Stock Abundance Dynamics of Azabachye Lake and Dvukhyurtochnoye Lake Sockeye Salmon *(Oncorhynchus nerka)* from the Results of Sockeye Salmon Origin Identification in the Coastal and River Catches of Kamchatka River Basin

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The Azabachye Lake sockeye salmon "A" stock inhabiting the lower reaches of the Kamchatka River, is very abundant and contributes up to 50–60% of the total Kamchatka River catch in some years. The sockeye salmon "D" stock reproducing in Dvukhyurtochnoye Lake basin is the next most abundant stock and contributes from 3 to 10% (maximum – 15–20%) of the Kamchatka River total sockeye salmon stock.

From the results of sockeye salmon complex identification; including the analysis of fresh-water scale zone (Bugayev 1983, 1986), the frequency of *Diphyllobothrium sp.* infection, and the time of harvest; the contribution of "A" and "D" stocks in total Kamchatka River sockeye salmon coastal and in-river escapement has been estimated for the period from 1978 to 2002. The results provided accurate estimation of "A" and "D" stock contributions to the fishery for the period 1957–1977.

It is estimated that 70-80% of the abundance of the "A" and "D" stocks are composed of age 2.3 fish. Therefore, estimation of the sockeye salmon abundance has been made on the 2.3 age group only. The stock abundance of the "A" stock and "B" stock is equal to the stock abundance of mature fish in the sea before the drift gill net fishery started (Fig. 1–2).

From the analysis of sockeye salmon "A" stock abundance, the level of reproduction (RL) has been subdivided: 1 (high RL) – 1957–1988 after the effect of Azabachye Lake fertilization from volcanic ash (1960–1962, 1977–1979) and years with outstandingly favorable conditions of juvenile feeding (1986–1988) (Fig. 1b); 2 (low RL) – 1957–1988 where the fresh-water period of feeding took place in years without the effects of fertilization, and juvenile feeding conditions were below average (1957–1959, 1963–1976, 1980–1985) (Fig. 1c); 3 – 1989–1996 where the RL was enhanced as a result of favorable feeding conditions during their marine period of life (Fig. 1d–f). Analysis indicates similar conditions of stock abundance dynamics in both the early and late runs of "A" stock sockeye salmon.

The differences between Fig. 1d and Fig. 1f consist only in the assessment of the abundance: a standard year in Fig. 1d and an atypical year in Fig. 1f (for example 1995 and 1996 when adult escapement was 690,000 and 268,000 respectively). The high escapements in 1995 and 1996 resulted in an unusually high percentage (up to 40%) of four ocean age fish in 2002 of the "A" stock (SMP) sockeye salmon for the first time since 1946–1947. We estimate that the abundance of the "A" stock for the years 1957-1994 was equal to the abundance of the SMP of the "A" stock in the ocean before the drift gill net fishery started (Bugayev 1983). In 2003 the "A" stock was composed of about 80% age 2.3 fish.

Current escapement to the spawning grounds in Azabachye Lake should be 100,000 fish for maximum effective reproduction. For the period 1957–1988 the escapement should be 100,000 fish in the case of a high RL , and 50,000 in the case of a low RL .

Prior to 1987 (1957-1986) analysis of the "escapement-progeny" relation in the "D" stock for 1957–1996 (Fig. 2) indicates higher progeny abundance in odd years compared to that in even years since parental escapements in 1987 and 1988. Progeny generations of odd and even years from the parental generations of 1957–1986 do not demonstrate any differences. For the years 1957–1996, we estimated the abundance of the "D" stock to be equal to the abundance of mature fish (SMP) in the ocean before the drift gill net fishery started (Bugayev 1983).

The optimum escapement of sockeye salmon for the Dvukhyurtochnoye Lake basin since 1987–1988 should be about 100,000 fish in odd years (since 1987) (Fig. 2e) and 30,000 fish in even years (since 1988) (Fig. 2f). For 1957–1986 the optimum escapement of the "D" stock has been estimated to be 20,000–30,000 fish (Fig. 2b–d).

Figures 3–4 show the abundance of the "A" and "D" stocks in 1957–2002.

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Fig. 1. "A" stock brood year abundance and abundance of the mature portion of the "A" stock (SMP) sockeye salmon in the ocean that is dependent on the parental escapement in Azabachye Lake for 1957–1996 (combined data on early and late run seasonal "A" stock), in thousands.

a - combined data for 1957–1996 (returns of 1963–2002);
b - brood years of 1957–1988 were influenced by volcanic ash fertilization of Azabachye Lake (1960–1962, 1977–1979) resulting in excellent rearing conditions (1986–1988);
c - brood years of 1957–1988 resulting from below average rearing conditions after the years of volcanic ash fertilization (1957-1959, (1963–1976, 1980–1985);
d - brood years of 1989–1996 when reproduction levels were principally influenced by ocean feeding conditions;
e - brood years of 1989–1996 (with the exception of 1995 when 690,000 fish spawned);
f - brood years of 1989–1996 (with specified abundance of brood years of 1995–1996).

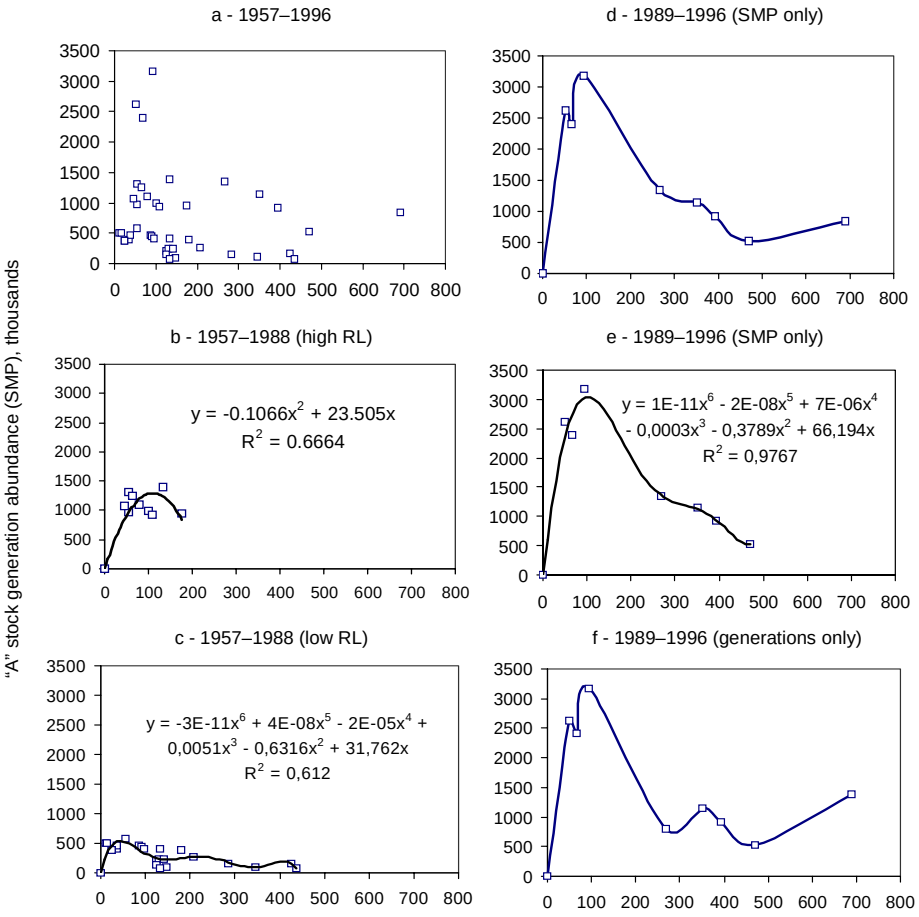

Fig. 2. "D" stock brood year abundance and abundance of the mature portion of the "D" stock (SMP) sockeye salmon in the ocean dependent on parental escapement in Azabachye Lake for 1957–1996 (combined data for early and late run "D" stock), in thousands.

a - combined data on brood years of 1957–1996 (returns of 1963–2002);
b - brood years of 1957–1986 (all years);
c - brood years of 1957–1985 (odd years);
d - brood years of 1958–1986 (even years);
e - brood years of 1987–1995 (odd years);
f - brood years of 1988–1996 (even years).

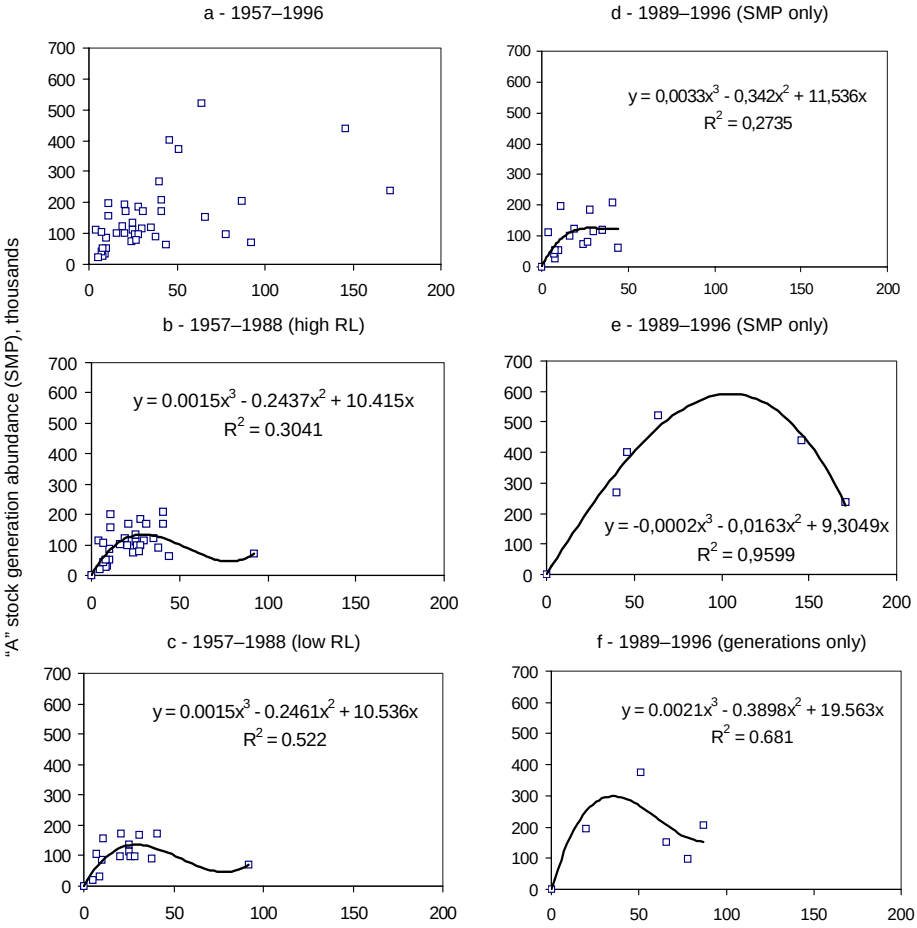

Fig. 3. Sockeye salmon abundance of the "A" stock in 1957–2002: the mature portion in the sea before drift net fishery (1), run (coastal catch + escapement) (2), escapement in Azabachye Lake (3), in thousands.

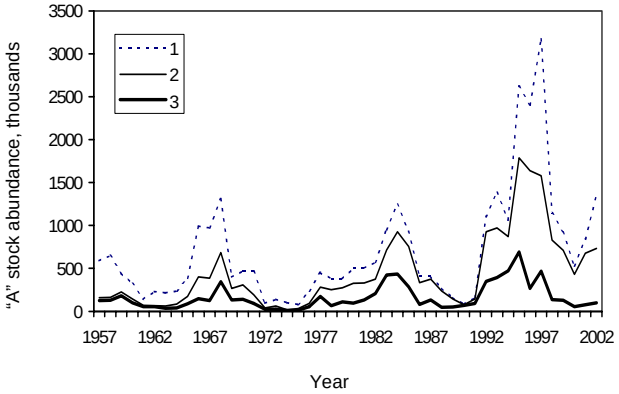

Fig. 4. Sockeye salmon abundance of the "D" stock in 1957–2002: the mature portion in the sea before drift net fishery (1), run (coastal catch + escapement) (2), escapement in Dvukhyurtochnoye Lake (3), in thousands.