A hierarchical analysis of trends in common rocky reef fish species: Evidence of reserve effects using the REEF Survey Program Database

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Volunteer divers conducted fish surveys at sites throughout the Channel Islands since 1996 as part of the Reef Environmental Education Foundation (REEF) Survey Program. Between 1996 and 2006, volunteer divers collected 1,595 visual fish surveys from 113 sites throughout the Channel Islands. 767 surveys were gathered before state marine reserves were established at the Channel Islands (1997-2002), while 807 surveys were conducted, both inside and outside reserves, after the reserves were established (2003-2006). We analyzed REEF data to evaluate changes in the density of fishes inside versus outside reserves at the Channel Islands. We adapted methods developed to analyze volunteer bird watching data to detect trends in fish densities. The analysis included 25 species of common rocky reef fishes, including targeted and non-targeted species. Rather than focusing on changes in the density of individual species, our analysis evaluated changes in multiple species to characterize responses of marine communities to protection from fishing in reserves.

Key Findings:

- On average, fish populations had ~20% higher growth rates inside reserves as compared to outside, although there was a high degree of variability across species.
- In contrast to other survey techniques, we found that both species targeted by commercial or recreational fishing, and non-targeted fishes, responded similarly to protection in reserves. We detected an overall positive response to protection in reserves regardless of a species' status as targeted.
- As the number of volunteer diver surveys increases over time, we can better evaluate the effectiveness of marine reserves because the power of our modeling approach to infer fish population trends increases with sample size.

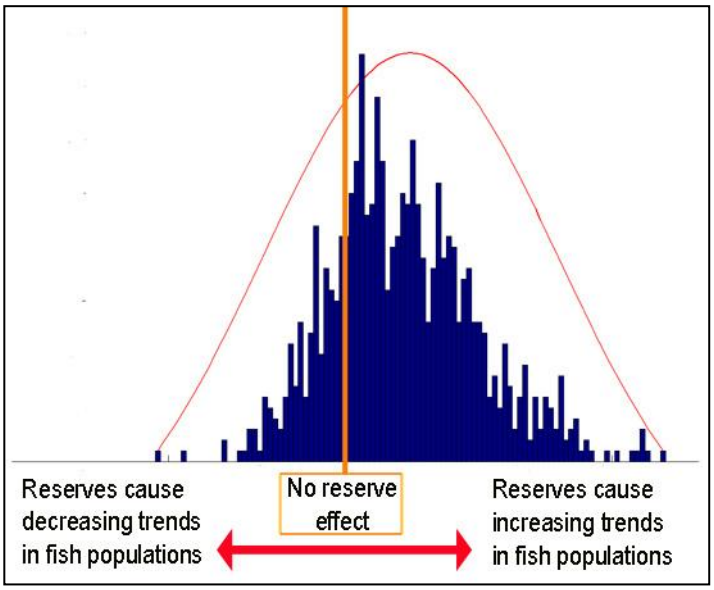

Figure 1: Model output that describes the effect of marine reserves on density and population growth rates of 25 fish species at the Channel Islands. The yellow line (center) indicates the value at which reserves have no effect on density and population growth rates. Blue bars on the right side of the orange line indicate positive effects of marine reserves on density and population growth of fish, while blue bars on the left side of the orange line indicate negative effects. The majority of the model output falls to the right of the orange line, indicating an over-all positive effect of reserves on fish density and population growth.

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