California MLPA Master Plan Science Advisory Team
Draft Background Information on Artificial Structures in the MLPA South Coast Study Region

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Artificial structures in the marine environment, such as artificial reefs and breakwalls, are common in the Marine Life Protection Act (MLPA) South Coast Study Region (SCSR). The many types of artificial structures in the marine environment were created for different reasons, and they are designed and constructed in a variety of ways. For example, oil and gas platforms, sanitation outfall pipelines, and most shipwrecks were not intended or designed to be artificial reefs or permanent features, but they provide habitat and potentially enhance the productivity of specific populations and communities[1]. In contrast, the San Onofre Nuclear Generating Station (SONGS) reef is a large rock reef spanning 174 acres and was designed specifically to mimic natural reefs[2].

The MLPA Master Plan Science Advisory Team (SAT) is tasked with providing scientific information about how artificial structures interact with the surrounding ecosystems and how they relate to meeting the goals of the MLPA through the design and implementation of marine protected areas (MPAs). This document provides background information on artificial reefs in California; how artificial structures act [in terms of meeting the goals of the MLPA]; and how artificial structures are dealt with in SAT evaluations of MPA proposals.

Protecting the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems is a key goal of the MLPA[3]. In addition, specific goals for designating marine protected areas under the Marine Managed Areas Improvement Act are to protect or restore marine species, habitats, and ecosystems[4]. Artificial structures identified in the fine-scale habitat data layer[5] include artificial reefs, sanitation outfall and seawater intake pipes, and some breakwalls. This document largely focuses on artificial reefs as defined in California Fish and Game Code (FGC) because they were intentionally constructed as reefs and are well studied. Artificial reefs are defined in FGC as “manmade or natural objects intentionally placed in selected areas of the marine environment to duplicate those conditions that induce production of fish and invertebrates on natural reefs and rough bottoms, and that stimulate the growth of kelp or other midwater plant life which creates natural habitat for those species”[6].

In 1958, the California Department of Fish and Game (DFG) began a pilot study to determine the feasibility of improving nearshore marine habitat and increasing sport fishing opportunities

[1] Emery, B. M., L. Washburn, M. S. Love, M. M. Nishimoto, and J. C. Ohlmann. Do oil and gas platforms off California reduce recruitment of boccacio (*Sebastes paucispinis*) to natural habitat? An analysis based on trajectories derived from high-frequency radar. Fishery Bulletin 104:391-400.
[2] Reed, D. C., Schroeter, S. C., Huang, D., Anderson, T. W., and R. F. Ambrose. 2006. Quantitative assessment of different artificial reef designs in mitigating losses to kelp forest fishes. Bulletin of Marine Science 78(1):133-150.
[3] California Fish and Game Code, Section 2853.
[4] Marine Managed Areas Improvement Act, Section 36700.
[5] Fine-scale substrate data are a union of data provided by Seafloor Mapping Lab, California State University Monterey Bay, United States Geological Survey, Ocean Imaging, and the San Diego Association of Governments
[6] California Fish and Game Code, Section 6421.

by constructing artificial reefs[7]. Following the construction of these early artificial reefs, DFG biologists noted the attraction of large numbers of fishes, which lead to the development of more reefs. Currently, there are 25 artificial reefs in the south coast study region (Table 1), which were constructed for two main purposes: 1) to develop better techniques for increasing production of living marine resources through scientific investigations of reef design and function (developmental reefs), and 2) to improve nearshore recreational fishing opportunities (recreational reefing reefs) [7](Figures 1 & 2).

The artificial reefs in the SCSR are quite small (median size is 3.3 acres) and mature (average age is 24.5 years), however the exception is the SONGS reef (now named Wheeler North Reef) which is a 174 acre reef completed in September 2008. The most common reefing material used in California is quarry rock because of its environmental acceptability, and there appears to be almost no difference in the performance (i.e. fish utilization) between quarry rock, concrete, and natural reefs[6,8]. Based on the size of artificial reefs reported by DFG and the availability of hard bottom habitat estimated using the current fine-scale habitat data, artificial reefs in the SCSR account for about 1.8% of the hard bottom habitat along the mainland coast.

Although artificial reefs have been constructed in southern California since the1950's, there is much scientific debate about their ecological benefits[9]. Numerous studies conducted in the SCSR comparing fish assemblages on artificial structures to natural reefs have found similar or greater fish densities and biomass on artificial structures[10,11,12,13]. However, studies conducted at oil platforms have found that some fish species, particularly kelp-associated, are in lower abundance on oil platforms than natural reefs[12, 13]. The observed differences in these studies may stem from differences in reef age, isolation, and size, because the natural reefs in these studies were typically much larger, older and less isolated than the artificial reefs[14]. In addition, the performance of artificial reefs relative to natural reefs may vary depending on whether they possess similar structural features,[15] including the abundance and species composition of

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[7] Artificial reef plan for sportfish enhancement,1990. California Fish and Game Admin Report 90-15
[8] Pondella, D. J., L. G. Allen, M. T. Craig, and B. Gintert. 2006. Evaluation of eelgrass mitigation and fishery enhancement structures in San Diego Bay, California. Bulletin of Marine Science 78:115-131.
[9] Pickering, H.,D. Whitmarsh. 1997. Artificial reefs and fisheries exploitation: a review of the'attraction versus production' debate, the influence of design and its significance for policy. Fisheries Research 39-59.
[10] Ambrose, R. F., S. L. Swarbrick. 1989. Comparison of fish assemblages on artificial and natural reefs off the coast of southern California. Bulletin of Marine Science 44(2):718-733.
[11] DeMartini, E.E, D.A. Roberts, T.W. Anderson. 1989. Contrasting patterns of fish density and abundance at an artificial rock reef and a cobble-bottom kelp forest. Bulletin of Marine Science 44(2): 881-892.
[12] Love, M. S., D. M. Schroeder and M. M. Nishimoto. The Ecological Role of Oil and Gas Production Platforms and Natural Outcrops on Fishes in Southern and Central California: A Synthesis of Information. OCS Study MMS 2003-032
[13] Carr, M.H., M.V. McGinnis, G.E. Forrester, J. Harding, and P.T. Raimondi. 2003. Consequences of Alternative Decommissioning Options to Reef Fish Assemblages and Implications for Decommissioning Policy. OCS Study MMS 2003-053.
[14] Carr, M.H., M.A. Hixon. 1997. Artificial reefs: The importance of comparison with natural reefs. Fisheries vol 22, no.4.
[15] Perkol-Finkel S., N. Shashar., and Y. Benayahu. 2006. Can artificial reefs mimic natural reef communities? The

macroalgae. Relatively few studies have examined fish production on artificial reefs[16,17]; however, a recent study indicated that for some species artificial structures (i.e. King Harbor breakwall) can act as a source of production rather than a sink[18]. Some artificial reefs are newly constructed (i.e. Wheeler North Reef) and the degree to which they provide habitat that is similar to natural features and how they function compared to natural features may not be known for several years. Research conducted in southern California suggests that it may take 10-15 years for turf communities on new artificial reefs to mimic those on natural reefs[19]

Whether artificial reefs act more as fish aggregation devices or actually contribute to increased regional fish production has not yet been demonstrated and is extremely difficult to measure[14,18,20,21]. With respect to management areas (e.g. MPAs), the relative contribution of an artificial reef to the overall fish production of the management area may be positive or negative[12]. For example, in an area containing natural reefs, overall production to a management area may be enhanced if overall settlement rates are increased due to the presence of an artificial reef. Conversely, artificial reef presence in a management area could potentially lower survival and production if the artificial reef(s) in that area do not perform as well as the natural reef(s) (e.g. lower survival and reproduction), or if the presence of the artificial reef(s) reduces recruitment to adjacent natural reefs. However, the influence that an artificial structure(s) may have on a management area (whether positive or negative) will likely depend on the size of the structure(s) relative to the size of the management area and the amount and spatial distribution of natural reef habitat within the management area.

Another consideration of artificial structures that bears on the goals of the MLPA is the extent to which these structures modify otherwise natural soft-bottom or low relief hard-bottom habitats and their ecological functions. If the goal of an MPA is to protect an ecosystem associated with a soft-bottom habitat, the presence of an artificial structure can detract from that goal by its modification of the ecological function of that habitat (or the ecosystem) targeted for protection. For example, a plan to construct artificial reefs in soft-bottom habitats along the coast of Molokai Island (Hawaiian Islands) was abandoned when it was realized that the reefs would support populations of predators of juvenile opakapaka, *Pristipomoides filamentosus*, that otherwise benefited from the refuge afforded them by the absence of these

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roles of structural features and age. Marine Environmental Research, 61 121-135.
[16] Demartini, E. E., A. M. Barnett, T. D. Johnson, and R. F. Ambrose. 1994. Growth and Production Estimates for Biomass-Dominant Fishes on a Southern California Artificial Reef. Bulletin of Marine Science 55:484-500.
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[18] Stephens, J., and D. Pondella. 2002. Larval productivity of a mature artificial reef: the ichthyoplakton of King Harbor, California, 1974-1997. Journal of Marine Science, 59.
[19] Aseltine-Nelson, D.A., B.B. Bernstein, M.L. Palmer-Zwahelen, L.E. Riege, and R.W. Smith. 1999. Comparisons of turf communities from Pendleton artificial reef, Torrey Pines artificial reef, and a natural reef using multivariate techniques. Bulletin of Marine Science, 65(1): 37-57.
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[21] Polovina, J. J. 1991. Fisheries applications and biological impacts of artificial habitats. In: Seaman, Jr. and Sprague (eds.), Artificial habitats for marine and freshwater fisheries. Academic Press, 285 p

predators on the soft-bottom habitat[19,22].

SAT Evaluation of Artificial Structures

Individually, most of the artificial reefs in the SCSR are small, and collectively contribute a very small (1.8%) portion of the estimated hard bottom habitat along the mainland coast. Therefore, any positive or negative influences artificial reefs might have on MPA function are not likely to be substantial.

The MLPA South Coast Regional Stakeholder Group currently has access to separate GIS data layers for artificial reefs, oil platforms, hardened manmade structures (e.g. breakwalls and jetties), and shipwrecks in MarineMap. However, within the fine-scale habitat data layer, 16 of 25 artificial reefs are identified as hard bottom habitat in the 0-30 meter depth zone. The habitat representation evaluation for the 0-30 meter depth hard bottom habitat utilizes a linear proxy (using multiple sources of information) to estimate the alongshore length of nearshore habitat that is dominated by rock and does not incorporate every spec of 0-30m rock. Therefore, due to their small size, artificial reefs contribute very little to the overall hard bottom habitat and are not included in the evaluations as hard bottom habitat. The only possible exception to this would be the newly constructed 174 acre Wheeler North Reef. This is the largest mitigation reef constructed in California, and was designed to mimic a natural kelp reef. However, its contribution to shallow hard bottom habitat is not included in the habitat representation and replication evaluations because it (1) was built subsequent to the habitat data collection and therefore is not identified as hard bottom habitat in the fine-scale habitat layer, and (2) its function is still unknown. Thus, inclusion of the Wheeler North Reef will not contribute to representation of hard bottom, and instead reduces the areas or quality of soft-bottom targeted for protection in an MPA that includes it.

Other artificial structures present in the fine scale habitat data include some sanitation outfall pipes and breakwalls. While breakwalls (e.g., Los Angeles Federal Breakwater) may act as artificial reefs, they usually occur near major harbors, and thus may not be the best location for an MPA. Undersea wastewater discharge pipes and diffusers occupy space on the seafloor and represent an anthropogenic change to natural habitat. The wastewater agencies must perform maintenance on these structures, and that activity has the possibility of disturbance to habitat and benthic organisms. Furthermore, permittees are required to perform monitoring, which in some cases involves collecting and sacrificing marine life, and may cause some habitat disruption (e.g., research vessel trawling impacts).

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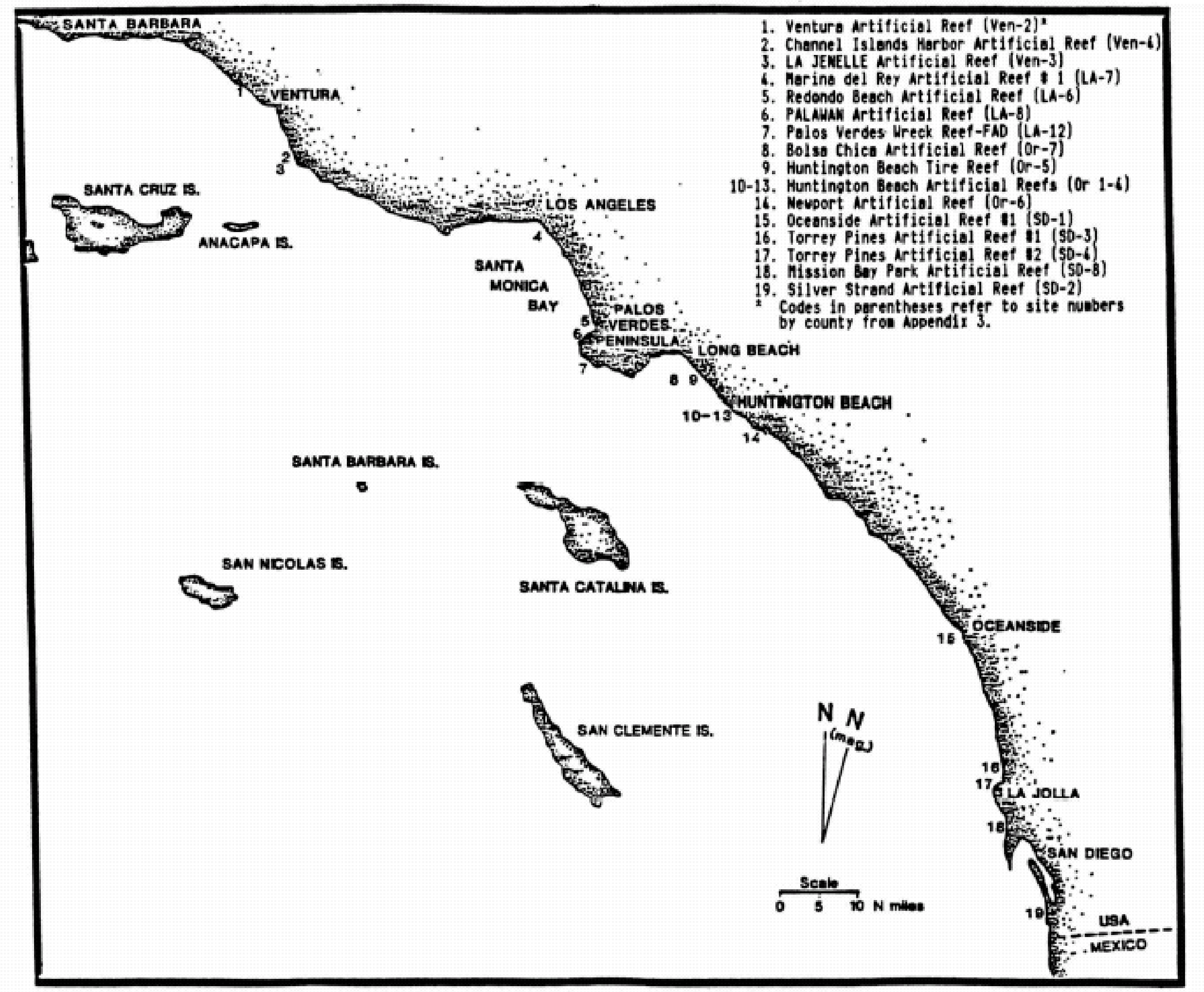
[22] Parrish, F. A., E. E. DeMartini and D. M. Ellis. 1997. Nursery habitat in relation to production of juvenile pink snapper, *Pristipomoides filamentosus*, in the Hawaiian Archipelago. Fishery Bulletin 95:137-148.

Table 1. A Summary of the Attributes for Existing Artificial Reefs Constructed in Southern California from 1960 to 2008.

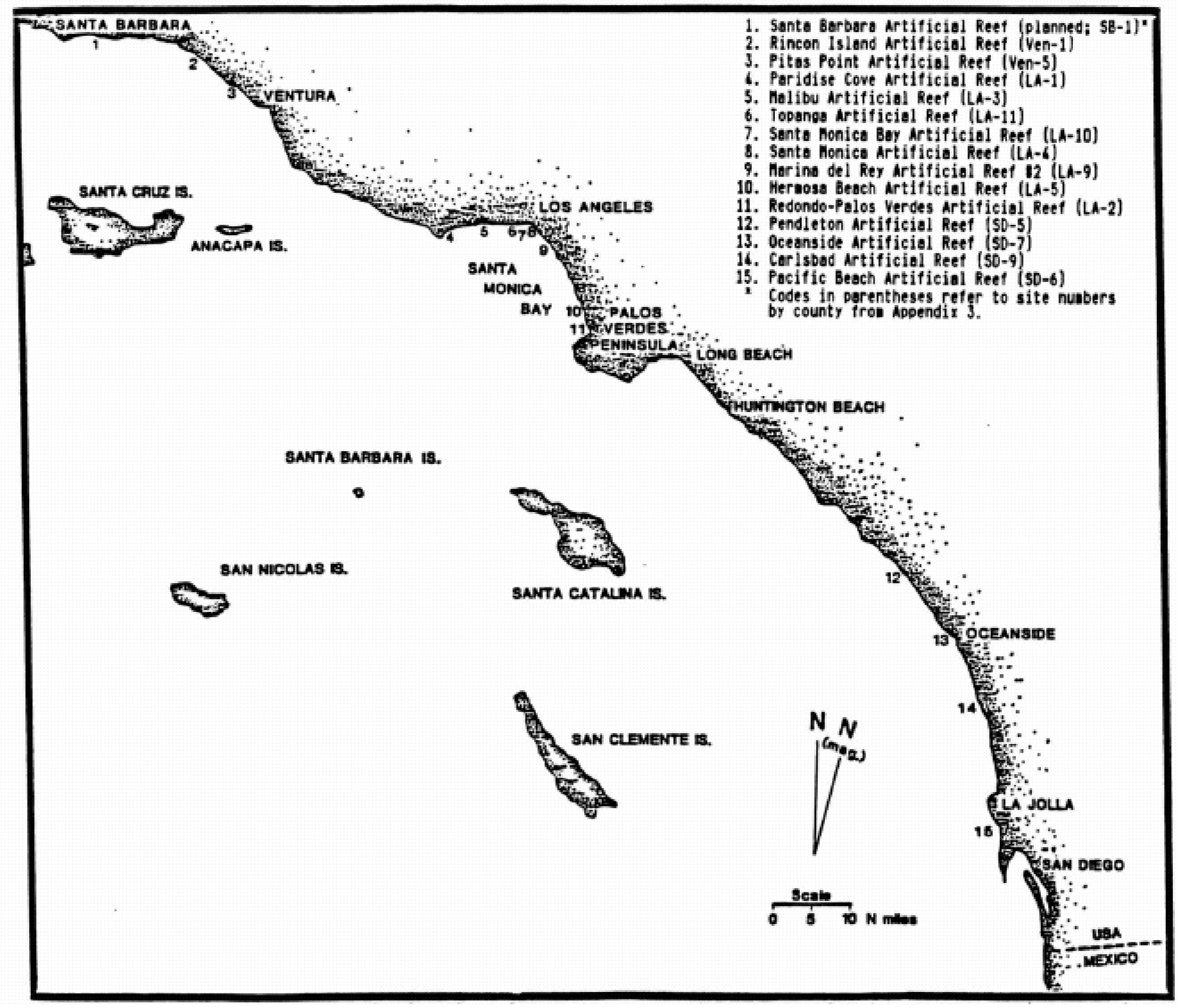
NAME	Year built	depth (ft)	Size (acres)	Captured in fine scale habitat data	Type of work (Purpose)	Organizaton	Material	Funding
Pitas Point	1984.	28	1.1	n	sportfish habitat enhancement - developmental fishing reef (designed for kelp growth	DFG	7,200 tons quarry rock	Wildlife conservation board
Malibu Center	1960	60	0.5	n	Developmental study reef	DFG	333 tons quarry rock	Wildlife conservation board
Topanga	1987	28	2	y	sportfish habitat enhancement - developmental fishing reef designed for kelp growth	DFG	10,000 tons quarry rock	Senate Bill 400
Santa Monica Bay	1987	42-72	7	y	developmental fishing reef to investigate rock size, depth, and relief sportfish habitat enhancement-	DFG	20,000 tons quary rock	Senate Bill 400
Santa Monica	1961/1971	60	0.5	y	Replicate developmental study reef (same materials as Malibu Center reef)	DFG	330 tons quarry rock/100 tons pier pilings	Wildlife conservation board
Marina Del Rey 2	1985	65	6.9	y	sportfish habitat enhancement- developmental fishing reef to investigate module spacing	DFG	10,000 tons quarry rock	Wildlife conservation board
Marina Del Rey 1	1965/1978	65	3.2	y	sportfish habitat enhancement- Recreational fishing reef	DFG	2,000 tons quarry rock/4,000	L.A. County F&G Commission
Hermosa Beach	1960	60	0.5	n	Developmental replication study reef	DFG	330 tons quarry rock	Wildlife conservation board
Redondo Beach	1962	72	1.6	n	Recreational fishing reef	DFG	1,000 tons quarry rock	L.A. County F&G Commission
Palawan	1977	120	0.6	n	Recreational fishing reef	DFG	450 ft ship	donated ship
Huntington Beach A	1963	60	3.7 (total for all)	y	Recreational fishing reef	DFG	1,000 tons quarry rock each	Wildlife conservation board
Huntington Beach B	1963	60	3.7	y	Recreational fishing reef	DFG	1,000 tons quarry rock each	Wildlife conservation board
Huntington Beach C	1963	60	3.7	y	Recreational fishing reef	DFG	1,000 tons quarry rock each	Wildlife conservation board
Huntington Beach D	1963	60	3.7	y	Recreational fishing reef	DFG	1,000 tons quarry rock each	Wildlife conservation board
Newport Beach	1979	72	8	y	Recreational fishing reef	DFG	10,675 tons concrete blocks, pilings,& rubble	Wildlife conservation board
San Clemete	1999	45	22	no data	sportfish/kelp habitat loss mitigation	SCE	6 types of rock and concrete modules	SCE
Wheeler North (SONGs)	2008	45	150	n	sportfish/kelp habitat loss mitigation	SCE	85,000 tons quarry rock	SCE
Pendleton	1980	43	3.5	n	Pilot developmental study reef	DFG/SCE	10,000 tons quarry rock	SCE
Oceanside 2	1987	42-72	3.5	n	developmental fishing reef - investigation of module depth and relief	DFG	10,000 tons quarry rock	SB 400
Oceanside 1	1964/1987	82-100	4	y	Recreational fishing reef	DFG	2,000 tons quarry rock	Wildlife conservation board
Carlsbad	1991	37-60	6	y	habitat enhancemet/recreational fishing reef	DFG	10,000 tons quarry rock	
Torrey Pines 2	1975/1979	44	1	y	Recreational fishing reef	DFG	3,000 tons quarry rock	City of San Diego/Wildlife conservation board
Torrey Pines 1	1964	67	?	y	Recreational fishing reef	DFG	1,000 tons quarry rock	Wildlife conservation board
Pacific Beach	1987	42-72	1.5	y	developmental fishing reef - investigation of module depth and relief	DFG	10,000 tons quarry rock	SB 400
Mission Bay Park "AKA wreck alley"	1987	80-90	173 (~ 11 acres of rock)	y	Recreational fishing reef	DFG	3 sunken ships/ 9000 tons of concrete rubble	

Figure 1. The locations of recreational fishing reefs in southern California. Artificial reefs number 2,3,7,9, and 19 either were never constructed or no longer exist.



Source: Department of Fish and Game Administrative Report 90-15

Figure 2. The locations of developmental reefs in southern California. Artificial reefs numbered 1, 2 and 4 either were never constructed or no longer exist.



Source: Department of Fish and Game Administrative Report 90-15