NATIONAL SHELLFISHERIES ASSOCIATION

Papers and Discussions

Annual Convention, June 2-3, 1943
Hotel Benjamin Franklin
Philadelphia, Pa.

Officers
(1942- 43)

President : Joseph B. Glancy, West Sayville, Long Island, New York

Vice-President: Dr. Leslie A. Stauber, Bivalve, New Jersey

Secretary : Richard Messer, Richmond, Virginia

Treasurer : J. Richard Nelson, Warren, Rhode Island

National Shellfisheries Association, Philadelphia Meeting, June 1943

ANNUAL ADDRESS OF PRESIDENT

By Joseph B. Glancy, President

National Shellfisheries Association convenes again in Philadelphia during our second war year. There was some doubt as to the advisability of meeting this year due to travel restriction and the curtailment of all but necessary war activities. The program committee decided, however, that National Shellfisheries Association, representing as it does an essential industry, had full justification to proceed with the regular annual meetings, particularly since our agenda mostly deals with subjects pertinent to effective war effort.

1. Restriction of Scientific Research

It is regrettable, but at the same time inevitable, that much of the scientific research activity of the members of National Shellfisheries Association will be placed in abeyance until the end of the war, unless, of course, the research concerns itself with problems, the solution of which contributes directly to more quickly winning the war. Note, for example, that many of the able, experienced research investigators of the U. S. Fish and Wildlife Service have been forced recently to relinquish scientific studies to assume the administrative details of the Office of Coordinator of Fisheries.

Likewise, another scientific casualty this year was the cancellation of the Symposium on the Food and Feeding of Oysters, which we planned at last year's sessions, worked on during the year, and had in form to present this year. Great credit goes to Drs. Nelson, Loosanoff, and Galstoff in offering to contribute. The subject is of importance and hope is expressed that postponement will not be unduly prolonged. When one considers that no biologist can describe and explain adequately the exact conditions necessary for good growth and fattening in oysters it becomes apparent that lamentable gaps exist in our knowledge of oyster culture.

2. Publication of Convention Papers

It may be recalled that in my address last year, I called attention to the desirability of obtaining wider distribution of our convention addresses. Dr. Galstoff acting for the committee, recommended use of the so-called planographic method, since regular printing was out of the question. The estimated cost was $500 for 500 copies, which would have just about denuded our treasury. I sounded this proposition among the officers and some of the members, and the consensus of opinion was not to use this planographic method, chiefly on account of cost. Consequently, the 1942 National Shellfisheries Association papers were mimeographed as usual and sent to all members. Extra copies were made and distributed to interested parties and institutions.
Our secretary, Major Messer, deserves credit for faithfully accomplishing this. Also, we are grateful to Dr. Galstoff's committee for the investigation of the methods of reproduction of the National Shellfisheries Association convention papers. As a general policy, however, it behooves the Association to secure the widest distribution of its annual proceedings.

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3. Howard W. Beach

It is with sorrow that I announce the great loss to the National Shellfisheries Association in the death last winter of Howard W. Beach, our treasurer for the last twelve years. It was during Mr. Beach's presidency that the National Shellfisheries Association was reorganized from the National Association of Shellfish Commissioners. A great believer in scientific research, Mr. Beach's generous and intelligent promotion of its application to the shellfish industry remains unsurpassed by any individual interested in the advancement of oyster culture. Fortunately for National Shellfisheries Association, Mr. J. Richards Nelson accepted the responsibilities of filling the unexpired term of Mr. Beach as Treasurer.

4. Greater Utilization of Marine Resources

My report for this year would not be complete if I did not comment on the acute development since our last meetings of an exceedingly important trend towards greater utilization of the lesser known marine species inhabiting our oyster beds and their vicinity. There is opportunity here to not only contribute to the wartime food effort but to popularize and establish permanently the production and distribution of valuable marine resources. To mention a few, we have among the shellfish species mussels, conchs, and a variety of clams; and of the finny fish swellfish, sea robins, and whiting, so called trash fish, which in the past have practically been ignored, yet when properly handled offer perfectly nutritious and highly palatable sea food. These are particularly of value because they are protein foods, and dietary economists are stressing continually the necessity of supplementing with these the country's supply, which tends toward a preponderance of the carbohydrate constituents. Some of the scientists and engineers among our membership are and have been contributing essential data for the exploitation of these virtually unknown sea foods, but all will be of but little avail, unless first, methods of preparation for market are entirely adequate, and secondly, the wholesaler and retailer are given every encouragement to distribute them. Consequently, I would suggest that the convention consider the advisability of recommending to the Office of Price Administration that no ceilings be placed on or no ration points necessary for the sale of these little known fishery products, because there is but little experience available upon which to base costs of the properly packed article, and price ceilings will discourage the all-important wholesaler from venturing to handle the new products.

In closing, I wish to urge all the scientists and engineers engaged in shellfish research and development to maintain, if at all possible, and if they do not interfere with the immediate war effort, the long range projects started before the war. When victory comes, these studies will be of inestimable value in enabling the shellfish industry to obtain the knowledge whereby it can progress and grow.

United States Department of the Interior
Fish and Wildlife Service

Fishery Leaflet 22

Chicago, Ill. * June 1943

INCREASING THE PRODUCTION OF OYSTERS AND OTHER SHELLFISH IN THE UNITED STATES

By Paul S. Galtsoff, In Charge,
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(Revision of an address presented at the annual meeting of the National Shellfisheries Association, June 2-3, 1943, Philadelphia.)

Contents

DECLINE OF THE OYSTER FISHERY

A hundred years of practical experience has demonstrated that the yield of the shellfishery can be materially increased by farming or cultivation. Nevertheless, production of oysters in this country during the past years has been declining. Taking as an illustration the figures for the last few years for which complete statistical data are available, we find that the total yield declined from 95.6 million pounds of oyster-meat in 1937 to 93.1 in 1939 and 89.4 in 1940. Even the substantial growth of Pacific Coast oyster production from 7.8 to 10.8 million pounds during these years was not enough to counterbalance the general trend. Statistics for 1940 show that more than fifty percent of oyster meats, namely, 48.7 million pounds, were produced on privately-owned or -leased bottoms as compared with 40.68 million pounds obtained from public reefs.

The present yield is much smaller than that gathered years ago. Thus, in 1890-92 the total production of oysters was probably not less than 182.8 million pounds of meat* (table) and Maryland alone contributed at least 70.8 million pounds, or about 79 percent of the total amount produced in 1940. A steady decline in oyster production to approximately half of that of 50 years ago is due primarily to the system of free fishing under which the full utilization of our oyster grounds is impossible. Pollution of inshore waters by industrial wastes and domestic sewage is another factor in the decrease, resulting in the closing of productive grounds by Public Health authorities, or, in certain instances, the destruction of the shellfish themselves by accumulation of toxic or decomposing matters.

The total acreage of oyster bottoms in our coastal waters can be estimated only approximately. According to present computations, there are in the territorial waters of the United States about 1,428,500 acres officially designated as oyster-producing bottoms. A small proportion of this area, not exceeding 185,000 acres of privately-leased or -owned bottoms, produces 54.5 percent of the total oyster crop. There is, thus, a very great difference in the productivity of cultivated and natural oyster beds. One must remember, however, that there are considerable areas of privately-leased grounds which, for various reasons, are not cultivated and that many of the natural oyster reefs or rocks at present include areas that are totally devoid of oysters and, therefore, do not contribute to the fishery. In many States, their utilization for oyster farming is impossible, however, because of legislation which prohibits the leasing of natural beds.

The state of depletion of the public oyster grounds can be illustrated by several examples. The best one is found in Georgia. According to Drake, Coast and Geodetic Survey Bulletin No. 19 (1890), there were within the waters of that State 30,000 acres suitable for oyster cultivation. In 1908 these produced 1,446,100 bushels of these shellfish. In 1923, the production had dropped to 245,762 bushels and, in 1937, was only 28,872 bushels increasing, however, in 1939, to 78,133 bushels. In 1937, Georgia oysters were the poorest in the country, yielding only 2.75 pounds of meat per bushel. Thus, the oyster fishery in Georgia almost ceased to exist and the canneries which still operate in the State are dependent on supplies from South Carolina. No outside causes, as floods, dredging of navigable waters, filling-in of bays and estuaries with dredged material, can be blamed for the destruction of the industry which once brought more than $300,000 annually to the Georgia oystermen. The principal cause of this decline was the system of management, or rather, mismanagement of the natural resource, under which destructive methods of harvesting were not only tolerated but encouraged. The responsibility rests equally with the canners who were buying cluster-oysters and who never bothered to return small, undersized individuals to the grounds, and with the State government which made no effort to protect the natural supply of oysters by establishing spawning reserves, enforcing cull laws, planting cultch, or employing similar conservation measures.

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*Computations were made by using the factors of yields for 1939 given in "Fisheries Industries of the United States, 1941", Administrative Report No. 41, published by the Bureau of Fisheries, now a part of the U. S. Fish and Wildlife Service.

Production of Oysters in the United States in 1890-1892 and in 1939 in pounds of oyster meat

States	Pounds of meat per State-bushel 1939	Total pounds of meat	
		1890-92	1939
Massachusetts	6.57	381,106	269,800
Rhode Island	7.00	1,210,615	2,313,500
Connecticut	7.63	14,803,528	5,222,200
New York	7.50	19,382,965	6,272,700
New Jersey	6.05	15,924,308	5,096,100
Delaware	7.00	1,227,324	285,100
Maryland	6.09	70,343,326	20,342,300
Virginia	5.92	35,429,045	16,504,300
South Carolina	5.98	377,637	1,719,400
North Carolina	5.56	4,488,365	1,055,600
Georgia	6.83	1,532,345	234,400
Florida	4.74	2,220,363	1,065,500
Alabama	5.01	2,410,161	1,357,700
Mississippi	5.30	4,274,333	7,706,400
Louisiana	4.63	3,896,538	13,586,400
Texas	4.38	1,930,704	987,300
Total		180,532,663	84,018,700
Washington	7.00	999,110	8,526,900
Oregon	7.00	17,500	215,300
California	7.00	1,250,515	245,600
Grand Total		182,799,788	93,006,500

Depletion of oyster bars in the upper part of Chesapeake Bay is another example of the gradual exhaustion of natural resources under a system of "free" fishing. According to the estimate made by Edwin G. Baetjer of the Maryland Board of Natural Resources, the average production of oysters on the 130,000 acres of the so-called dredger's area in Chesapeake Bay has been reduced from 54 bushels to 4 bushels per acre, or less. The inadequacy of restrictive measures enforced in this State, but not accompanied by a program of cultivation, is further demonstrated by conditions in the Potomac River. According to the survey made in 1928 by the former U. S. Bureau of Fisheries, now part of the Fish and Wildlife Service, the population of oysters in the river averaged 0.9 bushels per acre. A 14-year period of restricted fishing during which dredging on these bars was prohibited by the State of Maryland, but permitted by Virginia, resulted in only partial recovery of the resource. The present oyster population, as estimated last winter by the Fish and Wildlife Service, averages 8.9 bushels of marketable oysters per acre. This is only a very small fraction of the population that could be maintained under cultivation on an oyster bottom capable of supporting from 500 to 1,500 bushels of oysters per acre.

LEGISLATIVE MEASURES

The fact that continuous fishing on natural oyster beds leads to their rapid exhaustion was recognized long ago. The earliest, and probably the first, regulation concerning the oyster fishery in this country was passed on June 4, 1661, when the Court held at Plymouth, Massachusetts, enacted "that five shillings shalbee payed to the Countrey vpon every barrell of Oysters that is carryed out of the Gov'ment . . ." (Quoted from Ingersol, The Oyster Industry, 1881, p. 20), and nineteen years later on the 7th of July 1680, the 2nd Session of the General Court at Plymouth ordered "that such as are not of our collonie be heerby prohibited of fetching oysters from Taunton River with Boates or any other vessells . . ." Seizure of such "boates and vessels for the collonie's vse" was a punishment for the transgressors of this regulation.

While the New Englanders already realized the value of their shellfisheries and took steps to protect them, the people of Maryland thought so little of the value of oysters as food that in depositions made by the "Kent Islanders" in the famous Claiborne suit of about 1680 they cited among their grievances and hardships "that their supply of provisions becoming exhausted it was necessary for them, in order to keep from starvation, to eat the oysters taken from along the shores" (quoted from C. H. Stevenson, 1894, The Oyster Industry of Maryland, p. 208).

Conditions were different in 1820. By that time the oyster industry of the State reached such a development that the General Assembly of Maryland passed an act which prohibited, under penalty of a fine of $20 or sixty days' imprisonment, the use of any implements in catching oysters within the State other than the ordinary tongs, and also, the transportation of oysters out of the State in vessels that had not been owned wholly by a citizen of the State for the preceding twelve months. The reasons for this enactment are clearly stated in the following quotation from its preamble: "Whereas . . . a great number of large vessels from the Northern

and Middle States frequent our waters for the purpose of transporting oysters to those States; and whereas well-grounded apprehensions are entertained of the utter extinction of oysters in the State, as well in consequence of the immense quantity thereof exported as the destructive implements used in catching them: Therefore, . . ."

As the one hundred and twenty-two years of history of the Maryland oyster industry show, apprehensions of "utter extinction of oysters," was well-founded. Moreover, numerous attempts to conserve the fishery by purely restrictive measures, produced no good results. Oyster bars, subject to intensive dredging, became depleted, and the natural propagation of oysters could not keep pace with the rate of fishing. A general decline in production followed, and the yield of the largest oyster-producing area in the world diminished to only a fraction of what it was fifty years ago.

The decline of the oyster industry in Maryland attracts special attention, because in no other state of the Union has the legislative body devoted so much of its time to the consideration of oyster laws and regulations. It is said that since 1820, the greater part of the time of the Maryland General Assembly has been devoted to the discussion and enactment of oyster laws, and that the number of general and County measures adopted by this legislative body surpasses the total dealing with all other subjects. Certainly, there has been no lack of legislative attention to the oyster problems of the State. The record indicates the vital importance of the oyster industry to the people of Maryland, but at the same time shows the futility of attempts to solve the problem of oyster conservation solely through laws and regulations.

No serious efforts have been made to rehabilitate the depleted bottoms by introducing a system of cultivation of oysters. The same is true of other states; the policy of free fishing on public reefs has been maintained, and oyster farming by private enterprise was discouraged, and sometimes made virtually impossible through lack of adequate legal and administrative protection. Oyster-farming cannot be expected to progress if the bottom leased to a private planter can be taken away from him on the testimony of two or three citizens, testifying under oath that the ground in question was formerly a natural oyster bed and produced oysters in quantities sufficient to provide profitable fishing. Disregard of property rights, poaching and stealing of oysters from private grounds, and leniency of courts in dealing with trespasses present in many States almost insurmountable difficulties to the establishment of oyster cultivation.

NATURAL OYSTER BEDS AND CONSERVATION

Legal definitions of a natural oyster bed vary from state to state, are usually ambiguous and are, therefore, subject to different interpretations. Although some of the states recognize that natural beds may cease to produce oysters in commercial quantities and, therefore, should be leased to private oyster growers, the period of time required for the ground to remain nonproductive before it can be leased is too long. When such a bed becomes available to private growers, it may be so nearly destroyed that it is no longer desirable.

The oyster laws of virtually every coastal state contain provisions of conservation intent, such as restrictions on gear or rate of fishing, closed periods, and requirements for culling, and return of a certain portion of the shells to the natural beds. While sound and justified by the circumstances, these measures are shown to have been ineffective by the present condition of the natural grounds.

Failure of the laws is probably a result of our faulty concept that the adoption of a new regulation is by itself sufficient to solve a problem of conservation. The facts, however, show that the enactment of numerous conservation laws had little effect in conserving the oyster beds, and that honest enforcement of the restrictive measures failed to stop depletion.

The reason for this unfortunate result is that, at the present time, under the most favorable conditions, the rate of natural propagation and growth of the oyster population is too low to replace the stock taken by commercial fishermen. However, the productivity of oyster beds can be materially and rapidly increased by adopting a system of cultivation and by applying proper methods of oyster farming.

PLANTING OF SHELLS AND SEED

In the absence of a definite system of management, incidental measures such as planting of shells and seed or enforcement of cull laws, etc., are incapable of protecting our resources from further deterioration for they deal with only a few phases of oyster cultivation while neglecting others that are equally important. Obviously, there is no reason for planting shells in a location where setting cannot be expected because of the lack of spawners, fouling of shells, or for some other cause. Yet millions of dollars and thousands of tons of shell have been wasted in the past to comply with the law demanding that shells be returned to oyster bottoms. Huge rehabilitation projects carried out only a few years ago by some of the states, as part of the national relief program, involved the transplanting of millions of bushels of shells and seed oysters. So far as the restoration of the oyster beds was concerned, the results were entirely out of proportion to the money spent, and in many instances were negative. In several well-known cases, failure was due to the ignorance or inefficiency of the supervisors of the projects who piled oyster shells on the bottom of the sea in heaps several feet high with the expectation that tides and currents would distribute them; planted them in polluted areas where fishing is prohibited; or mistook a small noncommercial variety of oyster (*O. equestris*) for a year-old eastern oyster and transplanted thousands of bushels of this "seed" which of course never increased in size and only damaged the beds. Even when large scale planting operations on public beds were carried out intelligently and skillfully, they resulted only in a temporary improvement, for the supply of marketable oysters was removed within a few weeks after the grounds were opened to fishing.

Alabama

Florida

Planting of seed or shells by the government is considered by many as an indirect subsidy to the dredgers and tongers. Even as a subsidy, the system is not effective because the benefit obtained from it is of

very short duration. It does not result in permanent improvement of grounds and under present conditions has very little value as a conservation measure. Yet it is a well-established fact that planting of shells and seed is the principal operation employed by every oyster grower in the cultivation of oysters. The state governments fail to obtain even a small degree of success in rehabilitating public grounds because, not having a comprehensive or continuous system of management, they are not in a position to determine what should be undertaken under existing circumstances. In deciding when, where, and how many shells or seed to plant, or when and under what conditions the marketable oysters should be harvested, they often act in ignorance or are influenced by political considerations.

PRODUCTIVITY OF OYSTER BOTTOMS

Maintenance of oyster bottoms on a sustained yield basis and full utilization of the potential productivity of oyster grounds are possible but can be achieved only as a result of a well-planned and carefully executed system of cultivation. Thus, if public oyster grounds are to return to productivity, their management must take into consideration the suitability of bottoms for catching seed or for growing marketable stock; the rate of growth of oysters; the natural productivity of bottoms; establishment of spawning grounds; and planting of cultch. Plans must be worked out after the adaptability of the existing bottoms for definite phases of oyster farming has been ascertained, and the extent of various areas and their potential productivity determined.

An estimate of the present assets of the oyster fishery indicates that the potential yield of our public oyster grounds is far greater than their present crop. There are at present about one and a quarter million acres of oyster grounds which yield only about 45.2 million pounds of oyster meat--or on the average from 5 to 6 bushels of oysters in the shell per acre. Many of these grounds are so depleted that they no longer attract the oystermen who, naturally, seek more prolific areas. The average figure of productivity is, therefore, too low because it includes areas, which, at present, do not contribute to the fishery. If through the application of methods of cultivation 500,000 or less than half of the total number of acres could be made to produce annually about 30 bushels per acre, a total yield from public grounds of between 75 and 90 million pounds of meat, or about twice the present amount might be expected.

Of course, such an improvement cannot be made in a short time. Usually much more time is required for the restoration of a natural resource than for its destruction. The sooner, however, we adopt a policy of better management, the sooner we can expect results. From the example of the cultivation of the Pacific oyster in the State of Washington, we know that within a few years the yield of this industry grew from virtually nothing to about 10.7 million pounds annually with the expectation that production can be increased materially in 1943 and 1944. This is an outstanding example of the success of oyster farming conducted by private enterprise and with very little encouragement by the government. Despite this achievement, there exists in many states almost unconquerable opposition to the idea of private oyster culture so that attempts to obtain legislation liberalizing the conditions for the leasing of natural beds are doomed to failure. This situation leaves the state governments no other alternative but themselves to engage in the cultivation of oysters.

CULTIVATION OF OYSTERS

There are various degrees of cultivation. The most elaborate system practiced by the large commercial concerns in northern waters comprises several distinct operations such as, preparation of bottoms, planting cultch to catch spat, transplanting it to growing grounds, planting of young oysters grown from spat to maturing and fattening ground, and harvesting and preparation of the oysters for the market. An almost complete lack of cultivation is found, for instance in Georgia, where the supply of oysters for canneries and shucking houses is obtained from badly neglected and depleted public grounds or is imported. Oyster culture in Delaware and New Jersey is in an intermediate condition for the growers are partly dependent on the existence of public reefs from which to obtain seed for planting on privately-owned beds.

Since the limits of this leaflet do not permit a detailed discussion of the legal and technical problems of individual States, certain basic principles are outlined which, with necessary modification, can be applied to a variety of local conditions. One must bear in mind that natural oyster beds cannot produce as many oysters as can cultivated bottoms. The chief reason for this is that the wild population of the natural bed is composed of various age groups which, to a certain extent, interfere with each other. Spat and seed attach themselves to the adult oysters and compete with them for water, oxygen, and food. Some of the small oysters cannot be culled off, and are destroyed when the catch is delivered to the shucking house, while others are injured in culling and perish. Shells of young are easily broken by the teeth of heavy dredges adjusted to take large oysters and harvesting sometimes results in the destruction of large numbers of undersized specimens.

On the other hand, a unit of the planted bottom of a well-conducted farm contains a population of oysters of a uniform age which are placed in a desired concentration and are not disturbed by dredging. There is less competition for food and the oysters have better conditions for rapid growth and fattening. Harvesting from a cultivated bottom does not require culling and is, therefore, more efficient and economical.

In planting operations as usually conducted by State governments, no attention is paid to the segregation of oysters of various ages. Thus, in spite of the efforts and money expended, the planted bed still retains all the undesirable conditions of a wild "natural" one, under which production in pounds of meat per acre cannot be high.

MANAGEMENT OF PUBLIC GROUNDS

Considerable improvement in the management of public oyster grounds can be expected if state planting operations are conducted by a plan similar to that used by private oyster growers. Simple computation shows that it is more advantageous to plant spat than seed oysters two or three years old. A bushel of shells containing about 2,000 spat may be expected to produce, by the end of the third year, between 4 and 5 bushels of marketable oysters (assuming 300 oysters to a bushel and cumulative mortality

of 20 percent). With the higher concentration of spat that sometimes prevails, an even higher yield of 6 to 7 bushels from 1 bushel of spat may be attained. However, a return of 1:1 is the average that can be expected from planting 2- and 3-year-old seed. Since the cost of planting one bushel of shells with spat or one bushel of seed oysters is about the same, the advantages of planting the former are obvious.

To ensure a sufficient supply of seed, existing setting areas should be utilized to establish spawning grounds closed to fishing, and by providing cultch. State grounds from which planters are permitted to take seed for planting should be protected by prohibiting the removal of adult oysters and shells. The taking of these is probably one of the chief reasons for the exhaustion of seed grounds in Delaware Bay. The situation can be easily remedied by the enforcement of existing laws and by the establishment of sanctuaries.

Planted areas should be closed to fishing and opened only when the oysters reach marketable size. Then the bed can be opened to fishing and the oystermen encouraged to remove and market all of the oysters in order to have the ground ready for the next planting. Since natural growth of an oyster population is not great enough to keep pace with the rate of commercial fishing, no good purpose is served by leaving marketable oysters on planted ground. They should be removed and replaced by seed.

Harvesting of oysters should be regulated because the opening of state-cultivated grounds to free fishing may result in such a rush and competition among the dredgers and tongers that the market may be glutted, prices fall, and the harvest largely wasted. These undesirable features, which in the past have caused great confusion and disorganization in the fishing industry, can be avoided by establishing a daily catch limit per boat, and by restricting the number of boats, or both. This can be accomplished by various means, as by issuing special permits good for a limited period and by checking the boats and their loads when they leave the grounds. For the successful operation of a program of state management, the control of the harvesting is as important as the production of the crop.

In carrying out this general scheme it is suggested that, at first, the badly depleted bottoms be set aside for state planting. Since fishing on them is unprofitable, their closing will not interfere with the existing fishery. The areas selected for planting should be closed, posted, and cleaned.

From the very beginning, distinction should be made between the setting and growing grounds and no shells should be planted on the latter except for reinforcing soft bottoms. Depending upon local conditions and the time required for the oysters to reach marketable size, grounds should be used in rotation to be ready for harvesting in 2, 3, or 4 years.

Two questions naturally arise: (1) How should these oyster-farming operations by the state be financed, and (2) why should all the work be carried out for the benefit of the oystermen who appear only as reapers of a crop

they do not plant? An indirect subsidy to the oystermen from the general taxpayer's money can be avoided if, for the privilege of harvesting from planted areas, a special assessment is made on each bushel or gallon of oysters taken, and the money so collected is in turn spent on the improvement program. Funds for shell planting which several states have at their disposal could be used to defray initial expenses. At present, this money is spent in more or less indiscriminate planting and is usually dissipated without producing permanent improvement. Suppose that under a new system of management, the state plants several thousand acres of prepared, good grounds at the rather high cost of 75 cents a bushel of shells, each containing about 2,000 spat. By the end of the third year when the oysters are ready for market, they can be expected to yield about 4 1/2 bushels to one of the original seed. The grounds would then be open to the oystermen who would pay, however, a special assessment for the privilege of taking cultivated oysters, and whose catch should be regulated.

Harvesting oysters from cultivated grounds requires less effort than working on depleted natural beds where oysters are scarce, and it is reasonable to expect that the oysterman would be able to make a good profit even if assessed at the rate of 20 cents a bushel. Because the yield of cultivated oysters in pints per bushel averages higher than that of wild ones, the assessment covering the cost of cultivation cannot be considered too burdensome, especially if the market price of oysters remains at the present level. Even at a selling price of $1.00 a bushel the oystermen would be able to make a substantial profit because of the better yield and consequent higher efficiency of harvesting on planted areas. At the rate of 20 cents a bushel, the State would collect 90 cents (4 1/2 x 20) for each 75 cents invested in the planting and could apply the money to a revolving fund from which further oyster farming operations would be administered and financed. The figures suggested are here given only in illustration and should not be considered as definite recommendations. The proper rate of assessment would vary in different states and in different years depending on the success of planting operations, market conditions, and other factors. The assessment is restricted to the crop harvested from state-planted grounds and does not apply to other beds under the jurisdiction of the state that are not cultivated. For collecting the assessment, a system of checking can be adopted similar to that now in operation in Louisiana. Oysters gathered in Louisiana for the canneries at Biloxi, Mississippi, must be cleared through a port of entry where a certificate is given showing the number of bushels and the point of origin of oysters taken outside of state waters. Payment of the assessment is made through the operator of the plant receiving the oysters. I believe a similar system for the collection of a special assessment on cultivated oysters taken from state-planted grounds can be worked out in every state.

The proposed system of management can be put into operation gradually, by a state, beginning with a limited area, carefully selected, in a section where it can easily be patrolled.

In states where strong antagonism exists between the tongers and the dredgers, a certain degree of reconciliation may be attained by offering to both groups an opportunity to participate with the state in oyster-farming operations. Dredgers who agree to prepare the bottoms and plant specified

amounts of shells or seed may receive in return preferred rights in harvesting the crop. Similarly tongers may be encouraged to engage in the production of seed by planting shells and other cultch in the inshore waters and selling their surplus to the state. It is believed that in this way production of seed oysters can be increased. Tongers who own small farms along the shores can obtain additional income from this source and utilize with profit the time they are not engaged in fishing. Other methods of cooperation between the state and the oystermen can be devised. For instance, the right to harvest planted oysters may be offered at public auction and granted to the highest bidders.

It is not the present purpose to discuss details of organization which obviously must differ in the various states, in accordance with natural, economic, and social conditions. It should be reemphasized, however, that the productivity of oyster bottoms can be maintained only through cultivation. If the development of private oyster-farming is impossible, then the cultivation of bottoms must be carried out by the state governments. In the majority of the states, the management of the oyster fisheries is in the hands of the legislative bodies and often becomes a political issue in which the interests of conservation are submerged or lost. Even in states where the administrative officer enjoys discretionary power, his tenure of office is indirectly dependent on the voters. Many difficulties in the past can be attributed to the failure of state administrators to acquaint the fishermen with the reasons for adopting certain restrictive measures. The success of a new system of management of oyster bottoms, as outlined above, depends on the support it may receive from the people who earn their livelihood by oystering. It is, therefore, essential to popularize new ideas among the oystermen through meetings, publications, and demonstrations and to gain their confidence by organizing local councils to formulate their specific needs and discuss ways of overcoming difficulties. The animosity between the fishermen who naturally want to use the most effective methods of fishing and the administrator who restricts their activity can be minimized or eliminated if attempts are made to explain the principles of management and make the fishermen a party to the conservation effort. The task may be difficult especially at the beginning but it is certain to produce good results in the long run.

The execution of a new program of management must be based on a thorough knowledge of local grounds and on an understanding of the behavior of oysters in each locality. It will be necessary, therefore, to have a staff of competent oyster biologists or oyster culturists to study local conditions and to direct oyster farming operations. Extensive experimental research may be needed in many localities in order to determine the best method of rehabilitation of oyster bottoms and their protection against enemies, parasites, and pollution. These are services which, perhaps, may best be rendered by a Federal or interstate organization.

SEED OYSTERS

Students of oyster problems in the United States realize that the production of spat and of an adequate supply of seed is essential to success of the industry. Future progress is dependent on our ability to produce

seed oysters in the localities, and at the times when they are needed. In past years, considerable progress has been made in acquiring knowledge of the factors that control the spawning and setting of oysters, but still more specific information is needed in order to understand how the oyster larvae react to the outside environment and why they set successfully in one place and fail to do so in another. It is well-known that good setting grounds may be very poor for the growing of oysters and that good maturing grounds may be useless for catching spat. In general, the best seed grounds are close to the mouths of rivers in waters of low salinity.

Seed grounds close to industrial and densely populated areas suffer more from industrial and domestic pollution than do those located farther offshore in deeper waters. A great many formerly productive seed-oyster grounds have been destroyed by industrial wastes. Furthermore, seed areas cannot be fully utilized because they are under the jurisdiction of municipal or county governments which have a tendency to issue regulations intended to protect the rights of local residents rather than those of the entire state or country. Under these conditions full utilization of the seed-oyster possibilities becomes impossible.

Observation of the practices employed by private growers and by some of the state governments shows that transplantation of seed is often carried on without proper safeguards. For instance, no effort, as a rule, is made to remove the oyster-drills and their egg-capsules and no attention is paid to the condition of young oysters. Recent studies disclose that on many of the natural seed grounds, especially in southern waters, the oysters are badly infected with a protozoan parasite (Nematopsis). Yet rather large quantities of the infected seed have been gathered and planted among healthy oysters. Apparently, Nematopsis infection does not destroy the oysters under normal conditions and it is firmly established that the parasite is not injurious to human health, yet there is no doubt that its presence is undesirable for it may affect the quality of the oysters and even render them unmarketable. As in the case of the oyster-drills, which are being spread primarily by the oystermen, the Nematopsis parasites also are distributed over a wide range through carelessness of the planters.

The problem of adequate production of healthy seed oysters is a serious one that should be given careful attention by the state governments. Establishment of spawning and seed reserves appears to be one of the methods of meeting the situation, and of making good use of many of the depleted and abandoned public grounds.

CONTROL OF ENEMIES

Depredation by starfishes continues to be a major concern of oyster-growers in the North. That starfish infestation can be controlled and that thousands of pounds of oyster meat devoured by these pests can be saved for human consumption have been demonstrated by the work of biologists of the Fish and Wildlife Service and others. It has been shown also that, to be a success, the control of starfishes requires organized effort on the part of private oyster-growers and the state governments.

Surveys conducted by the U. S. Fish and Wildlife Service in Long Island Sound give ample evidence that abandoned private beds neglected by the owners, and unattended natural beds neglected by the state, are the principal breeding places of starfishes. It is an obvious responsibility of the state government to prevent publicly owned grounds from becoming a menace to the nearby private oyster-farms. On the other hand private planters, in fairness to their neighbors, should be required to free their uncultivated plots from dangerous pests.

POLLUTION

The increase in domestic pollution of inshore waters is a serious obstacle to the progress of the shellfish industry. Evidence indicates that not only is there a considerable increase in the spread of domestic pollution, resulting from increased war production activities, and the construction of new military and naval establishments and housing projects for war workers, but that there is a tendency on the part of the health officers to relax their vigilance. The interests of the oyster industry demand that public health be fully safeguarded and that no compromise be accepted where there is danger of an infected product reaching the market. For the sake of self-preservation the industry should insist on strict enforcement of public health regulations. In doing so, it will prevent repetition of the disaster of 1925.

Industrial pollution also interferes with the oyster industry. Various chemicals, oils, and pulp-mill wastes enter our coastal waters in ever-increasing quantities. Extensive research is necessary in order to devise methods of purification, or recovery of various wastes so that they will not be discharged into our bays and estuaries and accumulate on the shellfish bottoms. The toxic effect of many of the pollutants has been demonstrated by numerous studies conducted by the U. S. Fish and Wildlife Service and by various state and university laboratories in this country and abroad. Many progressive manufacturers show their willingness to cooperate with those engaged in the conservation of our food resources, while others protest the results of scientific findings and try to prove that the wastes that are discharged into the waters are not only harmless to marine life but are even stimulating to its propagation and growth.

The solving of pollution problems should be sought through cooperation in research conducted jointly by fishery biologists and the technologists working for manufacturing concerns. Scientific and technical studies of the method of recovery and purification of industrial wastes may lead to economies and funds expended for this purpose, in the long run, will bring higher dividends than money spent in unconstructive litigation.

CONCLUSION

It has been shown that the potential productivity of shellfish bottoms is much greater than their present yield and that the decline in the production of oysters is due to lack of cultivation on public grounds. The rehabilitation of depleted bottoms can be attained by adopting a system of management which will result in their development and permit long-continued utilization. Certain principles of such a system have been suggested to stimulate interest and focus attention on the urgent need for

modifying obsolete and inefficient methods of administration of the oyster fishery. The management of shellfishery resources is a state problem that should be solved separately by the citizens of the various states through their legislative bodies. Action should be prompt as our present system, or lack of one, is leading to the gradual depletion of our valuable shellfish resources. However, it is certain that production can be materially increased by following certain basic principles of cultivation and management.

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National Shellfisheries Association, Philadelphia Meeting, June 1943

HOW NEW JERSEY PLANS FOR MORE OYSTERS *

Dr. Thurlow C. Nelson, New Jersey
Oyster Research Laboratory, Rutgers
University, Outlines Program

Successful production of oysters requires three things: (1) a dependable supply of seed; (2) a reliable source of oyster food for growth and fattening; (3) adequate control of oyster enemies. New Jersey is unique among our states in that better than 90 percent of the seed oysters planted upon privately leased grounds come from State controlled natural oyster beds. These beds furthermore are used solely for seed production and not for raising marketable oysters. The industry is concentrated in three areas: Great Bay and the Mullica River; Great Egg Harbor, Great Egg Harbor River and Tuckahoe River on the Atlantic seaboard; Maurice River Cove and Delaware Bay where most of the industry is located.

The map of Maurice River Cove and Delaware Bay shows a wide cove which narrows down to the bay and the river. Maps of Great Bay and of Great Egg Harbor would show an essentially similar situation. The oyster planting grounds lie well down in the broad expanse of the lower bay while the natural oyster beds lie in the much narrower area where the bay funnels down into the river. In Maurice River Cove lie approximately 30,000 acres of planting grounds with some 20,000 acres of natural oyster beds in the upper narrow portion of the bay.

Dr. Julius Nelson showed in 1917 that oyster larvae rise during flood tide and thus are carried toward headwaters. Our own studies in Little Egg Harbor published in the same year and later work in Barnegat Bay and in Delaware Bay have abundantly confirmed this reaction of the larvae to the tides. As a result of this distribution of the larvae there are in Delaware Bay as a whole three primary setting areas; above the Southwest Line on the New Jersey side, the corresponding area on the Delaware side and the Cape May shore of the lower bay. Among the factors responsible for this distribution of the oyster larvae, the most important appears to be the set of the currents resulting from the rotation of the earth. The contribution of science to the problem of seed production in New Jersey has been to demonstrate where the larvae are most abundant and the period over which setting may be expected to occur.

The survival of the natural beds in Delaware Bay has been due solely to the enforcement of the Rough Cull Law of 1899 which provides that not more than one-seventh of the catch shall consist of shells to which no oysters are attached. All other shells must be returned at once to the bottom. Supplementing the natural supply of shells has been the shell planting program carried out jointly by the State of New Jersey and the oyster growers. A portion of the tax on gross tonnage of the boats and of the license fees of tongers is used to match on equal terms the state appropriation for shell planting. The shells are purchased from the local shucking houses and planted where the prospects of a favorable set are good and where they are most needed in maintaining the beds. In 1928 more than a million bushels of shells were planted under this cooperative agreement. Furthermore, they were planted according to advice received from the Oyster Research Laboratory. That this method of handling the beds is economically and biologically sound is proved by the steady rise of the industry to its peak of over five million dollars worth of oysters in 1928.

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* Published in Atlantic Fisherman, Inc., Goffstown, N. H., August 1943.

Value of "Sanctuaries"

Our experience over more than half a century in New Jersey proves the value of placing the natural beds upstream from the planting grounds. The larvae are carried here from the planting grounds while the low salinity keeps down the various enemies of the oyster all of which are marine. The young spat are, therefore, able to pass through the dangerous first months, when their shells are very thin, protected from these enemies.

Experience has also shown the wisdom of providing "sanctuaries" of spawning oysters in close proximity to the planted shells. Again and again we have found on the natural oyster beds of Delaware Bay only light sets on newly planted shells except in a zone above and below the sanctuaries where the set has often been very heavy. For example, we recently dredged shells adjacent to New Beds and found only three clusters of last year's set in a dredge full of empty shells. A short distance away where large oysters were planted with the shells, practically every shell bore a heavy set.

The decade 1930 to 1940 will long be remembered as the driest on record in this State. The food available to the oyster was sharply diminished while the enemies all of which are marine enjoyed a Roman holiday. This coupled with loss of oysters on bottoms shifting during two hurricanes reduced New Jersey's output from approximately 14 million pounds of oyster meats a year to about half that figure.

This is the war's challenge to the industry in New Jersey; can we return to the production figures of the years before 1931? Our first step is to reduce our losses due to our worst enemy, the oyster drill. On a conservative estimate we lose from this pest alone at least one quarter of our total possible crop. Three practical methods for control of drills are: the drill trap, the drill dredge, and the deck screen. The trap is a small bag of one inch chicken wire containing young oysters and strung on a trotline. Drills are attracted to these younger oysters and may be shaken out into the boat by lifting the line as often as necessary. The drill dredge drawn through a bed of oysters permits these to tumble up the inclined grid while the drills fall through into the pan beneath. The deck screen receives the catch from the dredge; the oysters are shoveled back, the drills fall through. Use of this device during transplanting should be made mandatory. In its present form, however, the deck screen is not wholly satisfactory, the chief drawback being that screens are not lifted frequently enough to keep the trash with the drills cleared from underneath. An improved model now being planned will stand well above the deck and be used after the manner of a coal chute. The oysters will be shoveled onto this screen from which they roll overboard.

As a practical demonstration of the results of drill trapping may be cited a 100-acre ground which after planting was divided into four equal quarters. One quarter was drill trapped for a two-year period, the other three-quarters left alone. Upon harvesting the quarter which had been trapped yielded more oysters than the other three-quarters combined.

The third means of increasing production of oyster meats through more abundant food for the oyster is still very much in an experimental stage. The ultimate possibilities in this field are shown by the fact that a single species of diatom, Skeletonema costatum, by its unusual abundance added approximately one-half a million dollars to the value of a year's crop of oysters from Delaware Bay. Experiments to determine the substances necessary for growth of this diatom have been carried on during the year and will be continued. We are also experimenting with ways through which the diatoms and other organisms on the oysters' shells may be increased.

National Shellfisheries Association, Philadelphia Meeting, June 1943

INCREASING PRODUCTION OF OYSTERS IN MARYLAND

By Edwin Warfield, Jr.
Chairman, Board of Natural Resources
State Department of Tidewater Fisheries, Anapolis, Maryland

We have listened with particular interest to Dr. Galtsoff's proposals directed to the more effective management of the public rocks in our oyster producing states as we in Maryland have been undertaking to put into effect a program for the management of our public oyster resources quite similar to the program which he is proposing. It would perhaps, therefore, be pertinent to this discussion if I should comment briefly at this time concerning the problems we have encountered and our efforts to overcome them.

The importance which this question of the better management of our public rocks holds for Maryland can best be indicated by calling attention to the fact that we have now under private lease some 7,000 acres, whereas the areas of our natural rocks in round numbers comprises 275,000 acres.

We are quite aware as has been pointed out by Dr. Galtsoff that as compared with the results obtained by private oyster farmers, the results of efforts on the part of the several states to increase or in fact maintain the production of their natural oyster rocks have been quite outstanding for their lack of success. Viewing the matter realistically, however, in our State, we are of the opinion that proposals looking to the leasing of public rocks to private interests are likely to fail in the future as they have in the past. Our choice of procedure in Maryland is not public versus private development, but seems to be a choice between efficient and inefficient public operation. Our Commission, therefore, has attempted to lay the groundwork for effective state oyster farming on its natural rocks. In this undertaking, it recognizes fully the difficulties inherent in this type of state operation. It believes, however, that though the State is not likely to equal the results obtained by the more successful private oyster farmers, there is still the possibility of improving by a wide margin the results now being secured. In carrying forward a program of state operation, however, we hope to enhance the possibilities of successful operation of the private planters on leased bottoms through the development of an adequate source of seed supply for their use.

Three years ago it was my privilege to outline before this group a plan by means of which we hope to increase oyster production in Maryland. As indicated above, it was essentially the same plan as that proposed by Dr. Galtsoff. In putting this program into effect, however, we have been confronted with restrictive laws and rather difficult administrative problems, and our efforts in the intervening years have been largely directed toward overcoming these obstacles.

The basic requirement for any oyster farming program, whether private or public, is, of course, the provision of an adequate and reasonably dependable source of seed. The most promising seed areas in our State appear to be located principally in tributary or county waters, whereas the greatest degree of depletion in our natural rocks has taken place in the bars located in the Chesapeake Bay and the deeper waters of the larger tributaries. Our restrictive laws have prohibited the transplanting of seed from country waters to State waters, or for that matter, between counties. Though our efforts to have this restrictive law amended were only partially successful in 1941, we did succeed in the recent session of the Maryland Legislature in securing a broad grant of power enabling us to undertake measures for the development and full utilization of potential seed areas. Thus for the first time our Commission finds itself in a position to embark on a program of oyster farming.

The prospect for the development of seed areas proportionate to our needs have to date, however, been none too promising. While this is discouraging, it is our belief that on the basis of experience gained in a few favorable localities and with the application of better oyster farming techniques supported by adequate research, it should be possible to produce seed oysters in substantially increasing quantities.

Since our program contemplates the planting of seed on growing bars where they would be protected until they have obtained a desirable and profitable growth, it is necessary that complete control of these planted areas be vested in the Commission. The authority of the Commission in this respect has been broadened by legislative enactment and is now thought to be sufficient.

Adequate research appears to be essential to successful oyster farming, whether private or public. We have been laboring under a considerable handicap in this respect in our Chesapeake Bay oyster operations due to insufficient appropriations for research. We are pleased to be able to report, however, that a substantial sum was appropriated for oyster research to our State Department of Research and Education, which agency was established in 1941 to serve the several State conservation agencies. We are hopeful also that the U. S. Fish and Wildlife Service will extend its oyster studies in Maryland waters and that the cooperative effort of these two agencies will provide essential information in support of this State's oyster farming activities. This cooperative effort has already borne fruit in a study now in progress of the oyster resources of the Potomac River and its tributaries.

Oyster farming, whether private or State, requires considerable capital. Annual appropriations of substantial sums have been made in Maryland for a number of years for use in oyster rehabilitation activities. The effectiveness of these expenditures in the past is open to serious question. It has, in the main, been treated as a subsidy and only relatively small amounts have been recovered through direct taxation of the industry. This taxpayers money should, in our opinion, be treated as a capital investment and must be recoverable through subsequent taxes levied on the harvested crop to provide funds for reinvestment if the program is to be expanded to a point of real significance. Under our existing laws, such a procedure seems practicable and it has been adopted by our Commission as an essential part of our program.

Protection of the planted crop until ready for harvest is, of course, necessary. We are fully aware of this fact and have been striving for increased effectiveness on the part of our law enforcement personnel.

Another important element in the ultimate success of our State oyster farming program would appear to be the degree of cooperation in carrying through the program which it will be possible to obtain on the part of the oystermen and the industry. Provision has been made by recent legislation for an educational director to function under the Department of Research and Education. We are hopeful that with the activities of this educational agency combined with the efforts of the personnel of our Department, substantial progress may be achieved along this line.

Even though a plan may be carefully worked out based on adequate research and implemented by the necessary legislative authority, it will obviously fail if sound administration is lacking. I think I am safe in saying that it has yet to be demonstrated that the necessary type of business administration can be provided under the political systems prevailing in most of our States. Maryland has been no exception in this respect. There have, of course, been able administrations at different times and in different places.

One of the greatest hindrances to successful State operation, however, has been a lac of continuity of program and policy and the prevalence of political interference. We have attempted to meet this problem in Maryland on the one hand by extending the terms of office of the members of our Commission of Tidewater Fisheries from four to six years on a staggered term basis and by an extension of its discretionary powers. On the other hand, we are undertaking to build up a competent staff of administrators having permanent tenure of office under the protection of the Merit System law.

This brief discussion has had to do with the problems of producing more oysters on our natural rocks. This is the urgent problem facing us today when the adequacy of our food supply is a matter of national concern. With the return of normal times and lessened demand for oysters coincident with an increasing supply should our program be successful, we will again in all likelihood be faced with a marketing problem. That problem, I think you will agree, will await later discussion.

In closing, I should like to state that we are pleased at finding ourselves in general agreement with Dr. Galtsoff's proposals on this occasion. However, after four years of close contact with all of the problems involved, we are very conscious of the difficulties of the undertaking.

National Shellfisheries Association, Philadelphia Meeting, June 1943

LOUISIANA'S SHELLFISH PROSPECTS *

By

Mr. J. N. McConnell, Director
Division of Oyster & Water Bottoms
Louisiana Dept. of Conservation - Louisiana

"I Wish . . . . . . to give you a brief summary of what Louisiana is now doing and expects to do to increase oyster production as a part of the concerted national effort to increase seafood production as rapidly as possible.

"We have just completed the bedding of 180,000 bushels of shells delivered to us by the various oyster steam canning plants operating in both Louisiana and Mississippi. This amount represents 10 percent of the amount removed from our natural reefs during the season 1942-43.

"These shells were planted at factory expense under the direct supervision of the Oyster Division of the Louisiana Department of Conservation. From the experience acquired from 10 years of this type of planting we can reasonably expect a crop from this planting alone of 700,000 bushels ready for the market during the season 1944-45.

"For the past two years we have been transplanting 18,000 to 24,000 bushels of seed oysters from overcrowded areas to depleted reefs. This work was done by several factories in lieu of shells and excellent results were obtained. This type of cultivation has the advantage of a resultant better grade of oysters remaining on the reefs and also having marketable oysters available on the depleted reef in one year's time, from the date of transplanting, and important additional food.

"Before leaving New Orleans, for this convention, I received assurance from the Governor of Louisiana and the Commissioner of Conservation that a special sum of $50,000 would be set aside for the immediate bedding of additional oyster shells as "cultch" and additional transplanting of seed from overcrowded areas.

"At this point I wish to emphasize the practical value obtained by scientific information gathered in our biological experiments. We have been conducting these experiments with the advice and assistance of Dr. Galtsoff and Dr. Hopkins and in many cases have used the splendid facilities available to us at the Fish and Wildlife Laboratory at Pensacola.

"The fact that we had graphs to show the necessity of planting cultch now if we wanted maximum results was, I am sure, the deciding factor in having the money made available for immediate use.

"We are fortunate in Louisiana in having large deposits of dead oyster shell reefs. Some of these reefs covering hundreds of acres with depths ranging from 1 foot to 35 feet of dead reef shells.

"A royalty of 5 cents per cubic yard is charged for shells severed from these dead reefs and during the calendar year of 1942 the Department of Conservation collected approximately $88,000.00 from this source alone. At present this money goes into the general fund of the State. It is now planned to ask the Louisiana Legisla-

* Published in Fishing Gazette, 461 Eighth Ave., New York, June 1943.

ture to set aside annually from this fund $50,000 to be used for oyster propagation and we have every reason to believe this request will be granted.

"Louisiana is glad to be able to state that in spite of all of the wartime problems, we have had to face, we are still able to show a small production increase during the past year.

"In reading Dr. Galtsoff's address it was a distinct pleasure to note that Louisiana showed by far the greatest increase in oyster production from the period 1890-92 to 1939, with the lone exception of the State of Washington where such great strides have been made with the Japanese oysters.

"It is the considered opinion of most of us in Louisiana that a great future is opening to all oyster producers for the following reasons:

First, the shortage of all seafoods on the market today.

Second, the large number of military camps using oysters, which has cultivated a taste for same among the personnel from states where this food is not a part of their regular diet.

Third, the new method of refrigeration which now makes possible a quick frozen package which retains most of the original flavor and texture of our oysters.

Fourth, transportation--with tremendous developments in aviation, we can reasonably expect both freight and express to be taken to all parts of the world as soon as the war is over.

"I sincerely believe that no matter which section of the country sells additional oysters to people that have not been in the habit of eating them, all sections alike will benefit from resultant increased demands.

"When I had the honor of addressing this Association two years ago in Atlantic City I mentioned that we were hoping to obtain an aeroplane to assist us in patroling our coastal areas. We have been using a small 65 h.p. two-seated plane with pontoon, for the last 18 months and it has proved extremely satisfactory. The moral effect on law violators is surprising, as they never can tell when we will drop in on them. This plane has been of great assistance to the Commissioner of Conservation as well as to all of the various Division Directors. We have found it to be the most economical and efficient way for us to know at all times what is going on along our coast line and inland waterways."

(Address given at Oyster Convention)

National Shellfisheries Association, Philadelphia Meeting, June 1943

Problems of Oyster Production in Texas

Gordon Gunter, Marine Biologist

Texas Game, Fish and Oyster Commission

(Read by Title)

The bay area of the Texas coast covers 3,460 square miles of water, about 700 square miles larger than the area of Chesapeake Bay. However, Texas oyster production is very small compared to that of the Chesapeake area. Oysters grow only along a little more than two-thirds of the length of the Texas coast, that is from Galveston Bay to Corpus Christi Bay. Along the whole area of the Laguna Madre, a distance of 130 miles, extending from Corpus Christi to Mexico, no oysters live except for a small patch at the very lower end, near Port Isabel. Here only a few hundred gallons are produced annually, and, although this small patch of oysters is very interesting biologically, being separated by many miles from other reefs, the significance of it is entirely negligible from the standpoint of production. Evidently these oysters grow under conditions that are far from optimum and there is a special law permitting small oysters to be taken. For practical purposes, oyster production may be said to end south of Corpus Christi Bay.

At the end of the last ice age, when sea level returned to its approximate present position, an offshore bar was formed along the Texas coast, so that today it has a double coastline. The area between the offshore bar and the mainland is the coastal lagoon. It averages about four miles in width. In addition, the mouths of rivers have been embayed by wind and wave action, practically all of them at right angles to the coastal lagoon, so that the bay area of the Texas coast may be said to be composed of two parts, the coastal lagoon and the more recently embayed back bays. Today the back bays are silting up rather rapidly as geological processes go, but the depths of the coastal lagoon have been static since the coming of the white man, except for the Laguna Madre, which is a special case, and except in areas where channels have been dug. In these areas silting has taken place. Growth of oysters takes place both in the back bays and the coastal lagoon. Oysters growing in the back bays have to continually fight against silting and periodically they are killed out by freshets every ten years or so. The Texas oyster grows almost at the extreme southerly part of its range and conditions in Texas undergo large changes every few years. This holds true especially along the drier portion of the Texas coast. From East Texas to South Texas along the coast, the climate changes and four separate climatic divisions which range from humid to arid have been designated by Thornthwaite. The arid part covers the Laguna Madre where salinities of the bay sometimes reach a point three times as high as sea water.

Today Matagorda Bay is the center of oyster production in Texas and the quality of the Karankawa Bay oyster, under the best conditions, is probably not excelled by those from any area of the Gulf Coast. Galveston Bay is the other main producing area, but this part of the Texas coast is also the most heavily industrialized and the most polluted. Aside from the main question, it seems to be true that the flavor of the Gulf Coast oyster is different from that of the Chesapeake oyster and a person who is accustomed to one will prefer it to the other. This difference probably derives from differences in the species of diatoms eaten by oysters in the two localities.

Texas is one of the few remaining states in the union whose oyster production comes almost completely from natural reefs. In 1904 the Texas coast produced approximately 200,000 barrels of oysters. That was the peak year. Since that time production has steadily declined until today it only amounts to 50,000 barrels annually. It may be said that production is at a very low stage. The improvement and increase in Texas oyster production lies in short in two things; first, better control of the natural reefs, and, second, introduction of oyster cultivation.

Oystermen should be required by law to use a culling hatchet when culling oysters for the market. Today any tool is used, from a leaf of an automobile spring to a ball pein hammer. Therefore, many of the culls are destroyed before being returned to the water.

Many reefs in shallow water are not fished and are overcrowded, so that the oysters are poor, misshapen, small and of no utility whatsoever. This is because dredging is not permitted in water less than six feet in depth. This law was passed many years ago to protect the tongers from the competition of the dredgers. Since that time the tonger has become a thing of the past on the Texas Coast, as a class, and probably not more than a dozen full time oyster tongers remain in Texas. Nevertheless, the old law has been changed and today many reefs in shallow water are under-worked while many others in deeper water are overworked. As an answer to this situation it has been suggested that the Game, Fish and Oyster Commission be empowered to open or close any or all oyster reefs, regardless of depth of the water, when inspection and examination of the reefs show that such action is necessary or will be beneficial.

Texas oyster laws were designed to prevent a monoply in oyster cultivation and promoters took advantage of the law preventing any one company or individual from leasing more than 100 acres, by contracting to work bottoms for leaseholders who paid for the work. The promotional phase has run its course in Texas and finally died out due to intrinsic handicaps of the total situation. Dr. Paul S. Galtsoff has recommended laws which will prevent revival of the promotional phase.

The only reefs now leasable for cultivation are those with no history or only long past history of oyster production. Obviously, such bottoms are not productive and some relaxation of the rigid laws governing leasing are advisable to permit utilization of bottoms with better prospects of production.

There are many problems of oyster cultivation in Texas that are unsolved and many which, doubtless, are unrecognized and unknown. This program will result in better care of the natural oyster reefs. Encouragement of oyster cultivation should be carried out by the enactment of certain less restrictive laws and by an experimental study of oyster culture conditions in Texas. These two combined activities comprise the only action that can be taken to replenish the depleted oyster resources of the State.

National Shellfisheries Association, Philadelphia Meeting, June 1943

SHELLFISH PROGRAM OF THE CHESAPEAKE BIOLOGICAL LABORATORY

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The research program of the Chesapeake Biological Laboratory during the past year has, as is true of nearly all other activities, been markedly affected by war-time conditions. The loss of two staff members, coupled with travel and equipment restrictions, prevented the completion of much of the oyster research planned for 1942. However, several new oyster investigations were initiated, and continued observations were made of local spat-fall and state wide oyster set on shell plantings. In addition to oyster work, investigations regularly carried on by the staff embrace fish, crab, plankton, diatom, pollution and other studies. The necessity for cooperative assistance among staff members on many of these projects has made it impossible for any one to give his full time to oyster research.

During the summer of 1942 routine sampling for oyster larvae was carried on at Solomons throughout the season. Water temperatures at the end of the Laboratory pier averaged 20°C or above from May 21st to Oct. 10th, indicating approximately the normal spawning season. Local oysters were very thin and watery at the beginning of the summer, a carry over from the extremely poor condition of oysters during the preceding winter. Probably in large part as a result of this condition, oyster larvae failed to appear in abundance at any time during the season at this location. A very few umbo larvae were found in samples taken around June 15th, August 4th and September 22nd. A few spat set on experimental shells during the August 4th and September 22nd periods. When examined in late fall, a nearby state shell planting of 18,564 bushels was found to have a catch of only 12 spat per bushel. Similar poor setting conditions prevailed in most waters of the State that season.

Counts of the spat on all state shell plantings were made in early winter in cooperation with the Department of Tidewater Fisheries. St. Marys River, an estuary of the Potomac, and Eastern Bay, a shallow protected area in the upper part of the Chesapeake, again produced the heaviest sets and show definite potentialities as seed areas. In a few other localities shells secured light sets, but sufficient for paying production with the shells remaining where planted. Plantings in Chesapeake Bay proper, Tangier Sound and the larger rivers failed to secure adequate sets. Throughout the State the set was found to have taken place mostly from about mid-season to very late.

The results from shell plantings this year demonstrate once more that the bulk of our shells should be placed on those areas most suitable for the production of seed oysters. Sufficient brood stock must, of course, be present. From such plantings the shells, after they have secured an adequate strike, can be transplanted to the many depleted bottoms of the State which are known to offer favorable conditions for growth. It is hoped that such a policy can be more largely entered upon in the future. Past records have shown that indiscriminate shell plantings throughout the State on depleted bars have yielded, for the most part, little or no return.

Although legal restrictions preventing the removal by the State of oysters from the waters of one county to those of another have greatly hampered the development of seed areas, three of the 1942 plantings were made with the express purpose of producing seed which could be transplanted within certain limitations. Two of these plantings received good, though not exceptionally heavy sets. In deciding whether or not such shells should be moved with the oysters as spat or should be left a year in order to produce larger seed, it is important to know the mortality likely to occur as well

as the density of the set. General observations have indicated that in very light sets, due to the few oyster enemies present in the brackish waters of the State, little mortality occurs after the first fall. On a moderately heavy set in 1940, where the shells had remained undisturbed, approximately one-third of the spat had died at the end of the second season. One of the 1942 shell plantings has been carefully checked this spring for over-winter mortality. With an original count of 716 spat per bushel, 19.4% were found to have died when examined on May 10th. The set had been a late one and the spat averaged about one inch when measured this spring. This and other plantings will be carefully checked this season and future records accumulated so that normal mortalities under different conditions can be determined. The additional powers granted this year to the Department of Tidewater Fisheries will permit the more extensive development and use of seed areas in the future. More intensive study of the factors influencing setting in these areas will be undertaken.

In contrast to the poor condition of oysters in early summer they were exceptionally fat throughout the State when the season opened in the fall. This seems to have been due largely to the unusually abundant blooms of dinoflagellates which occurred throughout the Bay and tributaries during the late summer months and early fall. Large areas of reddish brown water, caused by quantities of these organisms, were frequently observed in the Patuxent River and on the Bay during hydrographic sampling trips. Diatoms of the genus <u>Skeletonema</u>, said to produce excellent flavor in oysters, were also quite abundant in the fall and early winter. A series of stomach examinations were instituted and continued during the fall until winter hibernation. These gave ample proof of the importance of these two forms in the oyster's diet at this time. If personnel permits, it is planned that such qualitative studies of stomach content may be continued over several seasons and correlated, if possible, with the condition and fecundity of oysters.

In conjunction with an investigation of pollution effects in lower Baltimore Harbor, an effort was made to determine whether or not nearby bars in the upper Bay were being affected. The major pollutant dumped in this area consists of copperas (ferrous sulphate) which is produced in large quantities as a by-product in the manufacture of titanium dioxide, a paint pigment, and in the pickling of steel preparatory to galvanizing or plating. This ferrous sulphate hydrolyzes and oxidizes rapidly after being released, resulting in a marked lowering of the pH and oxygen content of the water. Fortunately, the areas where this occurs are local and highly industrialized so that no commercial fisheries are affected. However, a flocculant precipitate of ferric hydroxide is formed which settles slowly, and, while not toxic, might cause the carrying down of plankton organisms or excessive silting. By means of water sampling and special sediment collectors a survey of the extent of this pollution was made. The findings to date indicate that all of the oyster bars are well outside the affected area and that settling is complete before the sluggish tidal movements have carried the water masses far from the sources of pollution. Plankton is carried down to a certain extent, especially the filamentous diatoms and those having long processes. However, due to the richness of this polluted area in nutrient salts, or because of some other factor, reproduction seems to be so stimulated that normal and sometimes high counts are obtained from the water in heavily polluted zones.

As an extension of this work a series of spectrographic analyses of water and oyster samples from the entire State was inaugurated. In addition to disclosing evidence of pollution, it was hoped that plotting the occurrence of trace elements in the different regions might show some correlation with oyster spawning and larvae survival. Only a few spectrographic analyses were made when the needs of war research made it impossible to obtain further use of a spectrograph for this work until after the emergency. Examination of spectrographic plates made from twenty

oyster samples taken at widely scattered points showed the presence as trace elements of iron, nickel, silicon, aluminum, manganese, magnesium, titanium and phosphorus. These were all uniformly distributed. Silver and zinc were present in greater quantity in samples from the two bars nearest Baltimore. Vanadium was also found in the upper Bay samples. Copper was generally in greater abundance in the bay samples than in those taken from the tributaries. The elements named were the ones whose lines were measured with a densitometer. When further examination of the plates can be made, others may be determined. The spectrographic plates and ash samples are being stored in the hope that this study may be renewed and extended when future conditions permit.

Since the sex ratios among oysters according to their size have been found to be somewhat dependent on environmental conditions, a study of such ratios in local oyster populations was begun last fall. Insufficient data have been gathered from which to draw any conclusions at present. Plans have been made to carry out this investigation more extensively in the future. It is hoped that the findings may be of value in selecting for brood stock oysters having the most effective sexual composition for efficient reproduction.

During the past two winters abnormal oyster mortalities have been reported from a number of bars in different parts of the State. Investigations indicate that a number of local factors may have been involved. However, it was observed that infections by <u>Nematopsis</u> were present on all of the bars examined and in certain cases may have contributed largely to the losses. A more extensive survey of the distribution of this parasite and degree of infection in various parts of the State is planned for this year.

Naval operations have resulted in some destruction of natural oyster rocks. The Laboratory has conducted surveys of the extent of such damage and aided in the estimation of the value of the oysters and rocks destroyed.

In line with the demand for greater food production, an oyster program is being formulated in cooperation with the Fish and Wildlife Service. This involves a general survey of all oyster producing regions of the State. Oyster populations, seed production, physical condition of the bars, and methods of obtaining maximum yields are to be studied. The Laboratory also plans to investigate the possibility of more effective utilization of the soft shell clam or manninose.

As a result of the appropriation of badly needed funds by the 1943 Legislature it will be possible to carry on our oyster program and other research much more effectively in this and future years. Four new biologists will be added to the staff together with needed maintenance workers and helpers. One of these biologists will devote his entire time to oyster work and will have the cooperative assistance of others as needed. Aside from the handicap of war limitations and manpower shortages, Maryland seems on the threshold of a far more comprehensive and coordinated program of study and management of our natural resources than at any time in the past.

National Shellfisheries Association, Philadelphia Meeting, June 1943

SHELLFISH RESEARCH PROGRAM OF THE VIRGINIA FISHERIES LABORATORY
of the
Commission of Fisheries and the College of William and Mary

CURTIS L. NEWCOMBE, Director
Virginia Fisheries Laboratory

The urgent need for increasing food production throughout the nation gives reason for examining existing seafood resources from three points of view; One involves a consideration of how the existing supply may be increased, i.e., what methods can be employed to substantially increase the present supply; a second problem is the old question of adequate protection of the existing supply while production proceeds at varying levels of intensity. An evaluation of current industrial practices sometimes proves to be a necessary consideration. A third consideration involves the quantity of seafood present and the quantity that can be removed immediately without endangering the future supply.

These three considerations are of basic importance to the Commission's research program, particularly that planned for the current season. I shall refer briefly to the oyster studies being conducted by R. Winston Menzel, work on the crab by M. Sandoz and S. H. Hopkins and the experiments on the culture of the ribbed mussel by George M. Moore.

Referring first to the oyster, I may point out that since 1912 oyster production in Virginia has dropped about 60 percent---from about 43 million pounds to 17.7 millions in 1940. The large acreage of unproductive oyster bottom in our state is well known to most of you. To restore many of these barren or partially barren bottoms is an established policy of the Commission of Fisheries. Small scale experiments were conducted in 1941 and 1942 to determine the best time to plant shells. Time and amount of "strike" were observed and also the percent survival during the growing season. Winter survival in the case of young oysters was also determined. The experiments seemed to indicate that in the locale of the experiments (at Seaford, Virginia), while there was a relatively large strike throughout the summer and fall, the late summer and early fall plantings yielded by far the best results. The results of these preliminary experiments stress the importance of fouling organisms in limiting survival of "spat" during the period when "strike" was greatest, and suggest that August and September may be the best times for planting. The program for the coming season includes a continuation of these experiments but on a small <u>commercial</u> scale in the York and Rappahannock Rivers, and designed to show the best time, number of shells and type of bottom for planting purposes. I may add here that the planting of seed oysters is done on a rather large scale as a part of our repletion program. Experiments to signify the number of bushels per acre that need to be planted to assure best results in terms of meat weight are projected for the present season.

Virginia's worst enemy of the oyster is the screwborer. Last season's work demonstrated the efficacy of drill traps for controlling its infestations on submerged bars in Hampton Roads. The cooperative assistance of local planters in that area made it possible to estimate the means and cost of drill control through the trapping methods so successfully worked out in New Jersey. This summer experiments will be continued on ways of reducing the spread of screwborers from infected to uninfected bars during transplantation.

From a standpoint of food production the blue crab is a major fishery of the Chesapeake, amounting in 1939 to over 50 million pounds and fairly equally distributed between Maryland and Virginia. During the past two decades there have been

pronounced fluctuations in the catches generally attributed to weather conditions and industrial practices. From 1939 to 1940 the crab catch declined nearly 40% in Maryland and 16% in Virginia, according to available Federal statistics. Recently, There has been a significant increase in volume produced. At the request of the Hampton Crab Packers Association the State Commission established in 1941 and maintained thereafter, a rather large crab sanctuary at the mouth of the Bay to protect the brood stock. The extent and importance of this sanctuary is, seemingly, one deserving attention. To determine the value of this body of water for the hatching and larval development of the crab, studies have been carried out since 1941 aiming to define the environmental conditions most suitable for embryonic and larval development. It was first necessary to establish beyond question the identity of the blue crab larvae and then to devise a means of hatching them out in large quantities for purposes of studying their preferences and toleration points with respect to the salinity and temperature factors. Thus far it has been found that, as far as stages up to and including the third zoeal stage, are concerned, the range of optimum temperature and salinity corresponds with environmental conditions prevailing in the sanctuary during summer. As larval development advances the optimum range of salinity for the more advanced stages seems to narrow down considerably. This summer an effort will be made to identify and rear the remaining zoeal stages and define their optimum ranges with respect to salinity and temperature. In light of these experimental findings, it appears that Virginia is now making a major contribution to the maintenance of a high level of crab production for the future without seriously curtailing the overall output at the present time.

At this point, I may mention the loss to the soft crab fishery of Virginia arising from holding crabs on shedding floats. Our preliminary observations made in 1941 indicated that an important factor, in addition to the condition of the crab when placed on the float, may be responsible for the mortality rates. Available evidence strongly suggests that crabs during the moulting process have a much higher oxygen demand than at other times. Yet, we have found during August that in some commercial floats the oxygen content of the water is far below that of the water outside but nearby the float. Talks with crabbers and preliminary data on the subject lead me to believe that the supply of oxygen available to crabs kept on commercial floats is a factor worthy attention in any attempt to reduce current losses in shedding crabs. This summer, therefore, further observations will be made on floats in the Rappahannock River and at Cape Charles. It would seem that attention should be given to placing floats where there is adequate water movement and also to making a change in the construction of float so as to give better aeration for the shedding crab. It is particularly important at this time to prevent the loss through improper methods of handling of crabs already produced.

I shall turn now to make a brief mention of the Laboratory's program of study on the Biology of the Ribbed Mussel that Dr. Moore is conducting. Two years ago it was my privilege to tell you of our work on this highly interesting and important bivalve that occurs in Virginia and the Carolinas. In my opinion, no single one of our fisheries is playing or is destined to play a greater role in the war effort. Being the major natural animal source of available provitamin D, we are confronted with the need for a basis on which first, to regulate the use of the existing supply and second, to supplement the natural supply by cultural practices. The present program calls for testing out on a small commercial scale varying types of "cultch" found thus far to be the best. Also, transplantation experiments are in progress designed to test out the possibilities for utilizing for seed purposes the fairly large numbers of small mussels that will otherwise never be gathered.

In my opening remarks I referred to three basic economic considerations: one involving how the existing supply may be increased and I had in mind the oyster industry of Virginia; a second consideration, dealing with giving adequate protection to the existing supply while production is permitted to continue, applies to the Virginia crab fishery. The third and last consideration involves an analysis of the quantity of available product and the amount that it is possible to remove without endangering the future supply. In this category belongs the ribbed mussel. The Laboratory's program is aimed toward the fulfillment of these considerations.

National Shellfisheries Association, Philadelphia Meeting, June 1943

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A year ago I had the opportunity to bring before the members of this convention the subject of cultivation of the sea mussel, M. edulis. In my address I tried to emphasize the fact that because of the war demands any new source of food that could be developed would be of significant importance. The opinion was expressed that seeking and developing such sources should be considered a major task by the persons engaged in food research of any kind. Attention was called to the fact that in the case of shellfisheries we may do our share by advocating the use of our sea mussels or, as they are more often called, black mussels. At that time, as will be remembered, the mussel fishery was virtually non-existent.

Prior to developing the fisheries on a broad scale it was considered necessary to ascertain the quantity of mussels of a marketable size available on the natural beds along the North Atlantic coast. To accomplish this, a series of surveys was undertaken. The chief purpose of these surveys was to determine the location of large mussel beds, and to estimate their population. The information obtained was to be made available to the men who intended to engage in mussel fishery. Furthermore, the data secured during the surveys could serve in the future, as a basis for formulating regulations for the mussel fishery.

During the past year surveys of mussel resources have been conducted in the States of New York, Connecticut, Rhode Island, Massachusetts and Maine. Because of the lack of personnel these surveys are not completed. Nevertheless, the information thus far obtained is sufficient to form general conclusions in regard to the mussel resources.

In almost all instances the conducting of the surveys was made possible because of the cooperation of the fisheries and conservation authorities of the states named. Surveys in Massachusetts and Maine were carried on under the direction of Mr. Herrington of the North Atlantic Fishery Investigation.

It is perhaps more convenient to begin a description of the survey by starting with Long Island Sound and proceeding north. Our survey of that body of water, although still incomplete, shows, nevertheless, that the Sound is not very rich in mussels. However, in the course of our work several large beds were encountered, each being of such dimensions that limited fishing could be considered profitable from a commercial viewpoint. One such bed was found outside the New Haven breakwater; another at Point No Point near the natural oyster bed, and the third near Penfield Reef. Unfortunately, these three beds were severely damaged by winter storms and one of them almost completely disappeared. There were several other considerably smaller beds located in other parts of the Sound along the Connecticut shore, as well as numerous scattered mussel colonies in all bays and harbors. However, taken as a whole, the Connecticut mussel resources are not large enough to support mussel canneries. They may, nevertheless, materially contribute to the fresh supply of shellfish sold at local markets.

Our estimates of the mussel resources of Connecticut, as well as those of the other states, do not include mussels which are found living in so-called polluted areas. In Connecticut large numbers of such mussels are found in the harbors of large cities, such as New Haven and Bridgeport, and in the Housatonic and Westport Rivers.

Although the mussels from such areas cannot be shipped directly to the markets they may, nevertheless, be utilized in case of necessity by first being transplanted to clean water areas for a sufficiently long period of time, and later sold as food.

Several medium-sized mussel beds are known to exist in the area confined between Throg's Neck and Flushing. However, almost all these areas are closed to fishing because of polution, and therefore they cannot be regarded as important. Large beds of good sized and good flavored mussels exist in the Oyster Bay and Cold Spring Harbor districts. Perhaps this district is at present the most important mussel producing center of Long Island.

Mussel beds are found in several localities along the northern shore of Long Island. In Northrup and Huntington Bays, mussels set along the shore but, as a rule, very few of them reach a large size. Beds of marketable sized mussels are also encountered in Peconic Bay and Gardiners Bay but again these beds are not extensive enough to promise a large supply of mussels either for canneries or markets. In Great South Bay proper a good set of mussels occurred in the Summer of 1941. They grew very rapidly reaching the marketable size of 2 1/2 inches one year later. However, almost all of them died during the Summer and Fall of 1942.

According to Mr. Gibbs, Fish and Game Administrator for the State of Rhode Island, who conducted a survey of Narragansett Bay, the mussel resources of that body of water are perhaps even less abundant than those of Long Island Sound. The results of the survey of Narragansett Bay showed that very extensive mussel beds, which were known to exist there two or three years ago, were recently destroyed by starfish, or disappeared because of some other causes. The only exceptions were found in the case of a large area located south of Hog Island, and in inshore areas extending from Bristol Ferry to Common Fence Point. Mussels collected there were of an unusually large size and of excellent quality. It is believed that E. B. Blount and Sons will use the mussels from these beds for canning.

Results of the survey of New York and the southern New England states showed that, in general, this area cannot be regarded as a chief source of mussel supply on our North Atlantic coast. It is true, nevertheless, that the mussel resources of these three states, even if limited, should be considered as capable of furnishing a steady supply for retail trade. For instance, according to our Market News Service the quantity of mussels sold during 1941 in New York City markets amounted to approximately 41,000 bushels.

It is estimated that the quantity of marketable mussels now available along the coast of Massachusetts may be between 250,000 and 350,000 bushels. The mussel resources of Maine are considerably richer than those of the sections already discussed. A survey of the mussel beds in Maine was begun last fall and continued until January. The area covered by that survey extended from Penobscot Bay to Jonesport. Judging by the character of the coast line this area is probably the richest mussel growing section of the coast of Maine. According to Mr. Scattergood, who conducted the survey, this entire section contained approximately 315,000 bushels of marketable mussels. It is quite possible that future surveys will locate good mussel beds in other sections of the coast of Maine, such as Casco Bay and Booth Bay Harbor. I doubt, however, that the quantity of mussels of those districts will be equal to that of the area confined between Penobscot Bay and Jonesport. Even if we assume that the supply of mussels in the areas to be surveyed will approach that of the sections already covered then the total quantity of mussels of a marketable size that we can count on from Maine will be approximately 650,000 bushels. Of this quantity about 60,000 bushels of mussels cannot be used because they contain too many pearls.

Thus, according to information now available, we may assume that the supply of marketable mussels on the beds of New York, Connecticut and Rhode Island is between 250,000 and 350,000 bushels. About the same quantity may be obtained from the mussel beds of Massachusetts. The waters of Maine may yield another 500,000 or, in the best case, 750,000 bushels. Therefore, we may conclude that the total supply of marketable able mussels obtainable from the North Atlantic waters is approximately 1 1/2 million bushels. This figure does not include the mussels of polluted areas, nor those of numerous small beds, utilization of which would be difficult and costly.

When starting our work on mussels about 3 years ago we were under the impression that the supply of mussels available from our coastal waters was somewhere between 10 and 15 million bushels. The fact that the present supply of mussels is actually much smaller than anticipated may necessitate the revision of some of the plans for the utilization of these animals.

As was mentioned above, during the past year mussels began to be used on a comparatively large scale. In addition to those sold in the markets of large cities, a considerable quantity of them are now being processed. There are several establishments in the State of Maine which are already canning these animals. I understand that the largest portion of the product so prepared will be turned over to Lend-Lease authorities. Several other concerns are preparing pickled mussels.

Since there is only a limited supply of mussels, and because most of the mussel beds are so located that they can be easily worked on, these beds may be rapidly depleted. It is true that after the easily obtainable supply is exhausted, additional deep water beds may be discovered and their mussel population utilized. However, such beds, no doubt, will also be quickly depleted. As a result, at the end of a comparatively short period, the newly created mussel industry will be faced with lack of these animals and may experience a crisis. Therefore, since the utilization of mussels is increasing, and because the value of this source of food begins to acquire more importance, it becomes necessary to begin planning for a rational utilization and conservation of these mollusks.

Studies on the biology of mussels, carried on by our Service during the last several years, resulted in the accumulation of data which at this time permit us to speak intelligently about many phases related to the utilization and conservation of these animals. One of the first questions which had to be answered was when during the year mussels are at their best. Naturally, it is of advantage to utilize the mussels for canning or sell them in a fresh condition during the period when the animals are in their prime. It was found that, as in the case of many mollusks of the same group, seasonal variations in the condition of the mussel meats are very pronounced. Of course, changes of this type depend to some extent upon the location of the mussel beds. As a rule, mussels of warmer waters behave somewhat differently than the animals of colder, deep water beds. However, in all cases the cycle is very well defined, and in each locality there is a definite period when mussels are fatter than at other seasons of the year.

Contrary to conditions existing in oysters, which attain their prime in about 2 or 3 months after spawning, the mussels reach such conditions prior to their spawning activities. According to studies carried on by Mr. Engle and me at our laboratory during the last 2 years, it has been established that mussels of Long Island Sound begin to approach their best condition during the early winter. From then on, during late winter and spring, conditions of the mussel meats continuously improve and they reach their maximum nutritive value just before the beginning of their spawning season. Following this maximum development of gonad tissue there is a discharge of spawn, and the body of the animals begins to decrease in volume and weight.

There is a difference of opinion as to temperature and time of the year at which mussels begin to discharge their spawn. Some observers express the opinion that the mussels of our waters spawn as early as February, when the water temperature is only several degrees above freezing. It is also believed that mussels may spawn twice a year, once in winter and once in summer. However, our examination of the gonads of mussels collected at bi-weekly intervals throughout a period of two years, showed very definitely that spawning of the mussels of North Atlantic waters occurs when the temperature of the surrounding water is approaching 60.0°F. This usually takes place in late April, in May or early June, depending on localities. There was no evidence whatsoever that so-called winter spawning of mussels exists.

On the basis of our observations it can be recommended that the mussels should be utilized during the period of 6 or 8 months which precede the beginning of mussel spawning. In some cases the condition of the mussels may remain excellent during the first part of the spawning period, when the gonads are only partially discharged. Perhaps the animals can also be used during this time. As a rule, however, throughout the late summer and early fall the mussels of Long Island Sound are usually in a poor condition and it would be disadvantageous to use them as food.

Another disadvantage of gathering and selling mussels in the summer time is that it will be necessary to expose the animals to a comparatively high air temperature for considerable periods of time. This is usually followed by a significant loss in weight and high mortality of the mussels. To obtain more accurate information regarding this matter a series of experiments was carried on by Mr. Engle and me during the past winter. The chief purpose of these studies was to determine the loss in weight and mortality of sea mussels kept in storage at different temperatures. Common edible mussels, *Mytilus edulis*, approximately 2 1/2 years old and measuring from 2 3/4 to 3 inches in length, were used in the experiments. Each sample of mussels consisted of 100 individuals. The samples were exposed to temperatures of 30.0, 40.0, 50.0, 60.0 and 70.0°F. In addition to the above mentioned samples, one more group of mussels was kept outside during a severe cold spell then the air temperature was at times as low as 0.0°F.

The results of the experiment indicated that within the range of 30.0 to 70.0°F. the loss in weight and mortality of mussels increased with the increase in temperature. The experiments may be summarized as follows:

Rapidly frozen mussels lost little weight while in a frozen condition. Upon thawing all animals were found dead. Rapid loss in weight followed thawing.

When exposed to air temperatures of 30.0, 40.0, 50.0, 60.0 and 70.0°F. the mussels suffered the greatest loss in weight during the first 24-hour period. This loss was due to the escape of shell fluid.

At the end of the experiments in which the mussels were exposed to air temperatures ranging from 30.0 to 70.0°F., the loss in weight of the samples reached from 43 to 47 percent of the initial total weight.

Mortality of mussels began later and proceeded more slowly at lower temperatures. The first cases of mortality at temperatures of 30.0, 40.0, 50.0, 60.0, and 70.0°F. were recorded on the 14th, 8th, 7th, 5th and 4th day respectively.

Fifty percent of the mussels exposed for 30 days to a temperature of 30.0°F. were still alive at the end of that period. At temperatures of 40.0, 50.0, 60.0 and 70.0°F. the last animals of the samples died during the 22nd, 15th, 11th and 8th day respectively. The experiments showed very clearly that it is most advantageous to handle and ship mussels at air temperatures ranging from 30.0 to 40.0°F.

One of the outstanding characteristics of mussel beds is that they are very unstable. It is a well known fact that very often the population of large mussel beds may disappear within a brief period of time. We have observed a number of such pheonomena taking place in various parts of Long Island Sound. This is especially true of the beds that are exposed at low water stages. Such beds are very often destroyed by heavy ice, or the mussels are winter-killed.

Deep water beds also suffer a similar fate by being destroyed during heavy storms when the wave action is strong enough to tear the mussels from the bed and carry them ashore where they perish. As is the case with all commercial shellfish, mussels have their enemies too. In Connecticut and New York waters starfish destroy an exceedingly large number of mussels, whereas in Maine sea urchins also contribute to the mortality of these mollusks.

In general, however, mussels are hardy animals. Our experiments conducted during the past year indicated that if mussels are protected from their enemies and the elements, the mortality rate among them is relatively low. In one series of experiments, which was recently completed, we learned that the mortality among a large number of mussels kept suspended at mean low water mark was only 5 percent for the entire year. The sample located at the bottom in 6 feet of water showed, during the same period of time, a higher mortality amounting to about 12 percent. However, in the case of a sample which was kept at +5 tidal elevation, and which was exposed to freezing temperature, the mortality was 100 percent.

If the mussel fishery is to be maintained on a comparatively large scale and if the depletion of commercial beds should be avoided, protective steps should be taken at the earliest possible time. Several such measures which can be applicable to all mussel-producing districts may be suggested. It is thought that setting aside certain areas to serve as spawning beds should be practiced. In places where some of the beds have a considerable number of mussels possessing pearls such beds should be set aside for spawning purposes. It should also be advocated that, whenever practicable, culling of mussels should be conducted on the beds, and all undersized animals should be thrown back to propagate and grow. Developing various devices for the collection of mussel set, on which I reported at the last convention, may also be profitably practiced in many localities.

It is thought that for the protection of mussel beds a closed season should be established in each area where mussels are obtained for commercial purposes. We think that such closed seasons should begin soon after the mussels commence to discharge their spawn and continue until the end of the setting season. The establishment of the closed seasons is desirable because, if mussel beds are left undisturbed during the setting period, the young mussels will have a better opportunity to survive and to grow to marketable size. Work on the beds, expecially on those exposed at low water stages, will undoubtedly result in the destruction of a very large number of tender young mussels.

Our knowledge on the setting time of mussels is not very extensive. It is quite certain, however, that the spawning and setting of mussels begin and end at different times in different localities. Thus far, we have only one summer of observations on

the setting of mussels in Milford Harbor. Perhaps the data obtained are not typical for other localities. It may be that the setting of last summer was not typical even for Milford Harbor. However, since we are continuing the study, we shall eventually secure enough information to possess sufficient knowledge as to the setting periods of mussels.

Our studies of 1942 were designed to determine the beginning and end of the setting season of mussels, and to determine at what particular part of the season the setting was most intense. We were also trying to determine at what tidal levels the mussels set in largest numbers. The collectors were placed in the water on April 27, but no set was recorded until the first week of June. The setting was most intense between June 15 and July 6. The heaviest set took place on the collectors placed near the bottom below low water mark. After July 6 it began rapidly to decrease in number, and the last mussel set was recorded on August 31. Thus, the length of the setting period of mussels in 1942 was approximately from June 1 to the end of August, a period of only 3 months.

Studies of the above mentioned nature, if conducted in all areas where mussels are abundant and are utilized on a commercial scale, would greatly help in formulating policies for the conservation of mussels, and would undoubtedly result in a more profitable and rational utilization of our mussel resources.

National Shellfisheries Association, Philadelphia Meeting, June 1943

BLACK QUAHAUGS

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Rhode Island has long been noted for its oyster industry and for the other varieties of shellfish which Narragansett Bay produces in abundance and for which the State is justly proud.

Over the years our hard clam fishery has steadily increased in volume. Recently, due to the demands for food and more food, prices of hard clams increased, the fishery attracted more men and boats and at the last session of the Legislature our State laws were amended extending the open season when quahaugs could be taken by dredges and also opening new areas to dredging.

We have, however, a closed season on dredging. The trade is supplied by the "free fishermen" who catch quahaugs with rakes and tongs. As many of these free fishermen were working at other trades the problem has been met, in part, by utilizing the Black Quahaug (Cyprina Islandica).

All along the Rhode Island coast line is found this species of shellfish which resembles in many ways the common quahaug or hard clam, (Venus Mercenaria). The ocean quahaug is a dark brown in color, the older individuals are almost black, and the meats are slightly yellower.

Everyone who has fished in "outside waters" has known of these clams but to my knowledge, no attempt had ever been made to utilize them commercially, although the possibilities of putting them on the market have been discussed a good many times. There had never been any good reason to try to commercialize these black quahaugs--there had always been ample supplies of the regular quahaugs; no one had used them for food, there was too much sales resistance for such an untried product.

After my Division had exhausted the possibilities of finding mussels in sufficient quantities to interest the producers, (the starfish had nearly wiped out our once well-populated beds) and after we had looked into the dehydration of certain types of "trash fish" that are taken in huge quantities by our commercial fish traps, we again turned our attention to the black quahaugs.

The Narragansett Marine Laboratory, under the direction of Dr. Charles Fish had already spent a year in scientific research in this field.

We suggested to one of the dealers that here was a product that had possibilities. We must have put on a good sales talk for a dredge boat was sent out; they could be taken with little change in the gear or equipment used for catching hard clams; there were some extensive beds. The clams could be shucked as easily as the quahaugs and above all, it was proved by all the good chowder makers in the town that black quahaugs were good to eat--they were delicious.

The boats were sent out, they came back with 125 to 150 bushels each day. They were put on the market and sold. They were used by the Army in their menus. One shop was opening several hundred gallons each day. The Black Quahaug had arrived.

This is still a new product and many problems have arisen and will continue to present themselves for a solution. It may be that it is too soon to make statement that may have to be modified later. It is also possible that we have made a valuable contribution to the War Effort.

National Shellfisheries Association, Philadelphia Meeting, June 1943

PROGRESS OF STUDIES IN UTILIZATION OF STARFISH

By C. F. Lee and J. M. Lemon
Fish & Wildlife Service

At the meeting of the Associations last year, a resume of the technological studies of interest to the oyster industry was presented. Included in this paper was a brief report of the progress made in finding commercial use for the natural enemies of the oyster, particularly the starfish. It was also reported that the research work on the oysters was being continued, and that progress had been made toward satisfactory means of evaluating the relative quality of oysters during periods of shipment. Due to the declaration of war, it was found to be advisable to revise the oyster research program and devote a greater portion of the effort to finding shipping containers of non-critical material which can be substituted for tin containers.

The studies dealing with that portion of the oyster research specifically related to the nutritive value of oysters has been continued. Thus far it has been found that oysters contain appreciable quantities of vitamins A, B Complex and D, and that the food value is not adversely affected by freezing and storing over long periods of time. These studies have not been completed.

The technologists of the service have also been called upon to furnish the purchasing officers of the Army and Navy with information as to indices for judging the quality of oysters, as well as other seafoods being purchased for consumption by the armed forces. This has enabled the Fish & Wildlife Service to suggest methods of judging quality which were practical and would guarantee palatable shellfish without being unduly conservative in making purchases.

The investigation directed toward utilization of the starfish has continued during the past year, although limited essentially to feeding tests designed to determine its value as a protein supplement. Several factors have served to limit the extent of the work done during this period.

During the season 1941-42, to review briefly, it was found that starfish meal could be prepared experimentally from raw starfish in the ratio of about 1 ton of meal from 3 tons of drained fish. As taken directly from the boats this ratio would probably be at least 1 to 4, or less. The meal was found to contain on an average of 28 percent protein, 8 percent oil, and 58 to 60 percent mineral matter, largely calcium carbonate. The protein was found by rate feeding tests to be 76 percent digestible and have a biological value of 84 percent, which indicates a rather high grade protein suitable for use in farm animal rations.

It was also found that fresh starfish oil had less than 1000 International Units vitamin A per gram and that vitamin B^1 or thiamin was absent from the fresh fish. Starfish oil, amounting to from 2 to 2.5 percent of the fresh fish, contains about 10 percent of unsaponifiable matter including several unidentified sterols. A quantity of this oil was prepared for Dr. Werner Bergman of Yale University to complete an investigation of the structure and identity of these sterols. No recent report on the progress of this investigation has been received.

About a year ago, it appeared that starfish could best be used for the production of a protein food supplement. Feeding tests using various levels of starfish meal were conducted, using both rats and chicks. The first of these tests had not been

concluded when the earlier paper on this subject was presented in the 1942 Convention, and the last of them is still under way.

All control groups of chicks were fed a 23 percent protein mash containing pilchard meal as the source of animal protein. Four diets containing starfish were fed; two contained 32 percent, a third 16 percent and the fourth 8 percent of starfish meal. The diets were balanced to 23 percent protein content by variation in the pilchard meal and corn meal content. The 32 percent level of starfish was selected to determine any adverse effect that would possibly be due to the high quality of mineral matter and oil in the meal.

The conclusion from this test was that starfish meal was a good source of protein when used in relatively small amounts of mash. Larger quantities produced poor growth and high mortality, but the addition of thiamine improved the growth rate so it was concluded that part of the difficulty was due to vitamin deficiency. In rat feeding tests starfish meal was fed to levels of 12, 24, and 48 percent, with the protein content of the diets balanced in the same manner as used with the chick growing mashes. Growth of all rats was was retarded to an extent roughly proportional to the starfish meal content of the diet. The rats fed the highest level were extremely stunted and emaciated, but otherwise normal. The addition of thiamin to the diet did not result in any improvement either in condition or rate of growth, in contrast to the result with chicks. The digestibility of the meal was very nearly the same at all three levels fed, averaging 80 percent, so that this could not account for their failure to grow normally.

The chicks remaining from the before mentioned growth tests were fed a commercial mash for 5½ months until laying age. Ten laying hens were then divided into two groups and fed experimental laying mashes containing either starfish meal sufficient to supply 2.5 percent protein as the only animal protein source, or pilchard meal to an equal protein level plus four percent ground oyster shell to balance the calcium carbonate content of the starfish.

Four hundred and thirty-six eggs were produced by the starfish fed group against 413 produced by the pilchard fed hens. On the other hand, the average size of eggs laid by the pilchard fed group was slightly larger, 42.8 grams compared to 51.2 grams for the starfish fed hens. It is doubtful that these differences can be considered significant, and it may be assumed that starfish and pilchard meals are of equal value as an animal protein source when used in a laying mash at a 2.5 percent protein level.

Meanwhile a second feeding test with chicks was under way in which starfish meal was fed at 3.6 and 9 percent levels in a growing mash with a pilchard control fed group as before. In this test however, ground oyster shell was added to all diets, so that each diet contained an equal calcium content as well as having approximately equal quantities of animal protein. After a seven weeks period the average weights of the groups indicated that the starfish meal at both the 3.6 and 9 percent levels was a good protein supplement. The group fed 9 percent starfish was apparently receiving more than the optimum level, although the growth rate was still satisfactory. All groups gained more rapidly than the previous lot of chicks, and were in good condition. A second laying test was planned to check the previous observations. This group of hens has only recently started to lay, and were first fed the experimental mashes on May 1, so that it is much too early to estimate the relative efficiency of these new mashes.

All evidence to date, however, supports the conclusion that starfish meal can be included in chick growing mashes as an animal protein source at levels up to about 5 percent. In laying mash formulas, 8 to 9 percent starfish meal can be used, supplying not only needed protein but also necessary calcium.

One ton of starfish meal therefore replaced 880 pounds of high grade pilchard meal worth $33 and 1120 pounds of oyster shell worth approximately $7, which equals $35 to $40 per ton of meal. This value is low compared to a ceiling price of about $75 a ton for 65% protein pilchard meal.

Another important factor in the production of meal is the available supply. On several trips to the starfish infested area, inquiries have been made of boat captains and plant managers to find out the quantity of starfish taken in the course of normal operations. A large seed oyster company operating out of Milford, Conn. with four boats fishing in what is considered one of the more heavily infested areas, collected a total of 1400 bushels of starfish during the five months period between the past November 1 and April 1. The total trips made were not stated, but if the trips were only made one day in three, the daily catch per boat was only seven bushels. On a previous trip to Milford, contacts were made with two boats during dredging operations to clean grounds, and in each case it was stated by the captain that the usual daily cull of starfish from the dredge material was only five to six bushels.

In New Haven three large oyster firms were contacted. In one plant current figures average about one bushel per hour fishing effort. Other estimates were based on the number of drags with the mops. Apparently the catch varied from less than 5 to perhaps 60 bushels, with 25 bushels at a high estimate of the average daily catch per boat.

It if is assumed that fifteen bushels or 500 pounds of starfish are caught per boat per day for the whole Connecticut area, the total daily production amounts to about three tons of fresh starfish.

This would produce 1200 pounds per day with a market value of about $25. This compares with an operating cost per boat variously stated to be from $35.00 to over $100 per day, or perhaps $600 per day for the 12 boat starfishing fleet. Actual production of meal, of course, would entail transportation to a central point, costly drying and grinding operations, packaging and distribution costs. Commercial fish meal plants in general utilize products having a much higher protein content, and in most cases having an oil by-product that really pays the bill. So far we have not been able to find a very valuable component in starfish.

Only one conclusion seems possible. Starfish are a menace to oyster beds. Continual control efforts are necessary to avoid almost complete loss of set or young oysters in certain areas. Important as they are in cost of irradication or in potential destruction of oysters they are virtually insignificant in terms of tons of meal, and future efforts may be more profitably devoted to finding better and more economical methods for their elimination.

National Shellfisheries Association, Philadelphia Meeting, June 1943

SANITARY CONDITIONS AT OYSTER PLANTS TO MEET ARMY REQUIREMENTS

Colonel Frank H. Woodruff, Service Command
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Since the outbreak of the present war the Armed Forces of the United States have become the largest single consumer of foodstuffs. You have heard the fishery requirements as explained by the chief of the Office of the Quartermaster General.

That office is concerned with the procurement, storage and issue of immense quantities of perishable food and must maintain close supervision and inspection of each item from production to issue to insure the uninterrupted flow of proper amounts of the many items in their best possible condition.

All foods procured for the Army are inspected with two objects in mind:

First: To protect the health of troops against disease transmitted through spoiled, damaged or contaminated foodstuffs.

Second: To protect the financial interests of the Government by determining that the quality of the product complies with the contract requirements.

Foods of animal origin which comprise a large percentage of perishable foodstuffs are inspected by the Veterinary Corps of the United States Army. In accomplishing the First Objective, - protection of the health of troops, this inspection is a direct extension of the sanitary service of the Medical Department, United States Army. The Second Object, - determination of quality ordinarily is carried on simultaneously with the first and in its accomplishment the Veterinary Corps inspector acts in an advisory capacity to the contracting officer.

Among the products of animal origin listed in Army Regulations we find fish and other seafoods; and their inspection is carried out according to the same general plan as other products in this class. The inspection plan divides itself into three phases:

First: An inquiry into the general sanitation of the producing plant or establishment including the source of raw material.

Second: A supervision of processing and manufacture.

Third: Inspection for compliance with standards of quality set up in the purchase instrument and specifications cited threin.

Let us consider these three phases according to the methods followed in their accomplishment with special emphasis on shellfish establishments. The first step necessary is the request for Army inspection. This is initiated by the dealer or vendor in the form of a letter addressed to the Commanding General of the Service Command in whose area the vendor's establishment is located geographically. This letter should indicate the desire for inspection, a brief description of the plant's capacity, its exact location including that of any subsidiary plants which are to be utilized and the exact commodity or commodities which are to be offered for purchase. As soon as possible following such request, an inquiry is made including state and Federal regulatory agencies charged with inspection of the subject commodity. In the case of shellfish plants the State authorities, the United States Public Health Service and the Pure Food and Drug Administration are consulted. At the same time a

physical inspection of the establishment for which request was made is carried out. The Army Medical Dept. has not set up detailed requirements of its own with reference to oyster plant sanitation. We use as a guide the revision in force of "The U. S. P. H. S. Minimum Requirements for Endorsement of State Shellfish Control Measures and Certifications for Shippers in Interstate Commerce." These are the requirements endorsed by State Health Officers of the various states and are exactly the same as govern the shipment to normal market outlets.

In general our experience has been that we have found the various plants complying with these requirements, especially after the first few weeks of the oyster season. At the beginning of the season as a result of conversion of the plants from packing other seafoods to oyster packing some exceptions have been noted.

Perhaps at this point it would be well to point out some of the most common sanitary defects which we have noted with a view to correcting them prior to inspection.

(a) Lack of adequate toilet facilities.

(b) Lack of sanitary towels, soap dispensers and hot and cold water facilities for hand-washing.

(c) Packing rooms not effectively protected against access by flies.

(d) Shipping containers not kept in dust-proof covering and filled without proper washing.

(e) Employees whose hands come in direct contact with oysters in packing, with hands less than "scrupulously clean" as required.

(f) Employees in washing and packing rooms not in possession of up-to-date health cards.

(g) Stored shipping containers dusty and dirty and unprotected from insect, rat, and bird contamination.

(h) Domestic animals permitted in packing room and in storage rooms.

(i) Evidence of rat and mouse contamination.

These exceptions are not general, neither are all found in any one plant. The fact that they have been recorded is offered solely for your information in order that their existence if noted may be corrected.

Following a satisfactory sanitary inspection or reinspection, the name of the firm is listed as approved and purchasing agencies for the armed forces notified of such approval. The vendor then becomes eligible to furnish the subject commodity.

On the placing of an order with an approved firm a request for inspection with a copy of the purchase instrument is made by the purchasing agency in our office. An inspector is then assigned who supervises the shucking, washing and packing of the product at the contractor's plant. Simultaneously he carries out the last two phases of inspection, - supervision of preparation and compliance with purchase conditions. The item packed, sealed and stored properly for shipment is stamped with the official stamp of the U. S. Army Veterinary Corps, indicated that all type, class and grade requirements have been met. At destination a further inspection for soundness

and quantity is made before final acceptance.

The experience of last season indicates that the entire inspection procedure is sound and practical. Rejections at source were practically nil and only two rejections at destination were recorded for oysters originating at the states of Pennsylvania, Maryland and Virginia. This excellent record in the case of a perishable food was due, in my opinion, as much to the painstaking care and cooperation offered by the shippers, as to the actual inspection.

We have found the oyster industry as a whole to be highly cooperative and entirely ethical as business men.

You are concerned with the production and shipping of an extremely valuable foodstuff which the Armed Forces will require in greater and greater quantities. The oyster with its nutritive value, its palatability, its freedom from waste and the apparent ease of transportation without spoilage has become an Army institution. We look forward to a season of greater production and greater recognition by the Service of this food item.

National Shellfisheries Association, Philadelphia Meeting, June 1943

STANDARD METHODS OF THE AMERICAN PUBLIC HEALTH ASSOCIATION for the BACTERIOLOGICAL EXAMINATION OF SHELLFISH *

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Due to the inability of the Chairman of the Committee on Standard Methods for the Bacteriological Examination of Shellfish, Mr. James Gibbard, Department of Pensions and National Health of Ottawa, Ontario, to discuss the new procedure, the writer attempted to briefly outline and criticize the main features of the new report.

The present procedure was approved by the Committee on Research and Standards of the American Public Health Association at a meeting in St. Louis, Missouri, on October 29th, 1942, subject to certain minor changes. These changes were made by the Chairman and the report was published in the May 1943 issue of the American Journal of Public Health. The report had previously been approved, after discussion, at a joint meeting of the Laboratory and Sanitary Engineering Sections of the American Public Health Association meeting in Atlantic City on October 15, 1941.

The final report represents six revisions since the first was drawn up in December, 1935. Every effort has been made to sound out the opinion of all those interested in the report. The final report represents the collective judgment of this group so far as was possible. The chief objective of the new report has been to provide bacteriological methods which will indicate, with reasonable reliability, whether or not oysters and other mollusks have been dangerously polluted from fecal material. A second objective has been to determine whether or not such shellfish have been handled in a sanitary manner. For the first purpose it is necessary to use as an indicator an organism of unquestionable fecal origin. Escherichia coli is the obvious organism to use for this purpose. No one questions the fecal character of E. coli. The fecal origin of most other coliform bacteria, on the other hand, is open to much controversy while the common coliform of oysters and certain other shellfish, Aerobacter cloacae, is definitely not a fecal organism. This coliform organism can be found only occasionally in fresh feces from man and other mammals and then in all probability as an adventitious intestinal bacterium. It is chiefly an extrafecal saprophytic organism which grows wherever a suitable supply of organic matter is present such as in the slime of shell oysters, the slime of shucked oysters, in barnacles and in waters containing a certain amount of organic matter. A temperature above 60°F. is usually associated with such proliferation. The finding of E. coli in oysters and other mollusks may rightly be considered to indicate potential fecal pollution and the danger may be estimated to be roughly in proportion to the number of E. coli present. The presence of excessive numbers of A. cloacae may be construed to indicate that the shellfish have been subject to warm weather conditions or to improper handling. Excessive numbers of A. cloacae may be found in shell oysters when the temperature of the water over their natural beds exceeds 60°F. A. cloacae and other coliform bacteria may also multiply in the oysters while held in storage if the temperature is above 60°F. They may multiply in the slime on utensils in shucking houses or in the shucked oysters during transit from the packer to a dealer or customer. Excessive numbers may, therefore, represent failure to properly clean equipment or failure to refrigerate the oysters constantly. The use of the coliform group has,

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* Presented at joint annual convention of The National Shellfisheries Assoc., and the Oyster Growers & Dealers Assoc. of North America Inc., at the Benjamin Franklin Hotel, Philadelphia, Pa., June 3, 1943.

therefore, been continued in the new procedure as an indication of possible extra-fecal contamination or lack of proper handling of the product. The same purpose is served, and possibly better, by a colony count. The colony count method has also been included in the new procedure as a means to determine whether or not shellfish have been properly handled.

There are various other changes in the new procedure, such as the use of "most probable numbers" (M.P.N.) to express the number of bacteria belonging to the coliform group. This replaces the old "score" method which represents the number of bacteria of the coliform group in 5 cc. of water or an equivalent amount of the shellfish. The M.P.N. expresses the number per 100 cc. and is more accurate. There are other changes in the new procedure such as the use of the whole shellfish rather than the shell liquor. One of the important technical changes is the use of a simple confirmation method (gas in brilliant green lactose bile medium) for bacteria of the coliform group. This is the method prescribed in the current edition of Standard Methods of Water Analysis of the American Public Health Association. There are certain other technical changes or changes in records which would not be particularly interesting to this group.

It should be borne in mind that all standard procedures are constantly being improved and revised. The new procedure for the bacteriological examination of shellfish represents a great step forward particularly in providing for the use of E. coli. The methods for determining E. coli, however, are more involved than the simple confirmatory test (gas in brilliant green lactose bile medium) for bacteria of the coliform group. An effort has already been made to find such a comparatively simple medium for E. coli. A new medium, for instance, has been proposed which promises to make the isolation of E. coli just as simple at a temperature of 45.5°C. The evaluation of such a new method requires time. Even though the method is an excellent one, it requires time for laboratory workers to learn how to use it skillfully. The chief difficulty in evaluating the present procedure has been the very limited number of laboratories which have had the facilities or the interest to critically test proposed methods. We should not consider the present methods as in any final stage of perfection. It is immensely important that at least a few laboratories which retain highly qualified bacteriologists, use their workers to help develop and evaluate newer methods

None-the-less, the new procedure represents an important step forward and should make the bacteriological examination of shellfish of real value to both the sanitary officer and the oyster grower. For the first it will provide a reasonably accurate means of detecting significant fecal contamination and faults in handling. For the oyster grower, it should prevent condemnation of stock which might be judged to be dangerously polluted on the basis of coliform bacteria, particularly of the A. cloacae type, but which on the basis of the absence of E. coli would be shown not to be polluted. Both considerations are, of course, immensely important to all concerned. There have been sincere differences of opinion among scientific workers as to the sanitary significance of different coliform organisms. In eight years, however, we have all had a chance to evaluate these differences of shellfish by both the Sanitary Engineers and the Laboratory Section of the American Public Health Association and acceptance by the Committee on Research and Standards, indicates that a large majority are satisfied with the objectives of this new procedure.