FAO STUDY TOUR IN USSR

By Dr. Dayton L. Alverson*

[For several years, FAO has sponsored study tours in the Soviet Union for developing nations. While the topics of these tours change from year to year, they deal generally with technical fisheries matters. The subject of the 1967 study tour, Sept. 21-Oct. 18, was "Fish Behavior as Related to Fishing Techniques and Tactics." It was selected to augment the FAO conference of the same title in Bergen, Norway, Oct. 19-28. Dr. Alverson was a lecturer on the Soviet study tour and chairman of the FAO conference. Below are some impressions of his trip.--Ed.]

There is a high degree of integration in Soviet fisheries science. This is evident from the studies of the All-Union Research Institute of Marine Fisheries (VNIRO), the field laboratories, and the Soviet Academy of Science. A statement at the opening ceremony of our tour suggested that Soviet fisheries research was strongly motivated by the desire to understand behavior--in order to harvest fish and to improve survival of fish populations and the productive capacity of the oceans.

Some of our meetings were held in the Georgian Scientific Research Institute in Batumi, which is on the southeast coast of the Black Sea, near Turkey. The institute is under the line authority of VNIRO.

They Seek Important Answers

Many lecturers were from the Soviet Academy of Science. I was impressed with the fact that Academy scientists were conducting research and evaluating its results from the standpoint of their application to improving Soviet fisheries. There seemed to be no stigma attached to their involvement in applied research. These scientists were studying sensory physiology with particular emphasis on understanding the sensory modalities involved in detecting various stimuli within the fishes' environment.

They are asking and seeking answers to the following types of questions: By what means do fish detect sound? How is the sound transmitted internally? What are its sensory capabilities regarding sound intensity and frequencies? How can or does a fish orient to sound? Does a fish have orientation capabilities in the near field and, if so, how is this achieved? Similar questions were being asked about vision.

The results of these studies seem to flow to the behaviorists who were, more often than not, involved in VNIRO or other field projects. These researchers attempted to utilize the information on sensory physiology and general behavior to determine in what means knowledge of behavior could be used to improve harvest capabilities.

ACOUSTICAL HERDING

Perhaps the most exciting and certainly one of the most interesting lectures presented was by Prof. A. Shein of VNIRO. Actually, the work is being done at PINRO (Polar Research Institute of Marine Fisheries and Oceanography). Shein discussed three areas of interest to the future of high seas fisheries. They involved acoustical herding, acoustical counting, and near-bottom detection methods. The information on acoustical herding was by far the most interesting and revealing development that I have seen in the Soviet Union in the past several years. Apparently, the Soviets have been investigating biological sounds produced by fish and mammals, and the individual and group reaction of fishes to various biological and nonbiological sounds.

In investigating the behavior of cods and herring in the North Atlantic, the Soviets determined that they could drive midwater schools of cod and herring down to within 2-3 meters of the seabed by using low-frequency

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sound. The original experiments involved (1) detecting schools of herring or cod; (2) transmitting a signal of about 1,000 cycles for a period of about 15 seconds; the signal strength at one meter from the microphone was 2,000 bars and the signal nondirectional. This brought about an immediate response on fish schools observed on the echo sounder. The fish moved rapidly toward the seabed but soon began to ascend in the water column. The signal would then be reproduced and a similar reaction would occur. However, the amplitude of vertical movement decreased with each successive reproduction of the 1,000-cycle sound. The fish apparently acclimate to this nonbiological sound rather quickly. Subsequent changes in the power or character of the sound, that is, simple or compound combinations, would no longer bring about the desired response.

Biological Sounds

The second phase in the investigation dealt with application of biological sounds, or as the Soviets put it, "sound which had biological meaning to the fishes involved." Recordings were made of various mammals and fishes which preyed on cod or herring, and a variety of predator sounds were thus catalogued. In subsequent experiments with herring and cod, low-frequency biological sounds were used to drive fish toward the seabed. In a serial presentation of a number of echograms, there was a rather dramatic response to these biological sounds. Schools of fish as much as 50 meters above the seabed (cod and herring) moved rapidly down toward the ocean floor and remained there during periods the biological sounds were being broadcast. For herring, the effect was more dramatic and appeared to represent almost a total change in school distribution. The sounds used for herring represented a species of tooth whale. Dr. John H. S. Blaxter, University of Aberdeen, Scotland, Prof. Toshero Kuroki, Hokkaido University, Japan, and I did not doubt that the echo tracings, as shown, implied a dramatic breakthrough in acoustical herding and one which could have a real impact on the utilization of ocean resources. The idea here is not to eliminate the behavior that leads to escape, but to increase the density of fish within the influence of a harvesting device. This coupled with Soviet experiments now underway to eliminate, via electronarcosis, behavior that leads to escape from the harvesting devices, could bring about a major increase in efficiency.

The Soviets stated that they had increased catches utilizing the acoustical herding method from 300 to 500%. We did not, however, see any actual comparative tow data. All the lecturers, however, were convinced that the echograms were legitimate. The validity of the Soviet claims was later verified by the fact that Scottish investigators working out of Aberdeen have had similar results in their studies.

Echo Counting and Bio-acoustics

Prof. Shein commented further on acoustical studies in the Soviet Union. They are apparently investigating the use of various echo sounders ranging from 10 KC to 200 KC and are deeply involved in acoustical counting procedures. Their equipment and approach seem to be similar to those now being used at Lowestoft by David Cushing's people and perhaps not as far along, but certainly well ahead of the U. S. push in this direction. The Soviets claim to be using now the world's largest crystals in their acoustical studies, particularly for the application of piezoelectrical effect for passive and active sound studies. According to Shein, they have developed a technique that allows the study of fish close to the seabed. My impression was that it was similar to the white line techniques used in other countries; however, it completely blocks out the bottom echo.

On the day following Shein's lecture, we went out on the Black Sea to have a first-hand look at the various acoustical equipment aboard the research vessel, "Boridev." It was literally a floating acoustical laboratory with twenty-some different echo-sounding devices--both foreign and domestic--and a variety of acoustical detection (listening) instruments. The vessel was not involved in the acoustical herding work described by Shein, but did have more electrical equipment aboard than all BCF vessels combined. On the other hand, I saw nothing in electronic equipment that impressed me as being substantially different or better than the rest of the world uses.

Opto-motor Reactions
and the Secondary Stimuli

For the next several days we heard a good deal about other physiological and behavioral studies being conducted by the Soviets, and there are areas of work worth mentioning. One uses the so-called opto-motor reaction to

improve catching efficiency. A lecture by D. S. Pavlov dealt with the opto-motor reaction and peculiarities of fish orientation in a stream of water.

The opto-motor reaction is a behavioral response that takes place in the animals following a visual moving object or reference point; it is characteristic of many classes of animals. The main biological significance of opto-motor reaction in fish is that it enables the animal to orient itself in a water stream, providing visual reference points are available. The opto-motor reaction is an unconditioned reflex or "reo-reaction" and occurs in early stages of a fish's development. It is a characteristic of the overwhelming majority of fishes, and occurs when fish do not have tactile contact with the bottom. Apparently, it is very important in midwater fishes and hence in midwater fishing activities. The Soviets are stressing the application of this knowledge to the harvest of midwater species. By altering the character of the background (webbing), it is expected that one can create an opto-motor reaction in certain parts of the trawl and eliminate it in others. This would eliminate swim-out, which now occurs in some midwater trawl fishing.

Increasing Harvest Efficiency

Pavlov was followed by D. V. Radakov, who also lectured on how knowledge of behavior could be employed to increase harvest efficiency. According to Radakov, the Soviets feel that escape from trawls, purse seines, and other active gears can be decreased by creating a "secondary stimuli." That is, if the fish's attention or sensory modalities are taxed by secondary stimuli, these may confuse and even inhibit the behavior that might lead to escape from a particular type of gear (this relates to acoustical herding). Apparently by creating certain predator sounds in an area around trawls, the tendency of fish to dart away from the gear in attempts to avoid it may be eliminated completely. The success of these studies, however, was not well-documented to the lecture group. It is an area being investigated.

CUBA'S FISHERIES DEVELOPMENT

At the end of our stay at Batumi, each participant was asked to give a short summary of his nation's fisheries development work. Here is some information I abstracted from the Cuban presentation.

Prior to 1959, the fisheries of Cuba were of a subsistence nature. There was no organized national effort to develop and utilize the fisheries potential surrounding the island. At that time, production was approximately 25,000 tons[1] and marketed through "middlemen." After the revolution, the fishermen were organized into cooperatives under a National Institute of Fisheries. This organization involves itself with catches, management of fishing fleets, marketing, distribution, and fisheries research.

32 Cooperatives Control 3,000 Boats

The Cuban fishing industry is organized into approximately 32 cooperatives, which control about 3,000 boats. About 50 vessels fish on the high seas. Eight modern stern trawlers have been acquired from Spain.[2] Fishing on Georges Bank has or was scheduled to begin in 1967.[3] Production in 1967 has exceeded 100,000 metric tons[4] and the target for 1970 is 175,000 metric tons. The breakdown of the 1970 planned catch, by species, although not clearly provided by the lecturer, was: 30,000 metric tons tuna; 40,000 metric tons trawl--hake, flounders, etc.; 50,000 metric tons cod; and 45,000 metric tons other.

The large new fishing port at Havana, which was financed by the Soviets and is staffed with Soviet technicians, now provides logistic support for most distant-water fishing activities. Closed circuit television is used to monitor port activities.

3 Labs Do Research

The research activities are coordinated by three laboratories: (1) marine biology, (2) oceanology, and (3) laboratory of fishing technology. There are now 56 Cuban scientists

1/FAO gives Cuba's 1959 production as 28,200 metric tons.--Ed.

2/Cuba bought 26 fishing vessels: 6 stern trawlers that fish for cod in the Northwest Atlantic, mostly off Labrador. The remaining 20 units bought from Spain were tuna longliners. (For details, see CFR, Jan. 1966, p. 71.)--Ed.

3/No Cuban vessels fished during 1967 on Georges Bank. A few were sighted on their way to or from Labrador.--Ed.

4/There is no evidence for this statement.--Ed.

assigned to these labs, 30 administrators, 90 crew members on research vessels, 16 Soviet scientists and 3 FAO scientists. The Soviets have provided two medium refrigerated trawlers as research vessels, apparently on loan from VNIRO, and 9 smaller ships ranging from 16-25 meters. The overall budget of the Cuban oceanographic and fishery research programs was said to be 1.2 million pesos in 1967.

(The fisheries development program obviously is being supported technically and financially by the USSR.)

MURMANSK, THE "BARREL CITY"

We went on to Murmansk. The city, which dates back some 50 to 60 years, now has 300,000 people. This in itself does not seem particularly important until one realizes that almost the entire population depends on the fishing industry, although there are also fur farms, small industries, and military activities in the region. The Murmansk fishing fleet operates from the North Atlantic west to the coasts of America. More than two billion pounds, or a million metric tons of fish, now are landed annually in Murmansk. The catch is made in the North Sea, the Faeroes, Icelandic region, Greenland, Newfoundland, and Georges Bank.

Fleet and Docks

The fleet is made up of many standard SRT-type side trawlers, BMRT's, and support vessels ranging up to 19,000 tons. We were given a tour of the docks and fishing facilities. Compared with those I have seen in other areas of the world, the Murmansk dock facilities are extremely modern. There are many railway-supported mobile cranes used to load and unload the large number of fishing vessels calling at Murmansk. The access to the docks appears good. The fishing fleet, particularly the support vessels, is modern.

We visited several SRT catcher vessels, several BMRT's, and a support ship. I was impressed by the fact that the skippers on all these boats were relatively young and acutely aware of what government people were doing in the area of fisheries. Of the half dozen or so vessels that I boarded, all but one were apparently foreign built; they were constructed in either Poland, East Germany, or Western Europe. Most were powered with German engines and had a large variety of Eastern and Western European electronic devices aboard.

Visit to Fish-Processing Plant

The study tour included a visit to one of the processing plants in Murmansk where a large variety of fish products was preserved. We observed smoking of redfish, cod, and catfish (wolf eels); filleting of various demersal (bottom dwelling) species; and lunched on about 22 different products made by the plant. Again, most processing machinery appeared foreign made. The plant did not seem particularly well laid out, and many activities were not automated. Safety features were entirely lacking. In contrast to the dock facilities and vessels, the plant seemed to me a rather inefficient operation, at least from the standpoint of using workers.

Barrels

One quickly becomes aware when moving around the docks or fish-processing plants, or even around the countryside, that there must be an awful lot of herring making their way in barrels to Murmansk. If there are 300,000 people in Murmansk, there are at least 30 million barrels. They are stacked every where: on the docks, throughout the city, and in the surrounding countryside. So I dubbed Murmansk, the "Barrel City."

PINRO

In addition to Murmansk's large fishing activities, one of the larger fisheries research laboratories is centered there. The PINRO lab or labs are in downtown Murmansk. A large building houses the labs involved in marine studies in the North Atlantic. The group at PINRO includes 600 persons, of which 200 are scientists, and the remainder staff technicians, secretarial help, etc. I was particularly interested in some work in fish behavior and the methods used to gain a better insight into this field.

Study Behavior of Demersal Fishes

We looked at a hydrostat being used to investigate the behavior of demersal fishes. For all practical purposes, the hydrostat can be considered a cylinder sealed at each end and with a number of ports for the observer. It has a maximum operational depth of 600 meters, and a life support system of approximately 12 hours. The hydrostat weighs 2.4 tons and can be operated from a vessel at drift or when anchored. Although it has its own oxygen and life support system, there is direct

contact via cable to the research vessel. The device is lowered much like the bathyscaph or sphere used by Beebe to a predetermined depth, and then observations are made on fish life. About 70 drifts had been made with this particular hydrostat by scientists at the PINRO laboratory. The drifts ran from four to eight hours. Generally, the device is lowered to within one to two meters of the seabottom, and observations made on demersal fishes as the hydrostat drifts slowly over the ocean seabed. A number of excellent photographs were shown to the study tour by Dr. Kiselev, who was one of the main investigators studying fish behavior from the hydrostat.

A Submersible

The PINRO lab has designed and apparently has now under construction a new, self-contained, independently operated, submersible. Called the "North I", it will have a depth capability of 2,000 meters and a speed of five knots. It will be assigned the investigation of fish behavior in their natural environment and their reaction to fishing gear. It also may play a role in fish detection and scouting. Although the fisheries submarine "Severyanka" still is in use, it is having increasing maintenance problems. Its use in future fisheries studies seems questionable.

PINRO Organization Impressive

I was impressed by the organizational structure at PINRO and how programs were designed and developed and related to the overall national goals of fish production. At least one-half the PINRO budget (2.5 million rubles or about $2.75 million) comes from the fishing industry, and the other half from the Fisheries Ministry's budget. This PINRO budget does not include research vessel support. Overall program planning and objectives are evaluated by industry and scientific leadership. It is obvious that the lab's mission is closely related to fish production and efficient utilization of the Murmansk fleet.

A relatively large group is involved in predicting changes in year-class strength for the various species exploited. The purpose of prediction does not concern management in the sense of regulation; it is applied to reallocate fleet deployment. Its purpose is to make the best use of the Murmansk fleet--to put greater emphasis in those areas where natural production looks favorable, and to diminish the effort on stocks in which natural production looks poor. How well this actually works is difficult to say.

BOROK'S BIOLOGICAL INSTITUTE

Our next stop was Borok, which is north and east of Moscow. Borok is a village of about 2,000 people and sits on the southwest side of the Rybinsk Reservoir. The whole town is built around the Academy of Science's Biological Institute for Inland Water Research.

The Biological Institute, directed by I. D. Popanov, was established in 1959 and is made up of independent laboratories. Some of the more important include Laboratory of Hydrology and Hydrochemistry, Laboratory of Microflora and Microbiology, Laboratory of Ecology and Physiology, Laboratory of Zooplankton and Zoobenthos, Laboratory of Zoology and Parasitology, Laboratory of Ichthyology and Physiology of Lower Invertebrates.

Electrical Fishing

While the group at Batumi apparently is directing its energy to using the anode reaction for capturing fish, at Borok they are experimenting with alternating current to stun fishes in front of a trawl. The objective involves agitation and electronarcosis. Electro-fishing was demonstrated on the Rybinsk Reservoir aboard the new 120' research vessel, which was well equipped with chemical and physiological laboratories and acoustical equipment. The electro-trawl displayed has a series of electrodes along the ground rope, uses AC power, non-pulsed. (Voltage and power output and other details can be obtained from the author.)

Dr. Poddubnii lectured on acoustical tracking. The work is similar to that conducted on salmon in the Pacific Northwest. However, the acoustical tag now being used on sturgeon and other species seems a little more sophisticated, and the tracking system allows one to record the position and depth of up to nine fish at the same time. The tag was built in somewhat of a saddle shape, with the power source on one side and acoustical transmitting equipment on the other. The Soviets had tracked the migration of sturgeon in the reservoir and in the Volga River, and suggested various methods the fish were using to orient themselves.

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There were about 100 scientists at the conference of 30 nations, with strong representation from the Soviet Union (they sent a ship to Bergen from Murmansk), Great Britain, Germany, France, and Norway. Australia, Canada, and the U. S. were represented. There were individuals from all parts of the globe. The strongest laboratory representation came from PINRO, VNIRO, the Atlantic Research Institute for Marine Fisheries and Oceanography (ATLANTNIRO), the Marine Laboratory at Aberdeen, Scotland, and the Fisheries Laboratory at Lowestoft, England.

The conference was divided into five major topic sections: (1) field observations on fish behavior and important fisheries; (2) methods and techniques for studying fish behavior in their natural environment; (3) experimental studies of fish reactions to physical and biological stimuli, both in their natural and in a controlled environment; (4) experimental studies of fish reactions to moving and fixed objects in order to clarify reactions to fishing gear; and (5) application of observations and experiments on fish behavior in designing fishing gear and tactics.

The discussions were highlighted by differences in opinions, particularly concerning swimming speeds and the use of theoretical models for crystallizing needed inputs for improving the design of fishing devices. Work parties were organized to consider in greater detail: (1) use of submersibles in behavior studies; (2) short-term migration or movements of fishes--their effect on fishing strategy; (3) possibilities of herding, aggregating, and controlling and/or restricting movements of fish for the purpose of improving harvest; (4) sensory physiology--its possible contribution to behavior studies and design of fishing gear; and (5) experimental design of behavior studies and design of facilities.

Approximately 63 papers were submitted and will be published in the proceedings. The proceedings should be available early in 1968 in limited numbers and should provide an excellent reference for those interested in fish behavior, particularly as it might be applied to capture and harvest.

I was particularly impressed with the state-of-the-art of acoustical counting and its application to both behavior and population studies. Both English and Norwegian investigators are attempting to resolve the problem of acoustical signatures--identifying acoustical targets as to fish species. The Norwegians appear to be making some progress.

I suspect that the impact of the papers presented on the future of fisheries will be of more importance than that at many other conferences.

FISH GET ULCERS TOO!

Fish, like humans, have ulcer problems. Kenneth Higgs, field officer of the Metropolitan Toronto Conservation Authority, told an authority meeting that 250 dollars will be spent this year on drugs to keep fish in Authority ponds free of ulcers and other ailments. The Authority raises its own game fish. ("Current Affairs Bulletin.")