THE IMPROVEMENT OF METHOD FOR ESTIMATION OF THE ABUNDANCE INDEX FOR HANASAKI CRAB (*PARALITHODES BREVIPES*) AND OBTAINED TREND

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Fig. – 9, ref. – 2.

1. INTRODUCTION

Hanasaki crab (*Paralithodes brevipes*) is one of the most popular fisheries stock around Nemuro peninsula and the fisheries management is required urgently, because the annual catch amount has been reduced recently. Nemuro city has been conducting the fishery independent survey of stock abundance since 1996 by using crab-traps. In 2005, they constructed 89 survey points and deployed 25 crab traps in each survey point. They caught 2 246 individuals by this survey. The catch amounts per traps were calculated from these survey data and the stock density was estimated by using the equation for Stock Density-Catch per traps relation (S-C relation). Then the estimated stock density was separated by age group based on observed age frequency in each survey point and the biomass of stock was calculated by using age-weight relationship. Total biomass was estimated by swept area method. The estimated total biomass by this method was used to calculate allowable biological catch (ABC) and total allowable catch (TAC) as the basis for stock management.

Through this procedure they used S-C relation that was estimated by using mark recapture data in 1982, 1983 and 1999 (**Miura, 2004**) but there was no size specific analysis. Hanasaki Crab migrates seasonally from Northern area of Nemuro peninsula to Southern area and that migration pattern is depending on their size (Kudo pers. comm.). It results in difference of size distribution in each area. Therefore, it may cause significant estimation error when this relationship is applied to the areas with different size distribution. Firstly the stock abundance is estimated without size separation and the exact value and confidence interval are clarified. Secondly, the accuracy of S-C relationship is evaluated with and without size separation. Based on these results, it is concluded that the stock management with actual stock abundance is difficult and recommend feedback control using the trend of relative abundance index. A preliminary trial of a method to estimate abundance index by using fishery independent data is shown in this paper, and its advantage and problems are discussed.

2. MATERIAL AND METHOD

2.1. Estimation of stock density without size category

The distribution of total stock abundance is estimated by bootstrap method following same procedure used for stock estimation in 2005. Size categorizing was not applied for simplification. Instead, in order to examine the effect of crab trap saturation, two type of Stock Density-Catch per unit effort relation (S-C relation) were tested. The Type 1 was the S-C relation by **Miura (2004)**; i. e. $Density=0.0031e^{0.5848CPUE}$ (**Fig. 1**). This is the same equation used to estimate stock density by Nemuro city. The Type 2 was the S-C relation with maximum stock density at the catch of 10 individuals per trap, under assumption that the stock density is expressed in number of individuals with standard size (Fig. 1). By using these two types of S-C relations, the effect of the S-C relation without catch saturation for any size of individuals can be evaluated.

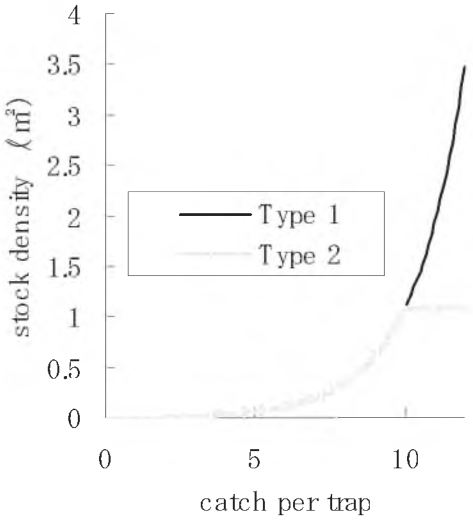

Fig. 1. Stock density – catch per each trap relation for each type of equations

2.2. The evaluation of accuracy for S-C relation

The mark-recaptured data, obtained through the surveys in 1982 and 1983 at Hanasaki, Owattarausu, Ochiishi and Hamamatsu, were used for analysis. Because the recapture ratio and catch amount at Habomai were very small, the relationship could not be estimated and the accuracy of estimation was low so the data was omitted from this analysis. Because the digitalized data in 1999 was not available, this data was not used for this analysis.

Miura (2004) used the Jolly-Seber method to estimate stock abundance from mark-recapture data. Both the Schnabel method and the Jolly-Seber method are used for this study and those results are compared, because some of survey cannot satisfy the postulate of the Jolly-Seber method, e. g. the recaptured individuals were released without attaching new tags.

The bootstrap method was used to evaluate the confidence interval of S-C relation.

2.3. The optimal model for standardized abundance index

The trial to estimate the abundance index for Hanasaki crab around Nemuro peninsula was made using the survey catch data from 1997 to 2005 by Nemuro city. The generalized linear model (GLM) was applied to standardize the abundance index. Both direction step wise method was used to select optimal model with AIC as the index for evaluating optimal factors (**Langley, 2003**). As the initial model, following equation was used:

$$\log(C+0.5) \sim y+t+d+\mathrm{pol}(lon, 6)+\mathrm{pol}(lat, 3)+\varepsilon,$$

where C is the catch per each trap, y is the year, t is the trap number in each survey point, d is the water depth, lon is the longitude of fishing site, lat is the latitude of fishing site, pol(variable, n) is a fitting polynomial equation of n-th order for variable, and ε is the nominal error. Both whole and legal size catch were applied as analyzed catch.

3. RESULTS AND DISCUSSION

3.1. Estimation of stock abundance without size categorizing

The estimated total stock abundances based on the S-C relation of Type-1 and 2 are shown on **Figs. 2** and **3**, respectively. The Type-1 relation resulted in the 95% confidence interval of big range and for the worst year; i.e. 2000, the range becomes larger than 8 orders. As the result, it is difficult to estimate stock abundance using the Type-1 relation. The Type-2 relation resulted in the 95% confidence interval of tight; within one order range. Current S-C relationship was estimated from the data of CPUE and Stock Density on the CPUE range of less than 10 individual per trap. Thus the evaluation of the error for stock density estimated from the S-C relation when the CPUE is larger than 10 individuals per trap.

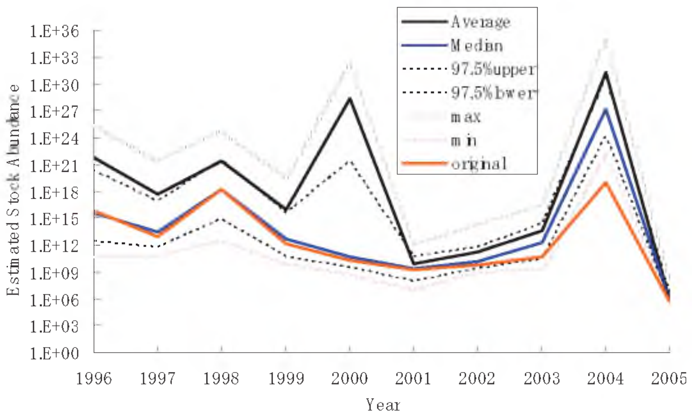

Fig. 2. *Estimated stock abundance by scenario 1*

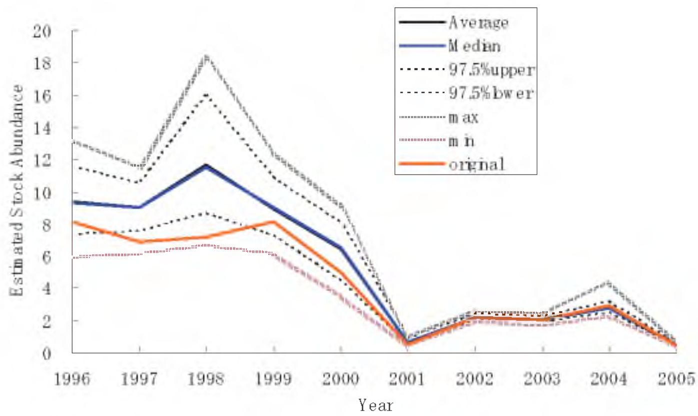

Fig. 3. *Estimated stock abundance by scenario 2. Y axis shows million number of estimated stock abundance*

3.2. The evaluation of accuracy for S-C relation

Figure 4 shows the estimated stock densities in Hanasaki, Owattarausu, Ochiishi and Hamamatsu area. In this figure, horizontal axis shows catch per trap, vertical axis shows stock density, and each plots indicates the estimated stock density by each bootstrap's trials. There is some difference between estimated values between by Schnabel and Jolly-Seber methods but not so big. **Figure 5** shows the estimated S-C relation and the 95% confidence interval of these estimates. The confidence interval of estimated relationship by Jolly-Seber method is wider than the one by Schnabel method. Especially, larger catch per trap make the larger difference. However the median of S-C relation does not show large difference.

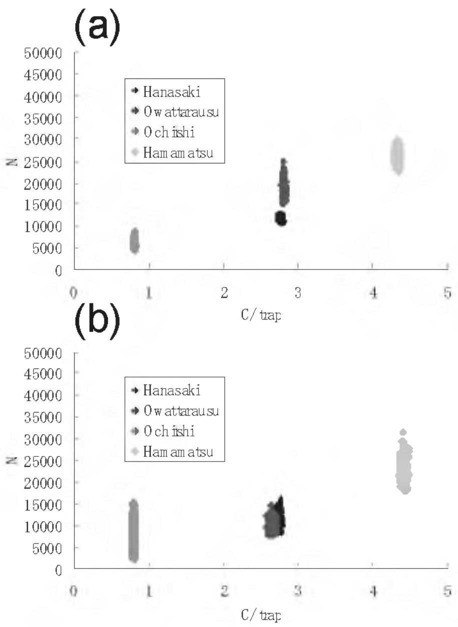

Fig. 4. *(a) Estimated stock density in each area by Schnabel method. (b) Estimated stock abundances in each area by Schnabel method. Jolly-Seber method*

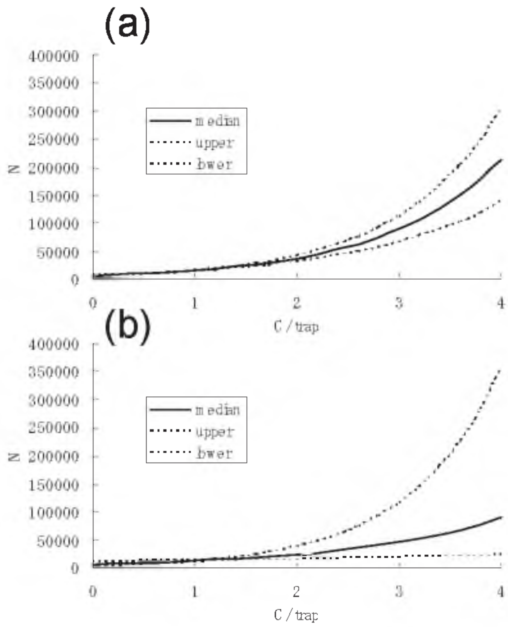

Fig. 5. *(a) S-C relationship estimated by using Schnabel method. (b) S-C relationship estimated by using Jolly-Seber method*

Figure 6 shows the estimated S-C relation by using the data on the catch of crabs with carapace length larger than 80 mm. The range of confidence interval of this size-limited S-C relation is larger.

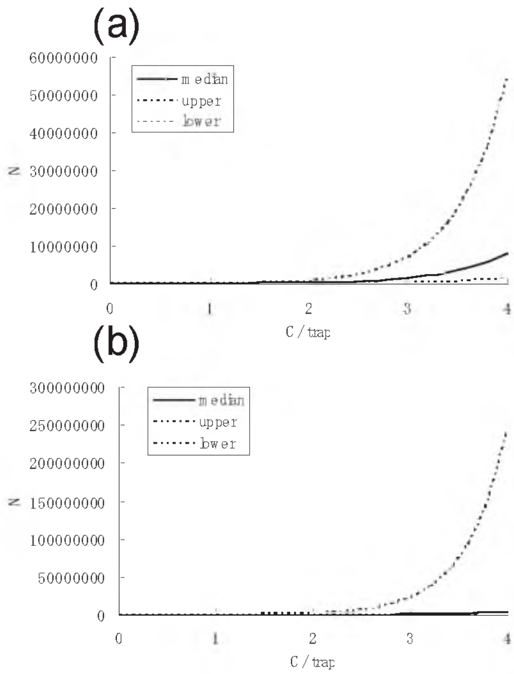

__Fig. 6.__ (a) S-C relationship for larger size individuals estimated by using Schnabel method. (b) S-C relationship estimated by using Jolly-Seber method

By the size limited S-C relation shows higher stock density compared with original S-C relationship at the same catch per trap (Fig. 5 & 6). This means that if there is same number of individuals, the catch per trap for larger size individual is fewer than that for smaller individuals. This is conformed to general expectation.

The exploitable stock abundance is estimated by using this size limited S-C relation (**Fig.** 7). Before 2000, there is no size data so the average size composition data between 2001 and 2005 was used to expand the size data before 2000. The range of 95% confidence interval is realistic except for 2004. In 2004, the observed catch per trap was so large that the stock density could not be estimated by using S-C relationship. Neglecting 2004, we cannot find any evidence of increasing trend in the stock density.

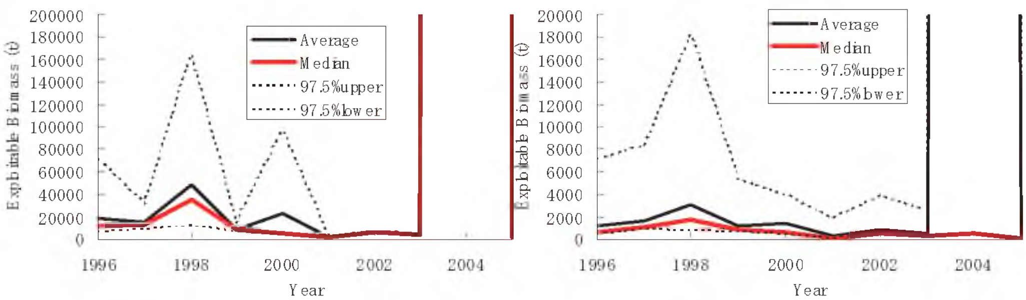

__Fig. 7.__ Estimated exploitable stock abundance by using (a) Schnabel and (b) Jolly-Seber methods

It is not clear that the increase of catch per trap like 2004 means whether increase of stock density or change of stock availability. This is the subject for future study.

3.3. The optimal model for standardized abundance index

Selected optimal model was

$$\log(C+0.5) \sim y + \mathrm{pol}(lon, 6) + \mathrm{pol}(lat, 3) + \varepsilon.$$

The annual trend of abundance indices is shown in **Figure 8.** Both of relative abundance indices for whole and legal size show minimum level in 2001, increase till 2004 and decrease after that. Spatial distribution of relative abundance indices are shown in **Figure 9.** In the latitudinal distribution, the peak abundance index for legal sized individuals exists in more northern part comparing to the distribution for whole size.

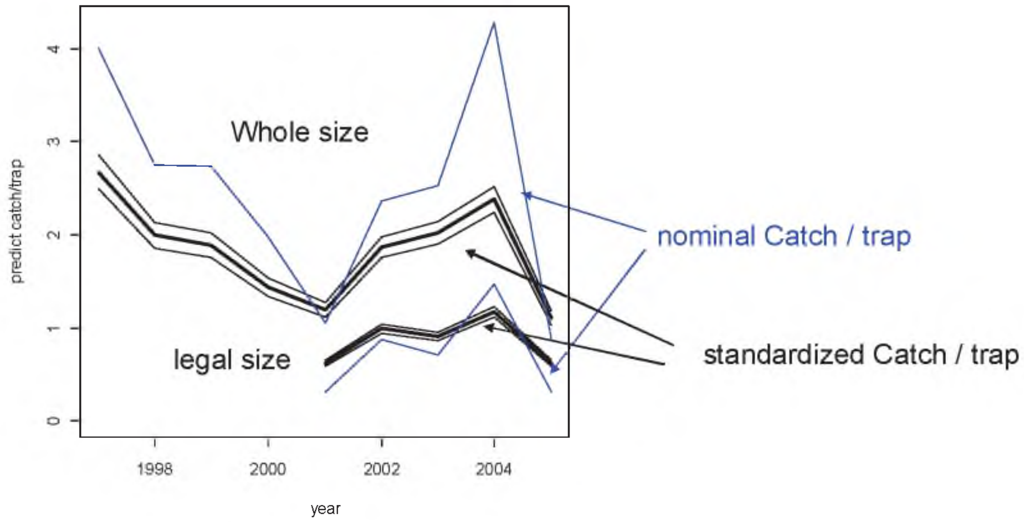

Fig. 8. *Annual trend of estimated standardized and nominal CPUE for individuals of whole and legal size*

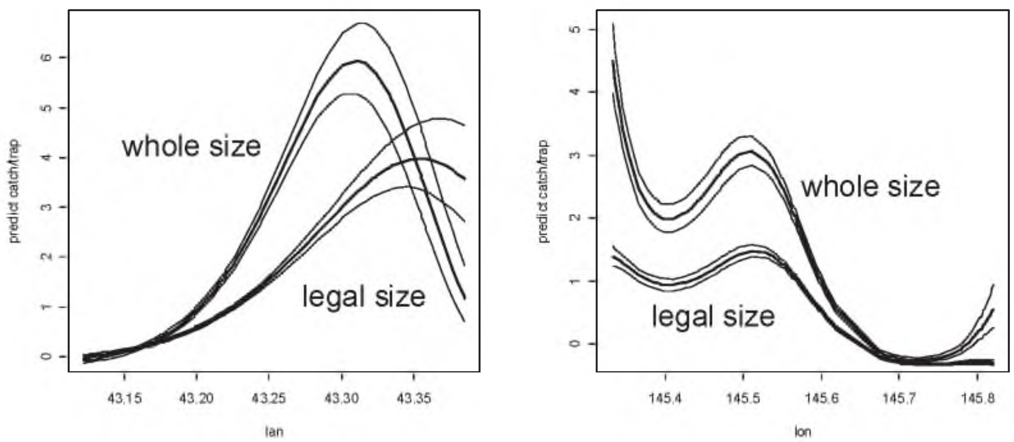

Fig. 9. *Spatial trend of estimated standardized and nominal CPUE for individuals of whole and legal size*

4. SUMMARY

In the current procedure for estimating stock abundance, the interaction among size categories in catch is not considered. For example, the existence of some individuals in a trap should affect to the capture ratio, but in current stock assessment no consideration is made about such saturation effect. If age separation is applied after estimated stock density, this can be partially solved. However as the fishing intensity can change by body size and size composition, there still remain problems.

The estimated stock abundance without size separation is much larger than current estimated stock abundance. If we can assume that the stock density remains at the same level when the number of caught individual per trap is larger than 10, the estimated stock abundance become similar to the current one, i. e., the estimated stock density changes much depending on S-C relation.

Because the confidence interval of S-C relation has large range, it is hard to estimate absolute number of stock abundance. It is suggested that the trend of relative abundance index with enough accuracy for feed back control can be estimated by GLM analysis using fishery independent data to be obtained from a survey before fishery season. As difference in spatial distribution between larger and smaller individual and difference of spatial migration according to their size or age are reported, so much more information on their spatial and seasonal distribution, and on catch data with size distribution are required. As future work, the quality of fishery dependent data should be improved and it is important to make observer program in Hanasaki crab's fishery.

5. REFERENCES

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