Alaska Fisheries Science Center

Survey protocol for the Alaska sablefish longline survey

By
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Introduction

Sablefish (*Anoplopoma fimbria*) are a commercially important fish species in the northeast Pacific Ocean. Found along the upper continental slope, in Alaska they are caught primarily by longlines. Catches in the Alaskan EEZ have averaged 15,000 mt in recent years with an annual value of about $100 million. The fishery has been managed by an Individual Fisheries Quota system since 1995. Fishery-independent longline surveys have been conducted annually since 1978 to assess the relative abundance of this valuable resource. The survey abundance indices are combined with age, length, and fishery data to estimate absolute abundance and recommend catch quotas with age-structured models.

Since 1978, the U. S. National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center (AFSC) has conducted annual longline surveys with Japan (Japan-U.S. cooperative longline survey, 1978-94) and alone (1987-present, domestic longline survey). The survey has covered the upper continental slope (1978-present) and selected gullies (1987-present) of the Gulf of Alaska and the upper continental slope of the eastern Bering Sea (1982-94, biennially since 1997) and Aleutian Islands region (1980-94, biennially since 1996). A unique aspect of this survey is that the charter vessel retains most of the catch after the scientific data are recorded. The survey lasts three months. The survey is conducted jointly by two components of the AFSC: the Auke Bay Laboratory and the Resource Assessment and Conservation Engineering Division.

History of survey

Sablefish have been exploited since the end of the 19th century by U.S. and Canadian fishermen. The North American fishery on sablefish developed as a secondary activity of the halibut fishery of the United States and Canada. Initial fishing grounds were off Washington and British Columbia and from there spread to Oregon, California, and Alaska during the 1920's. Since then, and up to 1957, the sablefish fishery was exclusively a U.S. and Canadian fishery, ranging from off northern California northward to Kodiak Island in the Gulf of Alaska. Japanese longliners began operations in the eastern Bering Sea in 1958. As the fishing grounds in the eastern Bering Sea were preempted by expanding Japanese trawl fisheries, the Japanese longline fleet expanded to the Aleutian Islands region and the Gulf of Alaska. Heavy fishing by foreign vessels during the 1970's led to a substantial population decline and fishery regulations in Alaska which sharply reduced catches. Data collection from sablefish fisheries in Alaska began in 1963. Catch, effort, age and length data have been collected to compute relative abundance indices

(catch/hook), age and length compositions.

With passage of the Magnuson Fisheries Conservation and Management Act in 1976, foreign vessels fishing in U.S. waters were required to provide either fisheries research or markets for this privilege. This requirement sometimes is called the "fish-and-chips" policy. The Japan Fisheries Agency began a longline survey for sablefish in Alaska in 1978 as a "chip" to trade for continued commercial fishing for sablefish in U.S. waters.

The Japan-U.S. cooperative longline survey was conducted annually from 1978 to 1994. In 1987, the AFSC began an annual survey intended to replace the cooperative longline survey so that a U.S. vessel, rather than a Japanese vessel, would conduct the survey for what had become a wholly U.S. fishery in 1988. The two surveys overlapped for several years to compare and test for differences between them and thus link the time series of standard longline surveys. By 1994, statistical analyses by Kimura and Zenger (1997) showed that enough data had been collected to complete a valid comparison. As a result, the cooperative longline survey was discontinued after 1994. The annual longline survey begun by the AFSC in 1987 has continued to the present.

Survey objectives

The survey objectives are: 1) Determine the relative abundance and size composition of the commercially important species: sablefish, shortspine thornyhead (*Sebastolobus alascanus*), Greenland turbot (*Reinhardtius hippoglossoides*) and rougheye and shortraker rockfishes (*Sebastes aleutianus* and *S. borealis*); 2) Determine migration patterns of sablefish, shortspine thornyhead, and Greenland turbot by tag and release methods; and 3) Determine the age composition of sablefish through otolith collections.

Survey description

The survey covers the upper continental slope and selected gullies of the eastern Bering Sea, Aleutians Islands region, and Gulf of Alaska (Figure 1). The survey covers nearly all areas where adult sablefish are found. Depths sampled during the survey of the upper continental slope range from about 150-1,000 m (82-547 fm). Sampling occurs during the summer and lasts 3 months. Survey operations are conducted using a chartered U.S. longline freezer vessel with overall length of about 55 m (150 ft).

Survey gear

The basic unit of survey gear is termed a skate. A skate consists of 100-m (55-fm) of line with 45 hooks spaced 2-m (6.5-ft) apart and baited with squid. A longline set consists of 80 skates with weights between each skate. The gear sinks to the sea floor where it samples fish near the bottom.

Gear construction and configuration

Skates of gear are 100-m (55-fm) long and contain forty-five size 13/0 Mustad[1] circle hooks (Figure 2). Hooks are attached to 38-cm (15-in) tied length (untied length 74-cm [29-in]) gangions secured to 46-cm (18-in) beckets tied into the groundline at 2-m (6.5-ft) intervals. Lengths of gangion and becket material are cut by burning. Gangion eyes are 10-cm (4-in) long. Hooks are hung by inserting the tied end of the gangion through the eye face closest to the hook tip (the inside of the hook). The groundline of each skate is marked with bright-colored flagging and red ink at the first and forty-fifth beckets, and with red ink at the remaining forty-three beckets. Five meters (16 ft) of groundline are left bare on each end. Skate eyes are 46-cm (18-in) long. The splice to form the eye is tapered, but the ends are not burned because the burned ends abrade the surrounding line when it is stretched. Gangion, becket, and groundline materials are medium lay #60 thread, medium lay # 72 thread, and soft medium lay 9.5 mm (3/8 in) American Line SSR 100[1] (or equivalent nylon line), respectively.

A set consists of 80 skates, is 8-km (4.3-nmi) long, and contains 3,600 hooks. Each end of a set has a flag and buoy array, followed by a buoyline made of 183-1,281 m (100-700 fm) American Line (length depends on water depth) and 92 m (50 fm) of 9.5-mm (3/8-in) polypropylene line, a 16-kg (35-lb) piece of chain to dampen wave effects on the buoyline, 92-m (50-fm) American Line, a 27-kg (60-lb) halibut anchor, 366-m (200-fm) American Line, and finally the groundline with hooks. Buoyline length varies with water depth and is 92-276 m (50-150 fm) greater than water depth. The groundline is weighted with 3.2-kg (7-lb) lead balls attached at the end of each skate. The lead balls are tied to a stainless steel snap with a 20-cm (8-in) tied length polypropylene line of 6.2-mm (1/4-in) diameter.

Measurement of hook spacing during gear construction

A template is used to mark hook spacing during gear construction. NOAA personnel construct the longline skates in the Net Loft at the Alaska Fisheries Science Center in Seattle. The groundline is laid across the floor and stretched until straight. Painted marks on the floor spaced 2-m apart are used as a template to mark hook spacings with a red marker. Beckets are inserted at the red marks and gangions are attached. All construction except attachment of hooks is completed by NOAA personnel.

Gear maintenance

The gear is maintained to the following standard aboard the vessel. If the groundline is damaged in a short interval of line, the worn line is replaced by splicing such that the replacement line maintains hook spacing of 2 m. A splice consists of 3 tucks for each line end. Damage includes chafing, nicks, and wear. Gangions and beckets are replaced when the outer covering is worn or broken. Hooks are replaced when severely bent or broken. Slightly bent hooks are straightened. If the groundline is damaged over a long interval, the damaged skate is replaced with new gear built by NOAA personnel at the Net Loft.

Citation of the above brand names does not constitute U.S. government endorsement.

Measurement of hook spacing during gear maintenance

Marks placed 2-m apart at each baiting and repair station are used to measure hook spacing after splicing.

Baiting of gear

Bait specification

East Coast or North Atlantic squid (*Illex illecebrosus*), 2-3 count per lb or larger, is the survey standard; *Loligo* or market squid is not acceptable. The general commercial designation is brown color, fit for human consumption (used as an index of freshness), 100-200 grams per squid. The mantle length should be 15-23 cm (6-9 in) long.

Bait size

The mantle is cut into 3-4 pieces, each 4-5 cm (1.5-2 in) long. Only the mantle and viscera are used for bait. The head and tentacles are not used for bait.

Baiting method and quality

Blocks of bait, usually 20 kg (44 lb) in weight, are taken from the freezer the evening before baiting. The bait thaws overnight, but remains semi-frozen when baiting occurs. The squid are individually separated, chopped into pieces, then returned to the freezer. The chopped squid are taken from the freezer to partially thaw before baiting.

Each hook is hand baited with chopped squid at a rate of about 5.5 kg (12 lb) per 100 hooks. The hooks are baited with semi-frozen squid. Semi-frozen squid are firm and easier to bait than completely thawed squid which are slippery and hard to handle. The gear is baited, maintained, and coiled into tubs the day before deployment. The bait remains cool due to ambient air temperature which is 4-15°C. If gear deployment is delayed, the chief scientist will monitor bait quality for freshness. For deployment, the bait must be fit for human consumption. Bait deterioration can be detected by change in color to dark reddish-brown, dryness, and smell.

Operations procedures

The objective of the setting pattern is to evenly distribute sampling effort over depths of about 150-1,000 m. The same station locations have been sampled all survey years. The gear is set from shallow to deep and retrieved in the same order.

Setting and hauling

Setting takes 1-1/2 to 2 hours. The vessel travels at 6-7 knots. Retrieval begins at the same end where deployment began. Retrieval lasts 7 to 9 hours, depending on station depth and sea conditions. The vessel travels at about 1 knot.

Soak time and gear length

The gear soaks from three to nine hours. Gear retrieval begins after the gear has soaked three hours. The longer soak times occur because of the lengthy time needed to retrieve the gear. One-hundred sixty skates are set each day, totaling 16 km (8.6 nmi). The gear is set in two equal parts of 80 skates laid end to end.

Direction of set

The set direction follows the prevailing current. The same station tracks are followed each year. The standard station tracks are recorded on maps in both electronic and paper formats. The vessel track each year is recorded with GPS-linked electronic navigation software to verify that the standard station track is followed.

Bottom topography

Station locations were chosen regardless of bottom topography even though the sampled area, the upper continental slope, is often steep and irregular. The gear is slack and can follow irregularities because the setting speed is moderate. The negative buoyancy of the groundline and the lead balls sink the gear to the bottom. Station tracks avoid gear hangups such as boulders, coral, and lost fishing gear.

Daily schedule

The vessel typically arrives at a station the night before sampling. The captain may transit the standard station track to familiarize himself with the bottom. The gear is set each morning starting at 6:30 AM. Retrieval begins at 9:30 AM which allows a minimum of 3 hours of soak time. Retrieval and data collection continues until completion, usually about 1800-2200 hours, with a lunch break between retrieval of the two sets. Hooks are baited and gear is repaired throughout each day to ready gear for the following day. The vessel travels to the next day's station following hauling.

Criteria for deploying longline gear

Longline gear is not deployed if weather and sea conditions exceed 10 foot seas and 25-35 knot winds. In these conditions fish drop off the longline and the abundance index is biased. Sampling is delayed until the weather improves so that the affected station is not skipped. Typically weather delays the survey only by one day every 3-4 years. If weather conditions worsen during retrieval hauling continues until all gear is retrieved.

Fishing vessels occasionally fish at or near survey locations. The survey station is moved if the fishing location overlaps the survey location. When a small amount of gear (less than ten skates) is within 0.5 nmi (0.9 km), then the station track is slightly shifted. When a large amount of gear (more than ten skates) is within 0.5 nmi or the exact fishing locations are unknown, then the station is moved 3-5 nmi (5.6-9.3 km) away. The objective of the setting pattern at the alternate station location is to evenly distribute the sampling effort (gear) over depths of about 150-1,000 m.

Killer whales sometimes remove fish from the gear. The killer whales may follow the survey vessel from one station to the next. If this occurs, the station sampling order may be changed to avoid continued depredation.

Criteria for a successful longline set

Status of bare hooks is recorded at retrieval. Hooks are classified as ineffective if they are broken, bent, or tangled. This information is used to analyze the survey data after the survey is complete. If six or more of the forty-five hooks of a skate are ineffective, then the skate is declared ineffective and not included in computations of catch rate. If fewer than six hooks are ineffective, then the catch rate is adjusted by the number of ineffective hooks (i.e. only effective hooks are considered in computation of effort and catch rate).

Gear occasionally is lost during retrieval. Typically this occurs when the gear hangs on the bottom and breaks. If the gear breaks the vessel travels to the second buoy of the set to retrieve the rest of the gear. Occasionally the gear breaks again and gear is lost. If twenty or more skates are lost the vessel typically attempts to retrieve the lost gear by dragging for it with a grapple. Stations are not repeated due to lost gear because gear loss each year has been less than 0.5 percent of survey effort. Catches from lost gear are not recorded.

Killer whales sometimes remove fish from the gear. These occurrences are documented in specialized forms intended to quantify marine mammal interactions. Whale damaged fish are coded in the electronic catch forms. Catches are adjusted for killer whale depredation because removals are large, easily detected and documented, and we have historic information on occurrence to adjust historic catches.

Sperm whales sometimes remove fish from the gear during retrieval. These occurrences are documented in the marine mammal interaction forms. Whale damaged fish are coded in the electronic catch forms. Catches are not adjusted for sperm whale depredation because the removals are small, depredation occurs only occasionally, and we lack historic information on the occurrence to adjust historic catches.

Rationale for gear configuration and survey methods

Survey area

The survey area covers nearly all adult sablefish habitat in the Alaska EEZ.

Station placement

The longline survey follows a systematic design (Sasaki 1985) by placing stations 20-30 nmi (37-56 km) apart and sampling these same locations every year. Experiments comparing systematically located survey stations to nearby, randomly placed stations found no substantial difference in catch rates.

Gear configuration

Two gear configurations have been used during the history of sablefish longline surveys in Alaska. The original gear used during the Japan-U.S. cooperative longline survey followed the configuration of the Japanese longline fishery in Alaska. The configuration was 100-m skates with 2-m spacing between hooks, tara hooks (a kind of J-hook) baited with squid and attached by 1-m long, lightweight gangions, and 3-kg weights between skates. The gear used during the domestic longline surveys followed the materials of the U.S. longline fishery, but maintained the configuration of the cooperative longline survey. The configuration of both surveys is 100-m skates with 2-m spacing between hooks, baited with squid, and 3-kg weights between skates. The domestic longline survey uses circle hooks and shorter, heavy-weight gangions.

Relationship of catch rate and abundance

Several experiments have been conducted to test whether survey catch rate is a linear function of abundance (Sigler 2000). Hook timer, on-bottom (soak) time, hook density, hook pattern, bait type, and bait condition experiments and mathematical models were used to evaluate the performance of the longline surveys for estimating sablefish relative abundance. The rate that sablefish encountered the longline gear decreased with on-bottom time independently of sablefish density in the sampled area. Sablefish were adept at locating available baits, even when few remained. The decrease in encounter rate appears related to odor concentration at the leading edge of the odor plume. The ability to locate baits, even when few remain, differs from previous models of fish capture by longline in which the probability that a fish located a bait was proportional to the number of available baits. Decreased encounter rate and the ability to locate baits efficiently imply that longline catch rates likely provide an accurate index of fish abundance if the on-bottom time is long enough to cover the period when most fish encounter the gear and the initial bait density is high enough that baits remain available throughout the soak; the weak link between catch rate and abundance is the unknown extent that factors such as temperature and food availability affect the proportion of fish caught.

References

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Sasaki, T. 1985. Studies on the sablefish resources in the North Pacific Ocean. Far Seas Fisheries Research Lab. Bull. 22:1-108.

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Tables and figures

Table 1.–Materials required for one set of longline gear.

Quantity	Units	Item
16	box	1800-ft length of American Line SSR 100 soft/medium lay (groundline)
3600	each	Mustad #39965-13/0 hooks
25	pounds	Medium lay #60 thread round braided nylon gangion twine
10	pounds	Medium lay #72 thread becket material
81	each	7 lb. lead balls with eyelets
81	each	Stainless steel groundline snaps for 3/8" groundline
108	feet	Polypropylene braided line 1/4" diameter
2	each	Flags
4	each	Buoys
5	box	1800-ft length of American Line SSR 100 soft/medium lay (buoyline)
100	fm	9.5 mm (3/8") polypropylene line
2	each	16 kg (35 lb) piece of chain
2	box	American Line SSR 100 soft/medium lay (line from chain to anchor and anchor to groundline)
2	each	27 kg (60 lb) halibut anchor

Figure 1.–Survey area for Alaska sablefish longline survey.

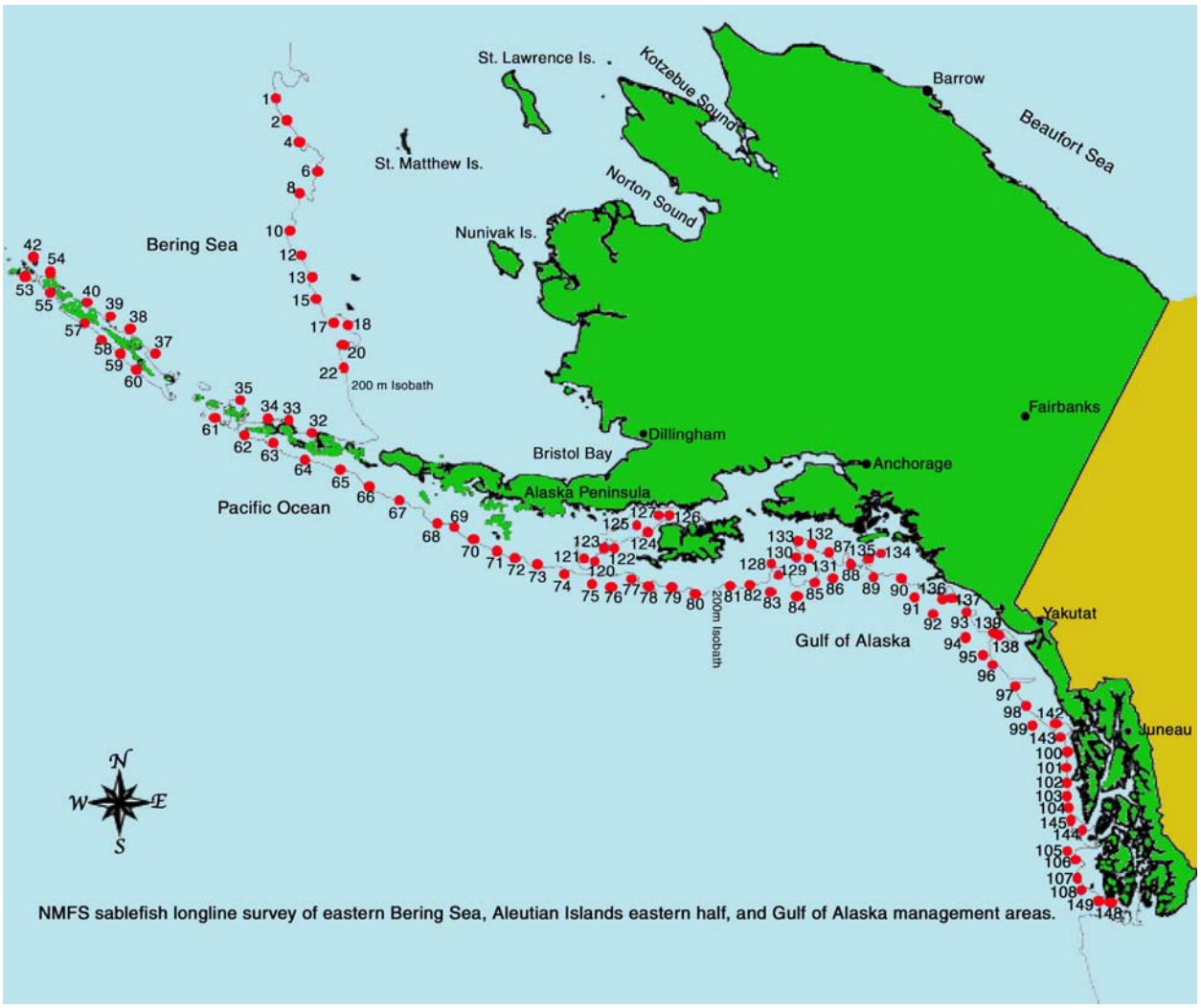

Figure 2.–Diagram of one skate of longline gear.