B. J. Webb

NEW ZEALAND MARINE DEPARTMENT

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MUSSEL SURVEY HAURAKI GULF AND FIRTH OF THAMES 1958

BRIAN REID

WELLINGTON, NEW ZEALAND

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MUSSEL SURVEY

HAURAKI GULF AND FIRTH OF THAMES 1958

Brian Reid,

(Present location -
Wildlife Division,
Dept. Internal Affairs,
Wellington, N.Z.)

CONTENTS

I. SUMMARY

The Hauraki Gulf once contained extensive areas of mussel beds. Considerable commercial extraction during the last four decades has depleted many previously well stocked areas and the future is not promising.

It appears that more than abundant spat is required to re-establish a bed as spat may require hard objects to settle on before it will develop. Available information suggests that spat is plentiful and growth rapid, and yet the beds are not recovering as quickly as expected.

Annual catches over the last eight years show a steady increase. This is mainly the result of increased dredging effort to meet greater consumer demand.

A brief discussion is given on construction of dredges and their efficiency. This part of the report suggests that one Company has so perfected their dredging that their methods may be detrimental to the grounds.

II. INTRODUCTION

Originally the Hauraki Gulf and Firth of Thames contained extensive mussel beds (*Perna canaliculas*), but the level of extraction by commercial fishermen during the last four decades has so reduced stocks that commercial dredging has virtually ceased. The peak of the Auckland/Thames/Coromandel production was reached in 1961 with a total catch of 40,910 sacks. Since then catches have declined to reach an all-time "low" of 384 sacks in 1967.

This report outlines the position of the Mussel fishery in 1958 when, despite the rising catches, there were already indications of over-fishing and, although there appeared to be abundant spat-fall and rapid growth, the beds were not being replenished. It seems, from available information, that part of the failure of mussels to re-establish themselves was because of a lack of solid objects on which initial settlement could occur. This aspect is discussed as is growth, location, and density of the various beds and areas at that time.

A brief discussion is given on construction of dredges and their efficiency. It is thought that one type is so efficient as to be detrimental to the grounds.

The Hauraki Gulf/Firth of Thames mussel fishery in 1958 was dominated by two families, the Gundlocks and the Strongmans; much of the following report is derived from information supplied by them.

Although it is over ten years since the investigation was made it is thought that its publication will be useful if only for comparison with present day conditions and studies on mussels.

III. SPAWNING AND GROWTH RATE

(a) Spawning:

Captain C. Daniels, the District Inspector of Fisheries for Auckland between 1930-1944, recorded that mussels spawned from November to the following May, and Mr Tilby, when Inspector of Fisheries for Kaipara, stated the mussels of Kaipara Harbour spawned in August and early September. These observations when combined, suggest an extensive spawning period of approximately ten months for northern mussels.

(NOTE: The Tasman Bay/Nelson mussel fishermen advised Government of the desirability of a closed season for the taking of mussels from 1 November to the following 28 February to cover the local spawning season in the greater part. A regulation to this effect was gazetted on 11 November 1968).

(b) Growth Rate:

In late May 1956 the Gundlock Brothers placed a marker buoy on a mussel bed at Kaiaua. The buoy which was constructed from a 44 gallon drum, eight fathoms of holding chain and several feet of heavy ground chain was left for 30 weeks. When lifted on 20 December 1956 the drum and both chains were densely and evenly covered with mussels. Some mussels on the drum were located only six inches below the waterline, but irrespective of position from ground-chain to drum, the mussels at all depths were comparable in size. Measurements taken from 55 of these shellfish showed a variation in length from 0.35 inches (9m.m.) to 1.6 inches (41 m.m.). Such differences in size suggest mussels have a lengthy spawning period and/or a long free-swimming larval phase. Data on growth obtained from this buoy show that spat will settle and grow into mussels with shell length of 4.1 cm in 30 or less weeks.

During March 1958, in an effort to obtain a full growth curve in one year, 349 mussels were sorted into different average length classes and each class was placed in a separate galvanised mesh cage. Four cages were placed under the Putiki wharf on Waiheke Island and four were taken to Woolshed Bay, Coromandel Harbour. These mussels were remeasured on 8/8/58 after an interval of 22 weeks. During this period five small mussels died and 26 others were taken from cages containing the longer length classes. Data in the following table is based on the assumption that average length mussels were removed and if only the largest mussels were taken from each of the robbed cages the true growth increment for four inch and six inch mussels will be greater than the values given.

TABLE I MUSSEL GROWTH RATE (Inches)
Putiki and Woolshed Bay
7/3/58 to 8/8/58 (22 weeks)

Cage No.	No. Mussels	Average Length 7/3/58	- 8/8/58	Ave. Increase
1	97	(c) 1.51	2.43 (d)	0.92
2	62	(e) 2.03	2.84 (f)	0.81
3	51	(g) 2.80	3.48 (h)	0.68
4	43	(i) 3.47	4.07 (j)	0.60
5	34	(k) 4.14	4.60 (l)	0.46
6	25	(m) 4.42	4.83 (n)	0.41
7	20	(o) 6.03	6.20 (p)	0.17
8	17	(q) 6.28	6.44 (r)	0.16

Small letters, i.e. (c) refer to points on growth curve (Fig. C). Letters a & b on the graph refer to the 1.6 inches in length attained by spat in 30 weeks on the Gundlock marker buoy.

These data show the pattern and rate of growth (Fig. C.) that was attained by mussels in unnatural conditions and in the autumn and winter months only. Neither the pattern, nor the rate, may be typical of mussels in natural beds and it is not known whether there is any difference in seasonal growth rates. The extrapolated curve merely presents a possible growth rate which shows that at 2 inches (5.1 cm) a mussel could be about 40 weeks old; at 3 inches (7.6 cm) about 65-70 weeks; at 4 inches (10.2 cm) about 95-105 weeks; at 5 inches (12-7 cm) about 140-160 weeks; and at 6 inches (15.2 cm) about 220-240 weeks old.

IV. LOCATION AND DENSITY

In 1958 mussels were still widespread and in places abundant in the Hauraki Gulf and Firth of Thames. Wherever dredging took place in these waters at that time either mussels or broken shell from previous beds were obtained. Although widespread, however, the mussel beds were not of equal density and despite the presence of some well-stocked areas there was evidence that some beds were worked out. The latter condition was especially noticeable in the case of beds easily located by prominent land-marks. These beds once known were worked extensively and yielded good catches until fished to exhaustion. (See Figs A and B).

The following notes are given of the mussel stocks in the various areas in 1958:

(a) Auckland Coastline:

(i) Rangitoto Channel still contains fairly extensive and well-populated mussel beds although some 9,000 sacks have been extracted. These beds have not been worked in the last two or three years. Apparently, shortly after commercial operations commenced, rock oysters picked at Rangitoto Island were found to be infected with *Salmonella* bacteria and operators ceased mussel dredging as the mussels, too, could be infected. The mussels extracted were stated to be large and in good condition. It was claimed that large numbers were left when dredging ceased.

(ii) Islington Bay lies between Rangitoto Island and Motutapu Island and at one time contained good mussel beds of limited area. These beds have not been dredged for some time and their present condition is not known.

(iii) Tamaki Strait. The mussel beds in this area originally contained moderate stocks. These beds were lightly exploited but have not been fished, other than sample tows, for several years. Dredge shots, even on virgin grounds, were never rewarded with full "bags" except in some areas along the coastal margin off and adjacent to BEACHLANDS on the south coast of WAIHEKE ISLAND where reasonable catches were formerly obtained.

(iv) Ponui Island. Extensive beds lying to the east and south of Ponui Island have been worked sporadically for the last thirty years. These are now showing signs of depletion. During the present season (1958) the beds have not been touched.

(v) Ponui - Thames. The main source of supply of large mussels for many years was a long narrow bed which extended along the 10 fathom line from approximately south-east of Ponui Island to the mouth of the Thames River. Mussels up to seven inches long and one pound in weight were apparently common at one time, and good quantities were taken commercially for many years. At present, however, the beds contain moderate to poor stocks of small mussels.

(vi) Orere Point - New Brighton. This area contains extensive mussel beds and has been the main source of supply for the last three or four years. The mussels average 3 to 4½ inches in length and generally are in good condition. The two operating Auckland mussel dredging vessels average about four sacks per 5 to 8 minute tow on these beds.

(vii) New Brighton - Thames. This stretch of shallow water along the head of the Firth of Thames apparently never contained really dense mussel beds. Nevertheless the weight of shellfish taken was large mainly because of the extent of the area populated and it being adjacent to the landing port of Thames. This latter feature permitted proportionally more time on actual dredging and less on steaming which, in turn, compensated for both the small size of mussel taken and the smaller catch per towing time. These beds are seldom worked now.

(b) Coromandel Coastline:

At one time mussel beds varying in abundance extended along the whole of the Coromandel coastline from Te Puru to Colville Bay. This stretch ofcoastline had the most abundantly stocked beds in the Hauraki Gulf area. Over the years these beds were the most extensively exploited and are now the most depleted. The localities of greatest one time abundance are discussed below.

(i) Tapu - Waiomu. A fairly extensive bed that once contained abundant mussels. This bed was heavily exploited and today the population density is only moderate. Stocks are still sufficient, however, to support commercial activities and in December 1956 one mussel dredging operator reported these beds as being the most productive on the coast. Local opinion held that stock would increase if the beds were left alone for a while.

(ii) Waikawau. This was a small bed, at one time heavily stocked with large 5-6 inch mussels, and able to be dredged to within 150 yards of the shore. The bed was narrow and ran at right angles to the coast. It was a bed with "peculiarities" since it was best worked by vessels towing with the ebb tide. According to one commercial operator, who carried out some sample dredging in December 1957, it no longer paid to dredge this bed as very few mussels remained.

(iii) Kirita Bay. This area formerly included a medium-sized bed which ran along the coast. It then contained average to large-sized mussels, but is now barren.

(iv) Mania - Cow Island. The mussel beds here were originally well stocked but over-exploitation has reduced the number of shellfish and commercial dredging is now uneconomical.

(v) Kikowhakarere Bay. This Bay and its environs yielded what were probably the highest catches per acre of any known mussel beds. Today it is believed to be the most depleted. The mussels, when present, were concentrated around the bay margins, and around the headlands and adjacent islands. The more central part of the bay, despite a bottom of soft mud and plenty of weed, carried beds of mussels of lesser density than those around the margins.

This bay was one of the areas worked methodically and almost continuously for several years by local commercial operators, and Auckland based boats also made heavy catches at this time. The combined efforts resulted in depletion and in December 1956 one Auckland boat dredged only 1½ sacks from 14 tows.

(vii) <u>Colville Bay</u>. The mussel beds from Kikowhakarere to Colville Bay carried only moderate stocks and were only lightly dredged on occasions. North of Colville Bay mussels were never dredged in any quantity although Danish seine boats recorded their presence from time to time.

V. DISCUSSIONS

The preceding notes being based on honest but undocumented testimony of mussel fishermen give only an approximately correct account of the location and history of the Hauraki Gulf/Firth of Thames mussel beds to 1958.

The picture is not promising since it appears that the shellfish are not re-establishing themselves on depleted areas. Many areas in Hauraki Gulf, and along the Coromandel coast in particular, contained dense mussel stocks at one time, but although many of these beds have not been worked (other than periodic tows) for some six to ten years, they have failed to become re-populated to their former density.

The Coromandel fishermen hold interesting views to account for the present lack of mussels along the local coast. These explain, at least in part, the state of depletion of many formerly well stocked beds. It is held that although the mussels are on, or embedded in the mud, they only initially established themselves by attachment to hard objects. Thus the origin of extensive beds was along the rocky coastline. From these fixings and those on adjacent rocks and reefs, the mussels spread gradually over the sea-floor by attachment to other vessels or clusters of these shellfish. With successive spawnings there was, in time, the formation of extensive dense beds as spat settled on and attached to the continuously firm base of large dead shells. With continued dredging, however, most of the stock was removed except for narrow zones around rocks and reefs, This left little attachment surface on which spat could settle as most of those mussels which at the end of their free-swimming larval period settled on soft ground perished by being smothered. If hard rubble was dumped near or on some depleted and uneconomic beds and then if these were not fished or disturbed for many years they may re-establish through slow colonization spreading from those pockets of mussels remaining on and around rocky outcrops.

In support of the above theory one fisherman stated that he dredged nothing during trial drags in Kikowhakarere Bay except from logs and other hard debris which carried a dense covering of mussels from one to five inches in length. This suggested the presence of ample quantities of spat for re-stocking the former beds. He also reported having undertaken dredging between various rocks which would not be exploited normally because of damage to gear. He found good quality mussels of large size, many having smaller mussels adherent. My observations on mussels brought up in dredges substantiate this view. These frequently come up in clusters which often contain one or two large empty shells that form a solid base to which live mussels of all sizes are attached. The large empty shells once contained live fish, but are retained in the cluster by the attachments and connections formed by the byssal threads of the live mussels.

A second theory is based on the position of the mussel axis relative to the terrain. The mussel is a filter-feeder and normally has its distal end exposed in the water to allow full functioning of the inhalent and exhalent siphons clear of the soft and muddy bottom. If turned upside down the mussel dies through smothering and inability to feed. It was stated that the Auckland mussel dredges, with a scoop-line action and a quick tow-rate, ploughed along the bottom and scooped the shellfish into the "bag". However, any clusters which the knife-edge or "bit" struck above their mid-line were just as likely to be turned upside down as collected, and the dredge would ride over the top of them. Many, if not all, so displaced would be smothered and probably die.

There are two points of interest to be raised before closing this part of the present investigation:

(a) One of the Coromandel mussel dredgers recently carried out trial tows from Colville Bay to Tapu without recording any mussel beds of marketable value. Many of the few mussels dredged were black and slimy inside.

(b) Also of interest was that limited quantities of mussels exist in 25-30 fathoms. One dense bed was located off Cow Island in 16-18 fathoms.

VI. ANNUAL CATCH AND VARIATION

(a) Fig. B. shows the annual commercial extraction of mussels from the Gulf and Firth from 1943 to 1956 inclusive. There was a gradual decline in the annual catch from 1943 to 1946. This coincides with and is partly accounted for by the depletion of the Coromandel beds. These beds were worked fairly consistently up to 1946 even though catches in terms of sacks per trawling time were decreasing. The increased catch in 1947 is due to two additional boats dredging. The "Roa" which had been taken over by the Navy was now operating. The very low catch in 1946 is only partly due to the depletion of the Coromandel beds as during that year there was a period of 2 or 3 months, during the spawning season, when due to their very poor condition virtually no mussels were landed. During 1948-1950 catches were fairly constant. The size of the catches during these years was determined by two main factors:

(i) Meeting a consumer demand which was stable and not excessive.

(ii) The boats were working and trying various former beds and exploring possible new areas in the hope of locating profitable mussel beds.

From 1950 to the present day there has been a noticeable increase in the weight of mussels extracted each year. In 1954, the year in which solid exploitation started on the Kaiaua beds, the annual catch increased by more than 6,000 sacks. Prior to 1954 much time was spent trying the various known beds and many netted good catches compared with the Coromandel beds, but none had the abundant stocking of those off Kaiaua which, consequently, have been consistently and profitably worked since. The total mussel catch will probably be down for 1957 because of their poor condition during the first three months of this year.

During the 12 months ending on 31/3/1957 the Auck-Coromandel Mussel Co. landed 578 sacks less than they did for the year ending 31/3/1956. This is only a decrease of 2.8% during a year in which there was no extraction for 3 months, (January, February and March). It is usual for mussels to lose some condition at the peak spawning period but they are generally "fat" enough to be acceptable. Because of this and of a reduced demand over the holiday period catches are usually lower at this time of the year, but during the first 3 months of this year their condition was such that they were not worth harvesting. This very poor condition is atypical and was last recorded to the same extent in 1946. This is of interest, as it was during both these years (1946 and 1956) that the fishermen had to dump a high % of their snapper catches because of the thin, soft milky condition of the flesh.

(b) Discussion.

Over the last 8 years (1949-1956 inclusive) there has been a steady increase in the weight of mussels landed from the Gulf and Firth: From 12,806 sacks in 1949 to 30,849 sacks in 1956 - an increase of 140% approximately. There were two boats working in 1949 and six boats working in 1956.

These figures suggest mussel stocks will continue to meet the demand, but, in effect, all they show is a far greater exploitation of this fishery.

The Auck-Coromandel Mussel Co. catches for the last 6 years are more significant (see graph) as during this period their fishing gear has remained constant and yet the catches have noticeably increased.

In looking at the trends in the annual extraction of mussels over the last eight years it must be stressed that the quantity removed is mainly the product of greater fishing effort to meet an annually increasing consumer demand. This increased extraction in no way indicates an increase in the number of mussels surviving on the beds.

VII. DREDGING - METHODS AND GEAR

(a) Efficiency of Dredging - "Roa" (Ak.50) and "Wee Pat" (Ak.51)

These boats, both owned by the Auck-Coromandel Mussel Co., are efficient units and their efficiency is comparable on well stocked beds, but on beds with a sparse population the "Roa" drags approximately twice the weight of mussels as does the "Wee Pat" in a tow of comparable time.

Both boats are of similar length, beam and draught. The "Wee Pat" draws roughly 9 inches more water giving her a better grip for towing but this is more than offset by the horse power of the "Roa". The "Wee Pat" is powered by a 40 h.p. Ruston engine whereas the "Roa" is equipped with a 72 h.p. Gardner engine. This increased horse power gives the "Roa" greater pulling efficiency, enabling her to tow a 9 ft wide dredge while the "Wee Pat" drags a 7ft 4 in. dredge.

The "Wee Pat" has the power needed for obtaining good catches on well stocked beds, but where the beds are thin and it is necessary to scoop deeply her efficiency drops sharply because of insufficient power. The "Roa" has the power to drag a well sunken dredge.

(b) Types of Dredges used for Musseling (See Figs. 1 and 2)

Fig. 1 is a sketch of the Gundlock dredge.

Fig. 2 is a sketch of the Strongman dredge.

Both of these dredges are similar in construction, having a bag made from 4 in. Cyclone wire mesh, the top and bottom halves of which are joined by a light chain mesh along either side. Chain, in preference to wire, is used as it makes the bag more flexible. The mouth-piece is made from either 1 in, $\frac{3}{4}$ in., or $\frac{1}{2}$ in. flat iron depending on the size of the dredge. This is oblong in shape and has either a single or double half-loop at each side. These loops act like sledge runners and also keep the front of the bag open, especially when the mouth is tilted from the vertical.

(c) <u>Differences between the Strongman and Gundlock Dredges</u>
These differences are important as they, along with the fact that the Gundlocks tow faster, account for the Gundlocks successful extraction of mussels from areas regarded as finished by the Strongmans.

(d) <u>Differences include</u> -
The towing arms of the Gundlock dredge (Fig 1) are attached to the top corners of the mouth and set at an angle so that during normal towing (length of warp : depth of water 3:1) the mouth of the dredge is either perpendicular to the bottom or else inclined so that it faces slightly downwards. On the Strongman dredge (Fig. 2) the two towing arms are attached to the middle of the uprights forming the sides of the mouth and they are at right angles to the plane of the mouth. During normal towing the tow bar will be pointing diagonally upwards and therefore the mouth of the dredge will be inclined upwards. It will tend to ride over many mussel clusters or alternatively only scoop the higher clusters. From the above - the Strongman dredges works like a plane while the Gundlock dredge works like a scoop. Also, the Gundlock dredge can be lowered only one way, but the Strongman dredge, having a dorso-ventral symmetry, would dredge equally well if it was shot upside down.
Though the dredges were of similar construction, the Strongman dredge was stiffer and was less inclined to fold into the pockets between mussel clusters from where it would be in a good position to scoop the next cluster.

(e) <u>Effect of these Differences on Towing Efficiency</u>
Irrespective of the length of warp run out for any depth of water the Gundlock type of dredge appears to be more efficient than the Strongman dredge. (See Figs 3 to 7).

(f) <u>Effect of Water Flow on Dredge Performance</u>
Trawlermen have a saying - "You only tow against the tide when there is none" - as in towing against the tide the gear is likely to be lifted off the bottom or the mouth of the gear inclined upwards due to the pressure of water exerted against the front undersurface of the warp. With a set dredge a given stream flow may raise the knife edge slightly above the ground, but with a dredge with no set this pressure flow could make it completely inefficient. (Figs 8a and 8b)

Towing with the tide has the opposite effect as water pressure against the back of the warp bows the warp forward of its two points of attachment and in so doing arcs the towing bar and knife edge downwards. This places the knife edge in a better position for scooping the mussels. (Fig 10a and 10b).

Even the dredge without any set could have its mouth inclined downwards if it was towed in and with a sufficiently strong current, and with enough warp out to provide the surface area for this current to push upon. (See Fig. 11). Earlier in this report it was stated that the Waikawau mussel beds could only be towed with the ebb tide. This bed contained a dense population of large mussels. Presumably the mussels must have been fairly deeply bedded or so evenly spread that a good bite (as obtained when towing with the tide) was necessary to lift them out.

(g) Discussion -

It is doubtful if the Gundlock type dredge could be improved upon as a means of exploiting mussels. If it was made after the style of the scallop dredge with a set on both the tow bar and the knife edge and this edge also has a series of teeth along its front margin, it would probably scoop deeper, but even so, it appears to be of such efficiency as to denude the grounds to an extent that re-establishment is uncertain. This may make it more destructive on the beds without making it more efficient at lifting mussels.

VIII. ACKNOWLEDGEMENTS

I wish to acknowledge the help of the Marine Department in publishing this report and in particular Mr J. H. Sorensen and Mr D. T. Williamson fortextual and diagram revision.

IX. LIST OF FIGURES

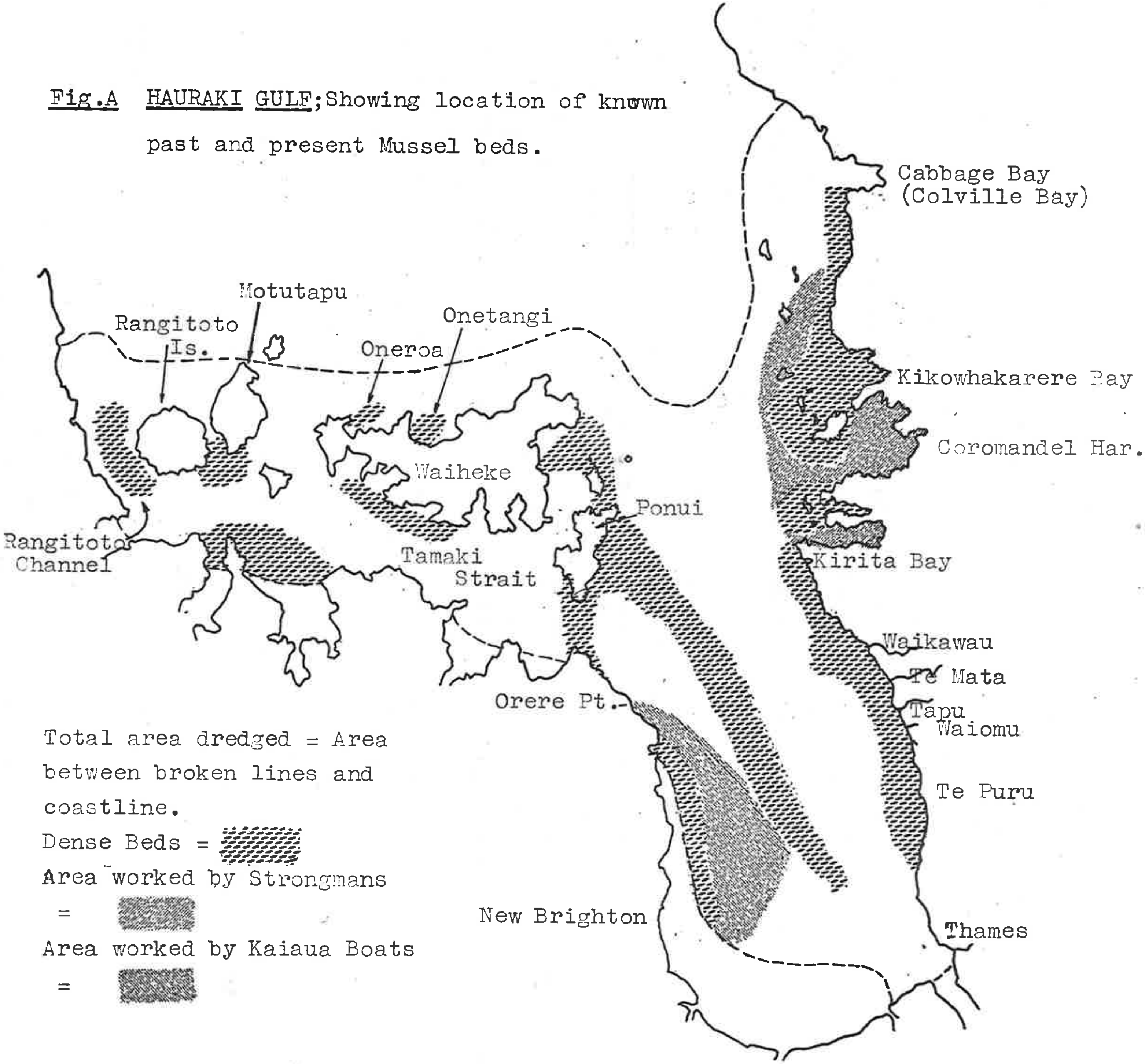
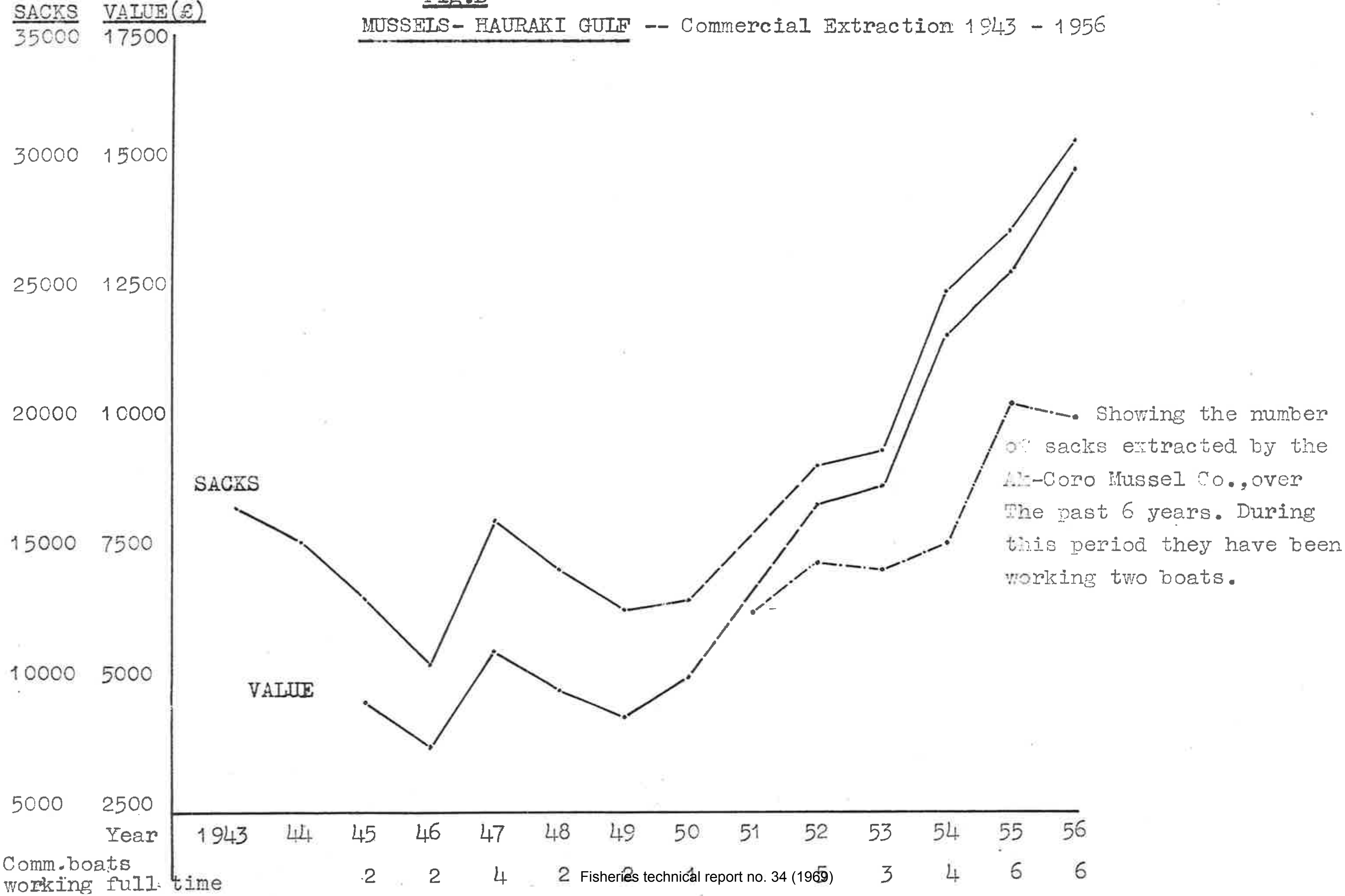


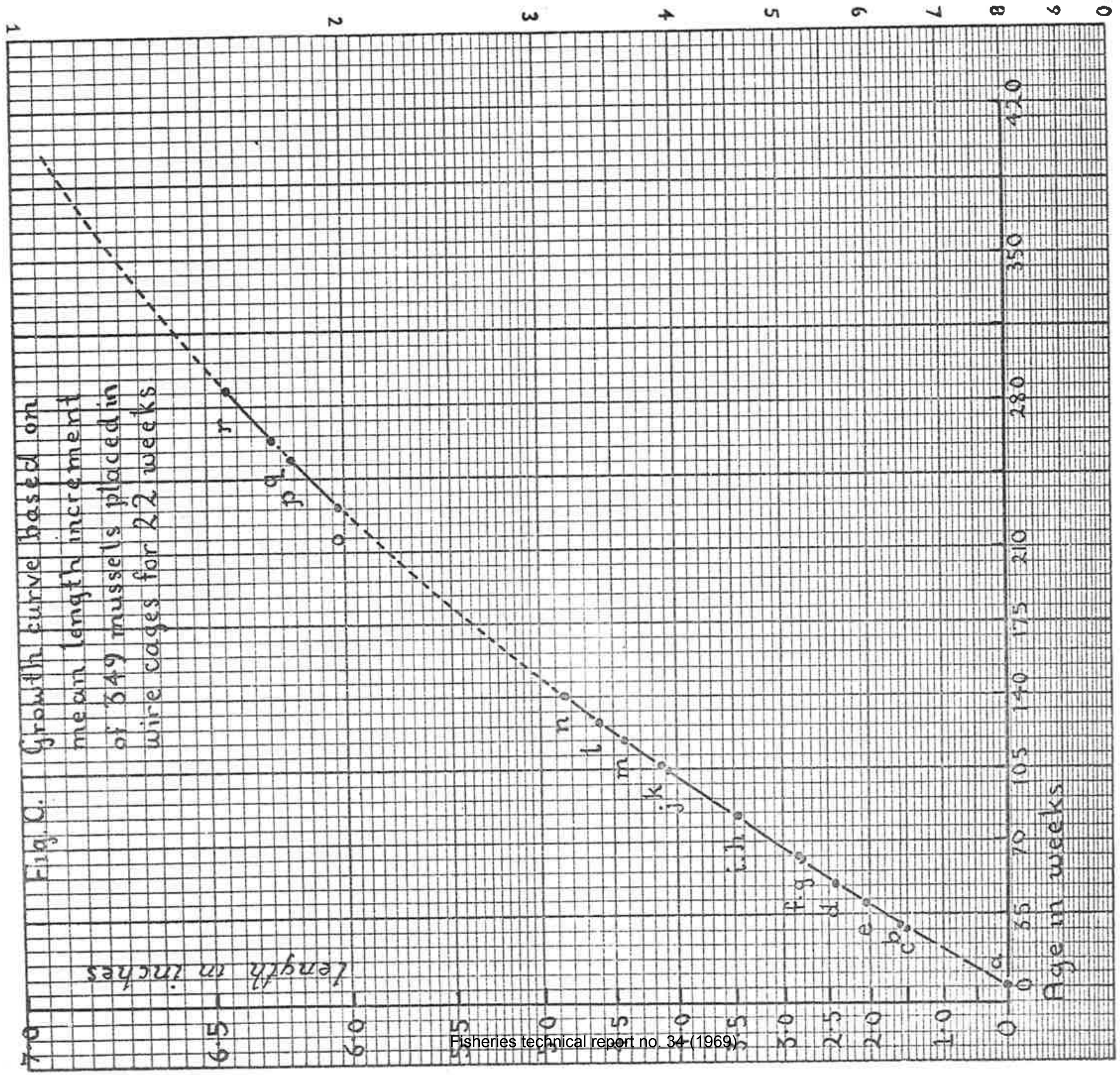
Fig.A **HAURAKI GULF**; Showing location of known past and present Mussel beds.

Fig.B

MUSSELS- HAURAKI GULF -- Commercial Extraction 1943 - 1956

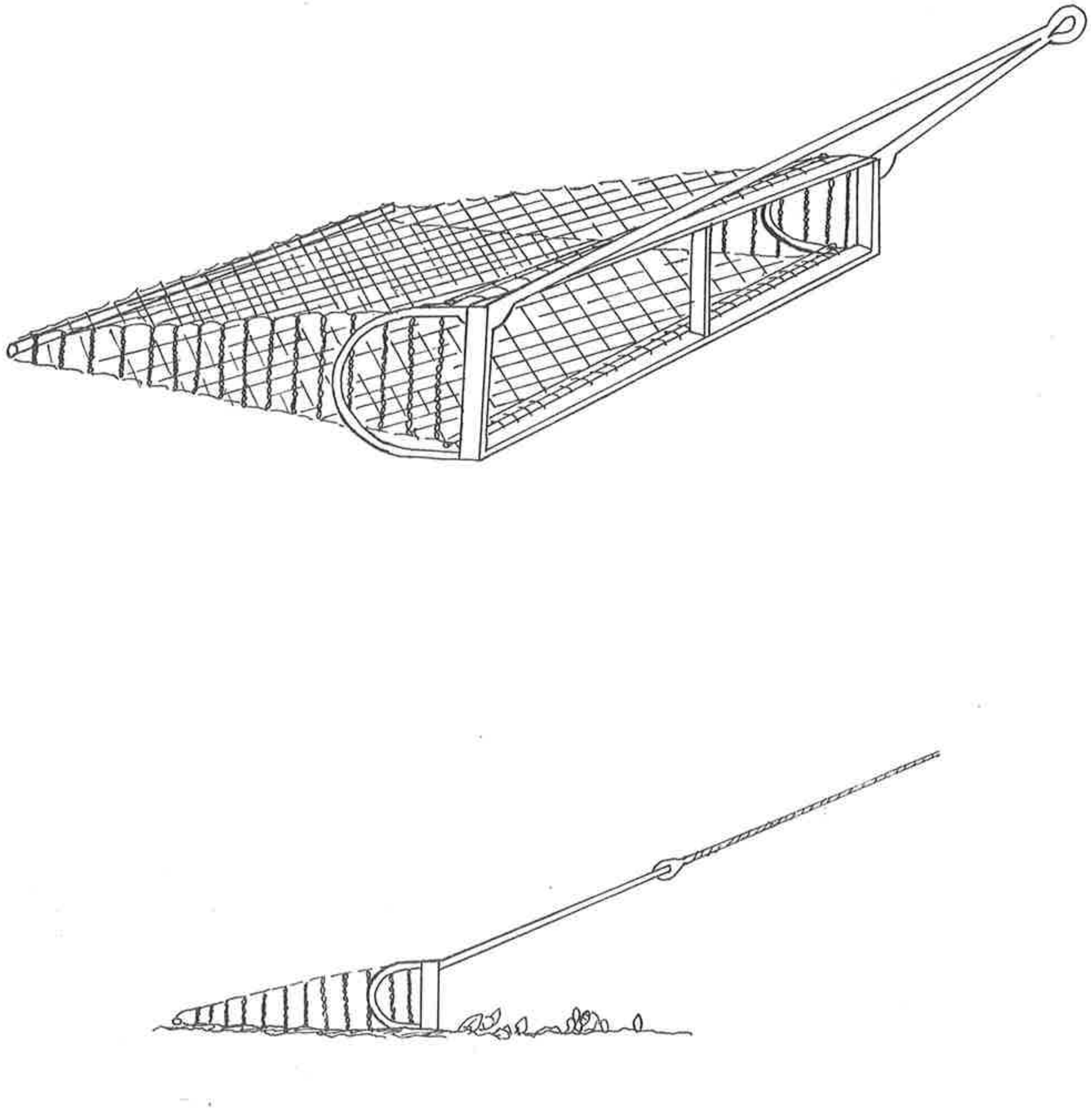


No. 3A: Logarithmic, 1 cycle x inch



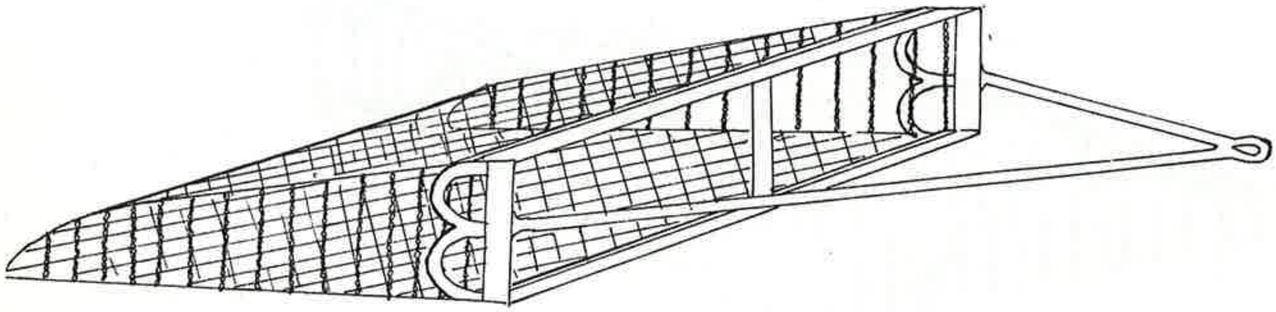
Types of dredges used on the Hauraki Gulf and Firth of Thames.

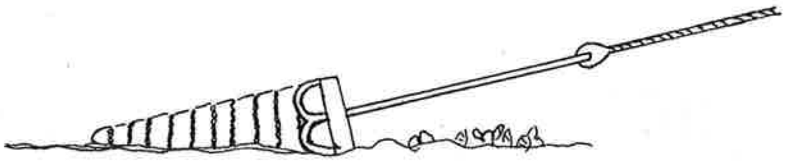
Fig.I. Gundlock type.



Types of dredges used on the Hauraki Gulf and Firth of Thames.

Fig.2. Strongman type Dredge.





Comparison of the Gundlock and Strongman Type Dredges.

Fig.3, Gundlock Type Set Dredge - position of mouth when Approx. 2:I (length Warp-depth water) The mouth is inclined upwards and would only collect the more superficial mussels.

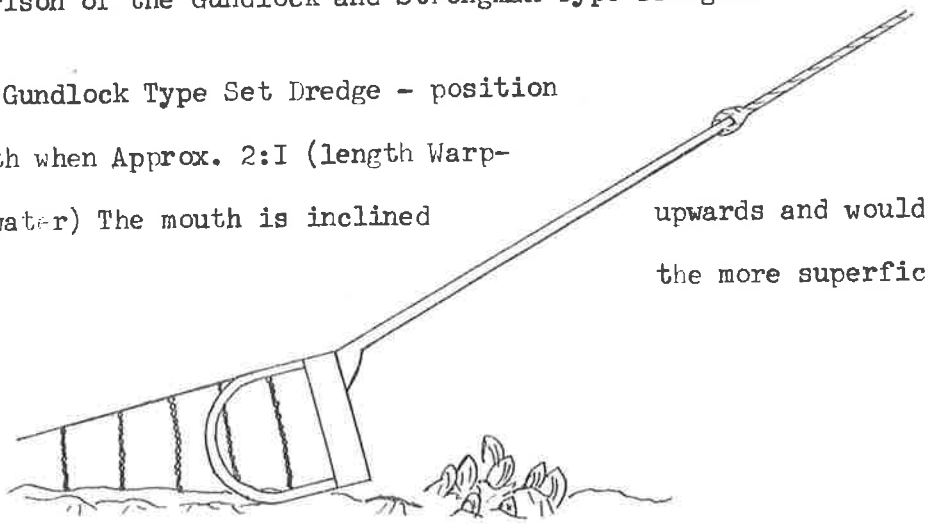


Fig.4. Gundlock type set Dredge - position of mouth is vertical during normal 3:I towing.

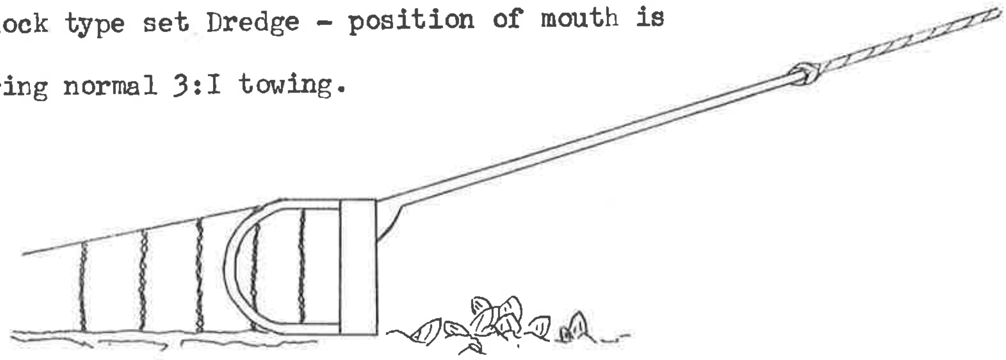
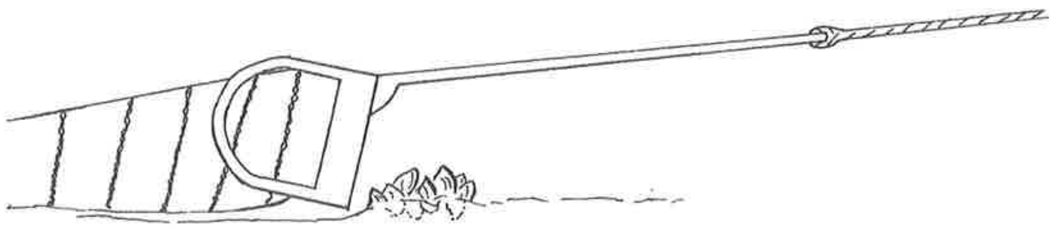


Fig.5. Gundlock type set Dredge - if plenty of wire is given, the mouth is inclined downwards and bites in. If the power is available to drag the dredge in this position, virtually everything is collected,



Comparison of the Gundlock and Strongman Type Dredges.

Fig.6. Strongman type Dredge (no set) - Mouth is inclined upwards during Normal 3:I towing and the dredge would tend to ride over many clusters that the set dredge would collect.

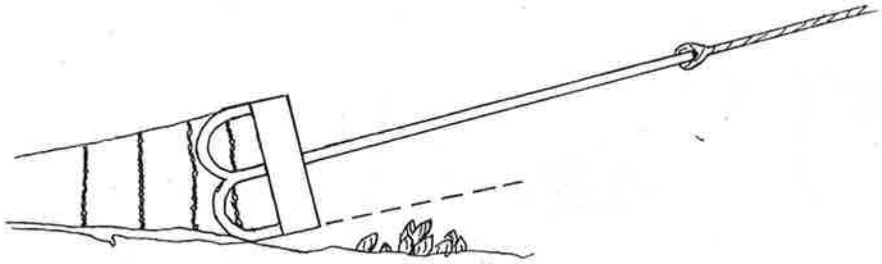
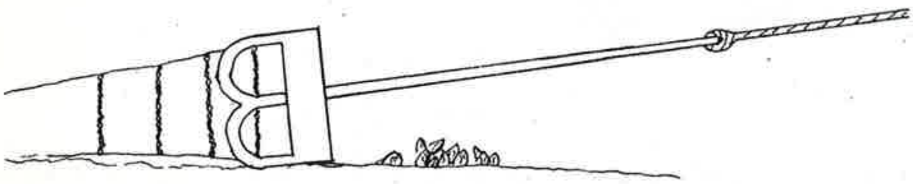


Fig. 7. Strongman type dredge with same length of warp as in no.5. Whereas the set dredge pictured in no.5 is biting in well, this dredge is inclined slightly upwards and is probably not as efficient as the set dredge pictured in no.4.



These last 5 sketches are only diagramatic and refer only to slack water. None the less, they show how the Set Dredge is more efficient in that it can be made to bite right in.

Effect of Water Flow on Dredge Performance

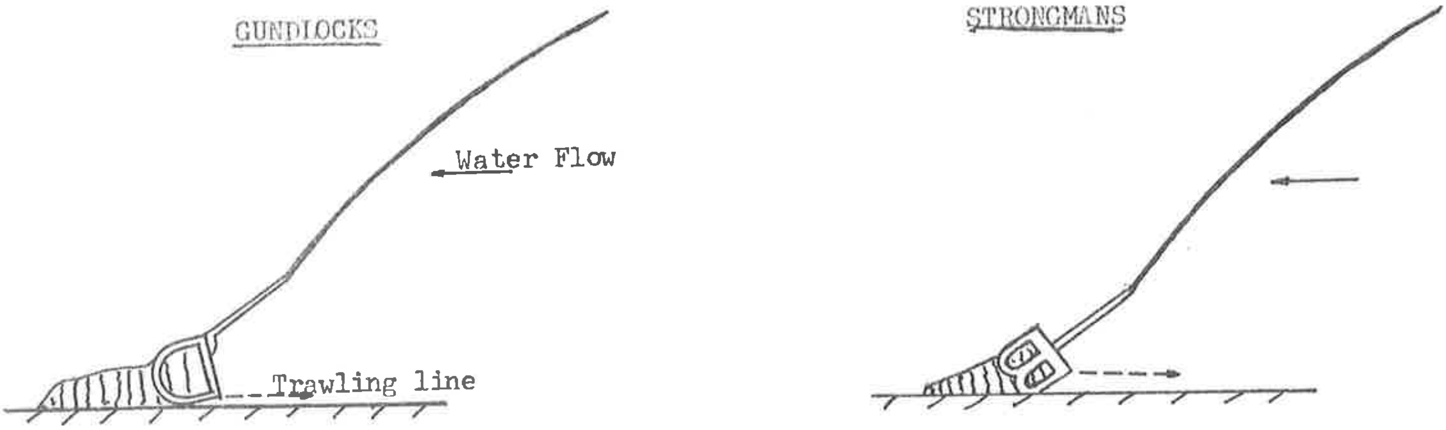


Fig 8(a) (b)

Towing against the tide- Water flow lifts the warp, raising the tow-bar and Dredge Mouth.

Fig 9(a) (b)

Slack water towing- Dredge mouth lined up according to set of the Tow-bar.

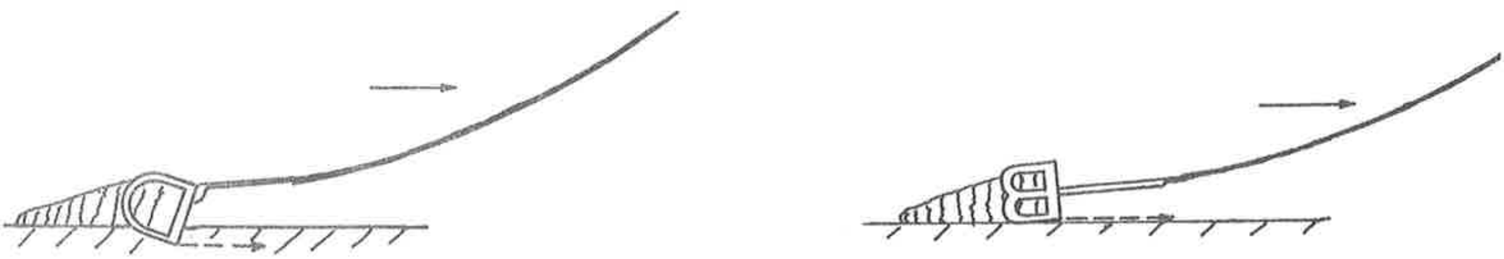
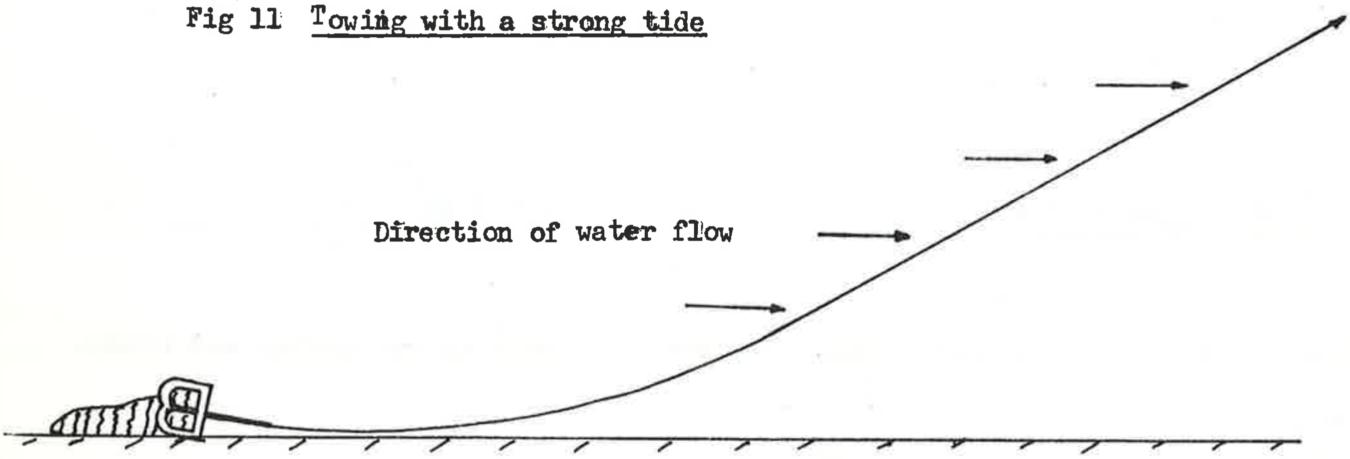


Fig 10(a) (b)

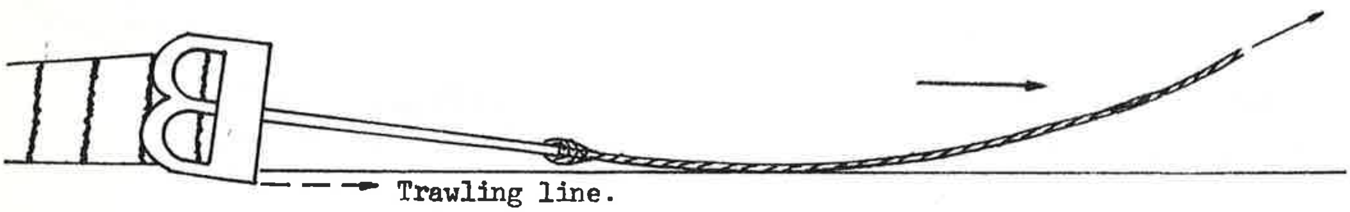
Towing with the tide- Water forces the warp forward and the trawl mouth down so That it gets a good bite into the bottom.

Effect of water flow on Dredge Performance

Fig 11 Towing with a strong tide



If there is enough warp out to provide an adequate surface area for the water flow to exert itself on, the bottom part of the warp may drag along the ground. In such a case even a dredge with no set could bite into the bottom.



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