

Population fluctuation of the Northwestern Pacific stock of Japanese anchovy

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INTRODUCTION

Japanese anchovy stock assessment is conducted annually in support of the fishery management process in the Japanese EEZ. The population fluctuation of its northwestern Pacific stock and annual changes of relating parameters are described based on the results of stock assessment. Japanese anchovy, *Engraulis japonicus*, in the northwestern Pacific are landed mainly by purse seiners and also their larval and juvenile stages are landed as "Shirasu" by purse nets off the northern Pacific coast of Japan. According with the population declining of Japanese sardine, *Sardinops melanostictus*, the stock size of Japanese anchovy increased and the one-year-old age class have been mainly landed by the purse seiners in recent seven years. Fishing grounds concentrated only in the coastal area, although the distribution of the Japanese anchovy expanded from the coast of Japan to 160° E as their population increases (Fig.1).

BIOLOGICAL PARAMETERS

Stock Structure:
Single stock from off Kyushu island to off Hokkaido island (Fig.1)

Length-weight Relationship:
 $W(g) = 0.0153 \times SL(cm)^{3.269}$ (2004, n = 21,809, $r^2 = 0.981$)

Length-at age Relationship: (t is the age in month)
 $L_t(cm) = 14.82(1 - 0.915e^{-0.142t})$ (Hayashi & Kondo, 1957)

Maximum age and size:
Maximum age is 3 years and the size is 17cm in recent years

Maturity Schedule:
Biological minimum is 8cm in SL (one year-old)

Natural Mortality:

Age	Natural mortality
0	1.0
1	1.0
2	1.6
3	1.9

Natural mortality was estimated by Pauly(1980) and Chen & Watanabe (1989)

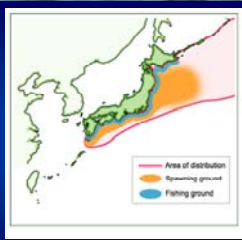


Fig. 1 Distribution of the northwestern Pacific stock of Japanese anchovy.

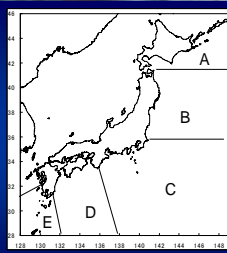


Fig. 2 Area definition off the Pacific coast of Japan.

FISHERY DATA

Landings (Fig. 3)
Annual landings of Japanese anchovy increased from 1990 off the northern Pacific coast of Japan (Areas - A & B) and the total annual landing recorded more than 200 thousands metric ton. The annual landing decreased to be 100 thousands metric ton in 1993 and then increased to be 200 thousands metric ton in 1996. The annual landings have increased since then and the landings exceeded 300 thousands metric ton except 1997, 2000 and 2001. The annual landings of recent two years might reach a ceiling 400 thousands metric ton.

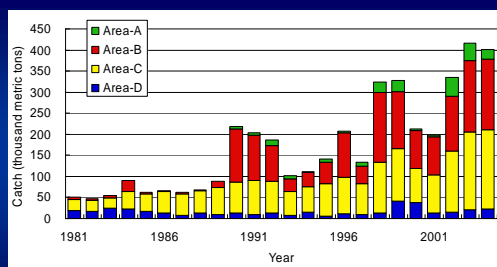


Fig. 3 Annual catch of Japanese anchovy off the Pacific coast of Japan.

CPUE (Fig. 4)

Fishing effort of purse seiners increased and the CPUE (metric tons haul⁻¹) decreased from 2000 off the northern Pacific coast of Japan (Area-B). The CPUE generally have continued to be stable in recent four years.

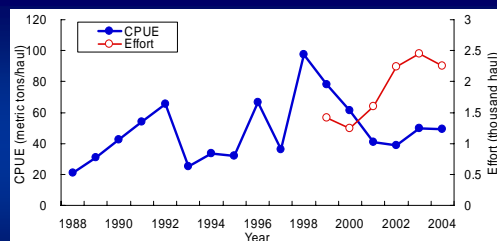


Fig. 4 Annual change of CPUE and fishing efforts of purse seiners for Japanese anchovy off the northern Pacific coast of Japan (Area-B).

Catch-at-Age (Fig. 5)

The young-of-the-year had been mainly landed until 1988. The Age 1+ fishes have been mainly landed after 1989 and the Age 2+ fishes were also landed after 1990. High amount of landings were supported by the catch of Age 1+ fishes in recent seven years, except 2000 and 2001.

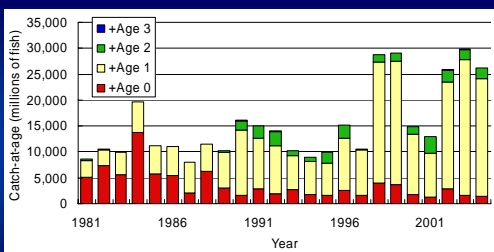


Fig. 5 Annual change of catch-at-age in number of Japanese anchovy off the Pacific coast of Japan.

FISHERY-INDEPENDENT DATA

Egg production (Fig. 6)
Monthly egg production surveys have been conducted from 1949 along the Pacific coast of Japan by the 3 National Fisheries Research Institutes and 18 prefectural Fisheries Experimental Stations. Vertical towing net samples have been obtained from 150 m deep (or near bottom) to the surface by the Long NORPAC net (0.335 mm mesh size, 45 cm mouth diameter and 65 cm + 130 cm-long cylindrical-conical net).

Monthly egg production is calculated by summing up 30' x 30' squares egg production E_{ij} in month i and square j as the following equation:

$$E_{ij} = \frac{1}{s} \cdot \frac{D_i}{d_{ij}} \cdot A_j \cdot \bar{C}_{ij}$$

where s is the average survival rate during egg stage (0.600), D_i is the number of days in month i , d_{ij} is the egg incubation time (in days) in the j th square in month i , A_j is the area of the j th square in m^2 , and \bar{C}_{ij} is the average density of egg distribution in the j th square in month i . The egg incubation time d_{ij} is calculated as the following equation:

$$d_{ij} = \frac{1}{24} \cdot 10^{\left[\frac{4060}{t_{ij}^{2.773}} - 12.2 \right]}$$

where t_{ij} is the average surface temperature in the j th square in month i .

Egg productions of Japanese anchovy have been at the high level since 1999 in the Pacific coast of Japan and the annual egg production in 2004 was higher than that in 2003.

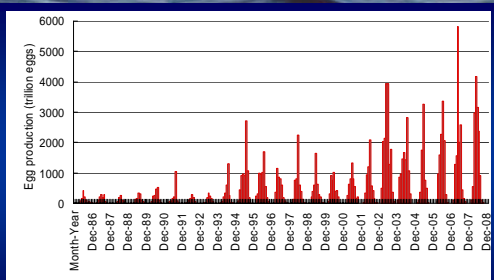


Fig. 6 Monthly egg production of Japanese anchovy off the Pacific coast of Japan.

RESULTS

Population numbers at age (Fig. 7)

Recruitment of the Japanese anchovy indicated high level from 1997 at the Pacific coast of Japan. The recruitment of 2004 might be three quarters of 2003 according to the VPA, but the recruitment failure might have occurred when the results of egg production were considered (Fig.6).

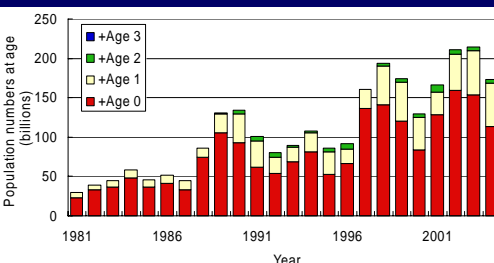


Fig. 7 Annual changes of estimated population numbers at age of Japanese anchovy off the Pacific coast of Japan.

Comparison between AEPM and VPA (Fig. 8)

Annual changes of spawning stock biomass (SSB) estimated by VPA was compared to those estimated by the annual egg production method (AEPM), because of the limited fishing grounds compared to their broad distribution areas. The SSB based on AEPM was estimated by the parameters in Takasuka et al.(2005). These two SSB values indicated similar trends and almost the same level, although variability of the value estimated by AEPM was greater than that by VPA. Therefore, the results of VPA was adopted to estimate the Acceptable Biological Catch (ABC).

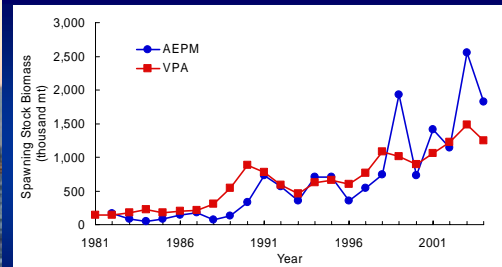


Fig. 8 Comparison of estimated spawning stock biomass between AEPM and VPA of Japanese anchovy off the Pacific coast of Japan.

Estimated stock biomass and exploitation rate (Fig. 9)

Estimated stock biomass was less than 500 thousand metric tons until 1988 and increased to be 887 thousand metric tons in 1990. After 1988, the estimated stock biomass continued to be around one million metric ton. The estimates still recorded high level as 1.16 million metric tons in 2004, although it slightly decreased from 2003.

Exploitation rates in recent years were estimated to be around 30%, indicating the increasing trend.

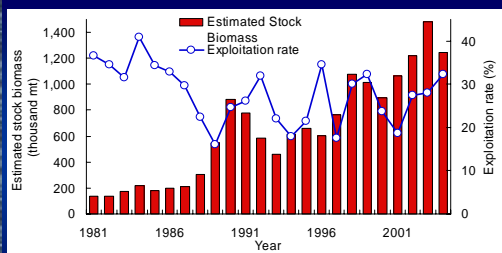


Fig. 9 Annual change of estimated stock biomass and exploitation rate of Japanese anchovy off the Pacific coast of Japan. Values are calculated by VPA.

Stock-recruitment relationship (Fig. 10)

The relationship between SSB and recruitment was significant and its linear relationship was used to forecast the future recruitment.

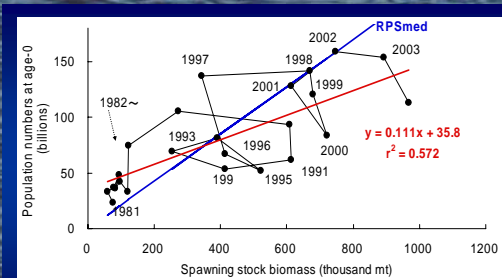


Fig. 10 Relationship between recruitment and spawning stock biomass of Japanese anchovy off the Pacific coast of Japan. Values are calculated VPA.

RECOMMENDATION

ABC

From the historical datasets, the current stock status is still at the high level during recent 20 years, although the recruitment was smallest in 2004 among recent 4 years.

ABC_{limit} was estimated under the F_{lim} , which can continue the lowest SSB level during the recent five years in the northwestern Pacific stock of Japanese anchovy.

	ABC in 2006	Reference point	F	Exploitation rate
ABC _{limit}	322 x 10 ³ mt	F_{lim}	1.38	30 %
Year	Stock biomass(x 10 ³ mt)	Catch(x 10 ³ mt)	F	Exploitation rate
2003	1,484	415	1.43	28 %
2004	1,244	401	1.13	32%
2005	1,102			

F: F-value of Age 1+ mainly caught by fishing.