__Writing Format for Full Paper__

30 mm

A4 size paper (210 x 297 mm)

Symposium on Advanced Techniques of Sampling Gear and Acoustical Surveys for Estimation of Fish Abundance and Behavior (Title:13pt, bold)

Oshoro HOKUDAI[1] , Yakei HAKODATE[2]
and Ken HOKUSUI[3] (Authors: 12pt)

(Affiliations &Addresses: 10pt)
[1]Hokkaido University, 3-1-1, Minato, Hakodate, Hokkaido 041-8611, Japan
[2]Future University Hakodate, 116-2, Kameda-nakano, Hakodate, Hokkaido 041-8655, Japan.
[3]Hokkaido National Fisheries Research Institute, Katsurakoi, Kushiro, Hokkaido 085-0802, Japan

Sampling and acoustical techniques have been used extensively to study aquatic populations. These methods and tools provide valuable information to fisheries biologists as well as to ecologists dealing with

ABSTRACT and Manuscript FORMAT:

- The following format is required.
- Size: Below 10 pages of A4 size paper.
- Margin: Top 30 mm, bottom / left / right 25 mm.
- Font: Times New Roman.
- Title: 13 point font size, bold and align center.
- Author(s), Affiliation(s), and Address(es): 10 point, align center.
- Text: 10 point, single space and fully justified.
- Keywords: 10 point in one line volume at maximum.

25 mm

25 mm

ocean ecosystems. This symposium will review and discuss new analytical techniques, new technologies, and their innovative implementation for fish stock assessment or ecological research. (Abstract: 10pt)

KEYWORDS: Sampling gear, Acoustical techniques, Stock Assessment, Ecological research (10pt)

INTRODUCTION (10pt, bold)

Gillnets are used widely, both as commercial gear and as sampling gear for stock investigations. Gears used in stock investigations are used for biological sampling and determining the size distribution of target species. Researcher must consider mesh selectivity when estimating the size distribution of target species[1,2] a[illegible]re selectivity curve therefore can be estimated without being dependent on the catch if the length –girth relation of the target fish in each season is known. However, Reis and Pawson[3] and Pet *et al.*[4], who applied Sechin's method, report that this method is unsuitable for some species.

Times New Roman 10pt

METHODS (10pt, bold)

Distinctions of the data by catch part

To reduce the influence of the dispersion by [illegible] [illegible] in the mesh selectivity curve estimation, data must be separated based on the body part that is most often wedged or entangled in the net. Because of course thus part has a position range, it is desirable to use data on the part that has no change in the girth inside the range, such as the trunk of pacific saury. Accordingly, a part is appropriate to selectivity estimation when the length–girth relationships at both

---

[1] E-mail: sos@echo.fish.hokudai.ac.jp

Corresponding author's Email Address

25 mm

ends of the range is no difference.

The catch per unit effort, C_{ij}, by the mesh size m_i to the length l_j is assumed in the following equation from expansion of the equation of Kitahara[5)].

Where S_{ij} is the mesh selectivity by mesh size m_i to length l_j, d_j is the relative density of fish at l_j expressed in Eq. (2) and A is the number of fish in the population. The catching efficiency q is assumed to be constant for all fish size and mesh size. When the selective target of the mesh is the girth, that is, S_{ij} is substituted for S_{ip}, the length distributions shown in the Eq. (2) must be taken into consideration. That distribution continues with the girth in accordance with the length-girth relationship of Eq. (1), as shown in Fig.1.

Therefore, the numbers caught C_{ij} in this case is the total number at length l_j of each girth g_p. The catching efficiency q is influenced by the behavior character of each fish species and its diurnal activity [6)], and the net material [7,8)]. In the present study, the value q is assumed to be constant because the nets were made of the same material, and used with the same fish species. The mesh selectivity S_{ip} of mesh size m_i to girth g_p is assumed in the follow equation to be a function of girth: Here, λ_i is the optimal girth with maximum selectivity, and ω_i is the

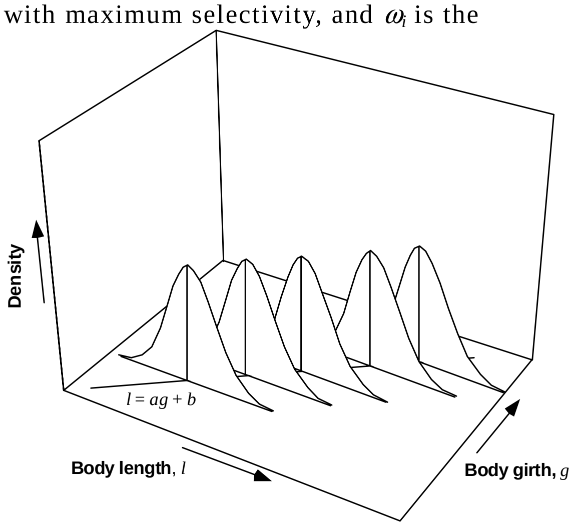

Fig.1. The schematic of length distribution continued toward the girth with linear relationship.catch.

parameter which etermines the width of the selectivity curve.

RESULTS (10pt, bold)

Frequencies of catch part

Table 1 shows the length distribution of the fish in the tank and fish caught for each mesh size. The 4.1cm-mesh net had the highest The distribution of net marks on the fish is shown in Fig.4. For the 4.1cm-mesh net, the highest frequency of catch position occurs at

Table 1. Length frequency distribution of fish used in experiment and fish caught

Length class	Mesh size (2bar + 2knot)					
	4.1cm		4.6cm		5.1cm	
(cm)	Fish in tank	Fish caught	Fish in tank	Fish caught	Fish in tank	Fish caught
15.5	23	2	12	0	4	0
16.5	86	13	46	0	44	0
17.5	160	43	134	8	128	0
18.5	185	45	220	24	197	2
19.5	183	41	125	41	169	16
20.5	121	19	50	10	42	17
21.5	33	1	13	5	15	5
22.5	9	1	0	0	1	1
23.5	0	0	0	0	0	0
	800	165	600	88	600	41

0.15-0.2 in relative length, decreases gradually after that, and shows a mode again at 0.4-0.45. There are modes near 0.2 and 0.4-0.45 for the other mesh size as well. The position of the first mode around 0.2 clearly corresponds with the range that contains the pre-operculum, operculum, and pectoral fins from Fig.2. Furthermore, the position of the second mode (0.4-0.45) occurs near the front base of the dorsal fin. These results show that the catch of rainbow trout occurs at these two parts. These parts can be divided into two ranges of 0.15-0.3 and 0.3-0.45 relative length. There are not many differences in girth in the range to the dorsal fin after the pectoral fin (Fig.3). It is therefore considered that the catch data in the range of 0.3-0.45 are suitable for estimating the mesh selectivity curve.

Mesh selectivity curve

Table 2 shows the parameter and AIC value[9] of the linear regression for the relations between length and girth. The calculation was done using the data from the pectoral fins and dorsal fin, which are at both ends of the 0.3-0.45 range, and the data of both was

calculated for the mean length $l = ag + b$ (σ = 0.80, min: 0.65, max: 0.95). Fig.5 shows the numbers caught in the experiment and determined by the calculation in Eq. (4). The range and form of the distribution by the calculation corresponded well with the experimental data (Kolmogorov-Smirnov test, $P<0.05$).

selectivity curve.

DISCUSSION (10pt, bold)

The mesh selectivity curves of each mesh size have the same shape, even though the curves were estimated individually for each mesh size. In addition, the linear relationship between the optimal girth and the mesh size had a high correlation. These results support the theory of Baranov [10], which explained the geometric similarity between mesh size and fish-body size. Thus, it is considered that dividing the catch parts is important when estimating mesh selectivity

This method was validated since the estimated length distribution fit the length distribution of the population used in the experiment. From now on, examination of the model in consideration of the productive unevenness of mesh size and measurement error will be necessary to further improve the precision of the mesh selectivity curves. In this study, the variance σ used in the estimation was not determined from the gillnet catch. It was calculated using different samples collected by a cone net. This was done to collect information on the fish body precisely without introducing the effect of mesh selectivity.

REFERENCES (10pt, bold)

1. Ferro, R.S.T. and Xu, L., “An investigation of three methods of mesh size measurement”. *Fish. Res.*, **25,** 171-190 (1996).
2. Fujimori, Y., Matuda, K., Losanes, L.P., and Koike, A., “Water tank experiment on the catching efficiency and mesh selectivity of gillnets”, *Nippon Suisan Gakkaishi*, **56,** 2019-2027 (1990).
3. Fujimori, Y., Tokai, T., and Matuda, K., “Effect of diurnal activity of rainbow trout and light intensity on gillnet catching in water tank experiments”, *Nippon Suisan Gakkaishi*, **60,** 577-583 (1994).
4. Hamley, J.M. and Regier, H.A., “Direct estimates of gillnet selectivity to walleye (Stizostedion vitreum vitreum)”, *J. Fish. Res. Board Can.*, **30,** 817-830 (1973).
5. Hamley, J.M., “Review of gillnet selectivity”, *J. Fish. Res. Board Can.*, **32,** 1943-1969 (1975).