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THE 1998 INTERNATIONAL COOPERATIVE SALMON RESEARCH CRUISE OF THE *OSHORO MARU*

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THE 1998 INTERNATIONAL COOPERATIVE SALMON RESEARCH CRUISE OF THE *OSHORO MARU*

ABSTRACT

Preliminary information is presented on international cooperative salmon research conducted during the June-July 1998 cruise of the *Oshoro maru*. An objective of cooperative high-seas salmon research conducted under the North Pacific Anadromous Fish Commission Science Plan is salmon stock assessment through annual surveys along standard transects in the North Pacific Ocean and Bering Sea. Salmon surveys conducted aboard the *Oshoro maru* along 180° longitude in the central North Pacific Ocean in June since 1978 have provided a valuable time series of fisheries and oceanographic data. This was the fifth consecutive year of cooperative Japan-U.S. sampling for salmon along a 145°W-longitude transect in the central Gulf of Alaska in early July, and the first year of a new transect along 165°W. The primary objective of the 1998 cooperative research was to continue the collection of oceanographic and biological data along the 180°, 165°W, and 145°W transects. In 1998, mid-June sea surface temperatures (SSTs) at gillnet fishing stations were about the same as in 1997 at 43° and 45°N and 1.3°C cooler (5.9°C) at 47°N along the 180° transect. Late-June mean SSTs were about 8.4°C at four gillnet stations on the 165°W transect, and early July mean SSTs (10.2°C) were 2.2°C cooler along the 145°W transect than in 1997. This represents a return to cooler conditions found from 1991 to 1996 at 145°W (mean 9.8°C). Catches by gillnet totaled 3,165 salmonids, including 256 salmonids (225 in 1997) in the central North Pacific Ocean (180° transect), 645 salmonids along the 165°W transect, and 2,264 salmonids (1,811 in 1997) in the Gulf of Alaska. At longline stations, 10 salmon (11 in 1997) in the central North Pacific Ocean, 41 salmon along 165°W, and 28 salmon (28 salmon in 1997) in the Gulf of Alaska were tagged and released. Temperature-recording data tags were attached to 13 of the tagged salmon, one at 48°30'N, 165°W and 12 along 145°W. Three double-tagged salmonids carrying temperature data tags and released in the Gulf of Alaska were recovered in Alaska. A pink salmon tagged on 3 July was recovered in a commercial purse seine fishery off Afognak Island (near Kodiak Island, Alaska) on 24 July 1998. A steelhead trout released on 9 July was recovered in a commercial gillnet fishery at the delta of the Copper River, Alaska on 14 August 1998. A coho salmon tagged on 3 July was recovered in a commercial gillnet fishery in Togiak Bay, Alaska on 24 August 1998. Biological samples and data were collected for various other cooperative studies of salmon distribution, abundance, stock origins, maturity and growth, food habits, bioenergetics, and other aspects of ocean biology and ecology; results will be reported later.

INTRODUCTION

This document reports on preliminary results of the 1998 international cooperative salmon (*Oncorhynchus* spp.) research cruise of the T/S *Oshoro maru* in the central North Pacific Ocean and Gulf of Alaska. An objective of international cooperative high-seas

salmon research conducted under the North Pacific Anadromous Fish Commission (NPAFC) Science Plan is salmon stock assessment through annual surveys along standard transects in the North Pacific Ocean and Bering Sea (FAJ 1994a,b; NPAFC 1995, 1996, 1997). Salmon surveys conducted by the *Oshoro maru*, Hokkaido University, Faculty of Fisheries, along 180° in the central North Pacific Ocean since 1978 have provided a valuable time series of fisheries and oceanographic data. In recent years, the Faculty of Fisheries and the Fisheries Research Institute (FRI), School of Fisheries, University of Washington, have cooperated in salmon research aboard the *Oshoro maru* in the central North Pacific and Gulf of Alaska (Walker 1993, Walker and Myers 1994, Walker et al. 1994, Myers et al. 1995, 1996, 1997). In 1998, scientists from the Fisheries Agency of Japan (FAJ), Hokkaido Tokai University, and the Canadian Department of Fisheries and Oceans also participated in the Gulf of Alaska survey. The primary objective of the 1998 cooperative salmon research was to continue the collection of oceanographic and biological data along the 180° transect in the central North Pacific and the 145°W transect in the central Gulf of Alaska and along a new transect at 165°W.

METHODS

Survey Area and Cruise Schedule

Hydrographic, plankton, salmonid sampling, and additional sampling for salmonid feeding ecology, growth, maturity, and stock identification studies was conducted in the central North Pacific Ocean and Gulf of Alaska (Fig. 1, Tables 1 and 2). In international waters, surface longlines (B-gear) and gillnets (C-gear is non-selective varied research mesh and A-gear is commercial mesh) were used to catch salmonids. At stations within the U.S. 200-mile zone, only the surface longline was used to catch fish. Along 180° longitude in the central North Pacific Ocean, fishing for salmonids was conducted northward from 39°N to 50°N latitude. Along the 165°W transect, fishing occurred at stations southward from 52°40'N to 45°30'N. Along the 145°W transect, salmonids were sampled southward from 56°N to 50°N.

The *Oshoro maru* departed Hakodate on 3 June 1998. From 9 to 17 June, salmon and oceanographic research was conducted northward along the 180° transect. The vessel made a port call in Dutch Harbor, Alaska, from 20 to 22 June, where scientists participating in the Gulf of Alaska cruise leg boarded. From 22-29 June, oceanographic and salmon research was conducted along 165°W longitude. From 2-10 July salmon and oceanographic research was conducted along 145°W in the Gulf of Alaska. On 13 July, the *Oshoro maru* arrived in Seattle, Washington, where Gulf of Alaska participants disembarked. On 17 July, scientists participated in a post-cruise workshop, "Ecosystems of the North Pacific."

Oceanographic Sampling

Oceanographic research conducted in 1998 included hydrographic, plankton, larval fish, and beam trawl sampling (Table 1A-D). Computer files of CTD data summaries were used to plot temperature and salinity isopleths along the 180°, 165°W, and 145°W transects.

Gillnet Sampling

Gillnet sampling was conducted by *Oshoro maru* personnel (Table 1E). Gillnet gear was set in the evening, allowed to soak overnight, and was retrieved the following morning. As the gillnet was hauled, the catch was sorted into baskets by mesh size and species. As the sorted fish were moved down the processing line, scale samples were collected, and species, fork length (mm), body weight (g), sex, and gonad weight (g) were recorded by mesh size on biological data forms. The catch by mesh size and species was recorded in an operations book, and was later entered into a computer file.

Longline Research and Tagging

All viable salmonids caught on longlines were double-tagged with both FAJ (red and white, 1.6 cm in diameter) and FRI (red and white, 2.0 cm in diameter) Petersen disk tags (Table 1E). Some salmonids were also tagged with thermal logger tags, archival tags which record temperature (Walker et al. 1998). Significant efforts were made by *Oshoro maru* personnel to minimize handling and holding time of salmon prior to release. As the longline was retrieved, the fish were landed in a dipnet and quickly put into a tank with flowing water for recovery. If possible without injuring the fish, the longline hook was removed. Viable fish were removed from the tank and placed on a measuring board. Fork length (mm) was measured, and a scale sample was taken. In regular tagging with Petersen disks only, the tags, which have a hole in the center, were threaded onto a plastic cinch strap, which is inserted into a hollow needle. The fish was held firmly upright, and the needle was inserted through the dorsal musculature, just in front of the dorsal fin. The plastic strap was quickly cinched, and the tagged fish was either put in the holding tank to recover or released immediately over the side. Data on species, length, and tag number of each fish were recorded on data forms.

Temperature-recording archival data tags (40 x 23 x 8 mm; 9.5 g) were attached with two 76 mm pins inserted through the back just anterior to the dorsal fin. On the opposite side of the fish, the pins were inserted through FAJ and FRI disk tags; the ends of the pins were then twisted with pliers into knots lying flush with the disk tags. During the tagging procedure, the fish were held in a V-shaped tagging cradle which minimized movement. The cradle was immersed in a shallow trough with running seawater to minimize hypoxic damage to the fish during the procedure, which took slightly longer than standard tagging with a single cinch strap. Collection of scales and data on length, species, and tag numbers was the same as in the standard method. Only fish with good likelihood of recapture (based on maturity, condition at capture, and likely fisheries encounter) within a few months were tagged. This criterion meant that only maturing sockeye (*O. nerka*) and steelhead (*O. mykiss*) were evaluated for tagging along the 165°W transect, and maturing sockeye, chum (*O. keta*), pink (*O. gorbuscha*), coho (*O. kisutch*), chinook (*O. tshawytscha*)and steelhead were evaluated along 145°W.

Fish Lacking Adipose Fins

By prior arrangement with FAJ, snouts were collected from salmonids lacking an adipose fin (Table 2C). Snouts collected from fish lacking adipose fins were labeled with catch and biological information and frozen. After the Seattle port call, snout samples

were shipped to the U.S. National Marine Fisheries Service, Auke Bay Laboratory (ABL), where they were examined for coded-wire tags. FRI reports release and recovery information on coded-wire tags to NPAFC.

Scale Sampling

Scale samples were collected for verification of species identification, and for age, growth, and stock origin studies (Tables 1 and 2). Scale samples were collected by *Oshoro maru* personnel from all longline-caught fish and from up to 30 fish of each species caught in each mesh size of gillnet used in each set. All scales were collected from the International North Pacific Fisheries Commission (INPFC) preferred body area (identified by the letter "A" on data forms; Davis et al. 1990), except in cases where all preferred scales were missing (identified by the letter "C" on data forms), and placed on gummed cards.

Additional Biological Sampling

At gillnet and longline stations in the Gulf of Alaska, additional research activities by Canadian, Japanese, and U.S. scientists included collection of salmonid stomachs, blood, brains, olfactory organs, otoliths, muscle, liver, heart, eye, and scales for food habits, growth, maturity, migration, and stock identification studies (Table 2).

RESULTS AND DISCUSSION

Oceanographic Conditions

Temperature and salinity isopleths along the 180°, 165°W, and 145°W transects in 1998 are shown in Figure 2. In 1998, mid-June sea surface temperatures (SSTs) at the gillnet fishing stations at 43°N (8.8°C) and 45°N (7.8°C) were about the same as in 1997 and were 1.3°C cooler at 47°N (5.9°C) along the 180° transect. Late-June mean SSTs were 8.4°C along 165°W. Early-July mean SSTs (10.2°C) were 2.2°C cooler at comparable stations along the 145°W transect than in 1997, returning to conditions more like those in 1996.

Gillnet Catches

Different gillnet configurations were used along the 180°, 165°W, and 145°W transects, and these configurations were similar to those used in 1996 and 1997 (Table 3; Myers et al. 1996, 1997). Salmonid sampling was conducted at 16 gillnet stations (Fig. 1; Table 4). Because of poor weather and sea conditions, there was no gillnet sampling at the 41°N station along the 180° transect. One station (44°N) on the 165°W transect was cancelled because of time lost for a medical emergency, and one station (49°N) on the 145°W transect was added because of available time. The total catch at gillnet stations was 3,265 salmonids: 978 sockeye (912 in 1997), 871 chum (506 in 1997), 822 pink (371 in 1997), 362 coho (185 in 1997), 31 chinook (*O. tshawytscha;* 2 in 1997), and 101 steelhead (60 in 1997). Catches of pink, coho, and chinook salmon and steelhead trout along the 145°W transect were higher than in 1997.

Longline Sampling and Tag Recovery

Salmonid sampling was conducted at 16 longline stations (Fig. 1; Table 5). Ten salmon in the central North Pacific Ocean, 41 salmon along 165°W, and 28 salmon in the central Gulf of Alaska were tagged and released. One salmon tagged with a temperature data archival tag was released at 48°30'N, 165°W and twelve salmon were released in the central Gulf of Alaska. The serial numbers of tags released at each station are reported annually to NPAFC by FAJ, and recoveries of tagged fish and releases of thermal logger tags are reported by FRI. One double-tagged pink salmon (maturing, age 0.1) carrying a thermal logger tag and released at 145°W, 56°N on 3 July was recovered in a commercial purse seine fishery off Afognak Island (near Kodiak Island, Alaska) on 24 July 1998. One double-tagged steelhead trout (maturing, age 2.3) carrying a temperature data tag and released at 50°N, 145°W on 9 July was recovered in a commercial gillnet fishery at the delta of the Copper River, Alaska on 14 August 1998. One double-tagged coho salmon (maturing, age 1.1) carrying a thermal logger tag and released at 145°W, 56°N on 3 July was recovered in a gillnet fishery in Togiak Bay, Alaska on 24 August 1998.

Fish Lacking Adipose Fins

Snouts were collected from 46 salmonids lacking adipose fins (35 steelhead, 6 coho, 2 chum, 2 sockeye, and 1 chinook; Table 2C). Information on coded-wire tags which may have been found in these fish will be reported later.

Scale Sampling

During the Seattle port call, U.S. scientists made two sets of acetate impressions (one for FRI and one for Hokkaido Tokai University) of all scales collected by *Oshoro maru* personnel. The original gummed scale cards were then mailed to FAJ, National Research Institute of Far Seas Fisheries, Shimizu, for age determination and laboratory verification of species identification. Age determination and laboratory verification of species identification was also done by FRI and these data were provided to FAJ. The results of these studies will be reported later.

Additional Biological Sampling

Along 165°W and in the Gulf of Alaska, biological samples were collected for stock identification, food habit, growth, maturity, and migration studies (Table 2). Japanese scientists collected blood serum samples from 110 salmonids for analyses of growth and sex hormones, and heart, liver, and muscle tissue for genetic studies from 562 chum and 387 pink salmon. Otoliths for stock identification studies using thermal marks were collected by Japanese scientists from 551 chum and 386 pink salmon. A Japanese scientist also collected brain and olfactory organ samples from 214 chum and 64 pink salmon for studies of mechanisms of migration. U.S. scientists collected and analyzed stomachs from 1,077 salmonids for food habit studies. A Japanese scientist preserved samples of digestive tracts and stomach contents from 528 salmonids (up to 10 fish per species in each gillnet operation) for additional laboratory studies of pyloric cecae and food habits. The results of these studies will be reported later.

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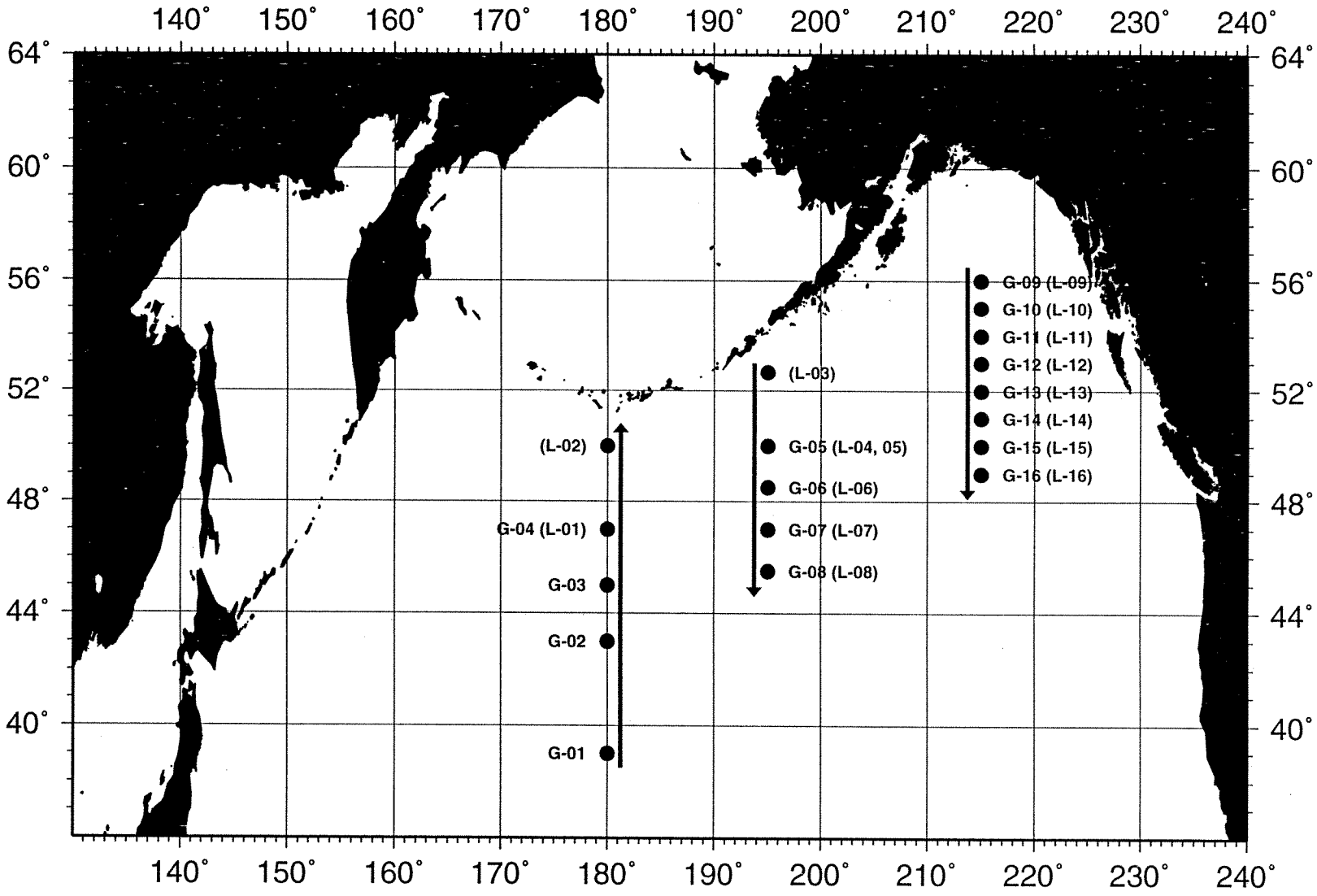

Figure 1. Location of fishing stations of the ***Oshoro maru,*** 11 June to 10 July, 1998 (G=Gillnet stations, L=Longline stations).

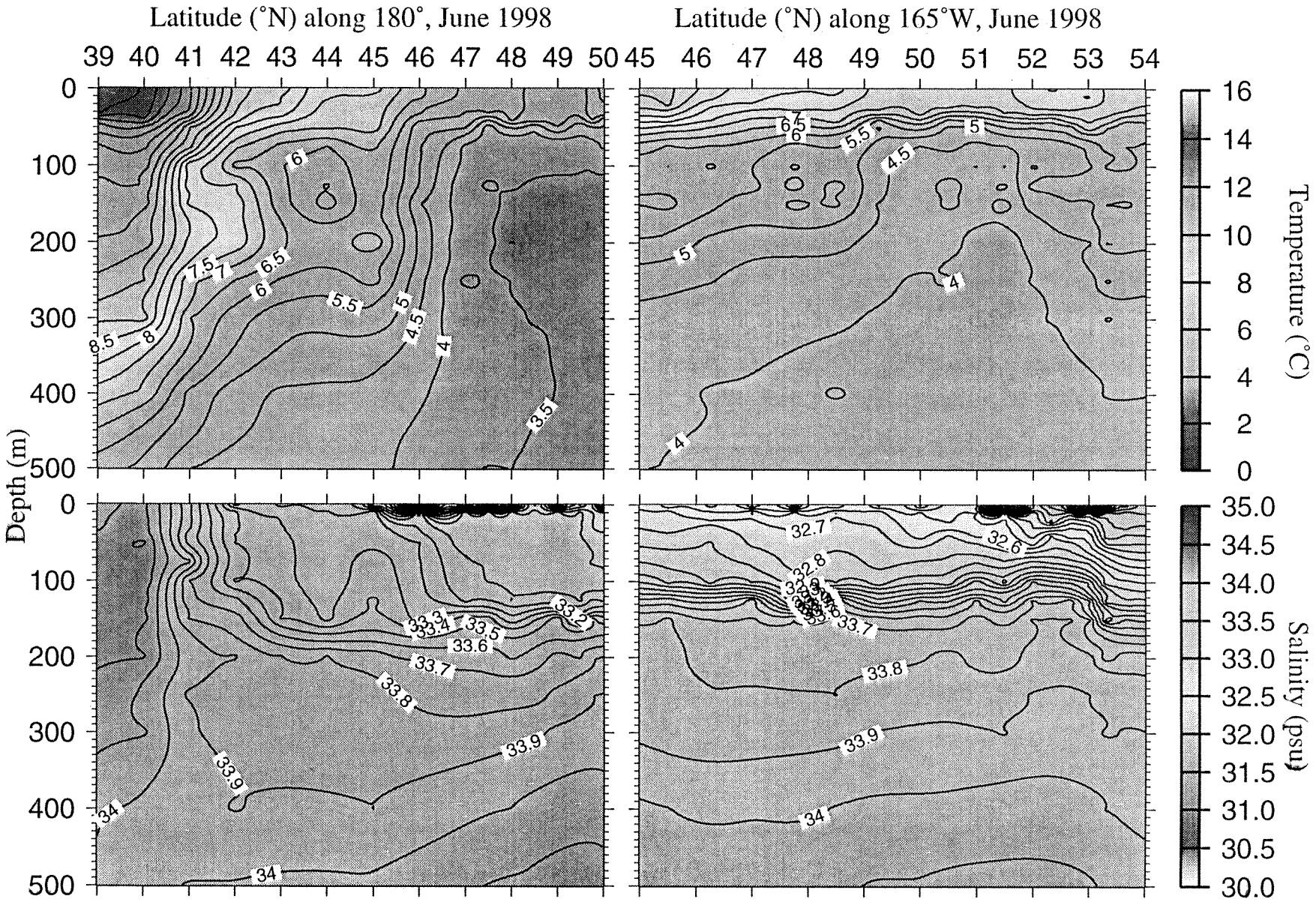

Figure 2A. Temperature and salinity profiles of the 180° (upper and lower left) and 165°W (upper and lower right) transect lines, from CTD data.

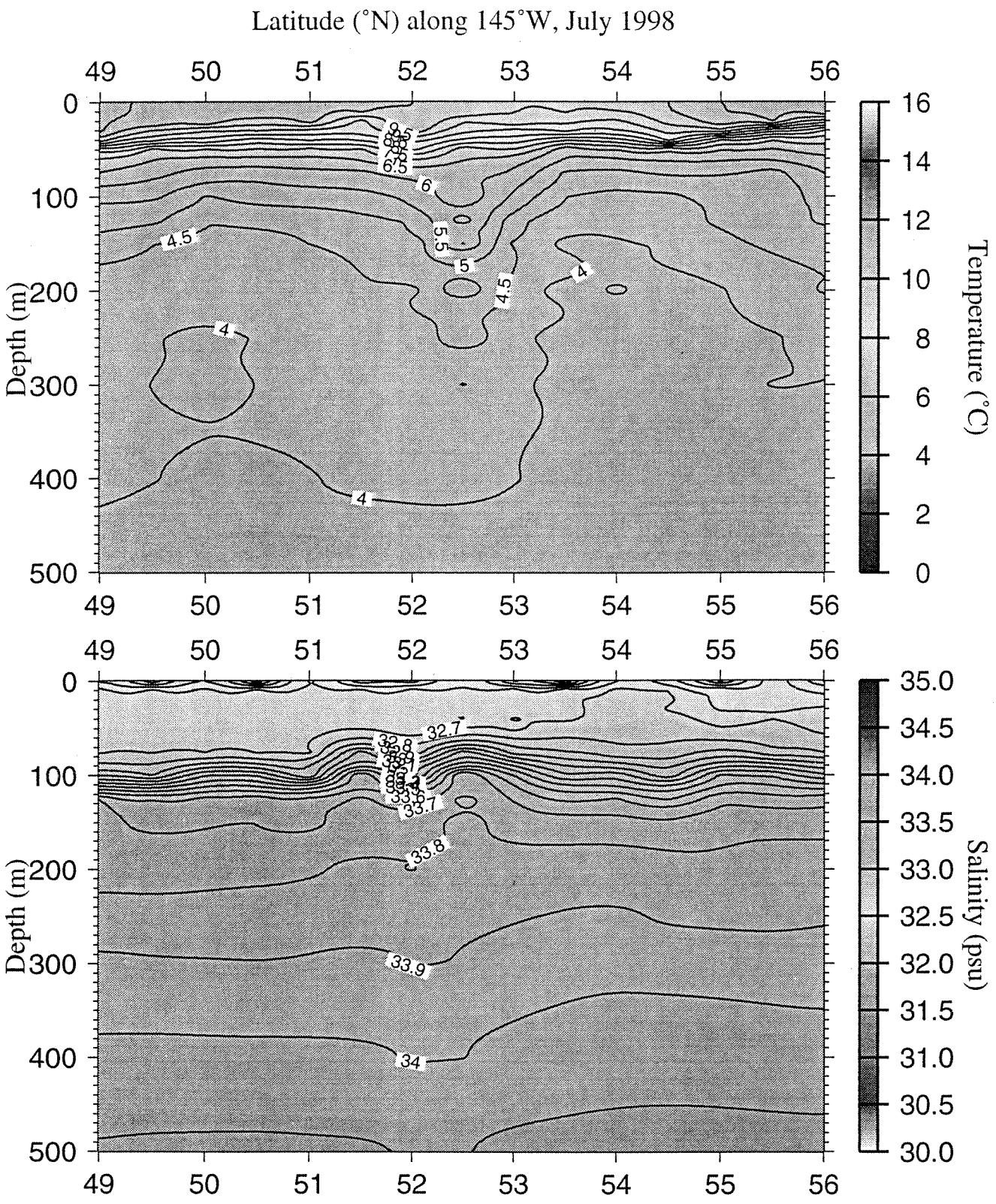

Figure 2B. Temperature and salinity profiles of the 145°W transect line, from CTD data.

Table 1. Description of research gear and fishing operations aboard the *Oshoro maru* in 1998.

Research Item/Gear	Purpose	Specifications	Deployment	Sample/Data	Comments
A. Hydrographic					
Neil Brown Mark III B CTD	Used to collect temperature, salinity, and water samples along the cruise track. These data have been collected in the North Pacific along the 180° transect since 1978, and in 1980-81, 1994-present on the 145° W transect.	CTD winch: Hydraulic 1t x 72 m/min., 6.4∅ x 4000 m	Vertical haul, to 1500m, 3000 m , or to bottom on shallow stations. Work on deck was completed by deck officers, crew, cadets and graduate students. Water samples and data processing on the ship was completed by graduate students.	Salinity, temperature, and dynamic depth anomaly were meas. at depths from 0-1500m, 0-3000m, or 0 - bottom. Water samples were collected at depth of 800, 500, 300, 200, 150, 125, 100, 75, 50, 30, 20, 10. Water samples were analyzed for nutrients and nitrates.	Sigma-t, thermosteric anomaly, specific volume anomaly, geopotential anomaly were calculated by the shipboard computer. Bucket samples collected for sea surface temperature and salinity.
Van Dorn Water Sampling	To obtain large sea water samples for analysis of the chemical compounds related to biological activity.	20-l Van Dorn bottle used to collect samples from particular depths.	20-l water samples were collected from depth of 0, 10, 30, 50, 100, 200 m.	The samples were filtered onto different pore size filters and stored at -80°C. Then later analyzed for particulate organic carbon (POC), chla, and phytoplankton pigment.	This sampling method allows for sampling of very small particles that cannot be collected in nets.
TSRB optical sensing	To obtain light spectra in surface waters to validate ("sea-truth") SeaWiFS satellite data.	TSRB equipment senses light levels of spectra recorded by SeaWiFS satellite (412, 443, 490, 510, 555, 670, 765, 865 nm with bandwidth 20-40 nm).	Sensor was floated approximately 50 m from the vessel attached by cable at daylight oceanographic stations for approximately one hour.	Data were recorded on amount of light and spectrum.	Data will be used in conjunction with satellite data to develop bio-optical algorithm for high latitude ocean color remote sensing.
B. Plankton					
Single Norpac Net Shallow Tow 0-500m	Estimate biomass and identify zooplankton. The time series of these collections in the Gulf of Alaska are in: 1956-62, 1980-85, 1987-present.	Ring diameter: 0.45m; Mesh Size: 0.35 mm; Filtering Cloth: #200; Length: 1.8 m	Vertical tow: 0-500 m. Ship holds position so the tow stays vertical. Net lowered at a speed less then 1.0 m/s and retrieved at 1 m/s.	Samples were bottled in 5% formaldehyde and stored for biomass work to be completed at the end of the cruise.	Copepods are the predominant taxa collected by this gear.

Table 1. cont'd.

Research Item/Gear	Purpose	Specifications	Deployment	Sample/Data	Comments
B. Plankton (cont'd.)					
Twin Norpac Net	Estimate biomass and identify zooplankton. This net system has been used periodically over the years.	This is two single Norpac nets held together by a metal frame. Ring diameter: 0.45 m;mesh size (each net had a different size mesh): 0.1 mm and 0.35 mm. Each of the nets had its own flowmeter.	Vertical tow: 0-150 m. Net was lowered at a speed less than 1.0 m/s, and retrieved at 1 m/s Ship holds position so the tow stays vertical.	Samples were bottled in 5% formaldehyde and stored for biomass work and copepod identification to be completed after the cruise.	The twin Norpac allows for collection of two samples from the same water column.
Single Norpac Net Deep Tow 0 -1200 m	This sampling was done to capture copepods, *Neocalanus* spp., after they have completed their life cycle and ontogenetic down migration	Ring diameter: 0.42 m; Mesh Size: 0.335 mm; Filtering Cloth: #200; Length: 1.8 m Flowmeter in the center of the ring.	Vertical tow: 0-1200 m. Net was lowered at a speed of 0.5 m/s, and retrieved at 1 m/s Ship holds position so the tow stays vertical.	The objective is to look for spatial and temporal variation in length as an index of previous growth and to estimate large-scale copepod year class strength.	Estimates of growth in relation to feeding. Spatial and timing fluctuations are most intense during the copepod seasonal peak (April-June). It is more efficient to average out fluctuations and estimate year class strength by sampling copepods which have completed their growth phase and migrated to overwintering depth. June-July sampling provides an initial baseline.
Gamaguchi Net	This net was used to collect zooplankton samples from specific areas in the water column. This net is like a Norpac net but has a closing mouth.	Ring Diameter: 0.6 m Mesh Size: 0.1 mm.	Separate night vertical tows to: 2000-1000m, 1000-500m, 500-250m, 250-thermocline, thermocline-0 m. Ship holds position so the tow stays vertical.	The samples are collected from specific depth areas. These samples are stored in formaldehyde and later analyzed for species composition.	This net allows for only a certain area of the water column to be sampled, which in turn allows for observations to be made on the separation of species throughout the water column.

Table 1. cont'd.

Research Item/Gear	Purpose	Specifications	Deployment	Sample/Data	Comments
B. Plankton (cont'd.)					
Net calibrations: Norpac net SCOR net Bongo net	This sampling was done to calibrate gear used 1956-66 to sample zooplankton at Station P (Norpac) with gear used later and currently (SCOR and Bongo).	Norpac: Ring: 0.42 m; Mesh: white 0.335 mm; Length: 1.8 m Flowmeter in the center of the ring. SCOR: Ring: 0.56 m; Mesh: black 0.335 mm; Length: 2.8 m Flowmeter in the center of the ring. Bongo: Rings: 0.56 m; Mesh Size: 0.236 mm; Length: 3.4 m Flowmeter in the center of one of the rings. All nets of Nitex monofilament.	Vertical tows: 0-150 m during daylight. Nets were lowered sequentially at a speed of 0.5 m/s, and retrieved at 1 m/s. One or two sets of three tows done at selected oceanographic stations. Ship holds position so the tow stays vertical.	The samples samples are stored in formaldehyde and later analyzed for species composition and biomass.	The objective is to provide calibration factors between gear so that historical zooplankton samples can be combined with current sampling to construct a long time series of zooplankton abundance, especially with data from Station P (50°N, 145°.
C. Larval fish					
Larval Net (MTD net)	This net was used for the collection of larval fish found near the surface at night. These samples have been collected for several years	Mouth diameter: 1.3 m; length: 4.5 m; mesh: 3-mm mesh cloth in the upper 300 cm, 0.33 mm mesh in the lower 150 cm. Flowmeter was centered at mouth of the net.	Horizontal haul with a fish-larva net was made just under the sea surface for 10 minutes at a speed of approx. 2 knots.	The larval fish samples were preserved in formaldehyde for later identification in the laboratory.	Many species of larval fish will come to the surface during the night.
D. Other non-salmon					
Micronekton Gillnet	This net is an experimental net designed to catch small squid and other micronekton	Two 50 m panels, 6 m deep (19 mm mesh and 24 mm mesh) separated by a 50 m gap; top of net was 20 m below the surface	Set evening, approximately 2000 ship time; 1 hr. soak before retrieval; or set overnight attached to salmon gillnet	No. of squid and other species for each panel; mantle length, sex,	Net was designed to fill gap in sampling gear.

Table 1. cont'd.

Research Item/Gear	Purpose	Specifications	Deployment	Sample/Data	Comments
D. Other non-salmon (cont'd)					
Beam Trawl	This horizontal tow collects species throughout the water column at sunset.	Net length: 17 m; cod end length :0.5 m; mouth opening: 2.0 m on one side, 2.5 m on other side.	Horizontal tow for 2400 m, with the trawl going down to 800 m (400 m at later stations after equipment problems) and then up.	The samples were preserved for carbon 14 analysis. Carbon ratios will give an idea of age of the water column.	Large variety and sizes of species were collected from small species such as copepods to large species such as octopus, approximately 20 cm in length.
E. Salmonids					
Research Gillnet	Salmon abundance and biological data for ocean ecology and stock assessment; non-selective research (C) net introduced in 1971; systematic surveys with gillnet for abundance estimation commenced in 1972, 145°W transect in 1980-81, 1994-1998; 165°W transect in 1998.	Net configuration varied at different stations (Table 3); overall length: 2.45 km (49 tans, 50 m/tan); depth: approx. 6 m; hydraulic net hauler: 0.3 t x 177 m/min.	Set (ship time: sunset, approximately 1800; Haul (ship) time: sunrise, approximately 0500.	No. of fish by mesh and species; for each mesh size in C-net: fork length, sex, gonad weight, scale(s) for up to 100 fish of each species (body weight for up to 60 fish); A-net (commercial meshes): same data as C-net except in 1998 only 30 fish of each species sampled per mesh.	1 scale per fish from sockeye, chum, and pink; 2 scales per fish from coho, chinook, and steelhead (1 scale from each side of body).
Surface Longline	Live capture of fish for high seas tagging research; long time series of data 1955-present in North Pacific.	No. hachi (basket) per operation varied in 1998 (Table 5); hachi mainline: 127 m long; 34 branch lines/hachi; 3 m between branch lines; fishing depth: approx. 2 m; bait: small salted anchovy.	Set and haul (ship) times varied in 1998 (see Table 5).	No. of fish by species; mortalities: fork length, body wt., scale(s); viable fish; fork length, scale(s), tag nos.	Fish are double-tagged with two red and white, approx. 1.6 -2.0 cm Petersen disk tags (one Japan tag, one FRI tag) attached to the fish in front of the dorsal fin with a plastic cinch. Selected fish were also tagged with temperature data tags (see text).

Table 2. Additional salmonid research activities conducted aboard the *Oshoro maru* in 1998.

Subject	Sample (no. collected)	Fishing Gear	Method	Data or Samples collected
A. Salmonid Food Habits and Feeding Ecology				
Stomach contents	Stomachs examined from 1,077 salmonids; stomachs and digestive tracts of up to 10 fish per species in each operation preserved in 10% formaldehyde	Gillnet and longline	Stomachs from esophagus to pyloric valve, or entire digestive tract, collected and examined on ship from up to 20 fish of each species in each gillnet operation	Prey weight, % composition by volume of each prey type, fullness and digestion indices; specimens of prey for caloric content analysis (frozen); preserved contents identified and counted later
B. Salmonid Ocean Growth, Maturity, and Mechanisms of Migration				
Growth and maturity indices and physiological studies	Blood serum samples: 50 sockeye, 50 chum, 5 coho, 5 steelhead	Gillnet	Blood drawn from caudal vein; centrifuged at 3000 rpm for 15 min; 1.0 ml in each of two 1.5 ml cryo-tubes; frozen at -80°C	Accompanying scale samples, biological, and oceanographic data
Phospholipid analysis and morphological studies of olfactory epithelium and CNS	Brain and olfactory tissue samples from 214 chum and 64 pink salmon	Gillnet	Samples frozen at -80°C	Accompanying biological and oceanographic data

Table 2. cont'd.

Subject	Sample (no. collected)	Fishing Gear	Method	Data or Samples collected
B. Salmonid Ocean Growth, Maturity, and Mechanisms of Migration (cont'd)				
Temperature-recording archival data tagging	Tagged fish (13 live fish: 4 sockeye, 1 chum, 4 pink, 3 coho, 1 steelhead)	Longline	Viable maturing salmonids in longline catches were tagged with thermal logger tags as well as Japan and FRI disk tags	Thermal tag nos. 8, 28, 52, 157, 158, 164, 167, 184, 189, 191, 196, 198, 199
C. Stock Identification				
Genetic stock identification	Muscle, liver, and heart collected from 562 chum and 387 pink salmon	Gillnet	Samples frozen for isozyme analysis	Accompanying biological and oceanographic data
High seas coded-wire tag recovery	Snouts from fish lacking the adipose fin (35 steelhead, 6 coho, 2 chum, 2 sockeye, 1 chinook)	Gillnet and longline (mortalities)	All fish in the catch were examined	Snouts (frozen) and accompanying catch, data, biological data, and scale samples; snouts shipped to U.S. NMFS, Auke Bay Laboratory, Juneau, for tag detection and decoding
Double tagging experiments	Tagged fish (79 live fish)	Longline	All viable salmonids in longline catches were double-tagged with Japan and FRI tags	Tag nos., Japan/FRI: DD601-05, DD6507-8, DD6509-80/LL1109-80

Table 2. cont'd.

Subject	Sample (no. collected)	Fishing Gear	Method	Data or Samples collected
C. Stock Identification (cont'd)				
High seas recovery of marked otoliths	Otoliths from 551 chum and 386 pink salmon	Gillnet	Otoliths cleaned and preserved dry	Accompanying biological data, and scale samples; otoliths taken to National Salmon Resource Center, Sapporo, for mark detection and decoding
Taxonomic studies of pyloric cecae	Intestinal tracts from 528 salmonids; entire digestive tracts of up to 10 fish per species in each operation	Gillnet and longline	Entire digestive tract, or pyloric valve to end of pyloric cecae, collected from up to 10 fish of each species in each gillnet operation; preserved in 10% formaldehyde	Accompanying scale samples, stomach contents, biological and oceanographic data

Table 3. Gillnet configurations used in 1998.
1 tan = 50-m long section of gillnet.

	Size	180° and 165°W	145°W
Type*	(mm)	No. tans	No. tans
A	115	6	9
F	19	1	0
F	29	1	0
F	37	1	0
C	48	3	3
C	93	3	3
C	157	3	3
C	106	3	3
C	63	3	3
C	121	3	3
C	72	3	3
C	138	3	3
C	82	3	3
C	55	3	3
F	42	1	0
F	33	1	0
F	25	1	0
F	22	1	0
A	121	6	10
Total		49	49

* A = traditional salmon commercial gillnet
C = salmon research gillnet
F = experimental gillnet (non-salmon research)

Table 4. Salmon caught in 1998 *Oshoro Maru* gillnet operations. Location, sea surface temperature (SST, °C), surface salinity (psu, practical salinity units) number of 50-m tans and catch by research-mesh and commercial-mesh gillnet for each fishing station.

Station	Recovery Date	Location	SST Salin.	Gear	*Tans*	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Total Salmon
G-01	11-Jun-98	39° 00 N	14.5	Commercial	*12*	0	0	0	0	0	0	0
		180° 00	33.98	Research	*30*	0	0	0	0	0	0	0
				Total	*42*	0	0	0	0	0	0	0
G-02	13-Jun-98	43° 00 N	9.0	Commercial	*12*	0	0	0	37	0	5	42
		180° 00	33.32	Research	*30*	0	18	0	20	0	6	44
				Total	*42*	0	18	0	57	0	11	86
G-03	14-Jun-98	45° 00 N	7.9	Commercial	*12*	0	0	0	4	0	2	6
		180° 00	32.89	Research	*30*	4	19	1	4	0	4	32
				Total	*42*	4	19	1	8	0	6	38
G-04	15-Jun-98	47° 00 N	5.9	Commercial	*12*	3	0	1	3	0	1	8
		180° 00	32.06	Research	*30*	72	43	5	2	0	1	123
				Total	*42*	75	43	6	5	0	2	131
		180° Transect Totals		**Commercial**		**3**	**0**	**1**	**44**	**0**	**8**	**56**
				Research		**76**	**80**	**6**	**26**	**0**	**11**	**199**
				Total		**79**	**80**	**7**	**70**	**0**	**19**	**255**
G-05	26-Jun-98	50° 00 N	7.2	Commercial	*12*	22	57	10	0	0	0	89
		165° 00 W	32.18	Research	*30*	78	82	14	0	0	0	174
				Total	*42*	100	139	24	0	0	0	263
G-06	27-Jun-98	48° 30 N	8.4	Commercial	*12*	12	20	2	0	2	3	39
		165° 00 W	32.40	Research	*30*	31	32	5	0	0	3	71
				Total	*42*	43	52	7	0	2	6	110
G-07	28-Jun-98	47° 00 N	8.9	Commercial	*12*	3	15	9	3	2	0	32
		165° 00 W	32.29	Research	*30*	20	26	23	5	1	0	75
				Total	*42*	23	41	32	8	3	0	107
G-08	29-Jun-98	45° 30 N	9.5	Commercial	*12*	3	5	8	27	1	2	46
		165° 00 W	32.51	Research	*30*	9	68	13	26	0	2	118
				Total	*42*	12	73	21	53	1	4	164
		165°W Transect Totals		**Commercial**		**40**	**97**	**29**	**30**	**5**	**5**	**206**
				Research		**138**	**208**	**55**	**31**	**1**	**5**	**438**
						178	**305**	**84**	**61**	**6**	**10**	**644**
G-09	3-Jul-98	56° 00 N	10.9	Commercial	*19*	51	45	103	44	0	2	245
		145° 00 W	32.29	Research	*30*	36	36	71	13	0	2	158
				Total	*49*	87	81	174	57	0	4	403
G-10	4-Jul-98	55° 00 N	10.4	Commercial	*19*	30	22	42	36	0	0	130
		145° 00 W	32.19	Research	*30*	19	23	54	30	0	6	132
				Total	*49*	49	45	96	66	0	6	262
G-11	5-Jul-98	54° 00 N	9.9	Commercial	*19*	93	58	64	22	12	3	252
		145° 00 W	32.60	Research	*30*	68	44	47	12	5	5	181
				Total	*49*	161	102	111	34	17	8	433
G-12	6-Jul-98	53° 00 N	9.5	Commercial	*19*	79	20	85	24	3	9	220
		145° 00 W	32.30	Research	*30*	40	24	40	17	2	9	132
				Total	*49*	119	44	125	41	5	18	352
G-13	7-Jul-98	52° 00 N	9.9	Commercial	*19*	31	68	41	8	2	1	151
		145° 00 W	32.25	Research	*30*	13	61	18	3	0	12	107
				Total	*49*	44	129	59	11	2	13	258
G-14	8-Jul-98	51° 00 N	10.4	Commercial	*19*	35	6	47	9	1	3	101
		145° 00 W	32.60	Research	*30*	15	29	31	5	0	7	87
				Total	*49*	50	35	78	14	1	10	188
G-15	9-Jul-98	50° 00 N	10.9	Commercial	*19*	73	2	14	1	0	2	92
		145° 00 W	32.50	Research	*30*	68	9	4	1	0	6	88
				Total	*49*	141	11	18	2	0	8	180
G-16	10-Jul-98	49° 00 N	10.6	Commercial	*19*	46	4	57	4	0	2	113
		145° 00 W	32.49	Research	*30*	24	34	12	2	0	3	75
				Total	*49*	70	38	69	6	0	5	188
		145°W Transect		**Commercial**		**438**	**225**	**453**	**148**	**18**	**22**	**1304**
				Research		**283**	**260**	**277**	**83**	**7**	**50**	**960**
				Total		**721**	**485**	**730**	**231**	**25**	**72**	**2264**
		Total Salmon Catch				**Sockeye**	**Chum**	**Pink**	**Coho**	**Chinook**	**Steelhead**	**Total**
		Stations G-01 - G-16		**Commercial**		**481**	**322**	**483**	**222**	**23**	**35**	**1566**
				Research		**497**	**548**	**338**	**140**	**8**	**66**	**1597**
				Total		**978**	**870**	**821**	**362**	**31**	**101**	**3163**

Table 5. Salmonids tagged and released during 1998 *Oshoro maru* longline operations. Location, sea surface temperature (SST, °C), surface salinity (psu, practical salinity units), and catch tagged and released.
S.M.T. = Ship Mean Time; hachi = unit of longline gear (34 hooks per hachi).

Station	Date	Time (S.M.T.)	Latitude	Longitude	SST	Salin.	Hachi	Sockeye	Chum	Pink	Coho	Chinook	Steelhead	Total
L-01	6/16/98	04:20-06:45	46° 59 N	179° 58 W	5.9	32.06	10	0	7	0	0	0	0	7
L-02	6/17/98	14:40-17:50	50° 05 N	179° 55 W	6.0	32.25	8	0	3	0	0	0	0	3
L-03	6/23/98	07:00-10:20	52° 40 N	165° 00 W	7.9	31.55	10	0	0	0	0	0	0	0
L-04	6/25/98	06:40-09:25	50° 02 N	164° 58 W	7.3	32.18	10	0	1	0	0	0	0	1
L-05	6/26/98	04:45-07:30	49° 59 N	164° 56 W	7.3	32.18	10	0	3	0	0	0	0	3
L-06	6/27/98	04:40-06:50	48° 29 N	164° 59 W	8.2	32.40	10	1	2	0	0	0	0	3
L-07	6/28/98	04:55-07:00	47° 00 N	164° 59 W	8.4	32.29	10	1	4	1	0	0	0	6
L-08	6/29/98	04:50-07:15	45° 30 N	164° 59 W	9.6	32.51	10	0	20	4	4	0	0	28
L-09	7/3/98	04:20-07:45	55° 59 N	145° 00 W	10.9	32.29	10	1	4	6	3	0	0	14
L-10	7/4/98	04:25-07:10	54° 59 N	145° 00 W	10.5	32.19	10	2	1	4	0	0	0	7
L-11	7/5/98	04:25-07:30	53° 59 N	145° 00 W	9.9	32.60	10	0	0	1	0	0	0	1
L-12	7/6/98	04:25-07:05	53° 01 N	144° 53 W	9.5	32.30	10	0	0	1	1	0	0	2
L-13	7/7/98	04:25-06:55	52° 01 N	144° 58 W	10.0	32.35	10	0	1	0	0	0	0	1
L-14	7/8/98	04:25-07:35	50° 59 N	144° 58 W	10.3	32.60	10	0	1	0	0	0	0	1
L-15	7/9/98	04:30-07:15	49° 58 N	144° 58 W	10.4	32.35	10	0	0	1	0	0	1	2
L-16	7/10/98	04:25-07:15	48° 58 N	145° 01 W	10.6	32.49	10	0	0	0	0	0	0	0
						Total		5	47	18	8	0	1	79