Thesis for the degree of Master of Science

Relationship between Pacific cod (*Gadus macrocephalus*) catch and environmental factors in southern East/Japan Sea

By

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The Graduate School

Pukyong National University

February 2008

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남부동해에서의 대구 (*Gadus macrocephalus*) 어획과 환경요인과의 관계

Advisor: Prof. Suam Kim

by

Sangdeok Chung

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Abstract

The catch of Pacific cod (gadus macrocephalus) has increased in East/Japan Sea recently, but biological characteristics as well as recruitment processes are yet explained. Relationship between Pacific cod catch and environmental characteristics in the eastern Korea was investigated using Cross-Correlation Function (CCF) analysis and cumulative sum (CuSum). In general, there was negative correlation between total catch from southern East /Japan Sea and Arctic Oscillation Index (AOI), and the highest correlation ($r = -0.451$, $P < 0.05$) was shown with a time-lag of 4 years. CCF analysis indicated that cod catch in Korea were also significantly correlated with February temperature in the spawning ground with time-lag of 5 years. Also, we found relationship between cod catch and zooplankton biomass in Korea. For example, catch had a significant correlation with

June biomass with a time-lag of 5 years (r = 0.452, $P < 0.05$) in the coastal area off the eastern Korea. Optimum range of adult cod caught appeared in seawater temperature at 100m depth range of 1-4℃ and salinity range of 33.8-34.2 PSU. Especially, highest catch occurred in seawater temperature range of 2-4℃ and salinity range of 33.8-34.0 PSU. These results emphasize the dynamic role cold habitats in southern East/Japan Sea.

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Introduction

1. Biological characteristics of Pacific cod

Pacific cod (*Gadus macrocephalus*, Pacific cod or cod hereafter) are widely distributed in the North Pacific and adjacent waters. In the western Pacific and the Yellow Sea, East/Japan Sea are the southern limit of Pacific cod distribution. To the north, they distribute off the east coast of Japan and off the coasts of the Sakhalin and Kuril Islands (Bakkala *et al*., 1984). Pacific cod are demersal and a cold water species and inhabit in continental shelf and upper slope. Adult Pacific cod occur as deep as 875 m, but the vast majority occurs between 50 m and 300 m (Allen and smith, 1988; Hart, 1986; Love, 1991; NOAA, 1990). Pacific cod have external fertilization (Hart, 1986; NOAA, 1990), and migrate into winter spawning area every year. Spawning time is from late fall to early spring. Their eggs are demersal and weakly adhesive. After hatching, larvae seem to be transported to nursery areas by tidal currents in Puget sound (Garrison and Miller, 1982).

In Korean waters, Pacific cod distribution widely in coastal areas of the East/Japan Sea, but their main spawning ground is Jinhae Bay (Zhang, 1984), the southern coastal area. It is known that peak spawning period is January. Choi (2007) revealed that the age of Pacific cod immigrated to Jinhae bay for spawning is 5 or 6 years. Sexual maturity seems to be completed at around 56 cm and fecundity varies with weight. For example, cod lighter than 5000g in Korean waters had a fecundity of 2.89 million eggs, but cod heavier than 8000g produced about 6.23 million eggs (Cha, 2007).

In the eastern Pacific, juvenile and adult Pacific cod show a opportunistic feeding behavior. They feed on a wide range of benthic and pelagic forage species (Allen and smith, 1988; NMFS, 2003; Palsson, 1990), and the main part of the adult Pacific cod diet would be whatever prey species is most abundant (Albers and Anderson, 1985; Kihara and Shimada, 1988; Jewett, 1978). In Japanese waters, Pacific cod larvae fed mainly on abundant taxa in the environment, suggesting that larvae are also opportunistic feeders (Takatsu *et al*., 2002), as adult Pacific cod are (Yamamura *et al*., 1993).

2. Abundance and fisheries of Pacific cod in the North Pacific Ocean

Commercial landing of Pacific cod ranged about from 45,000 to 205,000 metric tones (MT) in the North Pacific during the periods of 1950s – 1970s. However, catch of Pacific cod was dramatically increased since mid 1980s and stabilized through 1990s at about 400,000 MT (Fig. 1).

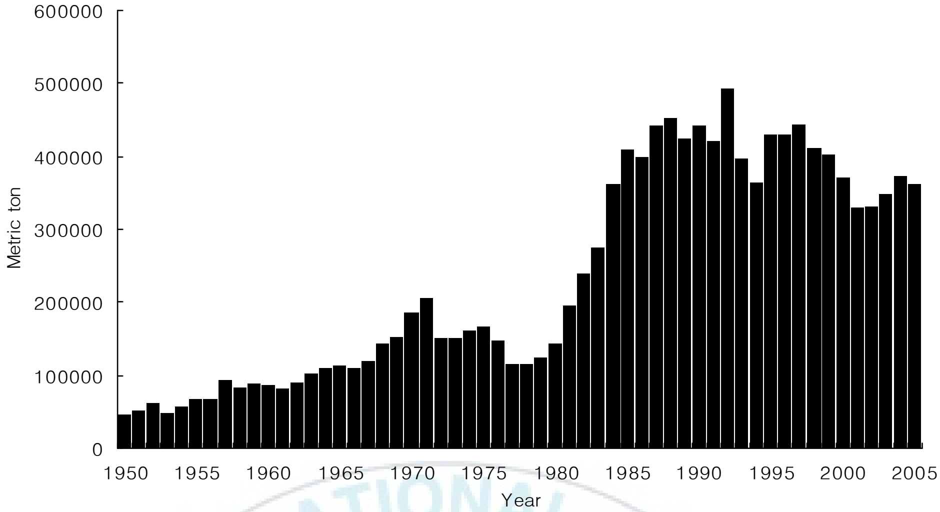

Fig. 1. Annual catch of Pacific cod in the North Pacific.

On the other hand, in southern East/Japan Sea, catches were high from late 1970s through late 1980s, and relatively low in 1990s (Fig. 2). Comparison between the eastern Korea (EKO) and western Honshu (WHS) stocks reveals that catches of WHS cod are larger than those of EKO cod. Commercial landing of EKO and WHS cod had suffered from collapse since early 1990's. However, the catch of Pacific cod has increased recently. In the case of Korean catch, there were high catches in early 1970s, early 1980s, and since 2000.

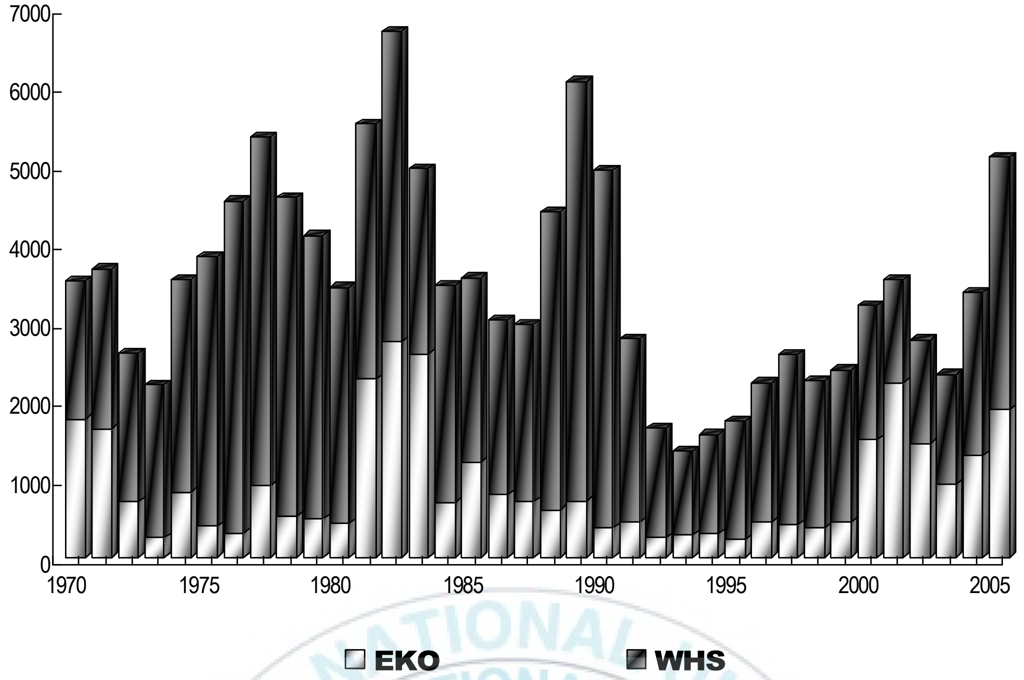

Fig. 2. Fluctuation of Pacific cod catch in the eastern Korea (EKO) and the western Honshu (WHS).

3. Purposes of the research

Although the cod catch is high recently in the East/Japan Sea, the research on Pacific cod is few, especially in Korean waters. One of local governments in Korea, Gyeongsangnam-do, established cod enhancement program in 1981, and has released eggs and larvae of Pacific cod to the sea every year. However, the release effects of eggs and larvae on Pacific cod population are not explained.

The objective of this study is to examine the relationship between cod populations and environmental (climate/oceanographic) conditions in the southern East/Japan Sea. Environmental conditions at spawning area ware investigated to see how environments during the early life stage affect cod catch with time-lag in southern East/Japan Sea. Examination also was made on the optimum range of adult Pacific cod habitat based on environmental and fishing information collected by the National Fisheries Research and Development Institute (NFRDI) and the National Federation of Fisheries Cooperative (NFFC) in Korea.

Materials and Methods

1. Pacific cod catch data

Catch data were obtained annually from 1970 to 2006 in Korea (Korean Fisheries Yearbook) and western Honshu area from 1964 to 2005 (Annual Report of Catch Statistics on Fishery and Aquaculture). To find-out relationship between Pacific cod catch and oceanographic conditions, catch data were divided by each province or prefecture. In Korean waters, annual catches from Gangwon, Gyeongbuk, Gyeongnam, and Busan provinces were collected, while those from Akita, Yamagata, Niigata, and Ishikawa in Japanese waters (Fig. 3A). For the distribution of Pacific cod in Korean waters, daily radio reports on fishing location and catch amount from fishing vessels to NFFC were collected during the period from 2001 to 2006. Radio report data used contain latitudinal and longitudinal locations and amount of Pacific cod caught by gill net (Appendix Ⅰ).

2. Environmental data

2.1 Arctic Oscillation Index (AOI)

The Arctic Oscillation Index, AOI, was obtained on a monthly basis from the climate prediction center, National Oceanic and Atmospheric Administration (http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/ao.shtml). The daily AOI is constructed by projecting the daily (00Z) 1000mb height anomalies poleward of 20°N onto the loading pattern of the Arctic Oscillation. To compare and correlate with data on fisheries of Pacific cod, data on the AOI anomaly were selected during 1950-2005.

2.2 Seawater temperature and salinity

Seawater temperatures were obtained from World Ocean Database 2001, World Ocean Database 2005, Korea Oceanographic Data Center (KODC) and Japan Oceanographic Data Center (JODC) at three main spawning grounds (the Jinhae Bay, Noto Peninsula and Awashima Island) during 1970-2005 (Fig. 3B). In Korean side, temperature at depth was collected bimonthly, and monthly in Japan.

Assuming Pacific cod stay around 100m, seawater temperatures and salinity at 100 m off the eastern Korea from the KODC were used to find the optimum environmental ranges of Pacific cod habitat.

2.3 Zooplankton data

Bimonthly zooplankton data in Korea waters were obtained from the KODC during the period from 1970 to 2002. They were extracted from shallow coastal areas (< less than 200 m) because expected feeding ground might locate near the coast (Fig. 3B). Total zooplankton biomass and the biomasses of 4 major zooplankton groups (i.e., copepod, amphipod, chaetognath, and euphausiid) were chosen.

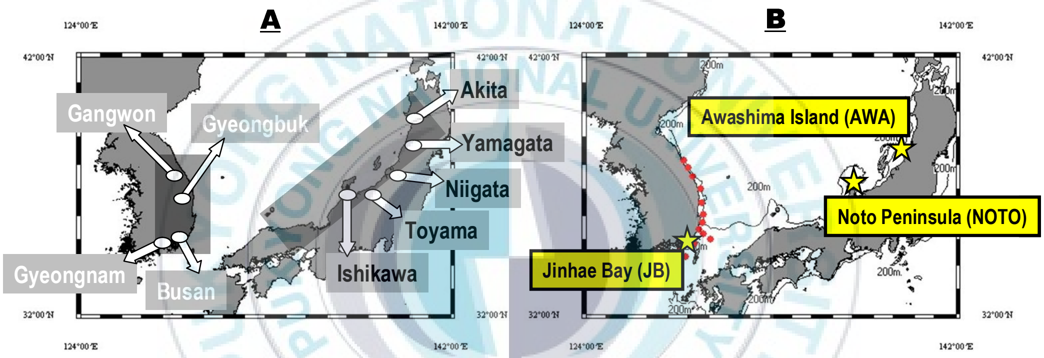

Fig. 3. Catch data were divided each province or prefecture (A). Main spawning grounds (☆) of Pacific cod in southern East/Japan Sea and Sampling stations for zooplankton (●) were shown in Korean waters (B).

3. Analytical Methods

Relationship between Pacific cod catch and environmental conditions in the southern East/Japan Sea was examined using SPSS software. Correlations were used to examine relationships between environmental factors and Pacific cod catch. Time lags of 0 to 7 years were used to examine cross-correlation function (CCF) and check the presence of delayed interaction between environmental and fisheries data of Pacific cod.

Also, Cumulative Sum, CuSum, was used to detect the timing of environmental change as well as change in resource conditions. Suppose that during a period of time the values are all above average. The amounts added to the cumulative sum will be positive and the sum will steadily increase. A segment of the CuSum chart with an upward slope indicates a period where the values tend to be above average. Likewise a segment with a downward slope indicates a period of time where the values tend to be below the average.

Results

1. Influence of oceanographic condition on Pacific cod fisheries

1.1 Japanese waters

Pacific cod catch in the western Honshu area fluctuated substantially (Fig. 4). Catches were significantly larger in 1965, 1977, 1989 and 2005, but relatively low from 1992 to 2003. Until 1990, the southern area (Ishikawa Prefecture) produced the biggest portion, and the northern area (Akita Prefecture) the second largest. However catch of Ishikawa was almost collapsed since 1992, while that of Akita was relatively strong.

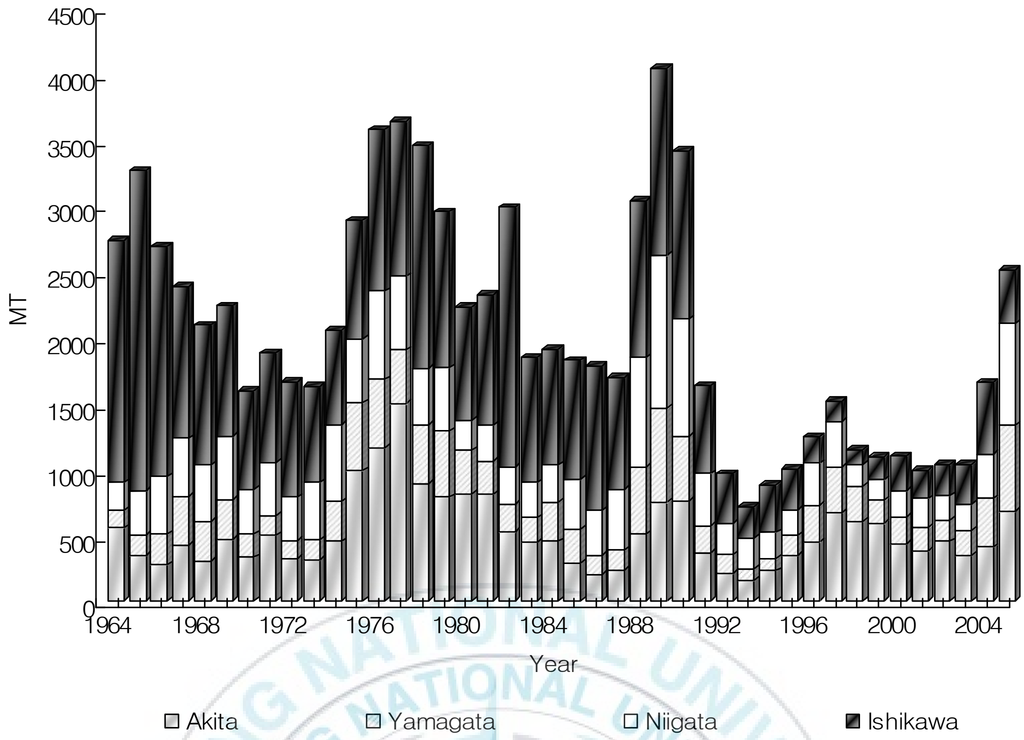

Fig. 4. Variations in catch of Pacific cod in the western Honshu during 1964-2005 (WHS).

Cross correlation function (CCF) analysis, with time-lags, showed a negative correlation between Pacific cod catch and 75 m seawater temperature of spawning ground with a time-lag of 5 years (Fig. 5). For example, Ishikawa cod catch and seawater temperature of Noto spawning area during winter showed a significant negative correlation with a time-lag of 5 years ($r = -0.374^{*}$). Also, spring seawater temperature at Awashima spawning area showed the negative correlations with some northern WHS catches such as Akita ($r = -0.383^{*}$), Yamagata (r = -0.449*), and Niigata (r = -0.496*) with a time-lag of 5 years.

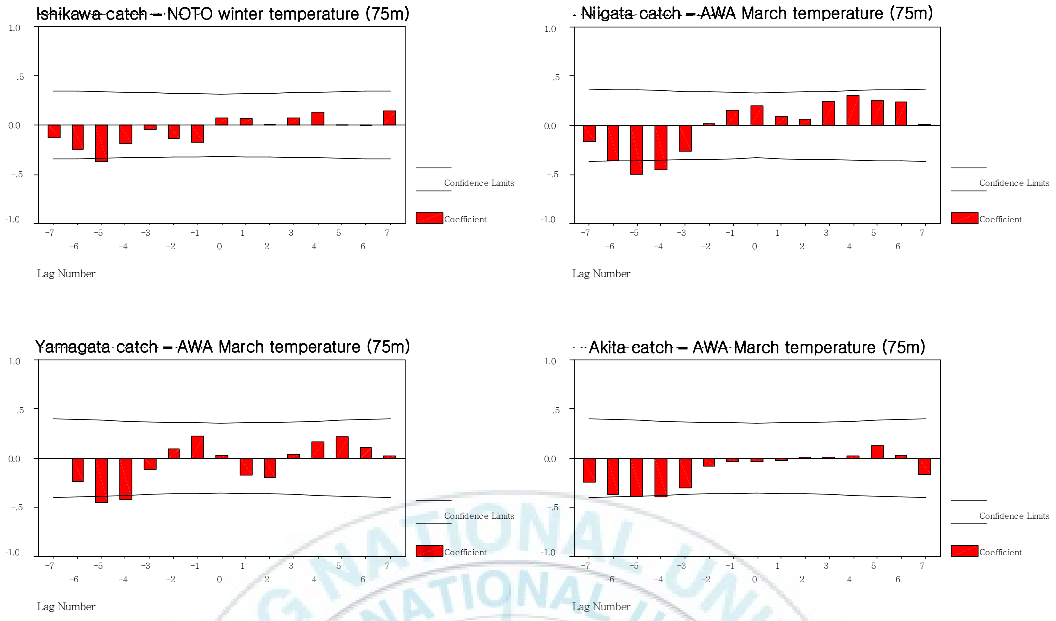

Fig. 5. Cross-correlation between cod catch and seawater temperature at 75m with a time-lag (in year) in the western Honshu area.

1.2 Korean waters

Pacific cod catch in Korean waters had outburst periods twice, i.e., from 1981 to 1983 and after 2000 (Fig. 6). During the first outburst period from 1981 to 1983, Busan and Gyeongnam catches including Jinhae Bay were dramatically increased and then collapsed until late 1990's. Gangwon and Gyeongbuk catches were relatively low level until early 1980s. However, the proportions of Gangwon and Gyeongbuk cod catch were very high compare to those of Busan and Gyeongnam catch during the low yield period in 1990s. Especially, they were increased after 2000 during the second outburst period.

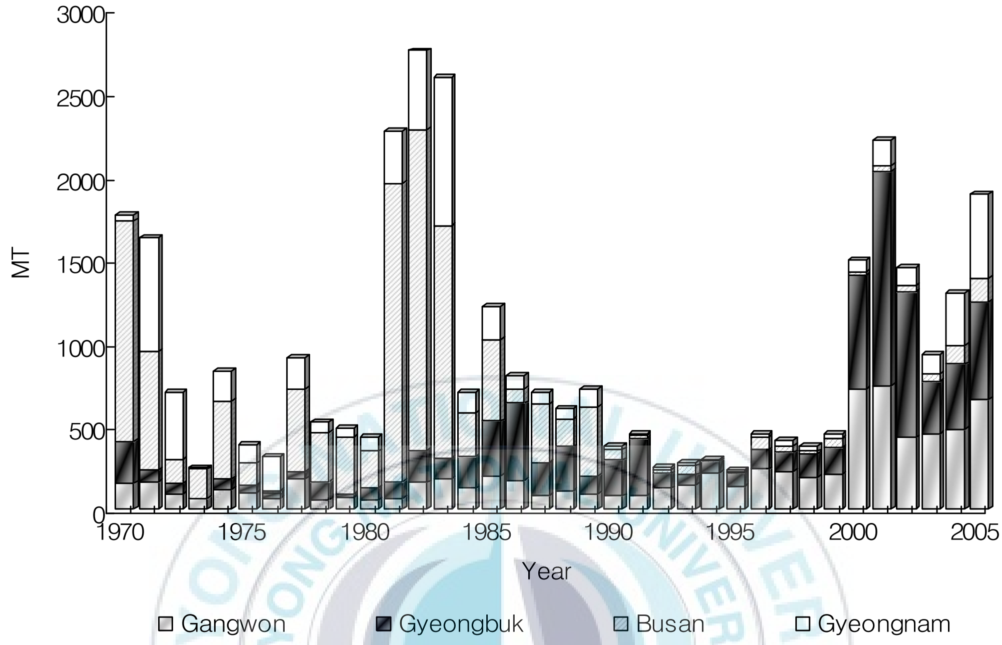

Fig. 6. Changes of Pacific cod catch in eastern Korea during 1970-2005.

Statistically significant correlation between Pacific cod catch and seawater temperature in Jinhae Bay spawning area was found with a time-lag (Fig. 7). Cross correlation function (CCF) analysis indicated that a negative correlation was found between Pacific cod catch and February temperature at 75 m with a time lag of 5 years ($r = -0.404^{*}$). Especially, catch from southern area containing

Busan and Gyeongnam province has a strong correlation with 75 m temperature at Jinhae spawning area with a time-lag of 5 years (r = -0.422*).

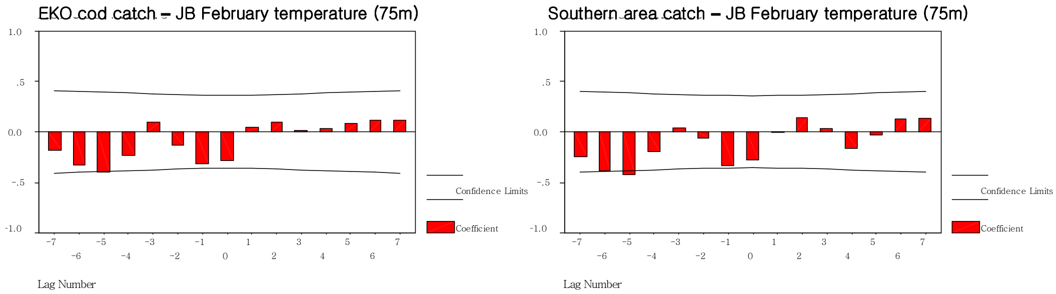

Fig. 7. Cross-correlation between cod and seawater temperature at 75 m with a time-lag (in year) in eastern Korea (EKO).

The correlation between Pacific cod catch and zooplankton during early stage of Pacific cod is significant (Fig. 8). For example, annual Pacific cod catch in the EKO and June zooplankton biomass in coastal nursery and feeding areas were positively correlated, and the highest correlation coefficient (r = 0.452*) was shown with a time-lag of 5 years. And statistically significant positive correlation (r = 0.421*) between EKO cod and February euphausiid was also found.

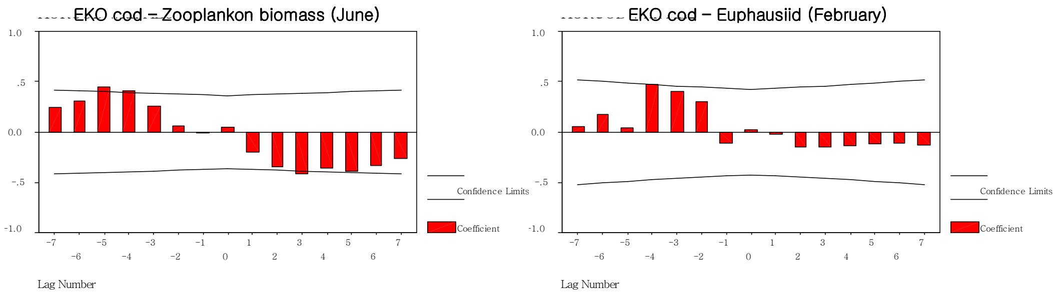

Fig. 8. Cross-correlation between Pacific cod catch and zooplankton with a time-lag (in year) in eastern Korea (EKO).

2. AOI phase and Pacific cod catch.

Wintertime AOI time series generally showed a negative trend until 1970, but changed to a positive until mid 1970, and decreased again through most 1980s. However, during 1988-1994, strong positive AOI appeared and then fluctuated since 1995. CuSum showed a dramatic change from negative slope to positive one in 1987 (Fig. 9).

Significant positive correlations were found between AOI and average winter (December - March) seawater temperature at 75 m in Noto spawning area (0.523^{**}) and between AOI and March seawater temperature at 75 m in Awashima spawning area (0.523^{**}). However, the correlation between AOI and February seawater temperature at 75m in Jinhae spawning area was not significant (Table. 1).

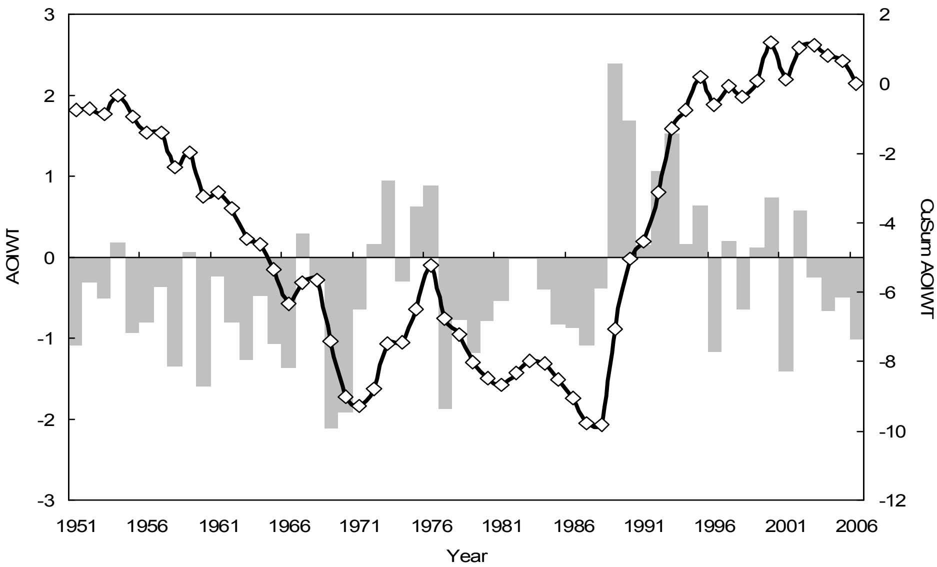

Fig. 9. Arctic Oscillation wintertime Index (December – March, AOIWT) from 1951 to 2006 the CuSum.

Table 1. Summary statistics of Pearson correlations for the AO wintertime index (December –March), February seawater temperature at 75 m in Jinhae spawning area (JB Feb. 75m temp.), average winter (December – March) seawater temperature at 75 m in Noto spawning area (NOTO win. 75m temp.), March seawater temperature at 75 m in Awashima spawning area (AWA Mar. 75m temp.).

	JB Feb. 75m temperature	NOTO win. 75m temperature	AWA Mar. 75m temperature
AOIWT	0.290	0.523**	0.518**

**P < 0.01

The CCF analysis indicated a negative correlation between southern East/Japan Sea cod catch and wintertime AOI, and the highest correlation (r = -0.500*) was shown with a time-lag of 4 years. CuSum curves of AO wintertime index and cod catch showed also 4-year difference in turning point (Fig. 10).

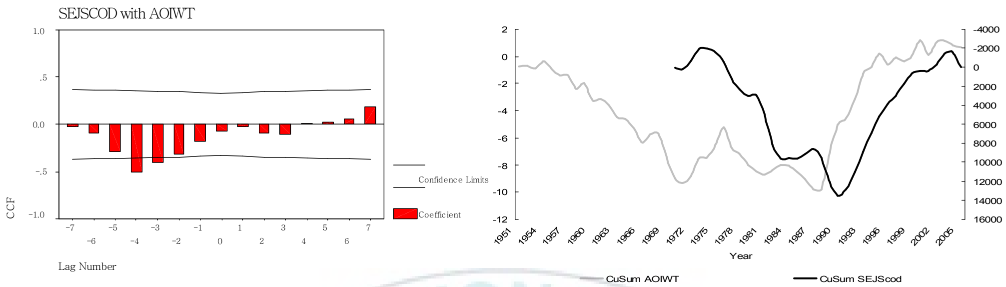

Fig. 10. Cross correlation function with a time-lag (left) and CuSum curve of southern East/Japan Sea (SEJS) cod and AO wintertime index (right).

3. The optimum environmental range of Pacific cod habitat

Off the eastern Korea, catch distribution appeared through a year along the eastern coast of the Korean Peninsula (Fig. 11A), and gill net fisheries are the biggest one in this area (Fig. 11B).

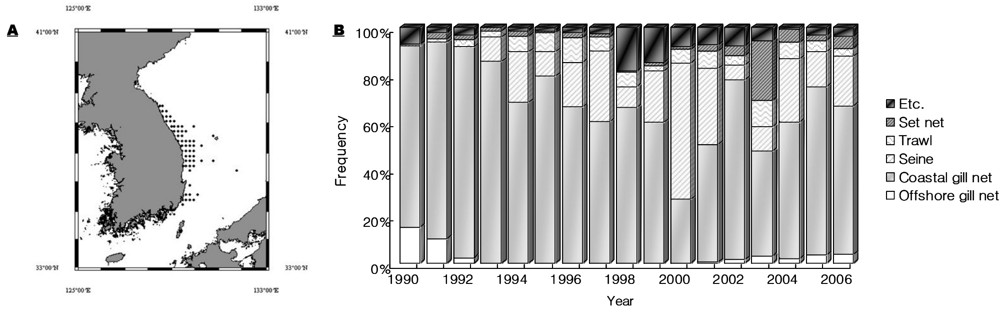

Fig. 11. Catch distribution of Pacific cod during 2001 - 2006 (A) and catch proportions by fishery of Pacific cod during 1990 – 2006 (B).

Optimum environmental range of cod habitats was investigated assuming the residence depth of 100 m. Information on seawater temperature and salinity at 100 m near the fishing place was extracted from the KODC. Catch amounts were allocated by cells having specific ranges of temperature and salinity. Seawater temperatures of cod habitats range 1-4℃ and salinity 33.8-34.2 PSU (Table. 2). Especially, highest catch occurred in seawater temperature range of 2-4℃ and salinity range of 33.8-34.0 PSU.

34.6 34.4 -		166 (n=1)				11 (n=1)
34.4 34.2 -	74 (n=1)					750 ± 200 (n=5)
34.2 34.0 -	19000 ± 979 (n=30)	43233 ± 760 (n=83)	2265 ± 324 (n=10)	2326 ± 321 (n=6)	3554 ± 1118 (n=6)	603 ± 80 (n=5)
34.0 33.8 -	4097 ± 888 (n=8)	52052 ± 2199 (n=50)	9409 ±1739 (n=11)	880 ± 158 (n=4)		153 (n=1)
33.8 33.6 -			224 (n=1)	1224 ± 632 (n=2)		2602 (n=1)
PSU / ℃	**0 - 2**	**2 - 4**	**4 - 6**	**6 - 8**	**8 - 10**	**10 -**

Unit : Kg

Table2. The optimum range of Pacific cod habitat based on the environmental factors.

Discussion

1. Fluctuation of Pacific cod catch

Environmental data such as seawater temperature, zooplankton and climate index were analyzed with catch data in the southern East/Japan Sea to reveal the effect of environmental change on Pacific cod catch fluctuation. The long-term catch and atmospheric trends seemed to correspond well with time-lag. Also the relationship between Pacific cod catch and seawater temperature at spawning area showed a negative correlation with a time-lag of 5 years for both stocks i.e. off the eastern Korea and western Honshu stocks (Fig.5; Fig.7). In other words, this statistical analysis can be interpreted like this; if temperature at 75m in spawning grounds is high, the catch of cod would be decreased 5 years later in southern East/Japan Sea, vice versa. However, the processes on this phenomenon were not known.

In case of the relationship between catch amounts and zooplankton, positive effect showed with a time-lag of 5 years (Fig.8) though there is no field at nursery ground of cod juvenile off the eastern Korea. During June in east coastal area of Korea, positive correlation between Pacific cod catch and zooplankton biomass at expected nursery ground may represent bottom-up process in ecosystem. Here, time-lag of 5 years agree with report of Choi *et al* (2007) that age of matured cod collected is 5-6 ages in Jinhae Bay. This might explain that environmental conditions, such as seawater temperature and zooplankton, during their early life stages affect cod recruitment and catch after 5 years.

Sullivan *et al*. (2005) confirmed that the NAO had a strong effect on the local oceanography and recruitment of *Limanda ferruginea* was closely coupled with the NAO and, to a lesser extent, average cold pool bottom temperature in the middle Atlantic bight. In this study, I found that temperatures at 75 m depth of NOTO and AWA spawning areas were associated with winter AOI. Also, the effect of AOI on fishery fluctuation indicated that there was a negative correlation between southern East/Japan Sea cod catch and AOI with a time-lag of 4 years. Seawater temperature tends to influence virtually every biological process leading up to recruitment (spawning pattern, egg viability, pelagic growth/mortality, etc.: Ottersen *et al*., 2001). And the time period of stages is not equal (e.g., egg, yolk-sac larvae, feeding larvae, late-stage larva and age 1 period) and environmental change occurs continuously. Therefore, another research except by environmental condition during early life stage needs to do. For example, research such as survival rate of egg and larvae, distribution of each stage, migration route, age and growth, must have done in order to predict well about recruitment. Also, localized index instructing environmental change of

East/Japan Sea must develop and confirm how that will affect cod catch.

2. The optimum environmental range of habitat

Daily radio report on fishing location and catch from fishing vessels to NFFC were analyzed with seawater temperature in southern East/Japan Sea to examine the optimum temperature range of cod habitat. Yun *et al*. (2004) and Min *et al*. (2007) confirmed that the southward movement of the cold and relatively fresh subsurface water, known as the North Korean Cold Water, exists over a period of six to seven months from April to October along the east coast of Korea and is pronounced in August. Superimposing catches over the distribution map of seawater temperature at 100 m depth where Pacific cod is caught by gill net was made. In result, cold water mass appeared along the eastern coast of the Korean Peninsula in all years and Pacific cod that cold water species distributed along the east coast due to effect of seawater temperature during 2001 – 2006 (Fig.12).

In Jinhae Bay, spawning ground, Pacific cod appears only spawning period from November to February. They were caught by the fyke net at 20 m depth in which seawater temperature is about 12℃. However, optimum range of their nursery ground appeared seawater temperature range of 1-4℃ and salinity range of 33.8-34.2 PSU (Table. 1). Habitat temperature between nursery ground and spawning ground showed considerable difference. This phenomenon can anticipate that they found high temperature so as to increase the hatching rate.

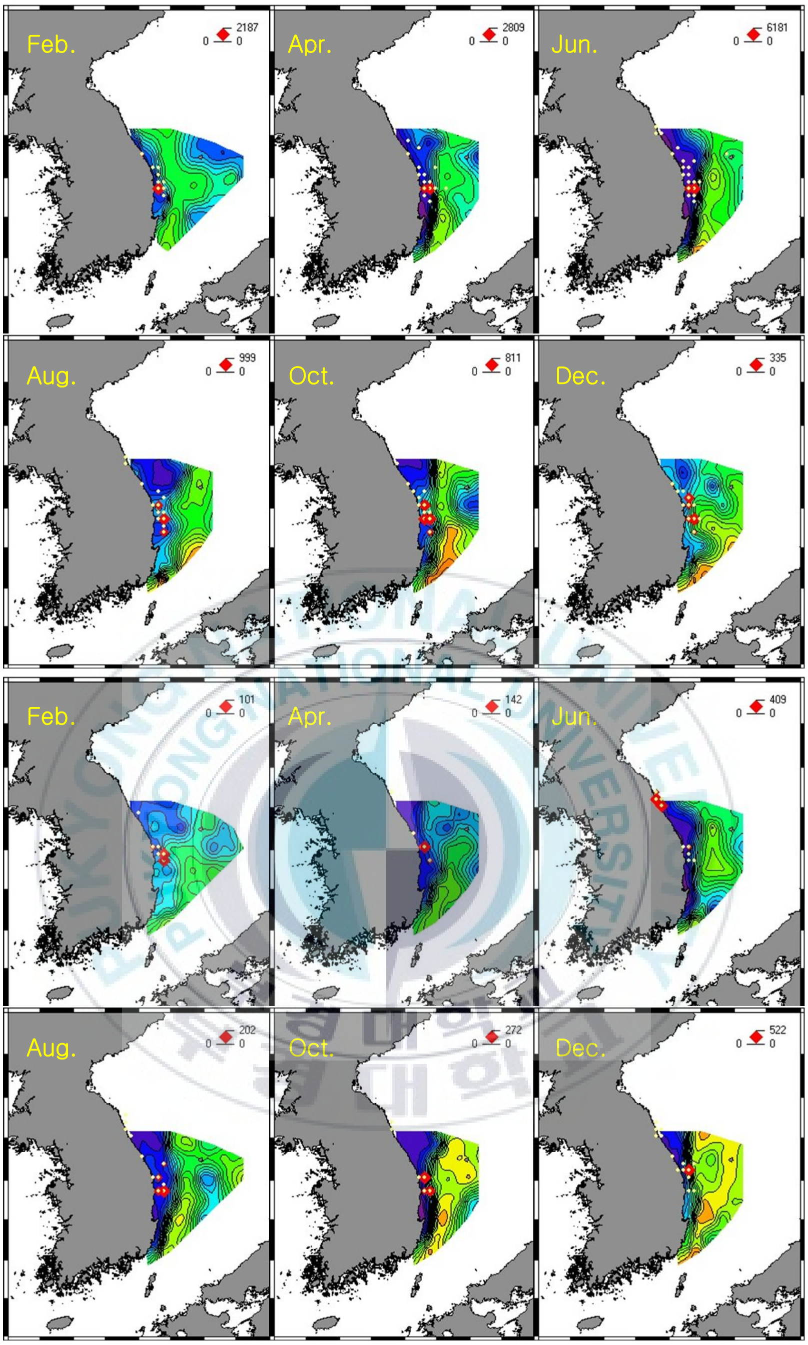

Fig.12 Superimposing catches over the distribution map of seawater temperature in 2002 (up) and 2003 (down).

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AO http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/ao.shtml.

APPENDIX Ⅰ

Year	Statistical Sub-area	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2001	55-4	0	0	0	0	0	0	165	15	0	0	0	0
2001	63-1	20	10	58	73	143	0	0	0	0	0	0	0
2001	63-7	100	468.5	10	0	50	0	56	968	595	735	28	329
2001	63-8	0	100	0	0	0	0	0	32	0	0	0	0
2001	69-2	0	925	0	0	0	0	30	0	0	0	0	0
2001	69-9	0	0	0	70	30	0	0	237	10	512	0	0
2001	70-5	0	0	1050	0	0	0	10	0	0	0	0	0
2001	70-7	0	829	640	837	50	0	415	153	248	983	75	268
2001	76-1	140	4	350	0	501.5	220	270	430	30	190	0	287
2001	76-2	0	0	0	0	0	0	550	0	0	0	0	220
2001	76-4	0	0	0	0	650	0	2450	0	0	0	0	0
2001	76-5	0	200	3950	15850	1980	3080	17110	0	0	3220	9150	790
2001	82-2	0	0	0	170	0	0	0	0	0	0	0	0
2001	93-3	0	0	0	0	0	0	0	0	0	0	10	0
2002	55-4	0	0	0	0	0	60	35	50	0	0	0	0
2002	55-7	0	0	0	0	0	10	70	210	80	0	0	0
2002	55-8	0	0	0	0	0	20	30	0	90	50	0	0
2002	63-1	0	0	0	50	0	0	50	0	0	0	0	0
2002	63-5	0	0	0	0	170	150	0	0	0	0	0	0
2002	63-6	0	0	0	2	0	0	0	0	0	0	0	0
2002	63-7	464	689	285	469.2	820	690	80	125	140	50	0	110
2002	63-9	0	0	20	0	0	0	0	0	0	0	0	0

2002	66-8	0	0	0	0	0	3	0	0	0	0	0	0
2002	69-2	0	0	0	0	130	0	5	0	0	35	10	50
2002	69-3	0	0	0	0	200	200	0	0	0	0	0	10
2002	69-5	0	0	100	0	100	0	0	0	0	0	0	0
2002	69-6	0	30	165	125	287	10	20	0	0	130	15	0
2002	69-8	0	0	0	0	0	0	0	0	20	0	0	0
2002	69-9	0	0	0	70	0	470	275	10	40	40	60	20
2002	70-1	0	0	0	0	110	0	0	20	0	25	0	0
2002	70-2	0	0	0	0	0	110	0	0	0	0	0	0
2002	70-4	0	33	0	0	20	210	0	0	0	0	50	270
2002	70-5	0	0	0	0	0	0	20	40	0	0	0	0
2002	70-6	0	0	0	6	150	0	0	0	0	0	0	0
2002	70-7	410	363	400	425	1980	1380	1382	733	1155	773	612	198
2002	70-8	0	0	0	0	0	0	0	0	0	0	0	20
2002	71-5	0	0	0	0	2	0	0	0	0	0	0	0
2002	76-1	35	15	0	40	1100	930	1750	310	170	50	30	0
2002	76-2	2100	77	50	158	1310	1042	970	180	155	310	0	0
2002	76-3	0	0	0	0	10	50	70	0	20	0	0	0
2002	76-4	2800	2168	2753	2204	3016	4491	1308	270	170	800	350	180
2002	76-5	6789	612	1667	2796	7009	6165	3468	990	350	780	760	330
2002	76-6	0	0	0	29	0	0	0	0	0	0	0	30
2002	76-7	0	0	8	53	0	170	0	0	20	0	0	0
2002	76-8	0	26	0	0	0	1196	938	70	0	0	0	0
2002	77-5	0	0	0	145	0	0	0	0	0	0	0	0
2002	78-5	0	0	0	0	200	0	0	0	0	0	0	0
2002	82-2	0	0	10	21	1292	1195	1929	680	540	510	240	150
2002	87-2	0	0	0	0	50	0	0	0	0	0	0	0
2003	48-7	0	0	0	0	0	0	0	30	0	0	0	0
2003	55-1	0	0	0	25	190	160	65	40	15	10	0	75
2003	55-4	0	0	0	0	455	375	120	35	110	60	100	115

2003	55-5	0	0	0	0	50	25	30	0	0	0	0	10
2003	55-7	0	0	0	0	0	0	40	0	70	0	0	10
2003	55-8	0	0	0	0	105	400	220	30	155	0	6	25
2003	62-3	0	5	0	0	0	0	0	0	0	0	0	0
2003	63-7	0	0	0	0	0	0	0	40	10	0	10	70
2003	69-2	0	0	0	50	0	0	0	0	0	0	0	0
2003	69-3	0	0	0	0	0	0	0	0	0	0	0	25
2003	69-5	0	0	0	0	0	0	0	0	0	0	0	10
2003	69-6	30	0	20	0	0	0	0	0	0	0	270	55
2003	69-9	0	50	10	0	0	80	0	40	30	50	0	0
2003	70-2	0	0	0	0	0	0	0	80	0	0	0	10
2003	70-4	0	0	0	0	0	0	0	0	0	0	110	520
2003	70-7	137	32	355	139	283	175	147	124	482	270	154	110
2003	70-8	0	0	0	0	80	0	0	0	0	0	0	0
2003	76-1	0	20	0	0	130	10	40	0	80	0	50	0
2003	76-2	0	100	0	0	70	0	0	40	0	0	0	0
2003	76-4	60	0	30	0	40	60	110	150	20	160	185	70
2003	76-5	20	100	40	60	260	50	140	200	150	230	190	100
2003	76-6	0	0	0	0	50	0	0	0	0	0	0	0
2003	82-2	0	0	110	0	0	0	30	0	0	0	0	0
2003	174-9	0	0	0	0	0	0	200	0	0	0	0	0
2004	48-7	0	200	0	0	0	0	0	0	0	0	0	0
2004	55-1	120	155	90	25	45	95	0	10	20	20	0	0
2004	55-2	0	0	0	0	20	0	0	0	0	0	0	0
2004	55-4	642	361	10	10	60	5	50	85	185	90	15	10
2004	55-5	80	0	10	0	5	0	0	0	0	0	0	0
2004	55-7	90	20	0	0	20	0	80	100	0	0	0	0
2004	55-8	451	319	87	99	37	94	639	507	180	80	472	203
2004	55-9	0	0	0	0	2	0	0	0	0	0	0	0
2004	62-3	1461	11284	25	79	36	210	84	44	100	1828	1094	2254.7

2004	63-1	24	0	0	0	0	0	0	0	0	0	96	0
2004	63-4	637	619	11	5	21	278	587	146	21	731	1782	1798.9
2004	63-7	70	0	0	0	110	1630	1540	0	0	0	50	350
2004	63-8	0	0	0	0	0	0	0	0	0	0	0	40
2004	64-4	0	11	0	0	0	0	0	0	0	0	0	0
2004	69-2	0	130	0	0	100	0	0	30	0	0	0	70
2004	69-3	0	70	0	0	150	0	150	0	0	0	0	0
2004	69-5	0	0	0	50	0	0	0	0	0	0	0	0
2004	69-6	120	5	0	20	0	160	100	0	0	0	0	0
2004	69-9	0	0	20	30	0	30	0	130	30	7	0	20
2004	70-1	0	0	0	0	0	0	20	0	0	0	0	0
2004	70-2	0	0	0	40	0	0	0	0	0	0	0	0
2004	70-3	0	0	0	50	0	0	70	0	0	0	0	0
2004	70-4	60	0	0	0	0	0	90	110	20	0	40	0
2004	70-7	5	30	110	163	30	70	201	760	550	362	408	30
2004	76-1	5	40	0	0	40	50	100	0	70	250	0	0
2004	76-2	0	0	0	50	0	0	0	90	0	0	0	0
2004	76-4	60	0	0	60	70	20	30	140	70	410	120	0
2004	76-5	0	0	0	50	160	40	0	50	120	100	220	0
2004	82-2	0	0	0	0	50	0	0	0	0	0	0	0
2004	92-7	0	0	0	0	0	0	0	0	0	0	0	30
2004	93-2	0	0	0	0	0	0	0	0	0	0	0	100
2004	99-2	0	0	0	0	0	0	0	0	0	0	0	150
2004	99-3	0	0	0	0	0	0	0	0	0	0	0	30
2004	100-1	0	0	0	0	0	0	0	0	0	0	0	500
2004	163-7	0	0	0	0	0	0	0	100	200	0	0	0
2004	164-4	0	0	0	0	0	0	0	0	0	2000	0	0
2004	173-5	0	0	0	0	0	0	0	0	0	200	0	0
2004	174-4	0	0	0	0	0	0	0	0	0	0	100	0
2004	176-3	0	100	0	0	0	0	0	0	0	0	0	0

2005	55-1	0	120	375	890	660	30	0	10	30	30	0	0
2005	55-4	112	25	155	1410	940	60	60	40	70	15	0	5
2005	55-5	0	70	0	65	10	0	0	0	0	0	0	0
2005	55-7	0	0	0	0	20	35	25	0	0	0	0	0
2005	55-8	493.5	350	433	1011	1700	788	85	1764.5	333	409.5	174	452
2005	55-9	0	0	0	10	0	3	5	3	0	1	0	0
2005	56-7	0	0	0	0	0	25	0	0	0	0	0	0
2005	62-3	1508	1073.3	1503.9	1447.2	3131.3	108.5	1	1234	1107	546	130	105
2005	63-1	4	4.5	0	0	0	104	85	0	0	5	0	0
2005	63-2	0	0	0	0	0	0	0	2	0	0	0	0
2005	63-3	0	0	0	0	0	0	0	0	0	30	0	0
2005	63-4	895.7	612.9	191	227	274	144.5	13	841	423	288	450	131
2005	63-5	0	0	0	0	0	0	0	0	0	80	499	0
2005	63-7	0	0	310	1130	580	0	100	280	30	2314.4	1552	120
2005	63-8	0	0	0	0	0	0	70	0	0	218	195	30
2005	64-4	0	0	0	0	0	0	0	0	0	0	1	0
2005	69-2	0	0	400	200	0	20	40	0	0	350	0	0
2005	69-3	0	0	400	0	150	0	0	30	0	0	60	23
2005	69-5	0	0	0	0	0	0	0	0	0	0	10	0
2005	69-6	0	0	200	1538	150	0	0	10	0	853	305	483
2005	69-9	0	0	20	130	0	40	40	260	320	722	217	30
2005	70-1	0	0	0	100	0	0	0	0	0	10	11	0
2005	70-2	0	0	0	50	0	0	0	0	0	30	0	0
2005	70-4	0	0	170	850	0	40	0	0	0	54	30	0
2005	70-5	0	0	0	800	0	0	0	100	0	0	0	0
2005	70-6	0	0	0	0	0	0	0	50	0	0	0	0
2005	70-7	15	20	90	640	160	100	100	490	1045	1210	385	310
2005	76-1	0	0	0	750	150	70	0	0	0	30	80	0
2005	76-2	0	0	0	1550	120	0	0	100	10	150	0	0
2005	76-3	0	0	0	500	0	0	0	0	0	0	0	0

2005	76-4	0	0	30	350	30	90	200	200	100	180	80	70
2005	76-5	0	50	100	1350	30	770	450	870	1000	560	0	0
2005	76-9	0	0	0	0	0	0	0	0	50	0	0	0
2005	82-2	0	100	0	0	230	0	0	100	100	0	0	0
2005	86-2	0	20	0	0	0	0	0	0	0	0	0	0
2005	87-7	0	0	0	0	0	0	0	0	0	0	0	130
2005	88-7	0	100	0	0	0	0	0	0	0	0	0	0
2005	92-3	0	0	0	0	0	0	0	0	0	0	0	130
2005	92-6	0	0	0	0	0	0	0	0	0	0	0	120
2005	93-2	200	0	0	0	0	0	0	0	0	0	100	180
2005	99-2	60	0	0	0	0	0	0	0	0	0	0	0
2006	47-9	0	0	0	0	0	0	240	0	0	0	0	0
2006	48-7	0	0	0	0	0	0	60	0	0	0	0	0
2006	55-1	60	85	395	485	1425	370	0	360	325	10	0	95
2006	55-2	0	0	0	0	0	0	0	0	0	0	0	30
2006	55-4	496	162	131	205	465	155	95	185	658	182	460	297
2006	55-5	5	30	0	100	160	0	30	75	265	60	15	25
2006	55-6	0	0	0	0	0	0	0	0	20	0	0	0
2006	55-7	50	0	0	5	0	0	20	0	0	30	5	5
2006	55-8	640	381	380.5	1704	4316	1472	1771	1214.5	3288	1698	3094	2244
2006	55-9	0	4	0	30	30	14	104	268	197	72	21	60
2006	62-3	365.5	157	161	707	688.9	226	394	485	1249	1144	2689	1285
2006	62-6	20	0	0	0	0	0	0	0	0	2	0	0
2006	63-1	5	0	0	4	105	15	593	0	0	0	3	8
2006	63-2	0	0	0	0	26	30	0	15	255	0	0	0
2006	63-3	0	0	0	0	0	0	0	0	360	75	0	0
2006	63-4	201	18.5	101	86	115	752	433	368	889	122	59	469
2006	63-5	285	120	0	330	90	150	480	30	0	0	0	30
2006	63-6	0	0	0	0	0	30	0	0	0	0	0	0
2006	63-7	4611	540	180	1050	3008	3811	7725	7239	8487	840	990	300

2006	63-8	316	30	15	120	750	75	0	330	522	365	100	120
2006	63-9	0	0	0	0	0	30	0	30	150	0	0	0
2006	64-3	30	0	0	0	0	0	0	0	0	0	0	0
2006	69-2	913	268	236	33	294	790	596	223	516	0	170	0
2006	69-3	100	10	0	10	50	0	87	75	104	0	0	100
2006	69-5	0	0	20	10	20	878	246	274	358	0	0	0
2006	69-6	1139	183	100	19	85	909	1015	928	2884	15	1520	475
2006	69-7	0	0	0	0	0	0	0	0	30	0	0	0
2006	69-9	200	43	60	20	60	30	32	68	84	0	0	53
2006	70-4	0	0	74	0	0	71	40	155	0	0	100	500
2006	70-5	0	0	0	0	10	0	0	0	0	0	0	0
2006	70-6	0	0	0	0	0	30	0	0	0	0	0	0
2006	70-7	110	30	330	0	190	130	510	237	63	50	70	0
2006	70-8	0	0	0	0	100	0	0	0	0	0	0	0
2006	70-9	0	0	0	0	0	50	0	30	0	0	0	0
2006	75-9	0	0	0	0	0	0	0	50	0	0	0	0
2006	76-1	0	0	40	0	100	50	0	0	0	0	0	0
2006	76-2	0	0	50	0	200	200	0	0	0	0	0	0
2006	76-3	0	0	0	0	0	50	0	0	0	0	0	0
2006	76-4	0	0	0	20	0	0	0	210	300	0	200	0
2006	76-5	0	0	0	0	250	250	100	0	0	0	0	0
2006	87-7	0	0	0	0	250	0	0	0	0	0	0	100
2006	87-8	0	0	0	0	0	0	0	0	0	0	0	400
2006	92-3	0	0	0	0	0	0	0	0	0	0	20	0
2006	92-6	0	0	0	0	0	0	0	0	0	0	0	600
2006	93-1	0	0	0	0	0	0	0	0	0	0	200	2600
2006	93-2	0	0	0	0	0	0	0	0	0	0	0	500
2006	99-3	0	0	0	0	0	0	0	0	0	0	20	0
2006	100-1	0	0	0	0	0	0	0	0	0	0	100	0
2006	154-5	0	0	0	0	0	0	0	0	0	0	500	0

2006	162-9	0	0	0	0	0	0	0	0	0	0	0	100
2006	163-2	0	0	0	0	0	0	0	0	200	0	0	0
2006	164-2	0	0	0	0	0	0	0	100	0	0	0	0
2006	164-4	0	0	0	0	0	0	0	0	350	100	0	0
2006	173-6	0	0	0	0	0	0	0	100	0	0	0	0

Unit : Kg