The Issue Paper on Ecosystem Approach for Proper Management of Pollock Resources in the Central Bering Sea

FISHERIES AGENCY of JAPAN

1 Background

a) The main objective of the convention(Convention of the Conservation and Management of Pollock resources in the Central Bering Sea) is to restore and maintain the pollock resources in the Central Bering Sea area. Although there has been no substantial catch of pollock in the Central Bering Sea area since 1993, no sign of stock recovery has been observed yet.

b) There are three possibilities which explain the present stock condition. One is that migration and fished area of pollock in the Central Bering Sea would be broader than the supposed one, i.e. it would be dispersed to US and/or Russian EEZ and fished in these areas. Another is the effect of possible high natural mortality rate caused by change of ocean environment or predators such as marine mammal, sea birds. The last one is possibility of poor recruitment of pollock.

c) On the other hand, taking the surrounding international situation into account, at the recent COFI and High level fisheries meeting of FAO in February and March in 1999, it was agreed that ecosystem approach is promoted to ensure development and better management of the fisheries. It is necessary for the parties of this convention to conduct a study of ecosystem approach.

d) On these backgrounds, Japan reviewed the stock status of pollock resources in the Central Bering Sea area as follows. Now this paper is distributed for other parties' review, as Japan mentioned at the last annual meeting of this convention. It is appreciated to comment on this paper by September 15, 1999, then we can discuss this matter on the occasion of the next annual meeting.

2 Status of Stock

In the Central Bering Sea area, there has been no fishing operation for pollock for more than five years. However, spawning biomass of pollock in the Bogoslof area has not increased, i.e. 1.1 million ton in 1995, 0.68 million ton in 1996, 0.39 million ton in 1997, 0.49 million ton in 1998.

3 Factors of the present stock

- Fishing Mortality

There is the possibility that pollock distributed around Bogoslof area would migrate to the US and/or Russian EEZ and are fished in those waters, and actual fishing mortality is not zero. This should be addressed through promoting stock identification study that include Eastern Bering Sea and Navarin stocks. Furthermore, pattern of fishing activity in the US and Russian EEZ such as location of fishing ground, fishing gear/method, fishing season, need to be reviewed.

- Higher Natural Mortality Rate

Provided that fishing mortality rates since 1993 are at zero and stock abundance is kept at low level, natural mortality rates (M) in late 90's are calculated at higher value than that in early 90's (Table 1). Environmental factors of natural mortality, such as change of ocean environment or predation, need to be examined.

(Table 1) Natural Mortality Rate(M)

year	88	89	90	91	92	93	94	95	96	97	98
Biomass	240	213	-	129	94	64	54	110	68	39	49
M				0.240	0.368	0.405	0.105	-0.711*	0.481	0.556	

Data: US research cruise report, Biomass: ten thousand ton
* This minus value is the result of calculation using high value of Biomass.

- Characteristics of natural mortality

The number of age 4 and 5 fish of 1989 year class were 4.8 times and 2.6 times that of average in 1981-1988 year classes, and the possibility was suggested that the 1989 year class could be a strong year class. The number of age 7 fish of 1981-1988 year classes increased by 26 % of age 6 on an average. However, it decreased to 67 % of age 6 for 1989 year class. These data suggested that there was significant mortality between age 6 and 7 for 1989 year class, regardless of the strong recruitment abundance at age 4. Their process of survival during age 4-7 is not known well, furthermore, information on mortality and migration route of age 0-3 is scarcely known.

- Changes in the age of recruitment

In the Bogoslof area, the recruitment starts at age 4. Before 1985 year class, the maximum fish number was observed at age 7, and it was suggested that the age 7 showed the peak of recruitment. In recent year classes (1986, 1987, and 1989), however, the maximum fish number were observed at age 6, and the peak of recruitment seemed to be shifted younger than the previous year classes. At the same time, there is some evidence that the growth rate of pollock is increasing in the recent years. With considering these situations, the higher natural mortality observed in the recent years is thought to be caused by predators and/or other factors, rather than the changes of ocean environment such as condition of feeding ground.

4 Ecosystem Approach

In 1984, U.S. introduced ecosystem approach into ground fish management system in the Eastern Bering Sea and Aleutian island (Laevastu and Larkins 1981) . Dr. Low made use of this model to estimate the stock abundance of ground fishes, which was the base of maximum level of ABC for the Eastern Bering Sea.

On the review of these models and considering their weak points, Japanese scientists developed their own model (Kishimoto et al., 1988). This study was presented to the INPFC meeting in 1988, and was regarded as having possibility to simulate the change of resources abundance such as pollock. Furthermore, Mito developed static model which made available for personal computer (Mito 1990) and changed it to dynamic model (Mito 1995). But because of insufficient data, these models could not estimate future stock abundance well.

Under the condition that pollock resources in the Central Bering Sea area has not been recovering, the parties of this convention should cooperatively promote the ecosystem approach under the scheme of this convention.

With considering ecosystem, as one of the most important factor, the effect of large predators should be examined in highest priority. There are several large predators such as sea lion, seals, whales, sharks, sea birds in the Bering Sea, these species could affect to ecosystem by eating a large amount of prey. The result of preliminary estimation for volume of consumed prey in the Bering Sea is shown in Table 2, and its effect on pollock resources in the Bering Sea is shown in Table 3.

(Table 2) :Amount of prey of marine mammals, including pollock in the Bering Sea

	Total prey+ consumed	% of pollock in total food	Pollock volume++ in total prey consumed
Pinnipeds			(thousand tons)
Northern fur seal	559.5	25.1	140.4
Steller sea lion	58.4	58.3	34.0
Harbor Seal	7.6	21.4	1.6
Cetaceans			
Fin whale	360.3	3.2	11.5
Humpback whale	78.4	10.3	8.1
Minke whale	327.1	3.2	10.5
Dall's porpoise	272.3	1.0	2.7
Total	1,663.6		208.8

+ see attachment 1
++ see attachment 2

(Table 3): Effect of predation by marine mammals on the pollock resources in the Bering Sea

	EBS	BASIN	WBS	Total
				(thousand tons)
Biomass	6,000-8,000	390*	1,700	8,090-10,090(A)
Mortality				
Fishing**	1,150.5	0.2	750	1,900.7(B)
Natural Mortality(Total)				?
Predation	?	?	?	308.8-408.8(C)
Marine Mammals	?	?	?	208.8(D)
Seabirds***	100-200	?	?	100-200(E)
(B)/(A)				18.8- 23.5%
(C)/(A)				3.1 - 5.1%
(D)/(A)				2.1- 2.6 %
(E)/(A)				1.0- 2.5%

* Data :US Bogoslof area research report
** Data: Ianelli et.al.(1998)
*** Hunt. et.al(1981)

Total energy of marine mammals was calculated from the expression E=aM0.75, where E is energy consumption in kcal/d and M is body mass in kg (Perez et al. 1990). The coefficient (a) varies among taxonomic groups, and is 372 for Otariids, 200 for Phocids, 192 for Mysticetes, 317 for Odontocetes. The body mass was used in Trites and Pauly (1998). Total amount of food consumed by marine mammals were calculated from generic estimate of the proportion of prey types taken, based on Pauley et al., 1998.

Many species would take pollock in the Bering Sea. However, at least three pinnipeds (Northern fur seal, Steller sea lion, Harbor Seal) and four cetaceans (Fin whale, Humpback whale, Minke

whale, Dall's porpoise) are well known to take some amounts of pollock.
In Table 2, total food consumption of these species was 1,664 thousand tons. Consumption of pollock was 1-58% of the total food volume, i.e. 209 thousand tons.

On the other hand, seabirds are also possible predator eating pollock, as Hunt et.al.(1981) reported 100-200 thousands tons of pollock are consumed by Seabirds in the Eastern Bering Sea.

Because there is insufficient information on the detailed distribution of predators within the Bering Sea, Table 2 cannot show separate figures of predation in the Aleutian Basin area. However, these figures show the possibility of a large amount of predation to pollock, 309-409 thousand tons, 3.1-5.1% of biomass in the Bering Sea as a whole. Population and food consumption of marine mammals and seabirds in Table 3 are not enough examined. Therefore, actual consumption of pollock may be increased. Furthermore, Sharks and other mammals (Sperm whale, Baird's beaked whale, Killer whale, Common porpoise etc) would also consume pollock (Nishiwaki and Handa, 1958, Nishiwaki, 1966, Nishiwaki and Ogeuo, 1971, Kawasaki, 1980). It is concerned that such predation gives a certain effect to stock recovery of pollock in the Central Bering Sea.

5 Further Study

- Data collection

<u>Predation</u>: Numbers and feeding behavior of Steller sea lion, Northern fur seal, Whales, Seabirds, Pollock and other fishes, etc

<u>Pollock</u>: Migration of immature fish originated to the Bogoslof spawning stock; Recruitment mechanism and distribution of the Bogoslof spawning stock

- Review and development of Ecosystem model for pollock resources in the Central Bering Sea

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Attachment 1. Estimated total prey consumption by marine mammals in the Bering Sea.

Species	* Abundance	Literature*	Days at colony	Mean Mass (kg)	Field Metabolic Rate ($x10^3$ kj/d)	Population Energy Intake ($x10^{10}$ Kj)	Total prey ($x10^3$ ton)
Harbor seal	13,300	2	122	63	18.7	3.0	7.6
Steller sea lion	20,000	3	122	200	82.8	20.2	58.4
Northern fur seal	995,000	4	122	28	18.8	228.2	559.5
Fin whale	4,380	1	122	42300	2369.5	126.6	360.3
Humpback whale	1,200	1	122	31800	1913.0	28.0	78.4
Minke whale	20,000	1	122	5300	499.0	121.8	327.1
Dall's porpoise	302,000	2	122	61	28.9	106.5	272.3
Total	1,322,580					611.1	1663.6

1: Abundance estimates for respective species are based on best guess through following considerations: For blue and fin whales, values are inferred from assumption 30% of entire North Pacific populations given in Table 9 (1600 and 14600 individuals, NMFS 1989) which migrates into Bering Sea during summer feeding migration; humpback whales, inferred from assumption 20% of entire North Pacific population estimated by Calambokidis et al. (1997, ca 6000 individuals); minke whales are based on best guess by Mr. T. Miyashita through analogy from Western North Pacific population by Buckland et al. (1990), in which beroyghly etimate at

2: Hill, P. S.,et al. (1997).

3. 16,500+392+3,082=19,974

16,500 was quoted from NMFS (1995), 392 from Boltnev and Mathisen (1996), and 3,082 from Loughlin et al. (1992).

4: Calculated following formula.

(1,019,192+225,000)*0.8=995,354

1,019,192 was quoted from Hill et al. (1997), 225,000 from Reijinders et al. (1993)

0.8 was portion of 3 and elder fur seals population which calculated from table in Lander (1981).

Attachment2. Estimated total prey consumption by marine mammals in the Bering Sea.

Species	Total prey comsumed	% of pollock in total food*	Pollock volume in total prey consumed
	$x10^3$ ton	%	$x10^3$ ton
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***Baba personal communication and caluculation by the stomack contents data of Tamura(1962) and Kobayashi personal communication**