forward to in the matter of price controls and its relationships with OPS. What would apply to the Southeastern states would also apply to the entire country. This question can best be answered by quoting again a recent OPS press release, dated October 22nd. Mr. Michael DiSalle sent a memorandum to the Office of Price Operations and declared "Our objective must be to keep from increasing prices and to reduce them wherever possible. Any increase should be the exception rather than the rule and I will not sign any regulations increasing prices past GCPR levels unless accompanied by the fullest kind of economic justification." This memorandum answers the canners' questions to a great extent.

As to fresh and frozen shell-fish, the Fish Section of OPS has kept running weekly charts of country-wide price fluctuations of the most important species of fish. With the few exceptions, and considering seasonal variations, prices are below those prevailing during the GCPR freeze period, December 19, 1950 to January 25, 1951.

If these prices are exceeded, there is every indication that ceilings will be imposed in the case of fresh fish and re-imposed in the case of frozen fish. This might be a rather strong unofficial statement, but in a general way this is believed to represent the present thinking of OPS.

What Are the Major Problems of the Fisheries?

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PROBLEMS DO NOT EXIST IN NATURE apart from ourselves; they are merely states of our minds about things we desire or think we ought to do. They motivate and determine what we do. The effectiveness of our efforts in research in the fisheries therefore depends on what we consider the problems to be, or our choice from all the things that we might be doing of those which will yield the greatest values.

The chief problem of the fisheries expressed in the broadest terms, is: What can science do to enlarge the contribution of the fisheries to human wealth and welfare?

It must be admitted that science has done very little to make the fisheries more productive in comparison with what it has done for agriculture. Agriculture has always been regarded as a source of wealth to be promoted in efficiency and productivity by every possible means, while the fisheries have been considered to be in danger of exhaustion and not to be promoted in efficiency but to be protected, conserved, restricted and hampered. The consequences, at least in part, of these two opposite public attitudes are easily seen in the comparative performances of fisheries and agriculture. The great increase in the human population of the earth in the past two centuries has been made possible by the enormously increased productivity of agriculture, resulting from improvements in fertilization and irrigation of the soil; scientific selection, transplantation, acclimation and genetic improvement of plants and animals; control of pests and diseases; grafting and budding of trees; animal nutrition; incubation of eggs; battery production of poultry; mechanization of work; storage and refrigeration of produce, statistical services, etc. In the United States in 160 years the portion of the population necessarily devoted to agriculture to provide the food, fibers, etc., has dropped from 96 to 23 per

cent and improvements continue by leaps and bounds. While the fisheries have improved slightly, they have no such record.

The human population of the whole earth appears to derive about one day's food supply (as calories of food energy) each year from the sea, and 364 days' from the land. The sea covers 71 per cent of the earth, the land 29 per cent, or about 63 acres of sea per capita of human population, with a production of less than one-half pound of fish per acre of sea, while the total land area of the earth is about 17 acres per capita of population, and yields about 100 pounds of food per acre, plus all the other non-food products of agriculture and forestry.

In the United States we have almost the same number of acres of farm land actually under cultivation as of fishery bottoms of lakes, rivers and offshore continental shelf; we derive a little less than one per cent of our food from the sea, and 99 plus per cent from the land, plus the non-food lumber, fibers, oils, etc. Agriculture is easily capable of further great increase in yield. It has been recently estimated that fertilization of grassland in this country, as recommended by the agricultural colleges, would make possible a further annual increase of 2.9 million tons of beef, the increase alone being 29 per cent greater than the present entire production of fish in the United States and Alaska; and similar improvements can be made by further fertilization of cultivated crops. The total round weight of all fishery products, edible and non-edible, in the United States is about the same as that of eggs, only about six times as much as the cheese, and its value is only four or five times that of honey.

These summary facts and figures indicate that we take practically nothing from the water, and so far as national nutrition and employment of labor are concerned, the fisheries would not be seriously missed if they disappeared altogether. No species of fish has ever become extinct, so far as we know, and no regional fishery exhausted, and there appears to be no possibility of exhausting any species of fishery for profit. There are vast areas of ocean, many containing known rich fisheries not now exploited, and the total world out-take from the sea is of infinitesimal proportions.

Fishing, however intense, in no way affects the supply of fertility in the water, nor does it affect the production of basic vegetation on which fishes subsist and which appears to be considerably greater at sea per square mile and vastly greater in total amount than it is on land.

Although particular species have fluctuated in abundance, in the North Carolina Survey there was found no evidence that there has ever been an over-all shortage of fish in the United States, nor are there any bumper crop or lean years in the fisheries generally comparable to those caused in agriculture by droughts, floods, etc. The production of fish in the whole United States has kept pace, since 1887, with the growth in human population; it has more than kept pace since 1920; the production of the old fisheries of the Atlantic-Gulf regions has grown with the Eastern States' population despite the precipitate decline in the oyster; the production of fish has been accomplished by fewer fishermen, and the product of the fishereies has been sold at lower prices in terms of all other commodities or all other foods. All of these are signs, not of scarcity, but of sufficiency.

Nevertheless, from the earliest times the main problem of the fisheries has been considered to be, how to maintain or increase the supply of fish or to prevent depletion. That is, abundance of fish was thought to be the main determinant of production.

In pursuit of this fear-of-scarcity motive the U. S. Fish Commission from its beginning in 1871 relied on hatching, transplanting and acclimation of species, and restrictive legislation. Hatching, which reached its peak in about 1915 with over 100 hatcheries, has been discredited for sea fisheries, and acclimation was discontinued by about 1895. Restrictive legislation, however, continues as an article of faith to impose inefficiency and disadvantage and discourage creative enterprise of fishermen in competition with agriculture.

The latest and currently popular doctrine which conceives scarcity as the main fisheries problem is that which proposes to maintain optimum or maximum yield of the fisheries by control based on statistical data relating to birth and death rates, recruitment, etc. It holds that public officials can operate the extremely complex and delicate ecological-economic mechanism to better advantage than it operates itself automatically, and implies the fallacious belief that, if each species is at a maximum, the fishermen will catch and can sell the maxima profitably. When critically examined in all its many other ramifications and implications, economic, jurisdictional, and bureaucratic, it seems certain that it will be found to have serious if not fatal defects.

Since we cannot here offer a catalog of problems, let us now take the oyster as one major problem which will illustrate the principles that ought to govern the choice of subjects in the fisheries.

In 1879 it was officially declared that the oyster was more valuable than all the rest of the fisheries. By 1890 (when comprehensive statistics had become available) the *net edible* weight of oyster meats was more than fifty per cent greater than the *gross round* weight of the nearest rival, the Atlantic and Pacific codfish, and was 16 per cent of all fish production. Oysters were the highest priced fishery product and the value was 35 per cent of all fish produced in the country. By 1940 the production of oysters was less than half what it had been in 1890, a decrease from 16 per cent to 3 per cent of all fish production, while the human population had doubled. The per capita production of oysters had therefore declined to one-fourth of what it had been in 1890.

Why did the oyster fishery decline? It was taken for granted that the cause was biological, that oyster rocks were fished out; innumerable researches and activities have since been conducted with a view to restoring abundance; efforts to induce more abundant set, planting of seed, planting of shells and other cultch, enactment of restrictive legislation, cull laws and minimum size limits, closed seasons, restricted sizes of dredges, prohibition in some states of power boats for dredging, attempts to control starfish and other enemies, limitations on export from states, and many other, with excise taxes imposed to meet the expense; not only this, but taxpayers' money has been used to plant shells and otherwise to pay the oyster industry in part what the consumers were unwilling to pay for the production of oysters. It did not seem to occur to anybody to consider economic influences, to ask what had happened to prices, profits, incentives to produce. It was tacitly or expressly assumed that business people have no foresight, must be restrained by law from wantonly destroying the source of their own business, and that profitable opportunities will be allowed to go by default.

A quite different conclusion is indicated when economic factors are included in the reckoning. While the quantity of production was being halved in total and quartered per capita from 1890 to 1940, the price failed to respond to scarcity. If we compare production in the early period 1887-1908 with the late period 1921-1940, it is seen that the annual average quantity

decreased 44½ per cent. The actual price increased only 41 per cent and the total number of dollars received by oystermen decreased by 22 per cent. But the value of the dollar had also decreased by 29 per cent; so that in terms of wholesale prices of all commodities, oysters decreased in price 14.9 per cent, and in terms of all other foods oysters decreased in price by 22½ per cent.

The economic effect of all this is that the net proceeds of sale of all the oysters produced annually on the average in the 20-year period 1921-1940, the oystermen could buy only 48 per cent as much of the average of all other commodities, or 46 per cent as much of the average of all other foods as they could during the period 1890 to 1908.

Now it is an article of economic faith that the pursuit of gain energizes business, that where the prospects of profit exist, business will find a way to produce, and if the prospects are dim or absent, the business will decline or die. It is also an article of faith that when the public demands something of which the supply diminishes, the price rises to the maximum point at which the total supply can be sold. This is the law of supply and demand. It is also a truism that as many men will engage in the business (oystering, here) as can make as good a living at *it* as they can at other opportunities open to them. The conclusion is inescapable here in falling production, falling real or purchasing power prices, declining total value, and diminishing numbers of oyster fishermen, that something happened to demand. For there is as much bottom land under water suitable for oyster growth now as there was in 1890, and there is much more bottom available elsewhere if needed; there is twice as big a human population of potential consumers as there was then and of much greater average income, and the art of cultivating oysters has been known all along, and is free for all to practice. If the demand were there, prices would rise, rising prices would make profits, profits would evoke production by private cultivation if natural beds were adequate.

Meanwhile, apparently more scientific papers have appeared about the oyster than about any other marine animal; but they have had little or no discernible effect. Many of them increased our general scientific knowledge, but were directed to no particular practical problem, while many of the purposeful papers were designed to solve the wrong problems.

We do not yet know exactly what the right problems are; they can be discovered only by taking a comprehensive diagnostic view of the whole oyster situation, biological, technological, economic and perhaps sociological, and food habits of the people, to discover just what has been holding the industry back. There are rather strong indications that there are numerous hindrances among which is the blowing and washing process, which will be solved by technological research concerned with the chemistry and conservation of the evanescent but elegant flavor of the oyster, for it is well known to executives in the food industries that palatability and delectability are more potent determinants of food consumption than nutritive values and "health appeal."

Thus, not only in the oyster industry, but in the whole field of fisheries research, the vitally important work of comprehensive examination and analysis of the complex and delicate web of economic-biological determinants is waiting to be performed to discover what and where the really critical problems are.

We mention here only a few in the fisheries generally that appear to be in this class: In biology, it appears strange that before policies and attitudes were adopted on the basis of supposed scarcities they would have been pre-

ceded long ago by far reaching studies to determine or estimate just what is the basic potential yield of fisheries in the accessible water, how it compares with the present and prospective drain upon it, and how the ecological system as a whole responds to removal of some of the species. Yet no such studies have ever been made or even thought of. We have only the sketchiest knowledge of the quantitative conversion factors of how much prey is required to make a pound of predator, nor how this over-all average factor of all the many and successive conversions for a fishery as a whole is affected by heavy exploitation.

Transplantation and acclimation of desirable species was once extensively practiced without proof one way or another whether it added anything to the total supply of fish or merely increased competition and predation. This field, if really scientifically studied might have great possibilities, both directly and indirectly. Indirectly, it may be related in an interesting way to the question: Vegetable plankton may depart from this life by dying and decomposing, by sedimentation and fossilization, or by being consumed as food by animals. It seems obvious that on land only a very small percentage of the total vegetation ever enters the animal chain at all. If this is so at sea, then interesting possibilities might exist to import suitable phytoplankton consuming crustacea, mollusks, gill straining fishes, etc., regardless of their direct usefulness, so as to build up a denser population of any kind of animal life at the base of the food pyramid which could, in turn, support larger populations of the kinds of larger animals that are useful to man.

There is a field of the very greatest importance that should afford opportunity for most fascinating and fruitful work for years to come in the study of sense organs, reactions and responses to all manner of stimuli and general teleological and "psychological" behavior of fishes and other marine animals with a view to devising more effective methods of finding and catching them. Among these are sounds of different frequencies, intensities and timbre, constant and intermittent, light and electric fields similarly varied in all these respects, gradients of temperature, salinity, oxygen, CO_2, chemical emanations that may be followed by fishes in pursuit of their prey, sex lures, directive influences in migrations, etc, etc. Such researches should be accompanied by the parallel researches in the engineering design of traps, nets, shelters and other gear made possible by the many new materials and techniques now available. If methods of catching were devised which are both selective at will and could coax or drive large volumes of fish into captivity not only of edible but trash fish at low enough cost to make them profitable, they would go a long way not only toward establishing a better competitive balance in the water but adding to the revenue of the fisheries.

The chemistry, pure and applied, of food flavors, especially the savory, meaty and salty flavors, and the delicate savory substances in lobster, clam, mussels, caviar, shrimp, roes, fish fats, etc., has not had attention. The conservation and manipulation of these substances in sea foods, and perhaps their identification and synthetic production and use as lures in the catching of fish can be of great importance. Further along this line is the whole field of scientific cookery, including the softening of bones without removing them, for, as said earlier, people eat first what they like and, second, what is good for them and cheap.

Extensive studies should be carried out in fundamental fishery economics, such as was barely begun in our North Carolina Survey.