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The Artificial Reef Debate: Are We Asking the Wrong Questions?

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COMMENTARY

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THE ARTIFICIAL REEF DEBATE: ARE WE ASKING THE WRONG QUESTIONS?—In the last several decades, and especially the last 5 yr, an enormous amount of literature has been published on artificial reef ecology (e.g., Fifth International Conference on Aquatic Habitat Enhancement, Bulletin of Marine Science 55: 265–1360, 1994; Special Issue on Artificial Reef Management, Fisheries 22: 17–36, 1997; Bortone, 1998; Technology and Management of Artificial Reefs: An Update, Gulf of Mexico Science 16: 31–105, 1998). Although numerous aspects of the issue have been addressed in these works, such as materials of construction, critical minimum size of area, and rates of recruitment, the one persistent question that appears to dominate all the synoptic treatises is do reefs simply aggregate fishes (and other organisms), or is an actual increased production of biomass attributable to reefs (Bohnsack, 1989; Bohnsack et al., 1997)?

The relevance of this question seems obvious. If the former is true, then reefs may be detrimental to fish populations, making certain species easier to harvest, thus accelerating the decline of stressed stocks. This opinion is held by many workers, at least in certain instances (Bohnsack et al., 1997; Grossman et al., 1997; Lindberg, 1997). Therefore, the utility of reefs as a management tool is discouraged and deemed counterproductive. With the latter hypothesis, increased biomass productivity is generally regarded as a positive, and unless the productive benefits are overwhelmed by increased fishing activity, artificial reefs are viewed as a viable and positive management tool.

The current status of the debate seems to have reached a partial "resolution" of sorts, with the general acceptance that much depends on location. The general agreement seems to be that in areas with little natural hard bottom, reefs may be beneficial in providing habitat that is limited (Grossman et al., 1997; Bortone, 1998). But in areas where abundant hard bottom is available, thus habitat is not limiting, placement of additional reefs is, at best, neutral and, perhaps, counterproductive.

Aggregation vs production: does it really matter?—Although I do not disagree with this consensus, I think it fails to address the aggregation vs production question. For what we really see in the location solution is not that production is necessarily increased where hard bottom is limited but that there is a fundamental modification of habitat. And with this, there is a concurrent transformation of biota. For instance, in a flat sandy mud environment such as is found in the north central Gulf of Mexico shelf, placement of artificial reefs displaces a fish fauna dominated by small benthic species with larger reef-related forms. A net change in fish biomass may or may not occur, but does that really matter from a management perspective? I am not so naïve that I don't realize that for many workers the production aspect really means production of desirable reef species (Grossman et al., 1997), but to many, it is a matter of production per se. Hard bottom is thought to support primary and secondary production, with the successional sequence of encrusting organisms, increased refuge habitat for prey species, and actual increase in biomass the result (Carter et al., 1985; Pamintuan et al., 1994; also see Stone et al., 1979; Bohnsack, 1989; Lindberg, 1997).

The Alabama shelf: a case study.—For a case study, I will use the expansive flat inner shelf of the north central Gulf of Mexico off Alabama. A large portion (4,000+ km^2) has been prepermitted for placement of artificial reef structure (Fig. 1). This area has been previously referenced and its history and current fishery status are well documented (Szedlmayer and Shipp, 1994; Minton and Heath, 1998).

Because this is probably the largest unified artificial reef site in the United States, and possibly in the world, it lends itself well to this discussion. During the decade of the 1970s, before establishment of the 4000+ reef area, we conducted a series of trawling surveys on this portion of the shelf. The study, designated SAMERI (South Alabama Marine Environmental Resource Investigation) included nearly 100 trawl samples, of 15-min tow time, with a 30-foot semiballoon trawl, at 15 fathoms. The sampling was conducted over 3 yr. Although the detailed seasonal and spatial variation and species composition are beyond the scope of this commentary, the fish faunal elements were dominated by relatively diminutive soft bottom species (Table 1), reflecting the near total lack

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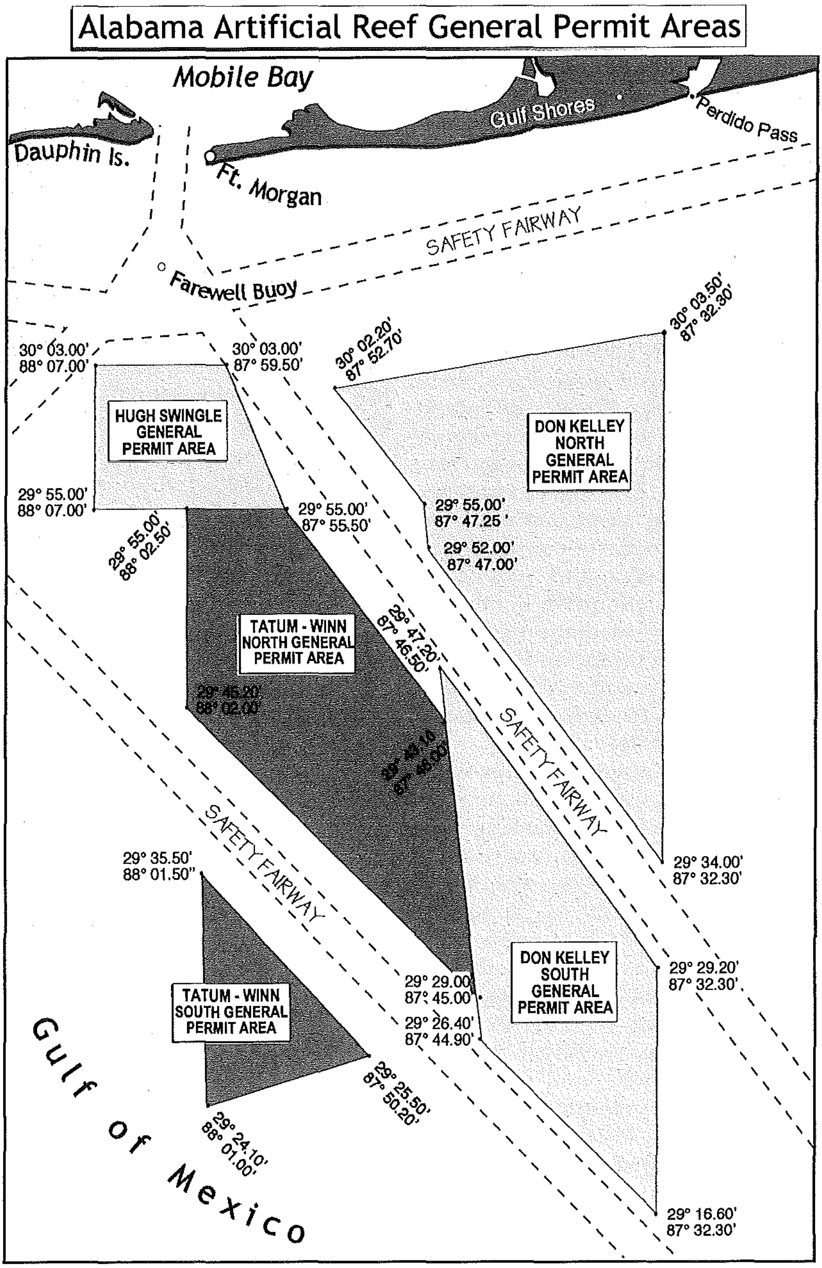

Fig. 1. Map of artificial reef permit area off the Alabama coastline. Prepared by Ralph Havard, Alabama Department of Conservation, Marine Resources Division.

of hard bottom in the area. The few reef species collected were juveniles or subadults (e.g., red snapper, *Lutjanus campechanus*).

The trawled species are almost exclusively of no current economic importance. The dominant groups are flounders and other flatfishes, cusk-eels, sea robins, and small species of sea basses. The flounder species all mature at very small sizes (maximum of 200 mm) and are not exploited. The cusk-eels are a dominant faunal component, primarily fossorial diurnally, but are an important prey species when they forage nocturnally. The other species are also too small to have any commercial value other than as minor components of the ground fish harvest. All of these species have extensive ranges over the entire Gulf of Mexico shelf, and many also on the United States Atlantic coast, thus

Table 1. Finfish catch of 30-foot semiballoon otter trawls taken in 15 fathoms, south of Mobile Bay during May (SAM 574-4, diurnal) and October (SAM 1074-2, diurnal, and SAM 1074-4, nocturnal) 1974 in areas now included in permitted artificial reef site (see Fig. 1).

Species	No. caught
SAM 574-4, diurnal	
Saurida brasiliensis, largescale lizardfish	14 juvenile–adults
Serraniculus pumilio, pygmy sea bass	2 juveniles
Centropristis philadelphica, rock sea bass	1 juvenile
Priacanthus arenatus, bigeye	1 juvenile
Lutjanus campechanus, red snapper	3 juveniles
Trichiurus lepturus, cutlassfish	2 juveniles
Peprilus burti, gulf butterfish	2 juveniles
Citharichthys macrops spotted whiff	1 adult
Ancylopsetta quadrocellata, ocellated flounder	1 adult
Etropus crossotus, fringed flounder	6 adults
Etropus rimosus, gray flounder	1 juvenile
Syacium gunteri, shoal flounder	61 juvenile–adults
Syacium papillosum, dusky flounder	15 juvenile–adults
Symphurus civitatus, offshore tonguefish	3 adults
Symphurus diomedianus, spottedfin tonguefish	1 adult
Monacanthus hispidus, planehead filefish	1 juvenile
Sphoeroides parvus, least puffer	4 adults
SAM 1074-2, diurnal	
Gymnothorax nigromarginatus, blackedge moray	2 juveniles
Porichthys porosissimus, midshipman	3 juvenile–adults
Halieutichthys aculeatus, pancake batfish	6 adults
Lepophidium brevibarbi, blackedge cusk-eel	30 adults
Ophidion welshi, crested cusk-eel	2 adults
Scorpaena calcarata, smoothhead scorpionfish	18 juveniles
Chaetodipterus faber, spadefish	1 subadult
Diplectrum bivittatum, dwarf sand perch	80 juvenile–adults
Centropristis philadelphica, rock sea bass	11 adults
Chloroscombrus chrysurus, bumper	10 juveniles
Lutjanus campechanus, red snapper	13 juveniles
Lutjanus synagris, lane snapper	5 subadults
Citharichthys spilopterus, bay whiff	1 juvenile
Cyclopsetta chittendeni, Mexican flounder	4 subadults
Etropus crossotus, fringed flounder	8 adults
Etropus rimosus, gray flounder	2 subadults
Syacium gunteri, shoal flounder	164 juveniles
Symphurus diomedianus, spotfin tonguefish	3 subadult–adults
Symphurus civitatus, offshore tonguefish	3 adults
Sphoeroides parvus, least puffer	24 subadults
SAM 1074-4, nocturnal	
Ophichthus punticeps, palespotted snake eel	1 adult
Trachinocephalus myops, snakefish	5 adults
Lepophidiun jeannae, mottled cusk-eel	2 adults
Lepophidum brevibarbi, blackedge cusk-eel	1 adult
Ophidion holbrooki, bank cusk-eel	2 adults
Ophidion welshi, crested cusk-eel	1 adult
Scorpaena calcarata, smoothhead scorpionfish	48 juveniles
Bellator militaris, horned searobin	3 juveniles
Prionotus ophryas, bandtail searobin	3 adults
Prionotus roseus, bluespotted searobin	7 adults
Centropristis philadelphica, rock sea bass	5 subadult–adults
Lutjanus campechanus, red snapper	11 juvenile–subadults
Lutjanus synagris, lane snapper	2 subadults
Eucinostomus gula, silver jenny	13 adults
Stenotomus caprinus, longspine porgy	8 subadults
Etropus rimosus, gray flounder	10 adults
Ancylopsetta quadrocellata, oellated flounder	1 adult
Syphurus diomedianus, spotfin tonguefish	4 adults
Symphurus civitatus, offshore tonguefish	2 adults

Fig. 2. Seafood dock at Mobile, Alabama, circa 1895, with a wagon load of red snappers. From the Armistead Collection, archives of the University of South Alabama.

are in no danger of any imaginable substantial stock depletion.

This trawled bottom now is contained mostly within the heart of the reef permit area (Fig. 1). Approximately 8,000–10,000 artificial structures have been placed there, constructed of various materials (Minton and Heath, 1998). Included are 100 decommissioned army tanks, cement bridge rubble resulting from hurricane damage, thousands of buses and automobiles, prefabricated cement modules, and a variety of other structures. Early in the program, little restraint was placed on materials for reef deployment, and thousands of reef sites have probably been removed or destroyed by hurricanes and other natural events. Nevertheless, because of recent more stringent regulations on reef materials, several thousand likely remain.

When reef structure is placed in these areas, the reef biota is in sharp contrast to the preexisting fauna. Previous to the reef building effort, few reef fish were taken off the Alabama shelf (Minton and Heath, 1998). Although historically Mobile was considered a major market for red snapper (Fig. 2), these fish were harvested primarily from Pensacola southeastward to Tampa (McEachran and Fechhelm, 1998) or from the Campeche Banks off Mexico (Albert King, pers. comm.). But Schirrippa (1998) reported that recently more than a third of recreationally caught red snapper from the Gulf of Mexico came from off Alabama, although this area represents less than 5% of the U.S. Gulf shelf. Similar statistics are provided by the 1993–96 Southeast Area Monitoring and Assessment Program (SEAMAP). Thus, the ichthyofauna of a quarter century ago has been transformed from an economically depauparate biomass to one supporting an industry, which, according to Minton and Heath (1998), is valued at 60 million dollars annually. Has the total biomass increased? We don't know. Does it matter in terms of management decisions? I think the citizens of Alabama's coastal communities would offer a strong negative.

Research needs.—Other questions are relevant, even if those regarding absolute biomass

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changes are not. If, in fact, there is some dependence on surrounding forage species for the reef residents, this would eventually become limiting to the carrying capacity of the reefs. Bioenergetic studies to address carrying capacity are strongly warranted and, in fact, are currently under way in the Alabama setting (James Cowan, pers. comm.). Likewise, if these large areas do approach maximum carrying capacity, or if these micro population concentration centers are disturbed or even destroyed, do the reef residents move to nearby or even more distant sites, thus becoming de facto emigration resources for other areas? This latter question was partially answered by Watterson et al. (1998) for the Alabama stocks. Their data strongly indicated hurricane impacts on the reef structures off Alabama resulted in near unidirectional migration of red snappers eastward, with many tagged fish from Alabama taken off the Florida panhandle as far east as Apalachee Bay.

Artificial reefs as marine sanctuaries.—The issue of marine reserves is emerging rapidly as a possible management tool for marine fish stocks. Several papers have addressed this issue recently (Bohnsack, 1994, 1998). The South Atlantic Fishery Management Council is considering creating reserves in habitat not currently used by fishers. Such a decision seems well founded on the basis of the Alabama experience. And the success of such an action is not likely to depend on whether artificial reefs aggregate fish or actually produce biomass.

Summary.—The production–aggregation debate has become central to much of the discussion of the utility of artificial reefs as management tools. This debate seems to have little relevance in areas where natural hard bottom is sparse or lacking. Rather, in these areas, biomass transformation from "less valuable" to "more valuable" species is indicated. Nevertheless, in my experience, the preeminence of the production–aggregation issue has often clouded the issue and reflected negatively on artificial reef benefits. Care should be taken that this debate be clearly reserved for habitats where additional hard bottom may be of little or no value because of recruitment limitations.

Literature Cited

Bohnsack, J. A. 1989. Are high densities of fishes at artificial reefs the result of habitat limitation or behavioral preference? Bull. Mar. Sci. 44:631–645.

———. 1994. How marine fishery reserves can improve reef fisheries. *In:* Proceedings of the 43rd Gulf and Caribbean Fisheries Institute 43:217–241.

———. 1998. Application of marine reserves to reef fish management. Aust. J. Ecol. 23:298–304.

———, A. Ecklund, and A. M. Szmant. 1997. Artificial reef research: is there more than the attraction–production issue? Fisheries 22:14–16.

Bortone, S. A. 1998. Artificial reef management perspective—resolving the attraction–production dilemma in artificial reef research: some yeas and nays. Fisheries 22:6–10.

Carter, J. W., A. L. Carpenter, M. S. Foster, and W. N. Jessee. 1985. Benthic succession on an artificial reef designed to support a kelp-reef community. Bull. Mar. Sci. 37:86–113.

Grossman, G. D., G. P. Jones, and W. Seaman, Jr. 1997. Do artificial reefs increase regional fish production? A review of existing data. Fisheries 22:17–23.

Lindberg, W. J. 1997. Can science resolve the attraction–production issue? Fisheries 22:10–13.

McEachran, J. D., and J. D. Fechhelm. 1998. Fishes of the Gulf of Mexico. Vol 1. Univ. Texas Press, Austin.

Minton, V., and S. R. Heath. 1998. Alabama's artificial reef program: building oases in the desert. Gulf Mex. Sci. 16:105–106.

Pamintuan, I. S., P. M. Alino, E. D. Gomez, and R. N. Rollon. 1994. Early successional patterns of invertebrates in artificial reefs established at clear and silty areas in Bolinao, Pangasinan, northern Philippines. Bull. Mar. Sci. 55:867–877.

Schirripa, M. J. 1998. Status of the red snapper in U. S. waters of the Gulf of Mexico: updated through 1997. NOAA/NMFS Sustainable Fisheries Division Contribution, SFD-97/98-30:15–18.

Stone, R. B., H. L. Pratt, R. O. Parker, and G. E. Davis. 1979. A comparison of fish populations on an artificial and natural reefs in the Florida Keys. Mar. Fish. Rev. 41:1–11.

Szedlmayer, S. T., and R. L. Shipp. 1994. Movement and growth of red snapper, *Lutjanus campechanus*, at artificial reef sites in the northeastern Gulf of Mexico. Bull. Mar. Sci. 55:887–896.

Watterson, J. C., W. F. Patterson III, R. L. Shipp, and J. H. Cowan, Jr. 1998. Movement of red snapper, *Lutjanus campechanus*, in the north central Gulf of Mexico: potential effects of hurricanes. Gulf Mex. Sci. 16:92–104.

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