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AS WE SEE IT

Coastal aquaculture and conservation can work together

Tim Dempster[1,*], Pablo Sanchez-Jerez[2], Fernando Tuya[3,4], Damian Fernandez-Jover[2], Just Bayle-Sempere[2], Arturo Boyra[3], Ricardo Haroun[3]

[1]SINTEF Fisheries and Aquaculture, 7465 Trondheim, Norway

[2]Department of Marine Sciences and Applied Biology, University of Alicante, PO Box 99, 03080 Alicante, Spain

[3]Biodiversity and Environmental Management Centre, Faculty of Marine Sciences, University of Las Palmas de Gran Canaria, 35017 Las Palmas, Spain

[4]*Present address:* Centre for Ecosystem Management, Edith Cowan University, 100 Joondalup Drive, Joondalup, Western Australia 6027, Australia

Current fishing practices are regarded as unsustainable (Pauly et al. 2002), yet our appetite for seafood grows. To meet the growing gap, there are increasing calls for mankind to tame the oceans through aquaculture (Marra 2005). Close to the coast, rapid expansion of marine aquaculture is underway throughout the world. Sea cages enclose 2.5 million tons of fish, while 12 million tons of mussels, oysters and clams hang from floating ropes or grow on racks or trays (FAO 2004). Aquaculture structures are now ubiquitous to many coastlines. As the expansion continues, how can we best manage the interaction between natural communities and aquaculture?

Negative impacts of marine aquaculture on the environment are widespread (see review by Naylor et al. 2000). Caged fish escape and mix with natural populations. Natural habitats are altered, either to make space for farms or through a build-up of nutrients and sediment beneath farms. The use of millions of tons of small pelagic fish each year to make fish food also places heavy fishing pressure on some natural fish stocks. Against this backdrop, the recent concept of creating Marine Protected Areas (MPAs) around coastal aquaculture installations (Dempster et al. 2002, 2005) seems like ecological heresy; how could the goals of an exploitative, industrial activity be compatible with the conservation-oriented goals of MPAs? While aquaculture sites are incompatible with the goals of MPAs, designed to conserve habitats and their biodiversity, they are ideally suited to the goal of boosting coastal wild fisheries.

Worldwide, over 330 species of fish use logs, jellyfish and seaweeds that float in the ocean as natural habitat (Castro et al. 2002). Aquaculture structures mimic these natural floating objects and are highly attractive habitats for many species of wild fish. Fish farms covering an area of just 1 to 4 ha may have up to 40 tons of wild fish around them (Dempster et al. 2004). These fish would otherwise be typically scattered across hundreds to thousands of hectares (Dempster et al. 2002). The phenomenon is widespread across the globe; large aggregations of wild fish occur around fish farms along the Mediterranean coasts of Spain (Dempster et al. 2002) and Greece (Thetmeyer et al. 2003), and around the Canary Islands (Boyra et al. 2004, Tuya et al. 2006), Scotland (Carss 1990), Norway (Bjordal & Skar 1992), Indonesia (D. McKinnon pers. comm.) and Australia (Dempster et al. 2004). Mussel farms also aggregate wild fish (Brehmer et al. 2003).

Wild fish that gather at farms tend to be large adults (Dempster et al. 2002). This is important as the 'big ones' do most of the spawning and produce the next generation (Birkeland & Dayton 2005). The constant supply of high protein food when feed is lost through the cages also means that these big fish are in better body condition than their wild counterparts elsewhere in the sea (Fernandez-Jover et al. 2006). Better condition increases the spawning success of fish (Izquierdo et al. 2001). Higher-order predators, such as large pelagic fish, rays and dolphins, are also present at farms to feed on the aggregated wild fish (Dempster et al. 2002, 2005, Boyra et al. 2004). Many of the fish species that occur at farms in high numbers are commercially important to coastal fisheries and are already subject to heavy fishing pressure.

MPAs designed to enhance fisheries generally aim to increase the number of large-sized fish to enhance the

*Email: tim.dempster@sintef.no

spawning stock and enable 'spillover' of both larvae and adults into surrounding areas (Roberts et al. 2001). This is achieved by protecting particular areas of habitat from fishing so that fish can grow to become large adults. Aggregation of large numbers of adult wild fish at fish farms and the increase in their condition achieves the goals of an MPA almost perfectly. Only protection is missing. Partial protection from fishing exists in a handful of areas, but no restrictions apply in the vast majority of countries that practise coastal aquaculture.

Another good reason to keep wild fish near fish farms is that they reduce the impact of farms on the seafloor (Dempster et al. 2005). Nutrient and sediment waste flows out from fish farms in the form of food and faeces. If the amount of such waste is high, the diversity of the seafloor flora and fauna in the surrounding areas can change dramatically. Most of the wild fish beneath farms eat food lost from the cages, thereby reducing the waste that reaches the seafloor by up to 80% (Vita et al. 2004).

Creating no-fishing MPA zones at fish farms will not relieve the pressure that culturing carnivorous fish species places on stocks of small pelagic fish that are used to make fish food (Naylor et al. 2000), nor will it be a panacea for all the environmental ills of coastal aquaculture. However, it will provide greater resilience for fish stocks where coastal aquaculture is practiced.

Thousands to tens of thousands of aquaculture sites currently operate in coastal waters. If each site aggregates tons to tens of tons of wild fish, we estimate that prohibiting fishing around coastal aquaculture sites worldwide would protect many tens of thousands of tons of adult spawning stock of wild fish vulnerable to fishing. As wild fish stocks diminish and oil prices rise, fishermen will naturally seek profitable alternatives and heavily target aggregations of wild fish near aquaculture sites. This may contribute further to overfishing.

New ecological knowledge shows that creating no-fishing MPAs at coastal aquaculture sites will boost coastal fish stocks and harness the ability of wild fish to reduce negative impacts upon the seafloor. Over the last 20 yr, marine aquaculture and conservation have been in conflict; numerous studies have demonstrated negative impacts of escaped cultured fish, transfer of parasites and disease, and alteration of the underlying benthic fauna. This array of impacts has dominated farm management in the coastal zone. We advocate that management of the impact of farms on closely associated wild fish should be considered equally important: fish farmers, conservationists and regulatory agencies should work together to protect wild fishes that aggregate at coastal fish farms.

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