NEW METHODS FOR STUDY OF FISHERY PROBLEMS

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One of the tasks of fishery biologists is the development of new techniques for obtaining information. Factual information on size of fish populations, on the rates and the patterns of fish migrations is necessary in order to properly regulate a fishery. Information is needed on factors affecting growth and survival of fish as a basis for decisions on hatchery or stream improvement programs. Detailed information on fish behavior and swimming abilities is required if effective fish passage facilities are to be designed that will pass anadromous fish upstream and downstream over dams. By its very nature, however, much of the information we need is difficult to acquire so we constantly seek new and improved methods to obtain it. The following examples of fishery research methods now being developed by the Pacific Salmon Investigations of the U. S. Fish and Wildlife Service are offered as illustrations of the search being made for new approaches to the study of fishery problems.

Electronic Fish Counting

Enumeration of fish runs has always proved to be a difficult task. Techniques vary from estimation by means of aerial photographic surveys or spawning surveys to actual counting of fish at weirs. Because of its accuracy we look upon weir counting, wherever it can be used, as the most desirable method of enumeration. However, weir counting is expensive and it also has a tendency to delay the fish. Fish are frequently reluctant to surface and pass over a bright counting board. At most counting stations the fish are not free to move through the station at will. Counting stations are usually closed at night and even at major dams where two shifts of observers are used, counting stations are normally closed for fifteen minutes out of every hour during the day. At the counting stations at some of the smaller installations the fish are required to swim into a trap and are counted and released only once or twice a day. To overcome these disadvantages to weir counting the Service is developing an electronic fish counter that will automatically count and record fish passing through a submerged orifice. A working model of the automatic counter which operates on the resistance bridge principle has performed satisfactorily in the laboratory and is now undergoing field testing. One of the limitations of the present model is its inability to differentiate species. However, several possibilities are being explored which may in the future enable the electronic counter to identify species. We confidently hope that within the next few years the development of the electronic fish counter will greatly reduce the cost of making accurate counts and at the same time reduce the delay inherent in the present weir counting technique.

The Use of Paper Chromatography in Racial Studies.

Fishery biologists concerned with racial studies will be interested in an attempt being made by the Fish and Wildlife Service to develop a method of identifying racial salmon stocks by means of paper chromatography. Thus far the method has been successful only to the extent that we are able to detect protein differences corresponding to species. It seems reasonable, however, that if protein differences of a racial nature exist, some refinement of the paper chromatography technique can be developed enabling us to identify races. The importance of a method which might enable us to determine if a fish came from Asian stocks or from racial stocks in North America can be readily appreciated.

Scale Marking.

There is a long-recognized need for a method by which we can accurately evaluate the contribution to our fisheries made by hatchery reared fish. One solution to the problem is to mark every hatchery fish. This is easier said than done.

Fin clipping has been used for large scale marking experiments. This method, however, is expensive requiring large amounts of manpower and there is always present the danger that we are actually handicapping the fish when we clip its fins. A project is now underway at the Seattle Laboratory of the Fish and Wildlife Service attempting to develop a method for marking scales by feeding techniques. There are two possibilities being explored. One is that the normal pattern of scale deposition can be disturbed enough to be recognizable through the feeding of hormones such as thyroid extracts. This aspect is being approached cautiously, however, because the use of such hormones may also result in some undesirable effects upon the metabolism of the fish. The second possibility being investigated is the feeding of elements such as bismuth, manganese, cobalt or strontium which are not normally in fish diets in an attempt to form a small trace deposit of the element in the scale. Analysis of scale samples by spectrographic or chemical means would then permit identification of the fish.

The Use of Infra Red in Studies of Fish Behavior in Darkness

How do fish behave in the dark? Fishery research workers have asked this question often. Now with the aid of the infra red part of the spectrum we can begin to answer it. The use of infra red at our Seattle Laboratory began as a result of our electrical fish guiding research. The electrical arrays being tested were significantly more effective when the lights were on. This phenomenon raised many questions on the differences between the behavior of fish in the light and in the dark. To answer them we turned first to infra red photography and then to the use of electronic infra red receivers which enable us to observe the fish continuously. Figures #1 and #2 illustrate one of the differences in behavior observed. The factors limiting the use of infra red appear to be approximately the same as those limiting the use of visible light. Turbidity, turbulence, entrained air and surface reflection all interfere with the ability to observe fish with infra red. Despite these limitations, we predict that infra red will become a standard fishery research tool in the very near future.

Sonic Fish Tracking

An important part of fishery research is concerned with subjects such as migration routes of fish, the rates of migration, the factors which control and guide the fish on these migrations, the reactions of fish facing obstacles along their migration paths, and similar aspects of fish behavior. Much of the information sought in

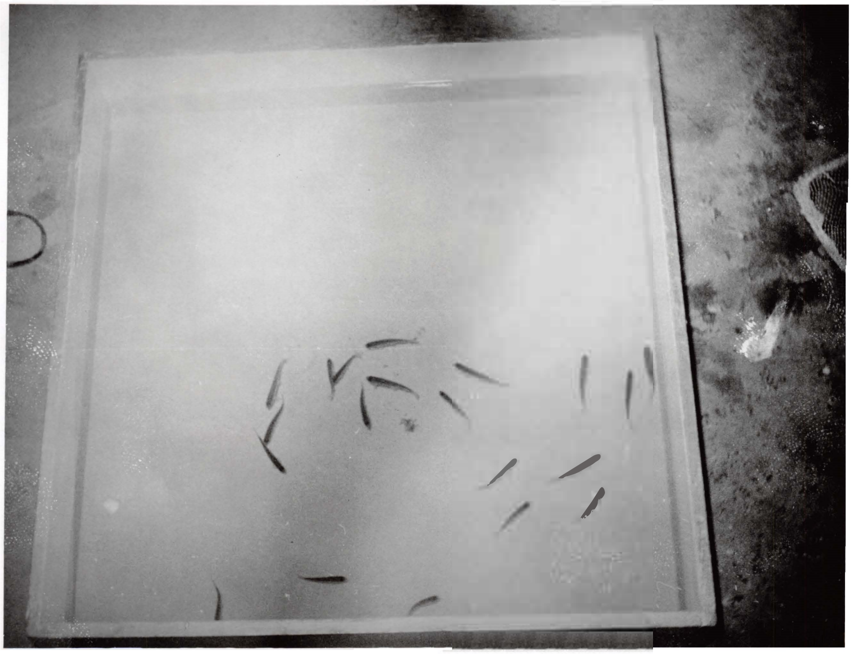

Figure 1. Infra Red Photograph
(Visible light 70 ft. candles, schooling behavior)

Figure 2. Infra Red Photograph

(Visible light zero, absence of schooling behavior) these studies could be supplied if we had a means by which we could follow in detail the movements of individual fish. The Service has initiated a fish tracking project which has as its goal the development of such a method utilizing the latest engineering advances in underwater sonic devices. The plan is to attach a small signal generator to the fish and then to track its movements by means of a sound receiver that automatically "homes" to the signal. The engineering research on the signal generator and the automatic tracking receiver is being done by the Marine Division of the Minneapolis Honeywell Co. under contract to the Fish and Wildlife Service. While the device has not been field tested as yet, we visualize a "homing" performance in ranges up to 1600 ft. in fresh water for a period of 75 hours with a signal unit weighing less than two ounces in air (actually having a negative weight of approximately .05 ounces in fresh water). The transducer will probably be a barium titanate crystal resonating at a frequency of 132 kilocycles.

Figure #3 shows a model of the signal unit and the proposed manner of attachment to the fish. Initial experiments will be made with large fish (over 2 ft. in length) because of the size of the signal unit. Our present models use standard parts available commercially. Further miniaturization of the signal unit will be possible with especially designed parts.

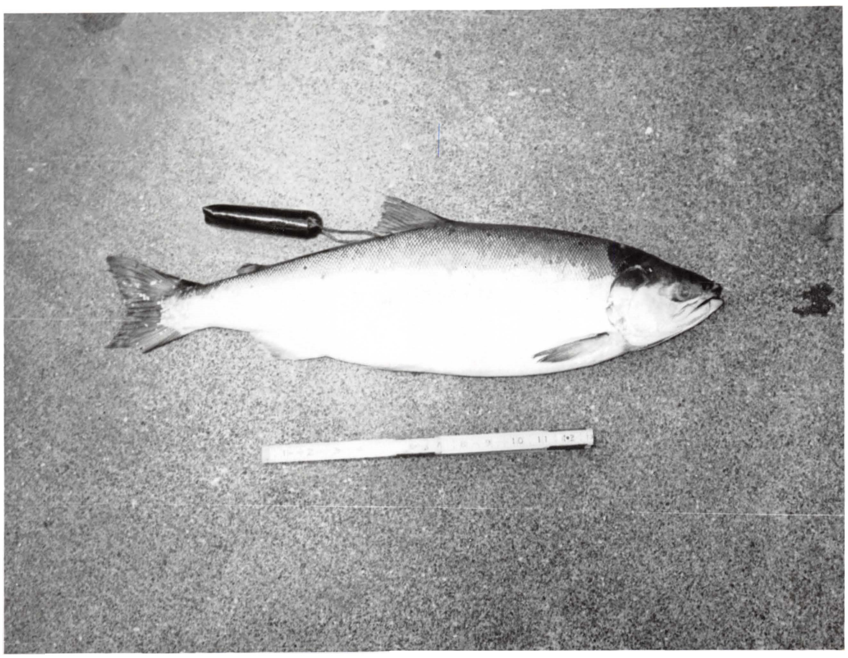

Figure 3. Sonic Fish Tracking Device

(Model of signal generator showing manner of attachment to fish)

Orientation Laboratory

In maintaining a salmon fishery there are few problems as critical as that of providing adequately for fish passage. Yet, our progress toward the solution of that problem has been painfully slow. It will probably continue to be slow until we have a better understanding of the basic principles involved. A knowledge is needed of the factors influencing the direction and rate of fish movement. The biological term for this aspect of fish behavior is fish orientation. It includes all of those reactions that determine the position and movement of the fish in relation to its surroundings. Principles of fish orientation are the basic principles involved in providing passage for fish. A systematic search for the principles of fish orientation may provide the shortest and surest route to a solution of the problem of fish passage at dams.

To provide a means of acquiring such information a special type of laboratory is being planned in which it will be possible to measure the reactions of the migrating fish under controlled experimental conditions. The structure will be located on a bypass into which fish can be diverted from one of the major fishways at Bonneville Dam. The fish will swim into the laboratory where they can then be subjected to a variety of experimental conditions without interfering with the normal passage of fish in the main fishway. When the fish have passed through the experimental area and their reactions are recorded, they will swim out of the laboratory and reenter the fishway. Experiments are planned investigating the swimming abilities of the fish, their reactions to light, form, water turbulence and spatial relationships. An effort will be made to discover the factors controlling their rate of movement through fishways and the size of fishway required for given numbers. By the use of choice techniques the preferences of the fish for various flow properties, water temperatures and chemical conditions will be measured. The behavior of fish in tunnels and conduits, open channels and pools will be examined using the actual full scale dimensions and flows used in fishways at major dams. The construction of this unique type of laboratory will make possible an entirely new experimental approach to the problem of fish passage.