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Proposed Cruise Plans of Japanese Research Vessels for Salmon in the North Pacific Ocean in 2004/2005 fiscal year

by

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Six Japanese salmon research vessels are tentatively scheduled to conduct the following scientific research in the North Pacific, the Bering Sea, and the Okhotsk Sea, in 2004/2005 fiscal year (Table 1). In case of gillnet operation, gillnets less than 2.5 km in length at sea will be used.

(1) The *Oshoro maru* will conduct research with gillnets, longline, hook-and-line and a trawl net to obtain data on the distribution and ecology of salmon and other pelagic fishes in the western North Pacific in mid May, in eaely-mid June, and from late May to late August (Fig. 1, 2, 3).

(2) The *Wakatake maru* will conduct research with gillnets and longlines to obtain data on the distribution and abundance of salmon along 180° longitude in the central North Pacific and the Bering Sea from early June to late July (Fig. 4).

(3) The *Kaiyo maru* will conduct research with a pelagic trawl and hook-and-lines to obtain information on the distribution and abundance of salmonids in the Bering Sea from mid June to mid July(Fig. 5).

(4) The *Sunyou maru* will conduct research with a pelagic-mid water trawl to obtain data on the distribution and ecology of neon flying squid, salmon and other pelagic fishes in the central North Pacific Ocean from mid July to early August (Fig. 6).

(5) The *Kaiun maru* will conduct research with gillnets to obtain data on the distribution and ecology of neon flying squid, salmon and other pelagic fishes in the central North Pacific Ocean from mid July to early August (Fig. 7).

(6) The *Hokko maru* will conduct research with a pelagic trawl to obtain information on the distribution and abundance of Asian chum and pink salmon in the Okhotsk Sea and the western North Pacific from late October to mid November (Fig. 8).

Table 1. Proposed cruise plan of Japanese research vessels for salmon in the North Pacific in 2004/2005 fiscal year

Vessel	Period	Survey area	Research objects	Gear equipped
Oshoro maru	May 8-May21	Western North Pacific	Fish community	Gillnets
	June 1-June 14	Western North Pacific	Fish community	Gillnets
	June 25 – August 23	North Pacific,	Fish community	Gillnets, longline, hook-and-line
Wakatake maru	June 7 - July 24	Central North Pacific, Bering Sea	Stock assessment	Gillnets and longline
Kaiyo maru	June 17 - July 16	Bering Sea North Pacific	Stock assessment	Pelagic trawl and hook-and-line
Sunyo maru	July 12 - August 6	Central North Pacific	Stock assessment	Pelagic –mid water trawl
Kaiun maru	July 2 – August 6	Central North Pacific	Stock assessment	Gillnets
Hokko maru	October 26 - November 19	Okhotsk Sea, Western North Pacific	Stock assessment	Pelagic trawl

Cruise #146

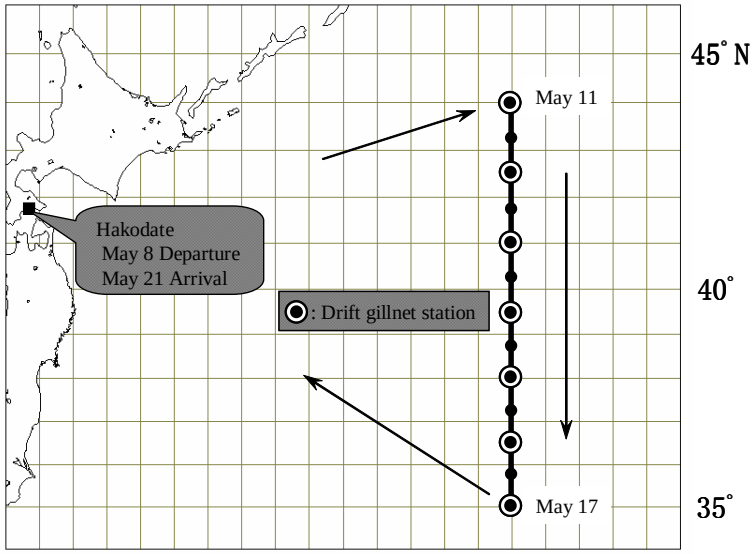

Fig. 1. Cruises plan of the *Oshoro maru* (#146) in the western North Pacific. May 8 (Hakodate) – May 21 (Hakodate).

Cruise #147

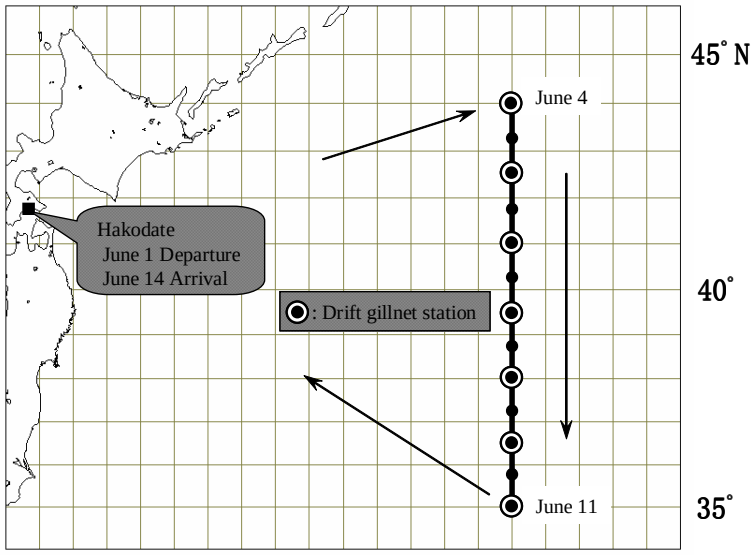

Fig. 2. Cruises plan of the *Oshoro maru* (#147) in the western North Pacific. June 1 (Hakodate) – June 14 (Hakodate)..

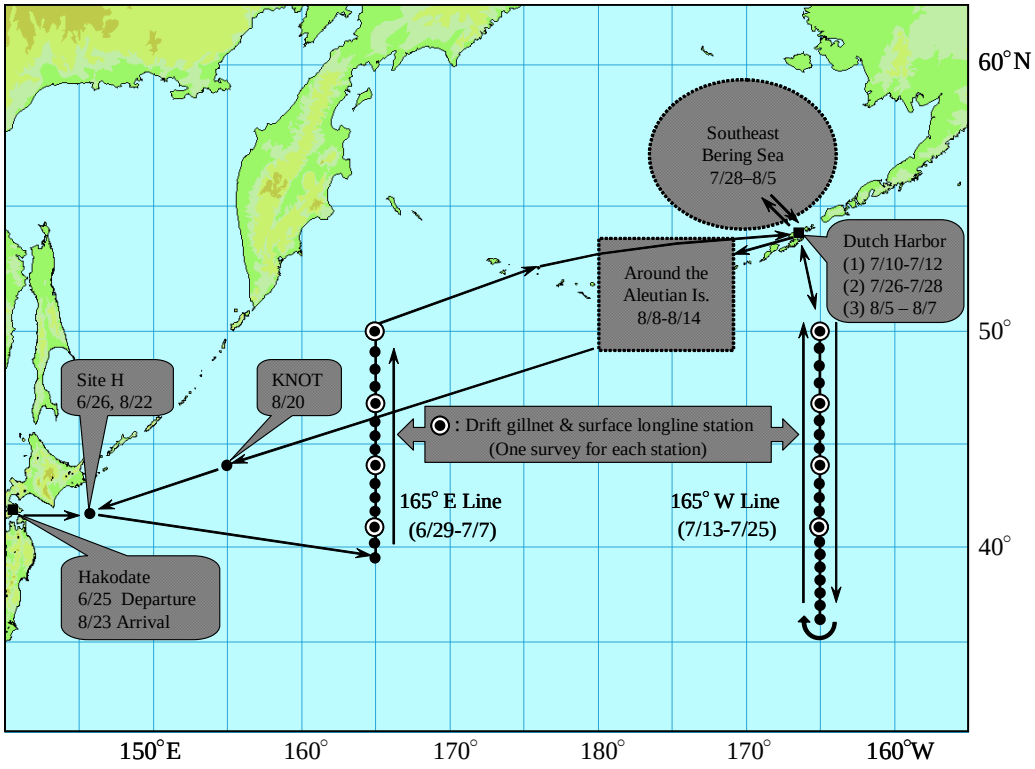

Fig. 3. Cruises plan of the *Oshoro maru* (#148) in the western North Pacific. June 25 (Hakodate) – August 23 (Hakodate) .

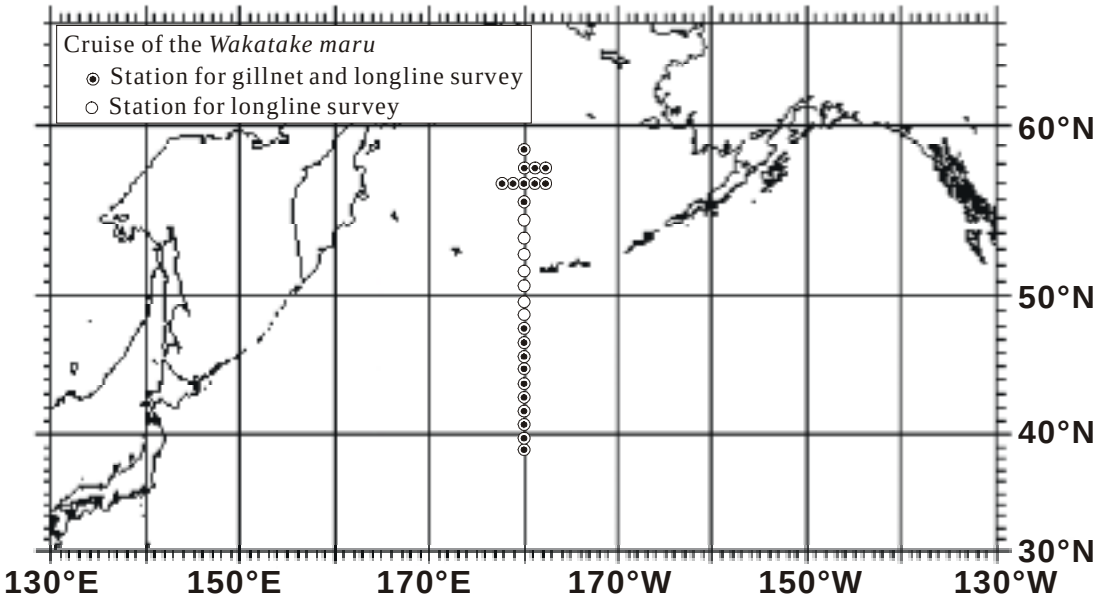

Fig. 4 Cruise of the *Wakatake maru.* June 7 (Hakodate) - July 24 (Hakodate).

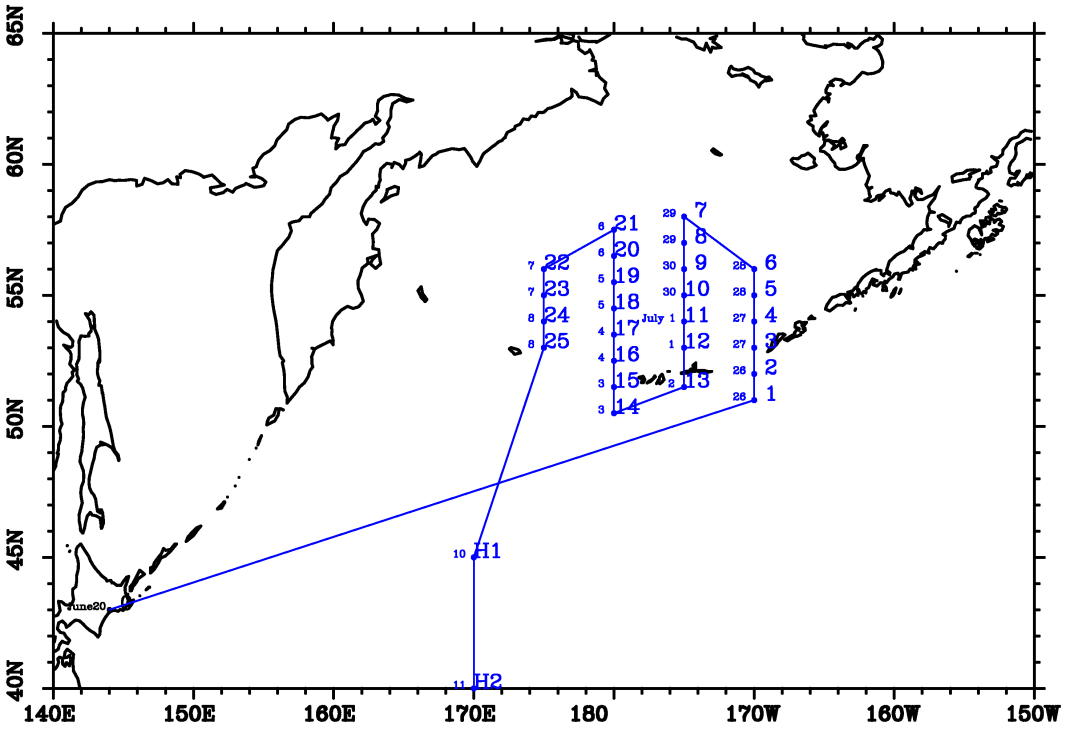

Fig. 5. Cruise of the Kaiyo maru. Excluding Russian 200-mile zone and U.S. 12-mile zone June 17 (Kushiro) – July 16 (Kushiro).

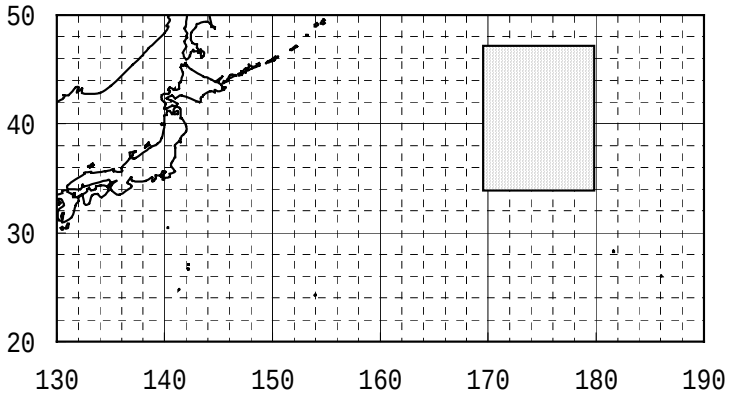

Fig. 6. Cruise of the *Shunyo maru*. July 12 (Shimizu) – August 6 (Shimizu).

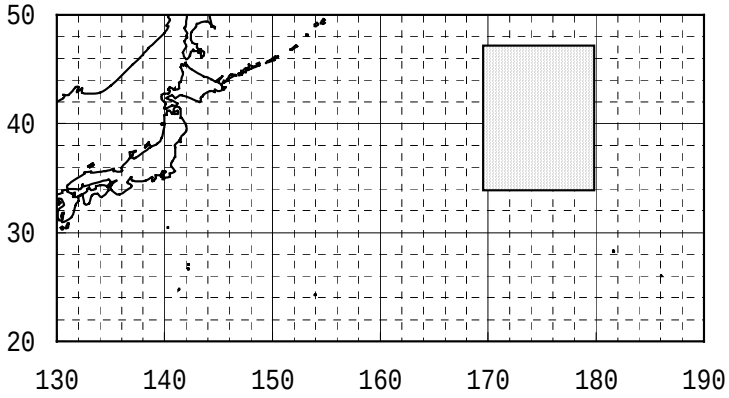

Fig. 7. Cruise of the *Kaiun maru*. July 2(Hachinohe) – August 6 (Hachinohe).

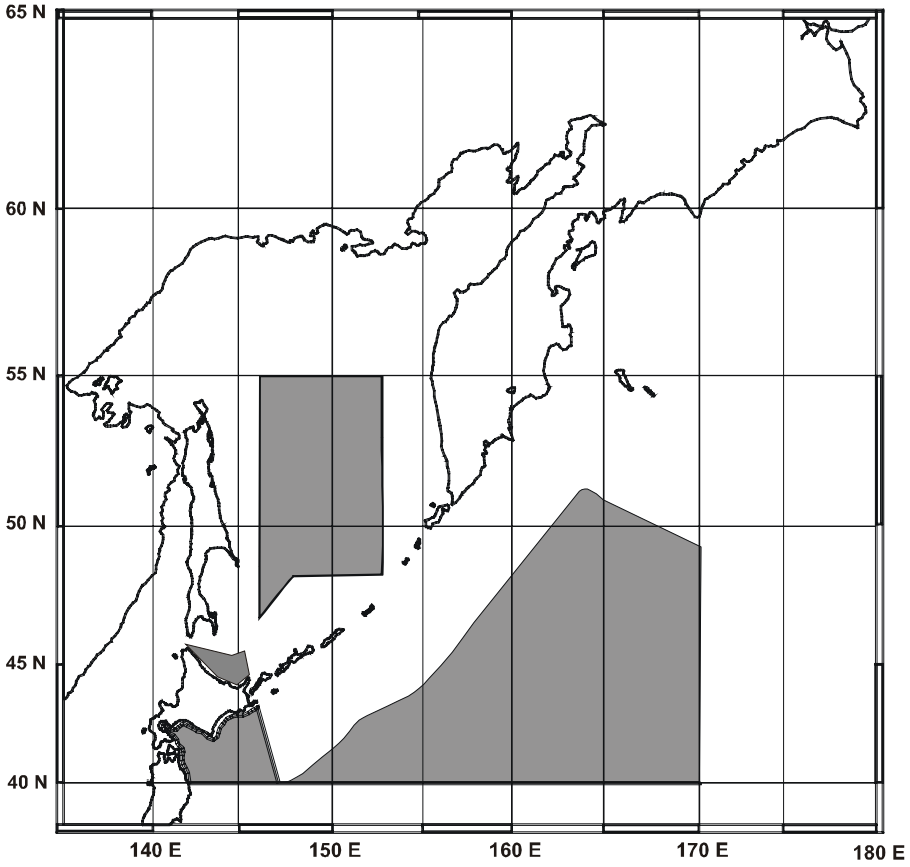

Fig 8. Cruise of the *Hokko maru* October 26 (Kushiro) – November 19 (Kushiro).

Appendix

Japanese Research Plan in the Bering Sea during Summer of 2004 for BASIS

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Introduction

Unanticipated changes in the ocean productivity of Bering Sea ecosystem are affecting Asian and North American societies and economies through reduction and possible elimination of important commercial and subsistence fisheries. An international effort is required to detect and monitor changes in salmon and their ecosystem because stocks from all major salmon producing nations are distributed in the Bering Sea, intermingle in international waters, and migrate across the national economic zones. At the 2001 annual meeting of the North Pacific Anadromous Fish Commission (NPAFC), Canada, Japan, Russia, and the United States agreed to plan and coordinate a new international program that will form the basis for long-term, large-scale ecosystem research on salmon in the Bering Sea (NPAFC 2001).

The somatic growth of Japanese chum salmon is affected by offshore environment in the North Pacific Ocean (Ishida et al. 1993). Environment in the Bering Sea may be a key to determine the somatic growth of Japanese chum salmon, because Japanese chum salmon are distributed in the Bering Sea during the summer growth period (Urawa 2000). Japan continues to monitor summer salmon stocks and environments in the Bering Sea using research gillnets since 1992. However, data of the monitoring research is not sufficient to estimate abundance of salmon, because of the limited survey area in the central Bering Sea. Thus, we need intensive surveys in the whole areas of the Bering Sea using trawl nets to determine salmon abundance and their ecosystem structures.

Objectives of Research

Our short term (5 years) purpose is to estimate abundance and spatial distribution of salmon by stocks, and basic ecosystem structures in the Bering Sea. Instead of the odd year, 2003, the catch number of pink salmon by Kaiyo maru was lower than that of chum salmon. However, catch number of pink salmon by Wakatake maru was the highest of all salmon species as expected. This discrepancy of catch number of pink salmon between Kaiyo maru and Wakatake maru is due to fishing gear. Thus, in the third year, 2004, we will not focus on spatial distribution of salmon only, but accumulate data of fishing efficiencies of trawl and gillnet. The research will be conducted in cooperation with the Bering-Aleutian Salmon International Survey (BASIS) plan (NPAFC, 2001).

Participants

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  Volkov Anatoly Fedorovich, Laboratory of the Pelagic Resource
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- Assistant researchers :
  Shunpei Sato, Hokkaido University
  Osamu Sakai, Hokkaido University
  Tamio Kamiya, Hokkaido University
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Research Vessel

Kaiyo maru (Fisheries Agency of Japan) 2,630 tonne, 3,500 horse power × 2

Tentative Schedule

June 17 –July 16, 2004 for 30 days

Survey Area

The sampling stations are *Wakatake maru* and the BASIS's fixed locations in the Bering Sea (Figure 1).

Field Survey

- **Fish Sampling**

Trawl operation

To catch salmon and other nektonic species, one-hour trawl operation will be made in the surface layer (from the surface to 60 m in depth) with 5 knots towing speed. The net size is 208 m long, 63.2 m head rope, 400 m warp and the cod-end made of 11 mm knotless mesh.

Salmon treatments

All salmon in the catches will be counted by species. The principal biological characters that will be measured include fork length, body weight, sex, and gonad weight. Gonad weight will be used as an index of maturity. Juvenile (ocean age-.0) salmon will be frozen in the round for laboratory collection of length, weight, stomach contents, scales, otoliths, and tissues for genetic analysis. Immature and adult salmon will be sampled aboard the vessel for scales, otoliths, tissues (muscle, heart, liver and brain), and stomach contents for feeding, growth, stock identification, parasite, and neuroendocrine analyses. Tissue samples for genetic analyses will be kept frozen at -80ºC. Some chum salmon will be frozen in the round for parasite and lipid analyses.

Salmon Abundance estimation

The abundance of salmonids in the whole areas of the Bering Sea using trawl nets will be estimated, and compared to those in the Central Bering Sea using gillnet by the R/V *Wakatake maru* in the same time around same time. These surveys will provide that it is adequate to conduct stock assessment of Japanese-origin salmon in the Bering Sea.

By-catch organisms

By-catch organisms will be sorted according to species and measured and its body weights

and body lengths will be recorded. Mainly Atka makeral and Pollack will be kept frozen and squids will be kept in a 10% formalin seawater solution.

Requests for samples
The United States, Russia and Korea requested that Japan collect the following samples during the Kaiyo maru BASIS cruise, listed in order of priority:
1.Chum salmon; liver, heart, muscle, and fin for DNA analysis (Korea).
2.Sockeye and Chinook salmon; fin for DNA analysis (U.S.A.)
These samples should be collected from the same fish that are measured for the principal biological characters (fork length, body weight, sex, and gonad weight).
3.Juday planktonic net

- **Zooplankton Sampling**

NORPAC net and Juday net (vertical tow) with attached flow meter will be hauled vertically from 150 m. The BONGO NET (nighttime) will be hauled with an angle of 45° from 100m with 0.2 m/s hauling speed.

Oceanography, DO and Nutrient

Oceanographic observations will be made with CTD before fishing operations. CTD observations will be changed to XCTD observations based on conditions at trawl locations. Several sensors on the CTD "octopus" will collect data (temperature, salinity, depth, and dissolved oxygen (DO)) from 0-1500 meters. CTD Rosette sampling using the 2.5 liter Niskin bottle x 13 depth will be made for collection of the water at the depth of 0 (bucket sample), 10, 20, 30, 50, 75, 100, 125, 200, 250, 300, 400 and 500 m for salinity and the nutrient, NO_2+NO_3, PO_4, and SiO_3. Investigations of vertical thermal and saline structure (0-1000 m) using XCTD (45 - 40°N, 170°E). Salinity will be confirmed by auto-salinometer analysis. Dissolved oxygen will be measured by titlation method.

- **Acoustic Survey**

Make echo soundering research during daytime at the station of the trawl observation by Simrad EK500. Reduce the cruising speed (8-10 knots) from the site that is 8-10 nautical miles before the fixed station in order to make echo soundering research when we have enough time to survey.

- **ADCP Observation**

Observe the vertical distribution of sea currents using the ADCP system. Currents direction and speed will be measured at multi layers (170E).

- **Solar Radiation**

Solar radiation studies using meteorological radiometer, Print out every 5 min.

- **Other Information on Sea Weather**

Measure and record continuously other meteorological elements on the sea weather using the automated meteorological monitoring equipment during the entire cruise.

- **Tag Survey**

Sampling of salmon may be done by hook and line fishing for tag survey.

Laboratory Survey

- **Nutrients Measurements**

Nutrient, NO_2+NO_3, PO_4, and SiO_3 will be analyzed .

- **Scale Analyses**

Ages will be determined by visual examination of scale patterns for all salmon. Scales will be collected from the INPFC preferred area of the fish body. For juvenile salmon, two scales per fish will be collected, placed on gummed cards with the sculptured surface up and impressed in transparent acetate. Procedures for immature and adult salmon will be similar, except that scales will be mounted on gummed cards during shipboard processing. Scale impressions will be provided to scientists in the member nations by request.

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- **Stomach Content Analyses**

The salmon stomachs will be removed and frozen individually. After thawing, the stomach samples will be weighted on a balance before and after removal of stomach contents. The weight of the contents will be obtained by subtraction. A stomach content index (SCI) will be calculated as the ratio of measured prey weight to salmon body weight times 100.

- **Genetic Stock Identification**

Origin of chum salmon will be estimated by allozyme and mitochondrial (mt) DNA analysis. The muscle, heart, and liver are collected from all chum salmon, and immediately frozen at -80ºC for laboratory analysis. The tissues are examined for 20 allozyme loci on horizontal starch gels at the National Salmon Resources Center, Sapporo. At Hokkaido University (Sapporo), DNA is isolated from the liver, and the nucleotide sequences of 500 bp variable portion from the 5' end of mtDNA are examined as described in Sato et al. (2001). We will also test a newly developed microarray system to determine mtDNA haplotypes by using blood samples on board. Stock contributions will be estimated with a conditional maximum likelihood algorithm using SPAM.

- **Otolith Mark Detection**

The left and right sagittal otoliths will be removed from all chum salmon to detect thermal marks. Otolith samples will be examined at the National Salmon Resources Center, Sapporo. The left sagittal otoliths will be mounted sulcus-side up, using thermal resin, on petrographic slides, and then ground to expose primordia. If left sagittal otoliths are not available or are overground, then right sagittal otoliths will be used. Otolith microstructure will be examined under a compound microscope, and the microstructure patterns will be compared to mark patterns from Asian and North American hatchery voucher specimens. All otoliths will be read independently by a second reader to minimize reader error and provide confidence in readings.

- **Lipid Content Analyses**

Total lipid content (TL) of chum salmon will be determined to estimate their trophic condition. The muscle and liver are collected from frozen round samples of chum salmon caught at four stations (n=100 each) in north, south, central and western waters. At the National Salmon Resources Center, Sapporo, TL will be extracted from the muscle and liver by Folch's method using chloroform/methanol and measured gravimetrically. Lipids were extracted by homogenizing the white muscle (10 g) or liver (10 g) with 50 ml of methanol and 120 ml of chloroform. The homogenate is filtered through a lipid free paper into glass vessel. The crude extract and water are mixed in a separately funnel in the proportions 8:4:3 by volume. The lower phase is collected, and solvent is evaporated with rotary evaporator. Water and protein contents will be also analyzed for several chum samples.

- **Molecular Neuroendocrine Basis Analyses**

The brain, pituitary, gonad and blood will be collected from individual chum salmon to analyze molecular neuroendocrine basis of initiation of homing migration. The brain and

pituitary are immersed in cold RNAlater immediately after removal, and the levels of mRNAs for hormone precursors are determined by a real-time PCR method. The gonad is histologically examined to see sexual maturity. The blood is centrifuged, separated into plasma and blood cells, and frozen in a deep freezer. The plasma is later used to analyze the levels of various hormones, while blood cells to determine haplotype for genetic stock identification.

References

Ishida, Y., S. Ito, M. Kaeriyama, S. McKinnell, and K. Nagasawa 1993. Recent changes in age and size of chum salmon (*Oncorhynchus keta*) in the North Pacific Ocean and possible causes. Can. J. Fish. Aquat. Sci., 50: 290-295.

North Pacific Anadromous Fish Commission. 2001. Draft plan for NPAFC Bering-Aleutian Salmon International Survey (BASIS). (NPAFC Doc. 579) 27 p.

Sato, S., J. Ando, H. Ando, S. Urawa, A. Urano, and S. Abe. 2001. Genetic variation among Japanese populations of chum salmon inferred from the nucleotide sequences of the mitochondrial DNA control region. Zool. Sci., 18: 99-106.

Urawa, S. 2000. Ocean migration route of Japanese chum salmon with a reference to future salmon research. National Salmon Resources Center Newsletter, 5: 3-9. (In Japanese.)

Figure 1. Sampling locations in the Bering Sea.
Large numbers indicate station number and small numbers indicate date.

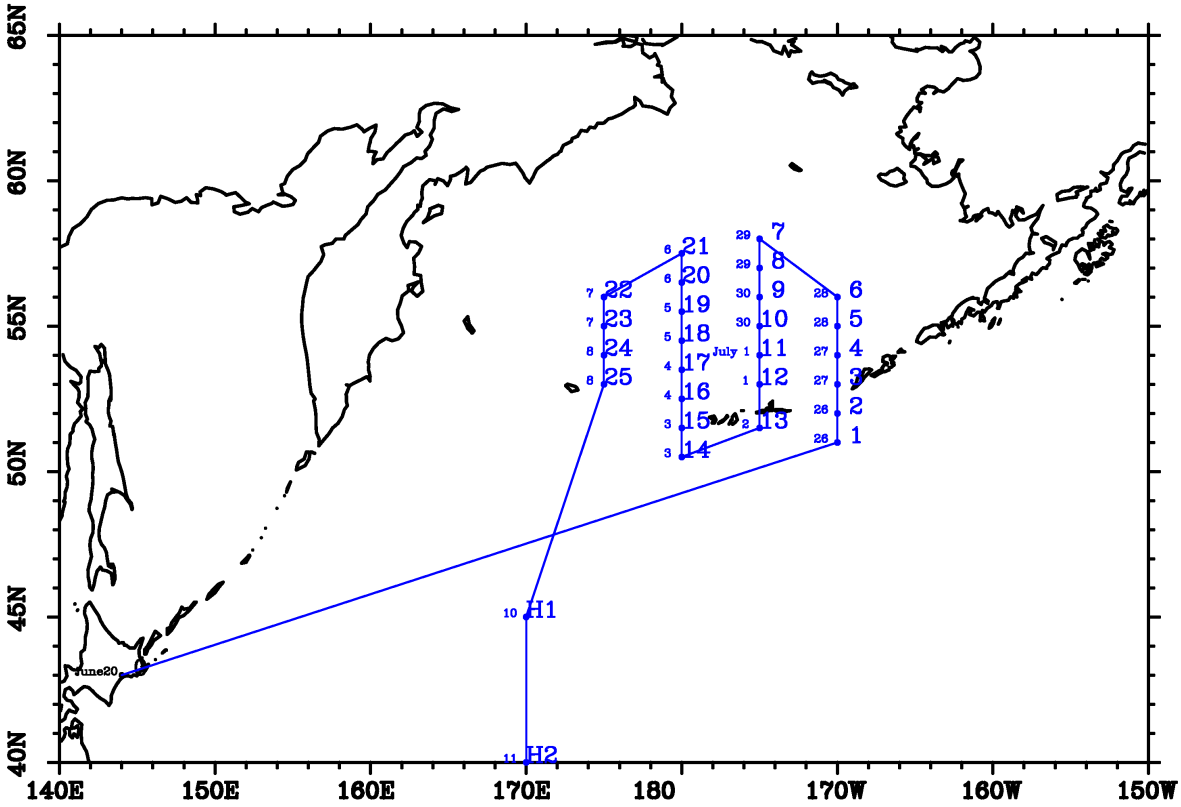

Table 1. Tentative cruise plan for *Kaiyo maru*, June-July 2004.

St	long	lat	Day	CTD	XCTD	NORPAC	Bongo net	Juday net	Hook & line	Trawl
LEG1										
Tokyo			17, June							
Kushiro			Arrive 19							
	144.0E	43.0N	Leave 20							
1	170.0W	51.0N	26	○		○		○		○
2	170.0W	52.0N	26	○		○	○	○	○	○
3	170.0W	53.0N	27	○		○		○		○
4	170.0W	54.0N	27	○		○	○	○	○	○
5	170.0W	55.0N	28	○		○		○		○
6	170.0W	56.0N	28	○		○	○	○	○	○
7	175.0W	58.0N	29	○		○		○		○
8	175.0W	57.0N	29	○		○	○	○	○	○
9	175.0W	56.0N	30	○		○		○		○
10	175.0W	55.0N	30	○		○	○	○	○	○
11	175.0W	54.0N	1, July	○		○		○		○
12	175.0W	53.0N	1	○		○	○	○	○	○
13	175.0W	51.5N	2	○		○		○		○
14	180	50.5N	3	○		○		○		○
15	180	51.5N	3	○		○	○	○	○	○
16	180	52.5N	4	○		○		○		○
17	180	53.5N	4	○		○	○	○	○	○
18	180	54.5N	5	○		○		○		○
19	180	55.5N	5	○		○	○	○	○	○
20	180	56.5N	6	○		○		○		○
21	180	57.5N	6	○		○	○	○	○	○
22	175.0E	56.0N	7	○		○		○		○
23	175.0E	55.0N	7	○		○	○	○	○	○
24	175.0E	54.0N	8	○		○		○		○
25	175.0E	53.0N	8	○		○		○		○
H1	170.0E	45.0N	10		○					
H2	170.0E	40.0N	11		○					
Tokyo			16, July							