The Benefits of "no-take" zones in Marine National Parks

Throughout the world there is increasing evidence that marine ecosystems are being altered beyond their range of natural variability by a combination of human activities, including fishing, pollution, and coastal development. This Backgrounder draws on research which shows that marine reserves that are completely and permanently protected from uses that remove animals and plants or alter their habitats can help to prevent, slow, or reverse negative changes in the ocean and increase productivity. It outlines the basis for the voluntary Queensland conservation movement and others urging that a significant proportion beestablished as a "no-take" zone to increase the overall productivity of the Great Sandy Marine Park.

The Californian based Partnership of Interdisciplinary Studies of Coastal Oceans (PISCO) has undertaken extensive studies of marine protected areas. PISCO carried out a scientific review of more than 80 marine reserves of many different sizes in a variety of temperate and tropical habitats around the globe.

This backgrounder draws extensively on their 2002 report summarizing the findings on the productivity of regional fisheries over time as a result of creating marine "no-take" zones. Their findings on the benefits have since been supported by the increased productivity on the Great Barrier Reef as a result of increasing "no take" zones from less than 5% to more than 30% of the total marine park area.

Reserves protect marine habitats in a particular place and the diversity of animals and plants that live in those habitats. Consequently, many animals and plants in reserves tend to:

- live in greater numbers,
- grow larger, and
- reproduce more than their counterparts outside reserves.

In contrast, other management strategies attempt to control only some activities or protect only a few species.

Around the World, more than 23 nations (including all Australian states) have established marine reserves for various reasons - to protect biodiversity, manage fisheries, or restore depleted populations of marine animals

A major purpose for establishing marine reserves is to protect the habitats and to restore animals and plants in particular sites.

A habitat is the place where an animal or plant lives. It has all the necessary environmental conditions for that species to survive. For example, many corals require sunlight and warm water. Their habitats are in shallow tropical seas. Habitats support many different communities of animals and plants. Natural or human-caused activities may change habitats and the species living there.

The marine environment is a mosaic of different habitats. Beach, mud flat, salt marsh, seagrass bed, kelp forest, and rocky shores fit together like puzzle pieces. Each habitat is home to a different and often unique community of plants and animals, all of which have their own environmental requirements. For example, clams, sand dollars, and burrowing worms thrive in sandy bottoms, whereas abalone and mussels live in rocky habitats. An important reason to protect a variety of habitats is that different habitats often influence each other. For example, estuaries serve as nursery habitats for some fishes of the open ocean. Organic matter produced in estuaries can flow into the ocean, fertilizing coastal marine ecosystems.

Some habitats, such as estuaries and mangroves, trap sediments moving down rivers, preventing these sediments from entering the ocean. Without these habitats, sediments could accumulate in the coastal waters, smothering life on coral and rocky reefs. Marine reserves have been designed to protect such habitats as rocky reefs, estuaries, sand and mud seafloors, rocky shorelines, seagrass meadows, and coral reefs.

A comprehensive review of studies in 80 diverse "no-take" marine reserves showed that most well-enforced marine reserves resulted in relatively large, rapid, and long-lasting increases in the biomass, density, size, and diversity of species living within their boundaries. This has also been shown to spill over to increase the productivity of the surrounding marine areas outside the reserves.

Most marine animals use more than one habitat during their lives. As animals grow, they may require different kinds of food and shelter, and animals meet these changing needs by moving between different habitats. Each habitat used by an animal or plant is important for its survival.

An organism may not be able to complete its life cycle if any one of these habitats is degraded. For example, as adults, many fish live in deep reefs offshore, while their larvae drift in the open waters on the surface of the ocean. The young fish move into shallow coastal waters as they grow and subsequently to deep waters, where they remain as adults. Since the ocean contains so many different kinds of animals and plants, all habitats play an important role. In order to support a variety of ocean life, it is essential that at least some of each habitat is preserved in a natural state. Marine reserves that include several adjacent habitats allow animals to move between habitats while remaining in protected areas

An ecosystem includes all the animals, plants, and microbes as well as the nonliving environment in a given area. All of these elements are connected through biological, chemical, and physical processes. Each species plays a role in an ecosystem. When one species is reduced or removed, others may be affected. Ecosystems can be large or small. Some very large ecosystems include diverse habitats across thousands of square kilometres.

Healthy marine ecosystems provide the basis for the "goods," such as food and medicines, and essential "services," such as the detoxification of pollutants, recycling of nutrients, control of pest outbreaks and diseases, and regulation of climate, atmospheric gases, and the water cycle on which humanity depends. If the ecosystem is damaged by habitat destruction, pollution, or over-fishing, the delivery of goods and services is impaired.

Essential goods and services are provided by many types of ocean ecosystems: coral reefs, kelp forests, mangroves, salt marshes, mud flats, estuaries, rocky shores, sandy beaches, sea mounts, continental shelves, abyssal plains, and open oceans. Each ecosystem contains many types of species that interact with each other and influence the physical and chemical environment.

Marine reserves protect major portions of an ecosystem, including all the habitats, plants, and animals. This protection allows the environment, the species, and their interactions to function in a manner that benefits humanity's wants and needs.

Scientists have found that the average biomass, or weight of all animals and plants studied, is more than four times larger in reserves than in unprotected areas nearby. On average, the density, or number of animals in an area, triples, and the number of species is 1.7 times higher in marine reserves than in unprotected areas. In addition, the average body size of animals is 1.8 times larger in reserves than in fished areas. These findings include not just fished species but other plants, invertebrates, and fishes.

The Benefits and Principles of "no-take" zones in Marine National Parks

"No-take" zones increase productivity because:

- protection from fishing allows animals in reserves to survive longer and grow larger.
- habitats can recover inside reserves and better sustain the plants and animals that rely on them.
- the plentiful prey in reserves can support more predators.

Marine reserves are currently the only marine management tool that provides this unique combination of effects, promoting the recovery of entire ecosystems.

L**arge populations are important:** Small populations are more likely to be driven to extinction by unpredictable catastrophes, such as oil spills. Large populations include more individuals and so they are more likely to contain individuals that are capable of surviving various stresses. In addition, population size can influence the reproductive success of animals that release their eggs and sperm into the water, such as abalone and sea cucumbers; when these animals are rare, their eggs and sperm can become so diluted that little or no fertilization occurs.

Outside the "no-take" zones

Although marine reserves aim to protect the habitats and to restore particular sites their benefits extend to areas outside the "no-take" zones. Spillover actually augments populations outside reserves.

The "spillover" into neighboring areas enables tiny newly born animals, called "larvae," and plant "propagules" to drift out of a reserve and "seed" the surrounding waters. This process is called "export." Spillover and export enables marine reserves to replenish nearby populations.

Because marine reserves tend to harbor larger populations than surrounding waters, some animals may move into less-crowded areas nearby to avoid competition for resources such as food and living space.

The rate of spillover of adults and juveniles increases with time after reserve establishment as populations become increasingly dense in the protected area. In addition, some fishes move from one habitat to another as they grow, regardless of population size, and may leave a reserve for this reason. The spillover depends in part on the mobility of species. Species that are attached to the seafloor as adults, such as mussels and clams, cannot migrate outside reserve boundaries, but swimming and crawling species like fish and crabs can.

Size: Because of the many different patterns of movement and habitat use among species, models suggest that one of the most effective strategies for protecting many species is to establish a network of multiple reserves of different sizes that are strategically placed in critical habitats.

(A) Currents often carry young animals and plant propagules away from their birthplace.

(B) Young produced in a large reserve are likely to stay in the reserve, which contributes to conservation. However, large reserves reduce the area open to local commercial and recreational fishing.

(C) A small reserve may protect animals while they are in the reserve, but most young may settle and grow in surrounding waters. If reserves are too small, few populations in the reserves will be able to sustain themselves, and the reserves are unlikely to contribute many young to adjacent fishing grounds.

(D) An alternative is to establish a net-work of reserves connected to each other through movement. Some animals and plants will be protected in reserves and others will move into surrounding waters.

This Backgrounder produced by the Fraser Island Defenders Organization as a supplement to MOONBI 112 is intended to show how larger "no-take" zones in accordance with the IUCN's recommended 20% to 30% can increase the Great Sandy Marine Park's productivity.

PISCO's General Principles in relation to Martine Reserves

- In marine reserves, animals and plants usually increase in their biomass, abundance, numbers of species, and body size — factors that can increase ecosystem resilience and productivity.
- Biological changes in marine reserves occur because individuals are not killed by fishing, and because their habitat is protected.
- Larger fishes and invertebrates typically produce substantially more young.
- Many species, not just those that are fished, respond positively to the protection of entire ecosystems in marine reserves.
- Each habitat supports a unique community of plants and animals.
- Many animals use more than one habitat during their lives, and if any one of these habitats is degraded, these animals may not be able to complete their life cycles
- Marine reserves that include several different types of habitats can be an effective way of protecting entire ecosystems.13
- Fast-growing animals that mature quickly and produce many young can respond rapidly to protection within reserves
- .Slow-growing animals that mature at a relatively old age and produce few young take longer to respond
- Currents carry larvae and nutrients, providing connections between different places in the oceans.
- Ocean water properties, such as temperature, can determine the types of animals and plants are found in a particular area.
- Small reserves can have positive effects within their boundaries. However, when a reserve is small, the overall benefits are small since few species are protected.
- If a reserve is very large, it will likely satisfy conservation goals, but fishing effort may be crowded into small spaces.
- Reserve areas of moderate size can protect and restore important habitats, plants, and animals while leaving substantial areas of the ocean open to fishing.
- As reserve size increases, the potential fisheries benefit from spillover and larval production will increase. After a certain point, the reserve becomes so large that spillover and export no longer offset the losses to fisheries due to the reduction in fishing grounds.
- A "network" includes a series of marine reserves connected by larval dispersal or juvenile and adult migration.
- To be an effective network, reserves must be located in critical and productive habitats, such as breeding grounds, and spaced appropriately to assure larval transport between them.
- Although mathematical models and our knowledge of life history and ecology of marine species suggest that networking is likely to be an effective strategy, few reserves have been established as networks.
- Reserve design can be based upon ecological, economic, and personal knowledge.
- Useful ecological criteria have been identified to guide reserve design.