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Tires have no harmful effects on black sea bass and pinfish.

Experiments on Some Possible Effects of Tire Reefs on Pinfish (*Lagodon rhomboides*) and Black Sea Bass (*Centropristis striata*)

R. B. STONE, L. C. COSTON, D. E. HOSS, and F. A. CROSS

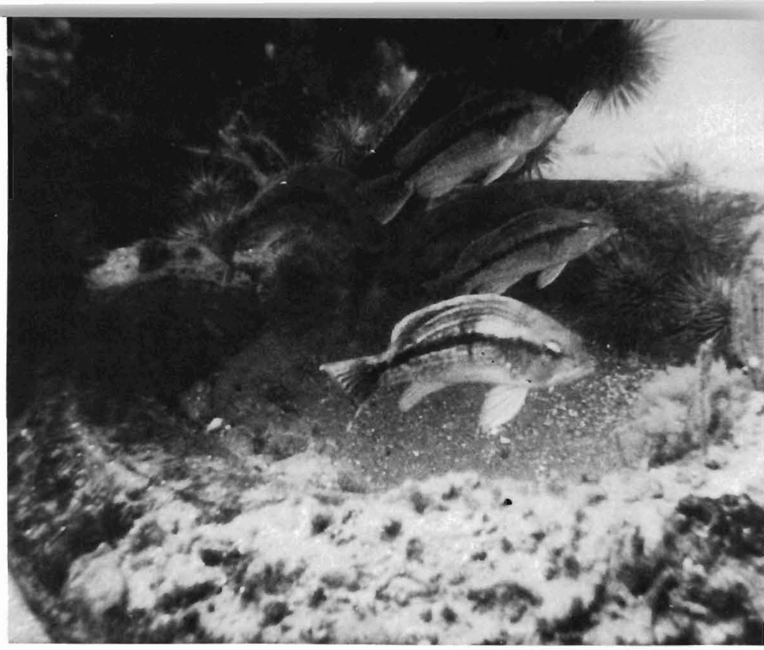

Figure 1.—The surface area of a tire unit provides shelter for fishes and effective substrate for attachment of encrusting organisms.

ABSTRACT—A simulated tire reef was constructed in a 2,000-liter circular fiberglass tank to determine if pollutants would leach from the tires and affect pinfish (Lagodon rhomboides) *or black sea bass* (Centropristis striata), *two fishes commonly associated with artificial reefs on the Atlantic and Gulf Coasts of the United States. Periodic samples of these fishes from both control and experimental tanks showed no significant increase in concentrations of zinc, organochlorine insecticides, or polychlorinated biphenyls (PCB's) in either pinfish or black sea bass.*

INTRODUCTION

Natural, rough-bottom fishing grounds nearshore are scarce off the Atlantic Coast of the United States and in the Gulf of Mexico. Anglers often go 15-40 miles offshore to find extensive areas of rough bottom and the associated reef fishes. Because of the scarcity of natural reefs close to shore, many coastal states are actively building artificial reefs close to fisherman access points (Table 1). Tires are one of the most popular construction materials (Stone, Buchanan, and Steimle, 1974), since they are readily available at no cost, last indefinitely, are inexpensive to assemble into effective units, and provide a good substrate for fishes and encrusting organisms (Fig. 1). Off the east coast of the United States alone there are over 100 artificial reefs, many of which are constructed of scrap tire units[1].

As the number of tire reefs has increased, some people have asked if toxic materials in tires would leach into the surrounding waters and harm fishes using these reefs. It is a valid question that we thought should be answered, although we have observed no evidence of fishes being harmed during our field studies on experimental tire reefs. Prominently mentioned pollutants are zinc, reported to be a major contaminant in rubber (Malmström, 1956), and polychlorinated biphenyls (PCB's). Both a literature search and direct communication with tire company scientists[2] indicate PCB's are not used in manufacturing tires. There is the possibility, however, that tires could become contaminated with pollutants, such as PCB's, zinc, or organochlorine pesticides, either while in use or after being discarded. In previous experiments Nozaka, Nogao, and Kikuchi (1973) found no harmful substances leached from a cut sample of used tire soaked in fresh water, but we could find no information on the possible leaching of toxic substances from tires in salt water. To supply some answers to the question of whether tire reefs harm fish,

[1]Stone, R. B. A brief history of artificial reef activities in the United States. Proc. Artificial Reef Conf., Center for Marine Res., Texas A&M Univ., College Station, TX 77843. In Press.

[2]C. F. Winors, Goodyear Tire and Rubber Company, Research Division, Akron, Ohio, Pers. commun.

R. B. Stone, L. C. Coston, D. C. Hoss, and F. A. Cross are with the Atlantic Estuarine Fisheries Center, National Marine Fisheries Service, NOAA, Beaufort, NC 28516.

Table 1.—Location of east coast artificial reefs that are constructed partially or completely of scrap tire units, March 1974.

Location	No. of tires
Ipswich Bay, Mass.	1,000
Shinnecock Bay, N.Y.	1,000
Ocean off Shinnecock, N.Y.	6,000
Ocean off Moriches, N.Y.	600
Great South Bay, N.Y.	3,500
Ocean off Fire Island, N.Y.	1,500
Ocean off Atlantic Beach, N.Y.	30,420
Ocean off Rockaway, N.Y.	6,500
Ocean off Monmouth Beach, N.J.	1,500
Ocean off Sea Girt, N.J.	80,000
Ocean off Indian River Inlet, Del.	2,000
Ocean off Ocean City, Md.	1,000
Bay near Millers I., Md.	660
Bay near Love Pt., Md.	660
Bay near Cedarhurst, Md.	660
Bay near Eastern Bay, Md.	660
Bay near Holland Pt., Md.	660
Bay near Patuxent, Md.	660
Tangier Sound, Md.	660
Ocean off Paramore I., Va.	2,500
Bay near Onancock, Va.	1,000
Ocean near Chesapeake Light Tower, Va.	300
Ocean off Morehead City, N.C.	1,000
Ocean off Wrightsville Beach, N.C.	500
Ocean off Lockwoods Folly, N.C.	3,800
Ocean off Murrells Inlet, S.C.	6,000
Ocean off Murrells Inlet, S.C.	36,000
Ocean near Charleston, S.C.	23,000
Ocean off Beaufort, S.C.	8,000
Ocean off Beaufort, S.C.	30,000
Ocean off Beaufort, S.C.	20,000
Ocean off Warsaw I., Ga.	40,000
Ocean off St. Simons, Ga.	24,768
Ocean off Brunswick, Ga.	25,536
Ocean off Cumberland I., Ga.	14,320
Ocean off Jacksonville, Fla.	7,000
Ocean off St. Augustine, Fla.	2,000
Ocean off Ponce de Leon Inlet, Fla.	1,500
Ocean near Cape Canaveral, Fla.	1,200
Ocean off Singer Island, Fla.	2,000
Ocean off Ft. Lauderdale, Fla.	300,000
Ocean off Hallandale, Fla.	1,000
Ocean off Elliott Key, Fla.	560
Total	691,624

we exposed two species of common reef fishes to the effects of tires in laboratory experiments.

EXPERIMENTAL PROCEDURE

We chose pinfish (*Lagodon rhomboides*) and black sea bass (*Centropristis striata*), since both species are known to inhabit tire reefs (Stone, Buchanan, and Parker, 1973). The fish were trapped near the laboratory and held in large tanks until used.

For the experiments, six used automobile tires were placed in a 2,000-liter circular fiberglass tank to simulate an artificial reef. A second identical tank without tires served as a control. Sea water entered at a rate of 15 liter/min after passing through an oyster shell filter.

Fish in both tanks were fed a mixture of dry commercial fish food and cut fish during the experiments. Salinity, temperature, and water flow rate were measured daily. Although we removed excess food and fecal material with a suction pump at least three times a week, some material did accumulate inside the tires.

In the first experiment, we analyzed 10 fish of each species for zinc, organochlorine pesticides, and PCB's and then weighed and placed 40 pinfish and 40 black sea bass in each tank. Samples of 10 pinfish were removed for analysis after 21 and 101 days and samples of 10 sea bass after 21 and 29 days.

In a second experiment using only sea bass, we duplicated the same experimental conditions except for cutting more holes in the tires to allow increased water circulation and thereby reduce the accumulation of organic material inside the tires.

In the pinfish-black sea bass experiment, we measured survival and concentrations of zinc, PCB's, and organochlorine pesticides in tissues. In the black sea bass experiment, only survival was documented. Metal concentrations were measured in muscle and liver tissue at our laboratory by atomic adsorption spectrophotometry. PCB's and pesticide levels were analyzed by gas chromatography at the Environmental Protection Agency Laboratory, Gulf Breeze, Fla. When we took samples of pinfish and black sea bass on day 21 to determine if there had been any accumulation of these pollutants, we had to remove the tires from the experimental reef tank since both the bass and the pinfish used them for cover. After removing 10 fish of each species from each tank we replaced the tires in the reef tank.

RESULTS

No mortalities occurred during the first 21 days of the pinfish-black sea bass experiment in either the control or experimental reef tank. But on the 22nd day, after the fish had been returned to the reef tank and the tires replaced, there was a definite change in their behavior. The bass, which normally utilized tire reefs for shelter, began swimming or lying around the edges of the tank near the surface of the water and the pinfish began to actively defend territories in and around the tires. Soon after this change in behavior the bass in the reef tank began to die and within 7 days after sampling, 16 had died. On the 29th day of the experiment, we again removed 10 black sea bass, but no pinfish, from the control and experimental tanks. The remaining bass in the reef tank died within the next week, but all the pinfish in both tanks were alive when the experiment was ended after 101 days.

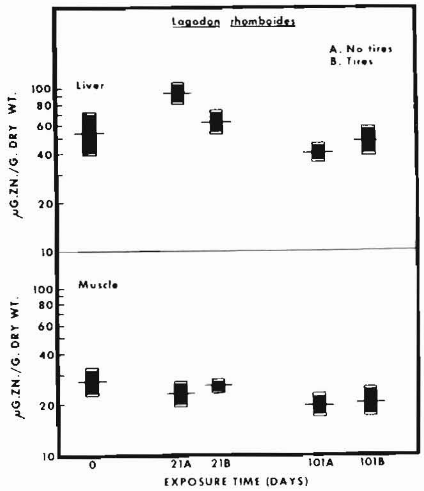

Figure 2.—Concentrations of zinc (µg/g dry weight) in muscle and liver of pinfish *(Lagodon rhomboides)* that were maintained in tanks with (B) and without (A) tires for periods of 21, and 101 days. The mean (horizontal line), ± standard deviation (clear areas) and ± 2 standard errors of the mean (solid (black) areas) were computed on log-transformed values, and the antilogs are shown on the graph. Each set of values represents analysis of 5 individual fish.

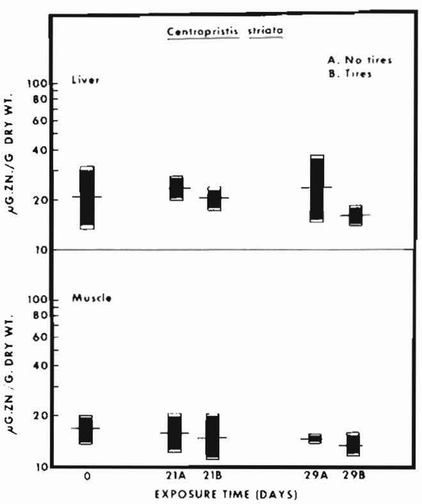

Figure 3.—Concentrations of zinc (µg/g dry weight) in muscle and liver of black sea bass (*Centropristis striata*) that were maintained in tanks with (B) and without (A) tires for periods of 21 and 29 days. The mean (horizontal line), ± one standard deviation (clear areas) and ± 2 standard errors of the mean (solid (black) areas) were computed on log-transformed values, and the antilogs are shown on the graph. Each set of values represents analysis of 5 individual fish.

Table 2.—Analysis of total fish for DDE, DDD, DDT, PCB, and Dieldrin (values of all compounds "not greater than").

Species	Day	Condition	DDE	DDD	DDT	PCB	Dieldrin
					µg/g wet wt.		
Pinfish	0		0.290	0.070	0.083	0.880	0.018
	21	With tires	.095	.061	.069	.420	.015
		Without tires	.130	.069	.060	.420	.019
	101	With tires	.100	.048	.074	.380	.010
		Without tires	.170	.060	.064	.730	.010
Black sea bass	0		0.032	0.039	0.030	0.190	0.011
	21	With tires	.034	.037	.037	.190	.012
		Without tires	.038	.039	.037	.240	.012
	29	With tires	.045	.041	.052	.230	.015
		Without tires	.043	.045	.045	.230	.011

There were no differences in the levels of PCB's and organochlorine insecticides in the tissues of fish sampled before and during the first experiment (Table 2), for either species. Neither were there any significant differences in the relative levels of pollutants in fish exposed to tires and fish not exposed. Before the experiment began, pinfish had higher concentrations of both pollutants than sea bass.

For both species, zinc did not increase significantly above the pre-experiment levels in muscle and in liver for black sea bass (Fig. 2 and 3). There was some increase in the zinc levels in livers of pinfish at the end of 21 days, but it was higher in the fish not exposed than in those exposed to tires; at the end of 101 days the level was lower than the pre-experiment level for both those exposed and those not exposed.

Significant quantities of zinc, at least in chemical form that was readily available to the fish, did not leach from the tires during the experiment. We made one analysis of the water for zinc 31 days after the start of the experiment and found no significant difference in the zinc content of the water in the two tanks: control tank 1.7 μgZn/liter, and reef tank 1.3 μgZn/liter.

The only mortalities in the black sea bass experiment occurred when 6 fish jumped out of the control tank and 1 jumped out of the experimental tank after being startled by lights turned on at night.

DISCUSSION AND CONCLUSION

There is no apparent relation between tires and concentrations of organochlorine insecticides, PCB's, or zinc in either black sea bass or pinfish. We found no change with time in the levels of PCB's, organochloride insecticides, or zinc between control and experimental fish exposed to a tire reef. Of the two species of fish tested, black sea bass and pinfish, it appears that pinfish accumulate higher levels of PCB's and insecticides. This may reflect differences in habitat and feeding habits. From the absence of mortalities in the black sea bass experiment (with the exception of those that jumped out of the tanks), and the results of our tests for accumulations of pollutants in the fishes, we concluded that the death of the bass in the pinfish-black sea bass experiment was due to the handling received during the first sampling (day 21), changes in behavior caused by competition for the limited habitat provided by the tires, or dietary deficiencies. Also, fecal material and unused food that accumulated within the tires may have washed out during the sampling (day 21) and contributed to the deaths. This problem was eliminated in the black sea bass experiment since the holes we cut in the tires resulted in better water circulation and less debris accumulation.

Since tires have no detrimental effects on pinfish and black sea bass and field studies of tire reefs demonstrate their potential to increase coastal fishery resources, improve catches in local sport fisheries, and beneficially affect the economics of local communities, (Stone, Buchanan, and Parker 1973), we consider tires suitable material for reef construction in many situations.

ACKNOWLEDGMENTS

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