The Use of Otolith Mass Marking to Estimate Adult Hatchery Sockeye Salmon Returns to the Bolshaya River (Kamchatka)

Nikolay A. Chebanov and **Marina A. Kudzina**
Kamchatka Research Institute of Fisheries and Oceanography (KamchatNIRO),
18, Naberezhnaya Str., Petropavlovsk-Kamchatsky 683000, Russia

Keywords: Sockeye salmon, otolith mark, identification, Bolshaya River

Large releases of hatchery salmon with otolith marks allows for identification of these fishes in marine and coastal catches. Without mass marking it is difficult to estimate hatchery benefits or to evaluate different hatchery strategies (Akinicheva and Rogatnykh 1997). In Russia, mass otolith marking of hatchery salmon is used in the Magadan Region, in Kamchatka and recently in Sakhalin. In Kamchatka it began at Malki and Ozerky hatcheries located within the Bolshaya River basin respectively in 1995 (Vasilkov 1995, 1996) and 1999. In 2002 all Kamchatkan hatcheries were included into the program of mass "otolith" marking. For the period mentioned, in addition to "thermal" marking, we have started to actively use "dry" marking as well; recommendations have been prepared on the procedure and optimal timing of marking, and also (on each salmon species, hatchery and year) a scheme of its realization and structure of marks (Chebanov and Kudzina 2001, 2002). In the recent years the returns of the marked fish to the base reservoirs of these hatcheries have been noted.

The purpose of this study was to estimate the proportion of hatchery sockeye salmon to total returns of the species to Bolshaya River by discovering marked individuals in samples. Work took place in the river estuary and tributaries where hatcheries were located in 2002.

As a result of analysis of the otolith structure of 193 sockeye salmon individuals that returned to the Malki hatchery in 2002, it was found that 93.3% of the fish were of hatchery origin. 5.7% of the fish had marks from 1998 (4-years old, put into incubation in 1997), 86% - marks from 1999 (3-years old, put into incubation in 1998) and 1.6% - mark from 2000 (2-years old, put into incubation in1999). Besides, one fish was of natural origin, and 12 raised doubts about their origin. The individuals were primarily adults from the generation released in 1999, but of 592,300 juveniles only (from 1,198,200), which were transported to Ketkino hatchery for incubation and rearing, and, hence, were not marked (released with average mass of 1g). Therefore, it could be suggested that among 15000 sockeye salmon that returned to Malki hatchery in 2002, 233 individuals were aged 2+, 12,902 - as 3+ (13,900 fishes including unmarked ones) and 855 - as 4+.

The data obtained from 2000 to 2002 on the age structure of sockeye salmon in runs to Malki hatchery permitted us to estimate the coefficient of return for some generation (from juveniles released in certain years) (Table 1). As it is clear from this table, the highest return coefficients were from the releases of 1998 and 1999. It should be taken into account, however, that the estimation of return of 1995 and 1996 releases was not complete, and that of 1999 and 2000 releases is still incomplete. Considering the above, the lowest return (among terminated ones) is the return of the 1997 release, and the highest one, evidently, should be the return of the 1999 release (4+ and 5+ fishes have not been included in the return yet).

Table 1. Characteristics of sockeye salmon returns to Malki hatchery.

Year of release	Released juvenile	Returns of this generation by years			Total return	Return coefficient from the number of released juvenile, %
		2000	2001	2002		
1995	370,100	16	-	-	16	0.004
1996	669,500	834	59	-	893	0.13
1997	331,700	866	29	-	895	0.27
1998	716,700	334	4324	855	5,513	0.77
1999	1,198,200	-	-	12,902 (13,900)*	12,902 (13,900)*	1.08 (1.16)*
2000	724,500	-	-	233	233	0.03

Note. * - including the return from the generation released with the average mass of 1g.

We also have tried to estimate the ratio between wild and hatchery adult sockeye salmon for the base reservoirs of Malki and Ozerki hatcheries (for Bystraya and Plotnikova Rivers respectively). We realize that this estimation is approximate because reliable information on hatchery fish straying is missing, and poaching in each of the reservoirs

All correspondence should be addressed to N. Chebanov.
e-mail: chebanov@kamniro.ru

is hard to estimate (though its intensity is most likely the same for both wild and hatchery salmon). Table 2 provides aerial estimates of salmons runs in Bystraya and Plotnikova Rivers (kindly granted by A.V. Maslov) and information about salmon runs to the hatcheries (granted by Sevvostrybvod). The contribution of hatchery fish to reproduction in these reservoirs has been estimated on the basis of these data.

According to the data Table 2, the activity of both hatcheries greatly influences the rate of summer sockeye salmon reproduction in the basins of these reservoirs.

In 2002 the otolith structure was described for 328 fishes caught from July 25 to August 8 within Bolshaya River estuary. Fourteen individuals had the marks of Malki hatchery and 2 individuals had the marks of Ozerki hatchery. These data allowed us to assume that the percent of marked sockeye salmon in the catches in Bolshaya River was approximately 4.88% (Malki hatchery – 4.27%, Ozerki hatchery – 0.61%). Among sockeye salmon of Malki hatchery 13 individuals (93%) had the mark of 1999 (3-years old), 2 individuals (7%) – of 2000 (2-years old). Among Ozerki hatchery fishes one individual (3-years old) had the mark of 1999 and the other (2-years old) - of 2000.

According to the statistics of salmon catches in Bolshaya River for 2002, 83.45 tons of summer sockeye salmon was harvested. The data (calculated by five-day periods) taken together with the information on the percent of marked fishes in samples at a certain date provided us with estimation of the hatchery sockeye salmon harvested (Table 3).

Here one should note that the period of sampling (July 25 – August 8, 2002) was shorter than the entire period of sockeye fishing in Bolshaya River (July 16 – September 5, 2002). We considered it reasonable for estimation of hatchery fish removal for the time until 25 July and after 8 August to use minimal values in available samples (1.63%). With that we estimated the approximate value of hatchery fish removal for corresponding periods as 0.35 tons. So, in total about 4.4 tons of hatchery fish were removed (3.9 tons of Malki and 0.5 tons of Ozerki hatcheries). Here we ignored catches by poachers.

The available data let us make some more conclusions. Knowing the average fish weight in the samples (2.86 kg), we could estimate the number of harvested hatchery sockeye salmon – approximately 1540 pcs (1360 pcs – from Malki hatchery, 180 pcs – from Ozerki hatchery). Among harvested Malki hatchery fish, 1265 individuals were 3-years-old and 95 – 2-years-old. Taking into account the first value in estimation of return coefficient from the release in 1999 increases the coefficient from 1.08 (1.16) to 1.18 (1.24)% (see Table 1). The percentage of harvested Malki hatchery sockeye salmon to its total return to the Bolshaya River (harvest + run to the hatchery) provides us with insight to the intensity of this fishery. The latter turned out rather low – 9.1% only. But, according to the Figure 1 Malki hatchery sockeye salmon was harvested mainly in the beginning of the fishery period. In the other words we may say that a relatively early run of Malki hatchery sockeye salmon to the river to a certain degree

Table 2. The ratio between wild and hatchery summer sockeye salmon in Bystraya and Plotnikova Rivers in 2002.

River	Total number of spawners in spawning grounds, $x10^3$	Escapement to the hatcheries, $x10^3$	Total escapement, $x10^3$	Hatchery fish contribution, %
Bystraya	45.1	15.0	60.1	25.0
Plotnikova	16.8	3.5	20.3	17.2

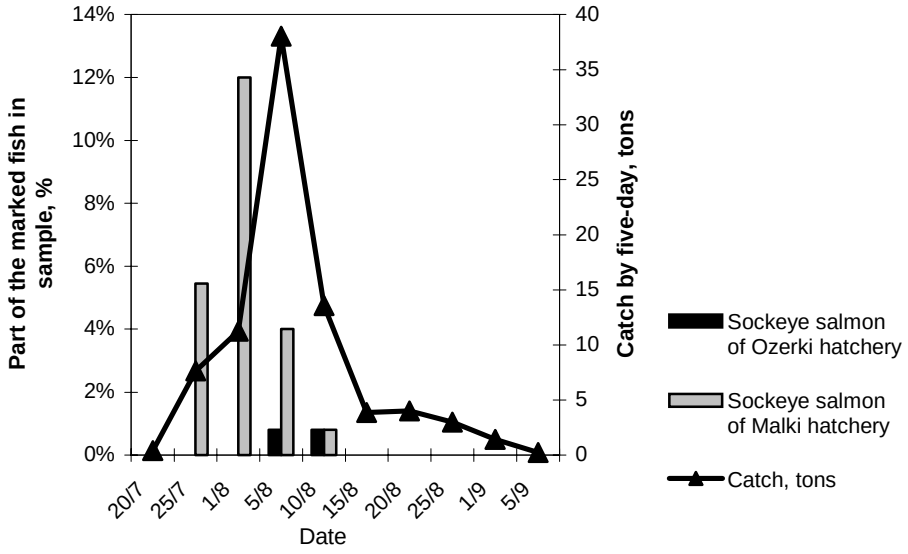
Table 3. Estimation of hatchery sockeye salmon harvested in Bolshaya River in 2002.

Period	Harvest, tons	Percent of hatchery fish, %	Harvest of hatchery fish, tons
16-20.07	0.4		
21-25.07	7.63	5.45	0.42
26.07-01.08	11.25	12.00	1.35
02-05.08	38.02	4.00	1.90
06-10.08	13.58	1.63	0.37
11-15.08	3.88		
16-20.08	4.03		
21-25.08	3.00		
26.08-01.09	1.42		
01-05.09	0.24		
Total:	83.45		4.04

allowed the fish to avoid a more intensive press of fishery. The reason is probably the use for artificial reproduction in 1998 of sockeye salmon from the earliest runs to Malki hatchery. From the data by Sevvostrybovod the last portion of eggs at that year was set for incubation on September 9 (usually incubation lasts up to the end of the second or even third week of September).

So, the described situation suggests one possible solution of the problem of fishery differentiated removals of individuals of different reproduction types. The fears of some researchers (Reisenbichler and McIntyre 1977; Allendorf and Ryman 1987; Fleming and Gross 1989, 1992) regarding the possibility of "genetic degradation" of salmon stocks with a big percent of hatchery fish may be, in our opinion, partially reduced by efficient temporal management of the fishery, differentiating between the time of spawning migration populations of natural and hatchery origin.

Fig 1. Dynamics of catches summer sockeye salmon in Bolshaya River (by five-day periods) and the percent (in these catches) of marked fish of Malki and Ozerki hatcheries in 2002.



REFERENCES

Akinicheva, E.G., and A.Y. Rogatnykh. 1997. The experience of the mass marking of the hatchery salmon using the method of otolith thermal coding. Magadan TINRO. Tech. Rep. Magadan: 36. (In Russian)

Allendorf, F.W., and N. Ryman. 1987. Genetic management of hatchery stocks. Population genetics and fishery management. University of Washington Press, Seattle, Washington. pp. 141–159.

Chebanov, N.A., and M.A. Kudzina. 2001. Results of mass otolith marking of hatchery juveniles in Kamchatka salmon hatcheries in 2000-2001. KamchatNIRO Tech. Rep. Petropavlovsk-Kamchatsky: 31. (In Russian)

Chebanov, N.A., and M.A. Kudzina. 2002. Results of otolith marking of juvenile in Kamchatka salmon hatcheries in 2001–2002 and preliminary data on the return of recovery of marked fishes. KamchatNIRO Tech. Rep. Petropavlovsk-Kamchatsky: 53. (In Russian)

Fleming I.A., and M.R. Gross. 1989. Evolution of adult female life history and morphology in a Pacific Salmon (Coho: *Oncorhynchus kisutch*). Evolution. 43: 141–157.

Fleming I.A., and M.R. Gross. 1992. Reproductive behaviour of hatchery and wild coho salmon (*Oncorhynchus kisutch*): does it differ? Aquaculture. 103: 101–121.

Reisenbichler R.R., and J.D. McIntyre. 1977. Genetic differences in growth and survival of juvenile hatchery and wild steelhead trout, Salmo gairdneri. Can. J. Fish. Res. Board Can. 34: 123–128.

Vasilkov, V.P. 1995. The method of thermal marking and identification of salmon in Kamchatka hatcheries from the otolith marks. Kamchatrybvod Tech. Rep. Petropavlovsk-Kamchatsky: 48. (In Russian)

Vasilkov, V.P. 1996. Recommendations to the thermal marking of juvenile salmon at Malkinsky hatchery. Kamchatrybvod Tech. Rep. Petropavlovsk-Kamchatsky: 22. (In Russian)