Concrete ideas for inshore fisheries

Artificial reefs are ideal havens for marine life if managed correctly, reckons Jenny Beaumont.

With an ever-increasing global human population, the majority of whom live in coastal areas, we can expect existing high pressures on inshore fisheries to increase. At the same time, changing weather patterns may produce a greater need for coastal defences. Add to this renewable energy sources, such as wind turbines, many of which are located offshore, and it is likely that we will place more artificial structures in coastal waters in the near future.

On a small-scale, artificial reefs, which include structures such as breakwaters and offshore wind farms, have a long history of enhancing, protecting and restoring selected fisheries. However, scientists have conducted little robust research into them and so have few reliable estimates of their value. The increasing size and number of artificial structures in the sea presents a real opportunity to combine the primary need for them being there with a design that could also benefit local fisheries.

In 1996 the Scottish Association for Marine Science joined forces with a quarrying company, Foster Yeoman Limited, to design and construct a matrix of artificial reefs large enough to generate some of the scientific and economic estimates that could aid future construction projects. Since 2002, following a period of consultation and pre-deployment research, we accurately placed nearly 200,000 concrete reef blocks on the seabed in Loch Linnhe, on the west coast of Scotland, to create one of the largest artificial reef complexes in Europe.

We designed the Loch Linnhe Artificial Reef with the fishing industry in mind so we could evaluate the economic potential for similar reefs. We also wanted to increase knowledge of how artificial reefs interact with their environment and affect associated reef-dwelling species.

The reef, which is about the size of 50 football pitches, sits on a licensed area of seabed. It is made up of 36 discrete reef modules deployed in depths ranging from 10 to 30 metres. Each module is a conical shaped reef measuring up to four metres high by 15 to 20m across. To create each reef module we dropped around 4000 concrete blocks (each measuring 42x21x21cm) from a barge onto a target buoy. As a result, the randomly stacked reef blocks provide many holes and crevices for marine life to use as shelter. We made half of the reef modules entirely from solid concrete blocks and the other half using blocks containing two large holes so we could examine the effects of habitat complexity on the resulting biological communities.

One of the main theories supporting artificial reef research is that the addition of a new habitat, in the form of a purpose-designed artificial reef, may increase the available shelter and food resource. This in turn will attract and support more marine life in the area. Although the majority of artificial reef research has focused on this theory, we need to consider many important questions before we can estimate the overall value of artificial reefs. For example, how does the placement of an artificial reef affect the existing natural environment? How do the biological communities on artificial reefs compare with those on natural reefs? Do artificial reefs actually increase the numbers of the fish and other marine life or do they simply attract marine life from nearby areas?

Drifting marine larvae, looking for a place to call home, quickly foul new submerged surfaces including artificial reefs. These animals, such as barnacles, sea squirts and tube worms, are filter-feeders. This means that they eat tiny floating marine plants and animals, known as plankton, that drift past them in water currents. These filter-feeders which colonise the artificial reef are eaten by mobile predators and grazers that live amongst the encrusted reef blocks such as fish, sea urchins, sea slugs and starfish. These, in turn, are eaten by higher predators and scavengers such as larger fish, crabs, squat lobsters and even the occasional octopus and conger eel. Large seaweeds, such as kelp, also grow on the tops of the reefs providing shelter for yet more marine life.

My PhD project focused on the ecological functioning of the reef and nearby natural rocky reefs. I used a combination of plastic panels and wire mesh predator exclusion cages, together with a comparison of the role of some key animal species in the food chains on the two reef types, to show that the biological communities at the base of the food web are the same at both artificial and natural reefs in Loch Linnhe. However, I found that the filter-feeding communities living on artificial reefs seemed to come under attack more than those at natural rocky reefs, which suggests that there are more predators at the artificial reef sites. This is likely to be a result of the increased habitat complexity provided by the artificial reef modules compared with the natural rocky reefs.

> "The artificial reefs support 30 times more biomass than before.

We have seen few negative impacts of artificial reef placement. Indeed, I have shown that the artificial reefs in Loch Linnhe can support up to 30 times the biomass found in the area of seabed before we built the reefs. This estimate does not include mobile animals, such as the fish species, of which there are many more on the artificial reefs now than were observed on the seabed before construction. So the estimate of a 30 times increase in biomass caused by the introduction of reefs is probably highly conservative.

Our research to date has shown that the reef modules can increase the amount of biomass that an area of seabed can support and may even be more productive than the local natural rocky reefs. Although this work is continuing, the indications are very positive. Planners and licensing bodies can use this information when they review applications for structures such as breakwaters and ballast around offshore wind farms.

Jenny Beaumont has just completed her PhD with the Scottish Association for Marine Science where she worked in a team led by Dr Martin Sayer. Fieldwork was supported, in part, by the NERC Facility for Scientific Diving.