WHAT IS AT STAKE? LIFE IN THE OCEANS.

Roger Grace

The sea means different things to different people. Some regard it as a “bread basket”, where they can take fish and other seafood for fun, for sustenance, or for commercial gain. Others regard the sea as a reservoir for biodiversity, with huge potential for pharmaceutically active substances from the vast array of sponges and other invertebrates smothering every square centimetre of deeper rocky reefs.

At the subtropical Kermadec Islands, our most northern territory, large tropical corals add an aspect unusual in New Zealand waters. Small numbers of crown of thorns seastars munch their way through the corals, just as they do in more tropical seas. Tropical lionfish look out of place in New Zealand waters. The Kermadec Islands Marine Reserve is host to probably the largest virtually intact population of tropical grouper in the world, their curiosity bringing them up close and personal with fascinated divers.

At the other extreme of the country, rich invertebrate life festoons the steep rock walls of Fiordland, where unique hydrological conditions encourage normally deep water red coral to occur in as little as six metres of water. And further south the open coasts and subantarctic islands are host to forests of giant *Macrocystis* kelp reaching as much as 30 metres from the seabed up to the life-supporting light.

Our northern harbours and estuaries are nurseries for coastal fishes such as the herbivorous parore, shellfish beds are popular for harvesters, and mangroves play an important part in the estuarine ecology but in some areas are expanding so fast they are becoming a nuisance.

And then there is the deep water beyond the continental shelf, the special realm of the deep sea trawlers, which drag their nets over seamounts 1000 metres down, not only catching the target orange roughy but numerous other unwanted weird and bizarre fish which never see the light of day, and knocking off bubble-coral “trees” several hundred years old in the process.

There is so much variety of sea life out there it is not possible to discuss it all in this programme. I will instead restrict my comments to life of our northern shallow rocky reefs, an area dear to the hearts of many recreational and commercial fishermen, scuba-divers, snorkellers and boaties.

Life on the rocky bottom shows a zonation pattern by depth, relating primarily to light levels and water movement. The typical pattern in northeastern New Zealand is a narrow band of mixed algae around low tide and a little deeper, dominated normally by species of *Carpophyllum*. This is the shallow mixed weed zone.

Below that is a band with no large algae, but instead a thin layer of red coralline seaweed affectionately known as coralline paint. The most obvious animal is the sea urchin or kina, which forms huge aggregations of 20 or even 50 per square metre. This is the kina barren. Up until a few years ago scientists thought the kina barren was just part of the natural sequence of zones on our shallow rocky reefs. We now know this zone is actually an artifact of fishing – more on that later.

Then there is the kelp forest – *Ecklonia radiata* – with its holdfast and erect stalk holding the fluffy top aloft toward the light. Beneath its shelter is a wealth of invertebrate life attached to the rock surface.

Heading deeper the kelp thins out as light levels become too dim to support large seaweeds, and at around 20 metres or so in the mid to outer Hauraki Gulf the bottom becomes dominated by a rich sponge garden of filter-feeding animals, including bryozoans, hydroids and sea squirts.

With many years of fishing pressure on the popular fish and other seafood species of the shallow rocky reefs, what have we lost over the years?

One of the largest of our reef fish is the hapuku. We think of hapuku as a deep water fish. It is caught by recreational anglers on rocky pinnacles on the edge of the continental shelf in 200 metres of water. Yet few people realize it was a common fish on our shallow reefs as little as 65 years ago. Because of heavy fishing pressure, hapuku is now extinct in diving depths, the remaining small population having retreated to much deeper water.

Red crayfish, once abundant on our shallow reefs, are now reduced to well under one percent of their original numbers, although in slightly deeper water they form the basis of an apparently sustainable fishery.

Snapper, our most important inshore fish from a recreational and commercial fishing point of view, is the target of intensive fisheries management effort to maintain stocks at around 20% of its pre-fished biomass, yet on the west coast its population has dropped to only 8%.

Historic data on snapper shows that in 1850 the snapper stock in northeastern New Zealand was around 270 thousand tonnes. In the early half of the 1900's the numbers dropped dramatically with the introduction of industrial fishing using trawlers and Danish seines which scooped up vast numbers of snapper. In 1986 the Quota Management System (QMS) was introduced, stabilizing and controlling snapper numbers.

Most commercial fish in NZ are managed to try to achieve the maximum sustainable yield or MSY. Fisheries science tells us that to achieve MSY for snapper, the population should be maintained at about 20% of its pre-fished biomass. This policy is applied throughout the fishery but it does have side-effects. The population becomes deficient in larger specimens, most fish ending up a little over the minimum legal size limit. That has implications for breeding. With 80% of the biomass of this predator removed, major trophic cascade effects occur on the associated ecology.

If we look at the population structure of snapper under different regimes and compare it to a reconstruction of the unfished population structure, we can see huge differences. The unfished population had many older fish – 20, 30, and 40 year old fish – and given a chance snapper can live to at least 60 years. The shape of the curve for the fished stock shows a very steep drop as soon as the fish reach a legal takeable size which equates roughly to 6 or 7 years. Most of the fish are caught soon afterwards. The curve for snapper in the marine reserve at Goat Island shows a lot more larger fish than in the fished population, but still nowhere close to the population structure of the unfished stock. Scientists have calculated that if we wanted to get back to the original pre-fishing population structure, this would be achievable if we had a no-take marine reserve of at least 40 square kilometers in area.

What about trophic cascade effects of removing 80% of the snapper population?

One of the richest shallow reef communities is the life associated with the *Ecklonia* kelp forest. Scientists from the Auckland Museum have found over 350 species living in the holdfasts of the kelp. Many invertebrate species live in the kelp forest only because of the shelter from light offered by the dense canopy of kelp fronds.

With so few snapper and crayfish on our shallow reefs because of heavy fishing pressure, one of their main prey species, the kina or sea urchin, has multiplied to huge numbers. They in turn eat kelp, and large areas of our shallow rock reefs have been stripped of their kelp cover by feeding hordes of kina.

Kina barrens are now widespread from North Cape to East Cape and in some more southern areas. This represents a huge loss of biodiversity and a major ecological disturbance directly attributable to taking too many snapper and crayfish from our shallow seas.

The extent of the kina barrens, and a history of their development, can be seen by examining aerial photographs of the coast over a long time period. This example shows a small emergent reef surrounded by shallow rock on a sandy bottom. In the 1950 photo the submerged reef is dark because it is covered in kelp. In the 2003 photo most of the reef is pale-coloured because the kelp is gone and the reef is now covered with coralline paint being grazed by kina.

Even in the marine park at Mimiwhangata, where commercial fishing is banned but recreational fishing is allowed, the shallow reefs are dominated by extensive kina barrens which show pale in the aerial photograph.

Closer to Auckland at Tiritiri Island where normal fisheries regulations apply, the shallow reefs are now kina barren deserts showing pale in this 2005 aerial photo. Some of my first dives were carried out in this area in 1961, when *Ecklonia* forest covered all the reefs and crayfish bristled out of every crevice! We have lost a lot in 50 years.

How can we fix these problems and restore some of the rich vibrancy of life in at least parts of our seas?

We can begin to get some ideas by looking at changes which have happened in some of our long-established marine reserves and no-take marine parks. Tawharanui Marine Park is a good example where monitoring has been going on for 34 years and there has been a no-take zone for 30 years.

The no-take Marine Park is on the north coast of Tawharanui. Five of my monitoring sites are inside the protected zone and five are outside on the fished coast.

If we look at changes in legal-sized red crayfish, prior to protection in 1981 there were small numbers of crayfish scattered through all monitoring sites. There had already been heavy fishing pressure on crayfish which had been reduced to a fraction of their former numbers. Just a few years after protection within the Park, legal-sized crayfish on the fished sites outside the Park dropped away to zero, and have remained that way ever since. In contrast, legal-sized crayfish at sites inside the protected zone gradually increased in numbers and sizes, and by 2010 had reached a staggering 1000 per hectare and over 800 kilogrammes per hectare.

Large crayfish are now common in the protected Marine Park, with many two and three kilogramme crays accompanied by a whole size range of animals in what seems now to be approaching a natural, healthy functioning population structure. Outside the protected zone the population is so scattered and of such small animals that it must be dysfunctional.

Not only have the numbers and sizes of the iconic species like crayfish and snapper increased, but associated habitat changes have occurred as well. The map of the western end of the Tawharanui Marine Park shows shallow reefs in the protected area and others to the west in the fished area. Those in the protected area have a continuous cover of algal forest, with shallow mixed weed species like *Carpophyllum* giving way to *Ecklonia* on the slightly deeper reefs. In the fished area to the west, there is a narrow band of *Carpophyllum* at and just below low water, but that quickly gives way to an extensive area of kina barren. Only on the very outer edges of the reef just before the sand is there a narrow fringe of *Ecklonia* forest.

A detailed aerial photo of Comet Reef inside the western boundary of the Park shows all the submerged reef as a dark colour, and an underwater photograph confirms that the reef is covered with *Ecklonia* kelp, and is in a healthy natural state.

A detailed aerial photo of Pukenihinihi Reef to the west outside the Park shows most of the submerged reef is a pale colour, and the underwater photograph confirms that this reef is mostly a kina barren, and in a seriously degraded state.

Parallel monitoring programmes have been carried out since the mid-1970's at Mimiwhangata Marine Park in Northland and at Tawharanui Marine Park in the Hauraki Gulf. At Mimiwhangata, some restrictions were placed on recreational fishing in 1984, and commercial fishing was banned in 1994. So since 1994 a partial-protection regime has been in place: No commercial fishing, but recreational fishing allowed. At Tawharanui Marine Park all fishing was banned in 1981, with normal fishing regulations applying outside the Park boundary.

From a wealth of other data, I have selected results for legal-sized red crayfish and divided them into decadal time groups for the three protection scenarios: Tawharanui open fishing area; Mimiwhangata partial protection; Tawharanui no-take zone. It is clear from the graph that in the Tawharanui open fishing area crayfish numbers dropped away to zero and have stayed that way. At Mimiwhangata, crayfish numbers have continued to decline to a very low level. Only in the Tawharanui no-take zone has there been any increase in crayfish over the 30+ years of protection, and that increase has been spectacular. The message is clear that if you want to get a positive result for marine conservation, then total protection is the best option. Partial protection is almost certainly doomed to fail.

At the Poor Knights Islands, a partially protected Marine Reserve was put in place in 1981. It was considered that fish life was not recovering as expected so in 1998 the whole reserve became fully protected. Within two years snapper numbers had increased 16 times, and within 10 years large snapper became common throughout the reserve.

May we have an opportunity within the Hauraki Gulf Marine Park to take a different approach to fisheries management and put in place a trial which could maintain a satisfactory fishing regime but also promote a recovery of degraded shallow reefs? Instead of striving for the maximum sustainable yield which requires elimination of 80% of snapper from the population, could we accept a slightly reduced yield by leaving more fish in the sea and maintaining the population at around 40 to 50% of the pre-fished stock?. Together with a similar approach to crayfish

management, we could see a recovery of snapper and crayfish to a point where kina barrens disappear and the shallow reefs revert to the rich kelp forests they once were, with much more abundant and larger fish.

This new approach to fisheries management within the Hauraki Gulf would still need to be supplemented by an effective network of Marine Reserves representing all habitats, and covering at least 10% of the Gulf. The features of the Hauraki Gulf which we all enjoy could be protected and enhanced for future generations.

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