fishermen were catching large quantities of food fish, when in reality they do not catch enough to feed their crews. After many meetings with sportsmen's groups, municipal officials, and others interested in conservation, it is now known by the majority that menhaden fishing is not detrimental to recreational fishing.

When the program was announced of the proposed plan to study the estuarine area of our Atlantic and Gulf Coasts, the menhaden people were the first to favor this worthy cause. The marsh lands are of the greatest importance to the menhaden industry, because all menhaden spend a large part of their first year in this area. The future catches depend upon the successful rearing of the juveniles, and it is natural that menhaden producers are interested in the wet lands.

The wet lands have a multiple use. They are used as a nursery area for many species of food fish, shell fish, water fowl, and the hunter. Here then is a common area of mutual benefit to both sport and commercial interest. Save the wet lands. Many thousands of acres of marsh land adjacent to menhaden plant installations have been purchased by the plant owners, and recreational privileges are granted to water fowl hunters and fishermen. This is concrete evidence of a new look.

Since the Saltonstall-Kennedy program came into being, millions of dollars are being spent in research. Most of the states have expanded their programs, and are cooperating with the Bureau of Commercial Fisheries to avoid duplications of effort. More work is being done by fishery scientists today than at any time in the history of the industry. One thing has become crystal clear. We have not in the past properly managed our fishery resources. In the future we should not pass a law unless it is supported by sound scientific fact based on research. We should not press our researchers for premature statements based on limited research, but should wait until they are able to make suggestions that are scientifically sound.

It is a must that sportsmen follow the example expressed by Hal Lyman and Dick Stroud at the recent meeting of the Atlantic States Marine Fisheries Commission at the Governor Clinton Hotel in New York. They suggested, among other things, that both groups meet more often, and try to reconcile their differences. Further, to support a scientific research program that will assure proper exploitation of our fishery resources, and through proper management there will be enough for all.

Potential Markets for Products of the Industrial Fisheries

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THE INDUSTRIAL fisheries form a unique and romantic segment of the fishing industry. Time was, when the industrial fisheries sailed comfortably along with assured markets for each of its products. Today, technological improvements in competitive products such as soybean meal, synthesis of cheap vitamins and other nutrients, development of totally new products such as the water-based paints, all have contributed to a gradual wearing-away of these previously assured markets. Today, this multi-million dollar industry is largely reduced to dependence on single major outlets for its meal and its oil. The instability of even these markets is pointed up by the increasing use of fish meal as "nutritive insurance." The feed formulator includes fish meal in his rations not because

of its known essentiality but because other cheaper products have not as yet demonstrated the capacity to yield as firm a nutritional foundation for chick growth as does fish meal.

Obviously, such an undesirable situation cannot be allowed to continue. The Bureau of Commercial Fisheries, in cooperation with the industry and the Industrial Products Division of the National Fisheries Institute, undertook research investigations to remedy the market outlook of the fishery. The research goals were three in number: (1) the accumulation of as much knowledge as possible on the chemical structure and chemical and nutritional properties of the industry's products (2) the diversification of market outlets to render the industry relatively independent of any one market and (3) having established new outlets, to so improve their products through continuous research as to maintain them on a par with competitors. These have been the guidelines used.

In attaining these goals, some success has been made, notably in demonstrating the nutritional value and total market value of fish meal. Our technologists have shown that when chicks are raised under normal stress conditions in pens, the inclusion of fish meal in the ration protects the chick and permits markedly better growth than does an all-vegetable protein ration. Some success has also been obtained, in exploring for new uses for fish oils. Last year, successful research results were reported with respect to use of fish oils in ore flotation and in the preparation of leather.

The pressure of the industry's need for immediate assistance prevented us from giving too much attention to the development of new markets for its products. It is felt that this objective of the research program can be no longer delayed.

Fortunately, our recent research findings, with respect to the cholesterol-depressant activity of fish body-oils have indicated a possible outlet for the oils. This is in the form of an encapsulated, concentrated, dietary supplement designed to balance the U. S. citizens' excessive intake of "hard" fats with its attendant hypercholesteremia, atheroma and other accompanying ills. Each of us here probably would evidence some degree of elevation of his blood-cholesterol levels. It is known that practically all U. S. citizens over the age of twenty-five have atheroma, waxy deposits of calcified cholesterol, in their vascular systems.

Two years ago, under contract with the Bureau, the Hormel Institute of the University of Minnesota undertook to determine whether cholesterol level reduction might be achieved by feeding fish oil and fish oil fatty acid fractions to hypercholesteremic animals. By means of special diets, the cholesterol levels of the blood of rats and miniature pigs were made to rise to approximately 300 per cent above normal. The animals were then randomly separated into a total of four different groups. One group, the control, was continued on a diet containing 10 per cent tallow or "hard" fat completely saturated or, at best, one point of unsaturation. Group two was fed a diet containing 7 per cent tallow plus 3 per cent of purified, standardized linoleate, the active agent in corn oil, safflower oil and other vegetable oils. Linoleic acid contains two points of chemical bond unsaturation. Groups three and four were fed a diet containing 7 per cent tallow and 3 per cent, respectively, of menhaden oil and tuna oil. These oils contained fatty acids varying in unsaturation from one to six points.

It is interesting to note three things. One, the cholesterol reducing activity of the fish oils was immediately observable whereas, in the case of corn oil's linoleate, a two week delay was observed. Second, the total over-all reduction

in cholesterol levels was significantly greater for the fish oils than for the linoleate. Whereas the corn oil acid reduced the cholesterol level to a high "safe" level, the fish oils both reduced the level to a point only slightly above the "normal." Third, whereas the corn oil agent was tested in its purified, standardized and concentrated state, the fish oils were tested largely as found in nature. The oils were therefore at a marked disadvantage. Nevertheless, they were much more effective than was the corn oil.

These findings led naturally to the assumption that the fish oils might (1) be more effective if concentrated and (2) show that cholesterol-depressant activity is a function of increasing chemical unsaturation of the fatty acid molecule. Further tests were made, feeding hypercholesteremic animals a diet containing 7 per cent of hard fats and 3 per cent each of certain fractions of fish oils. These fractions, as indicated by their I.V. (Iodine Value), were characterized by increasing unsaturation. These results conclusively demonstrated that the cholesterol reduction activity was proportional to the degree of unsaturation of the oil.

Three immediate benefits flow from these observations. The first is that highly unsaturated fish oil fractions should be the oils of choice in future clinical treatment of hypercholesteremia. The second is that feeding of such concentrates should reduce the caloric intake, itself a problem in terms of possible weight gain by the patient during treatment. Effective dosages of corn oil have been from 2 to 3 ounces daily whereas the dosage of a fish oil concentrate may well be in the ranges of from one ninth to one third of an ounce. Thirdly, such concentrates may conceivably be encapsulated and taken regularly like our ubiquitous aspirins and our tranquilizers. I must here mention that our results have not established high cholesterol as the cause of atherosclerosis nor have we cured any case of atherosclerosis.

It is the Bureau's hope that these findings will open a new market and possibly a new era for the fish body oil industry.

What are the chances for the development of alternative markets for products derived from the flesh of industrial fish? The Bureau of Commercial Fisheries considers the production of fish flour to be the most promising alternative outlet. Consumer acceptance tests have been successfully conducted in Chile, Thailand, Indonesia, Mexico and other countries. Production, on a day-to-day but rather erratic basis, is under way in South Africa, Canada, Great Britain, France, India, Germany, Russia, Morocco and the United States. All of this interest has been generated through the recent growing awareness of the world's ever more critical need for protein.

Protein malnutrition quite likely is the most important single nutritional deficiency in the world today. It is a problem both in the underdeveloped *and* the developed countries. The Bureau considers the development and production of a stable, nutritious fish-protein food supplement—fish flour, if you will—to be the next logical development in the industrial fisheries. The evolution of the industrial fisheries from producers of fertilizers, indirectly furnishing food for man, to producers of poultry feed ingredients, directly feeding the food of man, was justified because of the high nutritional value of the industrial fish. The next logical step, that of directly feeding man, is now long overdue.

There appear to be five potential markets for fish flour where cost of production is not presently a critical consideration. These are: (1) the underdeveloped countries, (2) the rations of the military, (3) children's diets, (4) geriatric (oldsters') diets, and (5) special medical diets. Such a stable, preserved product,

containing from 65-70 per cent or from 95-98 per cent animal protein depending upon processing method, B-vitamins, calcium and phosphorous, would help to give the protein-deficient child the 10 to 15 grams (about one third to one half ounce) so necessary to keep him in nitrogen balance. This would be comparable to the 30 or 40 grams of skim-milk powder necessary to sustain him for the day. It would permit easy incorporation within the field ration of the soldier and of the airman on the fringes of space of the most nutritious and most concentrated form of protein known to man.

In general, fish flour is ideally suited for the diet of children. Its biologically complete, easily digestible protein is excellently adapted to their still immature digestive processes. Its incorporation in breads, cakes, cereals, pastries, etc. would permit the parent to give her child his daily protein requirement in a most pleasing form and would eliminate the fear of his "spoiling his appetite for dinner." Four "toll-house" cookies containing three per cent of fish flour by weight would supply approximately two-fifths of his daily protein requirement.

Fish flour is potentially an excellent addition to the geriatric diet. Believe it or not, many of our elder citizens are suffering from a sub-clinical protein deficiency. They refuse or are unable to chew the tougher meat products and content themselves with a badly unbalanced diet of potatoes, cereals, cakes, bread or eggs. Fish flour contains little or none of the sodium or carbohydrate trouble-makers for old folks. Inclusion of fish flour in food products utilized by elderly persons would do much to help their nutritional well-being.

In general, fish flour is applicable to any medical diet which is designed to yield (1) biologically valuable trace minerals, (2) high levels of B-vitamins, (3) reduction of sodium intake, (4) reduction in fat and carbohydrate intake as well as (5) high levels of easily digestible, biologically complete, readily available protein.

Rough estimates as to costs indicate that fish flour, when judged on a per-pound-of-protein basis is even now cheaper than dry milk solids and closely competitive with soyflour. The Bureau feels that an adequate study of the engineering requirements and of nutritional standardization of fish flour would reduce costs further, open a potentially limitless market in the American food manufacturing business and possibly make available to the underdeveloped countries a gift more valuable than all of our contributions to date.

Continuous Distribution of Menhaden Along the South Atlantic and Gulf Coasts of the United States

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Introduction

THE MENHADEN purse-seine fishery of the Atlantic and Gulf Coasts of the United States depends almost exclusively upon two distinct and geographically separated species: the Atlantic menhaden *(Brevoortia tyrannus)* and the Gulf menhaden *(B. patronus)*. The Atlantic menhaden ranges from Nova Scotia to the central east coast of Florida, while the Gulf menhaden generally occurs from