

are able to instruct their fellows, it is again suggested that the governments request the assistance of the Food and Agriculture Organization or the Caribbean Commission in establishing the initial training programs. These organizations could probably secure or provide the initial personnel to put such projects into effect. The training of the fisheries officers should preferably take place in the Caribbean area itself.

Other preservation methods, such as smoking and drying, should be given consideration. Freezing has also been suggested, but it is not considered practical at the present time as most Caribbean countries are not capable of supplying the capital necessary for elaborate refrigeration plants. However, additional ice making plants should be constructed in order that ice may be more widely used, both in the storage and transportation of fish.

Since the main fisheries problems involve the training of practical fishermen and fishery technologists, it is suggested that biological research should be limited, for the present, to the collection of catch statistics to evaluate productivity and to detect trends of abundance. Formal fishery research involving studies of life histories and ecological relationships, as well as the exploration and development of offshore fisheries for tuna and other pelagic species, might best be entrusted to international organizations or private institutes or laboratories who could undertake to do this type of work for all the countries jointly. It is not felt that the fisheries resources justify individual governments each conducting such work. Once again, such organizations as FAO and the Caribbean Commission or competently staffed private laboratories are indicated as agencies best able to initiate and coordinate such programs. The governments concerned should consider approaching such organizations for assistance.

In summary, it is suggested that the development of the fisheries resources of the Caribbean can best be accomplished by simple and practical methods which involve the use of local people trained for the purpose, rather than foreign experts whose influence is transient. The importance of follow-up in all phases is emphasized as being essential to success. Government support is necessary to provide capital both for loans to individual fishermen or groups to finance the purchase of gear and equipment, and for the payment of specialists to train local fishery officers in the initial phases.

The original technical assistance might be provided by the Food and Agriculture Organization, the Caribbean Commission, or through cooperative agreements between governments concerned in the Caribbean region.

Potentialities of the Gulf of Mexico Fisheries and Recommendations for their Realization

J. L. BAUGHMAN

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THE FISHERIES of the Gulf of Mexico fall into two classes, the littoral or shore fisheries, generally carried on in the territorial waters of the various states, and the offshore fishery, most of which is in international waters.

The most important species of the littoral zone and their relative poundage for the last year of complete record (1945) are shown in Table 1.

TABLE 1

SPECIES	FLORIDA	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS
Menhaden	121,911,600		57,340,000		
Mullet	34,527,900	3,335,900	156,400	76,500	94,600
Spanish Mackerel	10,638,000	69,500	7,200	1,700	14,300
Trout	4,376,400	369,000	102,300	638,000	1,169,900
Redfish,					
Red Drum or Channel Bass	2,052,700	260,000	66,300	596,300	1,296,200
King Mackerel or Kingfish	3,897,300				22,100
King Whiting or Whiting	1,761,000	192,900	190,700	499,700	120,200
Black Drum	986,400	141,200	19,800	300,500	1,213,300
Blue Runner	1,981,700	1,500			
Bluefish	1,831,100	31,300	500		
Flounder	751,000	216,900	167,700	220,800	135,000
Pompano	766,400	4,500		500	3,700
Snook or Pike	512,200				1,200
Sharks	2,028,400			27,400	64,000
Blue Crabs	6,485,600	2,207,400	5,638,600	33,649,600	339,200
Sponges	266,000				
Other Littoral Species*	8,010,900	521,500	201,900	1,057,400	110,500
TOTAL	212,780,500	7,351,700	63,891,400	37,068,400	5,164,200

*Excludes shrimp and oysters.

Their value, in order of their monetary importance, is shown in Table 2.

TABLE 2

SPECIES	FLORIDA	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS
Mullet	\$3,842,974	\$400,428	\$ 18,768	\$9,180	\$9,460
Sponges	3,003,897				
Blue Crabs	190,010	110,370	282,030	2,124,516	39,141
Trout	839,750	88,728	24,342	204,416	368,898
Spanish Mackerel	1,363,847	13,900	1,440	238	2,455
Menhaden	770,841		425,176		
Redfish or Red Drum	249,652	62,294	15,912	143,112	233,432
King Mackerel or Kingfish	575,098				2,967
Pompano	334,094	2,340		250	1,480
Bluefish	306,231	6,260	125		
Black drum	64,558	16,944	2,376	36,060	132,151
Flounders	100,491	43,380	32,940	46,369	26,188
Whiting or King Whiting	61,397	22,428	22,884	59,409	13,220
Blue Runner	119,491	210			
Snook or Pike	63,612				180
Sharks	32,214			2,740	2,540
Other Littoral Species*	1,282,160	39,371	3,512	127,085	20,190
TOTAL	\$12,899,277	\$724,313	\$829,505	\$2,753,125	\$849,822

* Excludes shrimp and oysters.

In any survey of the potentialities of the Gulf, it seems well to consider first those fisheries which offer definite possibilities of expansion, under a program of research to determine their needs and the best methods of managing them. The following are worthy of attention:

Mullet production in Florida, due to overfishing and the ravages of the Red Tide, has declined during the past two or three years to the point where hardship is being worked on the fishermen. However, effective and continued research to determine correct management practices and, once these have been worked out, proper legislation to conserve the stock, should go far towards re-establishing the fishery at its former level, particularly as the ravages of the Red Tide are naturally replenished.

To the westward, Alabama production can be somewhat increased by the same means, but it is to Louisiana and Texas that we should look for any large increase in the catch. Although the mullet in these areas are smaller ($\frac{3}{4}$ to 1 pound on an average) than those in Florida, there is a rather large population in both states that could well be utilized, particularly if markets for the species could be developed in the midwest.

Next to mullet, the most valuable littoral fishery of the Gulf coast is the *sponge* fishery of southern Florida. At the present time this is badly depleted and threatened with extinction, due to the inroads of the sponge disease and to overfishing.

To re-establish this fishery, the size limit on wool sponges should be increased and strictly enforced, accurate production records kept so that the trend of the fishery can be followed closely, and mature sheepswool sponges planted north of the Tortugas region on suitable reefs. Oceanic currents from that area would carry the drifting sponge larvae from here to the deep reefs off the west coast of Florida and it is felt that the economic possibilities of doing this on a large scale should be thoroughly investigated. Exploration for new grounds should also be carried on, and may help, but it is probable that the future of the industry will depend on two things. These are research on (and management of) our present reefs, to give the sponges that are left a chance to re-establish themselves, and development of sponge culture on the extensive, suitable bottoms throughout the Florida Keys and about Tarpon Springs.¹

Trout, redfish and drum are grouped as they are similar in their requirements and habitats. All three species have been seriously depleted. Littoral species, dependent on the bays during the early part of their existence, they are particularly vulnerable to the inroads of civilization. Destruction of habitat and overfishing are the main causes of the depletion. However, research on their ecology and good management should, over a period of time, increase the annual catch.

The fishery for *blue crabs* is (exclusive of shrimp and oysters) the fourth largest on the Gulf coast. Nevertheless, it could be increased materially. Texas, for instance, produces almost no crabs, although possessing a large crab population.

Research to establish the ecology of the species along the Gulf (which is considerably different from the Chesapeake Bay area where the same crab is caught), and exploratory work to determine the presence or absence of crab populations, inshore or offshore, at all seasons of the year, should make it possible to expand this fishery considerably.

Almost the total production of *Spanish mackerel* is in the Florida area, a fact which would point to potential increases in the catch if the large population of this species in the western Gulf could be utilized.

Exploration to determine the extent of this population, biological data on which to base management practices, and the devising of fishing gear to meet conditions off the Texas and Louisiana coasts, are all necessary, however, before the fishery will be able to undergo any considerable expansion.

Although the tables given above show no *menhaden* fishery in Alabama, Louisiana or Texas, since they were compiled plants have been established at Cameron, Louisiana and Port Arthur, Texas, boats supplying both plants fishing in Louisiana waters. The fishery is capable of further expansion in the Gulf of Mexico, although, because of local prejudices, it will take much educational

1. Tierney, J. Q.—1949—*The sponge industry of Florida*. Fla. State Bd. Conser., Educational Series, 2:1-20.

work, based on research, to convince some segments of our population that the fishery is desirable and that it offers no threat to the fishery for the sciaenids.

Further exploration is needed to determine the extent of the far ranging schools, and much biological work to determine the life history and ecology of the species. With this and with wise management it should be an invaluable resource of the area.

Kingfish, which at times occur in great numbers along the Texas coasts, are little utilized anywhere but in Florida. This may be accounted for by the fact that the muddy waters of the Texas and Louisiana littoral force the schools far out to sea. So little is known about the species that it is difficult to evaluate its potentialities.

Exploration of the possibilities of the fishery, development of biological knowledge of the fish, and designing of adequate gear for its capture in numbers, are all necessary before any very large development can be expected.

In this connection, it is pertinent to suggest that the Japanese long-line, as used in the Pacific, might be an excellent method for catching both kingfish and Spanish mackerel in the western Gulf, where conditions (unlike those of Florida) make the use of nets extremely difficult.

The chief production of *pompano* is in the eastern Gulf. This seems strange, for, during the early summer, large numbers of young are present in the surf almost anywhere along the coasts of the western Gulf, it being by far the most common species in any haul of a minnow seine made at this time. These young fish range from $\frac{1}{2}$ to 6 inches in length. Either there is an almost 99 per cent mortality among the youngsters, which does not seem probable, or else, somewhere in our waters, there is a population of this species that we have not discovered and do not know how to catch.

Although *bluefish* were once caught commercially off Galveston, apparently there are few of them in the Gulf, and the fishery offers little or no chance for expansion.

The majority of the *flounders* occurring in the commercial catch are of the genus *Paralichthys*, generally found close inshore, and particularly in the bays. As far as the species comprising this genus goes, there appears little chance for expansion of the fishery, although more extended knowledge of their life history and ecology might make this possible.

However, other genera of the same family, notably those of the genus *Cyclopsetta*, are rather plentiful on the continental shelf. During the operation of the U. S. Bureau of Fisheries Ship "Pelican," they were caught throughout the area worked. While not as well liked for food as the paralicthyids, one of these, the sand dab or window pane, as it is known colloquially, is frequently marketed by the shrimp fishermen.

Exploration of the continental shelf of the Gulf, with proper trawling gear, should produce some very interesting results, possibly leading to the establishment of a deep water trawl fishery for flounders and other flatfish.

The fisheries for *king whiting*, *blue runner* and *snook* may be capable of some expansion in the Gulf, but it is doubtful whether it would be significant.

At present there is a well developed *shark* fishery in the Gulf, as far west as the mouth of the Mississippi. Recent research by the Marine Laboratory of the Texas Game, Fish and Oyster Commission is helping extend this south and west to Port Isabel.

Species in the fishery belong mostly to the genera *Galeocerdo*, *Sphryna* and *Carcharhinus*. So far these Gulf sharks have been utilized mostly on the basis of their fins and liver. The fins go to the Chinese market and the liver is used for

the production of vitamin A oils to fortify chicken and stock foods, the vitamin A potency, in all but a few individuals, being too low for pharmaceutical use.

On this basis, the average value of a shark is about \$5.34. However, during the experimental fishery, arrangements were worked out to use the hides, teeth and carcasses, thus raising the average value to about \$10 per fish. Such careful attention to the by-products of this fishery may make it more profitable, if labor costs are not too great.

Another interesting possibility lies in the development, through exploration, of new shark grounds at the edge of the continental shelf. Livers from this area may run much higher in vitamin potency and thus form the basis of a more valuable fishery.

Other littoral species include *amberjack*, *barracuda*, *crevalle*, *croaker*, *grunts*, *jewfish*, *muttonfish*, *pigfish*, *pinfish*, *sea bass*, *sea catfish*, *mangrove snappers*, *white trout* (*Cynoscion arenarius* and *C. nothus*), *tripletail*, *conchs*, *bay scallops*, *clams*, and *spiny lobsters*.

Several of these are capable of producing greater catches than at present. Sea catfish, if a market were developed for them, are very plentiful, as are the two species of white trout. None of these is taken to any great extent.

While the Florida fishery for spiny lobsters has declined in recent years, it could be re-established at somewhere near its former level by proper management. It is also probable that exploration may even disclose new grounds, as the topography of the Gulf bottom becomes more familiar. One specimen of this crustacean has recently been taken off the Texas coast, where the species was not known to occur.

Among shellfish other than oysters, which may repay investigation, there are considerable stocks of *clams* at various localities along the Gulf coast and there are some indications that there may be beds of deep-sea *scallops*.

THE OFFSHORE FISHERIES

So far we have discussed only the littoral fisheries, the majority of which are carried on close to shore, with comparatively small boats. In so doing, we have entirely neglected two of the most important fisheries in the Gulf, namely, the shrimp fishery, which far overshadows all the rest combined, and the fishery for red snapper and grouper, which ranks second among the fin fisheries.

Production for 1945 (the last year for which complete figures are available) of these fisheries, in pounds, is shown in Table 3.

TABLE 3

SPECIES	FLORIDA	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS
Shrimp	13,661,900	4,439,300	6,594,900	116,904,200	15,721,000
Groupers	8,593,400	168,600	7,300	3,000	17,200
Redsnapper	3,092,100	1,360,500	12,000	25,500	288,200
TOTALS	25,347,400	5,968,400	6,614,200	116,932,700	16,006,400

The dollar values are shown in Table 4.

TABLE 4

SPECIES	FLORIDA	ALABAMA	MISSISSIPPI	LOUISIANA	TEXAS
Shrimp	\$1,877,012	\$488,323	\$735,247	\$13,894,223	\$1,973,626
Groupers	998,947	23,604	1,094	480	2,234
Snapper	613,844	340,125	3,000	6,375	47,094
TOTALS	\$3,489,803	\$952,052	\$739,341	\$13,901,078	\$2,022,954

Prior to 1938, there was only a small offshore fishery for *shrimp*. Since that time, however, it has grown steadily. Larger boats, better gear, radios and Diesel engines have all contributed to this, until today approximately 8,000 boats of all sizes and types ply the waters of the bays and Gulf.

The great increase in the number of shrimp boats, along with a much greater increase in unit effort (it takes approximately 10 times the effort today (1949) than it did ten years ago to catch a pound of shrimp) make it imperative to develop, if possible, new fields for this fleet to work. The red, grooved, or "Golden Brazilian" shrimp may be the answer to this.

Until 1948, the white shrimp, *Penaeus setiferus*, formed 95 per cent of the total catch. Since then, the Brazilian or grooved shrimp, *Penaeus aztecus* and *P. brasiliensis*, and the sea bob have formed an increasingly large proportion of the production, until today (1949) in Texas, *P. aztecus* probably composes 50 per cent of the entire fishery.

Long familiar with the white shrimp, it was difficult for Gulf fishermen to adjust themselves to the different habits of the Brazilians, and to change their methods to produce an adequate catch.

Little is known about these species compared to the white shrimp and it will be necessary to explore and find new grounds where red shrimp can be caught if the fishery is to continue to expand. Otherwise, it is in for a serious setback. Fishing pressure is becoming exceedingly heavy and the fishery for *Penaeus setiferus*, or white shrimp, has already begun to show the effects of it.

The fishery for *red snapper* and *grouper* is at present in somewhat better condition than the figures given would indicate. Texas production alone has increased nearly 800,000 pounds over 1945, and probably there has been an attendant increase in Alabama and Florida, although 1949 figures for these states are not available.

Beginning as a littoral or shore fishery, when the nearer fishing grounds were exhausted, the boats extended their trips farther and farther to sea. Today boats from Pensacola, Mobile, Galveston and Port Isabel regularly make the trip to the Campeche Banks, off Yucatan, and it is from here the greater portion of our production comes. Nevertheless, there are indications that it may be possible, by exploration and biological research, to develop new fisheries closer to home.

From our present knowledge, which is extremely fragmentary, it seems that the snapper migrate not parallel to the coast, but vertically to it, and if this be true, then offshore, perhaps over the 100 fathom line, there may be large concentrations of snapper and grouper that will support a fishery. One of the main objections to this theory so far has been that the general bottom terrain of the northern Gulf, so far as was known, was not of the sort snapper and grouper preferred as a habitat. This plain, as far as we knew, had few coral reefs, gullies, or other topographical features of the sort found where snapper are usually caught.

This is incorrect. J. Ben Carsey, Chief Geologist of the Humble Oil and Refining Company, in a recent paper, calls attention to the fact that there are at least 164 topographical features occurring along the edge of the continental shelf of the Gulf.² Mr. Carsey's findings extend no farther eastward than Grand Isle, Louisiana. However, it is not at all improbable that similar topographical features and coral reefs are present in the eastern Gulf, all of them presenting what

2. To give an example: A restricted area, 90 miles south of Galveston, near 28° latitude and 94°30' longitude shows, upon contouring, two clusters of topographic features which have a relief of from 200-300 feet above the ocean floor, in 60 fathoms or less.

may prove to be an exceedingly profitable field of fisheries exploration for such fishes as red snapper and grouper.

While on this subject of the edge of the continental shelf, it might be well to explore another possibility. Less than two years ago a *tile fish* was taken on the Campeche Bank and, while "one swallow does not a summer make," nor a single fish a school, it is preposterous to believe that this one tile fish swam merrily down the sea from the New England coast (the only place from which it was previously reported) to the banks of Yucatan. It might be of some interest to note that Collins (Rept. U.S. Comm. Fish. 10:246) describes the habitat where it was originally found, over hard clay bottom, in deep water, where a warm water layer extends to the bottom.

Have we such a habitat in the Gulf of Mexico? Have we a tile fish fishery at our back door that some exploration will develop?

Another potential basis, for a new fishery in the Gulf of Mexico, is *tuna*.

Some years ago (Baughman, 1941, Trans. Tex. Acad. Sci. 1940:18) a number of tuna were caught which, upon identification, proved to be Lesson's Black-finned Tuna (*Parathunnus atlanticus*). Quoting from a letter from Stuart Adkins, of Port Isabel:

"Not many of them have been caught, for as a rule they run far offshore, well over the 100 fathom line. I have seen the Gulf covered with them. Some, I believe, would go over 200 pounds but there always are plenty of big sharks among them also. These fish are always headed southeast, or near that, and travelling plenty fast. We are not very familiar with their travels."

Early in 1948 a shrimper described a school of fish which he had seen far offshore, covering many acres. This may have been a school of tuna. In July of this same year, at Port Isabel, 4 more tuna were taken, and a few days later, a biologist, flying over the Gulf, slightly north of Tampico and about 200 miles offshore, saw a mile long school of mighty, fusiform fishes which he estimated at eight or ten feet in length. Again the word tuna suggested itself.

Lindner and others, in listing the fishes of the Caribbean, state that there are at least 4 species of tuna in that area, *Euthynus alleteratus*, *Thunnus thynnus*, *Neothunnus albacora*, and *N. allisoni*, as well as albacore, *Germo alalunga*, and 3 species of bonito. They state:

"Open surface offshore areas are the least known of the Caribbean habitats" [and, interpolating, of the Gulf of Mexico]. "The offshore-oceanic region is perhaps the least productive of food-organisms, for the supply of nutrient salts is low. Yet all available evidence points to considerable supplies of fish in the "blue" waters. The fish in this habitat may be divided into two groups—the long-range migratory such as tunas, sword fish, marlins and sailfish, and the limited migratory such as Spanish mackerel, kingfish, flying fish, and dolphins. The first group has been available to shore fishermen only at certain times of the year, but may be taken, possibly, in quantity offshore at other times. Hardly anything is known of the *distribution, abundance, migration routes, or seasonal occurrence of the pelagic fishes*. Since the abundance of these migratory fishes is not directly affected by the low productivity of the Caribbean Sea, there is some reason to believe that considerable amounts might be taken with proper methods. Limited migratory species are not now being utilized to the extent possible, and this is due chiefly to the limited radius of the present fishing methods.

"From all evidence available and after consideration of the other habitat types, it is suggested that the fisheries for the pelagic species, both inshore and

offshore, offer the greatest possibilities for fishing expansion in the Caribbean area."

The conclusion stated above probably holds true for the Gulf of Mexico also.

An interesting possibility that might be developed by a fisheries survey is connected with the Pacific tuna fishery. Whether or not a Gulf and Caribbean tuna fishery can be developed remains to be seen, but, the fact is, there are tuna within fishing distance of Gulf ports, for the tuna fishing grounds of the Pacific are many hundreds of miles closer to Houston and New Orleans than they are to the Californian ports from which the tuna clippers now operate. Live bait, on the west coast, is, as a rule, obtainable only in Mexican waters, and for years the Mexican government has levied exorbitant taxes on such bait. A supply in Gulf and Caribbean waters would make it possible for boats operating from the Gulf to travel to the Pacific grounds without payment of these prohibitive taxes, thus possibly giving badly needed room for expansion to our Gulf fishermen. Moreover, no such fishery could operate in either the Gulf or Caribbean unless they were certain of sufficient bait (Baughman, 1949, Proc. Gulf and Carib. Fish. Inst. 1:15-19).

Chilton, in 1949 (So. Fisherman 9 (10):48-49, 154), gives an extensive account of occurrences of the "little tuna" (*Euthynnus alleteratus*) along the Atlantic and Gulf coasts and in the Caribbean sea.

"Further exploration and development of this resource present possibilities of opening up a new industry. An investigation, both from a biological and commercial standpoint, seems justified."

We cannot overlook, either, the possibilities of the so-called deep scattering layer, which has been so much in the minds of oceanographers and biologists since the rapid development of sonic depth-finding equipment. While it now seems to be generally agreed that tropical and sub-tropical waters produce, in the aggregate, as much plankton over the course of a year as do more northern waters, there are apparently no such concentrations at any one time in the equatorial belt as are found in more boreal sections. Hence (so far as we know), no concentrations of fish occur similar to the cod and herring fisheries of the north Atlantic.

Other possibilities for development of the Gulf fisheries are plentiful, especially in the line of fisheries by-products.

We should not neglect the importance of *seaweeds* in any discussion of the Gulf. It has been known for a long time that some of these are excellent sources of potash and iodine. Another product is agar, used in microbiology, pharmacy, medicine, dentistry, photography and food manufacture. It occurs in red sea weeds such as those known as *Gelidium* and *Gracilaria* (Tarr, op. cit.). At least nine species of these appear on the Gulf Coast (Taylor, 1941, Mich. Acad. Sci. Arts Letters 26:69-79).

Another development in the seaweed field is the production of rayon-like fibers from certain metallic alginates (Speakman, *Nature* 155:655). Similar fibers have been produced from collagen, a by-product of fishes (Highberger and Kirstin, U.S. Patent 2,374,301). Alginic acid is present in *Sargassum*.

SUMMARY

The fisheries of the Gulf of Mexico present many potentialities for development. Among the littoral fisheries the ones holding the most promise are those for mullet, sponges, blue crabs, the Sciaenids, Spanish mackerel, King mackerel, pompano, flounders, menhaden, sea catfish, white trout, clams, and spiny lobsters. In all these, biological research, on which to base wise management

practices, is a prime necessity, along with legislation adequate to the needs of the particular fishery in question.

Offshore, the shrimp fishery, particularly that for the "golden Brazilian," or red shrimp, will probably stand considerable expansion, but needs exploration to develop new grounds.

Possibilities are present for the expansion of the red snapper and grouper fishery, and there are indications that two or three of the tunas, not now entering the commercial catch, may be present in sufficient quantity to support a fishery. Tile fish have also been found in the Gulf area.

Bearing these things in mind, the continental shelf should be thoroughly explored, with the following objectives:

- (1) Development of new shrimping grounds.
- (2) Development of new red snapper and grouper fisheries.
- (3) Development of new sponge grounds.
- (4) Location and development of a flatfish fishery.
- (5) Development of a shark fishery along the hundred fathom curve.
- (6) Location of tile fish in commercial quantities.
- (7) Location of deep sea scallop beds.
- (8) Location of tunas and determination of their abundance.
- (9) Investigation of the presence or absence of the "deep scattering layer," and its possible effect on fish.

A fertile field for development is presented in utilization of the by-products of the Gulf fisheries, and it is suggested that the seaweeds of the area may be plentiful enough to be utilized for various purposes.

Potentialities of the Gulf Oyster Industry and Recommendations for their Realization

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THE POTENTIALITIES of the Gulf coast for the production of oysters are apparently enormous, yet Dr. Radcliffe found in a recent survey that out of an estimated 916,000 acres of bottom available for culture, only 25,600 acres (*or less than 3 per cent*) are under lease. The balance of our steadily declining production comes from public reefs.

As an actual matter of fact, only one state on the Gulf coast has any appreciable production of cultivated oysters. That is Louisiana.

Within recent years there has been a good deal of research on the possibilities of the coast, and upon optimum habitats for the oyster of the area. More is needed, particularly on the time of spat fall, the best season to transplant oysters, the proper times to spread cultch, and *a thorough survey is needed of all bottoms to determine where it is possible to grow oysters with a reasonable degree of economic success.*

These things should be part of any state plan of research to protect the people engaging in such culture and to aid them in so far as is possible, to utilize their bottoms to the best possible advantage.

Research is also needed as to the best and most economical methods of improving bottoms not now fit for oyster production so that they can be used for this purpose.

There is widespread agreement with the statement made by Dr. Radcliffe that