THE POPULATION STRUCTURE OF PINK SALMON

M.K. GLUBOKOVSKIY and L.A. ZHIVOTOVSKIY

Institute of the Biology of the Sea, FE Branch, USSR Academy of Sciences, Vladivostok
N.I. Vavilov Institute of General Genetics, USSR Academy of Sciences, Moscow

Pink salmon, Oncorhynchus gorbuscha (Walbaum), is the most abundant representative of the pacific salmons: the average world catches over the past 15 years have comprised 115.9 million individuals, or 157,300 MT annually (Konovalov, 1986). Pink salmon is the dominant target species for the salmon fisheries of the Soviet Far East: its annual catch comprises up to 80% of all salmon harvested in our country (Historical..., 1979). In addition, pink salmon at present is the chief target of salmon aquaculture in the Soviet Far East: the portion of young pink salmon released by the salmon hatcheries reaches as high as 70% of the total (Sanin, Rukhlov, 1978). For this reason, the study of pink salmon is of great commercial significance.

Pink salmon inhabits the northern portion of the Pacific Ocean and the adjacent waters of the Arctic Ocean. It is distributed from the rivers of the Korean Peninsula to the Lena River in Asia, and from the rivers of California to the Mackenzie River in North America. Feeding schools at sea are concentrated in the pre-Kuril and pre-Aleutian regions, as well as in the Sea of Japan (Takagi et al., 1981). The numbers of Asian pink salmon are greater than the American. In the Soviet Far East, pink salmon is most abundant in the rivers of Southwestern and Northeastern Kamchatka, Southeastern Sakhalin and the South Kuril Islands. The dynamics of the numbers of this species are characterized by sharp short-term variations during even- and odd-numbered years, a fact which is related to the onset of sexual maturity of the predominant majority of individuals during the second year of life. There are also long-period (up to several decades) changes in the numbers of pink salmon of significant amplitude, which, it is believed, are determined by fluctuations in abiotic environmental factors that influence the reproduction of the populations of this species (Kaganovskiy, 1949; Birman, 1980, 1985; Davydov, 1981). In spite of certain successes in the study of the dynamics of the numbers of pink salmon, forecasting the size of the runs to coastal fishing areas are frequently unsuccessful: the amplitude of the fluctuations in the numbers of adults in each specific locale has turned out to be difficult to predict. This has caused great losses of catches in some fishing areas, and overfishing in others.

As is well known, a required scientific component for the rational utilization of fish stocks, and for satisfactory forecasts of the dynamics of their numbers as well, is knowledge of the population structure of the species (Nikolskiy, 1974; Altukhov, 1974; Konovalov, 1980; Larkin, 1981; McDonald, 1981; Exploration..., 1984). The population structure of pink salmon has been studied comprehensively: based on the particulars of ecology, morphological characteristics, genetic markers (Aspinwall, 1974; Smirnov, 1975; Utter et al., 1980; Takagi et al., 1981; Gritsenko, 1981; Kartavtsev et al., 1981; Salmenkova et al., 1981; Altukhov et al., 1983; Grachev, 1983; Ermolenko et al., 1983; Gagalchiy, 1985, 1986; Beacham, 1985; Beacham et al., 1985). The views of these researchers on the population structure of pink salmon differ rather sharply. However, they all agree on the principles of the population organization of this species, identifying several hierarchical groupings, each of which relate to a specific region. In other words, pink salmon, in the opinion of these researchers, is represented by a number of relatively independent self-reproducing regional groupings. These groupings correspond to the concept, popular in ichthyology, of a localized stock (Macleans, Evans 1981), which now lies at the heart of the strategy for salmon population research and rational utilization (Ricker, 1972; Aliukhov, 1974; 1983; Konovalov, 1980; Kuznutsov; Mina, 1985).

At the same time, by no means all data available, in our opinion, indicate in favor of the usefulness of the concept of a localized stock as adequately representing the population structure of

pink salmon. However, before beginning their discussion, we shall examine the problems associated with the study of the population organization of species.

THE POPULATION STRUCTURE OF PINK SALMON

1. A localized stock of pink salmon represents a fragment (subpopulation) of a self-reproducing even or odd year population. In its migration paths, it is associated with other stocks and thus cannot be viewed as being an independent unit for purposes of population research. Any study of the population structure of pink salmon must be built upon a unified program conducted simultaneously at various locations, and must include data collection to cover the full monogenetic and polygenetic spectrum, as well as the biological particulars of the species.
2. A key task in researching the structure of pink salmon populations is to study the factors relating to population dynamics, above all the need for qualitative evaluation of the directions, intensity and periodicity of changes in its migration paths and the environmental and anthropogenic factors that cause them. In addition, regularities in the role of selection at the various stages and the various locations of the pink salmon's life cycle must be studied.
3. A localized stock of pink salmon may not serve as an independent unit for purposes of prediction and fishing activity due to the fluctuations (sometimes extreme) in its boundaries and numbers. In order to find an effective answer to the question of rational utilization of the stocks of pink salmon, the system of interacting fluctuations within the stocks must be considered as a whole. In particular, forecasts of pink salmon runs must be of a global nature, i.e., must begin with an overall evaluation of the numbers of fish of a particular generation at sea, and must consider the hydrologic, synoptic, anthropogenic and other factors of its environment that will determine the most probable spawning migration paths for the particular year from the feeding grounds.
4. In certain years, if the barriers to migration have been significantly altered, a notable change should be expected in pink salmon migration paths from the feeding grounds to the spawning areas, which would lead to sharp changes in the numbers of pink salmon in the run to the various fishing areas over what could be expected based on the concept of a localized stock.
5. Ocean fishing causes less damage to pink salmon reproduction than to the reproduction of other salmon species whose population structure is in keeping with the concept of a localized stock. The intensity of fishing allowed in a specific area must be established on the basis of the nature of the migration paths of the pink salmon, and must take the interactions between fluctuating stocks into consideration.
6. The artificial reproductive efficiency at a particular pink salmon hatchery cannot be evaluated based on the size of the return of spawner fish to the home river without considering the particulars of the migration paths from the feeding concentrations at sea. On the whole, the efficiency of fish farming will be lower for pink salmon than for other salmon species whose population structure is more in keeping with the concept of a localized stock.
7. Success in the regeneration of localized stocks of pink salmon is determined not so much by the genetic characteristics of the donor populations as by the presence or absence of barriers standing in the way of spawning migration from the ocean feeding grounds, as well as the ecological particulars of the introduced fish (for example, the time frames and directions of their spawning migrations) which allow them to successfully overcome such barriers.