



## **CENTRE FOR EVIDENCE-BASED CONSERVATION**

### **SYSTEMATIC REVIEW No. 23**

# **ARE MARINE PROTECTED AREAS EFFECTIVE TOOLS FOR SUSTAINABLE FISHERIES MANAGEMENT? I. BIODIVERSITY IMPACT OF MARINE RESERVES IN TEMPERATE ZONES**

## **REVIEW REPORT**

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**COVER SHEET**

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## SYSTEMATIC REVIEW SUMMARY

### Background

Marine Protected Areas (MPAs) have been proposed and designated as a mechanism to address the problem of achieving sustainable fisheries, while simultaneously preserving biodiversity. However, empirical studies and research syntheses indicate that there is considerable variation in the ecological effects of MPAs and there is considerable debate over whether they can produce fisheries benefits. Of the various types of MPAs, marine reserves (no-take areas) have been perhaps the best studied. Furthermore, by focusing on marine reserves, it is possible to eliminate protection level as a co-variate. Consequently, as a first review in a proposed series on the effectiveness of MPAs for sustainable fisheries management, we objectively collated data to ascertain the impacts of temperate zone no take areas on the density, biomass and species richness of marine biota within reserve borders (as reflected in the subtitle).

### Objectives

- To determine the impacts of establishing temperate zone no take areas on density, biomass and species richness of marine biota within reserve boundaries.
- To ascertain whether the impacts of no take areas vary in relation to taxon, reserve parameters or organism parameters.

### Search strategy

Multiple electronic sources were searched using a range of keywords. Bibliographies, expert contacts and website searches were performed to access grey literature. Information from soft sediment systems was explicitly sought as well as the more common reef-based assessments. Foreign language searches were not performed.

### Selection criteria

**Relevant subject(s):** All marine biota

- **Types of intervention:** Temperate Marine Protected Areas (Marine Reserves) defined as geographically defined areas subject to no fishing activity (no take areas).
- **Types of comparator:** No restriction on fishing activity.
- **Types of outcome:** Density (other abundance measures), biomass, species richness.
- **Types of study:** Any primary study providing measures before and after implementation of a reserve, or comparing reserves to adjacent geographical areas without no-take protection.

### Data collection and analysis

Data extraction was undertaken using a review-specific data extraction form. Random effects meta-analysis was used to examine species level data, reserve level data, and species-reserve interactions. Subgroup analyses and meta-regression were used to explore variation in effectiveness in relation to species and reserve level co-variates.

## Main results

Density of marine biota is 23% to 196% higher within marine reserve no take zones than outside. Gains in biomass within no take are 20% to 422%, but there is uncertainty surrounding these results due to lower sample sizes. Species richness within marine reserves is 10% to 130% higher within no take areas than outside reserves, although this too is based on a small sample. Fish species density is 35% to 81% higher in marine reserves than in adjacent areas and variation in fish density response is not strongly linked to any species or reserve level parameters. Furthermore, it is not clear if these differences are due to marine reserve effects or other differences between the marine reserve and comparator, such as habitat variation. This lack of distinction is the primary reason for contention regarding marine reserve effectiveness and can only be resolved by improved monitoring.

Meta-analyses indicate that differences in the response of specific species, genera or functional groups are often small with effect sizes of  $<0.2$ . Power analysis indicates that detection of statistically significant differences for these small effects requires co-ordinated monitoring across a large number of marine reserves.

## Conclusions

**Implications for management / policy / conservation:** The available evidence suggests that temperate MPAs that impose no-take zones may achieve higher densities, biomass and species richness of marine biota within the boundaries of the no-take zone than outside. The evidence for higher densities and biomass of fish is notable in this context. However, considerable uncertainty and low predictive power arises from small sample sizes and possible confounding factors such as habitat quality.

**Implications for research:** Lack of data is a hindrance in the development of an evidence-base regarding the effectiveness of MPAs. Small sample sizes result in high uncertainty about the impacts on specific taxa. In particular, algae and invertebrates are understudied; insufficient data are available regarding biomass, species richness, deep water no take areas, pelagic fish species and soft sediment systems. It is also very difficult to distinguish habitat effects from reserve effects without integrated experimental monitoring programs that present data regarding the baseline condition. Before After Control Impact studies are required to allow comparison of rates of change from the same baseline condition. Large numbers of marine reserves require monitoring if small effects are to be detected. Data regarding the intensity of resource use are required alongside biological metrics for monitoring to be effective.