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CALIFORNIA EELGRASS MITIGATION POLICY

NATIONAL MARINE FISHERIES SERVICE
SOUTHWEST REGION

(ADOPTED XXXX)

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ATTACHMENTS

NATIONAL MARINE FISHERIES SERVICE (NMFS) SOUTHWEST REGION

CALIFORNIA EELGRASS MITIGATION POLICY
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I. EELGRASS BACKGROUND INFORMATION

Eelgrass species (*Zostera marina* L. and *Z. paci*fica [*Z. asiatica*, *Z. latifolia*]) are seagrasses that occur in the temperate unconsolidated substrate of shallow coastal environments, enclosed bays, and estuaries. Seagrass habitat has been lost from temperate estuaries worldwide (Duarte 2002, Lotze *et al.* 2006, Orth *et al.* 2006). While both natural and human-induced mechanisms have contributed to these losses, impacts from human population expansion and associated pollution and upland development is the primary cause (Short and Wyllie-Echeverria 1996). Throughout California, human activities including, but not limited to, urban development, recreational boating, and commercial shipping continue to degrade, disturb, and/or destroy important eelgrass habitat. For example, dredging and filling; shading and alteration of circulation patterns; and watershed inputs of sediment, nutrients, and unnaturally concentrated or directed freshwater flows can directly and indirectly destroy eelgrass habitats. The importance of eelgrass both ecologically and economically, coupled with ongoing human pressure and potentially increasing degradation and loss from climate change, highlights the need to protect, maintain, and where feasible, enhance eelgrass habitat.

Vegetated shallows that support eelgrass are considered a special aquatic site under the 404(b)(1) guidelines of the Clean Water Act (40 C.F.R. § 230.43). Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSA), eelgrass is designated as Essential Fish Habitat (EFH) for various federally-managed fish species within the Pacific Coast Groundfish and Pacific Coast Salmon Fisheries Management Plans (FMP) (PFMC 2008). Eelgrass is also considered a habitat area of particular concern (HAPC) for various species within the Pacific Coast Groundfish FMP. An HAPC is a subset of EFH; these areas are rare, particularly susceptible to human-induced degradation, especially ecologically important, and/or located in an environmentally stressed area.

II. PURPOSE AND NEED FOR EELGRASS MITIGATION POLICY

The mission of the Habitat Conservation Division, NMFS Southwest Region, is to conserve, protect, and manage living marine resources and the habitats that sustain them. Eelgrass is a habitat of particular concern relative to accomplishing this mission. Pursuant to the EFH provisions of the MSA, the Fish and Wildlife Coordination Act (FWCA), and obligations under the National Environmental Policy Act (NEPA) as a responsible agency, NMFS Southwest Region annually reviews and provides recommendations on numerous actions that may affect eelgrass resources throughout California, the only state within NMFS SWR that supports eelgrass resources. Section 305(b)(1)(D) of the MSA requires NMFS to coordinate with, and provide information to, other Federal agencies regarding the conservation and enhancement of EFH. Section 305(b)(2) requires all Federal agencies to consult with NMFS on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH. Under section 305(b)(4) of the MSA, NMFS is required to provide EFH Conservation

Recommendations to Federal and state agencies for actions that would adversely affect EFH (50 C.F.R. § 600.925). NMFS makes its recommendations with the goal of avoiding, minimizing, or otherwise compensating for adverse effects to EFH. When impacts to NMFS trust resources are unavoidable, NMFS may recommend compensatory mitigation to offset those impacts. In order to fulfill its consultative role, NMFS may also recommend, *inter alia*, the development of mitigation plans, habitat distribution maps, surveys and survey reports, progress milestones, monitoring programs, and reports verifying the completion of mitigation activities.

Eelgrass warrants a strong protection strategy because of the important biological, physical, and economic values it provides, as well as its importance to managed species under the MSA. NMFS developed this policy to establish and support a goal of protecting this resource and its functions, including spatial coverage and density of eelgrass beds. Further, it is the intent of this policy to ensure that there is no net loss of habitat functions associated with delays in establishing compensatory mitigation. This is to be accomplished by creating a greater amount of eelgrass than is lost, if the mitigation is performed contemporaneously or after the impacts occur.

This policy will serve as the guidance for staff and managers within NMFS SWR for developing recommendations concerning eelgrass issues through EFH and FWCA consultations and NEPA reviews throughout California. It is also contemplated that this policy inform SWR's position on eelgrass issues in other roles as a responsible, advisory, or funding agency or trustee. In addition, this document provides guidance on the procedures developed to assist NMFS SWR in performing its consultative role under the statutes described above. Finally, pursuant to NMFS obligation to provide information to federal agencies under Section 305(b)(1)(D) of the MSA, this policy serves that role by providing information intended to further the conservation and enhancement of EFH. Should this policy be inconsistent with any formally-promulgated NMFS regulations, those formally-promulgated regulations will supplant any inconsistent provisions of this policy.

Eelgrass impact management and mitigation throughout California has historically been undertaken without a statewide strategy. In southern and central California, eelgrass mitigation has been addressed in accordance with a policy that has been applied by NMFS, US Fish & Wildlife Service, California Department of Fish and Game, California Coastal Commission, US Army Corps of Engineers, and other resource and regulatory agencies since 1991 (Southern California Eelgrass Mitigation Policy), and which has generally been very effective at ensuring eelgrass impacts are mitigated in most circumstances. The Southern California Eelgrass Mitigation Policy has been updated periodically as needed to respond to changing management needs and to respond to advances in the science of eelgrass habitats. No comparable guidance exists for other regions of California, and effectiveness in eelgrass management and protection has suffered. As a result, effectiveness of achieving full compensation for authorized eelgrass impacts has been substantively lower throughout the remainder of California. Given the success of the Southern California Eelgrass Mitigation Policy over its 20-year history, this policy reflects an expansion of the application of the Southern California policy with minor modifications to ensure a high standard of statewide eelgrass management and protection. This policy is based on the Southern California Eelgrass Mitigation Policy and will supersede the Southern California Eelgrass Mitigation Policy for all areas of California upon its adoption. This policy is needed to ensure effective, statewide eelgrass mitigation and will help ensure that unavoidable impacts to eelgrass habitat are fully and appropriately mitigated. It is anticipated that the adoption and implementation of this policy will provide for enhanced success of eelgrass mitigation in California.

While many of the activities impacting eelgrass are similar across California, eelgrass stressors and growth characteristics differ between southern California (U.S./Mexico border to Pt. Conception), central California (Point Conception to San Francisco Bay entrance), San Francisco Bay, and northern California (San Francisco Bay to the California/Oregon border). The amount of scientific information available to base management decisions on also differs among areas within California, with considerably more information and history with eelgrass habitat management in southern California than the other regions. Gaps in region-specific scientific information do not override the need to be protective of all eelgrass while relying on the best information currently available from areas within and outside of California. Although the primary orientation of this policy is toward statewide use, specific elements of this policy may differ between southern California, central California, northern California and San Francisco Bay.

This policy is consistent with NMFS support for developing comprehensive resource protection strategies that are protective of eelgrass resources within the context of broader ecosystem needs and management objectives. As such, this policy provides for the modified application of policy elements for plans that provide comparable eelgrass resource protection.

III. General Guidance to NMFS SWR Staff and Managers and Information for Action Agencies Concerning Eelgrass Mitigation

For all of California, eelgrass compensatory mitigation should be considered only after avoidance and minimization of effects to eelgrass have been pursued to the fullest extent possible. Mitigation should be recommended for the loss of existing vegetated areas and the loss of unvegetated areas that have been demonstrated capable of supporting eelgrass based on recent history of eelgrass investigations, unless physical manipulation of the environment has permanently altered site suitability for eelgrass or a change in the baseline has occurred.

It is NMFS SWR policy that when NMFS is consulted pursuant to the MSA, FWCA or NEPA for any federal action that may adversely affect eelgrass, NMFS should generally recommend that the federal action agency incorporate the appropriate provisions of Appendices A-D of this policy document as conditions of their permit. However, as all mitigation will be decided on a case-by-case basis, circumstances may exist where NMFS SWR staff will need to modify or deviate from the recommended measures in Appendices A-D before providing their recommendation to action agencies. As such, NMFS SWR should consider information described below when developing mitigation recommendations:

(A) Avoiding and Minimizing Impacts to Eelgrass

Appendix A includes measures that NMFS SWR staff should recommend in order to avoid and minimize impacts to eelgrass caused by turbidity, shading, nutrient loading and alteration of circulation patterns. Not all measures are equally suited to a particular condition. Action agencies in coordination with NMFS should evaluate and establish impact avoidance and minimization measures on a case-by-case basis depending on the action and site-specific information, including prevailing current patterns, sediment source, characteristics, and quantity, as well as the nature and duration of work.

1. Turbidity

NMFS developed a flowchart for a stepwise decision making process as guidance for action agencies to determine when to implement BMPs for minimizing turbidity from dredging actions as part of a programmatic EFH consultation in San Francisco Bay. This document is posted on the Southwest Region HCD web page (http://swr.nmfs.noaa.gov/efh.htm) and may be used to evaluate avoidance and minimization measures for any project that generates increased turbidity.

For cases when minimization measures are not feasible, the need for light and turbidity monitoring should be evaluated on a case-by-case basis by the action agency in coordination with NMFS depending on site-specific factors including, but not limited to: distance to eelgrass, prevailing currents, sediment types, and anticipated duration of turbidity generation. Where applicable, NMFS may recommend that light/turbidity monitoring be incorporated into the action work description to provide data to facilitate adaptive management decision making during construction to avoid and/or minimize risk of impact to eelgrass as a result of increased turbidity. NMFS's recommendation for light and/or turbidity monitoring should be based on a reasonable likelihood of adverse effects to eelgrass resulting from the proposed action. Where appropriate, light and turbidity monitoring may be used.

Because turbidity-related impacts to eelgrass are a particular concern in San Francisco Bay, NMFS developed the "San Francisco Bay Light Monitoring Protocol" as regionally specific monitoring guidance. With some exceptions, higher water clarity levels, lower ambient suspended sediment load, and sandy sediment in shallow waters adjacent to eelgrass habitat areas have typically limited the extent of turbidity-related impacts to eelgrass in Southern California. In other regions, lower level of coastal development and eelgrass mitigation experience has resulted in limited attention being given to turbidity impacts to eelgrass. As a result, no formal light/turbidity monitoring protocol has been developed for the other regions. However, on a case-by-case basis, NMFS may recommend that the San Francisco Bay Light Monitoring Protocol or comparable monitoring be adapted for specific actions within other regions in the state.

2. Shading

A number of potential design modifications may be used to minimize effects of shading on eelgrass. NMFS developed a stepwise key as guidance for action agencies to determine which combination of modifications are best suited for minimizing shading effects from overwater structures on eelgrass as part of a programmatic EFH consultation in San Francisco Bay. This document is posted on the Southwest Region HCD web page (http://swr.nmfs.noaa.gov/efh.htm) and may be used to evaluate avoidance and minimization measures for any project that results in shading.

3. Circulation Patterns

Site-specific evaluations may be appropriate to identify measures for maintaining desirable circulation patterns to protect eelgrass in the vicinity of the action. By considering options during design, it is anticipated that an action will result in less overall eelgrass impact, and changes will further assist in addressing adverse water quality effects. For large-scale actions in the proximity of eelgrass habitats, NMFS may request specific modeling and/or field hydrodynamic assessments of the potential effects of work on characteristics of circulation within eelgrass beds.

(B) SURVEYING EELGRASS

Appendix B details appropriate parameters for staff to include in recommendations for assessing impacts, including eelgrass bed definition and metrics, eelgrass survey methods, and reference site selection.

1. Eelgrass bed definition and metrics

Eelgrass distribution fluctuates and can expand, contract, disappear, and recolonize beds within suitable environments. While eelgrass presence within these areas may not always be consistent, habitats that are suitable to support eelgrass are generally definable based on history of eelgrass presence, and/or physical characteristics.

For the purposes of this policy, an eelgrass bed is defined as the collective presence of multiple eelgrass plants, or individual eelgrass clones that provide habitat functions beyond those found in otherwise unvegetated subtidal or intertidal soft-bottom environments. It is not essential that eelgrass plants be contiguous across the bottom in order to define a functional bed. Habitat function can include structured habitat; increased detrital enrichment of the benthos; energy dampening and sediment trapping; and alteration of current, wave, or erosion patterns among other functions. Within a bed, eelgrass is expected to fluctuate in density and patch extent based on prevailing environmental stressors (e.g., turbidity, freshwater flows, wave and current energy, bioturbation, temperature, etc.). The local area of functional influence around individual eelgrass plants that define a bed varies based on many factors. However, absent unique environmental circumstances that allow for more expansive local effects of the eelgrass, the influence of eelgrass on the local environment would not be expected to extend more than 10 meters from individual eelgrass patches, with the distance being a function of the extent and density of eelgrass comprising the bed as well as local biologic, hydrographic, and bathymetric conditions (van Houte-Howes *et al.* 2004, Smith *et al.* 2008, Ferrell and Bell 1991). Detrital enrichment will generally extend laterally as well as down slope from the beds, while fish and invertebrates that utilize eelgrass beds may move away from the eelgrass core to areas around the bed margins for foraging and in response to tides or diurnal cycles (Smith *et al*. 2008).

An eelgrass bed may be characterized by a number of parameters that, collectively, describe the nature of bed, its spatial and temporal distribution, and persistence through time. While many parameters may be useful to define the bed condition (*e.g.*, plant biomass, leaf length, shoot:root ratios, epiphytic loading), many are too labor intensive and variable to provide suitable metrics for resource management applications on a day-to-day basis. For this reason, five parameters have been identified for use in assessment of effects of an action on eelgrass. These parameters are 1) the spatial distribution of the bed, 2) the areal extent of the bed, 3) the percentage of bottom cover within the bed, 4) the turion (shoot) density within the bed, and, where available, 5) the occurrence frequency and distribution of eelgrass beds through time. When evaluated in association with reference area response, these metrics provide definition to the bed that allows for assessment of eelgrass change related to an action.

Assessment of impacts to eelgrass habitat relies on the completion of quality surveys and mapping. As such, inferior quality of surveys and mapping may make proper evaluation of impacts impossible, and may result in a recommendation from NMFS to re-survey and re-map project areas.

a. Spatial Distribution of Eelgrass Beds

The spatial distribution of an eelgrass bed is the geo-spatial extent of the eelgrass bed bounded by the limits of local functional influence of plants in an aggregation. Spatial distribution should be delineated by a contiguous boundary around the eelgrass plants extending outward from all plants or plant aggregations a distance of 10 meters, excluding gaps within the bed that have individual plants greater than 20 meters from neighboring plants. Where such separations occur, either a separate bed is defined, or a gap in the bed is defined by extending a line around the void along a boundary defined by adjacent plants. The bed limits do not include a buffer but are limited to the zone of local environmental influence around the bed where physical, biological, and chemical conditions of the environment are influenced by the presence or proximity to eelgrass plants. Where depth, substrate, or existing structures limit bed continuity, the boundary of the bed should be defined by the limits of habitat suitability to support eelgrass.

b. Areal Extent of Eelgrass Beds

The aerial extent of eelgrass should be numerically defined as the two-dimensional area of bottom that is bounded by the polygon defining the spatial distribution of eelgrass beds.

c. Percent Bottom Cover within Eelgrass Beds

The proportional bottom cover within an eelgrass bed should be determined by totaling the area of eelgrass plant cover present within a defined bed and dividing this by the total bed area. Where substantial differences in bottom cover occur across portions of the bed, the bed may be subdivided and the percentage of eelgrass cover within subareas of the bed reported separately. In general, eelgrass will exhibit a vertical gradient of higher to lower coverage classes with changing elevation. Similar gradients may exist based on site energy exposure, circulation gradients, etc. Eelgrass cover exists when one or more leaf shoots (turions) per square meter is present.

d. Turion (Shoot) Density within Eelgrass Beds

Turion density should be defined as the density of eelgrass leaf shoots per square meter occurring as a mean across eelgrass plants occurring within mapped eelgrass beds. Turion density should be presented as shoots per square meter and should be a density reported as a mean ± the standard deviation of replicate measurements. The number of replicate measurements (n) should be reported along with the mean and deviation. Turion density characterizes the growth form of plants rather than bottom coverage of plants forming the beds. As such, turion densities are determined only within plants comprising the bed and not within unvegetated interstitial spaces within the beds and therefore, it is not possible to measure a turion density equal to zero.

e. Frequency and Distribution of Eelgrass Bed Occurrence

The occurrence frequency and distribution of eelgrass beds over time provides an indication of resilience and stability of the eelgrass beds. In some instances, several surveys have been completed over an action area over multiple years. Where data exist at a suitable scale and accuracy for comparison of changes in eelgrass distribution, a cumulative map of survey results should be prepared by the federal agency or action party to illustrate the frequency and extent of eelgrass presence in the action area. In some instances, aerial photographs may facilitate the preparation of such maps in suitably shallow waters and environments. Regional mapping may be utilized for this purpose where more refined maps are not available, however these maps are generally not prepared to the same resolution as action-specific maps and are thus not suitable for impact or mitigation assessment purposes. However, it is acknowledged that data may not always be available to the action party or pertinent action agencies.

2. Survey Methods

Appendix B describes methods for developing eelgrass distribution maps that articulate the parameters described above. All mapping efforts generally should be completed during the active growth period for eelgrass (typically March through October for southern California, April through October for central California, April through October for San Francisco Bay, and May through September for northern California), and should be considered valid for a period of 60 days to ensure significant changes in eelgrass distribution and density do not occur between survey date and the project start date. However, when the end of the 60-day validity period falls outside of the region specific active growth period the survey may be considered valid until the beginning of the next active growth period.

Eelgrass growth patterns do not always follow the seasonality identified above; this may be reason for the lead federal agency, in consultation with NMFS, to allow completion of surveys outside of this published survey window on a case-by-case basis. A survey performed outside of the survey window should still provide a valid representation of eelgrass habitat present in the area. Concurrent survey of known regional reference beds and evaluating the state of these reference beds relative to historic areal coverage and density data is the best method to accomplish this. Consistency of eelgrass coverage and density with norms of past surveys in regional reference areas could be considered as evidence that an out of season survey is valid.

Because eelgrass growth conditions in California vary, eelgrass mapping techniques will also vary. Diver transects or boundary mapping may be suited to very small scale mapping efforts, while aerial and/or acoustic survey with ground truthing may be more suited to larger survey areas. Aerial survey methods should be employed only where the lower limit of eelgrass is clearly visible or in combination with methods that adequately inventory eelgrass in deeper waters. Further, as survey technologies improve, it is expected that higher resolution and more spatially accurate mapping will be developed. Mapping methodologies may be updated as needed, and updates will be posted on the NMFS Southwest Region website. Until more refined protocols are developed for eelgrass mapping, mapping efforts should be completed in a manner adequate to accurately inventory eelgrass at the scale of the potential effect. This means that the resolution of mapping should be adequate to address the scale of effects reasonably expected to occur. For small projects, such as individual boat docks, higher mapping resolution is appropriate in order to detect true effects to the resource. At larger scales, the mapping resolution may be less refined over a larger area, assuming that minor errors in mapping will balance out over the larger scale.

3. Reference Site Selection

To the maximum extent practical, the selected reference site should be comparable in environmental conditions to the eelgrass within the pre-action implementation action area. This means selecting a site that best matches environmental conditions in the area of potential action impacts (*e.g.*, depth, salinity, proximity, circulation patterns, shoot density, etc.).

Progress milestones (discussed below) may be re-evaluated or modified if declines in mitigation site performance are also demonstrated at the reference site, and therefore, may be a result of natural environmental stressors that are unrelated to the intrinsic suitability of the mitigation site. Recommendations in Appendix B for size and coverage within the reference site(s) are meant to limit the potential for minor changes in a reference site (*e.g.*, propeller scaring or ray foraging damage) overly affecting action mitigation needs. This concern is especially important in highly dynamic beds or in areas where the reference site supports naturally sparse eelgrass coverage. It is also often beneficial to select and monitor multiple reference areas rather than a single site and to utilize the average reference site condition as a metric for environmental fluctuations. This is especially true when a mitigation site is located within an area of known environmental gradients, and reference sites may be selected on both sides of the mitigation site along the gradient.

(C) ASSESSING IMPACTS TO EELGRASS

Appendix C describes recommended methods for assessing direct and indirect project effects to eelgrass using pre- and post-project surveys. Direct effects are those that are caused by the action and occur at the same time and place as the action. Direct effects include localized losses of eelgrass from dredging or filling, construction of docks or piers that result in shading, construction associated damage, and similar spatially and temporally proximate impacts. Indirect effects are caused by the action and occur later in time or farther removed in distance. Indirect effects include elevated turbidity resulting in reduction of eelgrass distribution or density, damage resulting from changes to circulation patterns, changes to vessel traffic that lead to greater groundings or wake damage, changes that result in increased rates of erosion or deposition within eelgrass beds, or changes that otherwise diminish conditions of the physical environment in a manner that affects eelgrass either at the site or within an area of potential effect. Turbidity effects that result from the initial implementation and operations of an action are considered indirect effects.

Information on making comparisons of eelgrass beds to evaluate effects may be found at the NMFS Southwest Region website (http://swr.nmfs.noaa.gov/hcd/).

(D) MITIGATING FOR IMPACTS TO EELGRASS

Appendix D describes the recommended procedures for mitigating project impacts to eelgrass. In addition to information provided here, NMFS staff and eelgrass restoration experts can provide technical information regarding mitigation methods for impacts to eelgrass. However, any technical information provided by NMFS does not render NMFS responsible for achieving mitigation success or in any way alter the allocation of burden for successful mitigation.

1. Mitigation Site Selection

Eelgrass mitigation sites should be similar to the impact site. Site selection should consider distance from action, depth, sediment type, distance from ocean connection, water quality, and currents. Where eelgrass that is impacted occurs in marginally suitable environments, it may be necessary to conduct mitigation in a more preferable location and/or modify the site to be better suited to support eelgrass habitat creation.

2. Mitigation Area Needs

Appendix D includes recommendations for mitigating impacts to areal extent, bottom coverage, and density of existing eelgrass. For areal impacts, NMFS calculated standard mitigation transplant ratios using "The Five-Step Wetland Mitigation Ratio Calculator" (King and Price 2004) developed for NMFS Office of Habitat Conservation. Using the calculator formula, NMFS applied a period of 13 years as the time horizon for achieving full replacement of lost habitat function and the ecological service value lost prior to maturation of the mitigation. Using the calculator avoids arbitrary identification of size of the mitigation area and allows for consistency in methodology for all areas within California.

The calculator utilizes a number of metrics to determine appropriate ratios (see Attachment 2). Among other metrics, the calculator employs a metric of likelihood of failure within the mitigation site based on regional mitigation failure history. As such, the mitigation calculator identifies a recommended minimum transplant ratio (the transplant action area to eelgrass impact area) based on regional history of success in eelgrass transplantation; however, the policy also utilizes the specific recommended eelgrass mitigation ratio of 1.2:1 (mitigation eelgrass area to impacted eelgrass area) irrespective of the recommended initial transplant ratio. Based on these different components, an action party may achieve success and still fall short of the initial transplant area target. The objective of this element of the policy is to ensure that each mitigation effort has the greatest potential for succeeding by factoring in the regional failure risk in the planning and execution of the mitigation program. As regional eelgrass mitigation success improves, the minimum targeted transplant ratio should be reduced, but the compensation ratio for successful mitigation should remain unchanged. On a case-by-case basis and in consultation with action agencies, NMFS will consider proposals with lower initial transplant ratios where strong evidence exists that a mitigation site will be successful in achieving the ultimate mitigation need with a lesser initial eelgrass establishment effort.

To determine the appropriate initial transplant ratio for each region, the percentage of transplant failures was examined over the history of transplanting in the region. A 25-year history was examined for transplants in all mitigation regions. Eelgrass mitigation in Southern California has a 35-year history with 55 transplants having been performed over that period. In the past 25 years, a total of 47 eelgrass transplants for mitigation purposes have been conducted in Southern California. Forty-three of these have been established long enough to evaluate success for these transplants. An overall failure rate of 13 percent has been determined to exist. Eelgrass mitigation within central California has a better history of successful completion than within southern California, San Francisco Bay, and northern California. However, the number of eelgrass mitigation actions conducted in this region is low and limited to areas within Morro Bay. While the success of eelgrass mitigation in central California has been high, the low number of attempts makes mitigation in this region uncertain. Eelgrass habitat creation/restoration in San Francisco Bay and in northern California has had varied success (Attachment 1).

In all cases, best information available at the time of this policy's development was used to determine the parameter values entered into the calculator formula. As greater information becomes available, the input variables may be revised, and this will result in changing impact mitigation ratios. It is recognized that, as transplant history develops, the failure rate of eelgrass mitigation is expected to decrease. Updates in mitigation calculator inputs are not proposed to be made on an individual action basis, rather the regional transplant history should be re-evaluated approximately every 5 years by moving the 25-year history forward.

In most cases, NMFS should recommend using standard mitigation transplant ratios. The minimum mitigation transplant size is intended to minimize failure risks based on regional success rates. Increased initial mitigation site size should be considered to provide greater assurance that the success objectives, as specified in **APPENDIX D, VII. MITIGATION SUCCESS** will be met. This is a very common practice in the eelgrass mitigation field to reduce risk of falling short of mitigation needs.

3. Mitigation Technique

In general, conversion of unvegetated subtidal areas or disturbed uplands to eelgrass habitats is considered appropriate means to mitigate eelgrass losses, while conversion of other special aquatic sites (e.g., salt marsh, mudflats, and reefs) is unlikely to be considered suitable. In many instances, it may be necessary to develop suitable environmental conditions at a site prior to being able to effectively transplant eelgrass into a mitigation area. Developing suitable sites may need physical modification, including raising or lowering elevation, changing substrate, adding wave recurrent protection or removing impediments to circulation. Many other site modifications may be necessary to produce a viable transplant receiver site. In identifying potentially suitable mitigation sites, it is advisable to consider the current habitat values of the mitigation site prior to mitigation use.

Techniques for eelgrass mitigation should be consistent with the best available technology at the time of mitigation implementation and should be tailored to the specific needs of the mitigation site. Eelgrass transplants have been highly successful in southern and central California, but have had mixed results in San Francisco Bay and northern California. Bare-root bundles and seed buoys have been utilized with some mixed success in northern portions of the state. Transplants using frames have also been used with some limited success. For transplants in southern California, plantings consisting of bare-root bundles consisting of 8-12 individual turions each have been shown to be most successful (Merkel 1988).

Historically, eelgrass planting in southern and central California has been performed at a 1 square meter per planting unit spacing. Similar spacing and even more densely planted eelgrass have been used for bare root plantings in San Francisco Bay and in areas where mitigation sites are at elevated risks prior to full establishment (*e.g.*, high wave or current energy environments, areas of high bioturbation). Lower density plantings have been performed using bare-root units, seed buoys, and transplant frame techniques. For mitigation of impacts to large beds with naturally sparse bottom coverage, low-density plantings may be an appropriate and economical alternative to high-density transplantation.

It is important for action agencies to note that state laws and regulations may also affect the harvesting and transplantation of donor plants and permission from the state, where required, should be obtained; for example, California Department of Fish and Game may need to provide written authorization for harvesting and transplanting donor plants and/or flowering shoots. Site specific modification of harvest methods, densities, and donor site distribution may be needed in order to be protective of existing eelgrass and to enhance success of proposed mitigation areas.

4. Mitigation Delay

Delays in eelgrass transplantation result in delays in ultimate reestablishment of eelgrass habitat values, increasing the duration and magnitude of project effects to eelgrass. Delay multipliers (**APPENDIX D** Table 1) have been generated by altering the implementation start time within "The Five-Step Wetland Mitigation Ratio Calculator" (King and Price 2004).

5. Mitigation Success

Determining mitigation success should be based upon the following measures:

1) Was the initial mitigation area constructed and planted within appropriate environmental site conditions (including site modifications as may be appropriate), and was the area of an appropriate size considering the obligations to offset functional losses and scaling to the mitigation success history for the region?
2) Did the mitigation site meet establishment period progress milestones (see **APPENDIX D**) for eelgrass bed area (area), extent of eelgrass bottom coverage within the bed (percent cover) and eelgrass density (turions per square meter) for the successful mitigation area (*i.e.*, 1.2 times the impact area plus any delayed implementation supplemental area) during the post-planting monitoring period when adjusted to the performance of the reference site for the equivalent monitoring intervals?
3) Did the mitigation site meet the final mitigation objectives for coverage and density at the termination of the monitoring period (typically 60 months, unless extended)?

Where interim development of the mitigation bed falls short of achieving progress milestones during any interim survey, A Supplemental Mitigation Area (SMA) may be recommended to ensure that adequate mitigation is achieved. The SMA formula is described in APPENDIX D and provides flexibility in interim milestones to address variability of bed development due to local circumstances by allowing shortfalls in density to be partially offset by over achievement of the coverage criterion. The formula also provides the process for using reference bed performance in assessing mitigation site performance. Two examples of SMA applicability are offered below:

Example 1, For an action requiring an SMA: The 36-month monitoring event for an eelgrass transplant action that was implemented on time to offset a 2-acre impact to eelgrass shows that transplanted eelgrass has achieved 85 percent coverage and 75 percent of the density compared to the reference site percent coverage and density when compared to the reference site condition at the 0-month monitoring event. The reference site should have been originally selected to reflect the conditions of the impact area. During the 36-month monitoring event, the mitigation area for this transplant action shows a 5 percent decrease in area and 5 percent decrease in density when compared to the 0-month area and density of the reference site. Because the success milestones for the 36-month monitoring interval are 100 percent area and 85 percent density, the site performance has fallen below these metrics and an analysis of potential SMA is warranted.

Total Mitigation Area (TMA) = 2 acres x 1.2
= 2.4 acres

SMA = 2.4 acres x (|-15% + -10%| - | -5% + -5% |)
= 2.4 acres x 15%
= 0.36 acre

Based on the results of the monitoring, a supplemental mitigation area of 0.36 acre would be recommended to ensure that adequate mitigation is achieved.

Example 2, For an action not warranting a SMA: Consider the same 36-month monitoring period yielding differing coverage and density results. In this case, the eelgrass transplant action that was implemented on time to offset a 2-acre impact to eelgrass shows that transplanted eelgrass has achieved 85 percent coverage and 90 percent of the density compared to the reference site at the 0-month monitoring interval. During the 36-month monitoring event, the mitigation site for this transplant action shows a 25% decrease in coverage area and 5% decrease in density when compared to the reference site conditions at the 0-month interval.

TMA = 2 acres x 1.2
= 2.4 acres

SMA = 2.4 acres x (|-15% + 5%| - | -25% + -5% |)
= 2.4 acres x -20%
= -0.48 acre

A zero or negative value of SMA indicates that the mitigation is meeting or exceeding needs, and thus no additional mitigation is warranted.

In the event of a mitigation default, the action agency should convene a meeting with the action party, NMFS, and applicable regulatory agencies (e.g., California Department of Fish and Game, California Coastal Commission) to review the specific circumstances and develop a solution to bring the action back into compliance and fully compensate for ecological service losses resulting from habitat loss and delayed replacement.

(E) MODIFYING PROVISIONS OF THIS POLICY

As stated above, depending on the circumstances of each individual project, NMFS may make recommendations different from those identified in Appendices A-D. This is more likely to be considered appropriate when the issue concerns achieving compensatory mitigation rather than survey, assessment, or reporting. NMFS needs a proper understanding of the proposed project and project area in order to evaluate the full effects of authorized activities. Therefore, NMFS SWR should not, without a compelling reason, make recommendations that would result in surveys, assessments or reports inferior to those which would be provided with implementation of Appendices B-D.

1. All Regions

a. Plans for Comprehensive Management Strategies

NMFS supports the development of comprehensive management strategies that address eelgrass resources in a broader ecosystem context. Recommendations different from those identified in APPENDIX D may be appropriate where, pursuant to the implementation of a comprehensive management strategy, a separately developed plan (e.g., an enforceable programmatic permit, Special Area Management Plan (SAMP), harbor plan, or ecosystem-based management plan) exists that is considered to provide adequate population-level and local resource distribution protections to eelgrass.

In general, it is anticipated that such plans may be most appropriate in situations where a project or collection of similar projects will result in incremental but recurrent impacts to a small portion of local eelgrass populations through time (*e.g.*, lagoon mouth maintenance dredging, maintenance dredging of channels and slips within established marinas, navigational hazard removal of recurrent shoals, restoration or enhancement actions). Mitigation banks and in-lieu fee conservation programs are highly encouraged by NMFS-HCD in heavily urbanized waters.

In order to ensure that these alternatives provide adequate population-level and local resource distribution protections to eelgrass and that the plan is consistent with the overall conservation objectives of this policy, NMFS Southwest Region should be involved early in the plan's development.

b. Localized Temporary Impacts

NMFS SWR may consider modified target mitigation ratios for localized temporary impacts that result from such activities as placement of temporary recreational facilities, shading by construction equipment, or damage sustained through vessel groundings or environmental clean-up operations wherein the damage results in impacts of less than 100 square meters and eelgrass vegetation is fully restored within the damage footprint within one year of the initial impact. In such cases, the 1.2:1 mitigation ratio should not apply. Nevertheless, for the reasons stated above, a compelling reason should be demonstrated before any reduced monitoring and reporting recommendations are provided.

2. Southern California and Central California

Within southern and central California:
(a) If both NMFS and the authorizing action agencies concur, the compensatory mitigation elements of this policy may not be necessary for the placement of a single pipeline, cable, or other similar utility line across an existing eelgrass bed with an impact corridor of no more than 1 meter wide. After action construction, a post-action survey should be completed within 30 days, and the results should be provided to appropriate NMFS and authorizing action agency staff. The actual area of impact should be determined from this survey. An additional survey should be completed after 12 months to insure that the action or impacts attributable to the action have not exceeded the allowed 1-meter corridor width. However, NMFS should recommend that, if the post-action or 12 month survey demonstrates a loss of eelgrass greater than the 1-meter wide corridor, mitigation identified in **APPENDIX D** of this policy should be undertaken.

(b) If NMFS HCD concurs and suitable out-of-kind mitigation is proposed, compensatory mitigation may not be necessary for actions impacting less than 10 square meters.

3. San Francisco Bay

Eelgrass bed distribution and density in San Francisco Bay can vary widely from year to year. For example, an eelgrass bed may diminish in size to scattered patches and then increase again in subsequent years to a consolidated bed. Impacts to one or more eelgrass patches, therefore, could prohibit development of a full eelgrass bed at that location in the future. Because of this difference in bed dynamics between San Francisco Bay and southern California, reduced compensatory mitigation is less likely to be appropriate in the San Francisco Bay; when reduced compensatory mitigation is considered, the specific circumstances of the resource condition and anticipated impacts should be evaluated.

Within San Francisco Bay:
(a) The recommended 1.2:1 mitigation ratio may not be appropriate for actions impacting less than 10 square meters of eelgrass patches or isolated eelgrass patches. NMFS will consider mitigation on a 1:1 basis for impacts to smaller eelgrass patches and where impacts are limited to small portions of a well-established eelgrass bed or beds that, despite highly variable conditions, generally retain extensive eelgrass, even during poor years.

(b) A reduced mitigation ratio should not be considered where impacts would occur to isolated or small beds (less than 5 ha. in extent) within which the impacted area constitutes more than 1% of the eelgrass beds in the local area during poor years.

4. Northern California

Successful eelgrass mitigation within northern California has only been performed on a limited number of occasions and only within Humboldt Bay. Eelgrass presence, stability, and persistence elsewhere is poorly documented, and inadequate information currently exists to support significant modifications to this policy for these areas at this time.

Within Northern California in Humboldt Bay:
(a) The expanded mitigation size provisions of this policy may not be appropriate for actions impacting less than 10 square meters of eelgrass patches within a bed. NMFS may consider mitigation on a 1:1 basis for impacts to smaller eelgrass patches where these would be impacted by an action. A reduced mitigation ratio may be appropriate where impacts are limited to small portions of a well-established eelgrass bed or beds that, despite highly variable conditions, generally retain extensive eelgrass, even during poor years.

(b) A reduced mitigation ratio should not be considered where impacts would occur to isolated or small beds (less than 5 ha. in extent) within which the impacted area constitutes more than 1% of the eelgrass bed in the local area during poor years.

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APPENDIX A. RECOMMENDED AVOIDANCE AND MINIMIZATION MEASURES FOR EELGRASS IMPACTS

I. TURBIDITY

To avoid and minimize potential turbidity-related impacts to eelgrass:

- Where practical, actions shall be located as far as possible from existing eelgrass; and
- In-water work shall occur as quickly as possible such that the duration of impacts is minimized.

Where proposed turbidity generating activities must occur in proximity to eelgrass, measures to control turbidity levels shall be employed when practical to do so considering physical and biological constraints and impacts. Measures may include:

- Use of turbidity curtains where appropriate and feasible;
- Use of low impact equipment and methods (*e.g.*, environmental buckets, or a hydraulic suction dredge instead of clamshell or hopper dredge provided the discharge may be located away from the eelgrass beds and appropriate turbidity controls can be provided at the discharge point);
- Limiting activities by tide or day-night windows to limit light degradation within eelgrass beds;
- Utilizing 24-hour dredging to reduce the overall duration of work and to take advantage of dredging during dark periods when photosynthesis is not occurring; or
- Other measures that an action party may propose and be able to employ to minimize potential for adverse turbidity effects to eelgrass.

When the measures listed above are not practical, light and turbidity monitoring shall be required in relevant situations, both within areas of concern as well as an appropriate reference area outside of the area of potential influence by the turbidity generating activities. Monitoring shall be conducted to determine the average daily period of irradiance-saturated photosynthesis (H_{sat}) during action activities for comparison with H_{sat} levels determined from scientific literature that are necessary for the maintenance of whole plant carbon balance and growth (Zimmerman *et al.* 1991) or levels within a nearby reference eelgrass bed that would experience comparable ambient water quality conditions, absent influence of turbidity generating activities. H_{sat} values may vary between regions (Merkel & Associates 2000), so H_{sat} values cited in scientific literature and relevant to a specific region or water body shall be used. If relevant H_{sat} values are not available, site-specific information shall be developed either as a baseline determination or through parallel data collection in reference eelgrass beds.

Light monitoring conducted in San Francisco Bay shall be consistent with the "San Francisco Bay Light Monitoring Protocol" or updated versions, unless an appropriate variant is developed in conjunction with the local NMFS office to capture specific monitoring needs in a manner that allows for evaluation of activity effects to eelgrass. This information document can be found at the NMFS Southwest Region website (http://swr.nmfs.noaa.gov/hcd/).

II. SHADING

Boat docks, ramps, gangways, and similar structures shall avoid eelgrass habitat to the maximum extent feasible. If avoidance of eelgrass or habitat is infeasible, impacts shall be minimized by utilizing, to the maximum extent feasible, design modifications and construction materials that allow for greater light penetration. Action modifications shall include, but are not limited to:

- Avoid siting over-water or landside structures in areas where shading of eelgrass beds would occur;
- Maximizing the north-south orientation of the structure;
- Maximizing the height of the structure above the water;
- Minimizing the width and supporting structure mass to decrease shade effects; and
- Relocating the structure in deeper water and limiting work in shallow areas where eelgrass occurs to the extent feasible.

Construction materials used to increase light passage beneath the structures may include, but are not limited to, open grating or adequate spacing between deck boards to allow for effective illumination to support eelgrass habitat.

III. ALTERATION OF CIRCULATION PATTERNS

To reduce the adverse effects of altered circulation patterns, the action party shall evaluate the consequences of a proposed action on the hydrodynamics of the action area, particularly in the context of changes to areas supporting eelgrass within the action area or in proximity to the action area. Action parties shall make every effort to minimize changes in current flow patterns or velocities and to understand the ramifications of changes that are predicted.

To reduce effects to eelgrass, changes shall be made to minimize scouring velocities near or within eelgrass beds. Wind and tidal circulation shall be maintained to the extent practical by considering orientation of piers and docks to provide longer wave fetch and to maintain predominant wind effects. Setbacks on the order of 15 to 50 meters from eelgrass habitat shall be incorporated where practical to allow for greater circulation and reduced impact from boat maneuvering, grounding, and propeller damage, and to address shading impacts. Where piles are needed to support structures, these shall be minimized in number and spaced as far apart as practical to further maintain circulation.

IV. NUTRIENT LOADING

The following measures shall be implemented to reduce potential for excessive nutrient loading to eelgrass beds:

- diverting site runoff from landscaped areas away from discharges around eelgrass beds;
- implementation of fertilizer reduction program;
- reduction of watershed nutrient loading;
- controlling local sources of nutrients such as animal wastes and leach fields; and
- maintaining good circulation and flushing conditions within the water body.

V. REFERENCES

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APPENDIX B. RECOMMENDATIONS CONCERNING SURVEYS FOR ASSESSING IMPACTS TO EELGRASS

I. EELGRASS BED DEFINITION AND METRICS

For the purposes of field identification and mapping, eelgrass beds shall be defined as the aggregated extent of eelgrass patches bounded by a perimeter demarcated by plants located less than 10 meters from another plant. This definition encompasses interstitial spaces between individual plants or plant clusters that are directly influenced by the proximity of plants (e.g., aggregation of fish, increased detritus generation and trapping, benthic community enrichment, local alteration of physical environmental conditions). However, the definition excludes areas of unsuitable environmental conditions such as hard bottom substrates, shaded locations, or areas which extend to depths below those supporting eelgrass at the time of the survey or which have been documented previously to support eelgrass at the specific location.

II. EELGRASS SURVEY METHODS

For all actions that may directly or indirectly affect eelgrass habitat, an eelgrass habitat distribution map shall be prepared on an accurate bathymetric chart with contour intervals of not greater than 0.30 meters (local vertical datum of MLLW). The map shall include the entire action area and an adjacent buffer of not less than 20 meters, as well as a suitable eelgrass reference site in proximity to the action area. The eelgrass map shall serve as a basis for evaluation of potential effect of the action on eelgrass habitat. For this reason, the spatial area of coverage by the map shall be adequate to address both direct and indirect impact concerns and thus shall include greater or lesser buffering around the action area, depending upon the type and scale of the action. Any eelgrass beds and eelgrass habitat areas that may be affected by construction, footprint effects, and ongoing operations in relationship to depth contours shall be thoroughly mapped. This includes areas adjacent to the action site that could be indirectly or inadvertently impacted as a result of shading, vessel maneuvering, anchoring, turbidity generation impact, or changes in water circulation patterns.

Eelgrass surveys shall articulate the following facts: 1) the spatial distribution of the bed; 2) the area of the defined bed; 3) the percentage of bottom covered by eelgrass within the bed; and 4) the shoot (turion) density within the patches of eelgrass comprising the bed. These four intrinsic parameters of an eelgrass bed are expected to naturally fluctuate through time in response to natural environmental variables. As a result, it is necessary to extract natural variability out of the bed response when conducting surveys for the purpose of evaluating action effects on eelgrass. This is generally accomplished through the use of a reference site, which is expected to respond similarly to the action area in response to natural environmental variability. The Reference Site shall be selected to best represent the conditions present within the eelgrass beds located in an area of potential effect (that area in which an action may reasonably be expected to result in alterations to one or more of the four surveyed parameters). The selection of a reference area is discussed at section **III. REFERENCE SITE SELECTION**.

The survey area shall be scaled as appropriate to the size of the potential action and the potential extent and distribution of eelgrass impacts:

- A dock replacement action or a launch ramp widening action shall include a survey and mapping area limited to the permanent action footprint and immediately adjacent areas, anticipated construction areas, and an appropriate reference site(s).

- A breakwater or large marina action shall survey areas inclusive of the action footprint, construction work area, and areas likely affected by measurable changed circulation patterns as determined by appropriate hydrologic modeling and model verification.

- For other project types, survey area shall be determined by the action agency in cooperation with NMFS.

The differing methodologies for eelgrass mapping all have an inherent level of error that can be reduced with increasing survey expense. To ensure that surveys are economical to perform, yet accurate enough to serve their intended function, no more than a 5 percent error factor is allowable.

A. Determination of Spatial Distribution of Eelgrass Habitat

Eelgrass habitat shall be surveyed using mapping technologies and scales appropriate to the action, scale, and area of work. Eelgrass beds shall be plotted as polygons that delimit a boundary around plants located not more than 10 meters from adjacent plants and which encompass all internal eelgrass patches. Within this defined bed boundary, gaps in eelgrass plants that are greater than a 10-meter separation in plants should be removed from the defined bed. Thus, areas between plants, which are less than a 10-meter separation between plants and which also include suitable sediment, light, energy, and other environmental conditions appropriate to support eelgrass plant growth are within the defined bed. Where greater than a 10-meter separation exists between plants, a separate bed shall be defined. A single plant may define a bed, or a bed may be defined by a cluster of plants located within 10 meters of each other. Where environmental conditions unsuited to supporting eelgrass occur, these areas are to be excluded from the beds, even though they may be less than 10 meters across. For mapping purposes, all eelgrass patches shall first be plotted on a bathymetric chart that also includes a mapping of unsuitable substrate condition and shading structures. After plotting all features that preclude suitability to support eelgrass, the boundaries of the beds are defined. In no case shall interpolation error between data points, transects, or survey swaths be allowed to exceed greater than 5 percent of the mapped habitat area

B. Determination of Areal Extent of Eelgrass Habitat

Areal extent of eelgrass beds shall be determined by calculation of the area of mapped beds using commercially available geo-spatial analysis software or spatial design software such as that marketed by ESRI, Autodesk, or Bentley Systems. However, for very small projects, coordinate data for polygon vertices may be entered into a spreadsheet format, and area may be calculated areas using simple geometry (see **II. E. Eelgrass Mapping**).

C. Determination of Bottom Coverage within Eelgrass Beds

The bottom cover of eelgrass within the beds shall be determined by dividing the area of eelgrass patches that form the bed, by the area of the bed. Bottom coverage of eelgrass within the bed can then be reported as a percentage. If individual patch area is not determined, then a visual estimation of eelgrass coverage shall be made and data shall be reported using appropriate regional cover classifications (see **Section I. C.**). Where distinctly different coverage occurs within portions of the bed, cover classes may be mapped over portions of the eelgrass bed.

D. Determination of Turion Density

Turion (shoot) density shall be determined for mapped beds. It is not necessary for all mapped beds to have individual turion densities determined; rather the intent is to characterize the overall shoot density of plants within the beds. However, if different cover classes are used, a turion density shall be determined for each mapped cover class. Turion density is an eelgrass patch condition rather than bed condition; and thus, densities shall be determined only within plants and not interstitial gaps within the bed. This means that any turion density sample point should support at least one turion. Turion densities shall be determined by counting the number of eelgrass turions within a given area defined as a quadrat or strip transect of a given dimension. A minimum of twenty randomly selected plots shall be sampled with a good distribution across the full depth profile of the beds in order to obtain a mean density with a robust variance. More sampling may be needed in highly variable environments, and sampling may be allotted to and reported for differing portions of the beds in order to reduce sample variance terms. Densities shall be reported as the mean density of eelgrass shoots (turions per square meter) plus or minus the standard deviation of the samples. The number of turion sampling counts made shall be reported along with the density data. In large eelgrass beds, or those with complicated bathymetry, it may be necessary to block the bed by depth ranges or eelgrass cover class to facilitate a good distribution of sampling effort. Sampling replication shall be adequate to provide 90 percent power to detect differences where alpha and beta both equal 0.10.

E. Eelgrass Mapping

Unless region-specific mapping format and protocols are developed by NMFS (in which case such region specific mapping guidance shall be used), the mapping shall utilize the following format and protocols:

1. Bounding Coordinates

Horizontal datum - Universal Transverse Mercator (UTM), NAD 83 meters, Zone 11 (for southern California) or Zone 10 (for central, San Francisco Bay, and northern California) is the preferred projection and datum. Another projection or datum may be used; however, the map and spatial data shall include metadata that accurately defines the projection and datum. Vertical datum - Mean Lower Low Water (MLLW), depth in meters.

2. Units

Transects, grids, or scale bars shall be expressed in meters. Area measurements shall be in square meters.

3. File Format

A spatial data layer compatible with readily available commercial geographic information system software producing file formats compatible with ESRI® ArcGIS software shall be sent to

NMFS when the area mapped supports at least 10 square meters of eelgrass. For those areas supporting less than 10 square meters of eelgrass, a table may alternatively be provided giving the vertices bounding x, y coordinates of the eelgrass areas in a spreadsheet or an ASCII file format. In addition to a spatial layer and/or table, a hard-copy map shall be included within the survey report. The projection and datum shall be clearly defined in the metadata and/or an associated text file.

Maps shall be presented at a scale that is clearly legible, yet of a manageable size for a standard printed version. Eelgrass maps shall, at a minimum, include the following:

- A graphic scale bar, north arrow, legend, horizontal datum and vertical datum;
- A boundary illustrating the limits of the area surveyed;
- Bathymetric contours for the survey area, including both the action area(s) and reference bed(s) in increments of not more than 0.3 meter;
- An overlay of proposed action improvements and construction limits;
- The boundary of the defined bed including an identification of bed exclusions based on physical unsuitability to support eelgrass habitat; and
- The existing eelgrass patches within the defined bed at the time of the survey.

F. Survey Period

All mapping efforts shall be completed during the active growth period for eelgrass and shall be considered valid for a period of 60 days to ensure significant changes in eelgrass distribution and density do not occur between survey date and the project start date. However, when the end of the 60-day validity period falls outside of the region specific active growth period (typically March through October for southern California, April through October for central California, April through October for San Francisco Bay, and May through September for northern California), the survey may be considered valid until the beginning of the next active growth period. For surveys completed during or after unusual climatic events (*e.g.*, high fluvial discharge periods, El Niño conditions), NMFS HCD staff should be contacted to determine if any modifications to the standard survey procedures are warranted.

Copies of the pre-construction survey shall be provided to the lead federal regulatory agency and provided to NMFS within 30 days of completing the survey.

III. Reference Site Selection

A reference site shall be used as a control to monitor and extract natural variability in eelgrass bed dynamics from the performance of a mitigation area relative to a persistent surrogate of the impacted eelgrass beds. Environmental conditions (*e.g.*, sediment, currents, proximity to action area, shoot density, light availability, depth, onshore and watershed influences, etc.) at the reference site must be representative of the environmental conditions at the impact area. Where practical, the reference site(s) shall be at least the size of the anticipated mitigation area and shall be selected, at the time of establishment, to have a good representation of eelgrass within the site. The selection of a reference site shall be identified in consultation with NMFS staff within the appropriate area office for the action location. The logic for site selection shall be documented in the eelgrass investigation and mitigation planning documents.

APPENDIX C. RECOMMENDED MEASURES FOR ASSESSING IMPACTS TO EELGRASS

I. DIRECT EFFECTS

After action construction, a post-action survey of the eelgrass habitat in the action area shall be completed within 30 days of completion of construction, or within the first 30 days of the next active growth period following completion of construction that occurs outside of the active growth period. Copies of the post-construction survey shall be provided to the lead federal agency and NMFS within 30 days of completing the survey. The actual area of impact shall be determined from an analysis that compares the pre-action condition of eelgrass beds with the post-action conditions from this survey. The action party in coordination with the lead federal agency and NMFS will consider reference area eelgrass performance, physical evidence of impact, turbidity and construction activities monitoring data, as well as other documentation in the determination of the impacts of the action undertaken.

Impact analyses shall document whether the impacts are anticipated to be complete at the time of the assessment, or whether there is an anticipation of continuing eelgrass impacts due to chronic or intermittent effects. An assessment shall also be made as to whether impacts or portions of the impact are anticipated to be temporary. Where impacts are anticipated to be chronic, intermittent, or slow in developing, additional surveys beyond the initial post-construction surveys shall be undertaken. These are discussed under section **II. INDIRECT EFFECTS**.

II. INDIRECT EFFECTS

Because indirect effects of shading, vessel traffic impacts, and altered circulation patterns are not always fully determinable prior to action implementation, preliminary estimates of the effects of the action shall be made; this preliminary estimate shall be utilized in order to initiate mitigation planning and implementation (see **APPENDIX B** and **APPENDIX D**). However, for such impacts, an extended post-construction monitoring program shall be completed to determine the actual extent of eelgrass impacts and to ensure that mitigation is adequate to fully compensate for true impacts, including both those that occurred at the time of implementation and those that were subsequently manifested with time.

For actions where the impact cannot be fully determined until a substantial period after an action is taken, a preliminary estimate of impacts shall be made based on the best available information (*e.g.*, shading analyses, wave and current modeling). A monitoring program consisting of a pre-construction eelgrass survey and three post-construction eelgrass surveys shall be performed. The action party shall complete the first post-construction eelgrass survey immediately after completion of construction to determine direct effects of the action on eelgrass. The second and third post-construction surveys shall be performed in the first and second year's growing season following implementation. Eelgrass surveys and resultant maps shall follow the survey and mapping protocols provided below in **APPENDIX B**. Results shall be provided to federal action agency and NMFS within 30 days of completion of each survey.

A final determination regarding the actual impact and amount of mitigation needed to offset impacts shall be made based upon the results of two annual post-construction surveys conducted during the time period of maximum eelgrass growth (typically March through October for southern California, April through October for central California, April through October for San Francisco Bay, and May through September for northern California), which document the changes in the bed (areal extent, bottom coverage, and shoot density within eelgrass) in the vicinity of the action. This determination is subject to the review by the action agency and NMFS; it is not final until it is approved by both the action agency and NMFS. Any impacts determined by these monitoring surveys shall be mitigated in a manner consistent with the provisions of APPENDIX D. Action parties shall provide a statement indicating their understanding of the potential for an additional mitigation obligation that may follow the initial two-year monitoring. Underestimating the ultimate impacts of an action on eelgrass does not relieve the action party from fulfilling any obligations for full mitigation of actual impacts.

In the event that monitoring demonstrates the action to have resulted in greater eelgrass habitat impacts than initially estimated, a supplemental mitigation action is required if the initial mitigation area is of inadequate size to fully address impacts.

APPENDIX D. Recommended Measures For Eelgrass Impact Mitigation

When impacts to eelgrass may occur, action parties shall develop a mitigation plan following the procedures in this policy. The action party is solely responsible for achieving the mitigation target.

I. Mitigation Site Selection

The location of eelgrass mitigation shall be in areas of similar condition to those where the initial impact occurs. Factors such as: distance from action, depth, sediment type, distance from ocean connection, water quality, and currents are among those that shall be considered in evaluating suitable sites and making an ultimate site selection for mitigation. Modification to the mitigation site to make it better suited to support eelgrass habitat creation is acceptable and shall be fully coordinated with NMFS staff and other appropriate resource and regulatory agencies. While site selection and preparation shall be conducted in a manner that results in successful compensation for eelgrass habitat losses, mitigation shall be conducted within the same hydrologic system (*e.g.*, bay, estuary, lagoon) as the impacts and shall be appropriately distributed within the same ecological subdivision of larger systems (e.g., San Pablo Bay or Richardson Bay in San Francisco Bay), unless NMFS and the action agency concur that good justification exists for altering the distribution based on ecosystem functions and services.

II. Mitigation Area Needs

The size of the mitigation area and the initial transplant area shall be consistent with "The Five-Step Wetland Mitigation Ratio Calculator" (King and Price 2004) developed for NMFS Office of Habitat Conservation. This calculator is based on the "net present value" approach to asset valuation, an appropriate economics concept used to compare values of all types of investments, and then modified to incorporate wetland science. Formula parameters focus on comparisons of services and values provided by the mitigation relative to the site of impact.

Regardless of the transplant ratio applied to the different ecological regions, all mitigation actions shall meet success objectives (provided below) in order to satisfy compensatory mitigation needs. Failure to achieve mitigation shall result in supplemental mitigation implementation and may include additional mitigation for delays in achieving mitigation objectives.

A. Impacts to Areal Extent of Existing Eelgrass Beds

Mitigation of eelgrass beds shall be based on replacement of eelgrass bed extent and bottom coverage of eelgrass patches within the bed at a 1.2 (mitigation) to 1 (impact) mitigation ratio for eelgrass throughout all regions of California. For an eelgrass bed mitigation to be considered successful, it shall meet the eelgrass bottom coverage and eelgrass turion density over an area that is 1.2 times the impact area, unless delayed implementation, supplemental transplant needs, or NMFS and action agency agreement for use of different ratio result in altered mitigation area. However, given variable degrees of success across regions and potential for delays and mitigation failure, the minimum recommended transplant ratios for mitigation vary by region as discussed below.

1. Southern California (Mexico border to Pt. Conception)

For mitigation activities that occur concurrent to the action resulting in damage to the existing eelgrass bed resource, a ratio of 1.38 to 1 (transplant area to impact area) shall apply to counter the regional failure risk. That is, for each square meter adversely impacted, 1.38 square meters of new suitable habitat, vegetated with eelgrass, shall be planted in suitable conditions to support eelgrass with a comparable bottom coverage and eelgrass density as impacted beds. Notwithstanding this initial minimum transplant ratio, a total of 1.2 square meters of comparable new eelgrass bed habitat shall be successfully established (see **VII. MITIGATION SUCCESS**) for every square meter of eelgrass bed impacted.

2. Central California (Point Conception to mouth of San Francisco Bay)

For mitigation activities that occur concurrent to the action resulting in damage to the existing eelgrass bed resource, a ratio of 1.20 to 1 (transplant area to impact area) shall apply based on a 0 percent failure rate over the past 25 years (4 transplant actions). Again, the success ratio for mitigation in Central California is 1.2 square meters of comparable new eelgrass bed habitat that shall be successfully established (see **VII. MITIGATION SUCCESS**) for every square meter of eelgrass bed impacted. It should however be noted that all of these successful transplants included a greater area of planting than was necessary to achieve success such that the full mitigation area would be achieved, even with areas of minor transplant failure.

3. San Francisco Bay (including south, central, San Pablo and Suisun Bays)

For mitigation activities that occur concurrent to the action resulting in damage to the existing eelgrass bed resource, a ratio of 3.01 to 1 (transplant area to impact area) shall apply based on a 60 percent failure rate over the past 25 years (10 transplant actions). That is, for each square meter adversely impacted, 3.01 square meters of comparable new eelgrass bed shall be planted into suitable conditions identified or developed to support eelgrass. A total of 1.2 square meters of new eelgrass bed habitat shall be successfully established (see **VII. MITIGATION SUCCESS**) for every square meter of eelgrass impacted. In addition, alternative contingent mitigation shall be specified and included in the mitigation plan to address situations where performance standards (see **VII. MITIGATION SUCCESS**) are not met.

4. Northern California (mouth of San Francisco Bay to Oregon border)

For mitigation activities that occur concurrent to the action resulting in damage to the existing eelgrass bed resource, a ratio of 4.82 to 1 (transplant area to impact area) shall apply based on a 75 percent failure rate over the past 25 years (4 transplant actions). That is, for each square meter of eelgrass bed adversely impacted, 4.82 square meters of comparable new eelgrass bed shall be planted in suitable conditions to support eelgrass mitigation. A total of 1.2 square meters of new eelgrass bed habitat shall be successfully established (see **VII. MITIGATION SUCCESS**) for every square meter of eelgrass impacted. In addition, alternative contingent mitigation shall be specified and included in the mitigation plan to address situations where performance standards (see **VII. MITIGATION SUCCESS**) are not met.

B. Impacts to Bottom Coverage of Eelgrass

Within the defined bed, bottom coverage is calculated as a percentage of the bed supporting eelgrass at the time of impact based on the pre-construction survey. This is calculated as the area of eelgrass patches within the bed divided by the total area of the bed as delineated to exclude unsuitable environments to support eelgrass times 100. The bottom coverage of mitigation eelgrass beds shall not be less than equivalent bottom coverage as that occurring in the pre-construction surveys, as determined by the bottom coverage within the mitigation eelgrass beds and corrected to bottom coverage within suitable reference beds (see **APPENDIX B, II. REFERENCE SITE SELECTION**).

C. Impacts to Density of Existing Eelgrass

Degradation of existing eelgrass vegetated habitat that results in a permanent reduction of density greater than 25 percent shall be mitigated based on an equivalent area basis. In these cases, eelgrass remains present at the action site, but density may be potentially affected by long-term chronic or intermittent effects of the action. Reduction of density shall be determined to have occurred when the mean turion density of the impact site is found to be statistically different (α=0.10 and β=0.10) from the density of a reference and at least 25 percent below the reference mean during two annual sampling events following implementation of an action. Mitigation for reduction of turion density without change in eelgrass bed area shall be on a one-for-one basis. For example, a 25 percent reduction in density of a 100-square meter (100 turions/square meter) eelgrass bed to 75 turions/square meter shall be mitigated by the establishment of 25 square meters of new eelgrass with a density at or above the 100 turions/square meter pre-impact density.

III. MITIGATION TECHNIQUE

Where mitigation for eelgrass impact is to be undertaken, proposed mitigation shall be developed and presented within a detailed mitigation plan. Techniques for eelgrass mitigation shall be consistent with the best available technology at the time of mitigation implementation and shall be tailored to the specific needs of the mitigation site. However, whatever techniques are employed, they shall comport with the stated objectives and measures in this policy.

Specific spacing of transplant units shall be determined to meet desired expansion rates to achieve coverage and bed density, as discussed in **APPENDIX D, VII. MITIGATION SUCCESS**. The density of planting shall be determined based on the site-specific conditions and the planting methodology to be employed. Notwithstanding the selected planting density, the interim and final mitigation success milestones shall be achieved.

Donor material shall be taken from the area of direct impact whenever practical. In southern, central, and northern California, donor plant material shall be taken from a minimum of two additional distinct sites to better ensure genetic diversity of the donor plants. Site selections shall consider the similarity of physical environments between the donor site and the transplant receiver site and shall also consider the size, stability, and history of the donor site (*e.g.*, how long has it persisted and is it a transplant site). In particular, donor sites in San Francisco Bay shall be carefully evaluated, as sites have highly variable genetic composition and phenotypic expressions that may affect transplant success (Talbot *et al.* 2004, Merkel & Associates 2005).

For all geographic areas, no more than 5 percent of the below ground biomass of an existing donor bed shall be harvested for transplanting purposes. Plants harvested shall be taken in a manner to thin an existing bed without leaving any noticeable bare areas. Harvesting of flowering shoots for seed buoy techniques shall occur only from widely separated plants (*i.e.*, flowering shoots can only be harvested from plants that are at least 5 meters, but preferably 10 meters apart from each other).

IV. MITIGATION TIMING

Mitigation shall commence within 90 days following the initiation of the in-water construction resulting in impact to the eelgrass bed. If possible, mitigation shall be initiated prior to or concurrent with impacts. For impacts initiated within 90 days prior to, or during, the low-growth period for the region, mitigation transplanting may be delayed to the beginning of the following growing season, or 90 days following impacts, whichever is longer, without the need for additional mitigation as outlined in section **V. MITIGATION IMPLEMENTATION DELAY.**

A construction schedule, which includes specific starting and ending dates for all work including mitigation activities, shall be provided to NMFS at least 30 days prior to initiating in-water construction.

V. MITIGATION IMPLEMENTATION DELAY

To offset loss of eelgrass habitat value that accumulates through delay, an increase in successful eelgrass mitigation is required to achieve the same compensatory habitat value. Because service value is accumulated over time during which mitigation habitat is in place, the longer the delay in initiation of mitigation, the greater the additional habitat area shall be to offset losses and the more rapidly the rate of change increases. To offset delays in implementation of mitigation, Table 1 identifies the increases in mitigation planting and successful establishment that shall apply to delays from initial date of eelgrass impact. Because replacement of interim service value lost shall be replaced by greater habitat creation within a finite period of time, the delay in initiation of work has an escalating impact on mitigation needed to fully compensate for losses.

Delays in mitigation initiation in excess of 12 months shall be considered as default of permit conditions, unless a specific delay is authorized or dictated by the initial schedule of work. Where delayed implementation is authorized by the action agency, the mitigation shall be determined by multiplying the initial mitigation planting area and the successful mitigation area by the delay multiplier in Table 1.

Table 1. Mitigation delay multiplier to achieve full compensatory replacement of impacted eelgrass habitat.

MONTHS POST-IMPACT	DELAY MULTIPLIER (Percent of Initial Mitigation Area Needed)
0-3 mo	100%
4-6 mo	107%
7-12 mo	117%
13-18 mo	127%

19-24 mo.	138%
25-30 mo.	150%
31-36 mo	163%
37-42 mo.	176%
43-48 mo.	190%
49-54 mo.	206%
55-60 mo.	222%

VI. MITIGATION MONITORING

In order to document progress and persistence of restored eelgrass through and beyond the initial establishment period, monitoring the success of eelgrass mitigation shall be completed for a period of five years. Monitoring shall be completed at both the mitigation site and at an appropriate reference site (**APPENDIX B, II. REFERENCE SITE SELECTION**) to account for any natural changes or fluctuations in bed width or density. Monitoring shall determine the area of eelgrass and density of plants at the mitigation and reference sites and shall be conducted at 0, 6, 12, 24, 36, 48, and 60 months after completion of the mitigation. All monitoring work shall be conducted during the active vegetative growth period and shall avoid the recognized low growth season for the region to the maximum extent practicable (typically November through February for southern California, November through March for central California, November through March for San Francisco Bay, and October through April for northern California). Additional monitoring beyond the 60-month period may be required in those instances where the action agency determines that stability of the proposed mitigation site is questionable or where other factors may influence the long-term success of mitigation. Extended monitoring shall be evaluated and discussed with NMFS.

A monitoring schedule that indicates when each of the monitoring events will be completed shall be prepared as part of a detailed mitigation plan. Monitoring reports shall be provided to the action agency and NMFS in both hard copy and electronic version (PDF and ESRI GIS shapefile format) within 30 days after the completion of each monitoring period and shall include an eelgrass transplant status summary. These summaries shall include information that clearly identifies the action, the action party, mitigation consultants, relevant points of contact, and any relevant permits. The size of permitted eelgrass impact estimates, actual eelgrass impacts, and eelgrass mitigation needs shall be identified, as shall appropriate information describing the location of activities. The summary shall identify facts sufficient to document mitigation milestone progress (see **VII. Mitigation Success**). The summary shall also note important dates and reference information for the activities of eelgrass impact, installation of eelgrass mitigation, and initiation of mitigation monitoring. When the summary concerns a final assessment, it shall address the following questions: was mitigation met; were mitigation and monitoring performed timely; and, were mitigation delay increases needed or were supplemental mitigation programs necessary? An example summary is provided in Attachment 3.

VII. MITIGATION SUCCESS

To assess the performance of mitigation efforts, the following actions shall be performed:

1) Initial Mitigation Site Adequacy. At the 0-month post-planting monitoring interval, a report shall be submitted to NMFS verifying the completion of planting in accordance with the mitigation plan. The report shall document any variances from the plan, document the sources of donor materials and any distributional differences across the mitigation site, and document the full area of planting. If the implementation of the mitigation was subject to the mitigation delay provisions of section **V. MITIGATION IMPLEMENTATION DELAY**, these shall be noted and any expansion need for the initial mitigation transplant area as well as recommendations for successful transplant area shall be documented. This report shall confirm adequate compliance with mitigation planting needs.

2) Mitigation Site Achievement of Establishment Period Progress Milestones. Restored eelgrass habitat will develop through an initial establishment monitoring period such that, within 36 months following planting, it meets or exceeds the full coverage and not less than 85 percent of the density relative to the initial condition of affected eelgrass habitat. Restored eelgrass habitat is expected to sustain this condition through at least 60 months following initial planting. Natural variability of eelgrass beds shall be addressed by scaling of the mitigation needs against variation at the selected reference sites. Where the performance of the bed relative to reference sites is erratic, the establishment-monitoring period may be extended and supplemental transplants may be warranted.

   Establishment period progress milestones are as follows:

   Month 0– Monitoring shall confirm the full coverage distribution of planting units over the initial mitigation site as appropriate to the geographic region.
   Month 6– Persistence and growth of eelgrass within the initial mitigation area shall be confirmed, and there shall be a survival of at least 50 percent of the initial planting units with well-distributed coverage over the initial mitigation site. For seed buoys, there shall be demonstrated recruitment of seedlings at a density of not less than one seedling per four (4) square meters with a distribution over the extent of the initial planting area.
   Month 12–The mitigation site shall achieve a minimum of 40 percent coverage of eelgrass and 20 percent density of reference site(s) over not less than 1.2 times the area of initial action impact.
   Month 24–The mitigation site shall achieve a minimum of 85 percent coverage of eelgrass and 70 percent density of reference site(s) over not less than 1.2 times the area of initial action impact.
   Month 36–The mitigation site shall achieve a minimum of 100 percent coverage of eelgrass and 85 percent density of reference site(s) over not less than 1.2 times the area of initial action impact.
   Month 48–The mitigation site shall achieve a minimum of 100 percent coverage of eelgrass and 85 percent density of reference site(s) over not less than 1.2 times the area of initial action impact.
   Month 60–The mitigation site shall achieve a minimum of 100 percent coverage of eelgrass and 85 percent density of reference site(s) over not less than 1.2 times the area of initial action impact.

Where interim development of the mitigation bed falls short of achieving the progress milestones during any interim survey milestone, a Supplemental Mitigation Area (SMA) may be required to ensure that adequate mitigation is achieved.

The action party shall compare eelgrass coverage (area) and density (turions per square meter) between the mitigation site and reference sites and adjust requirements within the mitigation site based on performance of the reference site against the condition of the reference site at the time of initial mitigation success monitoring (0-month monitoring event). The action party in coordination with the action agency and NMFS shall determine the size of the SMA with the following formula:

$SMA = TMA \times (|At + Dt| - |A_r + Dr|)$
TMA = total mitigation area*.
At = transplant deficiency (-) or excess (+) in area of eelgrass criterion (% or target mitigation area).
Dt = transplant deficiency (-) or excess (+) in density criterion (% of initial reference site density).
Ar = natural decline (-) in area of the reference site (% of initial reference site area) **.
Dr = natural decline (-) or excess (+) in density of reference site (% of initial reference site density).

* The TMA is generally 1.2 times the eelgrass impact unless delays in planting have occurred. The TMA is based on the successful mitigation area and not the minimum initial transplant area that takes into consideration regional mitigation success history.
** Selected reference site should be 100 percent coverage at the time of establishment. As a result, deviation from baseline is always a negative value. The deviation is measured as a percent area reduction from the initial area of the reference site.

When using the SMA formula, action parties shall apply the following conditions:

a) In monitoring Months 24-60, a surplus in coverage of up to 30% over the stated criterion may be used to offset density shortfalls provided that density achieves at least 60% of the reference site density as determined during the same monitoring interval.
b) Only a surplus in area that is equal to or less than the deficiencies in density shall be entered into the SMA formula. Thus A_t cannot exceed D_t by more than the absolute value of D_t.
c) Densities that exceed any of the progress milestone achievements shall not be used to offset any deficiencies in area of coverage.
d) In some instances, eelgrass is not expected to fully track with annual milestones and may be slightly behind performance due to short-term incidents or protracted periods of site development that are not expected to affect ultimate development of the mitigation site.

Any SMA shall be initiated within 180 days following the monitoring event that identifies a deficiency in meeting the progress milestone achievements. Any delays beyond 180 days in the implementation of the SMA shall be mitigated according to the mitigation delay ratios outlined in section **V. MITIGATION IMPLEMENTATION DELAY**. Annual monitoring of the SMA shall be completed for five years following the implementation, and all progress milestones shall apply to the SMA.

3) Mitigation Site Achievement of Final Requirements for Coverage and Density. With the 60-month monitoring milestone report, the action party shall provide the action agency and NMFS with an overall assessment of the performance of the eelgrass mitigation site relative to natural variability of the reference site. The site shall have demonstrated a continuous achievement of reference site performance adjusted eelgrass coverage and density over the last three annual monitoring events (*i.e.*, 36, 48, and 60-month intervals).

   If the mitigation area fails to achieve continuous success over the last three monitoring years, the monitoring period shall be extended and corrective measures shall be implemented to address shortfalls, for example extended monitoring or supplemental mitigation efforts.

VIII. Mitigation Bank

At the request of the action party, any surplus eelgrass area that, after 60-months, exceeds the mitigation needs, as defined in section **VII. Mitigation Success**, may be considered by the action agency as credit in a "mitigation bank" subject to applicable regulatory agency concurrence. Establishment of any "mitigation bank" must be consistent with an appropriately developed mitigation banking program. Monitoring of any approved mitigation bank shall be conducted on an annual basis until all credits are exhausted.

IX. References

King, D. M., and E. W. Price. 2004. Developing Defensible Wetland Mitigation Ratios: A Companion to "The Five-step Wetland Mitigation Ratio Calculator." Prepared by King and Associates, Inc. for NOAA, Office of Habitat Conservation, Habitat Protection Division.

Merkel & Associates, Inc. 2005. Baywide Eelgrass (Zostera marina L.) Inventory in San Francisco Bay: Eelgrass Bed Characteristics and Predictive Eelgrass Model. Prepared for California Department of Transportation and NOAA Fisheries.

Talbot, S. L., G. K. Sage, J. R. Rearick, and R. Muñiz Salazar. 2004. Genetic Structure of Zostera marina in San Francisco Bay: Preliminary Results of Microsatellite Analyses.

ATTACHMENT 1

SUMMARY OF EELGRASS TRANSPLANT ACTIONS IN CALIFORNIA

SUMMARY OF EELGRASS (*ZOSTERA MARINA*) TRANSPLANT PROJECTS IN CALIFORNIA

No.	Region	System	Location	Year	Size*	Type**	Consistent with Permit Conditions	Success Status***	Net Result****
Southern California Eelgrass Restoration History									
	Southern	San Diego Bay	North Island	1976	<0.1	SP	yes	no	-
	Southern	San Diego Bay	"Delta" Beach	1977	1.6	SP	yes	partial	-
	Southern	San Diego Bay	North Island	1978	<0.1	SP	yes	yes	+
	Southern	Newport Bay	Carnation Cove	1978	<0.1	SP	no	no	-
	Southern	Newport Bay	West Jetty	1980	<0.1	SP	yes	partial	0
	Southern	Mission Bay	multiple beaches	1982	<0.1	SP	no	partial	0
	Southern	LA/LB Harbor	Cabrillo Beach	1985	<0.1	BR	yes	yes	+
	Southern	Alamitos Bay	Peninsula	1985	<0.1	BR	yes	yes	+
	Southern	Huntington Hbr.	Main Channel	1985	<0.1	BR	yes	no	0
	Southern	Newport Bay	Upper	1985	<0.1	BR	yes	no	0
	Southern	Mission Bay	Sail Bay	1986	2.7	BR	yes	yes	+
	Southern	San Diego Bay	NEMS I	1987	3.8	BR	no	yes	+
	Southern	San Diego Bay	Chula Vista Wildlife Reserve	1987	<0.1	BR	yes	no	+[1]
	Southern	San Diego Bay	Harbor Island	1988	0.1	BR	yes	yes	+
	Southern	Huntington Harbour	Entrance Channel	1989	0.1	BR	no	yes	+
	Southern	San Diego Bay	Le Meridien Hotel	1990	<0.1	BR	yes	yes	+
	Southern	San Diego Bay	Embarcadero	1991	<0.1	BR	yes	yes	+[2]
	Southern	Mission Bay	Sea World Lagoon	1991	<0.1	BR	yes	yes	+
	Southern	San Diego Bay	Loew's Marina	1991	<0.1	BR	yes	yes	+
	Southern	San Diego Bay	NEMS 2	1993	<0.1	BR	yes	yes	+
	Southern	San Diego Bay	Sea Grant Study	1993	<0.1	BR	yes	yes	+
	Southern	Agua Hedionda Lagoon	Outer Lagoon	1993	<0.1	BR	yes	yes	+
	Southern	San Diego Bay	NEMS 5	1994	0.4	BR	yes	yes	+
	Southern	Mission Bay	South Shores Basin	1994	2.9	BR	yes	yes	+
	Southern	Talbert Marsh	Talbert Channel	1995	<0.1	BR	na	yes	+[4]
	Southern	Mission Bay	various sites	1995	4.8	BR	yes	yes	+
	Southern	Mission Bay	Ventura Cove[5]	1996	0.5	BR	yes	yes	+[6]
	Southern	Mission Bay	Santa Clara Cove	1996	<0.1	BR	yes	no	0[10]
	Southern	Mission Bay	West Mission Bay Drive Bridge	1996	<0.1	BR	no	yes	0[10]
	Southern	Mission Bay	De Anza Cove	1996	<0.1	BR	yes	yes	+
	Southern	Batiquitos Lagoon	all basins	1997	21.6 [7]	BR	yes	yes	+[4]
	Southern	San Diego Bay	NEMS 5	1997	7.1	BR	yes	yes	+
	Southern	San Diego Bay	Convair Lagoon	1998	2.5	BR	yes	no	-[12]
	Southern	San Diego Bay	NEMS 6	1999	0.3	BR	yes	yes	+
	Southern	Aqua Hedionda	Bristol Cove	1999	0.3	BR	yes	yes	+
	Southern	Aqua Hedionda	Middle Lagoon and Inner Lagoon	1999	4	BR	yes	yes	+
	Southern	Newport Bay	Balboa Is.Grand Canal	1999	<0.1	BR	yes	yes	+
	Southern	Mission Bay	West Ski Island	2001	0.2	BR	yes	yes	+

No.	Region	System	Location	Year	Size*	Type**	Consistent with Permit Conditions	Success Status***	Net Result****
	Southern	San Diego Bay	Expanded NEMS 6	2001	0.6	BR	yes	yes	+
	Southern	Newport Bay	USCG Corona del Mar	2002	<0.1	BR	yes	yes	+
	Southern	Huntington Harbour	Sunset Bay	2002	<0.1	BR	yes	yes	+
	Southern	San Diego Bay	Navy Enhancement Is.	2002	1	BR	yes	yes	+
	Southern	San Diego Bay	Coronado Bay Bridge	2003	0.3	BR	no	no	0
	Southern	LA Harbor	P300 Expansion Area	2003	5.9	BR	yes	partial	-[9]
	Southern	Newport Bay	Newport Bay Channel Dredging	2004	0.4	BR	yes	no	-
	Southern	San Diego Bay	South Bay Borrow Pit	2004	4.2	BR	yes	yes	pending[8]
	Southern	San Diego Bay	USCG ATC Pier	2004	0.1	BR	yes	yes	+
	Southern	San Diego Bay	South Bay Borrow Pit Sup.	2006	4.2	BR	yes	yes	pending[8]
	Southern	San Diego Bay	D Street Marsh	2006	0.3	BR	yes	pending	pending
	Southern	LA Harbor	P300 Supplement	2007	0.8	BR	yes	yes	pending
	Southern	San Diego Bay	Glorietta Bay Shoreline Park	2007	0.2	BR	yes	yes	pending
	Southern	Bolsa Chica	Pilot Eelgrass Restoration	2007	0.5	BR	yes	yes	+[4]
	Southern	San Diego Bay	Borrow Pit Supplement	2007	4.2	BR	yes	yes	pending[8]
	Southern	San Diego Bay	Sweetwater Silvergate Frac-out	2008	<0.1	BR	yes	yes	0[11]
	Southern	San Diego Bay	Harbor Drive Bridge/NTC Channel	2009	<0.1	BR	yes	pending	pending
Southern California Eelgrass Success Rate (1989-2009, Last 20 Years)								**87%**	**n=43**
Central California Eelgrass Restoration History									
	Central	Morro Bay	Anchorage Area	1985	<0.1	BR	no	yes	+
	Central	Morro Bay	Target Rock	1997	<0.1	BR	no	yes	+
	Central	Morro Bay	Morro Bay Launch Ramp	2000	<0.1	BR	yes	yes	+
	Central	Morro Bay	Mooring Area A1	2002	0.3	BR	yes	yes	+
	Central	Morro Bay	Western Shoal	2010	0.8	BR	yes	pending	pending
Central California Eelgrass Success Rate (1985-2009, Inadequate History to Exclude Older Projects)								**100%**	**n=4**
San Francisco Bay Eelgrass Restoration History									
	San Francisco Bay	San Francisco Bay	Richmond Training Wall	1985	<0.1	BR	NA	no	NA[4]
	San Francisco Bay	San Francisco Bay	Keil Cove and Paradise Cove	1989	0.1	Plugs	NA	partial	NA[4]
	San Francisco Bay	San Francisco Bay	Bayfarm Island/Middle Harbor Shoal	1998	0.1	BR and Plugs	NA	partial	NA[4]
	San Francisco Bay	San Francisco Bay	Bayfarm Island	1999	0.1	BR	NA	partial	NA[4]
	San Francisco Bay	San Francisco Bay	Brickyard Cove, Berkeley	2002	0.2	BR	yes	yes	+[13]
	San Francisco Bay	San Francisco Bay	Emeryville Shoals	2002	0.1	Mixed Test	NA	no	NA[4]
	San Francisco Bay	San Francisco Bay	Marin CDay, R&GC, Audubon	2006	0.6	Seed Bouy	NA	partial	pending[4]
	San Francisco Bay	San Francisco Bay	Marin CDay, R&GC, Audubon	2006	<0.1	mod. TERFS	NA	partial	pending[4]
	San Francisco Bay	San Francisco Bay	Marin CDay, R&GC, Audubon	2006	<0.1	Seeding	NA	no	NA[4]
	San Francisco Bay	San Francisco Bay	Clipper Yacht Harbor, Sausalito	2007	<0.1	Frames	yes	pending	pending
	San Francisco Bay	San Francisco Bay	Albany, Emeryville, San Rafael	2007	<0.1	BR	NA	partial	pending[4]
	San Francisco Bay	San Francisco Bay	Belvedere	2008	<0.1	Frames	yes	pending	pending
San Francisco Bay Eelgrass Success Rate (1985-2009, Inadequate History to Exclude Older Projects)								**40%**	**n=10**

No.	Region	System	Location	Year	Size*	Type**	Consistent with Permit Conditions	Success Status***	Net Result****
Northern California Eelgrass Restoration History									
	Northern	Humboldt Bay	Indian Island	1982	unknown	BR	unknown	no	-
	Northern	Bodega Harbor	Spud Point Marina	1984	1.3	BR	yes	no	-
	Northern	Humboldt Bay	Indian Island	1986	<0.1	BR	yes	no	-
	Northern	Humboldt Bay		1986	0.2	unknown	unknown	no	-
	Northern	Humboldt Bay	SR255 Bridge	2004	<0.1	BR	yes	no	-
	Northern	Humboldt Bay	Maintenance Dredging Project	2005	<0.1	BR	yes	yes	+
Northern California Eelgrass Success Rate (1982-2009, Inadequate History to Exclude Older Projects)								**25%**	**n=4**

* size in hectares
SP = sediment laden plug
** BR = bare root
*** success status is measured as yes, no, partial, pending, or unknown. Success rate is reported as percentage of sucessful over total completed within the past 25 years.
yes = 1, partial = 0.5, no = 0, and pending or unknown are not counted in either the numerator or denominator in determining success percentage.
**** + = net increase in eelgrass coverage, 0 = no change in eelgrass coverage, - = net decrease in eelgrass coverage
1 Transplant was initially adversely impacted by an unknown source of sediment and was deemed unsuitable.
2 The transplant declined initially and later recovered from what was determined to be a one time sedimentation event.
3 Transplant was experimental due to dense beds of the exotic muscle *Musculista senhousia*
which inhibited the growth of the transplant. Replacement transplant done elsewhere.
Transplant was completed in an area deemed unsuitable. Insufficient coverage required the construction of a remedial site.
Monitoring continues at both the initial and remedial sites.
4 Transplant was experimental.
5 Multiple sites.
6 Mitigation for marina at Princess Resort, project not built
7 Amount of eelgrass present within all basins as of 2000 mapping.
8 Regional eelgrass decline has resulted in die-offs both within restoration and reference areas equally full recovery had not occurred at the time of evaluation, yet project exceeds control-corrected requ
9 Original site was constructed as a plateau that was underfilled and anticipated to fall short of objectives. A supplemental
transplant was therefore completed when development began to exhibit shortfalls in area.
10 Shortfall mitigated by withdraw from established eelgrass mitigation bank.
11 Exception conditions from SCEMP requiring only replacement in place for unanticipated damage
12 Mitigated out-of-kind with non-eelgrass to satisfy permit requirements after shortfall in eelgrass mitigation.

ATTACHMENT 2

WETLAND MITIGATION RATIO CALCULATOR

Wetland Mitigation Ratio Calculator

A spreadsheet program for applying the approach described and illustrated in:

Developing Defensible Wetland Mitigation Ratios:
Standard tools for "scoring" wetland creation, restoration, enhancement, and conservation

Prepared by

Dennis King and Elizabeth Price
University of Maryland, Center for Environmental Science

Next

APPROACH

In the rare case where wetland mitigation can be expected to fully, immediately, and risklessly replace lost wetland functions and values at the impact site, the appropriate number of acres of mitigation required to achieve "no net loss" of wetland functions and values would be equal to the number of wetland acres impacted. In practice, however, determining the “equivalency” of wetland gains and losses from on-site and off-site and in-kind and out-of-kind mitigation requires more complicated "quantity-quality tradeoffs." These tradeoffs usually result in the establishment of a “mitigation compensation ratio” that establishes the number of acres of mitigation required per acre of wetland impact. The proper mitigation ratio differs from case to case based on the characteristics of the impacted wetland and whether the proposed mitigation involves wetland creation, restoration, enhancement, or conservation. Since mitigation ratios can have an enormous impact on the cost of mitigation, they are often controversial and are frequently challenged by wetland permit seekers.

The spreadsheet tool presented in the following pages can be used to develop wetland mitigation ratios that are based on sound economic and scientific principles and, therefore, should be able to withstand technical and legal challenges. The tool is based on a standard "net present value" assessment of asset value and uses relative measures of the expected streams of wetland functions and values over time from the impacted wetland and from the mitigation wetland to determine the appropriate mitigation ratio. Establishing how many acres of an inferior wetland (e.g., a young wetland being restored as mitigation) can be expected to provide the same wetland "value" as an acre of a superior wetland (e.g., a mature, natural wetland that is impacted), in economic terms, is not much different than comparing how many shares in a risky start-up company (e.g., a penny stock) are equal to a single share in a mature, proven company (e.g., a blue chip stock) by examining differences in risk-adjusted earnings per share over time.

The approach requires the user to specify values for a set of parameters that characterize expected gains in wetland services at the proposed mitigation in relative terms based on the wetland services lost at the impact site. The version of the tool that is developed here can be used to estimate compensation ratios for mitigation that involves wetland creation, restoration, or enhancement, or wetland conservation, or any combination.

Next

Defintion of Terms and Generalized Equation

The Mitigation Ratio Calculator (MRC) requires users to estimate or settle upon acceptable values for the following nine parameters. The parameter k is assigned a zero value except when wetland preservation (conservation) is part of the mitigation package under consideration. A supplemental formula and "look up" table is provided for specifying appropriate values for k in these cases.

A The level of wetland function provided per acre at the mitigation site prior to the mitigation project, expressed as a percentage of the level of function per acre at the wetland impact site;

B The maximum level of wetland function each acre of mitigation is expected to attain, if it is successful, expressed as a percentage of the per acre level of function at the wetland impact site;

C The number of years after construction that the mitigation project is expected to achieve maximum function;

D The number of years before destruction of the impacted wetland that the mitigation project begins to generate mitigation values (negative values of D represent delayed compensation);

E The percent likelihood that the mitigation project will fail and provide none of the anticipated benefits (with mitigation failure, wetland values at the mitigation site return to level A);

L The percent difference in expected wetland values based on differences in landscape context of the mitigation site when compared with the impacted wetland (positive values represent more favorable landscape context at mitigation site);

k The percent likelihood that the mitigation site, in the absence of the proposed conservation action (e.g., purchase or easement) would be developed in any future year. This is treated as a cumulative distribution function in the equation;

r The discount rate used for comparing gains and losses that accrue at different times in terms of their present value;

T_{max} The time horizon used in the analysis (Using the OMB recommended discount rate of r=7%, the impact of gains and losses in wetland values beyond about Tmax = 75 years has a negligible effect on the resulting mitigation ratio)

The discrete time equation that can be used to solve for the appropriate mitigation ratio for mitigation that includes wetland creation/restoration or wetland conservation, or both, is as follows:

$$R = \frac{\sum_{t=0}^{T_{max}} (1+r)^{-t}}{\left(B(1-E)(1+L)-A\right)\left[\sum_{t=-D}^{C-D-1} \frac{(t+D)}{C(1+r)^{t}} + \sum_{C-D}^{T_{max}} (1+r)^{-t}\right] + \left[\sum_{t=-D}^{T_{max}} \frac{\left(1-(1-k)^{(t+D)}\right)}{(1+r)^{(t+D)}}\right]\left(A(1+L)\right)}$$

Advance to Calculator

ATTACHMENT 3

EELGRASS TRANSPLANT STATUS SUMMARY EXAMPLE

In order to ensure that NMFS is aware of the status of eelgrass transplants, action agencies should provide or ensure that NMFS is provided a monitoring report summary with each monitoring report. For illustrative purposes only, an example of a monitoring report summary is provided below.

ACTION PARTY CONTACT INFORMATION:

Action Name (same as permit reference):

ACTION PARTY INFORMATION

Name		Address	
Contact Name		City, State, Zip	
Phone		Fax	
Email			

MITIGATION CONSULTANT

Name		Address	
Contact Name		City, State, Zip	
Phone		Fax	
Email			

PERMIT DATA:

Permit	Issuance Date	Expiration Date	Agency Contact

EELGRASS IMPACT AND MITIGATION NEEDS SUMMARY:

Permitted Eelgrass Impact Estimate (m^2):			
Actual Eelgrass Impact (m^2):		On (post-construction date):	
Eelgrass Mitigation Needs (m^2):		Mitigation Plan Reference:	
Impact Site Location:			
Impact Site Center Coordinates (actionion & datum):			
Mitigation Site Location:			
Mitigation Site Center Coordinates (actionion & datum):			

ACTION ACTIVITY DATA:

Activity	Start Date	End Date	Reference Information
Eelgrass Impact			
Installation of Eelgrass Mitigation			
Initiation of Mitigation Monitoring			

MITIGATION STATUS DATA:

	Mitigation Milestone	Scheduled Survey	Survey Date	Bed Area (m^2)	Bottom Coverage (Percent)	Eelgrass Density (turions/m^2)	Reference Information
Month	0						
	6						
	12						
	24						
	36						
	48						
	60						

FINAL ASSESSMENT:

Was mitigation met?	
Were mitigation and monitoring performed timely?	
Were mitigation delay increases needed or were supplemental mitigation programs necessary?	