

extremely heavy spat fall was noted in all areas harboring oysters and a reliable source of seed is therefore almost assured. Growth is especially rapid. It was found that cultch planted in the spring would produce marketable sized oysters by the latter part of the ensuing oyster season. By comparison, northern oysters would require three to four years to attain a similar size. The growth is also continuous throughout the year, whereas in northern waters the growing season extends only through the warmer season.

An exceptionally long spawning has been found to exist. In Apalachicola Bay spat falls from the first of April to the first week of November. Studies further south indicate an even longer period of spawning.

Dr. Pierce, who collected plankton samples at Cedar Key, Bradenton, and Fort Myers monthly for a period of a year, very generously made his collection available to the author. Cedar Key plankton only has been studied to date. Oyster larvae were found for all months but three: January, February, and March. The samples from Bradenton and Fort Myers, which have not yet been examined, should prove interesting.

The usual oyster parasites and commensals have been found to be of exceptionally low incidence in Florida. *Nematopsis* infestation is light, as is *Polydora*. Boring sponges are present in large quantities in very few localities, none of which are of great potential value to the industry. Boring clams are not abundant in the principal areas of production. A great variety of predacious gastropods do exist, however, and the author has found strong evidence that *Melongenacornia corona*, and *Busycon perversum*, as well as the already incriminated *Thais haemastoma* annually ravage the oyster beds of the State. Studies should be made on these with the aim of control. Exploration should be made into the possibility of using these snails as bait, fertilizer, or other commercial products.

In summing up, an optimistic conclusion is difficult to avoid. The potentialities for Florida oyster culture are great. The waters of the Peninsular State confer potent advantages to oysters which eventually can lead only to greatly increased production if exploited.

The Texas Oyster Situation

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TEXAS OYSTER REEFS are, in general, characterized by their extreme depletion or entire absence. Oyster production dropped (in 1948-49) to an all time low of 12,951 gallons, or about 7000 pounds. The 1949-50 season will probably be at least as bad or worse. This drop has been due to a number of things, including over-fishing.

In a recent survey of the area made by Dr. Philip Butler of the U.S. Fish and Wildlife Service, and Mr. Byron B. Baker, Jr., of the Texas Game, Fish and Oyster Commission, the condition of the reefs was summarized by Dr. Butler as follows:

"Oyster reefs of the entire area were characterized by their serious depletion resulting from either over-fishing, drill predation, or both. With few exceptions, the oyster meats were of only fair to very poor quality. The high incidence of boring sponge and boring clam are probably the primary agents in causing this poor quality as (a) oysters living in marsh ponds cut off from infection with sponges and clams were of excellent quality even though salinity levels were

as high or higher than on adjacent reefs in open water and (b) oysters exposed at low tides, which automatically controls sponges, were of better quality than adjacent oysters which were heavily fouled with sponges.

"There were indications that oysters growing in deeper waters were better than those on shallow reefs. Oysters of satisfactory quality were found primarily in areas having salinity levels below 20 ppm, such as stations 67, 57, and 28; these reefs are located near the junctions of primary and secondary bays; while fouling and predators are partially controlled at these levels, there is the possibility of mortality due to excessive run-off of fresh water in some years.

"The absence of feeding at many locations indicates that the plankton may be low quantitatively and that poor oyster quality may be due to a small food supply, which may be of importance in determining the density of seed plantings.

"The topography of the bottom, consisting of elevated ridges and towheads surrounded by soft mud, suggests caution in attempting to expand reefs so that natural siltation areas will be avoided.

"Areas infested with drills are those having greatest access to waters of the Gulf, and the drill population will probably fluctuate regularly with the run-off from the several rivers.

"In areas where commercial harvesting was observed, the rate of spatfall was insufficient to maintain the reefs. The presence of spat of less than 1/2" diameter at many stations suggests that there is an important winter spatfall, or else that in these locations, the spat are extremely slow growing. These two possibilities should be investigated since other locations showed that there was a single important spatfall some months before this survey."

So much for the physical and biological aspects of the question.

There is another, and less frequently recognized, side to the matter. This is the fact that the laws of Texas, well intentioned though they are, do little to encourage the culture of oysters so badly needed to replenish our reefs. It would be bootless to discuss these laws at any length here. Suffice it to say that the following legislative changes are suggested, although further knowledge may lead to their modification.

All oyster reefs in the public waters of the State of Texas, except those set aside as seed beds, or as public reserves, shall be open to lease for oyster culture, and may be held for an indefinite period, subject to the following provisions:

1. Leases shall be acquired only by bidding (either sealed bids or at auction) as the state may direct, in substantially the same manner as oil leases are now made on state land.

2. The original bid shall serve as rental for five years.

3. After five years have elapsed, a rental of \$2 per acre per year shall be paid by the lessor.

4. It may be desirable to require a royalty on any oysters produced from such a lease.

5. Any lease from which no oysters are produced in five year period should revert to the state, even though the lessor is willing to continue to pay the rent. The object of this is to encourage oyster culture, not the idle possession of land or bottom for other purposes.

6. Such leases to be transferable so long as the bottom is to be used for oyster culture.

7. The position of our present oyster law limiting the holdings of any person, persons, firm, company, or corporation should be modified to this extent. When

any of the individuals mentioned above can show that he has his original 100 acres under valid cultivation, then he may, at the discretion of the Commission, be granted such additional acreage as he may need to expand his legitimate operations.

8. Any man taking oysters from the waters of the state, either from his own lease or elsewhere, shall return to the water 25 per cent of the shell remaining after shucking operations. He may place this on his own lease, under State supervision, to improve it, or should he decide that such shell would damage rather than improve his lease, then he shall return such shell to the water wherever directed by the Game, Fish and Oyster Commission.

9. A valid corollary of the above would then be the closure by regulation of all reefs not under lease. This would not remove such public reefs from availability for lease, but would insure that only those reefs leased, and in which an individual owner had sufficient interest to conserve them, would be worked. Every inducement should be given to the man wishing to work his lease, which should be easy to get, and promiscuous oystering on the public reefs should be discouraged. This would give the wild stock a chance to recuperate, and, if it was desirable, such reefs could be opened from time to time for public fishing.

In view of the findings of Dr. Butler and Mr. Baker, summarized above, the following program has been outlined, for immediate attention on the part of the Commission biologists:

1. Experimental plantings should be continued to determine the optimum locations for oyster culture with respect to environmental conditions. Under this heading would come (a) Establishment of oyster beds at Bird Point, in deep water on the west side of Aransas Bay, and others in an area of significantly lower salinity such as San Antonio Bay. (b) Maintenance of small experimental plantings at previous experimental plots to determine changes in environment.

2. Spatfall and spat survival rates should be determined, using test cultch, and these should be correlated with plankton analyses and hydrography. Stations should be established in areas of high and low salinities and on experimental as well as commercially productive reefs.

3. Mudshell and the "fines" resulting from shell dredging operations should be tested to determine their fitness for stiffening various types of bottoms. Initial tests should be made on Long Reef and on a new area near the laboratory.

4. Routine collection of data on hydrography and plankton should continue for correlation with oyster quality and productivity, and a permanent station should be established near the laboratory where comparable data may be collected over a period of years.

Besides the legislative changes and biological objectives outlined above, there is need for an extended program of long range research, covering the following objectives:

1. Further study is necessary of the environmental features which will determine areas suitable for the cultivation of marketable oysters, together with investigation of the costs and methods for improving and expanding natural reefs as well as for establishing new reefs in suitable areas. Detailed information on the following points will be required to reach a satisfactory conclusion:

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| (a) Spatfall and survival. | (f) Fouling organisms. |
| (b) Growth. | (g) Oyster quality. |
| (c) Mortality. | (h) Salinity. |
| (d) Feeding and fattening. | (i) Temperature. |
| (e) Predators | (j) Turbidity. |

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| (k) pH. | (o) Bottom strengthening methods. |
| (l) Currents. | (p) Plankton analyses. |
| (m) Nutrient salts. | (q) Population analyses. |
| (n) Bottom quality. | |

2. It will be necessary to properly evaluate existing and potential oyster resources. Surveys should be made of the size and location of existing reefs with analyses of their oyster population.

3. Factors affecting oyster culture should be studied where localized problems in pollution may occur. It is also necessary to gain understanding of the problems imposed by domestic and industrial pollution; and a survey is needed to determine the extent and effect of these factors on the oyster population.

4. Investigation of the fundamental aspects of oyster biology and the devising of experimental techniques to verify or evaluate field observations are necessary parts of this investigation.

5. Dissemination of scientific data so collected should be made available to the public and to legislative bodies for their information in enacting conservation laws relating to the oysters.

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Studies On The Edible Oyster Of Puerto Rico

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FROM NOVEMBER, 1946, hydrographic records of the environment and biological studies of *Ostrea rhizophorae* Guilding, the common edible oyster of Puerto Rico, have been carried out. This oyster is found attached to the aerial roots of the common mangrove, *Rhizophora mangle* L., in various lagoons around Puerto Rico. This habit of growth has given the name "mangrove oyster" to this species. These studies have been conducted in the Boqueron Lagoon, on the south west coast of Puerto Rico, where one of the largest colonies exist. This lagoon is approximately 1½ miles long by ½ mile wide and is entirely surrounded by mangroves bearing oysters.

This colony of oysters is of considerable economic importance to the fishermen of Boqueron. It is estimated that from 2,000 to 10,000 oysters are taken from this lagoon each week throughout the entire year. Based on average samples of marketed oysters, at least 25,000 pounds of oysters are taken from this one lagoon during the period of a year. These oysters are sold only in local markets and are considered by many to have a flavor superior to that of *O. virginica*. Problems of controlled harvesting of these oysters have been considered. Because of the continuous harvesting practices the marketed oysters are not of a large size. The average marketed oyster is little over 55 mm. in shell length. The largest specimen observed in this lagoon had a shell length of 96 mm. It is probable that larger oysters could be obtained by regulating the "picking" of the oysters in different parts of the lagoon.

Hydrographic observations indicate that this species lives under environmental conditions different from those of *O. virginica*. The salinity of the waters is much higher, averaging about 35 parts per thousand. Extremes of high salinity,