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NEW ZEALAND MARINE DEPARTMENT.

FISHERIES TECHNICAL REPORT

No. 2

SCALLOP INVESTIGATION, TASMAN BAY 1959-60

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WELLINGTON, NEW ZEALAND.

1960

SCALLOP INVESTIGATION, TASMAN BAY 1959-60

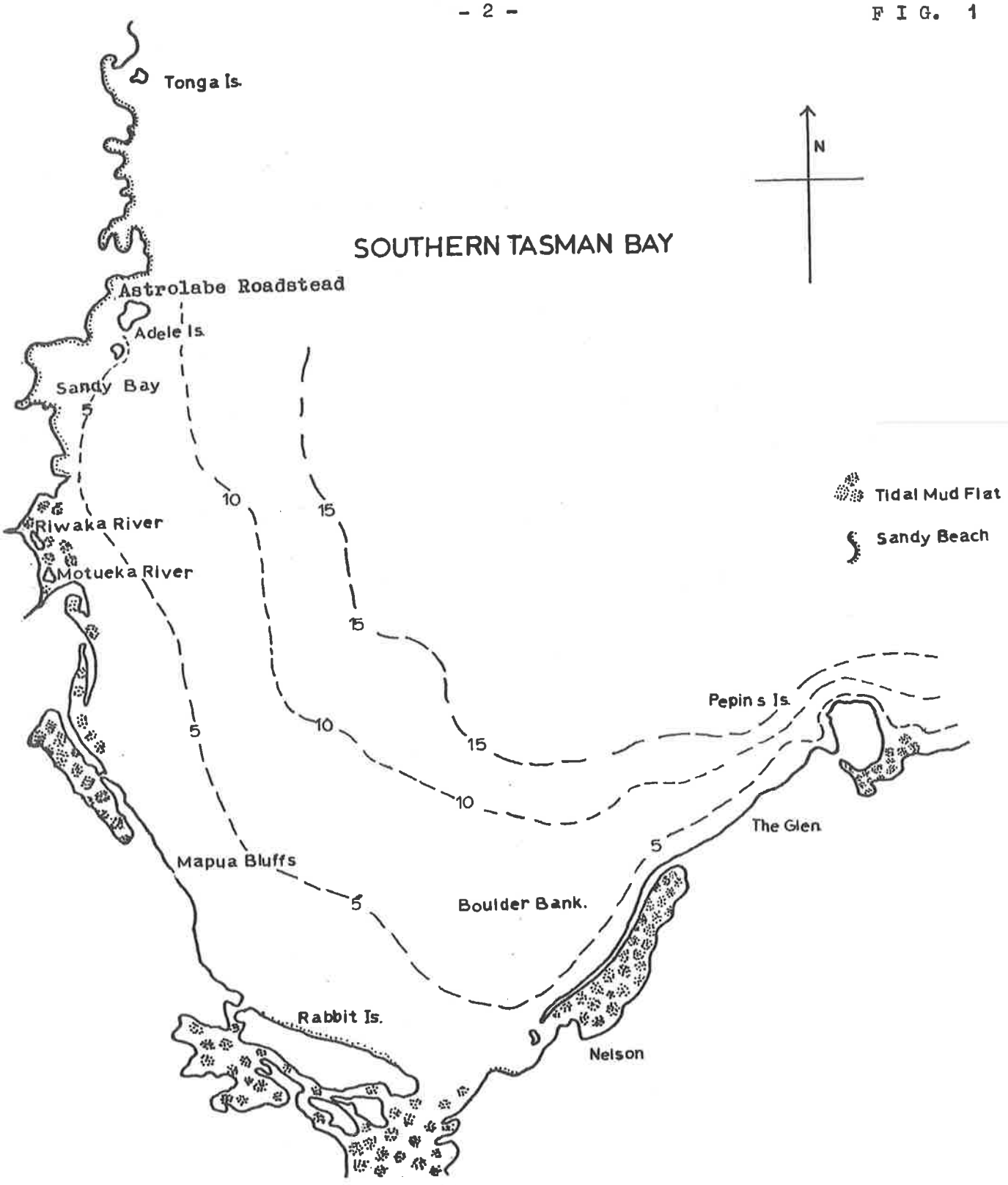
INTRODUCTION:

Due to the activities of private fishermen and dredgers the presence of scallops in certain New Zealand inshore waters has been noted, but little is known of their general biology, distribution, abundance etc. During the summer of 1959-1960 a short survey was made under the direction of the Marine Department to investigate these and other aspects of scallops and scallop beds in a pre-selected area where scallops were known to exist. The above-mentioned survey was carried out in southern Tasman Bay on the commercial vessel "Christine" NN.58 owned by Mr. Jack Cotton of Nelson to whom the first commercial scallop fishing licence was granted. Up to this juncture the taking of scallops was confined to private citizens on whom a limit bag of three dozen per day was imposed. Scallops are found in many of New Zealand's inshore waters; Tasman Bay and the tidal flats and channels of Manakau Harbour being the most notable of these. The commercial exploitation of scallops has been attempted with varying degrees of success in certain countries notably the British Isles, North America and Tasmania but the scope and value of these enterprises is not great when compared with other aspects of the fishing industries of these respective countries.

ENVIRONMENT:

The dredging operations carried out during this survey were confined almost entirely to the southern end of Tasman Bay, the northern boundary being taken as a line between Adele Island on the western side and Pepins Island on the eastern side. The eastern and southern shores bounding this area consist of extensive tidal mudflats (confined on the eastern side by the Boulder Bank) and the western shores of large sedimentary conglomerate boulders with beaches of coarse grained sand. Roughly 100 square miles of

FIG. 1


Tonga Is.
N
SOUTHERN TASMAN BAY
Astrolabe Roadstead
Adele Is.
Sandy Bay
5
10
15
Tidal Mud Flat
Sandy Beach
Riwaka River
Motueka River
15
Pepin s Is.
10
15
5
10
The Glen
5
Mapua Bluffs
5
Boulder Bank.
Rabbit Is.
Nelson

water lie within these boundaries. For the main part the substratum appears to be composed of silty mud, but in some areas, especially on the western side, a thick covering of dead shell predominates and one isolated area of the Mapua Bluffs consists of small rounded boulders.

The bottom appears to be remarkably uniform with little disruptive topography, and slopes down to approximately 20 fathoms at the northern extremity of the area investigated. Tidal waters carry large amounts of sediment out into the bay from the surrounding mudflat and a rain of detritus continually drifts to the bottom. The waters are generally opaque due to the large amount of suspended material. Tasman Bay is an extremely sheltered body of water and water movements due to currents is very slight. Drift tests have confirmed the presence of a 1-2 knot southerly current in the central region of the bay but this probably owes its existence to a prevailing northerly wind in the summer months and its sub-surface effects would not have a marked bearing on the bottom topography or bottom fauna. Evidence of this lack of water movements and currents is afforded by the paucity of algal growth especially on the western side of the bay. Tidal rise and fall is in the vicinity of 12 feet, moderate tidal currents being present in certain localities.

Three rivers drain into Tasman Bay, the Waimea, the Riwaka, and the Motucka. However these are not large or swift flowing and as they drain into the bay via extensive mudflats they would not exercise any profound reduction in salinity.

Figures obtained by coastal vessels and recorded by the Oceanographic Institute indicate that no great temperature fluctuations occur during the year. Summer and winter temperatures are in the vicinity of 68° F. and 51° F. respectively.

GENERAL BIOLOGY OF THE SCALLOP:

The scallops taken in Tasman Bay appear to agree with Reeve's description of the northern New Zealand form Pecten novaezelandiae novaezelandiae. (See Fleming, T.R.S.N.Z., Vol. 79 1951-52).

Due to the depth of water and the amount of suspended material it con-

tained it was found impossible to observe the scallops from the surface even at the lowest tides so for the purposes of direct observation a short diving programme was carried out. All scallops seen occupied saucer shaped depressions in the substrate with the flat valve flush with the surface. In most cases a fine layer of sediment covered this valve which was slightly agape with the mantle tentacles extended. On the approach of the diver the scallops abruptly closed their shells. A definite escape reaction was shown by one scallop when it was picked from the bottom and loosely held in the hand. Vigorous snapping of the valve occurred and the scallop swam for a distance of approximately six feet ventral edge foremost and then slid to the bottom in a zig-zag fashion. It is quite possible that scallops exhibit such an escape reaction prior to the readily perceivable approach of the dredge.

Due to the somewhat restricted working conditions only a brief examination of the gut contents was possible. Seven species of diatoms and some phytomastigina were discovered mixed with a considerable amount of detritus. True assessment of mortality due to predation was difficult. Certain shells were found with neatly drilled holes indicating the presence of boring gasteropods. Three gasteropods were commonly found in the dredge, the spiny Murex Poirieria zelandica, Aloithoe arabica, and Struthiolaria sp. These are known to be of carnivorous habits and may well play a part in scallop predation. Star fish were also common over the beds, large specimens of Coscinasterias sp. being dredged over the densest aggregations. These probably constitute the greatest predatory menace to scallops.

In some areas excessive mortality was noted. This was either confined to certain age classes or was quite indiscriminate, shells of all sizes and in various stages of decomposition being found. Beds of dead shell were frequently encountered on the western side of the bay.

Epizooites mainly hydroids and polyzon were common on the flat exposed valves and in many areas the shells were riddled with boring polychaetes, probably Polydora sp. Differences in shell colour in scallops from different depths and localities was noted. Scallops taken from the shallow shelly bottoms in the Astralabe vicinity were dull olive green and contracted with the paler forms taken at greater depths over muddy bottoms.

SPATIAL DISTRIBUTION

After a preliminary survey it was found that scallops had a fairly random distribution over the greater part of the southern end of the bay with areas of greater or lesser density. The factors controlling this distribution were difficult to assess. Certain areas subject to moderate tidal currents were investigated but no evidence was obtained to indicate that these areas supported a greater population than less agitated waters. In many cases the converse applied and shallow inshore populations on the western side such as Tonga and Astrolabe revealed extensive beds of dead shell with only small or moderate populations of living scallops. However the possibility that these areas once supported large and flourishing populations which due to their very numbers, died of starvation and overcrowding, should not be discarded. With the exception of Torrent Bay and the Astrolabe roads scallops were uncommon above the five fathom line but below this, depth did not appear to be a critical factor. Scallops were found randomly scattered down to twenty fathoms, the greatest depth dredged during this survey.

The most obvious factor governing scallop distribution appeared to be the type of substrate and the faunal association it carried.

Types of substrate encourntered (see fig. 2)

(a) Small Bouders
(b) Coarse broken shell
(c) Fine silty mud overlain by a light layer of detritus

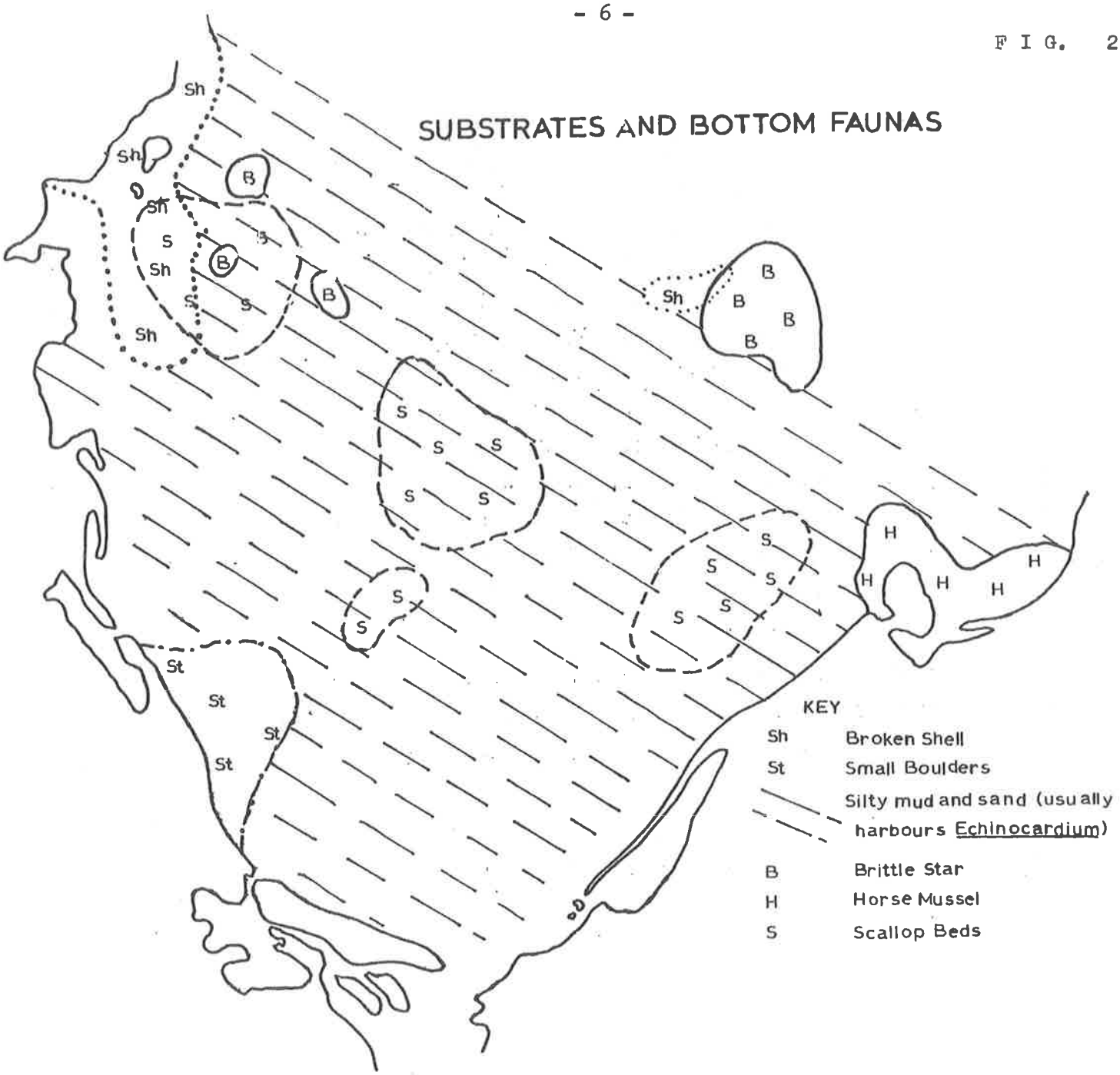
Small Bouders

These occur in a small area in front of the Mapua Bluffs at a depth of two to four fathoms. Scallops absent from this zone.

Broken Shell

Mainly Maoriculpus, Glycemeris and Pecten shell. Encountered in fairly shallow water on the western side of the bay. Scallop populations very sparse with the exception of Astrolabe. Scallops encountered in this area were a brownish olive green and usually infested with epizooites.

FIG. 2


SUBSTRATES AND BOTTOM FAUNAS
KEY
Sh Broken Shell
St Small Boulders
Silty mud and sand (usually harbours Echinocardium)
B Brittle Star
H Horse Mussel
S Scallop Beds

Fine Silty Mud

Found over the greater portion of the bay. Supports several distinctive faunal associations.

(i) The brittle star Amphiura rosea was found to be dominant in small isolated areas. May compete with Pecten for space and food material. Scallops very scarce in these areas.

(ii) The heart urchin Echinocardium forms dense communities over the greater portion of this type of substrate. Associated with these are certain molluscs which also form distinctive communities.

(a) Atrina the horse mussel (often associated with Terebretella); Scallops scarce or absent. Mainly in shallow water.

(b) Pecten and Mytilus. Abundant over the greater part of this substrate the proportion of one species to the other varying in different areas. In some areas (see fig. 2) only the large green mussel Mytilus was found, in great abundance. As this survey was carried out with a strong commercial bias only areas which were thought to support reasonable populations of scallops were examined but enough material was obtained to give a reasonable overall picture of the bay.

ABUNDANCE

Calculations involving the width of the dredge, duration of the tow, and the speed of the boat revealed that an average catch with the equipment used represented the capture of one scallop every seventeen square yards and even the best hauls realised only one scallop per eight square yards. Brief underwater observation has shown that scallops are more abundant than this and one must conclude that dredging reveals only a fraction of the true stocks. Two reasons are advanced to account for this

(a) The dredge was leapfrogging and only on the bottom for a limited time during the haul.

(b) The scallops perceived the approach of the dredge and took evasive action. This was recorded by Olsen in his work on the Tasmanian scallop. He noted that catches over recognised scallop beds increased after the first few hauls and discovered that scallops that escaped from the first hauls were caught when muscle fatigue prevented them from taking further

evasive action. Without any method to fix accurately a position, it was found very difficult to dredge consistently in one area so Olsen's results could not be checked. However, no drop in catch numbers was noted when continually dredging in the same general area.

During this survey it was discovered that there may be an unnatural factor to be considered in the distribution and abundance of mussels and scallops. Tasman Bay is subjected to intensive trawling operations and thousands of mussels and scallops are picked up in trawl nets and carried up to six miles before being dumped back in the sea. According to local fishermen many areas that were originally devoid of scallops have been unwittingly stocked in this manner.

SPAWNING

When the first scallops were examined at the commencement of this survey on the 25 November it was found that the majority of gonads were in poor condition; (criteria of condition based on colour, demarcation of ovary and testis, degree to which the intestine was visible, actual physical condition flabby, angular, rounded, etc.). This spent condition indicated that spawning activity of some kind had recently taken place. During the survey which lasted from the 25 November until the 27 January a gradual improvement was noted in the condition of the gonads and by late January the majority had improved in texture and colour although they were still slightly flabby and angular. It appeared that there was a single spawning period during the months of August and September but subsequent observations report that in the month of March the scallops again lost condition and the gonad became almost completely empty of sexual products. This was apparent in all scallops seen during this time. It therefore appears that the spawning season is a greatly extended one or that there is a subsidiary spawning period in August - September followed by a major one in March.

The following abnormal conditions were noted in the gonads examined.

(1) The gonad had a mottled brown transluscent appearance with a watery texture. Abductor muscle was very flabby. Microscopic examination revealed small scattered underdeveloped ova and spermatic tubules and much fluid in the gonad itself. Judged unfit for marketing.

(2) Gonad uniformly coloured a pale pink or white. These were probably abnormally late spawning individuals. Judged unfit for marketing.

These conditions were not encountered in any number sufficient to cause commercial loss. Occasional specimens were encountered with no demarcation between the ovary and testis the tissue of which occurred in scattered islets giving the gonad a speckled appearance. These were marketed with the bulk of the normal scallops. Due to the limited time and the generally poor condition of the muscle and gonad it was not possible to devise a reliable condition factor.

GONAD DEVELOPMENT IN JUVENILES:

A series of juvenile scallops from the Pepins Island area were examined. The smallest scallop showing evidence of gonad development was 29.5 mm. in length and gave some evidence of colouration and demarcation of the gonad. In 37 mm. samples the gonad showed greater development and the male and female regions were clearly defined. 41 mm. samples showed clear evidence of having recently spawned and in some cases were still in a gravid condition. Scallops between 41 and 47 mm. seemed to constitute an age class and this was tentatively placed at two years. It seems probable that scallops commence to spawn in their second year. From observations made on the spawning period it appears probable that the scallops would be in optimum condition during the months of April, May, June and July.

REPLACEMENT STOCK:

The presence of immature or juvenile scallops was noted in various parts of the bay (see fig.3). The majority of these appeared to fall into three size classes 37, 41-42, and 47 mm. in length. Smaller specimens of 17, 29 and 32 mms. were also encountered. The dredge, though not designed to retain scallops of this size gave good indication of their presence or absence in the areas dredged. In almost every shot clogging of the dredge bag mesh occurred and in this way much small material such as heart urchins, small oysters and juvenile scallops was retained so a fairly accurate picture of their distribution if not their abundance was obtained. Some areas showed a complete paucity of young stages and therefore have no replacement stocks. However if scallops are removed from a situation by dredging it is quite possible that the marginal populations would gradually repopulate the area in an attempt to achieve an optimum distribution pattern.

FIG. 3

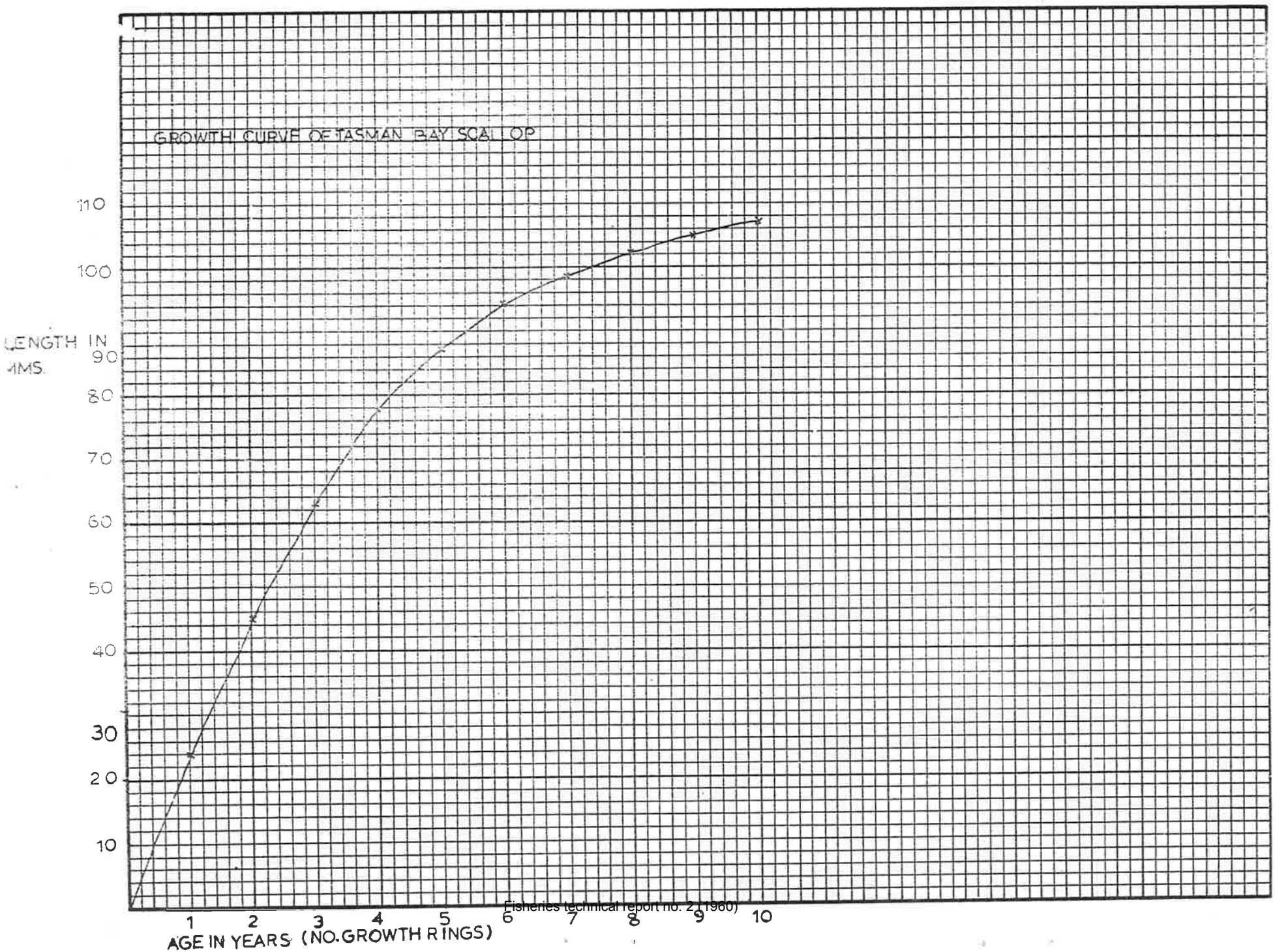
GROWTH RATE

An attempt was made to determine the rate of growth by the study of the rings on the flat valve of the shell. Unfortunately certain factors (which will be dealt with) greatly complicated this study.

Nature of the growth rings: Examination of the flat valve revealed numerous rings exhibiting various degrees of prominence. When an attempt was made to plot these it became apparent from the shape of the resultant graph that many supernumerary rings were present and had been included in the graph. Microscopic examination of the rings did reveal the presence of crowded striae in some (indicative of true annual growth rings) but no worthwhile degree of correlation of these rings was found in separate shells. No definite theory can be advanced to account for the presence of these supernumerary rings although disturbance by trawl nets may cause the retraction of the mantle to a degree sufficient to cause the formation of a growth disturbance ring. In many cases ring reading was prevented by the action of boring polychaete worms which disfigured large portions of the flat valve of the shell.

The true annual periodicity of these growth rings is another feature of this work that merits future investigation. Plotting of certain rings (which were present with a fair degree of correlation in most shells examined) produced a curve similar to the characteristic growth curve common to the majority of lamellibranchs. An approximate check was made using the growth zones seen in the ground down sections of the flat valves. No great accuracy is claimed for these and following figures but they are adequate for the purpose for which they were compiled; that is to give an approximate idea as to the length of time taken by scallops to reach commercially acceptable size. From the graph (fig. 4) it may be seen that the scallops reach a marketable size (80 mm) in their fourth year and after that growth continues slowly and a length of 100 mm is reached in the eighth year. Thus it can be seen that there is a great difference in growth rate of juvenile and mature specimens. Differences in growth rate probably occur in specimens from different localities but readings were not accurate enough for this to be checked.

FIG. 4

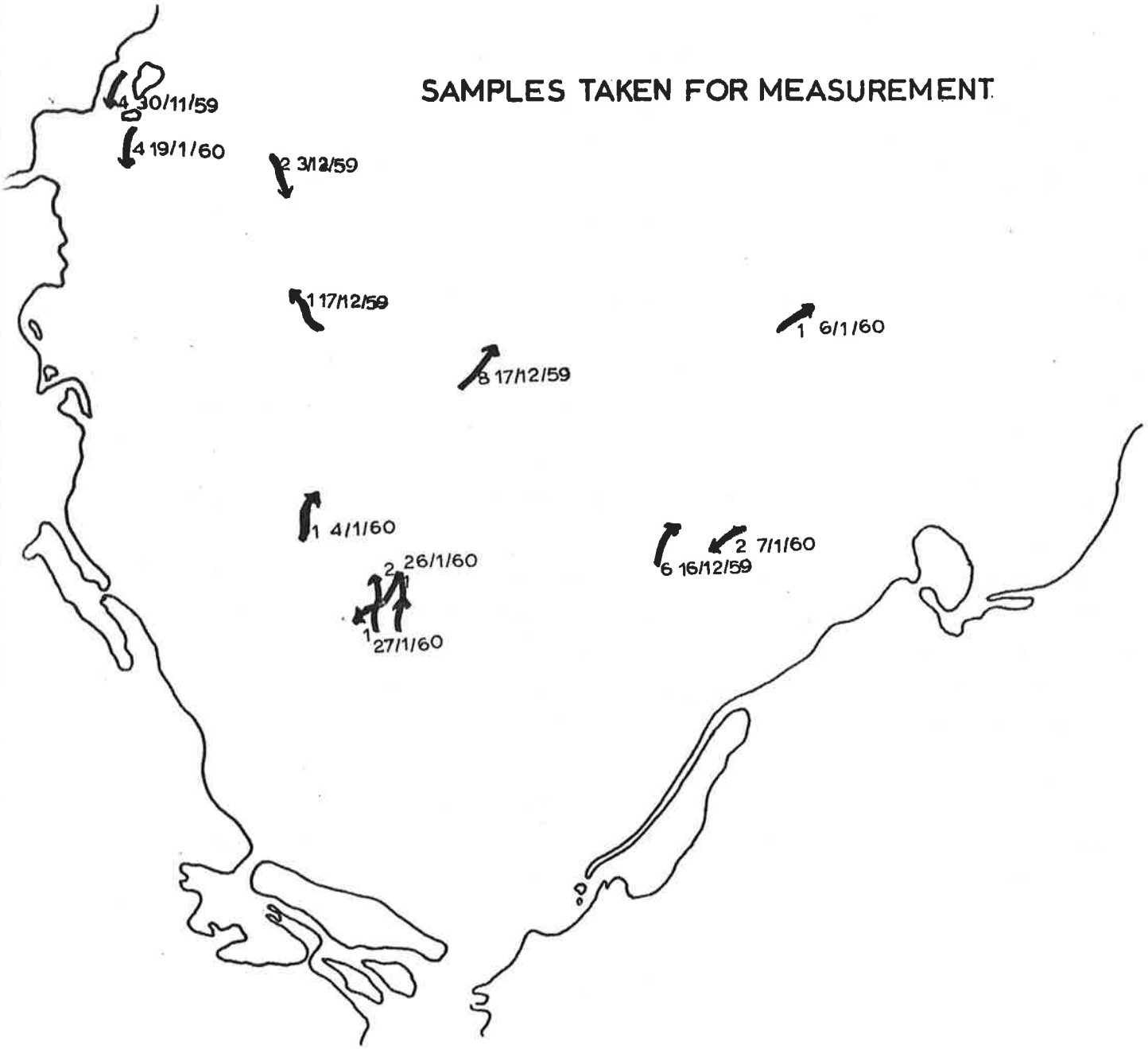


LENGTH FREQUENCY & SIZE COMPOSITION OF THE SCALLOP POPULATION

Length measurements were made only on the flat valves; these were made from the umbo to the ventral margin using a graduated millimetre scale. Samples for measuring were taken from as wide an area as possible (see fig. 5). Only scallops of commercial size are included in the following graphs (figs. 6 - 10), but some idea can be gained from these as to the state of commercially exploitable stocks. As can be seen the length frequencies of samples from different areas differ indicating that growth rates in these areas may differ. However the results are consistent enough to allow an approximate estimate of the ages to be made.

Analysis of the Astrolabe Roadstead population reveals the presence of a small size grouping falling mainly between 80-89 mms in length (Shot 4 30/11/59)(fig. 6.). These are apparently fourth and fifth year scallops and comprise approximately 90% of the population, no juveniles or specimens over 92 mm being recorded. Scallops from this locality are a light olive brown and stronger shelled than those from deeper water. As can be seen from the map (fig. 2) in the earlier part of this report the substrate of this locality consists almost entirely of Maoriculpus and Pecten shell overlying coarse sand. This area is subjected to intensive dredging by private scallopers. Samples measured from shots 4 and 5 19/1/60 (figs. 6 and 9) show that although these beds consist mainly of fifth and sixth year scallops 88-94 mms in length there are also two larger size groups present 96-97 mm and 102-103 mm which until more exact information comes to light are taken as being representative of seventh and eight year scallops. As in the nearby Astrolabe Roadstead no juveniles were recorded from these hauls. One of the most consistently worked beds during this project lies approximately one mile off the Glen (see fig. 1). Samples taken from these beds on the 16/12/59 (fig. 6) and on the 6-7/1/60 (fig. 8) were measured and the majority of scallops were found to fall into two size classes 92-93 mms and 97-98 mms. These were tentatively classified as sixth and seventh year scallops.

FIG. 5


SAMPLES TAKEN FOR MEASUREMENT
4 30/11/59
4 19/1/60
2 3/12/59
1 17/12/59
8 17/12/59
1 6/1/60
1 4/1/60
2 26/1/60
1 27/1/60
6 16/12/59
2 7/1/60

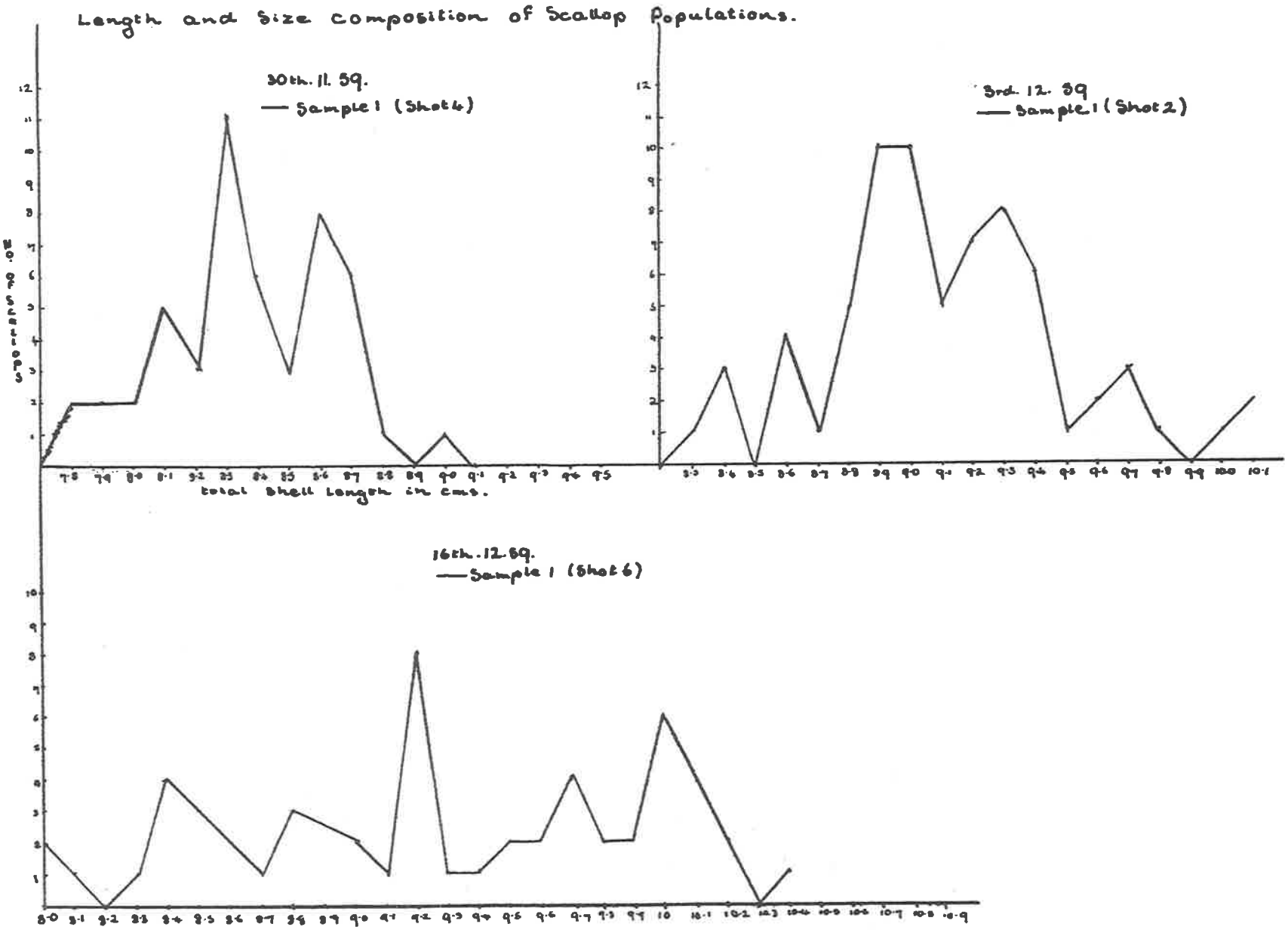

Length and Size Composition of Scallop Populations.
30th. 11. 59.
— Sample 1 (Shot 4)
3rd. 12. 59
— Sample 1 (Shot 2)
16th. 12. 59.
— Sample 1 (Shot 6)
No. of specimens
total Shell Length in cms.

FIG. 6

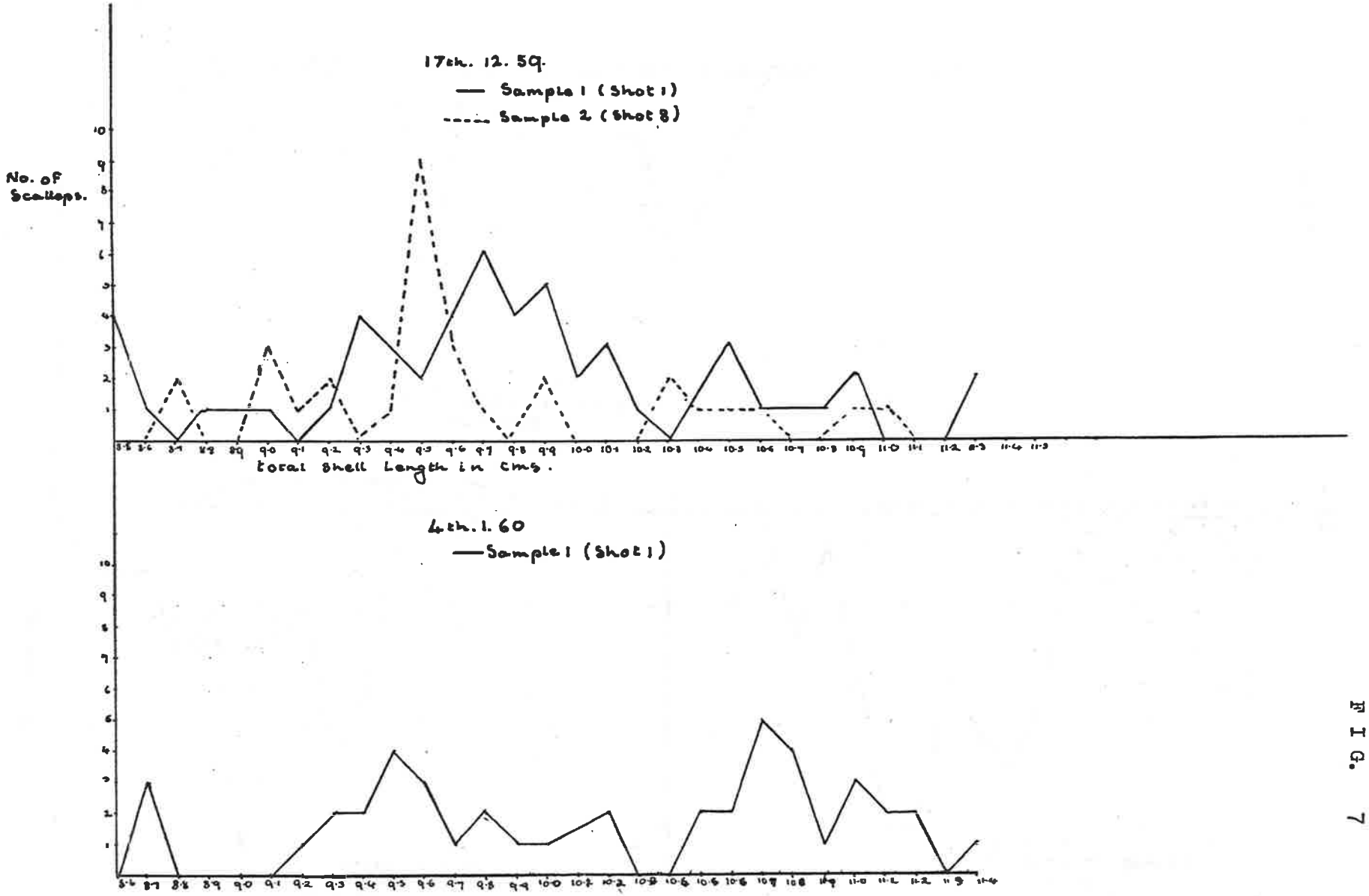
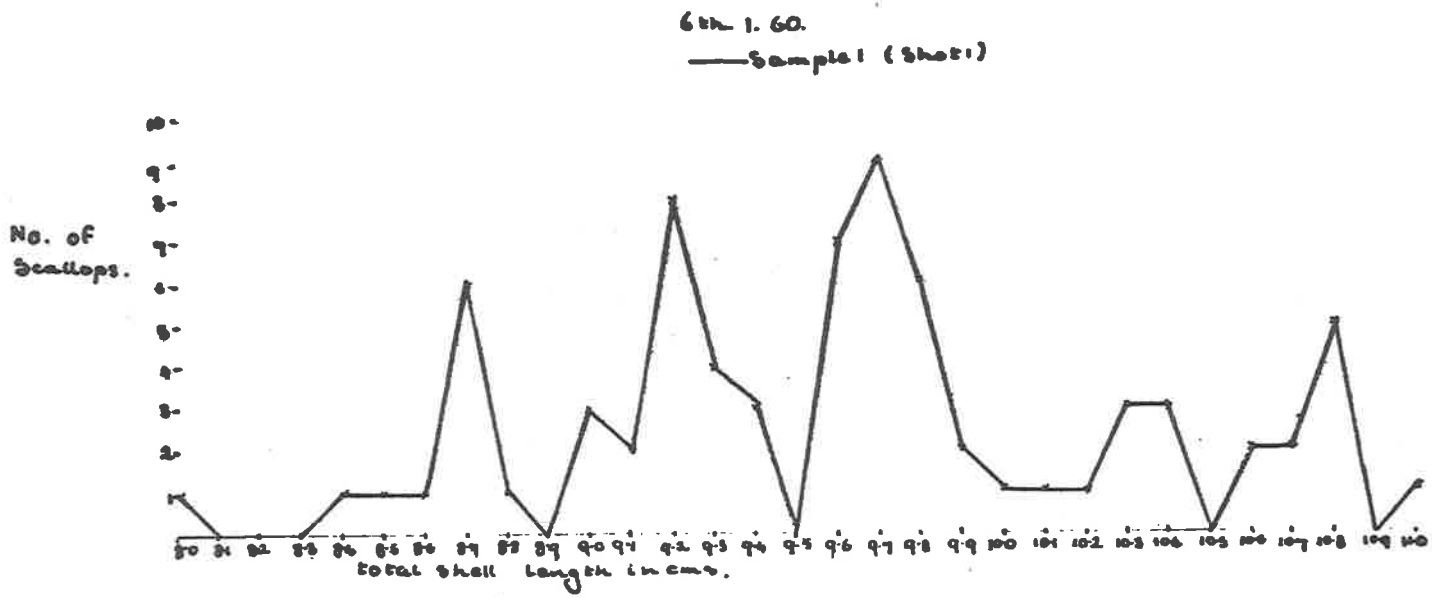
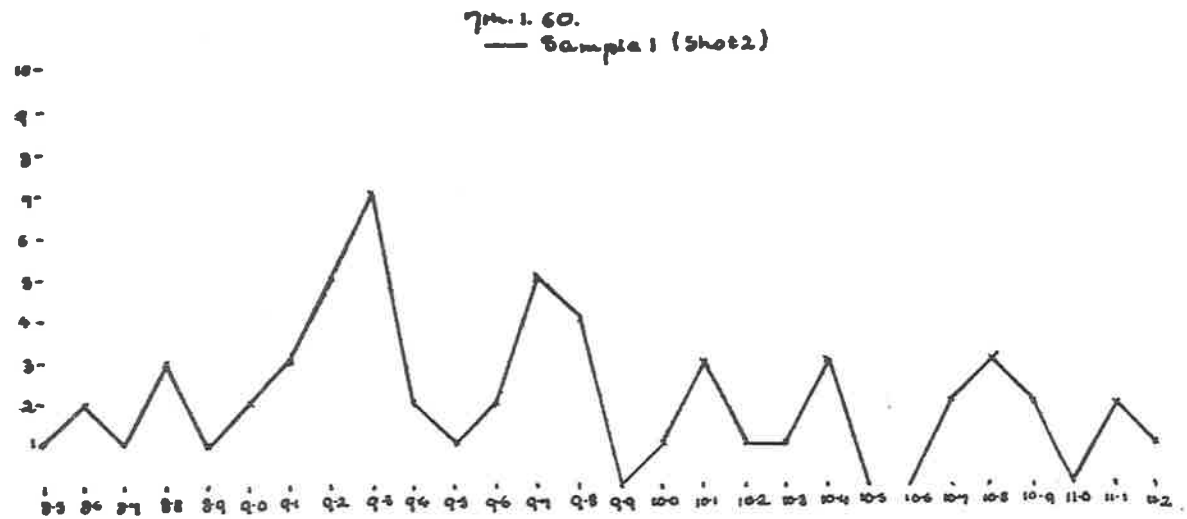

17th. 12. 59.
— Sample 1 (Shot 1)
----- Sample 2 (Shot 8)
No. of Scallops.
Total Shell Length in Cms.
4th. 1. 60
—Sample 1 (Shot 1)

FIG. 7


6th. 1. 60.
—Sample 1 (Shot 1)
No. of Scallops.
total shell length in cms.


7th. 1. 60.
— Sample 1 (Shot 2)

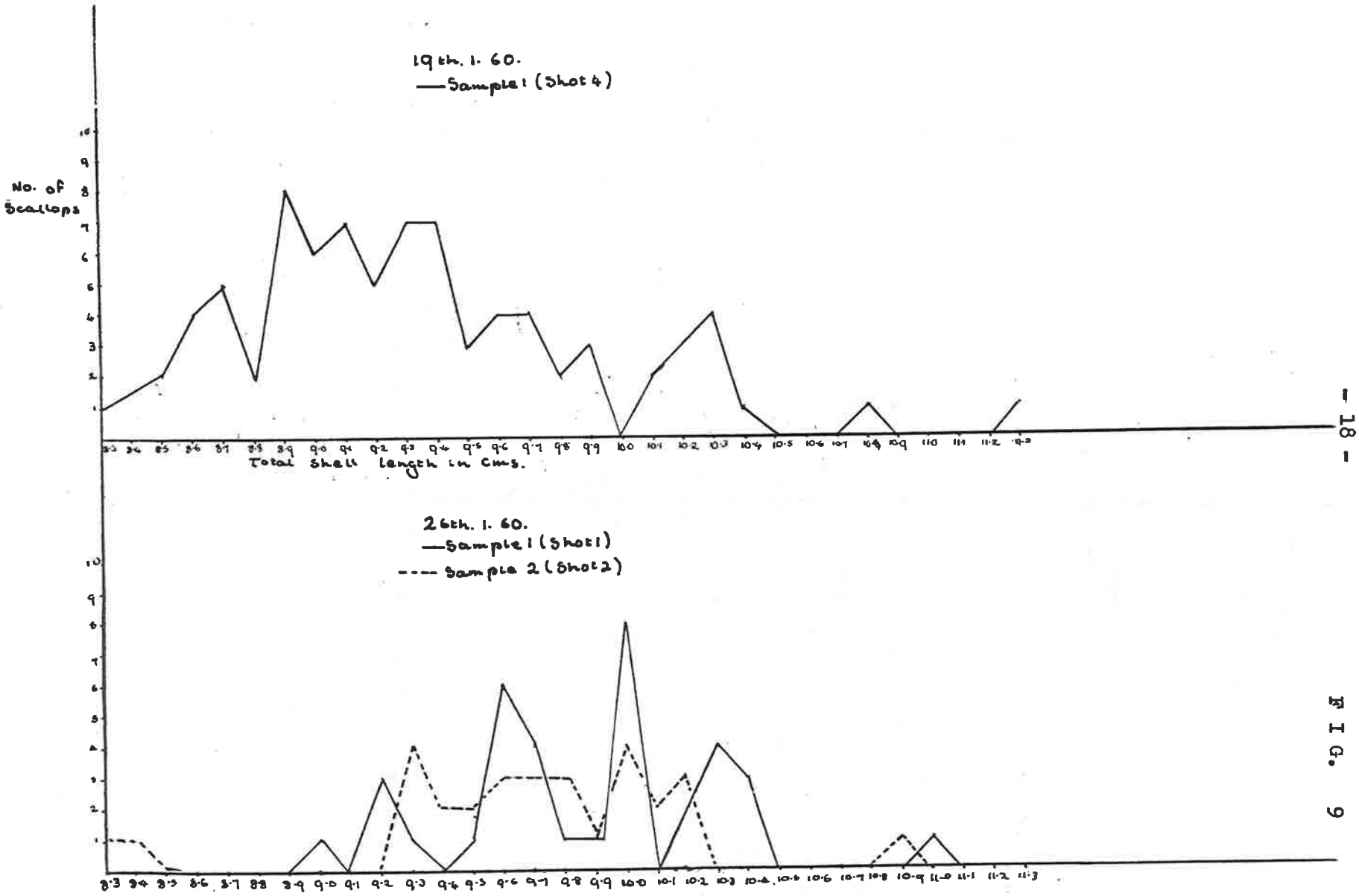
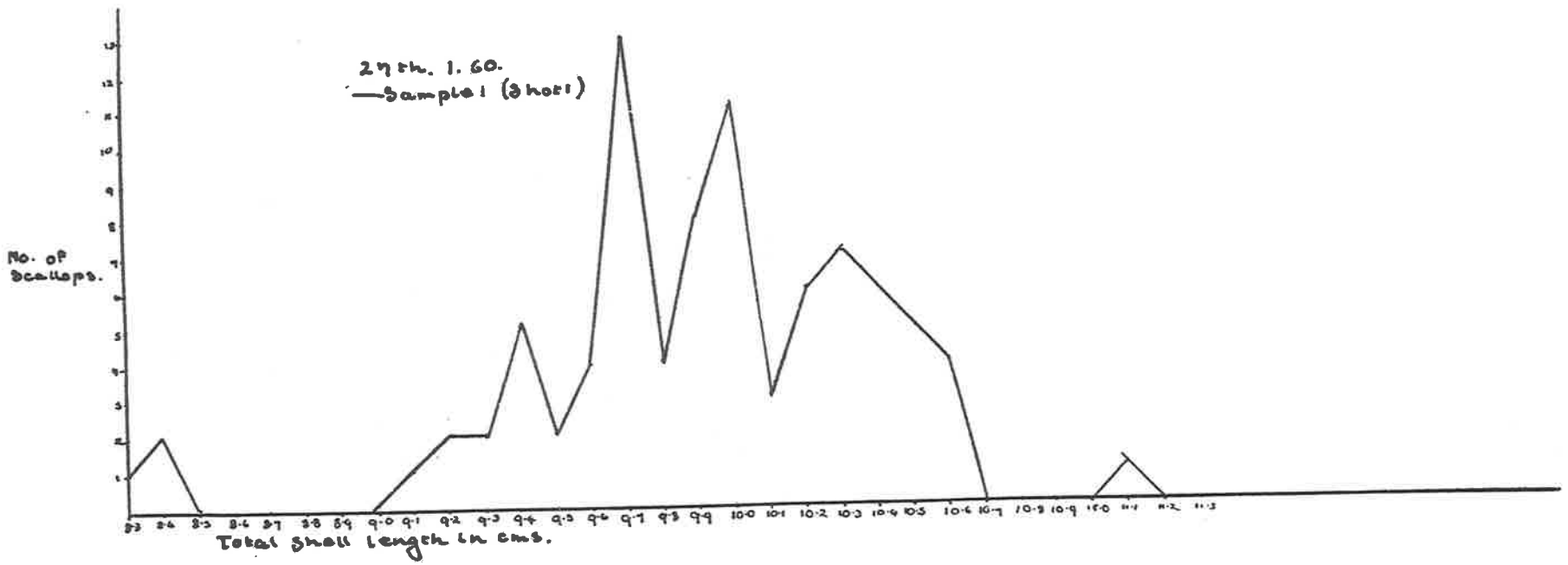

19th. 1. 60.
—Sample 1 (Shot 4)
No. of Scallops
Total Shell length in Cms.
26th. 1. 60.
—Sample 1 (Shot 1)
---- Sample 2 (Shot 2)

FIG. 9


27th. 1. 60.
—Sample 1 (3 hors)
No. of Scallops.
Total Shell length in cms.

- 19 -

FIG. 10

Three larger sizes were readily recognised, 100-101 mms, 103-104 mms, and 107-108 mms. Age determination with the larger size classes is difficult and prone to cumulative error but for the purposes of this work these may be considered as being representative of eigth, ninth, and tenth year scallops. Two smaller size groups were also evident 83-84 mms, and 87-89 mms. Juveniles were also numerous ranging from 17 to 48 mms. This situation with scallops ranging from 80 to 113 mms was encountered over the greater part of the beds dredged with the relative proportions of the sizes differing from locality to locality. Beds in the centre of the bay sampled on the 4/1/60 (fig. 7) and the 26-27/1/60 (figs. 9 and 10) produced a good proportion of large scallops ranging from 100 to 113 mms, some of the best catches being made in this area.

Certain size classes were found to be almost non-existent. Very few scallops between 50 and 70 mms were found although certain areas contained a high percentage of dead shell of this size.

From the dredging carried out during this survey it appears that the scallop population of southern Tasman Bay consists of fifth to eleventh year scallops with juveniles of one or two years occurring in beds over the greater part of a soft substratum and an almost complete paucity of third and fourth year specimens.

DESCRIPTION OF THE DREDGE AND TECHNIQUE OF DREDGING

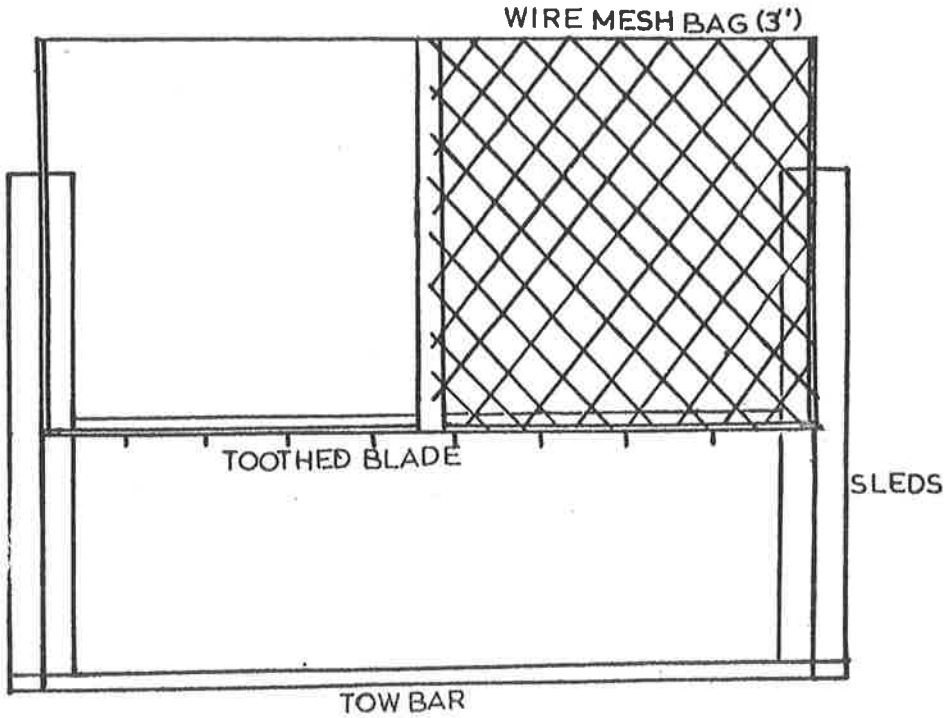
All scallops taken during this investigation except for a very small proportion taken by hand while diving were captured by the dredge mentioned on the previous page. Some experimental modifications were made on the bag but the form seen in the diagrams (figs. 11 and 12) was adhered to for the greater part of the programme. The dredge was modelled on a Japanese commercial design and while being adequate for the purposes of this survey the mouth and retaining bag were too small for really worthwhile catches to be made. In the early stage many problems involving the weighting and stability arose but in the main these were satisfactorily solved. The framework consisted of $1\frac{1}{4}$-$\frac{1}{4}$ inch steel and the sleds of 3-$\frac{1}{4}$ inch steel. The retaining bag consisted of cyclone wire with a diagonal mesh size of $3\frac{1}{2}$ inches. A bridle of $\frac{1}{2}$ inch link chain was used to attach the dredge to the towing cable. The angle of the blade in relation to the bottom could be altered by adjusting the ropes attached to the upper anterior corners

FIG. 11

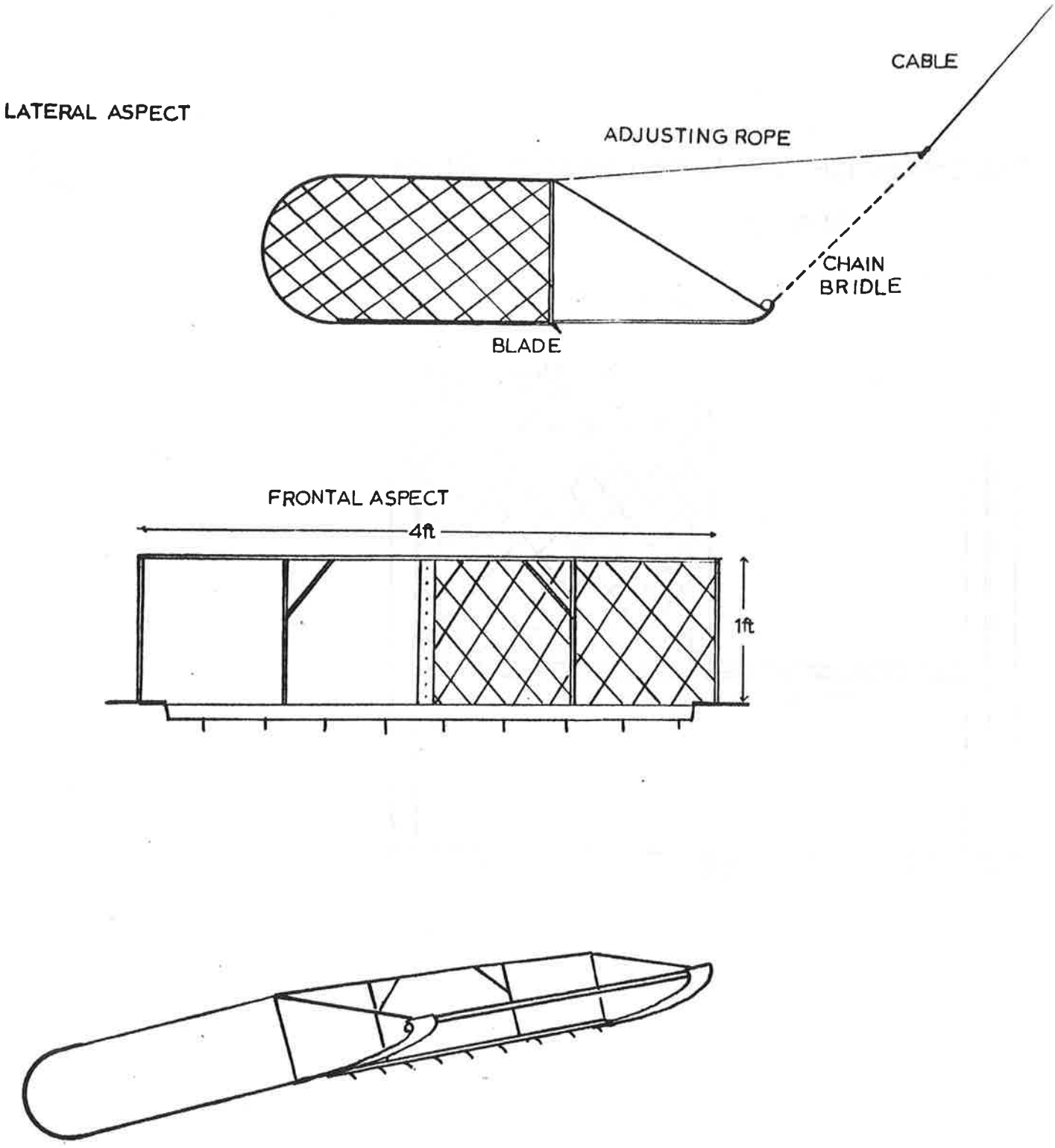
DIAGRAM OF DREDGE USED DURING SURVEY

SCALE 1 INCH: 1 FOOT

UPPER ASPECT



F I G. 12


LATERAL ASPECT
CABLE
ADJUSTING ROPE
CHAIN
BRIDLE
BLADE
FRONTAL ASPECT
4ft
1ft

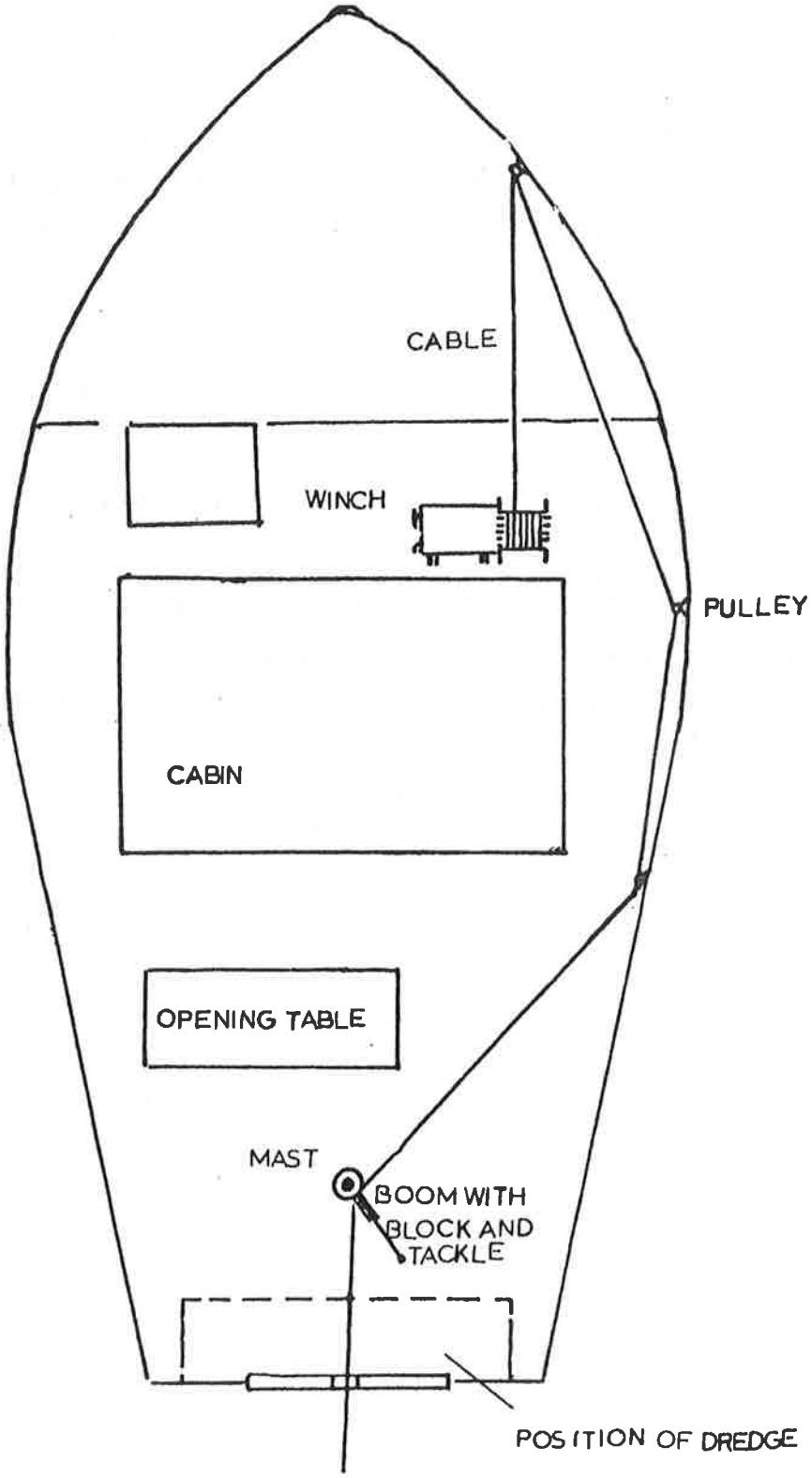
of the dredge. It was found necessary to increase the weight by the addition of 2-4 lbs. of iron. The teeth of the blade were approximately 2½ inches long and spaced 3½ inches apart. Their value as a selection agent is uncertain.

The boat used throughout the survey was the NN.58, a thirty-two footer with a beam of nine foot, powered by a Gardner diesel of approximately 100 h.p. The general layout of the boat can be seen from the diagram (fig. 13). An earlier layout consisted of a truck differential in place of the winch. A half inch manilla rope was used and as the truck differential, unlike the winch, had no provision for storing the rope or cable it had to be coiled on the deck and obstructed work especially if a sea was running. In the later layout as figured, a winch with a drum holding 56 fathoms of wire cable was fitted. The winch was powered by a belt from the engine. The set-up demanded two men for efficient working but could be handled by one experienced operator in a moderate sea.

Technique of dredging: Several factors must be considered to obtain optimum results. The two most important are the depth of water worked and the speed of the boat. The length of cable played out should be at least three times the depth of the water. Any less will cause the dredge to move along the bottom in a series of shallow leaps. The steel cable had the advantage over the manilla rope in that it allowed greater lengths to be used and also weighed the dredge down and kept it on the bottom. The optimum towing speed was found to be three knots or lower in deep water or if a sea was running. At higher speeds the dredge tended to leap-frog on meeting obstructions or undulations on the sea floor. Another influencing factor is the type of substrate encountered. Much of the floor of southern Tasman Bay is overlain by silty mud into which the dredge must have sunken to a depth of 2-3 inches to pick up the large numbers of heart-urchins. In this respect the wide sleds are an advantage in that they prevent the dredge from sinking too deep in the silt. The size selection agent of the dredge is uncertain. Due to the fact that the dredge blade digs the surface of the substrate it appears that the dredge scoops up most objects in its parth and selection is left almost entirely to the mesh which is not very efficient as it rapidly clogs up.

FIG. 13

DIAGRAMATIC LAYOUT OF N.N.58 DURING SCALLOP DREDGING



For a short period the dredge was fitted with the cod-end of a standard trawl in the place of the wire retaining bag. This increased its capacity but the dredge had to be hauled high into the air to allow the cod-end to be untied. This was impractical and even dangerous if any sea was running. The main objection was however that the cod-end frayed rapidly and was good for only two days of normal usage. The small size of the dredge used enabled much of its handling to be carried out manually. A block and tackle was used to lift the dredge aboard but in later stages when larger catches were being made this was connected to the winch and hauled aboard under engine power. The empty dredge presented no problem and could easily be lifted over the side manually. On hoisting the dredge aboard after a tow the catch was tipped out onto the deck for sorting and the dredge was immediately lifted overboard for another haul. The duration of each haul was usually 30 minutes and this allowed ample time to open and sort the catch. In practice eight or nine hauls were made during six hours of dredging. Sorting of the scallops was carried out by hand and the unwanted material was swept into the sea. A platform at the stern would facilitate easier sorting as the unwanted material could be more easily disposed of.

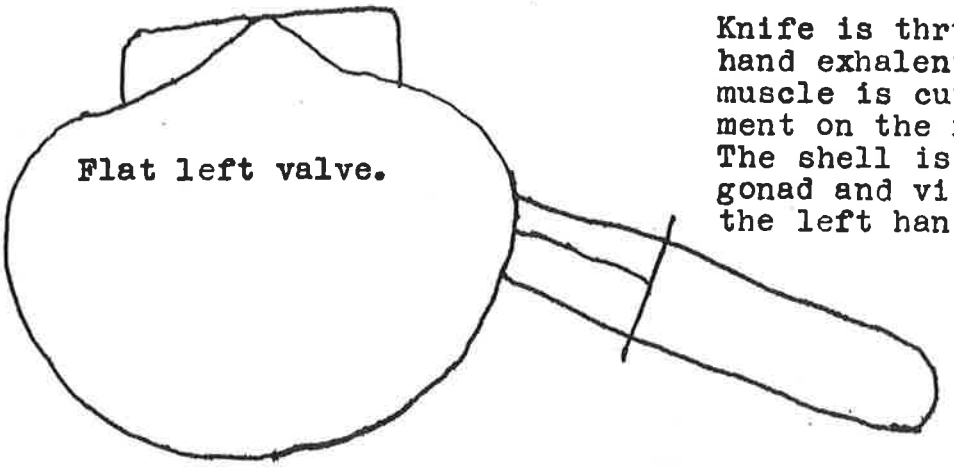
OPENING AND PREPARATION OF SCALLOPS:

With the numbers caught it was found possible to open all the scallops on board but with an improvement of gear and a correspondingly greater catch it may become necessary to open ashore. Unlike most commercially exploited shellfish, scallops are prone to desiccation on account of the large exhalant aperture on each side of the umbo that prevent complete closure of the valves. This greatly affects the storage and marketing of scallops which may die within three hours of capture. In practice the scallops were placed in a wooden case and washed to remove external mud. They were then opened as shown in the series of diagrams (figs. 14 and 15). The majority were found to be full of mud due to the snapping of the valves while in the dredge. The abductor muscle and gonad were retained for marketing while the gills mantle and shell were dumped back onto the bed being worked. The meats, as the marketable portions are termed, were thoroughly washed in a wire basket and stored in tins during the return

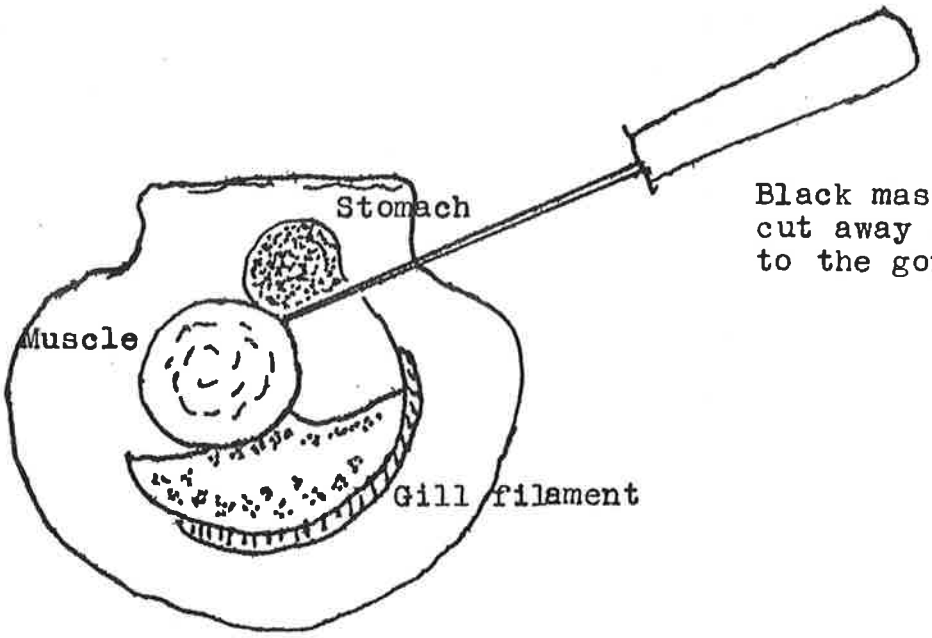
F I G. 14

OPENING OF SCALLOPS

Knife - short fairly flexible blade. Must be moderately sharp to cut away the viscera.

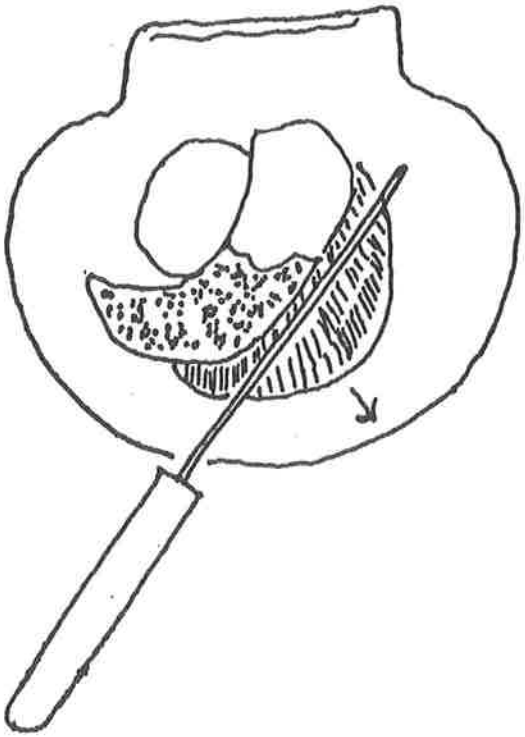


Knife is thrust into the left hand exhalent apeture and the muscle is cut at its attachment on the right hand valve. The shell is opened; the muscle gonad and viscera adhering to the left hand valve.

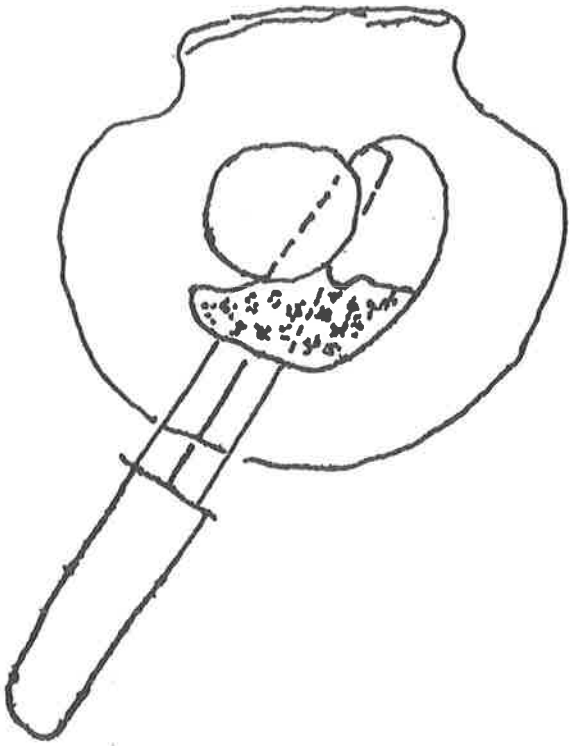


Black mass of the stomach is cut away from its attachment to the gonad.

F I G. 15



Gill filaments and mantle are then scraped away



Muscle and gonad are then cut away from the left valve and dropped into a container.

voyage. On one occasion scallops caught the previous day were stored overnight in crushed ice and found to be quite acceptable the next day. The rate of opening varied with the size and condition of the scallops but it was found that two workers could dispose of 150 in 15 minutes. Scallops were sold by measure of weight, 25 average sized specimens making a pound.

In the early stages of this survey catches over the same area tended to vary due to the problems arising in connection with the gear which needed modification, but when this was done the catches over the same area became reasonably consistent. Due to Mr Cotton's excellent knowledge of local landmarks positions could be recorded with a fair degree of accuracy except on days of mist and low cloud.

DISCUSSION

From the results of the survey it can be seen that scallops are widespread over the greater part of the bay with large beds of juveniles present. In the beds that have been roughly delineated (see appendix) scallops were found to be of good size 93-110 mms and in moderately large numbers, i.e. approximately 200 scallops per half hour haul in the better areas.

The evidence of further spawning activity during March, which came to light after this survey was completed may provide some clue as to the presence of the supernumerary rings on the shells as there is usually some correlation between spawning activity and the deposition of shell rings.

The gear used functioned excellently for the greater part of the survey and at the termination a larger dredge was constructed which should greatly increase the catch. Due to the nature of the area and also the port facilities scallop dredging would probably be more readily carried out by small boats, i.e. 30-45 feet in length.

The practice of throwing the unwanted parts of the scallops back into the beds is questionable. At the present time this would have little effect as the organic matter would quickly be removed by the normal popu-

lation of isopods, gasteropods, and echinoderms in the area. However if this practice was continued on a wider scale it could have an adverse effect.

(a) The organic matter could possibly cause ground pollution, e.g. products of decomposition might affect the filter feeding molluscs as there is little current to remove it.

(b) Any large concentrations of organic matter may attract isopods, and gasteropods from other areas. Such a shift in the population and concentration of predators could have a deleterious effect on the animals in the area.

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APPENDIX

An attempt has been made to analyse each dredge shot during the survey. From this some idea can be gained as to the abundance of scallops in various parts of Tasman Bay and the relationship of these scallops to the various types of substrate encountered and to the faunal associations these substrates harbour. Included in the count are the numbers of mussels and oysters taken in each dredge haul. Juvenile scallops are also included to give some idea of the distribution of replacement stock. (For the purposes of this survey those scallops under 48 mms. in length and under the age of 2 to 2½ years are termed juveniles).

Terms used in appendix.

Shot No. refers to the numbers of dredge hauls made during that day.

Position. Refer to the chart (fig. 16) of the areas dredged during the survey.

Duration. Time from the commencement of a shot to the starting of the winch to haul in.

Depth. Given in fathoms.

Substrate. S. refers to sandy bottom. Sh. to broken shell. M. to mud.

Fauna. Refers to the faunal association of the dominant species found in an area.

Ec. Heart Urchins (Echinocardium)

Br. Brittle Star (Provisionally identified as Amphiura rosea)

M. Maoriculpus (Nearly always associated with hermit crabs)

P. Pecten.

Ho. Horse mussels. (Atrina) Frequently associated with brachiopods.

Pol. Unidentified polychaete worms. (Mud tubes).

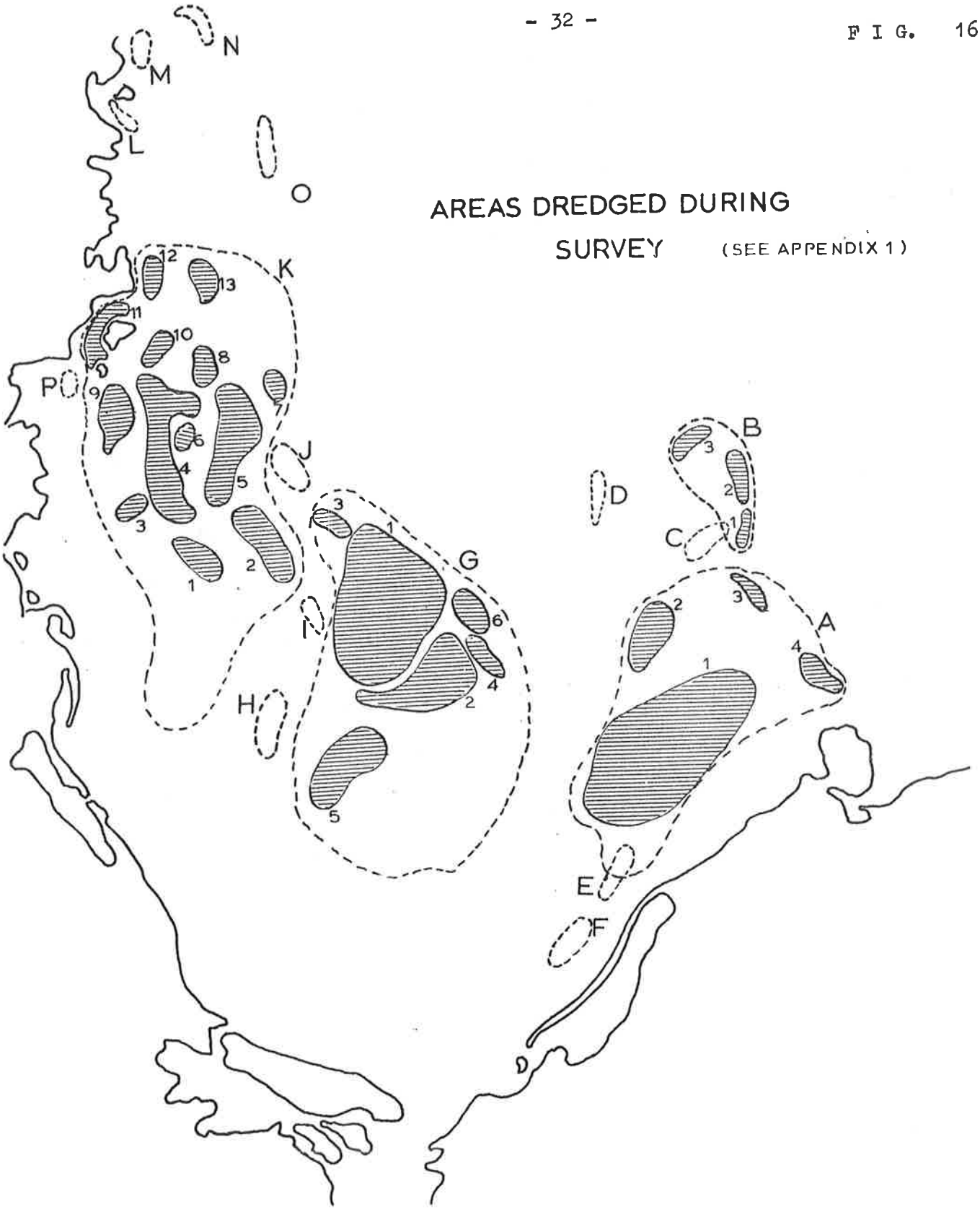
Catch. Refers to the number of marketable scallops i.e. those over 80 mms taken.

Juveniles. Refers to the number of juveniles i.e. those scallops under 48 mms taken.

In cases where catches are low due to malfunctioning of the gear footnotes have been entered.

Meat yield was the amount of marketable flesh (by weight) obtained from each day's catch.

FIG. 16


AREAS DREDGED DURING
SURVEY (SEE APPENDIX 1)
N
M
L
O
K
P
J
I
H
G
D
B
C
A
E
F

Record for dredging on the 30 November 1959

Shot No.	1	2	3	4
Position	K11	K11	K11	K11
Duration	11.15-11.25	11.30-11.44	1.05-1.20	5.05-5.20
Depth	2½-3	2½-3	5-8	3
Substrate	S.Sh.	S.Sh.	M.	S.Sh.
Fauna	M. P.	M. P.	Ec.	M. P.
Catch	60	106	2	178
Juveniles	-	-	-	-
Mussels	-	2	2	-
Oysters	-	-	5	-

Record for dredging on 1 December 1959

Shot No.	1*	2*	3	4	5
Position	K13	K13	K4	K4	K3
Duration	6.50-7.05	7.15-7.30	2.18-2.32	2.50-3.10	3.14-3.35
Depth	11	11	8	8	8-7
Substrate	M.	M.	M.Sh.	M.	Sh.M.
Fauna	-	-	Ec.	Ec.	-
Catch	1	1	27	51	3
Juveniles	-	-	-	5	-
Mussels	-	-	6	20	4
Oysters	-	-	-	-	3

*Shots 1 and 2 were carried out in a depth of water (11 faths.) that was beyond the limit of the rope then used. Dredge not on the bottom for most of the haul.

Record of dredging on the 3 December 1959

Shot No.	1	2	3	4	5
Position	K11	K5	J	G1	A1
Duration	4.58-5.16	6.35-6.57	7.35-8.00	8.30-8.51	9.20-9.40
Depth	3	11	12	15	12
Substrate	S.Sh	M.	M.	M.	M.
Fauna	M. P.	Ec.	Ec.Br.	Ec.	Ec.
Catch	65	71	18	24	5
Juveniles	-	1	-	4	2
Mussels	-	2	6	14	-
Oysters	-	1	6	23	2

Shot No.	6	7
Position	A1	F
Duration	9.49-10.12	11.03-11.30
Depth	16	7
Substrate	M.	M.
Fauna	Ec.	-
Catch	48	7
Juveniles	1	-
Mussels	25	-
Oysters	13	3

Record for dredging on the 15 December 1959

Shot No.	1*	2*	3
Position	A2	A2	A2
Duration	8.18-8.33	8.47-9.10	9.20-10.5
Depth	16	19	17-18
Substrate	M.	M.	M.
Fauna	Ec.	Ec.	Ec.
Catch	8	15	40
Juveniles	1	1	15
Mussels	-	-	-
Oysters.	-	6	-

*Dredge recently modified. Rope replaced with wire cable. Leapfrogged in the first two shots and was weighted before shot 3.

Record of dredging on the 16 December 1959

Shot No.	1	2	3	4	5
Position	B1	B2	B3	D	A2
Duration	7.20-7.45	7.50-8.30	8.50-9.20	9.30-10.00	10.43-11.10
Depth	18	18-19	19-20	20	17
Substrate	M.	M.	M. Sh.	M. Sh.	M.
Fauna	Br.	Br.	Br. Ec.	Ec.	Ec.
Catch	40	25	17	15*	37
Juveniles	-	-	-	-	2
Mussels	-	-	-	-	2
Oysters	5	6	7	-	12

Shot No.	6	7	8
Position	A1	A1	A1
Duration	11.21-12.00	12.8-12.50	1.00-1.45
Depth	14-12	12-14	10-15
Substrate	M.	M.	M.
Fauna	Ec.	Ec.	Ec.
Catch	58	73	110
Juveniles	7	15	25
Mussels	15	12	16
Oysters	6	8	9

*The only time that living scallops between 50 and 70 were found in any quantity.

Two size groups: 65-60 mms.
63-67 mms.

Record of dredging on the 17 December 1959

Shot No.	1	2*	3	4	5
Position	K2	K5	K4	K6	K4
Duration	6.33-7.08	7.15-7.45	7.57-8.15	8.23-8.45	8.51-912
Depth	10	10	10	8	8
Substrate	M. Sh.	M.	M.	M. Sh.	S. M.
Fauna	Ec.	-	Ec.	Br.Ec.	Ec.
Catch	50	4	30	9	36
Juveniles	6	-	10	5	15
Mussels	20	-	18	8	8
Oysters	25	-	11	4	-

Shot No.	6	7	8	9	10
Position	K4	G1	G1	G4	A1
Duration	9.18-9.47	10.25-10.57	11.8-11.42	11.50-12.30	12.40-1.20
Depth	9-14	13-14	13-15	17	13
Substrate	M. S.	M.	M.	M.	M.
Fauna	Ec.	Ec.	Ec.	Ec.	Ec.
Catch	54	55	63	18	47
Juveniles	20	5	2	-	41
Mussels	3	22	25	1	-
Oysters	1	15	40	3	-

*Towing speed too high. Dredge not on the bottom.

Record of dreding on the 4 January 1960*

Shot No.	1	2	3	4	5
Position	H	K2	K1	K4	K5
Duration	6.00-6.34	6.45-7.25	7.32-8.13	8.24-8.51	9.06-9.37
Depth	9-11	9	9	8	10
Substrate	M.	M.	M.	M. S.	M.
Fauna	Ec.	Ec.	Ec.	Ec.	Ec.
Catch	46	130	140	105	160
Juveniles	-	15	-	-	-
Mussels	14	23	14	1	4
Oysters	4	11	13	-	6

Shot No.	6	7'	8
Position	K5	J	G3
Duration	9.40-10.25	10.33-11.11	11.18-11.48
Depth	10-12	12-14	15
Substrate	M.	M.	M.
Fauna	Ec.	-	Ec.
Catch	80	3	70
Juveniles	-	-	-
Mussels	-	-	-
Oysters	8	-	4

*On the 5 and 6 January the dredge was fitted with a cod-end in place of the normal retaining bag.

'Shot 7. Speed to high, dredge not on bottom.

Meat yield (Gonad and Abductor muscle) 27 lb.

Record of dredging on the 5 January 1960

Shot No.	1	2	3	4	5
Position	G1	G1	G1	G1	G1
Duration	6.32-7.15	7.27-8.08	8.17-9.00	9.08-9.56	10.05-10.35
Depth	12-13	15	16	17	15-16
Substrate	M.	M.	M.	M.	M.
Fauna	Ec.	Ec.	Ec.	Ec.Br.	Ec.
Catch	170	95	220	97	68
Juveniles	25	50	112	100	65
Mussels	47	20	-	-	15
Oysters	23	46	36	10	22

Shot No.	6	7	8
Position	G1	G2	G2
Duration	10.47-11.19	11.28-12.8	12.18-1.03
Depth	14-12	13	12
Substrate	M.	M.	M.
Fauna	Ec.	Ec.	Ec.
Catch	72	55	107
Juveniles	15	-	-
Mussels	26	21	47
Oysters	12	10	19

Meat yield 33 lb.

Record of dredging on the 6 January 1960

Shot No.	1	2	3	4	5
Position	C	A3	A4	A4	A1
Duration	6.21-7.00	7.10-8.43	7.55-8.28	8.37-9.00	9.28-10.02
Depth	12-14	14-16	16	16	16-14
Substrate	M.	M.	M.	M	M.
Fauna	Ec.Br.	Ec.	Ec.Ho.	Ec.Ho.	Ec.
Catch	76	120	40	20	106
Juveniles	12	18	4	-	16
Mussels	52	37	10	3	43
Oysters	20	11	1	6	5

Shot No.	6	7	8	9	10
Position	A1	A1	A1	A1	A1
Duration	10.10-10.30	10.45-11.10	11.17-11.47	12.5-12.28	12.37-1.05
Depth	14	14	15-16	16-15	14-12
Substrate	M.	M.	M.	M.	M.
Fauna	Ec.	Ec.	Ec.	Ec.	Ec.
Catch	135	75	97	82	77
Juveniles	9	16	13	12	9
Mussels	32	39	25	18	20
Oysters	5	4	16	14	8

Meat yield 31 lb.

Record of dredging on the 7 January 1960

Shot No.	1	2	3	4	5
Position	A1	A1	A1	A1	A1
Duration	6.12-6.57	7.05-7.40	7.50-8.25	8.33-9.23	9.30-10.13
Depth	15	16	16	15	16
Substrate	M.	M.	M.	M.	M.
Fauna	Ec.	Ec.	Ec.	Ec.	Ec.
Catch	140	60	138	155	110
Juveniles	18	15	21	16	17
Mussels	26	58	34	45	37
Oysters	12	17	26	15	11

Shot No.	6	7
Position	A1	
Duration	10.25-10.55	
Depth	15-16	
Substrate	M.	
Fauna	Ec.	
Catch	123	
Juveniles	14	
Mussels	32	
Oysters	11	

Meat yield 34 lb.

Record for dredging on the 11 January 1960

Shot No.	1	2	3*	4	5
Position	E	A1	A1	A1	A1
Duration	6.00-6.33	6.41-7.17	7.23-7.55	8.03-8.33	8.43-9.24
Depth	9	11-13	13	14	16
Substrate	M.	M.	M.	M.	M.
Fauna	Ec.	Ec.	Ec.	Ec.	Ec.
Catch	75	82	24	76	146
Juveniles	12	11	-	18	13
Mussels	75	46	6	51	19
Oysters	14	17	-	12	12

Shot No.	6	7	8	9
Position	A1	A1	A1	
Duration	9.34-10.08	10.21-10.48	11.15-11.58	
Depth	14	11	11	
Substrate	M.	M.	M.	
Fauna	Ec.	Ec.	Ec.	
Catch	121	125	116	
Juveniles	4	17	10	
Mussels	21	1	15	
Oysters	8	4	6	

*Speed too high, dredge not on bottom.

Meat yield 40 lb.

Record for dredging on the 12 January 1960

Shot No.	1	2	3	4	5
Position	K2	K8	K12	L	M
Duration	7.40-8.31	8.40-9.15	10.03-10.19	10.47-11.02	11.20-11.47
Depth	13 -14	10	6	5	7
Substrate	M.	M. Sh.	Sh. S	Sh. S	Sh. S
Fauna	Ec.	Br. Ec.	M.	-[1]	-[1]
Catch	74	4	1	4	-
Juveniles	11	-	-	-	-
Mussels	25	-	-	-	-
Oysters	21	-	-	-	-

Shot No.	6	7	8	9
Position	N	O	K9	K9
Duration	11.55-12.28	12.35-1.10	5.46-6.32	6.40-7.25
Depth	17-18	17	10	10
Substrate	Sh. M.	Sh. M.	M.	M. Sh.
Fauna	Br.	Ec. Br.	Ec.	Ec.
Catch	10	16	110	97
Juveniles	-	-	-	-
Mussels	-	-	5	-
Oysters	-	-	-	-

[1] Bottom thickly covered with dead shell.

Record of dredging on the 13 January 1960

Shot No.	1	2	3	4	5
Position	K4	K4	K10	K5	K7
Duration	5.35-6.20	6.30-7.02	7.12-7.38	8.00-8.32	8.41-9.16
Depth	10	10	9-10	10	12
Substrate	M.	M.	M. Sh.	M.	M.
Fauna	Ec.	Ec.	Ec.	Ec.	Ec.
Catch	75	87	30	87	39
Juveniles	6	4	-	-	-
Mussels	21	26	2	24	10
Oysters	-	3	-	8	8

Shot No.	6*	7	8	9	10
Position	G1	G6	G1	G2	G2
Duration	9.39-10.16	10.25-11.00	10.13-10.35	11.42-12.24	12.33-1.25
Depth	15	18	16	14-15	15
Substrate	M.	M.	M.	M.	M. Sh.
Fauna	Ec.	Ec.	Ec.	Ec.	Ec.
Catch	22	80	78	90	50
Juveniles	-	-	4	-	-
Mussels	18	51	54	63	65
Oysters	29	8	4	12	10

*Dredge turned over.

Meat yield 12 and 13 January 37 lb.

Record of dredging for the 14 January 1960

Shot No.	1	2*	3	4
Position	A1	A1	A1	A1
Duration	5.57-6.20	6.38-7.09	7.20-7.55	8.03-8.36
Depth	11-12	14	14	13
Substrate	M.	M.	M.	M.
Fauna	Ec.	Ec.	Ec.	Ec.
Catch	45	40	111	54
Juveniles	-	-	15	9
Mussels	55	46	51	40
Oysters	7	6	10	10

*Retaining bag came adreft.

Meat yield 44 lb.

Record for dredging on the 18 January 1960

Shot No.	1	2	3	4	5
Position	A1	A1	A1	A1	A1
Duration	6.42-7.16	7.26-8.03	8.12-8.48	9.00-9.31	9.42-10.19
Depth	12	14	14-16	17	15
Substrate	M.	M.	M.	M.	M.
Fauna	Ec.	Ec.	Ec.	Ec.	Ec.
Catch	291	170	208	180	187
Juveniles	31	21	26	18	23
Mussels	42	38	34	29	47
Oysters	11	5	3	6	5

Shot No.	6	7
Position	A1	A1
Duration	10.29-10.58	11.10-11.50
Depth	14	14
Substrate	M.	M.
Fauna	Ec.	Ec.
Catch	197	205
Juveniles	24	14
Mussels	34	47
Oysters	7	2

Heat yield 63 lb.

Record for dredging on the 19 January 1960

Shot No.	1	2	3	4	5
Position	G2	I	J	K9	K9
Duration	6.05-6.44	6.54-7.35	7.45-8.28	10.25-11.08	11.16-12.02
Depth	13	13	14	8	8
Substrate	M.	M.	M. Sh.	M. Sh.	Sh.
Fauna	Ec.	Ec.	Br.	Ec.	Ec.
Catch	42	104	14	86	132
Juveniles	-	-	-	-	-
Mussels	6	42	10	6	8
Oysters	8	15	-	-	-

Record for dredging on the 20 January 1960

Shot No.	1*	2	3	4	5
Position	P	K9	K9	K9	K9
Duration	5.52-6.38	6.45-7.27	7.37-8.30	8.37-9.31	9.39-10.25
Depth	3-4	8	8	8-9	8
Substrate	M. S.	Sh. M.	M.	M. Sh.	M.
Fauna	Pol.	M. Ec.	Ec.	Ec.	Ec.
Catch	15	78	150	53	82
Juveniles	-	-	-	-	-
Mussels	-	21	17	15	17
Oysters	-	-	1	4	9

*As seen in the chart this shot was made very close to the beach. Encountered a dense association of mud tubes containing polychaete worms.

Meat yield 19 and 20 January 40 lb.

Record of dredging on 26 January 1960

Shot No.	1	2	3	4	5
Position	G5	G5	G5	G5	G5
Duration	6.14-6.50	7.00-7.34	7.43-8.21	8.30-9.10	9.18-10.00
Depth	8-10	9	9	10	10
Substrate	M.	M. Sh.	M.	M.	M.
Fauna	Ec.	Ec.	Ec.	Ec.	Ec.
Catch	107	191	219	240	169
Juveniles	-	-	-	-	-
Mussels	75	83	70	92	62
Oysters	42	26	31	27	64

Shot No.	6	7
Position	G5	G5
Duration	10.08-10.48	10.56-11.39
Depth	8-10	10
Substrate	M.	M.
Fauna	Ec.	Ec.
Catch	190	176
Juveniles	-	-
Mussels	73	64
Oysters	28	23

Meat yield 62 lb.

Record for dredging on the 27 January 1960

Shot No.	1	2	3	4	5
Position	G5	G5	G5	G5	G5
Duration	6.56-7.30	7.47-8.22	8.32-9.07	9.17-9.47	9.55-10.35
Depth	9	9	10-9	9	8
Substrate	M.	M.	M. Sh.	M.	M.
Fauna	Ec.	Ec.	Ec.	Ec.	Ec.
Catch	122	141	108	101	204
Juveniles	-*	-	-	-	-
Mussels	42	56	38	49	40
Oysters	11	35	25	19	22

Shot No.	6	7
Position	G5	G5
Duration	10.45-11.31	11.40-12.22
Depth	10	9
Substrate	M.	M.
Fauna	Ec.	Ec.
Catch	105	104
Juveniles	-	-
Mussels	85	64
Oysters	38	27

Meat yield 40 lb.

B. J. Webb

NEW ZEALAND MARINE DEPARTMENT.

FISHERIES TECHNICAL REPORT

No. 2

SCALLOP INVESTIGATION, TASMAN BAY 1959-60

J. H. Choat

WELLINGTON, NEW ZEALAND.

1960