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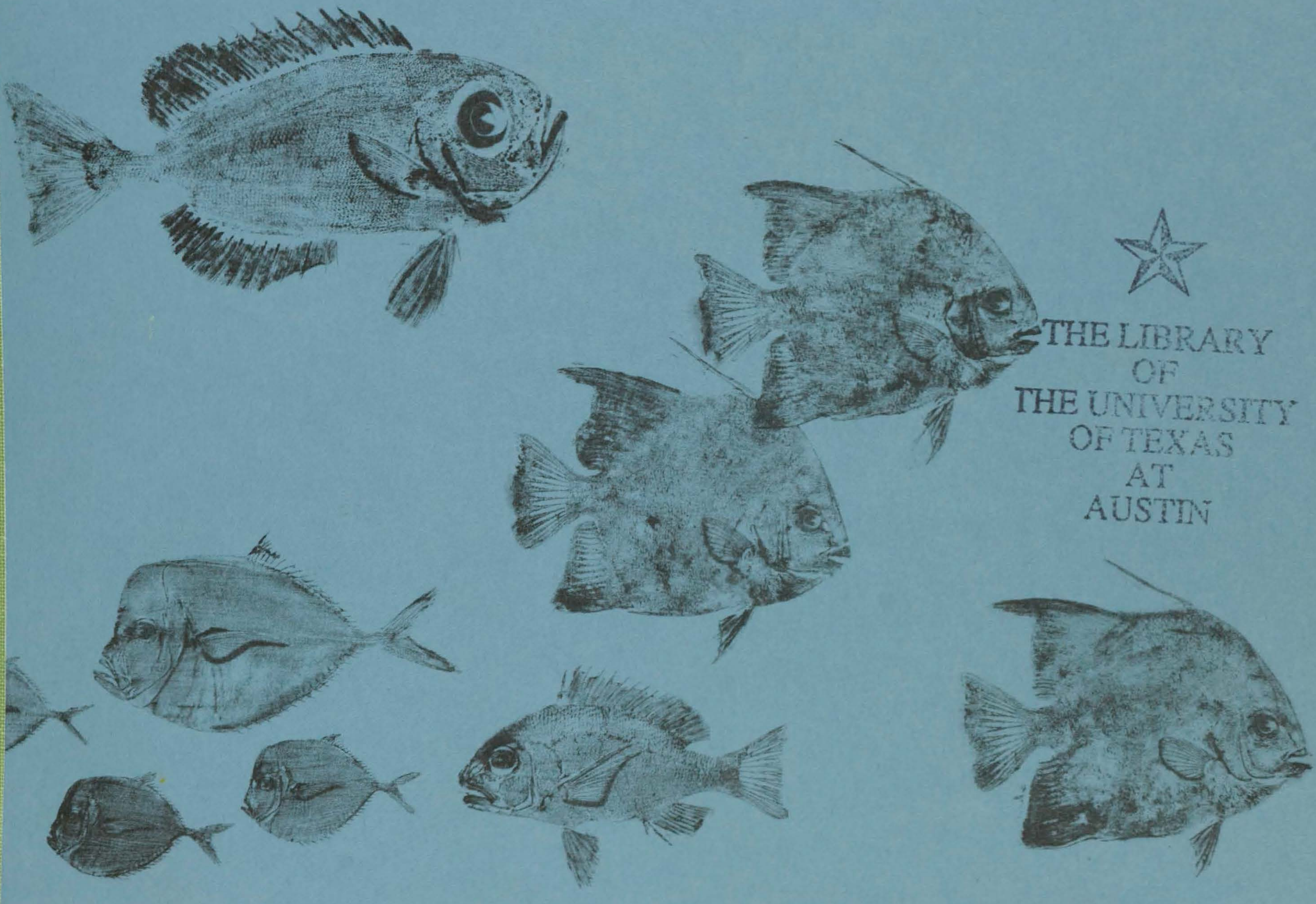
MAR 1978



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Winter Seasonal Report submitted to the Texas Coastal and Marine Council in partial fulfillment of IAC (78-79)-0869

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This study is an assessment of the biological effects resulting from the construction of an artificial reef consisting of three surplus Liberty Ships that were sunk off Port Aransas, Texas in 1976. A description of these reefs and a brief history of their development was included in a preliminary report (Vetter and Roels, 1977). The preliminary report was commissioned by the Texas Coastal and Marine Council to gather two types of information; recreational information assessing the amount and type of usage that the reefs were receiving and biological information substantiating their original premise that artificial reefs increase the populations of desirable fish species. Two additional studies, more detailed and specialized, have arisen from this original study. The first study is an effort by Robert Ditton and Alan Graefe of Texas A&M University to further document, through the use of computerized survey techniques, the amount of time recreational fishermen devote to fishing the artificial reefs. The second study, discussed below, is a biological assessment of the Liberty Ship Reefs, determining how such artificial structures affect the productivity and species composition of a previously low-relief area.

Due to budget limitations, the preliminary report relied upon user interviews and examination of the species, size and stomach contents of fish catches from the Liberty Ship Reefs. Although this approach provided much needed information, there were numerous shortcomings. Small and undesirable species were not kept by sportsmen, making it impossible to determine whether these forage fish are valuable intermediate trophic links between the epibenthos of the reefs and larger more desirable species. Fishing effort was seasonally inconsistent and fishermen made virtually no attempt to bottom fish areas of open bottom at depths equivalent to the artificial reef location; consequently, it was impossible to accurately compare the relative productivity of the two areas. In addition stomach contents of fish were often deteriorated and unrecognizable by the time catches were brought to the docks.

To develop a more thorough and systematic assessment of the effect of the artificial reefs on biological productivity, dock sampling was abandoned and the present study was begun. Systematic monthly assessment of the Liberty Ship Reefs presented a unique sampling problem. Snagging problems made trawling and other methods of netting unfeasible while depth, turbidity and currents precluded diver transects, baited camera recorders, or hook and line assessments, at least during the winter sampling periods. Fish traps were proposed as a reliable and cost effective means of sampling in all types of weather and sea conditions. Fish traps allow concurrent sampling of open bottom areas and reef with the same ship, making possible a true comparison of the relative productivity of artificial reefs. They also allow consistent day-night sampling and seasonal replication without the inherent variations in skill that bias diver transects and hook and line assessments.

This initial report describes the construction and deployment of traps and summarizes the data collected during January-February sampling cruises. These initial sampling cruises indicate that fish traps are a practical method of assessing the productivity of the artificial "Liberty Ship" reefs.

Methods

Fish traps designed for this study have an exterior configuration similar to those of Craig (1976) with a modified "horse neck" opening similar to Antillean traps described by Munro (1974). The final entrance portal employs a 90° downturn rather than lateral or longitudinal constriction to retain fish. Although the portal remains open, the egress of fish is inhibited by their natural escape behavior patterns. While it is apparently common for an investigating fish to contact the walls of the entrance and dart downwards into the holding pen, it is unlikely that a fish seeking escape will turn vertically and swim upwards, the appropriate response necessary for escape. The intention of this design is to attract a larger size range of fish and to attract free swimming species that might be wary of a highly constricted opening and hence not trap susceptible.

The holding pen consists of a rectangular framework (6 ft. x 4 ft. x 2 ft.) constructed of .5 in. reinforcing bar. The framework is covered by 1.5 in. mesh rubberized wire attached with stainless steel wire and steel "hog rings." The entrance cone is a framework of .25 in. stainless steel bar covered with .5 in. mesh nylon net. The entrance cone has an initial opening of 24 in. x 18 in. with a 90° downturn terminating in a 10 in. diameter entrance port. The traps are fitted with a nylon yoke and drag chain to inhibit drift of the traps. During periods of unusually strong bottom currents an 8 lb. Danforth anchor can be added to the drag chain.

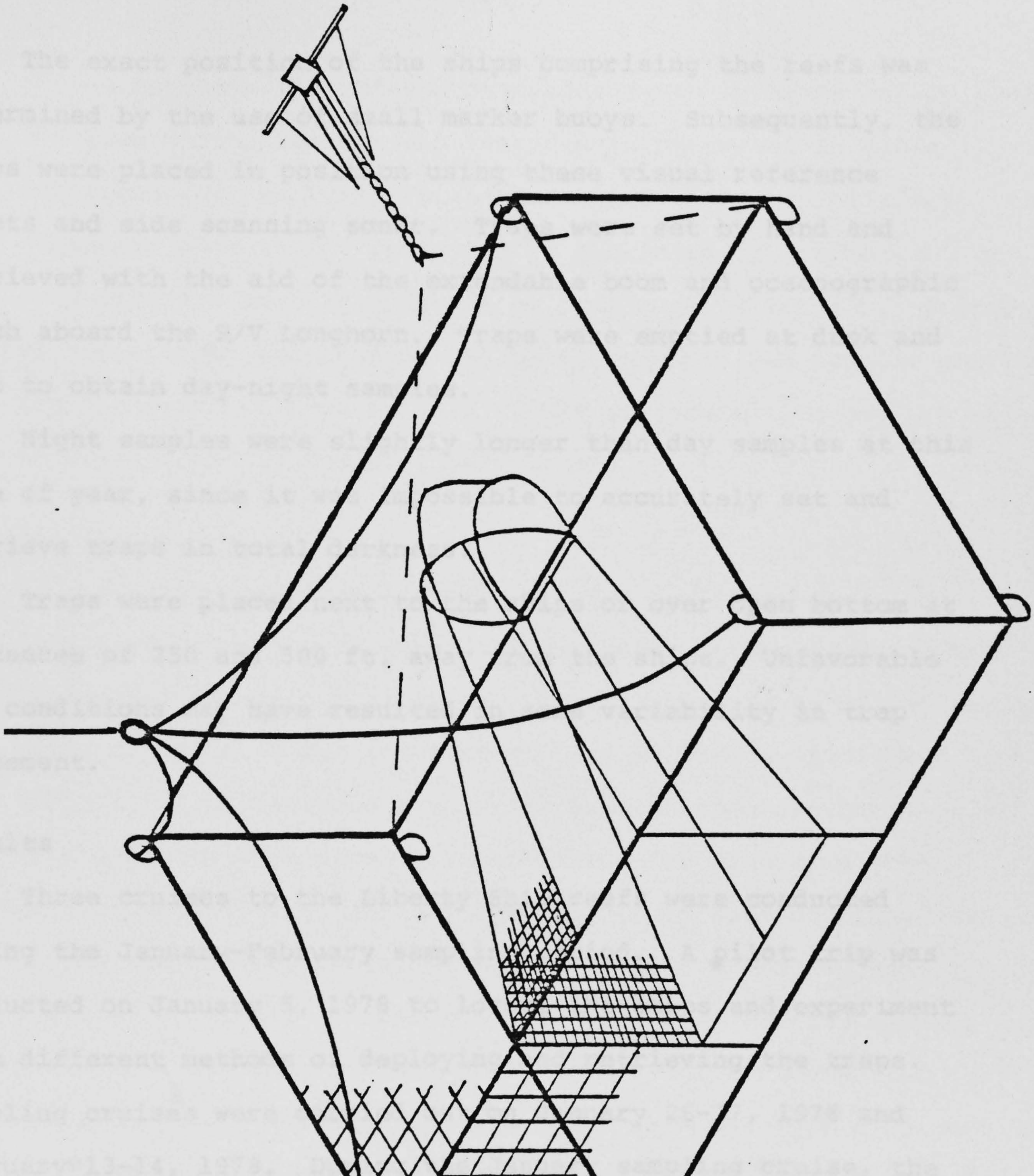

Figure 1

The exact position of the ships comprising the reefs was determined by the use of small marker buoys. Subsequently, the traps were placed in position using these visual reference points and side scanning sonar. Traps were set by hand and retrieved with the aid of the extendable boom and oceanographic winch aboard the R/V Longhorn. Traps were emptied at dusk and dawn to obtain day-night samples.

Night samples were slightly longer than day samples at this time of year, since it was impossible to accurately set and retrieve traps in total darkness.

Traps were placed next to the ships or over open bottom at distances of 250 and 500 ft. away from the ships. Unfavorable sea conditions may have resulted in some variability in trap placement.

Results

Three cruises to the Liberty Ship reefs were conducted during the January-February sampling period. A pilot trip was conducted on January 5, 1978 to locate the ships and experiment with different methods of deploying and retrieving the traps. Sampling cruises were carried out on January 26-27, 1978 and February 13-14, 1978. During the January sampling cruise, the bottom water temperature was 17.5^{o} C and the bottom salinity was 35.5 o/oo. The bottom temperature during the February cruise was 16.3^{o} C and the bottom salinity was again 35.5 o/oo. Wind and sea conditions varied by the hour from periods of complete calm to wind speeds of 35 mph and seas of 6 - 8 ft.

A complete list of the organisms taken by traps and by hook and line during January and February is presented in Table 1. A comparison of the relative abundance and diversity of the biotic community next to the reefs and at distances of 250 and 500 ft. away from the artificial reefs is presented in Table 2. A summary of the stomach contents of the more abundant fish species and some trophic links between members of the reef community are presented in Table 3 and in the discussion.

Discussion

Results from this initial sampling period seem to indicate that fish traps are an effective method of gathering data where other methods are not practical. Traps remained in place despite winds of up to 50 mph and seas of over 10 ft. As indicated in Table 1, traps captured a wider variety of species than hook and line and they were especially effective for capturing reef grazing species that are not susceptible to hook and line methods. During the January-February sampling period traps captured a total of 9 species of fish and 6 active invertebrates species while hook and line methods produced 5 species of fish and no invertebrates. The only species that was taken solely by hook and line was the Warsaw grouper Epinephelus nigritus which were probably too large for the traps. In all a total of 25.13 kilos of fish were taken with the traps.

One advantage of a series of traps is that several areas of reef and open bottom can be sampled concurrently, yielding a true comparison of the relative productivity of the two areas. Although more sophisticated measures of diversity and community structure cannot be computed until more data is collected, it

Table 1. Species occurring on Liberty Ships during January-February 1978.

Common Name	Scientific Name
I. Fish species occurring in traps	
Red Snapper	Lutjanus campechanus**
Rock Sea Bass	Centropristis philadelphica
Banded Shrimp Eel	Ophichthus sp.*
Pigfish	Orthopristis chrysoptera
Pinfish	Lagodon rhomboides**
Sand Trout	Cynoscion arenarius**
Spot Croaker	Leiostomus xanthurus
Golden Croaker	Micropogon undulatus**
Atlantic Spadefish	Chaetodipterus faber
II. Fish species occurring only on hook and line	
Warsaw Grouper	Epinephelus nigritus
III. Invertebrates actively entering traps	
Leopard Carb	Hepatus epheliticus
Portunid Crab	Portunis spinimanus
Portunid Crab	Portunis gibbsii
Blue Crab	Callinectes sapidus
Sea Urchin	Arbacia punctulata
Lightning Whelk	Busycon sp.
IV. Invertebrates accidentally occurring in traps (sessile)	
Barnacle	Balanus reticulatus
Jingle Shell	Anomia simplex
Winged Oyster	Pteria colymbus

* New species not as yet named (Hoese and Moore, 1977).
** These species also taken on hook and line.

Table 2. Abundance and diversityof fishes occurring in traps at various distances from the artificial reef.

Distance	# of Samples	Abundance*	Diversity**	Species Occurring	# of Individuals
0 ft.	9	4.60	.78	*Lutjanus campechanus*	31
				Orthopristus chrysoptera	3
				Lagodon rhomboides	3
				Centropristis philadelphica	1
				Micropogon undulatus	1
				Leiostomus xanthurus	1
				Chaetodipterus faber	1
250 ft.	6	.17	.17	*Ophichthus* sp.	1
500 ft.	5	.60	.20	*Chaetodipterus faber*	3

* Abundance = average # of individuals per sample

** Diversity = average # of species per sample

Table 3. Stomach contents of fishes* of Liberty Ship Reefs during January-February.

Species	Total # Examined	# Empty	Diet Item	% of Diet
Lutjanus campechanus (red snapper)	30	8	unidentified + bait	39.77
			Penaeid shrimp	31.82
			fish	22.73
			unidentified crustaceans	4.54
			Squilla shrimp	3.33
			Rock shrimp	.83
Epinephelus nigritus (Warsaw grouper)	7	2	Calappa crab	48.00
			pigfish	23.00
			croaker	10.80
			pinfish	6.22
			spadefish	7.76
			butterfish	3.09
			unidentified + bait	3.09
Orthopristis chrysoptera (pigfish)	7	3	unidentified + bait	50.00
			amphipods	50.00
Cynoscion arenarius (sand trout)	11	7	fish	34.50
			Penaeid shrimp	62.50
Chaetodipterus faber (Atlantic spadefish)	4	4		
Lagodon rhomboides (pinfish)	3	1	unidentified + bait	85.00
			isopods	15.00

*Insufficient data is available on the diet of other species listed in Table 1.

is already evident from Table 2 that reefs do maintain a greater abundance and diversity of species than surrounding open bottom. A total of 41 individuals and 7 species occurred in the 9 near-ship samples. In comparison 6 samples taken 250 ft. away from the ships over open bottom yielded one individual and 5 samples taken 500 ft. from the ships yielded 3 individuals of one species.

To understand how artificial reefs of this type increase the abundance and diversity of an area it is necessary to determine why fish utilize such an area. One theory suggests that the physical structure of a reef provides refuges for various species which forage away from the reef over open bottom or in the surrounding water column. If this is true, the primary function of the reef is not to increase productivity but to concentrate and hold fish that would normally be dispersed. An alternate hypothesis is that the carpet of epibenthos that covers the artificial reef provides an increased localized food source for small grazing fish and invertebrates that in turn form a food supply for larger species of sport and economic interest. Although the reasons why any one species chooses to inhabit the reef may vary, it may be possible to identify the more important factors by examining the stomach contents of reef species to determine where they procure the majority of their food.

The trapping of several species that have not been collected previously has provided information on intermediate links between the reef epibenthos and larger species. Pigfish, Orthopristis chrysoptera, contained 50% amphipods and bits of algae indicating that they probably graze directly on the attached epiflora and associated organisms. The pinfish, Lagodon rhomboides, contained small invertebrates such as isopods that are also probably part of the epibenthic community. The pinfish in turn was found to be a food source for sand trout, Cynoscion arenarius, and red snapper, Lutjanus campechanus, which in turn were food sources for Warsaw grouper, Epinephelus nigritus.

As more data is collected, an extended analysis of the trophic dynamics of this artificial reef will be possible. By identifying specific ways in which the artificial reef increases productivity, it may be possible to enhance those characteristics when building future reefs.

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