Some features of chum salmon biology (Oncorhynchus keta) in Inya river (the sea of Okhotsk)

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Abstract. Some biological indicators of chum salmon producers that spawn in the Inya river (Khabarovsk Territory, Sea of Okhotsk) in 2013-2014 have been studied. A comparative analysis of dimensional characteristics showed that in 2013, the range of changes in the length of chum salmon was higher (from 51 to 73 cm), while the dynamics of changes during the spawning season differed. Weight indices of chum salmon were higher in 2013. During the spawning season, both in 2013 and 2014 the average values of the mass of chum salmon decreased (in 2013 from 1.5 to 5.5 kg, in 2014 - from 2.0 to 5.0 kg). The chum salmon was harvested at the age from 2+ to 5+ years in 2013-2014. Fish prevailed at the age of 3+ years. The average value of the individual absolute fecundity was higher in 2013 (2412 ± 62 units) than in 2014 (2180 ± 83 units)

Keywords: chum salmon, Inya river, size composition, weight composition, age, linear growth, fecundity, sex ratio

1. Introduction

Pacific salmon are the most numerous representatives of the fish fauna of the rivers of the Okhotsk region. Traditionally, salmon on the northwestern coast of the Sea of Okhotsk are harvested during their spawning period (anadromous migration). At the same time, the rivers of the Okhotsk region (of all the watercourses of the northwestern part of the continental coast of the Sea of Okhotsk) play one of the leading roles in the Khabarovsk Territory in fishing and reproduction of Pacific salmon [1-3].

The reproduction of salmon in the Okhotsk region of the Khabarovsk Territory is supported mainly by natural populations. One of the factors influencing the size of stocks and the reproductive potential of salmon populations is the state of spawning waters. The spawning fund is in good condition, has about a hundred rivers of different size and a dozen lake-river systems. Salmon breeding sites are practically unaffected by economic activity, but in recent years some spawning reservoirs of the coast have been surveyed to assess reserves and transfer commercial gold deposits, which will inevitably lead to a reduction in the spawning stock and will have a negative impact on the chum salmon [4-8]. Regular research on reproduction biology, population dynamics, and the state of the stock of salmon species in the Okhotsk region was conducted for more than 50 years. Throughout the entire period of research, these questions were well studied for the Kuhtuy river basin. As for the Inya river the data is fragmentary.

The goal of this research was to study some biological indicators of chum salmon of the Inya river in 2013-2014.
2. Materials and Methods of Study
The work was based on field materials - analysis of control catches of producers during the spawning migration of chum salmon in the Inya river [1] (Okhotsk District, Khabarovsk Territory) in 2013-2014 (Fig. 1).

Collecting the ichthyologic material was carried out by fishing the control areas with smooth and fixed nets (mesh sizes of 50–70 mm). 600 chum salmon units were taken for biological analysis. Analysis of the biological state of chum salmon was carried out according to generally accepted methods [2].

3. Results and Discussion

3.1. Terms and dynamics of anadromous migration of chum salmon in 2013-2014
For many years, observations have shown that the dates of chum salmon approach to the rivers of the Okhotsk region fall at the beginning of July; the catch is fixed piece by piece from the first days of fishing [2, 9-12]. The main mass or peaks of the chum salmon are at almost the same time in different years. These are usually two powerful rune moves, the first in early August and the second in the middle, towards the end of the twentieth of August. The catch of the chum salmon in September is already noted piece. In 2013, the anadromous migration of chum salmon into the rivers of the Okhotsk region and the fishery began from the 2nd five-day of July and the end of the fishery began in mid-September. The peak of the move was noted in the second and third five-days of August, and the second peak was in late August. In 2014, the spawning of chum salmon in the Okhotsk region took place from the third five days of July to the fourth five days of September, inclusive. In July, there was significant rainfall, which caused a rise in the water level in the rivers of the region. The most intensive fishing was carried out in August (August 10-20), when daily catches in the region reached 600-800 tons. In September, fishing was actually stopped, due to insignificant fish catches in seines and fixed nets.

Figure 1 - Map of the research area

3.2. Size composition of chum salmon
According to multi-years data in the Okhotsk municipal district for the period 2006-2012, chum salmon was 63.7 cm long (males were 65.3 cm, females 62.2 cm) [2]. Comparative analysis of the
Dimensional characteristics of chum salmon producers in 2013 and 2014 showed that the range of changes in the length of the chum salmon was higher in 2013 (from 51 to 73 cm), while the dynamics of changes during the spawning season differed (Fig. 2-7). At the beginning of the spawning season in 2013, the minimum average length of chum salmon was observed (Fig. 2), and at the beginning of the spawning period in 2014, the chum salmon was characterized by larger average values than at the middle and end ones (Fig. 5-7). Common was the fact that the average length of males was higher than females.

![Figure 2 - Size composition of chum salmon in the Inya river at the beginning of the spawning run in 2013](image1)

![Figure 3 - Size composition of chum salmon in the Inya river at the middle of the spawning run in 2013](image2)
Figure 4 - Size composition of chum salmon in the Inya river at the end of the spawning run in 2013

Figure 5 - Size composition of chum salmon in the Inya river at the beginning of the spawning run in 2014
3.3. Weight composition of chum salmon

According to the multi-year biological indicators of salmon in the Okhotsk municipal district for the period of 2006-2012 the mass of chum salmon was 3.62 kg, the mass of males was 3.96 kg, the mass of females was 3.32 kg [2]. According to our data for the period of the study, the mass of chum salmon in the catches changed in 2013 from 1.5 to 5.5 kg, in 2014 - from 2.0 to 5.0 kg (Fig. 8-13). Weight rates of chum salmon were higher in 2013. The average mass of male chum salmon was higher than that of females. During the spawning season, both in 2013 and 2014, average mass of chum salmon decreased (Fig. 8-13).
Figure 8 - Weight composition of chum salmon in the Inya river at the beginning of the spawning run in 2013.

Figure 9 - Weight composition of chum salmon in the Inya river at the middle of the spawning run in 2013.
Figure 10 - Weight composition of chum salmon in the Inya river at the end of the spawning run in 2013

Figure 11 - Weight composition of chum salmon in the Inya river at the beginning of the spawning run in 2014
3.4. **Age composition of chum salmon**

In 2013, at the beginning of the spawning season, a chum salmon of three generations aged 2+ to 4+ years was harvested (Fig. 14-16). Fish prevailed at the age of 3+ years - 69%.
In the middle of the spawning run, spawning clusters were formed from individuals of two age groups - 3+ and 4+. As at the beginning of the spawning season, fish at the age of 3+ prevailed (91%) (Fig. 15). Chum salmon at the end of the spawning run was represented by individuals aged 2+ to 5+ years. The basis of chum salmon was fish aged 3+ years (73.0%) (Fig. 16).
Spawning age groups of chum salmon in the Inya river were three, four and six years in 2014. The modal group consisted of four years - this generation was born in 2010.

At the beginning of the spawning season, chum salmon of four generations (the ages of 2+ and 5+ years) was harvested (Fig. 17), with six-year-olds being represented by males. Fish prevailed at the age of 3+ years - 71%. The number of fish at the age of 2+ years was met individually; the number of five-year units was 22%. The average age of the fish during this period was $3.6 \pm 0.1$ years.

In the middle of the spawning run, spawning clusters consisted of chum salmon of three age groups - 2+, 3+, and 4+. As at the beginning of the spawning season, fish aged 3+ prevailed (89%) (Fig. 18). The average age of the fish was $3.2 \pm 0.1$ years.
Figure 18 - Age composition of chum salmon at the middle of the spawning period in 2014

Chum salmon at the end of the spawning run was represented by individuals aged 2+ to 5+ years. The basis of chum salmon was also fish aged 3+ years (73.0%) (Fig. 19). The average age was 3.4 ± 0.1 years.

Figure 19 - Age composition of chum salmon at the end of the spawning period in 2014

3.5. Linear and weight growth of chum salmon
The linear growth of female and male chum salmon according to our observations is somewhat different (Fig. 20). The average masses of female chum at the age of 3+ are lower than those of males (3.3 kg and 3.1 kg, respectively). At the age of 4+, the rate of weight growth is also higher in males. Five-year-old males had a mass of 3.5 kg, and females - 3.3 kg (Fig. 21).

3.6. Chum salmon sex ratio
According to average multi-year biological indicators of salmon in the Okhotsk municipal district for the period 2006-2013 the proportion of females was 52.1% [2]. According to our data, the females
also prevailed in 2013 in the catches of the Inya river. At the beginning of spawning, the ratio of males to females was 36% females and 64% males. In the middle of the spawning season, the sex ratio was the same. At the end of the spawning season, the percentage of females increased. The proportion of females was 48%.

**Figure 20.** Linear growth of chum salmon in 2013-2014

**Figure 21.** Weight growth of chum salmon in 2013-2014
In 2014, during the spawning migration at the beginning of the spawning run, the sex ratio was close to 1 : 1; the distribution during the spawning run was close to the classical one [2]: at the beginning of the run males prevailed, in the middle of the spawning run males prevailed slightly, and at the end the run females dominated. This sex ratio at the end of the spawning run is natural and is apparently due to a small anthropogenic (poaching) effect on the grouping of chum salmon in the Inya
river.

3.7. Fecundity of chum salmon in the Inya river

In the years of research, the individual absolute fecundity of chum salmon in the Inya river changed (Table 1).

| Sex              | IAF, un. | Amount, units |
|------------------|----------|---------------|
|                  | x_{min} | x_{max} | \bar{x} \pm m_x | \sigma |
| 2013 г.          |         |         |               |        |
| Beginning of run | 1613    | 4392    | 2348 \pm 56    | 552    | 56   |
| Middle of run   | 1863    | 3963    | 2690 \pm 80    | 400    | 55   |
| End of run      | 1608    | 5810    | 2290 \pm 82    | 540    | 37   |
| Total           | 1608    | 5810    | 2412 \pm 62    | 754    | 148  |
| 2014 г.          |         |         |               |        |
| Beginning of run| 1320    | 4150    | 2066 \pm 104   | 560    | 30   |
| Middle of run   | 1574    | 3820    | 2250 \pm 94    | 470    | 25   |
| End of run      | 1258    | 4319    | 2225 \pm 126   | 630    | 25   |
| Total           | 1320    | 4319    | 2180 \pm 83    | 742    | 80   |

The study showed that some biological indicators of chum salmon (length, weight, fecundity) in 2013 were slightly higher than in 2014. The information obtained will supplement information on the features of the biology of chum salmon in the Inya river and will be useful for rational fishing and reproduction.

4. Conclusion

1. At the beginning of the spawning period of 2013 in the Inya river, the average length of chum salmon was 60.7 \pm 0.3 cm, in the middle of the spawning period - 61.4 \pm 0.3 cm, at the end - the average value of chum salmon was maximum – 61.5 \pm 0.4 cm. In 2014, a decrease in the average length of the chum salmon from the beginning to the end of the run was observed from 60.9 \pm 0.3 to 59.2 \pm 0.3 cm. The average values of the length of the males were higher than that of the females.

2. At the beginning of the spawning run in 2013, the average weight of chum salmon was 3.4 \pm 0.05 kg. At the middle of the spawning run, the average weight of chum salmon was lower than at the beginning of the run and amounted to 3.2 \pm 0.04 kg, at the end of the spawning run - 3.1 \pm 0.1 kg. In 2014, the average weight of chum salmon was lower than in 2013 and at the beginning of the run was 3.15 \pm 0.06 kg, in the middle of the run - 3.10 \pm 0.05 kg and at the end of the spawning run - 2.70 \pm 0.04 kg.

3. In 2013-2014 the chum salmon was harvested at the age from 2+ to 5+ years. Fish prevailed at the age of 3+ years.

4. Intense linear growth of chum salmon occurs during the first three years of life. The rate of linear and weight growth is higher in males.

5. Females dominated at all stages of spawning in 2013. In 2014, males prevailed at the beginning of the run (64%); the proportion of males in the middle of the spawning movement was 56%, but at the end of the spawning movement, the proportion of females increased to 64%.
6. The average value of the individual absolute fecundity in 2013 was $2412 \pm 62$ units, with changes from 1608 to 5860 units. In 2014, the individual absolute fecundity changed from 1320 to 4319 eggs, making an average of $2180 \pm 83$ units.

7. Chum salmon population in the Inya river has stable biological indicators and its condition is assessed as favorable.

**Conflicts of Interest:** The authors declare no conflict of interests.

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