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NOAA SHIP MILLER FREEMAN
Cruise No. 96-03
Preliminary Cruise Results
Echo Integration-Trawl Survey of the Southeastern Aleutian Basin near Bogoslof Island

CRUISE PERIOD, AREA, AND SCHEDULE

Scientists from the Alaska Fisheries Science Center (AFSC) carried out an echo integration-trawl (EIT) survey of walleye pollock (*Theragra chalcogramma*) aboard the NOAA ship *Miller Freeman* from February 25 to March 8, 1996. The cruise began and ended in Dutch Harbor, Alaska. The survey area encompassed Aleutian Basin waters near Bogoslof Island from north of Akutan Island westward to the Islands of Four Mountains. This cruise was part of a cooperative survey effort involving scientists from the United States, Japan, Russia, China, Poland and South Korea. In addition to the *Miller Freeman*, the Japan Fisheries Agency's research vessel *Kaiyo maru* conducted an EIT survey of pollock in the southeastern Aleutian Basin.

The vessel's itinerary was as follows,

Feb 25	Embark scientists during touch and go in Dutch Harbor, Alaska
Feb 25-26	Intership calibration with *Kaiyo maru*
Feb 27-Mar 7	EIT survey of the Bogoslof Island region
Mar 7	Sphere calibration in Nateekin Bay, Alaska
Mar 8	Arrive Dutch Harbor

The primary objective of this cruise was to collect echo integration data and midwater trawl data necessary to determine the distribution, biomass, and biological composition of walleye pollock in the southeastern Aleutian Basin near Bogoslof Island.

Other cruise objectives were to calibrate the 38 kHz and 120 kHz scientific acoustic systems using standard sphere techniques, and to conduct an intership calibration of acoustic systems between the *Miller Freeman* and the *Kaiyo maru*.

Projects requested by other AFSC scientists included collecting whole stomachs from pollock, sharks, lanternfish (Myctophidae) and northern smoothtongue (*Leuroglossus schmidti*) for food habits studies (P. Livingston); collecting mature pollock ovaries for fecundity studies (B. Megrey); spawning pollock and rearing eggs for studies of larval growth rate and development (K. Bailey); and, conducting bongo tows near spawning pollock to examine pollock egg stages (R. Brodeur).

Throughout the cruise, meteorological and physical oceanographic data were collected, including temperature and salinity profiles at selected sites. Near surface currents were monitored using an acoustic Doppler current profiler (ADCP) (N. Cokelet, Pacific Marine Environmental Laboratory). Temperature, salinity, and light levels were continuously monitored.

VESSEL, ACOUSTIC EQUIPMENT, AND TRAWL GEAR

Acoustic data were collected with a quantitative echo-sounding system(Simrad EK500[1])on board the NOAA ship *Miller Freeman*, a 66-m (216-ft) stern trawler equipped for fisheries and oceanographic research. The Simrad 38 kHz and 120 kHz split-beam transducers were mounted on the bottom of the vessel's centerboard. With the centerboard fully extended, the transducers were 9 m below the water surface. System electronics were housed in a portable laboratory mounted on the vessel's weather deck. Data from the Simrad EK500 echo sounder/receiver were processed using Simrad BI500 echo integration and target strength data analysis software on a SUN workstation. Results presented in this document are based on the 38 kHz data.

Midwater echo sign was sampled using an Aleutian Wing 30/26 trawl (AWT), a full mesh wing trawl constructed of nylon except for polyethylene towards the aft section of the body and the codend. Headrope and footrope lengths each measured 81.7 m (268 ft) and

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[1] Reference to trade names or commercial firms does not constitute U.S. Government endorsement.

mesh sizes tapered from 325.1 cm (128 in) in the forward section of the net to 8.9 cm (3.5 in) in the codend. The net was fitted with a 3.2 cm (1.25 in) codend liner. It was fished with 82.4 m (270 ft) of 1.9 cm (0.75 in) diameter 8x19 non-rotational dandylines, 454.5 kg (1,000-lb) tom weights on each side, and 5 m^2 “Fishbuster” doors [1,250 kg (2,750 lb)]. Vertical net opening and depth were monitored with a WesMar third wire netsounder system attached to the headrope of the trawl. Additionally, one or two small-mesh nets, each 6.1 m (20 ft) long with a 10.8 m^2 opening and 0.5 cm mesh, were attached to several locations along the AWT to try to sample micronekton and macrozooplankton near the path of the trawl.

A bongo net was used to sample micronekton and macrozooplankton at two sampling sites. The bongo net system consisted of a 60 cm (23.6 in) bongo frame with 333 ?m mesh nets. A 40 kg lead weight was used as a depressor. To monitor depth and oceanographic conditions, a Seabird conductivity/temperature/ depth (CTD) profiler was attached to the wire about 0.6 m above the bongo frame.

Water temperature and salinity profile data were collected at calibration sites with a Seabird CTD system. Temperature profile data were obtained throughout the survey area by launching expendable bathythermographs (XBTs) and by attaching micro bathythermographs (MBTs) to each trawl. Sea surface oceanographic data and environmental data were collected using the *Miller Freeman's* Scientific Collection System (SCS). Ocean current profile data were obtained using the vessel's ADCP system whose transducer is mounted in the centerboard.

SURVEY METHODS

Four standard sphere calibrations were carried out in conjunction with the survey (Table 1). Two were completed before the cruise began, on February 4 in Puget Sound, Washington and on February 16 in Belkofski Bay, Alaska. The third and fourth calibrations were completed at the end of the cruise on March 8, in Nateekin Bay, Unalaska Is., Alaska, and on March 27, in Malina Bay, Kodiak Is., Alaska. No significant differences in the 38 kHz system parameters were observed between the four calibrations. Results from calibration of the 120 kHz system are not presented here as this system was not used in the acoustic data analysis.

Intership calibration of the acoustic systems aboard the *Miller Freeman* and the *Kaiyo maru* was conducted on February 25-26 to enable comparison of U.S. and Japanese EIT survey results. During an early February EIT survey of the southeast Aleutian Basin, Japanese scientists aboard the *Kaiyo maru* located suitable fish echo sign for the intercalibration in an area north of Umnak Island, approximately 140 nmi west of Dutch Harbor, Alaska. The two vessels met at the site in the afternoon of February 25 and ran transects over fish sign at speeds of 6-8 knots with one vessel leading the other by 0.5 nmi for the first 7 transects and 1.0 nmi for the last 5. After completing each pair of transects, the vessels switched leader-follower positions to reduce potential biases affecting acoustic data collection. After integrating fish echo sign for 24 hours, the two vessels transited to a shallower site west of Unalaska Is. to compare integration of the bottom signal.

The Bogoslof Island area survey began in early morning on February 27 and ended the morning of March 8. One EIT survey pass was made through the Bogoslof spawning area covering about 1450 nautical miles (nmi) of transects (Fig. 1). The survey trackline consisted of north-south transects beginning at long. 166^{o} W and proceeding westward to long. 170^{o} 20'W. Transect spacing at the eastern and western ends of the survey area was 10 nmi. Transect spacing was decreased to 5 nmi between transects 6.0 and 15.0. The southern transect endpoints were at approximately 100 m bottom depth on the Aleutian shelf but varied depending on bottom depth and fish echo sign. The northern extent of the 10 nmi-spaced transects was similar to that during previous winter surveys in the Bogoslof region, between latitudes 54^{o}30' and 54^{o}40'N east of long. 168^{o}W and between latitudes 54^{o}00' and 54^{o}30'N west of long. 168^{o}W. Additional acoustic data were collected along time-replicated and orthogonal transects in the Samalga Pass area where most of the spawning pollock were concentrated.

The EIT survey continued throughout day and night. Vessel transecting speeds ranged between 7 and 12 kts, depending upon weather conditions. We operated the acoustic system continuously along transects, collecting echo integration data from 14 m below the surface to within 0.5 m of the bottom, or to 1000 m depending on bottom depth. These data were thoroughly scrutinized by one or more scientists and stored in an INGRES database. When properly scaled they were used to provide estimates of pollock density.

Midwater trawl hauls were made at selected locations to identify echo sign and provide biological samples. The average trawling speed was about 3 kts. The AWT’s vertical opening averaged about 31 m. Standard catch sorting and enumeration procedures were used to process all catches. Each trawl catch was completely sorted unless it exceeded about 1000 kg; representative splits of large catches were sorted. Total weights and numbers of individuals, by species, were determined for each catch.

Individual pollock were further sampled to determine sex, fork length (FL), body weight, age, maturity, and ovary weight. An electronic scale was used to determine all weights taken from individual pollock specimens. Fish FLs were determined to the nearest cm with a Polycorder measuring device (a combination of a bar code reader and a hand held computer). During past EIT surveys, maturities had been determined by visual inspection of gonads based on a 5-stage scale; immature, developing, pre-spawning (mature), spawning, and post-spawning (spent). In winter 1996 EIT surveys, maturities were determined by visual inspection using a new 8-stage scale that we hoped would better describe spawning stages and provide similar maturity data among participating nations. The 8-stage scale can be expressed in terms of the 5-stage scale as follows: immature, developing 1, developing 2, pre-spawning 1, pre-spawning 2, spawning and post-spawning 1 and 2. Ovary tissue samples were collected from pre-spawning females and preserved in formalin for fecundity studies. Pollock stomachs, lanternfish, and northern smoothtongues were collected and preserved in 10% formalin for food habits studies. Midwater catches from the small mesh net(s) attached to the AWT were processed by weighing the non-gelatinous portion and preserving it in 10% formalin, and then weighing and discarding the gelatinous portion.

Bongo net tow samples were processed similarly to the small mesh net samples; the gelatinous fraction of the catch was weighed and removed, and the remainder subsampled and preserved in quart jars with 10% formalin.

PRELIMINARY RESULTS

Biological data were collected and specimen and tissue samples preserved from catches of 17 midwater rope trawls, and two bongo net tows (Fig. 2, Tables 2 and 3). Pollock dominated the midwater trawl catches in both weight and numbers (Table 4). Numerous lanternfish and northern smoothtongues were also captured. Northern smoothtongues were more numerous on the shallower, eastern half of the survey area. Lanternfish peaked in abundance near the middle of the survey area (haul 16) and appeared to be slightly more numerous than northern smoothtongues in the western half of the survey area over deeper bottom depths

(Fig. 3). For the 16 midwater hauls that caught more than one pollock the number of lengths sampled per haul ranged from 249 to 362, and maturity, otolith and body weight samples per haul numbered 69-102 (Table 5). Haul 13 targeted an echo sign layer that was often observed at about 200-300 m depth and not thought to be pollock. It caught a mixture of jellyfish, lanternfish, and squid.

Oceanographic data were collected from 8 XBT casts, 17 MBT casts and 1 CTD cast (Tables 6-8). Temperature profiles showed a well mixed water column with temperatures close to 4.0° C between 0 and 460 m depth (Fig. 4). Near-surface water was 3.4° C on the eastern Bering Sea shelf side of the survey area, and around 4.0° C on the western (Aleutian Basin) side.

Pollock echo sign was observed throughout the survey area. Aggregations of moderate density were distributed along the shelf edge north of Akutan and Unalaska Islands. However, most of the high density pollock aggregations were observed along the north side of Umnak Island west of long. 167°30'W to about long. 169°40'W (Fig. 1). The largest pollock aggregations, centered inside Samalga Pass, were west of where they had been observed in 1995 and in previous years. The vertical distribution of pollock echo sign ranged from 250 m to 750 m below the surface.

Pollock caught during the survey had fork lengths ranging from 34 to 65 cm, with the majority between 40-60 cm FL (Fig. 5). No fish with FL less than 34 cm were encountered. Hauls 1-6, and 16-17, east of 169 W, caught pollock with average FLs of 47.4 cm (males) and 50.4 cm (females). By contrast, for hauls 7-15, west of 169 W, the average FLs were 51.7 cm (males) and 54.7 cm (females). Data from all midwater rope trawls (except haul 13) showed that the sex ratio by haul ranged from 18% to 80% female and averaged around 56% female.

Maturity compositions for pollock 38 cm FL and larger were compared between east and west portions of the survey area (Fig. 6). Among female pollock in the east area, 1% were in a developing stage (developing 1 and 2) and not expected to spawn soon, 96% were in a pre-spawning stage (pre-spawning 1 and 2), and 2% were actively spawning. In the west, 97% were pre-spawning, 2% were spawning, and <1% were post-spawning (post-spawning 1 and 2). Hauls 1 and 16 caught the only developing stage females encountered. For males in the east area, 3% were developing, 87% were pre-spawning, 8% were spawning and 2% were post-spawning. In the west, males were 81% pre-spawning, 15% spawning and 4% post-spawning. Aside from indicating a higher percentage of actively spawning males in the west versus east, pollock maturity stages showed relatively minor differences between areas for both sexes. The mean gonadosomatic index (GSI), defined as the ratio of gonad weight to total body weight for pre-spawning females, was 0.17 (Fig. 7).

SCIENTIFIC PERSONNEL

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