

Part III

SHOULD ANYONE BUILD REEFS?

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Clearly my two distinguished panelists have fallen under the seductive spell of artificial reefs and are unable to view them objectively as just one of many fishery management tools. I can sympathize with them. Many of us here have built an artificial reef on a barren ocean bottom to evaluate them for fishery management. When the site is revisited later, it is supporting a thriving marine community. It is easy to feel a rush of satisfaction observing the life created at the reef. It is difficult to resist the strong desire to further evaluate the effects of different designs, more holes, more height, different materials, different spacings, and so on. We probably all know colleagues, not ourselves of course, who are so caught up in evaluating reef designs that they have lost sight of the reason for building the reefs: to evaluate them as a tool for fishery management. These people cannot pass a scrap yard without looking for reef building materials; their pulse rate skyrockets when they look at catalogues full of pictures of Japanese artificial reef modules. However, to objectively evaluate artificial reefs, it is necessary to look at the fishery rather than just at the artificial reef site. We need to consider artificial reefs as just another management tool along with minimum sizes, closed seasons, catch limits, limited entry, closed areas, effort or gear restriction, and protection and restoration of natural habitat. When we do this, it becomes apparent that, relative to other management tools, artificial reefs are generally inefficient and, at worst, counterproductive and expensive.

Most fishery managers in the United States will tell you that the biggest problem they face is prevention of, or more often recovery from, overfishing. Often it is when catches have fallen due to overfishing that people clamor for artificial reefs. Unfortunately, they are not the appropriate tool to solve this or most other problems facing United States fisheries. As an example, let's take the case of overfishing. There are two types of overfishing: growth overfishing and recruitment overfishing. In the case of growth overfishing, the maximum yield of a fishery for a given level of fishing effort is not achieved because the fish being harvested are too small. Often the correct choice of a minimum size increases the landing weight by at least 10%, and the only cost is the salary of a few enforcement agents. Even assuming artificial reefs can actually increase fishery production, for artificial reefs to increase landings of the east coast snapper fishery, for example, by 10% requires that artificial reefs equivalent to 10% of the most productive natural habitat be deployed. This would be prohibitively expensive and inefficient. At worst, artificial reefs may cause young fish below the optimum size of harvest to be vulnerable to fishing gear and, hence, increase growth overfishing. This appears to be the case with tunas caught around fish aggregating devices. Clearly artificial reefs are

an inappropriate tool to solve growth overfishing, yet they are commonly proposed and used in this situation instead of the less popular but more effective strategy of managing size at entry and fishing effort.

Recruitment overfishing, the other type of overfishing, occurs when the spawning stock biomass has been overfished and the stock is at low levels as a result of reduced larval recruitment. Here the tools managers need involve limiting fishing effort and/or protecting and replenishing the spawning stock. When the stock has been substantially reduced, habitat certainly is not limiting. Recall that the natural habitat supported a much larger pre-exploitation biomass. When a stock is fished at its maximum sustainable yield (MSY) level, the biomass may be about 50% of its pre-exploitation biomass, and when recruitment overfishing occurs, the stock may be further reduced to $\leq 25\%$ of the pre-exploitation biomass. As long as habitat has not been greatly reduced, even at MSY and more so when recruitment overfishing occurs, there is plenty of habitat per fish, and additional habitat in the form of artificial reefs is totally unnecessary. Again, artificial reefs are inappropriate as a tool to solve recruitment overfishing and yet are frequently proposed instead of less popular effort restrictions. It is amazing that when fish stocks are overfished and not enough fish occupy all the natural habitat, people spend money to dump more habitat into the ocean and argue about how expensive the material should be and whether to use volunteers or pay fishery biologists.

Some fishery managers take the view that just by aggregating fishes, artificial reefs are helping the fishermen. If the stocks are already overfished, aggregation will result in lower equilibrium catches. The reason is that aggregation increases catchability which increases fishing mortality even if fishing effort does not increase. But frequently, artificial reefs also result in a shift in fishing effort from the natural habitat, where stocks are less aggregated to the artificial reefs, where stocks are more highly aggregated. This additional effort, targeting aggregated fishes, where catchability is higher, further increases fishing mortality. This increase in fishing mortality due to the artificial reefs moves the fishery further along the descending limb of the production curve to lower catches.

Some biologists assume that, if it is shown that artificial reefs actually increase fishery production, that alone is sufficient to justify their use. Their assumption, of course, is wrong. Not even demonstrating the cost effectiveness of artificial reefs is sufficient to justify their use. It must be shown that, relative to other management tools, artificial reefs represent the best long-term management strategy.

I challenge you to look at all the papers that promote the benefits of artificial reef in this conference and ask: Are they just a short-term fix or really beneficial in the long-term? Can the same result be achieved more efficiently with a management tool other than artificial reefs?

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