

## INTRODUCTION

Annually since 1961, Canadian research vessels have conducted surface longlining to study the distribution of Pacific salmon (Oncorhynchus) in the eastern North Pacific Ocean. The results of this research have been summarized in reports of the International North Pacific Fisheries Commission. The purpose of the present report is to provide a convenient compilation of catch and effort data in the form of tables and a series of maps on which catch per unit effort data have been plotted.

From 1963 to 1966, United States vessels, operated by the Fisheries Research Institute of the University of Washington, also longlined in the eastern North Pacific. Results were published in Annual Reports of the International North Pacific Fisheries Commission. In 1967, the Alaska Department of Fish and Game conducted longlining off the coast of South-eastern Alaska. Results were reported in a series of progress reports released during the 1967 season. In most cases the Canadian and United States programs were planned cooperatively and their results are complementary. For this reason data from the United States programs have been included in the catch per unit effort maps.

## MATERIALS AND METHODS

### A. Materials

Surface longlining for salmon has been conducted for many years by Japanese commercial fishermen operating adjacent to the northern Japanese coast in both the western North Pacific Ocean and the Sea of Japan. Since 1958 Japanese research workers have used longlines for capturing salmon for tagging in the offshore waters of the western and central North Pacific (INPFC, Annual Report 1958).

In 1961, with the assistance of Japanese experts, Canadian workers began longline operations in the eastern North Pacific. The longlines used were essentially the same as those of the Japanese commercial fishery and were purchased from a Japanese commercial supplier.

The basic unit of the longline gear is the basket or skate consisting of 49 hooks attached to a mainline by branch lines (gangions) and 10 small floats (Fig. 1). The floats are attached to the mainline at 5 gangion intervals with 2 additional gangions at each end of the line, giving a total of 49 hooks per skate (Fig. 2). The mainline is doubled for 30 cm at each end to facilitate the joining of skates. The spacing between gangions, and between gangions and floats, varies slightly within a skate or between different skates but is usually about 2.3 metres; a full skate of gear is therefore approximately 138 metres (75.5 fathoms)

in length and a standard 30 skate "set" extends for 4.14 kilometres (approximately 2.25 nautical miles).

The main components of the gear are:

Mainline - Cotton or, in later years, Vinylon, a synthetic twine; diameter approximately 2 mm, two strand, left hand laid, with a breaking strength of about 23 kg. Lines were usually dyed brown, although in one year (1965) some were supplied dyed blue.

Gangions (branch lines) - Transparent monofilament nylon, 1 m long, breaking strength approximately 10 kg.

Hooks - Japanese designation - T8, tinned to resist corrosion. Hooks are not eyed; the shank being notched to clinch the gangion knot (Fig. 3).

Floats - Buoyant wood, 20 cm long × 2.5 cm × 3 cm, with a short (20 cm) line secured at one end for attachment to mainline; painted yellow to render more conspicuous when hauling the gear (Fig. 1).

Basket - 60 cm in diameter with a flat bottom of woven bamboo strips and a rim of closely packed "sedge" secured around the edge (Fig. 1).

Setting table - The gear is set from a sturdily constructed table positioned at the stern of the vessel. The table is approximately 2 m long, 1 m wide and 1 m high, with a free-turning metal turntable, of sufficient size to accommodate a single basket of gear, mounted at the after end. On vessels which have no suitable deck space aft, the gear has been operated successfully by setting from the ship's side; the table being positioned at the ship's rail (Fig. 4).

Hauling table - The gear is hauled to a table large enough to accommodate a single basket of gear, secured at a convenient height and position at the ship's rail. A small canvas holding tank, secured to the hauling table is used when unhooking fish after dipnetting them from the sea (Fig. 5).

Bait - Dry salted whole anchovy (Engraulis japonica) 7 to 10 cm in length, imported from Japan, has normally been used. Frozen and salted herring, herring strips and whole squid of the same size have also been used to a very limited extent. Baits are usually hooked through the isthmus and out through the top of the head.

## B. Methods

Before starting to set, the baskets of coiled gear, with hooks baited and lightly embedded in the sedge rim of the basket, are stacked in a position convenient to the setting table. The flag-equipped buoyed marker poles which are used at five-skate intervals and at each end of the gear are also placed in readiness. The ship is headed into the wind at low speed (4 knots), the first basket of gear is placed on the turntable and two additional baskets are placed on the forward section of the setting table (Fig. 4).

To begin the set, a marker pole is attached to the end of the first skate of gear by a 5-m length of line and the pole is dropped overboard astern (it has proved advantageous for this first, or downwind, marker pole to be longer and heavier than the intermediate poles, in order to provide more windage at the leeward end of the line and thus help to keep the longline straight). As the line from the basket pays out, the hooks are pushed clear of the basket rim in sequence and are drawn into the water (Fig. 6).

As the setting of the skate of gear progresses, the turntable and basket are turned slightly from time to time so that the mainline is pulled from the basket cleanly and the possibility of its fouling the hooks or wooden floats is avoided. As each of the wooden floats is pulled from the basket by the line paying out, it is held briefly until some tension is felt on the line, thus straightening out the section of line that has just entered the water and clearing any loops or minor tangles which may have occurred while setting.

As the end of the first skate of gear is approaching, the mainline of the second skate is knotted to the tail end of the first and, as the last few hooks of the first skate are paying out, the basket is lifted clear of the turntable and the second basket is placed in readiness for setting. When the last hook is clear of the first basket, this basket is dropped on the deck and the setting of the second skate begins. The above procedure is repeated until all the gear is set, the only deviation being at 5-skate intervals where the buoyed flagpoles are attached to the line. These poles are equipped with two 5-m lines which are used as joining lines between skates. During the setting of the last three skates of gear, the ship carries out a gradual alteration of course of about 45° to put a bow or "hook" in this last section of the line. This usually prevents the windward end of the line "telescoping" and tangling due to wind drift of the windward flagpole. When all gear has been set and the last flagpole released, the ship returns to the downwind end of the line preparatory to hauling the gear from that end, i.e., into the wind.

Five men are normally used in setting the longline, positioned around a stern-mounted setting table as follows:

- No. 1. Setting the gear. Starboard side, aft.
- No. 2. Passing baskets to turntable; knotting skates of gear together; tying in flagpoles. Starboard side, forward.
- No. 3. Stand-by with knife to cut gangions if hooks foul the basket, the setting table or a fisherman's clothing or person. Port side, aft.
- No. 4. Passing baskets of gear to setting table as required.
- No. 5. Releases flagpoles. Port side.

When setting from the vessel's side, access is available to only one side of the setting table and these dispositions are modified as required. With an experienced crew, the gear is set at 4 to 5 knots or approximately 1 skate of gear per minute.

In fog or poor visibility, where there is danger of losing contact with the gear, the longline may be set with the wind; the ship heaving-to close to the last flagpole as soon as it is released. The gear is then hauled with the ship proceeding into the wind in the normal manner.

The longline is hauled by hand at the ship's side with the ship steaming slowly along the line (Fig. 5). The mainline is coiled loosely into the basket, the hooks being placed in the more closely woven section of the basket bottom to prevent them falling through and becoming snagged in a lower basket when handling or stacking the baskets of hauled gear. Each skate of gear is hauled into a separate basket which is then placed to one side for subsequent recoiling and baiting. Fish are dipped from the sea with a long-handled dipnet and transferred to the holding tank, where the hooks are removed. The hauled, roughly coiled gear is then recoiled into empty bamboo baskets. The mainline, being left-hand lay, is coiled counter-clockwise and the coiled line is placed around and close to the rim of the basket. The monofilament gangions are coiled in with the mainline, the gangion leading along the line ahead of the hook so that, when the gear is being set, the point of attachment of the gangion will lead off the basket first, followed by the gangion itself and finally the hook. As the mainline and gangions are coiled, the hook points are pressed into the sedge rim of the basket; the hooks being placed slightly behind the coiled line so that, when setting the gear, the mainline will pay out slightly to one side (starboard) of the hooks and not over them. As the wooden floats come to hand during coiling they are arranged in sequence adjacent to the coiled mainline. Time spent in careful coiling of the gear is amply repaid by the reduction in the number of tangles when setting; tangles which reduce the efficiency of the gear and take considerable time to unravel. After recoiling, the gear is baited in readiness for the next set, and the baskets of gear are stacked, covered by a tarpaulin and securely lashed down.

Following the example of Japanese fishermen, most sets were begun just before dawn so that the gear was in the water through the dawn-sunrise

period, when salmon appear to be particularly vulnerable to longline gear (Shepard et al., 1967). Some sets were made at other times of day, particularly during the sunset-dusk period. For pre-dawn sets, from 1961 to 1964, exact setting times were left to the discretion of field workers in charge of individual vessels. Throughout 1966 and 1967 and during most of 1965, however, standard setting times of 20 minutes before morning Civil Twilight for 40 skate sets, 15 minutes before for 30 skate sets and 10 minutes before for 20 skate sets were adopted. Evening sets, which almost invariably consisted of 10 skates, were begun at 2 hours before evening Civil Twilight. In all years a standard soaking time (from completion of setting to beginning of haul) of 45 minutes was allowed.

The foregoing description of the salmon longline and its operation is based on the gear and methods used by the Fisheries Research Board of Canada in surveys carried out in the northeast Pacific from 1961 to 1967. Gear and methods of other agencies may have varied slightly but are believed to have been basically the same.

#### EXPLANATION OF TABLES

Tables I to VII are IBM printouts which show longline catches made by Canadian research vessels during the years 1961 to 1967. The tables list the following data:

Vessel name.

Set numbers. The tables include all longline sets. The missing set numbers for the G.B. Reed in 1963 (Table III) and for the Investigator No. 1 in 1965 (Table V) were gillnet sets.

Area. These are the INPFC statistical areas in which the sets were made (Fig. 7). They are 5° longitude by 2° latitude and are described from the southwest corner (the first digit of longitude is omitted) e.g., position 139°55' W 53°10' N is in area W4052 (the letter "W" indicates west longitude).

Position. The latitude and longitude in degrees and minutes.

Date. Month and day.

Time of day. The time of day when each set was made is coded as follows:

1 = Standard set at dawn  
2 = Standard set at dusk

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- 3 = Standard set during daylight hours
- 4 = Experimental set. In 1967 two series of experimental sets were carried out at intervals throughout the night and day using small amounts of gear with a reduced soaking time of 20 minutes.

Surface temperature. The sea surface temperature in degrees centigrade.

Skates. The number of skates used in set.

Catches. The catches of salmonids, birds, pomfret, and other animals (mostly other fish and seals). The catches are given in absolute numbers where known. For birds, pomfret, and other animals blanks indicate no catch information was available and letter categories indicate estimates as follows:

- A = Present in catch in unknown numbers.
- B = Low catch (estimated <20).
- C = Moderate catch (estimated 20 to 50).
- D = High catch (estimated >50).

#### EXPLANATION OF FIGURES

Longline catches of salmon and steelhead per thousand hooks by Canadian and United States research vessels, are shown by species, by month and year, in Fig. 8 to 217.

The monthly catch figures are divided into ten-day periods as follows:



1st to 10th



11th to 20th



21st to 30th/31st

Catches by Canadian vessels are indicated by solid symbols, those by United States vessels by broken symbols. Only catches made during the dawn period are included in the figures. Catches made on less than 20 skates (980 hooks) of gear are distinguished by asterisks.

#### ACKNOWLEDGEMENTS

Many individuals have participated in the planning, field work and data preparation involved in the surveys covered by this report. The long-line work was begun as part of Canada's contribution to the co-ordinated research program of the International North Pacific Fisheries Commission. The work was initiated in 1961 under the direction of Dr. F. Neave. Dr. M.P. Shepard has been in charge since Dr. Neave's retirement in 1965.

The initial success of the longline operations was made possible by the patient and thorough technical advice and direction of the Japanese salmon longline experts, Captains H. Nakata, E. Osuka, Y. Koborinai and T. Takada.

The following biologists and technicians of the Nanaimo Biological Station have taken an active part in the programs: Messrs. L.W. Barner, D.B. Donnelly, J.I. Manzer, R.J. LeBrasseur, H. Godfrey, I. Miki, D. Davenport, W.B. Harling, D.W. Jenkinson. Contributions have been made by numerous seasonal workers, with Mr. R. Leahy acting as a vessel supervisor from time to time. IBM tabulations were prepared by Mr. J.A. Thomson: Mrs. Mary Ann Besta was responsible for plotting the data. The illustrations were drawn by Mrs. Norah Moffat and the photographic work was done by Mr. C.J. Morley.

Catch data for vessels operated by the Fisheries Research Institute of the University of Washington are included in this report by kind permission of Dr. Robert L. Burgner, Director, and those for the vessel operated by the Alaska Department of Fish and Game by kind permission of Mr. Wallace H. Noerenberg, Deputy Commissioner.

To a considerable extent, the success of these programs was due to the skilful and conscientious operation by masters and crews of the FRB vessels G.B. Reed, A.P. Knight and Investigator No. 1, and the chartered fishing vessels Western Crusader, T.W. Sea Queen, Canadian No. 1, Western Producer, Skardale, Midnight Sun, T.W. Zelle and Fort Ross. Masters and crew members who made special contributions through the years were Captain G. Paterson, Captain W. Lankester, Captain G. Seter, Mr. T. Oikawa and Mr. E. Williams.

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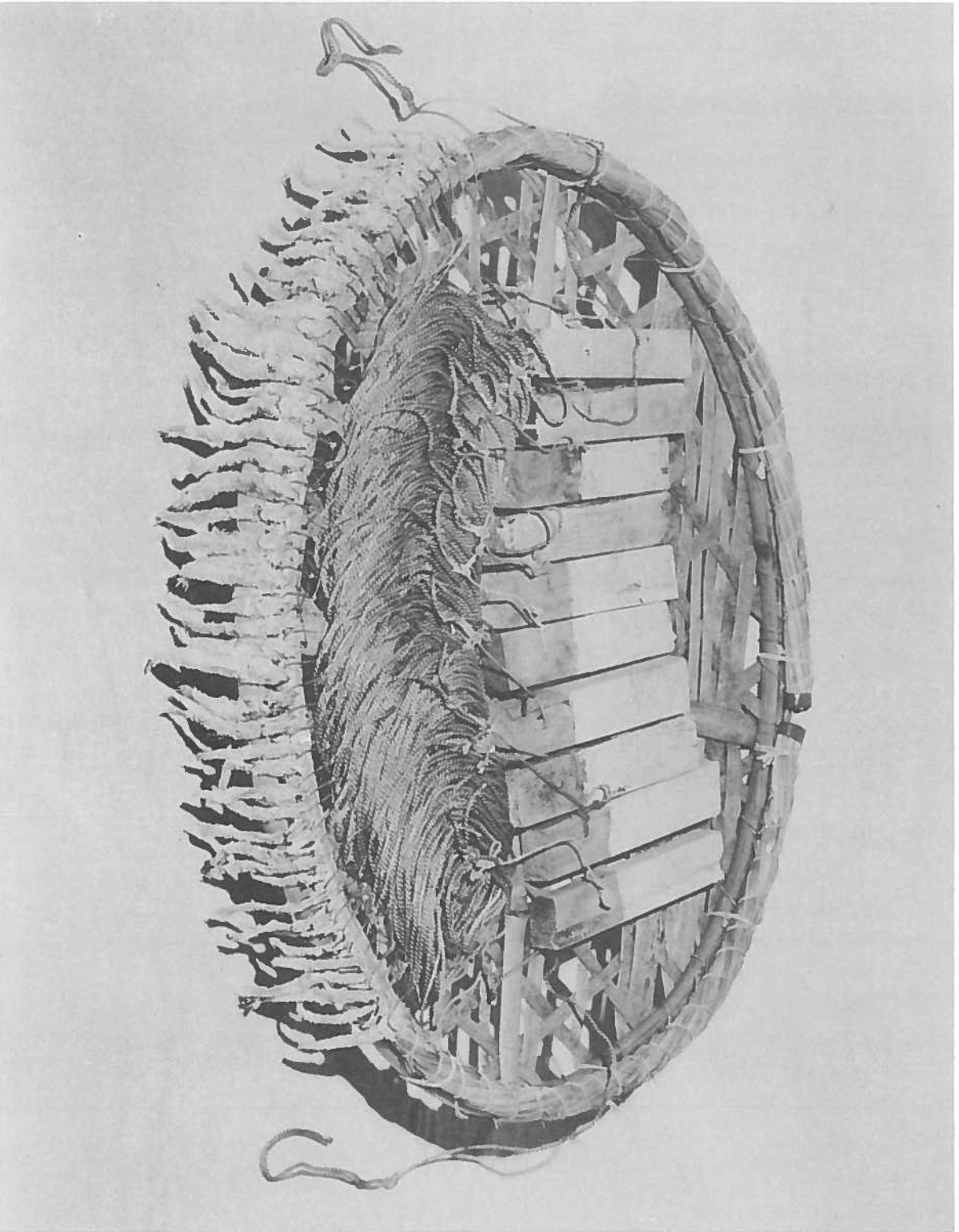


Fig. 1. A skate of salmon longline gear, baited and ready for setting.

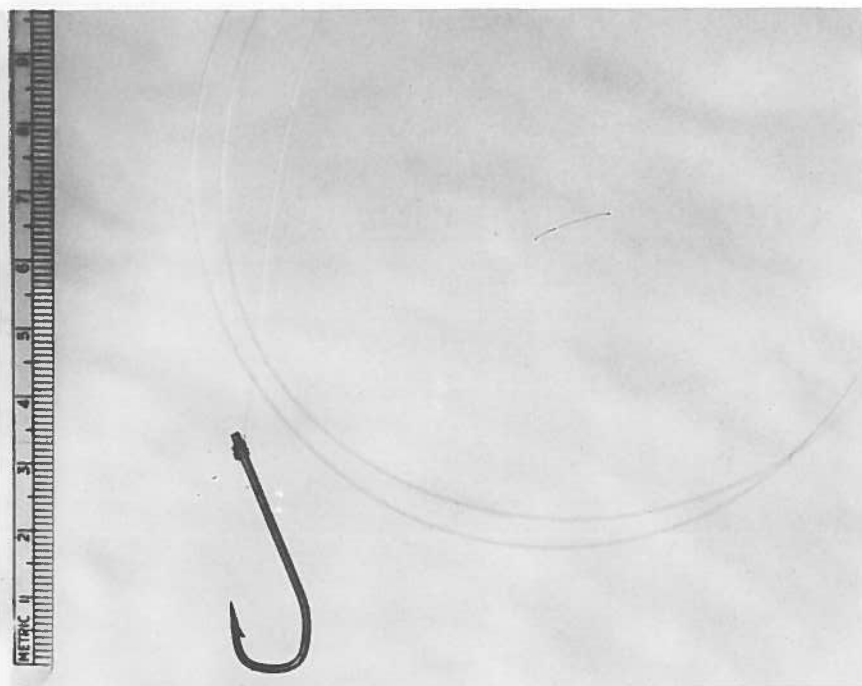


Fig. 3. Japanese TB hook with monofilament gangion.



Fig. 4. Setting table mounted at starboard rail of C.G.S. G.B. Reed.



Fig. 5. Hauling longline on C.G.S. G.B. Reed.

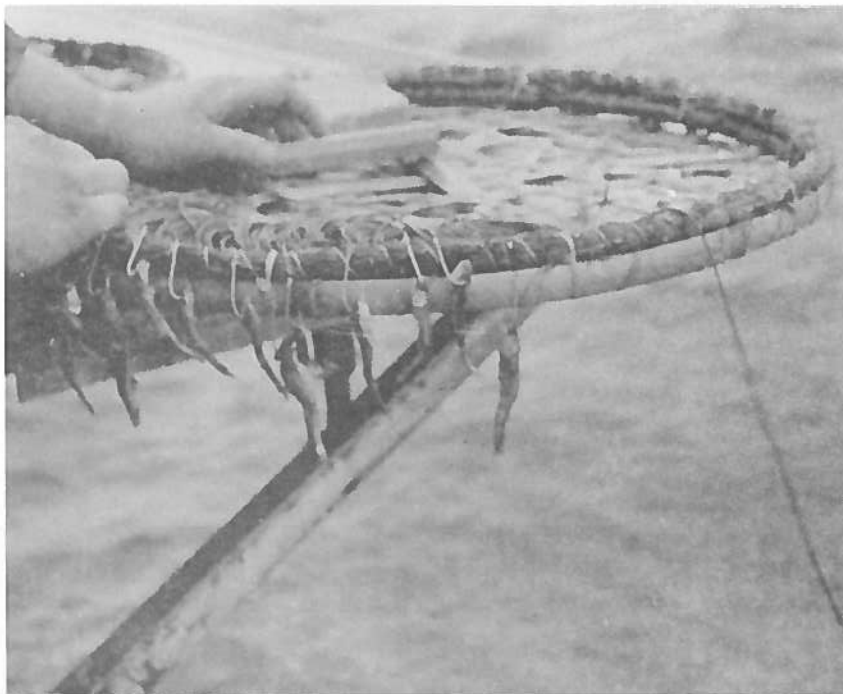


Fig. 6. Setting longline from C.G.S. G.B. Reed.

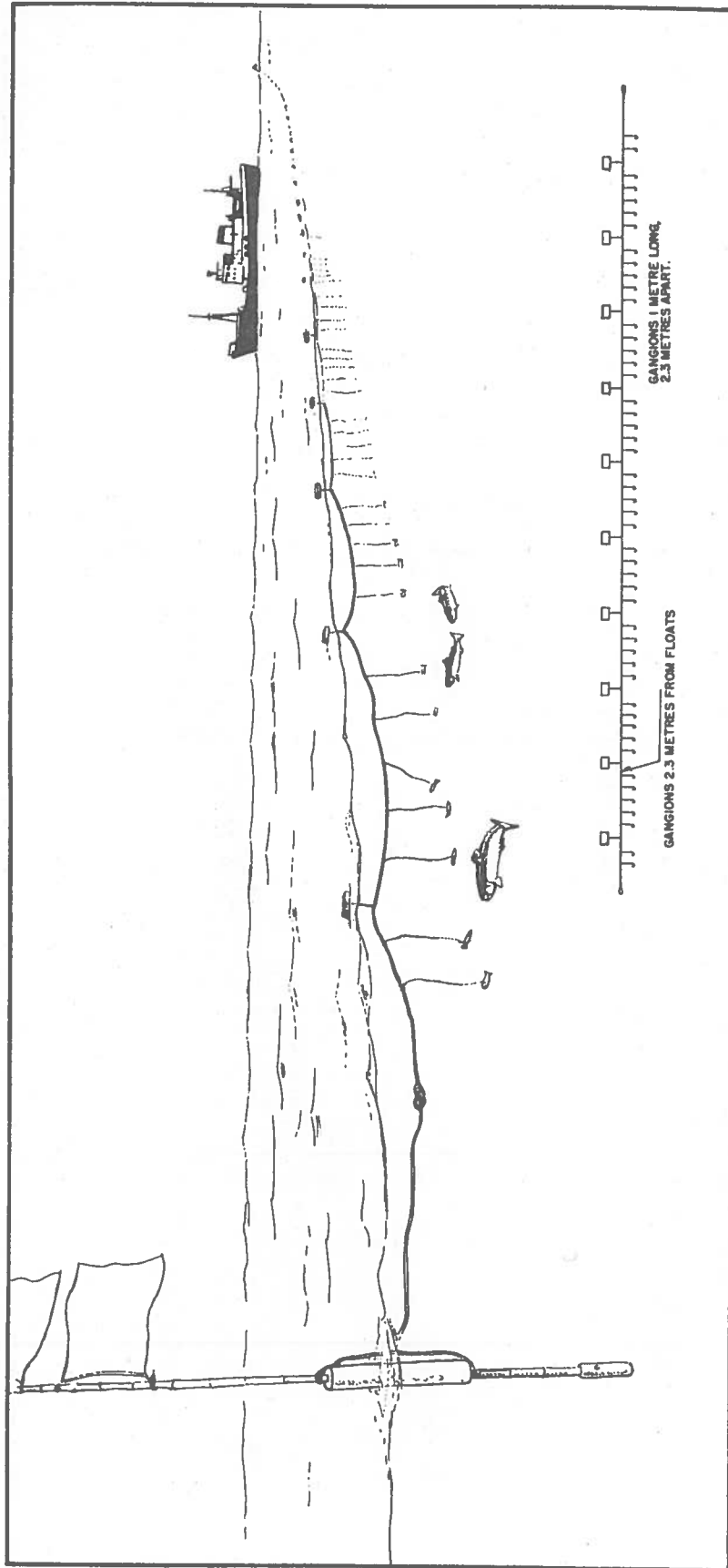


Fig. 2. Longline layout.