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Scientific principles for marine reserve systems

Progress with the establishment of fully-protected marine reserves has been generally slow and highly variable between regions. Most reserves have been small, isolated and were created for specific reasons that were locally acceptable. However, on a world scale, progress has been continuous and steadily accelerating. Over the past few years, discussion of systems of marine reserves has become common and last year the first two systems were established, in the state of Victoria, Australia and around the Channel Islands, California (see MPA News Dec. 2002 and Jan 2003).

Moving to a consideration of systems significantly changes almost everything, from science to politics. In particular, it becomes necessary to have clear scientific principles, but also makes these much easier to define and explain. In this article, I assume a commitment to systems and attempt to list as a set the scientific principles required. It is a little surprising (but very encouraging) to find that most members of the general public regard virtually all these principles as common sense. Argument with them comes almost entirely from those managers and scientists who find difficulty in upgrading their thoughts from the very real problems with single reserves.

1. Systems of fully-protected marine reserves are an addition to standard marine planning and management, which will continue to apply (and develop) for the majority of the sea. Marine reserves are a new and different approach, but provide important support to standard management (especially as a hedge against lack of data or full understanding).
2. Systems of marine reserves are fully proactive. The aim is to conserve (or restore) the whole range of marine biodiversity and to maintain all the intrinsic ecological processes.
3. Marine reserves have multiple benefits to many sectors of society. All of these derive from the less disturbed (more natural) state, and most of them are optimised by increasing the degree of naturalness.
4. In scientific terms, marine reserves are controls, not manipulations. Despite the understandable viewpoint of managers and politicians, by definition there cannot be an ‘effect’ of the blank, the undisturbed piece. This is not a trivial or semantic point. The reversal of logic in talking about reserve effects seriously distorts thinking. When the density of a target species inside a reserve reaches 10 or 20 times that outside, the fact is often welcomed as a ‘reserve effect’, when we should focus on the indication of serious overfishing outside the reserve.
5. Even single marine reserves become less disturbed (more natural), but this takes time. Some changes take place quite quickly, but others may take 5, 10, 20 or more years to develop.
6. Systems of marine reserves will become even less disturbed, but this also takes time. While it is clear that reserves are less disturbed (and therefore a sensible baseline), the baseline will shift.
7. Changes within the reserve system will begin to affect the region outside the reserves and produce changes there. These are the reserve effects and are of great interest to fisheries and other resource users.

8. All these changes are essentially unpredictable, although after particular examples have been observed, they may be predicted in similar situations.
9. The shifting baselines and the initial lack of prediction are often regarded as problems, but the whole situation should be regarded as an important opportunity for science and management. Analogous problems occur and are successfully coped with in other branches of science (e.g. physiologists can never precisely define a healthy animal and keep learning more about what this means). Although a wide watching brief is needed to discover the changes, for the first time we will have an objective (and steadily improving) measure of the intrinsic properties of the marine habitats and ecosystems.
10. The above considerations make the scientific principles for establishing marine reserve systems clear and straightforward. Each system must be:

(a) Fully-protected (against all reasonably-preventable human disturbances)
(b) Permanent (we do not know how long is required to
(c) Fully representative of all biogeographic regions and all major habitats within each region.
(d) Spatially replicated for each habitat and ecosystem (to guard against accidents, to improve benefits, etc.)
(e) Spread as a network of reserves throughout the region, spaced so as to promote connection by larval drift.
(f) Of a size which ensures self-sustainability. The separate reserves can only aim for a degree of ecological viability, but the whole system must be sustainable.

11. In any region there will be many possible ways of satisfying these principles. Provided the principles are adopted as policy, this is allows existing users and interest groups a useful and proper role in the precise arrangement of the reserves.

12. None of the above points or principles are original, and most have already been adopted in at least some regions for some aspects of reserve establishment. The move to systems, however, makes general acceptance of the basic principles urgent and important.