Document for 2002 STC meeting
Central BS Pollock Convention, September 2002

Cruise results of the winter 2002 Bering Sea pollock survey (*Kaiyo Maru*)

Akira Nishimura[*1], Takashi Yanagimoto[*1], and Yoshimi Takao[*2]
[*1]Hokkaido National Fisheries Research Institute
[*2]National Research Institute of Fisheries Engineering
Fisheries Research Agency

1. Cruise description and objectives

Hokkaido National Fisheries Research Institute (HNF) and National Research Institute of Fisheries Engineering (NRIFE), Fisheries Research Agency, conducted an echo integration mid-water trawl survey of walleye pollock (*Theragra chalcogramma*) in the Aleutian Basin aboard the R/V *Kaiyo Maru* of the Fisheries Agency of Japan. In this survey area, Alaska Fisheries Science Center (AFSC) had conducted pollock Echo Integration Mid-Water Trawl (EIMWT) survey by R/V *Miller Freeman* annually since 1989, and also Japan Fisheries Agency had conducted triennial survey since 1980s. In winter 2002, *Miller Freeman* conducted a survey in the Specific Area (Bogoslof area) that is defined in the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea. With considering the importance of the comprehensive research activities discussed and authorized at the Convention meeting, *Kaiyo Maru* went to the neighbor areas in the south Aleutian Basin, north of the Aleutian Chains, and collected fish distribution and its biological data. These two research cruise took an important part of the comprehensive research activities. The 2002 *Kaiyo Maru* survey was a cooperative work between HNF/NRIFE, AFSC, and TINRO-Centre.

The primary objectives of the survey were:
1) To determine the geographical distributions of walleye pollock in the southern Aleutian Basin.
2) To collect echo integration data to determine the biomass of walleye pollock in the area.
3) To collect biological information on walleye pollock in the basin area.
4) To collect information on the oceanographic and biological environments during the winter in the area.

2. Survey area and cruise itinerary

The research area was the southern part of the Aleutian Basin (**Fig. 1**). During February 9-12, we conducted EIMWT survey in the Specific Area (Bogoslof area: east of 170W) that is defined by the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea. This survey covered a part of the area historically surveyed by the *Miller Freeman*. And during February 21 to March 5, we conducted EIMWT survey in the neighbor area to the Specific Area, west of 170W. All these survey areas were included in the U.S. EEZ. For the accurate assessment, the Kaiyo Maru was allowed to survey inside 3-mile of coast of Aleutian Islands. Acoustic system calibration was carried out in the Captain's Bay of Unalaska Island. And inter-ship calibration with US *Miller Freeman* was carried out in the adjacent area to the Islands of Four Mountains.

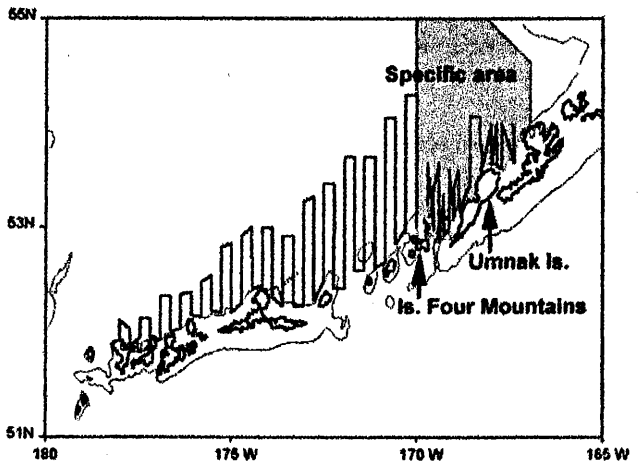

Fig. 1. Transect lines of the winter 2002 *Kaiyo Maru* survey.

3. Research vessel

Ship name: *Kaiyo Maru* (Fisheries Agency of Japan, Tokyo)
Type: Stern trawler
Length: 93.01 meters
Tonnage: 2,630 tons
Radio call sign: JNZL

4. Crew and researchers on board

1) Crew: Captain Yoshihiro KIKUCHI and 43 crew

2) Japanese Researchers

Preliminary survey

Researcher

Akira NISHIMURA, HNF
Takashi YANAGIMOTO, HNF
Yoshimi TAKAO, NRIFE
Kazutoshi WATANABE, NRIFE
Atushi NANAMI, NRIFE

Assistant researcher

Hiroki YASUMA, University of Tokyo

Main survey

Japanese researchers

Akira NISHIMURA, HNF (Chief scientist)
Takashi YANAGIMOTO, HNF
Yoshimi TAKAO, NRIFE

Foreign researcher

Alexander V. NIKOLAEV, TINRO-centre

Assistant researchers

Hiroki YASUMA, University of Tokyo
Seiji KATAKURA, Hokkaido University
Nobuo KOJIMA, Hokkaido University
Koutarou ONO, Hokkaido University

5. Vessel itinerary

Preliminary survey (in the adjacent waters of Tokyo)

Dec. 7, 2001	leave Tokyo
Dec. 8-10	Acoustic system calibration and noise measurements
Dec. 11	arrive Tokyo

Main survey (in the Bering Sea)

Feb. 2, 2002	leave Tokyo
Feb. 9-12	(U. S. date) EIMWT survey east of 170W (Leg 1)
Feb. 13-14	System calibration in the Captain's Bay
Feb. 15	arrive Dutch Harbor
Feb. 18	leave Dutch Harbor
Feb. 19-20	Intership calibration with the *Miller Freeman*
Feb. 21-Mar. 5	EIMWT west of 170W (Leg 2)
Mar. 14	(Japanese date) arrive Kushiro
Mar. 17	leave Kushiro
Mar. 20	arrive Tokyo; end of cruise

6. Methods

A standard sphere calibration of the acoustic systems was conducted at Manazuru Bay in the preliminary survey and at Captains Bay in the survey.

The EIMWT survey was conducted 24 hours per day in the both Leg. Acoustic data were collected continuously along a transect with a KFC3000 echo integration system (*Kaijo*). The *Kaijo* 38-kHz transducer was mounted on the hull. Ship speed and integration distance were usually kept between 8-10 knots and 1 nmi, respectively through the survey. However, under noisy conditions (e.g., during bad weather), the ship speed was decreased to 4-6 knots. Transect spacing was designed to be 10 nmi, and it was reduced to 5 nmi where fish aggregations were observed in Leg 1. Southern transect endpoints were at approximately 100-m bottom depth. The northern extent of the 10 nmi-spaced transects was approximately 60-80 nm distance from the southern end point east of 173° W. The transect distance was decreased to 20-40 nm at west of 173° W.

Biological sampling was conducted using a mid-water trawl net to identify the echo sign and to obtain biological data of the organisms. When significant echo sign appeared, the vessel returned to the area at typical signs, and a mid-water trawl was conducted. Hauling duration was kept to a minimum for obtaining adequate biological samples. Catch from the trawl was weighed and counted after sorting by species. A subsample of up to 300-500 pollock was selected randomly for length frequency analysis. An additional sample of 40 males and 40 females was collected, and length, maturity, and gonad weight were recorded. Maturity stages were classified according to U.S. manual. At the same time, parasites were observed, otoliths were dissected out, and a tissue sample was collected for genetic analysis.

Pollock abundance estimates were derived from the results of both acoustic and trawl data. Echo integration data were grouped into 2 areas for Leg 1 data and 4 areas for Leg 2 data as distinguished by echo sign characteristics, geographic location, length composition in the hauls, and transect spacing.

CTD cast was carried out at each trawl station. At the same time, plankton sampling was conducted by using a NORPAC net. At selected stations, an XCTD cast collected water temperature and salinity profiles.

7. Results

1) Sphere calibration and Inter-Ship calibration

Sphere calibration was conducted in the pre-survey in Manazuru Bay on December 7-9. A tungsten carbide sphere (38.1 mm) was used for the 38-kHz calibration.

Table 1. Information and the catch composition of Mid-water trawl sampling.

Trawl st	T0201	T0202	T0203	T0204	T0205	T0206	T0207	T0208	T0209	T0210
Date	8-Feb	9-Feb	12-Feb	21-Feb	23-Feb	24-Feb	25-Feb	26-Feb	27-Feb	1-Mar
Latitude	53-16.96	53-14.68	53-37.59	53-08.59	52-36.67	53-29.25	52-41.36	52-37.53	52-28.04	52-09.64
Longitude	169-41.84	169-17.93	167-37.63	169-27.84	171-05.44	171-39.05	171-57.57	173-20.63	174-25.54	175-39.70
Bottom depth (m)	733	1257	690	>1000	518	2198	675	652	1005	867
Net depth (m)	340	399	410	480	380	310	450	527	527	470
Duration (min)	28	35	8	34	27	30	50	41	15	31
Cover net	Close	Open	Open	Open	Close	Close	Close	Close	Open	Open
Catch composition	Catch composition in weight (kg)									
Scientific name	T0201	T0202	T0203	T0204	T0205	T0206	T0207	T0208	T0209	T0210
Theragra chalcogramma	11.4	1387.0	2029.5	3539.3	35.6		19.0		1.9	18.4
Stenobrachius leucopsarus					474.1	15.5	24.2	7.5	284.9	152.4
Coryphaenoides pectoralis					89.9		701.4	2.0		2.1
Lampanyctus jordani									20.1	80.3
Myctophidae	11.98	86.22	+	+		0.13	0.16	0.00	0.00	0.43
Leuroglossus schmidti					25.0		0.7	1.5	33.6	1.5
Dhiapus theta						0.1	0.0		15.1	31.2
Oncorhynchus tschawytsha	2.0	5.2	4.3	5.8			1.7	1.0	2.0	
Oncorhynchus keta										2.2
Aptocyclus ventricosus							3.0	1.1		
Suids	0.3	10.8	0.1	+	+	1.2	0.4	4.7	31.1	6.6
Other fishes	0.01	3.58	0.24	0.00	0.05	0.74	0.19	0.70	1.24	2.95

In the Bering Sea, sphere calibrations were conducted in the Captains Bay on February 14-18. Sphere integration results are shown in Takao *et al* (2002; STC submitted Doc.). Slightly lower TR factor (transmitting and receiving coefficient) was observed. Low water temperature was thought to be the major factor of the lower TR factor values. During the main survey period, the water temperature was almost constant about 3°C, and the accuracy of our system was maintained.

2) Catch composition and pollock distribution

Pollock were observed along the Aleutian Islands in the survey area. In the offshore area, only scattered or few echo signs of pollock were observed. Typical echo signs of lanternfish were observed throughout the offshore area in the 280-400 mm depth layer. Trawl sampling was conducted to confirm the lanternfish distribution at St. T0206, and T0208 (**Table 1**). Northern lampfish, *Stenobrachius leucopsarus*, was the dominant species and were followed by *Lampanycthus jordani* and *Dhiapus theta* in these stations. Pollock were observed in extremely dense aggregations from Umnak Island to the Islands of Four Mountains (IFM) in Leg 1 (**Fig. 2**). The highest concentrations were observed in the area northeast of the IFM. The vertical distribution of pollock echo sign ranged between 400 m and 600 m below the surface. In Leg 1, 3 trawl hauls were conducted. These trawl hauls were conducted to collect biological data of

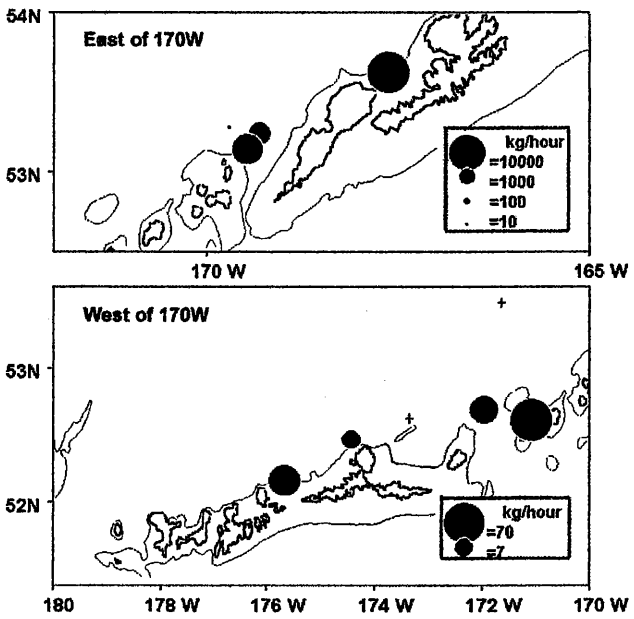

Fig. 2. Catch (kg/hour) of adult walleye pollock by mid-water trawl net in the *Kaiyo Maru* 2002 survey.

pollock from aggregations observed by acoustic instruments. The dominant catches were walleye pollock, and the catch from T0202 and T0203 was larger than 1,000 kg (**Table 1**). In these trawl hauls, the net monitoring system did not work well, and the depth information was not obtained during each hauling

operation. After net come up, we could get the depth information from attached depth sensor, and T0201 did not reached to the depth layer that the pollock aggregation was observed by acoustic system. So, the trawl results from T0201 showed small catch than we expected.

In Leg 2, 1 trawl haul was conducted in the Specific Area and the other 6 trawl hauls were conducted west of the Specific Area. Trawl hauls at T0206 and T0208 were conducted at the offshore area in the basin, and the dominant catch species was lanternfish. In the other stations along the Aleutian Islands, the fish echo sign was observed around the steep slope area, near the bottom. In this situation, we could not collect these fish by using our big mouse mid-water trawl net system. In these stations, our pollock catches were less than 100 kg.

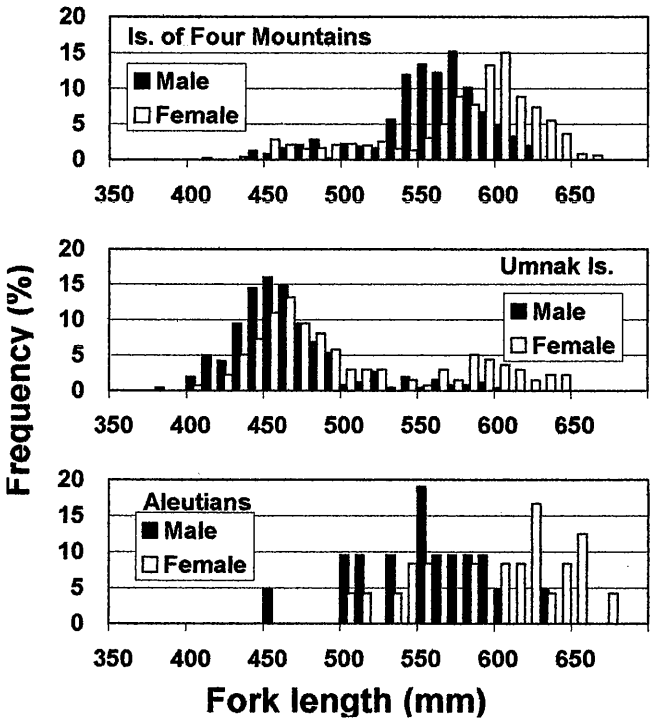

Fig. 3. Length frequency distribution of adult walleye pollock collected by mid-water trawl net in the *Kaiyo Maru* 2002 survey.

3) Length and weight of pelagic pollock

Biological data were grouped into two areas for Leg 1 data with considering difference in the length composition. Pollock from the IFM area showed length ranging 415-625 mm for male, and 435-665 mm for female (**Fig. 3**). Modal lengths of trawl hauls from IFM were observed 555-575 mm for male fish and 590-600 mm for female fish. No big difference was observed in the size range between T0202 and T0204. Average lengths at this area were 558.6 mm and 580.3 mm, for male and female respectively. Combined average length was 569.4 mm (**Table 2**).

Table 2. Average of the length and weight of walleye pollock collected by mid-water trawl net in the *Kaiyo Maru* 2002 survey.

		Average FL (mm)	Average Wt (g)
Is. of four mountains	Male	558.6	1321.2
	Female	580.3	1546.5
	Combined	569.4	1426.6
Umnak Island	Male	466.1	750.7
	Female	505.6	1029.5
	Combined	485.8	870.4
Aleutians	Combined	587.9	1648.6

Pollock from the Umnak Island (UI) area showed length ranging 385-600 mm for male, and 405-645 mm for female (**Fig. 3**). Modal lengths were observed 455 mm for male fish and 460 mm for female fish. Pollock from the UI showed smaller length than fish from IFM. The two components of small and large pollock are seemed to be coexisting in the specific area, and the boundary might exist between UI and IFM area. Presence of the pollock <500 mm suggests that a younger year class may have recruited to the spawning population in this area. Because of limiting ship time, we could not go east of 169°E.

Six trawl hauls were made from the area east of 167°W in our Leg 2. Pollock catches were only 60 individuals from these 6 trawl sampling. Because of limited number of the pollock catches, we combined all of these fish data to get the information from Aleutians. The major part of the fish was larger than 500 mm, and those fish appeared to be older fish. The average length was 588 mm.

The average weight at each area is shown in **Table 2**. An average weight of pollock from the IFM was 1.321 kg for males and 1.547 kg for females. The average length and weight showed continuous increasing from our previous *Kaiyo Maru* survey results. It indicated that the recruitment of young fish did not take place in this area. On the other hand, in the UI area, the average weights of pollock was 0.751 kg for male and 1.030 kg for female fish, and these estimates are smaller than our previous survey results. Newly recruitment took place in this area.

The length-weight relationships were obtained for IFM and UI. The following equations were calculated from length-weight data of male and female fish from each Leg by Geometric Mean Regression analyses

(n=100).

Island of Four Mountain area:

$W=8.180\times10^{-7} \times L^{3.352}$ for male (r=0.840),

$W=8.328\times10^{-6} \times L^{2.992}$ for female (r=0.923), and

$W=2.344\times10^{-6} \times L^{3.188}$ for combined (r=0.898).

Umnak Island area:

$W=5.321\times10^{-6} \times L^{3.054}$ for male (r=0.963)

$W=6.051\times10^{-7} \times L^{3.414}$ for female (r=0.942), and

$W=2.286\times10^{-6} \times L^{3.194}$ for combined (r=0.950).

4) Sex ratio and maturity

Data from 3 (except T0201) trawl hauls in the Specific Area showed that female percentages varied from 34-73%. At T0204, where the biggest catch was obtained in the IFM area, the female percentage was 56%. In Leg 2, the female percentage was almost 50%, though the catches was too small to discuss about the biological characteristics of the stock.

Maturity differed between sexes. Maturities for males were about 40% pre-spawning1 (stage4), and the remains were pre-spawning2 (stage5). As time elapsed, the percentage of pre-spawning1 stage in the IFM area (T0202 & T0204) decreased to 20%.

Among the female pollock, 10% were in a pre-spawning2 stage, and the remaining 90% were in a pre-spawning1 stage in both IFM and UI area **(Table 3)**. A few spawning females (stage6) were observed in the sample collected from the IFM area in the early February.

Table 3. Maturity stage and GSI of female walleye pollock collected during 2002 Kaiyo Maru winter survey.

St.	202	203	204	205, 207 &210
Area	IFM	UI	IFM	Aleutians
Date	9-Feb	12-Feb	21-Feb	23-Feb - 1-Mar
Maturity stage				
1	0	0	0	0
2	0	0	2	0
3	4	0	0	4
4	84	90	88	96
5	10	10	10	0
6	2	0	0	0
GSI				
Average	13.2	13.8	14.5	10.3
ST. Dev	2.9	2.6	3.1	2.9

During this survey, GSI of male and female pollock from the IFM area showed slight increasing between February 9 and 21, and gonad maturation is thought to be in an advanced stage to the spawning. Judging from ovary observation, it seemed to take a little more week for the beginning of the spawning period. On the other hand, GSI of female pollock collected from the Aleutians (west of 170°W) showed lower value than that from the IFM and UI area. Although our sample size in not sufficient, this observation might suggest that the spawning in the Aleutian area takes place in later period than the specific area.

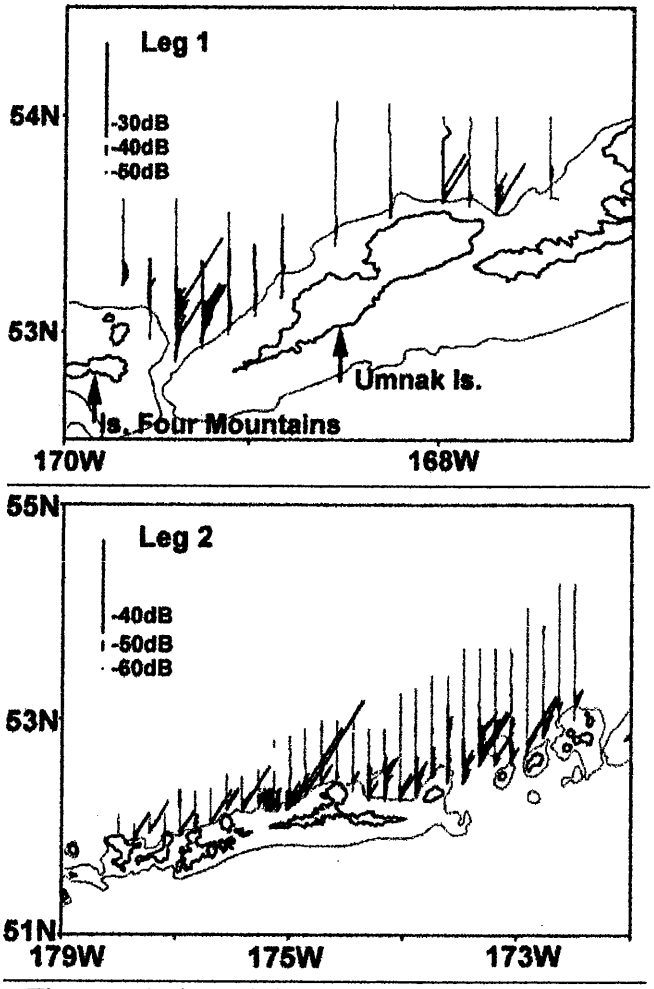

Fig. 4. Horizontal SA distribution observed in the winter of 2002 by the *Kaiyo Maru*.

5) SA distribution and biomass estimates

Horizontal SA distribution is shown in **Fig. 4**. Dense fish aggregation was found in the area from UI to the IFM. The survey area in the Leg 1 was divided into 2 blocks to estimate the biomass (**Fig. 5**): IFM area (Leg1-1), and UI area (Leg1-2). The estimated biomass of each area was approximately 140,000 t and 40,000 t, respectively **(Table 4)**. Though our survey area is limited, our estimates showed about 180,000 t of spawning pollock biomass in the specific area.

The survey area in the Leg2 was divided into 4 blocks with considering transect length. Most of the

pollock echo sign was distributed along the slope of the Aleutian Islands, and in this analysis we did not separate these fish to the Basin and Islands component. Our estimates in the Leg 2 were, 60,000 t, 20,000t, 25,000t, and 18,000t from eastern to western block. Total biomass estimate from the whole survey area in Leg 2 was 123,000 tons. Most of the fish were distributed in the slope area of the Aleutian Islands, and the biomass of the pelagic pollock was very small in this area. Due to the difficulty for operating our big-size mid-water trawl net on the steep slope area, our catches in this area is not sufficient. For the accurate species identification and accurate biomass estimation, more biological sampling is required.

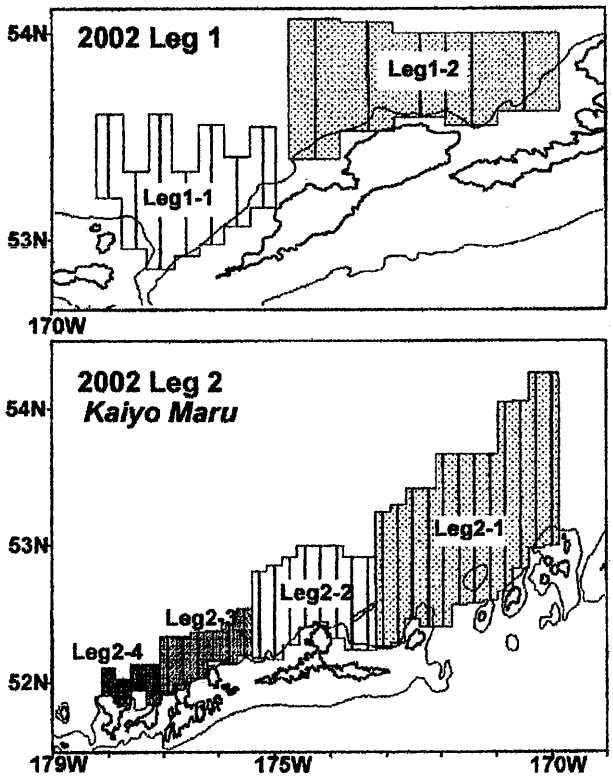

Fig. 5. Transect lines of the winter 2002 Kaiyo Maru survey. Biomass estimations were conducted by each sub-area.

6) Other sampling activity

Otoliths were collected from about 500 pollock during each leg for age determination. Aging and growth analyses will be conducted by the Japanese Institute, and shipped to the Alaska Fisheries Science Center. Oceanographic data were also collected. These samples and data were transferred to HNF and will be used for future study. Information about parasites was obtained and stomach contents, ovary, and genetic samples were collected for the future study.

	Leg1-1	Leg1-2	Leg2-1	Leg2-2	Leg2-3	Leg2-4
Spacing (nmi)	5	10	10	10	10	10
Transect length (km	356	268	1507	563	218	76
Area (km^2)	3300	4964	27902	10433	4045	1413
DOC *1	6.2	3.8	9.02	5.52	3.43	2.03
Average TS (dB)	-30.9	-32.3	-30.6	-30.6	-30.6	-30.6
*2						
Population (10^6)	99	45	37	12	6	2
Biomass (10^3ton)	142	39	61	19	10	3
Density (ton/km^2)	42.91	7.94	2.18	1.82	2.46	1.79
CV(%)	0.36	0.47	0.31	0.33	0.21	0.76
*3						
Estimation error (%	13.49	14.53	10.55	12.27	9.67	28.32

Table. 4 Results of the biomass estimation from 2002 winter Kaiyo Maru survey.
*1 Degree of coverage
*2 Cluster sampling theory
*3 1D transective theory

Acknowledgements

In order to get accurate biomass estimates in the CBS specific area, the *Kaiyo Maru* was allowed to conduct a trawl survey inside the 3-mile territorial waters of the U.S. We appreciate all the people who worked to make this arrangement possible. We thank Dr. A. V. NIKOLAEV for kind collaborations during survey cruise. We also thank the captain, crew and onboard scientists of the *Miller Freeman* for fruitful cooperation during inter-ship calibration. We also thank the captain and crew of the *Kaiyo Maru*.