Appendix F:

INDEX SITE SELECTION - DETAILED METHODS

Criteria 1: Marine protected area (MPA) design features

During the Marine Life Protection Act (MLPA) planning process, the MLPA Science Advisory Team (SAT) provided regional stakeholders with MPA science and design guidelines based on the best readily available science (CDFW 2008, MLPA SAT 2008, 2009, 2011). Regional stakeholder groups were advised to prioritize these guidelines in their design of MPAs; however, the MPAs proposed and eventually adopted vary in their level of compliance with SAT guidelines (Gleason et al. 2013, Saarman et al. 2013, CDFW 2016).

MPAs that meet scientific guidelines are expected to realize more significant conservation benefits, and therefore should be prioritized for long-term monitoring. To that end, coastal and island MPA sites were scored against SAT guidelines (MPA size, threshold of habitat representation and replication within and MPA), and overlap with Areas of Special Biological Significance (ASBS) and historically protected areas. For more information on methods for scoring estuary MPAs, see appendix F, page 220.

MPA size

The SAT recommended that "for an objective of protecting adult populations, based on adult neighborhood sizes and movement patterns, MPAs should have an alongshore span of 5-10 kilometers (3-6 statute miles [sm]) of coastline, and preferably 10-20 km (6-12.5 sm)" (CDFW 2008). The SAT also recommended that MPAs extend from intertidal to offshore areas in order to a) protect the diversity of species that live at different depths and b) accommodate the movement of individuals to and from shallow nursery or spawning grounds to adult habitats offshore. The recommended offshore span is from the mean high tide line to the offshore state waters boundary, generally a distance of 3.45 sm (three nautical miles), except in some areas such as offshore rocks where state boundaries may extend farther. Taking into account these two guidelines, the SAT recommended a minimum area of 9 square statute miles (sm^2) for each MPA, and preferably 18 sm^2 or larger.

Based on these recommendations, each MPA was scored for size as follows: two points if its size is greater than or equal to 18 sm^2; one point if its size is greater than or equal to nine sm^2 and less than 18 sm^2; zero points if its size is less than nine sm^2.

Threshold of habitat representation and replication within an MPA

The SAT recommended that "for an objective of protecting the diversity of species that live in different habitats and those that move among different habitats over their lifetime, every 'key' marine habitat should be represented in the MPA Network" (CDFW 2008). The key marine habitats described in the MLPA were subdivided by the SAT to reflect ecological differences at different depths. Twelve different habitats were classified and their spatial distribution within the MPAs was calculated. These habitat summaries include: rocky shores, hard bottom 0-30 meters (m), hard bottom 30-100 m, hard bottom 100-3000 m, beaches, soft bottom 0-30 m, soft bottom 30-100 m, soft bottom 100-3000 m, kelp, coastal marsh, eelgrass, and estuary.

The SAT also recommended that each of the above habitats be replicated within individual MPAs. To count as a replicate of any given habitat, an MPA must contain enough habitat to encompass 90% of the biodiversity associated with that habitat. The minimum size required to encompass 90% of the associated biodiversity varies by habitat and has been determined from biological surveys (CDFW 2008). A summary of the minimum size requirements for habitat replication, in linear miles or square miles, is provided in Table F1.

TABLE F1: The minimum size required to encompass 90% of biodiversity for key MPA habitats. Hard and soft bottom habitats include depth ranges in meters (m).

HABITAT	MEASUREMENT	MINIMUM SIZE
Rocky Shores	Linear miles	0.60
Hard 0 - 30m	Linear miles	1.10
Hard 30 - 100m	Square miles	0.20
Hard 100 - 3000m	Square miles	0.20
Beaches	Linear miles	1.10
Soft 0 - 30m	Linear miles	1.10
Soft 30 - 100m	Square miles	5.00
Soft 30 - 3000m	Square miles	7.00
Kelp	Linear miles	1.10
Coastal Marsh	Square miles	0.04
Eelgrass	Square miles	0.04
Estuary	Square miles	0.12

Based on these recommendations, each MPA was scored for habitat representation and replication as follows: one point per habitat type that met minimum size requirements, and zero points for habitat types that did not meet the minimum size requirement.

Level of protection (LOP) within an MPA

For comparisons among alternative MPA proposals, the SAT assigned a level of protection (LOP) to each MPA based on the proposed method of take within its boundaries. LOPs were based on the likely impacts of proposed activities to the ecosystems within an MPA. Conceptually, the SAT sought to answer the following question in assigning LOPs: "How much might an ecosystem differ from an unfished or unharvested ecosystem if one or more proposed activities are allowed (CDFW 2008, MLPA SAT 2008, 2009, 2011, Saarman et al. 2013)?"

The SAT assigned an LOP of "very high" to MPAs in which no take was permitted (SMRs and no-take SMCAs). MPAs that allowed extractive activities received LOPs ranging from "high" for low-impact activities to "low" for high-impact activities (e.g., habitat alteration). Both direct impacts (those resulting directly from the gear used or the removal of target or non-target species) and indirect impacts (ecosystem level effects of species removal) were considered in LOP assignments. For example, multiplier values ranged from 0 to 1 in increments of 0.2. A low LOP received a multiplier of 0, whereas, a very high LOP received a multiplier of 1 (Table F2).

TABLE F2: Possible levels of protection (LOPs) for each MPA type, corresponding LOP multiplier assigned for long-term monitoring site selection analysis, and examples of associated activities. SMR=State Marine Reserve, SMCA=State Marine Conservation Area.

LOP	MPA TYPES	MULTIPLIER	ASSOCIATED LOP ACTIVITIES
VERY-HIGH	SMR; SMCA (no-take)	1.0	No take
HIGH	SMCA	0.8	Salmon (hook and line [H&L] or troll in waters >50m depth); coastal pelagic finfish (H&L, round-haul net, dip net); white seabass and bonito (spear)
MOD-HIGH	SMCA	0.6	Dungeness crab (trap, hoop-net, diving); salmon (troll in water <50m depth); pier-based fishing (H&L, hoop net)
MODERATE	SMCA	0.4	Spot prawn (trap); sea cucumber (scuba/hookah); surfperch (H&L from shore); salmon (H&L in waters <50m depth)
MOD-LOW	SMCA	0.2	Lingcod, cabezon, rockfishes, sheephead, and greenlings (H&L, spearfishing, trap); red abalone (free-diving); urchin (diving)
LOW	SMCA	0.0	Rock scallop (scuba); giant kelp (mechanical harvest); ghost shrimp (hand harvest); mussels (hand harvest); bull kelp (hand harvest)

[1] Final North Coast LOPs: http://www.dfg.ca.gov/marine/pdfs/northcoastproposals/rec_description.pdf
[2] Final North Central Coast LOPs: http://www.dfg.ca.gov/marine/pdfs/ipa_description.pdf
[3] Final Central Coast LOPs: http://www.dfg.ca.gov/marine/pdfs/comparison_mpas.pdf
[4] Final South Coast LOPs: http://www.dfg.ca.gov/marine/pdfs/scsr_description_ipa.pdf

MPAs were scored for LOP by multiplying each MPA's habitat threshold points (described above) by its LOP multiplier.

MPA overlap with Areas of Special Biological Significance (ASBSs)

Although the MLPA does not specifically mandate water quality management within MPAs, marine life is known to be adversely affected by poor water quality. Ocean pollution has been linked to changes in marine population growth, reproduction, and mortality rates; decreased abundance of marine life; and shifts in community composition (e.g., decreased diversity and loss of sensitive species) (Pastorok & Bilyard 1985, Laist 1987, Derraik 2002, Echeveste et al. 2010). For MPA Network design, the SAT recommended that proposed MPAs avoid areas of poor water quality and be co-located with state water quality protection areas (e.g. ASBS) because they benefit from water quality protection beyond that offered by standard waste discharge restrictions (Fox et al. 2013). MPAs were scored for overlap with ASBSs by assigning a point value from 0 to 1 representing percent of area overlap with ASBS. For example, if an ASBS overlapped with 72% of the MPA's area, point value was 0.72.

MPA overlap with historically protected area

The MLPA mandated that the state redesign its existing MPAs to function as an interconnected statewide network. Prior to the MLPA, California's existing 63 MPAs were generally small and established in an ad hoc manner throughout the state over many decades and using at least nine different designations (McArdle 1997, 2002; Gleason et al. 2013). During the redesign process, several MPAs overlapped with historical MPA boundaries. To prioritize MPAs that include a portion of an MPA predating the MLPA, MPAs were scored by summing two different point values, defined as follows:

An MPA received historical MPA overlap credit equivalent to the percentage of area overlapping with the historically protected area. For example, if a historically protected area overlapped with 64% of the MPA's area, the overlap credit was 0.64.

In addition, similar to LOP scoring, a historical MPA protection credit was given. The MPA received one point if the historical MPA prohibited all take and zero points if the historical MPA allowed any type of take.

Total historical MPA points = historical MPA overlap credit + historical MPA protection credit

Calculating final design scores

Each MPA received a design score based on the following equation:

Design score = MPA size points + habitat threshold points + LOP points + ASBS points + historical MPA points

As an example, here are the points awarded to Point Lobos State Marine Reserve (SMR):

- MPA size points = 0
  - Point Lobos SMR is approximately 5.5 sm^2, which falls below the recommended minimum threshold of nine sm^2 as recommended by the SAT.

- Habitat threshold points = 6
  - Point Lobos SMR meets the minimum habitat thresholds for rocky shores, kelp, hard bottom habitat 0-30 m, hard bottom habitat 30-100 m, beaches, and soft bottom habitat 0-30 m.

- LOP points = 6
  - Point Lobos SMR was assigned an LOP of "very high" since it prohibits all take, therefore the MPA received a LOP "multiplier" of 1. LOP points were calculated by multiplying the LOP "multiplier" by the total sum of habitats protected, in this case 1*6 = 6.

- ASBS points = 0.2
  - Point Lobos SMR overlaps with the Carmel Bay/Point Lobos Ecological Reserve ASBS, with approximately 23.8% of the MPA overlapping with the ASBS.

- Historical MPA points = 1.3
  - The current Point Lobos SMR is an expansion of a historical MPA. Established in 1973, the historical Point Lobos SMR did not allow take (protection credit = 1 point) and comprised approximately 26% of the area encompassed by the new MPA (overlap credit = 0.3 points), so total historical MPA points = 1 + 0.3 = 1.3.

- Based on the above information, Point Lobos SMR receives a **final design score of 13.5.**

All final MPA design feature scores for each coastal and island MPA are in Table F3, and for each estuarine MPA are in Table F4.

Criteria 2: MPA historical monitoring

Responses of targeted fished species to MPA implementation can occur on the order of years to decades, and community responses tend to occur over longer time scales (Babcock et al. 2010, Caselle et al. 2015, Starr et al. 2015). **For a more informative and successful network evaluation, it is essential to prioritize MPAs with the longest possible time series of available data. This provides a more statistically robust before-after/control-impact analyses - in other words, a greater understanding of change over time.**

In order to offer an unbiased assessment of the statewide monitoring we used very specific criteria in order to include monitoring as part of "historical monitoring." Specifically, the monitoring had to occur consistently throughout the state both before and after MPA implementation. There are a multitude of programs that offer long-term monitoring data (see section 2.2 "Examples of Important Existing Programs"), but were ultimately not included due to either temporal or spatial limitations. The approach to only include historical monitoring consistently conducted statewide limited the analysis to only rocky substrate programs. However, data collected by spatially limited survey programs such as the National Park Service's KFMP at the Channel Islands will be integrated in future analyses.

Rocky intertidal monitoring: Multi-Agency Rocky Intertidal Network (MARINe) biodiversity and fixed plot surveys

MARINe has conducted surveys at a set of rocky intertidal monitoring sites for more than 15 years. MARINe conducts two types of intertidal monitoring surveys:

Biodiversity surveys are designed to gather detailed information about the diversity and community structure of rocky intertidal communities, and how these communities change over time across a large geographic area. During these surveys, researchers identify and count all algae and invertebrates in a wide swath of the intertidal; they also record topographical information in order to create three-dimensional species distribution maps. MARINe biodiversity surveys have been conducted in each bioregion every 2-5 years since 2001.

Fixed plot surveys are designed to measure population trends for important intertidal species such as sea stars and abalone. Each year, MARINe researchers survey a set of fixed plots, counting and measuring a subset of ecologically important species and recording percent cover of habitat-forming species such as mussels, rockweed, and barnacles. MARINe fixed plot surveys have been conducted in each bioregion every year since at least 2001, with the earliest surveys dating back to the 1980s.

Nearshore (0-30 m) subtidal kelp forest monitoring: Partnership for Interdisciplinary Study of Coastal Oceans (PISCO) and ReefCheck California (RCCA) SCUBA surveys

PISCO and RCCA collect data on kelp forest ecosystems including macroalgae, invertebrates, and fishes via SCUBA diver surveys. PISCO's sampling protocols and training methods are standardized across affiliated institutions and partners, including UC Santa Cruz and UC Santa Barbara, and have data dating back to 1999. Using protocols similar to PISCO, RCCA has trained volunteer recreational divers to conduct surveys statewide since 2006.

Mid-depth (30-100 m) remotely operated vehicle (ROV) monitoring: CDFW/Marine Applied Research and Exploration (MARE) surveys

CDFW and MARE have performed extensive ROV surveys inside and outside of MPAs since 2004. Data derived from ROV imagery is particularly powerful because all observations are precisely georeferenced, meaning that scientists can more effectively model species distributions and their habitat associations.

Calculating final historical monitoring points

All coastal and island MPAs were scored for level of historical monitoring according to the following rule: MPAs received a single point for each of the five surveys described above (MARINe biodiversity surveys, MARINe fixed plot surveys, PISCO surveys, RCCA surveys, and CDFW/MARE surveys) for each survey replicate that was conducted each year since the beginning of the survey program. As an example, here are the historical monitoring points awarded to Point Lobos SMR:

- MARINe biodiversity survey = 4
  - There is only one rocky intertidal site surveyed within Point Lobos. It has been surveyed for biodiversity by MARINe in 2001, 2005, 2014, and 2017, so receives a point value of 4.
- MARINe fixed plot survey = 19
  - There is only one rocky intertidal site surveyed within Point Lobos. It has been surveyed for fixed plot sampling every year from 1999-2017, so receives a point value of 19.
- Kelp forest monitoring, PISCO = 18
  - Within Point Lobos SMR, PISCO has three sites: Monastery (surveyed 1999-2016), Bluefish (surveyed 1999-2016), and Weston (surveyed 2001-2016). While multiple sites with years of survey data are available, Point Lobos only receives credit for the site with the greatest number of surveys. In this case two sites have 18 years of surveys, so 18 points are awarded.
- Kelp forest monitoring, RCCA = 12
  - Within Point Lobos SMR, RCCA has four sites: North Monastery (surveyed 2008, 2010-2017), South Monastery (surveyed 2007-2017), Middle Reef (surveyed 2006-2017), and Weston (surveyed 2006-2017). While multiple sites with years of survey data are available, Point Lobos only receives credit for the site with the greatest number of surveys. In this case two sites have 12 years of surveys, so 12 points are awarded.
- Mid-depth ROV monitoring = 2
  - Point Lobos SMR has been surveyed by ROV twice, once in 2008 and once in 2015, so receives a point value of 2.
- Total score: Based on this information,
  Point Lobos SMR receives a preliminary historical monitoring score of 55.

A multiplier was then applied as a filter to more highly weight MPAs that are capable of supporting multiple types of monitoring. The purpose of this filter was to determine which MPAs may be best suited for long-term monitoring across different habitat types. An MPA with a long survey history, but only one habitat monitored, is less likely to be of value in long-term monitoring than an MPA in which multiple habitats have been monitored. Therefore, for each of the monitoring habitats identified (rocky intertidal, kelp forest, and mid-depth rock) MPAs received a monitoring multiplier value of either 0, 1, 2, or 3 for each type of habitat surveyed by any method (i.e., if RCCA surveyed an MPA, but PISCO did not, the MPA still received credit for supporting kelp forest monitoring). Monitoring multipliers were then used in final historical monitoring scores as follows:

Historical monitoring score = (rocky intertidal biodiversity points + rocky intertidal fixed plot points + PISCO kelp forest monitoring points + RCCA kelp forest monitoring points + mid-depth ROV points) * monitoring multiplier

Based on the above information, Point Lobos SMR received a final historical monitoring score of 165 (all three types of habitats were surveyed, so monitoring multiplier = 3; 55*3 = 165); final historical monitoring scores for each coastal MPA are in Table F3.

Criteria 3: Habitat-based connectivity contribution modeling

California's MPAs were designed and are managed to function as an ecologically cohesive, statewide network, especially in terms of larval dispersal. For most nearshore marine species, planktonic larval transport is primarily driven by oceanographic factors such as currents and seasonal upwelling. Over the last decade, there have been significant advances in oceanographic modeling. One widely used approach is the Regional Oceanographic Modeling System (ROMS), which tracks particle movement in four dimensions (space over time) based on simulated nearshore oceanographic conditions (Moore et al. 2011).

ROMS was applied to examine the larval connectivity of key habitats in the MPA Network (rocky intertidal, kelp and rocky reef 0-30 m, rocky reef 30-100 m, sandy beach, soft bottom 0-30 m, and soft bottom 30-100 m). Particles representing larvae were "released" into the model and allowed to remain for a range of 30-60 days. This range represents the pelagic larval duration (PLD), or how long larvae remain in the water column before settling, for most nearshore species (Shanks 2009). The total larval output (i.e., donor, source) and settlement (i.e., recipient, sink) was assessed for all non-estuarine MPA sites in the network. Sites were then ranked based on their total contribution to the MPA Network as both source and sink.

General ROMS methods

- Simulated oceanographic conditions in ROMS were based on 15-year averages (1999-2013).
- General model expanse was U.S.-Mexican border to U.S.-Canadian border.
- Particles were released from 557 cells along the expanse. These cells included all coastal areas of California with one important exception – the Farallon Islands, located approximately 27 miles off San Francisco, were not included.
- Approximately 88,000 "larvae" were released from each cell (all releases through all years), with a total of 49 million larvae released. Total settlement depended on the PLD.
    - There have been a series of sensitivity studies to determine the number of particles required to provide an accurate set of results (the number required such the further increases do not affect the results). The number used in this study (1000 larvae released per month per cell) is much more than needed, but the model output can and has been used for other questions where larvae number requirements are higher.
- Model results for 11 PLDs (5, 10, 15, 20, 30, 45, 60, 90, 120, 150, 180 days) were obtained.
- Larvae moved hourly, but with daily averaged currents. Every hour, the daily average currents from the ROMS model were interpolated in space and time to find the current at each particle location. Then each particle was moved with its appropriate current velocity at that location. Landward of a certain depth range (500 m), the larvae were also given a random "kick" simulating tidal currents of 5 cm/s. This kick was also given every hour in addition to the daily-averaged motion.
- Settlement could only occur within 10% of PLD (e.g., for PLD of 30 days: 27-33 days)
- The ROMS output can be considered a measure of connectivity among cells (locations) but should not be considered an estimate of one cell's contribution of larvae (propagules) to other cells. This is because cells in ROMS grids are only characterized by oceanographic factors. In order to estimate the level of larval contribution, propagule production for donor cell, and amount of suitable habitat for receiving cells, high resolution habitat information must be incorporated as a sub-model.

Habitat sub-models

The area or linear extent of key nearshore habitats was estimated for each ROMS cell in California, including those within MPAs, using a suite of data sources (e.g., seafloor mapping and existing GIS data layers). Linear extent was used for sandy beaches and rocky intertidal habitats, and area was used for all other habitats.

Integrating ROMS and the habitat sub-models

Habitat and ROMS sub-models were integrated as follows. Raw larval connectivity between locations (i.e. cells, MPAs) was measured based on suitable habitat in the donor and recipient locations.

- An equation was applied to ensure that donor locations without certain types of habitat could not contribute propagules from those habitats. It also ensured that propagules associated with habitats not found in a location could not settle in recipient locations lacking those habitats.
- For a given PLD, or set of PLDs, the sum of contributions was calculated for all location pairs by habitat. For most locations, this is the same as the actual value (no summation required). However, some MPAs are found in multiple ROMS cells so the separate values for each portion of the cells represented by the MPA was summed to produce an MPA value.
- This suite of values was then queried to produce contribution or connectivity (or both) estimates for all habitats. In addition, other contribution/connectivity attributes were calculated as follows:
    - » The number of links to and from all locations. For example – the number of other locations that contributed to a recipient location or the number of other locations a donor location contributed to. Here the links were restricted based on the level of contribution or connectivity, which removed links where contribution or connectivity were very low (<0.0001).
    - » The diversity of links. This was calculated using the Shannon-Weiner Index (H'). This index incorporates the number of links and also the contribution or connectivity values for each link. High values are driven by many links of relatively even contribution or connectivity.

Examples of other metrics that can be produced via these methods:

- The contribution, links, and diversity of links (calculated using the Shannon-Weiner Index [H']) of specific MPAs to all locations
- The contribution, links, and diversity of links of all locations to specific MPAs
- The contribution, links, and diversity of links of specific MPAs to other MPAs

The final combined connectivity value (number of links to and from all locations) for each coastal MPA are found in Table F3.

Criteria 4: High resolution mapping of recreational fishing effort

Recovery trajectories of fished populations following MPA implementation are highly dependent on the level of fishing mortality (F) to which those populations were subjected prior to protection (Micheli et. al 2004, White et al. 2013, Caselle et. al 2015, Starr et al. 2015, White et al. 2016). **In other words, more pronounced ecological change should be expected inside MPAs where F was once high, and these sites should be prioritized for long-term monitoring.**

In cases where there are not sufficient data to estimate direct mortality due to fishing, a related measure, fishing effort, can provide a proxy of relative historical fishing pressure and guidance for where long-term monitoring could be focused. In order to attribute fishing effort at a spatial scale appropriate for determining influence on specific MPAs, data must include spatial attributes recorded at resolutions that support linking fishing location with MPA boundaries. CDFW's California Recreational Fisheries Survey (CRFS) program began in 2004, and employs fisheries technicians to interview recreational anglers about their catch and fishing activities from private/rental boats, on chartered commercial passenger fishing vessels (CPFVs, or "party boats") led by hired boat captains, and from beaches and manmade structures that include piers and jetties. The private and rental boat survey data collected includes spatial and sampling effort attributes recorded at scales that support summation of records within relatively high resolution mapping units, which are one-minute latitude by one-minute longitude in size, excluding estuaries. Ideally, similar resolution data would be used for analogous synthesis of commercial fishing effort or catch; however, current commercial landing records for similar targeted species only support summation of effort and catch at a resolution of ten-minutes latitude by ten-minutes longitude, which is too coarse for this analysis. As such, Criteria 4 presents an index of historical recreational bottom fishing pressure on MPAs prior to implementation, independent of fishing pressure from other modes of fishing. While this does not describe the complete state of all fishing effort, it does identify sites that historically received high recreational effort and thus are expected to have a measurable (biotic) response to MPA treatment. Using CRFS interviews from 2006 to the last year prior to MPA implementation for each MLPA planning region (2011 for North, 2009 for North Central, 2006 for Central, 2011 for South), estimates of relative recreational ocean fishing effort by private/rental boats were mapped. A relative index of historical fishing effort was calculated by standardizing the sampled number of angler boat trips over time and area at sites now located within MPAs (Table F3). The analyses here focus on boat trips on which anglers targeted bottomfish, and exclude trips representing seasonally high effort on salmon and pelagic species that are not expected to stay within MPA boundaries. A one-mile buffer was applied around intersections of MPAs with the gridded blocks. Results indicated that relative fishing effort prior to MPA implementation was concentrated in coastal areas surrounding major ports and cities and surrounding island areas closest to these ports. Across California, relative fishing effort was highest in the southern bioregion (for bottomfish), although there were hotspots in all three bioregions (Figures F1, F2, and F3). The maximum relative fishing block effort in an MPA ranged from 0 to 139 trips/year across the different regions.

Historical recreational boat fishing hotspots for bottomfish emerged in the northern bioregion around Crescent City (Point St. George Reef Offshore State Marine Conservation Area [SMCA]), Reading Rock State Marine Reserve (SMR)/SMCA, and Fort Bragg (MacKerricher SMCA and Point Cabrillo SMR) (Figure F1). In the central bioregion, high relative fishing effort mapped to Point Buchon SMR/SMCA and MPAs between Halfmoon Bay and Santa Cruz (Montara SMR, Pillar Point SMCA, Año Nuevo SMR, Greyhound Rock SMCA) (Figure F2). Relatively high fishing effort prior to MPA implementation was also concentrated around Monterey (Pacific Grove Marine Gardens SMCA, and Asilomar SMR) (Figure F2). Along the southern bioregion mainland, Cabrillo SMR near San Diego had the highest relative fishing effort focused on bottomfish in the state. Dana Point SMCA, and the area around La Jolla (San Diego-Scripps Coastal SMCA, Matlahuayl SMR, and South La Jolla SMR/SMCA) were also important fishing grounds for bottomfish. In the Channel Islands, historical recreational hotspots targeting bottomfish were concentrated at Footprint SMR, Anacapa Island SMR/SMCA, and around Catalina

Island (Arrow Point to Lion Head Point SMCA, Long Point SMR, Casino Point SMCA, Lover's Cove SMCA, Blue Cavern Onshore/Offshore SMCAs, and Farnsworth Onshore/Offshore SMCAs) (Figure F3). The final relative fishing effort scores for each coastal MPA are found in Table F3.

[1] https://www.wildlife.ca.gov/Conservation/Marine/CRFS
[2] Units are a relative index of effort (i.e., a result of 2.0 indicates twice as much effort relative to a result of 1.0). Values do not represent any measure of total effort.
[3] All species listed in the PFMC Pacific Coast Groundfish Fishery Management Plan (PFMC 2016) except leopard shark, California skate, sand sole and starry flounder; all species listed in the California Nearshore Fishery Management Plan (CDFW 2002); and unidentified bottomfish or groundfish, blacksmith, black croaker, white seabass, other flounders, sea chubs, groupers, grunts, Pacific halibut, sea basses (except spotted sand bass), kelpfishes, sculpins, wrasses, ocean whitefish, some surfperches (black, kelp, pink, rainbow, reef, sharpnose and striped) and other flatfish and sharks found in the nearshore over hard bottoms and offshore.

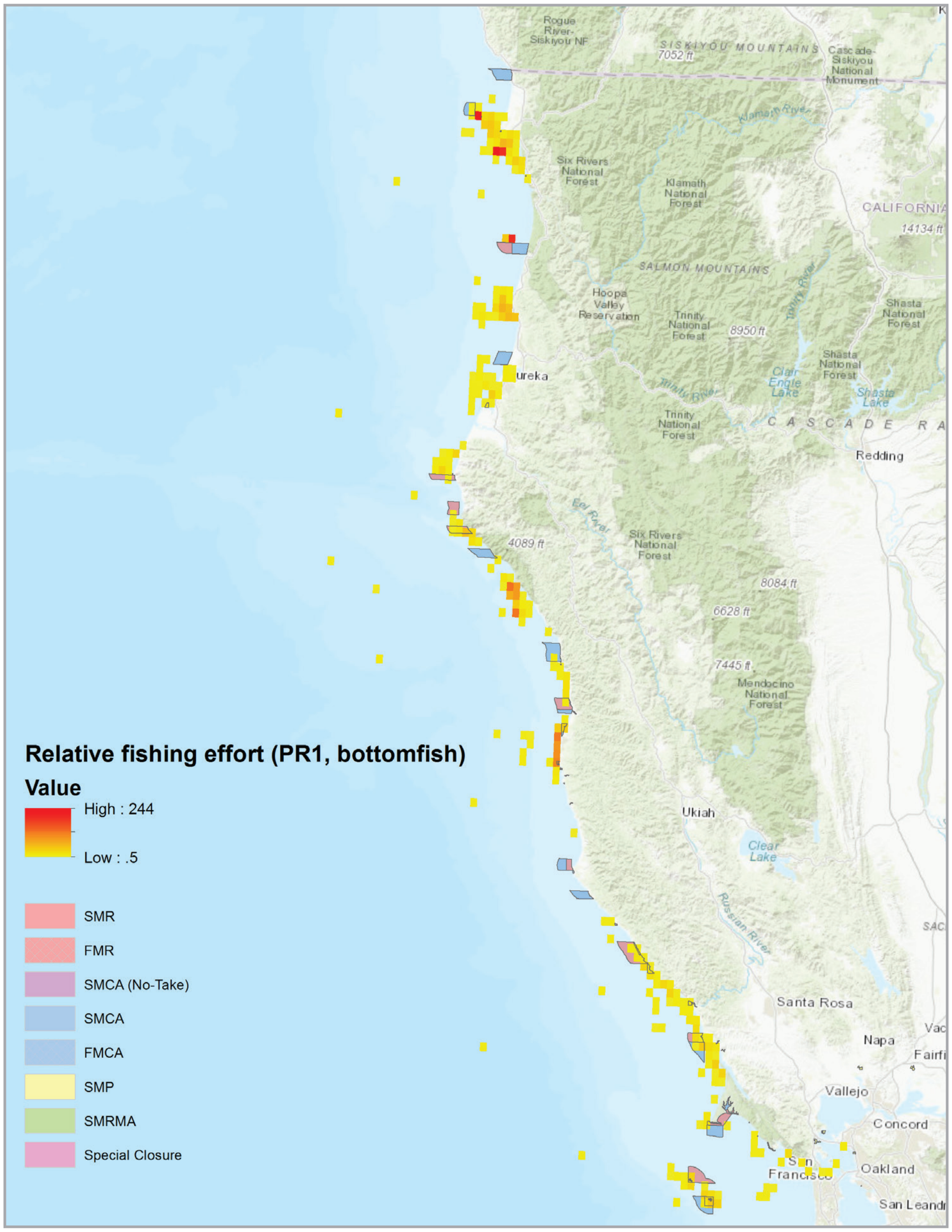

FIGURE F1: Distribution of maximum historical (pre-MPA) relative fishing effort by private/rental boat trips targeting bottomfish in the northern bioregion, based on California Recreational Fisheries Survey data. S[F]MR= state [federal] marine reserve, S[F]MCA=state [federal] marine conservation area, SMP=state marine park, SMRMA=state marine recreational management area.

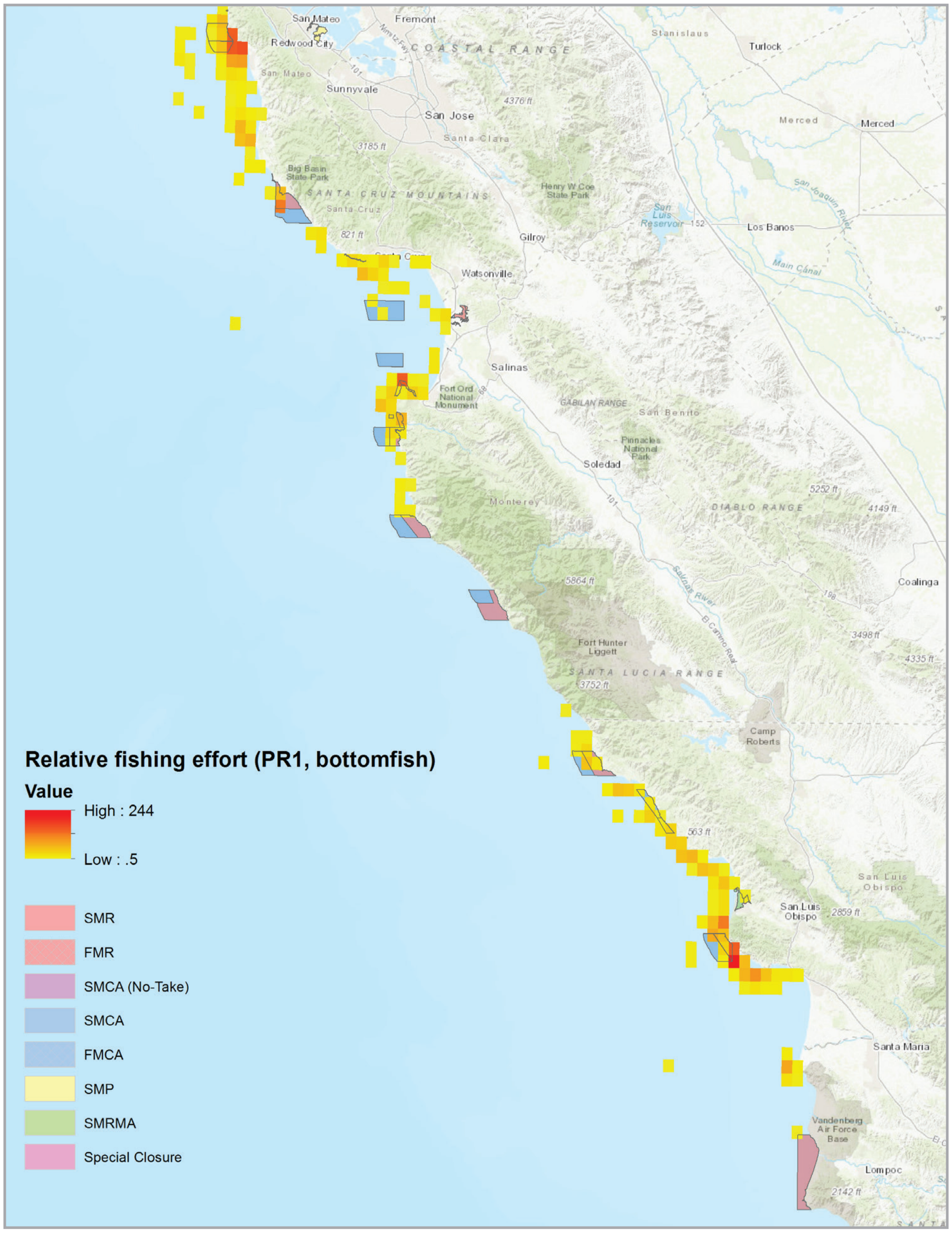

FIGURE F2: Distribution of maximum historical (pre-MPA) relative fishing effort by private/rental boat trips targeting bottomfish in the central bioregion, based on California Recreational Fisheries Survey data. S[F]MR= state [federal] marine reserve, S[F]MCA=state [federal] marine conservation area, SMP=state marine park, SMRMA=state marine recreational management area.

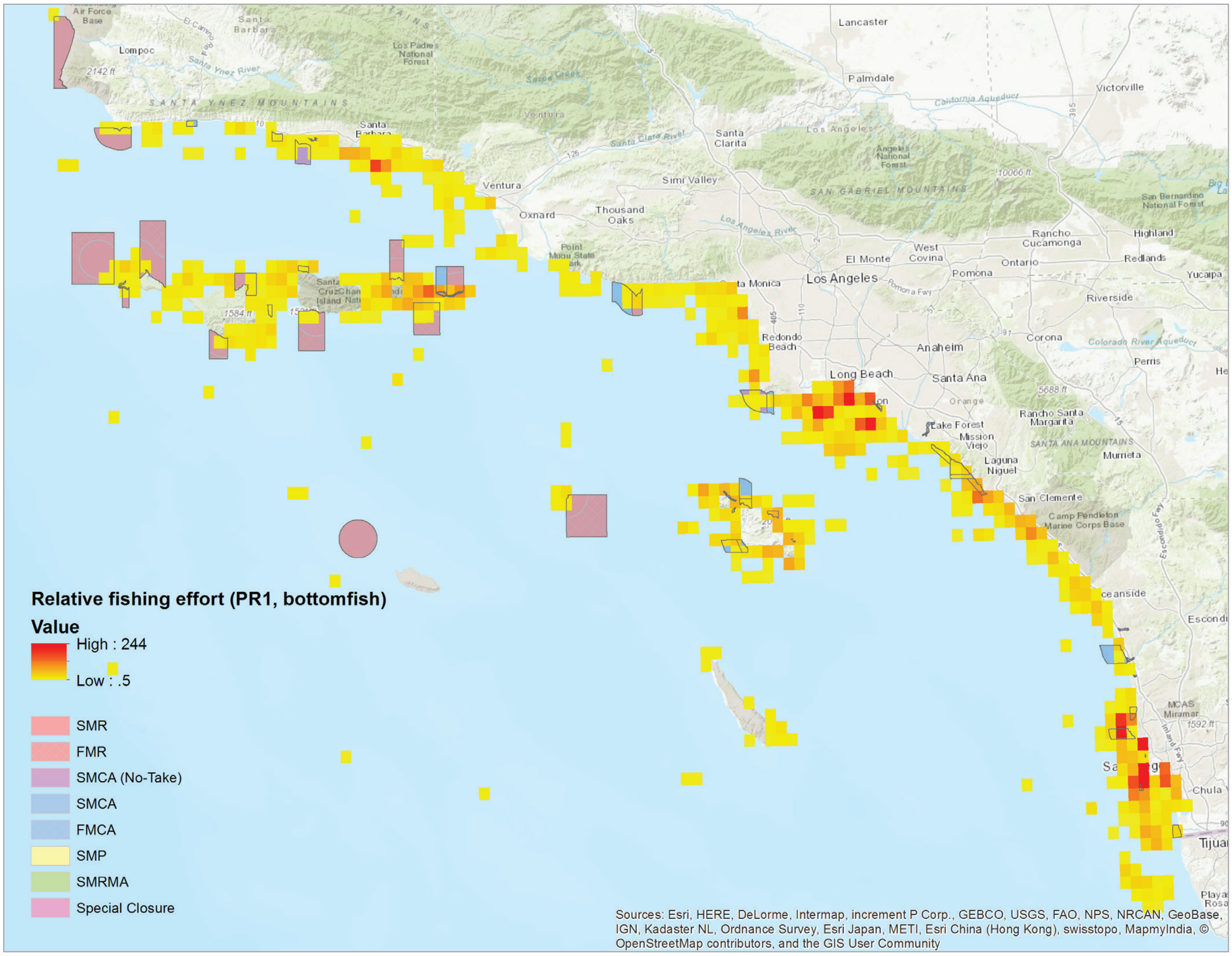

FIGURE F3: Distribution of maximum historical (pre-MPA) relative fishing effort by private/rental boat trips targeting bottomfish in the southern bioregion, based on California Recreational Fisheries Survey data. S[F]MR= state [federal] marine reserve, S[F]MCA=state [federal] marine conservation area, SMP=state marine park, SMRMA=state marine recreational management area.

MPA index site scores, rankings, and final tiered lists

Integrating Quantitative Criteria into Tiered Approach for Index Site Selection

For each of the four criteria listed above, a rank-order list of MPAs (excluding estuarine MPAs) within each bioregion was generated based on final scores. The four individual rank-order values were then averaged to generate a final integrated rank-order value. MPAs were sorted into tiers based on these values, with cutoffs for each tier varying by bioregion to ensure equal bioregional representation of the MPAs within each of the three tiers. For example, the 34 North Coast MPAs were sorted so that 11 MPAs fell into Tier I, 11 MPAs fell into Tier II, and 12 MPAs fell into Tier III (Table F3).

Tier I MPAs received the highest integrated rank-order values. They meet many of the design criteria needed for effective protection, are well connected components of the MPA Network, and may have long time series of monitoring data and/or experienced high historical recreational fishing effort, which make these MPAs good candidates for detecting the potential effects of protection over time. Many of the MPAs on the Tier I index site list are state marine reserves.

Tier II MPAs received the second-highest integrated rank-order values. Many of these MPAs ranked high in one or two of the quantitative methods and may be considered valuable index sites for more specific research questions. Tier II MPAs can be considered for long-term monitoring when funding permits, when an MPA cluster is split between tiers, or to help answer more regionally focused questions.

Tier III MPAs received the lowest integrated rank-order values. Many of these MPAs are small, represent fewer habitats, are difficult to access, have limited or no long-term monitoring data, or have more allowable take within their boundaries. Tier III MPAs are recommended for long-term monitoring only to answer very specific or localized research questions.

Raw points and rank for each method (design features, monitoring history, connectivity modeling, and historical fishing effort), as well as final rank, are reported in Table F3 below.

TABLE F3: Recommended coastal MPA tiers within each bioregion (MPAs listed north to south) based on final rank. MPAs are ranked regionally within each category based on points awarded. Abbreviations: SMR = state marine reserve, SMCA = state marine conservation area

MPA AND DESIGNATION	MPA DESIGN FEATURES		MONITORING HISTORY		CONNECTIVITY MODELING		HISTORICAL FISHING EFFORT		FINAL RANK (AVERAGE)
	Points	*Rank*	*Points*	*Rank*	*Points*	*Rank*	*Points*	*Rank*	
NORTH COAST									
TIER I									
READING ROCK SMCA	3.7	21	2.0	24	7.1	9	60.3	2	14.0
READING ROCK SMR	3.0	24	3.0	21	4.6	13	60.3	2	15.0
SEA LION GULCH SMR	11.3	4	3.0	21	5.2	12	15.5	6	10.8
TEN MILE SMR	15.0	1	6.0	12	7.2	8	2.7	23	11.0
MACKERRICHER SMCA	3.3	23	6.0	12	2.3	19	36.9	4	14.5
SAUNDERS REEF SMCA	8.3	9	24.0	5	5.9	10	0.0	27	12.8
STEWARTS POINT SMR	12.0	3	12.0	9	19.0	2	7.9	14	7.0
SALT POINT SMCA	5.5	15	12.0	9	2.3	20	7.9	14	14.5
BODEGA HEAD SMR	12.1	2	56.0	1	10.0	5	12.0	10	4.5
BODEGA HEAD SMCA	5.8	13	4.0	14	10.6	4	12.5	9	10.0
POINT REYES SMR	9.3	5	14.0	7	14.0	3	4.2	18	8.3
TIER II									
POINT ST. GEORGE REEF OFFSHORE SMCA	4.0	18	2.0	24	1.1	24	73.7	1	16.8
SOUTH CAPE MENDOCINO SMR	9.0	6	1.0	30	4.0	16	9.6	11	15.8
BIG FLAT SMCA	6.3	12	1.0	30	5.5	11	6.0	17	17.5
DOUBLE CONE ROCK SMCA	9.0	6	0.0	32	8.9	6	3.4	21	16.3
POINT CABRILLO SMR	2.5	28	4.0	14	0.8	25	32.6	5	18.0
POINT ARENA SMR	8.2	10	42.0	2	2.0	22	0.0	27	15.3
POINT REYES SMCA	2.6	27	3.0	21	21.7	1	4.2	18	16.8
DUXBURY REEF SMCA	4.6	16	15.0	6	3.0	18	0.0	27	16.8
NORTH FARALLON ISLANDS SMR	8.4	8	2.0	24	ND*	32	9.2	12	19.0
SOUTHEAST FARALLON ISLAND SMR	5.7	14	4.0	14	ND*	32	12.5	7	16.8
SOUTHEAST FARALLON ISLAND SMCA	4.6	17	4.0	14	ND*	32	12.5	7	17.5
TIER III									
PYRAMID POINT SMCA	3.0	24	4.0	14	4.6	14	0.0	27	19.8
SAMOA SMCA	4.0	18	0.0	32	8.1	7	0.0	27	21.0
MATTOLE CANYON SMR	7.0	11	2.0	24	3.4	17	1.4	26	19.5
TEN MILE BEACH SMCA	0.0	34	0.0	32	2.0	23	2.3	24	28.3
RUSSIAN GULCH SMCA	1.4	31	4.0	14	0.7	26	8.3	13	21.0
VAN DAMME SMCA	0.4	33	11.0	11	0.1	31	0.0	27	25.5
POINT ARENA SMCA	3.6	22	4.0	14	4.5	15	0.0	27	19.5
SEA LION COVE SMCA	1.2	32	40.0	3	0.5	27	0.0	27	22.3
DEL MAR LANDING SMR	2.8	26	14.0	7	0.3	29	1.8	25	21.8
STEWARTS POINT SMCA	4.0	18	2.0	24	2.2	21	3.9	20	20.8
GERSTLE COVE SMR	1.7	29	34.0	4	0.1	30	6.3	16	19.8
RUSSIAN RIVER SMCA	1.4	30	2.0	24	0.4	28	3.2	22	26.0

MPA AND DESIGNATION	MPA DESIGN FEATURES		MONITORING HISTORY		CONNECTIVITY MODELING		HISTORICAL FISHING EFFORT		FINAL RANK (AVERAGE)
	Points	*Rank*	*Points*	*Rank*	*Points*	*Rank*	*Points*	*Rank*	
CENTRAL COAST									
TIER I									
MONTARA SMR	11.1	7	27.0	17	15.5	3	46.4	3	7.5
AÑO NUEVO SMR	13.9	3	40.0	15	11.5	6	37.0	7	7.8
GREYHOUND ROCK SMCA	5.2	13	52.0	11	12.8	5	37.0	7	9.0
CARMEL BAY SMCA	6.9	9	165.0	1	3.7	18	20.0	9	9.3
POINT LOBOS SMR	13.5	4	165.0	1	10.3	8	20.0	9	5.5
PIEDRAS BLANCAS SMR	15.0	2	90.0	5	10.2	9	14.3	13	7.3
POINT BUCHON SMR	10.0	8	66.0	8	10.0	10	67.6	1	6.8
POINT BUCHON SMCA	6.4	11	3.0	19	13.2	4	67.6	1	8.8
VANDENBERG SMR	15.1	1	76.0	7	29.9	1	1.0	23	8.0
TIER II									
PILLAR POINT SMCA	3.2	23	3.0	19	9.2	13	46.4	3	14.5
NATURAL BRIDGES SMR	4.0	21	78.0	6	3.1	19	17.0	12	14.5
SOQUEL CANYON SMCA	6.2	12	1.0	23	20.8	2	1.9	22	14.8
PACIFIC GROVE MARINE GARDENS SMCA	4.0	20	46.0	13	2.8	20	45.8	5	14.5
ASILOMAR SMR	6.5	10	60.0	9	3.7	16	45.8	5	10.0
POINT SUR SMR	13.0	5	111.0	3	9.5	11	3.0	20	9.8
BIG CREEK SMR	12.2	6	46.0	13	7.0	14	0.0	24	14.3
CAMBRIA SMCA	5.0	14	50.0	12	4.5	15	10.5	16	14.3
TIER III									
PORTUGUESE LEDGE SMCA	4.6	17	1.0	23	3.7	17	0.0	24	20.3
EDWARD F. RICKETTS SMCA	2.0	26	30.0	16	0.5	24	10.4	17	20.8
LOVERS POINT - JULIA PLATT SMR	4.7	16	110.0	4	0.7	23	10.4	17	15.0
CARMEL PINNACLES SMR	2.9	24	4.0	18	0.2	26	20.0	9	19.3
POINT LOBOS SMCA	4.2	19	2.0	22	0.4	25	7.7	19	21.3
POINT SUR SMCA	4.6	17	3.0	19	11.1	7	3.0	20	15.8
BIG CREEK SMCA	2.4	25	1.0	23	1.4	22	0.0	24	23.5
PIEDRAS BLANCAS SMCA	3.6	22	1.0	23	9.2	12	14.3	13	17.5
WHITE ROCK SMCA	5.0	14	58.0	10	1.5	21	11.5	15	15.0

MPA AND DESIGNATION	MPA DESIGN FEATURES		MONITORING HISTORY		CONNECTIVITY MODELING		HISTORICAL FISHING EFFORT		FINAL RANK (AVERAGE)
	Points	*Rank*	*Points*	*Rank*	*Points*	*Rank*	*Points*	*Rank*	
SOUTH COAST									
TIER I									
POINT CONCEPTION SMR	18.0	2	108.0	7	24.3	2	2.5	41	13.0
CAMPUS POINT SMCA	15.0	5	141.0	3	12.6	10	3.5	36	13.5
HARRIS POINT SMR	22.2	1	165.0	2	33.8	1	6.0	34	9.5
CARRINGTON POINT SMR	13.0	6	28.0	22	15.7	7	10.0	26	15.3
SCORPION SMR	8.5	13	90.0	8	13.4	9	15.8	21	12.8
ANACAPA ISLAND SMCA	4.8	24	62.0	12	10.8	11	24.4	9	14.0
ANACAPA ISLAND SMR	11.0	10	225.0	1	16.0	6	28.5	8	6.3
POINT DUME SMCA	8.4	14	57.0	13	18.8	3	9.4	27	14.3
POINT DUME SMR	10.2	11	120.0	4	8.6	14	9.4	27	14.0
BLUE CAVERN ONSHORE SMCA	11.1	8	74.0	9	1.9	29	18.3	15	15.3
LAGUNA BEACH SMR	11.0	9	117.0	5	14.4	8	18.2	19	10.3
DANA POINT SMCA	5.0	22	64.0	11	9.2	13	38.8	5	12.8
SWAMI'S SMCA	11.9	7	1.0	31	17.0	4	12.1	24	16.5
SOUTH LA JOLLA SMR	8.0	16	36.0	20	5.8	15	69.5	2	13.3
TIER II									
SOUTH POINT SMR	16.4	3	50.0	15	4.7	19	7.0	32	17.3
GULL ISLAND SMR	15.3	4	46.0	19	5.4	16	3.8	35	18.5
BEGG ROCK SMR	8.4	15	0.0	35	16.5	5	0.0	42	24.3
SANTA BARBARA ISLAND SMR	4.4	26	117.0	5	3.0	24	7.0	31	21.5
POINT VICENTE SMCA	5.0	23	27.0	24	5.0	18	19.4	10	18.8
ABALONE COVE SMCA	5.4	21	28.0	22	5.2	17	19.4	10	17.5
ARROW POINT TO LION HEAD POINT SMCA	5.9	20	0.0	35	2.0	28	18.3	15	24.5
LONG POINT SMR	8.0	16	12.0	26	1.5	35	18.7	14	22.8
CRYSTAL COVE SMCA	4.6	25	74.0	9	9.9	12	7.4	30	19.0
LAGUNA BEACH SMCA	2.0	37	50.0	15	4.4	20	18.2	19	22.8
SAN DIEGO-SCRIPPS COASTAL SMCA	2.5	34	56.0	14	3.3	22	38.6	6	19.0
MATLAHUAYL SMR	7.5	18	48.0	17	2.5	27	38.6	6	17.0
SOUTH LA JOLLA SMCA	1.8	39	1.0	31	2.7	26	69.5	2	24.5
CABRILLO SMR	2.1	36	31.0	21	1.0	37	139.0	1	23.8

MPA AND DESIGNATION	MPA DESIGN FEATURES		MONITORING HISTORY		CONNECTIVITY MODELING		HISTORICAL FISHING EFFORT		FINAL RANK (AVERAGE)
	Points	*Rank*	*Points*	*Rank*	*Points*	*Rank*	*Points*	*Rank*	
SOUTH COAST									
TIER III									
KASHTAYIT SMCA	3.0	33	0.0	35	1.7	32	2.8	39	34.8
NAPLES SMCA	4.0	27	48.0	17	2.8	25	6.1	33	25.5
RICHARDSON ROCK SMR	3.6	30	0.0	35	0.8	38	2.7	40	35.8
JUDITH ROCK SMR	3.8	29	1.0	31	1.8	30	3.1	37	31.8
SKUNK POINT SMR	9.9	12	6.0	29	1.4	36	2.9	38	28.8
PAINTED CAVE SMCA	3.4	32	16.0	25	3.2	23	12.0	25	26.3
FOOTPRINT SMR	1.1	40	0.0	35	1.7	33	44.6	4	28.0
BLUE CAVERN OFFSHORE SMCA	1.8	38	0.0	35	0.0	41	18.3	15	32.3
CASINO POINT SMCA	0.0	42	12.0	26	0.0	42	18.9	12	30.5
LOVER'S COVE SMCA	0.3	41	0.0	35	0.1	40	18.9	12	32.0
FARNSWORTH ONSHORE SMCA	7.2	19	8.0	28	1.6	34	12.7	22	25.8
FARNSWORTH OFFSHORE SMCA	3.9	28	3.0	30	1.8	31	12.7	22	27.8
CAT HARBOR SMCA	2.4	35	1.0	31	0.7	39	18.3	15	30.0
TIJUANA RIVER MOUTH SMCA	3.6	31	0.0	35	3.4	21	8.2	29	29.0

* ROMS data from the Farallon Islands were not available due to spatial constraints.

In addition to the 102 new or redesigned coastal and island MPAs, the MPA design and siting process established 22 estuarine MPAs in California (see Action Plan, Section 2.3). Only one of the four quantitative methods (MPA Design Features) integrated into the tiered approach for index site selection could be applied to estuaries. Therefore, in order to assign estuarine MPAs into one of three tiers, they were separated from coastal MPAs and only evaluated on their ability to meet the SAT recommended MPA design features.

However, not all MPA design features evaluated by the SAT applied to estuaries. For example, estuarine MPAs were exempted from the size guidelines because MPA size was often constrained by estuarine boundaries, and spacing was not evaluated for the three estuarine habitats (Saarman et al. 2013). Additionally, ASBSs are only coastal features and do not apply to estuaries, and are therefore also excluded. Of the potential MPA design feature scores detailed earlier in this appendix, only habitat threshold points, LOP points, and historical MPA points apply to estuarine MPAs. Finally, since most estuaries are unique ecosystems, regardless of geographical location (see Action Plan, Section 2.3, Monitoring in Other Habitat Types, pages 41-42) estuarine MPAs were ranked relative to one another on a statewide rather than regional basis (Table F4).

TABLE F4: Recommended estuarine MPA tiers within each bioregion (MPAs listed north to south) based on final rank. MPAs are ranked statewide based on points awarded. Abbreviations: SMR = state marine reserve, SMCA = state marine conservation area, SMRMA = state marine recreational management area.

MPA and DESIGNATION	BIOREGION	MPA DESIGN FEATURES	
		Points	*Rank*
TIER I			
ESTERO DE LIMANTOUR SMR	North	10.5	1
DRAKES ESTERO SMCA	North	5.0	5
ELKHORN SLOUGH SMR	Central	5.5	4
GOLETA SLOUGH SMCA	South	4.9	7
BOLSA CHICA BASIN SMCA	South	6.2	2
BATIQUITOS LAGOON SMCA	South	6.2	3
SAN ELIJO LAGOON SMCA	South	4.9	6
TIER II			
SOUTH HUMBOLDT BAY SMRMA	North	3.0	11
NAVARRO RIVER ESTUARY SMCA	North	2.0	13
RUSSIAN RIVER SMRMA	North	4.0	8
MORO COJO SLOUGH SMR	Central	2.0	13
MORRO BAY SMRMA	Central	4.0	8
MORRO BAY SMR	Central	4.0	8
UPPER NEWPORT BAY SMCA	South	2.8	12
TIER III			
TEN MILE ESTUARY SMCA	North	1.0	15
BIG RIVER ESTUARY SMCA	North	1.0	15
ESTERO AMERICANO SMRMA	North	0.0	20
ESTERO DE SAN ANTONIO SMRMA	North	0.0	20
ELKHORN SLOUGH SMCA	Central	1.0	15
BOLSA BAY SMCA	South	0.9	19
SAN DIEGUITO LAGOON SMCA	South	1.0	18
FAMOSA SLOUGH SMCA	South	0.0	20

TABLE F5: Soft bottom habitats - area or linear extent of coastline and percentage of available habitats within each bioregion - Tier I MPA sites.

MPA	BIOREGION	TOTAL AREA (mi²)	BEACHES (linear mi)	%	SOFT SUBSTRATE 0-30M (linear mi)	%	SOFT SUBSTRATE 30-100M (area mi²)	%	SOFT SUBSTRATE 100 - 3000M (area mi²)	%	ESTUARY (area mi²)	%	EELGRASS (area mi²)	%	COASTAL MARSH (area mi²)	%
READING ROCK SMCA	NORTH	11.96	2.96	0.8%	2.82	1.2%	3.77	0.5%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
READING ROCK SMR	NORTH	9.60	0.00	0.0%	0.00	0.0%	9.43	1.1%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
SEA LION GULCH SMR	NORTH	10.42	2.42	0.6%	2.01	0.9%	3.86	0.5%	1.09	1.4%	0.00	0.0%	0.00	0.0%	0.00	0.0%
TEN MILE SMR	NORTH	11.95	2.63	0.7%	2.00	0.9%	8.13	1.0%	0.46	0.6%	0.00	0.0%	0.00	0.0%	0.01	0.0%
MACKERRICHER SMCA	NORTH	2.48	4.40	1.1%	0.00	0.0%	0.06	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.01	0.0%
SAUNDERS REEF SMCA	NORTH	9.36	1.83	0.5%	0.19	0.1%	5.25	0.6%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
STEWARTS POINT SMR	NORTH	24.06	0.89	0.2%	0.18	0.1%	21.89	2.7%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
SALT POINT SMCA	NORTH	1.84	0.59	0.1%	0.36	0.2%	0.37	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
BODEGA HEAD SMR	NORTH	9.34	1.32	0.3%	0.26	0.1%	5.38	0.7%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
BODEGA HEAD SMCA	NORTH	12.31	0.00	0.0%	0.00	0.0%	6.31	0.8%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
POINT REYES SMR	NORTH	9.55	8.38	2.1%	2.07	0.9%	1.20	0.1%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
MONTARA SMR	CENTRAL	11.81	2.14	0.8%	0.95	0.4%	7.75	1.3%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.01	0.0%
AÑO NUEVO SMR	CENTRAL	11.15	10.46	3.8%	3.34	1.4%	1.63	0.3%	0.00	0.0%	0.00	0.1%	0.00	0.0%	0.05	0.1%
GREYHOUND ROCK SMCA	CENTRAL	12.00	2.79	1.0%	0.70	0.3%	8.61	1.4%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
CARMEL BAY SMCA	CENTRAL	2.20	3.09	1.1%	1.58	0.7%	0.36	0.1%	0.07	0.0%	0.02	0.2%	0.00	0.0%	0.02	0.1%
POINT LOBOS SMR	CENTRAL	5.50	2.10	0.8%	1.36	0.6%	2.05	0.3%	0.33	0.2%	0.00	0.0%	0.00	0.0%	0.01	0.0%
PIEDRAS BLANCAS SMR	CENTRAL	10.44	5.48	2.0%	4.43	1.9%	2.25	0.4%	0.00	0.0%	0.01	0.2%	0.00	0.0%	0.06	0.1%
POINT BUCHON SMR	CENTRAL	6.68	1.46	0.5%	0.73	0.3%	4.56	0.8%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
POINT BUCHON SMCA	CENTRAL	12.19	0.00	0.0%	0.00	0.0%	8.11	1.3%	3.02	1.9%	0.00	0.0%	0.00	0.0%	0.00	0.0%
VANDENBERG SMR	CENTRAL	32.91	13.33	4.9%	12.82	5.5%	10.11	1.7%	0.00	0.0%	0.04	0.6%	0.00	0.0%	0.09	0.2%
POINT CONCEPTION SMR	SOUTH	22.52	2.73	0.6%	1.83	0.5%	15.79	2.4%	3.26	0.8%	0.00	0.0%	0.00	0.0%	0.01	0.0%
CAMPUS POINT SMCA	SOUTH	10.56	3.02	0.7%	1.21	0.3%	7.08	1.1%	1.48	0.4%	0.01	0.0%	0.00	0.0%	0.01	0.0%
HARRIS POINT SMR	SOUTH	25.40	2.71	0.6%	5.60	1.5%	15.93	2.4%	2.54	0.6%	0.00	0.0%	0.00	0.0%	0.00	0.0%
CARRINGTON POINT SMR	SOUTH	12.78	0.82	0.2%	3.32	0.9%	3.82	0.6%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
SCORPION SMR	SOUTH	9.64	0.89	0.2%	2.28	0.6%	4.88	0.7%	0.18	0.0%	0.00	0.0%	0.01	0.0%	0.00	0.0%
ANACAPA ISLAND SMCA	SOUTH	7.30	0.19	0.0%	1.74	0.5%	6.21	0.9%	0.18	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
ANACAPA ISLAND SMR	SOUTH	11.55	1.12	0.3%	2.59	0.7%	7.25	1.1%	0.78	0.2%	0.00	0.0%	0.00	0.0%	0.00	0.0%
POINT DUME SMCA	SOUTH	15.92	4.09	0.9%	3.14	0.9%	5.95	0.9%	7.18	1.8%	0.00	0.0%	0.00	0.0%	0.00	0.0%
POINT DUME SMR	SOUTH	7.53	2.77	0.6%	1.81	0.5%	1.07	0.2%	4.30	1.1%	0.00	0.0%	0.00	0.0%	0.00	0.0%
BLUE CAVERN ONSHORE SMCA	SOUTH	2.61	1.66	0.4%	1.89	0.5%	0.79	0.1%	1.43	0.4%	0.00	0.0%	0.00	0.0%	0.00	0.0%
LAGUNA BEACH SMR	SOUTH	6.72	3.48	0.8%	3.65	1.0%	2.82	0.4%	1.79	0.5%	0.00	0.0%	0.00	0.0%	0.00	0.0%
DANA POINT SMCA	SOUTH	3.47	3.60	0.8%	1.90	0.5%	0.79	0.1%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
SWAMI'S SMCA	SOUTH	12.71	3.77	0.9%	1.29	0.4%	3.85	0.6%	5.52	1.4%	0.00	0.0%	0.00	0.0%	0.00	0.0%
SOUTH LA JOLLA SMR	SOUTH	5.04	2.33	0.5%	0.07	0.0%	0.85	0.1%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
NORTH BIOREGION TOTAL		1618.90	391.45		227.31		820.08		75.93		60.84		13.31		136.88	
CENTRAL BIOREGION TOTAL		1317.84	272.90		231.37		602.63		158.19		7.02		1.94		45.02	
SOUTH BIOREGION TOTAL		2350.87	441.29		362.57		672.08		392.73		43.30		19.64		60.78	

*All miles are statute.

TABLE F6: Rocky habitats - area or linear extent of coastline and percentage of available habitats within each bioregion - Tier I MPA sites.

MPA	BIOREGION	TOTAL AREA (mi²)	ROCKY INTERTIDAL (linear mi)	%	KELP (linear mi)	%	HARD SUBSTRATE 0-30M (linear mi²)	%	HARD SUBSTRATE 30-100M (area mi²)	%	HARD SUBSTRATE 100-3000M (area mi²)	%
READING ROCK SMCA	NORTH	11.96	0.22	0.1%	0.00	0.0%	0.08	0.1%	0.00	0.0%	0.00	0.0%
READING ROCK SMR		9.60	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.16	0.2%	0.00	0.0%
SEA LION GULCH SMR		10.42	2.32	0.8%	0.19	0.2%	0.56	0.5%	2.86	3.6%	0.12	15.5%
TEN MILE SMR		11.95	6.77	2.2%	2.43	2.3%	1.10	1.0%	0.50	0.6%	0.00	0.0%
MACKERRICHER SMCA		2.48	3.91	1.3%	2.23	2.1%	0.00	0.0%	0.05	0.1%	0.00	0.0%
SAUNDERS REEF SMCA		9.36	4.29	1.4%	1.11	1.1%	2.52	2.2%	1.65	2.1%	0.00	0.0%
STEWARTS POINT SMR		24.06	4.57	1.5%	3.00	2.9%	3.03	2.6%	0.88	1.1%	0.00	0.0%
SALT POINT SMCA		1.84	4.03	1.3%	3.84	3.7%	2.46	2.1%	0.54	0.7%	0.00	0.0%
BODEGA HEAD SMR		9.34	2.74	0.9%	0.00	0.0%	2.27	2.0%	1.85	2.3%	0.00	0.0%
BODEGA HEAD SMCA		12.31	0.29	0.1%	0.00	0.0%	1.33	1.2%	5.11	6.5%	0.00	0.0%
POINT REYES SMR		9.55	5.37	1.8%	0.00	0.0%	1.49	1.3%	0.09	0.1%	0.00	0.0%
MONTARA SMR	CENTRAL	11.81	3.45	1.4%	0.55	0.4%	2.73	2.8%	0.72	1.6%	0.00	0.0%
AÑO NUEVO SMR		11.15	6.86	2.9%	0.24	0.2%	1.83	1.9%	0.79	1.7%	0.00	0.0%
GREYHOUND ROCK SMCA		12.00	3.39	1.4%	0.08	0.1%	2.38	2.5%	0.03	0.1%	0.00	0.0%
CARMEL BAY SMCA		2.20	2.66	1.1%	2.57	1.7%	1.15	1.2%	0.12	0.3%	0.02	0.1%
POINT LOBOS SMR		5.50	13.70	5.7%	4.61	3.1%	3.91	4.1%	1.38	3.0%	0.02	0.1%
PIEDRAS BLANCAS SMR		10.44	6.09	2.5%	4.18	2.8%	2.10	2.2%	0.54	1.2%	0.00	0.0%
POINT BUCHON SMR		6.68	2.71	1.1%	1.85	1.2%	2.59	2.7%	0.47	1.0%	0.00	0.0%
POINT BUCHON SMCA		12.19	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.32	0.7%	0.04	0.1%
VANDENBERG SMR		32.91	10.21	4.3%	0.63	0.4%	1.45	1.5%	0.08	0.2%	0.00	0.0%
POINT CONCEPTION SMR	SOUTH	22.52	3.13	1.1%	1.29	0.5%	1.84	1.0%	0.32	0.7%	0.10	1.6%
CAMPUS POINT SMCA		10.56	1.37	0.5%	1.62	0.6%	1.85	1.0%	0.04	0.1%	0.00	0.0%
HARRIS POINT SMR		25.40	8.18	2.9%	2.30	0.9%	1.96	1.0%	2.40	5.0%	0.25	4.1%
CARRINGTON POINT SMR		12.78	5.35	1.9%	1.24	0.5%	1.97	1.0%	0.27	0.6%	0.00	0.0%
SCORPION SMR		9.64	4.07	1.4%	0.05	0.0%	0.69	0.4%	0.33	0.7%	0.01	0.1%
ANACAPA ISLAND SMCA		7.30	3.50	1.2%	0.00	0.0%	0.54	0.3%	0.03	0.1%	0.00	0.0%
ANACAPA ISLAND SMR		11.55	6.50	2.3%	0.65	0.3%	0.65	0.3%	0.10	0.2%	0.00	0.0%
POINT DUME SMCA		15.92	0.44	0.2%	0.85	0.3%	1.05	0.5%	0.00	0.0%	0.00	0.0%
POINT DUME SMR		7.53	1.54	0.5%	0.57	0.2%	0.47	0.2%	0.00	0.0%	0.89	14.7%
BLUE CAVERN ONSHORE SMCA		2.61	1.68	0.6%	1.40	0.6%	0.88	0.5%	0.01	0.0%	0.00	0.0%
LAGUNA BEACH SMR		6.72	2.48	0.9%	0.00	0.0%	1.13	0.6%	0.00	0.0%	0.00	0.0%
DANA POINT SMCA		3.47	2.06	0.7%	0.80	0.3%	1.67	0.9%	0.00	0.0%	0.00	0.0%
SWAMI'S SMCA		12.71	1.20	0.4%	1.44	0.6%	1.43	0.7%	0.02	0.0%	0.04	0.7%
SOUTH LA JOLLA SMR		5.04	1.45	0.5%	0.72	0.3%	1.95	1.0%	0.50	1.0%	0.00	0.0%
NORTH BIOREGION TOTAL		1618.90	301.58		104.23		114.65		79.24		0.76	
CENTRAL BIOREGION TOTAL		1317.84	238.83		151.07		95.97		46.60		29.98	
SOUTH BIOREGION TOTAL		2350.87	280.71		253.51		191.62		47.79		6.05	

*All miles are statute.

LITERATURE CITED

Babcock RC, Shears N, Alcala AC, Barrett NS, Edgar GJ, Lafferty KD, McClanahan TR, Russ GR. 2010. Decadal trends in marine reserves reveal differential rates of change in direct and indirect effects. Proceedings of the National Academy of Sciences of the United States of America. 107(43):18256-18261.

California Department of Fish and Wildlife. 2002. Nearshore Fishery Management Plan. California Natural Resources Agency, California Department of Fish and Wildlife, Marine Region.

California Department of Fish and Wildlife. 2008. Draft California Marine Life Protection Act Master Plan for Marine Protected Areas. Adopted by the California Fish and Game Commission in February 2008.

California Department of Fish and Wildlife. 2016. California Marine Life Protection Act Master Plan for Marine Protected Areas. Adopted by the California Fish and Game Commission on August 24, 2016. Retrieved from www.wildlife.ca.gov/Conservation/Marine/MPAs/Master-Plan.

Caselle JE, Rassweiler A, Hamilton SL, Warner RR. 2015. Recovery trajectories of kelp forest animals are rapid yet spatially variable across a network of temperate marine protected areas. Scientific Reports. 5:1–14.

Derraik JGB 2002. The pollution of the marine environment by plastic debris: a review. Mar. Pollut. Bull. 44(9):842–852.

Echeveste PJ, Dachs J, Berrojaldiz N, Agusti S. 2010. Decrease in the abundance and viability of oceanic phytoplankton due to trace levels of complex mixtures of organic pollutants. Chemosphere. 81:161–168.

Fox E, Hastings S, Miller-Henson M, Monie D, Ugoretz J, Frimodig A, Shuman C, Owens B, Garwood R, Connor D. 2013. Addressing policy issues in a stakeholder-based and science-driven marine protected area network planning process. Ocean & Coastal Management. 74:34-44.

Gleason M, Fox E, Ashcraft S, Vasques J, Whiteman E, Serpa P, Saarman E, Caldwell M, Frimodig A, Miller-Henson M et al. 2013. Designing a network of marine protected areas in California: Achievements, costs, lessons learned, and challenges ahead. Ocean & Coastal Management. 74:90-101.

Laist DW. 1987. Overview of the biological effects of lost and discarded plastic debris in the marine environment. Marine Pollution Bulletin. 18:319–326.

McArdle DA. 1997. California Marine Protected Areas. California Sea Grant College System, La Jolla, California. Publication No. T-039.

McArdle DA. 2002. California Marine Protected Areas: Past & Present. California Sea Grant College System Publication. La Jolla, California.

Micheli F, Halpern BS, Botsford LW, Warner RR. 2004. Trajectories and correlates of community change in no-take marine reserves. Ecological Applications. 14(6):1709–1723.

MLPA Science Advisory Team. 2008. Methods used to evaluate marine protected area proposals in the north central coast study region. Marine Life Protection Act Initiative, May 30, 2008 revised draft.

MLPA Science Advisory Team. 2009. Methods used to evaluate marine protected area proposals in the north central coast study region. Marine Life Protection Act Initiative, October 26, 2009 revised draft.

MLPA Science Advisory Team. 2011. Methods used to evaluate marine protected area proposals in the north central coast study region. Marine Life Protection Act Initiative, January 13, 2011 revised draft.

Pacific Fishery Management Council. 2016. Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery. August 2016.

Pastorok RA, Bilyard GR. 1985. Effects of sewage pollution on coral-reef communities. Marine Ecology Progress Series. 21:175-189.

Saarman ET, Gleason M, Ugoretz J, Airamé S, Carr MH, Fox E, Frimodig A, Mason T, Vasques J. 2013. The role of science in supporting marine protected area network planning and design in California. Ocean Coast Manag. 74:45-56.

Starr RM, Wendt DE, Barnes CL, Marks CI, Malone D, Waltz G,Yochum N. 2015. Variation in Responses of Fishes across Multiple Reserves within a Network of Marine Protected Areas in Temperate Waters. PLOS ONE. 10(3):e0118502.

White J, Scholz A, Rassweiler A, Steinback C, Botsford L, Kruse S, Costello C, Mitarai S, Siegal D, Drake P, Edwards C. 2013. A Comparison of Approaches Used for Economic Analysis in Marine Protected Area Network Planning in California. Ocean & Coastal Management. 74:77-89.

White JW, Nickols KJ, Malone D, Carr MH, Starr RM, Cordoleani F, Botsford LW. 2016. Fitting state-space integral projection models to size-structured time series data to estimate unknown parameters. Ecological Applications. 26(8):2677-2694.