Commercial Fishing for Gulf Butterfish, *Peprilus burti*, in the Gulf of Mexico

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ABSTRACT—This study was done to determine if gulf butterfish, Peprilus burti, *is a reasonable alternative to traditional resources for commercial fishermen in the northern Gulf of Mexico. A commercial fishing firm which has successfully fished for and marketed butterfish off New England was contracted to conduct operations in the Gulf of Mexico. Two of the firm's stern-rigged freezer trawlers fished for 1 month (May-June 1986) on the outer continental shelf off Mississippi. Both vessels caught gulf butterfish in quantities and sizes that were commercially valuable, and the fish were successfully marketed in Japan. Data on catch rates, unloading and shipping costs, and marketing results are presented.*

Introduction

The decline of oil prices during the 1980's has caused serious problems for the petrochemical-based economy of southwestern Louisiana. One result of the high unemployment rates (>14 percent) in this area has been that many unemployed workers have turned to commercial fishing, especially shrimping, as a source of income. This, in turn, has increased competition for resources in the shrimping industry, which was already highly competitive before these times of economic hardship.

In addition to shrimp, many other fisheries resources are available in the Gulf of Mexico. Some have not been harvested in the past, even though there are indications that they may be abundant and marketable. One of the most promising of these latent fishery resources is the gulf butterfish, *Peprilus burti*.

A commercial fishery exists in the Middle Atlantic Bight for a very similar species, the Atlantic butterfish, *Peprilus triacanthus* (Murawski and Waring, 1979). This butterfishing industry has included both domestic fishermen and the distant-water fleets of foreign nations, although foreign fleets have not had a directed butterfish allocation since 1979 (G. T. Waring, NMFS, Woods Hole, Mass., personal commun., 1987). Most of the catch, which peaked at 19,454 metric tons (t) in 1979 (Gledhill[1]), is marketed overseas, primarily in Japan. Landings of Atlantic butterfish have fluctuated considerably from year to year for reasons which are not well understood (Murawski et al., 1978). Thus, demand for butterfish cannot always be met by the U.S. East Coast butterfish industry.

Exploratory trawling by the National Marine Fisheries Service (NMFS) has indicated that gulf butterfish are abundant and the stock could sustain an annual harvest of as much as 50,000 t (Gledhill[1]). Furthermore, butterfish of marketable size have been taken primarily in deep water on the outer continental shelf, offshore of the fishing grounds for both brown shrimp and white shrimp. Therefore, a butterfish industry could develop in the Gulf of Mexico without increasing competition on traditional fishing grounds.

Before local fishermen can be expected to invest in the conversion necessary for deep-water trawling, there must be a clear indication that such expenses are economically justifiable. Research trawling by NMFS using established methods such as random or fixed site selection cannot fully address the question of whether a commercial butterfishing operation can be economically successful. Therefore, the Lake Charles Harbor and Terminal District, together with McNeese State University, arranged for a New England firm experienced in catching and marketing butterfish to conduct exploratory operations in the Gulf of Mexico.

The objectives of this project were to 1) examine the methods used in commercial butterfishing, 2) determine the availability of gulf butterfish using commercial methods, and 3) determine whether the resource could be marketed successfully.

Methods

Two freezer-trawlers[2] rigged for stern trawling were committed to this project. Technical specifications of these vessels, the F/V *Huntress* and the F/V *Old Colony*, are summarized in Table 1. Both vessels fished large nets (Table 2) which were manipulated through a ramp in the stern. The nets were rigged with louvered steel doors (Bison doors from Great Britain) and were towed on a double

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[1]Gledhill, C. T. 1986. A preliminary estimate of gulf butterfish (*Peprilus burti*) MSY and economic yield. Southeast Fisheries Center Mississippi Laboratories, National Marine Fisheries Service, NOAA, Pascagoula, Miss. Unpubl. rep.

[2]Mention of any trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 1.—Technical specifications of fishing vessels.

F/V *Old Colony*	
Length overall:	132 feet
Width:	28 feet
Draft:	15 feet
Main Engine:	1,500 HP
Generator capacity:	370 KW
Electronics:	Chromascope color fish finder Loran C Single-sideband, VHF, CB radios Radar
Refrigeration:	2 ea. 100 KW compressors 4 contact freezers, freezing temp. −40°C. Refrigerated hold, temp. −30°C.
Freezing capacity:	34 t/24 hours
Holding capacity:	150 t
Processing area:	Enclosed, cooled
Construction:	Steel, sterntrawler, shelterdecked
F/V *Huntress*	
Length overall:	100 feet
Width:	26 feet
Draft:	12 feet
Main Engine:	700 HP
Generator capacity:	310 KW
Electronics:	Chromascope color fish finder Loran C Single-sideband, VHF, CB radios Radar
Refrigeration:	2 ea. 100 KW compressors 3 contact freezers, freezing temp. −40°C. Refrigerated hold, temp. −30°C.
Freezing capacity:	27 t/24 hours
Holding capacity:	65 t
Processing area:	Enclosed, cooled
Construction:	Steel, sterntrawler

Table 2.—Net Specifications.

Shuman trawl
170 foot sweep, 15 foot rise
32″ mesh in face, grading through 12″ and 8″ to 4″ in cod end
Ground cable, 75 fathoms
Bison doors
Whiting trawl
140 foot sweep, ca. 12 foot rise
Mesh similar to above, but with $3\frac{1}{2}$″ cod-end liner
Ground cable, 75 fathoms
Bison doors
Roller trawl
60 foot sweep, 9 foot rise
4″ mesh throughout, $3\frac{1}{2}$″ cod-end liner
Ground cable, 25 fathoms
Bison doors
24″ diameter rubber rollers along footrope

warp with a 3:1 scope. Long ground cables of rope-wrapped wire connected the doors to the nets. Duration of tows varied but was generally within the range of from 30 minutes to 2 hours. When not being towed, the nets were stowed on large hydraulic net drums, of which each vessel had two.

Each vessel made three trips of 5-10 days duration during the 30-day project period, returning to port for 2-4 days between trips for unloading and repairs. I accompanied the *Huntress* throughout the period of the project and recorded data on operations and catch characteristics. An observer from NMFS recorded similar data on the *Old Colony* on two of its three trips. Therefore, the data are somewhat more complete on the *Huntress*' operations and catch. Towing sites were selected by the captains of the vessels based on experience and chromascope traces. Whereas bottom depths at towing sites ranged from 35 to 223 m (19-121 fathoms), most tows were in the 129-185 m (70-100 fathoms) depth range along the edge of the continental shelf (Fig. 1). Towing direction generally followed depth contours. Although fishing was conducted mostly during daylight hours, some tows were made before sunrise and after sunset.

Both vessels were fitted with movable stanchions in which boards could be fitted to form corrals of various sizes on deck. After each tow, the catch was winched up the stern ramp, and then dumped in a corral. After removal of large sharks, rays, and other fishes, deck hoses were used to wash the catch into a sump from which a conveyor belt lifted the catch to a sorting platform. If the catch was mostly butterfish, other species were culled at the sorting platform and the butterfish were fed into a grading machine which removed unmarketably small fish based on body thickness. If the percentage of butterfish in the catch was low, they were picked out manually at the sorting platform. In either case, the butterfish were then passed to an enclosed, cooled processing area where they were boxed whole (not graded by size) in 11.25 kg boxes and then frozen on contact-plate freezers. Once completely frozen, the boxes were transferred to a freezer storage hold.

Composition of the catch was determined by sampling the catch as soon as it was dumped on deck. A standard 30 kg sample was removed and examined in detail. This sampling method did not include the sharks and other large fishes, but these were subjectively noted in the field log. All butterfish in the sample were counted and their aggregate weight was determined. Either 25 or 50 butterfish were selected arbitrarily and measured (standard length, SL) from each sample. Some butterfish were selected arbitrarily as representative of the entire length range and weighed to construct a length-weight regression. Parameters presented below include 1) catch rate (kilograms of butterfish boxed and frozen per hour of towing), 2) percentage of the sample which was butterfish, 3) average weight of individual butterfish in the sample, 4) median length of measured butterfish in the sample, 5) length-frequency distribution of butterfish in the sample, 6) length of the largest butterfish in the sample, and 7) the relationship between standard length and weight for butterfish in the study area at this time of year. Observations on bycatch composition (species, total number, and aggregate weight) were recorded for most samples.

Results

Catch Characteristics

Gear Comparisons

Although it might be expected that the different types of nets would vary in catch characteristics, none of the differences among the three types of nets in the parameters listed above were statistically significant.

Catch Rate

The amount of product frozen per hour on F/V *Huntress* differed significantly both among trips and among days (based on analysis of variance (ANOVA), with statistical significance defined as <5 percent probability that the pattern observed could be random). Catch rate on the *Huntress* averaged 367 kg/hour on the first trip, then decreased to average 323 kg/hour on the second trip. Average catch was substantially higher on the third trip (1,137 kg/hour); This may be a result of significant (based on ANOVA, d.f.=111,2; F=19.9; $P<0.01$) differences in the depth fished among the three trips. Whereas the largest catches were consistently taken at depths of 155-225 m (Fig. 2), the average depth fished on the

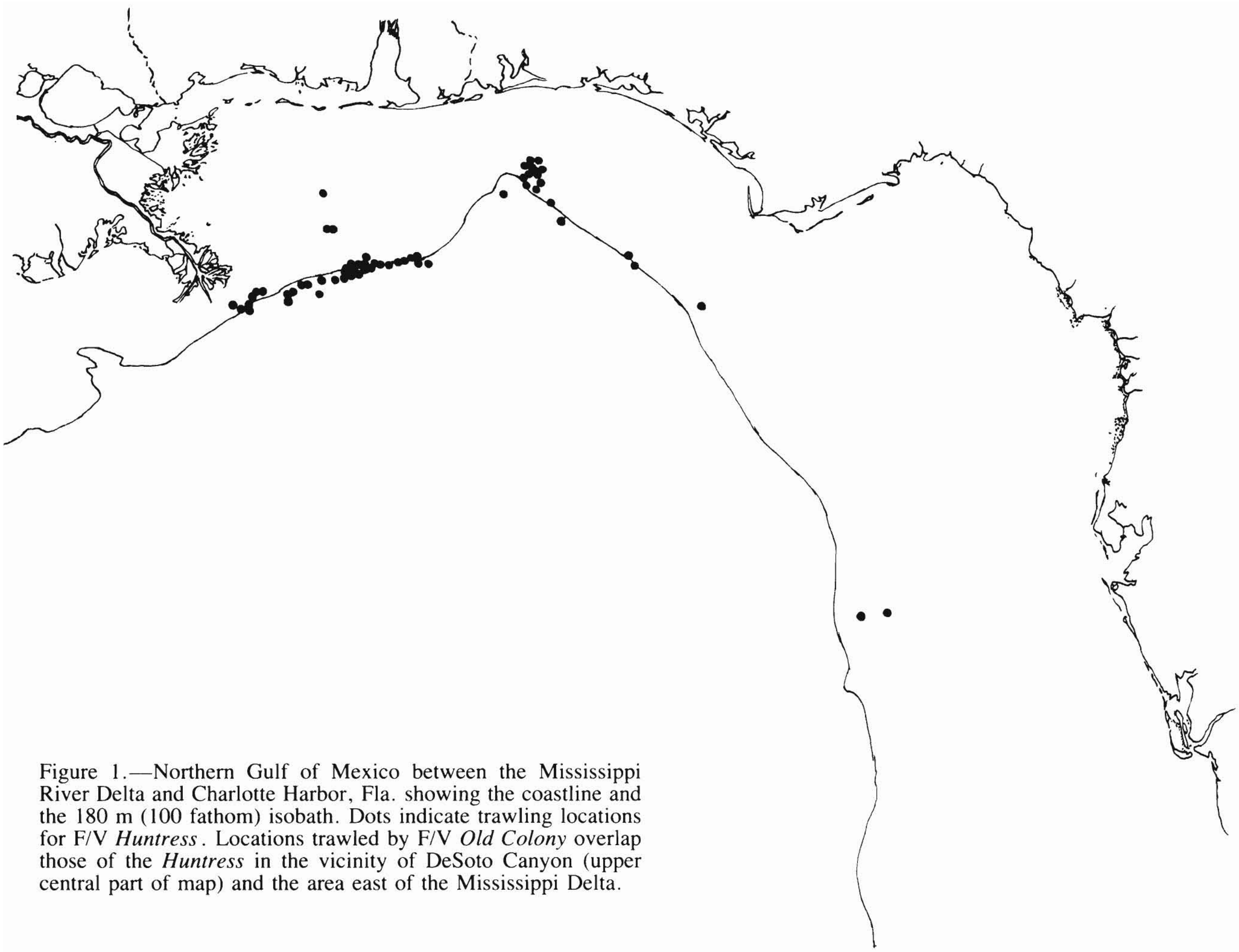

Figure 1.—Northern Gulf of Mexico between the Mississippi River Delta and Charlotte Harbor, Fla. showing the coastline and the 180 m (100 fathom) isobath. Dots indicate trawling locations for F/V *Huntress*. Locations trawled by F/V *Old Colony* overlap those of the *Huntress* in the vicinity of DeSoto Canyon (upper central part of map) and the area east of the Mississippi Delta.

second trip was 135 m. The average depth fished on trip 1 was 164 m, and the average depth on trip 3 was 179 m. Although catch rates >1000 kg/hour were recorded anytime between 0700 and 2000 hours, times of the largest catch rates were 0800-1630 hours. Very little was ever caught either before sunrise or after sunset.

The pattern of fishing by the *Old Colony* was less consistently variable than that of the *Huntress*. For instance, the difference in the average depth fished (150 m on trip 1 and 147 m on trip 2) was not statistically significant. This pattern, in turn, is reflected in the amount of product frozen per hour; although the average catch rate on trip 1 (1,309 kg/hour) was almost twice that of trip 2 (699 kg/hour) the difference was not significantly different from random. The depths trawled by the *Old Colony* during trips 1 and 2 ranged from 105 to 160 m. Four out of the five highest catch rates came from waters deeper than 150 m, and the two catch rates of >10,000 kg/hour were the two deepest tows made. As with the *Huntress*, average daily catch rates were highly variable. The pattern of catch rate related to time of day was quite similar to that of the *Huntress*.

Percentage of Butterfish in the Samples

Butterfish comprised 0-99 percent of the catch with great variability among tows. Except for the few tows made in comparatively shallow water (<85 m), neither temporal nor spatial variability in percentage of butterfish caught on the *Huntress* was significantly different from random. The shallow-water tows were all <5 percent butterfish. Subjectively, though, large total catches often were primarily butterfish whereas small total catches were mostly other species.

Size of Butterfish

Two size classes of butterfish were caught (Fig. 3), one of 7-11 cm SL and the other of 12-18 cm SL. Therefore, although the mean lengths of butterfish in the samples were calculated, the median length is a better overall representation of

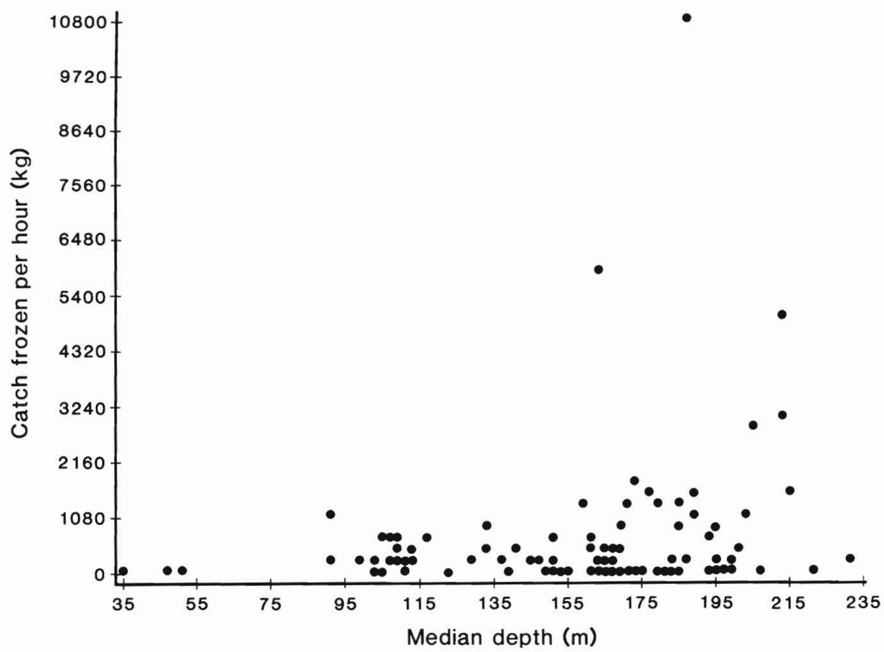

Figure 2.—Relationship between catch rate and bottom depth for the *Huntress*.

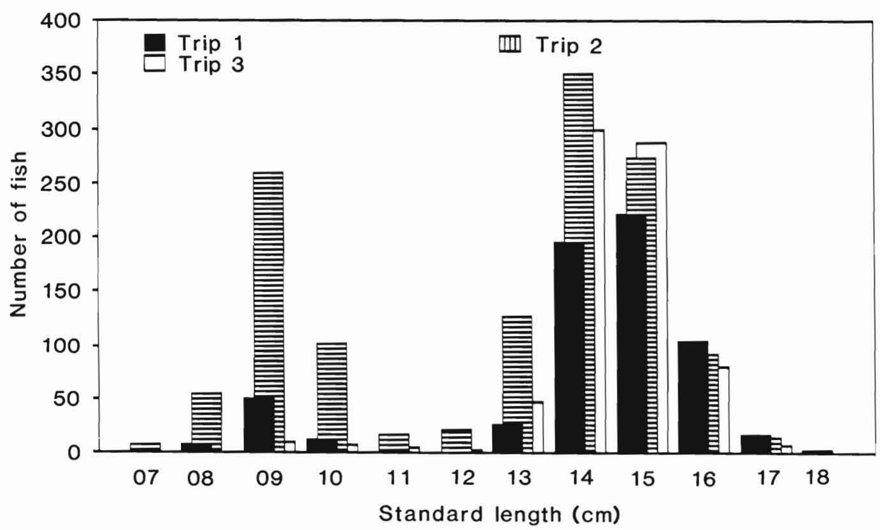

Figure 3.—Distribution of sampled butterfish among size classes for the three trips made by the *Huntress*.

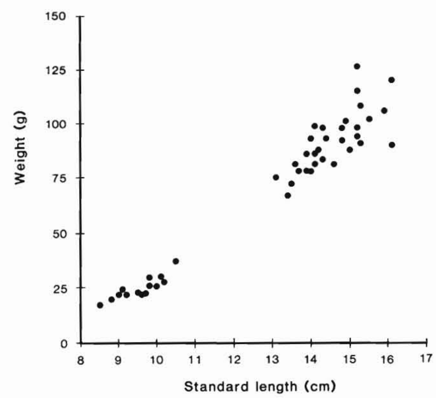

Figure 4.—Relationship of length to weight for sampled butterfish during May-June.

butterfish size in the sample because lengths were not normally distributed. Based on a length-weight regression (Fig. 4), the larger group of fish was mostly within the commercially marketable weight range of >79 g, while the smaller fish were all well below marketable weight.

Substantially more of the 7-11 cm fish were caught on the *Huntress*' trip 2 than on either of her other trips (Fig. 3). Indeed, on some days during trip 2, these very small fish made up most of the catch (Fig. 5). Thus, the median size of butterfish on trip 2 was less than marketable size for 18 out of 52 tows, compared with 2 out of 30 tows on trip 1 and 1 out of 32 tows on trip 3. While this pattern could represent true temporal variability (e.g., relationship of catch with lunar cycle, etc.), an alternate explanation is that the fishing characteristics on trip 2 were different than on the other trips. Tows with small median length of butterfish were all from depths <170 m; As was stated above, the average depth of the tows on trip 2 (135 m) was within this depth zone and was significantly different than that on trips 1 (164 m) and 3 (179 m). A much larger data set would be needed to determine which of these explanations is correct.

No such relationship was evident between median size of butterfish and time of day. The two size classes were quite evident and each dominated some catches throughout the day. Differences among trips in the average time of day that tows were made were not statistically significant.

Butterfish are graded based on weight: "super-small", <80 g; "small", 80-100 g; "medium", 100-150 g; and "large", >150 g. The "super-small" butterfish are not generally marketable. The average weight of butterfish in the samples, which included both the large and the small length classes, followed patterns

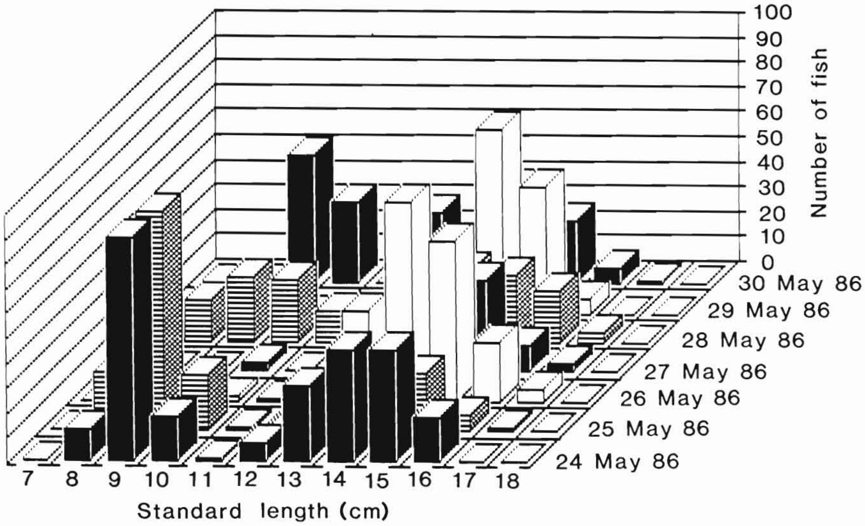

Figure 5.—Distribution of sampled butterfish among size classes for each day of *Huntress'* second trip.

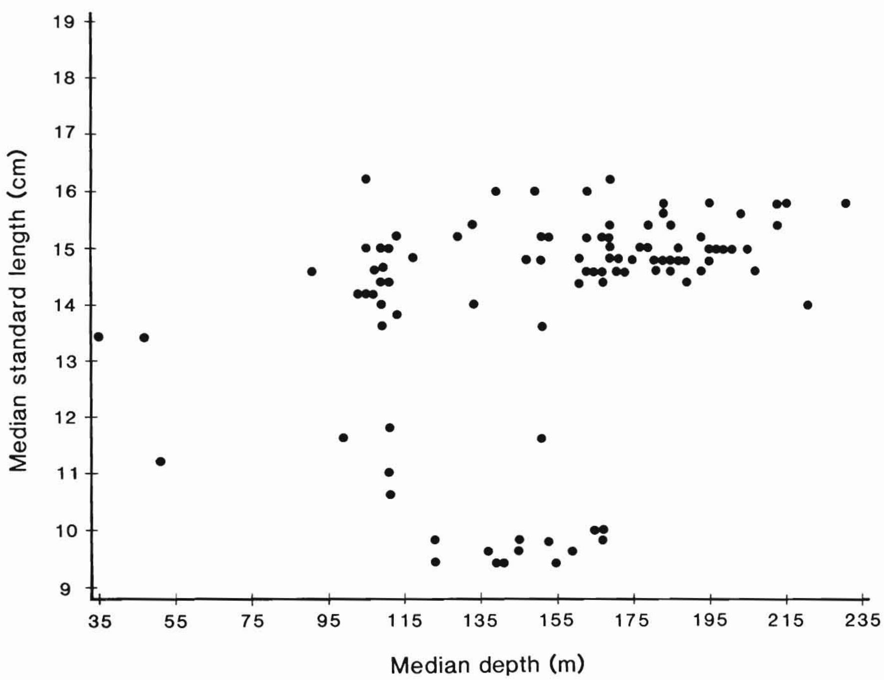

Figure 6.—Relationship of median length of sampled butterfish from *Huntress'* catches with bottom depth.

Table 3.—Bycatch.

Fishes which sometimes comprised one-third of the catch or more (based on weight).
- Rough scad, *Trachurus lathami*
- Pinfish, *Lagodon rhomboides*
- Longspine porgy, *Stenotomus caprinus*
- Spot, *Leiostomus xanthurus*
- Atlantic croaker, *Micropogonias undulatus*
- Atlantic cutlassfish, *Trichiurus lepturus*
- Chub mackerel, *Scomber japonicus*

Shrimp, squid, and fishes which sometimes were very numerous in the catch.
- Rosy shrimp, *Parapenaeus* sp.
- Long-finned squid, *Loligo pealei*
- Freckled pike-conger, *Hoplunnis macrurus*
- Round herring, *Etrumeus teres*
- Smallscale lizardfish, *Saurida caribbaea*
- Inshore lizardfish, *Synodus foetens*
- Singlespot frogfish, *Antennarius radiosus*
- Luminous hake, *Steindachnaria argentaea*
- Southern hake, *Urophysis floridanus*
- Rock seabass, *Centropristis philadelphica*
- Blueline tilefish, *Caulolatilus microps*
- Wenchman, *Pristipomoides aquilonaris*
- Silver seatrout, *Cynoscion nothus*
- Red goatfish, *Mullus auratus*
- Spinycheek scorpionfish, *Neomerinthe hemingwayi*
- Longspine scorpionfish, *Pontinus longispinis*
- Sea robins, *Prionotus* spp.
- Dusky flounder, *Syacium papillosum*
- Longspine snipefish, *Macrorhamphosus scolopax*

Large fishes which were often caught.
- Silky shark, *Carcharhinus falciformis*
- Blacktip shark, *Carcharhinus limbatus*[1]
- Sandbar shark, *Carcharhinus plumbeus*
- Dusky shark, *Carcharhinus obscurus*
- Florida smoothhound, *Mustelus norrisi*
- Scalloped hammerhead, *Sphyrna lewini*
- Atlantic angel shark, *Squatina dumerili*
- Roundel skate, *Raja texana*
- Roughtail stingray, *Dasyatis centroura*
- Spotted eagle ray, *Aetobatus narinari*
- Blackedge moray, *Gymnothorax nigromarginatus*
- Banded shrimp eel, *Ophichthus* sp.
- Bearded brotula, *Brotula barbata*
- Bluespotted cornetfish, *Fistularia tabacaria*
- Scamp, *Mycteroperca phenax*
- Bigeye, *Priacanthus arenatus*[1]
- Tilefish, *Lopholatilus chamaeleonticeps*
- Greater amberjack, *Seriola dumerili*[1]
- Atlantic bonito, *Sarda sarda*
- Swordfish, *Xiphias gladius*
- Southern flounder, *Paralichthys lethostigma*[1]

[1]Frozen for market.

similar to those of median length. Average weight was marketable, either "small" or "medium", in 79 percent of the tows made by the *Huntress*. Most of the tows in which the average weight of butterfish was in the "super-small" range came from trip 2. Butterfish averaged "medium" in size in 36 percent of the samples and "medium" fish were particularly common in tows from deeper water (Fig. 6).

Very few "large" butterfish were taken, never in substantial numbers. Butterfish of >17 cm SL were not found at depths of <112 m. Such large fish were, however, taken on all trips and throughout the day.

Bycatch

Substantial catches of nontarget species were occasionally a problem, especially when catches of butterfish were small. By-catch species (Table 3) can be divided into three categories. First, some species were both abundant and large enough to contribute substantially to the

Table 4.—Landing and storage of butterfish.

Vessel	Date	Pounds landed	Unloading	Storage	Total cost	Cost per pound
Huntress	22 May 86	22,904.00	465.14	376.38	841.52	.04
Huntress	02 June 86	32,646.00	746.00	489.32	1,235.32	.04
Huntress	10 June 86	104,196.00	2,908.50	1,365.72	4,274.22	.04
Old Colony	16 May 86	122,223.00	2,174.50	1,672.12	3,846.62	.03
Old Colony	28 May 86	75,850.00	2,340.41	1,069.92	3,410.33	.04
Old Colony	17 June 86	111,552.00	4,933.75	.00	4,933.75	.04
Total		469,371.00	13,568.30	4,973.46	18,541.76	.04

Table 5.—Shipping and sales of butterfish (container loads) in 1986.

Date	Pounds shipped	Freight	Cost per lb	Price	$/lb
19 May	37,723	2,475.00	$0.07	23,011.03	$0.61
20 May	39,435	670.00	0.02	23,661.00	0.60
20 May	39,435	2,475.00	0.06	23,661.00	0.60
05 June	37,504	750.00	0.02	22,877.44	0.61
10 June	35,812	900.00	0.03	21,487.20	0.60
16 June	37,584	686.75	0.02	23,677.92	0.63
16 June	37,687	1,100.00	0.03	23,742.81	0.63
16 June	37,521	1,100.00	0.03	24,013.44	0.64
16 June	36,487	1,100.00	0.03	24,081.42	0.66
17 June	36,487	686.75	0.02	24,081.42	0.66
17 June	37,184	686.75	0.02	21,566.72	0.58
17 June	41,111	1,178.75	0.03	29,188.81	0.71
18 June	37,632	1,200.00	0.03	26,718.72	0.71
23 June	36,113	1,541.00	0.04	15,528.59	0.43
24 June	39,056	1,300.00	0.03	25,776.96	0.66
25 June	37,806	1,614.00	0.04	26,086.14	0.69
Overall	604,577	19,464.00	$0.03	379,160.62	$0.63

total weight of the catch. All of these species caused problems with handling and sorting the catch, as well as substantial wasted biomass. Perhaps the most troublesome of all was the longspine porgy, which was abundant, common, and similar in thickness to the marketable butterfish (and therefore prevented use of the automatic sorting machines), and which had dorsal spines that made manual sorting painful and difficult. Second, some species were numerous, although some of these were quite small, and large numbers of individuals were destroyed during the trawling operations. Third, some large species were caught quite regularly, but because of their size were not included in the standard sampling of the catch. In this last category, some species, such as angel sharks, were quite numerous in almost every tow but were discarded, whereas other species, such as amberjacks and southern flounder were also numerous and were kept for subsequent sale. Swordfish and bonito were consumed within hours of their catch.

Economics

Landing and Storage

The total amount of butterfish frozen and landed by each vessel was as follows: *Huntress*, 71,886 kg (159,746 pounds); *Old Colony*, 139,331 kg (309,625 pounds). All cargo was unloaded and stored in Pascagoula, Miss., except for trip 3 of the *Old Colony*, which was unloaded at and immediately shipped from Lake Charles, La. Although the overall cost per pound (unloading+storage) was about the same ($0.04/pound) in both places (Table 4), unloading costs were substantially higher in Lake Charles ($0.04/pound) than in Pascagoula ($0.02-0.03/pound). Cold-storage facilities in Lake Charles could not be used for large amounts of frozen butterfish without extensive renovations and additional handling equipment.

Shipping

The *Old Colony* actually began fishing before the beginning of the contract period, and both vessels continued fishing beyond the end of the contract period. Furthermore, their marketing firm, Seafreeze Ltd., had another vessel, the *Atlantic Harvester*, join the two contract vessels butterfishing in the same area and landing the catch in Pascagoula. Once the catch of any vessel was landed and transferred to cold-storage facilities, it could be combined in refrigerated containers with fish from other vessels for timely and efficient transportation. Therefore, the data on shipping and sales in Table 5 include the butterfish caught within the scope of this project as well as butterfish that were caught independently.

The first 900 kg (2,000 pounds) of butterfish sent to Japan were airfreighted to get reactions of consumers rapidly. Following that, all butterfish were trucked in refrigerated containers (Table 5). Two container loads (Tables 5, lines 1 and 3) were shipped through Los Angeles, Calif., for minimum transit time. All other container loads were shipped through Savannah, Ga. The cost per pound of shipping through Los Angeles was substantially greater than that of shipping through Savannah.

Marketing

Before the beginning of this project, concerns had been raised about the marketability of gulf butterfish because of a high infestation rate by parasites (larval tapeworms found encysted along the backbones of many gulf butterfish). These preliminary concerns about parasites proved to be largely unfounded. Fat content at this time of year also appeared to be acceptable to consumers in Japan. After aggressive marketing by Seafreeze, the product sold well, averaging $0.63/pound. This was about 75 percent of the value of Atlantic butterfish caught and shipped from New England. Seafreeze sold all of its catch despite a sales contract that allowed the buyer almost unlimited flexibility to cancel. No negative comments about product quality were received.

Discussion

The life history of the gulf butterfish has been described by Murphy (1981), based primarily on samples from the Texas shelf. A bimodal size distribution similar to that presented above is also found off Texas. Murphy (1981) proposed that the two size classes represent recruitment from two annual spawning peaks (spring and fall), rather than two separate year classes. He therefore concluded that most butterfish off Texas spawn and die at the age of about 1 year. There are some indications, though, that butterfish in the north-central Gulf may have a life span of 2½ years (Gledhill[1]).

Murphy (1981) also demonstrated that gulf butterfish undergo an ontogenetic (i.e., related to age and growth), cross-shelf migration. Spawning occurs in spring and fall on the outer continental shelf. Eggs and larvae are carried inshore by surface currents, and juveniles recruit to the bottom on the inner shelf. The butterfish then move into progressively deeper water as they grow and mature. This life-history pattern explains why fishing in water shallower than 150-170 m often results in catches composed mostly of the smaller of the two size classes. It also explains why the large catches of marketable butterfish all came from the outer shelf, in waters not trawled for traditionally exploited fishery resources in the Gulf of Mexico. Thus, commercial trawling for gulf butterfish probably should be confined to waters deeper than 150 m, at least during May and June.

Gulf butterfish were caught mostly during daylight hours, as is the catch pattern for the Atlantic butterfish (Murawski et al., 1978). This pattern probably results from diel vertical migration, in which the fish aggregate close to the bottom during the day and move upward at night to feed and perhaps to spawn. Thus, bottom trawling would be successful only during the daytime period of aggregation. Midwater trawling at night has been attempted on NMFS research cruises but has not proven to be very successful (A. Kemmerer, NMFS, Pascagoula, Miss., personal commun., 1986). It therefore appears that the U.S. East Coast strategy of bottom trawling during the day and laying to at night is appropriate in the Gulf of Mexico as well.

Small-scale patchiness in the abundance of gulf butterfish was very evident on the fishing grounds. Sequential tows within a very small area resulted in orders-of-magnitude changes in the amount of marketable butterfish caught and frozen. Furthermore, often three or more vessels would tow literally side-by-side and one of the vessels would catch tens of thousands of pounds while the others would catch merely hundreds of pounds. This is the pattern to be expected when very tight schooling occurs. An alternate explanation is that some physical condition is causing small-scale aggregation in this area. The outer continental shelf south of Mississippi is characterized by transient thermal fronts resulting from eddies off of the Gulf Loop Current (Fig. 7). A behavioral interaction of temperature preference with depth preference could cause small-scale aggregation unrelated to schooling behavior (R. Herron, NMFS, Pascagoula, Miss., personal commun., 1986). Regardless of the reasons for this patchiness, substantial variability in catch rate can be expected even within productive fishing grounds.

The contract requirements for this project were for two vessels, each to be committed for 30 days, including running time between port and the fishing ground and unloading time. In all, this work extended over about 1½ months (the beginning of May to the middle of June). It may be, however, that the project period, which ultimately was determined on legal and logistical bases, was neither optimum nor representative of conditions during a sustained fishery. Information on possible seasonal changes in the fishery is very limited. Seasonal changes are being investigated by the NMFS, though, and preliminary indications are that commercial butterfishing would be justified throughout the spring and in the late fall. Indeed, the optimum time appears to be in the spring; if so, the project period coincided with the end of the optimum annual period for butterfishing. The vessels working with Seafreeze continued fishing in the Gulf of Mexico through June and July. Catch rates declined as the warm season progressed, and during July they became so low that the vessels returned to New England.

The lack of statistically significant differences in catch characteristics among different types of trawling gear probably means that, given fairly large nets, net design has little to do with the ability to catch butterfish. If, however, fish in the dense small-scale aggregations inferred above do not all stay within 1-2 m of the bottom, a high-rise net, such as a semi-balloon shrimp trawl may be an advantage.

Ability to process the catch adequately is of utmost importance in maintaining the quality necessary to sell the catch in Japan, the primary market. It is possible to hold the fish for several days using methods like seawater/ice slurry, but the capability to freeze the catch onboard is an unquestionable advantage. Vessels outfitted with onboard freezers could be improved further by equipping them with refrigerated-seawater holding tanks to prevent extremely large catches from spoiling on deck before they can be processed completely.

Economic problems included high labor costs, lack of adequate onshore cold-storage facilities in southwestern Louisiana, and difficulties with land transportation to container ports. Upon arrival in Japan, though, sales of the product were better than expected. While this project was going on, the catch of Atlantic butterfish was very low. This probably stimulated consumer interest in the gulf butterfish and contributed to the success of the intensive efforts of Seafreeze to sell the gulf fish.

At $0.63/pound, the 211,217 kg (469,371 pounds) of gulf butterfish landed during this project would have a gross value of $295,704. After subtracting the costs of unloading, storage, and transportation, the value of the fish on the dock would be $263,081. Vessel costs must be estimated and may vary widely. In addition to operation costs such as fuel and provisions, repairs to nets, equipment (compressors, winches, chromascopes, etc.), and crew costs (figured on a share basis), such things as loan payments, insurance, and depreciation must be included in the estimate. If the Seafreeze bid price of $2,100/day/vessel is used as an estimate of actual cost (it included the cost of steaming from New England), then the net profit from this venture (not including special costs such as those involved in the intensive marketing effort in Japan) could be estimated to have been $137,081 or $2,285/vessel/day. It has been reported (Anonymous[3]) that in the Spring of 1987 "...two Seafreeze boats, the Persistence and the Atlantic Harvester, have arrived in the Gulf..." for another season of butterfish fishing.

[3]Anonymous. 1987. [News article.] Natl. Fisherman 67(13):22-23.

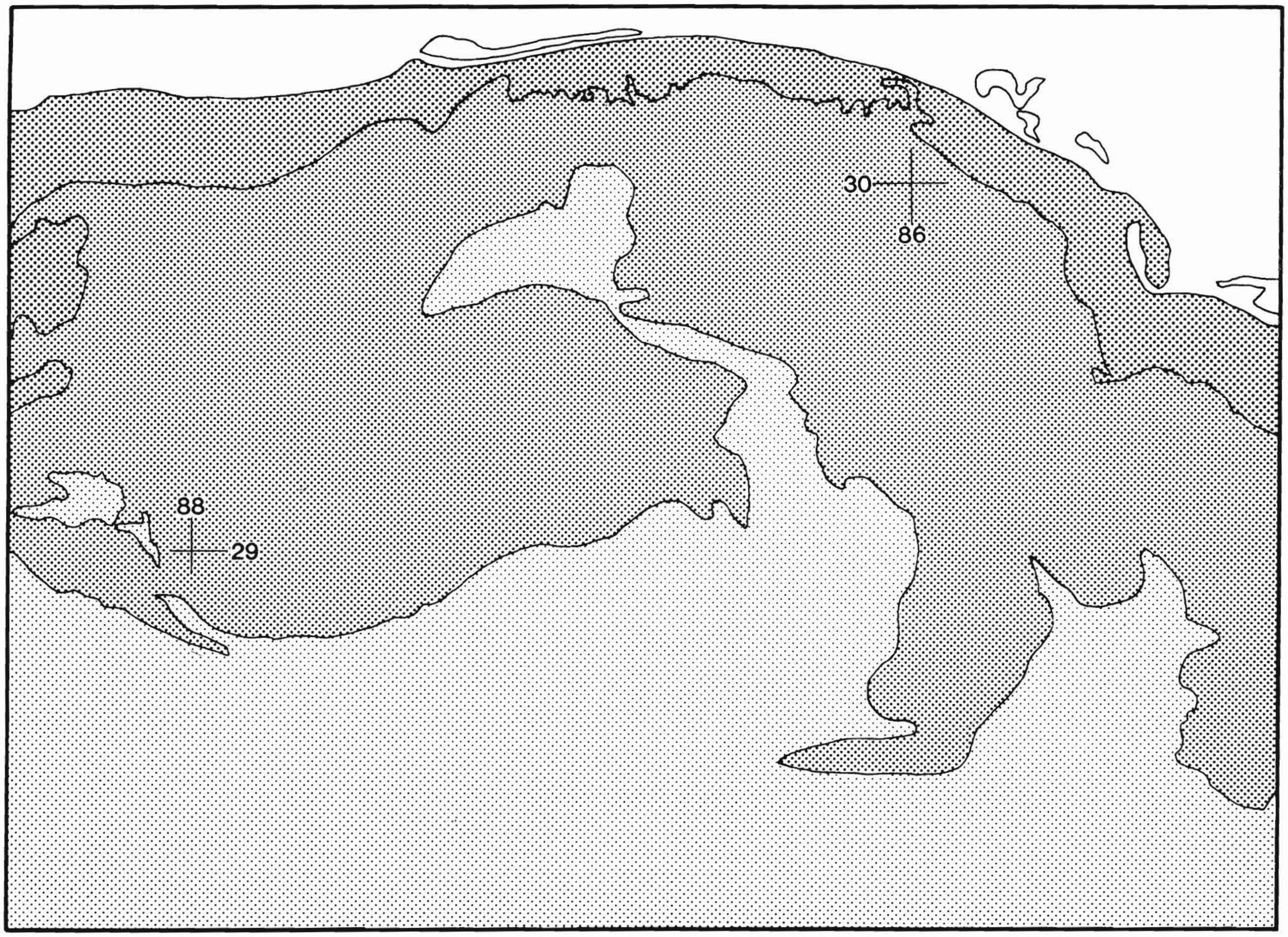

Figure 7.—Satellite image of the northern Gulf of Mexico taken on 22 May 1986. White areas are land. Dark shading of the water area indicates high concentrations of chlorophyll *a* from phytoplankton. The swirl in the central area is an eddy located in the vicinity of DeSoto Canyon and probably originating from the Loop Current. Such eddies are accompanied by rapid changes in water temperature.

Conclusions and Recommendations

1) It is possible to catch gulf butterfish in quantities and sizes which are commercially valuable, at least in late spring.

2) Commercial butterfishing in the Gulf of Mexico should concentrate on daytime bottom trawling on the outer continental shelf in waters deeper than 150 m.

3) Local vessels could be rigged with relative ease to catch gulf butterfish. Such conversions could be made so that local vessels could shrimp during part of the year and butterfish to supplement their income. Processing the catch, however, could be a substantial problem. Because of extended running times between deep water and ports with freezer facilities, techniques such as seawater/ice slurry are less viable as a processing option in areas with wide continental shelves than in areas with narrower shelves. Conversion to freezer trawling requires large vessels (about 100 feet or more), as does deep-water trawling a great distance from port. It therefore seems that only the largest local vessels should be considered for conversion to butterfish fishing.

4) Net profits potentially in excess of $2,000/vessel/day could make butterfish fishing an attractive option for local vessels. To expect such profits, though, certain conditions must be met. As in this project, whoever is marketing the catch must be experienced in dealing with potential customers, especially in Japan. The potential market, which currently is not large but which may be somewhat expandable, must not be saturated. Fi-

nally, adequate onshore support for cold-storage and transportation must be available.

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