

AN ASSESSMENT OF THE SPORTFISHERY
ON ARTIFICIAL "LIBERTY SHIP" REEFS
OFF PORT ARANSAS, TEXAS

SEP 1977

A report to the Texas Coastal and Marine Council
in fulfillment of Contract No. IAC(76-77)-2149

Submitted by
Russell D. Vetter
Oswald A. Roels

The University of Texas Marine Science Institute
Port Aransas Marine Laboratory
Port Aransas, Texas 78373



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I. INTRODUCTION

The concept of using surplus World War II Liberty Ships for the construction of artificial reefs to increase the availability of sportfish off the Texas coast was originally suggested in 1974. It became a reality, under the guidance of the Texas Coastal and Marine Council, when three ships were sunk off Port Aransas in the winter of 1976. Since that time, the ships have rapidly become encrusted with algae, anemones, sea urchins, gorgonian coral and other attached marine life. These in turn have provided refuge and food source for a host of small invertebrates and fishes.

In June of 1977, one and a half years after sinking the first ship, the Texas Coastal and Marine Council commissioned this study to evaluate the impact of the Liberty Ship reefs on sportfishing in the Port Aransas area. For a project such as the Liberty Ship reefs to be successful, there are two criteria: the ships must increase the supply of desirable sportfish and fishermen must be willing to utilize the new resource. The present study is an attempt to evaluate both aspects of the project. A user survey was conducted to determine the amount and type of recreational usage the Liberty Ships receive.

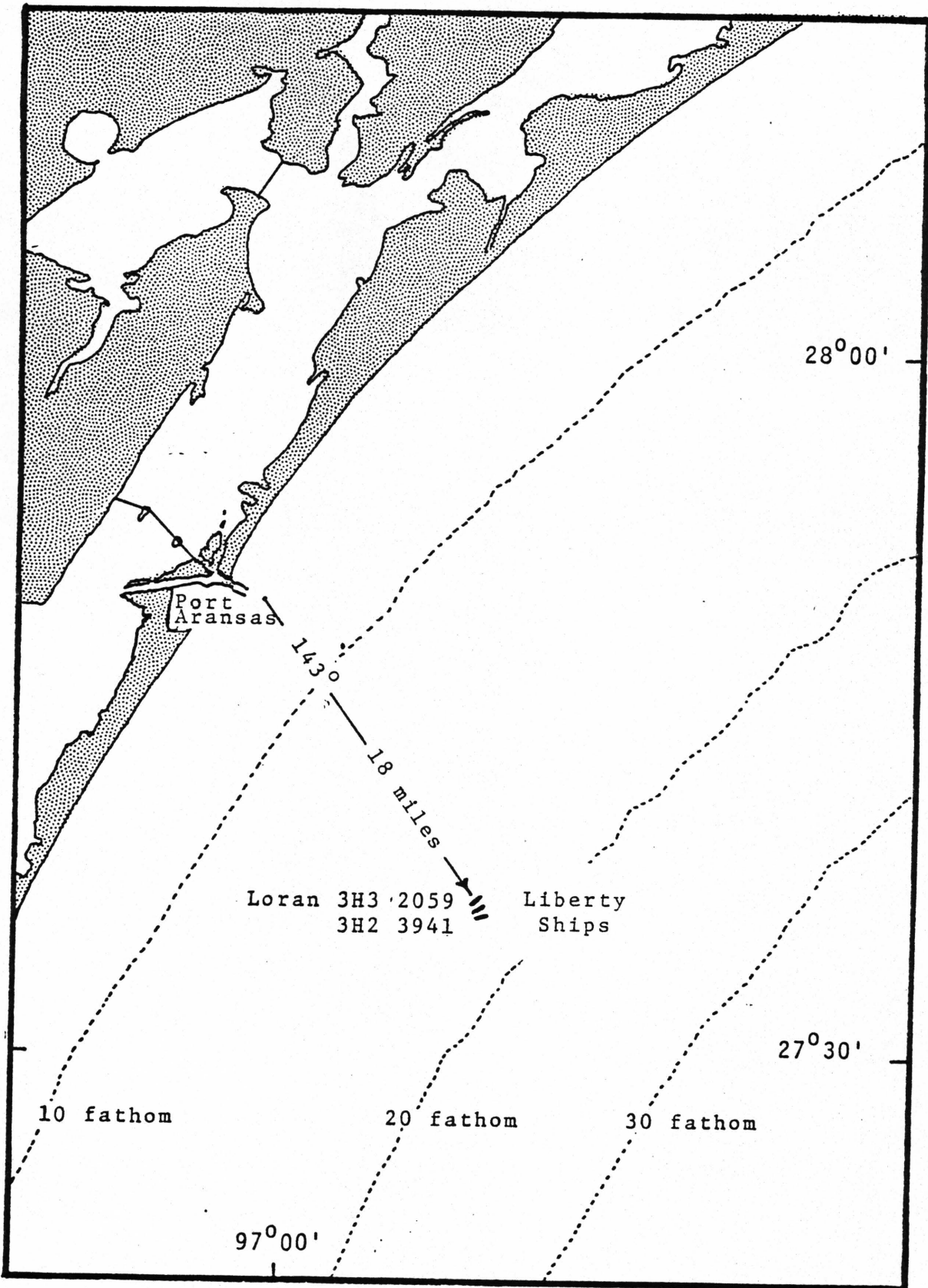
II. SURVEY OF RECREATIONAL USAGE OF THE LIBERTY SHIP REEFS

Although many studies of this type have recorded usage on a per individual basis (Buchanan, 1973) this was not suitable for the present study due to the high turnover rates of visiting recreational fishermen. Instead, data were recorded on a per

boat basis and emphasis was placed on boats that occupied a permanent boat slip throughout the study period. This same technique is used by the National Marine Fisheries, Oceanic Gamefish Investigations and has proved highly successful.

To meaningfully assess recreational usage of the Liberty Ships, fishing and recreational diving interests were separated into five user groups. Group 1 comprises party or "head" boats that offer regularly scheduled fishing trips with payment on a per individual basis. Group 2 are private charter boats generally carrying 2-6 anglers on a group contract basis. Group 3 are private recreational boats 28 feet or greater in length. Group 4 encompasses private recreational boats under 28 feet long. Group 5 consists of all recreational divers.

There are six party or "head" boats that routinely operate out of Port Aransas during the summer months (Table 1). Fishing trips generally last four or eight hours with bait and tackle supplied by the operator. Two party boats operate out of the Deep Sea Headquarters: the Marlin Queen I, 91 feet, and the Marlin Queen II, 60 feet. Fisherman's Wharf operates two catamarans; the Wharf Cat, 80 feet, and the Scat Cat, 75 feet. Rick Corn's Sportmans Center operates the Pelican, 45 feet, and Dolphin Docks runs the Dolphin, 65 feet. These boats operate every day during June, July and August, weather and mechanical considerations permitting. This represents a potential total fishing effort of 552 boat-days.



Port Aransas

1430

18 miles

Loran 3H3 2059
3H2 3941

Liberty Ships

10 fathom

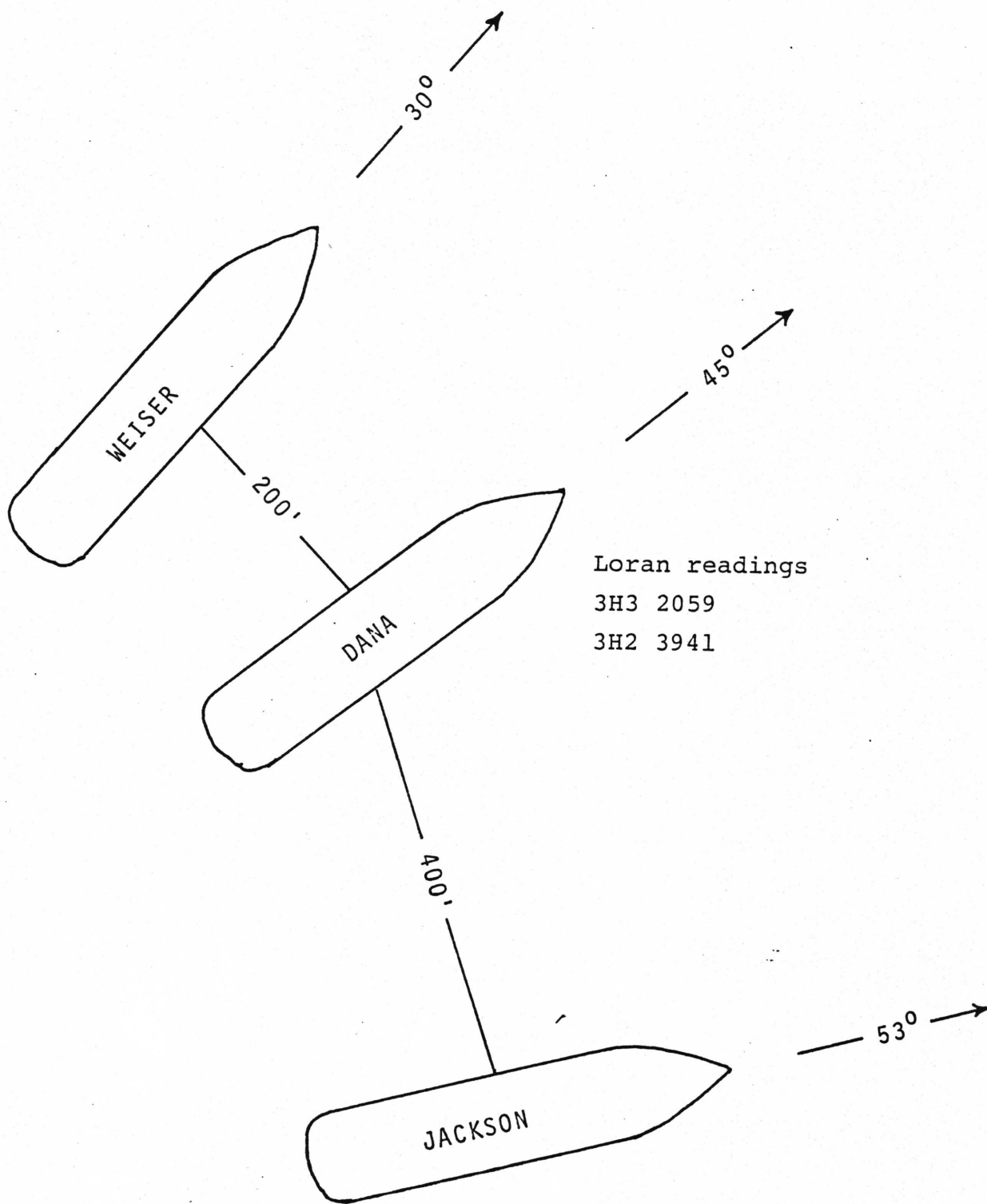
20 fathom

30 fathom

28°00'

27°30'

97°00'



Loran readings
3H3 2059
3H2 3941

1. Utilization by Party Boats

Table I
Party Boats Participating in Survey

<u>BOAT NAME</u>	<u>RESPONDENT</u>	<u>UTILIZATION¹</u>
Wharf Cat	Edward Shepard	0
Scat Cat	Edward Shepard	6
Dolphin	Warren Hamm	0
Marlin Queen I	Willis Langford	0
Marlin Queen II	Willis Langford	4
Pelican	Kennith Reiter	2
Shark Hunter	Paul Dirk	0

¹Utilization is expressed as total boat-days fished during the three month study period

This interest group directs its effort almost exclusively towards migratory, schooling, pelagic species. Early in the season the primary species landed is the jackfish (Caranx hippos). Later in the summer as jackfish landings decline, king mackerel (Scomberomorus cavalla) are the most important species. The method of fishing from these boats is almost exclusively drift fishing, with anglers using dead bait fished from the surface down to a depth of 30 feet.

Utilization of the Liberty Ship reefs by regularly scheduled party boats during the months of June, July and August must be considered minimal. The portion of the total 552 boat-day fishing effort that was devoted to the Liberty Ship Reefs was only 12-boat days, including 4 by the Marlin

Queen II, 2 by the Pelican and 6 by the Scat Cat.

Two reasons for the low utilization of the reefs by this interest group were time and fuel costs. The three boats that did not utilize the ships at all usually run four-hour fishing trips. These boats average one hour to one and one half hours to reach the Liberty Ships and slightly less to return. The one and a half to two hours remaining for fishing is not sufficient to produce a satisfactory catch.

Aside from the time factor, the high cost of fuel is an important consideration. Most party-boat captains are able to find sufficient stocks of kingfish and jackfish around gas wells, drilling platforms, anchored shrimp boats and other features located within 10 miles off shore. The added cost of traveling 16 miles to the Liberty Ships has not been justified by the size of the catches off the reefs. The total number of anglers fishing from party boats on the Liberty Ship reefs was 354 and the total fees paid were \$9,760.00 for the three month study period.

Although utilization during the summer months was low, all people concerned with party-boat operations enthusiastically support the Liberty Ship reefs and indicated that they intended to utilize the reefs at other times of the year. When kingfish, jackfish, ling and Spanish mackerel migrate away from this area with the onset of cool weather, party-boat operators must rely on other fish stocks. Traditionally, this has been bay fishing. However, these species are declining in abundance. Red snapper and Warsaw grouper fishing trips to the Liberty Ships are offering

new fishing opportunities and new sources of revenue during the off season.

Although this user group is not as visible as the party boat business, charter boats constitute a large segment of the commercial sportfishing industry in Port Aransas (Table II). Charter boat operators rely on word-of-mouth advertising and bookings arranged through party boat docks to obtain customers. They generally average four anglers per trip, with trips lasting eight hours. The method of fishing is either trolling or driftfishing at or near the surface. Charter boat operators also rely primarily on migratory schooling pelagic species such as kingfish, ling, jackfish and Spanish mackerel.

2. Utilization by Private Charter Boats

Table II

Private Charter Boats Participating in Survey

<u>BOAT NAME</u>	<u>RESPONDENT</u>	<u>UTILIZATION¹</u>
Bess & Fess	John E. Mathews	3
Lady Bea	Byrd Mintner	4
Poco II	Charles Holmes	0
Hustler	Jay Lancaster	1
Hustler II	Rick Corn	12
Hustler III	Nick Fryar	4
Lil Hustler	Cricker Mathews	0
Diablo	Tom Lambertson	3
Peggy Sue	Robert Butler	1
Schatzie	Bob Palmer	6

<u>BOAT NAME</u>	<u>RESPONDENT</u>	<u>UTILIZATION</u> ¹
B-G	Bruce Ponton	0
Colonel Rice II	Randy Turner	0
Mo-Jo	Bob Kelly	0
Sugarfoot II	Ed Hall	0
Patti II	Ken Grimes	10
Foolish Pleasure	Gary Eincoff	2
Sand Dollar	Mac Carpenter	1
La Isla		3
100 Proof		NR ²
Wheeler Dealer		NR
Carla Ann	O. H. Salyers	0

¹Utilization is expressed as total boat-days fished during the three-month study period

²NR indicates that the respondent did not return log book

The cost of a private charter fishing trip is dependent on the size and type of boat and the type of fishing desired. Charters generally begin at \$150.00 for a party of four and can range over \$400.00. The primary consideration of charter operators is to provide an enjoyable fishing experience with a minimum expenditure of fuel and running time. This is the determining factor for utilization of the Liberty Ships by this group.

During the three-month study period, charter operators were surveyed to determine the amount of usage of the reefs. Almost all charters during this period fished for kingfish. Most operators surveyed indicated that the reefs were too far and too unproductive of this species to justify the expense, the average

catch being four to five kingfish per trip. Of the group interviewed 11 boats fished the reefs at least once. Use averaged 2.5 days per boat with a total of 49 days recorded for this group. The total expenditure by anglers fishing the Liberty Ship reef from this kind of boat was \$12,356.

Many charter businesses operate only during the peak summer months. However, those that do charter throughout the year indicated that they intended to run red snapper and Warsaw grouper trips to the Liberty Ships during the fall and winter. Although the reefs are not highly productive of kingfish, most operators realize that the reefs were not intended to significantly stimulate pelagic fisheries. One charter operator who regularly fishes the reefs has been able to generate interest in barracuda fishing on the reefs as an alternative to kingfishing. In general, most charter operators are favorably impressed with the reefs and believe that they have stimulated productivity.

This user group is composed of privately-owned boats generally operated by a professional captain, and possibly a mate, that devote most of their fishing effort towards off-shore species. The 28 ft. or larger boat-length used to define this group, although arbitrary, does encompass most boats capable of safely operating at distances greater than thirty miles offshore. A list of boats and participants in this part of the survey can be found in Table 3. The primary species of fish that are sought by this group of anglers are the billfishes, blue marlin, (Makaira nigricans), white marlin (Tetrapturus albidus), and sailfish (Istiophorus platypterus).

Other pelagic species commonly landed include: dolphin (Coryphaena hippuris), wahoo (Acanthocybium solanderi), blackfish tuna (Thunnus atlanticus), yellowfin tuna (Thunnus albacares) and Bonito (Euthynnus alletteratus). The method of fishing for these species is almost exclusively trolling of natural or artificial baits at the surface.

3. Utilization by Private Offshore Boats

Table III

Offshore Boats 28' and Larger Participating in Survey

<u>BOAT NAME</u>	<u>RESPONDENT</u>	<u>UTILIZATION¹</u>
Hokus Polus	Chris Page	0
A Boat Named Sue	Curly Johnson	0
Carey On	Jeff Carey	0
Mi-Mi	Carlos Moore	0
Black Topper	Jim Graves	0
Pixie	Bruce Furlough	0
Breaker I	Bob Hollinger	0
Coeco	Bill Hart	5
Olympia III	Bubba Curry	0
Wolverine	Burton Curry	0
Bessie W	Tom Martin	1
Tempest	Roy Smith	0
Rebel	Tom Masterpole	3
Samaki	Smokey Gaines	0
Webb Tide	Jerry Webb	0

<u>BOAT NAME</u>	<u>RESPONDENT</u>	<u>UTILIZATION¹</u>
Hot Tamale	Lefty Strong	0
Cora Belle	Tom Keeler	0
La Tonina	Fred Rhodes	0
Stella Mae II	Doyle Merrick	0
Sundancer	Corky Furlow	0
Mo Misery	Scott Frost	3
Deep Sea C. D.	Roger Goodwin	0
Born Free	Earl Rasberry	NR ²
Lorelei	Louis Sczaborczk	NR
Pauper's Pride		NR
Kaydiddle		NR
Fractured Jaw	Roger Byrne	NR
Aquarian	Glenn Mathison	0
Escort II	Ro Chandler	NR
Jayhawker	Ron Arbogast	NR
Fat Daddy		NR

¹Utilization is expressed as total boat-days fished during the three-month study period

²NR indicates that the respondent did not return log book

The primary factors governing Liberty Ship usage by this group are not the distance or economics of traveling to the reefs. Most boats routinely fish at distances greater than the reefs. The main factor limiting usage of the Liberty Ships by this group is their single-minded devotion to billfishing. Many of these boats fish the Liberty Ships for Warsaw during the cooler months. However, during the summer season they fish almost exclusively for billfish.

Four boats did utilize the Liberty Ships during the study either for variety or when weather did not permit offshore fishing. They logged 12 boat-days.

This user group was the most difficult to accurately survey for several reasons. Most boat owners in this group do not permanently moor their boats but prefer to keep them on trailers and launch them at various launching ramps when needed. The owners were generally not present throughout the study period, but tended to actively fish for one or two weeks, then leave the area. People tended to return from fishing and retrieve their boats at the same times I monitored the fish cleaning areas and were seldom present at other times during the week. For these reasons owners of boats in this group were given log books and asked to record the numbers and types of fish they caught and the hours they spent fishing the reefs. These log books were to be mailed in at the end of August. People participating in this aspect of the survey are listed in Table IV.

4. Utilization by Recreational Boats Under 28 Feet

Table IV

Inshore Boats Under 28' Participating in Survey

<u>BOAT NAME</u>	<u>RESPONDENT</u>	<u>UTILIZATION¹</u>
Granny J	Wilburn Rocket	4
Sunchaser	Wayne Kirby	0
My Fair Lady	Charles Craig	0
Jeannie Bell II	Russ Williams	0
Stella K	Joe Klonek	2

<u>BOAT NAME</u>	<u>RESPONDENT</u>	<u>UTILIZATION¹</u>
Mako 19'	Bill Cleveland	0
Boca Chica	Paul Kennedy	0
Shana Lee	W. C. Gustofson	NR ²
Flo's Boat	Bob Jones	NR
Blodgett	Ed Collett	NR
Peanuts	F. A. Price	NR
Misty Dawn	James Rice	NR
Blue Fin		NR
Myra Jean		NR
Miss Billi		NR
Blue Eyes		NR
Galadriel	Mark Poff	0
24'	Ken Winters	0
20'	James Cameron	0

¹Utilization is expressed as total boat-days fished during the three-month study period

²NR indicates that the respondent did not return log book

The limiting factor determining usage of the Liberty Ships by this group is the wind and sea conditions. The Liberty Ships are located off Port Aransas at a compass heading 145°. It is necessary for boats to run directly into the prevailing southeast summer winds to reach the ships. Most recreational boat operators are apprehensive about traveling to the ships except when weather conditions are favorable and fishing is poor in other areas.

The return of log books by this group has been the largest shortcoming of this study. This is partly due to complacency on the

part of recreational fishermen and partly due to inclement weather. Although hurricane Anita did not hit Port Aransas, almost all boats were removed from the water and boating activity from August 28 through Labor Day has been virtually nonexistent. Consequently, it has been difficult to reach recreational fishermen and prod them into returning log books. To date 12% of the log books have been returned.

Much of the original impetus to construct the Liberty Ship reefs came from sport diving interest generating petitions to the Texas Coastal and Marine Council in support of this project. Not surprisingly, this same group has been one of the most frequent users of the reefs.

Recording individual recreational diver usage of the reefs is extremely difficult as there is no central dock or launching area through which they can be monitored. Consequently, most diver usage was monitored through dive shops in the Corpus Christi area, see Table V. It became immediately apparent from all people interviewed that the Liberty Ship reefs are an important new resource for recreational divers.

5. Charter Diving Groups

Table V

Dive Charter Groups Participating in Survey

<u>CHARTER ORGANIZATION</u>	<u>RESPONDENT</u>	<u>UTILIZATION¹</u>
Copeland's Dive Shop	Saundra Copeland	2
Padre Island Dive Shop	Pat McMillan	64

<u>CHARTER ORGANIZATION</u>	<u>RESPONDENT</u>	<u>UTILIZATION</u> ¹
Oceaneers Dive Shop		12
Frenchie(Charter Boat)	Bill Beaudreau	3

¹Utilization is expressed as total boat-days fished during the three-month study period

There are three dive shops in the Corpus Christi area, and all of them have begun charter services to the reef. They vary in the numbers of divers they accommodate per trip and the frequency of trips to the reefs. One dive shop operates trips on a per individual basis as do party fishing boats. A trip is scheduled and advertised and anyone wishing to go may register until the trip is full. They generally carry 50-60 divers per charter and made two trips during they survey period. The other shops and private charter boats generally handle small groups that organize among themselves and charter the boat as a group. These shops average six divers per trip and make more frequent trips. One shop ran 12 charters, the other 64 during the three-month study period. 15% of the divers surveyed used the Liberty Ships for spearfishing with the remainder of the divers involved in photography or viewing. The total number of trips recorded from this user group was 85. The average expenditure by each diver was \$36.42 and the total recorded expenditures were \$15,080.00. All respondents indicated that they intended to continue running charters to the Liberty Ships during other seasons.

III. BIOLOGY OF SELECTED FISH SPECIES INHABITING THE LIBERTY SHIP REEFS

Fishermen were asked to report the five most commonly encountered

species on the Liberty Ships during the study period. These species were: barracuda (Sphyraena barracuda), ling (Rachycentron canadum), king mackerel (Scomberomorus cavalla), red snapper (Lutjanus campechanus), and Warsaw grouper (Epinephelus nigritus). The relative abundance of different species landed by anglers may be as much a reflection of the methods employed as it is of the actual abundance of the species. A complete list of species taken by anglers or sighted by divers is included in Table VI.

Table VI

Fish species taken by angles or sighted
by SCUBA divers on the Liberty Ships Reefs
during the months of June, July and August

<u>COMMON NAME</u>	<u>SCIENTIFIC NAME</u>
Red Snapper	<u>Lutjanus campechanus</u>
Warsaw Grouper	<u>Epinephelus nigritus</u>
Jewfish	<u>Epinephelus itajara</u>
Spadefish	<u>Chaetodipterus faber</u>
Angelfish	<u>Pomacanthus paru</u>
Spanish mackerel	<u>Scomberomorus maculatus</u>
King Mackerel	<u>Scomberomorus cavalla</u>
Bonito	<u>Euthynnus alletteratus</u>
Dolphin	<u>Coryphaena hippuris</u>
Sailfish	<u>Istiophorus platypterus</u>
Ling	<u>Rachycentron canadum</u>
Barracuda	<u>Sphyraena barracuda</u>
Redfish	<u>Sciaenops ocellata</u>

<u>COMMON NAME</u>	<u>SCIENTIFIC NAME</u>
Sandtrout	<u>Cynoscion arenarius</u>
Atlantic Croaker	<u>Micropogon undulatus</u>
Whiting	<u>Menticirrhus americanus</u>
Crevalle Jack	<u>Caranx hippos</u>
Sheepshead	<u>Archosargus probatocephalus</u>
Sergeant Major	<u>Abudefduf saxatilis</u>
Moonfish	<u>Vomer setapinnis</u>
Pinfish	<u>Lagodon rhomboides</u>
Damselfishes	<u>Pomacentridae</u>
Butterflyfishes	<u>Chaetodontidae</u>
Squirrelfish	<u>Holocentrus sp.</u>
Tarpon	<u>Megalops atlantica</u>

The following is a brief description of the five most common species.

1. Red Snapper (Lutjanus campechanus)

In the Gulf of Mexico red snapper is one of the most valuable and sought after species by both commercial and recreational interests. Bromberg (1973) reported red snapper ranked fourth in popularity after trout, snook and grouper by recreational boats and first by commercial sportfishing boats. The interest in red snapper as a sport fish is not nearly as great in South Texas as in other Gulf States. Unlike other areas of the Gulf, recreational landings of red snapper do not exceed commercial landings. The reason for this in the Port Aransas area is probably the distance of suitable snapper banks from shore. Hospital Rock, the nearest available reef, is located 38 miles off Port Aransas. This is outside the safe

operating range of most recreational boats under any but the most ideal weather conditions. The Liberty Ships have provided a red snapper fishing area that is accessible to small boat operators; however, sportfishermen need to be made more aware of this new resource and should be encouraged to bottomfish as a new form of offshore sportfishing.

One of the rationales for placing all the ships in one area was to concentrate enough reef habitat to support a breeding self-supporting population of red snapper instead of merely attracting and concentrating snapper from other areas.

Recent studies on the life history of red snapper indicate that red snapper are not nearly as territorial as previously believed (Moe, 1963; Johnson et al., 1976). Red snapper move away from outcroppings to sandy featureless bottoms to spawn (Moe, 1963). The planktonic eggs are subject to dispersal over wide areas and are able to colonize outcroppings other than those of their parents.

Although the self-sustaining idea may be simplistic, there is good evidence that the Liberty Ships are already supporting a true resident population of red snapper. Both sexes are present and all size classes except young of the year have been reported. The smallest red snapper recorded was 20 cm and the largest was 18 lbs. Most fish caught off the ships weighed approximately 1 lb. According to age-growth studies (Mosley, 1965), these fish are age class 2, spawning class 1+. This indicates that most of the population is capable of reproducing. The absence of juveniles (<20cm) does not indicate that the reefs are not self-sustaining. Juveniles frequent open sandy and muddy bottoms away from outcroppings and bottom irreg-

2. Warsaw Grouper (Epinephelus nigritus)

The Warsaw grouper is a seasonal resident on the Liberty Ship reefs. This species is more temperate in its distribution than other groupers and prefers cooler waters. Unfortunately, this study was begun just as Warsaw were migrating from the ships to deeper cooler waters. Large catches of up to 700 lbs. were reported through the winter and spring prior to this study. Anglers landed individual grouper weighing over 150 lbs. on many occasions and divers reported grouper estimated visually at 300-400 lbs.

Due to their large maximum size and consequent fighting abilities, Warsaw are probably the main reason most anglers specifically fish the Liberty Ships at other times of the year. Several charter boat operators indicated that they intended to rely on Warsaw fishing trips for their income through the fall and winter season.

Although there are few data on the life history or commercial landings of Warsaw, it is doubtful that Warsaw can withstand as intense fishing pressure as red snapper. Growth patterns determined for a similar species, Epinephalus morio (the red grouper), indicate that spawning does not occur until after five years of age (Moe, 1963) and that the species may reach 30 years of age. Moe cautions that long-lived slow growing species such as the grouper are more susceptible to population reduction through fishing pressure than short-lived faster growing species such as the red snapper. Since fishing pressure is light in offshore areas, there may be sufficient stock to replenish the reefs through seasonal migrations.

Several Warsaw were landed in June before they had migrated completely from the reefs. Four Warsaw stomachs were examined to

determine dietary preferences. In general they consumed small invertebrates and schooling fish that may have been drawn to the reefs. In three of four fish, penaeid shrimp averaging 10 cm constituted 69% of the stomach contents. The remaining 31% consisted of small (8-10 cm) school fish, primarily rough scad (Trachurus lathami), and Gulf butterfish (Peprilus burti). Although most of the Warsaw stomachs contained numerous small prey items, they are capable of taking large items also. The stomach of one 45 lb. warsaw contained a fish head, possibly a ling (Rachycentron canadum), that completely filled a 2,000 ml beaker. In addition, the fish contained 200 ml of other fish remains and a callapa crab. This same individual contained a large hook and about 2 feet of monofilament leader. The hook was completely overgrown with a layer of stomach epithelium and apparently had little effect on the fish judging from outward appearances of health.

3. Barracuda (Sphyraena barracuda)

Barracuda are primarily a tropical species that inhabit the Liberty Ship Reefs only during the warmer months. They were extremely abundant on the reefs during the study and also constituted one of the major complaints about the reefs. In general they are strongly attracted to underwater structures such as artificial reefs and drilling rigs. On the Liberty Ship reefs they commonly occupy the midwater zone above the ships but below the surface.

Barracuda rely on vibrations emitted by struggling or wounded prey to stimulate feeding behavior (Bohlke and Chaplin, 1968). Consequently, they are difficult to hook using dead baits or lures. Most anglers encounter barracuda while attempting to land other fish.

The barracuda is attracted to the struggling fish and responds by attacking it. When the original fish is eventually boated it is often completely ruined. I have inspected several catches of kingfish from the Liberty Ships where the majority of the catch consisted of heads and body pieces.

In other areas of the Gulf and Caribbean, barracuda are considered a worthy sportfish that is actually sought and whose flesh is considered edible. In this area of Texas, barracuda are considered despoilers of normal sportfishing and their absence is greatly appreciated. The flesh is considered marginally edible at best. Consequently, no barracuda were brought to the fish cleaning areas that I monitored and no stomachs were obtained.

I can foresee no solution to the barracuda problem on the reefs as they co-occur during the warmer months with kingfish. The best alternative would be to demonstrate methods of catching barracuda and encouraging anglers to pursue barracuda as a legitimate sportfish.

4. Kingfish (Scomberomorus cavallo)

Kingfish or king mackerel are "perhaps the most popular offshore gamefish in the northeastern Gulf of Mexico, where the appearance of kingfish is regarded as the marine harbinger of summer" (Moore and Hoese, 1977). This aptly describes the position of this species in the recreation and economics of the Port Aransas area. Kingfish are a highly migratory member of the tuna and mackerel family (Scombridae) that appear off the Texas coast during the summer months. They apparently follow a continuous migratory path from summer feeding areas off Texas and Mexico to winter grounds off Florida. This pattern has been recently substantiated by tag returns. A kingfish

tagged in Port Mansfield during August of 1976 was recovered the following winter from Florida. In the course of this study, a tag was recovered from a kingfish tagged in Key West, Florida, in February, 1977 and recovered from Port Aransas in August of 1977.

It is apparent that bottom structures such as the Liberty Ship reefs can do little to enhance the overall abundance of such a pelagic migratory species. However, the increased supply of forage fish may tend to concentrate them.

Kingfish occupy the upper water column over the Liberty Ships where they are caught by people drift fishing or trolling from the surface to a depth of 30 feet. Although kingfish are common to the ships, no one surveyed indicated that the reefs were unusually productive of this species or that the area was superior to any other area. Most boats interviewed averaged about five kingfish per trip. Increased productivity may be possible by enhancing the fish-attracting capabilities of the reefs through the emplacement of floating mid-water structures as described by Ogren (1974). These structures tend to draw small pelagic schooling fish and consequently, pelagic predators in the same way as bottom structures draw small benthic forage fish.

Most anglers fish a variety of places on the way to and from the reefs; hence, it is impossible to identify which of the catch came from the Liberty Ships. Consequently, no kingfish stomachs were examined from fish definitely from the reefs.

5. Ling (Rachycentron canadum)

Ling do not school as do most other pelagic sportfish. They are most often found alone or in small groups of up to five individ-

uals (Bohlke and Chaplin, 1968). For this reason anglers do not usually fish specifically for ling but catch them incidentally with other species, primarily kingfish. Although they are caught incidentally, they are highly regarded as a food fish.

Ling are also migratory, occurring off Port Aransas from April to November (Springer and Pearson, 1958). For this reason their absolute numbers are probably not enhanced by artificial reefs. Ling are strongly attracted to any object in the water column such as floating debris, anchored boats, buoys, drilling rigs or artificial reefs. The Liberty Ships probably concentrate ling to some degree. However, this could be greatly enhanced by the addition of midwater or surface structures such as additional mooring buoys.

Few ling stomachs were obtained because anglers usually brought in mixed catches from several places. Two stomachs were examined; one was empty; the other (an unusually large 32 lb. specimen) contained one fish, a midshipman (Porichthys porosissimus) 10 cm long. Randall (1968) indicated that ling depend heavily on crabs, shrimp, and other benthic invertebrates commonly found around the Liberty Ships.

IV. SUMMARY AND SUGGESTIONS

1. The utilization of the Liberty Ship reefs by recreational fishermen during the months of June, July and August was not as heavy as might be expected due to the nature of the summer sportfishery off Port Aransas, Texas. Anglers pursue pelagic species, primarily kingfish, while the reefs are designed primarily to increase populations of benthic species.
2. Recreational divers extensively utilized the reefs for spearfishing, photography and viewing. All dive shops in the area have organized charter services to the reefs.
3. Although fishing pressure was low during the summer months, fishermen indicated that they intended to rely heavily on the reefs from September through April when most pelagic species migrate from the area. Warsaw grouper and red snapper are the primary species sought during the cooler months.
4. Examination of stomach contents of Warsaw grouper and red snapper revealed small invertebrates, primarily penaeid shrimp and portunid crab, were the mainstay of their diet. The abundance of this type of prey item is probably enhanced by the Liberty Ship substrate.
5. The outer two ships, without marker buoys, are probably underutilized because smaller boats without depth recorders are unable to find them. Many divers and boat operators have requested that buoys be placed on the other two ships.

6. The fishing success of anglers using the Liberty Ship reefs and consequently, their opinions of the value of the ships is, to a large extent, determined by their knowledge of how to fish an artificial reef and how to fish for new species. The success of many recreational anglers could be improved by publication of proper techniques for anchoring around reefs and methods of fishing for Warsaw grouper, red snapper and underutilized pelagic species, such as barracuda.

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