recognizes that such short-term fluctuations at WNR are to be expected even if it is performing as well as or better than natural reefs in the region. As in the past, all absolute standards must be met in a given year for that year to count towards compliance with Condition C.

2. Changes with respect to how the relative performance standards are evaluated

Previous approach: All relative standards at WNR must be met in a given year for that year to count towards compliance with Condition C. In order for WNR to meet a relative performance standard the value for that standard at WNR must be statistically equal to or greater than the value at the lower of the two reference reefs. In addition, WNR cannot have the lowest value (regardless of statistical significance) for more standards than expected by chance in order for that year to count towards compliance.

New approach: The following changes were made

1) Instead of requiring WNR to meet every relative standard in a given year, it must meet only as many of the relative standards as the lowest performing reference site.
2) A four-year running average calculated from data collected for that year and the previous three years (instead of the mean calculated from data collected only in

that year) will be used to determine whether a performance standard is met in that year.

3) Assessment of the fish community and benthic community of algae and invertebrates is based on an equal (instead of unequal) number of standards pertaining to the fish and benthic communities.
4) The number of species of fish, invertebrates and algae is based on the mean number of species per transect (species density) rather on estimating the total number of species on the reef (species richness) using a two-parameter model two parameter model relating the number of species encountered to the number of transects sampled.

Rationale for change # 1: Analyses of the monitoring data collected to date show that reference reefs would not consistently meet all the relative performance standards required of WNR. Thus requiring WNR to meet all the relative standards each year for that year to count towards compliance with Condition C in effect requires WNR to consistently outperform the reference reefs. By requiring WNR to meet only as many relative standards as the lowest performing reference reefs achieves the desired mitigation goal, which is for WNR to perform as well as the natural reefs in the region chosen as suitable measures of comparison.

Rationale for change # 2: The purpose for the relative standards is to ensure that WNR performs at least as well as the natural reference reefs over the operating life of SONGS. Using a running average rather than a mean value for a given year recognizes that short-term fluctuations in the biological attributes of WNR are to be expected even if it is performing as well as natural reefs in the region. An either /or criteria (i.e., using data from either a single year or a running average) is not appropriate in this case because the desired goal for the relative performance standards is not to achieve a specified value that is linked to estimated losses at San Onofre kelp forest. Instead the purpose of the relative standards is to evaluate whether the abundances and numbers of species of kelp forest biota at the Wheeler North Reef are similar to that of the reference reefs. This is best accomplished using a short-term running average that accounts for natural variation. A running average calculated over four years approaches the desired monitoring goal of being able to reliably detect a 20% difference between WNR and the reference reefs while providing the CCC and SCE with a reasonable time frame for evaluating the performance of WNR.

Rationale for change #3: The relative performance standards described in the SONGS permit do not specify the metrics to be used to evaluate whether the fish and benthic communities are similar to those of the reference reefs. The CCC contract scientists chose to evaluate the performance standards using metrics that best met the intent of the permit (i.e. similarity with the reference reefs) in the fairest manner possible. The number of standards pertaining to the fish community relative to those pertaining to the benthic community was not critical using the previous approach because all standards had to be met. The number of metrics used to evaluate each relative standard, however, was important because

the probability of WNR meeting all the relative standards in a given year diminishes with an increasing number of metrics evaluated. Thus to meet the objectives of Condition C in the fairest manner possible a concerted effort was made to institute the fewest number of metrics in the previous approach. Limiting the number of metrics is not a constraint in the new approach because it requires WNR to meet only as many standards as the lowest performing reference reef. However, implementing the new approach requires a more equitable balance in the number of standards that pertain to the fish and benthic communities, because both are equally important in ensuring that WNR complies with Condition C. Consequently, the ratio of fish standards to benthic standards in the new approach is 5:5 compared to 6:3 in the previous approach (see Table 1).

Rationale for change #4: The two parameter model previously used to estimate species richness of an entire reef required WNR to meet both model parameters (i.e., the slope and asymptote), which in effect resulted in two separate performance standards for species number. Species density is a direct and easily measured estimate of the average number of species per unit area and provides a single measure of the number of species in each of the four groups of organisms targeted in the monitoring plan (i.e., algae, invertebrates, resident fish and yoy fish). Thus the use of species density for assessing reef performance resulted in the abundance of individuals having the same weight as the number of species, which is consistent with the intent of the Permit.

Table. 1. Previous and revised relative standards for evaluating the performance of the Wheeler North Reef

	PREVIOUS		**REVISED**
	Benthic Community Standards		***Benthic Community Standards***
1.	Algae + sessile invertebrate cover	1.	Algal cover
2.	Mobile invertebrate density	2.	Algal species richness
3.	Benthic species richness	3.	Sessile invertebrate cover
		4.	Mobile invertebrate density
		5.	Invertebrate species richness
	Fish Standards		***Fish Standards***
1.	Resident fish density	1.	Resident fish density
2.	Resident fish species richness	2.	YOY fish density
3.	YOY fish density	3.	Fish species richness (all ages)
4.	YOY fish species richness	4.	Fish production
5.	Fish production	5.	Fish reproductive rates
6.	Fish reproductive rates		
	Fish + Benthic Community Standard		***Fish + Benthic Community Standard***
1.	Food chain support	1.	Food chain support

Changes made in March 2014 revision.

Revisions reflect recent decisions on the methods used to determine the as-built footprint area of the Phase 1 and Phase 2 portions of Wheeler North Reef that were jointly agreed upon by SCE and CCC contract scientists at a meeting in La Jolla on Sept 24, 2013. Other changes include clarification of methods used to estimate fish biomass and fish reproductive rates (including updating Appendix 2).

Changes made in January 2015 revision.

Revisions reflect changes in the multibeam sonar data used to assess the footprint area of SONGS. Bathymetry data have proven to be more reliable that backscatter data in estimating the area of Wheeler North Reef. Consequently, bathymetry data are now used to determine changes in the footprint area of Wheeler North Reef. The exception is in 2008 when only backscatter data were collected.

Changes made in April 2017 revision.

Revisions were made to the methods used to evaluate the performance standards pertaining to Fish Reproductive Rates and Benthic Food Chain Support. These revisions involved making slight changes to the methods used to calculate standardized Fecundity and the standardized Food Chain Support Index to insure that all species and years were weighted equally when assessing performance.

CALIFORNIA COASTAL COMMISSION
45 FREMONT, SUITE 2000
SAN FRANCISCO, CA 94105- 2219
VOICE (415) 904- 5200
FAX (415) 904- 5400
TDD (415) 597-5885

W16a

October 20, 2017

TO: Commissioners and Interested Parties

FROM: John Ainsworth, Executive Director
Susan M. Hansch, Chief Deputy Director
Alison Dettmer, Deputy Director
Dr. Kate Huckelbridge, Senior Environmental Scientist, Energy, Ocean Resources, and Federal Consistency Division

SUBJECT: Review of and Possible Commission Action on 2018 and 2019 Two-Year Work Program and Budget for the San Onofre Nuclear Generating Station (SONGS) Mitigation Independent Monitoring Program

SUMMARY OF STAFF RECOMMENDATION

The staff is recommending Commission approval of a two-year work program and $6,261,250 two-year budget paid by Southern California Edison for the independent monitoring and technical oversight of the San Onofre Nuclear Generating Station (SONGS) mitigation projects. The mitigation projects and the permittee funded independent monitoring are required under Southern California Edison Company's coastal development permit (No. 6-81-330-A, formerly 183-73). The staff is also recommending Commission approval of a $216,794 contingency fund to be used for the independent monitoring, in consultation with SCE, if needed.

The permit conditions originally were adopted by the Commission in 1991 to mitigate the adverse impacts of the operation of SONGS Units 2 and 3 on the marine environment. The conditions require SCE and its partners to: (1) create or substantially restore a minimum of 150 acres of southern California wetlands (Condition A), (2) install fish barrier devices to reduce the biomass of fish killed inside the power plant (Condition B), and (3) construct an artificial reef large enough to sustain 150 acres of medium to high density kelp bed community together with funding for a mariculture/marine fish hatchery (Condition C). The conditions also require SCE to provide the funds necessary for technical oversight and independent monitoring of the mitigation projects, to be carried out by independent contract scientists under the direction of the Executive Director (Condition D). Implementation of the mitigation projects is the responsibility of SCE whereas the Commission is responsible for overseeing the independent monitoring and technical

oversight. The independent monitoring and oversight also includes periodic public review of the performance of the mitigation projects.

The independent field monitoring program is carried out through a contract with the University of California, Santa Barbara. Under this contract monitoring data are collected by university contract biologists under the direction of three Principal Scientists that serve as project managers for the monitoring effort (collectively known as "contract scientists"). Southern California Edison also provides funds for a science advisory panel to provide independent scientific expertise to the Commission and to the Principal Scientists.

Work Program for 2018 and 2019

The two principal components of the mitigation project, the wetland and the reef, are progressing on slightly different timelines. The Commission approved the CDP for the San Dieguito wetland restoration project on October 12, 2005 (CDP #6-04-88). Construction began in August 2006 and was completed in fall 2011 with inlet dredging. During the 2016-2017 work period, the contract scientists implemented the fifth and sixth year of independent performance monitoring to evaluate whether the wetland restoration met the standards set forth in the SONGS permit. In 2018 and 2019, independent performance monitoring will continue.

After construction and monitoring of an experimental reef, the Commission approved the coastal development permit and final reef mitigation plan on February 6, 2008 (CDP #E-07-010). Construction of the artificial reef was completed in September 2008, and on January 27, 2009, the Executive Director determined that the constructed reef met the Final Design Plan specifications in the SONGS permit. During the 2016-2017 work periods, contract scientists implemented the eighth and ninth years of independent performance monitoring to evaluate whether the mitigation reef met the standards set forth in the SONGS permit. Reef tasks for the 2018 and 2019 work period will continue with the tenth and eleventh year of post-construction performance monitoring. As discussed below, the reef has failed to meet performance standards for the last nine years, and in response, the Executive Director of the Commission required SCE to remediate the reef. A permit implementing the required remediation is anticipated to be before the Commission in the next year, and could necessitate revisions to the 2018-2019 work program.

Budget for 2018 and 2019

The proposed budget for calendar years 2018 and 2019 covers the independent monitoring and technical oversight program costs for the independent contract scientists, science advisory panel, consultants, administrative support, and operating expense. The proposed independent scientific staff is the minimum needed to meet the goals specified by the permit under Condition D and to complete the tasks identified in the 2018-2019 work program. The proposed funding totals $6,261,250 for the two years. Coastal Commission staff also is proposing pre-approved contingency funds in the amount of $216,794 specifically for potential additional costs for: (1) the Scientific Advisory Panel, (2) early office lease termination, (3) unexpected repair and/or replacement of field vehicles and outboard engines, and (4) tasks associated with the review of SCE's proposed reef remediation project. The Commission's permanent staff also spends a portion of their time on this program, but except for direct travel reimbursements, their costs are paid by the Commission and are not included in the monitoring program budget.

SCE has indicated its satisfaction with the proposed Commission oversight and independent monitoring work plan and budget for the wetland and reef mitigation program for 2018-2019. Staff recommends that the Commission approve the 2018-2019 work program and budget for the independent monitoring and technical oversight of the San Onofre Nuclear Generating Station (SONGS) mitigation projects.

The Coastal Commission staff and the contract scientists will provide an in-depth report on the status of the SONGS Mitigation Program for the Commission at the November 2017 meeting.

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APPENDICES

EXHIBITS

I. MOTION AND RESOLUTION

Motion:

> *I hereby move that the Commission approve the 2018 and 2019 two-year SONGS Work Program and Budget and contingency fund as recommended by the staff.*

The staff recommends a **"yes"** vote on the foregoing motion, which will result in the adoption by the Commission of the following resolution:

> *The Commission hereby determines that the 2018 and 2019 two-year SONGS Work Program and Budget and contingency fund that is set forth in the staff recommendation, dated October 20, 2017, carries out the intent of Condition D of Permit 6-81-330-A (formerly 183-73) by requiring the permittee to provide reasonable and necessary funding for the independent contract scientists' technical oversight and independent monitoring responsibilities pursuant to the mitigation and lost resource compensation conditions (A through C).*

II. FINDINGS AND DECLARATIONS

A. SONGS PERMIT BACKGROUND

In 1974, the California Coastal Zone Conservation Commission issued a permit (No. 6-81-330-A, formerly 183-73) to Southern California Edison Company for Units 2 and 3 of the San Onofre Nuclear Generating Station (SONGS). A condition of the permit required study of the impacts of the operation of Units 2 and 3 on the marine environment offshore from San Onofre, and mitigation of any adverse impacts. As a result of the impact studies, in 1991 the Coastal Commission added new conditions to mitigate the adverse impacts of the power plant on the marine environment which require the permittee to: (1) create or substantially restore at least 150 acres of southern California wetlands (Condition A), (2) install fish barrier devices to reduce the biomass of fish killed inside the power plant (Condition B), and (3) construct a 300-acre kelp reef (Condition C). The conditions specify both physical and biological performance standards for the wetland restoration and kelp reef, and require continuing monitoring of the effectiveness of the fish barriers. The 1991 conditions also require SCE to provide the funds necessary for Commission contract scientific staff technical oversight and independent monitoring of the mitigation projects (Condition D). Monitoring, management and remediation, if needed, are required to be conducted over a period of time equivalent to the "full operating life" of SONGS, defined as past and future years of operation of SONGS Units 2 and 3, including the decommissioning period to the extent that there are continuing discharges. Operation of Units 2 and 3 began in 1983 and 1984, respectively.

Both reactors were shut down in January 2012 due to excessive wear in the cooling tubes of the steam generators, and permanently retired in June 2013. Although Units 2 and 3 have been permanently shut down, SONGS still circulates ocean water within the plant to cool the spent fuel, and thus continues to discharge cooling water. Thus the number of years of mitigation credit that the SONGS mitigation project must obtain to fulfill the requirements of the SONGS CDP is a minimum of 30 years.

In 1993, the Commission added a requirement for the permittee to partially fund construction of an experimental white sea bass hatchery. Due to its experimental nature, the Commission did not assign mitigation credit to the hatchery requirement.

After extensive review of new kelp impact studies, in April 1997 the Commission approved amended conditions which: (1) reaffirm the Commission's prior decision that San Dieguito is the site that best meets the permit's standards and objectives for wetland restoration, (2) allow up to 35 acres credit for enhancement of wetland habitat at San Dieguito Lagoon by keeping the river mouth permanently open, and (3) revise the kelp mitigation requirements in Condition C. Specifically, the revised Condition C requires construction of an artificial reef large enough to sustain 150 acres of medium to high density kelp bed community that supports 28 tons of reef associated fish (which could result in a reef larger than 150 acres) together with funding for a mariculture/marine fish hatchery as compensation for the loss of 179 acres of medium to high density kelp bed community resulting from the operation of SONGS Units 2 and 3. The artificial reef is to consist of an experimental reef of at least 16.8 acres and a larger mitigation reef to meet the 150-acre kelp bed and 28 ton fish standing stock requirements. The purpose of the experimental reef is to determine which combinations of substrate type and substrate coverage will most likely achieve the performance standards specified in the permit. The design of the mitigation reef will be contingent on the results of the experimental reef.

The Commission also found in April 1997 that there is continuing importance for the independent monitoring and technical oversight required in Condition D to ensure full mitigation under the permit.

B. Commission Oversight and Independent Monitoring

Condition D of the permit establishes the administrative structure to fund the independent monitoring and technical oversight of the mitigation projects. It specifically: (1) enables the Commission to retain contract scientists and technical staff to assist the Commission in carrying out its oversight and monitoring functions, (2) provides for a scientific advisory panel to advise the Commission on the design, implementation, monitoring, and remediation of the mitigation projects, (3) assigns financial responsibility for the Commission's oversight and monitoring functions to the permittee and sets forth associated administrative guidelines, and (4) provides for periodic public review of the performance of the mitigation projects.

Condition D requires SCE to fund the Commission's oversight of the mitigation and independent monitoring functions identified in and required by Conditions A through C. The permittee is required to provide "reasonable and necessary costs" for the Commission to retain personnel with appropriate scientific or technical training and skills, as well as reasonable funding for necessary support personnel, equipment, overhead, consultants, the retention of contractors needed to conduct identified studies, and to defray the costs of members of any scientific advisory panel convened by the Executive Director to provide advice on the design, implementation, monitoring and remediation of the mitigation projects.

Pursuant to this condition, the Commission has operated under approved work programs and budgets since 1993. The funds for the oversight and monitoring program are managed by an independent accounting firm. The Commission retains a science advisory panel under contract to provide scientific expertise to the Commission, contract staff scientists to manage and operate the monitoring program and administrative support personnel to manage administrative tasks. In

addition, independent consultants and contractors are called upon when specific expertise or assistance is needed for specific tasks. The Commission's permanent staff also spends a portion of their time on this program, but except for direct travel reimbursements, their costs are paid by the Commission and are not included in the monitoring program budget.

In approving the work programs and budgets for the monitoring and oversight program, the Commission has authorized an implementation structure through a contract with the University of California, Santa Barbara that utilizes the existing contract scientists as project managers at no additional cost, with data collection done by university contract staff biologists under their direction. The Commission found, based on a comparison of estimated costs from UCSB, other universities, and private consultants, that this implementation structure is the most efficient, cost-effective, scientifically rigorous, and timely method of achieving the goals of the independent monitoring required by the permit. This implementation structure will continue during the two-year period of the 2018 and 2019 work program.

C. Status of Mitigation Program

1. Status of Wetland Restoration Mitigation

Condition A of the permit requires the permittee to create or substantially restore a minimum of 150 acres of wetlands to mitigate for the reduction in the standing stocks of nearshore fishes caused by the operation of SONGS Units 2 and 3. In April 1997, the Commission revised Condition A to allow the permittee to meet its 150-acre requirement by receiving up to 35 acres enhancement credit for the permittee's permanent, continuous tidal maintenance at San Dieguito Lagoon. On October 12, 2005, the Commission approved the Final Restoration Plan and CDP #6-04-88, for the San Dieguito Wetland Restoration Project (See Exhibits 1 and 2 and Appendix A for a complete list of specific condition compliance dates). Construction of the wetland restoration project at San Dieguito (Exhibit 2) commenced in August 2006 and was completed on September 29, 2011, with the completion of the inlet opening.

Wetland Vegetation. Following excavation and grading, portions of the restoration project were planted with salt marsh vegetation. Planting of selected species (largely pickleweed) in high marsh habitat occurred in January/February 2009. The performance of these plantings varied among modules with the best survival and growth occurring in W4/W16, whereas plantings failed to survive in W2/W3. Some natural recruitment of pickleweed has occurred in all modules. Discussions between Commission staff, contract scientists, and SCE regarding the failure of these plantings and the patchiness of natural plant establishment lead to the construction of tidal networks and re-grading of some areas of W2/W3 in November 2010 to better convey tidal waters throughout these modules. Plant establishment improved in areas adjacent to the tidal creeks, but remained sparse at higher elevations that received infrequent tidal inundation. Further discussions between Commission staff, contract scientists, and SCE lead to the re-grading of W2/W3 in March 2014 to lower tidal elevations with more slope to improve the drainage of tidal waters. Natural recruitment of pickleweed was observed in the re-graded areas in spring 2015 and 2016 and has continued to expand since then. Based on observations of an increase in vegetation cover in spring 2017, we expect the continued development of salt marsh vegetation over the next few years.

Pacific cordgrass, a native low marsh plant, provides habitat for the endangered Light-footed clapper rail (recently re-named the Ridgway's Rail) and other bird species. Cordgrass (1200

individuals) was planted in November 2008 and April 2009 with a larger planting (19,450 individuals) in November 2011. Cordgrass was sparsely distributed during the first two years following planting. However, the acreage of cordgrass has subsequently increased to cover approximately 5 acres of restored habitat along the margins of the restored basin (W1) and throughout lower elevation areas of modules W4/W16. These results are encouraging and suggest that cordgrass will become well established in low marsh habitat throughout the wetland.

Wetland Acreage and Topography. The SONGS permit required independent monitoring by Commission contract scientists to ensure that the restoration work was conducted according to approved plans. To accomplish this task, CCC contract scientists established good communication with SCE and its partners involved with implementation of the Final Plan and a frequent on-site presence at the restoration site. CCC contract scientists monitored construction activities through attendance at briefings, discussions with SCE and its consultants, and field inspections of work in progress to ensure the wetland was constructed according to the approved Final Plan. These inspections included verifying module boundaries and elevations, planned habitat areas, and the appropriate tidal regime. CCC contract scientist surveys indicated that SCE has met the acreage requirement of 150 acres of tidally influenced habitat in 2013 through 2016.

CCC contract scientists also monitored the impacts of unplanned construction activities. Unplanned construction changes have caused impacts to existing habitat through changes in the alignment of a haul road, and unforeseen impacts of a disposal site and berm on wetland habitat. Staff administered these changes through condition compliance, where appropriate, and through permit amendments as needed.

Monitoring Plan and Adaptive Management

Condition A of the SONGS permit requires that monitoring of the wetland restoration be done for a period of time equivalent to the full operating life of SONGS Units 2 and 3. This monitoring will be done to measure compliance of the mitigation project with the performance standards specified in the SONGS permit. In accordance with Condition D (Administrative Structure) of the permit, contract scientists retained by the Executive Director developed the Monitoring Plan to guide the monitoring work and are overseeing the monitoring studies outlined in the Plan. The SONGS permit provides a description of the performance standards and monitoring required for the wetland mitigation project. A Draft Monitoring Plan for the SONGS Wetland Mitigation Program was reviewed by State and Federal agencies and SCE in May 2005. A revised Monitoring Plan was part of the coastal development permit (No. 6-04-88) for the wetland restoration project and was considered and approved by the Commission on October 12, 2005. The Monitoring Plan was most recently updated in July 2017.

The Monitoring Plan for the SONGS Wetland Mitigation Program closely adheres to the monitoring requirements of the SONGS permit and includes a description of each performance standard and the methods that will be used to determine whether the various performance standards have been met. The performance standards that are being used to measure the success of the wetland restoration project fall into two broad categories. Absolute standards are evaluated only in San Dieguito Lagoon and pertain to topography, tidal prism, habitat areas, reproductive success of salt marsh plants, and exotic species. Relative standards require that the value of the variable of interest be similar to that measured in reference wetlands in the region. The relative standards pertain to water quality (i.e., oxygen concentration), biological communities (i.e., fish, invertebrates, and birds), salt marsh vegetation, *Spartina* canopy

architecture, and food chain support functions. The successful achievement of the relative performance standards will be measured in comparison to three reference wetlands, which are specified in the SONGS permit to be: (1) relatively undisturbed, (2) natural tidal wetlands, and (3) within the Southern California Bight. The wetlands that best met these three criteria and that were selected as reference sites are Tijuana River Estuary, Mugu Lagoon, and Carpinteria Salt Marsh.

Management issues relevant to the SONGS wetland mitigation requirement are also discussed in the Monitoring Plan. These issues include inlet maintenance, excessive changes in topography, and exotic species. Although the Commission's contract scientists are not responsible for managing the wetland restoration, their monitoring will measure several parameters that can be used in adaptive management to ensure the success of the restoration project.

The SONGS permit requires SCE to develop and implement a plan for managing the inlet in perpetuity to ensure uninterrupted tidal flushing of the restored wetland. This plan, initially submitted to CCC staff on March 30, 2006, revised and finally accepted by the Executive Director on January 27, 2011, provides conditions that would indicate the need for additional maintenance dredging at the inlet. Commission contract scientists are measuring water elevation, tidal exchange, salinity, and dissolved oxygen concentration in the wetland during their evaluation of the water quality performance standard. These variables change dramatically with a reduction in tidal flushing and provide a useful trigger for inlet maintenance. Monitoring by CCC contract scientists have found no evidence of reduced tidal flushing or degradation of water quality. However, monitoring by SCE contractors found increasing movement of beach sand into the inlet and as a result, dredging of the inlet was conducted in November of 2015.

Wetland Performance Monitoring

Construction of the wetland habitats in San Dieguito Lagoon was completed in 2011 and annual post-construction monitoring to evaluate whether the restoration meets the performance criteria identified in Condition A began in January 2012. The success of the San Dieguito Wetlands in meeting the mitigation requirement for a given year is based on its ability to meet the physical and biological performance standards contained in the SONGS Permit. In 2013 through 2016, the San Dieguito Wetlands Restoration Project satisfied four of the five absolute standards, which pertained to topography, tidal prism, plant reproductive success, and exotic species. The project has yet to meet the habitat areas standard. This standard requires that habitat areas in the Restoration be within 10% of the areas provided in the Final Plan. The restoration met a higher proportion (0.87) of the relative standards than the proportion met in the lowest performing reference wetland (0.73) in both 2015 and 2016. The relative standards that were met in both years pertained to water quality, the densities and species richness of fish and birds and macro-invertebrates in main channel habitat, invertebrate species richness in tidal creek habitat, *Spartina* canopy architecture, and food chain support. The relative standards that were not met in both years pertained to the cover of salt marsh vegetation and the densities of macro-invertebrates in tidal creek habitat. There is an additional permit requirement that the standards for Biological Communities must be met within four years of construction of the wetland. These standards were met in 2015 and 2016, thus satisfying this permit requirement.

As of 2016, the San Dieguito Wetlands Restoration has not earned any mitigation credit for resources lost due to SONGS operations because it has not yet met the habitat areas standard. The slow development of vegetation in modules W2/3 is responsible for the failure of the

restored wetland to meet both the habitat areas standard and the vegetation standard. SCE is aware of the problem and is implementing a planting program to increase vegetation cover to bring the project into compliance with the requirements of the SONGS permit. The reason for the slow development of macro-invertebrates is unknown at present, but more time may be required for macro-invertebrates to become established. Conditions in the San Dieguito Wetland that will warrant close observation during 2018 and 2019 include development of salt marsh vegetation cover and macro-invertebrate density in tidal creeks. Results from monitoring in 2015 and 2016 were presented at an annual public review workshop held on May 9, 2016 and May 8, 2017 in the City of Del Mar and are posted on UCSB's SONGS mitigation monitoring website (http://marinemitigation.msi.ucsb.edu/documents/annual_review_workshops/wetland/index.html).

2. Status of Kelp Reef Mitigation

Condition C of the permit requires construction of an artificial reef that consists of an experimental reef and a larger mitigation reef. The experimental reef must be a minimum of 16.8 acres and the mitigation reef must be of sufficient size to sustain 150 acres of medium to high density kelp bed community with a standing stock of reef fish that is at least 28 US tons. The purpose of the experimental reef was to determine which combinations of substrate type and substrate coverage would most likely achieve the performance standards specified in the permit.

The Coastal Commission approved the coastal development permit for the experimental reef on July 15, 1999. The final plan approved by the Coastal Commission was for an experimental artificial reef located off San Clemente, California that tested eight different reef designs that varied in substrate composition (quarry rock or recycled concrete), substrate coverage (low, medium, and high), and presence of transplanted kelp. All eight reef designs were represented as individual 40 m x 40 m modules that were replicated in seven areas (i.e., blocks) for a total of 56 artificial reef modules totaling 22.4 acres. SCE completed construction of the experimental reef on September 30, 1999. Five years of post-construction monitoring of the experimental reef were completed in December 2004. Results from the five-year experimental phase of the artificial reef mitigation project were quite promising in that all six artificial reef designs and all seven locations (i.e., blocks) tested showed a high tendency to meet many of the performance standards established for the mitigation reef. It was concluded from these findings that a low relief concrete rubble or quarry rock reef constructed off the coast of San Clemente, California had a good chance of providing adequate in-kind compensation for the loss of kelp forest biota caused by the operation of SONGS Units 2 and 3.

The Commission approved CDP #E-07-010 for the Phase 2 mitigation reef on February 12, 2008 (See Exhibits 3 and 4, and Appendix B for a complete list of specific condition compliance dates). The plan called for the addition of 127.6 acres of reef construction to the existing 22.4 acres built in September 1999 for the Phase 1 experimental reef. Construction of the Phase 2 mitigation reef began on June 9, 2008 and was completed on September 11, 2008.

Monitoring Plan

The SONGS permit requires the Wheeler North Reef to be monitored, managed, and, if necessary, remediated upon the completion of its construction. The purpose of the mitigation monitoring program, conducted by independent contract scientists working for the CCC, is to: (1) determine whether the performance standards established for the mitigation reef are met, (2)

determine, if necessary, the reasons why any performance standard has not been met, and (3) develop recommendations for appropriate remedial measures. The SONGS coastal development permit requires the CCC's contract scientists to develop a monitoring plan for the reef mitigation project that describes the sampling methodology, analytical techniques and methods for measuring performance of the mitigation reef relative to the performance standards identified in the SONGS coastal development permit. UCSB scientists working under contract for the CCC submitted a monitoring plan for the SONGS' reef mitigation project to the CCC on September 27, 2007. The monitoring plan contains: (1) a description of the process used to evaluate condition compliance, including a list of the performance standards by which the Wheeler North Reef will be judged and the general approach that will be used to judge the overall success of the mitigation project, (2) descriptions of the specific sampling methods and analyses used to evaluate each of the performance standards, (3) an explanation of how project data will be managed and archived for future use, and (4) a description of how the results from the monitoring program will be disseminated to the CCC, the applicant, and all other interested parties. The Monitoring Plan for the SONGS' Reef Mitigation Project is a dynamic document that is modified as needed to ensure and maintain rigorous monitoring and evaluation of Condition C in the most cost-effective manner possible. The reef monitoring plan, most recently updated in April 2017 to include general modifications to how the performance standards are evaluated, is available at: (http://marinemitigation.msi.ucsb.edu/documents/artificial_reef/ucsb_%20mm_reports/mitigation_phase/monitoring_plan4reef-mitigation_project_rev_apr2017.pdf).

Reef Performance Monitoring

Concurrent monitoring of physical and biological attributes of the Wheeler North Reef and two reference reefs (San Mateo and Barn) is conducted annually to evaluate whether the Wheeler North Reef meets the performance criteria identified in Condition C. To date, Commission contract scientists have completed annual quantitative underwater surveys of all three reefs for 2009 -2017. Results from the 2016 surveys were reported at the annual public review workshops held in Dana Point, CA in April 2017 and are available at: http://marinemitigation.msi.ucsb.edu/documents/annual_review_workshops/artificial_reef/index.html.

Monitoring results obtained thus far have been mixed, with Wheeler North Reef consistently meeting many of its objectives, but failing to meet others. Notably, the biological community on the Wheeler North Reef has consistently met as many or more of the relative performance standards pertaining to the kelp forest community as the reference reefs. However, the success of the Wheeler North Reef is also assessed on its ability to meet all four absolute performance standards as well as a similar number of relative performance standards as the two reference reefs. In 2016 the Wheeler North Reef failed to meet the absolute performance standard requiring to sustain 150 acres of adult giant kelp, though it consistently met this standard from 2010 - 2015. The failure of the Wheeler North Reef to meet the standard for giant kelp in 2016 is believed to have resulted from a sustained period of anomalously warm water that adversely affected the growth and survivorship of giant kelp throughout southern California.

Of greater concern is the failure of the Wheeler North Reef to meet the absolute standard that requires it to support a fish standing stock of at least 28 tons. Since monitoring commenced in 2009, Wheeler North Reef has failed to meet this requirement and thus, has not earned any mitigation credit for compensating the kelp forest resources lost due to SONGS operations. Results of analyses using longer-term data collected from the reference sites and the

experimental modules during the Phase 1 and Phase 2 periods of the project indicate that the present size and configuration of the Wheeler North Reef is not sufficient to consistently support 28 tons of kelp bed fish. On May 24, 2016, the Commission's Executive Director informed SCE that to comply with the requirements of CDP 6-81-330-A, SCE would be required to remediate Wheeler North Reef by building new reef acreage that meets minimum size, relief and cover requirements (described in detail in the letter). Over the past year and a half, Commission staff, the contract scientists and the SAP have worked with SCE to develop a remediation project that is sufficient to consistently meet all the requirements of the SONGS permit. Currently, SCE has developed a project description and is working with the SLC to ensure that CEQA requirements are satisfied. Commission staff anticipates that remediation of Wheeler North Reef will come before the Commission in spring or summer of 2018.

More complete information on the results of monitoring the performance of the Wheeler North Reef can be found in the annual reports on kelp reef mitigation available at: http://marinemitigation.msi.ucsb.edu/documents/artificial_reef/index.html.

3. Status of Fish Behavioral Mitigation

Mitigation Requirement

Condition B of the SONGS permit requires SCE to install and maintain behavioral barrier devices at SONGS Units 2 and 3 to reduce fish impingement losses.

Fish Behavioral Mitigation Compliance

The impact studies for the operation of SONGS Units 2 and 3 conducted between 1983 and 1991 found that annual losses of juvenile and adult fish in the cooling water systems under normal operations averaged about 20 metric tons. Although the SONGS permit does not specify any criteria for evaluating the effectiveness of these devices, the Commission accepted the studies' recommendation that "the techniques" (behavioral barrier devices) "be tested on an experimental basis, and implemented if they reduce impingement by at least 2 metric tons (MT) per year", which is equivalent to at least 10% of the average loss due to impingement (Section IV– Proposed Findings and Declarations in the SONGS 1991 permit). None of the experiments showed evidence that these devices would reduce fish impingement losses as required by Condition B. At the same time, SCE continued its modified heat cleaning treatments of the cooling water intake systems of Units 2 and 3 (called the fish chase procedure), which can result in a considerable reduction in fish impingement.

In October 2000, the Commission reviewed the results of the experiments and concluded that no further testing of alternative behavioral barriers should be required at that time, provided that: (1) SCE continues to adhere to the operating, monitoring, and reporting procedures for the heat cleaning treatments, and (2) SCE makes every effort to test and install, if feasible, future technologies or techniques for fish protection if such techniques become accepted industry standards or are required by the Commission in other power plant regulatory actions. (See staff report entitled *Executive Director's Determination that Fish Behavioral Barriers Tested at SONGS are Ineffective*, dated September 22, 2000.)

The contract scientists and staff review the annual data and analyses on the fish chase procedure at SONGS against two key standards discussed in the staff report:

(1) The **Fish Return Standard**: This standard is a measure of the effectiveness of the Fish Chase procedure used during heat treatments. This procedure can lead to a reduction in impingement by causing fish that would be impinged to be returned to the ocean by means of the fish return system. The standard is that the return should be at least 10% of the overall impingement biomass for the year.

(2) The **Mortality Standard**: There should not be higher than normal mortality. Higher than normal mortality is defined as: (1) a sequence of three or more heat treatments where the mortality rate exceeds 50%, (2) more than 50% of heat treatments in a given year have more than a 50% mortality rate, or (3) mortality rate for the year exceeds 50%.

Between 2000 and 2011, the fish chase Procedure effectiveness relative to impingement (Fish Return Standard) was 10% or greater in only 7 of the 12 years, and the Mortality was met in only 5 of those years (2000-2011). There were only 4 years in which both standards were met.

In January 2012, normal operations of SONGS Units 2 and 3 were shut down, one unit due to routine maintenance, the other due to the discovery of a leak inside its steam generator. With the units shutdown and thus, not generating heat, SCE was unable to implement the fish chase procedure. However, shutting down SONGS Units 2 and 3 led to a significant decrease in both the intake flow rate (~96%) and velocity (~94%). In 2013, this reduction translated into reductions in the total abundance (~69%) and biomass (~94%) of fish impinged at SONGS that were significantly larger than the 10% reduction required by the Fish Return Standard in the Executive Director's 2000 determination.

With SCE's June 2013 announcement that SONGS would be permanently decommissioned, the reduction in intake volume and velocity reported in 2013 is expected to be a permanent project feature, until such time as SONGS is fully decommissioned and seawater is no longer needed. Thus, as long as these intake reductions remain in place, the abundance and biomass of fish impinged by SONGS is expected to continue to be significantly lower than the long-term average measured between 1983 and 2011. Based on this information, Commission staff notified SCE in a letter dated March 27, 2015 that with the shutdown of Units 2 and 3 and the resulting decreases in intake flow and velocity and fish impingement, SCE had met the intent and requirements of Special Condition B and the Executive Director's determination regarding behavioral barriers at SONGS. As long as the reductions in intake flows are maintained, SCE is no longer required to conduct heat treatments or monitor and report on the efficacy of the Fish Chase Procedure. However, if the total intake flow increases above a monthly average of 50 MGD and/or the instantaneous flow velocity increases above 0.5 feet per second[1], SCE is required to consult with Commission staff to determine if impingement monitoring and reporting should resume.

4. Status of Hatchery Program

Permit Requirement

In two separate permit actions in 1993 and 1997, the Coastal Commission required the permittee to contribute to the California Department of Fish and Wildlife's (formerly, Dept. Fish & Game)

[1] These thresholds align with thresholds developed by the State Water Resources Control Board under the 2014 Once-Through Cooling Water Policy that allow an existing power plant to demonstrate compliance with the policy under Track 1, indicating that flow reductions in place are sufficient and additional monitoring is not required.

Ocean Resources Enhancement and Hatchery Program (OREHP) for a total required mitigation fee of $4.8 million to be used toward the construction of an experimental white seabass fish hatchery and an evaluation program to determine if the hatchery is effective at increasing the stock of white seabass. SCE has fulfilled all of its obligations for funding the fish hatchery requirements of the SONGS permit. Permanent Commission staff provides oversight of the Department of Fish and Wildlife's continuing fish hatchery program.

California Department of Fish and Wildlife Hatchery Program

The marine fish hatchery program is operated by Hubbs Sea World Research Institute and the State of California through the Ocean Resources Enhancement and Hatchery Program (OREHP), which is administered by the California Department of Fish and Wildlife. Although the SONGS' mitigation funds were exhausted at the end of the 2004-2005 fiscal year, the OREHP program is ongoing and funded primarily through the sale of recreational fishing licenses in southern California. White seabass are spawned at a hatchery in Carlsbad operated by the Hubbs-Sea World Research Institute and then tagged and transferred to grow-out facilities operated jointly by the California Department of Fish and Wildlife and volunteer fishermen. After the fish attain a minimum length, they are released. The OREHP is currently authorized to release up to 350,000 fish annually, based on the active broodstock population at the hatchery. The OREHP operates under the terms and conditions of numerous state, local, and federal permits and authorizations. These include a Memorandum of Agreement among the California Department of Fish and Wildlife, Coastal Commission, and OREHP's Scientific Advisory Panel.

Review of the hatchery program is conducted by permanent Coastal Commission staff thus, there are no tasks funded through the SONGS work program.

D. WORK PROGRAM: 2018 AND 2019

Condition D requires the permittee to fund scientific and support staff retained by the Commission to oversee the site assessments, project design and implementation, and monitoring activities for the mitigation projects.

Implementation Structure

Scientific expertise is provided to the Commission by a small technical oversight team hired under contract and paid by an independent accounting firm with non-State SCE funds. The technical oversight team members include three Principal Scientists from UC Santa Barbara: Stephen Schroeter, Ph.D., marine ecologist, Mark Page, Ph.D., wetlands ecologist (half time), and Daniel Reed, Ph.D., kelp forest ecologist (half-time). A part-time senior administrator (Lane Yee) completes the technical oversight team. In addition, a science advisory panel advises the Commission on the design, implementation, monitoring, and remediation of the mitigation projects. Current science advisory panel members include Richard Ambrose, Ph.D., Professor, UCLA, Peter Raimondi, Ph.D., Professor, UC Santa Cruz, and Russell Schmitt, Ph.D., Professor, UC Santa Barbara.

To meet the goals specified in the permit under Condition D and to complete the tasks identified in the 2018-2019 work program, the technical oversight team is aided by contract biologists who are responsible for collecting and assembling the monitoring data. The technical oversight team is also assisted on occasion by independent consultants and subcontractors when expertise for specific tasks is needed or when additional field assistance is needed for monitoring tasks. The

Commission's permanent staff also spends a portion of their time on this program, but except for direct travel reimbursements, their costs are paid by the Commission and are not included in the SONGS budget.

The staff implements the Commission's technical oversight and independent monitoring program through a contract with the University of California, Santa Barbara. UCSB has an international reputation for excellence in ecology and marine biology and is well equipped to support extramural contracts and grants in these areas. The UCSB contract uses the existing Principal Scientists as project managers for both the wetland restoration and reef mitigation oversight and independent monitoring, with data collection done by the university contract staff biologists under their direction. The Principal Scientists are responsible for supervising the contract staff biologists, subcontractors and consultants, authorizing purchases, interacting with UC administrative staff on issues pertaining to personnel, budget, and UC policies (e.g., boating and diving safety regulations) relevant to the project, and interacting with CCC staff assigned to the mitigation efforts. Monitoring of these projects is being adaptively managed in order to streamline effort and minimize costs without compromising the integrity of the data and their value in decision making with regards to the performance of the mitigation projects. Continuous interaction between the Principal Scientists and contract staff biologists is crucial to fulfilling the monitoring tasks for both the wetland restoration and mitigation reef.

Before starting the five-year experimental reef monitoring program in 1999, Coastal Commission staff conducted a cost comparison among UCSB, other universities, and private consultants and concluded that use of a qualified university would save SCE a substantial sum over use of private consultants. Based on 1995 real cost data from private consultants for work that included the same physical and biological variables used in the SONGS reef monitoring program, costs for private consultants were nearly three times higher than the cost of implementing the monitoring program through UCSB.

The Commission concurred with staff at the start of the monitoring program and continues to find that implementing the field monitoring programs through a contract with UCSB, funded through non-State SCE funds, is the most efficient, cost-effective, scientifically rigorous, and timely method of achieving the goals of the independent monitoring required by the SONGS permit.

Staffing Levels for Wetland Performance Monitoring

Staff has determined the staffing levels for the wetland monitoring tasks based on a consideration of the effort (time) involved to complete each task, location of the task (field sites, laboratory), the number of contract biologists required to complete each task in a timely and efficient manner, the frequency with which each task will be performed, and the expertise required to complete the task. Much of the information used to determine staffing level was developed during pre-restoration monitoring at San Dieguito Lagoon and the reference wetlands (Tijuana Estuary, Mugu Lagoon, Carpinteria Salt Marsh) and during pre-construction and construction monitoring.

The Principal Scientists will continue to be assisted in performance monitoring in 2018-2019 by five full time university contract wetland biologists and one database programmer/systems analyst working 30% time on the wetland project and based at the SONGS Mitigation Program office in Carlsbad. One full time wetland biologist based at the SONGS Mitigation Program office will work with the database programmer to develop the web based wetland database,

which involves the preparation of data entry schemes, quality assurance and quality control procedures, and the training of other project personnel in the use of the database. This biologist will also assist the Principal Scientists with the supervision of project staff, and with the scheduling of monitoring activities. Two other full time wetland biologists/database assistants at the SONGS Mitigation Program office have primary responsibilities to: (1) work with the wetland project database programmer/systems analyst to prepare data entry schemes, and quality assurance and quality control procedures for the wetland data, (2) enter data, (3) assemble field sampling protocols, metadata, and create database user guides, and (4) conduct monitoring activities at the San Dieguito Lagoon restoration and at Tijuana Estuary, one of the reference wetlands.

The Principal Scientists will also be assisted in performance monitoring in 2018-2019 by two full time wetland biologists based at UCSB with primary responsibility for the monitoring tasks at the northernmost reference wetlands (Mugu Lagoon, Carpinteria Salt Marsh), including organizing the field sampling team and leading the field and laboratory work (assessing water quality, cover of saltmarsh vegetation and algal mats, sampling of fish and invertebrates, processing of invertebrate samples). These contract staff biologists are also responsible for organizing and entering data into the project's wetland database, quality control and quality assurance of the data, and consulting with the project's database programmer/systems analyst based in Carlsbad, as well as other tasks as needed.

Temporary employees are used to provide cost-effective assistance with the labor-intensive sampling surveys of fish and macro-invertebrates in the restored and reference wetlands. These are lower level field assistants, some may be university students, who provide logistical support with transporting gear in the wetlands, deploying and retrieving nets during sampling, collecting invertebrate samples, and recording data. Based on monitoring completed to date the Principal Scientists have determined that a total of seven temporary field assistants are the optimal number needed to sample fish and invertebrates in each wetland. Since the San Dieguito restored wetland will be sampled concurrently during the summer with the three reference wetlands, Tijuana Estuary, Mugu Lagoon and Carpinteria Salt Marsh, the three permanent wetland contract biologists based at Carlsbad will be assisted by three temporary field assistants during the intensive summer sampling. The two permanent wetland contract biologists at UCSB will be assisted by four temporary field assistants at the two northern reference wetlands.

In addition to being skilled in invertebrate, fish and plant taxonomy, the use of environmental data loggers, global positioning systems, and data collection methods, wetland contract staff biologists have other skills, similar to those of biologists employed on the reef project, that are required to complete the monitoring requirements of the mitigation project. These skills include data entry, database development, quality control and quality assurance as well as expertise in the use of statistical software, equipment maintenance, fabrication of sampling devices, and expertise in information technology.

The contract scientists seek to minimize the time between sample collection, sample processing, and the analysis of collected data, so that the monitoring results can be completed and reported in a timely manner. Full-time wetland contract scientists are highly qualified scientists capable of performing all the technical and scientific aspects of the monitoring program.

In conclusion, the staffing levels identified in the work plan for the wetland project in 2018 and 2019 have been carefully thought out using information obtained from prior monitoring, and

vetted through the Science Advisory Panel and Coastal Commission staff, as the minimum level needed to meet the monitoring requirements for the wetland mitigation as specified in the SONGS permit.

Staffing Levels for Reef Performance Monitoring

A team of marine biologists employed by UCSB assists the Principal Scientists in monitoring the performance of the Wheeler North Reef. Staff has determined that the staffing levels of 8 university-certified scientific divers are required for the reef monitoring tasks. This determination is based on a number of considerations. First, university and industry accepted standards require that diving be done in pairs. Because most kelp forest organisms show substantial seasonal variation in recruitment, growth and overall abundance, data need to be collected at the mitigation reef and the two reference reefs contemporaneously during a relatively short season (June through October) each year. This, coupled with the often-marginal diving conditions typical of the project site prevents using fewer divers over a longer period of time. Second, safe diving practices limit the amount of time divers are able to spend underwater on a given day and the number of days diving in any given week. Third, full time university-trained research divers can more cost-effectively accommodate the inevitable unforeseen contingencies caused by weather or logistical constraints that arise during the course of the monitoring work than can part time employees. Fourth, completion of the field work requires a substantial level of expertise and training. UCSB's project staff biologists are trained in identifying over 200 species of benthic algae and invertebrates and some 45 species of kelp forest fishes, which is needed to properly evaluate the performance standards for the artificial reef.

Extensive use of part-time biologists would require either highly paid experts or would entail significant (and costly) training of less qualified individuals. Moreover, the logistics of deploying part-time scientific divers in an environment where field conditions for diving are often marginal and vary unpredictably is inefficient and can result in a less than satisfactory completion of assigned tasks (as was borne out during the 1999-2001 work programs in which private consultants were used for some of the tasks).

Lastly, in addition to being experts in scientific diving and data collection, UCSB's research divers are trained in a number of other tasks necessary for completing the monitoring requirements of the mitigation projects. These tasks include: data management (data entry, quality control and quality assurance) and processing using statistical and database software, equipment maintenance, fabrication of sampling devices, small marine boat operations and maintenance, and expertise in information technology. If ocean conditions are not conducive for diving, then project contract staff are assigned other project-related tasks.

The Principal Scientists employ additional temporary field assistants during the summer, the period of the most intense sampling surveys. These are lower level field biologists who are qualified to dive and drive the boats, which is especially critical during the fish surveys as the diving teams complete multiple short dives without having to anchor the boat at each location.

Based on the above considerations, the Principal Scientists have determined that eight diver biologists working full time during the six-month field seasons of each year are needed to complete the reef monitoring activities. During the non-field season, five biologists working full time will be responsible for database development and management, data analysis and reporting, computer network administration and support, equipment repair and maintenance, planning and

preparation for the annual workshop required by the SONGS permit, and other assorted tasks needed to maintain a functional working environment.

In sum, the staffing identified in the 2018-2019 work plan is predicated on meeting the monitoring requirements specified in the SONGS permit and is based on the considerable experience from the 5-year experimental reef monitoring and completion of the first nine years of performance monitoring of the mitigation reef. The currently proposed work program represents a carefully thought out minimum staffing model to accomplish the performance monitoring tasks for the next two years.

Consultation with Permittee

Pursuant to the permit conditions, the staff has consulted with SCE on the proposed work program and budget for 2018 and 2019. SCE indicated its satisfaction with the proposed Commission oversight and independent monitoring work plan and budget for the wetland and reef mitigation program for 2018-2019. SCE's letter of support is attached (Exhibit 5).

1. Wetlands Tasks

The SONGS permit requires independent monitoring by Commission contract scientists to determine whether the physical and biological performance standards of Condition A are met. To accomplish this task, the Principal Scientists will continue to interact closely with SCE and others involved with implementation of the Final Plan.

The following wetland tasks will be completed during the 2018-2019 work period.

1.1 Monitoring of the Restored Wetland

The SONGS permit requires the Commission's independent contract scientists to design and conduct monitoring of the restored wetland to: (1) evaluate compliance of the wetland with the physical and biological performance standards set forth in Condition A, (2) determine, if necessary, the reasons why any performance standard has not been met, and (3) develop recommendations for appropriate remedial measures. The primary monitoring activities planned for 2018-19 entail collecting data that will be used to evaluate the performance of the restored wetland. The particular monitoring activities needed to accomplish this task are specified in the Monitoring Plan for the SONGS Wetland Mitigation Program (http://marinemitigation.msi.ucsb.edu/documents/wetland/ucsb_mm_reports/wetland_mitigation_monitoring_plan_%20updated_february2017.pdf). Wetland construction was completed upon the opening of the inlet on September 29, 2011 and performance monitoring of the wetland began in January 2012.

1.1.1 Performance Monitoring

The following tasks will be undertaken by the Principal Scientists and contract wetland biologists:

a. *Conduct field surveys and use aerial photographs to assess the performance standards pertaining to topography and habitat areas.*

   Observations by the Principal Scientists during construction monitoring indicate that noticeable sediment erosion and deposition can occur within a period of a few months.

Therefore, field observational surveys will be done monthly throughout the restored San Dieguito wetland to monitor for any sign of substantial erosion or sediment deposition that could impede tidal flow within the wetland. Additional surveys will be done following extreme weather events. Annual ground surveys using RTK GPS and low level aerial photographs taken in the spring will be used to determine whether the areas of wetland habitats (subtidal, intertidal mudflat, vegetated marsh) deviate more than 10% from areas specified in the Final Plan. Commission staff has defined 4.5' NGVD as the upper limit of tidally influenced habitat for the calculation of acreage credit for this restoration project. Because of this, the upper edge of the 4.5' contour is of special interest and will be checked annually to evaluate compliance with the acreage requirement and performance standard on habitat areas. Professional surveyors will be engaged as needed to assist in this evaluation.

b. *Conduct field sampling and use environmental data loggers to assess the performance standards pertaining to water quality and tidal prism.*

Because of its documented importance to wetland health, the concentration of dissolved oxygen will be used to evaluate water quality within the restored wetland. Measurements of dissolved oxygen will be made using continuously recording environmental data loggers deployed in the restored and reference wetlands at sites that encompass average conditions. A reduction in the tidal prism of the restored wetland can have detrimental effects on water quality and alter the area of inundated habitat. Tidal prism will be calculated by integrating measurements of tidal flow taken near the inlet using a portable acoustic Doppler profiler/discharge measurement system over a range of predicted tides twice monthly.

c. *Survey fish, macroinvertebrates, and birds to assess the performance standards pertaining to biological communities and food chain support.*

During pre-restoration monitoring, the Principal Scientists developed and refined methods to sample fish and macroinvertebrates. These methods were published in the scientific literature and are being used to evaluate the performance standards pertaining to biological communities. Sampling fish in the restored and reference wetlands, in particular, is a labor intensive task that requires the employment of temporary field assistants to help with enclosure trap and seine sampling during the summer. The methods developed for fish sampling employ the minimum number of personnel for completing the task and a sampling design that balances the conflicting goals of adequate spatial and temporal sample replication to evaluate wetland performance with the time, cost and impacts of sampling in the restored and reference wetlands. The performance standard pertaining to food chain support will be evaluated by measuring bird feeding activity during the same period that bird densities are measured, and using bird species that are present in both restored and reference wetlands. Bird specialists will be retained to assist the Principal Scientists to determine the abundance and number of species of birds and assess bird feeding activity.

d. Use aerial photographs and ground surveys to assess the performance standards pertaining to the cover of wetland vegetation and open space and the coverage of algal mats.

The use of low-level multi-spectral aerial photography provides a means of obtaining a whole wetland estimate of the cover of vegetation, bare space and macroalgae in the restored and reference wetlands. Multi-spectral photographs also allow the identification of plant species assemblages throughout the wetlands, which is useful in locating the presence of exotic species. Aerial photographs will be taken in the restored and reference wetlands in late spring to early summer, which is the period of maximum growth of marsh plants and algae. Ground surveys for the presence of unusually thick algal mats, which typically indicates poor tidal flushing or excessive nutrient enrichment, will also be made during routine water quality monitoring.

e. Assess the performance standard pertaining to Spartina *canopy architecture.*

This task will be accomplished through the measurement of the height of cordgrass (*Spartina foliosa*) stems in sampling quadrats located in stands of cordgrass. Sampling of cordgrass will be done in late spring to early summer concurrently with the monitoring of wetland vegetation.

f. Sample seeds of salt marsh plants to evaluate the performance standard pertaining to the reproductive success of these plants.

The reproductive success of salt marsh plants will be evaluated by measuring seed set in seven plant species in the restored wetland. Sampling will be done annually in late summer-fall when seed set is expected to be greatest.

g. Examine monitoring data and conduct a survey to assess the performance standard pertaining to exotic species.

Monitoring data collected for fish, invertebrates, birds, and plants will be used to evaluate this standard. In addition, a special survey of exotic species that covers as much of the restored wetland as possible will be conducted once a year during the summer to adaptively manage for exotic species. This special survey will focus on plants and visible invertebrates and incorporate a diver survey of the subtidal portion of the main basin (W1, Exhibit 2).

1.1.2 Monitoring of transition habitat as mitigation for construction impacts

a. Conduct surveys to determine if the acreage of transition habitat may be used to mitigate for impacts to seasonal salt marsh caused by construction

Areas between elevations of greater than 4.5’ to 5.0’ NGVD are defined in the Final Restoration Plan (SCE 2005) as a transitional habitat between tidal wetlands and non-tidal or seasonal wetland habitats. In accordance with CDP 6-04-088, data on native vegetation type and cover will be collected in transitional habitat areas annually and

compared to reference site data to determine if transitional habitat acreage can be used to offset impacts to seasonal salt marsh that occurred during wetland construction.

1.2 Wetland Data Management, Analyses and Reporting

a. Enter, organize, and manage data collected during the monitoring studies.

Data management and quality assurance are critically important tasks that require a substantial amount of effort by the team of contract scientists. All monitoring data for the wetland and reef mitigation projects are entered and stored in electronic databases. The SONGS reef mitigation monitoring project's data entry procedures have been designed to facilitate rapid data entry while continuing to ensure the quality and integrity of the data as they are transformed from physical to electronic form. The project employs a highly redundant, multi-server system to ensure maximum data integrity, preservation, and access. The system consists of a central data server, and multiple mirror and backup servers located at UCSB's Carlsbad office, and at the Marine Science Institute on UCSB's main campus in Santa Barbara, CA. The operation, maintenance, and security of this system require a dedicated system administrator in Carlsbad who works closely with the scientific staff on the project and with system administrators on UCSB's main campus.

b. Analyze monitoring data and use them to determine whether the restored wetland is in compliance with the performance standards specified in the SONGS permit. Conduct analyses to determine reasons for any failures to meet the performance standards.

c. Prepare annual reports for the Commission (with a copy to SCE) on the performance of the wetland restoration project and the accumulation of mitigation credit.

d. Respond to requests from SCE and other parties for data and analyses.

e. Maintain a public website with current information on the monitoring of the wetland restoration project.

The Principal Scientists have developed a public website that provides information on the history, current status, and other relevant information pertaining to the monitoring of the SONGS reef and wetland mitigation projects (http://marinemitigation.msi.ucsb.edu/). The website serves as a repository for progress reports, workshop proceedings and other project related documents and thus helps facilitate the transfer of information between the contract scientists and the Commission, SCE, other agencies and the general public.

f. Present monitoring results at annual public workshops and at scientific meetings deemed appropriate by the Coastal Commission and post results on the project's public website.

1.3 Wetland Management, Oversight, and Administration

a. Direct the wetland monitoring studies described in the work plan. This involves planning these activities, managing personnel, and engaging consultants as needed to carry them out.

The Principal Scientists manage a team of university contract research assistants (i.e., wetland biologists trained in data management and analyses) who are responsible for conducting the rigorous field work and extensive data management. They will also participate in field work in the restored and reference wetlands as needed to assist in data collection, resolve issues that arise in the monitoring, and conduct site visits to inspect routine and unexpected changes in the physical and biological properties of the restored and reference wetlands.

b. Resolve any issues pertaining to logistics and data analyses that arise.

c. Work with University of California administrative staff on project issues pertaining to contracts, payroll, purchasing and personnel.

d. Maintain database software, hardware, and network services. Troubleshoot and remedy any problems that arise. Consult with computer consultants as needed to maintain reliability and security of network and desktop operations.

e. Meet with the Science Advisory Panel (SAP) and Coastal Commission Staff to discuss the planning, status and findings of the monitoring studies. Consult with the SAP and Commission staff, members of other resource agencies, and the permittee and its contractors on the planning and permitting of any needed remediation and adaptive management.

f. Perform assorted tasks to maintain a functional working environment.

g. Prepare 2020-2021 Work Plan.

2. Reef Tasks

The permit requires the Commission's contract scientists to monitor the mitigation reef to determine whether: (1) the performance standards of Condition C are met, (2) if necessary, determine the reasons why any performance standard has not been met, and (3) develop recommendations for appropriate remedial measures. Thus the primary monitoring activities planned for 2018 and 2019 entail collecting data that will be used to evaluate the performance of the mitigation reef. The particular monitoring activities needed to accomplish this task are specified in the Monitoring Plan for the SONGS Reef Mitigation Project (http://marinemitigation.msi.ucsb.edu/documents/artificial_reef/ucsb_%20mm_reports/mitigation_phase/monitoring_plan4reef-mitigation_project_rev_apr2017.pdf) . Data management, analysis and reporting, network administration, equipment repair and maintenance, planning and preparation for the annual workshop required by the SONGS permit, and other assorted tasks needed to

maintain a functional working environment are the primary staff activities during the non-field season.

As described in Section C.2, the Commission's Executive Director has required SCE to remediate Wheeler North Reef in accordance with the requirements of CDP 6-81-330-A. Planning for remediation is ongoing, but a specific timeline for permitting and construction is uncertain. If the project progresses quickly, it may become necessary to revise this Work Program and budget to reflect necessary changes to the mitigation monitoring program that address remediation. If revisions become necessary before the end of the two year period, Commission staff will bring a revised Work Program and budget to the Commission for approval.

The following tasks pertaining to the mitigation reef will be completed during the 2018-2019 work period.

2.1 Performance Monitoring of the Wheeler North Reef

a. Conduct diver surveys of the Wheeler North Reef and the two reference reefs in late spring through summer of 2018 and 2019 to assess the performance standards pertaining to substrate coverage, kelp density and the benthic community of algae and invertebrates.

Extensive analyses of data collected during the experimental phase of the reef mitigation project showed that a minimum of 82 sampling stations at the two reference reefs was needed to adequately assess whether the Wheeler North Reef was performing similarly to them with respect to the performance standards identified in Condition C. A slightly higher number of sampling stations (92) are needed to sufficiently characterize the physical and biological characteristics of the 176 acre Wheeler North Reef in order to compare it to the reference reefs. Each sampling station requires a team of 2 to 3 divers who can sample at most 2 stations per day.

b. Conduct diver surveys of the Wheeler North Reef and the two reference reefs in summer and autumn 2018 and 2019 to assess the performance standards pertaining to the standing stock, density, species richness, and recruitment of kelp bed fishes.

Unlike kelp and benthic invertebrates, fish are highly mobile visual predators and their abundances as estimated by divers typically vary dramatically in space and time. Diver sampling of mobile fishes is also complicated by the fact that it requires greater underwater visibility than does the sampling of sessile bottom-dwelling algae and invertebrates. Consequently, it is not always possible to collect data on fish during the diver surveys of the kelp forest community (described in 2.1.a above). Past experience has shown that the combination of these factors requires additional fish surveys be done in summer and autumn to obtain sufficient data to properly evaluate the performance standards for fish standing stock, density, species richness, and recruitment.

c. *Collect fish specimens during the spawning seasons (May-October) of 2018 and 2019 for use in evaluating the performance standards for fish production, fish reproductive rates, and benthic food chain support.*

Unlike the performance standards pertaining to the abundance and number of species of algae, invertebrates and fish, which can be assessed visually by divers, those pertaining to fish production, reproductive rates and food chain support require fish to be collected for processing and analyses in the laboratory. Five key indicator species were selected to evaluate these standards to minimize impacts to the fish assemblages. Data collected during previous work plans determined that 75-150 individuals of each species collected from each reef are needed to properly evaluate these standards. These collections will have little impact on fish populations as they represent < 1% of the standing stock of these species on each of the reference reefs and ~ 0.5% of the standing stock requirement for the Wheeler North Reef. The Principal Scientists will be assisted by subcontractors from California State University, Northridge (CSUN) with expertise in fish production and reproduction.

d. *Process samples used to evaluate the performance standards for fish production, fish reproductive rates, and benthic food chain support.*

Collected specimens must be carefully processed in the laboratory shortly after collection to obtain viable samples for evaluating the performance standards pertaining to fish production, reproductive rates and benthic food chain support. The Principal Scientists will be assisted by subcontractors from CSUN with expertise in fish production and reproduction.

e. *Analyze prepared samples for fish growth, fecundity, and gut fullness.*

Estimates of fish growth will be used to evaluate the fish production standard. These estimates will be obtained using standard methods of analyzing annular rings in fish ear bones (otoliths). Histological analyses of female gonads will be used to evaluate the performance standard pertaining to reproductive rates, and data on gut fullness in two species that feed on the bottom will be used to assess the performance standard pertaining to benthic food chain support. The Principal Scientists will be assisted by subcontractors from CSUN with expertise in fish production and reproduction.

f. *Develop methods for estimating standing biomass of giant sea bass*

The giant sea bass (*Stereolepis gigas*), a top kelp forest predator, was historically common in southern California but was so rare in the 1970's -2000 due to overfishing that it was not observed during the impact assessment phase of the SONGS project. Its abundance has increased following its protection from fishing and it is now commonly seen on Wheeler North Reef and well as the reference reefs. Their large size (up to 600 pounds), low density, large home ranges and attraction to divers leads to inaccurate and highly variable estimates of standing stock using current methods. Techniques of mark and recapture for estimating population size of giant sea bass that rely on identifying

individuals based on unique markings will be developed to improve estimates of their standing stock on Wheeler North Reef.

g. Monitor recruitment, growth, and survivorship of the sea fan Muricea *in long-term plots on the experimental modules.*

The sea fan *Muricea* has been known to colonize artificial reefs in high densities to the exclusion of other reef biota, including giant kelp. Data collected from permanently located sampling plots on 21 rock modules of the experimental reef since summer 2000 have provided valuable information on patterns of *Muricea* colonization, growth and survivorship. Project scientists will continue to monitor these plots in 2018 and 2019 for additional colonization by *Muricea,* and to determine whether there is evidence for density dependent changes in *Muricea* growth and survivorship that might minimize (or at least stabilize) the potential adverse effects of *Muricea* on giant kelp and other components of the benthic community.

h. Monitor reef fish density and sizes in long-term plots on the experimental modules.

Time series data on fish density and size in permanently located sampling plots on 21 rock modules of the experimental reef have been collected by divers since summer 2000. The longer time period of these data encompasses a much wider range of oceanic conditions than those experienced by the Phase 2 mitigation reef, and thus provides important insight into the expectations of the more recently constructed Phase 2 reef. Specifically, these data have provided valuable information on the extent to which fish biomass varies from year to year and in relation to the percent cover of rock covering the bottom. Project scientists will continue to monitor the density and sizes of fish in these plots in 2018 and 2019 for use in analyses aimed at determining the configurations (i.e. rock coverage) and footprint area needed for the Wheeler North Reef to consistently meet the performance standards.

2.2 Reef Data Management, Analyses and Reporting

a. Enter, organize, and manage data collected during the monitoring studies.

Data management and quality assurance are critically important tasks that require a substantial amount of effort by the team of contract scientists. All monitoring data for the wetland and reef mitigation projects are entered and stored in electronic databases. The SONGS reef mitigation monitoring project's data entry procedures have been designed to facilitate rapid data entry while continuing to ensure the quality and integrity of the data as they are transformed from physical to electronic form. The project employs a highly redundant, multi-server system to ensure maximum data integrity, preservation, and access. The system consists of a central data server, and multiple mirror and backup servers located at UCSB's Carlsbad office, and at the Marine Science Institute on UCSB's main campus in Santa Barbara, CA. The operation, maintenance, and security of this system require a dedicated system

administrator in Carlsbad who works closely with the scientific staff on the project and with system administrators on UCSB's main campus.

b. Analyze monitoring data and use them to determine whether the mitigation reef is in compliance with the biological and physical performance standards specified in the SONGS permit. Conduct analyses to determine reasons for any failures to meet the performance standards.

c. Prepare annual reports for the Commission (with a copy to SCE) on the performance of the mitigation reef project and post annual reports on the project's public website.

d. Respond to requests from SCE and other parties for data and analyses.

e. Maintain public website with current information on the monitoring of the reef mitigation project.

The Principal Scientists have developed a public website that provides information on the history, current status, and other relevant information pertaining to the monitoring of the SONGS reef and wetland mitigation projects (http://marinemitigation.msi.ucsb.edu/). The website serves as a repository for annual reports, workshop proceedings and other project related documents, and thus helps facilitate the transfer of information between the contract scientists and the Commission, SCE, other agencies and the general public.

f. Present monitoring results at annual public workshops and at scientific meetings deemed appropriate by the Coastal Commission and post results on the project's public website.

2.3 Analyses and Planning for Reef Remediation

a. Refine analyses as needed to ensure that the area of additional reef planned for remediation is sufficient to ensure that the Wheeler North Reef consistently meets the performance standards for fish standing stock and giant kelp.

b. Meet with members of the Science Advisory Panel, Coastal Commission staff, SCE and other appropriate agencies to discuss reef remediation planning and permitting.

2.4 Reef Project Management, Oversight, Administration, and Daily Operation

a. Direct the field and analytical studies described in the 2018-2019 Work Plan.

The Principal Scientists manage a team of university research assistants (i.e., marine biologists trained in scientific diving and data management and analyses) who are responsible for conducting the rigorous field work and extensive data management. They also dive periodically at the artificial reef and nearby reference reefs as needed to resolve issues that arise in the monitoring, and conduct site visits to inspect routine and unexpected changes in the physical and biological properties of the artificial reef and natural reference reefs.

b. *Perform assorted tasks to maintain University of California research diver certification (e.g. pass physical exams, attend classes in CPR, First-Aid, Nitrox, O_2 administration, complete dive logs, service scuba equipment, etc.).*

c. *Maintain boats, vehicles and other equipment in proper working condition.*

d. *Work with University of California administrative staff on project issues pertaining to contracts, payroll, purchasing and personnel.*

e. *Maintain database software, hardware, and network services. Troubleshoot and remedy any problems that arise. Consult with computer consultants as needed to maintain reliability and security of network and desktop operations.*

f. *Consult with members of the Science Advisory Panel, Coastal Commission staff, other resource agencies, and the permittee and its contractors on the status, planning and findings of the reef monitoring studies and inform them of any unexpected changes or concerns that might arise.*

g. *Perform assorted tasks to maintain a functional working environment.*

h. *Prepare 2020-2021 Work Plan.*

E. BUDGET: 2018 AND 2019

Condition D of the permit requires SCE to fund the Commission's oversight of the mitigation and independent monitoring functions identified in and required by Conditions A through C. The permittee is required to provide "reasonable and necessary costs" for the Commission to retain personnel with appropriate scientific or technical training and skills, as well as reasonable funding for necessary support personnel, equipment, overhead, consultants, the retention of contractors needed to conduct identified studies, and to defray the costs of members of any scientific advisory panel convened by the Executive Director to provide advice on the design, implementation, monitoring and remediation of the mitigation projects. The Commission has operated under approved work programs and budgets since 1993. The non-State SCE funds for the oversight and monitoring program are managed by an independent accounting firm.

The budgets for the Commission's monitoring and oversight program are "zero-based budgets," that is, each budget period begins anew, based on the proposed activities, with no funds from the previous budget carried forward to the new budget period. The total budget to implement the work program is intended as a "not-to-exceed" amount. The permittee provides funds periodically throughout the budget period rather than as a lump sum to minimize the advance outlay of cash. Any funds not expended at the end of the budget period are returned to the permittee.

History of Expenditures for Independent Monitoring

The Commission began its oversight and independent monitoring program in November 1991 following adoption in July 1991 of the SONGS mitigation requirements. This start-up period was funded directly by SCE and covered the work necessary to establish the implementing structure and the initial administration of the program. The next year the Commission operated under an

interim work program and budget, during which time the first contract scientists were hired and the Scientific Advisory Panel convened to begin working with SCE on project planning. The Commission approved annual work programs and budgets for calendar years 1994 through 1997, and then, in accordance with the provisions of the permit, adopted two-year work programs and budgets beginning with the 1998-1999 period. These work programs have included planning, environmental analyses, permit compliance issues, five years of experimental reef monitoring, construction monitoring and the first seven years of performance monitoring of the Phase 2 mitigation reef, pre-restoration and construction monitoring for the wetland project, development of performance monitoring plans, and six years of performance monitoring at the wetland. The status section of this report (see Section C) summarizes the accomplishments of the Commission's program.

The budgets and expenditures for the SONGS oversight and monitoring program since its inception are summarized below. As a normal practice, the Commission requires an independent financial audit of the independent monitoring expenditures for each budget period. To date, those audits have disclosed no discrepancies or deficiencies in the financial systems.

Period	Total Budget	Actual Expenditures
Nov 1991-Dec 1992	$ 57,654	$ 57,654
Oct 1992-Dec 1993	610,646	334,632
1994	1,173,105	387,096
1995	849,084	467,888
1996	440,139	397,631
1997	423,035	379,571
1998-1999	1,039,072	970,118
2000-2001	2,293,162	2,151,820
2002-2003	2,423,045	2,174,706
2004-2005	2,338,957	2,256,543
2006-2007	2,266,141	2,162,750
2008-2009	3,055,170	2,776,632
2010-2011	3,953,014	3,559,266
2012-2013	4,738,886	4,634,500
2014-2015	5,214,283	4,984,228
2016-2017	5,844,930	5,497,717 (projected)
26-YEAR TOTAL	$36,719,786	$33,178,420

The oversight and independent monitoring program has consistently come in under budget, and in some years substantially so. The early work programs and budgets were marked by considerable uncertainty in the timing of the planning process for the two major projects (wetland restoration and experimental kelp reef) as well as significant discussions with SCE regarding the Commission staff's interpretation of the permit conditions. In more recent years, the staff has been able to better predict the funding necessary to carry out the program. As performance monitoring for the mitigation projects is implemented, the staff, in consultation with SCE, has made its best predictions for the required tasks, timing, and funding necessary to support those tasks in the 2018 and 2019 work program and budget.

Proposed Budget for 2018 and 2019

The proposed budget for calendar years 2018 and 2019 covers the monitoring and oversight program costs for the Commission's contract scientists, contract field biologists and subcontractors to monitor the wetlands and mitigation reef, science advisory panel, consultants, contract administrative support, and operating expense during the two-year budget period. All of the current and proposed contract program staff, except for the part-time administrator, are hired under contract with the University of California, Santa Barbara, while subcontractors are retained through separate contracts and paid by an independent accounting firm with non-State SCE funds. Costs associated with the implementation of the SONGS permit and attributable to permanent Coastal Commission staff work are not paid by the permittee and thus are not included in this budget.

The funding proposed to cover the monitoring and oversight program costs during the two-year budget period (calendar years 2018 and 2019) is $6,261,250 as shown below. This budget is based on the minimum scientific staff required to accomplish the goals of the SONGS permit and carry out the proposed tasks (see discussion above). The wetland project will continue with its sixth and seventh year of performance monitoring in 2018-2019. The tenth and eleventh years of performance monitoring will be the primary work for the reef. Personnel rates are set by U.C. Systemwide Administration. Narrative budget notes explaining each budget category are contained in Appendix A.

SONGS PROGRAM BUDGET 2018

	2018 Wetland	2018 Reef	2018 Admin/Mgt	2018 Total
SALARIES				
Core Program Staff				
Principal Scientist (0.5 PY)	10,322	92,899		103,221
Principal Scientist (1.0 PY)	76,659	76,659		153,318
Principal Scientist (0.5 PY)	59,405	6,601		66,006
Sr. Administrator (0.15 PY)			19,502	19,502
Field Biologists				
Computer & Network Technologist IV (1.0 PY)	37,066	86,468		123,552
Staff Research Associate IV (1.0 PY)		79,572		79,572
Staff Research Associate IV (1.0 PY)	72,240			72,240
Staff Research Associate II (1.0 PY)	57,024			57,024
Staff Research Associate II (1.0 PY)	51,903			51,903
Staff Research Associate II (1.0 PY)	51,903			51,903
Staff Research Associate II (1.0 PY)		51,903		51,903
Staff Research Associate II (1.0 PY)		51,903		51,903
Staff Research Associate I (1.0 PY)		51,903		51,903
Staff Research Associate I (1.0 PY)	44,925			44,925
Lab Assistant III (3 @ 6 mos, 1.5 PY)		65,295		65,295
Lab Assistant I (4 @ 4 mos; 1.33 PY)	58,468			58,468
Lab Assistant I (3 @ 6 mos; 1.5 PY)	65,295			65,295
SUBTOTAL SALARIES	585,210	563,221	19,502	1,167,933
UCSB Indirect Cost @ 26% (excluding SrAdmin)	152,155	146,437		298,592
TOTAL SALARIES	**737,365**	**709,658**		**1,466,525**
BENEFITS				
Core Program Staff				
Principal Scientist	3,944	35,498		39,442
Principal Scientist	36,897	36,897		73,794
Principal Scientist	28,052	3,117		31,169
Field Biologists				
Computer & Network Technologist IV	5,710	51,386		57,096
Staff Research Associate IV		31,513		31,513
Staff Research Associate IV	33,341			33,341
Staff Research Associate II	26,677			26,677
Staff Research Associate II	25,599			25,599
Staff Research Associate II	46,200			46,200
Staff Research Associate II		39,769		39,769
Staff Research Associate II		34,330		34,330
Staff Research Associate I		25,879		25,879
Staff Research Associate I	23,856			23,856
Lab Assistant III (3)		5,485		5,485
Lab Assistant I (4)	4,911			4,911
Lab Assistant I (3)	5,485			5,485
SUBTOTAL BENEFITS	240,672	263,874		504,546
UCSB Indirect Cost @ 26%	62,575	68,607		131,182
TOTAL BENEFITS	**303,247**	**332,481**		**635,728**

2018 Budget continued.

	2018 Wetland	2018 Reef	2018 Admin/Mgt	2018 Total
SCIENTIFIC ADVISORY PANEL	**58,684**	**58,684**		**117,367**
CONSULTANTS AND CONTRACTORS				
Wetlands				
Task 1.1a&d – Aerial photo surveys	54,000			54,000
Task 1.1a&d - Wetland Engineering Habitat Delineation	26,650			26,650
Task 1.1c - Bird sampling	68,227			68,227
Reef				
Task 2.1c-d-e - Fish reproductive rates, food chain support, and fish reproduction		289,431		289,431
UCSB Indirect Cost @ 26%[2]	20,969	6,500		27,469
TOTAL CONSULTANTS & CONTRACTORS	**169,846**	**295,931**		**465,777**
TRAVEL				
Reimbursement for permanent CCC staff	5,400	5,400		10,800
UCSB Principal Scientists, Field Biologists	20,650	17,350		38,000
UCSB indirect cost (excl. CCC staff)	5,369	4,511		9,880
TOTAL TRAVEL	**31,419**	**27,261**		**58,680**
OPERATING EXPENSE				
General expense (SF office)			32,000	32,000
General expense (UCSB contract, incl. indirect cost)	68,010	78,765		146,775
Facilities operations (Carlsbad office) & Marina storage/offsite facilities (UCSB contract)	57,680	61,153		118,833
Computer technical support, repair & maintenance			1,500	1,500
Review workshop			1,700	1,700
Administrative/financial processing services			12,000	12,000
TOTAL OPERATING EXPENSE	**125,690**	**139,918**	**47,200**	**312,808**
EQUIPMENT				
Two 250 hp outboard engines (UCSB)		31,600		31,600
TOTAL EQUIPMENT		**31,600**		**31,600**
TOTAL EXPENSE 2018	**1,426,250**	**1,595,534**	**66,702**	**3,088,485**

[2] Indirect costs are applied to all contracts held by UCSB. The contract for Task 2.1 c-d-e is charged 26% only on the first $25,000 of the 2-yr contract. The contract under Task 1.1c for $68,227 is not held by UCSB and does not incur this overhead charge.

SONGS PROGRAM BUDGET 2019

	2019 Wetland	2019 Reef	2019 Admin/Mgt	2019 Total
SALARIES				
Core Program Staff				
Principal Scientist (0.5 PY)	10,685	96,166		106,851
Principal Scientist (1.0 PY)	81,417	81,417		162,834
Principal Scientist (0.5 PY)	60,593	6,733		67,326
Senior Administrator (0.15 PY)			20,496	20,496
Field Biologists				
Computer & Network Technologist IV (1.0 PY)	38,176	89,078		127,254
Staff Research Associate IV (1.0 PY)		81,960		76,487
Staff Research Associate IV (1.0 PY)	74,406			74,406
Staff Research Associate II (1.0 PY)	58,734			58,734
Staff Research Associate II (1.0 PY)	53,463			53,463
Staff Research Associate II (1.0 PY)	53,463			53,463
Staff Research Associate II (1.0 PY)		53,463		53,463
Staff Research Associate II (1.0 PY)		53,463		53,463
Staff Research Associate I (1.0 PY)		53,463		53,463
Staff Research Associate I (1.0 PY)	46,269			46,269
Lab Assistant III (3 @ 6 mos, 1.5 PY)		67,248		67,248
Lab Assistant I (4 @ 4 mos; 1.33 PY)	60,216			60,216
Lab Assistant I (3 @ 6 mos; 1.5 PY)	67,248			67,248
SUBTOTAL SALARIES	604,671	582,990	20,496	1,208,157
UCSB Indirect Cost @ 26% (excluding SrAdmin)	157,214	151,577		308,792
TOTAL SALARIES	**761,885**	**734,568**	**20,496**	**1,516,949**
BENEFITS				
Core Program Staff				
Principal Scientist	4,107	36,963		41,070
Principal Scientist	39,372	39,372		78,744
Principal Scientist	28,749	3,194		31,943
Field Biologists				
Computer & Network Technologist IV	5,909	53,183		59,092
Staff Research Associate IV		32,642		32,642
Staff Research Associate IV	34,507			34,507
Staff Research Associate II	27,609			27,609
Staff Research Associate II	26,488			26,488
Staff Research Associate II	47,708			47,708
Staff Research Associate II		41,084		41,084
Staff Research Associate II		35,481		35,481
Staff Research Associate I		26,778		26,778
Staff Research Associate I	24,673			24,673
Lab Assistant III (3)		5,649		5,649
Lab Assistant I (4)	5,058			5,058
Lab Assistant I (3)	5,649			5,649
SUBTOTAL BENEFITS	249,829	274,346		524,175
UCSB Indirect Cost @ 26%	64,956	71,330		136,286
TOTAL BENEFITS	**314,784**	**345,676**		**660,461**

2019 Budget continued.

	2019 Wetland	2019 Reef	2019 Admin/Mgt	2019 Total
SCIENTIFIC ADVISORY PANEL	**61,741**	**61,741**		**123,483**
CONSULTANTS AND CONTRACTORS				
Wetlands				
Task 1.1a&d-aerial photo surveys	54,000			54,000
Task 1.1a&d-Wetland Engineering Habitat Delineation	26,650			26,650
Task 1.1c-bird sampling	71,707			71,707
Reef				
Task 2.1c-d-e-fish reproductive rates, food chain support, and fish reproduction		291,331		291,331
UCSB Indirect Cost @ 26%[3]	20,969	0		20,969
TOTAL CONSULTANTS & CONTRACTORS	**173,326**	**291,331**		**464,657**
TRAVEL				
Reimbursement for permanent CCC staff	5,675	5,675		11,351
UCSB Principal Scientists & Field Biologists	21,703	18,235		39,938
UCSB indirect cost (excl. CCC staff)	5,643	4,741		10,384
TOTAL TRAVEL	**33,021**	**28,651**		**61,673**
OPERATING EXPENSE				
General expense (SF office)			33,632	33,632
General expense (UCSB contract, incl. indirect cost)	71,479	82,783		154,262
Facilities operations (Carlsbad office) & Marina storage/offsite facilities (UCSB contract)	59,856	63,507		123,363
Computer technical support, repair & maintenance			1,500	1,500
Review workshop			1,787	1,787
Audit			4,000	4,000
Administrative/financial processing services			12,000	12,000
TOTAL OPERATING EXPENSE	**131,335**	**146,290**	**52,919**	**330,544**
EQUIPMENT				
Replacement Tow Vehicle		15,000		15,000
TOTAL EQUIPMENT		**15,000**		**15,000**
TOTAL EXPENSE 2019	**1,476,093**	**1,623,257**	**73,415**	**3,172,765**

TWO-YEAR TOTAL EXPENSE FOR 2018 and 2019 **$6,261,250**

[3] Indirect costs are applied to all contracts held by UCSB. The contract for Task 2.1 c-d-e is charged 26% only on the first $25,000 of the 2-yr contract. The contract under Task 1.1c for $71,707 is not held by UCSB and does not incur this overhead charge.

F. PRE-APPROVED CONTINGENCY FUND FOR 2018 AND 2019

Staff is proposing pre-approved contingency funds in the amount of $216,794, specifically for potential additional costs for: (1) the Scientific Advisory Panel, (2) early office lease termination, (3) unexpected repair and/or replacement of field vehicles, and (4) tasks associated with the review of SCE's proposed reef remediation project. Staff proposes these pre-approved contingency funds as a way of reducing the overall budget, but still providing the necessary Commission authorization for certain specified activities that may become necessary during the two-year work period. Staff has used this approach since the 2002-2003 work program. To date, staff has not had to authorize use of the contingency funds.

A contingency amount is proposed for the Scientific Advisory Panel as that effort may increase over past years' expenditures for advice to the Commission on the performance monitoring for the wetland restoration and mitigation reef projects, as well as potential compliance issues with the performance standards contained in the SONGS permit. Although the permit authorizes the Scientific Advisory Panel to be funded up to $100,000 *per year*, plus annual adjustments due to increases in the consumer price index applicable to California[4], staff proposes less total funding for the Scientific Advisory Panel for the two budget years ($117,367 for 2018 plus $123,483 for 2019, for a two-year total of $240,850) based on current rates of expenditure. However, the overall budget does not provide any cushion for any increased effort that may be required; thus, the staff proposes a two-year pre-approved contingency fund amount of $163,750 to be earmarked for the Scientific Advisory Panel to allow the timely response to changing circumstances. This amount is derived from the total authorized amount for the two years as adjusted ($404,600, see footnote) less the budgeted amount ($240,850).

In addition, staff proposes funds for early lease termination for the Carlsbad office. The need for early lease termination is unlikely; however, should circumstances arise that necessitate canceling the lease, the contingency fund amount of $38,044 would be available to satisfy the lease obligations. Similarly, the contingency fund includes $15,000 for unexpected repairs of high mileage field vehicles.

Any expenditure from the pre-approved contingency fund would be made in consultation with SCE. If a dispute arises, the staff would bring the issue to the Commission for resolution.

[4] Based on the average percent change in the Consumer Price Index-All Urban Consumers for the San Francisco and San Diego areas from the original 1991 permit to mid-year 2013, the adjusted amount for 2018 is $197,270. A 5.1% escalator is used for estimating adjustments for 2019, resulting in an adjusted amount for 2019 of $207,330. Thus, the total adjusted amount authorized for the two budget years 2018 and 2019 is $404,600.

Appendix A

Detailed list of condition compliance dates for the wetland

- On August 22, 2006, Commission staff issued the Notice of Acceptance for condition compliance required prior to issuance of the permit and issued CDP #6-04-88.
- On September 13, 2006, Commission staff issued the Notice of Acceptance for condition compliance required prior to commencement of construction; however, the Notice of Acceptance excluded authority to construct certain plan elements that require compliance with additional site-specific conditions (i.e., least tern nesting habitat, public trails, freshwater runoff treatment ponds, inlet dredging, use of North Beach staging area and beach restoration activities, river bend revetment, a disposal site, and a mitigation site).
- On October 2, 2006, Commission staff issued the Notice of Acceptance for condition compliance required prior to commencement of construction of segments 1 through 3 of the Coast-to-Crest public trail (from Jimmy Durante Boulevard along the northern edge of the river to I-5).
- On November 20, 2006, Commission staff issued the Notice of Acceptance for condition compliance required prior to commencement of construction on disposal site DS32.
- On November 29, 2006, Commission staff issued the Notice of Acceptance for condition compliance on a revised design and alignment for the temporary construction haul road under Interstate Highway 5.
- On January 29, 2007, Commission staff issued the Notice of Acceptance for condition compliance required prior to commencement of construction of the Least Tern nesting sites.
- On February 20, 2007, Commission staff issued the Notice of Acceptance for condition compliance on a revised construction haul road route to Disposal Site 36.
- On November 21, 2007, Commission staff issued the Notice of Acceptance for condition compliance required prior to commencement of construction of the Freshwater Runoff Treatment Ponds and Segments 4 through 8 of the Coast to Crest Trail.
- On June 3, 2010, Commission staff issued the Notice of Acceptance for condition compliance required prior to commencement of construction of the North Beach access improvements.
- On September 15, 2010, Commission staff issued the Notice of Acceptance for condition compliance required prior to commencement of construction of the riverbank revetment.
- On November 30, 2010, Commission staff issued the Notice of Acceptance for condition compliance required for the 29th Street South Beach access improvements.
- On January 27, 2011, Commission staff issued the Notice of Acceptance for condition compliance required for the inlet channel excavation and dredging.
- On April 6, 2011, Commission staff issued the Notice of Acceptance for condition compliance required for dredge disposal.

- On August 10, 2011, Commission staff issued the Notice of Acceptance for condition compliance required for Least Tern nesting sites and beach nourishment/dredge disposal.
- On August 29, 2011, Commission staff issued the Notice of Acceptance for condition compliance required for the North Beach Staging Area plan.
- On December 20, 2011, Commission staff issued the Notice of Acceptance for condition compliance required for the JPA Mitigation Program for Trail and Treatment Pond Impacts. The potential to restore additional acreage within the San Dieguito restoration site as proposed by other parties had delayed a portion of the JPA's mitigation program and required consideration of alternative mitigation sites. A material amendment was approved in September 2011 to address these changes (see Amendment 10).
- On January 26, 2012, Commission staff issued the Notice of Acceptance for condition compliance required for final construction information for Least Tern Nesting Sites.
- On September 26, 2014, Commission staff issued a Notice of Acceptance for the San Dieguito Lagoon October 2014 maintenance dredging plans. Dredging of the inlet has been delayed until winter 2015.
- SCE continues to submit quarterly beach survey reports in accordance with Special Condition 25 of CDP #6-04-88 reports posted at http://www.coastalenvironments.com/presentations, see section on City of Del Mar beach profile reports). This condition requires SCE to implement a beach monitoring program, consisting of beach profiles and inlet channel cross-sections, data analysis and reporting. The purpose of this program is to guide and direct placement of dredged beach quality sand and to identify unanticipated changes to the shoreline condition. To date the monitoring has not reached any triggers and review by the Coastal Processes Technical Panel, as required under the permit, has raised no issues of concern.

Detailed List of Wetland CDP Amendments

The following permit amendments have been approved:

1. On August 24, 2006, the Commission issued an immaterial amendment to modify the language of special condition #4 with regard to the timing of submittal of final plans for berm and slope protection. Originally, the condition required such plans be submitted "prior to issuance of the coastal development permit." This immaterial amendment changed the timing of the submittal to "prior to commencement of construction of the revetment located on the south side of the river east of Jimmy Durante Boulevard."
2. On July 10, 2007, the Commission approved an amendment to include in the wetland restoration project the removal of the berm north/northeast of the Grand Avenue Bridge.
3. On August 14, 2007, SCE submitted an amendment request to address several changes in the Final Restoration Plan, including changes to restoration module W45, exclusion of the riverbank revetment, and an alternative South Beach access plan. This amendment was revised in September 2009, and on June 9, 2010, the Commission approved an amendment to replace restoration module W45 with module W16, modify the timing of

construction of public beach accessways, and modify the riverbend revetment requirements in Special Condition #4.

4. On October 25, 2007, the Commission issued an immaterial amendment to modify special condition #8 regarding the mitigation plan for impacts from construction of the trail and wetland treatment ponds.
5. On February 28, 2008, the Commission issued an immaterial amendment to modify the trail crossing under Interstate 5 from open bottom box culverts to bridges.
6. On October 13, 2009, the Commission issued an immaterial amendment to modify segment 8 of the Coast to Crest trail to designate a pedestrian-only path along an existing erosion-control stability bench on the slope of disposal site 32. The pedestrian-only segment would be in addition to and would connect with segment 8 to form a loop trail.
7. On November 19, 2010, the Commission issued an immaterial amendment to modify designated mitigation sites for creation of coastal sage scrub as required by Special Condition #8 regarding trail and treatment ponds.
8. On July 20, 2011, the Commission issued an immaterial amendment to modify the timing restriction on the staging area at North Beach to allow staging of construction equipment associated with dredging activities to begin immediately after Labor Day.
9. On September 21, 2011, the Commission issued a material amendment to: (1) add the Mesa Loop Trail to the project, and (2) modify Special Condition #8 to allow integration of 2.736 acres tidal or seasonal salt marsh mitigation into the SANDAG proposed restoration, with a back-up plan for restoration of 2.736 acres of seasonal high marsh adjacent to El Camino Real on JPA property.
10. On September 12, 2012, the Commission issued an immaterial amendment to modify the permanent access roads within the lagoon system by: (1) eliminating a maintenance access point from the end of Race Track Drive, (2) converting an internal construction road from temporary to permanent, and (3) converting access to the maintenance road system from El Camino from temporary to permanent.

Appendix B: Detailed list of condition compliance dates for the reef

- On March 25, 2008, Commission staff accepted the additional GIS data and files requested for the experimental reef modules and the phase 2 mitigation reef polygons.
- On April 14, 2008, Commission staff issued the Notice of Acceptance for condition compliance required prior to issuance of the permit and issued CDP #E-07-010.
- On May 16, 2008, Commission staff issued the Notice of Acceptance for condition compliance required prior to commencement of construction.
- On August 22, 2008, Commission staff issued the Notice of Acceptance for condition compliance requiring an initial construction audit.
- On January 27, 2009, Commission staff issued the Notice of Acceptance for condition compliance requiring a final construction report. Acreage from the experimental reef modules (22.4 acres) and "as-built" primary reef polygons (130.3 acres) shown on Exhibit 4 meet the SONGS permit and SCE *Final Design Plan* specifications required by CDP #E-07-010.
- On May 9, 2013, Commission staff issued a Notice of Acceptance for condition compliance requiring Kelp Wrack and Rock Hazard Monitoring under Special Condition #12.
- On May 24, 2016, the Commission's Executive Director informed SCE that to comply with the requirements of CDP 6-81-330-A, SCE would be required to remediate Wheeler North Reef by building new reef acreage that meets minimum size, relief and cover requirements (described in detail in the letter).

Appendix C: Budget Notes

SALARIES. Includes salaries and wages for the contract program staff, which includes two scientist positions, administrative support, and field biologists. All of the current and proposed contract program staff except a part-time administrator are hired under contract with the University of California, Santa Barbara; costs include the University's indirect costs.[5] The part-time administrator is hired under contract with Simpson & Simpson CPAs, the firm that provides financial services for the program. The costs for the Commission's permanent staff that spend a portion of their time on this program are not included here; they are paid by the Commission.

BENEFITS. Includes benefits and employer-paid payroll taxes for contract program staff. Includes the indirect costs for personnel hired under contract to UCSB.

SCIENTIFIC ADVISORY PANEL. The Scientific Advisory Panel is a panel of experts established by the Commission pursuant to the permit conditions to provide scientific and technical advice. Expenses cover members' time and travel and are authorized in the permit at $100,000 per year adjusted annually in accordance with the consumer price index (CPI) applicable to California. CPI adjustments have been made in previous budgets. Based on previous years' expenditures, staff budgeted less than the authorized amount. However, staff proposes additional funds in a pre-approved contingency fund up to the adjusted yearly authorized amount to be expended as needed, in consultation with SCE.

CONSULTANTS AND CONTRACTORS. Includes estimated costs for consultants and contractors to provide the technical and expert advice identified in individual tasks of the work program to assist the contract scientists in completing the tasks. Estimated costs are based on previous experience with similar consultants, at rates ranging from $50 to $210 per hour.

TRAVEL. Covers travel for meetings with SCE, Commission staff, consultants and contractors, field monitoring work, attendance at agency and public workshops and meetings, site visits, and attendance at conferences related to wetland and kelp forest community restoration issues. Total travel costs are based on previous years' expenditures plus anticipated increases in airline fares. A 5.1% escalator is applied for 2019.

GENERAL EXPENSE (SF). Covers operating expense for contract program staff working out of the Commission's San Francisco office (part-time administrator). Annual costs are based on the Commission's operating expense per PY for general expense, printing, communications, postage, training and facilities operations.

GENERAL EXPENSE (UCSB CONTRACT). Covers annual costs for reef surveys (NITROX for SCUBA), miscellaneous office, laboratory and field supplies, annual boat operating expense, annual insurance, registration and license fees for boats and vehicles, annual dive physicals required of each diver, and on-campus communications services for contract staff located at UCSB. A 5.1% escalator is applied for 2019.

FACILITIES OPERATIONS (UCSB CONTRACT). Rented office space in Carlsbad houses one full time contract scientific staff and contract field biologists for the reef and wetland monitoring programs. Annual costs cover space rental, utilities, security, office services and supplies, and communications (including telephone, cell phone service, and DSL service). A 5.1% escalator is used for 2019 where anticipated increases are not yet known.

OFFSITE STORAGE/FACILITIES (UCSB CONTRACT). Covers costs for storage and launch fees for the reef dive boats. A 5.1% escalator is applied for 2019.

COMPUTER TECHNICAL SUPPORT. Covers costs for maintaining the computers used by contract program staff and field biologists, including regular maintenance, repairs, and technical support needed for troubleshooting problems.

REVIEW WORKSHOP. Covers costs for conducting an annual review workshop, excluding costs for consultants who may be requested to attend the workshop. The intent of the workshop is to review whether performance

[5] The indirect cost rate of 26% of direct costs is the U.S. Department of Health and Human Services negotiated, pre-determined off-campus rate for research projects. For these costs, the project receives: office space at UCSB for two 0.5 PY contract scientists (even though the on-campus overhead rate is normally 46%), utilities, internet services, laboratory facilities and equipment, administrative services associated with payroll, employee benefits, liability insurance, dive and boat safety programs, and purchasing for both on-campus staff and staff located in the Carlsbad office, library services, UC subsidized pricing on goods and services, site licenses for software, and access to faculty and staff expertise on a wide variety of issues.

standards have been met, whether revisions to the standards are necessary, and whether remedial measures are required. A 5.1% escalator is applied for 2019.

AUDIT. Covers costs for an independent audit of the contract reimbursements and service fees for the Commission's oversight and monitoring program. Independent audits have been conducted since 1994; no deficiencies in the financial systems have been discovered. Costs are estimated for a 2-year audit.

ADMINISTRATIVE/FINANCIAL PROCESSING SERVICES. Covers the annual cost of administrative and financial processing services provided by Simpson & Simpson CPAs.

EQUIPMENT. Covers durable equipment for the reef and wetland monitoring programs, including replacement of two outboard engines for two dive boats and a replacement tow vehicle (used) used for the reef monitoring program.

Daniel C. Reed
Curriculum Vitae

Marine Science Institute, University of California, Santa Barbara, CA, USA, 93106
Telephone**:** (805) 893-8363, danreed@ucsb.edu

Area of Expertise: marine benthic ecology, coastal restoration

EDUCATION

B.A. Biology - Moss Landing Marine Laboratories and San Francisco State University, 1978
M.A. Biology - Moss Landing Marine Laboratories and San Francisco State University, 1981
Ph.D. Biological Sciences - University of California, Santa Barbara, 1989

ACADEMIC EMPLOYMENT HISTORY

1989-1994	Assistant Research Biologist, Marine Science Institute, UC Santa Barbara
1994-2000	Associate Research Biologist, Marine Science Institute, UC Santa Barbara
2000-present	Research Biologist, Marine Science Institute, UC Santa Barbara
2008-present	Deputy Director, Marine Science Institute, UC Santa Barbara

AWARDS AND HONORS

Graduate Research Award, David and Lucille Packard Foundation, 1978
Regents Fellowship, Regents of the University of California, 1984, 1988
Antarctic Service Medal of the United States of America, 1984
Lancaster Award for Outstanding Dissertation, UC Santa Barbara 1989
Lifetime Achievement Award presented at the 11th International Temperate Reef Symposium in Pisa Italy, 2016

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CURRICULUM VITAE
Stephen C. Schroeter

EDUCATION:

B.S., Zoology, Brigham Young University	1969
M.S., Zoology, Brigham Young University	1972
Ph.D., Ecology, University of California, Santa Barbara	1978

POSITIONS HELD:

1978 – 1983	Allan Hancock Fellow and Research Associate Department of Biological Sciences University of Southern California
1983-1988	Research Assistant Professor, Department of Biological Sciences University of Southern California
1987–present	Consulting Ecologist and Partner, Ecometrics
1989–2000	Adjunct Associate Professor, Department of Biology San Diego State University
1996–2000	Associate Research Ecologist, Marine Science Institute, UC Santa Barbara.
2000–present	Research Ecologist, Marine Science Institute, UC Santa Barbara.
2000-present	Adjunct Professor, Department of Biology San Diego State University

HONORS/AWARDS/FELLOWSHIPS:

1971	University Fellowship, Brigham Young University
1971	NSF Graduate Traineeship, Brigham Young University
1975	University Fellowship, UC Santa Barbara
1975, 1976	Sea Grant Traineeship, UC Santa Barbara
1976, 1977	Ford Foundation Fellowship
1985	Outstanding Publication, Marine Fisheries Review with Susumu Kato
1985, 1986, 1987	Faculty Research Incentive Grants, Dept. of Biol. Sciences University of Southern California

2. Reviewer for: Sea Grant, National Science Foundation, Ecology, Ecological Applications, Journal of Applied Ecology, Oecologia, Journal of Experimental Marine Biology and Ecology, Canadian Journal of Fisheries and Aquatic Sciences, American Naturalist, Marine Biology, Marine Ecology Progress Series, California Cooperative Oceanic Fisheries Investigations, MMS-UC Coastal Marine Institute, PLOS ONE

3. Scientific Advisor to: California Coastal Commission, California Department of Fish and Game, NOAA Damage Assessment, National Park Service, Minerals Management Service, EPA, Channel Islands Marine Sanctuary

4. Selected Publications:

Cameron, R.A. and S.C. Schroeter. 1980. Sea urchin recruitment: effect of substrate selection on juvenile distribution. Marine Ecology Progress Series. 2:243-247.

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