ATTACHMENT 2

Characterization of Marine Habitat and Associated Species at Rincon Island (UCSB 2021)

CHARACTERIZATION OF MARINE HABITAT

AND ASSOCIATED SPECIES

AT RINCON ISLAND

INDEPENDENT RELEVANT ENVIRONMENTAL STUDY SUPPORTING SOI 2020-01:

RINCON ISLAND DECOMMISSIONING PROJECT

UC SANTA BARBARA
Marine Science Institute

CHARACTERIZATION OF MARINE HABITAT

AND ASSOCIATED SPECIES

AT RINCON ISLAND

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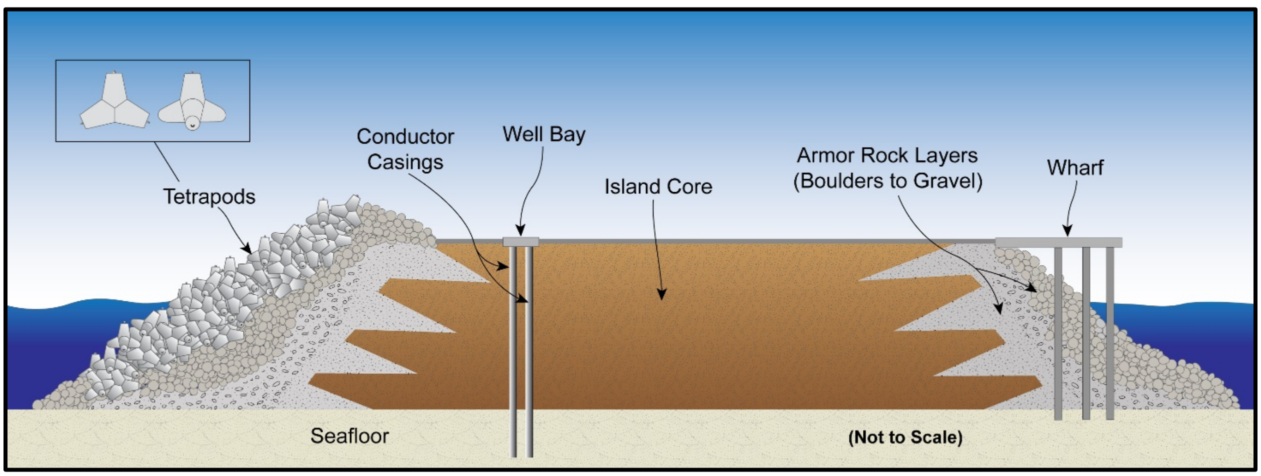
1.0 INTRODUCTION

Rincon Island is a man-made island a little over 2 acres in area constructed for oil and gas production and processing. Rincon Island is made up of 160,000 yd3 of dredged sand and gravel. This core is surrounded with 72,600 yd3 of imported armor rock (Figure 1). The top surface of the island is primarily covered with asphalt and concrete and extends over approximately 1.2 acres of the island. This area previously contained oil production facilities, piping systems, electrical supports, and various office and support building space that were removed as part of the Phase 1 decommissioning activities. The depth of water at the base of the island is roughly 55 ft. Above ocean level, the island covers a total area of a little over 2 acres and is concave with a depressed center. The working area of the island is approximately 1 acre and is located within the low-lying center of the island. The perimeter of the working area is surrounded by a 4 ½-foot sea wall. The Rincon Island Causeway is a 2,732-foot-long wood and steel bridge that connects Rincon Island to the coastline. The causeway provides vehicle, equipment, and personnel access to the island. Oil and gas pipelines that ran along the causeway were removed as part of the Phase 1 activities. The layout of Rincon Island and partial causeway are depicted in aerial view in Figure 2.

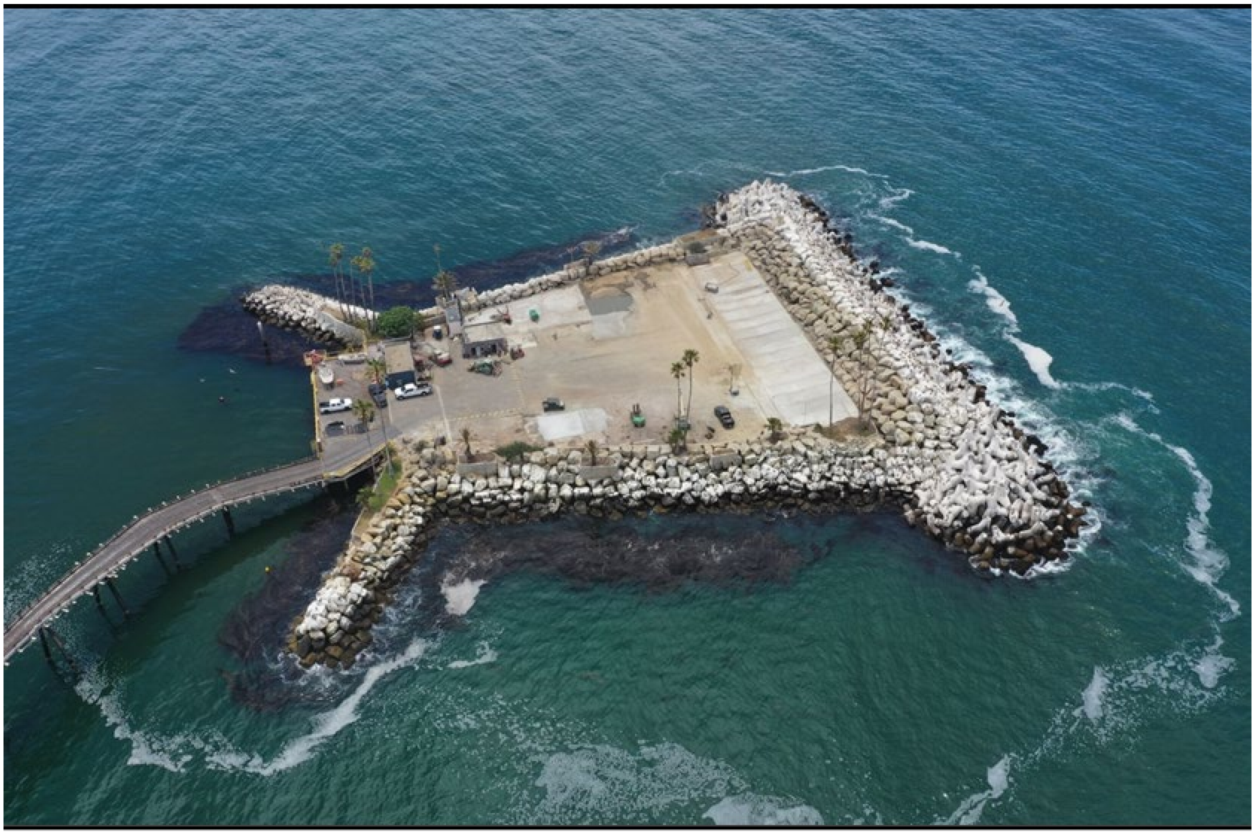
Additionally, the western seaside exterior is reinforced with a jumble of 1,100 cement tetrapods, each weighing approximately 31 tons (Figures 1, 2, and 3). Each tetrapod has four, 6-foot-long concrete legs that are greater than 2 ft in diameter at the end.



Source: Figure provided by Driltek

Figure 1. Cross-section of Rincon Island

The wells were contained in a single 160-foot-long well bay supported with a monolithic rig apron and wall. Abandonment operations commenced in July of 2018. All wells were plugged and permanently abandoned during Phase 1 operations and the well bay wall removed to ground level. There were 50 wells and 19 undrilled conductors on the island. Of the 50 wells, 47 were oil and gas wells and three were water source wells.



Source: Figure Provided by Driltek

Figure 2. Aerial view of Rincon Island

Figure 3. West Side Tetrapods from the Sea Surface

2.0 PART 1. SUMMARY OF PAST OBSERVATIONS OF MARINE BIOLOGICAL RESOURCES AT RINCON ISLAND

2.1 PAST OBSERVATIONS OF MARINE BIOLOGICAL RESOURCES

There are three previously published environmental evaluations of marine biota at Rincon Island, none more recent than 1978. In Part 2 of this report, we briefly compare our contemporary observations with information from these past evaluations.

- Carlisle, J. B., C. H. Turner, and E. E. Ebert. 1964. Artificial habitat in the marine environment. California Department of Fish and Game, Fish Bulletin 124.
- Keith, J. M. and R. E. Skjei. 1974. Engineering and ecological evaluation of artificial-island design, Rincon Island, Punta Gorda, California. U.S. Army Corps of Engineers, Coast Engineering Research Center Technical Memorandum No. 43, Appendix "The Biota of Rincon Island."
- Johnson, G. F. and L. A. deWit. 1978. Biological effects of an artificial island, Rincon Island, Punta Gorda, California. U. S. Army, Corps of Engineers, Coastal Engineering Research Center, Miscellaneous Report No. 78-3.

In this summary, we reviewed these past evaluations to ascertain if there are historical, somewhat predictable, species compositions that can be used to inform us about what to expect if and when Rincon Island is completely removed. Appendix 1 is a master list of species compiled from the three studies by Johnson and deWit (1978).

2.1.1 Pre-Construction Observations

There was no organized study of the biota in the area before construction of Rincon Island. Dr. William Brisby, in his ecological evaluation, "The Biota of Rincon Island," in Keith and Skjei (1974) described the area prior to installation of the island as a "biological desert." Brisby made such an analogy because without hard substrate for attachment, algae and sessile invertebrates are mostly absent in the sand-silt habitat except for where rock is exposed in scattered, transitory places.

Brisby provided the following listing of "preconstruction biota" from personal observations and from discussions with sportsmen and the California Department of Fish and Game.

> "The in-and epi-fauna consisted primarily of [cnidarians] such as the [elongate sea pen] *Stylatula elongata*, [tube dwelling worm *Cerianthidae*], [crabs] of the genus *Cancer*, and echinoderms, primarily [spiny sand star] *Astropecten armatus*, [bat star] *Patiria miniata*, and [sea cucumber] *Parastichopus* sp. Occasional growths of [giant kelp] *Macrocystis* sp. came to the surface from the few rock outcroppings on the bottom.
>
> The pelagic organisms were mostly transients with the exception of silversides [Atherinidae] and flatfish [Pleuronectiformes] which might be considered resident forms. Transient vertebrates included many of the migratory sportfish and the three major mammals, [California sea lion] *Zalophus californianus*, [harbor seal] *Phoca vitulina*, and [gray whale] *Eschrichtius glaucus*."

Brisby's reasoning for providing a brief description of preconstruction conditions "simply is to indicate this sparsity of life."

2.1.2 Post-Construction Observations (1958 - Early 1970s)

"Artificial Habitat in the Marine Environment" (Carlisle et al. 1964)

Construction of Rincon Island began in February 1957 and the armor revetments surrounding the island were completed in January 1958 (Keith and Skjei 1974). Initial observations of the marine community at Rincon Island by Carlisle et al. (1964) began in July 1958. Rincon Island was one of six installations of man-made artificial structures in Southern California observed by diver scientists from California Department of Fish and Game in late 1950s to mid-1960s. Unlike the artificial reef sites in Santa Monica Bay, Carlisle et al (1964) did not survey the natural habitat at the Rincon Island site before construction.

Twenty-six scuba dives were made over the course of nearly 2.5 years from August 1958 through December 1960, logging 53.4 hours underwater at Rincon Island. It was apparent to Carlisle et al. that many changes had already occurred in the area: numerous fishes of at least 50 species in 22 families were observed, a modest kelp bed (giant kelp, *Macrocystis pyrifera*) grew on the rock and tetrapod revetments on all sides of the island, and an abundant community of at least 117 invertebrate species in 10 phyla, and at least 14 algal species were found living on the armor revetment and soft bottom substrate of sandy silt adjacent to the island's base. Water visibility varied from 0 to 35 ft averaging 8 ft (usually murky), which made fish estimates difficult. The fish population gradually trended upward, but there were many fluctuations that Carlisle et al. surmised may have been because of water clarity or incoming year-classes of fishes.

Carlisle et al. lists the fishes and the number of dives that each species were observed. Reported occurrences of species ranged between 1 and 26 (all) dives. The most frequently encountered reef fishes were four species of surfperch (pile perch (*Rhacochilus vacca*), black perch (*Embiotica jacksoni*), rubberlip perch (*Rhacochilus toxotes*), rainbow seaperch (*Hypsurus caryi*)), halfmoon (*Medialuna californiensis*), and two recreationally important species, kelp bass (*Paralabrax clathratus*) and barred sand bass (*Paralabrax nebulifer*)—all seen in at least 21 dives. Other recreationally important reef fishes often seen were blue rockfish (*Sebastes mystinus*), brown rockfish (*S. auriculatus*), olive rockfish (*S. serranoides*) and cabezon (*Scorpaenichthys marmoratus*).

Carlisle et al. narratively describes some apparent fish species associations, invertebrate species associations, associations between species and habitat features, and seasonal and interannual variability in the physical and biotic environment. Size ranges of a number of fish species and some observations of individual and schooling behaviors, a few related to feeding and reproduction, are included. They observed the young-of-the-year of a number of fish species including surfperch species (Embiotocidae), kelp bass (*Paralabrax clathratus*), blacksmith (*Chromis punctipinnis*), garibaldi (*Hypsypops rubicundus*), olive rockfish (*Sebastes serranoides*), blue rockfish (*S. mystinus*), and bocaccio (*S. paucispinnis*). Young-of-the-year were seen throughout the year; several hundred 1.5-inch rockfish were observed in May and June 1960.

Carlisle et al. provide a graphical representation of the intertidal-subtidal distribution of 32 major algal and invertebrate groups on the rock revetment of the east side (lee) of Rincon Island where water clarity, reduced surge, and ease of access was found to be best. These data collected in July 1961, about 4.5 years after construction of the island began, were obtained by sampling a 1 square-foot area at each 10-foot depth interval and by making numerous diving observations. Red, brown and green algae occurred in the intertidal down to about 30 feet (ft) deep. Mussel beds were densest above depths of 10 ft and extended down to the base of the revetment. Giant kelp was found from about a depth of 10 to 20 ft. Acorn barnacles (*Balanus* spp.), snails, and worms were relatively dense along the entire length that extended down to about 40 ft. The greatest diversity was at depths between 15 and 25 ft. Fan-like and bushy soft corals (gorgonians) were most abundant at these depths and occurred down to the base of the revetment. A pronounced vertical zonation of the major taxonomic groups was apparent.

"The Biota of Rincon Island" (Brisby *in* Keith and Skjei, 1974)

The second examination of the marine resources at Rincon Island was by William Brisby in "The Biota of Rincon Island," Appendix A in the report, "Engineering and Ecological Evaluation of Artificial-Island Design, Rincon Island, Punta Gorda, California" (Keith and Skjei,1974). Dr. Brisby, a professor of Marine Biology at Moorpark College, Moorpark, California, was permitted to use Rincon Island as a field station after its construction and had been conducting detailed field studies at the island for years.

Brisby's lengthy period of surveys, presumably through the 1960s and into the 1970s, consisted of observing and identifying marine organisms on or near the island using scuba in-situ observations, collections, and photography. As in the other studies, underwater turbidity limited scuba opportunities. Other methods employed to collect samples of the biota were Peterson grabs (a clamshell scoop), dredges, trawls, fishing gear, and traps. Brisby provides a listing of names of all flora and fauna either observed or collected after construction of the island. Reported are at least 27 species of algae, 167 species of invertebrates, 78 species of fishes (including 9 sharks and rays), 32 species of birds, and 4 species of marine mammals. The variety of methods utilized by Brisby to survey the community contributed to the greater number of some taxonomic groups, in particular the fishes, compared to the other studies.

Brisby discusses how the offshore positioning of the island allows for varied wave exposure and currents around the island providing an environment which has exposed zonation, protected zonation, and stages in between and making possible a diversity of marine life greater than usually found in a coastal area this size. The wave-exposed, seaward, west side of the island was noted to be particularly rich in life. Mussel beds several feet thick had developed on the tetrapods with "myriad populations" of organisms associated with these beds. Extensive beds of giant kelp (*Macrocystis pyrifera)* and feather boa kelp (*Egregia* sp.) on this side of the island were most luxuriant in the summers, and Brisby identified perches (Embiotocidae) and blennies (Blenniidae) as the primary resident fishes in this habitat. On the east side, in the lee of the island, where eddies can come around the island, and where it is most quiescent among the four sides, a great number of juvenile fishes were observed in the summer amid small kelp beds. The south side of the island had the least amount of algal growth, and Brisby surmised this may be due to grazing by a large population of urchins (unspecified red urchin (*Mesocentrotus franciscanus)* or purple urchin (*Strongylocentrotus purpuratus*)) observed on this side of the island. The north side of the island had the largest gorgonian formations around the island. One gorgonian stand primarily composed of *Muricea* sp. was over 50 ft long and 20 ft wide.

A bathymetric survey conducted in March 1973 showed a deposit of mussel shells at the base of the west face and smaller deposits at the base of the north and south faces. Brisby describes the "talus slope" of mussel which "in some areas extends 15 ft above the toe of the rock slope." Brisby adds, "This formation is important in helping to keep down the sediments and in providing small shelter areas for nudibranchs [also known as sea slugs], gobies [a small fish species], and various marine worms. While the landward [east] side has a small footing of this type, it is probably not so prominent because of the lack of large mussel beds and also the lack of general storm action which may be a large way responsible for the destruction and dispersing of the mussel beds on the other three sides." Keith and Skjei (1974) report detectable changes in soft bottom sediments adjacent to the island from 1957 to 1973. An estimated maximum erosion of about 3 ft on the west side of the island probably was a result of wave-induced turbulence on this wave facing side of the island.

"Biological Effects of An Artificial Island, Rincon Island, Punta Gorda, California" (Johnson and deWit, 1978)

The last and most comprehensive study was completed more than 40 years ago by Johnson and deWit (1978). The objectives of the study were to: (a) delineate, map and quantitatively characterize major species associated around Rincon Island, and compare these with the biota of the natural bottom between the island and shore; (b) document the morphology and volume of the beds of shell debris lying along the flanks of each of the four sides of the island; (c) survey major benthic organisms along permanent transects on each side of the island on a seasonal basis documenting changes in biotic composition and habitat character; and (d) expand the existing species list of the area compiled from Carlisle et al (1964) and Brisby's Appendix A in Keith and Skjei (1974).

Five separate survey projects were carried out to meet the objectives: a fish survey, seasonal transect surveys, an island-wide species-association survey, a natural bottom survey, and talus (shell) bed survey. Overall, a total of 330 species of macrobiota were encountered during the Johnson and deWit study; 160 of these taxa had not been reported as occurring at Rincon Island and brought the total species list to 458 (Appendix 1).

Fish surveys. Johnson and deWit surveyed fishes at the island by conducting gill net surveys over the course of two days, 15 and 16 June 1977. The nets extended from the intertidal zone to the toe of the armor revetment on each side of the island. The nets were fished for two periods: a daytime period for four hours and a day-night period ranging from 17 to 23.5 hours. The deployments yielded a total of 270 fishes of 23 species. The use of only gill nets to sample the fishes accounted for a different suite of species and a relatively low number of species observed by Johnson and deWit compared to Carlisle et al. and Brisby. Five taxa accounted for 61% of individuals captured. In decreasing order, they were olive rockfish (*Sebastes serranoides)*, midshipman (*Porichthys* spp.), walleye surfperch (*Hyperprosopon argenteum)*, swell shark (*Cephaloscyllium ventriosum*), and white seaperch (*Phanerodon furcatus)*. Four of these species were captured on all four sides of the island. Four swell sharks were caught only during the day-night period on the east side of the island.

The highest number of individuals and species was captured on the most wave protected, east side of the island.

Seasonal transect surveys: Johnson and deWit summarize the seasonal variability in the densities of 250 taxa (70 macroalgae and 180 macroinvertebrates) and provide quantitative graphical representations of the vertical depth distribution of dominant macrobiota (24 algae and 30 invertebrate species) on the four sides of the island. Four seasonal quadrat surveys were conducted along permanent transects over the course of 1 year from summer 1976 to spring 1977. The transects, one on each side of the island, extended from the upper limit of the wave splash zone to the limit of the island's influence on the bottom. Divers recorded counts or percent cover of all macrobiota in 1 meter square (m^2) quadrats placed along the permanent transect at 1 m increments. Species of uncertain identify were collected. Each quadrat was photographed.

In their analysis of the permanent transect data, Johnson and deWit regarded species occurring on all four sides of the island as ubiquitous and generally the dominant macrobiota over the entire island. Of 52 common taxa, 37 taxa (71%) exhibited significant seasonal changes in densities. Of these, 20 taxa were absent during one or more seasons and 17 showed significant changes in abundance despite being present in all four seasons. For example, significant seasonal differences were shown by the strawberry anemone (*Corynactis californica)* and brown cup coral (*Paracyathus stearnsii)*. Gorgonians of *Muricea* spp. varied seasonally while the red gorgonian *Leptogorgia chiliensis* did not.

Island-wide species-association survey: Another extensive survey of 250 quadrats (0.25 m^2) around the island was carried out to map the distribution of major species associations over all submerged parts of the island. Two hundred-fifty randomly placed quadrats (0.25 m^2) were photographed, individuals were counted in the quadrats, detachable macrobiota were collected and attached organisms were scraped from measured areas for biomass measurements. Faunal and floral associations were identified on the basis of substrate character and recurrent groups of species conspicuous by virtue of size, abundance, or biomass.

Nine major algal and invertebrate species associations were identified:

- Barnacle-limpet association found in the uppermost zone relatively uniform in composition and found on all sides of the island;
- Mussel-Gooseneck barnacle (*Mytilus/Pollicipes*) association confined to a narrow band on the west side of the island;
- Green anemone (*Anthopleura* spp.) association occurring as patches within the macrophytic algae zone;
- Macroalgae ("Macrophyic algae") association occurring as a continuous band around the island except under the wharf on the east side where light is presumably the limiting factor;
- Coralline algae-red algae (*Lithothamnium-Veleroa*) association including bat stars and urchin abundant on all sides of the island;

- Red algae-bryozoa ("moss animal")-gorgonia (*Veleroa-Lagenipora-Leptogorgia-Muricea*) association, the deepest of the nine associations;
- Red algae (*Rhodymenia-Veleroa*) association found only on the east side of the island where it was significantly depauperate of the *Lithothamnium* complex;
- Coralline algae-thatched barnacle (*Lithothamnium-Tetraclita*) association located above the *Rhodymenia-Veleroa* association on the east side of the island;
- Tube worm-tube anemone (*Diopatra*-Cerianthidae) association occurring on shell talus and extending into the natural soft bottom habitat.

Johnson and deWit mapped and described the dominant biota characterizing each association and the habitat including where around the island and at what depth each association was found.

Natural Bottom Survey. Johnson and deWit investigated the ecological conditions in nearby natural bottom habitats. The epibenthic biota was surveyed by scuba divers along a transect about 20 ft from the causeway running parallel to it from the island to shore. The deeper areas of the transect are representative of the natural bottom existing before the island was constructed. The bottom was predominantly sedimentary (sandy silt grading into silty sand in the shoreward direction). Biomass, numbers, and the diversity of epibiota encountered visually over natural bottom areas were much lower than that of epibiota observed on the rock revetments of the island.

Rocky areas were encountered in the shallower part of the transect, but the biota observed on the natural hard substrate was lower in abundance and variety than the biota occurring at corresponding depths on the island. Macroalgae coverage in natural rocky areas along the transect was broader than on the island; however, depth zonation in general was much less distinct over the natural bottom transect than over the island's revetments.

Triplicate sediment samples for infauna (animals inhabiting the sediments) were taken at the outer terminus of the transect at 13.7 m depth and at a point midway in the transect at a depth of 10.7 m mean low low water (MLLW). A total of 62 species where identified from sedimentary infauna samples. Polychaetes accounted for 35% of the wet weight biomass and 50% of the taxa present in the samples taken collectively. Also abundant were small crustaceans, clams, ribbon worms, and brittlestars. Many of these novel to the species lists of the previous studies.

Talus bed survey. Scuba divers located and measured the planar dimensions and depths of the talus beds. From these measurements, the volume of the shell beds on each of the four sides of the island was estimated. Johnson and deWit mapped the talus bed dimensions on cross-sections of the slope of each side of the island and charted the boundaries of the beds.

As Keith and Skjei (1974) found, Johnson and deWit described the west side talus beds as more extensive and voluminous than the beds on the other sides, and estimated the beds occupied 16.5 m^3 per meter of linear distance along the west revetment. This is because the tetrapods on the wave exposed, west side of the island supported a very heavy growth of mussel (*Mytilus californianus*) in the intertidal zone that would break off in heavy surf and accumulate at the foot of the revetment.

In contrast, the sheltered, east side was nearly devoid of shell talus and was an area of deposition for sediment carried to the lee of the island by turbulent eddies. The north and south-side talus beds were comprised mostly of the shells of the bivalves, jingles (*Pododesmus macrochisma)* and rock scallop (*Crassadoma gigantea).*

Biota frequently encountered in association with the talus beds included tube worm (*Diopatra ornate)*, tube anemone (*Pachycerianthus* sp.), Kellet's whelk (*Kelletia kelletii)*, bat star (*Patiria miniata)*, and hermit crabs including *Paguristes ulreyi* and *Isocheles pilosus*.

2.1.3 Summary and Conclusions

The previous studies conclude that Rincon Island has had a major effect on local ecological conditions, substantially increasing the biodiversity of fishes, invertebrates, and algae. The island's rock and tetrapod revetments provide a great variety of habitats for a diverse community of marine flora and fauna that do not occur in the local area's natural bottom habitats (Figure 4). The hard substrate is colonized by encrusting and attached biota. Many are habitat-forming species that provide shelter and food for additional species that in turn serve as food for more species. The orientation of the offshore island allows for varied wave exposure and currents around the installation providing an environment that has exposed zonation, protected zonation, and stages in between. This makes possible a diversity of marine life greater than that found in a nearby coastal areas. A total of 458 species have been encountered at Rincon Island from the reports of Carlisle et al. (1964), Keith and Skjei (1974), and Johnson and deWit (1978) (Appendix 1).

It has been over 40 years since the last ecological evaluation of Rincon Island conducted by Johnson and deWit (1978). This study together with the two previous evaluations by Carlisle et al. (1964) and Keith and Skjei (1974) provide a comprehensive, yet dated, characterization of the macroalgae and macroinvertebrate community at Rincon Island. Johnson and deWit showed statistically significant seasonal variation in the densities of three-fourths of 53 common taxa around the island. They mapped nine dominant species associations around the island. They surveyed biota along a transect over natural bottom from near the island to shore and sampled infauna in the soft bottom substrate showing that the biota in the natural habitat was far less abundant than the biota at corresponding depths on the island's revetments. Present information gaps include whether these species associations still exist and species abundance and distribution have been altered.

At least 85 species of fishes have been observed at Rincon Island. Different methods were used in the three studies to characterize the fish community, and quantitative estimates of abundance are limited. Carlisle et al. reported only the number of dives (of a total of 26 dives) that fish species were encountered. Brisby in Keith and Skjei compiled a name-only list of species observed during scuba dives, trawling, fishing with hook and line, and trapping. Johnson and deWit provided catch data from only two gill net samples. Quantitative estimates of fish species densities from methods widely used in studies of this region are needed to evaluate the importance of Rincon Island in comparison to nearby natural areas as fish habitat. Quantitative data on the seasonal and interannual variability of fish populations is lacking.

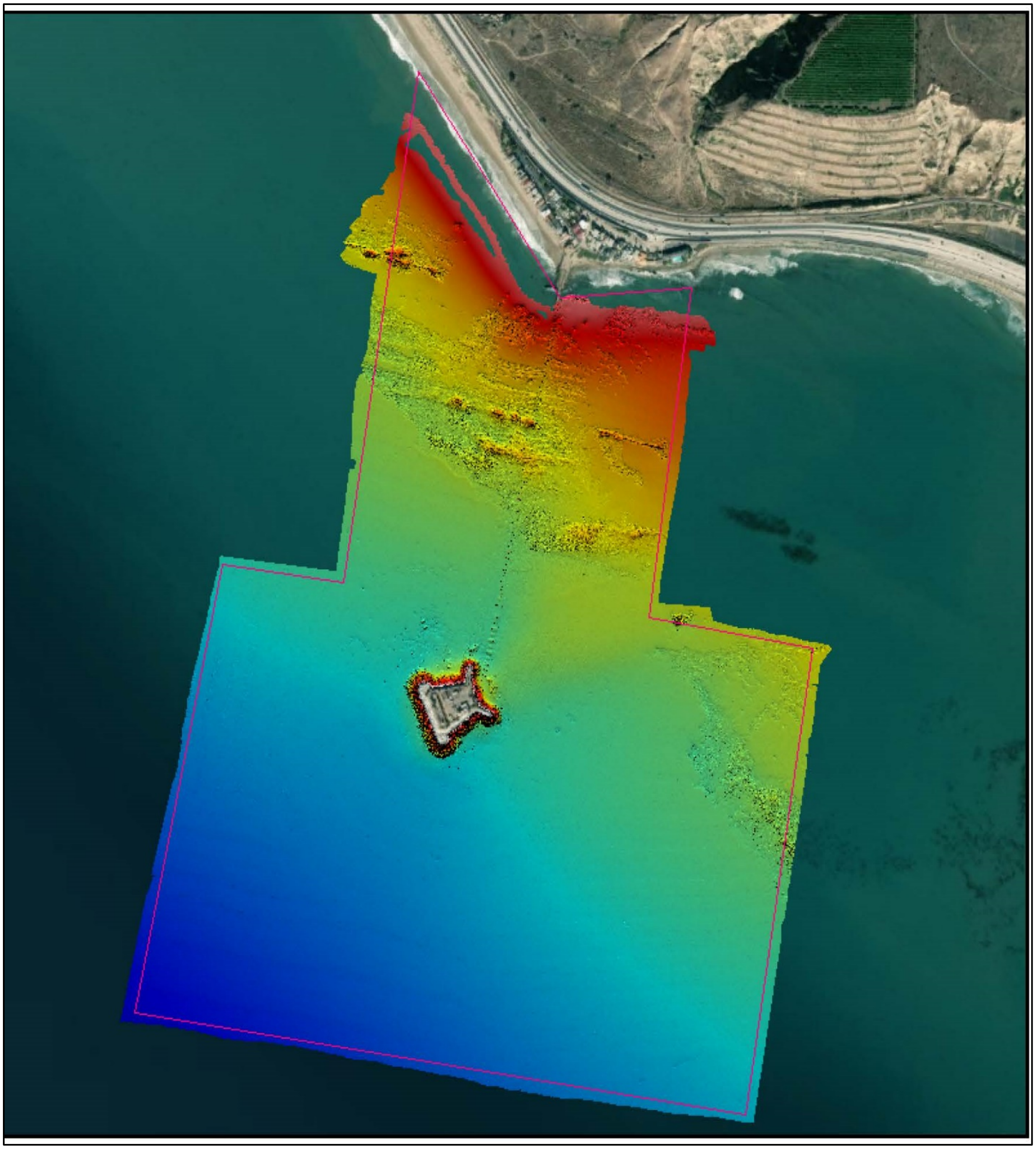


Figure 4. Bathymetry Rincon Island and Subtidal Coastline (eTrac, 2021)

3.0 PART 2. RECENT OBSERVATIONS, METHODS, RESULTS, AND COMPARISON OF NEW AND PAST FINDINGS OF MARINE BIOLOGICAL RESOURCES

An evaluation based on contemporary comprehensive surveys of the marine biological environment was necessary to assess the potential impact of removing Rincon Island. It is important to characterize the current condition of the habitat and establish the abundance of commercial and recreationally important fish and invertebrate species.

3.1 DESCRIPTION OF *IN SITU* MARINE METHODOLOGY

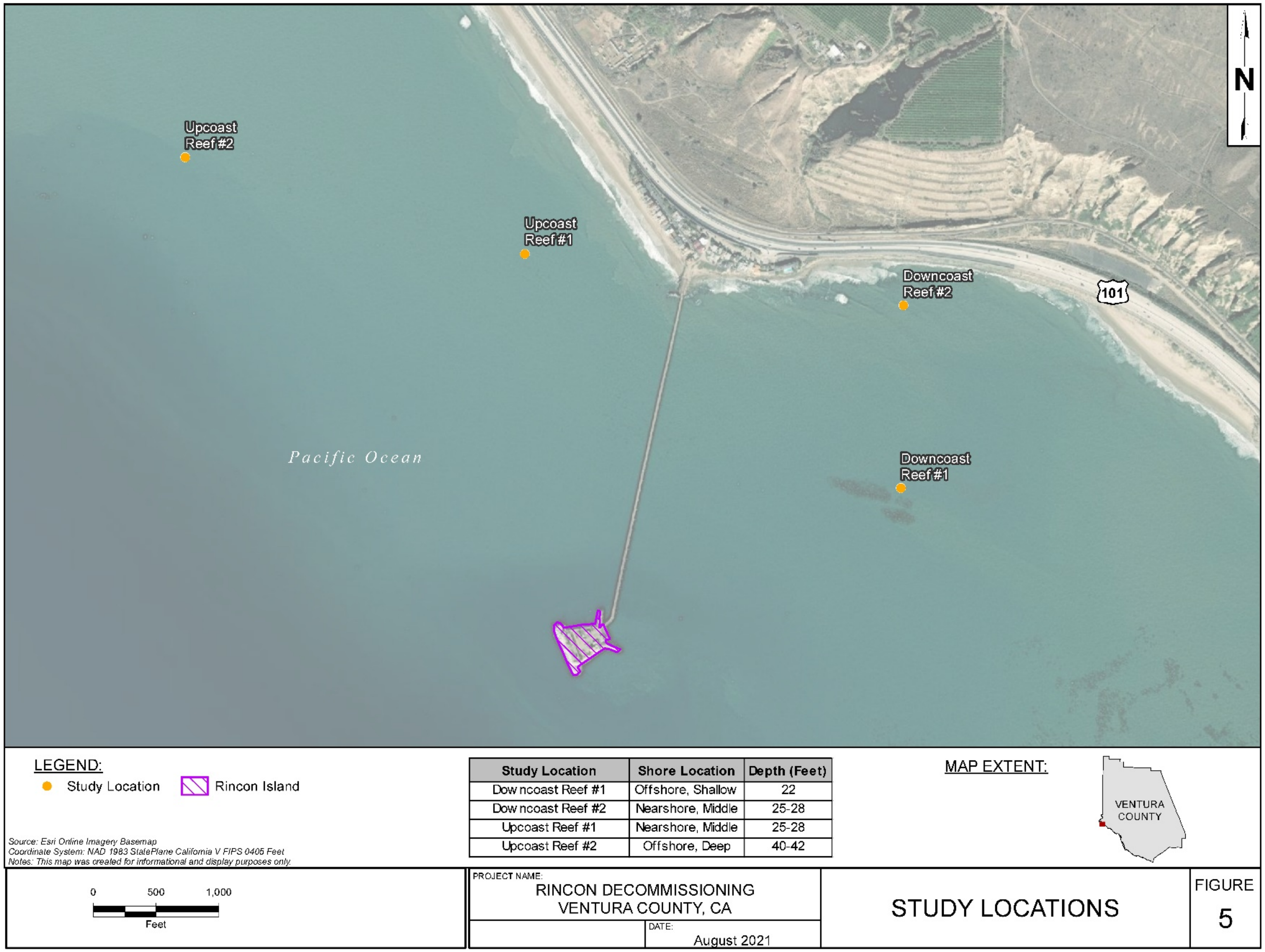
3.1.1 Transect Surveys

Over the course of four nonconsecutive days from October 9 to November 5, 2020, a team of scuba divers from the University of California Santa Barbara (UCSB) performed a series of belt transects for fishes, macroinvertebrates, and macroalgae at Rincon Island and four unnamed natural rocky reefs nearest to the island, two to the northwest (upcoast) and two to the northeast (downcoast) of the island, the closest site is 0.8 km from the island (Figure 5, Table 1).

A total of 16 transects (960 m^2) were surveyed at each site of Rincon Island and the natural reefs. These surveys were initiated after reports of fairly good water visibility apparent to personnel on Rincon Island in late summer 2020. It was expected that scuba diving conditions would deteriorate through the winter and spring. The UCSB scientific dive team, aware of island decommissioning and a feasibility study in development, decided to proceed with the surveys as soon as possible.

The survey effort was limited due to logistical and personnel constraints imposed by COVID-19 restrictions. Visibility during the surveys was highly variable from survey to survey and with depth and location around the island and at natural reefs. An effort was made to also survey the natural soft-bottom habitat away from the influence of the island, but the survey was aborted due to very poor visibility.

Either two or three scuba divers working together performed surveys along a series of belt transects at each locality. Each belt transect was 30 m long and 2 m wide covering an area 60 m^2. The transect length was delineated by a measuring tape laid along the bottom substrate (Figure 6A). The divers surveyed four transects along each of the four sides of Rincon Island: two transects were over the armor revetment near the mud seafloor and two transects were shallower at a depth on the revetment slope half that of the deeper transects (Table 1). The four natural reefs were patch-like, and the number of transects completed by the divers at each of those sites depended in part on the size and shape of the reef and visibility.



Study Location	Shore Location	Depth (Feet)
Downcoast Reef #1	Offshore, Shallow	22
Downcoast Reef #2	Nearshore, Middle	25-28
Upcoast Reef #1	Nearshore, Middle	25-28
Upcoast Reef #2	Offshore, Deep	40-42

Figure 5. Study Locations Area

Table 1. Site Locations, Schedule, Number, and Water Depth of Survey Transects Conducted at Rincon Island and Four Natural Reefs.

Survey Locality	Survey Date	Latitude, degrees North	Longitude, degrees West	Number of Survey Transects	Depth, (m)	Depth Level
Site: Rincon Island		34.364	119.445			
North side	10/9/20			2	18	shallow
				2	35	deep
East side	10/16/20			2	15	shallow
				2	30	deep
South side	10/9/20			2	20	shallow
				2	40	deep
West side	10/9/20			2	20	shallow
				2	40	deep
			Total Transects	**16**		
Sites: Reefs						
Upcoast reef 1 (nearshore, middle)	10/16/20	34.356	119.447	3	25-28	middle
Upcoast reef 2 (offshore, deep)	11/5/20	34.358	119.456	3	40-42	deep
Downcoast reef 1 (offshore, shallow)	10/30/20	34.351	119.437	6	22	shallow
Downcoast reef 2 (nearshore, middle)	11/5/20	34.355	119.437	4	24-28	middle
			Total transects	**16**		

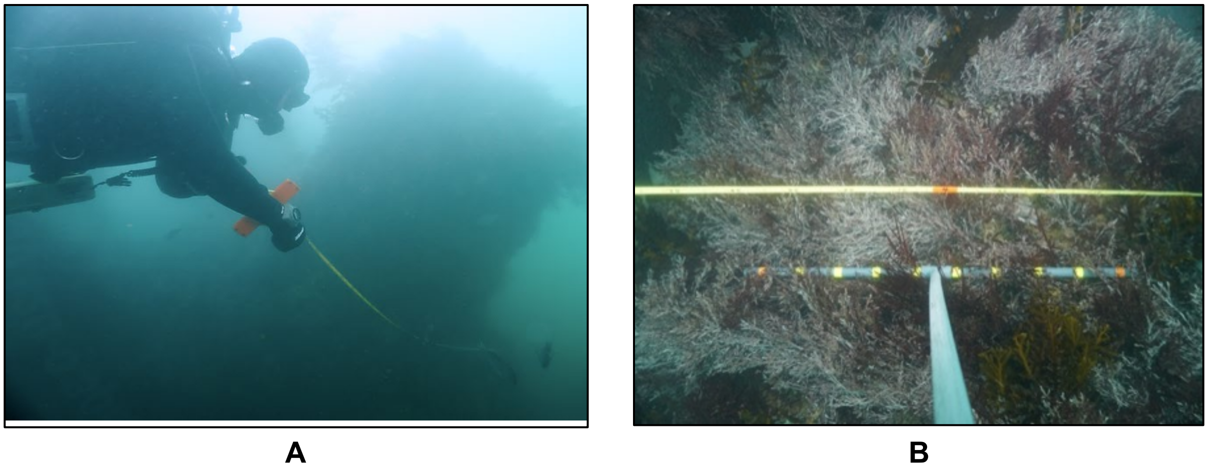


Figure 6. (A) Diver Performing a Belt Transect, (B) Image for the Photoquadrat Analysis

All fishes and mobile benthic macroinvertebrates encountered by the observing divers along the belt transects were recorded. One diver identified, counted, and estimated the total length of all fishes that occurred within 2 m of the bottom substrate. A second diver identified and counted all of the macroinvertebrates observed. Based on the counts, abundance was estimated as density, the number of individuals per 100 m^2 for fish, the number of individuals per 1 m^2 for invertebrates.

The fish surveys were completed at Rincon Island (n=16 transects) and the four reefs (n=16 total) (Table 1). The mobile invertebrate surveys were conducted at only three of the four reefs: the upcoast reef #1 (n=3), downcoast reef #2 (n=4), and the deeper upcoast reef #2 (n=3).

Habitat complexity was characterized by substrate rugosity at the six random points where the quadrats were placed along each transect. Rugosity was visually estimated as the change in the height of the rocky substrate classified as 0–0.1 m, 0.1–1 m, 1–2 m, or greater than 2 m, and later coded for analysis as 1, 2, 3, and 4, respectively. The shallow and deep levels on the south and east sides (n=4 each), and the deep level on the north side (n=1) of Rincon Island and two reefs--the shallow downcoast reef #1 (n=3) and deep upcoast reef #2 (n=3) were surveyed.

Macrocystis pyrifera stipes (i.e., giant kelp frond strands growing from holdfasts) were counted along the belt transect to estimate frond density. Rincon Island (n=16), downcoast reef #2 (n=4), and upcoast reef #2 (n=3) were surveyed.

The surveys of mobile invertebrates, substrate rugosity, and kelp stipes at Rincon Island and the reefs were less extensive than the fish surveys due to diving conditions and logistical limitations at times when two rather than three divers were performing the surveys.

3.1.2 Photoquadrat Surveys

Photographic surveys were conducted to assess the algae and sessile benthic macroinvertebrates at Rincon Island and the natural reefs. Figure 6B is an example of an image taken for the photoquadrat analysis at one of six randomly spaced sample markers along the 30-m transect tape. The diver would photograph each sample area by stabilizing directly above a marker on the tape, holding one end of a T-shaped guide against the substrate, and capturing the measurement reference bar marked in 10 cm increments within the field of view.

Initially, when sampling the north and west side of Rincon Island, the images were set by the T-bar at a distance from the substrate that encompassed a 1 m x 1 m quadrat area; however, visual resolution of the imagery was impaired by turbidity at the base of the revetment. Subsequently, the T-bar was modified to reduce the field of view to fit a 0.5 m x 0.5 m quadrat (0.25 m^2 area) and improve resolution. The east and south sides of Rincon Island were surveyed using this smaller field of view. The quadrat area analyzed in the images was 0.25 m^2 regardless of the size of the field of view.

Photoquadrat surveys were conducted at only 2 of the 4 reefs, the shallow downcoast reef #1 and deep upcoast reef #2, due to diving conditions and logistical limitations at times when two rather than three divers were performing the surveys.

3.2 DESCRIPTION OF ANALYTICAL METHODOLOGY

3.2.1 Transect Analysis

Statistical analyses were performed on the measures of abundance of the most common fishes and mobile invertebrates observed in the scuba transect surveys to determine if there were differences between island and reef habitats. A parametric test or a nonparametric method was used to test the null hypothesis of no group difference, $\alpha=0.05$ (JMP 15 Pro, 2021). Values were either square-root or log(x+1) transformed to reduce heterogeneity of variances if needed. The Tukey Honestly Significant Difference multiple comparison test was used when differences among habitats were detected in a Welch analysis of variance (ANOVA). When group variances were found to be unequal, the nonparametric Wilcoxon rank sums test was used, followed by the Steel-Dwass method for nonparametric comparison to identify differences between group pairs. Results from the parametric test and nonparametric test were compared for consistency

3.2.2 Photoquadrat Analysis

In the laboratory, the photoquadrat images were uploaded into CoralNet, an open-source online system for benthic resource analysis (https://coralnet.ucsd.edu/). We used the Uniform Point Contact (UPC) analysis tool to quantify the sessile macroinvertebrates and algae in the images. CoralNet permits the user to define the size of the UPC grid and the number of points in the grid to annotate on an image. We chose to overlay 25 points equally spaced in a 5x5 grid configuration over an approximate area of 0.25m2 on each image (Figure 7). The quadrat area was sized to the image using the measurement reference bar that was included in the photograph. This allowed us to include data from images with the larger field of view of the 1-m T-bar as is shown in Figure 7.

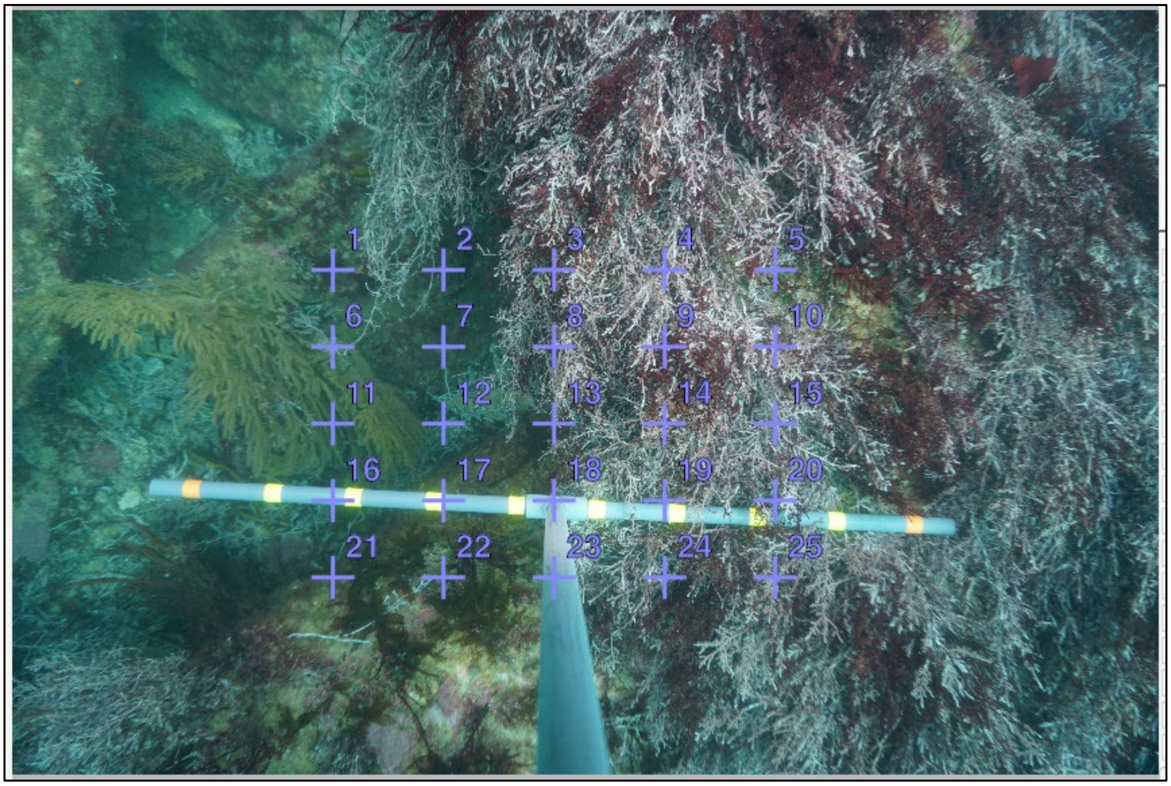


Figure 7. Example of UPC Grid on Photoquadrat Image from Rincon Island

Each annotation entered in the *CoralNet* system by the user specifies what was seen on the image under a point: an organism identified to the lowest taxonomic level possible; type of hard or soft substrate; or unresolvable (either water or unidentifiable under the point). Images with more than five unresolvable points were excluded from the dataset, so the total number of points per quadrat ranged from 20 to 25 points. If the UPC point overlayed the T-bar, then what was adjacent and likely to be under the marker was annotated. The abundance of each identifier (an organism or substrate type) under one or more UPC grid points was measured as the proportion (percentage) of 25 points. This is a relative measure rather than an estimate of areal coverage in an image. Relative abundance of an organism was examined as three measures: the points within a quadrat, the points summed across all quadrats, and frequency of occurrence (FO) in the total number of quadrats. We defined categories of relative abundance: 0, absent; 1-10% of points or FO, uncommon; 10 to 50% of points, common; 51 to 100% of points, abundant.

In addition to the UPC method to estimate relative abundance, a second method was used to estimate the density (number per 1m^2) of gorgonians (soft corals) in the images. All gorgonians that occurred, fully or partly, within the 0.25 m^2 quadrat area were identified to species, if possible, counted and measured.

3.2.3 Community Analysis

We used Primer v6 (Clarke and Gorley, 2006) to examine the species assemblage data in relation to the islands and reefs. The fishes, sessile invertebrates, and mobile invertebrates were analyzed separately. First, the count per sample (transect or quadrat) of species and types identified to a higher taxonomic level were square-root transformed to reduce the effect of large outliers. Next, Bray-Curtis similarity coefficients were calculated to quantify the resemblance between samples, and a similarity matrix was generated. Then, natural groupings of samples were examined using hierarchical clustering with the group average linkage option and multidimensional scaling (MDS) ordination. The primary hypothesis to be tested was whether or not there is difference among the assemblages found at Rincon Island and natural rocky reefs. The ANOSIM sample test statistic, R, ranges from 0 (no difference between groups) to 1 (all dissimilarities between the groups are larger than any dissimilarities among samples within either group). A statistically significant ($p<0.05$) but negligibly small R value close to 0 indicates that species composition strongly overlaps and the difference between groups may not be biologically meaningful.

3.3 RESULTS AND FINDINGS

3.3.1 Island and Reef Habitat Characterization

The physical structure supporting the biological communities at Rincon Island and the more nearshore natural reefs are strikingly different. The sloped armor revetment surrounding the island is composed of rock boulders with crevices of a variety of sizes and the west side of the island is reinforced with concrete tetrapods creating caves in excess of 3 m deep at the seafloor and cavernous gaps in all directions up the slope of the seawall. In contrast, the natural reefs in this study are mostly very low relief, rarely exceeding 1m in height. More often they were relatively flat rock with few crevices.

Thus as expected, rugosity measured by the divers at Rincon Island ranged from an index of 1 (0.1 m or less) to 4 (greater than 2 m), mean 3.0, SD 0.9 (index 3 is 1–2 m). In contrast, natural reef habitat was significantly less rugose ranging from 1 to 3, never exceeding 2 m (mean 1.9, SD 0.5; index 2 is 0.1–1 m) at two reefs combined (X2=33.968, $p<0.0001$).

Much of the habitat at both Rincon Island and the reefs was covered with a carpet of fuzzy, light brown "turf" primarily composed of colonial hydroids, bryozoans, and tunicates, bits of detritus, and biofilm. In the UPC analysis, turf occupied 38% of the points in all the photoquadrat from Rincon Island and 41% of the UPC points in photoquadrats from the shallow downcoast reef #2 and deep upcoast reef #2 combined.

As in earlier studies, divers observed mussel shell debris on the lower reaches of the island rock revetment that had broken off at shallower depths not surveyed. Shell debris from mussel and other mollusks was common, occurring in 11% of the photoquadrats and occupying 3% of the UPC points at Rincon Island. For comparison, shell debris was observed in 6% of the photoquadrats and 1% of the UPC points at the reefs.

3.3.2 Algae

Seven types of algae were identified in the UPC analysis of 148 photoquadrats from both Rincon Island and the natural reefs (Table 2). Although feather boa kelp and giant kelp were identified to species, small plants of these species were not distinguishable from other brown algae.

Table 2. Algal Species and Groupings

Common name	Scientific name	Grouping
Algae		Unidentified seaweeds
Brown algae	Class Phaeophyceae	Unidentified brown seaweed other than giant kelp and feather boa kelp
Red algae	Class Florideophyceae	Red seaweeds
Coralline algae, articulated	Possibly *Bossiella* spp. and/or *Calliarthron* spp.	Unidentified species of articulated coralline algae
Coralline algae, crustose	Possibly *Lithothamnion* spp., *Lithophyllum* spp., and/or *Pseudolithophyllum* spp.	Unidentified species of crustose coralline algae
Feather boa kelp	*Egregia menziesii*	
Giant kelp	*Macrocystis pyrifera*	

There were similarities and differences in the algal assemblages at Rincon Island and reef habitats (Table 3). In the UPC photoquadrat analysis, giant kelp was uncommon in the 94 images from Rincon Island; it occurred in only 1% of the photoquadrats and 0.3% of the UPC points. Divers observed kelp cover during their belt transects surveys only on the east side of the island. Giant kelp was common in the set of 54 photoquadrats pooled from two reefs. However, this was due to the presence of kelp at only one of the two reefs: kelp occurred in 58% of the photoquadrats from the shallow downcoast reef #2 under 9.1 % of the UPC points. The bottom depth of this reef is 22 ft. Kelp did not occur in the UPC analysis of photoquadrats from the deep upcoast reef #2 at a bottom depth of 40' ft.

Table 3. Abundance of Algae at Rincon Island and Two Reefs

	Rincon Island			Natural Reefs		
Algae	Abundance	Proportion of images	Proportion of UPC points	Abundance	Proportion of images	Proportion of UPC points
Red seaweeds	Common	73%	28.1%	Common	70%	22.9%
Brown seaweeds	Common	30%	4.7%	Uncommon	2%	0.1%
Coralline algae, articulated	Common	13%	2.4%	Not observed	0%	0.0%
Feather boa kelp	Uncommon	4%	0.7%	Not observed	0%	0.0%
Coralline algae, crustose	Uncommon	2%	0.2%	Uncommon	9%	0.4%
Giant kelp	Uncommon	1%	0.3%	Common	39%	6.1%
Algae, unidentified		5%	0.5%		0%	0.0%

Note: Abundance is based on the proportion of images a taxon is present and/or the proportion of UPC points occupied by a taxon at Rincon Island (94 images, 2350 UPC points), and from two reefs combined (54 images, 1350 UPC points). Categories of abundance: absent, 0; uncommon, 1-10%, common, 11-50%, abundant, 51-100%, Similarly, the *in situ* stipe count survey showed that significantly more kelp occurred at the shallower downcoast reef #2 than at Rincon Island, 870 stipes/transect (SE=121) and 9 stipes/transect (SE=5), respectively (Z=-3.25811, p=0.0032). Only three stipes of kelp were seen on transects at the deep upcoast reef #2, which confirms the finding from the UPC analysis. At Rincon Island, kelp was patchy and sparse (16, 70, 41, and 18 stipes on the north, south, west, and east sides, respectively). Nearly all were at shallow depths (Figure 8).

Figure 8. Feather Boa Kelp and Giant Kelp at Rincon Island

Although giant kelp was observed on all four sides of Rincon Island during the 2020 survey, only a small patch was observed near the surface on the east side of Rincon Island. In comparison, a dense kelp canopy was observed at the downcoast reef #1 over 50-100% of the area of the belt transects. The kelp canopy was sparse at the upcoast reef #2, kelp near the surface covered no more than 20% of any transect. There was no kelp canopy at the deep upcoast reef.

Red algae were the abundant and dominant taxa, present in 73% of the images from Rincon Island and 70% of the images from the natural reefs. Red algae occupied 28% of the total of 2350 UPC points in Rincon Island photoquadrats and 23% of 1350 points in reef photoquadrats (Table 3). At the shallower reefs where giant kelp shaded the seafloor, other algae were relatively uncommon. In contrast, brown algae and articulated coralline algae ranked second and third in abundance at Rincon Island where giant kelp was uncommon (Figure 9).

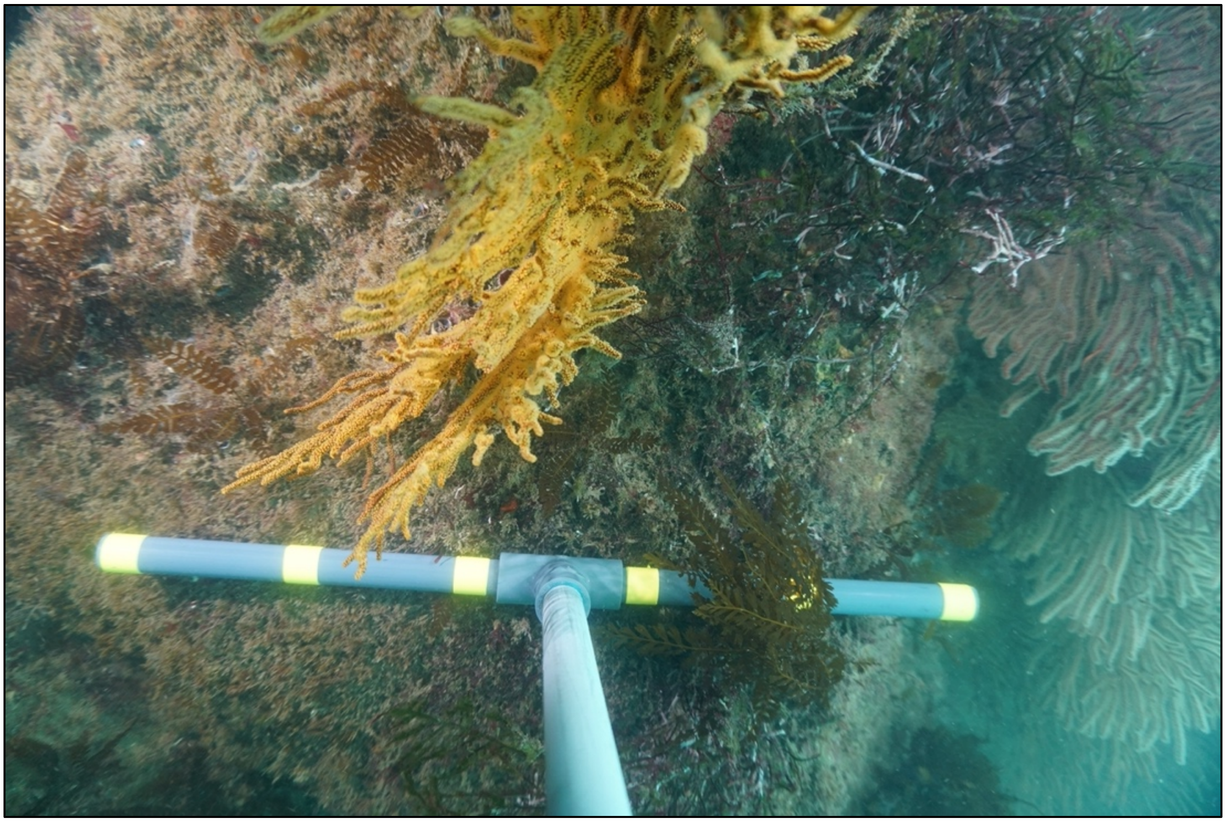


Figure 9. Red and Brown Algae and California Golden Gorgonian and Brown Gorgonian at Rincon Island

3.3.3 Invertebrates

Eighteen invertebrate taxa were identified to the species or genus level (Table 4). Nine were identified in the transect surveys and twelve in the UPC quadrat surveys, including four species of soft corals (gorgonians) that were enumerated in the quadrats (non-UPC method) (Appendix 2). No species listed by the Endangered Species Act or species of concern were observed.

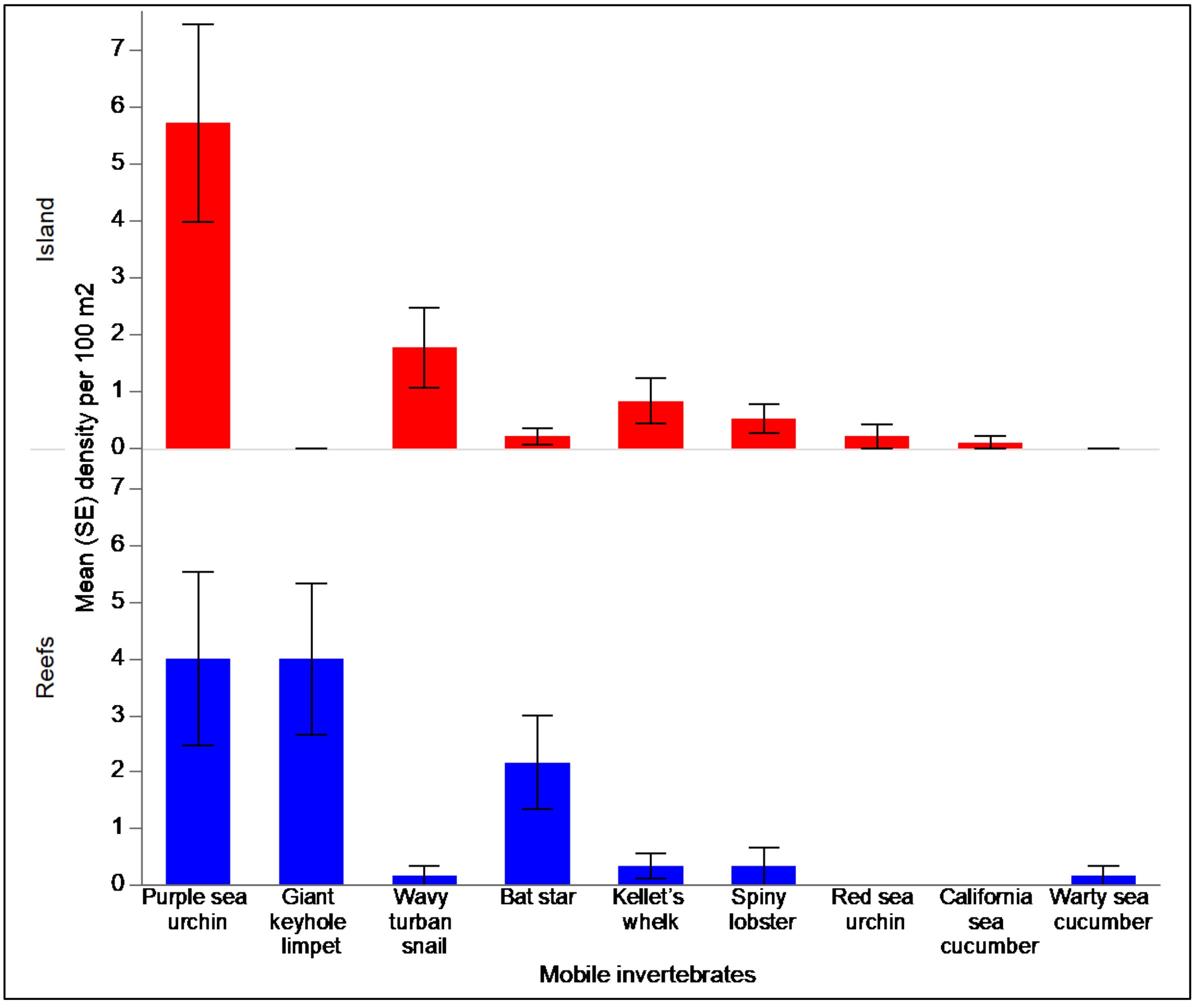
Table 4. Benthic Mobile and Sessile Invertebrates Observed Using Three Methods

Common name	Scientific name	Phylum/Class	Mobile or sessile	Transect count	Photo-quadrat UPC	Photo-quadrat non-UPC
Mobile invertebrates						
Spiny lobster	*Panulirus interruptus*	Arthropoda/ Malacostraca	Mobile	x		
Bat star	*Patiria miniata*	Echinodermata/ Asteroidea	Mobile	x		
Purple sea urchin	*Strongylocentrotus purpuratus*	Echinodermata/ Echinoidea	Mobile	x		

Common name	Scientific name	Phylum/Class	Mobile or sessile	Transect count	Photo-quadrat UPC	Photo-quadrat non-UPC
Red sea urchin	*Mesocentrotus franciscanus*	Echinodermata/ Echinoidea	Mobile	x		
California sea cucumber	*Apostichopus californicus*	Echinodermata/ Holothuroidea	Mobile	x		
Warty sea cucumber	*Apostichopus parvimensis*	Echinodermata/ Holothuroidea	Mobile	x		
Giant keyhole limpet	*Megathura crenulata*	Mollusca/ Gastropoda	Mobile	x		
Kellet's whelk	*Kelletia kelletii*	Mollusca/ Gastropoda	Mobile	x		
Wavy turban snail	*Megastraea undosa*	Mollusca/ Gastropoda	Mobile	x		
Sessile invertebrates						
Parchment tube worm	*Chaetopterus* sp.	Annelida/ Polychaeta	Sessile		x	
Red-rust bryozoan	*Watersipora sp.*	Bryozoa/ Gymnolaemata	Sessile		x	
Southern staghorn bryozoan	*Diaperoforma californica*	Bryozoa/ Stenolaemata	Sessile		x	
Brown gorgonian	*Muricea fruticosa*	Cnidaria/Anthozoa	Sessile		x	x
California golden gorgonian	*Muricea californica*	Cnidaria/Anthozoa	Sessile		x	x
Gorgonians, unidentified	*Muricea spp.*	Cnidaria/Anthozoa	Sessile		x	x
Orange cup coral	*Balanophyllia elegans*	Cnidaria/Anthozoa	Sessile		x	
Purple gorgonian	*Eugorgia rubens*	Cnidaria/Anthozoa	Sessile		x	x
Red gorgonian	*Leptogorgia chilensis*	Cnidaria/Anthozoa	Sessile		x	x
Scaled wormsnail	*Thylacodes squamigerus*	Mollusca/ Gastropoda	Sessile		x	
Sponge, unidentified	Porifera	Porifera/	Sessile		x	

3.3.4 Mobile Benthic Invertebrates

The mobile benthic invertebrate species assemblage differed between Rincon Island and the natural reefs combined (upcoast reef #1, n=3 transects; upcoast reef #2, n=3; and downcoast reef #2 n=4) ($R=0.284$, $p=0.01$) (Appendix 2A). Two non-fisheries species contributed to the differences in the assemblages at the two habitats: bat stars and giant keyhole limpet were more abundant among the suite of species at the reefs compared to the island (Figure 10). Mean density of the other species did not significantly differ between the two habitats.



Note: Observed along belt transects at Rincon Island and three reefs combined.

Figure 10. Density of Mobile Benthic Invertebrate Species at Rincon Island and Reefs

Additionally, two commercial fisheries species, Spiny lobster and Kellet's whelk, and the wavy turban snail were common based on the proportion of transects in which a species occurred at Rincon Island; the three species were encountered by divers in 25%, 25%, and 44% of the 16 transects, respectively, at Rincon Island. By comparison, Spiny lobster and Kellet's whelk, and the wavy turban snail occurred in 10%, 20%, 10% of the 10 transects, respectively, at three natural reefs: upcoast reef #1 (middle depths), upcoast reef #2 (deep), downcoast reef #2 (middle). The fourth reef was not surveyed for benthic invertebrates (Table 5).

Table 5. Abundance of Mobile Invertebrates at Rincon Island and Reefs

Mobile invertebrates	Rincon Island (n=16)				Natural Reefs (n=10)			
	Abundance	Co unt	Occur-rence in tran-sects	Propor-tion of tran-sects	Abundance	Cou nt	Occur-rence in tran-sects	Propor-tion of tran-sects
Purple sea urchin	Common	55	13	81%	Common	24	6	60%
Wavy turban snail	Common	17	7	44%	Uncommon	1	1	10%
Kellet's whelk	Common	8	4	25%	Uncommon	2	2	20%
Spiny lobster	Common	5	4	25%	Uncommon	2	1	10%
Bat star	Common	2	2	13%	Common	13	6	60%
California sea cucumber	Uncommon	1	1	6%	Not observed	0	0	0%
Red sea urchin	Uncommon	2	1	6%	Not observed	0	0	0%
Giant keyhole limpet	Not observed	0	0	0%	Common	24	6	60%
Warty sea cucumber	Not observed	0	0	0%	Uncommon	1	1	10%

Note: Abundance of mobile benthic invertebrates is based on the proportion of transects where a species occurred at Rincon Island (n=16 transects) and three natural reefs combined (n=10 transects). Categories of abundance: Absent, 0; uncommon, 1-10%, common, 11-50%, abundant, 51-100%,

3.3.5 Sessile Benthic Invertebrates

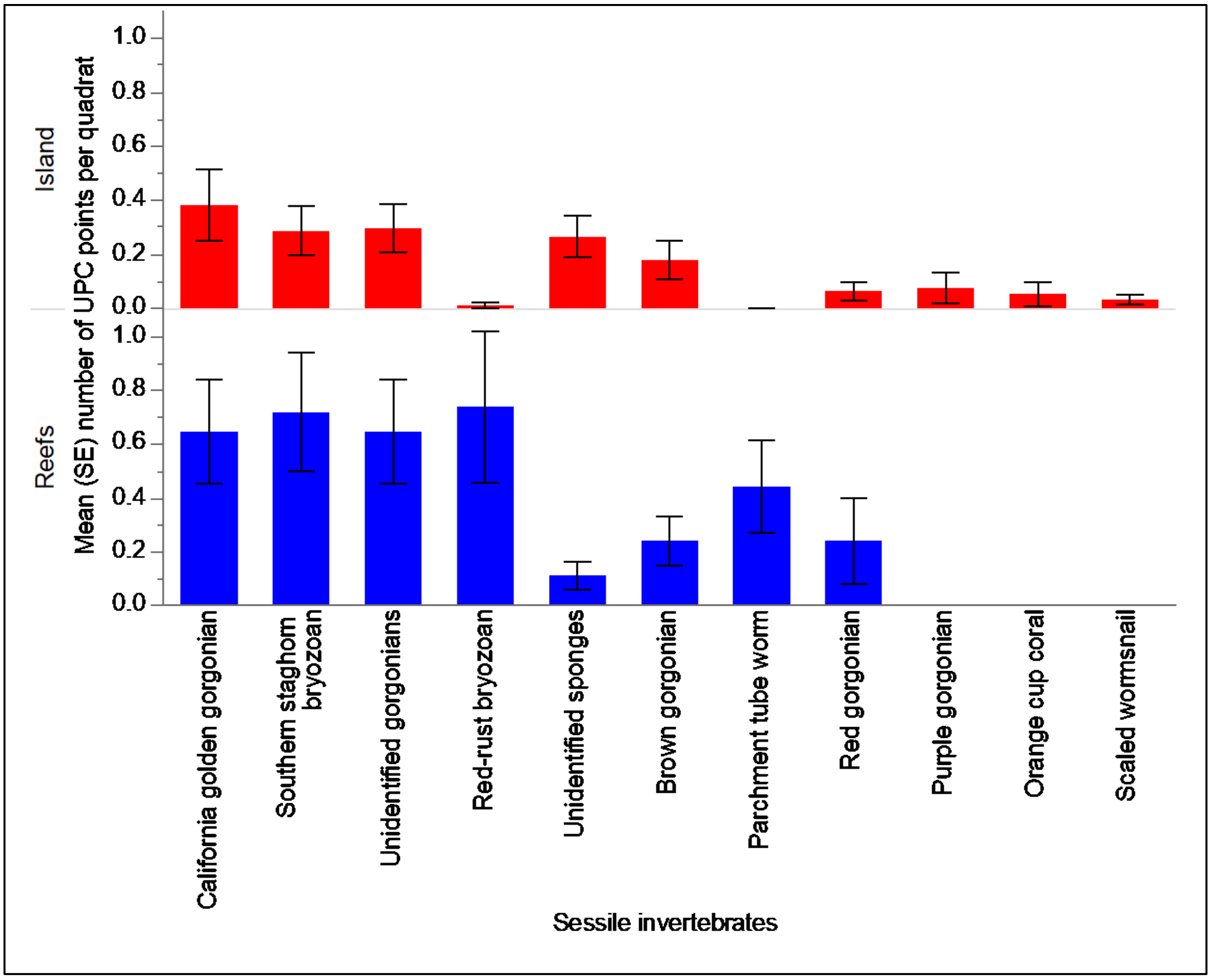
The species assemblage of sessile invertebrates at Rincon Island and the rocky reef habitat significantly differed (R=0.054, p=0.007) based on the UPC counts of invertebrate taxa in the photoquadrats (Appendix 2B). The dominant taxa at Rincon Island, based on frequency of occurrence in photoquadrats and the number of UPC points occupied in photoquadrats, were unidentified sponges, California golden gorgonian, brown gorgonian, unidentified gorgonians, and southern staghorn bryozoan (Table 6). The unidentified gorgonians are likely California golden gorgonian or brown gorgonian that are difficult to identify with certainty when polyps were retracted or when resolving the image was difficult. The total number of gorgonians observed was greater at Rincon Island than at the combined reefs (Appendix 2C)

Table 6. Abundance of Sessile Invertebrates at Rincon Island and Reefs

Sessile invertebrates	Rincon Island			Natural Reefs		
	Abundance	Pro-portion of images	Pro-portion of UPC points	Abundance	Pro-portion of images	Pro-portion of UPC points
Sponges, unidentified	Common	15%	1.1%	Uncommon	9%	0.4%
Southern staghorn bryozoan	Common	14%	1.1%	Common	28%	2.9%
California golden gorgonian	Common	13%	1.5%	Common	26%	2.6%
Gorgonians, unidentified	Common	13%	1.2%	Common	22%	2.6%
Brown gorgonian	Uncommon	9%	0.7%	Common	15%	1.0%
Red gorgonian	Uncommon	4%	0.3%	Uncommon	6%	1.0%
Scaled wormsnail	Uncommon	3%	0.1%	Not observed	0%	0.0%
Orange cup coral	Uncommon	2%	0.2%	Not observed	0%	0.0%
Purple gorgonian	Uncommon	2%	0.3%	Not observed	0%	0.0%
Red-rust bryozoan	Uncommon	1%	0.0%	Common	19%	3.0%
Parchment tube worm	Not observed	0%	0.0%	Common	15%	1.8%

Note: Categories of abundance: Absent, 0; uncommon, 1-10%, common, 11-50%, abundant, 51-100%,

Several sessile invertebrate species were significantly more abundant in reef habitat than at Rincon island (Figure 11). The density of California golden gorgonian was significantly greater at the reefs combined than at Rincon Island (X2=4.1893, p=0.0407) based on the counts of gorgonians in the non-UPC analysis (Appendix 2C). The UPC counts per quadrat for rust-red bryozoan (X^2=15.3294, p<0.0001), southern staghorn bryozoan (X^2=4.5103, p=0.0337), and parchment tube worm (X^2=14.609, p<0.0001) were significantly greater at reef habitat than at Rincon Island. The invasive red-rust bryozoan can outcompete native benthic sessile invertebrates for space on rocky reefs. It was detected in 19% of the UPC photoquadrats from the natural reefs and in only 1% of photoquadrats from Rincon Island.



Note: Per photoquadrats from Rincon Island and two reefs combined.

Figure 11. Mean UPC Points Occupied by Sessile Invertebrates at Rincon Island and Reefs

Purple gorgonian, orange cup coral, and scaled wormsnail were only detected in the UPC analysis of the island photoquadrats and not in the reef photoquadrats (Figure 12). Density of purple gorgonian was significantly greater at Rincon Island than at the reefs combined (X2=4.1893, p=0.0407) based on the counts of gorgonians in the non-UPC analysis (Appendix 2C). Sponges were more common at Rincon Island than at the reefs although the difference between habitats was not statistically significant (Table 6 and Figure 11).

3.3.6 Fishes

A total of 1500 fishes were observed in 32 total survey transects conducted at Rincon Island (16 transects), and four nearshore natural reefs in the vicinity (16 transects). Of the 28 fish species observed, 19 are recreational fisheries species, and 7 are commercial fisheries species. All of these species are associated with nearshore natural rocky reef habitat in the Santa Barbara Channel at large (Table 7).

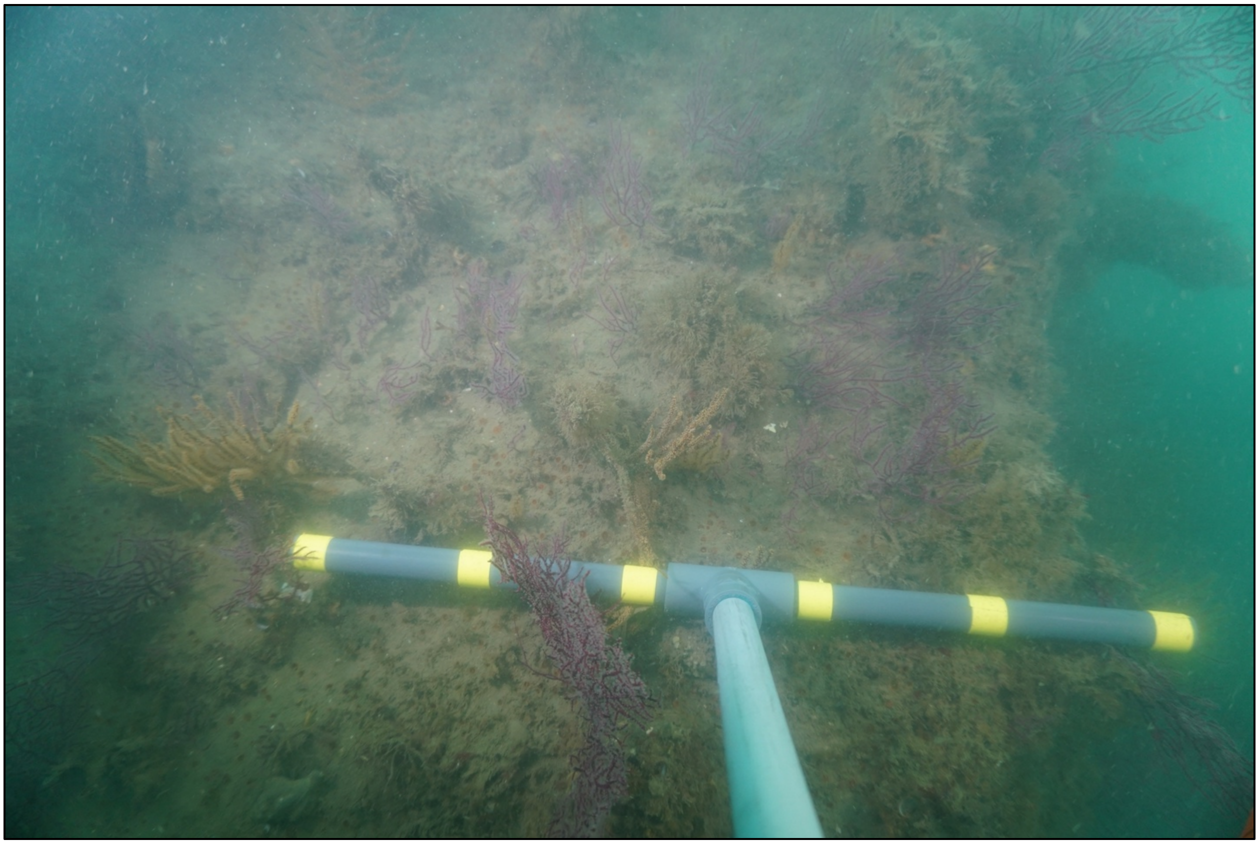


Figure 12. Purple Gorgonian and California Golden Gorgonian at Rincon Island

Blacksmith was the most numerous fish species observed comprising 23% of the total count of fishes. Topsmelt was the second most abundant species numbering 310 fish, however this was because a school of 300 and a smaller group of 10 were observed during the survey of the east side of Rincon Island at the shallow depth of 15 ft. Kelp bass, the fourth most abundant species comprising 11% of the fishes observed, is a highly desirable sportfish, and notably, commercial fishers are prohibited from landing the species. California sheephead, rank 7th in overall count (4%), was the most common fish species observed in this study that can be landed in the commercial fisheries. Rockfishes as a group (genus *Sebastes*) rank 12th (1%); brown rockfish was the most common rockfish species, followed by olive rockfish, kelp rockfish, and black-and-yellow rockfish. The group is important in the commercial and recreational fisheries.

Table 7. Fish Species, Resource Type, and Total Number Observed in This Study

Family	Scientific Name	Common Name	Fisheries Resource[1]	Total Count
Pomacentridae	*Chromis punctipinnis*	Blacksmith	N	344
Atherinidae	*Athernopsis affinis*	Topsmelt silverside	R	310
Labridae	*Oxyjulis californica*	Señorita	N	238
Serranidae	*Paralabrax clathratus*	Kelp bass	R	157

Family	Scientific Name	Common Name	Fisheries Resource[1]	Total Count
Kyphosidae	*Girella nigricans*	Opaleye	R	86
Pomacentridae	*Hypsypops rubicundus*	Garibaldi	N	76
Labridae	*Bodianus pulcher*	California sheephead	C*, R	66
Haemulidae	*Anisotremus davidsoni*	Sargo	R	53
Embiotocidae	*Embiotoca jacksoni*	Black perch	R	47
Serranidae	*Paralabrax nebulifer*	Barred sand bass	R	32
Kyphosidae	*Medialuna californiensis*	Halfmoon	R	28
Scorpaenidae	*Sebastes auriculatus*	Brown rockfish	C**, R	16
Embiotocidae	*Phanerodon furcatus*	White seaperch	R	14
Hexagrammidae	*Oxylebius pictus*	Painted greenling	N	10
Labridae	*Halichoeres semicinctus*	Rock wrasse	N	5
Embiotocidae	*Embiotoca caryi*	Rainbow seaperch	R	3
Scorpaenidae	*Sebastes serranoides*	Olive rockfish	C**, R	3
Scorpaenidae	*Scorpaena guttata*	California scorpionfish	C*, R	2
Scorpaenidae	*Sebastes atrovirens*	Kelp rockfish	C**, R	2
Labrisomidae	*Alloclinus holderi*	Island kelpfish	N	1
Sciaenidae	*Atractoscion nobilis*	White seabass	C*, R	1
Scyliorhinidae	*Cephaloscyllium ventriosum*	Swell shark	N	1
Embiotocidae	*Damalichthys vacca*	Pile perch	R	1
Heterodontidae	*Heterodontus francisci*	Horn shark	N	1
Clinidae	*Heterostichus rostratus*	Giant kelpfish	R	1
Embiotocidae	*Rhacochilus toxotes*	Rubberlip Seaperch	R	1
Sebastes	*Sebastes chrysomelas*	Black and yellow rockfish	C**, R	1
All fishes				1500

Notes:
[1]Commercial fisheries species, C; recreational fisheries species, R; species is not a recognized fisheries resource, N
* Commercial fishery managed by California Department of Fish and Wildlife
**Commercial fishery managed by the Pacific Fisheries Management Council

Fishes were more abundant at Rincon Island than at the surveyed natural reefs. The average density was 84 fish/100 m^2 (S.E. 14.3 fish/100m^2) at Rincon Island and 39 fish/100 m^2 (S.E. 9.3 fish/100m^2) in natural reef habitat (Figure 13). The difference in densities between Rincon Island and the natural reefs was statistically significant (X^2=8.3327, DF=1, p=0.0039, with topsmelt included in total abundance; F=7.1422, p=0.0129, without topsmelt).

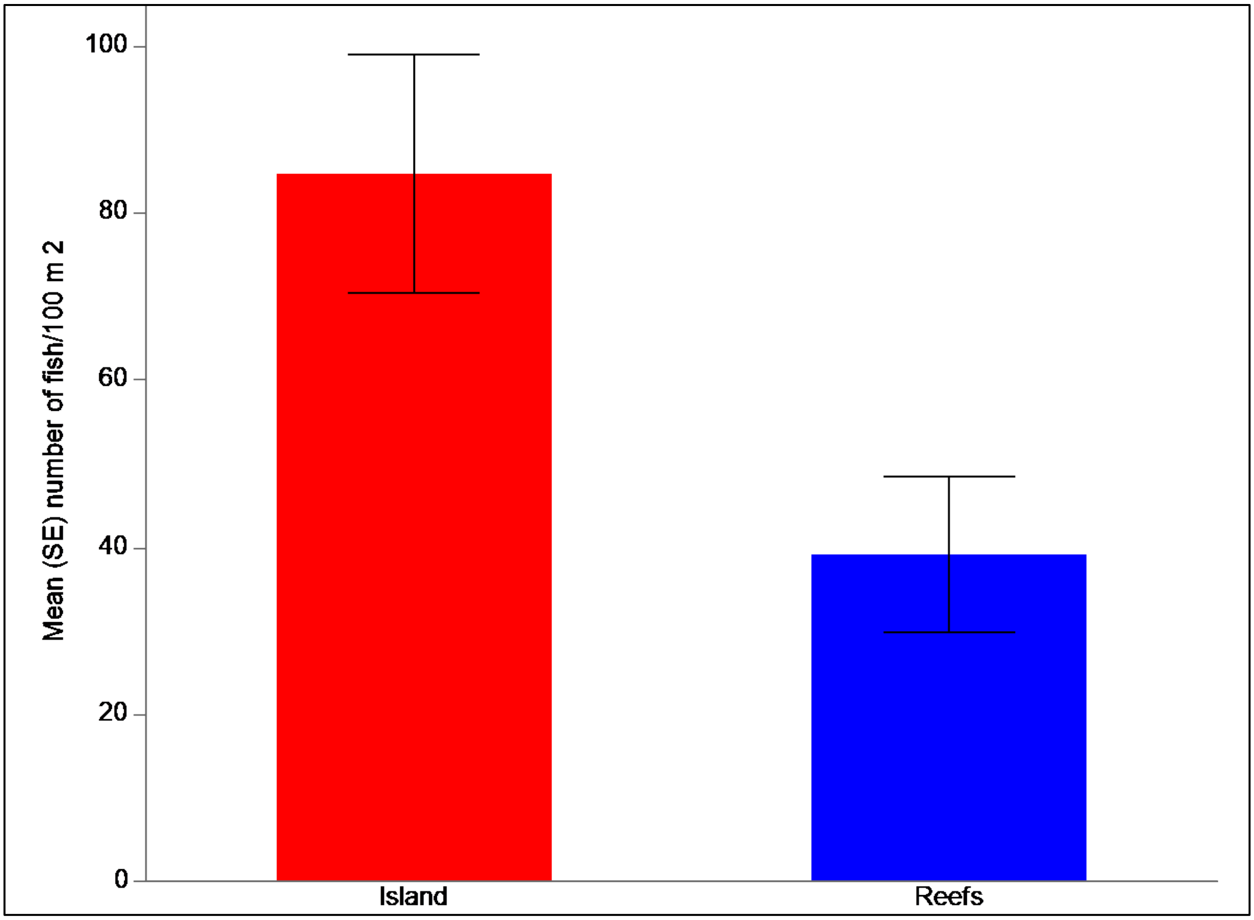


Figure 13. Fish Density at Rincon Island and Reefs

The size distribution of fishes, in total, significantly differed between Rincon Island and the reefs (Kolmogorov Smirnov 2-sample test, X2=260.6266, $p<0.0001$) (Figure 14). Fishes ranged in size from 4 to 80 cm TL (total length) at Rincon Island and 12 to 85 cm TL at the reefs. The largest encountered was a white seabass at the island and a swell shark at a reef. Younger and smaller fishes dominated the fish assemblage at Rincon Island: 615 of 1124 fishes (55%) were 15 cm TL or less. This includes 310 topsmelt (10-12 cm TL), an important forage species for predatory fishes, marine birds, and marine mammals, observed at Rincon Island. In contrast, only 65 of 376 fishes (17.3%) of the fishes at the four natural reefs were 15 cm TL or less. Although the proportion of larger fishes greater than 25 cm TL was greater at the reefs (40%) than at Rincon Island (14%), more of these larger fishes were observed at Rincon Island (160 fish) than at the reefs (139 fish). Appendix 3A summarizes the size distribution of individual species.

The assemblage of fishes at Rincon Island and the rocky reefs significantly differed. This was the case whether or not topsmelt were included in the multivariate analysis of similarity: R=0.329, p=0.01 with topsmelt included in the assemblage; R=0.346, p=0.01 excluding topsmelt) (Appendix 3A). Species composition at Rincon Island and the rocky reefs differed in terms of species richness (i.e., the number of species) and the abundance of dominant species.

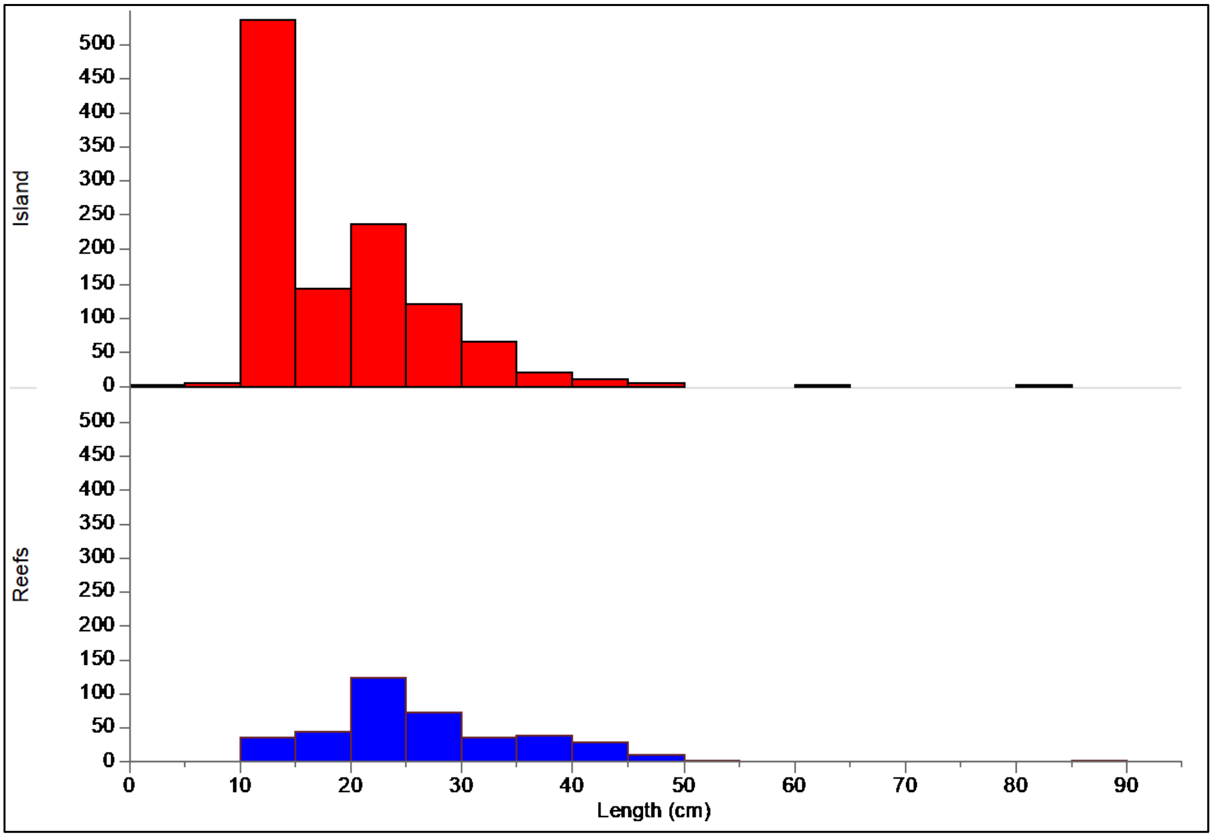


Figure 14. Size Distribution of Fishes at Rincon Island and Four Reefs

Species richness was greater at Rincon Island than at the four reefs combined. Overall, there were 26 species of fishes seen at Rincon Island and 15 species at the reef. Five species were significantly more abundant at Rincon Island than in reef habitat: blacksmith (X^2=12.1492, p=0.0005), senorita (X^2=11.1524, p=0.0008), sargo (X^2=7.0577, p=0.0079), black perch (X^2=5.1200, p=0.0237), rock wrasse (X^2=5.7407, p=0.0166). Barred sand bass was the only species significantly more abundant in reef habitat than at Rincon Island (X^2=7.9662, p=0.0048). The densities of 10 species that were observed at both Rincon Island and natural reefs did not differ between habitats (Figure 15, Appendix 3B).

Combining the recreational fisheries species (Table 7), the density of this grouping was significantly greater at Rincon Island than at the four reefs combined (X^2=10.9, p=0.001) (Figure 16). Non-fisheries species as a group was also significantly more abundant at the island than at reef habitat (X^2=4.5394, p=0.0331). There was no difference in the densities of commercial species as a group between the two habitats.

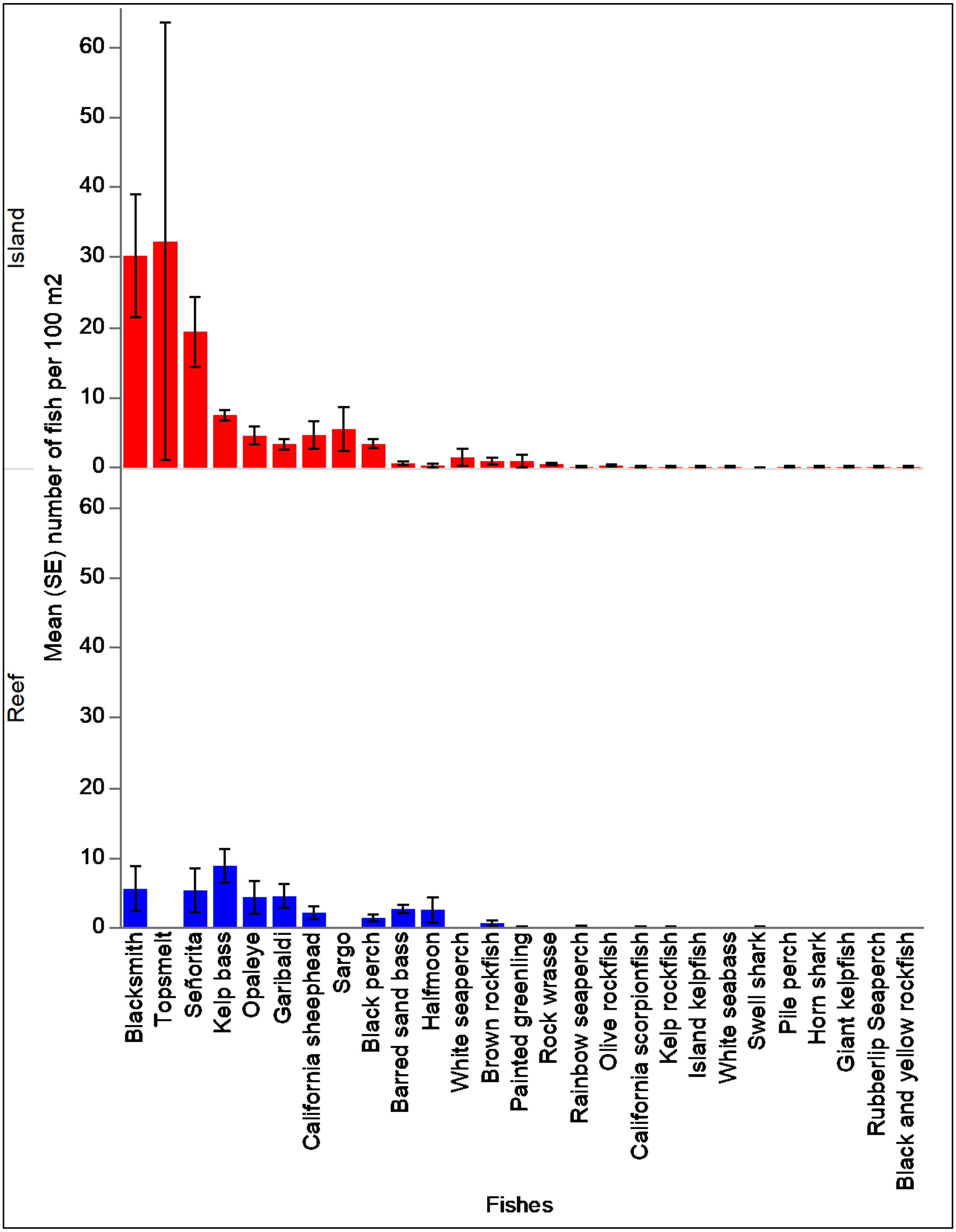


Figure 15. Fish Assemblages at Rincon Island and Natural Reefs

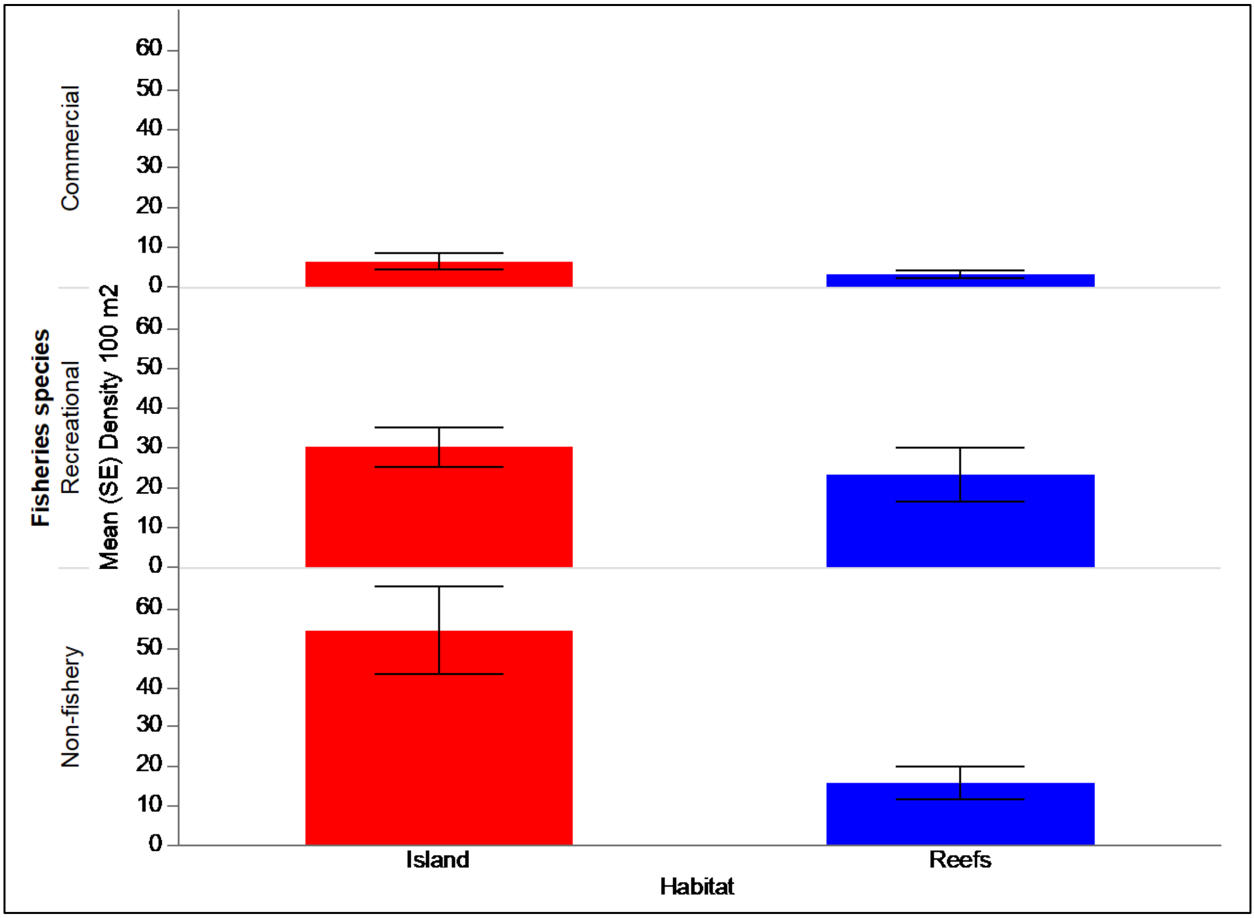


Figure 16. Densities of Commercial/Recreational/Non-fisheries Species at Rincon Island and Reefs

3.4 COMPARISON OF PAST AND RECENT OBSERVATIONS

It has been over 40 years since the last ecological evaluation of Rincon Island conducted by Johnson and deWit (1978). That study together with the two previous evaluations by Carlisle et al. (1964) and Keith and Skjei (1974) provide a comprehensive, yet dated, characterization of the marine community at Rincon Island. Carlisle et al. stated that it was apparent from their first surveys in August 1958, only one-half year after completion of the construction of Rincon Island, that they were observing kelp, numerous kinds of algae, invertebrates and fishes typical of natural reefs in the area.

This report compares the biological communities recently observed at Rincon Island and natural rocky reef habitat using typical methodologies employed by other researchers monitoring and examining the California coastal marine ecosystem. The previous studies of Rincon Island not only used the same methods, but also other methods that included sampling scrapings off rocks, sediment coring and Peterson grabs (a clamshell scoop), dredges, trawls, gill nets and other fishing gear, and traps. These studies included observations from the intertidal to beyond the base of the armor revetment. Additionally, observations and collections were made across seasons and years capturing temporal variability in the occurrence and abundance of species. Given these differences, this report provides a high-level discussion comparing past and present observations of the man-made rocky reef environment. Table 8 compares the observations at Rincon Island in 2020 and previous studies.

Table 8. Current Taxa Observed Versus Past Surveys

	This Study	Past Studies
Algae		
Brown algae	Giant kelp, feather boa kelp, unidentified species	12 species identified among at least 16 different kinds observed
Red algae	Articulated coralline algae, crustose coralline algae, unidentified species	29 species identified among 62 kinds
Invertebrates		
Sponges (Phylum Porifera)	Unidentified species	15 species among 25 kinds
Anemones and corals (Cl. Anthozoa)	Orange cup coral, brown gorgonian, California golden gorgonian, red gorgonian, purple gorgonian	11 species of 20 kinds
Marine worms (Ph. Annelida)	Parchment tube worm	16 species of 20 kinds
Barnacles, crabs, lobster, shrimp, amphipods, isopods (Cl. Crustacea)	Spiny lobster	12 species among at least 14 kinds of barnacles 24 species of at least 29 kinds of mobile species (e.g., spiny lobster, crabs, shrimp, amphipods, isopods)
Snails, seaslugs, abalone (Cl. Gastropod)	Giant keyhole limpet, Kellet's whelk, wavy turban snail	74 species of at least 84 kinds
Moss animals (Ph. Bryozoa)	Southern staghorn bryozoan, *Watersipora*	15 species of at least 18 kinds
Sea stars (Cl. Asteroidea)	Bat star	6 species of at least 7 kinds
Urchins (Cl. Echinoidea)	Purple sea urchin, red sea urchin	3 species
Sea cucumbers (Cl. Holothuroidea)	California sea cucumber, warty sea cucumber	4 species of at least 6 kinds
Fishes		
Sharks and rays (Cl. Chondrichthyes)	Swell shark, horn shark	9 species
Bony fishes (Cl. Osteichthyes)	24 species	76 species

3.4.1 The Island Ecosystem

The revetment around Rincon Island continues to provide a great variety of habitats for a community of marine flora and fauna. The scale of relief and complexity that is innate to the revetment structure extending up from the seafloor to above the splash zone provides a unique ecosystem that is significantly different from nearshore reefs in the area. We found that the armor is intact down to the soft substrate at 45 to 50 feet deep. The rock and tetrapod surfaces, holes, and crevices have not been silted over and continue to shelter a diversity of fishes (Figure 17). The orientation of the offshore island allows for varied wave exposure and currents around the installation providing a unique environment that has exposed zonation, protected zonation, and stages in between. Carlisle et al. and Johnson and DeWit described zonation of plants and invertebrates from the intertidal to base of the revetment that differs among the sides of the island. Many of the flora and fauna serve as habitat providing shelter and food for additional species that in turn serve as food for more species. A total of 458 species have been encountered at Rincon Island from the reports of Carlisle et al. (1964), Keith and Skjei (1974), and Johnson and deWit (1978) (Appendix 1).

Figure 17. Horn Shark at Rincon Island

We found that the hard substrates at Rincon Island and the reefs, at the depths surveyed, are colonized by the same encrusting and attached biota that were observed in the previous studies. One difference is that a non-native species, the red-rust bryozoan, *Watersipora subatra*, now occurs in both habitats. It can outcompete native benthic sessile invertebrates for space on rocky reefs. This invasive species is widely distributed in central and southern California, and more common in harbors and coastal embayments than in open coastal habitats (Simons et al. 2016) such as Rincon Island. The species occurred at higher abundances at the natural reefs than at Rincon Island.

3.4.2 Algae

The abundance of kelp at Rincon Island is highly variable. In the fall 2020 survey, giant kelp was uncommon at Rincon Island and was found almost exclusively in the shallower depths surveyed on the rock revetment. At the same time, kelp was relatively abundant at the shallower natural reefs (20to 28 ft bottom depths), and absent at the deeper reef (40 ft bottom depth). Previous studies observed the absence of kelp on suitable habitat at deeper depths of the island attributing it to less light penetrating the turbid waters to deeper depths. By spring 2021, personnel observed an extensive kelp canopy around Rincon Island.

Observations from the previous studies varied. Brisby describes abundant giant kelp at Rincon Island and particularly extensive beds on the west side of the island. In comparison, Johnson and DeWit report that giant kelp occurred only on the north side of Rincon Island. Carlisle observed that giant kelp formed moderate to heavy canopies at times, but exhibited considerable fluctuations in density from August 1958 through December 1960. Over time, senescence and loss of kelp was related to either heavy surge or seasonal rising water temperatures cycling with recovery when new plants recruited and grew. All previous studies note the incidence of urchins heavily grazing kelp at times.

Red seaweeds, brown seaweeds, and coralline algae were the dominant algae observed in 2020 (Tables 2 and 3). Six of 13 community associations at Rincon Island defined by Johnson and DeWit include these dominant algae with invertebrates. Recent surveys were too few to determine whether these associations have persisted; however, we did find that species or higher level taxa that represent the associations occurred in our surveys. For example, Johnson and deWit found that red algae (*Veleroa* complex) and coralline algae (*Liththamnium* sp.) formed a complex with bat stars and urchins. Keyhole limpets and sea cucumbers were frequently encountered as well, and these were present in the 2020 surveys. The predominant association in deeper water is red algae (*Veleroa* spp.), an encrusting bryozoan (*Lagenipora* sp.), red gorgonian (*Leptogorgia chilensis*), and California golden gorgonian/brown gorgonian (Muricea spp.). Although the red algae and bryozoan were not identified to species in photoquadrats from the 2020 survey, what may be the same assemblage was common in 2020 (Figure 18).

Figure 18. California Golden Gorgonian, Red Algae Encrusted with a Bryozoan Growing on Tetrapods

3.4.3 Invertebrates

The sessile invertebrate species observed in 2020 were also the dominant taxa in the previous studies. California golden gorgonians and brown gorgonians (and unidentified gorgonians that were likely these two species), sponges, and southern staghorn bryozoan commonly occurred and were the dominant sessile invertebrates (Figure 11, Table 6). The other soft corals, red gorgonian and purple gorgonian were uncommon in 2020 and in the past. These two species tend to be found at reefs deeper than 50 ft, the depth of the base of the rocky revetment around Rincon Island. The non-native bryozoan, *Watersipora*, was relatively uncommon at Rincon Island compared to other taxa seen at the island (Figure 19). Mussel shell debris was observed in rock crevices and at the base of the armor revetment (Figure 20). Live mussel were not seen along transects at Rincon Island at depths 15 ft and deeper or at the natural reefs, but likely are in shallow depths extending up to the intertidal.

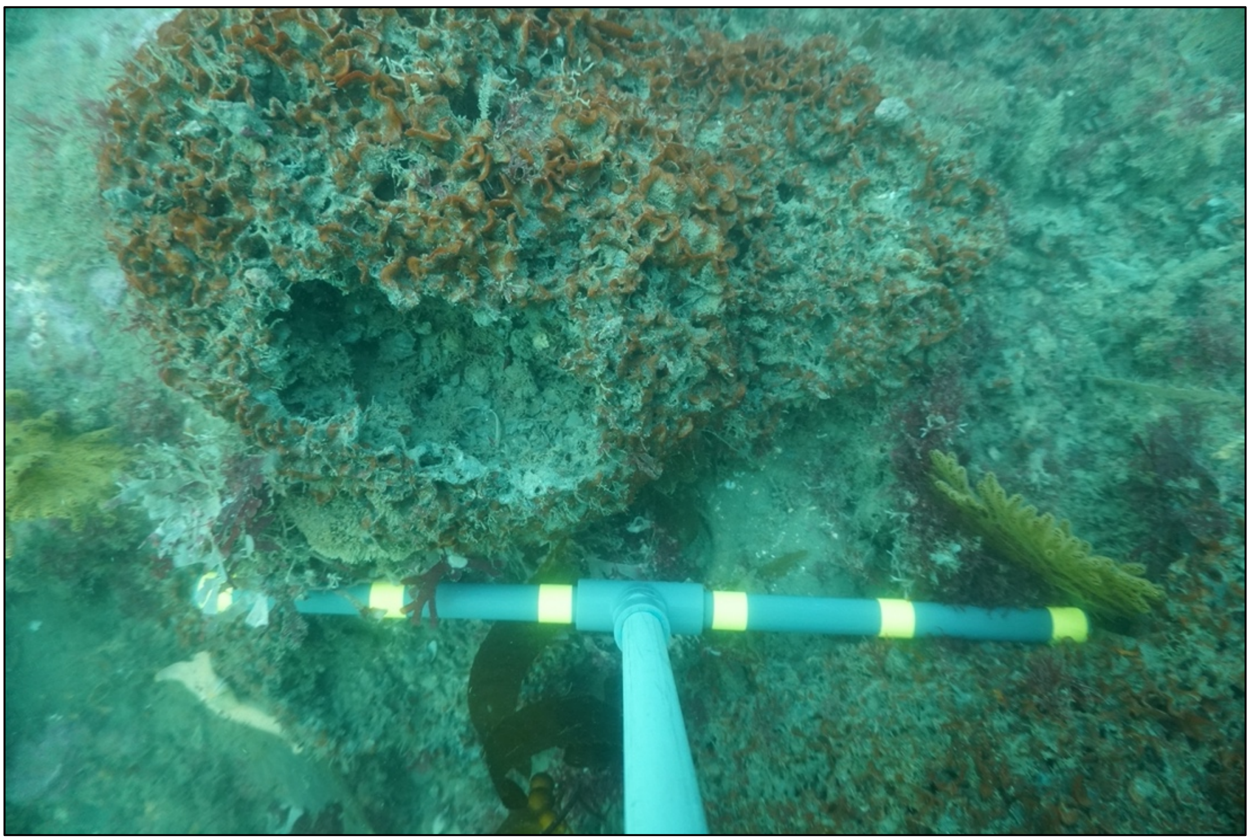


Figure 19. Red-rust Bryozoan, a Non-native Species, at a Natural reef

Figure 20. Base of the Armor Revetment on West Side of Rincon Island

Seven species of mobile invertebrates were observed at Rincon Island in 2020 (Figure 10 and Table 5). All at the island were as abundant as in the surveyed reef habitat. The species were purple sea urchin, wavy turban snail, kellet's whelk, spiny lobster, California sea cucumber, and warty sea cucumber. The latter four are commercial fishery species, and spiny lobster also is a highly sought-after recreational fishery species.

A total of five live spiny lobster were observed in a total of 16 transects at Rincon Island and two in 16 transects in reef habitat in 2020. Crevices and caves formed by the armor revetment around Rincon Island provide shelter for fishes and invertebrates such as the two lobster and a sheephead in Figure 21. Carlisle et al. encountered lobster only in shallow waters between 5 and 20 ft at Rincon Island, and there were never any "large concentrations." As in the past, divers in 2020 observed the surface buoys of numerous commercial lobster traps set close to Rincon Island, indicating that lobster were abundant enough to make it economically viable to fish there. A variety of crabs that were seen in previous studies were not encountered on either the island or reefs in 2020.

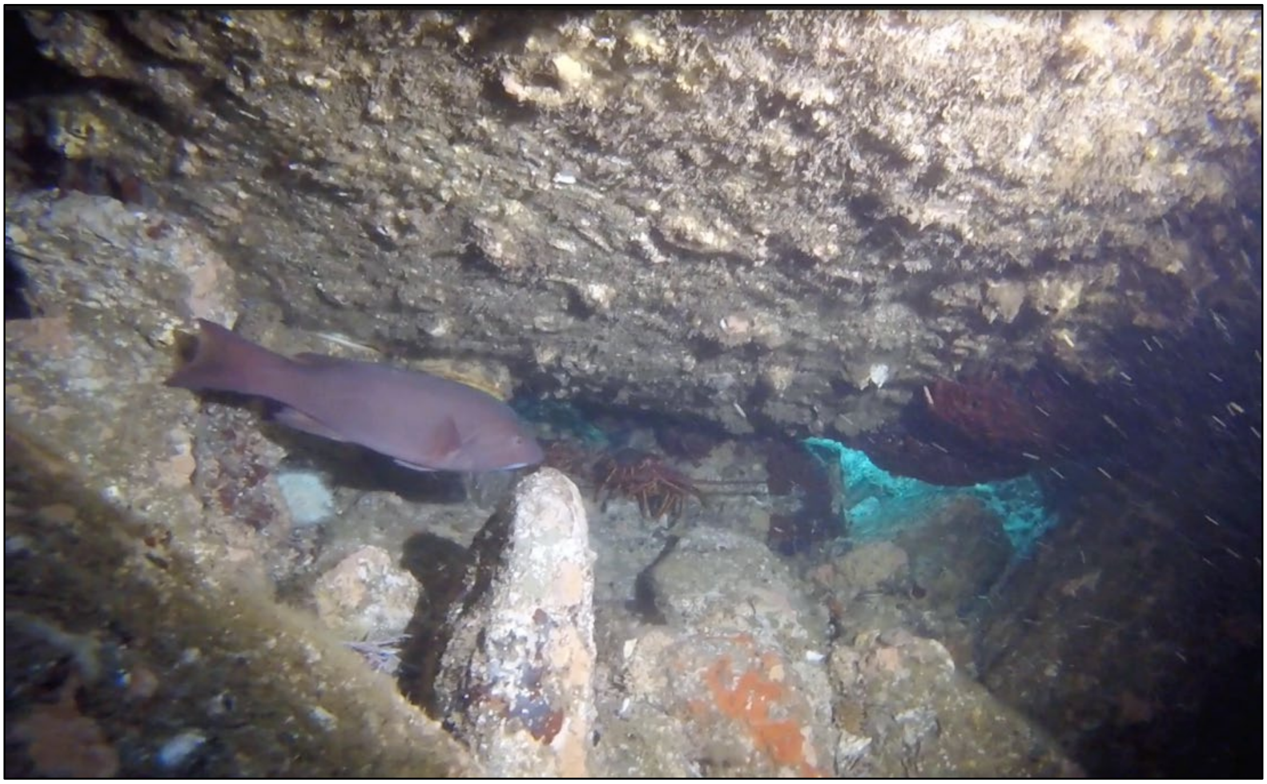


Figure 21. Sheephead and two spiny lobsters at Rincon Island

The Bat star was the only sea star encountered in 2020 of the five species observed in past surveys (Appendix 1). Bat stars were relatively more abundant in reef habitat than at Rincon Island. Between 2013 and 2015, at least 20 species of sea stars along much of the North American Pacific coast experienced massive die-off due to the mysterious "sea star wasting syndrome." Physiological stress brought about by ocean warming made these animals susceptible to the devastating disease. Substantial numbers of wasting stars were spotted around southern California starting in December 2013. The presence of only one species at both Rincon Island and the surveyed reefs in 2020 raises uncertainty in recovery (https://marine.ucsc.edu/data-products/sea-star-wasting/). The *Pisaster* sea stars and sunburst seastar that were observed in the previous studies are considered keystone species. These prey on urchin and control their numbers, curbing the impact of urchin grazing kelp beds. The nearshore rocky reef ecosystem is drastically altered by the loss of kelp forests if the urchin population growth is unchecked.

No live specimens of rock scallop, a highly sought-after recreational fishery species, were observed at Rincon Island in 2020; however, a shell about 10 cm in width amid shell hash debris was captured in a photoquadrat image from the island (Figure 22). Carlisle et al. monitored growth after first encountering rock scallop in August 1959 at Rincon Island, and estimated individuals grew 2.5 to 3.2 cm per year. Rock scallops, measuring 10 to 13 cm across, tended to be found attached to rocks in crevices where water current swept through.

Figure 22. Scallop Shell at the Base of the Armor Revetment

Abalone was not observed in 2020. Carlisle et al. also never encountered abalone at Rincon Island in the initial years after island construction. However, in 1969, pink, green, and black abalone were transplanted to Rincon Island from San Clemente Island (California Department of Fish and Game, 1971). In years following, Brisby reported seeing pink abalone, black abalone, and green abalone (Appendix 1). He noted that most of the abalone probably had been collected by sport divers. Red abalone seen at Rincon Island by Brisby and Johnson and DeWit was a species that had not been transplanted.

3.4.4 Fishes

At least 85 species of fishes had previously been observed or collected at Rincon Island (Appendix 1). Of these, Carlisle et al. had observed a total of 53 reef-dwelling fish species in 22 families during 26 scuba dives, beginning in August 1958, 18 months after construction began, and ending in December 1960. In addition to reef-dwelling species, pelagic fishes and soft substrate-dwelling fishes were collected by Johnson and DeWit in gill nets, and by Brisby with fishing gear, in trawls, and traps. The diversity of species recorded from all previous studies combined is partly due to surveying the Island habitat across many seasons and years and also sampling the adjacent environment surrounding the island that is primarily soft silt/sand substrate.

In the 2020 survey, four benthic scuba transects were conducted over the rock revetment on each of the four sides of the Island at two depths, two near the base of the revetment and the two at about ½ that depth. Twenty-five species that occurred at Rincon Island in the previous studies were observed. Only one species, black-and-yellow rockfish, had not been seen previously at the island (Appendix 1 and 3A).

Some of the species observed or captured at or adjacent to Rincon Island in the previous studies but not in the 2020 study are California moray, ocean sunfish, coho salmon, bat ray, Pacific barracuda, California halibut, and albacore. These are transient or uncommon species at rocky reefs in the local area. Some species that were reported in the previous studies but not observed in 2020 and are commonly seen in rocky reefs shallower than 40 ft in the local area are lingcod, cabezon, blue rockfish, and grass rockfish. Most of these examples are commercially and recreationally important species.

The diversity of fish was much lower at the four surveyed reefs. A total of 15 fish species were observed in 16 scuba transects. All of the fish species observed at the reefs, except for one swell shark, were observed at Rincon Island in 2020 (Appendix 3B). The substrates at the surveyed natural reefs were a mix of flat rock, cobble, sand, and few boulders at 1 m in height. The reefs are much smaller and far fewer crevices and holes for fishes to find protection in at the reefs compared to the highly complex environment at Rincon Island.

In the 2020 survey, the size distributions of fishes differed between Rincon Island and the reefs; fishes observed along the scuba transects ranged in size from 4 to 80 cm TL at Rincon Island and 12 to 85 cm TL at the reefs. Carlisle et al. and Brisby do not provide a summary of fish size distributions observed in scuba surveys at Rincon Island to compare. DeWit summarizes the fish distributions from a gill net survey at Rincon Island; the fishes ranged in size from 6 to 72 cm TL. In the 2020 scuba survey, both proportionately more younger and smaller fishes, including a few recruits to the habitat, were observed and more large fishes were counted at Rincon Island than at the reefs.

4.0 PART 3. DISCUSSION AND CHARACTERIZATION OF MARINE HABITAT AND ASSOCIATED SPECIES AT RINCON ISLAND

There was no organized study of the biota in the area before the construction of Rincon Island. Dr. William Brisby, in his ecological evaluation, "The Biota of Rincon Island," in Keith and Skjei (1974) described the area prior to construction of the island as a "biological desert" with a "sparsity of life." Brisby made such an analogy because without hard substrate for attachment, algae and sessile invertebrates are mostly absent in a sand-silt habitat and even in coastal surf zones areas where rock is sparsely exposed in very shallow, scattered locations. Lack of substrate variability limits the diversity of associated species. It is reasonable to assume that the biota associated with the site of Rincon Island would have remained impoverished without (1) the establishment of a substrate conducive to the attachment of a diverse set of marine forms and their associates, and (2) the island's orientation, location and private status one-half mile off the coast which inhibits interaction with the public.

The placement of the large slabs of quarry rock and tetrapods added further positive components to the Rincon Island environment by providing crevices and caves of a broad range of sizes into which various animals can retreat for protection from wave action, currents, and predators (Figure 23). Reef fish density and species richness are often higher at sites with more structural complexity. Higher complexity results in more surface area for attached biota and greater availability and extent of shelters, which is critical for many reef species (Menard, et al. 2012).

Figure 23. Kelp Bass and Soft Corals under Tetrapods at Rincon Island

Early observations by Brisby, in Keith and Skjei (1974), states that nearly all forms of marine life found around the Channel Islands now exist on and around Rincon Island. Recent observations in this description confirm that initial interpretation.

Rincon Island has had a major positive effect on local ecological conditions, significantly increasing the biodiversity of fishes, invertebrates, and algae. The island's rock and tetrapod revetments provide a great variety of habitats for a diverse community of marine flora and fauna that would not otherwise occur in the local area's natural bottom habitats. The island hard substrate is colonized by encrusting and attached biota. Many are habitat-forming species that provide shelter and food for additional species that in turn serve as food for more species.

The revetment around Rincon Island continues to provide a wide range of habitats for a community of marine flora and fauna. The scale of vertical relief and rugose complexity that is innate to the revetment structure extending up from the seafloor to above the splash zone provides a unique ecosystem that is significantly different from the small, scattered, nearshore reefs in the area. Crevices and caves of a variety of sizes provide many species with shelter and protection from the intertidal zone to the base of the armor revetments that surround the island. The orientation of the offshore island allows for varied wave exposure and currents around the installation providing an environment that has wave-exposed zones, protected zones, and stages in between. This makes possible a diversity of marine life greater than that found in a coastal area this size.

Any demolition action would forcefully remove the well-established marine habitats of Rincon Island. With that deconstruction, numerous fishes, invertebrates, and algal species would either die or, if possible, relocate to a similar habitat and compete for space and resources there. Similar habitats, such as Carpinteria Reef, Naples Reef, and the Channel Islands are relatively far to quite distant for many fishes and likely too far for even mobile invertebrates, and certainly for algae, to relocate successfully.

Therefore, alternatives should be explored that would leave the island structure with surrounding gravel, rock, and revetment in place and remove the causeway while either leaving the island asphalt lid intact or removing it and leaving the sand fill exposed. The partial removal alternative would likely retain most of the associated fauna intact.

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APPENDIX 1. MASTER LIST OF SPECIES OBSERVED FROM CARLISLE ET AL. (1964), KEITH AND SKJEI (1974) AND JOHNSON AND DEWIT (1978), COMPILED BY JOHNSON AND DEWIT.

SCIENTIFIC NAME	COMMON NAME
ALGAL DIVISION CHLOROPHYTA	**GREEN ALGAE**
Bryopsis corticulans	
Chaetomorpha aerea	
Cladophora sp.	
Codium fragile	Deadman's fingers
Derbesia marina	
cf. *Enteromorpha* sp.	
Ulva sp.	Sea lettuce
Unid. green algae #1	
ALGAL DIVISION CYANOPHYTA	**BLUE-GREEN ALGAE**
cf. *Phormidium* sp.	
ALGAL DIVISION PHAEOPHYTA	**BROWN ALGAE**
Cystoseira osmundacea	
Desmarestia herbaceae	
Dictyota binghamiae	
D. flabellata	
Ectocarpus sp.	
Egregia menziesii (=*laevigata*)	Feather-boa kelp
Giffordia granulosa	
Halidrys dioica	
Macrocystis sp.	Giant kelp
Petrospongium rugosum	
Pterygophora californica	
Ralfsia pacifica	
Taonia lennebackeriae	
Unid. brown alga #1	
Unid. brown alga #2	
Unid. brown alga #3	
Unid. juv. laminariales	
ALGAL DIVISION RHODOPHYTA	**RED ALGAE**
Antithamnion sp.	
Bossiella orbigniana	
Bossiella sp.	

SCIENTIFIC NAME	COMMON NAME
Callithamnion sp.	
Callophyllis flabellulata	
Ceramium codicola	
cf. *Ceramium* sp.	
Corallina officinalis	
Cryptopleura cf. *crispa*	
Delesseria sp.	
Gelidium coulteri	
G. cf. *robustum*	
G. purpurascens	
G. cartilagineum	
G. sp. #1	
G. sp. #2	
Gigartina canaliculata	
G. cf. *exasperata*	
G. sp.	
G. spinosa armata	
G. sp. (juv.)	
Grateloupia doryphora (=*abreviata*)	
Hildenbrandia prototypus	
Laurencia pacifica	
Lithothamnium/*Lithophyllum* complex	
Lithothrix aspergillum	
Lomentaria hakodatensis	
Microcladia cf. *coulteri*	
Neoagardhiella (=*Agardhiella*)	
Peyssonellia sp.	
Platythamnion villosum	
P. sp.	
Polysiphonia simplex	
P. cf. *pacifica*	
P. spp.	
Porphyra perforata	
Prionitis lanceolata	
Pterosiphonia dendroidea	
Pterosiphonia sp.	

SCIENTIFIC NAME	COMMON NAME
Rhodoglossum affine	
Rhodymenia sp.	
R. californica	
cf. *R*. sp.	
Schizymenia pacifica	
Stenogramme interrupta	
Tiffaniella snyderiae	
Veleroa subulata/Murrayellopsis dawsonii complex	
Unid. red alga #1	
Unid. red alga #2	
unid. filamentous red alga #1	
Unid. juvenile red alga	
Unid. filamentous red alga #2	
Unid. "leafy" red alga	
unid. "tall" red alga	
Unid. red alga #3	
Unid. red alga #4	
Unid. red alga #5	
Unid. "flat" red alga	
Unid. red alga #6	
Unid. red alga #7	
Unid. coralline #1	
Unid. coralline #2	
Unid. coralline #3	
PHYLUM PORIFERA	**SPONGES**
Cliona celata californiana	Boring sponge
Geodia mesotriaenia	Geode sponge
Halichoclona gellindra	Lavender sponge
Haliclona ecbasis	Lavender-blue encrusting sponge
Hymenamphiastra (=*Hymoniacidon*) *cyanocrypta*	Blue leaf sponge
Hymeniacidon ungodon	Little leaf sponge
H. sinapium	Yellow leaf sponge
Leucetta losangelensis	
Leucilla (=*Rhabdodermella*) *nuttingi*	Urn sponge
Leuconia heathi	Thistle sponge

SCIENTIFIC NAME	COMMON NAME
Leucosolenia sp.	Finger sponge
Lissodendoryx noxiosa	Noxious sponge
Spheciospongia confoederata	Liver sponge
Tedania toxicalis	Sponge
Tethya aurantia	Orange puff-ball sponge
Verongia thiona	Sulfur sponge
Unid. "sulfur" sponge	
Unid. red sponge #1	
Unid. purple sponge #2	
Unid. orange sponge #3	
Unid. yellow sponge #4	
Unid. grey sponge #5	
Unid. sponge #6	
Unid. sponge #7	
Unid. "white" sponge	
PHYLUM CNIDARIA	**ANEMONES, HYDROIDS, CORALS, GORGONIANS, HYDROIDS**
CLASS HYDROZOA	
Aglaophenia struthionides	Ostrich plume hydroid
Antennella avalonia	
Campanularia sp.	Campanulate hydrozoan
cf. *Eudendrium* sp.	
Obelia sp.	
Sertularia cf. *furcata*	
cf. *Plumularia* sp.	
cf. *P. lagenifera*	
cf. *Sertularia* sp.	
Unid. green hydroid	
Unid. hydroid sp. #1	
Unid. hydroids	
CLASS ANTHOZOA	**ANEMONES/CORALS**
Anthopleura xanthogrammica/A. elegantissima	Green anemone
Antropora tincta	
Astrangia lajollaensis	Colonial coral
Balanophyllia elegans	Solitary orange coral
Cerianthiopsis sp.	Burrowing anemone

SCIENTIFIC NAME	COMMON NAME
Corynactis californica	Colonial red anemone
Eugorgia rubens	Purple sea fan
cf. *Epiactis prolifera*	Prolific anemone
Lophogorgia chilensis	Pink gorgonian
Metridium sp.	Solitary anemone
Muricea californica/M. Fructicosa	California/rust gorgonians
cf. *Pachycerianthus* sp.	Tube anemone
Paracyathus stearnsii	Solitary coral
Renilla kollikeri	Sea pansy
Stylatula elongata	Elongate sea pen
Tealia sp.	Anemone
Unid. anemone #1	
Unid. white anemone #2	
Unid. burrowing anemone	
Unid. red cerianthid	
PHYLUM ANNELIDA	**WORMS**
Chaetopterus variopedatus	Parchment tube worm
cf. *Chaetopterus* sp.	Parchment tube worm
Dexiospira spirillum	
Diopatra ornata	
Dodecaceria fewkesi	
Eudistylia polymorpha	Feather-duster worm
Eudistylia sp.	Feather-duster worm
Eunereis longipes	Nereid worm
Eupomatus gracilis	
Halosydna tuberculifera	Scale worm
H. brevisetosa	Scale worm
Nereis eakini	Nereid worm
N. mediator	Nereid worm
Paleonotus bellis	Chrysopetalid worm
Salmacina tribranchiata	Colonial tube worm
Serpula vermicularis	Serpulid worm
Spirorbis eximius	
Polyopthalmus pictus	
Unid. serpulids	
Unid. Syllidae	

SCIENTIFIC NAME	COMMON NAME
PHYLUM ARTHROPODA	**JOINT-LEGGED ANIMALS**
CLASS CRUSTACEA	**CRUSTACEANS**
Alpheus clamator	Shrimp
Ampithoe sp.	Amphipod
Balanus cariosus	Acorn barnacle
B. crenatus	Acorn barnacle
B. galeata	
B. glandula	Acorn barnacle
B. nubilus	Acorn barnacle
B. pacificus	Acorn barnacle
B. tintinnabulum	Acorn barnacle
B. sp.	Icorn barnacle
Cancer antennarius	Rock crab
C. anthonyi	Yellow crab
Cancer cf. *productus*	Rock crab
Chthamalus fissus	Acorn barnacle
Crangon dentipes	Pistol shrimp
Erichthonius brasiliensis	Amphipod
Heptacarpus palpator	Shrimp
Hippolysmata californica	Red rock shrimp
Hyale frequens	Amp hi pod
Jaeropsis dubia	Isopod
Loxorhynchus crispatus	Sheep crab
L. grandis	Sheep crab
Membranobalanus orcutti	Barnacle
Munna chromatocephala	Amphipod
Pachycheles pubescens	Hermit crab
Pachygrapsus crassipes	Striped shore crab
Paguristes turgidus	Hermit crab
P. ulreyi	Hermit crab
Pagurus californiensis	Hermit crab
Pandalus gurneyi	Shrimp
Panulirus interruptus	Spiny lobster
Petrolisthes cinctipes	Porcelain crab
Petrolisthes sp.	Porcelain crab
Pollicipes polymerus	Gooseneck barnacle

SCIENTIFIC NAME	COMMON NAME
cf. *Isocheles pilosus*	Hermit crab
Pugettia producta	Kelp crab
P. sp.	Kelp crab
Scyra acutifrons	Masking crab
Spirontocaris brevirostris	Bent-back shrimp
Tetraclita squamosa rubescens	Thatched barnacle
Unid. pagurids	Hermit crabs
Unid. shrimp	
Unid. barnacles	
PHYLUM MOLLUSCA	**SNAILS, NUDIBRANCHES, CLAMS, OCTOPUSES**
CLASS GASTROPODA	**SNAILS AND NUDIBRANCHES**
Acanthina spirata	oyster drill
Acanthodoris lutea	Nudibranch
Acmaea mitra	White-cap limpet
A. persona	Mask limpet
Amphissa sp.	Arnphissa-
Anisodoris nobilis	Nudibranch
Antiopella barbarensis	Nudibranch
Aplysia californica	Sea hare
A. vaccaria	Sea hare
Archidoris montereyensis	Light yellow sea slug
Armina californica	Pansy sea slug
Astraea undosa	Wavy turban snail
Cadlina luteomarginata	Nudibranch
Callistochiton crassicostatus	Chiton
Calliostoma annulatum	Purple-ringed top shell
C. canaliculatum	Channeled top shell
C. gloriosum	Glorious top-shell
C. supragranosum	Granulose top-shell
Ceratostoma nuttalli	Nuttall's hornmouth
Collisella cf. *conus*	Limpet
C. digitalis	Fingered limpet
C. cf. *limatula*	File limpet
C. pelta	Shield limpet
C. scabra	Rough limpet

SCIENTIFIC NAME	COMMON NAME
C. sp. #1	Limpet
C. sp. #2 (ridges)	Limpet
C. sp. #3	Limpet
C. cf. *strigatella*	Limpet
Conus californicus	California cone
coryphella trilineata	Nudibranch
Crepidula cf. *aculeata*	Spiny slipper shell
crepipatella lingulata	Half-slipper shell
Cypraea spadicea	Chestnut cowry
Diaulula sandiegensis	Circle-spotted sea slug
Diodora aspera	Rough keyhole limpet
Doriopsilla albopunctata (=*Dendrodoris fulva*)	Yellow sea slug
Fissurella volcano	Volcano limpet
Flabellinopsis iodinea	Purple sea slug
Haliotis corrugata	Pink abalone
H. cracherodii	Black abalone
H. fulgens	Green abalone
H. rufescens	Red abalone
Hermissenda crassicornis	Yellow-green sea slug
Hypselodoris californiensis	Blue-orange sea slug
Jaton festivus	Festive murex
Kelletia kelletii	Kellet's whelk
Laila cockerelli	Orange-white sea slug
Littorina planaxis	Eroded periwinkle
L. scutulata	Checkered periwinkle
L. sp.	Periwinkle
Lottia gigantea	OWl limpet
Maxwellia gemma	Gem murex
Megathura crenulata	Giant keyhole limpet
Mitrella carinata	Carinate dove shell
Mitra idae	Ida's mitre
Nassarius mendicus	Lean nassa
Navanax inermis	Nudibranch
Neosimnia sp.	Pink louse shell
Norrisia norrisii	Smooth turban
Ocenebra foveolata	

SCIENTIFIC NAME	COMMON NAME
O. poulsoni	Poulson's dwarf triton.
O. cf. *barbarensis*	
Ocenebra sp.	
Polycera tricolor	Nudibranch
Pteropurpura festiva	Festive murex
P. macroptera	Murex
Pterynotus trialatus	Three-winged murex
Serpulorbis squamigerus	Scaled worm shell
Simnia (Neosimnia) vidleri	Vidler's simnia
Tegula aureotincta	Gilded tegula
T. brunnea	Brown tegula
T. funebralis	Black turban snail
Triopha maculata	Nudibranch
Tritonia festiva	Nudibranch
Unid. limpet #1	
Unid. limpet #2	
Unid. blue/white eolid	
Unid. navanax-like eolid	
Unid. gastropod #1	
Unid. dorid #1	
Unid. chiton #1	
Unid. limpet #3	
Unid. eolid #1	
Unid. eolid #2	
CLASS PELECYPODA	**CLAMS AND SCALLOPS**
Anomia peruviana/Pododesmus cepio	Pearly jingle/Abalone jingle
Bankia setacea	Ship worm
Chaceia ovoidea	Wart-necked piddock
Chama pellucida	Agate chama
Chlamys latiaurata	Kelp scallop
Gari californica	Sunset clam
Hiatella arctica	Nestling clam
Hinnites multirugosus	Rock scallop
Kellia laperousii	
Lima hemphilli	File shell
Lithophaga plumula	Date mussel

SCIENTIFIC NAME	COMMON NAME
Mytilus californianus	California mussel
M. edulis	Bay mussel
Nettastonnella rostrata	Beaked piddock
Parapholas sp.	Boring clam
Pecten diegensis	San Diego scallop
Penitella penita	Flap-tipped piddock
Pseudochama exogyra	Reversed chama
Semele rupicola	Rock dwelling semele
Teredo diegensis	Ship worm
Unid. pholads	
Unid. boring clam	
CLASS CEPHALOPODA	**OCTOPUSES AND SQUIDS**
Octopus bimaculoides	Two-spot octopus
Octopus sp.	
CLASS POLYPLACOPHORA	
Mopalia muscosa	
Callistochiton crassicostatus	
PHYLUM BRYOZOA (=ECTOPROCTA)	**MOSS ANIMALS**
Antropora tincta	
Bugula neritina	
Crisia occidentalis	
Diaperoecia californica	
Filicrisia franciscana	
Lagenipora punctulata	
Hippothoa hyalina	
Membranipora membranacea	
M. savarti	
M. tuberculata	
Phidolopora pacifica	
Rhyncozoon rostratum	
Scrupocellaria diegensis	
Smittina sp.	
Thalamorporella californica	
Unid. encrusting ectoprocts	
Unid. ectoproct #1	
Unid. yellow ectoproct	

SCIENTIFIC NAME	COMMON NAME
PHYLUM ECHINODERMATA	**SEASTARS, URCHINS, BRITTLE STARS, CUCUMBER**
CLASS ASTEROIDEA	**SEASTARS**
Astropecten armatus	Sand starfish
Patiria miniata	Bat star
Pisaster brevispinus	Pink seastar
P. giganteus	Giant seastar
P. ochraceus	Ochre seastar
P. sp. (juv,)	
Solaster dawsoni	Sunburst starfish
CLASS ECHINOIDEA	**URCHINS**
Lytechinus pictus	Pale urchin
Strongylocentrotus franciscanus	Red urchin
S. purpuratus	Purple urchin
CLASS OPHIUROIDEA	**BRITTLE STARS**
Ophiopsilla californica	Brittle star
Ophiopteris papillosa	
Ophiothrix spiculata	
Unid. ophiuroid	
CLASS HOLOTHUROIDEA	**SEA CUCUMBERS**
Cucumaria sp.	Sea cucumber
Dermasterias imbricata	Leather star
Eupentacta quinquesemita	Yellow sea cucumber
Parastichopus californicus/P. parvimensis	
Unid. holothuroid	
Unid. burrowing holothuroid	
PHYLUM CHORDATA	**CHORDATES**
CLASS ASCIDIACEA	**TUNICATES (Sea squirts)**
cf. *Amaroucium californicum*	
Aplidium californicum	
Boltenia villosa	
Chelyosoma productum	Simple sea squirt
Cystodytes lobatus	Compound sea squirt
Didemnum carnulentum	
Pyura haustor	Tunicate
Styela gibbsii	

SCIENTIFIC NAME	COMMON NAME
S. montereyensis	
S. sp.	
Unid. white tunicate	
Unid. orange tunicate	
Unid. encrusting pink tunicate	
CLASS CHONDRICHTHYES	**CARTILAGINOUS FISHES**
Cephaloscyllium ventriosum	Swell shark
Cetorhinus maximus	Basking shark
Heterodontus francisci	Horn shark
Prionace glauca	Blue shark
Rhinobatos productus	Shovelnose guitarfish
Sphyrna zygaena	Smooth hammerhead shark
Squalus acanthias	Spiny dogfish
Triakis semifasciata	Leopard shark
Urolophus halleri	Round stingray
CLASS OSTEICHTHYES	**BONY FISHES**
Alloclinus holderi	Island kelpfish
Amphistichus argenteus	Barred surfperch
A. koelzi	Calico surfperch
Anisotremus davidsoni	Sargo
Artedius lateralis	Smoothead sculpin
Atherinops affinis	Topsmelt
Atherinopsis californiensis	Jacksmelt
Brachyistius frenatus	Kelp perch
Cheilotrema saturnum	Black croaker
Chromis punctipinnis	Blacksmith
Citharichthys sordidus	Pacific sanddab
Clinocottus globiceps	Mosshead sculpin
Clupea harengus pallasi	Pacific herring
Coryphopterus nicholsi	Blue-spot goby
Cymatogaster aggregata	Shiner surfperch
Cynoscion nobilis	White seabass
Embiotoca }acksoni	Black perch
E. lateralis	Striped seaperch
Genyonemus lineatus	White croaker
Gibbonsia metzi	Striped kelpfish

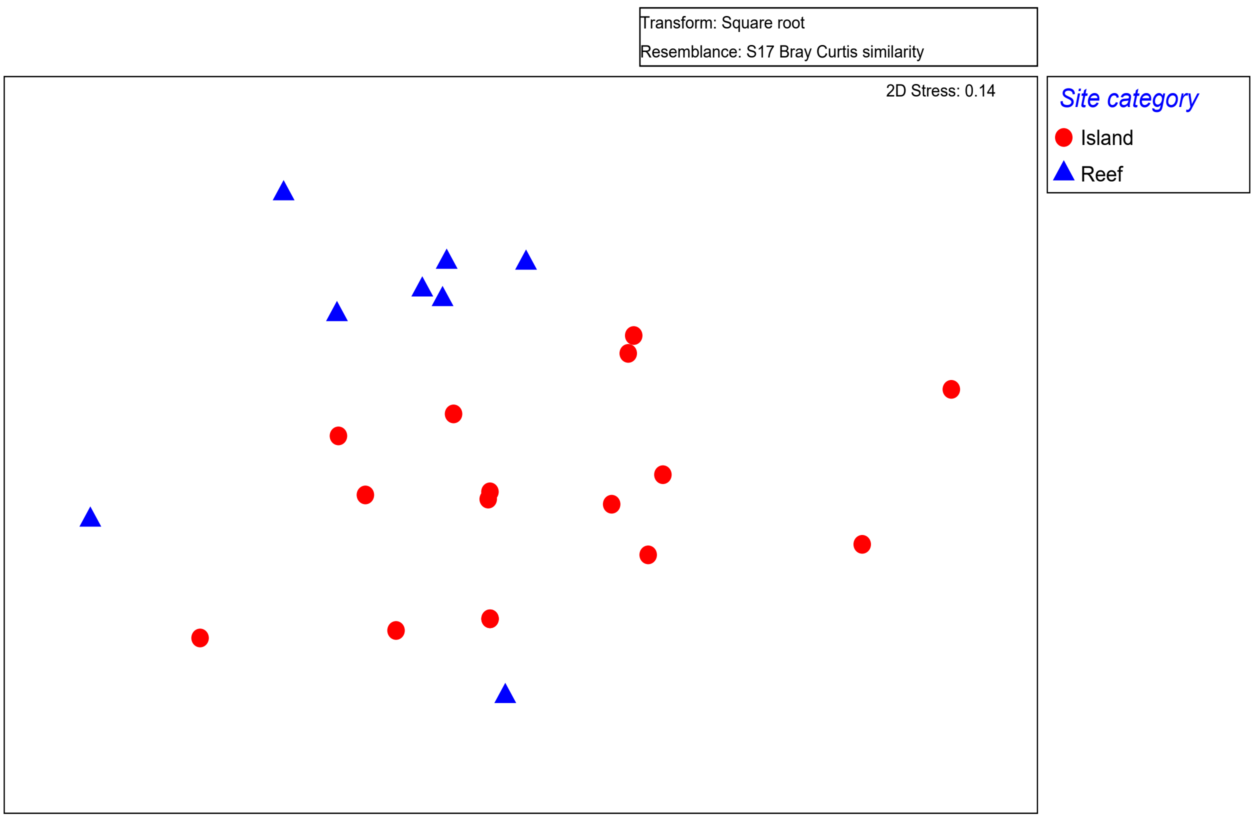
SCIENTIFIC NAME	COMMON NAME
G. montereyensis	Crevice kelpfish
Girella nigricans	Opaleye
Gymnothorax mordax	California moray
Halichoeres semicinctus	Rock wrasse
Heterostichus rostratus	Giant kelpfish
Hyperprosopon argenteum	Walleye surfperch
H. ellipticum	Silver surfperch
Hypsoblennius qilberti	Rockpool blenny
Hypsurus caryl	Rainbow surfperch
Hypsypops rubicunda	Garibaldi
Leuresthes tenuis	California grunion
Lynthrypnus dalli	Bluebanded goby
Medialuna californiensis	Halfmoon
Mola mola	Ocean sunfish
Myliobatus californica	Bat ray
Oncorhynchus kisutch	Coho salmon
Ophiodon elongatus	Lingcod
Oxyjulis californicus	Senorita
Oxylebius pictus	Convict fish
Paralabrax clathratus	Kelp bass
P. maculato-fasciatus	Spotted sand bass
P. nebulifer	Barred sand'bass
Paralichthys californicus	California halibut
Pimelometopon pulchrum·	California sheephead
Platichthys stellatus	Starry flounder
Phanerodon furcatus	White seaperch
Porichthys spp.	Midshipman
Rathbunella hypoplecta	smooth ronquil
Rhacochilus toxotes	Rubberlip seaperch
Rhacochilus vacca	Pile perch
Sardinops sagax	Pacific sardine
Scomber japonicus	Pacific mackerel
Scomberomorus concolor	Monterey Spanish mackerel
Scorpaena guttata	California scorpionfish
Scorpaenichthys marmoratus	Cabezon
Sebastes atrovirens	Kelp rockfish

SCIENTIFIC NAME	COMMON NAME
S. auriculatus	Brown rockfish
S. cf. caurinus	Copper rockfish
S. chlorostictus	Greenspotted rockfish
S. elongatus	Greenstriped rockfish
s. miniatus	Vermilion rockfish
S. mystinus	Blue rockfish
S. paucispinis	Bocaccio
S. rastrelliger	Grass rockfish
S. rubrivinctus	Flag rockfish
S. serranoides	Olive rockfish
S. serriceps	Treefish
Sebastes sp. #1	
Sebastes sp. #2	
Seriphus politus	Queen fish
Sphyraena argentea	Pacific barracuda
Symphurus atricauda	California tonguefish
Syngnathus californiensis	Kelp pipefish
Thunnus alalunga	Albacore
Trachurus symmetricus	Mack mackerel
Blenniidae	Unid. blenny

Note: The scientific names have not been updated and the common names are as originally presented.

APPENDIX 2A. ANALYSIS OF THE MOBILE BENTHIC MACRO-INVERTEBRATE ASSEMBLAGES

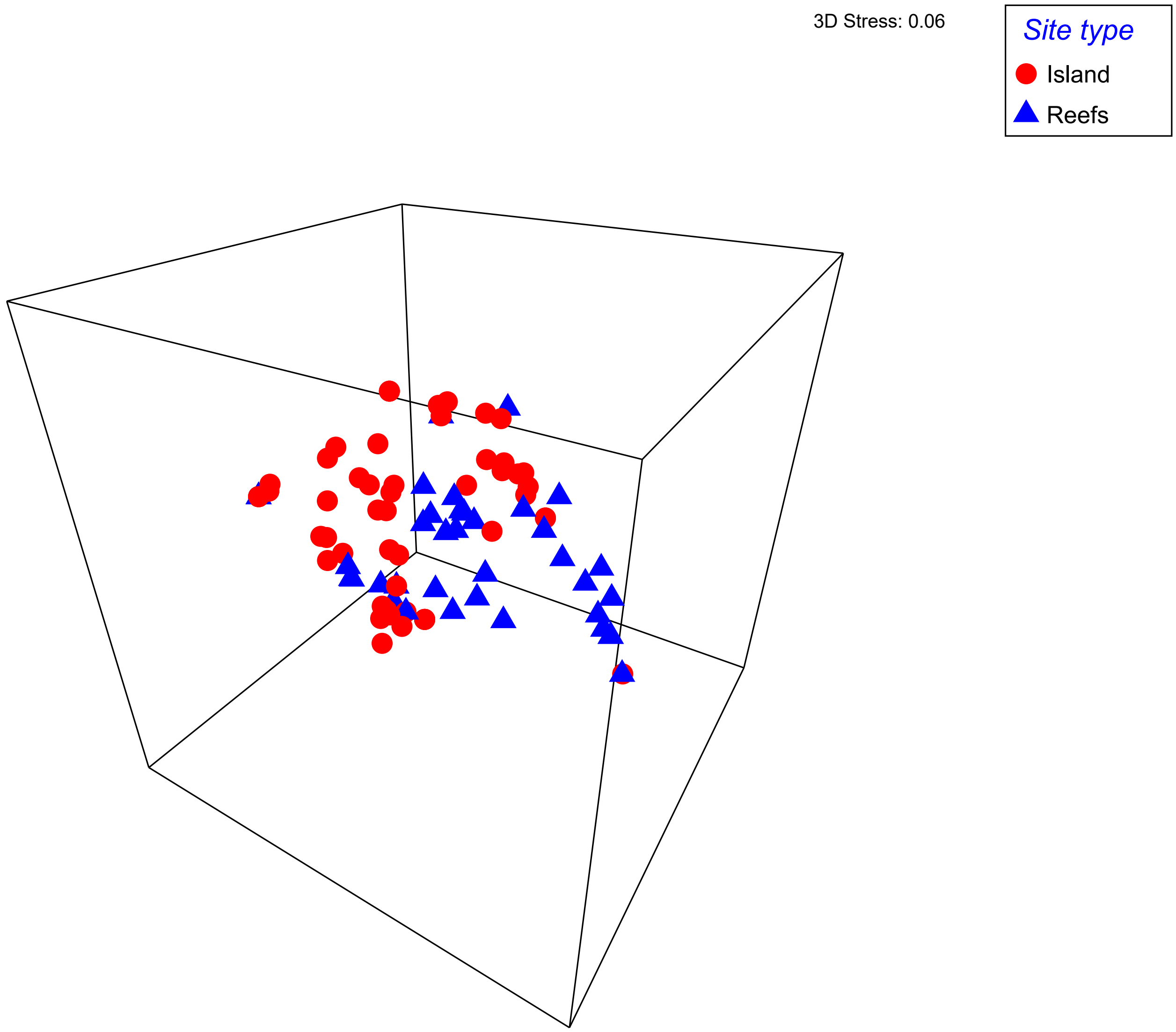
In the non-parametric multidimensional scaling plot below, each point represents a transect. The distance between the points is a relative measure of how similar transects are in terms of species composition and abundance of the species. The reef samples, with exception of two transects, are clustered together and separate from the island samples. This indicates that the mobile benthic invertebrate assemblages tend to be more similar within the island and reef habitats than between habitats. The species composition of the island transect samples are quite variable. The analysis of similarity (ANOSIM) test determined that the mobile benthic invertebrate species assemblages of Rincon Island and natural reef habitats (upcoast reef #1, upcoast reef #2, and downcoast reef #2 combined) statistically differ (R=0.284, p=0.01).



Non-parametric multidimentional scaling (nMDS) plot

APPENDIX 2B. ANALYSIS OF THE SESSILE BENTHIC MACRO-INVERTEBRATE ASSEMBLAGES

The species assemblage of sessile invertebrates at Rincon Island and the rocky reef habitat significantly differed ($R=0.054$, $p=0.007$) based on the counts of the sessile macroinvertebrate taxa in the photoquadrats. The three-dimensional nMDS plot provides a more conservative representation of the degree of similarity among photoquadrat assemblages (stress=0.06) than the two-dimensional plot not shown (stress=0.1). Samples from Rincon Island and reef habitat are clustered.



Non-parametric multidimensional scaling (nMDS) plot of the assemblages of sessile invertebrate species in photoquadrats from Rincon Island and reef habitat.

APPENDIX 2C. DENSITY OF SOFT CORALS (GORGONIAN) AT RINCON ISLAND AND REEFS

	Island (n=94)					Reef (n=54)				
	Total count	Mean density	Std Err	Min	Max	Total count	Mean density	Std Err	Min	Max
Purple gorgonian	43	1.8	0.3	0	25	0			0	0
Red gorgonian	6	0.3	0.0	0	2	5	0.4	0.1	0	3
California golden gorgonian	34	1.4	0.1	0	6	51	3.8	0.3	0	16
Brown gorgonian	14	0.6	0.1	0	4	15	1.1	0.1	0	3
Unidentified gorgonians	33	1.4	0.1	0	5	44	3.3	0.2	0	9
All gorgonians	130	5.5	0.4	0	35	115	8.5	0.5	0	21

Density (number per 1 m^2) was estimated from the count of gorgonians that occurred either fully or partly in the area 0.25 m^2 quadrat.

APPENDIX 3A. SIZE DISTRIBUTIONS OF FISHES AT RINCON ISLAND AND REEFS

			Island (n=16) Total length (cm)					Reefs (n=16) Total length (cm)				
Family	Common name	Fisheries resource[1]	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Serranidae	Barred sand bass	R	6	40.0	0.0	40	40	26	38.2	5.2	22	45
Sebastidae	Black and yellow rockfish	C**, R	1	20.0		20	20	0				
Embiotocidae	Black perch	R	33	22.5	4.3	12	30	14	21.6	5.4	12	28
Pomacentridae	Blacksmith	N	290	12.4	2.2	4	22	54	14.6	1.0	13	20
Sebastidae	Brown rockfish	C**, R	9	15.4	2.5	13	18	7	23.9	9.9	13	40
Scorpaenidae	California scorpionfish	C**, R	1	32.0		32	32	1	35.0	.	35	35
Labridae	California sheephead	C*, R	45	28.5	7.5	12	60	21	35.8	7.2	25	50
Pomacentridae	Garibaldi	N	32	23.3	1.4	20	25	44	23.4	1.2	22	26
Clinidae	Giant kelpfish	R	1	30.0		30	30	0				
Kyphosidae	Halfmoon	R	3	22.7	0.6	22	23	25	22.4	1.7	20	25
Heterodontidae	Horn shark	N	1	45.0		45	45	0				
Labrisomidae	Island kelpfish	N	1	13.0		13	13	0				
Serranidae	Kelp bass	R	72	24.8	6.3	11	40	85	27.6	7.4	13	40
Sebastidae	Kelp rockfish	C**, R	1	26.0		26	26	1	25.0		25	25
Sebastidae	Olive rockfish	C**, R	3	34.7	2.5	32	37	0				.
Kyphosidae	Opaleye	R	44	30.0	2.8	22	36	42	29.9	3.9	25	35
Hexagrammidae	Painted greenling	N	9	10.0	0.0	10	10	1	13.0		13	13
Embiotocidae	Pile perch	R	1	16.0		16	16	0				
Embiotocidae	Rainbow seaperch	R	1	20.0		20	20	2	13.0	0.0	13	13
Labridae	Rock wrasse	N	5	28.8	1.8	26	30	0				
Embiotocidae	Rubberlip Seaperch	R	1	30.0		30	30	0				

Family	Common name	Fisheries resource[1]	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Haemulidae	Sargo	R	53	27.6	1.6	20	32	0				
Labridae	Señorita	N	186	19.5	1.4	12	22	52	19.5	1.3	16	20
Scyliorhinidae	Swell shark	N	0	.	.	.	.	1	85.0		85	85
Atherinidae	Topsmelt	R	310	10.1	0.4	10	12	0				
Sciaenidae	White seabass	C*, R	1	80.0	.	80	80	0				
Embiotocidae	White seaperch	R	14	19.9	0.5	18	20	0				
	Total fishes		**1124**	**17.0**	**7.7**	**4**	**80**	**376**	**25.0**	**8.7**	**12**	**85**

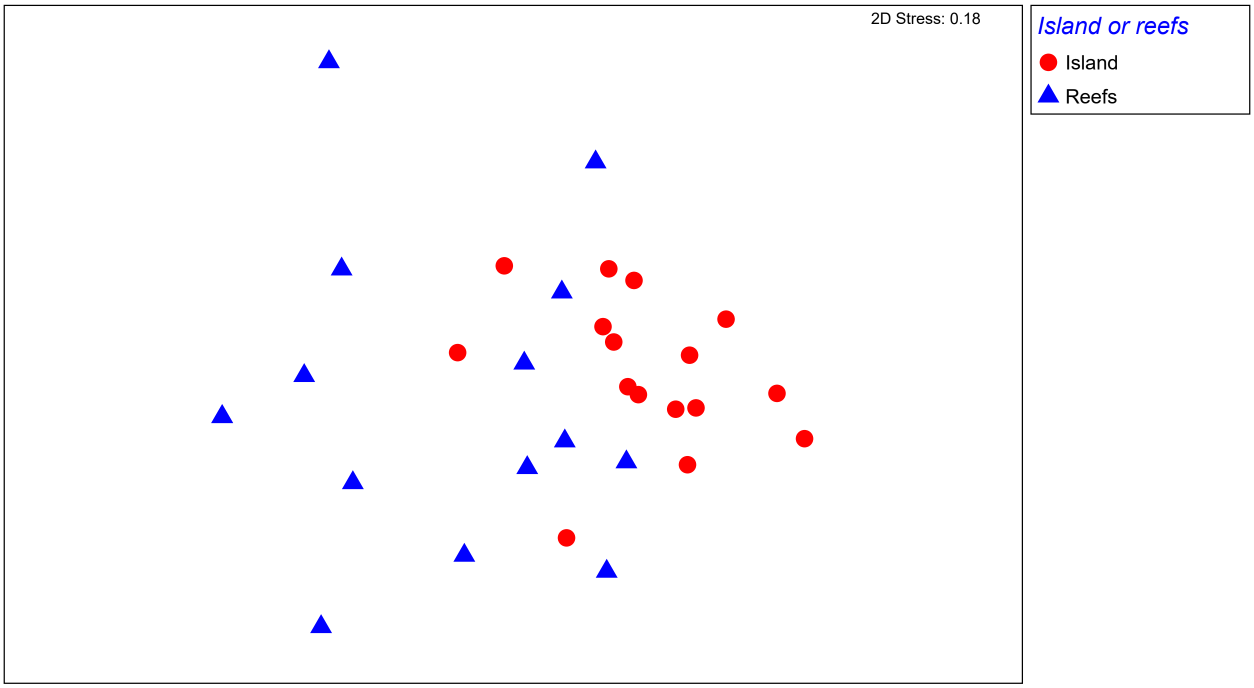
Note: Rincon Island (n=16 transects) and four natural reefs combined (n=16).
[1]Commercial fisheries species, C; recreational fisheries species, R; species is not a recognized fisheries resource, N
* Commercial fishery managed by California Department of Fish and Wildlife
**Commercial fishery managed by the Pacific Fisheries Management Council

APPENDIX 3B. DENSITY OF OBSERVED FISH SPECIES AT RINCON ISLAND AND REEFS

Scientific name	Common name	Island (n=16)			Reefs (n=16)		
		Mean	SE	FO	Mean	SE	FO
Paralabrax nebulifer	Barred sand bass	0.6	0.3	5	2.7	0.6	12
Seb astes chrysomelas	Black and yellow rockfish	0.1	0.1	1	0.0	0.0	0
Embiotoca jacksoni	Black perch	3.4	0.7	13	1.5	0.5	8
Chromis punctipinnis	Blacksmith	30.2	8.7	15	5.6	3.2	5
Sebastes auriculatus	Brown rockfish	0.9	0.5	5	0.7	0.4	4
Scorpaena guttata	California scorpionfish	0.1	0.1	1	0.1	0.1	1
Bodianus pulcher	California sheephead	4.7	2.0	11	2.2	0.9	7
Hypsypops rubicundus	Garibaldi	3.3	0.8	12	4.6	1.7	9
Heterostichus rostratus	Giant kelpfish	0.1	0.1	1	0.0	0.0	0
Medialuna californiensis	Halfmoon	0.3	0.2	2	2.6	1.8	2
Heterodontus francisci	Horn shark	0.1	0.1	1	0.0	0.0	0
Alloclinus holderi	Island kelpfish	0.1	0.1	1	0.0	0.0	0
Paralabrax clathratus	Kelp bass	7.5	0.7	16	8.9	2.4	14
Sebastes atrovirens	Kelp rockfish	0.1	0.1	1	0.1	0.1	1
Sebastes serranoides	Olive rockfish	0.3	0.2	3	0.0	0.0	0
Girella nigricans	Opaleye	4.6	1.3	12	4.4	2.3	5
Oxylebius pictus	Painted greenling	0.9	0.9	1	0.1	0.1	1
Damalichthys vacca	Pile perch	0.1	0.1	1	0.0	0.0	0
Embiotoca caryi	Rainbow seaperch	0.1	0.1	1	0.2	0.1	2
Halichoeres semicinctus	Rock wrasse	0.5	0.2	5	0.0	0.0	0
Rhacochilus toxotes	Rubberlip Seaperch	0.1	0.1	1	0.0	0.0	0
Anisotremus davidsonii	Sargo	5.5	3.1	6	0.0	0.0	0
Oxyjulis californica	Señorita	19.4	5.0	15	5.4	3.1	4
Cephaloscyllium ventriosum	Swell shark	0.0	0.0	0	0.1	0.1	1
Athernopsis affinis	Topsmelt	32.3	31.2	2	0.0	0.0	0
Atractoscion nobilis	White seabass	0.1	0.1	1	0.0	0.0	0
Phanerodon furcatus	White seaperch	1.5	1.2	3	0.0	0.0	0

APPENDIX 3C. ANALYSIS OF THE FISH ASSEMBLAGES

The assemblage of fishes at Rincon Island and the reefs significantly differed. This was the case whether or not topsmelt were included in the multivariate analysis of similarity: R=0.329, p=0.01 with topsmelt included in the assemblage; R=0.346, p=0.01 excluding topsmelt). The nMDS plot shows a fair degree of dissimilarity between assemblages in the two different habitats. The fish assemblages observed in transects at Rincon Island were more similar to each other than to those at the reefs.



Non-parametric multidimensional scaling (nMDS) plot of the assemblages of fish species observed in transects from Rincon Island and natural reef habitat.