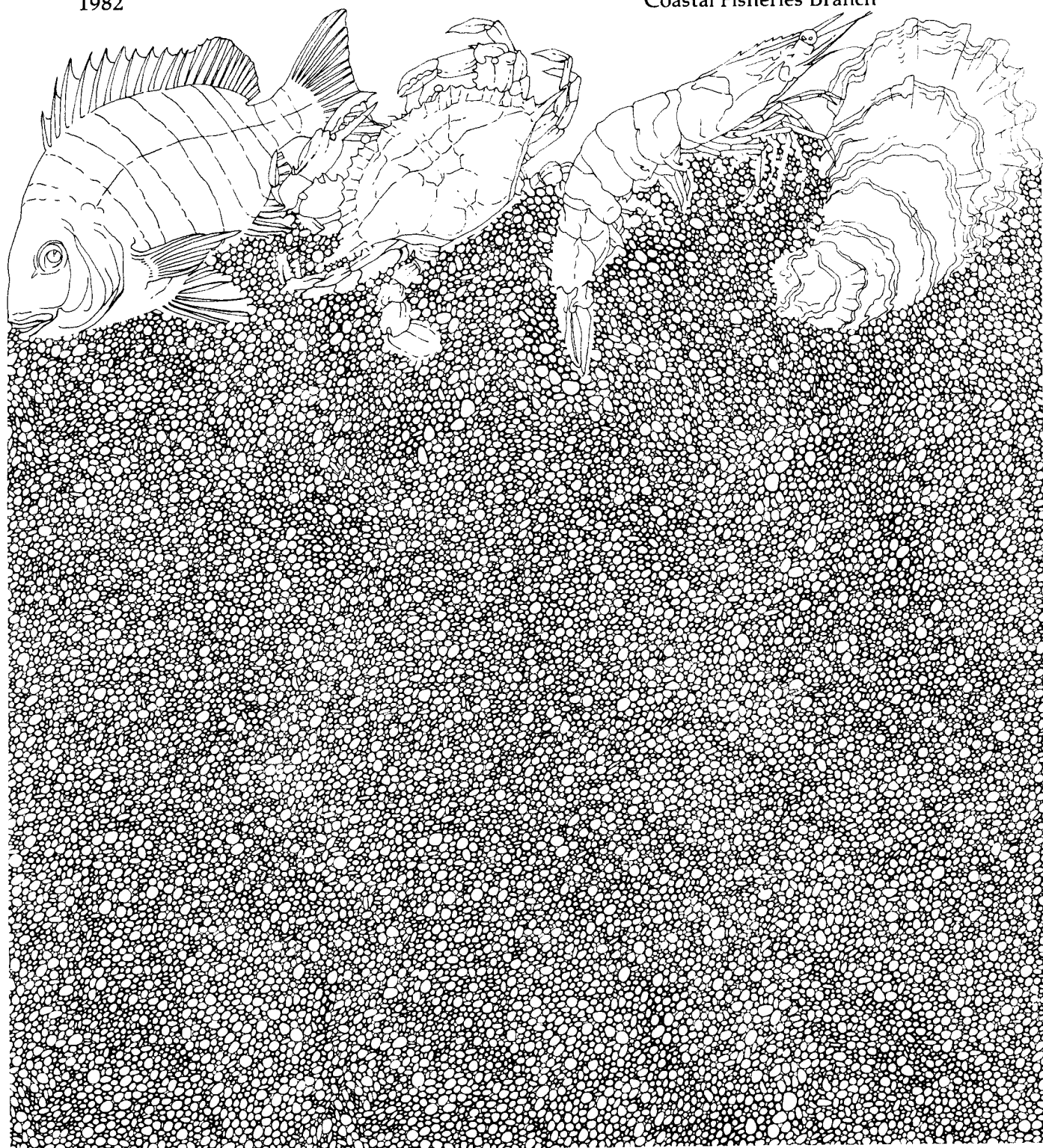


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by Richard L. Benefield and William E. Mercer

Management Data Series, Number 32
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Texas Parks and Wildlife
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ACKNOWLEDGEMENTS

We wish to thank the Texas Coastal and Marine Council for project funding and Howard T. Lee for invaluable aid in interagency coordination of project activities; Robert La Blanc, City of Port Arthur; Dr. Charles Turco, Lamar University; J. Robert Rowley, Ted Woodall, Jim Pearson, Goodyear Tire and Rubber Company; Robert Parker, Jr. of Parker Bros. Inc.; and members of the Coastal Fisheries Division of the Texas Parks and Wildlife Department for their invaluable assistance in completing this project. A special thanks is extended to Lanelle Hayes and Barbara Smith for help in preparing figures and typing the manuscript.

TIRE REEF CONSTRUCTION AND NATURAL REEF MARKING IN TEXAS BAYS

ABSTRACT

Six artificial reefs made from 11,400 automobile tires were built in the Sabine Lake, Galveston, Matagorda (Tres Palacios Bay), Aransas and Corpus Christi Bay systems in April-October 1977. Reefs were built in waters 1.2-2.7 m (4-9 feet) deep. A Goodyear tire punch and baler were used to bale tires to form compact modules for five reefs, and a single reef made with truck and tractor tires that were laid flat to form a wadefish reef in shallow water. Reefs ranged in size from 0.1 to 0.4 ha.

Natural fishing reefs were marked with buoys and PVC pipe to enable fishermen to find them. Buoys were placed on reefs in waters deeper than 1.2 m and polyvinylchloride (PVC) pipes were installed on reefs in waters less than 1.2 m. In all, 41 buoys and 22 PVC pipes were placed on natural reefs.

INTRODUCTION

Artificial fishing reef construction is not new. Over 300 artificial reefs have been built in coastal waters in the United States (Hill 1977). California Fish and Game has experimented with various types of reef materials (Carlisle et al. 1964, 1969). Tire reefs were built in Humbolt Bay, Monterrey Bay and the Pacific Ocean near Ventura (Duffy 1974). Tire reefs have also been constructed in Florida (Woodburn 1974), Georgia (Smith 1974), North Carolina (Buchanan 1974) and South Carolina (Myatt 1974).

The Texas Parks and Wildlife Department (TPWD) built three reefs in the Gulf of Mexico in 1958 near Freeport, Port Aransas and Port Isabel (Stevens 1969) using automobile bodies. A fourth offshore reef was constructed using concrete pipes in 1962-63 near Galveston. During the 1960's, oyster shell was used to build reefs in several bays.

In 1966, automobile tires were first used in Texas as reef materials in Trinity Bay. The reef consisted of tires interconnected by cable, tread to tread, to form a single layer--5 tires wide by 25 tires long. About 250 tires were used to cover 0.02 ha in 3 m of water on a mud bottom. In 1968 a scuba diver found barnacles and other encrusting organisms on the tires (Murray, unpublished). There was no indication of excessive settling of the reef into the mud. By 1975, only two clusters of tires could be found above the mud line. The remaining tires had apparently settled into the mud.

In July 1971 the Sportsmen's Club of Texas (SCOT) and the Boating Trades Association of Houston provided resources to build a tire reef in west Galveston Bay. This reef was composed of 500 units each consisting of four tires joined by steel rods and weighted with concrete. The reef covers approximately 3.2 ha in 2.1 m of water with the perimeter marked by pilings.

The Texas Parks and Wildlife Department and the Texas Coastal and Marine Council entered into a cooperative program in 1976 for the construction of six tire reefs and the marking of oyster reefs in Texas bays. This project was designed to provide fishing areas and reef location assistance to recreational fishermen. Artificial reef sites were selected to offer easy assessibility to anglers and oyster reefs were marked with fiberglass spar buoys and PVC pipes. This report details the reef construction and marking activities conducted in 1977 by TPWD.

MATERIALS AND METHODS

Used automobile tires were selected as reef materials because of their availability, durability and low cost. The Goodyear tire and

Rubber Company provided an air compressor, tire punch and tire compactor for baling tires.

Three criteria were required at each tire assemblage and baling site: (1) electrical power (220 voltage); (2) adequate tire storage space; and (3) a chain link fence for security purposes. When a suitable work site was found, local tire dealers were notified as to the need for used tires. Most dealers were happy to deliver the tires to the baling area because many sanitary land fills refuse to dispose of tires.

The tire punch and baling equipment operated on compressed air. The air compressor used 120 or 220 voltage electricity. Two people were considered a minimum operating crew, whereas three provided maximum efficiency with a baling capacity of 300-500 tires during a 6-h period. Tires were stored as close to the machines as possible for easy access for the tire punch operator. Standard auto and light truck tires were most suitable for baling. When three people were available, one person supplied tires for the tire punch and removed baled tires. A second worker operated the tire punch (Fig. 1), and a third person baled and strapped tires (Fig. 2 and 3). Four holes were punched through the tire tread removing a round divot of rubber about 2.5 cm in diameter. These holes were spaced to allow air to escape from tires when placed in the water. Twelve tires were placed on the compactor and pressed to form a bundle 1.1-1.2 m long and weighing about 110-160 kg, depending on sizes of tires used. Four commercial grade plastic strapping bands were attached to each bundle to hold the tires in a compact module after the baling machine compactor was released. The tire modules were then rolled to a storage area. When tires were ready to be placed in the bay, six modules were interconnected using a 9.5-mm tarred steel towing cable joined together by four galvanized steel cable clips. This was done to contain the tires in event the plastic strapping broke and to reduce or prevent movement in individual bundles by tidal and wave action.

The largest tire reef built was at Sabine Lake near Port Arthur (Fig. 4). The city of Port Arthur arranged for local tire dealers to donate and deliver used tires to the work site. About 6,000 tires were punched and baled at the Lamar University Marine Facilities on Pleasure Island at Sabine Lake. The city of Port Arthur maintenance personnel at Pleasure Island assisted with the baling of tires. Upon completion of tire baling, local business, city and county governments coordinated efforts to provide a barge, dragline and towboat to be used for reef construction. Tires were loaded on the barge 18 April 1977 and placed on site the following day. In all, 500 tire bales were deposited to form two separate reef sections (Fig. 5).

The Goodyear Tire and Rubber Company plant at Bayport provided baling and storage facilities for the Galveston Bay and two Tres Palacios Bay reefs. Local tire dealers in La Porte furnished tires for the three reefs. Contract workers were hired to assist with the baling of tires on this project.

Upon completion of baling, about 1200 tires (100 modules) were transported to Parker Brothers, Inc. shipyard on the Houston Ship Channel. On 30 April 1977, a barge and towboat carried the bales to the Galveston Bay site where the tires were placed by dragline approximately 38 m north of the public fishing pier in 1.8 m of waters (Fig. 6). A fiberglass buoy was placed on the east or bayward end of the reef (Fig. 7).

Tires for the Coon Island reef in Tres Palacios Bay (Fig. 8) were barged from the Parker Brothers facilities to Palacios on 20 September 1977. A 0.1-ha reef was built the following day using a dragline to offload the tire bales adjacent to the west side of an existing piling structure (Fig. 9). A sign was later placed on the platform to mark the reef location.

A different type of reef was built in Tres Palacios Bay on 19 October 1977 near the Baptist Encampment at Palacios about 122 m from the shoreline in 1.2-1.5 m of water (Fig. 8). Large truck and tractor tires were strung bead fashion on 3/8 inch tarred cable and secured to a piling. The reef design resembles the spokes of a wagon wheel (Fig. 10). Each tire was placed flat on the bottom presenting a low profile (25.4-38.1 cm) that would not present a hazard to boaters. The reef covered about 0.08 ha and 70-80 tires were used.

Tires were baled for the Aransas and Corpus Christi Bay reefs at the TP&WD Marine Laboratory at Rockport by department personnel. A small barge was loaded with 25-30 bundles of tires which was then towed to reef site where the modules were dumped over the side. Cables were attached to six bundles as previously described. The Aransas Bay reef was near the baling area and little time was expended in transporting tires to the site. A trip of 4 h was required for barging the tires from Rockport to the Corpus Christi Bay site, and several trips were required to complete construction.

A reef was built adjacent to the Rockport harbor jetties during July 1977 in Aransas Bay. Numerous old pilings are in the area. Tire bundles were placed so that none were on the bayward side of the pilings (Fig. 11). About 1,700 tires (140 bales) were placed on site (Fig. 12).

A reef containing 1,200 tires was completed in Corpus Christi Bay in August 1977, near the Cole Park fishing pier in 2.1-2.4 m of water (Fig. 13 and 14). The reef was marked by buoy for sight location by both pier and boat anglers.

A second aspect of the reef project involved marking oyster reefs with buoys or PVC pipe. Popular fishing reefs were marked to enable anglers to locate them by sight. Fiberglass buoys 1.45 m long and 0.12 m in diameter were anchored by 91 kg concrete blocks (Fig. 15) attached by 9.5-mm tarred steel towing cable. The buoys were white in color marked by international orange stripes with a TPWD decal, and the reef name was stenciled on tow sides. Buoys were placed on reefs where the minimum water depth was 1.2 m. Several long, narrow reefs were marked by a buoy at each end.

Reefs in waters less than 1.2 m deep were marked by placing a PVC pipe (10.2 cm diameter-schedule 40 thickness) on a segment of the reef normally too shallow for boats to cross. This reduced the chance of boats hitting the markers. A TPWD decal, international orange stripes and the reef name were placed on each marker. Pipes were implanted in reefs by using a water pump to jet the marker into the shell. This method involved using a long metal water pipe placed down the center of the PVC pipe and pumping water through the pipe into the reef to dislodge shell particles. Each pipe was buried about 1.2 m into the reef and the exposed pipe extended 1.8-2.4 m above the water. A 41-kg sack of Redimix concrete aggregate was poured inside the installed marker. When hardened, the concrete added stability to the markers.

RESULTS

Six artificial reefs were built in five Texas bay systems. The reefs were in waters from 1.2 to 2.1 m deep and situated near shore for fishermen convenience. Reef locations were as follows:

Sabine Lake System: The reef location was at latitude $29^{\circ} 47' 08''$ and longitude $95^{\circ} 05' 37''$ in 1.8 m of water (Fig. 4). The bottom consisted of oyster shell and mud. The reef covered about 0.4 ha.

Galveston Bay System: The reef was built 38 m north of the Sylvan Beach fishing pier near La Porte at latitude $29^{\circ} 38' 48''$ and longitude $95^{\circ} 00' 48''$ (Fig. 6). The reef was in 1.8 m of water on a mud and sand bottom.

Matagorda Bay System: Tres Palacios Bay, where two tire reefs were built, lies northeast of Matagorda Bay (Fig. 8). A wadefish reef was constructed approximately 122 m from shore near the Baptist Encampment in Palacios at latitude $28^{\circ} 41' 48''$ and longitude $96^{\circ} 12' 39''$. The water was 1.2 m deep and the bottom was mud with scattered oysters. The second reef site was situated near Coon Island at latitude $28^{\circ} 39' 35''$ and longitude $96^{\circ} 13' 50''$. The reef was built in 1.8 m of water west of an experimental oyster study platform. The bottom was mud with scattered oysters and mudshell. This reef was accessible only by boat.

Aransas Bay System: This reef was built on the east side of and adjacent to the Rockport jetties in 1.8 m of water at latitude $28^{\circ} 01' 30''$ and longitude $97^{\circ} 02' 04''$ (Fig.11). The reef extended 76 m into the bay and could be fished by wade, jetty and boat anglers. The bottom was mud and shell.

Corpus Christi Bay System: The Corpus Christi reef site was on the north side of the Cole Park fishing pier in about 2.1-2.4 m of water. The location was at latitude $27^{\circ} 46' 28''$ and longitude $97^{\circ} 23' 12''$ and was within the Corpus Christi city limits. This reef could be fished by pier and boat anglers (Fig. 13).

The second segment of the project was that of placing markers on oyster reefs in selected bays. In all, 41 buoys and 22 PVC pipe markers were placed on reefs in eight bays. Buoys were set on reefs prior to June 1976 and most PVC markers were installed during the summer of 1977.

Buoys were placed on reefs in seven bays. Thirteen buoys were placed in Galveston Bay (Figure 6); one in San Antonio Bay and one in Espiritu Santo Bay (Fig. 16); nineteen in Copano and Aransas Bays (Fig.11); three in Corpus Christi Bay (Fig. 13); five in Alazan and Baffin Bays (Fig.17).

PVC pipe markers were placed on one reef in East Matagorda Bay and twenty placed on reefs in Copano and Aransas Bays. Maintenance checks revealed that 6 of the 21 markers were lost after 1 year on site. When replacement markers were installed, Redimix concrete was poured inside the pipe. To date, no markers containing concrete have been lost.

DISCUSSION

Tire reefs have proven to be successful in attracting marine fishes on the Atlantic and Pacific coasts (Stone et al. 1974, Buchanan 1973, Stroud and Wassermen 1966, and Carlisle et al. 1969). The success of previous tire reef construction in west Galveston Bay is unknown. Anglers have been observed fishing several of the new tire reefs but no catch records were obtained.

Perhaps the greatest concern about tire reefs is their stability in shallow waters. Reefs built by other states have generally been in waters 7.6 m or greater. Reefs in shallow waters may be exposed to greater forces from currents and wave action than are reefs in deep waters. It is impossible to determine if reefs in shallow waters will remain in position if exposed to extreme conditions such as a hurricane.

Public inquiries about reef locations were received and the project has been well accepted by sport fishermen. Reef construction and reef marking has probably been beneficial to anglers.

Some problems were encountered in maintaining markers on reefs. The initial buoys were rigged to anchors by plastic coated, 6.4 mm steel wire cable. This cable did not resist wearing and several buoys broke loose. A heavier 9.5 mm tarred cable has proven to be more durable. Some cables were found to have been intentionally cut as buoys were recovered with cable cuts that were mechanical and not natural wear. Some PVC pipe markers on reefs were lost. These losses were thought to be the result of anglers tying boats to markers.

Project costs were difficult to calculate for reef construction. Most expenses that would normally be incurred were donated by local governments and business. Barge and dragline services were donated at Sabine Lake and Galveston and Tres Palacios Bays. Facilities at each baling site were used without charge. Contract labor, shipping charges for baling equipment and baling supplies (straps, cable and clips) were the only costs involved other than salaries of project personnel.

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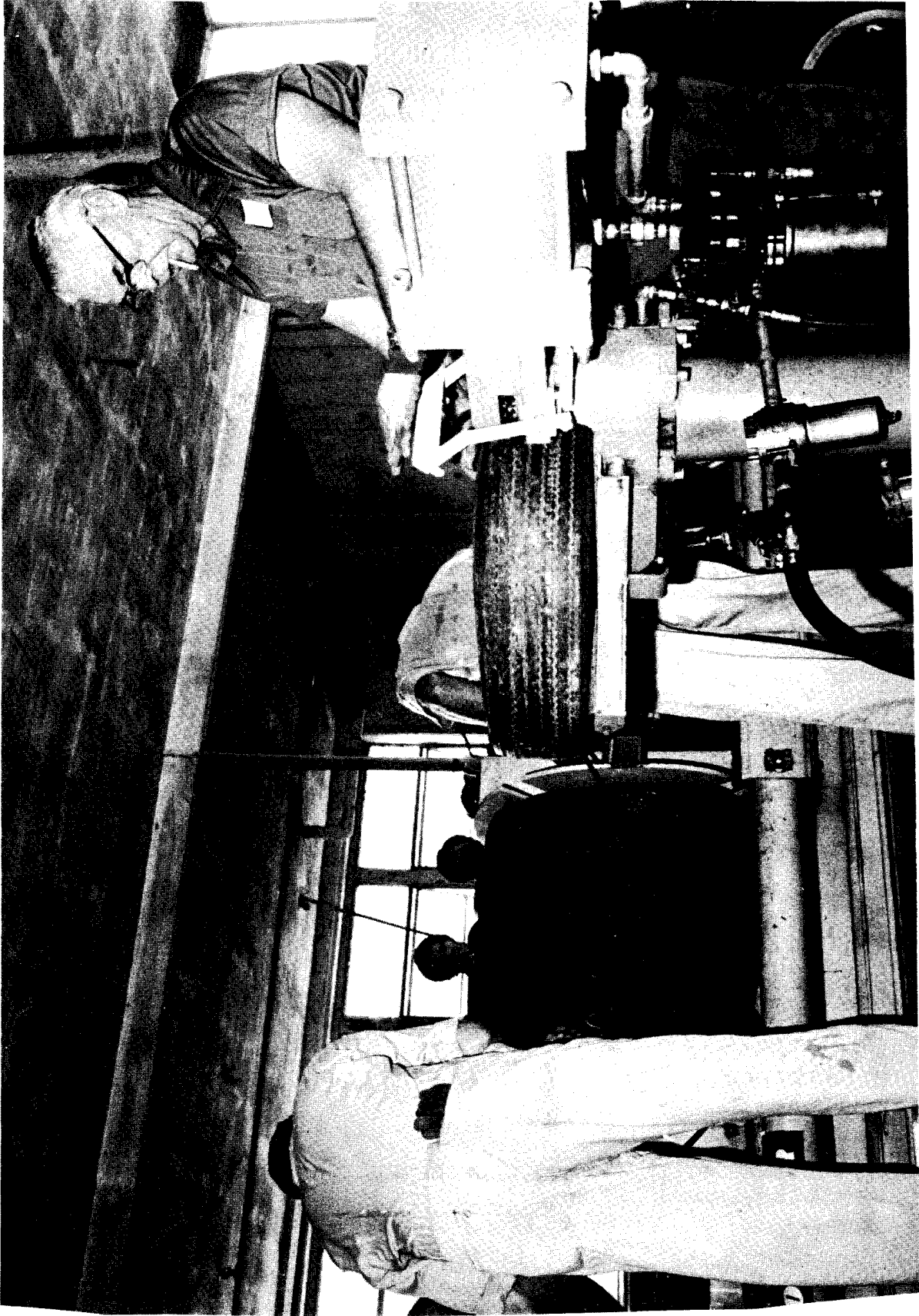


Figure 1. Goodyear tire punch in operation.

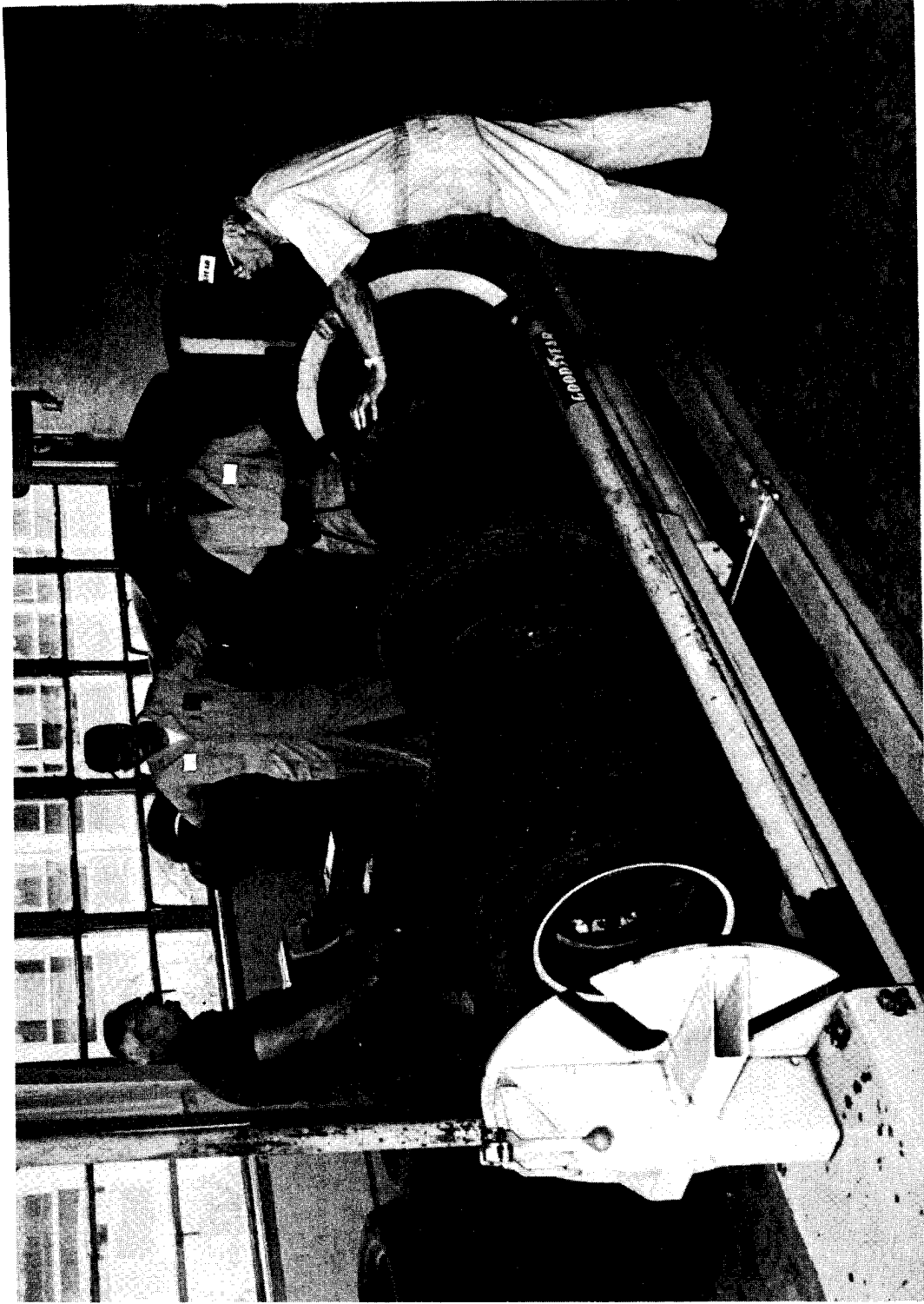


Figure 2. Tires placed on Goodyear compactor prior to being pressed.

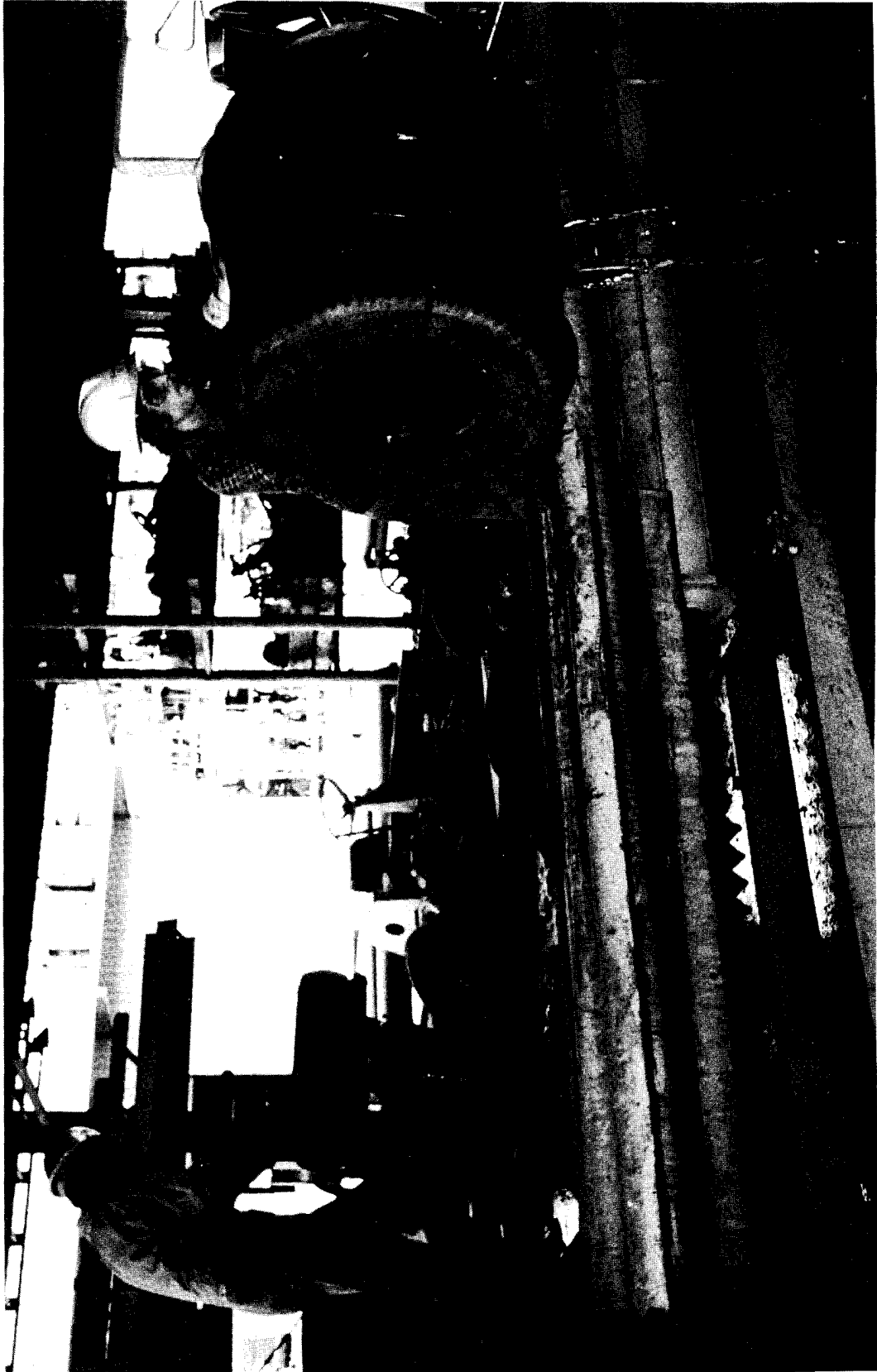


Figure 3. Tire module after compaction.

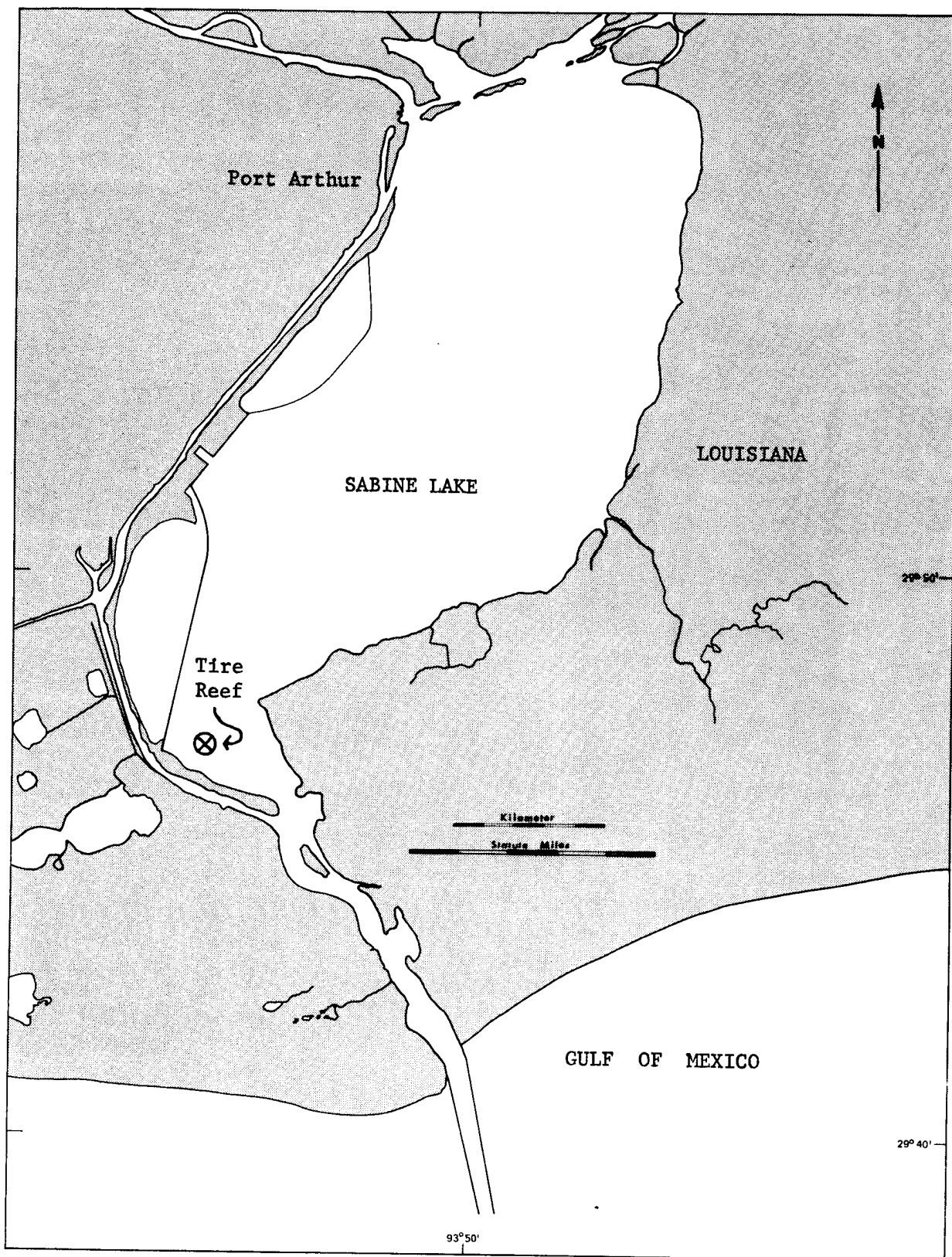
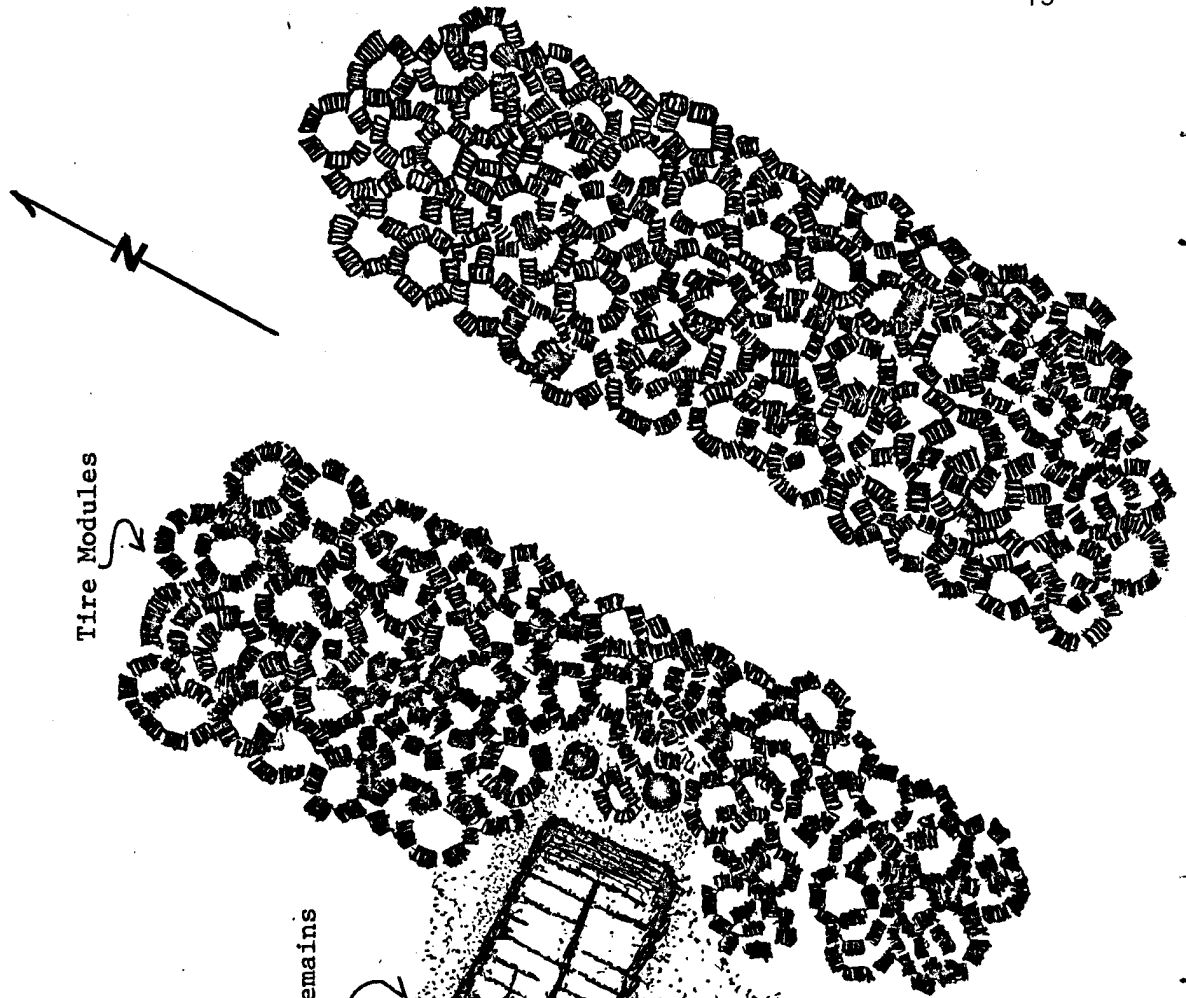


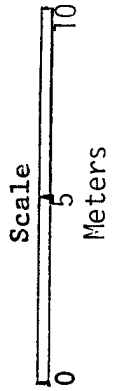
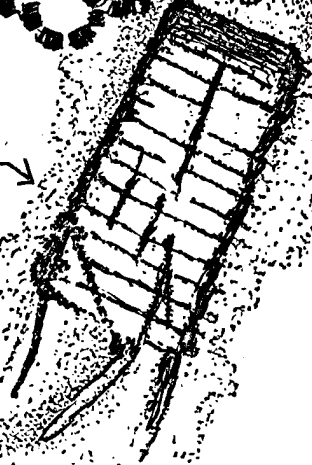
Figure 4. Tire reef location in Sabine Lake.

Figure 5. Sabine Lake tire reef.



Tire Modules

Dredge Remains



6,000 tires
500 bales

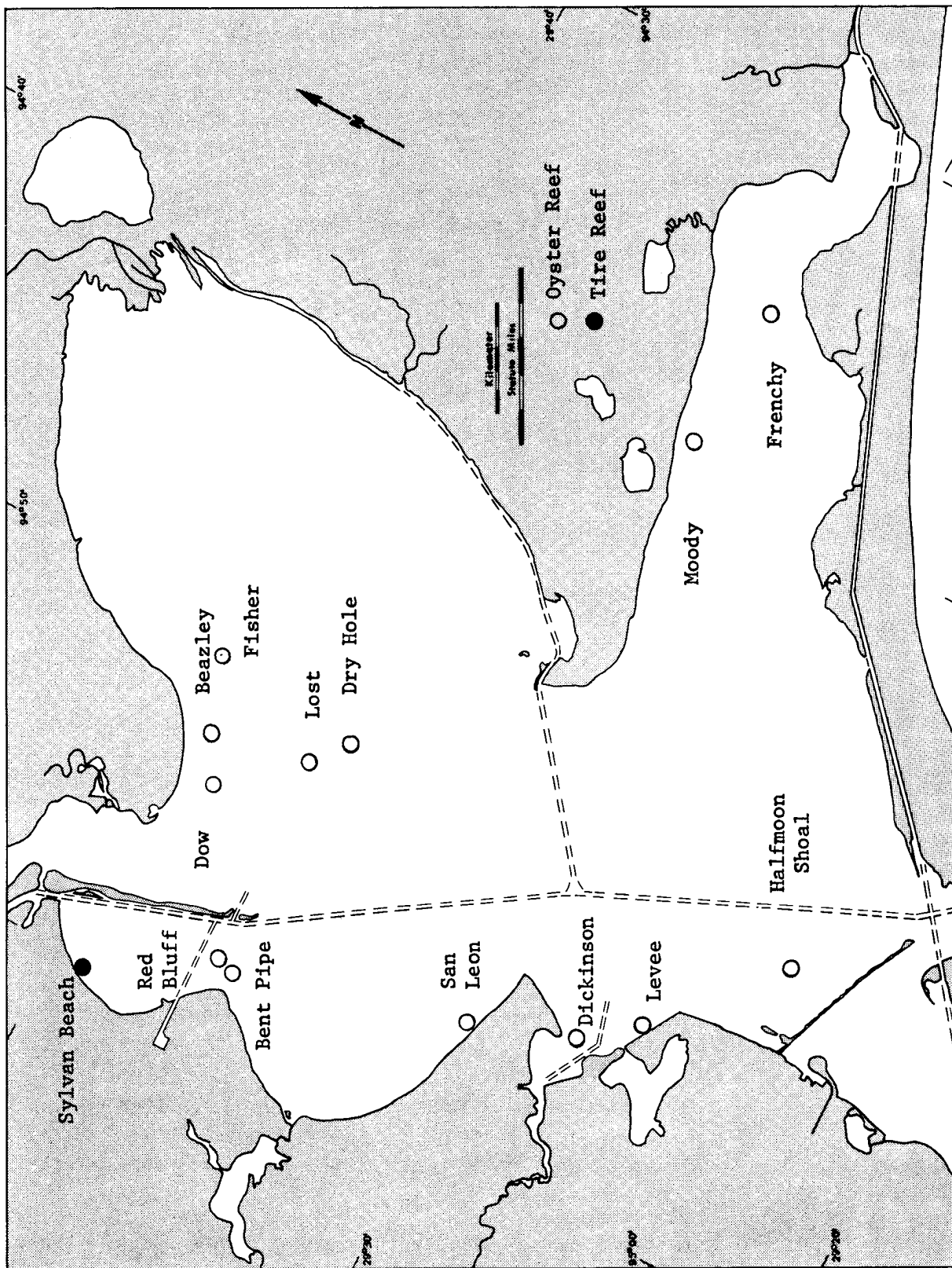


Figure 6. Locations of tire reef and fishing buoys in Galveston Bay.

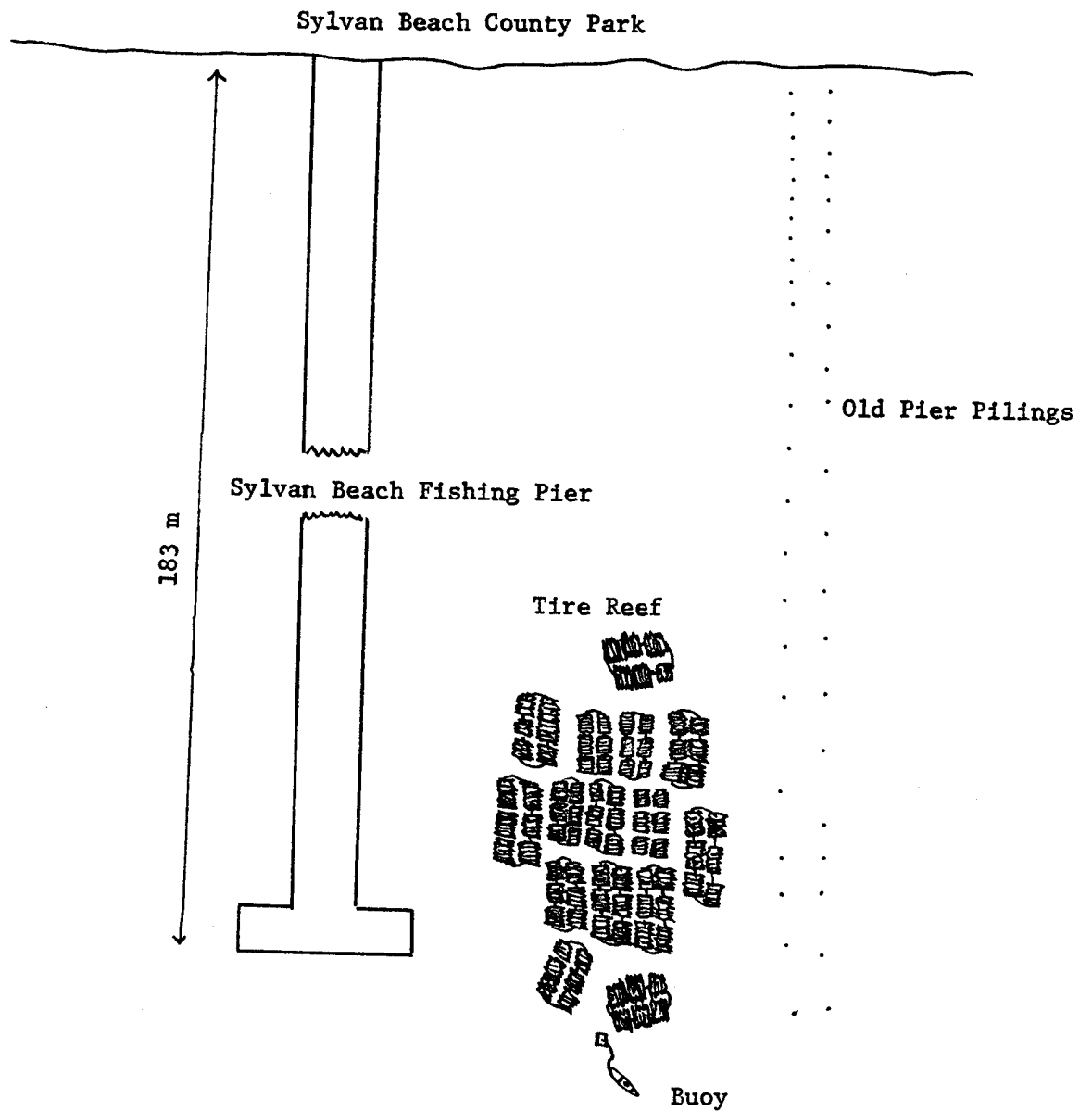


Figure 7. Artificial tire reef at Sylvan Beach in Galveston Bay.

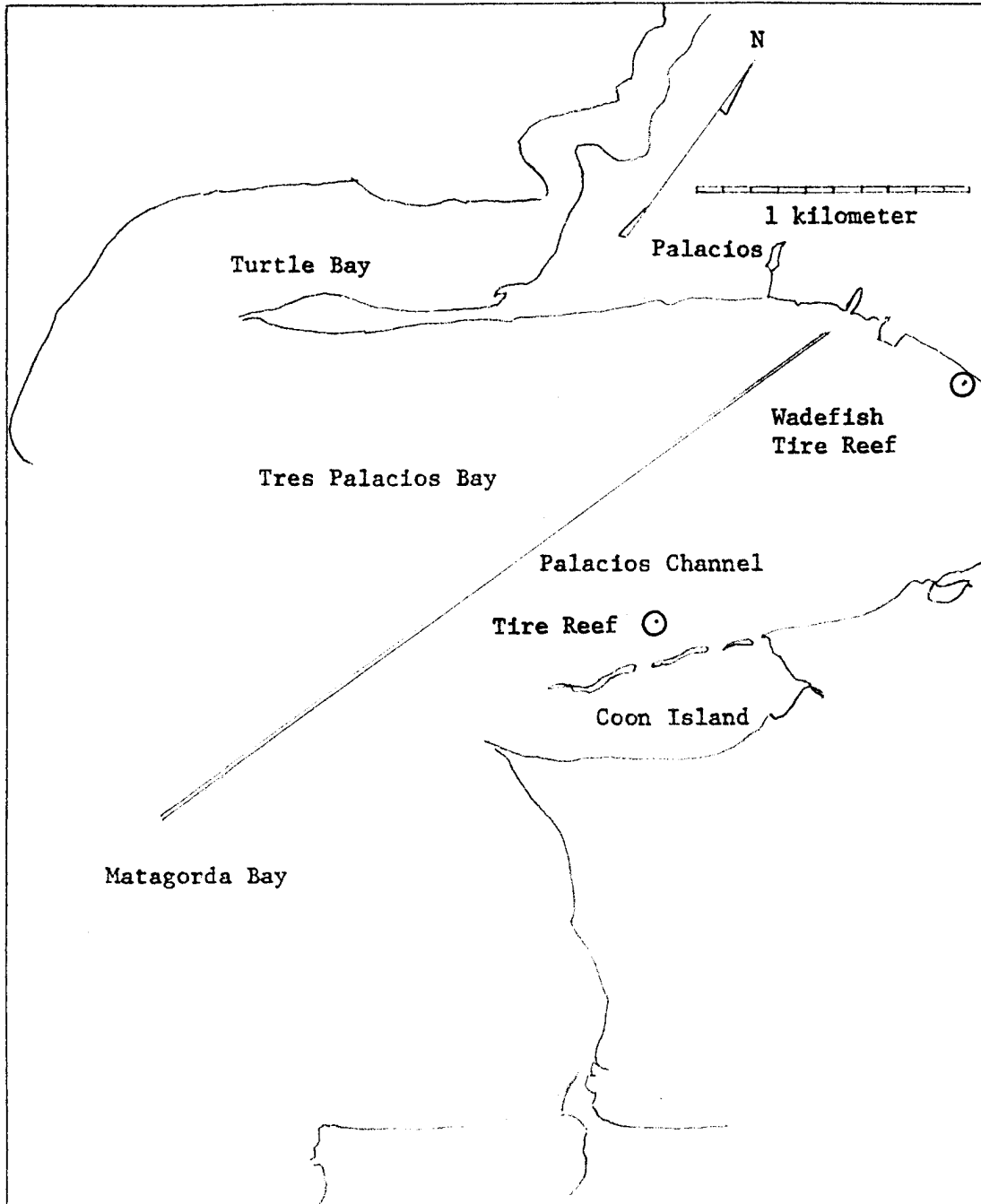


Figure 8. Artificial reef sites in Tres Palacios Bay.

Experimental Oyster Platform

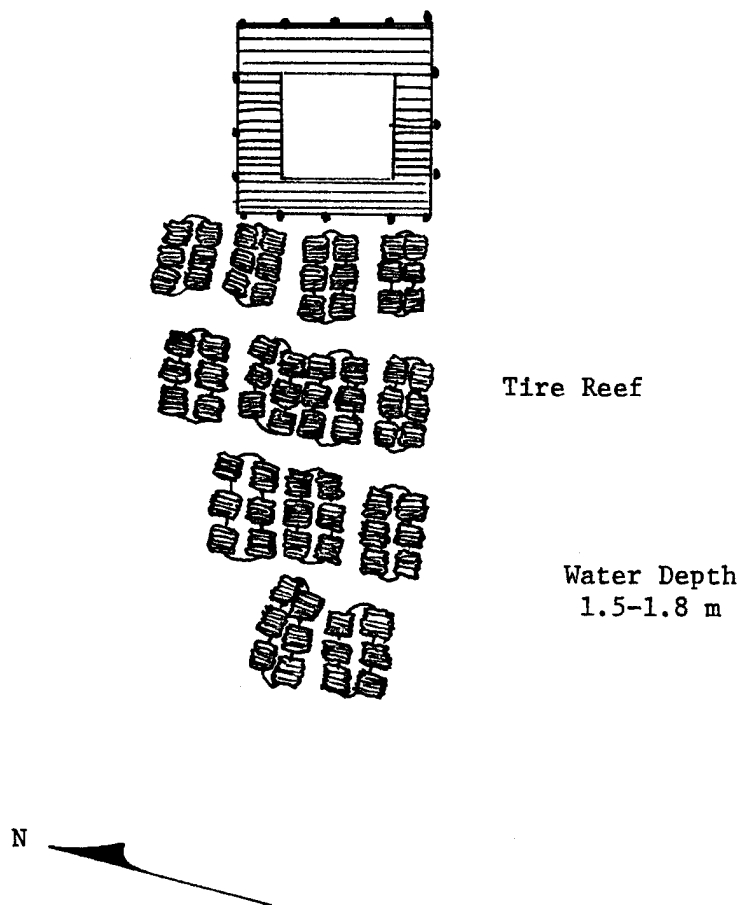


Figure 9 . Artificial tire reef near Coon Island in Tres Palacios Bay.

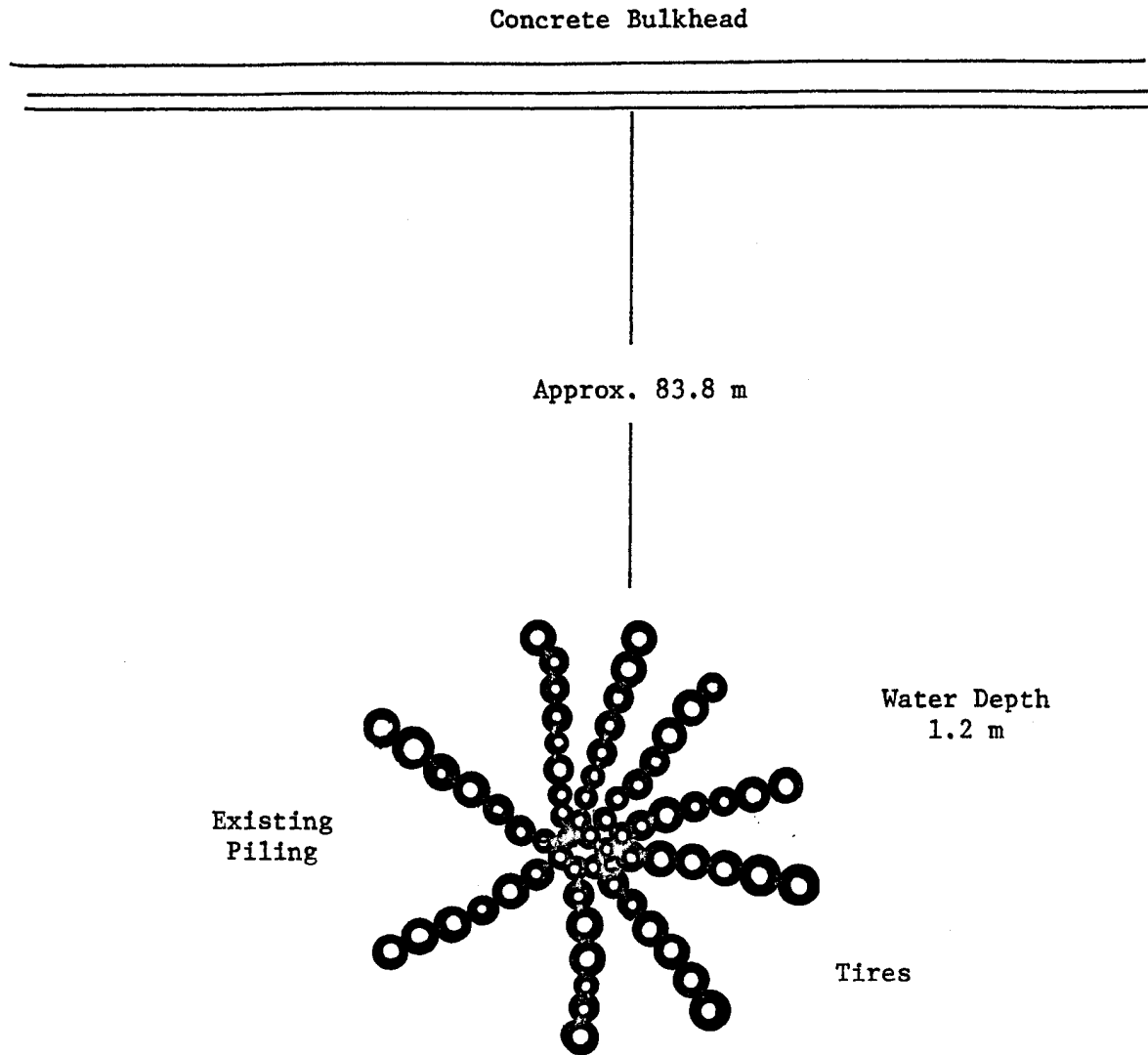


Figure 10. Artificial tire reef near Palacios shoreline in Tres Palacios Bay.

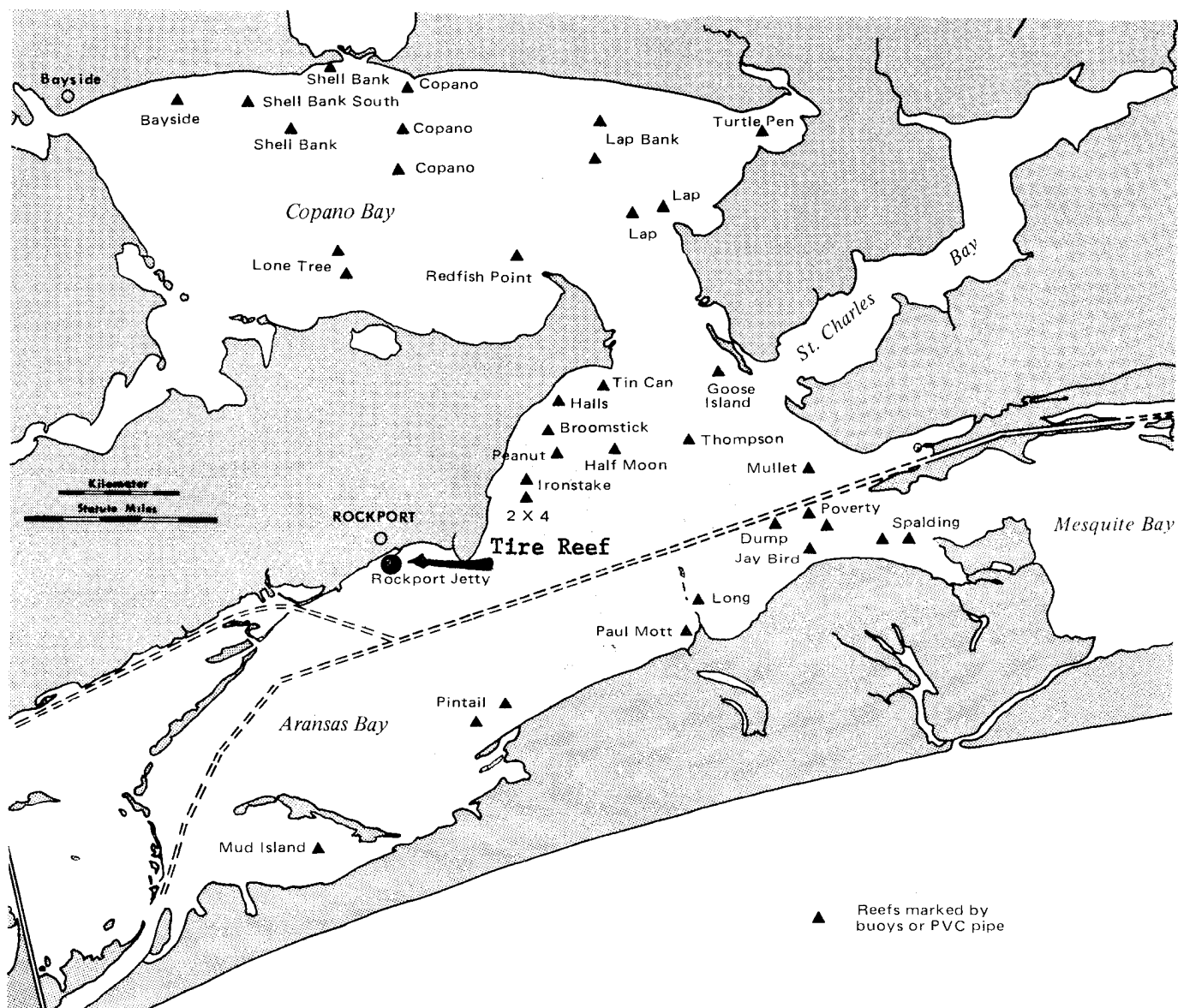


Figure 11. Tire reef and marked oyster reef locations in Aransas and Copano Bays.

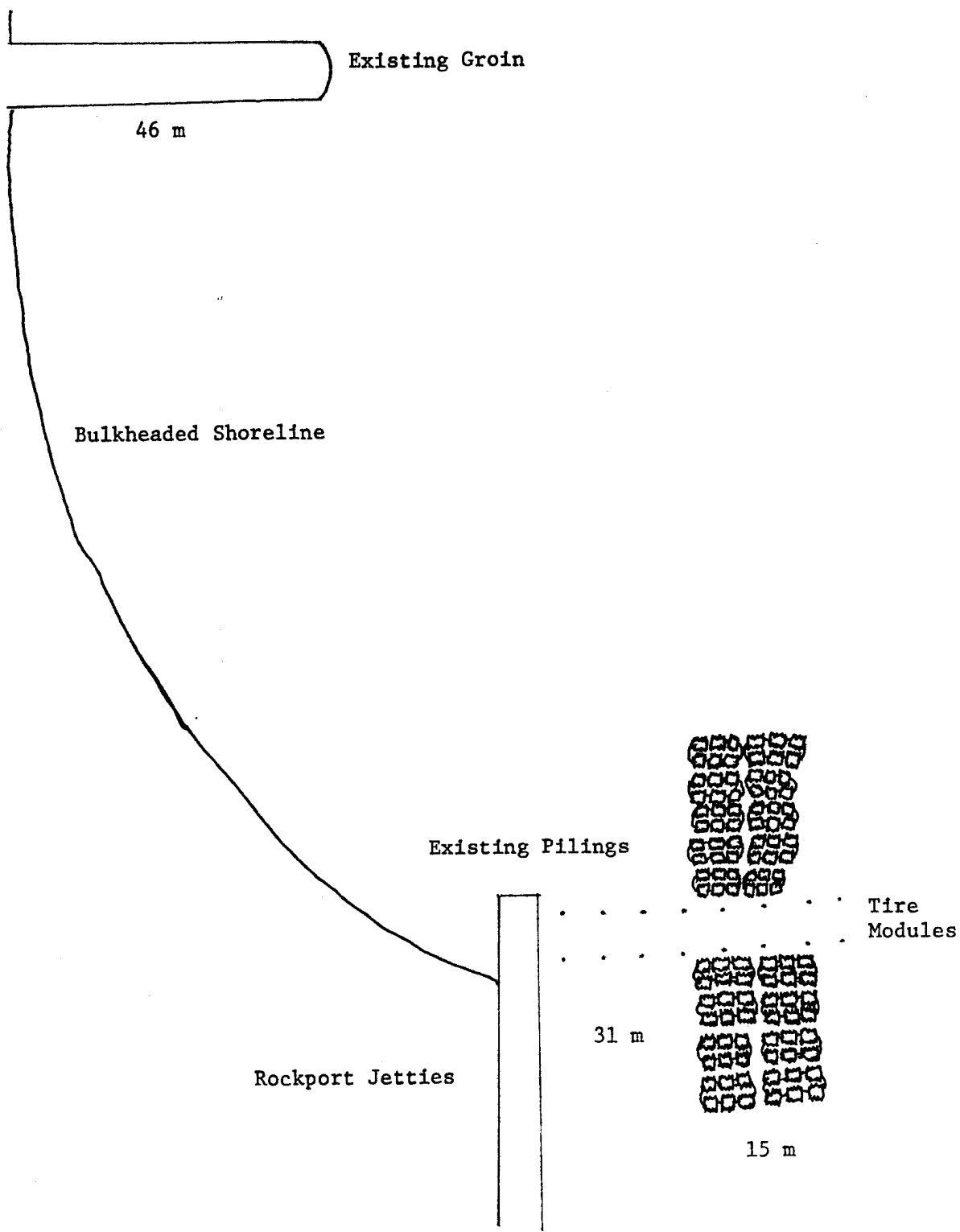


Figure 12. Artificial tire reef at Rockport jetties in Aransas Bay.

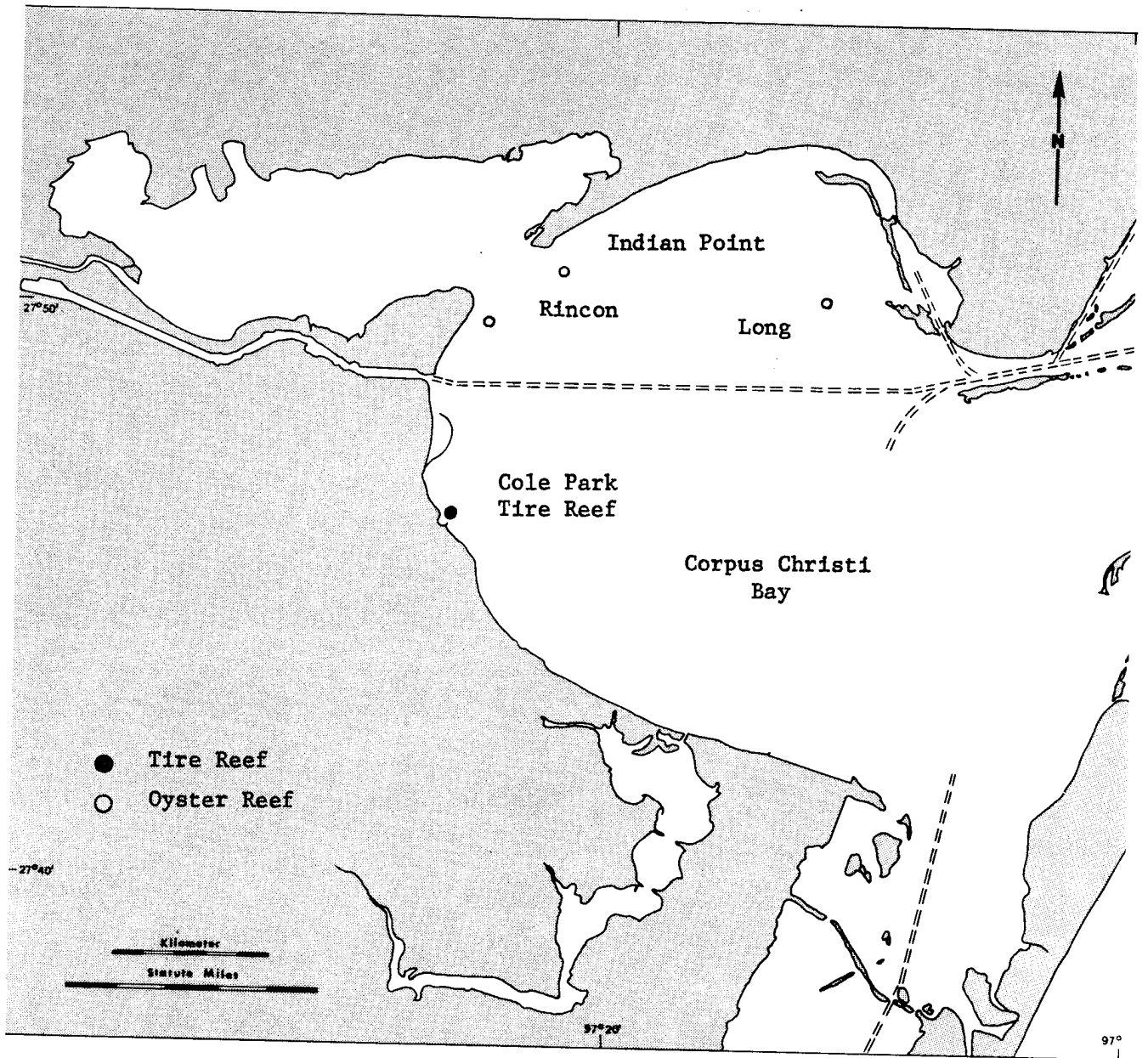


Figure 13. Tire reef and marked oyster reef locations in Corpus Christi Bay.

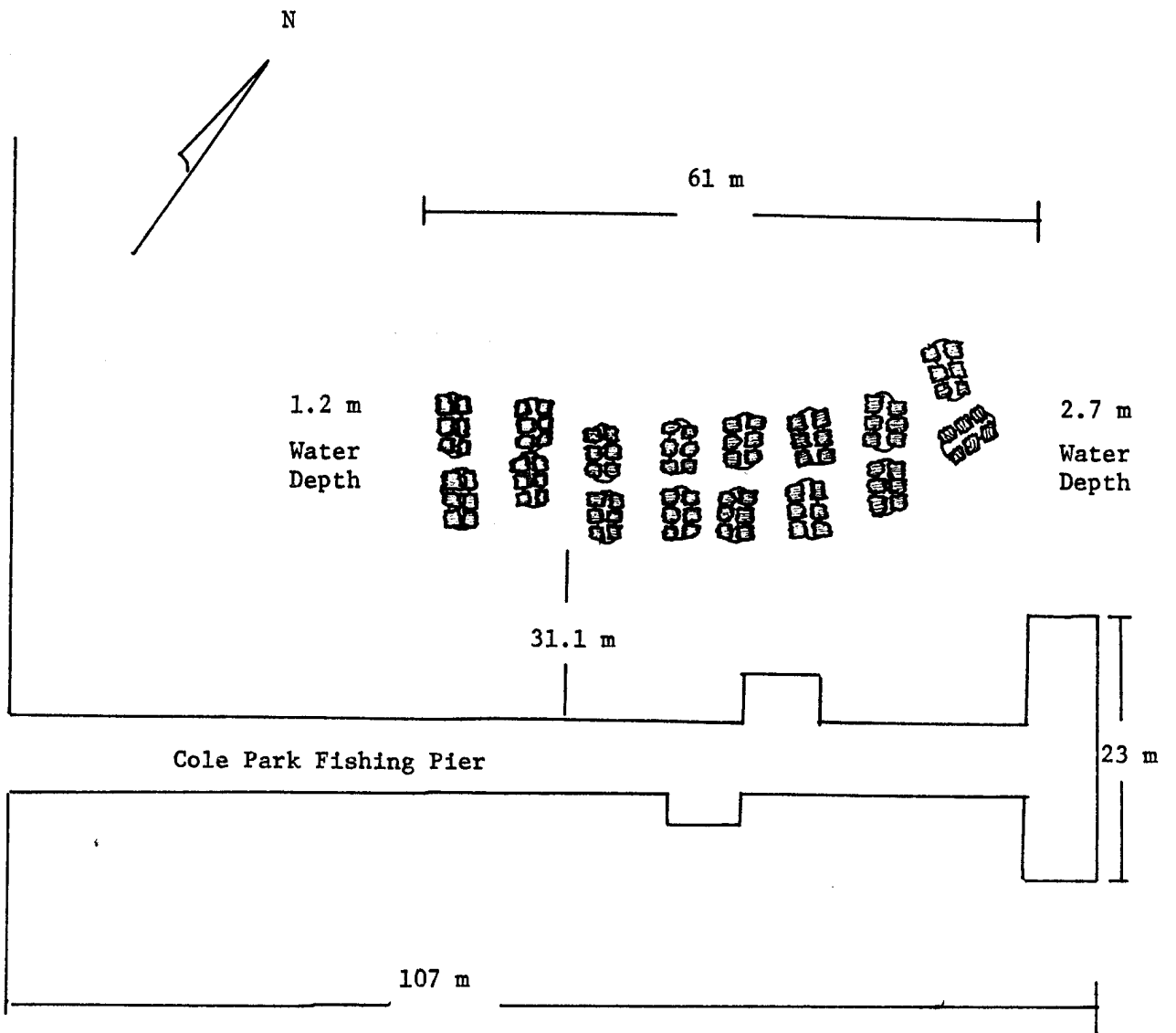


Figure 14. Artificial tire reef at Cole Park fishing pier in Corpus Christi Bay.

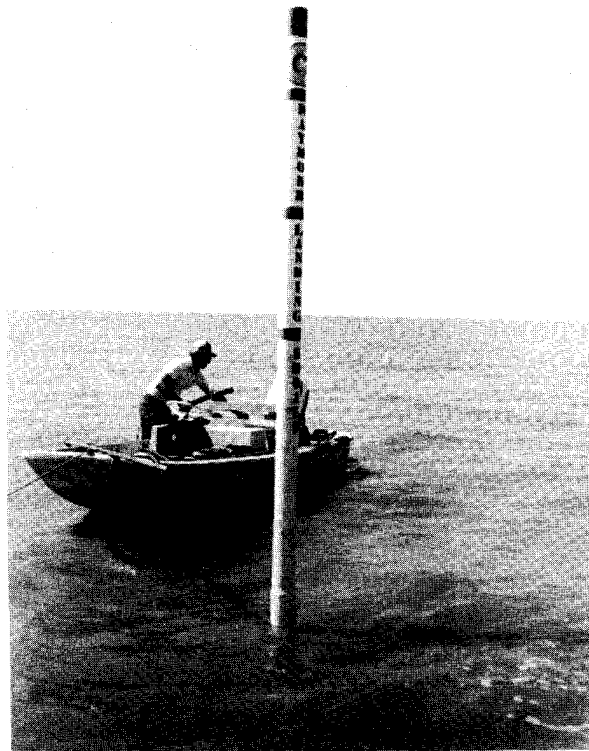
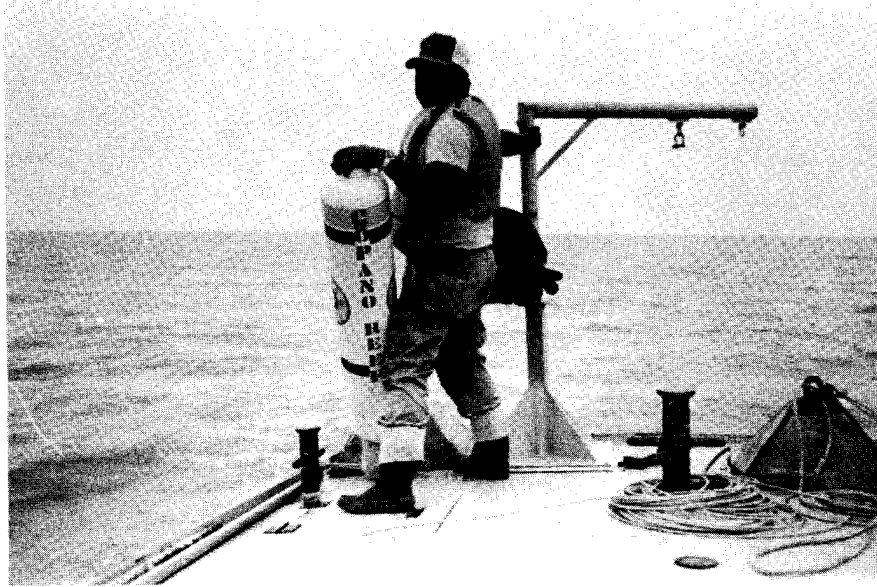


Figure 15. Fiberglass buoy and anchor ready to be placed in Copano Bay.

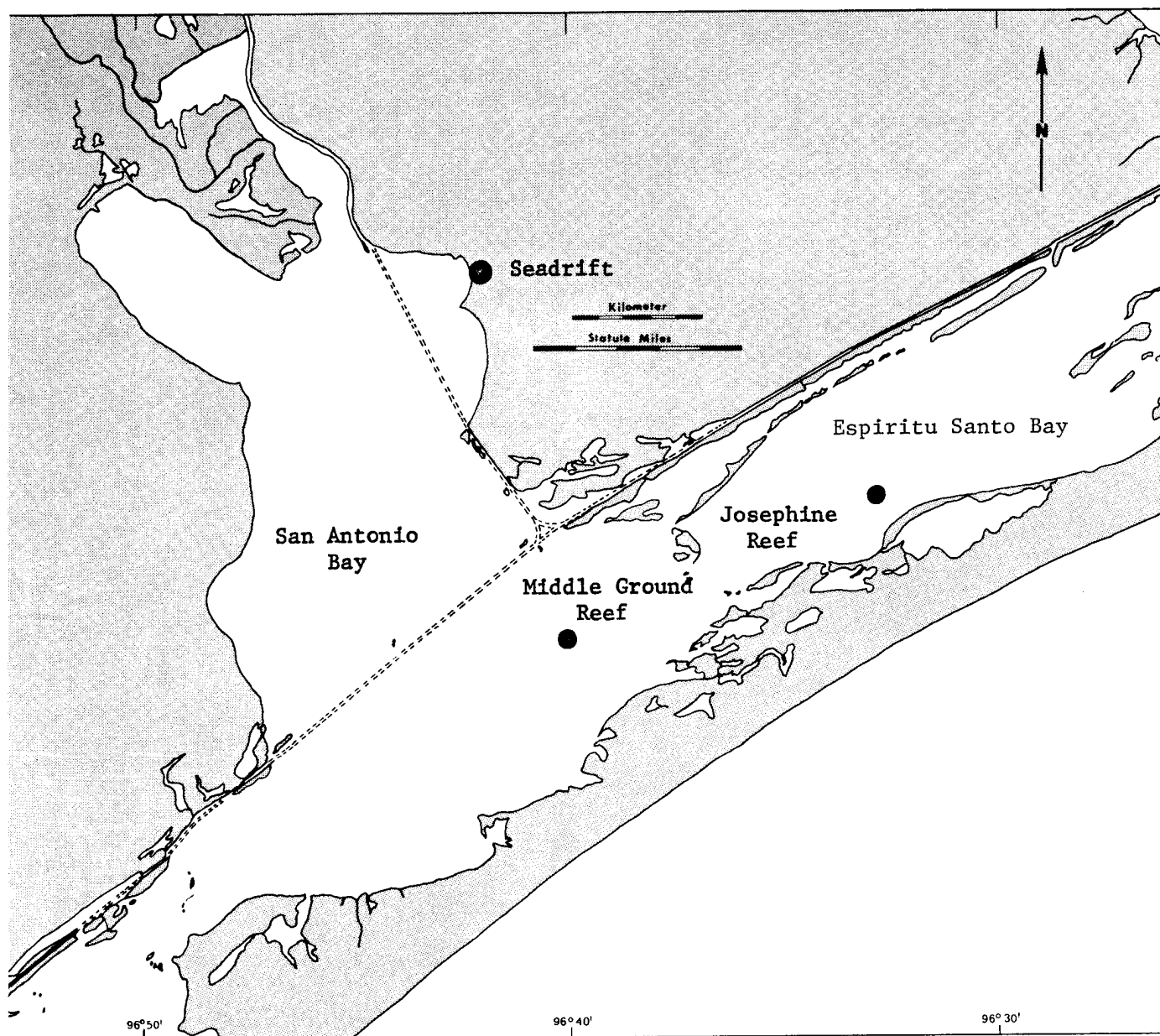


Figure 16. Locations of reefs marked by buoy in San Antonio and Espiritu Bays.

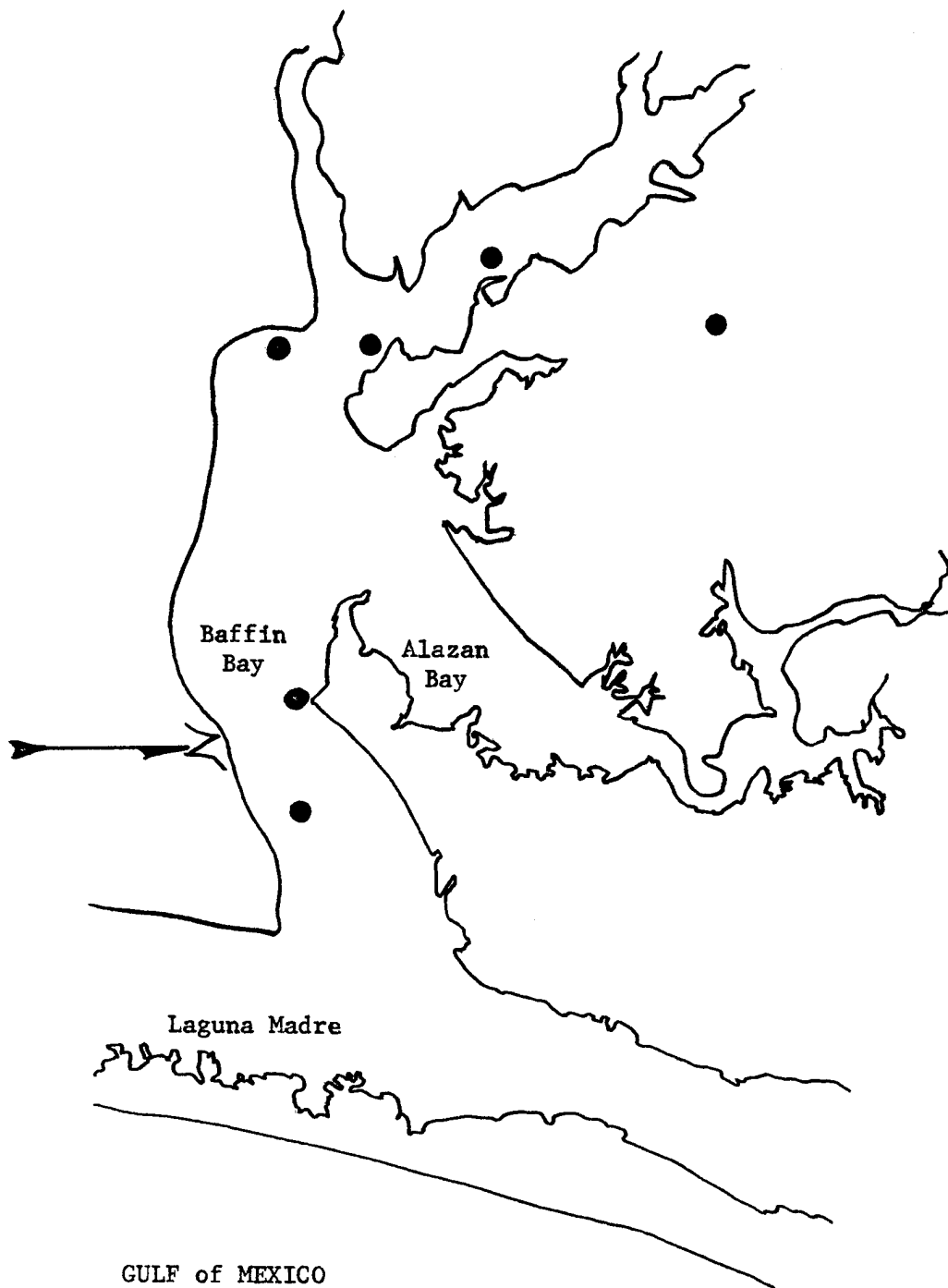


Figure 17. Locations of fishing buoys in Baffin Bay.

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