Reprints of ten magazine articles on

FISHERY RESOURCES FOR ANIMAL FOOD

DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

BUREAU OF COMMERCIAL FISHERIES

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CONTENTS

The Use of Fish In Pet Foods

First of a series analyzing industry fish needs and how they can be supplied

by WALTER G. JONES

WALTER G. JONES

was born January 13, 1920, near Guymon in the Oklahoma Panhandle and was brought up on a farm on the central Kansas plains. He was graduated from McPherson (Kan.) High School in 1938, served 2½ years in an army engineer battalion in the U. S. and Western Pacific areas, then attended University of Oregon and Oregon State College, receiving his B.S. degree in fish and game management from Oregon in 1951.

Granted a research assistantship from the Agricultural School of Oregon State College, to conduct feeding experiments on ranch-raised mink, utilizing nonhuman consumption fish, his graduate work included further studies into fisheries biology and animal nutrition.

Mr. Jones was employed by the Oregon Fish Commission in 1953 as a fishery biologist. He worked for five years on research of the Oregon trawl fisheries, specializing on fishes used for animal food, then received his M.S. degree from Oregon State College in the spring of 1958.

He accepted a position as fishery marketing specialist with the U. S. Bureau of Commercial Fisheries in August of 1958. Stationed at Ann Arbor, Mich., he was placed in charge of developing markets for the under-utilized fish species in the waters of Central United States, a position he now holds. He may be reached at 920 N. Main St., Ann Arbor, Mich.

THE PET FOOD INDUSTRY will produce in excess of 3,000,000,000 pounds of animal food, principally for dogs and cats, in 1958. This is a lot of feed in anybody's language. However, it is only a fraction of the food required for the estimated population of 25,000,000 dogs and 29,000,000 cats in the United States last year. There is no doubt that the demand for pet food would increase even if the dog and cat population remained static. Since neither the pet population nor consumer demand can be expected to remain static, pet food manufacturers will continue looking for new sources of raw material.

The largest potential source of this raw material is undoubtedly fish—fresh-water and ocean fish. The high nutritional qualities of fish, as well as its value as a low cost protein, are well known to members of an industry utilizing many millions of pounds annually. They have learned that most fish and fishery by-products are relished by cats and dogs alike.

In the search for new supplies of fish, manufacturers of both wet and dry pet foods have indicated the following questions concerning fish are foremost in their minds:

1. Where are the undeveloped or underdeveloped fisheries which can be considered as potential sources for pet food?
2. What is the proximate composition of these underutilized fish species?
3. Is there a fishery at present on these species, and if so, to what extent?
4. What is the estimated potential production?
5. Is there more than one species available for pet food in the fishery?
6. Can the underutilized fish sustain a quantity fishery for several months each year, over a period of years?
7. Can the fish be delivered at a competitive price?
8. Are there facilities for plant operations in the area of the fishery?
9. In what way can the present pet food fishery be further developed?
10. To what extent can competition from other users of industrial fish be expected?

The answers to some of these questions are readily available. Others are more complicated and require a great deal of research to obtain the answer. This research is now being conducted by members of the Department of Interior, Bureau of Commercial Fisheries, in regions throughout the United States.

Broadly outlined, a summary of the activities of the Bureau

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of Commercial Fisheries which will benefit the pet food industry is as follows:

1. Investigations to improve and develop methods of catching, handling, processing, storing, transporting and marketing fishery products and by-products.

2. Determination of the composition, properties and nutritive value of fishing products and by-products.

3. Conduct biological research investigations to determine life histories, population units, population renewal characteristics, natural fluctuations and environmental requirements of fish populations.

4. To manage or advise in the management of fishes in marine, estuarine, and fresh-water environments of the United States, so as to maintain an optimum sustained yield of the fishery resources for the greatest public benefit.

5. Exploratory fishing operations to determine the character, extent and availability of resources, and to test, devise and demonstrate most effective gear and vessel types.

6. Conduct surveys to collect, analyze and disseminate statistics on the production, processing, storage and marketing of fishery products.

7. Conduct a Fishery Market News Service for the collection and publication of current information on fishery commodities.

8. Develop and increase markets for fishery products by assisting the industry in problems of production and distribution.

9. Conduct economic research on costs, labor and prices in the fishing industry.

10. Conduct studies and prepare recommendations with respect to international trade, tariff problems and trade agreement negotiations.

These services are performed by marketing specialists, fishery biologists, technologists, fishery gear development specialists, statisticians and marketing analysts, located at strategic points throughout the United States.

In forthcoming issues of this magazine, it is planned to answer the above questions posed by pet food manufacturers to the best of available knowledge. Each major fishing area, beginning with the Great Lakes fishery, will be discussed with emphasis on availability, present production, potential production where known, and proximate analysis.

The primary concern of the Bureau of Commercial Fisheries is to aid and encourage the fishing industry of the United States. One of the major means of accomplishing this objective is to assist industries dependent on fishery products and to develop and encourage new uses for fishery products. With this in mind we offer our services and invite questions from you people in the pet food industry.

NEXT MONTH

Mr. Jones tells about the fish of the Great Lakes, sources of supply for pet foods, and the quantities available and when. Last year 5,000,000 pounds of Sheepshead were thrown back because there was no market for them. Lake fishermen claim they can produce fish for animal food at a "competitive" price. Problem is short season and shortage of transportation.

Sources of Lake Fish for Pet Foods

Second of a series on "Fish in Pet Food," by Walter G. Jones

THE GREAT LAKES and connecting bodies of water form the largest single freshwater area in the world, comprising some 70,000,000 acres. As might be expected, many species of fish abound in the lakes. Of these, about 35 species, totaling 123,000,000 pounds, were sold on the commercial fish markets in the United States and Canada in 1957.

From a standpoint of quantity production, pet food manufacturers would probably be interested in only a few of these fish species. They are: alewives, smelt, sheepshead, carp and gizzard shad.

Other fish which are not generally caught in great numbers, but which would be included in the catch of the above species, depending on the gear used, are: burbot, goldfish, suckers, quillback, bloater chubs and tullibees.

A major problem in the production of Great Lakes fish for animal food is the dispersal of the fisheries over 9,607 miles of shoreline. At present, the fish are caught mainly with gill nets, trap nets, and haul seines fished from small boats, and are landed daily at many small ports. This situation may eventually be changed, as the result of gear experiments using trawls, purse seines and lampara nets. These experiments are now being conducted by the U. S. Bureau of Commercial Fisheries and the Wisconsin and Ohio State Conservation Departments.

One or more of these types of gear should prove effective on such schooling species as alewives and smelt. Larger vessels will be necessary for efficient operation of the fishing gear, and to handle the volume of catch expected from trawls or large seines. The larger vessels, with a longer range of operation, will permit landings to be more centralized.

Sheepshead are harvested by means of trawls from Lake Winnebago, under the supervision of the Wisconsin Conservation Department. In 1957, over 4,000,000 pounds were taken from this lake. This may be the peak production of sheepshead from Lake Winnebago, according to Wisconsin Conservation Department biologists. Practically all of this production is utilized by mink ranchers and would probably be of little interest to pet food manufacturers.

The haul seine fishery at Sandusky Bay presents a different picture. In this area, around 3,000,000 pounds are sold annually on commercial markets. However, another 5,000,000 pounds, or more, are thrown back because there have been no markets for them. A potential production of around 15,000,000 pounds annually was estimated by members of the Ohio Commercial Fishermen's Ass'n. In addition, lesser quantities of carp and goldfish are produced in the Sandusky Bay area.

Commercial fishing for sheepshead starts in March with the heaviest production occurring in May and June. For all intents and purposes, the fishery is over by July. This means that a large quantity of fish must be handled in a short time.

Facilities for freezing and storing fish in the Sandusky Bay area are very limited. The fish must be loaded and iced from the beach where the seines are hauled in. According to the fishermen in the areas, this is not a major problem. With the use of mechanical loaders, 30,000 pounds of fish can be loaded and iced aboard trucks in a short time.

Lake Erie and other Great Lakes fishermen have not felt in past years that they could produce fish at the price animal food fish processors could afford to pay. As ways have developed to cut handling costs of fish in recent years, this attitude has changed. Fishermen in the Port Clinton area now claim they will produce fish for animal feed at a "competitive price."

Transportation of the fish from place of capture to the processing plant might present a problem. However, this does not appear to be an insurmountable problem. Trucking services from a local Port Clinton firm are available, and more could undoubtedly be procured.

The main competition for the fish would probably come from mink ranchers. There has not been a very heavy production of Sandusky Bay sheepshead for mink feed, principally because the ranchers do not have facilities for handling the large quantities of fish produced. Comparatively little sheepshead from this area is sold for human consumption. Lake sheepshead is "hard-meated" and less desirable by the trade for human consumption than the "soft-meated," river-caught sheepshead.

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To summarize, a pet food processor wishing to use sheepshead in his product would find his best source of fish in the Sandusky Bay area. Annual production could probably be maintained between 5,000,000 and 10,000,000 pounds. Practically all of this production would fall in the months of April, May and June. Freezing and storage in the area is limited. Transportation by means of trucks could be arranged for. The fish are competitively priced for pet food manufacturers in the Port Clinton area.

Inquiries concerning fishermen and firms supplying sheepshead, as well as proximate composition assays, may be directed to the U. S. Bureau of Commercial Fisheries, 920 N. Main St., Ann Arbor, Mich.—WALTER G. JONES.

Potential Production of "Rough Fish" In the Great Lakes Area

by WALTER G. JONES

ONE OF THE QUESTIONS often asked by pet food manufacturers concerning utilization of rough fish for pet foods is: "Is the production of fish great enough and sustained over a long enough period to make it practical for a pet food manufacturer to set up operations somewhere around the Great Lakes?" or words to that effect.

This question, and others, can best be answered by the manufacturer, provided he has sufficient information. The purpose of this article is to give the available information about the present and potential production of the more important rough fish. Other factors will also be discussed, both good and bad, which might affect the operation of a pet food plant.

The three species of particular potential value for pet food in the Great Lakes area are the smelt, alewife and gizzard shad.

These species occur in prodigious numbers in some of the Great Lakes. As an example, biologists have reported sighting in Lake Erie from the air a school of fish which measured seven miles long and a half mile wide. The fish were identified as smelt. Such schools are not unusual. Another example can be cited, namely, the cyclic die-off of the gizzard shad in Lakes Erie and Huron in January and February of 1953 and 1956. Many miles of lake shore were littered with estimated millions of pounds of dead fish, much to the annoyance of local citizens. Huge quantities were removed from the West Basin near Erie, Pa., in those years. This situation occurred again last January in Lake Erie.

Carp is also a potentially important animal food. Brought from Europe by people who wished to retain some of the old-country eating habits, carp have flourished in American fresh-water bodies, from coast to coast, and across international boundaries. The carp are considered both a curse and a blessing. Over 7,000,000 pounds were taken commercially in 1957, mostly by haul seines, for both human consumption and animal food. This is probably only a very small part of the potential production in the Great Lakes area.

Associated with the carp, and taken in the same seine hauls, are several species of suckers and rough fish, not previously mentioned. These species, individually, are not of much importance in the commercial catch. In the aggregate, however, they may represent a considerable tonnage.

PROXIMATE COMPOSITION OF SOME FRESH-WATER FISH

Species	Moisture	Protein	Fat	Mineral Matter	Thiaminase
	%	%	%	%	%
Smelt	72	16	4	4	present
Alewife	*68.8-70.6	14.9-15.7	12.8-14.4	2.8-3.1	present
Gizzard shad	61.2-63.0	15.7-16.2	17.6-20.1	3.0-3.2	present
Carp	67.3-69.0	16.5-17.6	7.9-12.5	5.0-6.9	present
Buffalofish	72.6	16.3	7.3	5.4	present
Goldfish	67.3	16.5	10.7	5.0	present
Suckers	75	15	5	3	present

*Multiple percentage values indicate range for two or more samples. Single percentages are an average of several samples. The range in these cases was not reported.

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Only limited information on the proximate composition of fresh-water fish is available in comparison to that for marine fish. However, new data on the composition of fresh-water fish, including variations due to season and geography, are constantly being gathered by technologists of the U. S. Bureau of Commercial Fisheries, and other organizations. The data in the accompanying table of the composition of some fresh-water fish indicate that all of the fish, except smelt and suckers, have a comparatively high fat content. All fish listed contain thiaminase, an enzyme which destroys thiamine. This enzyme, however, can be destroyed by cooking the fish.

Potential Production

The potential production of the fish discussed here, and of sheepshead discussed in a previous article, in the Great Lakes area is conservatively estimated as tens of millions of pounds. Several seemingly ambiguous statements such as, "several million pounds," "many millions," "great quantities," etc., have been made about the potential production of individual species. More specific statements could not be made simply because maximum production has not been attempted due to lack of demand.

Predictions of future productions can be made, provided the fishery is fully exploited, from studies of age and growth of the fish, and from the trend of the catch statistics. Only limited biological studies have been made on these species, since most of the work has been expended on species of higher economic value to the commercial and recreational fishermen. Thus, potential production of rough fish must be estimated from observations on the existing fisheries, and from the limited biological studies. There is every indication that the production of rough fish can be increased considerably.

Problems Involved

There is no doubt that the quantity of fish available in the Great Lakes could support one or more pet food processors. The chief factor in quantity production of rough fish is the limitations of the inadequate fishing gear and methods now being used. Gill, pound and trap nets, and other stationary fishing devices, must depend upon fish coming to the net. The fishing boats and the methods used to handle the catch are not designed for sustained quantity production. The catches of such migrant fish as smelt, alewives, and gizzard shad are restricted to short seasons, resulting in glut productions.

Nevertheless, for economic reasons, the present fishing gear must be adapted to new fishing methods, wherever possible, for rough fish utilization. Progress in this direction is being made by the gear research men of the U. S. Bureau of Commercial Fisheries, and with state agencies and fishermen. Lampara and purse seines for fishing surface and subsurface schools of fish are being tested. Trawls and other gear are being used to catch the fish at different depths. In conjunction with the gear research, better methods of handling the fish aboard the boats will be studied. This work was only started in the fall of 1958. Some of the results are encouraging, and more experiments will be carried out this year.

The use of mobile and efficient fishing gear, such as the trawl, may cause anxiety among some commercial fishermen and recreational fishermen. These men will need to be convinced that stocks of fish utilized for human consumption and recreation will not be harmed. There are strong arguments in favor of the removal of rough fish to benefit stocks of the more sought-after fish. I make no predictions about what state legislatures might do; however, the problem can be solved to the mutual benefit of most of those concerned.

Must Extend Season

The seasonal production of individual species has discouraged pet food manufacturers from utilizing Great Lakes fish in the past. The problem of extending seasons is expected to be solved with the refinement of fishing gear and development of new gear and fishing methods, but that is for the future. Even with present fishing methods, however, fishermen in the Green Bay area can produce rough fish from March through August, and possibly through the fall. All species should be utilized, however, for an efficient operation. In late winter and spring, smelt could be utilized. In the early summer, alewives are available. Later in the spring, and in the summer and fall, carp and associated species would also be available.

A factor adding to the cost of fish for animal food is the scattered nature of the fishery over hundreds of miles of shore line. There are at least some ports where the catch from an area could be concentrated. Even so, much of the catch must be transported by trucks and the handling and icing add to the cost. This is a problem which involves major capital expenditures which might be supplied either through cooperatives or private industry. It is possible, however, that fruit or vegetable canneries near the larger fishing areas can be utilized in the off season to process pet foods. This is presently being investigated, and information will be supplied upon request of those interested.

All of the problems mentioned above are interrelated, and the solution depends, in part, on the development of markets for rough fish in general. The pet food industry is capable of utiliz-

ing a major part of the potential production of rough fish from the Great Lakes area, and is indeed using a small portion of the present production. The continued interest of this industry will stimulate solutions of the difficulties involved in developing a full-scale fishery for rough fish in the Great Lakes area.

FISH for PET FOODS in the Gulf of Mexico

by
WALTER G. JONES

BILOXI, PASCAGOULA, Apalachicola, St. Petersburg, and Key West — at every port the story is the same; prodigious supplies of fish. This is what I saw and heard during a recent inspection of the Gulf of Mexico fisheries.

Only since World War II have the so-called scrap or industrial fish been taken in the Gulf of Mexico. First, the fish meal industry boomed to increase the catch of menhaden to 500,000,000 pounds annually. More recently, industrial fish from the trawl fishery have been processed for canned pet foods. In 1958, 66,000,000 pounds of these small fish were landed in the Biloxi - Pascagoula area for pet foods.

Many ideal locations for pet food canneries are available near sources of fish and distribution centers. Most of the shrimp ports from Brownsville, Tex., to Key West, Fla., have facilities and sites available for establishing pet food processing operations. Communities along the gulf usually favor industrial development.

Seasonal variation in production of industrial fish from trawling operations is not such a big problem in the gulf as in other fishing areas. However, reduced production can be expected during the winter months when stormy weather limits availability of fish.

Cost of fish to pet food canneries on the U. S. Gulf Coast is from $35 to $40 a ton. Competition for fish is negligible, except in areas with pet food canneries, fish meal processors, or mink food producers already established.

You may wonder if the fishery potential is great enough to support an expansion of pet food canning in the gulf. According to Harvey Bullis, chief, U. S. Bureau of Commercial Fisheries, branch of exploratory fishing and gear development program in the gulf, fishermen have hardly touched the available stocks.

The present fishery is conducted mainly by small shrimp trawlers who seldom fish deeper than 15 fathoms. The greatest potential, however, exists from 15 to 200 fathoms. In the deeper water, fish-finding instruments of the bureau's research vessels have discovered large schools of fish. Test netting of the schools have shown them to consist of industrial species.

The gulf fishery potential is further indicated by calculating the amount of fish discarded during shrimp - fishing operations. For every pound of shrimp caught, from two to six pounds

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of fish are discarded at sea. In 1957, almost 100,000,000 pounds of shrimp were landed by the gulf fisheries. An average discard ratio of 3:1 would indicate a total catch of about 300,000,000 pounds of fish. At present, only a small part of this catch is retained for commercial use because of limited markets and other economic factors.

The small shrimp trawler operators, fortunate enough to have available markets, profitably deliver industrial fish to processors in or near shrimp ports. Although shrimp boats are usually poorly equipped to handle volume catches of fish, some are being modified for this purpose. Moreover, new vessels are being planned which are designed mainly for industrial fishing. Operators of the larger shrimp boats spend many days on distant fishing banks and cannot profitably deliver fish in the quality needed for pet food. Some attempts have been made to have "mother ships" collect industrial fish at sea, but this has not been a profitable operation in the past.

Trawl and purse seine operations have supplied most of the industrial fish until recently. Another gear, the lampara net, is now being tested along the west coast of Florida. Lampara nets take surface and subsurface schools of fish. Experiments with this gear were initiated by the experimental fishing personnel of the Bureau of Commercial Fisheries to find an economical method of taking the many large schools of herring, and herring-like fishes along the west Florida coast.

Following the bureau's lead, commercial fishermen are testing modified designs of lampara nets and are using airplanes to spot schools of fish. Recently quantity catches have been produced.

In the past year, bureau personnel have uncovered additional sources of industrial fish available to commercial fish trawlers. Gulf fishing grounds previously considered too rough for trawling have been successfully fished with specially designed trawl gear.

Trawl landings for pet food from gulf waters contain fish of many shapes and descriptions. Seventy different species have been identified, most of them under eight inches in length. Fishermen report their catches are about 90% croakers. Croakers, however, usually make up much less than 90% of the total catch, more often around 50 to 60%. Lampara net catches, on the other hand, usually consist of only one species, such as thread herring or anchovies, depending on the school of fish taken.

The percentage of the various species in the trawl landings varies from season to season, and from fishing ground to fishing ground.

Proximate composition analyses of several species of fish taken in the summer, fall, and winter seasons as compiled from data prepared by the fishery research technologists of the Bureau of Commercial Fisheries at Pascagoula, Miss., are shown in the accompanying table. Details of this and additional data gathered may be obtained upon request.

Of more interest to pet food processors, is the proximate analyses of samples taken from pet food deliveries. Gulf scrap fish is usually considered low in fat. More than half the samples, however, contained 4% fat or better.

Potential industrial fisheries' resources and general business climate are very favorable for enlargement of the pet food canning industry at a number of locations around the U. S. Gulf Coast.

PROXIMATE COMPOSITION OF SOME GULF OF MEXICO FISH COMMONLY INCLUDED IN PET FOODS*

Common Name	Moisture			Protein			Fat			Mineral Matter			Thiaminase
	Summer	Fall	Winter	Summer	Fall	Winter	Summer	Fall	Winter	Summer	Fall	Winter	
	%	%	%	%	%	%	%	%	%	%	%	%	
Anchovies	77.3	77.2	75.7	17.2	16.2	17.3	2.6	3.1	2.6	3.3	3.7	3.5	Present
Anchovies	—	—	75.9	—	—	16.4	—	—	3.5	—	—	3.5	—
Bumper	71.3	72.2	—	18.7	18.6	—	6.0	5.1	—	4.2	3.9	—	—
Butterfish	76.0	78.5	79.3	15.6	16.6	15.1	6.2	2.6	2.2	2.4	2.4	2.8	Trace
Croaker	69.9	76.0	77.2	15.9	16.5	15.2	8.6	3.6	2.2	4.9	4.0	6.0	None
Croaker-banded	—	75.6	—	—	17.8	—	—	2.3	—	—	4.0	—	—
Grunt	—	70.2	—	—	16.6	—	—	9.9	—	—	3.7	—	—
Hardheads	71.0	69.8	—	17.0	15.7	—	6.7	8.8	—	4.1	5.3	—	None
Harvest fish	73.0	75.1	—	16.4	18.3	—	7.5	3.6	—	2.3	2.6	—	—
Menhaden	63.3	65.4	—	14.9	14.8	—	17.8	16.0	—	3.7	3.4	—	Present
Razor bellies	71.8	69.0	67.1	18.4	18.5	18.9	5.0	6.7	7.7	4.8	5.8	7.7	Present
Round herring	—	75.3	73.8	—	18.7	18.9	—	3.0	2.5	—	3.7	3.8	—
Scad	—	76.9	—	—	17.3	—	—	2.2	—	—	3.6	—	—
Shad	—	—	73.6	—	—	19.6	—	—	3.2	—	—	2.5	—
Silver eels (cutlass fish)	77.9	76.4	75.4	16.3	17.8	18.1	2.6	2.7	4.3	2.3	3.5	3.0	None
Silver perch	—	76.9	—	—	16.4	—	—	2.2	—	—	4.5	—	—
Silversides	—	—	67.5	—	—	17.4	—	—	5.9	—	—	8.2	—
Spots	68.1	76.7	76.5	15.2	16.9	14.1	12.9	3.5	5.5	3.4	4.0	4.1	Trace
Star drum	76.3	—	—	15.0	—	—	3.8	—	—	4.1	—	—	—
Threadfin	76.6	71.7	—	17.3	17.8	—	1.8	6.8	—	4.0	3.7	—	—
Thread herring	74.4	—	69.3	18.6	—	18.9	3.5	—	8.1	3.3	—	3.2	—
White trout	74.3	73.1	—	17.5	17.7	—	5.0	6.2	—	3.1	2.9	—	None

*The proximate compositions are given as averages of whole fish. Ranges in values and area of capture will be furnished upon request. —Means no analysis made.

FISH for PET FOODS in the Pacific Northwest

by WALTER G. JONES

THE PACIFIC NORTHWEST—Oregon Territory of yesterday—is a land of many natural resources, some still largely undeveloped. Among the foremost of these is the ocean commercial fishery. When Northwestern fishery products are mentioned, most people visualize salmon migrations and halibut steaks. They are not aware of the flourishing trawl fisheries for such bottom-dwelling fish as flounder, rockfish and cod, off the coasts of California, Oregon and Washington.

The trawl fishery is very efficient at catching bottom fish, but is sometimes wasteful. Fish for which there are no markets today amount to 30 to 60% of the catch. These must be discarded —shoveled back into the sea. Most of them are dead after being in the net several hours, hauled from depths up to 200 fathoms, and then left lying on deck for a half hour or more.

These discarded fish are a readily available source of supply for you, the pet food packer. What is the potential production from the trawl fisheries? Pacific Coast biologists conservatively estimate this to be 200 million pounds annually.

No one actually knows the potential production of industrial fish from the coastal waters of the Pacific Northwest, but estimates can be made from known catches and from observations by biologists and fishermen. Following is a list of fish and fishery by-products that might be used in pet food processing, including production estimates to show relative abundance.

Common name	Estimated annual potential production (Millions of lbs.)
Pacific hake	50-60
Pollock (whiting)	very numerous
Arrowtooth sole (turbot)	20-30
Flounder and sole	5-10
Rockfish	10-20
Ratfish	10-15
Skate	50-60
Dogfish shark	60-80
Other sharks	5-10
Tuna cannery scrap	12-14
Fish filleting scrap	40-50

Of the species listed, hake, turbot, skate and dogfish are the most abundant. All four are found on fishing grounds from northern California to Vancouver Island, B. C. A minimum of competition exists for these fish from other markets. None are used for human consumption, nor are they likely to be as long as there are other food fish available.

Hake is a scourge to trawl fishermen who sometimes must seek different fishing grounds to avoid filling their nets with this cigar-shaped fish. At present, there is only a limited market for hake, mainly for mink food in California. Experiments have shown that it can be used very successfully in formulated pellets to raise young salmon. Hake is very low in fat (1-2%), and relatively high in moisture content (around 80%). Individual fish in the catch are uniform in size, averaging around two pounds.

Arrowtooth sole (better known as turbot to Oregon and Washington fishermen), though not as abundant as hake, is also a nuisance to fishermen when it is caught during trawling operations for other species. Often large schools of turbot are encountered, much to the fishermen's exasperation unless they have a specific market for them. It is sought for mink food in the spring and summer months, but this market only utilizes possibly a third of the potential production. Turbot has proved an even better feed than hake for rearing young salmon. It is relatively high in fat (8-10%) with about average moisture content (about 72-75%). In size, individual fish in the catch range from two inches to 10 pounds or more. Turbot are carnivorous, feeding mainly on other fish, although I

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once found an adult California murre (a sea bird) in the stomach of a large turbot.

Several species of skates are numerous on certain fishing grounds. Fishermen avoid them when possible, but almost every trawl haul contains several hundred pounds of this primitive creature. A limited market exists for skates as human food and for mink feed, but most are pitched overboard at sea.

The dogfish sharks are reported to be very numerous and cause trawl fishermen from San Francisco to Alaska to sing the blues, usually in very colorful language. Any pet food packer who can utilize this annoying Selachi in his product will be praised by fishermen up and down the coast. It should be noted that sharks, and skates to a lesser extent, contain enough urea to cause problems in canning operations, if used alone.

Rockfish, flounder and sole should probably be considered as supplements to the fish mentioned above. Some species in these families form the mainstay of the West Coast filleting operations. All of them, where state laws permit, are used for mink feed. However, this market cannot absorb the catches that could be delivered in some areas, principally at Puget Sound ports, though in northern California and in Oregon, pet food packers could expect lively competition from mink ranchers for these species.

Several other species are taken in trawl fishing operations that could be used to augment the fish portion of pet food packs. These species vary by area. Some could be the object of a major fishery if the demand developed.

Fish waste from tuna processing in Oregon and California, and from bottom-fish filleting operations in all three states, also offers a good source of protein for the pet food packer in the Northwest. Here, too, competition can be expected from mink ranchers, but surpluses occur in periods of heavy production.

The major trawl fisheries, from northern California north, operate out of Eureka, Calif.; Coos Bay, Newport, and Astoria, Ore., and several ports in the Puget Sound area. At all these ports, suitable sites and facilities for pet food canning operations are available. These cities are seeking new industries, and can be expected to cooperate in the selection of plant sites.

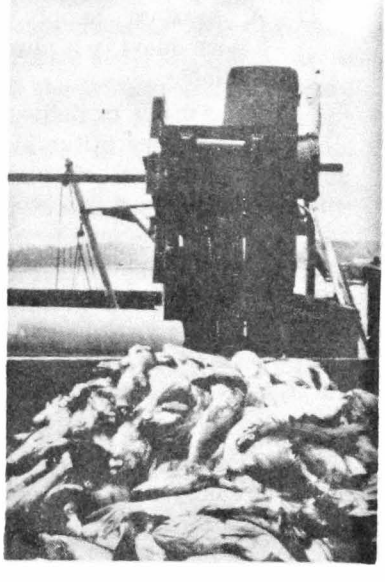
Any of these ports harbor trawl fleets of sufficient size and fishing range to supply a cannery operation. Trawl fishing operations are carried on throughout the year, but usually at a reduced rate during the season of winter storms from November through March.

At present, fishermen receive from $30 to $60 a ton at the dock for fish sold as animal feed. The price varies by species and port.

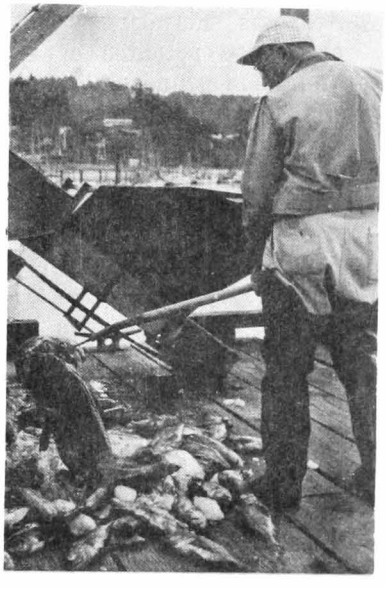
Fishery scientists, both federal and state, along the West Coast assure us that sufficient stocks of bottom fish are available for use by dog and cat food processors. Stocks of hake, turbot and skate alone would guarantee this. Research to expand existing fisheries and to develop new ones is in progress. State management of the trawl fisheries impose regulations to protect certain fish stocks and to insure protection on a sustained yield basis.

Other fishery resources on the West Coast, of interest to the pet food industry, will be discussed in later issues. May I suggest to any pet food manufacturer who plans to visit Oregon or Washington that he do so in July or August. Those water-dancing silver salmon and sea-run trout and tackle-busting chinook salmon should be hitting about then. Maybe I'll see you out there.

If you want more information about the possibilities for pet food canning on the West Coast, write to the Branch of Market Development, U. S. Bureau of Commercial Fisheries, 920 N. Main St., Ann Arbor, Mich.



A load of bottom fish delivered to Newport, Ore., for fur animal feed.



A sample of fish from a trawl landing. The author holds a big cod.

FISH *for* PET FOODS *from the* Arkansas Farmlands

by
WALTER G. JONES

Fish from farmlands? Hard to believe. But actually test packs of pet food made with fish harvested from farmlands is a coming venture of the U. S. Bureau of Fisheries Laboratory at Pascagoula, Miss. Here you will learn how fish farming fits naturally with rice farming and the government allotment program. With a potential of one to two billion-pound production, our industry may have a valuable insurance source should a protein shortage ever develop. You can almost pick your fish species and have it raised for you at a ton or more to the acre.

YES, YOU READ the title right —Fish for Pet Foods From Arkansas Farmlands — with a production potential of around 25 million pounds within a year and upwards to 180 million pounds annually within three years.

Preposterous? Not at all. Arkansas has 90,000 acres of rice fields, water impoundments and storage reservoirs, either in commercial fish production or capable of being put into production within two years, according to the U. S. Soil Conservation Service. Proper fish culture can produce yields of certain fish species amounting to 1,000 to 4,000 pounds per acre annually.

Fish farmers in the Dumas, Ark., area say they are ready to produce fish for pet food. They point out several advantages to pet food production in their area:

(1) The canning plant can be centrally located within a few miles of the farthest producing area.

(2) A constant supply of known quantity is always available.

(3) The fish can be delivered to the plant in the highest condition of quality —fresh from the water and still flopping.

(4) The fish can be harvested at the size preferred by the processor.

(5) The processor can select the variety of fish he prefers (within limits).

(6) Arkansas farmers also produce some or all of the cereals included in pet food.

Malcolm Johnson, fish culturist and manager of the Arkansas Fish Farmers Co-op, states that fish farmers in the Dumas area can produce 10 million pounds of fish for pet food processing within a year's time.

What kind of fish? Johnson mentioned gizzard shad, tilapia, carp, bullheads, and a mixture of numerous wild species. Goldfish, suckers and Rio Grande perch might also be added to the list.

To fill you in on the background of how this fish farming business came about, listen for a moment to U. S. Senator J. W. Fulbright from Arkansas:

"Arkansas rice farmers became interested in fish farming almost by accident. In bringing new rice acreage into production, it is customary to build levees around a tract of land, filling the resulting reservoir with water, and letting it stand for a couple of years, until the timber dies and the decayed vegetation has enriched the soil.

"Following this procedure, farmers soon found that the water in the reservoirs always contained abundant supplies of the local species of fish.

"Some farmers began selling rights on their reservoirs for sport fishing, but on draining the reservoirs for cultivation, there were still tons of edible fish left, regardless of how much fishing there had been in the reservoirs. Additional experimentation by farmers resulted in determination that productions of fish in the reservoirs greatly increased the fertility of the soil, causing a

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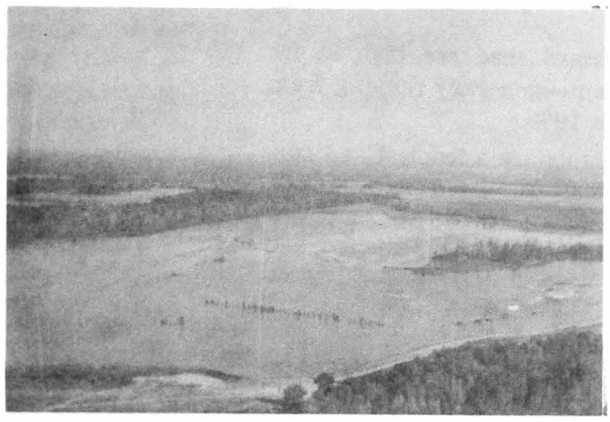
In the foreground of this air view are the hatchery ponds for spawning and rearing fish to proper size for planting in fields.



Here are flooded rice fields which are left idle for one year to restore fertility, during which time a crop of fish can be grown.

marked increase in production of soil grown crops. This knowledge led eventually to beginning of commercial production of fish for food in rotation with rice and other crops."

(Quoted from Hearing on S. 1552 before subcommittee on Interstate and Foreign Committee, July 8, 1957.)

Water storage reservoirs and impoundments flooded to kill unmarketable timber vary greatly in size. As can be imagined, most are out of the farm-pond class. Several hundred acres may be flooded, but usually such large areas are divided by levees into areas of 200 acres, or less, for ease of manipulating water for farming practices.

Rice fields are flooded during the rice-growing season to kill weeds, reduce damage from insect pests, and, of course, for irrigation purposes. A crop of rice is usually not harvested from the same field each year. The fields are left idle to restore the fertility of the soil, and to comply with regulations under the government rice allotment program. The fields are flooded during this period to keep down weeds. Thus, fish farming fits in very naturally with rice farming.

Fish were found to increase the fertility of the soil (rice yields have been increased by 25% and more), and to help tillability of the soil. It was also discovered that carp and buffalo fish, in their search for food, helped level the rough and torn ground of newly cleared and flooded fields.

Harvest Size in Two Years

The general practice of the rice-fish farmers, after a land crop has been harvested, is to flood the field to a depth of two to four feet, and then to plant fry of the fish species to be raised —usually buffalo fish and catfish. In the two years the fields are flooded, the buffalo fish will grow from less than an ounce to between four and eight pounds in size. When the fish are to be harvested, water is pumped out of the field until all the fish are concentrated in a ditch, called a bar pit, at one corner of the field. There the fish are caught with hand seines, iced in boxes and hauled to the processors.

Warm water fish culture, centuries old as a business in Asian and European countries, has only developed in the United States during the past 25 years. Most of the work in this field has been done to propagate game fish for sport fishing. With the advent of the rice-fish farming rotation program, more emphasis has been placed on raising nongame species. Research on various species by Dr. H. S. Swingle (Agricultural Experiment Station, Alabama Polytechnic Institute, Auburn), by Arkansas and Oklahoma state agencies; by federal government agencies and experiments by private biologists and fish farmers, have all contributed toward advancement of the science of warm-water commercial fish culture.

Carp and goldfish have been cultivated by the Chinese at least as early as 500 B.C., and later by Europeans. Yields up to 1,500 pounds per acre for carp, and 3,000 pounds per acre for goldfish can be expected with proper management. Some fish farmers are experimenting with a variety of common carp, called Israeli carp, or mirror carp. This species has very few scales, and can produce yields nearly equal to goldfish.

Carp and goldfish are relatively high in fat content—around 10%.

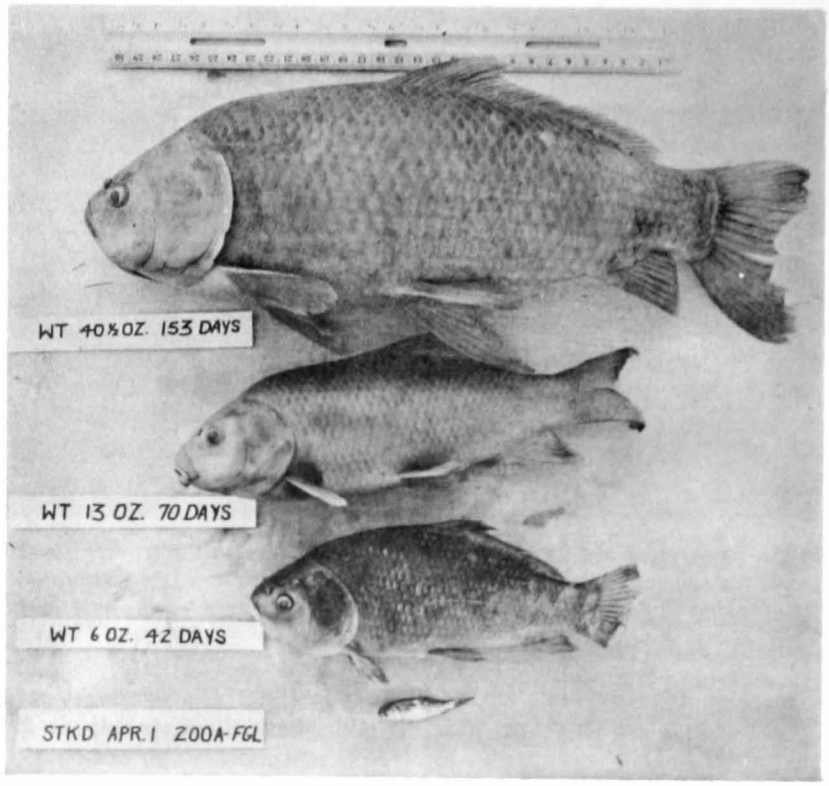
Gizzard shad are native to waters of the United States, and are generally considered a nuisance by state conservation agencies. Yields of around 1,000 pounds per acre can be produced from this species. With study and experimentation, this yield can undoubtedly be increased.

Gizzard shad are high in fat content—generally ranging from 15 to 19%.

Tilapia are a tropical and subtropical fish from Africar and Indo-Asian countries. This fish has been extensively studied, and subjected to fish cultural practices. Bas-reliefs on ancient Egyptian tombs show these people used a species of tilapia in fish culture operations in constructed ponds, probably before 2000 B. C. Experiments with tilapia in Thailand have produced yields of 15,700 pounds per acre annually. In this country, Dr. Swingle has produced yields of up to 4,000 pounds per acre over a six months' period from *Tilapia mossambica.*

Tilapia cannot withstand temperatures below 50 degrees F. This means the producing period in Arkansas for this species occurs between March and November. *Tilapia mossambica* spawn about every 30 to 40 days, commencing at two to three months of age. One hundred to 1,500 eggs are deposited in a redd (hole) dug by the male. After fertilization, the female picks the eggs up and carries them in her mouth for an incubation period of about two weeks. For a period of several days after hatching, the fry swim back into the mother's mouth in times of danger. It is quite a comical sight to watch some little fry, who got left out when the door closed, picking frantically at his mother's mouth to get her to open up.

Other fish native species such as bullheads, suckers, sunfish and bass (it is legal to sell game species, raised commercially in Arkansas), are usually present in limited quantities when the fish are harvested. Such species, though incidental, should be considered in the total volume produced.



How those buffalo fish do grow—153 days from fingerling to harvest size.

Fish production of the volume mentioned here does not just happen. Fish farming is as much a science as other types of farming. Careful management and proper feeding, either through fertilization of the water to produce plankton blooms, or direct feeding of a formulated fish food is necessary for a profitable business. The fish farmer should harvest about a ton of fish per acre to make production for pet food processing economically feasible.

The merits of these species for inclusion in pet food packs need to be determined. Test packs utilizing these species in a canned cat food will be made at the U. S. Bureau of Commercial Fisheries Technological Laboratory at Pascagoula, Miss. This will be done to find a general formula base to produce an acceptable product.

In order to centralize and increase marketing of rice-farm cultivated fish, the fish farmers around Dumas formed the Arkansas Fish Farmers Cooperative. Market demand for buffalo fish, the principal food fish produced from the fish farming operations, is limited, although increasing. Thousands of acres are relatively unproductive for lack of markets. Members of the Arkansas Fish Farmers Co-op feel they are now ready to expand their operations to produce fish for pet food or other animal food.

I have mentioned Arkansas rice-fish farming primarily; however, there are four major rice-producing states in the South. These states, including Arkansas, contain in excess of one million acres of flatlands suitable for fish farming. This represents a total potential production of between one and two billion pounds —a comfortable margin for the day when this valuable source of protein will be needed for both human and animal consumption.

FISH for PET FOODS

The New England Industrial Fisheries

by WALTER G. JONES

IN SEVERAL OF the previous articles presented here, I have described the potential industrial fisheries production of the Great Lakes, the Gulf of Mexico, the Pacific Northwest, and the Arkansas rice fields as representing tens and hundreds of millions of pounds. Those estimates were generally on the conservative side; but, I suspect, some readers may have looked askance at the figures since the present production in these areas is only a fraction of the potential.

The New England industrial fishery, however, needs no apologies. It has arrived, so to speak, to the tune of better than 200 million pounds annual production, and has an even greater potential. Since this fishery developed 10 years or so ago, it has increased to compose approximately one-third of the total New England landings. The major factors contributing toward this spectacular rise in industrial fish production were the decline of the California sardine fishery and the extension of the menhaden fishery into New England waters.

Fish meal and homogenized-condensed fish products form the base for the present New England industrial fish production. In the last two years, the New England menhaden fishery, the principal contributor of raw material for meal, has been declining (1958 landings decreased by 57% from 1957). However, this slack has been taken up in part by increased landings of trawl-caught fish for which there were no markets or only restricted markets for human consumption.

Three New England ports, Point Judith, R. I., and New Bedford and Gloucester, Mass., receive the lion's share of New England industrial fish. Landings at these and four other New England ports in 1958 are listed in Table 1, which also shows the relative magnitude of production at each port and the average price paid for the fish.

TABLE 1.—INDUSTRIAL FISH LANDINGS AND AVERAGE PRICES PAID AT PRINCIPAL NEW ENGLAND PORTS IN 1958

Port	Quantity (Millions of Lbs.)	Av. Price (Cents Per Lb.)	Av. Price (Dollars Per Ton)
Point Judith	88	0.84	16.80
Gloucester	62	0.98	19.60
New Bedford	43	0.72	14.40
Provincetown	9	1.33	26.60
Portland	9	0.75	15.00
Stonington	3	0.59	11.80
Rockland	1	0.70	14.00
Total	215	0.87	17.40

Between 40 and 50 million pounds of menhaden are included in the landings. However, since pet food manufacturers are probably not interested in this fish for pet food packs, menhaden is not included in the following discussion.

The majority of the industrial fish catch is composed of fish taken with trawl gear. Some 44 species are present in the landings, according to the studies made by U. S. Bureau of Commercial Fisheries biologists.

On the surface, this sounds like a wide variety to choose from. However, studies of the industrial catch in 1955 and 1956 revealed that two species, red hake, *urophycis chuss*, and silver hake (whiting), *merluccius bilinearis*, accounted for 68% of the catch, 45 and 23%, respectively. Skates, *raja spp.*, accounted for about 7%, angler fish, *lophius americanus*, and eel pout, *macrozoarces americanus*, contribute 5% each, and spiny dogfish (a shark) add another 3%. Some 36 other species make up the remaining 12% of the landings.

In addition to whole fish, fillet waste from food-processed haddock, pollock, ocean perch, floun-

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ders, dabs, and other species are available in generous quantities (491 million pounds of food fishes landed in New England in 1958). In processing these fish, up to 60% of them are wasted for human consumption. The waste, called gurry by New Englanders, is a good source of fish protein.

The species composition of the landings vary some by port, and vary seasonally to some extent within a port. Industrial fish landings in Maine ports are mostly composed of pelagic fishes (Maine sardines and other herrings) taken by purse seines or trapped by weirs in shallow bays.

Industrial fish delivered to the other ports are taken almost exclusively by trawlers. Table 2 was prepared to give you an idea of the proportionate abundance of each species contributing one million pounds or more to the landings at each of the three major ports.

Point Judith landings amount to more than twice those at the other ports and offer a greater abundance of the less important species. Red hake and whiting are by far the dominant species in all three ports.

Fish are landed throughout the year at these major ports; however, the majority of the fish are taken from March through November. Explanation of the seasonal variation in abundance of the species on the several fishing grounds is too lengthy to go into here, but this information will be furnished if requested.

Most of the industrial species are low in fat content as shown in Table 3 which lists the proximate composition of some of these fish. Few species other than herring contain thiaminase.

Competition for fish supplies would come mainly from fish meal processors, and to a lesser extent from mink feed processors. Whiting are also used for human consumption and are more sought after for this market when production of other food fishes is down, a situation which occurred in 1958.

How long can this production be maintained? Will it be curtailed because of harmful effects on populations of food species? According to Dr. R. L. Edwards, supervisory biologist, Bureau of Commercial Fisheries Biological Laboratory at Woods Hole, Mass., the fishery for industrial species has not adversely affected the fishery for food fishes. In fact, he states that should the market demand it, industrial fish production could be doubled from the New England fishing areas.

Drop us a line at U. S. Bureau of Commercial Fisheries, 920 N. Main St., Ann Arbor, Mich., if you would like more information on the New England industrial fisheries.

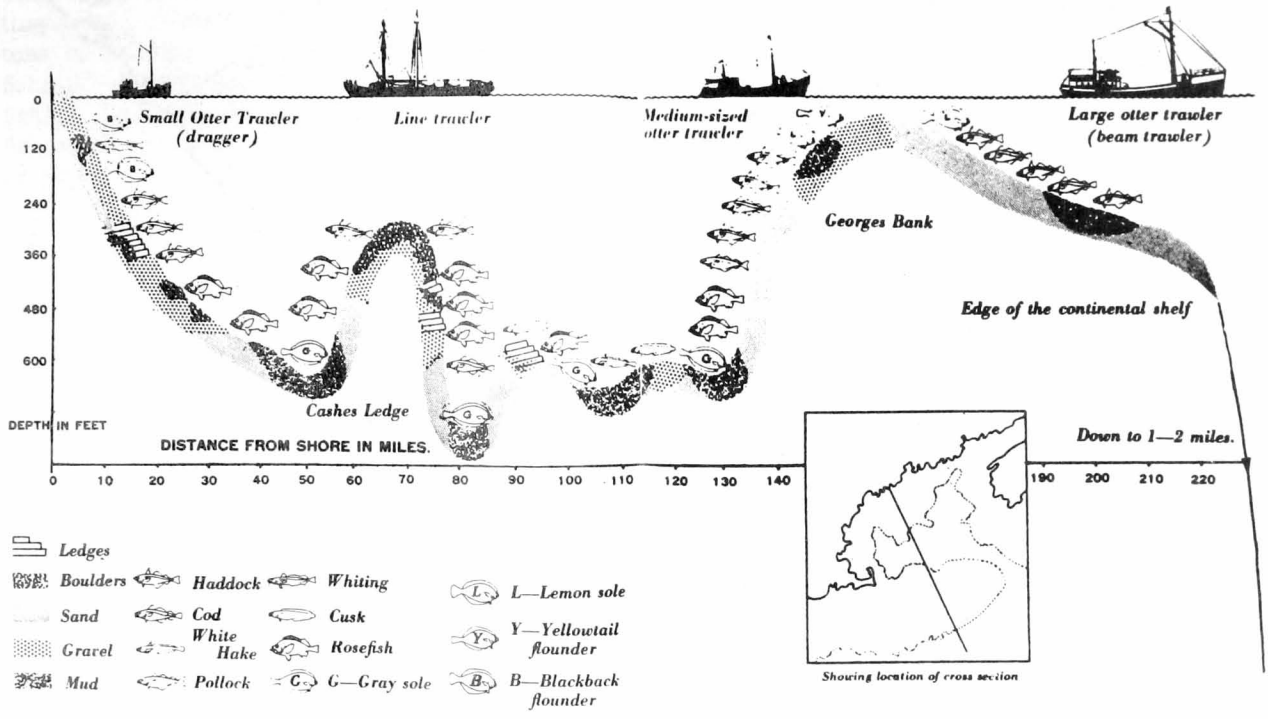
TABLE 2.—RELATIVE ABUNDANCE OF PRINCIPAL INDUSTRIAL FISH SPECIES LANDED AT MAJOR NEW ENGLAND PORTS, 1957

Species	Point Judith *Million Lbs.	New Bedford Million Lbs.	Gloucester Million Lbs.
Red hake	22	25	17
Silver hake	28	6	12
Haddock	—	trace	1
Skates	8	5	trace
Dogfish	5	trace	1
Flounders	3	1	2
Sea herrings	trace	trace	2
Long-horned sculpin	2	1	trace
Angler	7	1	1
Eel pout	8	1	trace
Misc. species	6	2	1
Total landings	89	42	37

Trace—less than 500,000 pounds.
*Production figures rounded off to the nearest million pounds.

TABLE 3.—PROXIMATE COMPOSITION ANALYSIS OF SOME FISH IN NEW ENGLAND INDUSTRIAL FISH LANDINGS

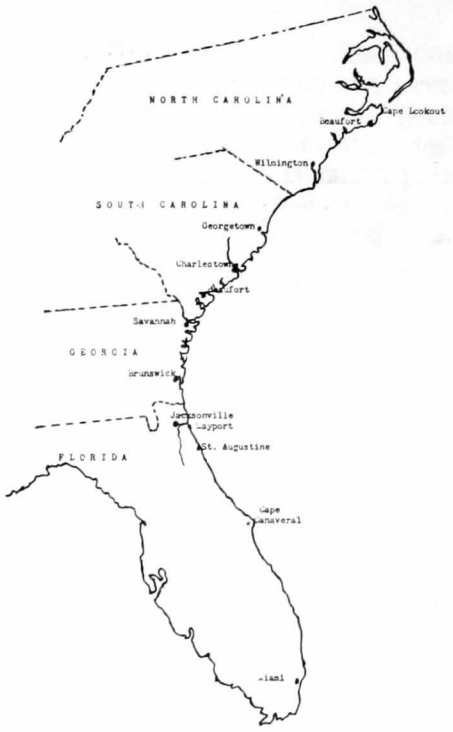
Species	Moisture	Protein	Fat	Ash
	(Per Cent)			
Red hake	81.7	17.7	0.5	1.3
Silver hake	81.5	17.0	1.0	2.6
Skates	79.2	18.1	1.5	2.6
Long-horned sculpin	80.6	14.2	2.5	2.7
Sea robin	72.5	15.8	4.8	4.0
Sea angler	85.8	11.4	0.3	2.5
	Thiaminase—None			



Cross section of the Gulf of Maine, showing distribution of groundfish by depth and type of bottom.

FISH for PET FOODS

South Atlantic Coast



by WALTER G. JONES

THE ATLANTIC SHRIMP fishermen are worried. From North Carolina to East Florida (and elsewhere, it might be added), imports, smaller catches and lower prices for shrimp are causing troubled minds.

In an effort to maintain their income, fishermen groups at Savannah, Ga., and Jacksonville, Fla., met this past August with U. S. Bureau of Commercial Fisheries' personnel to discuss means of diversifying their fishing operations. One of the most obvious means of doing this was to utilize fish caught during the shrimp trawling operation, and to trawl for fish during the off-season for shrimping. At present, South Atlantic fishermen have only a very limited market for fish caught incidental to shrimp trawling. Most of the fish taken would have to be used for animal food.

A catch of shrimp and industrial fish (one tow) delivered to a dock near Savannah, Ga. The ratio of pounds of shrimp to pounds of fish in this catch is about one to thirty. The skipper claimed this was one of the best tows for shrimp in several days.

Several questions were posed concerning the ability of the South Atlantic shrimp trawling fleet to support an industrial fishery. I had the opportunity to discuss these questions with fishermen and fish processors from Beaufort, N. C., to St. Augustine, Fla. The answers to these questions should prove of interest to pet food manufacturers:

1. *What is the industrial fish potential of the South Atlantic states?*

Fishermen say there is a great abundance of fish, generally. Only preliminary biological studies of population abundance have been made. State conservation biologists at Bears Bluff Laboratories, South Carolina, report that in recent years croakers have increased several times in abundance on shrimp fishing grounds (Contributions from Bears Bluff Laboratories, No. 24). They also state: "Aside from evidences of fluctuation, these data indicate that as heavy as are catches of croaker and other small fishes in the shrimp nets, there is no indication that their numbers are being reduced as a result of shrimp trawling."

This shrimp trawling off the South Atlantic Coast is similar to operations in the Central Gulf states. Most of the trawling covers grounds in less than 20 fathoms of water. Exploratory fishing cruises for shrimp by South Carolina and U. S. Bureau of Commercial Fisheries' biologists beyond 20 fathoms have encountered large schools of bottom fish commonly used for industrial purposes. For this year, plans are being made by the U.S.B.C.F. exploratory fishing staff to study the distribution and abundance of South Atlantic industrial fish.

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JANUARY, 1960

Shrimp fishermen usually avoid fish when possible but most claim they could deliver up to four tons of fish daily while shrimp fishing. Fishermen stated that fishing primarily for industrial fish would produce a much greater yield.

2. *What kinds of industrial fish are included in the trawl catches?*

Much the same as delivered to Gulf states ports. Over 50% of the catches consist of croakers or spots. In addition, small flatfishes, weakfish, whiting, razor bellies, silver eels and many other species are taken. Most of the fish are under eight inches in length.

3. *Is the supply of fish seasonal?*

Some seasonal fluctuation in catches can be expected as with most fisheries. However, fishermen claim industrial fishing trips could be made throughout the year, weather permitting.

4. *Are the numbers of shrimp trawlers sufficient to keep a pet food plant operating full time?*

There is no doubt about this. Over 1,000 shrimp trawlers operate out of ports from North Carolina to the Central Florida coast. Many ports berth 25 to 150 vessels. Shrimp trawlers move up and down the coast. They can be expected to seek out the markets.

5. *Will shrimp fishermen deliver fish caught incidental to shrimp?*

Many will—some just to help pay for the expenses of a shrimp trip. Others, if industrial fishing proves profitable, will turn to this type of operation as trawlers have done in the Gulf. The cream has been skimmed from the shrimp fishery. The fishermen realize they must diversify to stay in business.

6. *Do state regulations permit delivery of trawl-caught fish for animal food?*

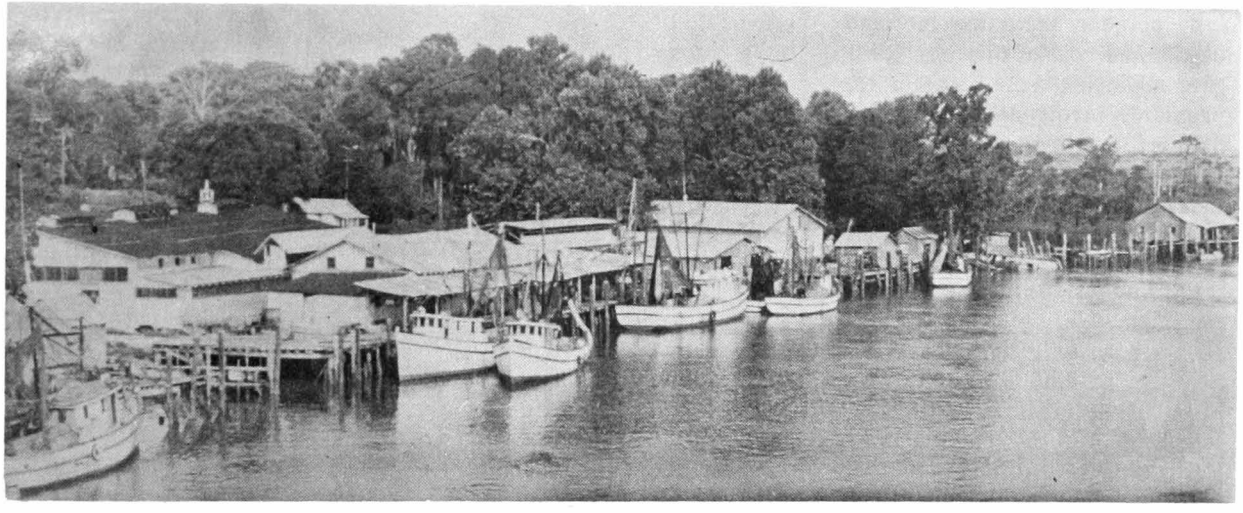
North Carolina has some stringent regulations which, if enforced, could sharply reduce landings of industrial fish. The laws were designed to protect North Carolina's human-food fishery.

South Carolina has restrictive legislation, but some state conservation authorities are working for legislation which will allow greater latitude in harvesting of fish for animal food.

Georgia has a legislative problem in determining what constitutes an "edible" fish, since there is some question about the use of "edible" fish for animal food. However, Georgia authorities are not expected to object to the species of industrial fish commonly caught.

Florida allows deliveries of trawl-caught fish for animal food. There are restrictions on certain species, however.

A hearty welcome awaits pet food manufacturers investigating the possibilities of establishing plants in South Carolina, Georgia and northern Florida. This is particularly true in the Mayport-St. Augustine, Fla., area where a fleet of vessels has been lined up, a supply of fish guaranteed, as far as that is possible, and all possible cooperation offered the manufacturer who is interested in establishing a plant.



Pictured above is part of the shrimp trawling fleet berthed at Brunswick, Ga.

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FISH AREN'T FREE

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The inside on how fish are caught and how much it costs

by WALTER G. JONES
U. S. Bureau of Commercial Fisheries

TRAWLS, GILL NETS, purse seines, lampara seines, trap nets, pound nets—all these different types of fishing gear, used to produce fish for pet food—have been offhandedly mentioned in previous articles.

Many are acquainted with these methods of fishing. Others are perhaps like the writer, whose closest experience to commercial fishing gear until a few years ago was limited to running trot lines along some prairie river.

A brief description of each type of gear, including methods of use and cost of operation, will give an insight into some of the problems involved in producing fish for pet food, and acquaint readers with some commercial fishing terminology.

Commercial fishing equipment is divided into two general classifications: mobile and fixed gear. Mobile gear, such as trawls and seines, are used to search out the fish in their habitat. The result is often volume catches, containing many species. Fixed gear fishing methods include gill netting and trap fishing. Here the fish must come to the nets and traps. This usually results in smaller catches of a few species.

Fish for pet food are taken with both mobile and fixed gear, but by far the greatest amount are caught with trawls. Trawling is a very efficient method for catching the numerous species that spend most of their lives on or near the ocean or lake floor. There are several types of trawls: otter trawl, beam trawl, midwater trawl and paranzella trawl are the types used most by United States fishermen. All employ the same basic principle: dragging a cone-shaped bag of netting over the fishing grounds. Fish in the path of the wide-mouth net drift or swim back to the narrow end, usually called the cod end. Here the fish are captured and retained until the net is brought aboard.

Trawling is a fairly recent innovation compared to such methods as the trap and hook. The first recorded mention of trawl gear was in a complaint to the English Parliament in 1376. It seems some oyster fishermen had contrived a bag to drag behind their oyster dredge of such small mesh that ". . . no manner of fish, however small, entering within it, can pass out and are compelled to remain therein and be taken." Times have not changed much for this is a problem which confronts conservation authorities today.

You've heard the words, "Fish are free—just get a boat and load it up. Fish is one pet food ingredient where the price should be cheap—just the cost of catching them." You may change your mind after reading this story of fishing gear, cost of a trawler and the crew that caught the one "fish" capable of pulling them all down to Davy Jones' locker.

Otter Trawl Is Preferred

The otter trawl is, by far, the most common type of trawl used by U. S. fishermen. This gear is so named because a pair of otter boards (also called doors) act like kites on a horizontal plane and hold open the mouth

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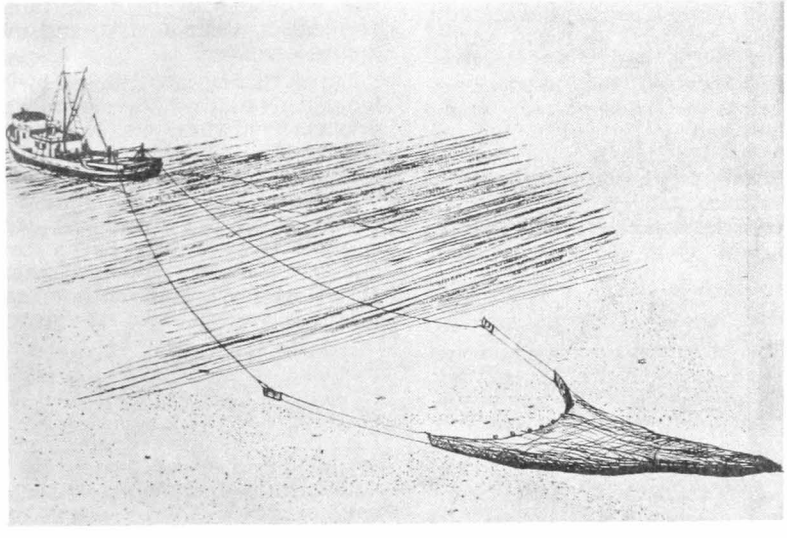
of the net (note the illustration).

Otter trawling apparently developed in England and was in use there about 1850. By 1905, its use had spread to the East Coast of the United States. Full-scale use of this method of fishing did not occur on the West Coast until World War II provided a stimulus for development of the groundfisheries there.

The volume of fish produced by otter trawling brought about a revolution in handling and processing groundfish that is still going on in the United States today. Catches of up to 150,000 pounds per tow have been recorded. Catches from nothing (called a water haul) up to 20,000 pounds per tow are more normal. A tow or drag may last from one to four hours, during which the net is pulled at a speed of from two to five miles per hour. The net itself may be over 100 feet long with the mouth opening up to 80 feet in width and 36 feet in height. Common trawls, however, have a mouth opening of 12 by 60 feet. The dimensions of the net, mesh sizes, the way it is rigged to fish, etc., will depend upon the fish sought and the power of the fishing vessel. A distinct advantage of the otter trawl is that it can be used in all but the roughest weather.

The otter trawl has been confined mainly to commercial production in ocean waters of the East and West Coasts and the Gulf of Mexico. Recently, however, otter trawling has been introduced in several areas of the 8,000 miles of our northern coastline on the Great Lakes. Experimental trawling in Lakes Erie and Michigan by government agencies and private individuals has indicated that this gear can profitably produce volume catches of underutilized fish species. Further development of trawling in the Great Lakes may make possible an economical harvest of abundant populations of smelts, alewives, bloater chubs, gizzard shad and other species for both human and animal food.

A great number of species of ocean fish are taken with trawls, many of which have been listed in previous articles here. The species presently most important to pet food packers include: hake, cod, rockfish, and flounder on the East Coast; croakers and related species in the Gulf, and hake, rockfish, and flounder on the West Coast.



Schematic diagram shows the trawl net working below the surface of the water. This is an otter trawler dragging from the stern in the manner typical of Pacific Coast operations.

Cost of Outfitting

The cost of trawling operations varies greatly between the shrimp vessel in the Gulf of Mexico with a two or three-man crew and the larger steam trawler of New England with a bigger crew. For this reason, mention of an average cost would be meaningless. Trawl vessels of 50 to 70 feet in length and operated by a two or three-man crew, such as the Gulf shrimpers or West Coast trawlers, are responsible for most pet food fish deliveries. It costs between $15,000 and $25,000 annually to operate this type of trawler. A new trawler of this type, fully equipped to fish, will cost between $40,000 and $90,000. Used vessels can be purchased for half or less of this amount, but refitting and maintenance costs are often high. Trawl nets for these vessels are relatively inexpensive, costing $500 to $800, fully rigged, as compared to several thousand dollars for gill nets and purse seines.

The efficiency of modern otter trawlers is greatly increased through the use of electronic fish finding and navigation gear, which, although it adds to the cost of equipment and operation, takes some of the guesswork from fishing. Electronic fish finders allow the fisherman to "see" schools of fish so well that he is often able to identify the kind of fish making up the school (see illustration). With electronic instruments, it is possible to trawl in depths of 400 fathoms (2,400 feet) and over. Off the United States, however, practically all trawling operations are in waters of less than 200 fathoms, or 1,200 feet, as a landlubber would say.

GREAT LAKES Trawl Fishery For Mink Food

By WALTER G. JONES

A REVOLUTION is under way in the Great Lakes fisheries. It is a revolution that not only involves Great Lakes fishermen, but will most certainly have an effect on the mink ranching industry in the Midwest and other areas as well. This revolution . . . and it is that even in the inflammatory sense of the word . . . involves the application of a method of fishing new to the Great Lakes—trawling—to efficiently harvest the abundant but little-used species of fish thriving in these northern fresh waters.

Trawling, the most common method of commercial fishing in marine coastal waters, has undergone difficulties in becoming established in the Great Lakes. It is a radical change from the traditional gill net and trap net methods of fishing. Because trawling is new to these northern waters, it is the subject of considerable controversy and misunderstanding among fishermen, state conservation people, and others interested in the Great Lakes fishery resources.

Just what is trawling? Why is it the subject of controversy? What are some of the possible effects this gear might have on the Great Lakes fishery resources? How will it affect the mink ranching industry?

The otter trawl is basically a funnel-shaped net dragged slowly along the ocean or lake bottom. The mouth of this net, 40-70 feet wide, is spread and kept open by the kite-like action of otter boards or doors, which tend to herd the unwary fish into the net where they drift or swim lazily back to cod-end and are entrapped. The bottom trawl was originally designed for catching fish that live on or close to the bottom. For this purpose it is a very efficient piece of fishing gear, particularly when operated in conjunction with an electronic fish finding device. Within limits it can be designed and operated to fish for specific species. Recent variations of this net, called the mid-water trawl, have been experimented with by several countries with some success to take fish schooling anywhere between the surface and the bottom.

Trawling has several advantages over gill net and trap net fishing:

1) it is more mobile . . . particular fishing grounds inhabited by specific species can be sought out and the fish followed if necessary;

2) a greater volume of catch can be taken by a single trawling unit at less cost per pound of fish. This will permit Great Lakes fishermen to compete profitably and extensively in the animal food markets for the first time;

3) a fresher and therefore better quality fish can be delivered, which is of prime importance to mink ranchers;

4) trawling can be conducted in favorable weather throughout the year, thus reducing seasonal glut production, and in general, to maintain a sustained supply;

5) the foregoing points all accentuate the necessity of establishing adequate processing and cold storage plants to handle the volume of catches anticipated for both human and animal food . . . facilities that are desperately needed for future development of the Great Lakes fisheries.

Trawling, however, is not all milk and honey. The initial investment in vessels and equipment is high, although the trawl nets themselves are considerably less expensive than gill or trap nets. Then, too, trawling is a science. Operators must become skilled in manipulation of complicated equipment and in the use of electronic devices. They must learn the bottom terrain—usually through hard-earned experience with nets lost and torn on rocks, snags, sunken boats, and other obstructions. Above all, they must learn the habits and idiosyncrasies of an elusive and constantly moving quarry. They must also conform to restrictive regulations imposed by the various states in good faith to protect fish stocks and existing fisheries, both sport and commercial.

The infant Great Lakes trawl fishery is undergoing severe socio-economic problems at present. Its chances of survival and expansion will depend on how it conducts itself in this and the next year and on the technical and regulatory assistance given it by federal and state governments. The depredation of the commercially important Great Lakes fish species by the sea lamprey and the invasion and multiplication of certain ocean species has made the traditional Great Lakes fishing methods increasingly unprofitable in many areas. Despite this, the independent and individualistic nature of the Great Lakes fishermen cause many of them to view the trawl fishery with distrust, which by its very nature of volume production, must depend on a few large centrally located processing plants for existence. Many fear the trawl fishery will further reduce catches of existing commercial fisheries and interfere with rehabilitation of previously commercially valuable lake trout. Some of those now most outspoken against trawling will no doubt in time be its staunchest advocates; while others now trawling who will not be able to survive the initial "shaking down" period this fishery will undergo, will be resentful and perhaps antagonistic to it. Sport fishermen, resort and recreation center owners, and municipalities also have a very jealous interest in Great Lakes fishery resources and will watch this new fishery with a very sharp and prejudiced eye.

These are some of the non-technical problems besetting the infant trawling industry. Nevertheless, the U. S. Bureau of Commercial Fisheries feels that this gear is one of the best methods available to harvest the abundant potential of underutilized fish species in the Great Lakes. To this end the Bureau is cooperating with fishermen and state conservation authorities by making available to them the services of biologists, gear specialists, economists, technologists, and marketing personnel.

Trawl fishing is regulated by the individual states. Wisconsin — the only state in whose waters commercial trawling has been conducted for a year or more—issues trawl permits annually for the taking of chubs, smelt, alewives, and other so-called "rough" fish. Seven trawlers are operating from Wisconsin ports. At least four of these have proven successful with this gear.

Indiana has no restrictions on trawling, and one operator is now trawling out of Michigan City. The State of Michigan has recently issued trawl permits for waters south of Ludington. Four vessels out of Saugatuck and Holland, Michigan, have begun trawling operations. Two of the Lake Michigan trawl fleet are shrimp trawlers brought up from the Gulf by way of the Mississippi River.

The Ohio legislature allows trawling for smelt only; however, no fishermen are actively trawling there. Canadian fishermen, however, are taking advantage of their trawling

privileges on Lake Erie. Fishermen in the other Great Lakes states are watching with considerable interest the trawling operations in Lake Michigan. Some of them can be expected to try trawling as they learn more about it, and as their state regulations allow.

The most valuable asset of trawling is that it makes possible economical volume production of underutilized fish. These species presently of most importance to mink ranchers are:

1) The bloater chub, **Leucichthys hoyi** and/or **kiyi.** These species are members of the whitefish family and are close cousins to the lake herring, tullibee, and ciscoes. Most bloater chubs do not grow large enough for the smoked fish trade which utilizes chubs ten inches and over in length. Gill net fishermen consider them a nuisance. Some idea of the potential abundance of these fish in Lake Michigan alone can be gained from past biological studies by Bureau of Commercial Fisheries biologists. In a recent report (unpublished) W. F. Carbine, regional director of the BCF, states: ". . . Even though the biologist cannot make a guess as to the possible annual production of bloaters, he can offer sound speculation in support of the view that the figure may be high. Assuming a 5:1 conversion ratio, 30 million pounds of chubs were required annually to produce the former commercial take of six million pounds of trout. The standing crop of trout has been estimated to be five times the production; therefore, upwards of 150 million pounds of fish, mostly bloaters, could have been used annually by the lake trout in Lake Michigan alone. Yet both bloaters and most other chubs were plentiful when trout were abundant. The standing population of bloaters has been estimated by Dr. James W. Moffett as being 3½ times as plentiful now as formerly . . ." The poundage represented by these estimates is staggering, yet there is no reason to believe they are other than conservative.

Close studies of commercial trawl catches will be maintained to determine what fishing pressure bloater chubs in Lake Michigan and the other Great Lakes can withstand. Bloater chubs are non-thiaminase. Proximate composition analyses show the fat content to be between 8 and 10 per cent.

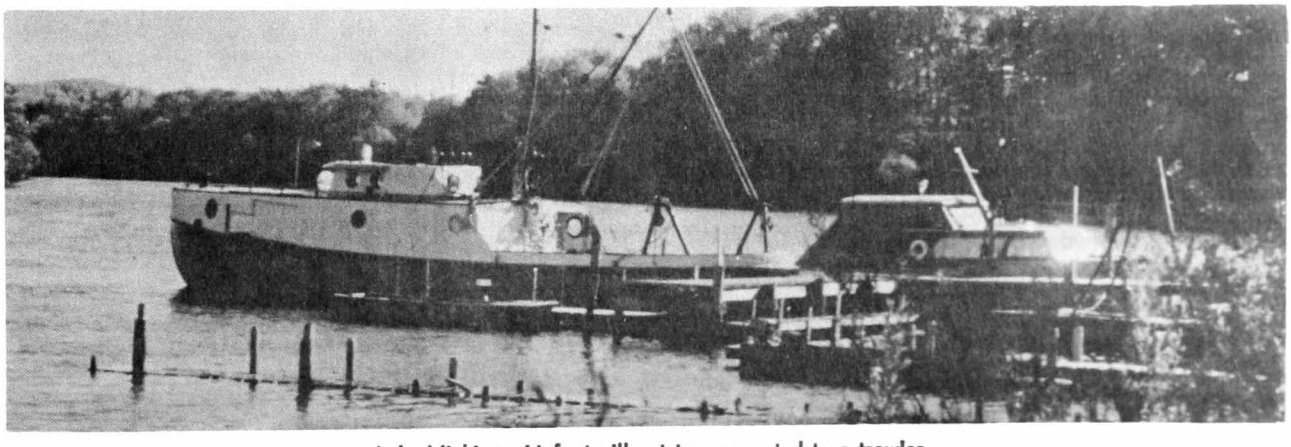
2) The lake smelt, **Osmerus mordax,** is a marine species which is native to Lake Ontario. It was introduced into the Upper Great Lakes in 1912 and in later years. Although this fish has varied greatly in population abundance in past years, it is presently extremely abundant in Lakes Erie, Huron, and Michigan, and is increasing in Lake Superior. No studies have been made on the population abundance of smelt in the Great Lakes. Some idea might be gained in this respect from a graphic recording by Bureau exploratory fishing technicians of a continuous school of smelt 38 miles long and six miles wide in Lake Erie last year. Similar "smelt islands" have been noted by Canadian technicians. It must be assumed that these fish offer a potential harvest of hundreds of millions of pounds annually. The smelt contains the thiaminase factor.

3) The third major species, the alewife, **Pomolubus pseudoharengus,** is also a marine species that invaded the upper Great Lakes by way of the Welland Canal. This species, which is a member of the true herring family, has found Lake Michigan so much to its liking that it has undergone a population explosion in the past three to four years. This fish is native to Lake Ontario, abundant in Lake Huron, and spreading to Lake Superior. Gill net fishermen are forced to cease fishing operations when alewives are running in their fishing grounds. No studies of alewife population abundance in the Lakes have as yet been made. We can only say they are extremely abundant, possibly greater than the smelt, particularly in Lake Michigan. The alewife contains the thiaminase factor and is high in fat content—about 15 per cent. This has discouraged its use for mink food even as a cooked product.

Other species of fish which may prove of value as mink food can be taken with trawls. As state conservation agencies become better acquainted with this fishing gear as a management tool for both commercial and sport fishing, it is possible that they may allow a greater variety of species to be taken.

Trawling is too new on the lakes and too little is known about fish populations in the lakes for anything more than a speculative answer as to what effect trawling will have on Great Lakes fishery resources. Windrows of dead smelt, alewives, and gizzard shad that appear periodically on Great Lakes beaches indicate a great waste of a resource that could be harvested with proper fishing methods. How the super-abundance of these species affects more desirable game and commercial fish is yet unknown. Certainly trawling can take only a fraction of the apparently abundant bloater chub population. Bear in mind that trawling is restricted to comparatively smooth bottoms which greatly limits its area of operation.

Trawling can be so conducted and certainly will be so controlled as to be no more lethal on small lake trout than the traditional fishing methods. On this subject Mr. Carbine states, "To assess possible damage to other species, information should be obtained on the actual species composition of trawl catches. This is projected or in progress by Wisconsin and the Bureau. Trawl catches made by Wisconsin fishermen and checked by Bureau personnel and the (research vessel) **Cisco** so far this year indicate that bloaters make up over 90 per cent of the fish caught. Whether (yellow) perch stocks might be harmed is highly questionable, but perch are about the only species which might be taken in addition to chubs, alewives, smelt, and suckers. Many of



Lake Michigan 61 foot gill net tug converted to a trawler.

the problems of trawling selectively for certain species without taking significant numbers of others can be solved by a sound program of gear development and exploratory fishing as they have in other areas."

The mink ranching industry, particularly in the Midwest, will be vitally affected by the development of a trawl fishery which for some time must be primarily aimed at producing fish for animal food.

Your industry will utilize approximately **256 million pounds** of fresh and frozen fish in 1960. Of this, Midwest mink will consume the lion's share—164 million pounds, which will be only about 30 per cent fresh water fish. The proximity of this substantial market to the potentially economic production of a Great Lakes trawl fishery will most certainly have a pronounced effect on both industries.

To mink ranchers a progressive trawl fishing industry on the Lakes should mean:

1. An immediate increase in the availability of the more desirable fresh water species for mink food. This increase will not be great in 1960—probably around 10-15 million pounds of bloater chubs—but it can be expected to increase substantially in the following years.

2. Stimulation of research to: (a) find ways to make greater use of the cheaper but equally nutritious thiaminase fish in mink rations; and (b) determine ways for Eastern and Midwestern mink ranchers to profitably increase the use of fish and fish products in mink rations to the level used by Western ranchers. Some work of this nature is now under way by feed industry research units, and work on the thiaminase factor is now in progress by Bureau technologists.

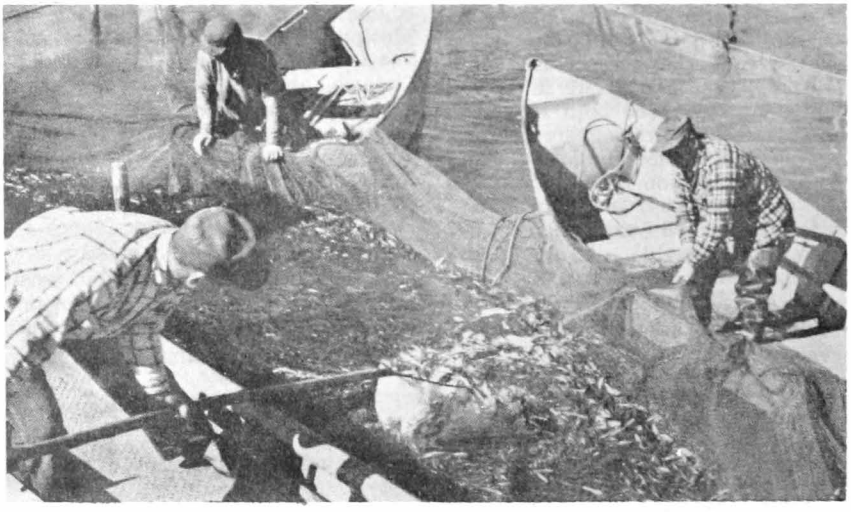
3. A moderate decrease in cost of fish. Competition of Great Lakes trawl fish with other sources of fish for mink food should benefit ranchers in all areas; however, ranchers should not expect too much in this regard. There is a very definite minimum limit in cost of production, even for volume methods of fishing. Present prices do not allow for such manipulation. The greatest savings will have to come in increased efficiency of handling, storage, and transportation.

4. A better quality fish. Volume production of fish for animal food, particularly mink food, requires establishment of modern, efficient processing plants and cold storage facilities. This will work to the advantage of the mink rancher as well as the fisherman. These same plants will be used to process fish from trawls and other gear for human consumption, and will encourage development of new fish products from Great Lakes fish. Waste or scrap from processing human food fish can be used to an economic advantage for mink food.

Trawling alone may not—indeed, will not—be the whole answer to rejuvenating the Great Lakes fishery. Trawling will undoubtedly find its place along with the gill nets, trap nets, haul seines, and other commercial fishing gear. However, establishment of trawling on the Great Lakes is the beginning of the revolution that will eventually bring these fresh-water fisheries into a modern era of development, and permit harvesting of the valuable and abundant resources of underutilized species present along the extensive "fourth seacoast" of the U. S. The mink industry cannot help but benefit from this revolution.

*Talk presented at Kellogg's Annual Mink Nutrition Symposium, June 7, 1960.

Periodic natural "die-off" of smelt, alewives and gizzard shad cause many problems for beach residents and municipalities.



Laborious, slow and costly method of taking smelt caught in pound nets. Lake Michigan.

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