Editor's Note. The further development of power, industry, and irrigation is associated with an increase of water consumption, which is often realized from sources having fisheries importance. In a nature conservation aspect the problem of protecting young fishes during intake of water has acquired particular importance for fulfilling the Food Program. The presently used devices have not produced the expected effect.

The research department of the All-Union Planning, Surveying, and Scientific-Research Institute (Gidroproekt) (Volgograd Branch) has put forth the concept of the decisive significance of engineering hydraulics in the solution of this problem and proposes to develop purposeful programs of protecting fish at intakes for individual regions on the basis of an integrated systems approach to the solution of the problem and use of hydraulically substantiated protective screens washed by hydraulic jets and to include their realization in the national economic plans.

At the same time, there are suggestions on protecting fish at intakes without the use of barriers, in particular, on the basis of ecological principles of protection. The article of B. S. Mal'evanchik, "Engineering Aspects of Fish Protection at Intakes," was published in 1981 (No. 6), which contained the suggestion of using a barrier-free device—a curved canal with diversion of the fishes from the concave bank. The article of V. M. Sinyavskaya continues the discussion.

**COMPLEX PROBLEM OF PROTECTING FISH AT WATER INTAKES**

V. M. Sinyavskaya

The planned development of the country's economy and the realization of the Food Program are associated with increasing water consumption. The water-conservation measures being carried out, such as treatment of industrial and domestic sewage, temporary restrictions on fishing, some restrictions on water transport, improvement of spawning grounds, fish-breeding measures, construction of fishways at many hydro developments, and others, are creating favorable conditions for natural reproduction of fishes in streams and water bodies of the country. However, active withdrawal of water, which, for example, on the Ural River reaches 30% of the natural runoff, and the colossal damage to fisheries from intakes do not permit obtaining a due return from the measures taken with respect to an increase of fish stocks and make the problem of fish protection at intakes a major one.

The hydropower industry is successfully solving many problems occurring in the design and construction of multipurpose hydro developments by methods of engineering hydraulics; the Volgograd Branch of Gidroproekt, headed by the author, has considerable experience in hydraulics-laboratory and on-site investigations performed for scientific and engineering substantiation of projects. Research and development are being carried out at many successfully operating Soviet and foreign hydro developments. It was logical when solving the new problem posed by the State Science and Engineering Committee in 1976 to evaluate the available developments and already constructed fish protective devices (FPDs) at intakes from the standpoint of engineering hydraulics, to determine the virtues and faults of the constructed FPDs, and to establish the possibilities and role of engineering hydraulics in the creation of effective devices and methods of protecting fishes at intakes. Research
and patent investigations, on-site inspections of 35 Soviet intakes, laboratory hydraulic investigations of standard FPDs, and a numerical evaluation of their operating regimes gave grounds to conclude that the main cause of the low effectiveness of FPDs is their hydraulic imperfection. This convinced us of the need to develop hydraulic direction of the solution of the problem.

As a result of this direction of works, methods and FPDs having a hydraulic principle of action were proposed, brought to the design stage, and some of them were manufactured and tested full-scale under experimental and on-site conditions. With fulfillment of the design parameters they showed a consistently high (from 90 to 100%) effect of protecting young fish under various conditions. This gave grounds to consider the hydraulic direction to be the main and decisive one in solving the problem and the hydraulically improved devices and methods of protecting fishes to be the only effective ones. However, such a conclusion is not shared by certain specialists, mainly biologists, who are also studying this problem, elaborating it, and, through the Ichthyological Commission of the USSR Ministry of Fisheries (Minrybkhoz), are setting the scientific-technical policy in this area not only theoretically but also practically, since they make recommendations on the use of new developments. The considerable death of fishes at intakes, the irretrievability of the losses and the urgency of the problem under conditions of realization of the country's Food Program, and the great economic significance of the problem make further delay of the solution of the problem impermissible and necessitate a broad discussion of the problem.

It seems expedient to examine, possibly for purposes of discussion, such problems: what intakes have been and are being put into operation in the country and what is the relative loss to fisheries from small, medium, and large intakes; how many and what devices should be manufactured and constructed for fish protection and what are the causes of their low effectiveness; what does biological science suggest for solving the problem; what does engineering hydraulics suggest and what place should it occupy in solving the problem; at the current stage of scientific development can fish protective measures at intakes be included in the national economic plan and how should the plan be substantiated? We will give our views on some of them and will dwell in more detail on the causes of the low effectiveness of the FPDs being used and on the hydraulic aspects of the problem.

Intakes. We will agree to call intakes with water withdrawal up to 10 m³/sec small; from 10 to 50 m³/sec medium; from 50 to 200 m³/sec large; and more than 200 m³/sec especially large. Small intakes number tens of thousands, medium hundreds, large tens, and especially large units tens.

Small intakes - these are mainly irrigation, and also of industrial, domestic, power, and fishery purpose; medium - irrigation and power; large - mainly power, partly irrigation; especially large - mainly power and a few irrigation or multipurpose.

Small intakes as a consequence of their large number inflict maximum damage on the country's fisheries in all regions. According to the data of the Caspian Fisheries Research Institute (KasNIRKh), it amounts for certain water sources to 40-70% (Lower Volga, etc.) of the total loss from intakes. On the Ural River within the Gurev Region small intakes are the cause of all fisheries damage. Medium intakes are widely distributed and therefore their negative effect on natural reproduction of fishes in the country is quite substantial. Large and especially large intakes inflict considerable damage on fisheries in those regions where they are located. On the whole, more fishes perish on intakes than are produced by all hatcheries of the country [1].

It follows from the aforesaid that to achieve a maximum economic effect it is necessary to implement fish protective measures mainly on small and medium intakes. Here it is necessary to take into account that they require a minimum investment of material resources. For especially large intakes it is most expedient to make decisions about compensating measures, which, however, should be substantiated by a technical-economic comparison of variants of the decisions.

Fish Protective Devices. In the evolutionary development of the problem of protecting fishes at intakes we distinguish three directions - technical, biological, and hydraulic. They can be characterized so.

Technical Direction of Solving the Problem. The period of development of the technical direction, having a duration of 50-60 years if reference is to world practice and 25 years if we are speaking about Soviet practice of constructing fish protective devices, is char-