NOAA Technical Memorandum NMFS

DECEMBER 1980

FISHING METHODS AND EQUIPMENT OF THE U.S. WEST COAST ALBACORE FLEET

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NOAA-TM-NMFS-SWFC-8

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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Ronald C. Dotson

National Marine Fisheries Service
Southwest Fisheries Center
La Jolla, California 92038

U.S. DEPARTMENT OF COMMERCE
Philip M. Klutznick, Secretary
National Oceanic and Atmospheric Administration
Richard A. Frank, Administrator
National Marine Fisheries Service
Terry L. Leitzell, Assistant Administrator for Fisheries

INTRODUCTION

North Pacific albacore, Thunnus alalunga, support an important U.S. commercial fishery on the west coast of North America as well as a substantial sport fishery. The fishery is seasonal, beginning in mid to late June when albacore migrate into the coastal waters and extending through November when most of the fish leave the coast. Trolling (also called jig fishing or jigging) and live bait fishing account for almost the entire landings of albacore by the U.S. west coast albacore fleet (Clemens and Craig 1965). A small quantity of albacore, usually mixed with bluefin tuna (Thunnus thynnus), is usually caught each year by purse seiners fishing for the bluefin tuna. The nucleus of the fleet is composed of approximately 1200-1400 jigboats and 70 baitboats. Many of the jigboats have the capacity to fish bait and do occasionally during the season. An additional 700-900 boats may jig for albacore when the fish are abundant nearshore and the weather is good.

Bait fishing has been described by Godsil (1938), and trolling has been described by Scofield (1956) and Roberts, Baker and Slack (1972). Technological advances over the years have resulted in numerous changes in vessels and the equipment fishermen use to find, catch and hold albacore. These changes have resulted in new methods as well as variations of old methods employed to catch albacore. This paper is a description of the equipment that is presently used by the baitboats and jigboats in the U.S. west coast albacore fleet. Bait fishing and jig fishing methods are described in detail, as well as are some of their advantages and disadvantages.

FISHING VESSELS

Traditionally, the U.S. albacore fishery has been concentrated within 50-250 miles of the west coast of North America. In 1972 albacore boats began fishing 1000 miles off the west coast of the United States and in 1975 they began fishing 1000 miles off Japan in the western Pacific. Albacore vessels must have the range to traverse the distance to the fishing grounds, catch fish, and return. Baitboats and trolling vessels have evolved from different design criteria and a vessel designed for one method may not be suitable for the other. Basic designs for each are described below.

In the early 1900s albacore boats were simple wooden vessels which plied the nearshore waters off the coast of southern California. Wood continued to be the predominant boat building material until after World War II. Following the war steel became an increasingly popular building material, especially for larger vessels. In the late 1950s and early 1960s both fiberglass reinforced polyester (FRP) and aluminum alloy became popular as hull materials for fishing vessels. Each hull material has certain advantages and disadvantages (Table 1).

Over the years fishermen have been quick to take advantage of technological advances. Radios, radar, auto-pilots, electronic navigation systems, fish finding and catching equipment are part of the gear found on most albacore vessels and these are discussed in separate sections.

Boat Success

Whenever albacore fishermen get together and discuss boats and fishing it is not unusual to hear the phrase "good-fishing boat" applied to a particular vessel. It is accepted among the fleet that certain boats regularly outfish others working in the same area irrespective of who is running them. Although certain hull designs may fish better than others these vessels come in all shapes, sizes and ages and there does not appear to be any single common denominator which distinguishes them from less successful boats. The fishing history of a boat may have a siginificant effect upon its market value.

Several factors appear to affect the fishability of a boat and fishermen will change or modify these in an attempt to improve their catch. Noise and vibration from the prop and shaft are changed by switching propellers and using new or rubberized shaft bearings. The stern may be filled with cement or sandbags to dampen noise and vibration. Trolling speeds are varied to check whether one speed results in a greater number of strikes. Electrical systems are thoroughly checked to be sure that there are no short circuits in the system and that there is no electrical charge in the hull. Pumps, exhaust systems, engines, generators and water outflows may be moved or changed. The trim of the boat will be varied. Different lengths and location of trolling lines are tried, in conjunction with different maneuvers. Through experimentation and experience each fisherman learns the idiosyncrasies of his vessel and those factors which will affect his success.

TROLLING VESSEL HISTORY

The first trolling vessels to fish commercially for albacore in the early 1900s were small vessels (less than 30 ft) which did not have the capacity to carry a bait tank on deck for bait fishing (Scofield 1956). In the 1920s the bait fleet concentrated on tropical yellowfin tuna (Thunnus albacares) and skipjack tuna (Katsuwonus pelamis) while jigboats caught a greater percentage of the albacore. In 1936, albacore trolling expanded from the traditional grounds off of southern California up to Oregon and Washington (Godsil 1949). In general the season started off southern California and then progressed northward. As a result the fishermen built larger boats to gain greater range and carrying capacity. By 1956 the majority of the fleet was made up of 35-45 ft vessels (Scofield 1956).

Trolling is a simple method of fishing, requiring very little specialized hardware. As the need for larger boats increased specific boat designs emerged for trolling vessels (Hanson 1955) and for the increasingly popular combination boat (Petrich 1955).

In recent years U.S. trolling vessels have further extended their range in search of albacore. Exploratory trolling begun in 1972 has resulted in commercial catches as far as 1200 miles off the U.S. west coast in the eastern Pacific in an area called the "Transition Zone" (Laurs and Lynn 1977). Trolling exploration since 1975 has resulted in the "Midway fishery" located 700 miles north of Midway Island and 800-1200 miles off Japan. To provide

greater range and for safety in the open ocean, most new jigboats built in the past several years have been 55-65 ft. This size vessel is gradually replacing the smaller vessels.

The trolling fleet can be separated into three "size classes" of vessel based on length and utility. In 1972, 30% of the fleet was made up of vessels less than 37 ft, 50% were between 37-48 ft and the remaining 20% greater than 48 ft (Broadhead 1974).

The largest size class, by number, consists of medium sized vessels which developed with the expansion of the fishery in the 1940s and 1950s. These vessels can effectively work in the moderate seas which prevail within 100-200 miles of the coast and have the range to search and fish a wide area. They carry 10-30 tons of fish in refrigerated holds and stay at sea for 1-3 weeks per trip.

The number of large vessels (over 48 ft) has been increasing gradually over the past decade as albacore fishermen search over greater distances and make longer trips in an attempt to increase their fishing success in this highly competitive fishery. The larger vessels have the capacity to remain at sea for several weeks and travel hundreds of miles. They carry 25-55 tons of albacore in refrigerated holds. Their greater seaworthiness and larger accommodations allows them to run farther from shore and to remain at sea under all but the worst weather conditions, often riding out a storm on the fishing grounds rather than losing valuable fishing time running for shelter. The result is more time on the grounds and an increased catch over the smaller

vessels (Broadhead 1974). It is these vessels which are expanding the U.S. albacore fishery to other regions of the Pacific.

The upper size limit in trolling vessels appears to be 75 ft in length. Boats larger than this have increased fuel and maintenance costs which are not presently offset by an equal increase in fishability.

The final group of boats are the smaller trolling vessels, many of which are opportunistic participants in the troll fishery, making the number of such boats in the fishery vary widely from year-to-year. These small craft are pleasure boats, day trollers, salmon and crab skiffs, and small trollers which can make quick trips of 1-5 days. They carry 1-10 tons of fish in deck boxes or iced holds. Their limited range, inability to handle rough weather, and small fish capacity restrict them to periods of calm weather when the fish occur nearshore, typically within 60 miles of port, much like the first boats used in the albacore fishery. The advantage of such a boat is the small capital investment, low expenses, and the ability to fish for many other nearshore species when the albacore are out of range or season.

TROLLING VESSEL DESCRIPTION

Trolling vessels are equipped with a pair of outriggers or jig poles (described below) and have enough deck space aft to permit the crew to pull and land the albacore. The fish are held in deck boxes on smaller boats or in holds kept cold with ice or refrigeration on the large vessels. Accommodations for the crew of 1-3 persons vary with the size of the vessel.

Almost any hull design will fulfill the simple criteria above and the U.S. albacore jig fleet is composed of a variety of vessels; however, there has developed a vessel design which seems particularly suited for trolling (Hanson 1955). These boats have a raised bow sweeping back to a low stern. The house is located forward and the after deck is clear for working (Figure 1). The hold is located below deck amidships and crew accommodations are located either in the forecastle or in the deck house with the galley. The forward part of the house is reserved for the steering, navigation and radio equipment.

The main engine is a single diesel centered below the house. The auxiliary generator and various pumps and refrigeration are connected to the main drive by power take off units or run by a smaller auxiliary engine located to the side of the engine room.

The horsepower of the main engine depends on the length of the vessel, hull design, displacement, propeller size and pitch, RPMs and amount of auxiliary equipment which it must run. For boats of 40-75 ft the range is approximately 70-300 hp, the majority having less than 150 hp. Vessels are equipped with either direct drive in low RPM engines or a reduction gear of 2:1 to 4.5:1 in high speed engines, with resultant shaft RPMs of 300-450.

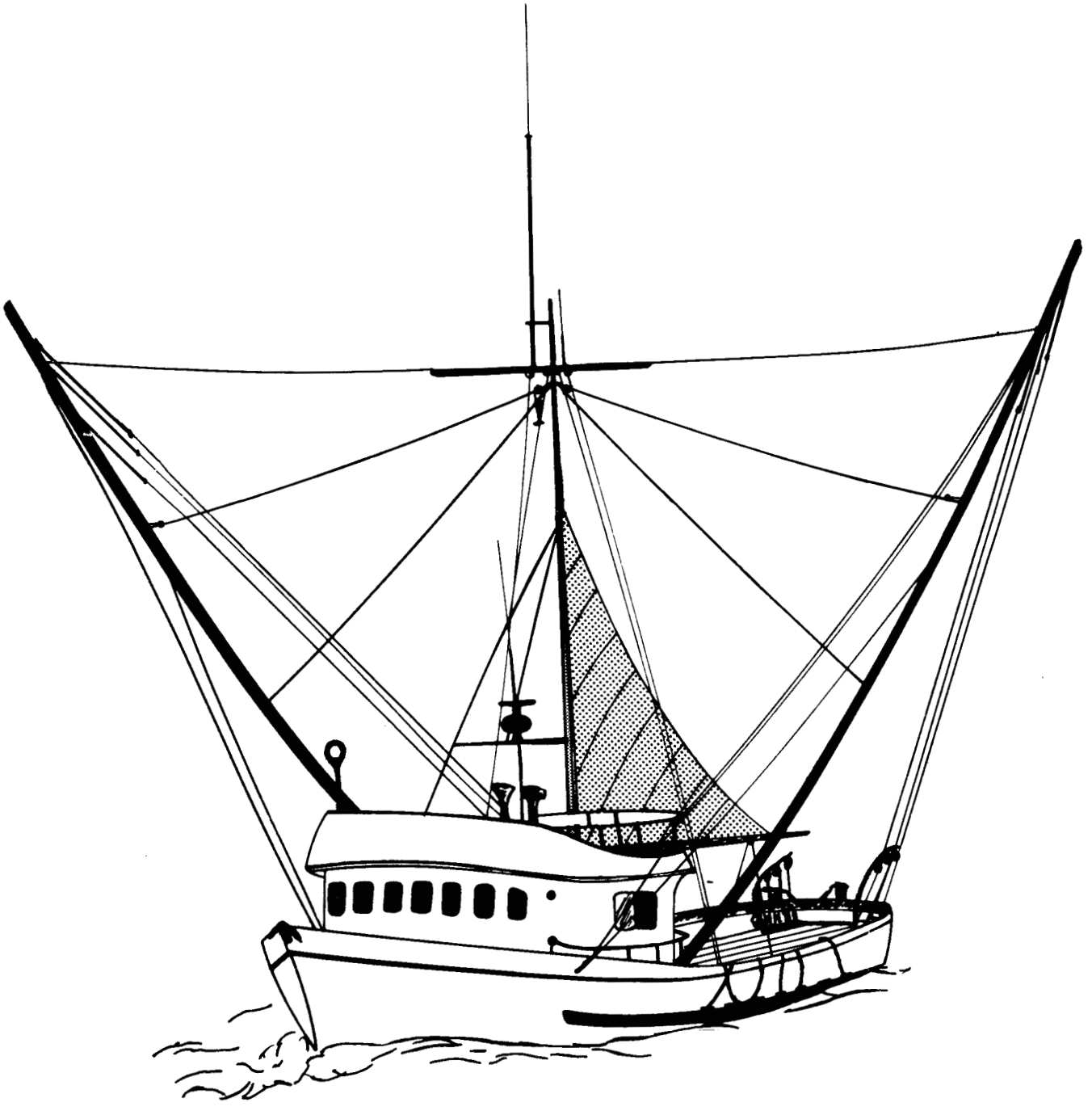

Figure 1. An albacore trolling vessel with outriggers lowered, steadying sail up, and gurdies in corners of the stern.

The cruising speed of a jigboat is typically 8-10 kts, with maximum speeds of 10-13 kts. Greater speeds require an inordinate increase in horsepower because of the hull design. The increased cost of a larger engine and fuel for the slight increase in speed will not result in a comparable increase in earnings from increased mobility on the fishing grounds.

BAITBOAT HISTORY

The Japanese technique of fishing for albacore with a stout pole, short line and barbless hook baited with a live fish, known as bait fishing, developed in southern California in the early 1900s on boats which fished within a days run of port (Conner 1931). The poor catch of albacore in 1918 forced baitboats to turn south for yellowfin and skipjack to fill the cannery's demand for tuna (Conner 1930). The amount of baitboat effort expended in the albacore fishery was thereafter greatly influenced by events in the tropical tuna fishery. The subsequent expansion of this tropical tuna fishery was accompanied by rapid changes in the design of baitboats that culminated in the "tuna clipper" described by Godsil (1938). This "clipper" fleet grew to a high of 228 vessels in 1951 (McNeely 1961). These vessels ranged in size from 90-169 ft in length and carried up to 630 tons of tuna (Petrich 1955). They continued to fish for albacore during the summer runs and concentrated on the tropical tunas the remainder of the year or when there was a poor albacore run.

In addition to the large "clippers" smaller vessels, generally with less than 30 tons capacity, were built to fish albacore with bait. These are the "combination" boats, so called because they fished in several fisheries. By changing deck gear and utilizing a versatile hull design these boats operate as trawlers, crabbers, longliners, gillnetters, trollers and baitboats. Such craft can be utilized all year round in the North Pacific fisheries (Hanson 1955).

In 1956 potential fishing effort on albacore was diverted to the tropical fishery with the introduction of the all-nylon purse seine and the puretic power block. These greatly increased the efficiency of purse seining for the tropical tunas, resulting in a mass conversion of the large "clippers" to purse seiners over the next 5 years (McNeely 1961). In 1962 only 41 "tuna clippers" remained in the baitboat fleet which regularly fished for albacore, mostly vessels too small or too old for conversion.

Good bait fishing for albacore, yellowfin and skipjack and increasing prices paid for these species in the years 1967-71 revitalized the bait fleet. Most "clipper" vessels having less than 50 tons capacity were replaced in 1972-75 by vessels with 50-100 ton capacity and a few with greater than 100 ton capacity (IATTC, unpubl. data). In 1976, Mexico issued new laws concerning fishing in their territorial waters which includes capturing bait. This action effectively ended the addition of new vessels to the bait fleet. The number of large U.S. baitboats fishing albacore and tropical tunas has decreased through attrition from 59 in 1976 to 30 in 1979 (IATTC, unpubl. data). The albacore bait fleet is presently composed of these baitboats and an additional

100-150 combination vessels equipped for bait fishing, most of which carry less than 30 tons of fish.

BAITBOAT DESCRIPTION

Baitboat design has not changed basically from that described by Godsil (1938). Most new vessels have been constructed of steel, however, many of the old baitboats are of wood construction and combination boats are made of steel, wood, fiberglass or aluminum.

The fishing operation of a baitboat requires a low after deck with little freeboard (Figure 2). On the aft deck are one or two bait tanks covered with a canopy which protects the "chummer" from an errant bait hook, artificial lure, fish, or pole. Lights located under the canopy are directed to shine down into the bait tanks because the bait becomes easily frightened in the dark. The stern and port bulwarks hold hinged racks (described below) which are lowered outboard during fishing. The bait tanks and racks are portable and can be removed for other types of fishing on combination boats.

These vessels have a large deck house to accommodate a crew of 4-12 men. The house sits forward and its roof extends to the bow. This raised "boat deck" creates a dry ship and acts as a stop for fish thrown on deck, as well as being a storage area for skiffs and the bait net (Figure 2). The pilot house and flying bridge are above the deck house. The pilot house contains ship controls, communication, navigation and fish finding equipment. The mast is equipped with a crow's nest or platform for spotting fish schools at a distance.

Figure 2. A baitboat depicting the raised or "boat deck" typical of this design. Other details include the crows nest on the mast, the net skiff on the boat deck, a stern bait tank and fishing racks (raised position) characteristic of these vessels.

The refrigerated fish hold is located amidship below deck. Smaller boats have a single hold whereas larger vessels may have several watertight wells with a high shaft alley running between them. The watertight wells are used to carry fuel or bait at the beginning of a trip and can be cleaned and filled with fish as the trip progresses. The shaft alley contains the piping and valves for refrigeration and water circulation and may also have access hatches to the wells.

The engine room is well forward under the house. Fuel oil and fresh water are held in stern tanks and in tanks in the bow or along the sides.

The size and weight of the above equipment necessitates a hull design with greater displacement than is necessary in trolling vessels. Design allowances must be made for the low stern. In addition the center of gravity should be low enough to allow a bait tank holding several tons of water to be placed on deck without seriously affecting the stability of the vessel. The weight requirements and the expense of additional equipment restrict baitboats to vessels greater than 35 feet.

TROLLING VESSEL EQUIPMENT

There has been little change in the design of trolling equipment since the description by Scofield (1956). Tougher, longer lasting synthetics have replaced many of the natural fiber materials previously used. Automation has

been introduced through the use of hydraulic line pullers. The methods of rigging the gear remain unchanged. Some names have been dropped or changed in reference to pieces of equipment; and no attempt has been made here to establish specific terms for individual items but rather to use the name commonly used by fishermen.

Outriggers

The most distinctive physical characteristic of a trolling vessel is the pair of outriggers. Outriggers or jig poles are long poles of wood, metal or fiberglass which are used to fish more trolling lines and get the lines away from the vessel. They are attached to the deck or gunwale just forward of amidships opposite the mast (Figure 1, 3, 4). The poles are generally the length of the boat or slightly longer, running 30-60 ft in length. The butt end of wooden poles (usually eucalyptus or fir) is about 4" in diameter running to 2" at the tip. Many vessels now use aluminum poles made from either square tubing or pipe. They may be made of straight 2-1/2 to 4" diameter stock or tapered by welding sections of decreasing diameter together. Small vessels may use 15-25 ft tapered fiberglass poles but wood or metal is more popular.

The butt of the pole fits into a metal sleeve which is hinged so that the pole may be raised or lowered by one or two lines run from the pole to a pulley or block and tackle on the mast. The poles are stored in a cradle on the mast and lowered to a 25-55° angle from the water when fishing. In rough weather poles are fished higher. The pole is guyed by two forward stays and one aft stay, usually of stainless or galvanized wire.

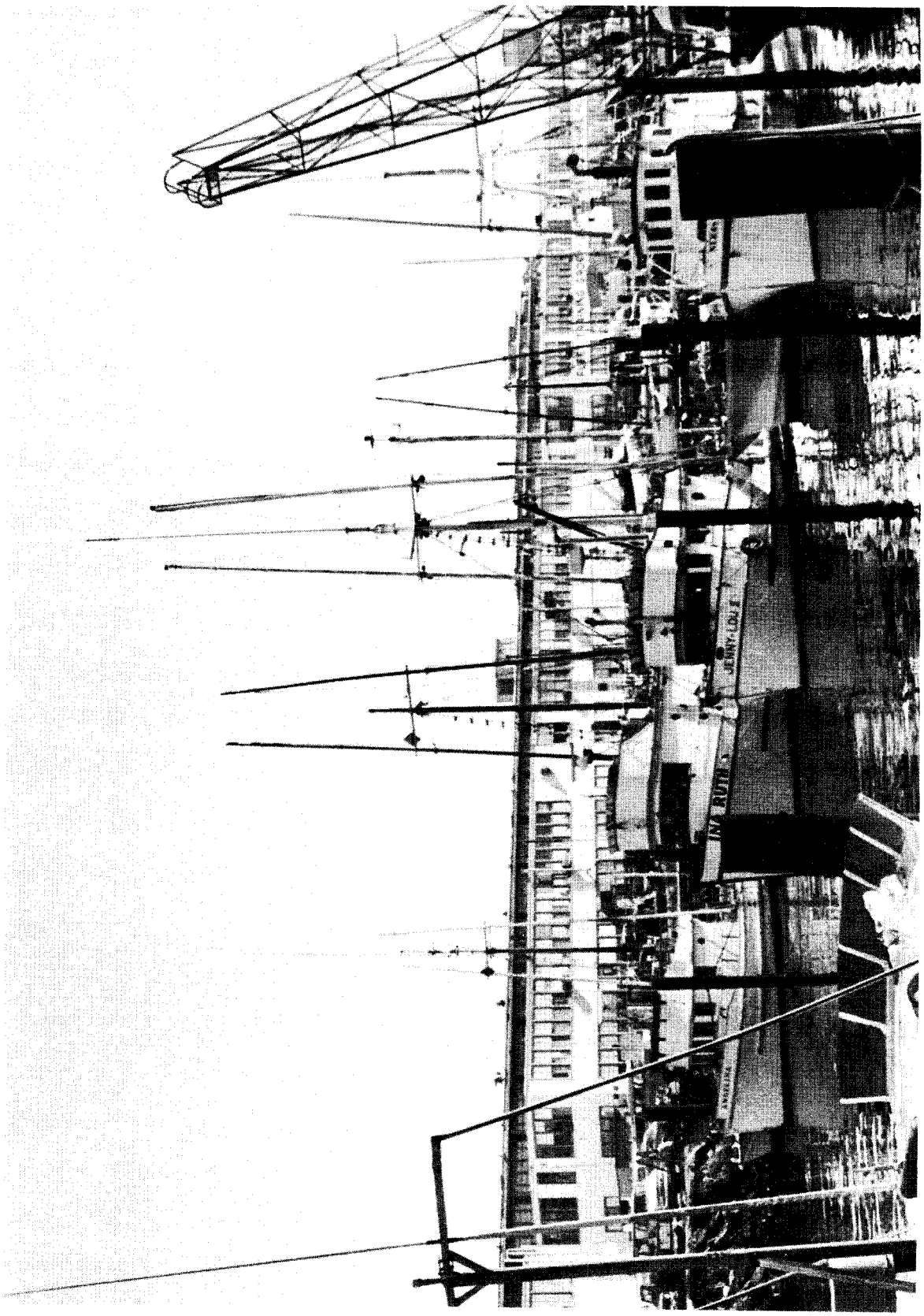

Figure 3. Jigboats in port with outriggers raised.

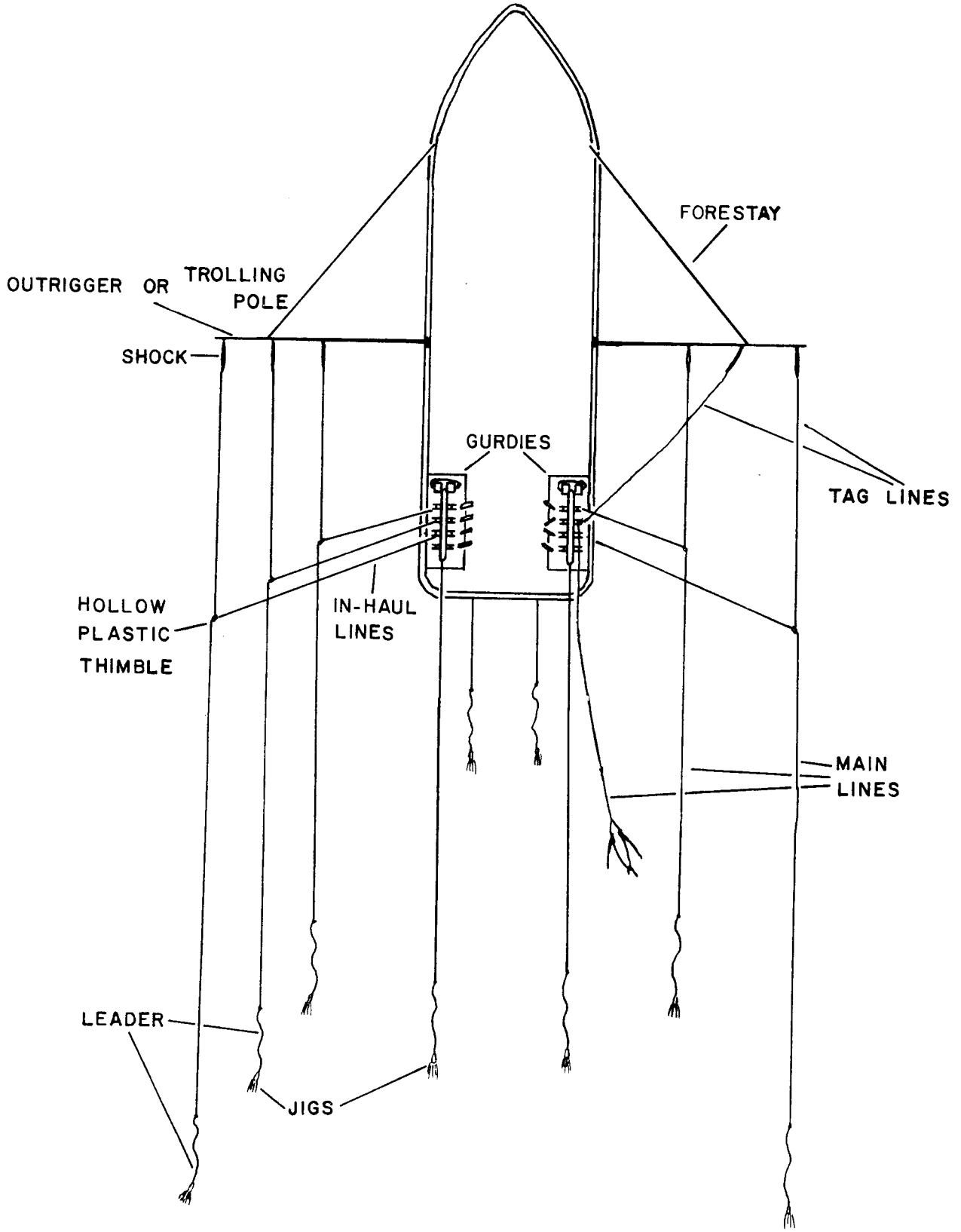

Figure 4. Illustration of trolling line arrangement and names of various parts of the trolling gear of albacore trolling vessel.

Gurdies and Line Pullers

Gurdy systems for pulling lines have been used for salmon trolling since the 1920s and were very common on salmon trollers in the 1950s but were not used for albacore trolling (Scofield 1956). Gurdies and line pullers for albacore were introduced in 1959 and have become quite popular in the albacore fleet; almost all jigboats now use one or both.

Gurdies

The gurdies used in the fleet are multiple-spool hydraulic units (Figure 5). A set is placed on deck in the fishing cockpits or on the port and starboard rail at each corner of the stern (Figure 4, 6). Each gurdy has 3-5 spools made of plastic or hard rubber; the metal spools used for salmon are not used for albacore. Each spool operates independently so line can be let out, brought in or held stationary. Retrieval speed is controlled by a foot pedal. The hydraulic pressure is regulated so that a large, hard struggling fish will stop the unit from pulling, thus preventing too much strain on the line from tearing the hook out of his mouth.

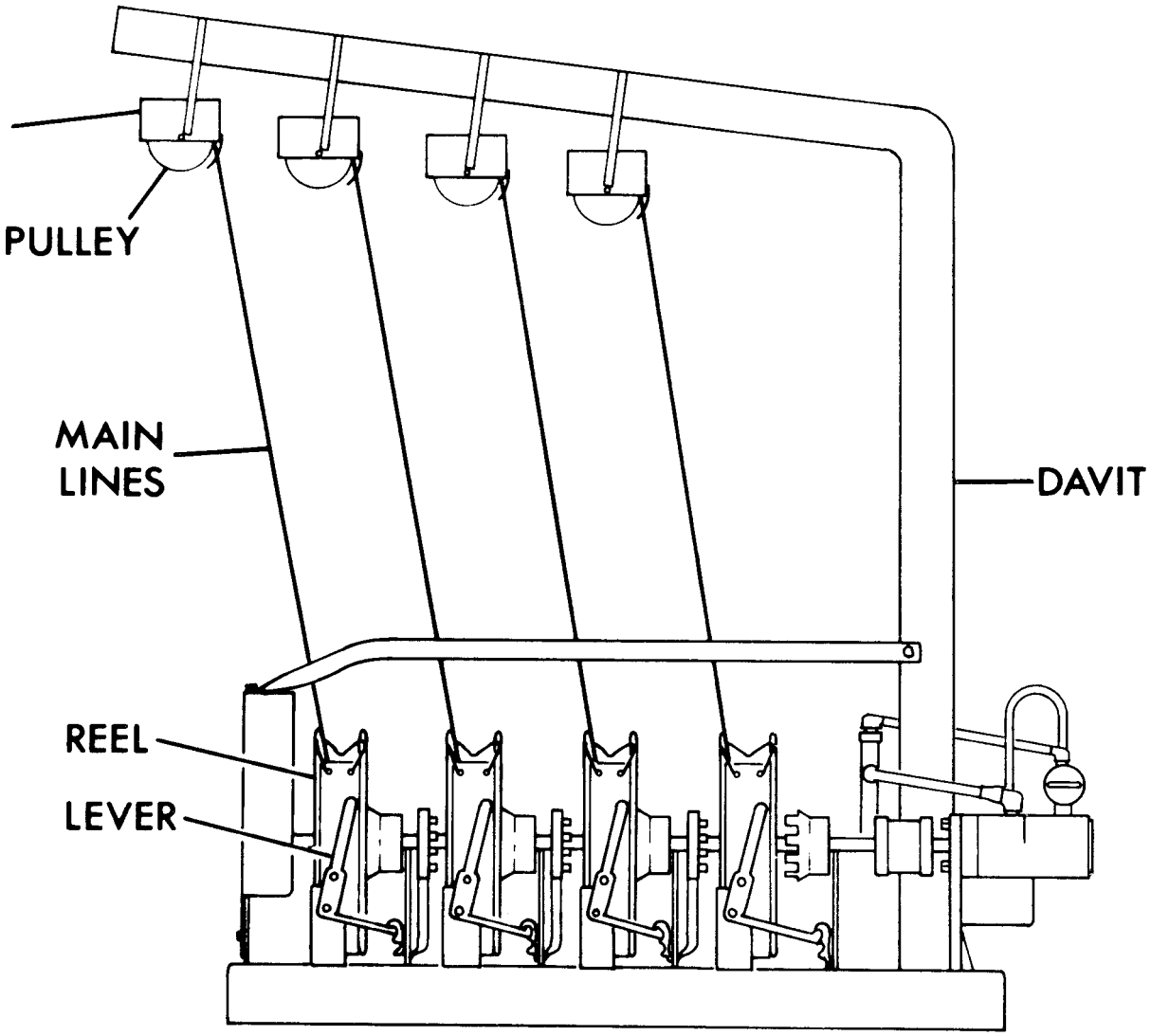

Figure 5. Detail of albacore trolling gurdy.

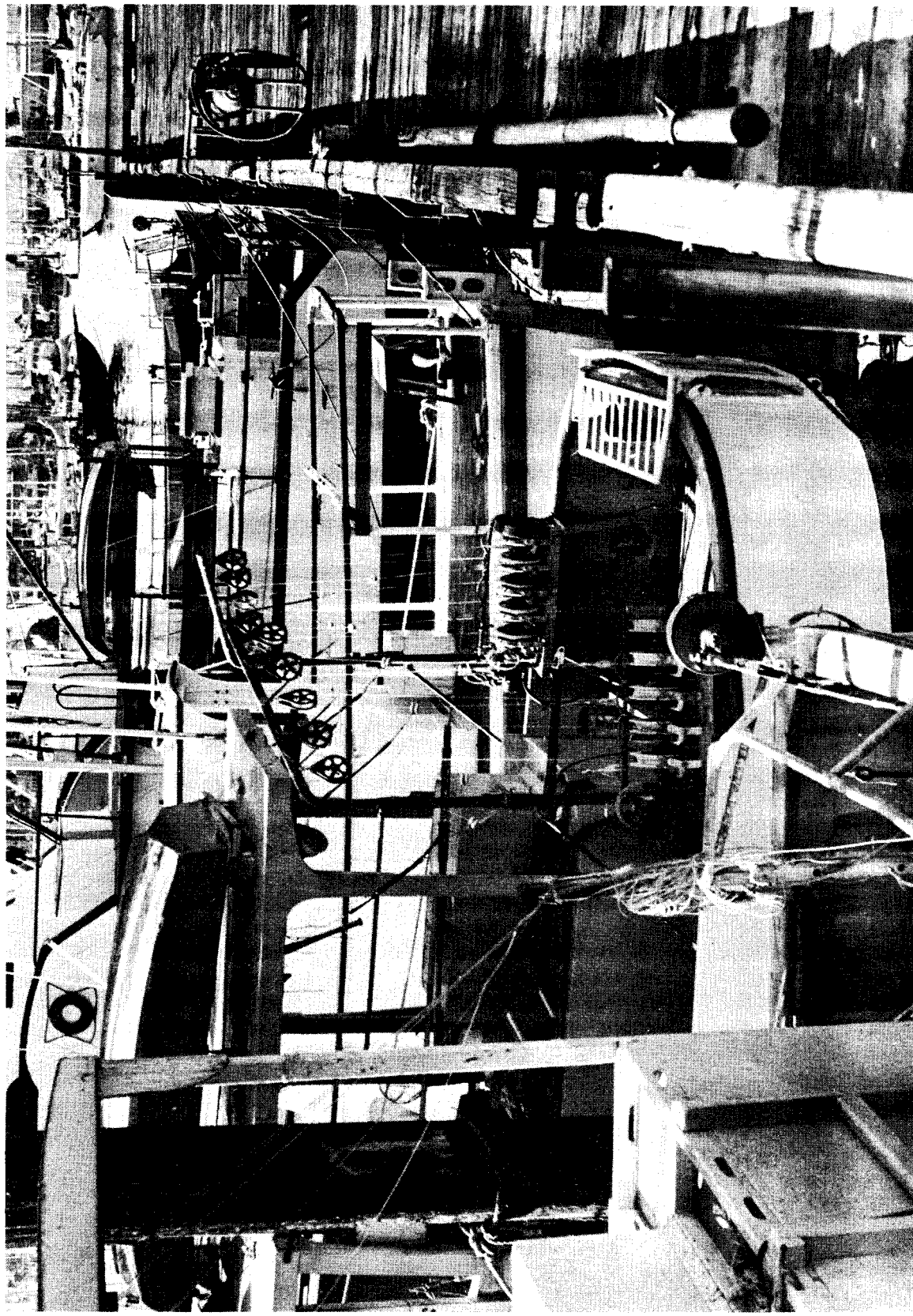

Figure 6. Position of gurdies and line pullers on sterns of albacore vessels in port.

Gurdies are used on the outrigger lines rather than the stern lines and can pull fish in as fast or faster than a man pulling by hand. They save wear an tear on the hands and fishermen believe that because of their smooth pulling action fewer fish are jerked off the line than when pulling by hand. Gurdies wind the line on the spool which prevents it from becoming tangled, often the case if it is dropped on deck or in a basket; thus saving time in getting one line out and pulling another.

Line Pullers

Line pullers are also hydraulic, consisting of a single spool with a V-shaped taper on the inside (Figure 7). The line is layed in the V and pulled by friction as the spool revolves. Speed and pressure are variable and controlled by hand valves. The line is kicked out of the back of the puller by a line stripper and either falls on deck or in a basket placed at the rear of the puller.

More than one line may be pulled if a long line is placed in first and then a short line is pulled; however, most fishermen pull only one line at a time to prevent tangling fish and lines. The fish is pulled up to the boat, after which the line is disengaged from the puller and the fish lifted aboard by hand.

Line pullers are usually located directly on the stern, one on each side of the midline (Figure 6). All the jig lines on the boat can be hauled with the puller but short lines are often pulled by hand while the puller is used for long lines.

Figure 7. Close-up of albacore line puller.

Lines

The arrangement and naming of the various trolling lines is variable. Each fisherman experiments with line lengths, placement and construction until he feels that he has attained the most effective system for his vessel. The names assigned to lines are generally descriptive of their construction, placement or function. Consequently, a line may have several names, and the addition of some local slang terms further confuses the identification of a given line. I have used names commonly given to each line in the albacore fleet, but the reader should note that other names may be used by fishermen and familiarity is the key to defining which line is under discussion.

Tag Line

The tag line is the line attached to the outrigger and is long enough to reach from this point of attachment to the corner of the stern or fishing cockpit with some slack. There is one tag line for each of the 3-5 lines attached to each outrigger (Figure 4). One tag line is normally located at the tip of the outrigger and remaining lines are spaced 4-5 ft apart down the pole.

For hand pulling or using line pullers the end of the tag line has an attachment for the inhaul line and main fishing line (see below). One of the simplest is the use of a ring with three brass swivels attached (Figure 8). The tag line is tied to one of the swivels and the main line and inhaul to the other two. This arrangement precludes the quick disconnect of the lines for storage without untying one or more knots. Frequently, the tag line has a snap attached which connects to a loop or ring on the main line with the inhaul line attached solidly or by another snap. This allows quick disassembly of the gear for storage or replacement.

With a gurdy system the tag line ends in a snap swivel attached to a ring or more often to a teflon sleeve. The inhaul line runs from the gurdy spool through a pulley and out to a metal (or teflon) ring which will not pass through the sleeve. The main line is attached to the ring and runs out through the sleeve (Figure 8). This arrangement throws the strain of striking fish onto the tag line rather than onto the gurdy davit and spool.

Tag lines may be made of nylon cord or light rope but are most commonly made from twisted stainless steel wire because of its greater strength, lasting ability, and its decreased resistance to wind.

Inhaul Line

The main fishing lines trailing from the outriggers may be up to 30 or more feet from the sides of the vessel. The line which is used to pull them to the vessel is known as the inhaul line. This line is attached at the

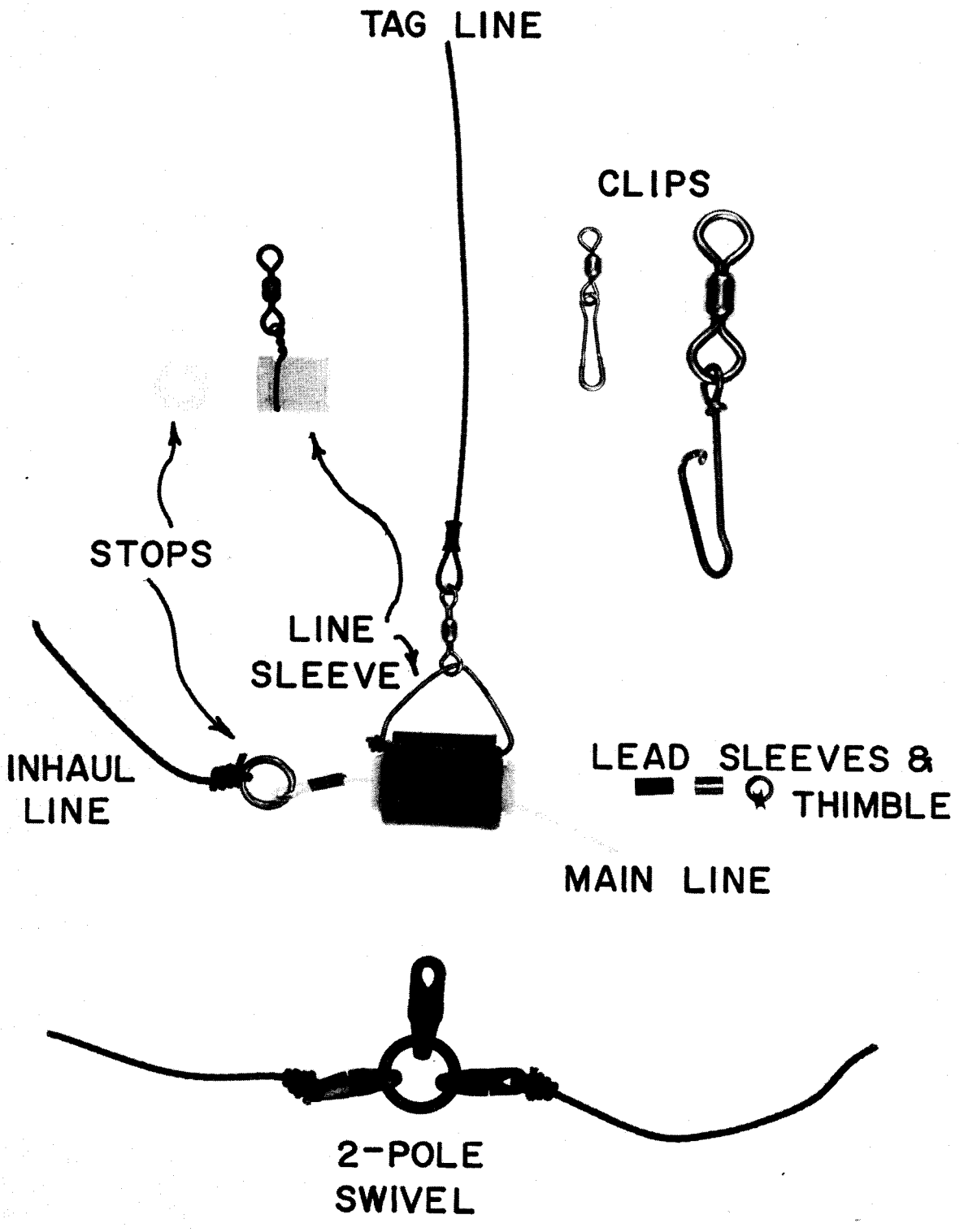

Figure 8. Equipment used to rig trolling lines. Two types of line sleeves used on gurdy systems are depicted. The center sleeve is rigged for trolling with a stainless steel tag line, braided nylon inhaul line, brass ring as a stop, and 260 lb. test monofilament main line. Lead sleeves have been used to connect both the tag line and monofilament. The 2-pole swivel at bottom is used on outrigger lines pulled by hand or line puller.

junction of the tag line and main line with the other end tied off at the gunwale in the fishing cockpit or corner of the stern (Figure 4).

The inhaul line is slightly longer than the distance out to the tag line and may be adjusted at the gunwale should the wind blow the tag line and main line outboard or inboard. To minimize entanglement the inhaul lines of the longer main lines pass over the shorter lines so that the main line, when pulled to the corner of the vessel, will pass over the shorter lines. In a like manner, shorter lines may be pulled under the longer lines rather than over them.

Inhaul lines are made of braided nylon, cotton or light nylon rope. On a gurdy the line running from the spool to the stop is braided nylon or heavy 260# test monofilament.

Main Line

The main line is the line to which the leader and lure or jig are attached. It is attached to a tag line or to the stern. It is also referred to as the jig line or trolling line but since these terms are also used for the setup of main, tag and inhaul lines together, the term "main line" is used here to avoid confusion. Various names are used for the different main lines, such as tip lines, lead lines, short line, outside line, stern line, etc.

The main line is usually braided nylon although cotton or light rope may be used. On gurdies the main line from the stop to the jig may be entirely monofilament nylon to decrease abrasion of the ring or teflon sleeve through which it is pulled. Cotton is rarely used because it is more susceptible to wear than the nylon now available. The line is usually colored a shade of green or blue.

Main lines vary in length from 3-20 fathoms depending on location and fisherman preference. There are usually 3 to 5 outrigger lines and 2 to 5 stern lines depending on the size of the boat. The outrigger lines are commonly arranged in one of two fashions with slight variations (Figure 9). Both arrangements are a V shaped with (1) the longest lines on the tips of the outriggers and line lengths decreasing as you approach the boat, or (2) the shortest lines on the outside and the longer lines inside. The most common variation to setup 1 is that the innermost line is as long as the outside line. In setup 2 the second line in may be lengthened to that of the innermost line. Generally the longest outrigger line is approximately 15 fathoms long with each additional line decreased by 3 or 4 fathoms, resulting in a progression such as 15, 11, 8, and 5 fathoms for four lines.

Stern lines have no tag or inhaul lines attached but are tied directly to the vessel. Usually there are 2 or 3 stern lines but there may be as many as 5. Two of the stern lines are 3-6 fathoms long and located on each side of the stern. When the albacore are biting well these "short" lines will often get hit as soon as they are thrown in the water. Additional stern lines may be short or of moderate length.

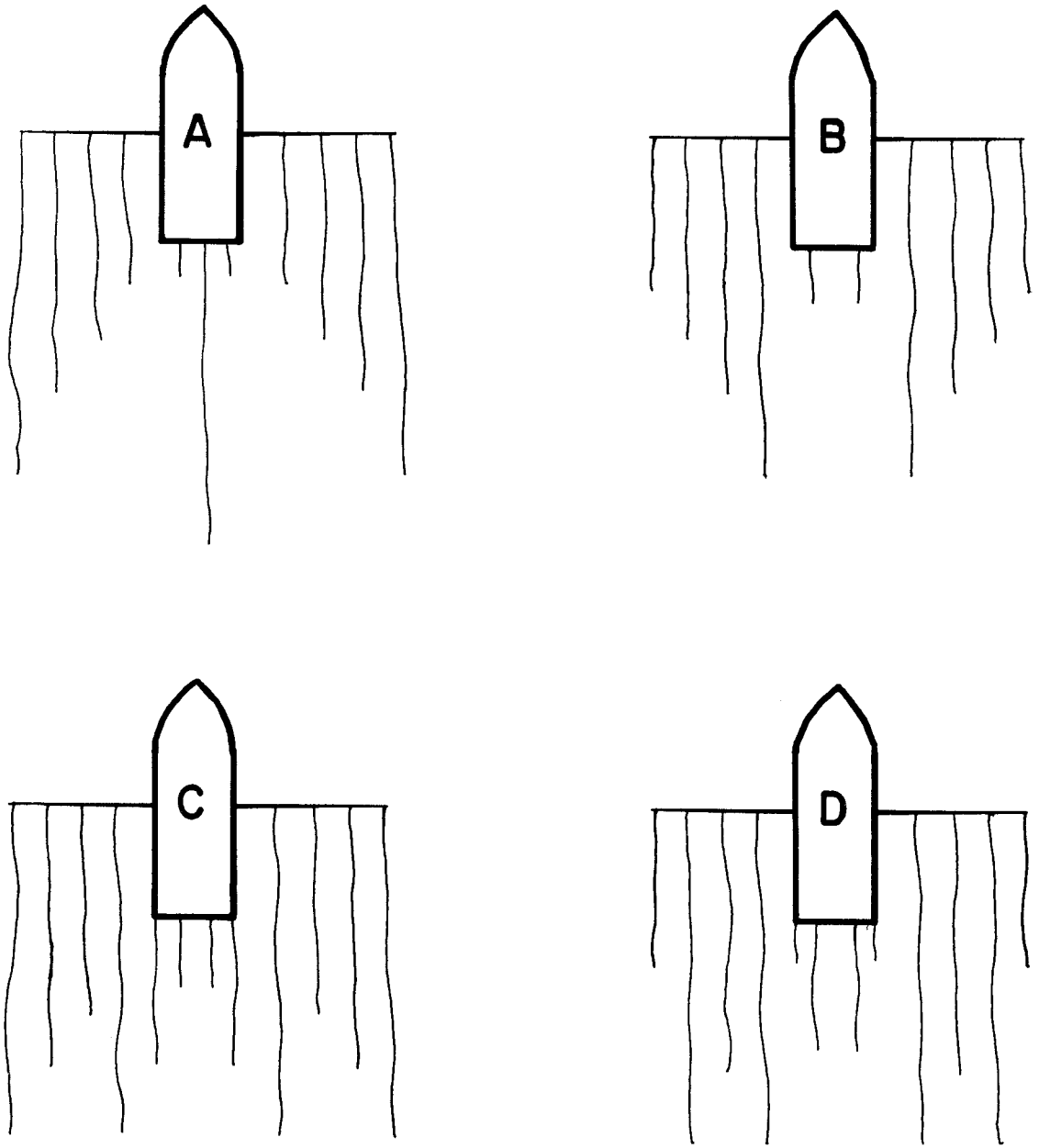

Figure 9. Some trolling line arrangements. A and B are most common with C and D being variations on these themes. A shows a whiskey line running from center of the stern.

There is often a "whiskey line" attached to the boom or mast and trailing over the stern. This line is 15 to 20 fathoms long and so named because in the old days the catch from this line paid for the whiskey for the crew, or so it was hoped (Figure 9).

Leader

The leader is attached to the terminal end of the main line, usually with a swivel, and has the jig and hook on the trailing end. Leaders of dacron, wire, or monofilament and wire have now been replaced by monofilament alone. Leaders are 1 to 4 fathoms long, usually 2 fathoms. Monofilament is difficult to pull by hand so those vessels which use hand lines often have shorter leaders. To withstand the force of a striking albacore the leader material must be 200 to 260 lb test. It is difficult to tie knots in heavy monofilament so many fishermen use lead sleeves, crimped with a pair of pliers or crimping tool, to attach the leader to the jig and main line (Figure 8). Monofilament leader material is clear, pale green or pale blue.

Bells

Many fishermen rig a bell system to their lines so that they may remain in the cabin or wheelhouse and yet know the instant that the lines are hit. A line is attached to the inhaul lines either by tying it directly to a loop in the lines or using a clip. This line is then run to a bell with a spring loaded trigger. When a fish strikes one of the outrigger lines the slack is taken out of the inhaul line and the resultant tension on the bell line sets

off a bell located where it may be heard over the engine noise.

Shocks

There is a considerable strain placed on the line and outriggers when an albacore strikes the jig. To reduce this strain and decrease the loss of fish many fishermen use some form of shock absorber. The most common type of shocks are springs, rubber bungies (1 to 2 feet of 1/2" rubber with eyes at each end) or heavy bungie cord (1/2" rubber with a woven nylon covering which will stretch (Figure 10).

Springs are normally attached between the outrigger and the tag line, one or two per line, and are 1-1/2" to 2" in diameter and 10" long. Rubber shocks and bungie cord may be attached at the outrigger, on the terminal end of the tag line before the main line junction or on the main line within a few feet of the junction of the tag and inhaul lines. When using gurdies the main line must be pulled through the ring or sleeve so a shock can not be used on it; however, shocks may be located at the spool or on the tag line.

A safety line is used with the shock to prevent loss of gear. The safety line is a line attached to the terminal gear, fore and aft of the shock, which is long enough for the shock to stretch its full length yet will save the gear if the shock should break.

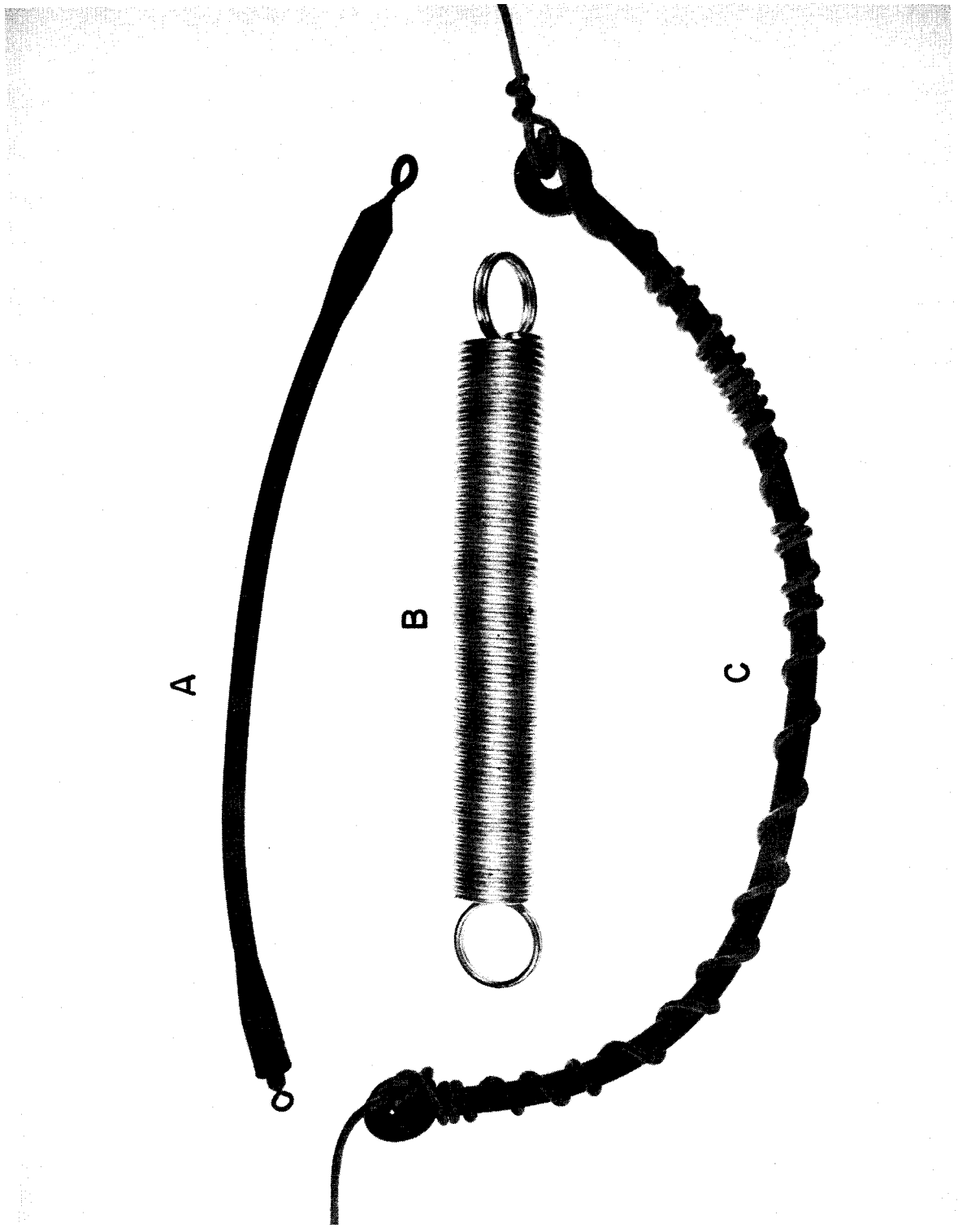

Figure 10. Trolling line shocks. A) Rubber with metal eyes for line attachment, B) spring, C) solid rubber with safety line attached.

Some fishermen think that shocks are unnecessary, particularly if the tag and/or main lines are of a material which will stretch when strain is applied. They believe that fish are hooked better when striking a more solid line. The proponents of shock absorbers feel that more fish are lost if shocks are not used.

Weights

U.S. west coast fishermen generally do not troll for albacore below the surface. Jigs trolled for albacore are pulled on the surface or a few inches below so there is no need for heavy weights to sink the jig, however, some fishermen add a 1 to 3 lb lead weight to the main line so the jig travels 1 to 3 feet under the surface and to facilitate line crossings. Six or eight ounce weights may also be attached to the main line just forward of the leader to provide sufficient drag so the line will not blow in the wind. These setups must be used with caution because should a fish fall off the line after stretching the shock, the weight and jig may be propelled towards the boat.

The Japanese sometimes place 30 m (98 ft) of monofilament nylon forward of the jig with 1/4 or 1/2 ounce crimp-on sinkers placed every 20 to 30 cm (8 to 12") so that the jig is trolled 4 to 6 m (13 to 20 ft) below the surface (Webb 1973). The Japanese also use diving planes or depressors to carry trolling lines below the surface.

The terminal end of the tag line is often weighted down with a sinker or a short length of chain to prevent it from blowing around in the wind or tangling when one line is pulled under another.

A common substitute for sinkers is leadline (lead pieces with a woven nylon sheath), which is somewhat flexible, can be cut in various lengths, and to which eyes may be whipped so that it can be tied into the line. It is less likely to become a missile when attached to the main line and it will pass through the sleeves and pulley on a gurdy system.

Jigs

The jig or artificial lure is used to attract the albacore and entice it to strike, probably because of its similarity in shape and/or motion to a food item. There have been many changes in albacore jigs over the years as new designs and materials have become available and popular.

In the early days of albacore fishing a popular jig was the "bone jig". The "bone jig" was made from whalebone and was 5-6" long and 3/4" wide, rounded on one side, flat on the other with one hook attached to the flat side. As whalebone became less obtainable jigs of this design were made from horn, wood, plastic or metal and often came with a double rather than single hook (Figure 11). The bone jig design is still one of the more popular among salt water sport fishermen; however, it is now seldom used by commercial trollers.

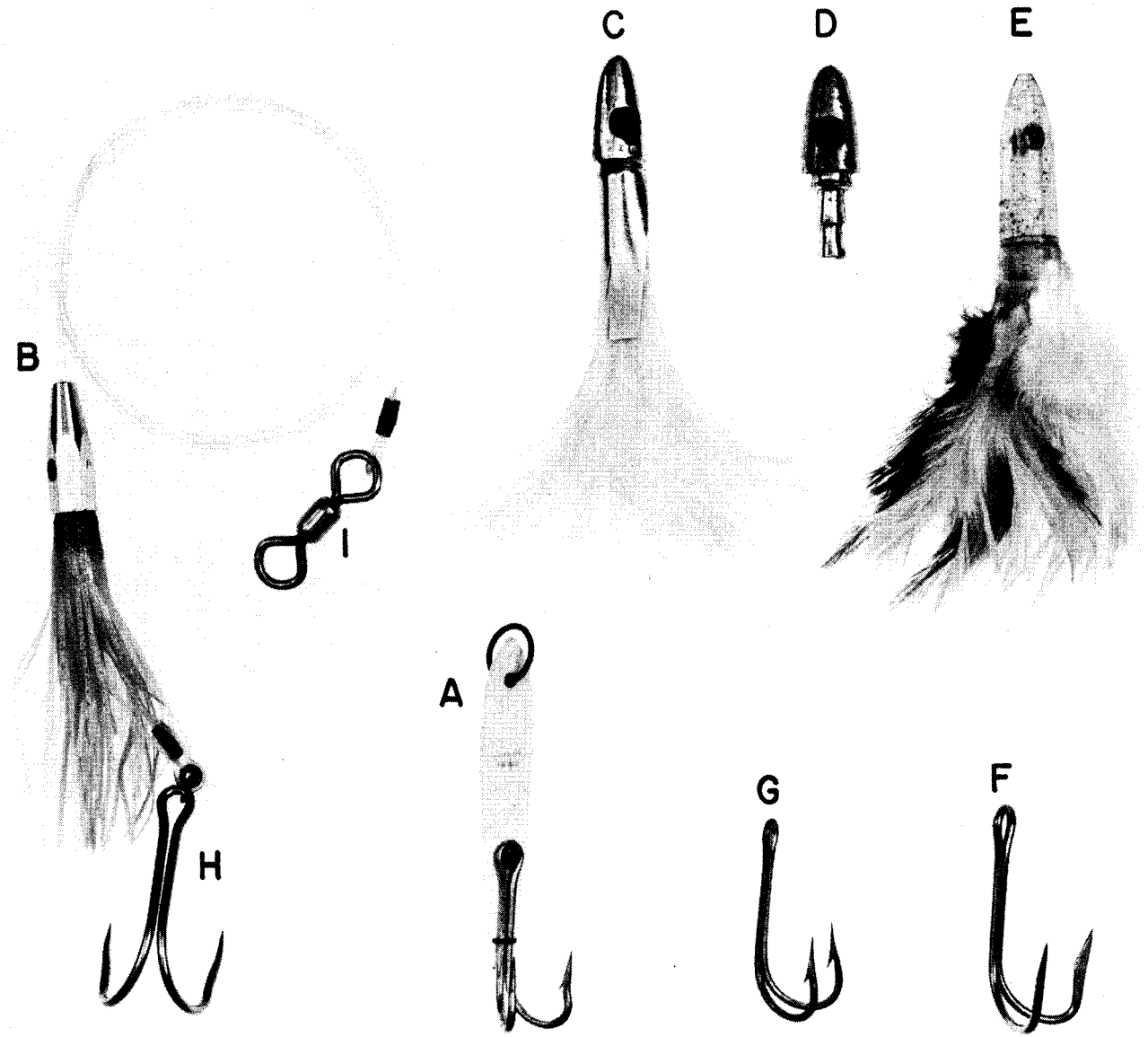

Figure 11. Jigs and hooks used for albacore trolling. A) bone jig, b) hex-head hig with plastic skirt, set up with leader for use, C) 2-ounce feather jig, D) 2-ounce head with feathers removed, E) plastic head feather jig, F) Argo or blade type barbless trolling hook, G) barbed trolling hook, H) crinkle-nose trolling hook, and I) Swivel to which main line attaches.

Feather jigs consist of a torpedo-shaped head which has a groove in which a bunch of 3-5" feathers are whipped (Figure 11). The base of the feathers is protected by a plastic sheath. The leader runs through a hole in the head and is attached to a barbless double hook which is pulled up among the feathers.

The head of feather jigs has been made of chromed lead, plastic and rubber; with and without some form of eye. The most common form is a 2 or 3 ounce chromed lead head with a red plastic eye. Plain white or dyed chicken feathers are used with various colors or combinations. Plain white, red and white, green and yellow, purple and black, and white with a fluorescent pink feather guard have been popular in the past. The feathers on these jigs can be replaced with fresh ones when the colors fade or are worn out.

Feather jigs have been the dominant lure used by albacore trollers for more than 25 years; however, they are rapidly being replaced by a new jig of the same basic design. This new jig has a hexagonal head rather than the smooth type and the feathers have been replaced by a filamented plastic body (Figure 11). The plastic body or skirt comes in various colors, most of them fluorescent. There appears to be some advantage to the hexagonal head (possibly more reflective) and the plastic skirt lasts considerably longer than feathers. The skirt can be replaced in a matter of minutes, which is a fraction of the time, effort and expense involved in replacing feathers.

Flashers and spoons, which are used extensively in the salmon fleet, are seldom found in the albacore fishery. Other jigs have included soft rubber squids and highly detailed imitations of the body shape and color of small fish. These may have caught more fishermen than albacore.

All fishermen have their own ideas regarding the best jig color and type, depending on their experience. Many have experimented with different combinations under various conditions of sea state, water color and temperature, sky conditions, time of day, time of year, size of fish and countless other variables. Whatever they have discovered is their secret. Most fishermen carry a large assortment of colors, sizes and types of jig to be ready for any situation. If one doesn't work they can always try something else.

Hooks

Commercial albacore fishermen generally use a barbless double hook. Removing barbed hooks from fish takes more time than removing barbless hooks. Since a constant strain is on the line when trolling, and albacore don't jump when hooked, a barbless hook is just as effective as a barbed hook. Single hooks on the other hand do not hook as many fish as double hooks and treble hooks are extremely difficult to remove, particularly when the fish is hooked deep in its throat. Double hooks ride with the hook points up catching fish in the upper jaw, which is much stronger and heavier than the lower jaw.

Several styles of barbless double hooks are used in the fleet. Some fishermen use pliers or a hammer to flatten the barb on barbed hooks, leaving a slight hump believed to aid in the holding ability of the hook. Two of the more popular hooks are Argo and Crinkle nose hooks made from high quality stainless steel. The Argo has a triangular blade for a point and the crinkle nose has a step-down bend near the point; both of these factors supposedly aid in hooking and holding ability (Figure 11). The leader is tied directly to the hook or to a brass ring, often with a thimble, which is slipped onto the hook (Figure 11). Hooks which become rusty, dull or straightened are replaced. Most fishermen will not chance losing a fish worth $10-$15 to save a hook worth $0.50.

TROLLING METHODS

Commercial albacore trollers have refined trolling to the extent that approximately 75% of the total landings of albacore by the U.S. west coast fleet comes from troll-caught fish (Clemens and Craig, 1965).

Speed

Albacore are fast, predacious fish which can strike a jig traveling 13 kts; however, most albacore trollers run their vessels at 5-8 kts when fishing. Faster speeds rip the hooks from the fish's jaw and increases the loss of fish. Speeds are varied with weather and sea conditions, direction of travel, and what the captain feels is the optimum fishing speed of his vessel.

During rough weather, slower speeds may be necessary to keep the jigs in the water and also to prevent fish from being jerked off the hook. On calm days an increase in trolling speed often results in more jig strikes. If a large swell is running, higher trolling speeds may be used running upswell than downswell.

Some vessels have one speed at which they seem to get more jig strikes. This may be due to how the jigs ride, differences in the wake, variations in the sound of the boat or a combination of factors. Each captain, through experience and experimentation becomes familiar with his own vessel and its optimum trolling speed under various conditions.

Fishing Time

Fishing usually begins 1/2-1 hour before sunrise and continues until an hour after sunset. Though most albacore trollers fish 14-15 hours per day it is quite common for the majority of the day's catch to be landed in 1 or 2 hours of the total fishing day. Quite often one hears the term "morning", "afternoon" or "evening bite" referring to the time in which most of the fish are landed in an area.

The better fishermen troll all day, every day, no matter when the best fishing time was the previous day. Fishing is totally unpredictable and conditions change from day-to-day. A boat which shuts down early, starts late, or doesn't fish in the middle of the day may miss the best bite of the day. Albacore fishing often consists of pulling one to three fish per hour.

This "scratch" fishing is slow but profitable when maintained for several days time.

Pulling Fish

Albacore vessels typically carry two persons. The "captain" is usually the boat owner who hires a crewman or "puller" for assistance. One person steers the vessel while the other watches the lines and pulls the fish when fishing is slow. During a good bite when many fish are being hooked, both fishermen go to the stern to pull fish while the boat is left on autopilot or otherwise held on course or circled.

Only one fisherman handles the lines on one side of the vessel to avoid confusion and tangling of lines. The greatest efficiency is achieved by pulling the fish on the shortest line first. The two short stern lines are pulled first as they are usually the shortest lines on the boat. Often lines are struck as soon as the jig re-enters the water and they are pulled again while fish on longer lines are allowed to drag.

As each fish is pulled on board, the barbless hook is removed and the jig and line returned to the water before the next line is pulled. The next fish may be pulled as the last line is going out if the lines do not tangle. The object being to keep as many lines fishing as possible.

The nylon and monofilament used on jig lines is difficult to hold by hand and can cut the hands, particularly when the skin is softened by immersion in water. Many fishermen wear cotton or neoprene gloves, or make grippers (also called nippers) from sections of motorcycle inner tube which fit over the palm of the hand and provide a good gripping surface. These may be necessary even with gurdies and line pullers as the fish must still be lifted from the water to the deck of the vessel.

The fish are put in low boxes or in a boarded off area to keep them out of the stern. When time permits they are washed off and placed in the hold.

The jig lines are pulled and checked periodically during the day to see that they are not fouled by grass or some other material. Albacore will not strike a jig that has pieces of eel-grass, kelp, paper or other flotsam or jetsum trailing from it.

Chumming the Lines

Chumming the trolling lines is sometimes an effective method for increasing the catch. Albacore are sometimes reluctant to strike a jig, particularly early in the season, and a little chum will sometimes entice them to strike. The fishermen use either live anchovies or anchovies and herring which have been frozen or salted. The bait generally is not caught by the jig fishermen but purchased from a supplier or acquired from a baitboat. The bait is thrown out among the jigs a few fish at a time, usually when the boat is in a circle. Once the fish begin biting more chum may not be necessary.

Throwing a large quantity of bait rather than a few fish can do more harm than good. Albacore may wait until a bait floats past the jigs and then take it, ignoring the jigs. This behavior of waiting for the bait is common in albacore. If a little bit of bait does not bring more jig strikes it is better to go on to another spot rather than waste time and bait.

Circling

Most jigboats troll 11 or 12 lines and it is not unusual for jig strikes to be limited to one or two at a time, particularly in the early season. However, should several fish strike the jigs at one time, it is common for the boat to be turned and run in a circle. This tactic often results in continued jig strikes and may be maintained for several hours during which several hundred fish are landed.

Jigboats circle left or right and the circle is maintained by tying the wheel over or by use of an automatic pilot which will continue the turn while both crewmen are pulling fish. The diameter of the circle varies with the boat and skipper but is on the order of 150 ft. Too small a circle causes lines to tangle while too large a circle might carry the boat away from the fish.

Tacking

Circling is sometimes unsuccessful in getting additional strikes and is not used if there is a large sea and swell or high winds. "Tacking" is the

term used to describe the maneuver of reversing course to go back over an area. It can be used to cover as large an area as the skipper wishes and works in weather conditions where circling is impractical.

Tacks of several miles are not unusual if fish bite over the entire distance. Short tacks are productive over a small spot of fish. Occasionally albacore will only strike when the vessel is running upswell, downswell, or in the trough, and tacking over a previously non-productive area may bring jig strikes.

Fishermen who time each tack in a given direction can often concentrate their effort on a smaller area which has proven to have fish. They may also tack until the fish are well located and then try to circle over the area of apparent highest concentration.

LIVE BAIT FISHING EQUIPMENT

The equipment required for live bait fishing is basically the same as it was when described by Godsil (1938). In addition to the trolling gear used to locate fish the baitboat carries equipment to locate, capture and maintain bait alive, plus the equipment used to bait fish albacore. The equipment is simple yet effective and an experienced crew may land several tons of fish per man on a good fishing day.

Bait Net

A lampara net is used to capture the bait, usually anchovies. The lampara net with its long wings works by encircling the bait on three sides (Figure 12). As the net is pulled aboard, the leading edge of the bottom goes under the fish, cutting off their escape. This net may be used effectively in deeper water if the fish can be kept at the surface until they are surrounded by the net and the wings are pulled.

The construction of a typical lampara net consists of wings made of 6" mesh which are 52 fathoms long and 22 fathoms deep (stretched mesh). The apron is 8 fathoms long and 44 fathoms across and made of 4" mesh. The sack is made of 7/16 to 1/2" mesh and consists of a 5 fathom square piece with two 3-1/2 fathom strips around two sides and the bottom. The bottom of the wings has a leadline to make it sink, 1 pound per fathom along the wings and apron and more at the throat. Corks are placed every 4 ft along the top of the net except for the sack, where the corks are placed side by side to prevent the bait from sinking the net.

Net Roller and Puller

The bait net must be pulled over the side of the boat or skiff and to facilitate this operation many vessels use a roller (or fairlead) to reduce friction and prevent snagging of the net on the rail. The net roller is a smooth cylinder which rotates freely on a shaft or bearings, equipped with

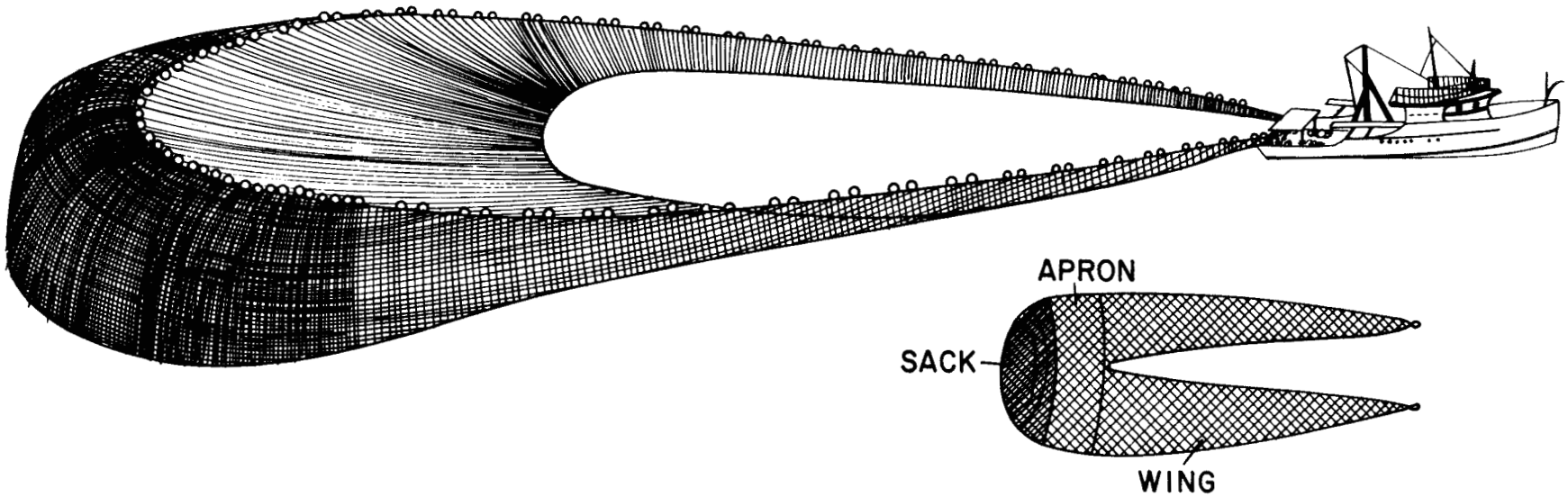

Figure 12. Lampara net showing detail of construction and net as set from the fishing vessel.

guides to keep the net on the roller and some means for solid attachment to the rail of the vessel. A hydraulic net puller may also be used. A net puller is a motor driven spool over which the net may be laid and as tension is placed on the net the friction against the spool pulls the net in the direction of rotation of the spool.

Scoops

Two types of scoops are used on a bait boat. Bait is transferred from the lampara net to the wells and bait tanks, or from one well or tank to another, using a bait scoop. This scoop has an 8 to 10 ft handle and a net covered frame 15" in diameter and depth, made of 7/16" nylon mesh. When transferring live bait the scoop is filled about half way and holds approximately 8 lbs of fish. For chumming purposes fishermen use a small scoop with a net 6" in diameter and 4" deep, and a handle 3 or 4 ft long.

Bait Tank

Bait tanks are square, rectangular or round containers on deck for holding bait alive for chumming and fishing (Figures 13, 14). Tanks may be constructed of metal, wood, wood and fiberglass, or all fiberglass. The size and number of tanks varies considerably with the type of hull, available deck space, size of vessel, capacity of the seawater pumps, etc. The tanks must be large enough to carry bait for several days fishing. The maximum bait capacity of a tank is about one scoop of bait for each 2 ft^3.

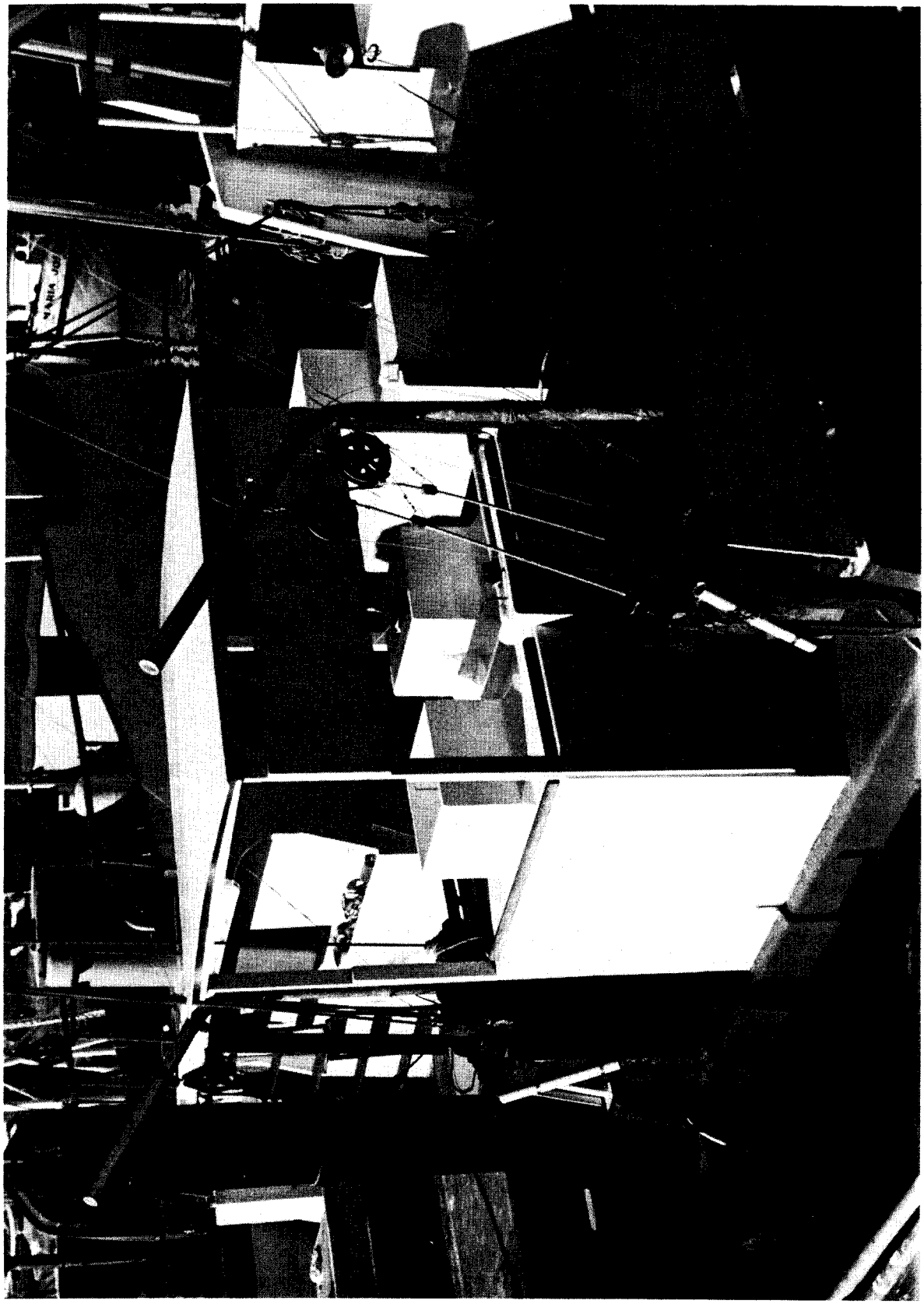

Figure 13 & 14. Bait tanks on stern of albacore vessel showing coaming (13) and canopy.

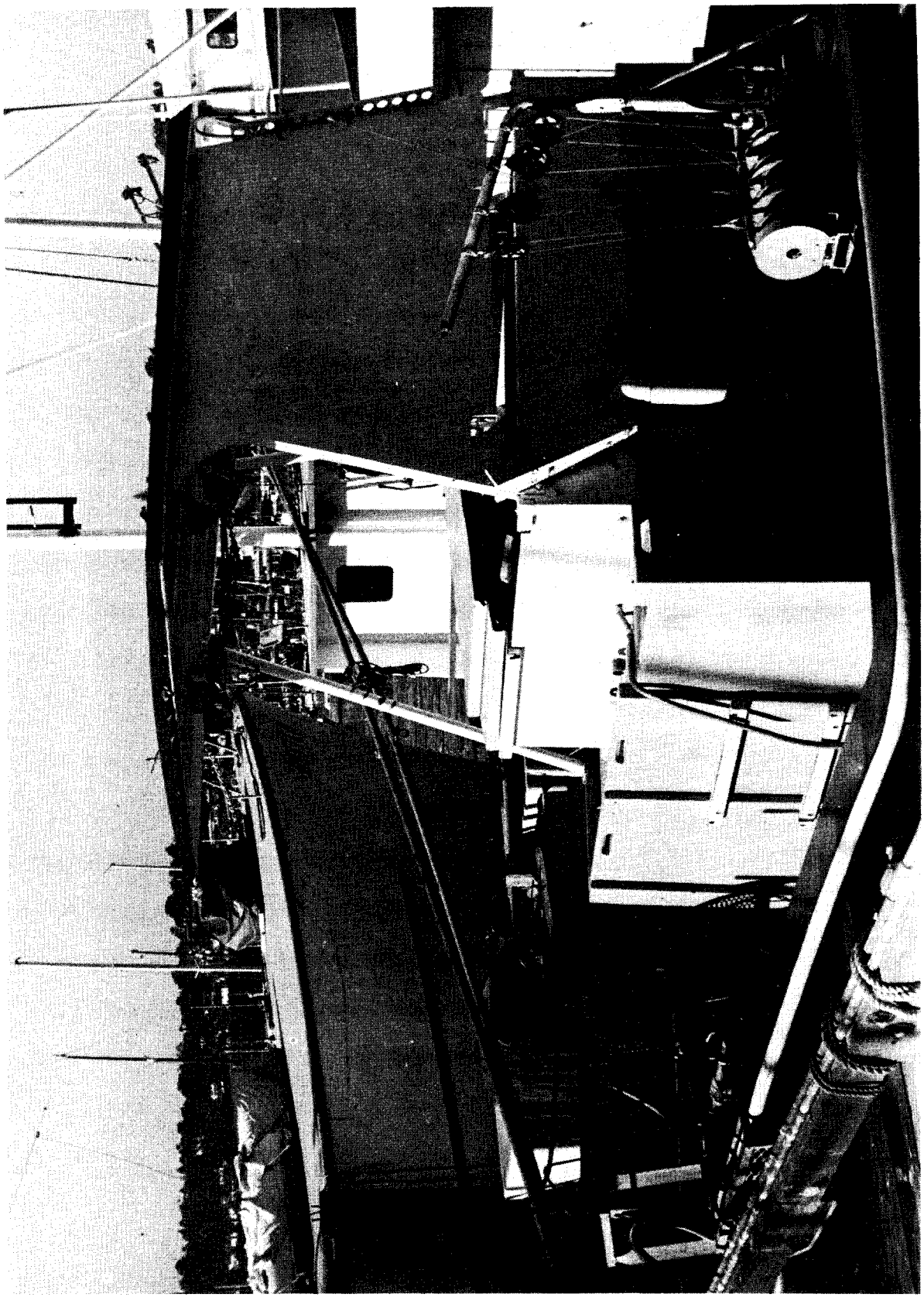

Figure 14. (See Figure 13)

The top of the tanks are usually 2 to 4 ft off the deck to facilitate the addition or removal of bait. The top of the tank is covered except for an opening in the center which has a coaming or raised lip around it. The water level in the tank is kept above the bottom of the coaming to prevent sloshing in the tank which would injure the bait.

A continuous flow of water is provided to the tank and may be varied depending on the size of the bait, temperature of the water, etc. A good measure of flow is to turn over the total capacity of the tank every 12 minutes. The water flowing into the tank is broken up by a screen or shield to permit gentle circulation of the water. The outlet is a screen covered overflow in the coaming with the water piped over the starboard side of the vessel. In a bait tank which has square corners a triangular piece of wood is placed on the inside at each corner to make the angle more obtuse. The bait does not swim in the corners and the piece of wood removes the dead space and saves unneeded weight as well as providing better circulation of the water.

Four feet above the bait tank is a solid canopy to protect the chummer from being struck by the squids, hooks, fish, and poles used by the fishermen (Figure 15). At night, lights under the canopy are shown down into the bait tank to keep the bait docile.

Chum Box

A chum box is located on top of the bait tank, usually attached to the outside of the coaming. This box, 6-10" deep, has holes drilled through the

Figure 15. Canopy of bait tank with lights shining down into the tank. Note chummer (with scoop) under canopy.

bottom (the top of the bait tank) to allow water to flow up from the bait tank. The chummer keeps a small quantity of bait in the box where it is easily accessible when he is chumming. The chummer or a fisherman also takes bait from the chum box to fill the bait boxes behind the racks. The bait is replenished from the main tank when necessary.

Crowder

When working out of a large bait tank the chummer uses a crowder net to catch some of the bait and hold it up near the coaming of the tank where it is within easy reach. A crowder is a rectangular baggy net made from a section of 7/16" net laced to two poles which are long enough to reach the bottom of the bait tank. By guiding the net with the poles, a quantity of bait may be "crowded" into the closer confines of this net. The net is hung over the coaming so that about 2-3 ft of the bag remains in the tank and a metal ring or square is dropped in the bottom so the net hangs straight.

Racks

Fishermen stand in racks hung on the stern and port sides of the vessel to get better leverage for lifting fish. The bottom of the rack is approximately 3 to 6" from the surface of the water and the top of the rack is hinged to the gunwale (Figure 16, 17). Racks are 2-1/2 to 3 ft wide with an 18" high guard rail along the outboard edge against which the fishermen can brace a knee, often with enough clearance at the bottom to jam the toe of the boot. Racks are built to hold one to three persons and are made of galvanized

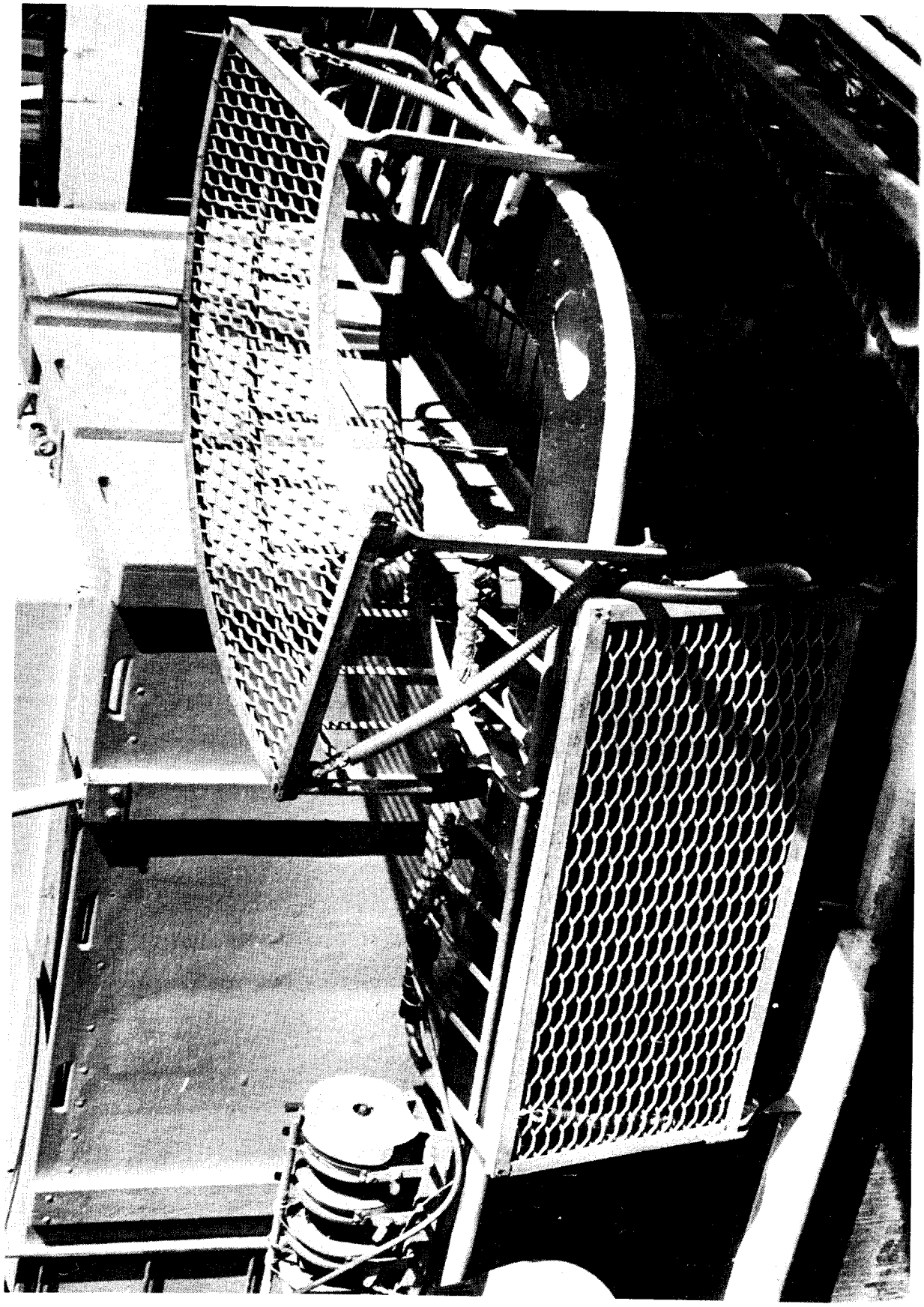

Figure 16. Bait fishing racks in raised position.

steel or aluminum grating welded to a heavier frame. The racks are supported by chain attached to the bulwarks and can be swung up so that the guard rail is over the bulwarks when they are not in use. In this manner they are out of the way when running and yet ready in seconds for fishing.

Poles

The poles used to fish albacore are made of bamboo or fiberglass. Bamboo poles were the only kind used until recently when fiberglass poles were introduced (Figure 17). The poles are 8 to 12 ft long. Bamboo poles have a base diameter of 2 to 3" tapering to a tip of 3/4" to 1", fiberglass poles are somewhat narrower at the base and tip. Longer poles are used for bait fishing and shorter poles for "squidding" fish (catching fish on lures or "squids" rather than bait); these are generally referred to as bait poles or squid/jack poles, respectively. The poles are stiff but not rigid and the amount of bend or flexibility in a pole is variable and a matter of preference among fishermen.

The joints at each section on bamboo poles are rasped smooth and the gripping area is rasped in a criss-cross pattern to provide a roughened area which is easier to hold when wet, bloody and slimy from fishing. On fiberglass poles the grip may be improved by whipping with cotton or nylon cord. The tip of the pole has a loop of 3/8" braided nylon rope whipped to it for attachment of the leader.

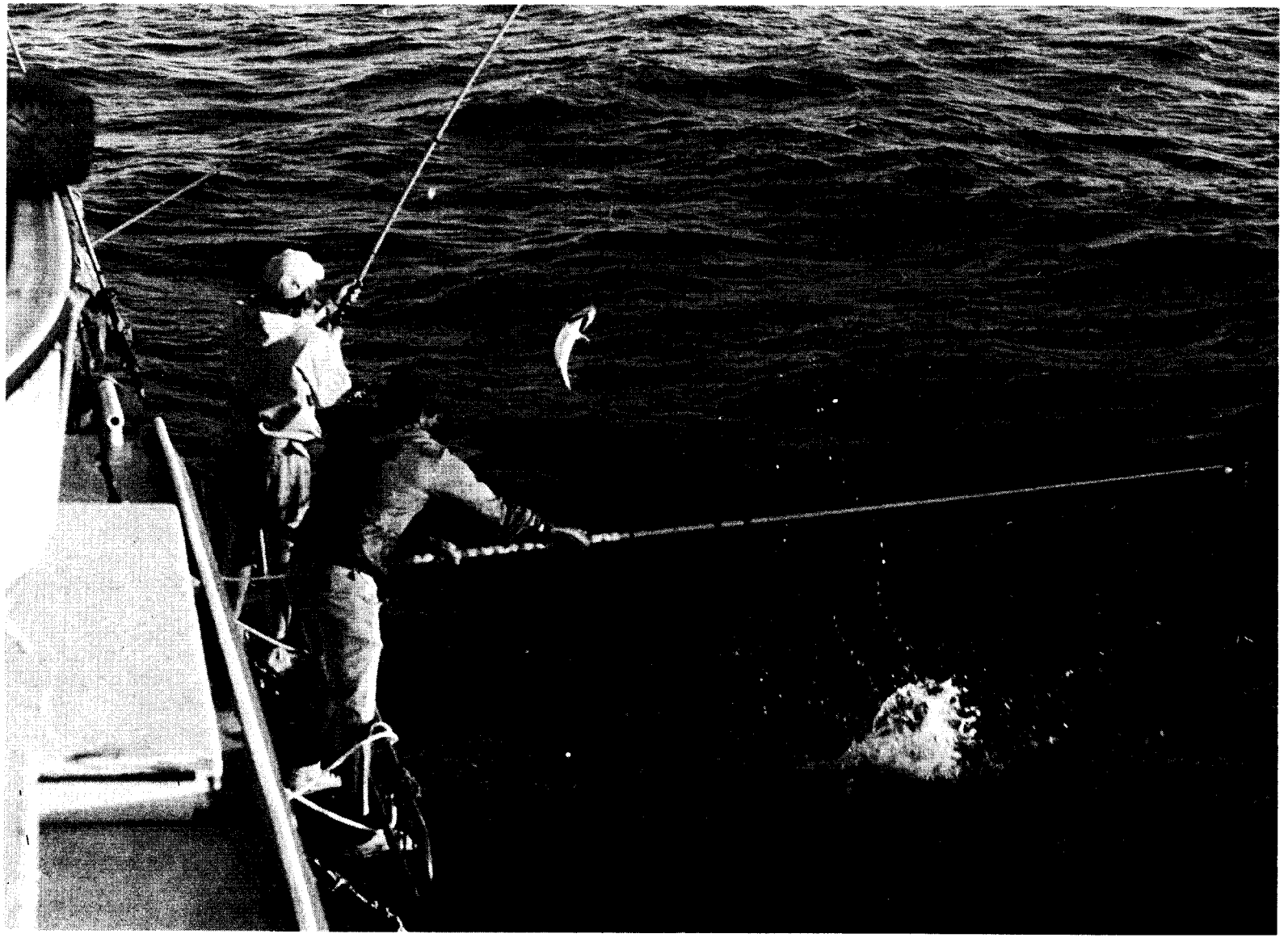

Figure 17. Bait fishing from port side of bait boat. Note the fishing rack as well as the fish pad in which butt of fiberglass bait pole is held. Fisherman in background is landing a skipjack.

Leaders

The leaders used on both squid poles and bait poles are made of two pieces connected by interlocking loops. The leader is connected to a pigtail or corkscrew swivel tied on a piece of nylon or cotton twine which is tied to the loop at the tip of the pole. The length of the twine attached to the pole is adjusted by each fisherman to account for differences in pole length, the fisherman's size and fishing style. Leaders are a standard length so that a leader can be replaced without any adjustments.

There is considerable variation in the materials used for leader construction, usually decided by the captain. The two pieces consist of a short piece connected to the hook or squid and a longer section which is attached to a pigtail swivel tied to the twine. The short section is made of 3 to 5" of piano wire, 16 or 18 gauge for bait leaders and 22 gauge for squid leaders. A loop is twisted in each end, one attached to the eye of the hook or squid and the other to a loop in the upper section of the leader (Figure 18). The upper section of a squid leader is made of 14 to 18" long 22 gauge piano wire. On a bait leader the upper section is 3 to 4 ft of 16 or 18 gauge piano wire or 6 to 8 ft of 175# braided wire or 220# test monofilament. This upper section is attached loop to loop with the short section and has a loop at the opposite end which is twisted onto the pigtail swivel attached to the twine (Figure 18).

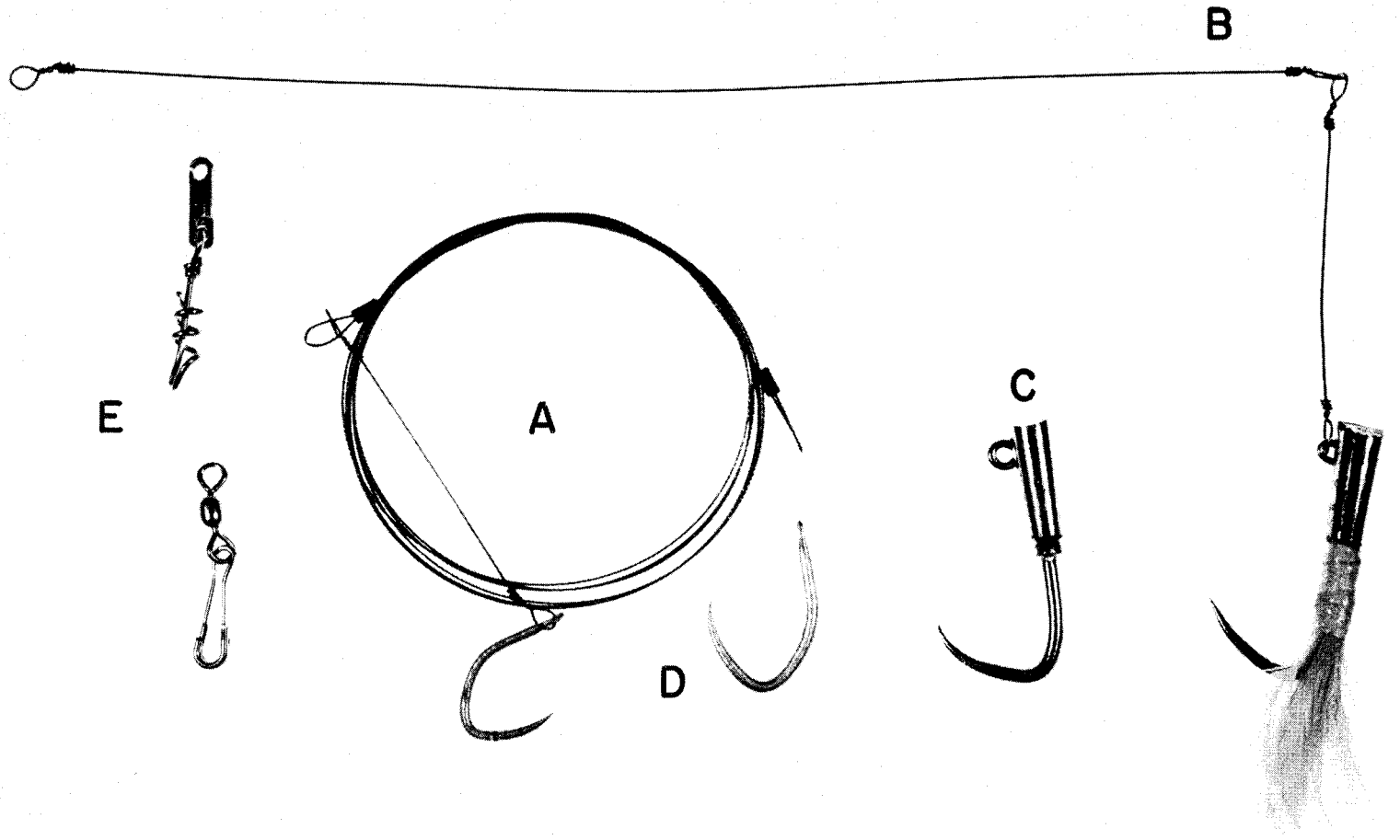

Figure 18. Bait fishing equipment: A) bait leader and hook, B) squid leader with squid attached, C) squid without feathers, D) bait hook, E) pigtail swivel.

The short section attached to the hook or squid prevents the leader from kinking when a fish is hooked. The free rotation of the joint between it and the upper leader also permits greater freedom to a swimming bait so that it looks more natural. Monofilament or braided wire have been substituted for the upper section of piano wire to reduce leader visibility and improve the freedom of the bait. In some instances the short section has been eliminated entirely in favor of a single leader of braided wire or monofilament on both bait and squid leaders. Monofilament stretches under strain and can be difficult to use in some types of bait fishing

Hooks and Squids

Hooks used for bait fishing are galvanized barbless hooks with a 3/4" to 1" gap and a 1" to 1-1/2" shank; sizes vary according to the size of the bait and the albacore (Figure 18). The hooks are completely smooth when new but the fishermen use side-cutting pliers to put grooves in the tip of the hook so that the bait will stay on better. The term "squid" is applied to a feathered lure with a one piece weighted chrome-plated head and barbless hook with very little bend to it. Squids are fished without bait, the feathers and chrome luring the excited albacore to strike. Each fisherman makes up his own squids; carefully matching the tips of individual feathers, usually white, before tying them on at the groove located at the base of the head (Figure 18). Hooks and squids are prepared and tied to leaders prior to the start of fishing operations so that spares are always available.

Automatic Fishing Poles

Several types of automated fishing poles of both foreign and domestic origin have been marketed recently in the United States. These poles fish with squids and some can also be used with bait. For squid fishing the poles are designed to work the lure up and down until a fish hits, setting off a trigger which causes the pole to lift the fish onto the deck. When the fish falls off or is removed the pole returns to the fishing position and resumes fishing. To be used with bait the pole must be stopped when a fish is landed, the fish removed and hook baited, and the pole returned to the fishing position. A heavy spray of sea water is pumped over the area where the poles are fishing and chum is used to keep the fish excited and biting.

The auto-poles work effectively when fish are biting well and will readily strike a jig, at which time they can be used in place of crewmen. The poles also handle large fish quite easily. When fished with bait they must be constantly attended and they do not fish bait as effectively or quickly as a fisherman in the racks. Most albacore bait fishing is done with bait rather than squids, so automatic fishing poles are used only to supplement the crew rather than to replace them.

Fishing Pad

The fishing pad is a heavy leather pad with a horseshoe-shaped cup in the center. The pad, which is belted around the fisherman's waist when

fishing, is 1/2" thick and 12" in diameter and the cup is 3" across and 2 to 3" deep (Figure 17). The butt of the pole is placed in the cup when pulling fish to protect the fisherman and to provide a leverage point when lifting fish.

LIVE BAIT FISHING METHODS

The method of live bait fishing for albacore off southern California was developed in the early 1900s. The method was adopted from the Japanese (Scofield 1913) and promoted in the U.S. by fishermen of Japanese, Portugese, Italian and Slavic extraction who crewed the early baitboats (Godsil 1938).

Bait fishing is more complex than trolling. The equipment and methods employed are simple yet considerable experience is necessary to develop the skills and to understand the nuances of the fishery. The effectiveness of this method is indicated by the fact that 25% of the annual U.S. landings of albacore come from baitboats, yet they comprise only 4% of the total fleet by number (Broadhead, 1974).

Bait fishing is composed of two distinct activities. The first is capturing the bait and the second is the fishing, which is totally dependent upon the success of capturing an adequate quantity of good bait. A crew of 4 to 12 persons participates in both the above activities as well as in maintaining the fishing equipment and assisting in the running of the vessel.

Making Bait

The term "making bait" is used in the bait fleet when talking of catching live bait. Locating and capturing bait is so important that a good bait man may be more valuable than a good fisherman. Bait is necessary for

chumming to attract the school and for use on a hook to catch fish. Without an adequate supply of good bait a baitboat cannot function.

Until the mid 1950s, sardines (Sardinops sagax caeruleus) were commonly used for albacore bait. With the demise of the sardine population the anchovy (Engraulis mordax) has become the primary baitfish used by the albacore baitboat fleet.

Locating Bait

A fathometer or sonar is run to determine bottom depth, to locate bait which may not be showing on the surface, and to indicate the size and density of the bait school. Crewmen look for bait from the flying bridge, crow's nest or platform on the mast. Sea birds are often important in locating bait. For instance, pelicans and terns dive on bait near the surface and cormorants, grebes and loons chase bait under water. Single birds will often locate schools of bait as they pick off individuals which swim too near the surface. Large flocks of birds, including gulls and those mentioned above, may congregate over schools of bait forced to the surface by predators. A flock of birds sitting on the water may also indicate that there is bait in the area. Schools of bait may be found near the coast, in bays or along sandy beaches.

If the water is glassy calm, or nearly so, bait swimming near the surface may cause a disturbance like a rippling or small wave in the water. This is called a "breezing school" due to the similarity of the disturbance to that caused by light winds blowing on the water. Bait may also "flip" as individuals break the surface of the water causing a small splash or dimple which can be seen from the boat.

Subsurface schools may be spotted in relatively clear water by looking for "black spots" which are caused by the darker coloration of a school of bait (Figure 19). On bright or sunny days flashes or "shiners" can often be seen underwater as the bait swims and reflects the sunlight. A spotter working from an airplane can see black spots and shiners much easier than can the crew of a boat and planes may sometimes assist boats in finding bait and in setting the net.

Fishermen also try to catch bait at night when bait is not schooling densely during the day, the water is very clear and the bait escapes the net, the bait is inaccessible, or the vessel is in a hurry. Two methods are used to locate bait at night. A boat may look for "fireballs" which are large areas of luminous light emitted by bioluminescent plankton as a school of bait swims through the water (Figure 20). The other method is to attract the bait to a light source, usually a torch or lantern in a skiff stationed away from the vessel. All other lights are turned off. After a large quantity of bait has gathered around the light skiff, fishermen set a lampara net around the skiff and capture the bait concentrated under it.

Figure 19. Anchovy black spot just outside of surf zone on sandy beach.

Figure 20. "Fireballs" of anchovy schools as seen at night. Large area in lower right hand corner is track of fishing vessel.

Catching Bait

Once a school of bait is located, the direction it is headed is determined, also, whether there are any currents that might affect setting the net. The object is to set the lampara net so that the bait is swimming towards the sack. When the sun is low, bait will often swim towards the sun, while at other times it heads up-current. Bait chased by predators may change course often and rapidly, making it difficult to capture.

Currents affect the shape and effectiveness of the net during a set. If the sack is set up-current it may not open properly and cross current sets can collapse the sac or otherwise affect the net's fishability, however these sets can be tried if necessary to capture bait.

Once a school is selected, the net is set in a circle around it (Figure 21). The net may be set by the fishing vessel itself or by one or two motorized skiffs when the water is too shallow for the fishing boat, or the fishing boat is too large to be tightly maneuvered.

Stacking the Net

Prior to setting the net it is stacked on the stern of the fishing boat or on a platform in the skiff. The portside wing of the net is stacked first for a clockwise (turn to starboard) set from a boat. Beginning with the forward part of the wing the corks and webbing are stacked simultaneously side

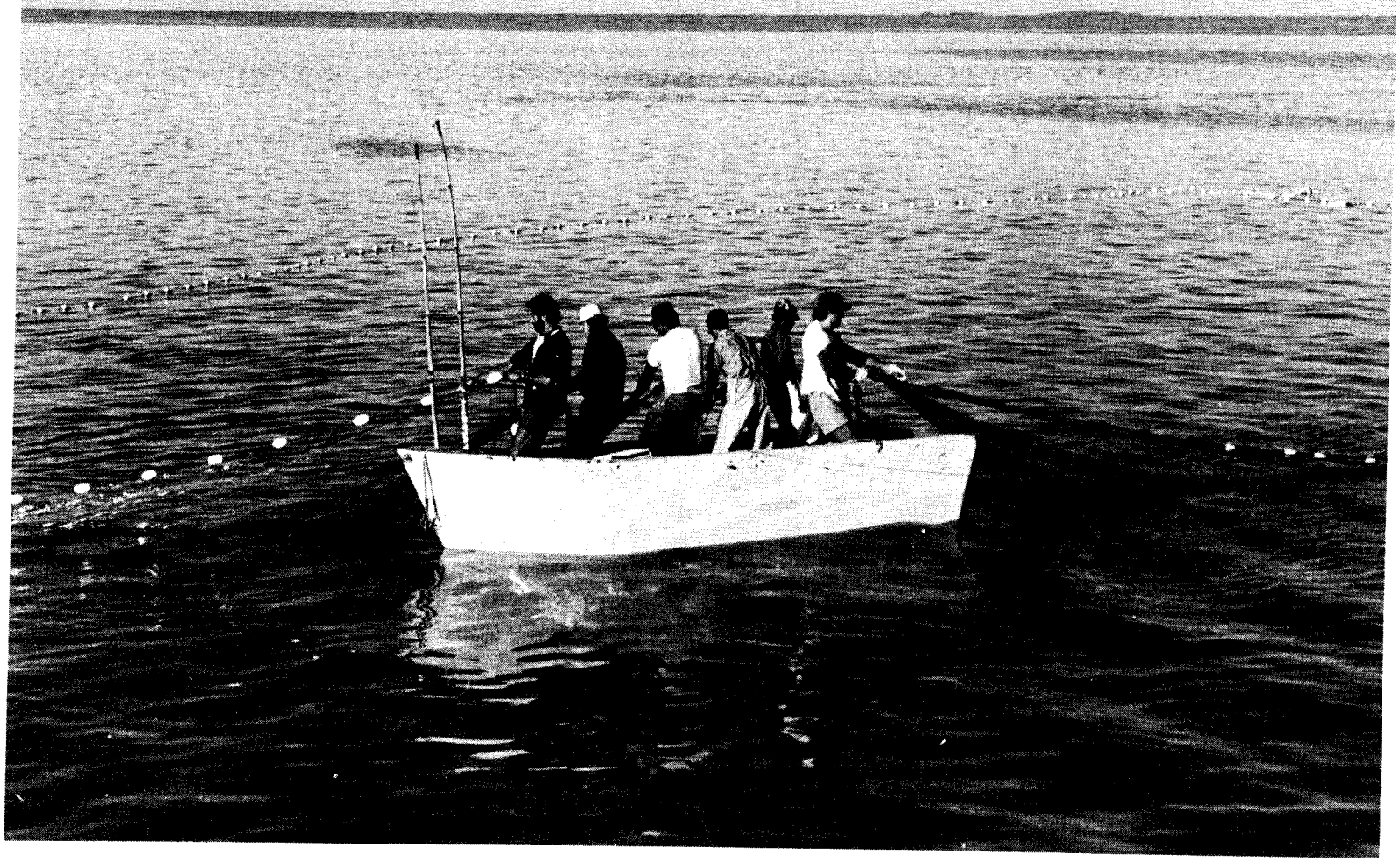

Figure 21. Hauling lampara net from bait skiff. There is a "breezer" of bait outside the net in the background (tip of poles).

by side. The corks are on the outboard (port) side of the stern. The webbing, gathered together with the leadline, is stacked together in a pile made by circling or crisscrossing. Both piles must be of sufficient diameter (about 3 to 4 ft) so that they won't topple with the roll of the boat. The webbing is kept in mesh with the corks (all meshes are in line) when stacked. Stacking continues as the sack is reached, however, both the webbing and corks are hung partially over the stern so they may be dumped during the set. When the beginning of the starboard wing is reached the corks are passed to starboard across the top of the sack and two new stacks of cork and webbing are made next to the previous two, with the corks in the port side stack. The end of the starboard wing is attached to a buoy or skiff.

Setting and Pulling the Net

Before the net is set it is wet down thoroughly with water so it will sink quickly. To launch the net, the buoy is thrown over and the boat circles the school of bait in a clockwise direction. The starboard wing pays out followed by the apron and sack which are dumped together. The port wing follows and the end has a tow line attached so that the vessel can reach the buoy or skiff if the circle is too large.

As soon as the circle is completed both wings are pulled simultaneously by the crewmen on the stern of the boat or in the skiff. On the fishing vessel a hydraulic net puller may be used to assist in the pulling operation so two persons can pull the net easily. While the wings are being pulled it may be necessary to stomp on the deck or splash in the water to scare the bait

towards the sack and prevent their escape under the boat. Power is used to keep the boat or skiff from drifting into the net while it is being pulled.

The net is pulled until the captured bait is concentrated in the sack. If the net is pulled from the boat it is lashed to the stern, the sack held open by poles pushing on the corks. When the net is pulled from a skiff (called the net skiff) the fishing boat maneuvers to the net and the outer edge of the sack is lashed to the stern racks. The net skiff is held away with poles or boathooks. If the net skiff is in water too shallow for the fishing boat to operate, it must be towed out to deeper water either by another skiff or with a line attached to the fishing vessel.

After sufficient bait is loaded the remainder in the lampara net is dumped and the sack and apron of the net are dragged behind the boat to wash out slime and scales before the net is put away. The net is stored out of the way by stacking in one pile. The stack is started with the starboard wing so the port wing will end on top, ready for stacking for the next set. The net is kept covered to protect it from dirt and the elements.

Passing Bait

The task of passing the bait from the net to the bait tanks starts as soon as the net is secured to the vessel. A line of crewmen is formed from the stern of the vessel to the bait tank. The man standing in the stern rack uses a long handled net to dip a scoop of bait from the sack. The scoop is then passed along the line to the person by the bait tank. This person,

usually the chummer, submerges the bait and net before inverting the net and releasing the bait. The empty scoop is then passed back by a second line. By using two or three scoops bait can be transferred quite rapidly. The procedure is the same for the bait wells.

An accurate tally is kept of how many scoops of bait go into each tank. Each scoop of bait is only half full to prevent injuring the bait and weighs approximately 6-10 lbs. If the bait is very weak it may be passed in buckets rather than a scoop to minimize the damage to it. There is so much variation in scoop size between different fishermen that weight cannot be used as an accurate measurement of bait capacity per unit volume. The capacity of each tank is left to the discretion of the chummer who must consider such variables as the species of bait, bait size, water temperature, tank size, water flow, apparent strength of the bait and numerous other factors. If there is too much bait in a tank the fish will weaken and die; too little and valuable fishing time may be lost. As a general rule smaller bait can be crowded slightly more that larger bait. Warmer water requires greater water flow and less crowding. Weak or skittish bait may not be crowded as much as strong bait.

Bait Quality

Strong, healthy bait begins milling in a circle soon after being put in the bait tank. Healthy anchovies have a dark green back and gill (open the mouth and flair the gill plates) frequently. Bait kept for a length of time may be fed with ground up fish, corn meal and miscellaneous bread, flapjacks

and crackers. Gilling by the bait is a sign that they are feeding. Weak bait will appear black in color and will not settle down in the tank. They swim aimlessly in the tank, often near the surface. Loud noises or vibration will cause the bait to swim into the side of the bait tank resulting in red noses and weakened or dead bait. The vessel usually anchors in clean water for a day or two to let the bait settle (called curing) and to see how much of the bait will survive. Dead bait is removed from the bottom of the tank daily with a 4" siphon hose attached to a pole.

The size of the bait is sometimes a very critical factor when fishing. Smaller bait has more individuals per scoop and therefore lasts longer when chumming and fishing. Large bait is easier to use as hook bait and may elicit more strikes than small bait, particularly when the albacore are touchy biters or sparse. Bait is separated into four size categories by fishermen. They are called bloodless bait (< 2" in length), pinheads (2 to 3"), small bait (3 to 5"), and large bait (> 5").

Bloodless bait is not used by albacore fishermen. Pinheads may be used for bait if there is nothing larger available, however they are difficult to use as hook bait even when the larger individuals are selected. Small bait is ideal because it is large enough to be used as hook bait and yet small enough to provide plenty of individuals per scoop. Large bait may increase fishing success but limits the holding capacity of the bait tanks and decreases the time spent on the fishing grounds. The selection of bait size by fishermen is highly subjective, influenced by the lasting quality of a size group, availability, distance to the fishing grounds from the bait grounds, fishing conditions and other factors.

Bait Fishing

Baitboats locate albacore in much the same manner as jigboats, usually trolling two or three jiglines and looking for bird flocks, jumpers, and temperature and color fronts (defined under "Locating Fish") in the water. In addition many of the larger baitboats have a side-scanning sonar which continuously sweeps a 360° arc and can locate albacore up to 400 ft from the vessel.

The entire crew is in a constant state of readiness while looking for fish. The chummer is stationed near the bait tank and the fishermen are outfitted in hip boots, oilskins and fishing pads.

When an albacore strikes a jig, or a school is noted on the echo sounder or sonar, the boat is immediately turned and stopped so that the port racks are downswell. The chummer throws live bait over to attract the school as the boat is coasting to a stop and the jig lines are pulled in. Chumming is very critical when bait fishing for albacore. The chummer pops the air bladder of the bait by squeezing the gut or he pokes out one eye of the bait with his thumb so the bait swims on the surface of the water. Each bait is thrown over individually and by the time the vessel is fully stopped 6 to 10 baits are on the water surface trailing behind the vessel. The chum is watched closely by the fishermen who look for a "boil", which is a swirl in the water as the albacore comes up and takes the bait. As soon as the first boil is seen a cry

goes up and the fishermen clamber into the fishing racks and grab their poles.

The chummer throws bait in front of the racks so that 2 or 3 fish are on the surface at all times. If too much bait is thrown albacore will wait for it rather than strike a hook and too little bait will not hold the albacore near the boat.

If the fishing is slow each fisherman will use a bait pole, baiting the hook with a live bait from a hand well located behind each rack and kept filled with bait by the chummer. The bait is hooked under the gill arch or through the middle of the back (Figure 22). The fisherman swings the bait out onto the water and then watches the bait as it sinks/swims, bracing himself with one knee against the front of the rack and his other foot positioned behind him. The butt of the pole is held in the pad by one hand, the fisherman extending his other arm and gripping the pole as far out as is comfortable (Figure 17). The tip of the pole is lowered as the bait sinks, often to within a few inches of the water. When an albacore grabs the bait the fisherman immediately lifts on the pole and brings the fish to the surface. The fish is positioned directly in front of the fisherman and then lifted and swung in towards the boat; this operation timed to occur when the boat is coming down off the swell so that minimal strain is placed on the hook. When the fish is swung in, its tail is allowed to drag in the water as this excites the albacore in the water and results in more bites for the fishermen nearby. The fish is swung directly past the fisherman's right shoulder, over the rail, and strikes the bait tank, which stuns the fish and usually knocks the hook out. More skillful fishermen land bait fish by a method known as "winging".

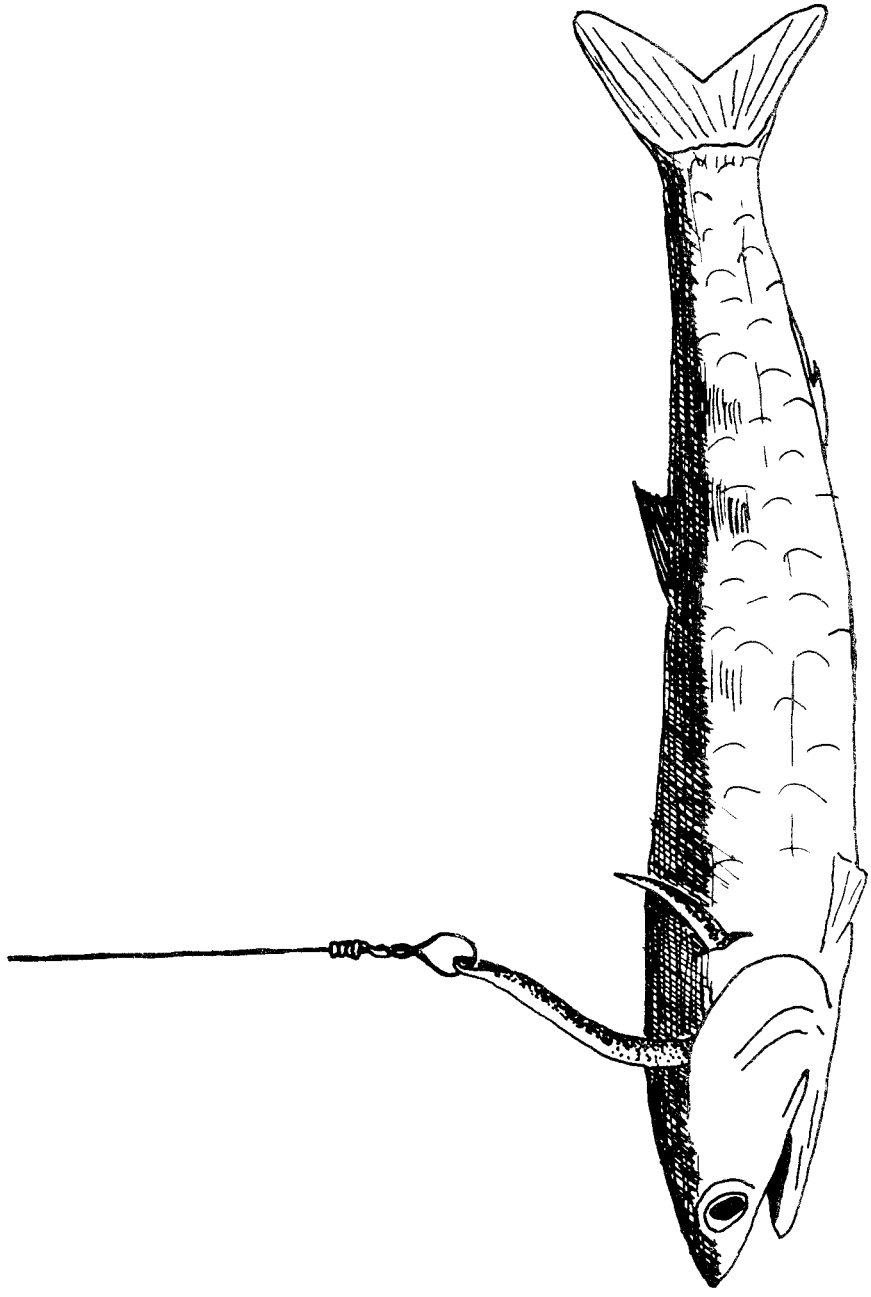

Figure 22. Method of gill hooking anchovy for live bait fishing.

As the fish is lifted from the water it is gently swung in on the fisherman's left side, caught, and cradled in his left arm. The pole is held in the crook of his right arm with the butt in the pad, and using his right hand the fisherman removes the hook from the fish and turns to drop the fish on deck and grab another bait. "Winging" is much faster and safer than landing fish on deck for the following reasons: 1) the leader is always in hand rather than flying around loose; 2) there is never the necessity to grab a decked fish and turn it so the hook may be removed; 3) the pole does not fall back and strike the bait tank; and 4) there is no wasted motion turning around and repositioning the pole before grabbing another bait.

When fishing, the hooked bait must look as natural as possible. The bait is swung out into the water downswell and the tip of the pole is always positioned over the bait as it drifts along. This allows the bait to swim with a minimum amount of drag and keeps the pole in position to pull directly upward when a fish bites. If the bait is not hit by the time it reaches the full extent of pole and leader at the end of the drift it is lifted out of the water. Many fishermen slap the water with the tip of the pole during the drift as it entices the albacore to bite. A weak bait may not swim on a hook for the entire length of a drift and albacore can be encouraged to hit it by lightly jerking on the bait with a slight lift of the pole. Because a new bait will be more lively, good fishermen change their bait on every drift rather than trying to drift a bait a second time.

Squidding Fish

Squidding albacore (also called jack poling) is much faster than using bait poles. The squid pole is shorter, 8-10 ft in length, with a leader about 3 ft shorter than the pole. The squid is flipped into the water with a rapid overhead casting motion of the pole ending in a splashing of the water surface by the pole. The squid is then jigged up and down while simultaneously being moved across a 4 ft arc in front of the fisherman, accompanied by frequent splashing with the pole. When an albacore bites the squid he is lifted and pulled, rather than swung, in towards the fisherman's right side. When the fish is airborne a couple of feet in front of the fisherman the squid pole is lowered, removing the leader tension, and the squid will usually fall from the fish's jaw. Momentum carries the fish onto the boat and the fisherman has already flipped the squid back into the water and begun fishing again. In a fast biting school each fisherman can land an albacore every 5 to 10 seconds.

Seldom is a school of albacore sufficiently excitable early in the season to be successfully fished with squid poles. During the middle and late season more schools of "biting" fish are encountered which can be fished briefly with squids before switching to bait poles, and occasionally a school will bite well enough for several tons to be landed on squid poles.

Although squid fishing is much faster than bait fishing there are usually one or two fishermen who fish with bait poles even when the fish are biting well enough to squid. When fishing slows to the point where the bait fishermen are outfishing those using squid poles then everybody switches to bait until the school bites better or leaves.

Miscellaneous Comments on Bait Fishing

The terms "touchy" biter, "slow," "cold" or "picky" fish are frequently heard when bait fishing for albacore. These terms refer to albacore which boil on the chum and come to the boat and then frustrate the fishermen by swimming up to within inches of their hook bait only to pass it without biting. Changing to a smaller hook will often improve biting but if the fish are large, pulling them from the water must be timed perfectly or the hook will pull out. Lighter gauge wire on the leader bends easier but is less visible and may help. Changing from wire to monofilament leaders will also decrease the visibility of the leader and the use of rod and reel sport fishing gear with light monofilament may be tried if it is the only way to catch fish. Selection of the largest, liveliest hook bait becomes very important when the fish become picky. It often helps if the hook bait is larger than the chum being thrown. All of the above techniques as well as splashing the water and jigging the bait are used when fish become touchy; however, they don't always work.

Several things are done as a matter of routine while fishing to maximize the chances of catching fish. The short section of piano wire attached to the bait hook or squid frequently becomes bent while fishing. If the fisherman does not straighten it immediately the chances of an albacore biting are severely curtailed. Leaders which become severely kinked and squids which are badly chewed are reason enough to switch to another pole which is already set up with new gear.

Constant maintenance of the fishing equipment reduces lost fish and is an important part of the crew's daily routine. Each crewman sets up several poles to his specifications, along with leaders and squids. Free time while looking for fish is often spent repairing bait scoops, replacing squids which are chewed up or discolored, making new leaders or setting up poles. Leaders are checked frequently for kinks in the wire, frayed line, or worn spots, and replaced when necessary. Bamboo poles may develop new cracks which should be taped, or the pole discarded if taping is not feasible. Such preparation pays off when fishing begins.

Losing a School

The chummer attempts to control the school and is the most important member of the fishing crew. If too little bait is thrown the fish will move on and yet if too much bait is thrown in the water, it may swim or drift away from the boat before the albacore can eat it. Albacore will often chase the bait or stay down deep and wait for it rather than coming to the surface where they can be caught. The chummer relies on his experience to gauge how much

bait to throw, and when and where to throw it to maximize the catch, and minimize the use of bait.

If a fisherman loses his pole to a fish it will often cause the school to leave. Loss of a pole is not a common occurrence in albacore fishing because of the limited size range of the fish encountered. Albacore caught by the U.S. west coast baitboat fleet seldom exceed 35 lbs (15.8 kg) and the average size is usually 18 lbs (8.2 kg); both sizes are fished with 1 pole rigs. Pole loss is not caused by overly large fish coming through but more often by fishermen who are not ready or whose hands have become slippery with blood and slime.

An albacore which falls back into the water with a large splash while being pulled disrupts the school. Experienced fishermen automatically determine where and how well a fish is hooked before pulling it from the water. Timing the pulling of a fish with the swell so that minimum strain is put on the hook is very important. Many times the fish will drop off in the rack rather than in the water because of the skill exhibited by the fisherman. On very large albacore it might be necessary to have a gaff handy for those fish which are not hooked well.

Fishing will frequently be interrupted by the appearance of sharks. The most common visitor is the blue shark (Prionace glauca), and occasionally hammerhead sharks (Sphyrna spp.) or mako sharks (Isurus oxyrinchus).

Albacore do not disappear when a blue shark appears but maintain a respectful distance, biting as the shark moves away from the boat and then moving away as one approaches. Blue sharks can be lured to the surface with a bait and hit on the head with the pole in an attempt to drive the shark off. A piece of pipe 10-12 ft in length with a pointed end used to put holes in the shark is much more effective at driving it away. The blue shark will readily take a baited hook and occasionally a fisherman is caught unaware and hooks one. The usual solution is to remove the leader from the pigtail swivel and release the shark, generally with as much damage as can be inflicted, or to cut the leader if it is necessary to save the pole.

Hammerhead and mako sharks seldom approach the boat close enough to be struck or hit. Within minutes of the arrival of either of these two species the albacore usually leave.

Merry Go Round and Walking Schools

At times an albacore school will not remain with a boat that is stopped, even though initially they may bite quite readily and a lot of fish are evident in the school. At such times the techniques of "walking" a school or "merry-go-rounding" may keep a school with the boat.

Walking a school consists of moving the boat at a very slow speed, usually downswell, while bait fishing or squidding. Idle speed is too fast unless the vessel is continuously taken in and out of gear. Many baitboats add a bypass valve to the transmission hydraulics which slips the clutch and permits the super-slow speed necessary to walk a school. The object is to run as slow as possible, just a little faster than the boat would drift. Some vessels cannot maintain steerage at these slow speeds and therefore "walking" is not practical. This technique, also used in rough weather when running downswell, eliminates excessive rolling and allows the fishermen to fish from the racks.

Merry-go-rounding, as its name implies, is a circling maneuver used to work a school. The boat is run in a circle at a very slow idle as the chummer throws bait forward. The circle may be made so that the fishermen are on the inside or the outside and is usually as tight as the boat will turn. Bait poling is not possible when merry-go-rounding due to the speed and angle at which the vessel moves. Because the vessel is constantly moving this technique requires that more chum be thrown and is therefore used primarily with fast biting fish.

LOCATING FISH

Both bait fishermen and jig fishermen locate schools of albacore by trolling jigs, however they do not wander aimlessly across the ocean. Albacore are generally caught in waters with a sea surface temperature of 58°-70° F so efforts are concentrated in this temperature range. Topographical

and oceanographic influences often concentrate albacore in areas year after year and these historical "fishing grounds" are base areas from which to begin searching. Fishermen also are aware of the presence of whales, porpoises, sea lions, and birds which feed on the same organisms as albacore and are indicative of an area containing albacore forage. Thus, awareness coupled with experience is used to maximize the probability that fish will be found, thus reducing the amount of non-productive searching.

Fronts

Fishermen work two kinds of fronts, those indicated by temperature changes and by water color differences, referred to by fishermen as temperature or color breaks. The changes in temperature and/or color are caused by currents, upwelling and storms and may be small, temporary, localized differences or very large, semi-permanent features of considerable extent.

Surface temperature and color breaks are often indicators of complex oceanographic phenomena with many subsurface manifestations. There may be an associated increase in the concentration of albacore food organisms or a decrease in the depth of water having the preferred temperature for albacore. For these and/or other reasons albacore have been found to concentrate near oceanic fronts (Laurs and Lynn 1977) and upwelling areas (Laurs et al. 1977).

The change in surface water temperature or color may be quite abrupt, occurring in a few yards, or it may be a steady but gradual change over several miles. The temperature may vary by 0.5° to 5.0° F and color changes may be subtle changes in shades of blue or green to sharp blue-green interfaces. Streaks in the water surface or a line of foam, detritus and flotsam also occur near fronts, and there may be "slicks" and "riffles".

Fish are often found in close proximity to the front and if fishermen notice a change in the surface temperature or color they often spend time working the area even if fish are not caught on the first pass. Working a front consists of tacking back and forth over the area or running along the edge. Circling on or near a front may also be very productive. Fishing on a front found in an area that has been producing only scattered jig strikes may result in very good catches, particularly in upwelling areas. The best catches made by jigboats working 1,000 miles off of the U.S. west coast were made near the frontal boundaries of the Transition Zone (a region of mixing of subarctic and subtropic waters) and especially where a loop or pocket was formed by the front (Laurs and Lynn 1977).

Banks

Fishing is often more productive in the vicinity of seamounts, banks and valleys on the ocean floor. Abrupt changes in bottom topography affects currents, presumably concentrating albacore forage and increasing the number of albacore in the area.

Fishermen utilize the association of albacore with topographical features to help them find fish. Effort is frequently concentrated in the vicinity of those areas which historically are focal points for locating fish. "Landmarks of the sea" such as Cortez Bank; San Juan, Davidson and Guide Seamounts; the 195-, 213-, 1500- and 945-fathom spots; Monterey sea-valley and others are well known and marked on navigational charts, with the shallowest point or contour often used to identify a spot for reference (Figure 23).

Fishing may be best directly over the bank, mount or sea-valley however it is often several miles from the specific reference point. The effect of topographical features on currents and forage may be more apparent and influential in affecting the abundance of albacore miles away from the feature, much as a rock in a stream creates disturbances above, beside and below it.

Jumpers

Albacore jumping out of the water, called "jumpers" by the fishermen is the most common visual sign of their presence. There may be only one or two fish or several dozen over a wide area. The fish will often clear the water and make a smooth arc in the air before re-entering head first. Frequently, there is no other surface disturbance except that made by the jumping albacore. This phenomenon occurs often early in the season and is easily seen on flat calm days.

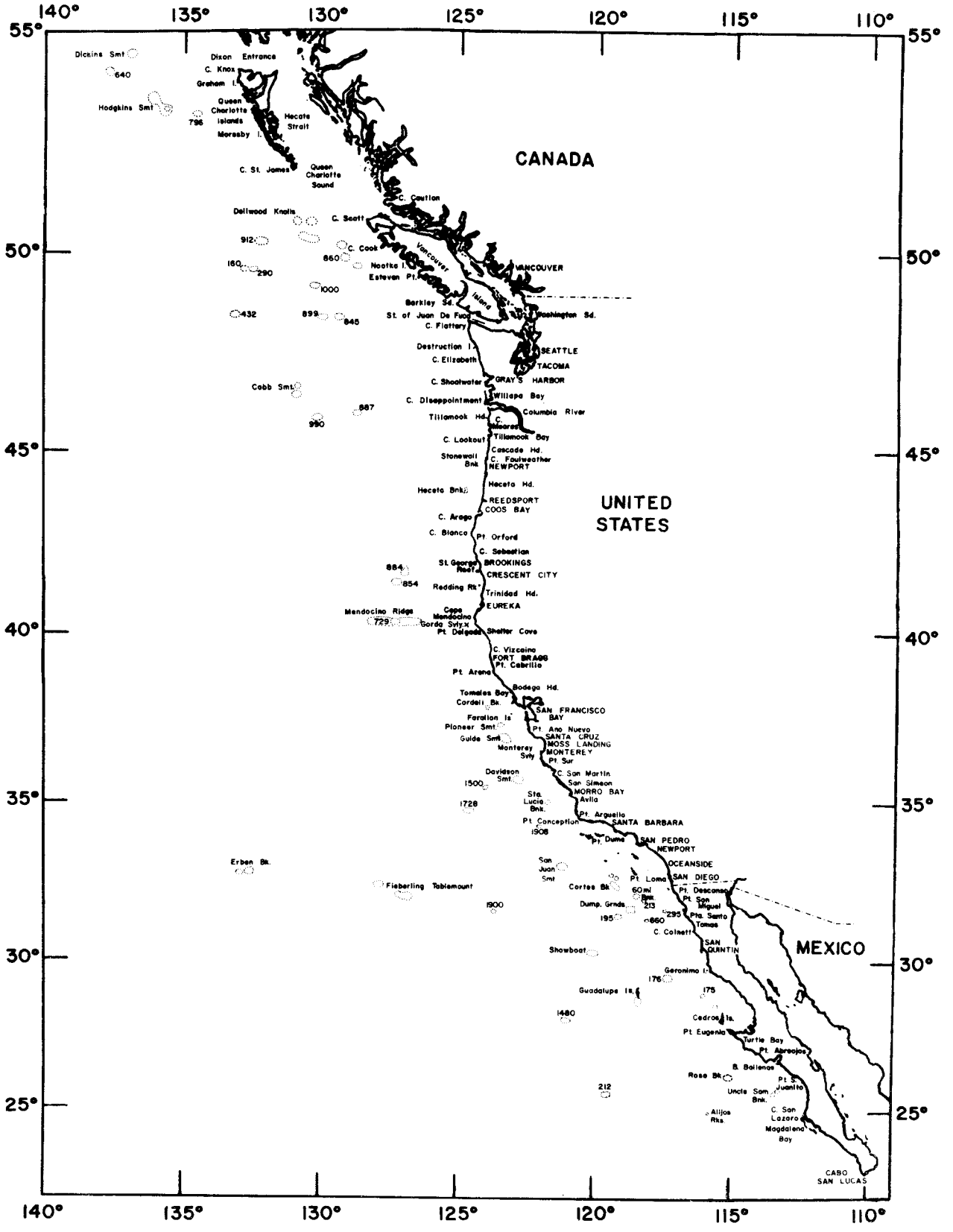

Figure 23. West coast of North America showing many of the coastal and offshore "landmarks" used by fishermen.

It is difficult to get jumping fish to bite jigs. Different tactics used are trolling near the fish, circling around the school, circling in front of their direction of travel, stopping and starting in front of the fish or combinations of these. Jumping fish appear to be traveling and if they bite usually only one or two fish are caught. Such meager returns when fish can be seen is frustrating, yet occasionally a boat will catch a considerable quantity of fish on jumpers.

Boiling Fish

Boiling indicates albacore feeding near the surface. They create a disturbance on the surface of the water indicated by splashing, froth and circular swirls. There may be jumping fish in the school and quite often birds will be associated with the school.

This type of school is generally found during the middle and late season rather than in the early season. These schools take jigs readily, resulting in fast and furious fishing activity. The most productive trolling technique is to circle on the school or to tack back and forth on the edges if the school is moving. Albacore often remain with a circling boat for several hours.

Breezers

A school of fish swimming near the surface may create a rippling of the water surface similar to that made by a breeze blowing on the surface. Such a

school is called a "breezer" or "breezing" school. On a glassy calm day a breezer may be seen from a considerable distance and looking for this disturbance is a common method of locating yellowfin and skipjack schools. Albacore do not school as tightly as either yellowfin or skipjack and it is very rare to see or hear of a breezing school of albacore, consequently albacore fishermen do not depend on this method to find fish.

Birds

Certain sea birds are used to locate fish as they are easy to see, even in rough weather. Sea birds and albacore feed on many of the same organisms, primarily crustaceans, small fish, squid, and plankton. A large number of birds in an area indicates large quantities of food on which albacore may also feed. The sea birds most commonly seen are the albatross, storm petrel, shearwater, tern and gull (Figure 24).

Albatross

The albatross is a large bird with a wingspan of up to 7 ft and is often seen gliding alone just above the water, beating its wings occasionally to continue its soaring. Two species occur on the fishing grounds, the Laysan and the black-footed. The Laysan occurs offshore, has a white body with dark upper wings and does not typically follow ships. The black-footed albatross is dark all over and follows a ship for days on end. They are often seen nearshore and sit on the water near a drifting boat. The albatrosses feed on fish and squid at night. Although as many as 8 or 10 albatrosses may be seen

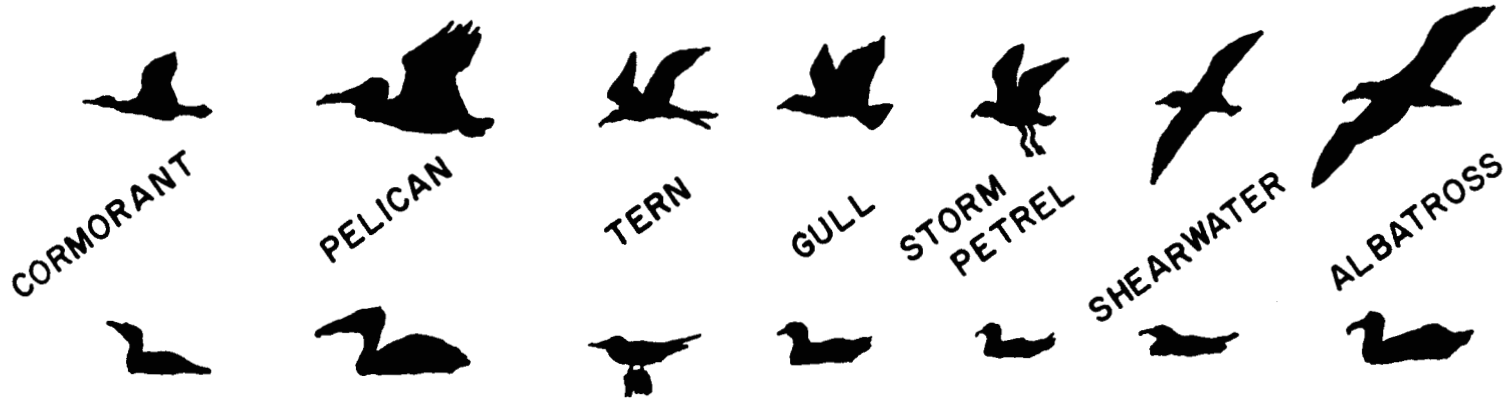

Figure 24. Silhouettes of seabirds commonly encountered at sea.

in the same area they do not congregate over albacore schools and are not used to locate fish.

Storm Petrels

Storm petrels are small dark birds, often with a white patch at the base of the tail. They have a jerky, irregular flight and often touch the surface of the water. They are frequently seen following in the boats wake, singly or in loose groups of 3-12, but not in large flocks. Petrels are called "tuna birds" by some members of the fleet, although their presence is not a definite indication of fish.

Shearwaters

Shearwaters are medium sized birds with slender wings and bill, dark brown on top with a white or brown underside. Their most distinctive characteristic is their flight, composed of a few deep wing beats and then a long glide, often tilted with one wingtip just above the surface of the water. They occur singly or in flocks of up to several hundred birds.

Shearwaters are good indicators of fish, particularly when seen in large flocks. A large group of these birds swooping and diving over the water indicates feed at the surface, often driven there by albacore underneath. A flock of shearwaters sitting on the water might be indicative of recent surface feeding in that spot and tacking through the area often results in a jig strike.

Terns

The terns have medium sized, slender bodies with long slender wings and forked tails. They are white, white and black, or brown in color. Their flight is graceful though somewhat bouncy and they dive into the water to capture their food. Often seen in large flocks, particularly nearshore, the terns, like shearwaters, are excellent indicators of bait near the surface and therefore possibly albacore. They are very good fishermen and are watched by crews looking for bait in shallow water.

Gulls

There are many species of gulls, all with square tails, a robust body and pointed wings. Coloration varies with combinations of brown, white, grey and black. Gulls are primarily scavengers and nearshore they may be associated with albacore. They will quickly join terns and shearwaters over food and can be seen as they attempt to rob the other birds or drop onto the water to pick up some food that was dropped.

Bird Flocks

Large, tight flocks of birds are not usually seen until the middle of the season. Early in the season birds will be seen singly or in small, very loose flocks. Fishermen consider any bird life to be a better sign than none at all. If all the birds in an area fly in one direction it may be wise to

follow since birds seem to have a way to communicate the location of food.

The birds mentioned above are often seen in mixed flocks as well as singly. Large flocks are indicative of a quantity of feed except when they are sitting on the water during bad weather or at night. The more time spent watching the birds at sea the greater amount of information which can be obtained. Changes in flight, calling and other behavior indicate whether a bird is traveling, hunting, feeding or just exercising his wings and can be differentiated with a little experience.

Birds working over albacore indicate that the albacore are feeding and fishermen work the school the same as boiling fish. They tack around the edges or circle around the school attempting to get their jigs as close to the fish as possible without running over the fish, as that often puts them down.

Planes

Albacore boats fishing nearshore sometimes make arrangements with a pilot to fly over the fishing area and spot schools of fish. This method is commonly used by bluefin fishermen but infrequently and usually on an opportunistic basis by albacore fishermen. The pilot is paid a percentage of what the vessels catch for his efforts. Albacore which are at or near the surface in clear water will look like a large dark spot from the air. An experienced pilot can locate fish and tell their direction of travel as well as the quantity of fish in the school.

BOAT INSTRUMENTATION

Many instruments are necessary on both jigboats and baitboats to provide safety and to improve the boat's ability to find, catch and hold fish. The larger the vessel generally the greater the investment and the more peripheral equipment it will carry. The following is a general description of boat equipment to familiarize the reader with various items used in the fleet.

Radios

The radio, once considered an extravagance, is now a standard part of every fishing boat. It allows communication with landbased stations and other boats for the exchange of fishing information and weather conditions. It is the surest and quickest means of obtaining assistance in case of emergency. Many boats carry different types of radios and spare units as backups should one or another fail. An external speaker mounted on deck allows the radio to be heard while the crew is working on the fantail.

Citizen's Band

A citizen's band radio (CB) is inexpensive but of limited use at sea due to its design as a low powered, line-of-sight communications system. The interference due to skip generally limits their effective range to under 10 miles at sea. The increase from 23 to 40 channels by the Federal

Communications Commission (FCC) has alleviated this problem somewhat and many vessels use them to pass information to friends or "code boats" working nearby but they are a limited communications source. In addition, the Coast Guard generally does not monitor CB frequencies so the CB radio cannot be relied upon in emergencies.

VHF

Radios which operate on Very High Frequency (VHF) have a maximum output of 25 watts and an effective range of 40-60 miles. These are the most common radios in the albacore fleet and are a constant source of information and chatter during the fishing season. There are 55 transmitting and 75 receiving channels in the VHF range and sets are available which have all or some fraction of these. Channel 16 (156.8 mHz) is the Coast Guard frequency reserved for emergency and distress messages and Coast Guard warnings of dangerous seas or navigational hazards. Frequencies 162.4 mHz and 162.55 mHz broadcast continuous local marine weather reports for much of the Pacific coast. These weather reports are put out by the National Weather Service and updated every 6 hours. The information given includes wind velocity and direction, wave and swell heights and direction, and cloud cover or fog.

Single Side Band

The single side band (SSB) radio puts out 100 to 1000 watts of power (100 to 200 is most common), and the effective range is several thousand miles

on the upper bands. Most albacore fishing vessels have crystal controlled sets working on simplex frequencies and using popular channels. Some boats which work together select a radio frequency on which they pass information within their select group. The more popular frequencies are in the 4 to 12 mHz range and are referred to by a number-letter code that corresponds to a given frequency (Table 2). The frequency 2182 kHz is always monitored by the Coast Guard for emergency calls.

Radiofacsimile

Radiofacsimile (FAX) broadcasts of marine weather are made daily on various SSB radio frequencies for most of the world's oceans (NOAA, DOC 1979). The information is received in chart form on FAX recorders with built in receivers or connected to the SSB on the vessel, and are easily read and interpreted. The charts provide analysis of pressure systems, prognosis (usually for 24 to 48 hrs), indications of storms, fog and rain as well as wave/swell/sea condition and sea surface temperatures. This information can be valuable in avoiding storms or weather frontal systems and finding optimal fishing areas.

Radio Direction Finder

Many albacore vessels are equipped with a radio direction finder (RDF). The RDF connects to the VHF-FM radio and indicates the relative bearing from the ship of a transmitted signal. RDFs for single side band (SSB) radios are

limited to close range because a SSB signal bounces off the atmosphere and therefore accuracy is limited. Some RDFs monitor a single frequency at a time and must be switched manually to another frequency while others will automatically scan several frequencies for a signal. Some VHF transceivers have a RDF built into the unit. The directional antennae used with these units are mounted above all other rigging on the ship to avoid interference.

The RDF permits the operator to locate buoys and beacons which have radio transmitters or to triangulate on land-based radio stations to determine the boat's position. Fishing information, water temperatures and weather conditions overheard on the radio are more valuable if the fisherman knows from what direction or area the information is coming from. The RDF provides the directional information when it is not included in the transmission. The RDF also provides a quick bearing on a vessel calling for emergency assistance or allows the operator to provide a heading to a vessel attempting to locate him.

Communication Regulations

Rules and regulations governing radio operation and their enforcement are the responsibility of the Federal Communications Commission (FCC). A vessel which uses radio equipment must have a Ship's Station License from the FCC and the operator must have a current 3rd class radio-telephone operator's license. Failure to conform to all FCC rules and regulations is punishable by fines and/or imprisonment.

Navigation

Since man first put to sea one of the constant problems has been to determine where he is and how to get from point A to point B once he is out of sight of land. Many systems have been developed over the years to aid the seaman in finding his way over the oceans. The following is a brief description of those used most frequently in the albacore fleet today. Much of the following information was obtained from Dutton's Navigation and Piloting (Maloney 1978) and the reader is referred to this or a similar reference source for more detailed information.

Compass

A compass is the primary navigational tool on any vessel and has been used by seamen since the early Viking days. The compass gives the seaman a constant reference point or direction from which the course of the vessel may be measured without the aid of visual landmarks or celestial bodies. Two types of compasses are used within the albacore fleet, the magnetic compass and the gyrocompass.

All albacore vessels carry one or more magnetic compasses, usually a good quality gimbled marine compass encased in a sturdy non-metallic case filled with oil or some other substance which will not freeze. Each compass must be calibrated (called swinging) after mounting to determine its deviation from magnetic North caused by the metallic influence of the boat. Calibration should be repeated periodically by a trained technician. This deviation can then be combined with the variation of magnetic North from true North, as indicated on charts, giving a calibration value for determining the boats true course.

Few albacore boats have a gyrocompass. Gyrocompasses point to true North and are advantageous when used with automatic piloting systems, however, they require a constant power supply and must be attended if the power is shut off or decreased.

Dead Reckoning

The most frequent method of determining the approximate position of a vessel at any given time is through dead reckoning (DR). DR requires an accurate fix from which to start, the speed and time, and the course followed. Distance is calculated from the speed and time and then plotted on the course traveled from the last known fix to give an approximate position. Drift due to wind and currents is not figured in DR.

Over short distances and in the absence of wind and current dead reckoning is accurate, however, errors caused by wind, current,and the effects of sea state on the course and speed increase with time and distance. Because of the inherent errors of DR navigation it is not relied upon to avoid nearby shoals or landfalls.

Charts

Navigation charts of the fishing area and coastline likely to be encountered are kept on board all fishing vessels. Navigational hazards, islands, buoys, shore markers and anchorages are identified to aid the seaman. The ship's course and positions may be plotted so that the ship's location can be determined at a glance and for figuring DR's. Many good fishing areas are identified by fishermen as banks, sea valleys, or other identifying characteristics from navigational charts and cannot be located without the proper chart. Most charts also have Loran lines on them for navigational purposes.

Celestial Navigation

Celestial navigation has been used by seamen for hundreds of years, however, the advent of electronic navigation equipment has reduced or eliminated celestial navigation in much of the albacore fleet. Most electronic systems are more accurate and easier to use than celestial navigation and captains no longer need navigate by the stars.

Loran-C

Loran (LOng RAnge Navigation) is a pulsed hyperbolic radio navigation system using time differences in the reception of signals from different stations to determine position. Matching the signals of a master and slave station to determine the time delay between stations gives a line of position relative to the master station. This can then be plotted on a chart with the proper Loran lines. The intersection of two or more lines of position will give a fix accurate to within 1-5 nautical miles.

Loran-C operates on frequencies of 90-110 kHz and can be used to obtain accurate navigational information over a distance of 1200 miles for groundwaves and over 3000 miles for skywaves. Loran-C uses multiple pulse signals and receivers have a built-in phase comparison of the signal which improves accuracy.

Loran is the principal means of navigation in the albacore fleet and has essentially replaced celestial navigation. Positions may be determined quickly and the use of the system can be learned in a few hours. Accuracy depends to a large extent on signal strength and the angle of intercept of the lines of position, the latter being very important. Fishing areas are often described as a Loran "block," which is the area contained by two pairs of intersecting lines on a chart. It is not uncommon for fishermen to give their course as "working along line. . ." with the designated Loran line given.

Omega

The Omega navigation system was established as a worldwide, all-weather positioning system working on very low frequency radio waves (10.2 kHz). The omega system uses a phase difference of continuous wave radio signals rather than the time difference used by Loran. Eight stations transmit signals and accuracy is purported to be within 1 mile in the daytime and 2 miles at night.

The Omega system has been gaining in popularity within the fishing fleet in the past few years, primarily because it can be used successfully in areas where Loran positions cannot be obtained. Receivers are available which give instantaneous readouts of latitude and longitude at the press of a button.

Satellite Navigation

Satellite navigation is now being used by some fishing vessels in the albacore fleet. Positions are determined by measuring the Doppler shift of radio frequencies as a satellite passes overhead and running the data through a microprocessor. The vessel is assumed to have maintained a constant course and speed during the satellite pass and the comparison of relative motion of the satellite and vessel as indicated by the Doppler shift is used to compute the ship's position from the known satellite position. Between satellite passes each change of the vessel's course or speed is entered into the microprocessor which updates the vessel's position by DR.

Accuracy on an immobile platform is within a few meters and on a vessel maintaining a constant speed and course accuracy is within 100 meters. Some vessels have units in which the computer is linked to the gyro compass and speed log so course and speed are updated automatically and an accurate, updated DR position may be kept between satellite passes. A satellite navigation system may be interfaced with an Omega to increase the accuracy on a moving vessel.

Radar

A radar is an extremely valuable piece of safety equipment as well as an aid to navigation. On moonless or cloudy nights or when there is fog or rain squalls the radar becomes the eyes of the boat. Much of the albacore fishing on th U.S. west coast is done in areas with cargo vessel traffic, as well as several hundred fishing boats, and a radar becomes invaluable in keeping track of surrounding traffic. Nearshore a radar may pick up indentifiable coastline contours which will assist in determining the boats location. Most albacore vessels have a radar, particularly if they fish in shipping lanes or in areas where fog is common.

The most popular size radar is the 3 cm set which operates on 9320-9500 mHz and gives maximum resolution of bearing and range. Several options are available in the number of ranges, course markers and resolution. Some radars have alarm systems which sound off if contact is made within range and intercept angles (up to 360°) set by the operator or the warning device can be

obtained as a separate unit which connects to the radar scope. The relative bearing of the contact is indicated on the radar scope and/or on a digital display. These collision avoidance systems supplement visual observation, which may be slack during fishing operations or when running on automatic pilot and can be used at night while the vessel is drifting to warn the sleeping crew of an approaching vessel.

A rapid fix may be made with a radar by determining the range and bearing on an object with a known position such as a buoy, lightship, mountain or point of land. Fixes may thus be obtained at ranges beyond the observers vision. Rain storms show up on radar and can be tracked allowing the vessel to avoid them.

There are some disadvantages to radar and its use. There are minimum and maximum range limitations. Information seen on the scope must be interpreted by the observer. Small boats, buoys and other small objects may not be detected, particularly in high seas or near shore and heavy rain may block the radar completely. For these reasons fishermen use the radar as a navigational aid but not as a substitute for proper precautions and common sense.

Automatic Pilot

Albacore fishing requires many hours of running to and from the fishing area, from one area to another, and during the fishing operation itself.

Jigboats run constantly while fishing and baitboats run except when stopped on a school of fish. Thus the ship must be steered for 14-16 hours each day. Hand steering is very tedious therefore most all albacore vessels have some form of automatic pilot to steer the vessel. Automatic pilots vary in complexity and versatility but typically they hold the vessel on a set course with sensitivity controls that adjust the response to different sea states and ship speeds to minimize under or oversteerage. A manual override allows a crewman to take over, and many units have a switch which changes course left or right while the boat is still on pilot. Trollers often rig a remote control on the stern for the auto-pilot so that the vessel may be steered while both crewmen are aft pulling fish. Although an automatic pilot can steer the vessel, it can neither see obstructions nor steer around them and must be manned at all times. Crewmen on jigboats being run remotely from the stern keep a careful watch to avoid running into another vessel.

Echo Sounder

The fisherman often needs to know the bottom depth and topography to anchor the vessel, find a bank, cross a shoal or enter an unmarked harbor. The old method of lowering a lead weight with a calibrated line over the bow has long been replaced by electronic echo sounders (also called depth sounders, fathometers or fish finders). The echo sounder is also used to locate concentrations of bait and sub-surface albacore schools (Figure 25).

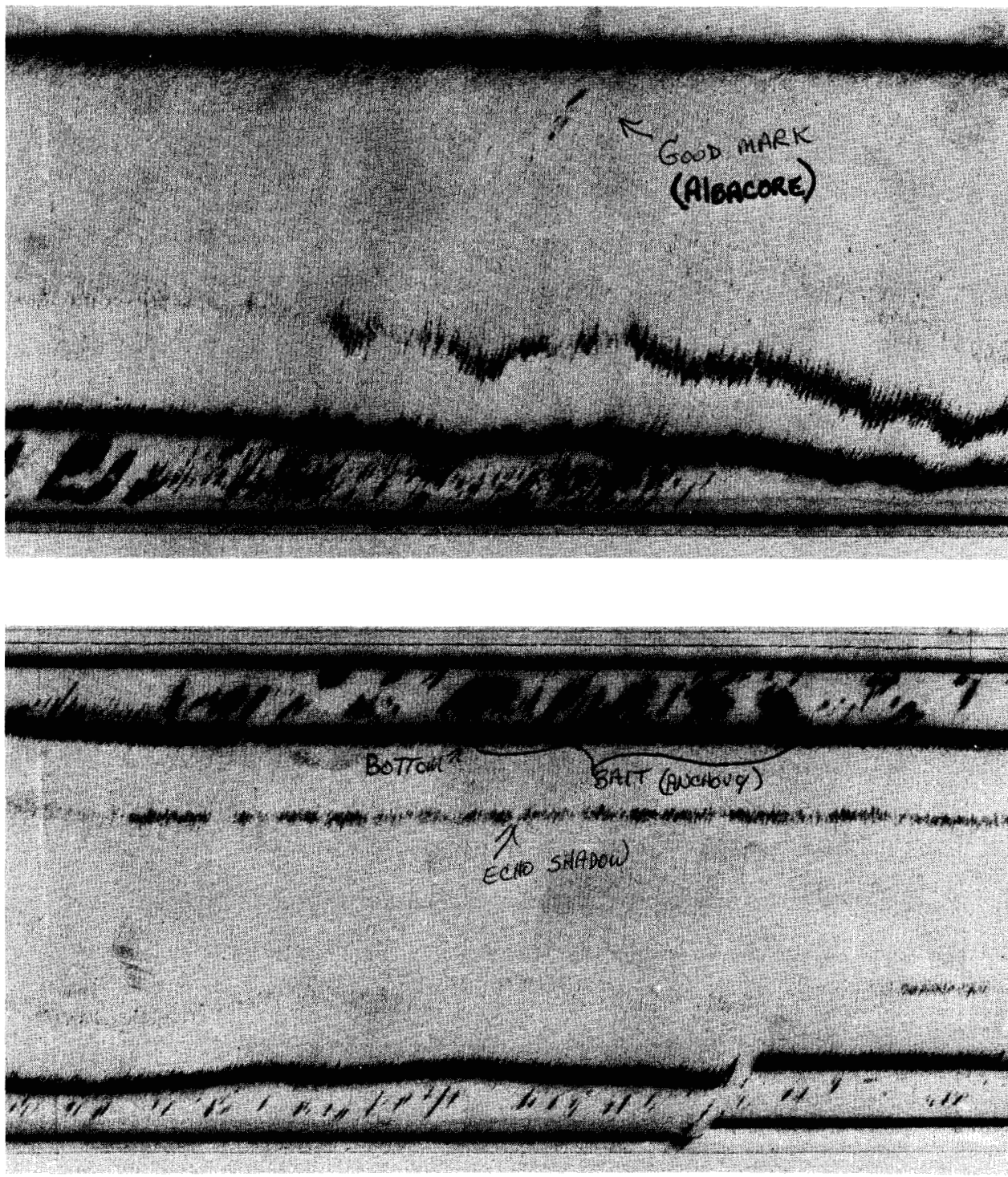

Figure 25. Echo sounder trace showing albacore (upper) and anchovy (lower). Notice that the paper has been turned over and run twice through the recorder.

A transducer located on the bottom of the vessel emits a 40-90 kHz sound pulse which travels downward and bounces off the ocean floor, other solid objects, air bladders and air sacs of fish, and back up to the receiver on the vessel. The speed of the sound pulse is assumed to be constant at 4,800 ft/sec and the time required for the sound to reach the bottom and return is used to compute the distance traveled. The depth is indicated on a recording device which emits a flash on a calibrated scale. Most units also emit an audible signal and mark the depth on heat sensitive paper for a continuous record.

Echo sounders available have various frequencies, scale options, recording devices and resolution capabilities. Most albacore vessels carry some type of echo sounder, the sophistication varying with the type and amount of use to which it is to be put.

Sonar

Sonar (SOund NAvigation and Ranging) works on the same principal as an echo sounder. A sonar may be directed from 0° horizontally to 90° down or vertically and set to scan an arc up to 360° around the vessel and lock on a target. Targets are displayed on a cathode ray tube as well as setting off an audible signal. Chart displays give a continuous visual record which can be saved for future reference.

Specifications and available options are highly variable between different units. There are usually several range scales to be selected on each unit with maximum ranges of 600-1500 meters. Operating frequencies are 40-150 kHz and power output is 1-2 KW. Most units will operate on several different AC and DC voltages.

Sonar greatly enhances the capability of a vessel searching for bait or albacore by helping to locate subsurface schools, determine their direction of movement, and to indicate school size and relative concentration. Baitboats use sonar when "walking" a school of albacore to follow the largest concentration of fish within the school as it moves. Many times albacore are located on the sonar and brought to the surface with bait when they will not strike a jig and would therefore have been missed.

Sea Temperature Gauges

Variations in surface and subsurface water temperatures are often indicative of environmental factors which affect availability and fishing success. Albacore tagged with ultrasonic transmitters and tracked as they moved through coastal waters congregate near upwelling fronts and respond to variations in sea surface temperature (Laurs, Yuen, and Johnson, 1977). Albacore catches made several hundred miles offshore were significantly higher in Transition Zone waters delineated by specific subsurface thermal characteristics (Laurs and Lynn, 1977). The optimal surface temperature preference of albacore ranges from 58° to 70° F. (14.4°-21.1° C; Clemens,

1961), and most are caught in waters with surface temperatures of 62° to 66° F (16.7°-18.9° C).

Fishermen in search of albacore closely monitor the sea surface temperature. Surface water temperature is often measured by an electric thermistor with approximately ± 0.1° F sensitivity placed in the sea water intake or less commonly on the keel or through the hull. The temperature is read on a gauge placed in the wheelhouse and a paper recorder may be used to keep a continuous retrievable record. Both the gauge and recorder are located where they may be easily checked. A mercury thermometer may be used to calibrate the thermistor, however, the requirement for a constant readout of temperature precludes their use as the primary source of temperature measurements.

Subsurface Temperature

Subsurface temperatures are measured by expendable bathythermographs (XBTs), a mechanical bathythermograph (BT), or a thermistor on a marked cable.

An XBT system consists of a launcher which is hand held or fixed, a recorder, and the expendable probes. The temperature is measured by a thermistor in the head of the probe as the probe drops through the water at a known rate. An electrical signal travels from the probe to the launcher via a fine wire and then by cable to the recorder where temperature versus depth is recorded on pressure sensitive paper. A variety of temperature and depth

scales are available, with the probe type and recorder paper being matched. The most popular scale in the albacore fishery measures temperatures from 30° to 95° F at depths from 0 to 1500 feet or a metric scale of -2° to 33° C and 0 to 450 meters.

A mechanical BT is lowered and raised on a cable while the ship is underway or stopped. Temperature and depth are etched on the surface of a smoked or gold plated glass slide and then read with the aid of a calibrated magnifying viewer.

When the ship is stopped, an electric thermistor may be lowered on a cable marked at designated lengths. The readout for the thermistor is typically on a gauge but may also be on a recorder.

CARE OF THE FISH

Once the albacore are caught they must be properly cared for to avoid loss due to spoiled or damaged fish. Fish are not left on deck any longer than necessary and at the first opportunity are rinsed with a deck hose to remove blood, slime and loose scales before being placed in the refrigerated hold. Some vessels use a conveyor belt which carries the fish from the deck to a chute or the well in which they are to be placed, thus eliminating considerable hand labor.

Refrigeration

Refrigeration methods for holding fish have improved immensely over the past few decades. Most albacore boats freeze the fish in the round using one or a combination of the following: refrigerated brine, spray brine, refrigerated coils and plates, or blower (blast) freezing. Only a small proportion of the albacore vessels use ice to hold the fish until they get into port. Each system is designed for the vessel and differs in the size and complexity of the equipment[1]. Variations in refrigeration design and use result in differences in the quality of the fish when they are unloaded. Selection of a system depends on cost, boat and hold size, fishing method,

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[1]The design and construction of a refrigeration system can be accomlished by referring to a handbook on the subject (e.g. Special Report 488 on marine refrigeration put out by Oregon State University, 1977). Other information sources are the local library or companies dealing in refrigeration supplies and equipment.

fishing area, and applicability to other types of fishing.

Most fish refrigeration systems use a freon refrigerant with a small percentage of boats using ammonia. Heat loss from opening the hatch, air and water temperature, and insulation must be taken into account in the design of the system.

Materials should be chosen carefully in designing a system. Some synthetic foam materials used for hold insulation emit a toxic gas when they burn. Copper or cupronickel pipe is to be avoided in areas where it will contact brine, such as in chillers or coils as copper ions can be toxic and may discolor the flesh of the fish (OSU Rep. 1977).

Ice

The albacore boats in the early 1900s which made trips of more than one day carried chipped ice to keep the fish from spoiling. With the advent of refrigeration boats that wished to make longer trips added refrigeration coils to their holds so that the ice would last longer. Ice is still used by small vessels which make short trips of 1 or 2 weeks and carry up to 10 tons of fish. Ice is cheap and requires neither the room nor equipment necessary to run a large refrigeration system.

Block ice is shaved or chipped and loaded into the hold of the vessel prior to the trip. Fish are kept in bins in the hold to prevent them from sliding around. The height of the bins is adjusted by 2 x 6" boards fit into slots on the front of the bin. To put fish down the crewmen shovel the ice out of a bin and place it on deck or to the side of the hold. Fish are laid belly down in the bin and covered with 3 to 5" of ice after which the next row is laid, head to tail with the previous row, and so on until all fish are covered. Ideally, fish are stacked with the largest fish on the bottom to prevent crushing the smaller fish. Large fish are not stacked greater than 3 ft deep, otherwise the fish on the bottom will split and the cannery will reject them.

Albacore may be kept in this manner for 2 weeks, possibly longer. The amount of time the fish will keep depends a lot on the size of fish, small fish keeping better than large fish. Fish from colder water do not have as much heat to lose so ice lasts longer, and if more ice is placed between the fish it may extend the length of time they can be kept. Refrigerated coils will extend the life of the ice by several days and permit longer trips.

Ice is simple and effective for short trips; however, it has several disadvantages. It greatly increases the amount of fish handling necessary to care for the catch, with several hours required to properly ice a large catch. The melting ice and fish blood must be constantly pumped over the side and makes a mess of the hold. The length of the fishing trip is limited by the speed at which the ice melts, whether or not fish are being caught. The fish remain somewhat soft and can split, making them unacceptable to the cannery.

The cost of the ice is a recurring expense.

The placing of refrigerated coils in the hold reduces the loss of ice; the coils serving to keep the temperature below freezing while the ice removes the heat from the fish. However, this also presents some problems. Moisture from the ice and fish which collects as frost or ice on the coils reduces their efficiency. Melted ice and blood which freezes on deck coils and around the fish requires the refrigeration to be turned off a couple of days prior to the removal of the fish or they cannot be separated. Also, cleaning around the coils is very difficult.

Brine

In the early days of bait fishing the last fish caught were put into the bait wells and bait tanks on deck. Sea water was run through a chiller and pumped through the tanks to keep the fish cool (Godsil 1938). This process was so successful that wells were converted to watertight compartments, additional piping and refrigeration was added and the entire catch was held in brine (Petrich 1955). Some albacore vessels now use brine holds to freeze their catch. Smaller boats which cannot handle the weight of an all-brine system may utilize a small brine tank on deck to cool the fish before holding them with another system.

Water conducts heat quite well and fish immersed in cold brine lose heat quickly. To cool salt water below its freezing point of 27° F the fishermen add salt to the water to form a "brine" solution. The amount of salt required depends on the temperature desired. To reach a freezing point of 8° to 10° F requires a 17% brine solution.

The watertight wells are encircled with coils which cool the brine. Pumps circulate the brine from bottom to top to eliminate "hot spots" among the fish. The brine is cooled prior to the addition of the fish and will cool a large quantity of fish extremely fast. Once the well is full and the fish are frozen the brine is pumped over the side to lighten the vessel. The refrigeration coils keep the fish frozen for the remainder of the trip. Prior to unloading, warm brine is pumped through the well to thaw the fish so they do not stick together.

The greatest advantages to brine are that there is a minimal amount of fish handling required and large quantities of fish can be frozen quickly and efficiently. The disadvantages are in the loss of space utilized for the additional coils, piping and machinery. The weight of the brine system requires a vessel with sufficient displacement to maintain stability. Excessive salt penetration in the fish may make them unacceptale to the cannery; however this is usually caused by improper thawing of the fish.

Coils and Plates

Once refrigerated coils were introduced to reduce the loss of ice the

next step was to increase the number of coils and eliminate the need for ice entirely. Plates attached to the coils to form a box-like affair are also used, often filled with a solution which cools to provide a greater heat sink. The plates are easier to clean than coils, however, a leak in a coil inside the plates is difficult to detect.

Coils and plates are restricted to small holds because air is a poor conductor of heat. To improve the freezing efficiency, fans may be installed to increase air circulation around them.

Although this freezing system eliminates the need for ice and does not have the weight of a brine system it still has several drawbacks. The fish still require a great deal of handling to spread them out and then stack them once they are frozen. If the fish are stacked while warm, the fish in the center will not freeze rapidly and may actually be insulated by the frozen fish on the outside so that those inside can decompose. The system will accommodate only a small number of fish at a time so following a large catch it becomes necessary to put more fish down every few hours until the entire catch has been frozen. There is some dehydration of the fish resulting in a loss of weight at dockside.

Since fish are frozen separately they remain in very good condition. It is also possible to "glaze" the fish. Glazing consists of dipping frozen fish in fresh water which covers them with a thin layer of ice; improving their keeping quality and marketability by reducing dehydration. Glazing is not commonly done with albacore but is used with salmon and other species.

Blower or Blast Freezing

In blast freezing air is ducted through a super-cooled chiller and blown out into the hold. This super-cooled air freezes fish more rapidly than coils and fans but the fish must still be spread out for freezing and stacked later. The coils are eliminated, increasing hold space and removing areas where blood, scales and slime will accumulate and be difficult to clean.

The quality of the fish is good although dehydration can be excessive and "freezer burn" can occur in fish held for long periods. Large quantities of fish can be handled easier if a small brine tank is used to remove much of the heat from the fish before they are put down in the hold.

Spray Brine

An alternate method of using brine to cool the fish is to spray the fish with super-cooled brine. Spray brine systems can handle a large quantity of fish because the brine circulates over the fish and removes heat effectively. Spray brine avoids the additional weight acquired when using full brine wells and has proven quite satisfactory for jigboats and small baitboats which carry up to 35 to 40 tons of fish.

The brine is cooled as it runs over evaporator coils placed in the bottom of the hold and covered with a screen. An open-impeller type pump, used because it is less prone to clog, sucks the brine from the bottom of the hold and pumps it through PVC pipe running along the overhead in the hold. The PVC pipe is equipped with several spray heads located such that all of the hold is covered by the brine as it sprays out. A filter should be installed between the pump and the spray heads so they are not clogged with fish scales, skin and other debris picked up from the bottom of the hold.

One problem that frequently develops with spray brine is foaming. Decreasing the pressure through the spray heads may take care of the problem. Although expensive, commercial de-foamers are made which decrease or stop foaming when added to the brine. Regular cooking oil also works and is cheaper to use.

Albacore held in a spray brine system at 10° to 20° F remain in good shape. It is easier to unload the fish if the temperature is raised to 27° to 28° F so they don't stick together. By decreasing the salt content a spray brine system may also be used to chill the load without freezing, making it applicable to other fisheries.

ANTI-ROLLING EQUIPMENT

As a boat drifts it naturally orients itself parallel to the swell and rides in the trough. This orientation maximizes the roll of the vessel as each swell passes. The rolling of an albacore boat is rough on the vessel,

crew and equipment. To decrease this wear and tear most albacore boats use one or more of the following methods to decrease roll.

Flopper Stoppers or Stabilizers

The "flopper stopper" gets its name because it is used to decrease or "stop" the vessel from rolling or "flopping" from side to side. Flopper stoppers are metal, triangular depressors hung over the sides of the vessel from the outriggers or davits, one on each side, and sufficiently deep to prevent them from clearing the water when the ship rolls.

As the boat rolls the unit on the downward side drops fast enough to keep tension on the chain to which it is attached while the unit on the upward side orients horizontally and presents maximum surface area to the upward pull on its chain. This causes considerable drag which reduces the speed and amplitude of the rolling motion. As the vessel rolls the opposite direction the depressors reverse their roles. These units are used when drifting at night or when running at slow speed in rough weather.

Steadying Sail

Some vessels employ a sail to decrease the roll of the vessel (Figure). A steadying sail catches the wind and holds the vessel over in a "steady" position like a sailboat. When there is no wind the sail may be lowered to keep it from flapping. Steadying sails present a greater surface area to the wind and thus increase wind drift which must be taken into consideration when

figuring courses and particularly when drifting at night near other vessels or land. It is not unusual for a vessel to drift 25 to 30 miles at night due to wind and/or currents, even without a sail.

Sea Anchor

A sea anchor decreases vessel roll, not by slowing the roll of the vessel, but by orienting the vessel so that the bow is pointed towards the wind and swell. It is used at night when fishing is done for the day or when drifting in rough weather.

The most common form of sea anchor is a parachute deployed so that the chute is open in the water, with the shrouds all connected to a line attached to the bow of the vessel. As the vessel is pushed by the wind and swell, it pulls on the anchor, which resists or drags in the water and thus pulls on the bow and orients it up swell. A slack trip line attached to the top of the parachute allows it to be collapsed and pulled in easily.

The sea anchor decreases drift due to wind, swell and currents. Vessels which use them are supposed to be careful not to drift downswell or downwind of a nearby boat which does not.

EMERGENCIES

Despite the wishes and best efforts of the vessel's captain and crew emergency situations do occur such as a medical problem, a major mechanical

breakdown or taking on water. Many steps can be taken to minimize these dangers when they occur.

Medical

A fishing boat is a platform which is constantly rolling and pitching, even in calm seas. Working with lines, wire, hooks, and handling fish produces cuts and scrapes. Even after acquiring "sea legs" there is a propensity to bounce off of obstructions. All vessels carry a medical kit which has antiseptics and bandages to keep small contusions and lacerations from becoming infected and a major problem. Fishermen are quite aware of their vulnerability in the event of a major medical emergency at sea. Many of them take courses in emergency medical treatment and/or have a book describing disease symptoms and emergency treatment so that they can help someone until proper medical assistance can be obtained.

There is a medical kit now on the market which contains a book describing disease symptoms and medical situations as well as treatments such as antibiotics, sedatives, other medicines and surgical supplies. Simple yet detailed instructions describe what to do until professional help can be obtained. The kit also has the phone number of a doctor or hospital that is aware of the contents of the kit and can provide assistance.

Breakdown

On most albacore boats the captain is responsible for the engines, generator and refrigeration equipment, although large baitboats may carry an engineer. The phrase "necessity is the mother of invention" fits fishing vessels more often than not. One characteristic of all albacore boats is the lack of adequate space to store provisions, fishing equipment, boat equipment and all the tools and spare parts that may be required. In preparation for a trip of many weeks duration and possibly hundreds of miles from port, tools, parts and repair equipment are selected for their utility and probable need. If the proper part cannot be fixed or replaced at sea an attempt will be made to make one, or circumvent the malfunction to keep the equipment running. If the vessel is totally disabled another fishing vessel, a commercial tug, or the Coast Guard may have to tow it in.

Safety Equipment

An audible bilge alarm which can be heard throughout the ship prevents the boat from taking on water without the crew's knowledge. Similar alarms for oil pressure and temperature protect the engine. A bilge pump which runs off of the main engine is generally available and hand pumps are used to supplement this pump or for use if the engines fail.

Fire extinguishers of the dry chemical or CO_2 type are placed where they are easily accessible in case of electrical or chemical fires in the engine room or galley. Some of the larger boats install an automatic fire extinguishing system which covers the entire engine room and can be set off from outside the room.

Boats carry a skiff and/or life raft which will accommodate the crew in the event that the boat should go down or appear to be in imminent danger of doing so. There are many life rafts on the market which are self-inflating and some which will release themselves from a sinking vessel and rise to the surface. Survival equipment carried on the vessel includes fresh water, energy food, a knife, signal flares, whistle, mirror, strong light (xenon strobes are popular), radar reflector (on vessel's mast), blankets, tarp or plastic cover, and radio signal device, all of which are usually kept with the life raft. If time permits, a distress call is put out on the radio giving the ship name, position and nature of the distress.

Other flotation devices are carried by various boats; such as life rings, floats, life vests, coats with built-in flotation and full survival suits that reduce exposure while in the water. These items have worked countless times to save the life of a fisherman who has fallen overboard or otherwise found himself in the sea.

Buddy System

Many albacore vessels work in conjunction with one or more vessels to

cover a greater fishing area as well as providing nearby assistance when a vessel has a problem. Originally established when radios were uncommon these "buddies" would fish within sight of one another. Now that the VHF radio has become standard equipment on most vessels, contact is maintained via frequent calls on the radio, often at pre-selected times of the day, and visual contact is not considered necessary.

The large number of boats now in the fleet who constantly monitor the radio has made the buddy system a safety factor primarily used by boats fishing away from the fleet or a great distance offshore. Many boat groups maintain a "buddy" system or "code group" for passing fishing information within a small select group by using codes or selected radio frequencies.

ACKNOWLEDGEMENTS

Special thanks are due Scott Haselton who patiently taught me how to bait fish and provided many of the technical details on bait fishing. Gary Stauffer, Bob Owen, Bill Craig and Mike Laurs read the manuscript and made many helpful suggestions. Countless albacore fishermen have unselfishly shared their knowledge over the years, each contributing some detail enclosed herein.

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Table I. Advantages and disadvantages of boat hull construction materials.

	ADVANTAGES	DISADVANTAGES
WOOD	Low specific gravity (floats) Good insulating properties Dampens noise and vibration, quiet Resilience adds to comfort of the ride.	Shortage of good timber for construction Lack of skilled shipwrights, high wages High maintenance costs to prevent fungi, rot and wood borer damage Hard to repair
FRP	Good insulating properties Low maintenance Easy to repair Light weight/high strength Easy to mold curved lines into hull design Good resiliency	Construction materials expensive Cost of mold added to material cost Construction facilities complex
STEEL	High strength Greater displacement/length than wood Construction materials inexpensive Easy to work with	High maintenance costs due to corrosion Hard to repair Material is heavy Poor insulating properties Transmits vibration and noise Stiff hull hard riding
ALUMINUM	Lighter weight than steel or wood Dent resistant Greater displacement/length than wood High salvage value Less corrosive than steel	High material cost Difficult to repair Galvanic corrosion occurs in contact with dissimilar metals Transmits vibration and noise Poor insulating properties

Table II

Single Side Band Simplex Frequencies

4A	4125.0 Mhz	8A	8291.1 Mhz
4B	4143.6	8B	8294.2
4C	4419.4	12A	12429.2
6A	6218.6	12B	12435.4
6B	6221.6	12C	12432.3
6C	6521.9		