FISH PROTECTION STRUCTURES AND FISH PASSAGE FACILITIES

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Keywords: specific fish population, different characteristics , speed of current, water depth, river bed and banks, movement regime, quality of the water, water temperature, atmosphere, radiation, evaporation, thermal stratification, speed of current, hydraulic development scheme, distribution of rheophily, flowing water, limnophile, calm water, ubiquitous species, dissolved oxygen content, availability of food、plankton, river bottom, benithic fauna, earnivorous species, nitrogen and phosphorous contents, young ayu, *Plecoglossus altivelis*, zooplankton, river bank, fishlife, mitigate, catadromous fish, eels, pebble bank, trout, barbell, nose carp、dace, eggs, biomass, dams act, barriers, migrate, regulation, fish pass, structure, communication, reservoir, diversity, plant, animal species, long-term persistent turbid water, surface layer intake, clear outlet water, turbid layer, fish pass facilities, migrating value, tidal barrier, small barrage, ladder, Denil fishway, baffle wall, fish lock, appropriateness, effectiveness, predator, successive pool, overflow weir, vertical slot, submerged orifice, bypass, salmon, aptitude, physical performance, Cyprinidae, alosa, navigation lock, elevator,

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Summary

For the purpose of maintain fish populations in the rivers, almost dams install clean water intake structures in reservoir for down river stream and fish pass ways through the dam. These structures are designed with characteristics of the rivers. General cases are presented in the figures. Fish protection structure is not cared in reservoir generally due to keep simple condition for changing of water level in reservoir.

1. Introduction

Each reach of a river is home to a specific fish population, which becomes established there because of the different characteristics of the river; speed of current, water depth, nature of the river bed and banks, possibility of movement regime of the river and more generally, quality of the water. Any changes in these characteristics will lead to a change in fish population.

Dams act as barriers to the movement of fish and may thus lead to the disappearance of certain species which need to migrate in order to survive. It is therefore sometimes required by regulations and in any case desirable to provide suitable fish pass structures for migrating fish. Such structures will also be useful for communication between reservoirs and will help maintain diversity among plant and animal species. General information on fishlife in river which should have minimum knowledge for dam builders as follows ((ICOLD Bulletin (1999)).

Water temperature is determined by the initial temperature from upstream and heat exchanges with the atmosphere through radiation and evaporation. The temperature can be modified by the dam which, by slowing down the current, prolongs the exchange with the ambient air. The increase in depth can result in thermal stratification of the reservoir. Since fish develop and reproduce within a fairly narrow temperature range, any change in this range can also result in a change in the fish species found in the river.

The speed of the current can be modified considerably by a hydraulic development scheme. Increased, current speed can be increased. A change in current speed following the construction of a dam leads to a change in the distribution of rheophile or “flowing – water” fish, and limnophile or “calm water” fish. However, there are also some species of fish which are not very sensitive to current speed. These “ubiquitous” species will hardly be affected by the changes in the speed of the current.

The depth of the water also plays a role. Some fish prefer deep water while others prefer shallow water. This factor is generally related to other factors which characterize deep water zones: current speed, nature of river bottom, temperature and dissolved oxygen content.

The availability of food obviously is of vital importance. This is the form of plankton, insects living on the river bottom (benthic fauna) or the surface, water grasses found on the river bottom pr the banks, algae and, of course, fish which provide food for carnivorous species. Food availability depends on the elements arriving in the section of the river from upstream, on the quality of the water ‘nitrogen and phosphorous contents) and on the nature of the river bottom and banks. Feeding habits differ with the age of the fish. For example, young ayu (*Plecoglossus altivelis*), which are highly appreciated in Japan, feed on zooplankton in the sea and when they reach adulthood swim up reverse to browse in plant communities growing among the pebbles.

The nature of the river bottom and the banks determines the development of water plants and benthic fauna. Solid, rocky bottoms are not conducive to such development, whereas loose rocks, especially on river banks, can provide the shelter required by certain fish. Sandy or gravely bottoms are generally more propitious to the development of fishlife. The type of bottom plays an essential role in terms of feeding and reproduction. Many fish species lay their eggs on aquatic vegetation. Each species requires a particular type of spawning ground with gravel or sand of a specific grain size.

The need to migrate is another very important factor to be considered by the dam builder since dams constitute an obstacle for migrating fish. The need is particularly

marked for fish which come from the sea to spawn in the rivers (anadromous fish such as salmon and sturgeon) or, for fish which go to spawn in the sea (catadrous fish such as eels). A few species such as the ayu migrate to the sea not only to reproduces but also to feed. In addition, certain fish species migrate over considerable distance to find spawning grounds which are distinct from their normal feeding grounds. Examples of such fish are the trout, barbel, nose carp and dace, which all migrate up rivers to lay their eggs on clean pebble banks in running water. It should be pointed out that riverine migratory fish species are among the most vulnerable in relation to dam construction, and their biomass may far exceed that of resident species.

2. Fish protection structures

Fish protection structure is generally no attention in reservoir for the purposes of hydro-power, food control, irrigation and water supply. Because the water lever in the reservoir will be changed due to the demand of the reservoir water. So these intake structures are designed for clear intake water in all reservoir level. In this consideration, fish protection structure in reservoir is usually not prepared without special case.

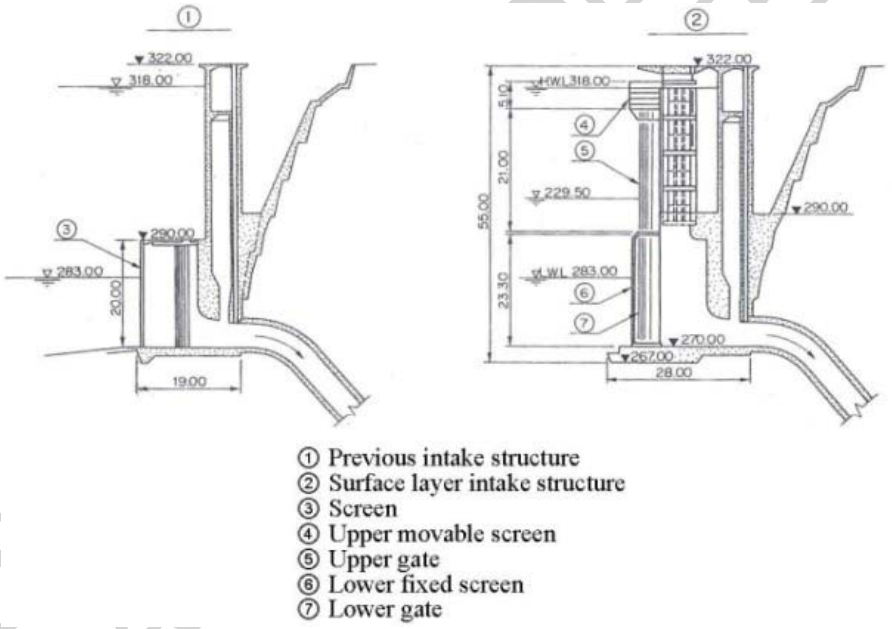

Figure 1. Cross sections of previous and surface layer intake of Ikehara Power Station (O.Iwashita, K.Kikuchi and M.Ohnishi (1994))

According to the concept of Applied Ecological Engineering**,** it should be cared to keep the natural condition after impounding the reservoir as an artificial lake or pond. It will be better to pay attention to mitigate the loss of natural conditions in the reservoir under concept of bio-manipulation and ecological conservation.

The countermeasures against long-term persistent turbid water by surface layer intake at Ikehara hydropower station for clear outlet water to downstream (.Iwashita, K.Kikuchi and M.Ohnishi (1994)). Ikehara reservoir was respectively clear water after impounding

up to reserve some floods during operation. However in this operation period, the reservoir water made persistent turbid layer, then intake water was from the layer by original intake structure in Figure 1 and the temperature of the persistent turbid layer in Figure 2. According to the consideration of the natural water condition in the downstream river, the intake structure modified to be intake water in clear layer in the reservoir in Figure 1. This case will be one of the examples of the fish protection.

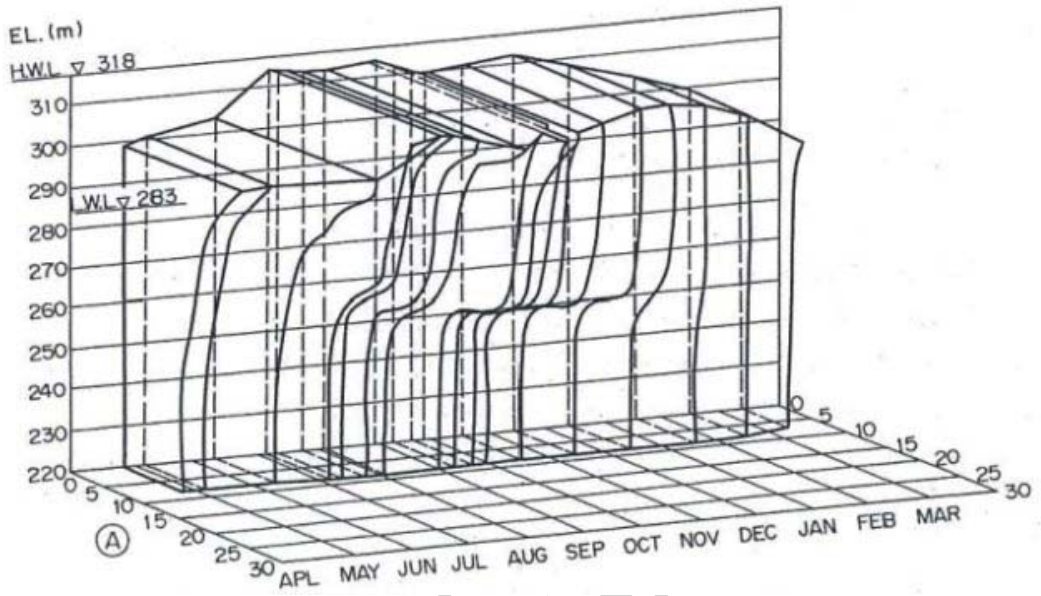

Figure 2 The temperature stratification in Ikehara Reservoir
(O.Iwashita, K.Kikuchi and M.Ohnishi (1994))

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Biographical Sketches

Kyohei Baba - Doctor Engineering. Past Vice-President of International Commission on Large Dams (ICOLD). Chairman of Committee on Environment of ICOLD and of Committee on International Affairs of Japan Commission on Large Dams. Lecturer, Science University of Tokyo. He has been engaged engineering works for large dam projects in the world since 1956. His special fields on dams engineering are environmental problems for reservoirs and structural designs of dams.

Toshio Hirose - Doctor Engineering. The honorary member of the Japan Society of Civil Engineers, past former Vice-Minister, the Ministry of Construction, the former President of the Japan Commission on Large Dams and the former President of the Ecology and Civil Engineering Society. He is the top leader of dam engineering in Japan. He has experienced every stages of dam engineering such as design, construction, and operation for river management and also environmental countermeasures for reservoir by biotechnological conception. Especially he has originally proposed the Roller Compacted Dam (RCD) method and applied on actual projects. He has also established the Ecology and Civil Engineering Society aiming at the close cooperation between civil engineering and ecology. It is organized by civil engineers and biologists from all biological fields such as algae, fishes, plants, animals and birds. He is now getting actively in these fields.