

# Ecological Analyses of Pelagic Shoals

J. Analysis of Salmon Gill-net Association in the Aleutians

3. Differences between the Food-selectivities of Five Species of Salmons \*

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In my previous papers, I reported, besides the distribution of salmons on the net, that the total food weight taken by each individual of the same species is not similar but varies considerably, that these salmons (*Oncorhynchus nerka*, *O. keta*, *O. gorbuscha*, *O. kisutch* and *O. tshawytscha*) are classified into three types according to the proportion of each group of their food animals, that the ecological orders of these fishes are determined by their food compositions and that the amounts of preys taken by individuals of the same species caught in the same day are considered to be independent one another.

However, the latter three can not be guaranteed to be the necessary phenomenon but not the apparent ones unless the existence of differences between the food-selectivities of these fishes is admitted. Therefore, I tried to examine on the data used formerly whether we can admit any difference between the food selectivities of these five species of salmons or not.

Before going further, I wish to express my sincere thanks to Prof. Dr. D. MIYADI (Kyoto University) for his kind guidance and criticisms given to my work. I must also record here my hearty thanks to Dr. M. MORISITA (Kyushu University) who taught me the statistical methods, Dr. T TOKIOKA (Seto Marine Biological Laboratory) who revised this report, Prof. Dr. I. MATSUI (Shimonoseki College of Fisheries) and Captain Y. SASAKI of the Shunkotsu-maru who afforded me many facilities in carrying out this work.

## Results and Discussion

1. Differences among the quantitative selectivities of foods.

As reported already, the total feed-weight of the same species vary considerably in days and also in individuals. Therefore, we can not easily admit the difference between the food-selectivities of these salmons, even if the inter-specific differences between the weight of a certain prey taken by each of these salmons are considered to be significant. Thus, we must examine whether the inter-specific variance of the percentage of the weight of a certain prey to the total food weight in these fishes are significant in comparison with the variance found within each species of salmons or not, when we analyse the differences between the quantitative food-selectivities of these fishes.

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\* Contributions from the Shimonoseki College of Fisheries, No. 106.

Table 1. Results of examinations on quantitative food-selectivities.

Pray	F <sub>0</sub>	F	Significance Level
Large	2.28	F <sub>2,4</sub> <sup>4</sup> (0.05) =2.7763	—
Middle	0.40		—
Small	1.99		—
Fishes	2.51		—
Squids	2.63		—
Copepods	1.96		—
Gammarids	2.99		0.05
Euphausiids	0.40		—

The percentages of weight of each pray group to the weight of total food taken by individuals of the same species caught in the same day are estimated in each species of fishes caught in each date, and on the values thus obtained the analysis of variance is tried after z-transformation. The results reveal that in spite of the apparent differences between the food compositions in these fishes the differences between the food-selectivities of these fishes can not be admitted as significant, except for gammarid amphipods, because the variance within the same species is too large.

2. Analysis of the differences between the food-selectivities from the point of the food-taking frequency.

In the process of the preceding analyses, the following fact is neglected, that some of the individuals of the same species caught in the same day are taking a certain sort of preys, while the others have no relation with that prey animal. Of course, it is obvious that this fact is innegligible. It may be a reasonable way to compensate for this defect, that the same analytical examination is pursued on the percentages of the weight of a certain prey group to the total food weight calculated in each individual of each species. But here remains such difficulty that we can not decide the predominance of the selectivity when a few individuals of a certain species of fishes take a certain sort of preys in a large quantity and other individuals do not take it, while most individuals of other species of fishes take it merely in a small amount, ..... the percentage of that prey animal in the former may possibly higher than in the latter in some cases. At present, it is rather preferable to analyse the problem from the point of food taking frequency. However, as there are many cases in which the observed frequency is less than 5 and consequently the  $\chi^2$ -value becomes too large as compared with that of the actual value when the examination using  $\chi^2$  is applied, we may often admit erroneously the differences between the food-selectivities of these fishes as significant. For these reasons, I applied here R. SATO's 3rd examination method for independence on the smaller sized samples, a modified FISHER's direct method. The significance levels under the supposition, as null hypothesis, that the ratios of the food taking frequencies of these fishes are equal are shown in Table 2. The results show that the values (excepting those underlined) are mostly higher than 0.05, this fact means that the differences between the ratios of food taking frequencies

**Table 2.** The significance levels under the supposition, as null hypothesis, that the food-taking ratios of these salmon are equal.

## a) Significance levels.

Date	Significance Level							
	Large	Middle	Small	Fishes	Squids	Copepods	Gammarids	Euphausiids
VI, 28	0.0060	0.5096	0.1320	0.0831	0.0624	0.3986	0.0330	0.5096
VI, 29	0.7172	0.2353	0.5777	0.5654	0.6569	0.6569	0.5147	0.2353
VII, 2	0.5270	0.4847	0.3990	0.7896	0.8609	0.6165	0.6242	0.4847
VII, 7	0.7620	0.01~0.02*	0.7263	0.5356	0.9560	0.7328	>0.001*	0.01~0.02*
VII, 10	0.7417	0.8643	0.1897	0.8077	0.6061	0.6079	0.0363	0.8643
VII, 18	0.8235	0.9368	0.6691	0.8235	1.0000	0.6691	1.0000	0.9368
VII, 20	0.2209	>0.001*	>0.001*	0.8804	0.8776	0.7912	>0.001*	>0.001*
VII, 21	0.8904	0.6364	0.4598	0.1169	0.6225	0.6389	0.7005	0.6364

## b) Individual number of examined fishes.

<i>O. nerka</i>	<i>O. keta</i>	<i>O. gorbuscha</i>	<i>O. kisutch</i>	<i>O. tshawytscha</i>
	38	26		
6	5	7		
36	24	2	4	2
5	22	22	15	4
18			10	24
			14	3
19	25	17	20	10
18	28	23		3

The significance levels with asterisk are estimated by  $\chi^2$ -method, because the total probabilities to take the frequency distributions more apart from the uniform ratio than actually observed is very high in these cases and it needs much labour to estimate these values. Consequently, these values ought to be higher than the values estimated by SATO's method.

The under-lined values are significant under 0.05 level of significance.

of these fishes are not significant.

### Conclusion

Summarizing these results, it may be said safely that no significant difference is discernible between the selectivities for each prey animal, except for the smallest prey ..... gammarid amphipods, in these five species of salmon in such a range of variations in body sizes measured during this season [the maximum size is *ca.* 5.0 kg of *O. tshawytscha* and minimum size is *ca.* 1.5 kg of *O. gorbuscha*].

### References

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- 2) SATO, R. 1947: Examination method for independence on the smaller-sized samples. Chubunkan, Tokyo (in Japanese).