

UC San Diego

Research Final Reports

Title

Effects of the San Diego-La Jolla Ecological Reserve on the Abundance, Diversity and Population Structure of Reef Fishes

Permalink

<https://escholarship.org/uc/item/3f80822s>

Authors

Hastings, Philip A.
Dayton, Paul K.

Publication Date

2006-07-24

R/CZ-183 FINAL REPORT; Philip A. Hastings and Paul K. Dayton
Effects of the San Diego-La Jolla Ecological Reserve on the Abundance, Diversity and
Population Structure of Reef Fishes

Project Goals. This project compiled current and historical records of fishes occurring in the vicinity of the San Diego-La Jolla Ecological Reserve (SDLJER), and assessed the effects of the Reserve on the abundance, diversity and population structure of resident fishes. This was accomplished by collection of quantitative data within the Reserve, immediately adjacent to the Reserve, and at site relatively distant from the Reserve that is not part of any marine reserve and subject to more intense fishing pressure. These assessments included transect surveys of densities and size distributions of conspicuous fishes. This study provides critical, but heretofore absent, baseline data for population monitoring of fishes in the Reserve and adjacent rocky-reef and kelp-forest communities in the San Diego region. In addition, records of fishes recorded within the vicinity of the SDLJER were compiled from the Scripps Institution of Oceanography Marine Vertebrate Collection in order to provide a detailed list of the ichthyofauna recorded in and around the Reserve.

Goals Accomplished. The Reserve site and the site immediately adjacent to the Reserve (Boomer's) were censused 24 times by our group every other month between January 2002 and December 2005. Initially we also sampled a more distant unprotected site at Point Loma, one of the few large kelp forests in San Diego County other than those in La Jolla. However, the reef habitat at that site proved to have significantly less vertical relief than our study sites in La Jolla (as well as significantly lower densities of reef fishes) confounding data comparisons. Instead we arranged a collaborative effort with Dr. D. Pondella (Vantuna Research Group, Occidental College) who was collecting similar data using identical methods at Palos Verdes Peninsula (Los Angeles County; approximately 160 km N of La Jolla). This site has similar vertical relief to that of the La Jolla sites, is not part of any marine reserve and is heavily fished by anglers from Redondo Beach to the north and Long Beach to the south. The Palos Verdes site, included in our analysis as an "unprotected, distant site," was sampled 16 times, at quarterly intervals, over the same four year period. Overall, our survey was based on 252 transects within the Reserve, 248 transects immediately adjacent to the Reserve, and 188 transects at Palos Verdes.

Comparisons Between Sites. Species composition of the ichthyofauna was similar at the three sites. Species richness over the four-year sampling interval was remarkably similar with 52 species recorded in transects in the Reserve, 50 adjacent to the Reserve, and 50 at Palos Verdes. Similarly, with only one exception, the ten most abundant species were the same at all sites although their rank order varied somewhat (Table 1). The Shannon-Weiner index of diversity for the Reserve and adjacent site were similar (1.88 and 1.91, respectively), but lower than at the distant Palos Verdes site (2.07). This difference appears to be the result of periodic high densities of two species (blacksmith, *Chromis punctipinnis*, and senorita, *Oxyjulis californica*) at the Reserve and adjacent site. While these species were the two most abundant species at all three sites (Table 1), at Palos Verdes their numbers did not fluctuate as greatly as at the other sites resulting in a higher overall Shannon-Weiner diversity index. The mean density of fishes within the

Reserve (2.04 fish per square meter) was higher than but not statistically different from the density immediately adjacent to the Reserve (1.55 fish per square meter; $P > 0.05$). However, fishes were more than twice as numerous at the Reserve than at the unprotected Palos Verdes site where the density was 0.85 fish per square meter ($P < 0.01$). Thus, overall the density of fishes was higher in and around the San Diego-La Jolla Ecological Reserve than at the distant, unprotected and heavily fished site at Palos Verdes.

Table 1. Rank order of the ten most abundant fish species at each of the three study sites in southern California between 2002 and 2005.

Reserve (SDLJER)	Adjacent Site (Boomer's)	Distant Site (Palos Verdes)
1. <i>Chromis punctipinnis</i>	<i>Chromis punctipinnis</i>	<i>Oxyjulis californica</i>
2. <i>Oxyjulis californica</i>	<i>Oxyjulis californica</i>	<i>Chromis punctipinnis</i>
3. <i>Hypsypops rubicundus</i>	<i>Hypsypops rubicundus</i>	<i>Xenistius californiensis</i>
4. <i>Paralabrax clathratus</i>	<i>Paralabrax clathratus</i>	<i>Girella nigricans</i>
5. <i>Girella nigricans</i>	<i>Halichoeres semicinctus</i>	<i>Halichoeres semicinctus</i>
6. <i>Halichoeres semicinctus</i>	<i>Girella nigricans</i>	<i>Paralabrax clathratus</i>
7. <i>Semicossyphus pulcher</i>	<i>Semicossyphus pulcher</i>	<i>Embiotoca jacksoni</i>
8. <i>Trachurus symmetricus</i>	<i>Brachyistius frenatus</i>	<i>Semicossyphus pulcher</i>
9. <i>Sardinops sagax</i>	<i>Trachurus symmetricus</i>	<i>Hypsypops rubicundus</i>
10. <i>Embiotoca jacksoni</i>	<i>Embiotoca jacksoni</i>	<i>Sardinops sagax</i>

This same trend in abundance was evident in the two most heavily fished reef species within southern California, the kelp bass, *Paralabrax clathratus*, and the California sheephead, *Semicossyphus pulcher*. First, there was a significantly higher density of kelp bass within and adjacent to the Reserve compared to the distant site, ($D = 0.11$, 0.08, and 0.03 fish per square meter at the Reserve, adjacent and distant sites, respectively). Second, density of sheephead was significantly higher within the Reserve than at the distant site, but not significantly different when compared to the adjacent site ($D = 0.06$, 0.04, and 0.02 fish per square meter for the Reserve, adjacent, and distant sites, respectively). These comparisons suggest a positive impact of the Reserve on the abundance of these heavily exploited fishes.

For fish species that are not targeted by local fishers, relative abundance patterns were varied. For example, the mean density of the garibaldi, *Hypsopops rubicundus*, the California State marine fish, at the Reserve and adjacent site (0.13 and 0.19, respectively) did not differ, but both were significantly higher than at Palos Verdes (0.02 fish per meter squared). This pattern was not observed in the most common embiotocid, the live bearing black surfperch (*Embiotoca jacksoni*). Densities of this species were similar at all sites (Reserve = 0.017; Boomer's = 0.031; Palos Verdes = 0.028).

Historical Records of Fishes in the La Jolla Region. The Marine Vertebrate Collection of the Scripps Institution of Oceanography includes fish specimens from the southern

California region, many dating back over 100 years. Collecting efforts in the La Jolla region were especially intense in the 1940s and 1950s after the arrival of the legendary ichthyologist Carl Hubbs at SIO and before the fishes of southern California were well known. Since that time, archived collections from the region are more sporadic and in most cases involve relatively rare species. For this reason, these and other natural history collections are not necessarily ideal for estimating changes in the relative abundance of species over time. However, they are extremely useful for gaining an understanding of the overall community of fishes inhabiting a particular region. Our survey of SIO collection records of fishes recorded in the La Jolla region recovered a total of 239 species that have been recorded in the vicinity of the San Diego-La Jolla Ecological Reserve. Thus the 52 species recorded in our transect surveys inside the Reserve represent approximately 20 percent of all fish species ever recorded in the vicinity of the Reserve. This discrepancy is not surprising and is a result of several factors. First, the historical samples include all fishes taken within the vicinity, including those from habitats not sampled in our transects such as pelagic habitats, sandy substrates and benthic areas deeper than 20 meters such as the La Jolla submarine canyon. Second, the faunal inventory includes numerous small, cryptic species that are typically not observed by divers counting fishes along transects. Third, this collection documents numerous rare occurrences of fishes in the region over the past 100 years. Nonetheless, this compilation highlights the potential importance of the San Diego-La Jolla Ecological Reserve for protecting the diverse ichthyofauna of the southern California region.

Benefits. Our data clearly indicate that there is a greater density of fishes in and around the San Diego-La Jolla Ecological Reserve than at the ecologically similar but unprotected and heavily fished Palos Verdes Peninsula. Also, the two most heavily exploited species in the region are more common in and around the Reserve than at the heavily exploited site. In addition, there are more subtle differences in the abundance of fishes in the Reserve compared to an unprotected site only a short distance to the south where targeted species are slightly less abundant. This was detected even though the lifetime home ranges of most fishes included in our survey are undoubtedly larger than the Reserve itself. In spite of the full legal access of fishermen to our study site immediately adjacent to the Reserve (Boomer's), relatively little fishing pressure is placed on the area compared to the Palos Verdes Peninsula which is readily accessible from two large, busy harbors. The high visibility of the San Diego-La Jolla Ecological Reserve to the public, together with the relatively long distance to the nearest harbors at Mission Bay and San Diego Bay, may serve to limit the number of fishers who visit the area. In either case, our data are consistent with the conclusion that the San Diego-La Jolla Ecological Reserve has a positive effect on the abundance of target species in and around the La Jolla area.

Summary. Our quantitative surveys demonstrate a significant positive impact of the San Diego-La Jolla Ecological Reserve on the reef fish populations of southern California. These results add to a growing literature documenting the beneficial effects of marine protected areas. These results are especially important because these beneficial effects are apparent and demonstrable even for such a small reserve. Finally, our results indicate that the San Diego-La Jolla Ecological Reserve encompasses relatively unique habitat within the San Diego region, providing a sound scientific basis for its continued protection.

Indeed, a strong case can be made for an expansion of the Reserve to include a greater proportion of the high-relief rocky reef habitat of coastal La Jolla.

Publications

Craig, M. T., P. A. Hastings & P. K. Dayton. 2002. The near-shore fish assemblage of the San Diego-La Jolla Ecological Reserve. *Bulletin of the Southern California Academy of Sciences*. 101(S102):36. (Abstract).

Craig, M.T., F. J. Fodrie & P. A. Hastings. 2004. Characterizing the nearshore fish assemblage of the Scripps Coastal Reserve. *Coastal Management* 32:341-351.

Craig, M., B. Erisman, P. Hastings, J. Hyde & D. Pondella. Abundance and diversity of fishes in and around the San Diego-La Jolla Ecological Reserve. In preparation.

Other Publications Citing Sea Grant Support to Trainees Craig and Erisman

Craig, M. T., P. A. Hastings, D. J. Pondella II, D. R. Robertson & J. A. Rosales-Casian. 2006. Phylogeography of the flag cabrilla *Epinephelus labriformis* (Serranidae): implications for the biogeography of the Tropical Eastern Pacific and the early stages of speciation in a marine shore fish. *Journal of Biogeography* 33:969-979.

Craig, M. T. & P. A. Hastings. 2007. A molecular phylogeny of the groupers of the subfamily Epinephelinae (Serranidae) with a revised classification of the Epinephelini. *Ichthyological Research* 54(1): in press.

Erisman, B.E., M. Buckhorn & P. A. Hastings. Spawning behavior and periodicity in the leopard grouper, *Mycteroperca rosacea*, from the central Gulf of California, Mexico. *Marine Biology*: in review.

Posters & Oral Presentations

Craig, M., J. Hyde & P. Hastings. 2002. The nearshore marine fish assemblage of the San Diego-La Jolla Ecological Reserve. Annual Meeting of the Southern California Academy of Sciences.

Craig, M., J. Hyde, B. Erisman & P. Hastings. 2004. The nearshore fish assemblage of the San Diego-La Jolla Ecological Reserve. Annual Meeting of the Western Society of Naturalists, Sonoma.

Craig, M., J. Fodrie & P. Hastings. 2004. Nearshore fish assemblage of the Scripps Coastal Reserve. Symposium of the University of California Natural Reserve System.

Media Coverage

Seagrant trainee M. Craig presented results from both this project and additional reserve work at the University of California Natural Reserve System (NRS) symposium in February, 2004. This symposium was covered by the NRS publication "Transect."

Cooperating Organizations

Vantuna Research Group, Occidental College (for data from Palos Verdes peninsula).

International Implications

This project will lead to a better understanding of the functionality of marine reserves in southern California aiding resource managers and biologists to better design and assess the performance of marine reserves in Baja California, Mexico, and worldwide.

Awards

American Institute of Fishery Research Biologists, Second Runner-up, 2002. The nearshore marine fish assemblage of the San Diego-La Jolla Ecological Reserve. (Presented to Matthew T. Craig, trainee, at the 2002 annual meeting of the Southern California Academy of Sciences).

Keywords: Marine Reserves, MPA's, fish assemblage, southern California.

Patents: None.

Notes: None.