NEW ZEALAND MARINE DEPARTMENT

FISHERIES TECHNICAL REPORT
No. 61

A PRELIMINARY SURVEY OF MUSSEL STOCKS IN PELORUS SOUND

D. H. STEAD

WELLINGTON, NEW ZEALAND
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DECEMBER 1968 - JANUARY 1969

D.H. STEAD

FISHERIES DIVISION

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CONTENTS

SUMMARY

The survey was made to determine the distribution and abundance of the green-lipped mussel Perna canaliculus in Pelorus Sound with a view to regulation of the fishery. Other shellfish species were also examined.

Dredge samples were taken at a total of 56 stations during the survey and most of the shoreline of the Inner Sounds out to Tawero Point was examined.

The commercially dredged areas off Skiddaw and Weka Point in Kenepuru Sound showed signs of depletion, though several unexploited and well stocked areas of Perna were found in shallow water on a rocky substrate along the shore, mainly in Kenepuru Sound.

Several well-stocked areas of Perna were also found in the intertidal zone, mainly in Kenepuru Sound and in Nikau Bay.

Methods which may prevent depletion of Perna, and lead to a more rational exploitation are outlined. Unexploited stocks of the blue mussel (Mytilus edulis aoteanus) would also support a limited fishery.

INTRODUCTION

According to local reports and available statistical data, (Table 1) the edible green-lipped mussel, Perna canaliculus, was first dredged commercially in Pelorus Sound by a boat from Havelock in 1962. Other boats worked in 1963, but there was only a limited commercial exploitation during the following two years. In 1966 several Havelock boats dredged the grounds in Kenepuru Sound.

Other vessels, mainly from Nelson, also entered the fishery at that time, and during 1968 up to eleven boats dredged the mussel grounds. Most vessels towed two dredges ranging from 4½' to 8' width.

Under the present system of fisheries de-licensing there is no Government restriction on the number of boats entering the fishery and it was feared by some that mussel stocks in Pelorus Sound were becoming depleted and that dredging was detrimental to snapper fishing and thus to the tourist trade.

In 1968, as a conservation measure, the area within harbour limits (Tawero Point to Whakamahawahi Point - Map 1) was closed to dredging. Hand-gathering of mussels only was permitted and the season was closed from 30 November to 1 March.

Experimental mussel farming, using suspended spat settlement devices and small rafts, has been carried out since mid-1968 at various sites in the Sounds by the Zoology Department of Victoria University (D.E. Flaws, 1969).

The landings (whole weight) of mussels from the Sounds are shown in Table 1.

TABLE 1

Landings of Mussels (Perna) - Marlborough Sounds

Year	Whole Weight Cwt.
1962	68
1963	624
1964	-
1965	24
1966	100
1967	146
1968	7,721

The purpose of the December 1968 - January 1969 investigation was to obtain factual information as a basis for future management of the commercial fishery in the Sounds area.

Maps 1-3 show the area under investigation.

The two main species examined during the survey were the green-lipped mussel (*Perna canaliculus*) and the blue mussel (*Mytilus edulis aoteanus*).

AIMS OF THE INVESTIGATION

(i) To map the occurrence and extent of beds of Perna suitable for commercial exploitation by dredging.

(ii) To map the occurrence of stocks of Perna suitable for hand-gathering.

(iii) To assess the commercial potential in the Sound of other shell fish including blue mussels (Mytilus edulis aoteanus) horse-mussels (Atrina zelandica), scallops (Pecten novaezealandiae) and mud oysters (Ostrea lutaria).

(iv) To assess the size of stocks.

(v) To obtain data on population structure and condition of edible mussels in different areas and to collect biological information, relevant to management of the fishery.

(vi) To devise a system of management most suited to this fishery.

METHODS

The fishing vessel "Gleam" (Plate 1) 42' in length, and equipped with commercial mussel/scallop dredges, was chartered from 16 - 20 December and from 21 - 24 January 1969. Most dredging was carried out during the first survey when 50 of the total of 56 dredge samples were taken.

The presence of inter-tidal mussels was recorded, and samples were obtained by hand.

A single 8' wide commercial dredge (Plate 2) was used to obtain sublittoral samples. The dredge was towed for 10 minutes at each of the stations shown on Map 2.

The shell length in centimetres, of all dredged Perna and Mytilus was recorded except when catches were too large to handle when a 4 gallon random sample was measured.

Mussel samples from selected areas were steamed open and data on flesh weigh and condition were recorded.

Other data recorded at each station included:- supports to which mussels were attached, spawning condition of mussel, presence of parasites and predators, abundance of dead mussels, associated fauna, bottom type, and any shell damage caused by dredging.

Sea surface temperatures were recorded at some stations.

RESULTS

GREEN MUSSEL (Perna canaliculus)

(a) Distribution

Map 3 shows dredge and shore observation stations with an assessment of the stocks present.

Those areas which have been commercially dredged for Perna are marked on the map; nearly all commercial dredging had occurred on two areas in Kenepuru Sound. One area is several hundred square yards of mud bottom overlain by broken shell and coral about 50 - 100 yards off-shore from Skiddaw (Map 3) in about 5 - 6 fathoms. The other area lies to the north-east of Weka Point and covers about one nautical square mile of mud bottom 4 - 9 fathoms deep. Mussel distribution is patchy however, and the best catches are taken close inshore.

Dredging ceased on the Skiddaw grounds when catches declined in 1967, but boats continued working the Weka Point grounds.

The distribution and density of Perna on these commercial grounds is not known but examination of dredge contents suggests a scattered distribution of clumps of Perna up to about 10, held together by byssus threads. (Plate 3). In most cases small mussels were attached to a large specimen or to dead mussel shell, the latter often showing evidence of having been partly buried in the mud.

Some fishermen say mussel ground is commercially profitable if a 30 - 45 minute tow with a large (8')

dredge yields over one case (over 100) marketable (longer than 4½") mussels.

During the survey 10 minute tows were made and when over 30 marketable Perna were taken the ground was noted as commercially fishable. Previously unexploited areas where Perna in commercial quantities were taken by the dredge or observed in shallow water are shown on Map 3, together with areas where Perna occurred in non-commercial quantities.

TABLE 2 shows the number of Perna taken by the dredge at each station (Map 2).

Station	No. of Perna	Station	No. of Perna	Station	No. of Perna
1	75	21	71	41	0
2	47	22	27	42	0
3	115	23	18	43	32
4	0	24	32	44	0
5	0	25	6	45	0
6	0	26	3	46	0
7	3	27	59	47	0
8	5	28	8	48	0
9	7	29	17	49	11
10	48	30	55	50	2
11	31	31	0	51	0
12	0	32	48	52	0
13	38	33	27	53	0
14	37	34	0	54	0
15	38	35	11	55	0
16	12	36	0	56	2
17	46	37	5		
18	13	38	0		
19	22	39	0		
20	13	40	24		

Dredge hauls in deeper offshore areas other than the main grounds did not indicate the presence of Perna in commercial quantities. Most survey dredging was confined to areas close inshore, usually shallower than 3 fathoms and on a firm shelving bottom. In some of these sub-littoral areas good catches of high quality Perna were taken by the dredge (See Table 2 and Maps 2 & 3).

Positions where Perna were seen on the shore at low water were also marked on Map 3 according to their estimated potential for hand-gathering. The density of large Perna often exceeded 70 per square metre. (e.g. some exposed rocky headlands in Kenepuru Sound and Nikau Bay). They also occurred frequently, individually and in clusters, along cobble or boulder-strewn beaches.

Plates 4 and 5 show Perna from different sample stations.

Kenepuru Sound

Perna were widely distributed in this Sound, with several patches, mostly in the shallow sub-littoral region within about 20 yards of the shore, estimated to be of commercial standard. Perna were also seen in variable densities around the low water mark along most of the shore line, and they occurred in high densities around headlands, rocky outcrops and islands such as Weka Point, Schnapper Point, Clark Island, Puketea Bay, and Portage Bay.

Mahau Sound

A limited amount of dredge sampling and visual sighting revealed a small population of Perna in this Sound, with only one sample area estimated to be of commercial standard. This was at station 30 (Map 2), just off the south headland of Putanui Peninsula.

Hikapu Reach

Perna were observed in high densities on a boulder bottom in about 2 fathoms in Mud Bay and Paradise Bay.

Only a few Perna were taken in deep water dredge samples although they were seen in variable densities along

both shores of this Reach.

Nikau Point

The northern shoreline of Nikau Bay was heavily populated by Perna and Mytilus in the station 37 area. (Plate 6) Most Perna occurred below extreme low water mark, with Mytilus occupying the upper levels of the intertidal zone.

Elsewhere in Pelorus Sound, including Nydia Bay, Popoure Reach, Crail Bay and Beatrix Bay, Perna occurred widely, but in low densities, along the lower intertidal zone and upper sub-littoral, but were rarely found in quantities comparable to those in Kenepuru Sound and at Nikau Point.

(b) Population Structure

Figure 1 shows a representative sample of Perna from the intertidal zone of Nikau Point. Many of these mussels were in the 15 - 16 cm (6 inch) length range and were often closely packed together. Many very small Perna under 2 cm in length were found in the spaces beneath the larger mussels. This distribution and length frequency pattern was typical of many intertidal mussel areas examined.

The Nikau Point mussels had never been commercially exploited.

Figure 2 represents a large dredge sample of Perna, taken from the shallow sub-littoral zone on a rock strewn substrate. The samples showed similar population characteristics with a large proportion of Perna in the 17 - 18 cm (7 inch) length range and relatively few below 12 cm ($4\frac{1}{2}$") in length.

These areas were largely unexploited.

Figure 3 represents a large sample of Perna dredged from soft mud areas at offshore stations. Some of these areas had been subjected to intermittent commercial dredging. The length frequency composition is similar to that shown in Figure 2 with a mode at 17 cm ($6\frac{1}{2}$") length, and again only a few under 12 cm ($4\frac{1}{2}$") in length.

Figure 4 shows a histogram for Perna from the heavily exploited Skiddaw grounds. It shows a maximum length mode in the 13 - 15 cm (5" - 6") range, i.e. smaller than that of mussels from lightly or undredged grounds. Figures 5 and 6 show length frequencies for Perna samples at different stations.

(c) Attachment of Perna

All Perna were attached by byssal threads to a support; intertidal Perna to rock, and those in the sub-littoral to hard objects such as dead shells, debris or other Perna. Perna from the offshore mud areas occurred mainly in clusters, often attached to empty shells; they were also attached to Atrina. On the Skiddaw grounds many Perna were attached to empty shells and broken coral. Perna were also found attached to miscellaneous objects such as sunken branches, bottles and other live shellfish.

(d) Condition of Perna

Mature Perna from the intertidal and upper sub-littoral zones usually had thickened brownish-black shells, whereas those from deeper water had thin, smooth shells with distinct green colouration of the shell rim.

Figure 7 shows mean flesh weight plotted against shell length for Perna from various sites in Pelorus Sound.

Results were fairly similar for most samples but Perna close inshore showed a relatively higher flesh weight/shell length ratio (condition factor) than samples from the deeper water or the intertidal zone.

These middle zone Perna were also noted for their normally unblemished creamy-white or pale orange flesh and large glycogen reserves. Perna from the intertidal zone often had coarse discoloured flesh sometimes containing small 'seed pearls'.

Several Perna bore raised pink blotches on the gonad, apparently caused by the sporocyst stage of a trematode parasite.

Some Perna had spawned recently and were in poor condition.

(e) Mortalities

Compared with the number of live mussels relatively few dead Perna were taken. Figure 8 shows that the total number of dead Perna taken in 9 survey dredge samples had a maximum length mode at 18 cm (7 inches). This data and other observations suggest low natural mortalities.

(f) Predators

The most common starfish taken in dredges and seen in shallow water were the eleven-armed starfish (Coscinasterias calamaria) and the reef star (Stichaster australia). These starfish, although not abundant, were seen attacking Perna in the intertidal zone by pulling the shells apart.

Two smaller gastropods, Lepsiella sp. and Buccinulum sp. were common among intertidal mussels and were occasionally seen drilling a round hole (1-2 mm dia.) in the shells of small Perna and Mytilus.

The gastropod Struthiolaria, which may also eat young mussels, was dredged with Perna at several stations.

One commercial fisherman claimed to have once found two small Perna in a snapper stomach, but another fisherman had never seen this in 20 years snapper fishing The mussels most vunerable to snapper would be young thin-shelled specimens. Snapper and other fish may also feed on mussels broken by the dredge.

(g) Parasites

Approximately 15 - 20% Perna examined were inflected by a parasite provisionally identified as the sporocyst stage of a trematode. Its presence was indicated by pink or red raised patches or spots on the gonad.

Several Perna examined contained a pea crab up to 2 cm carapace width. They were also found occasionally in Mytilus and in almost every specimen of Atrina examined.

The crabs are probably commensals rather than parasites.

(h) Spawning - Settlement - Growth Rate

The biology of Perna is being studied by Mr D.E. Flaws in connection with mussel farming experiments.

Most Perna examined during the survey in December were in good condition prior to spawning; only a few were found in a spent condition during the January survey.

D.E. Flaws (personal communication) states that January-February is the main spawning period for both Perna and Mytilus but many small Perna from about 4 mm in length were found attached and growing in the spaces beneath and between larger mussels in the intertidal zone. These must have come from a very recent spawning. Very few small mussels were seen in deep water samples.

D.E. Flaws (personal communication) states that, in Pelorus Sound Perna reaches a shell length of about 3 inches in its first year, and is marketable 18 months to 2 years after settlement.

BLUE MUSSEL (Mytilus edulis aoteanus)

(a) Distribution

Almost all Mytilus in Pelorus Sound occurred in the intertidal zone though they were also seen and dredged in some shallow sub-littoral areas.

Map 3 shows areas where abundant Mytilus were seen on the shore. Unmarked areas of the shore were not closely examined but Mytilus were seen in variable densities along most of the exposed rocky foreshore in Pelorus Sound. Some of the highest densities were recorded at Nikau Bay (Plate 6)

At present Mytilus is not taken commercially.

(b) Population Structure

Figure 9 shows a length frequency histogram of a representative sample of Mytilus from exposed shore sites in Kenepuru Sound and Crail Bay. The modes at $4\frac{1}{2}$ and 10 cm suggest different year groups.

Only very few Mytilus above 11 cm or 5 inches were seen in Pelorus Sound. Very small Mytilus under 1 cm in length were often numerous beneath dense patches of larger Mytilus and Perna.

(c) Attachment

Mytilus were attached to rocks by byssus strands from the anterior end and were usually upright in attitude. They were sometimes seen attached to Perna, Atrina and other miscellaneous large objects. They were often attached in high densities to branches of trees on the shore.

(d) Condition of Mytilus

Many of the larger Mytilus in the upper intertidal zone had thickened shells with white calcareous patches. Most other Mytilus had thin hard blue-black shells. No Cliona was seen in Mytilus shells.

Figure 7 shows flesh weight plotted against shell length for a representative sample of Mytilus. Up to the maximum recorded shell length of Mytilus mean flesh weights were comparable with those of Perna.

Most Mytilus examined contained good quality flesh, of cream or yellow-orange colouration with large glycogen reserves, and were of good flavour. Compared with Perna relatively few Mytilus were infected by visible parasites.

(e) Commercial Potential

Although Mytilus are not at present taken commercially it is considered that they would be acceptable to the consumer. The stocks in Pelorus Sound would support a limited fishery based on hand-picking.

OTHER SPECIES

HORSE MUSSEL (Atrina zealandica)

These bivalves were taken in the dredge at many stations in soft mud areas during the survey. The aboral or pointed end of Atrina is embedded several inches in the mud. Often the bulk of the dredge contents consisted of Atrina (Plate 7).

Map 3 shows sample stations where Atrina were taken.

Most dredged Atrina were around 9 - 12" in length, though they ranged from about 6" to 15" in length.

Only the anterior adductor muscle of this shellfish is eaten. This muscle is often large (1 - 2 ozs), is off-white in colour, and tastes similar to scallop.

SCALLOP (Pecten novaezealandiae)

Small numbers of large scallops were dredged on mud bottoms (see Map 3).

MUD OYSTERS (Ostrea lutaria)

A few small oysters were dredged at some stations; flesh condition was good.

Dredging Damage

Perna were sometimes broken by dredge action and most damage was observed among thin-shelled specimens from deeper water.

DISCUSSION

From the results it is not possible to plot the total area populated by Perna or to assess the abundance of accessible stocks, but this preliminary survey shows that Perna occur in commercial quantities in many areas, mainly in Kenepuru Sound. Many of these areas, notably those in the shallow, sub-littoral zone down to a depth of about 30 feet on a rock substrate, have never been commercially exploited.

The population of Perna on the heavily dredged Skiddaw grounds showed a smaller percentage of takeable stock than dredge samples from newly exploited areas. The presence of large numbers of juvenile mussels of all sizes on the Skiddaw grounds suggests that this area may regain its commercial potential if left undisturbed for a period. The firm broken shell-coral substrate overlying mud in this area appears suitable for regeneration of mussel beds.

The commercial grounds lying off Weka Point are still yielding good commercial catches of Perna although this is not expected to continue for the following reasons:

The mussels occur mainly in clusters on a soft mud bottom and there is little other substrate present on which Perna larvae may settle.

The high proportion of takeable stock in these areas means that few undersized mussels are returned to sea and those returned may become buried in the soft mud.

Thus intensive dredging will lead to rapid depletion on this ground with little chance of re-generation. Greenway (1969) reports that commercial dredging has led to rapid depletion of beds of Perna in the Firth of Thames and these have shown little regeneration in recent years.

By contrast, dredge in efficiency on rough bottoms ensures that a proportion of Perna remain, and any undersized specimens are returned to a favourable substrate. Thus firm substrates are less likely to be completely depleted by dredging.

Management of the Fishery

The following factors must be taken into account:

(i) Proposed raft cultivation of mussels in the Sounds requires the presence of adequate stocks of mature mussels to provide the larvae which settle on the suspended ropes.

(ii) The advisability of maintaining a small fishery based on existing methods to supply the local market, and to improve the condition of natural stocks by thinning mature mussels.

(iii) The main spawning period of Perna must be known so that any closed season imposed permits the extraction of mussels while they are in good condition, but protects them when they are spawning and in poor condition and also protects newly settled spat from disturbance.

(iv) Increased dredging effort will almost certainly lead to rapid depletion of the main offshore mussel beds.

(v) A certain amount of hand-picking in the exposed intertidal zone should improve stocks by increasing available growth and settlement space.

CONCLUSIONS

The main commercial dredge areas for Perna are showing signs of depletion and further intensive dredging of these areas may lead to rapid reduction of stocks to an unprofitable level.

There are many unexploited patches of Perna, mainly in the intertidal and shallow sub-littoral zones of Kenepuru Sound which would support a limited commercial fishery. Only a small commercial potential exists outside Kenepuru Sound.

It will not be possible to assess the optimum yield of Perna from Pelorus Sound until commercial catch data covering most workable areas become available, and more data on sub-littoral mussel density are obtained.

The blue mussel (Mytilus) is abundant in the intertidal zone in most parts of Pelorus Sound and would support a limited commercial fishery based on hand-gathering.

None of the other shellfish species recorded, such as horse mussels, scallops, or oysters, are considered to have much commercial potential due to lack of demand in the case of the former and paucity of the others.

RECOMMENDATIONS

In view of the presence of unexploited stocks of Perna, it is not considered necessary to prohibit exploitation of mussels in Pelorus Sound.

In order to reduce dredging intensity on the offshore grounds and to encourage a limited exploitation of Perna along the shore-line, the following methods are suggested:

1. Fishing Methods

(a) Each vessel should be allowed to use only one dredge not exceeding 4' in width, and without prongs or teeth on the bit.

(b) Hand-gathering of Perna and Mytilus should be permitted, together with the use of hand appliances such as tongs or rakes etc.

(c) Diving should be allowed, but the use of underwater breathing apparatus should not be permitted.

2. Takeable Size Limits

In order to protect the juvenile stock and to allow further increase in flesh weight the following minimum size limits are suggested:

Perna	5 inches
Mytilus	3 inches

Undersized dredged mussels should be deposited in shallow water, inshore areas on a firm substrate where they are likely to survive.

3. Closed Season

The peak spawning period for Perna is January-February, and in order to protect the spawning stock and prevent the taking of mussels in a depleted state a closed season of four months, December - January - February - March is recommended.

4. Return of Shell - Shore Cultivation

Empty shell from the processing sheds should be returned to commercially worked mussel areas to provide settlement surfaces for larvae. Ideally the shell, together with live undersized mussels, could be deposited in shallow sub-littoral areas as a method of cultivation. The two methods of mussel farming, shore and raft cultivation could develop simultaneously in many of the sheltered bays in Pelorus Sound.

5. Predator Control

The removal of known predators of mussels such as the starfish Coscinasterias and Stichaster, should be encouraged.

One method of control is to take them from the dredge or from the shore and to leave them above high water mark.

6. Fishing Record System

The Pelorus Sound area should be divided into a number of statistical areas for the purpose of catch recording and, if it is necessary to allow re-generation of mussel stocks then these areas could be closed in rotation.

Future Investigations

A post-season survey is recommended in November-December 1969 to assess the effects of exploitation and, if necessary, to modify the system of management. During this later survey, diving should be carried out to examine sub-littoral mussel density and fixation, dredge efficiency and the effects of dredging.

Long term studies of shore cultivation sites would also be useful.

ACKNOWLEDGEMENTS

I wish to thank the following:

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Dr D. Eggleston, Fisheries Division, Marine Department for criticism of the manuscript.

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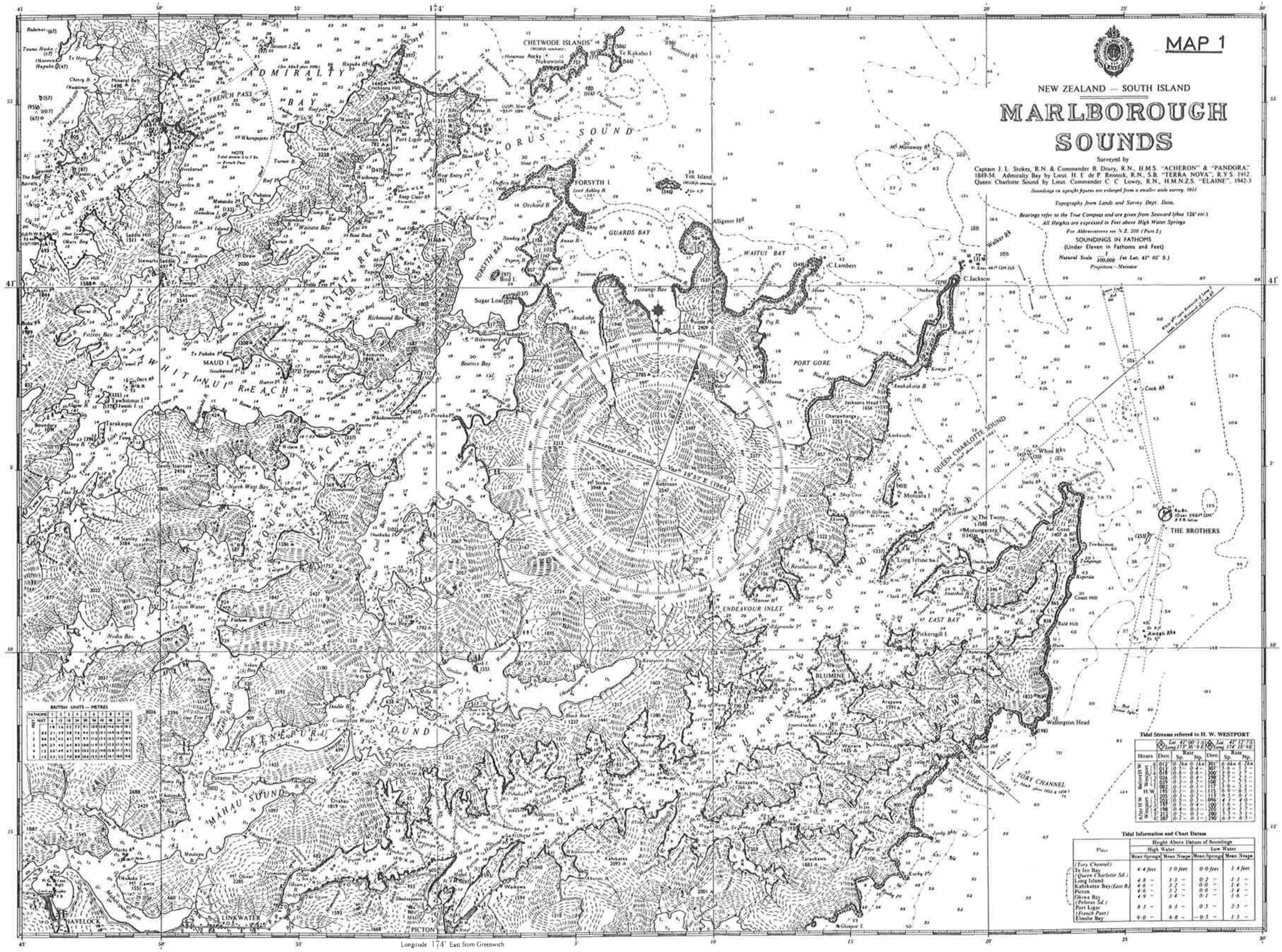
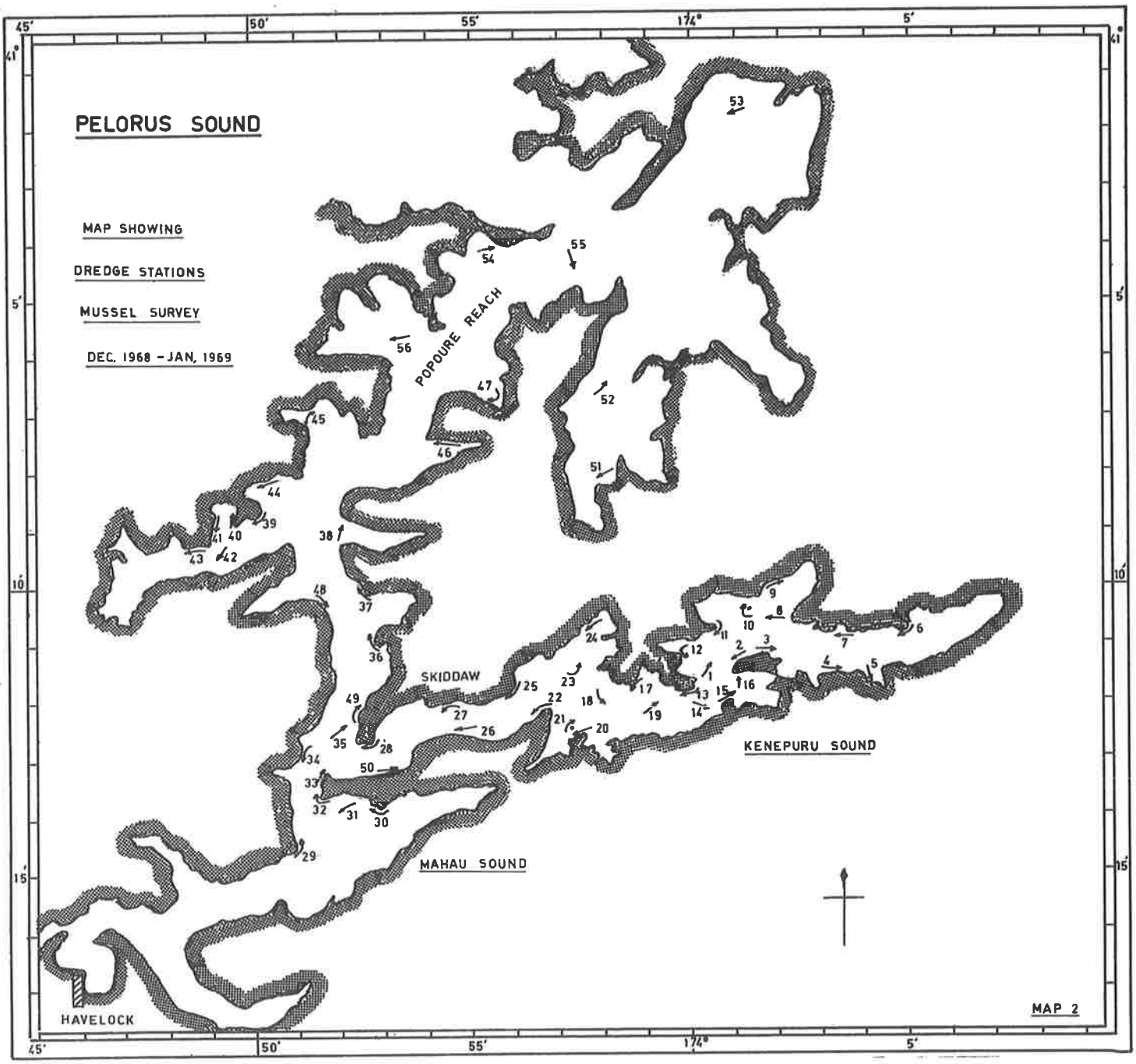
MAPS

PLATES

FIGURES



Fisheries technical report no. 61 (1971)


PELORUS SOUND
MAP SHOWING
DREDGE STATIONS
MUSSEL SURVEY
DEC. 1968 - JAN. 1969
POPOURE REACH
SKIDDAW
KENEPURU SOUND
MAHAU SOUND
HAVELOCK
MAP 2
45'
50'
55'
174°
5'
41°
5'
10'
15'

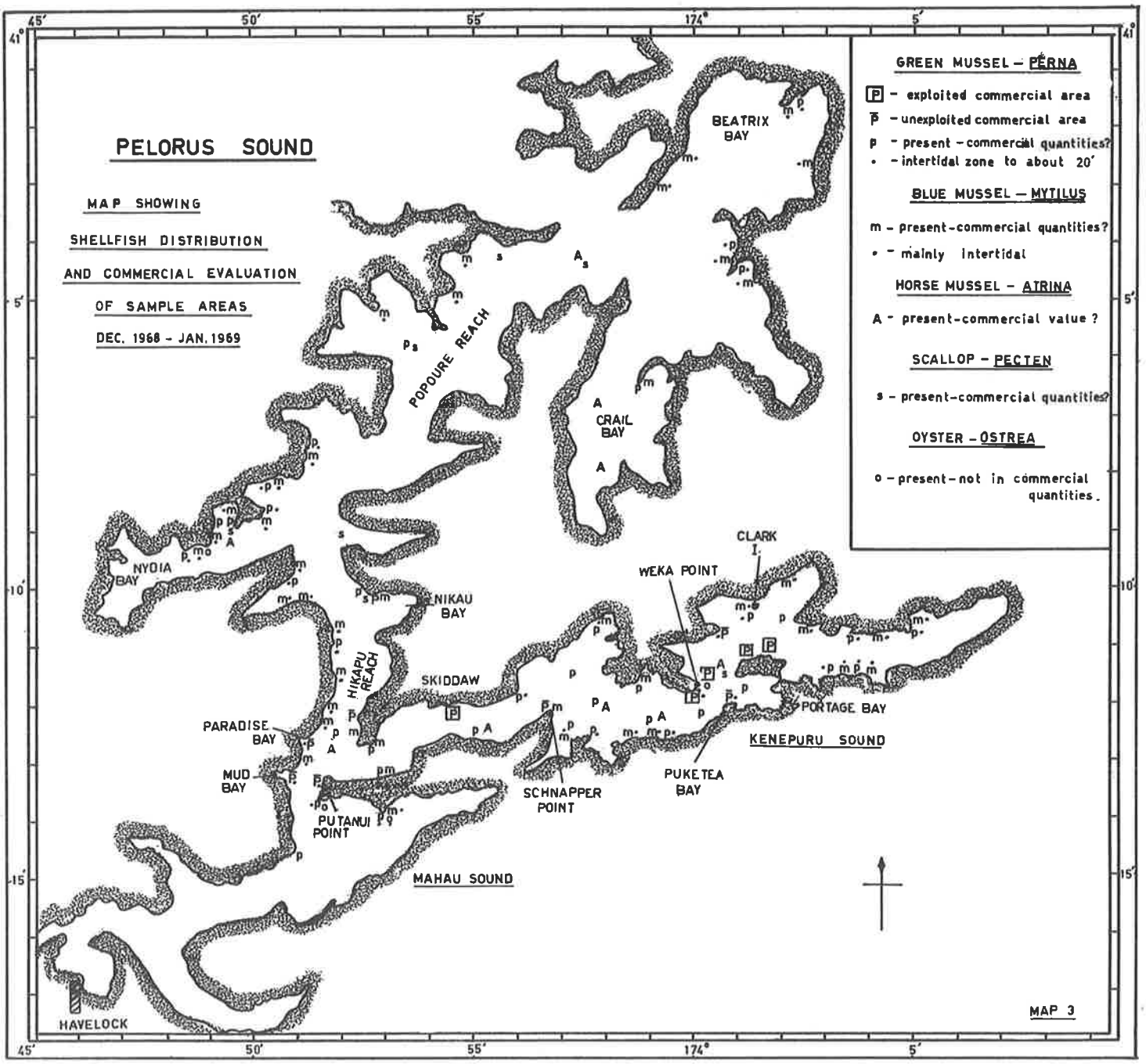

PELORUS SOUND
MAP SHOWING
SHELLFISH DISTRIBUTION
AND COMMERCIAL EVALUATION
OF SAMPLE AREAS
DEC. 1968 - JAN. 1969
GREEN MUSSEL – PERNA
P – exploited commercial area
P̄ – unexploited commercial area
p – present – commercial quantities?
• – intertidal zone to about 20'
BLUE MUSSEL – MYTILUS
m – present-commercial quantities?
• – mainly intertidal
HORSE MUSSEL – ATRINA
A – present-commercial value ?
SCALLOP – PECTEN
s – present-commercial quantities?
OYSTER – OSTREA
o – present – not in commercial quantities.
BEATRIX BAY
POPOURE REACH
CRAIL BAY
NYDIA BAY
NIKAU BAY
HIKAPU REACH
SKIDDAW
CLARK I.
WEKA POINT
PORTAGE BAY
KENEPURU SOUND
PUKETEA BAY
SCHNAPPER POINT
PARADISE BAY
MUD BAY
PUTANUI POINT
MAHAU SOUND
HAVELOCK
MAP 3
45'
50'
55'
174°
5'
41°
5'
10'
15'

Plate 1. Commercial shellfish dredger "Gleam".

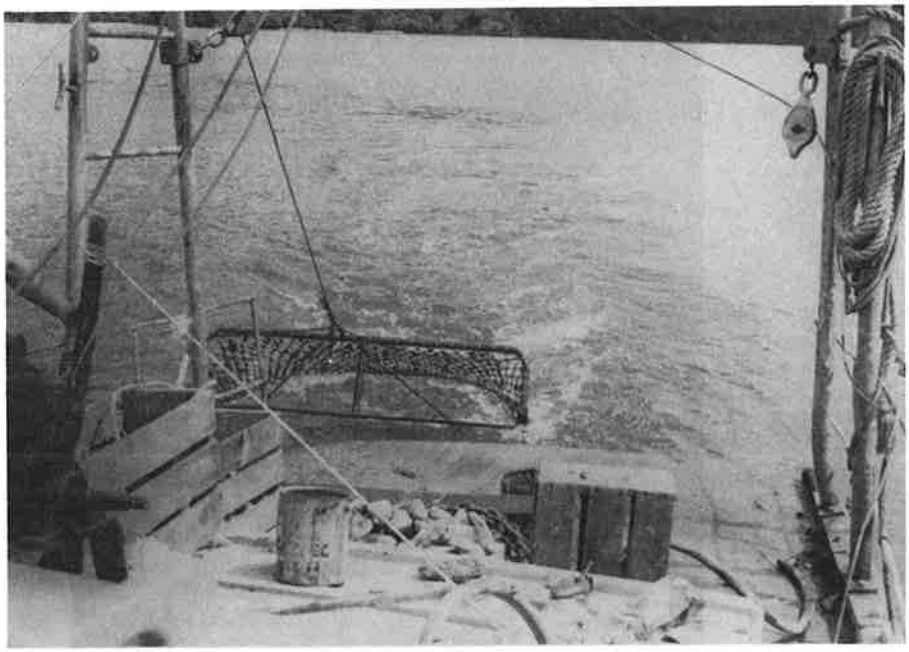


Plate 2. 8ft. wide dredge towed from "Gleam".

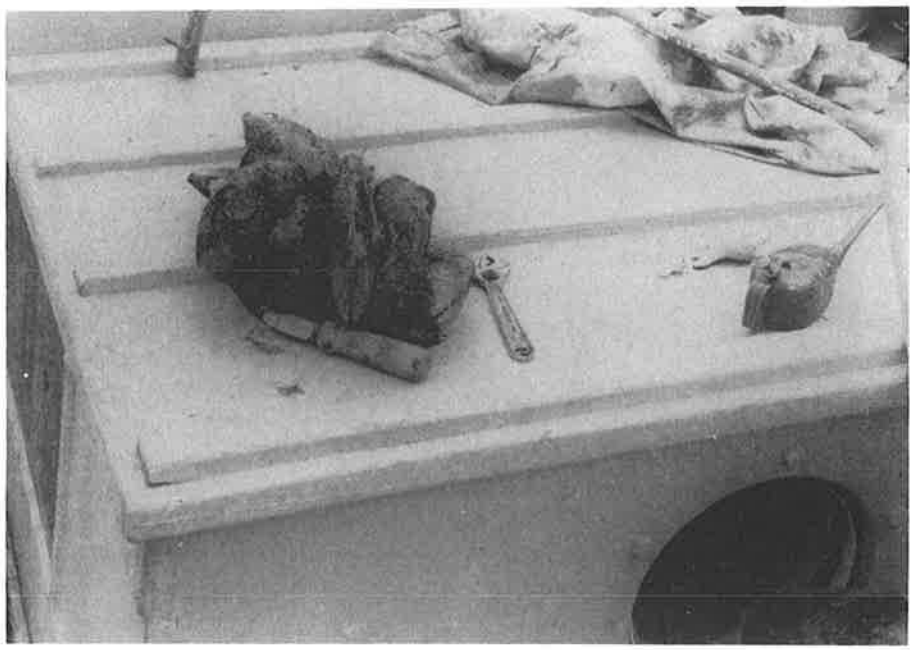


Plate 3. Typical *Perna* clumps from deep water mud bottom, Kenepuru Sound.

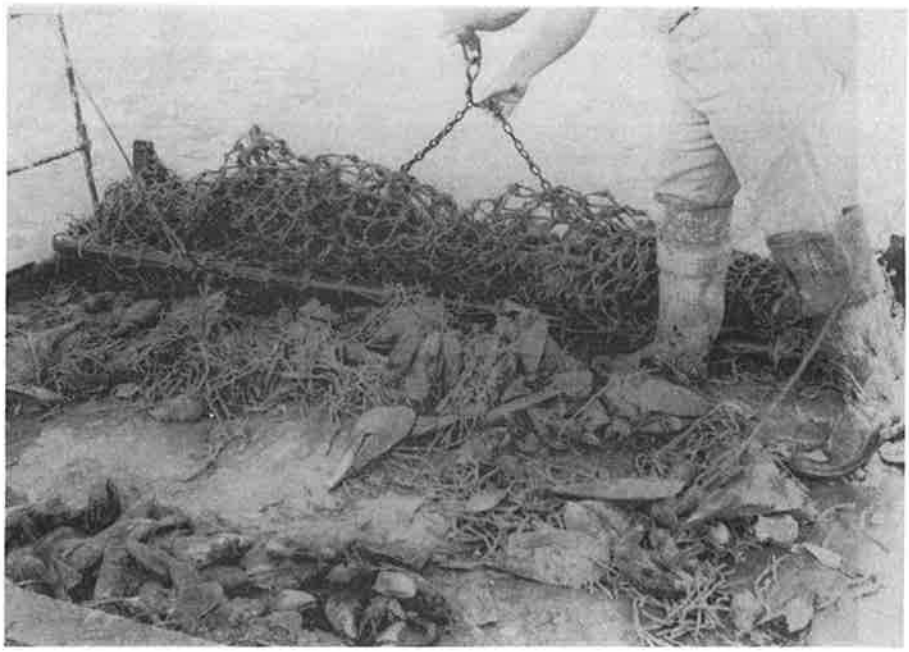


Plate 4. Dredge catch from deep water showing Perna and Atrina, Kenepuru Sound (Station 2 Map 2)

Plate 5. Dredge catch from hard bottom close inshore to Clark Island showing Perna and a few Mytilus. (Station 10 Map 2)

FIG. 2

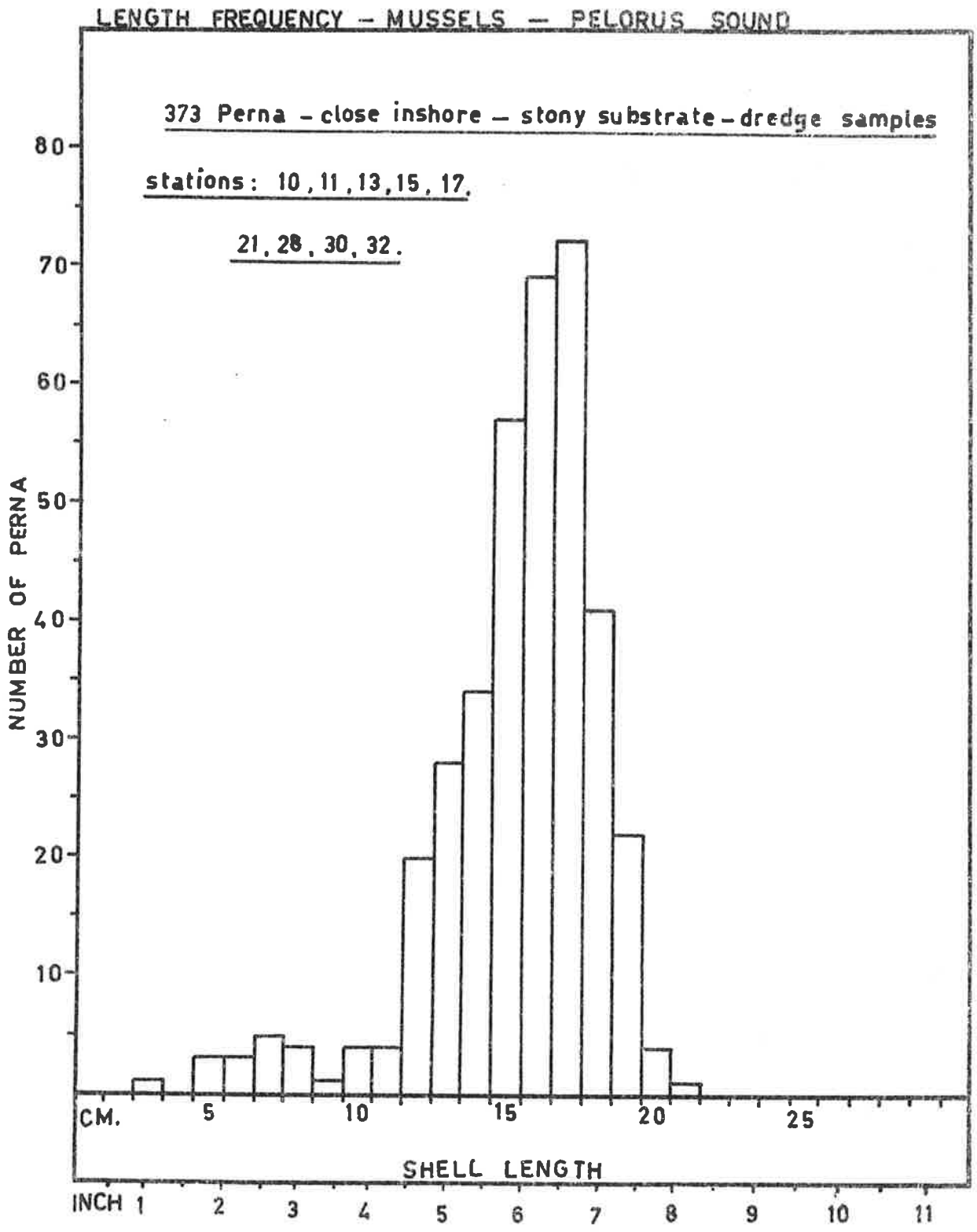

LENGTH FREQUENCY – MUSSELS – PELORUS SOUND
373 Perna – close inshore – stony substrate – dredge samples
stations: 10, 11, 13, 15, 17,
21, 28, 30, 32.
NUMBER OF PERNA
80
70
60
50
40
30
20
10
CM.
5
10
15
20
25
SHELL LENGTH
INCH 1
2
3
4
5
6
7
8
9
10
11

FIG. 3

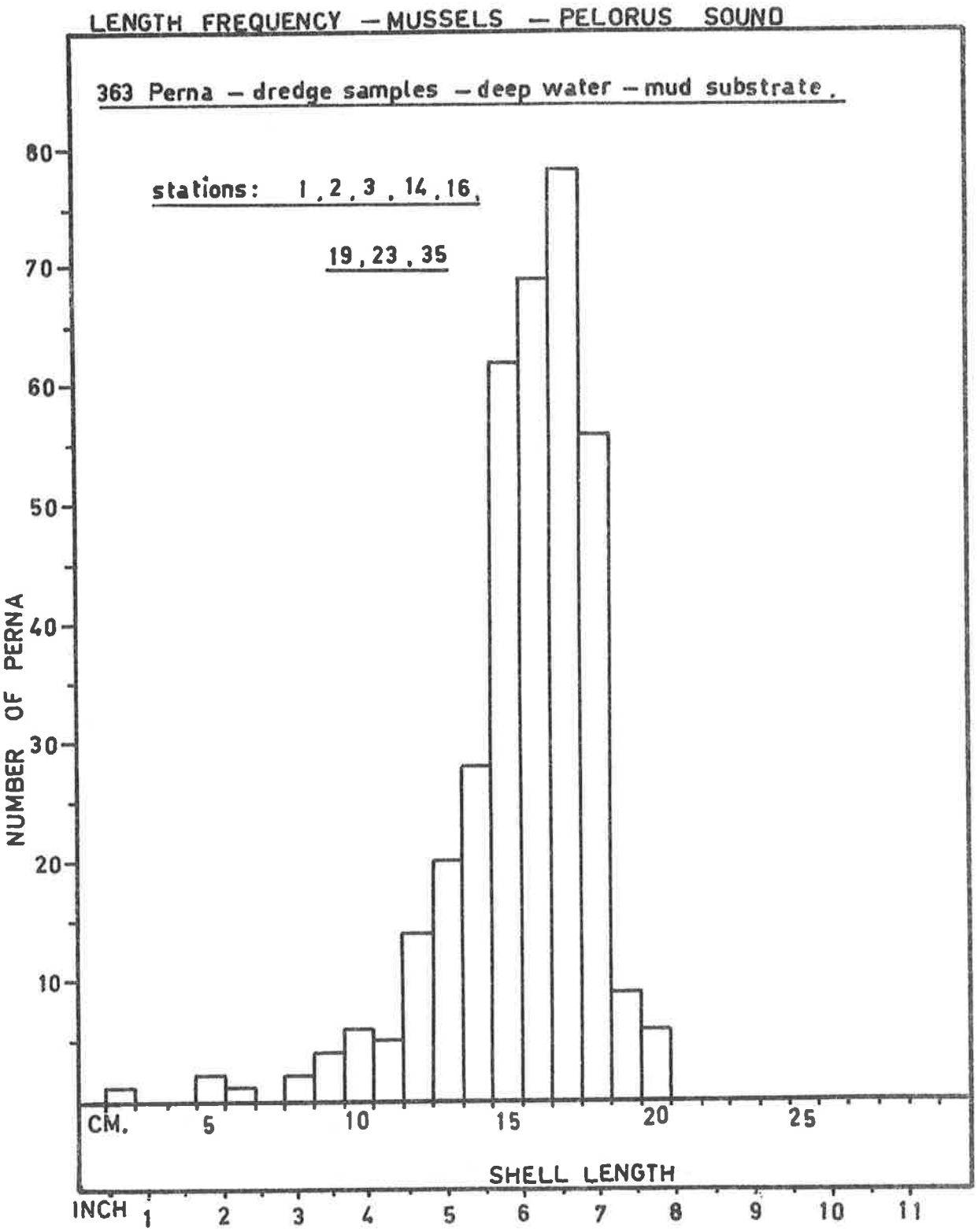

LENGTH FREQUENCY — MUSSELS — PELORUS SOUND
363 Perna — dredge samples — deep water — mud substrate.
stations: 1, 2, 3, 14, 16,
19, 23, 35
NUMBER OF PERNA
80
70
60
50
40
30
20
10
CM.
5
10
15
20
25
SHELL LENGTH
INCH
1
2
3
4
5
6
7
8
9
10
11

FIG.4

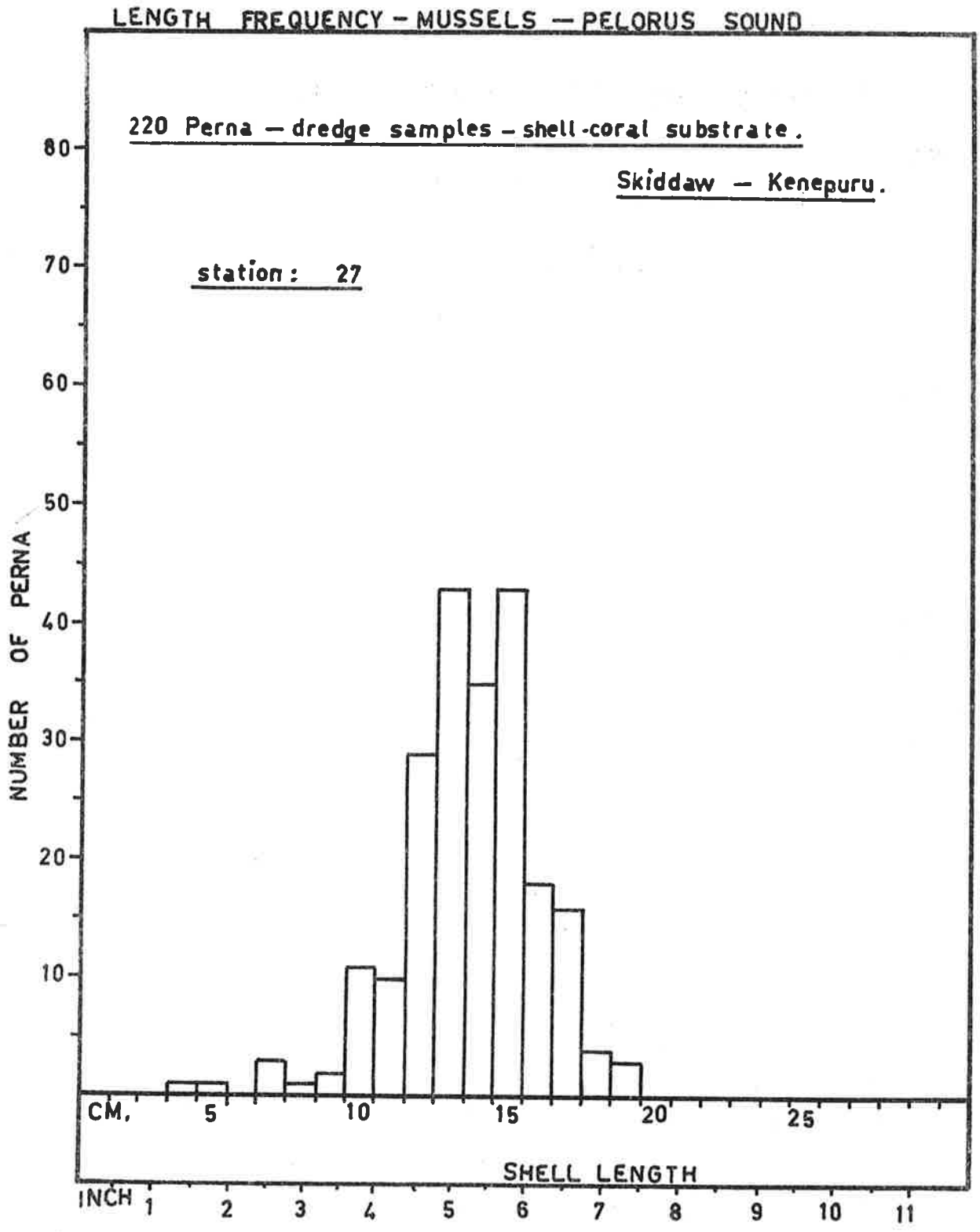

LENGTH FREQUENCY - MUSSELS — PELORUS SOUND
220 Perna — dredge samples - shell-coral substrate.
Skiddaw — Kenepuru.
station: 27
NUMBER OF PERNA
80
70
60
50
40
30
20
10
CM. 5 10 15 20 25
SHELL LENGTH
INCH 1 2 3 4 5 6 7 8 9 10 11

FIG. 5

MUSSELS — PELORUS SOUND

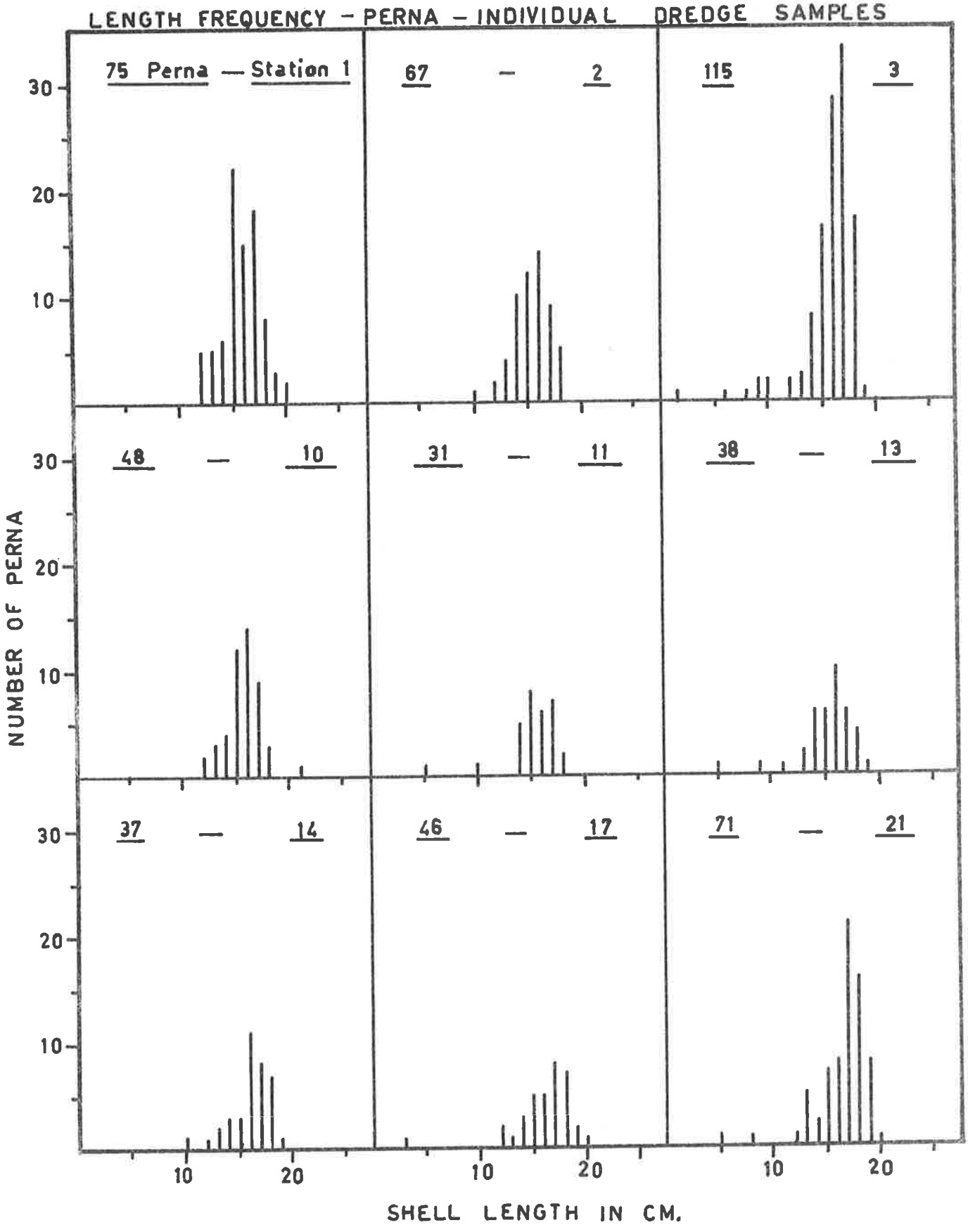


FIG. 6

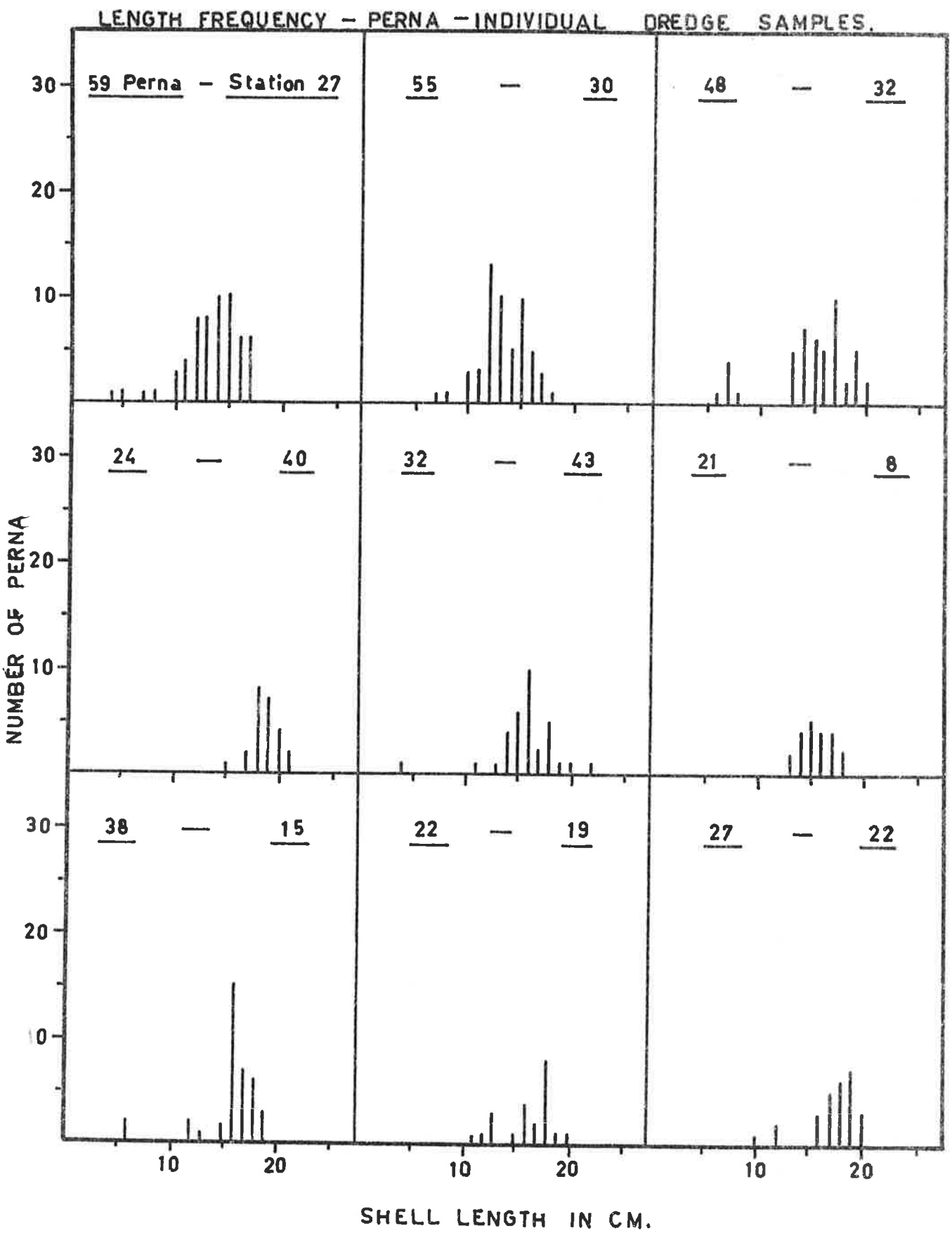

MUSSELS — PELORUS SOUND
LENGTH FREQUENCY — PERNA — INDIVIDUAL DREDGE SAMPLES.
59 Perna — Station 27
55 — 30
48 — 32
24 — 40
32 — 43
21 — 8
38 — 15
22 — 19
27 — 22
NUMBER OF PERNA
SHELL LENGTH IN CM.

FIG. 7

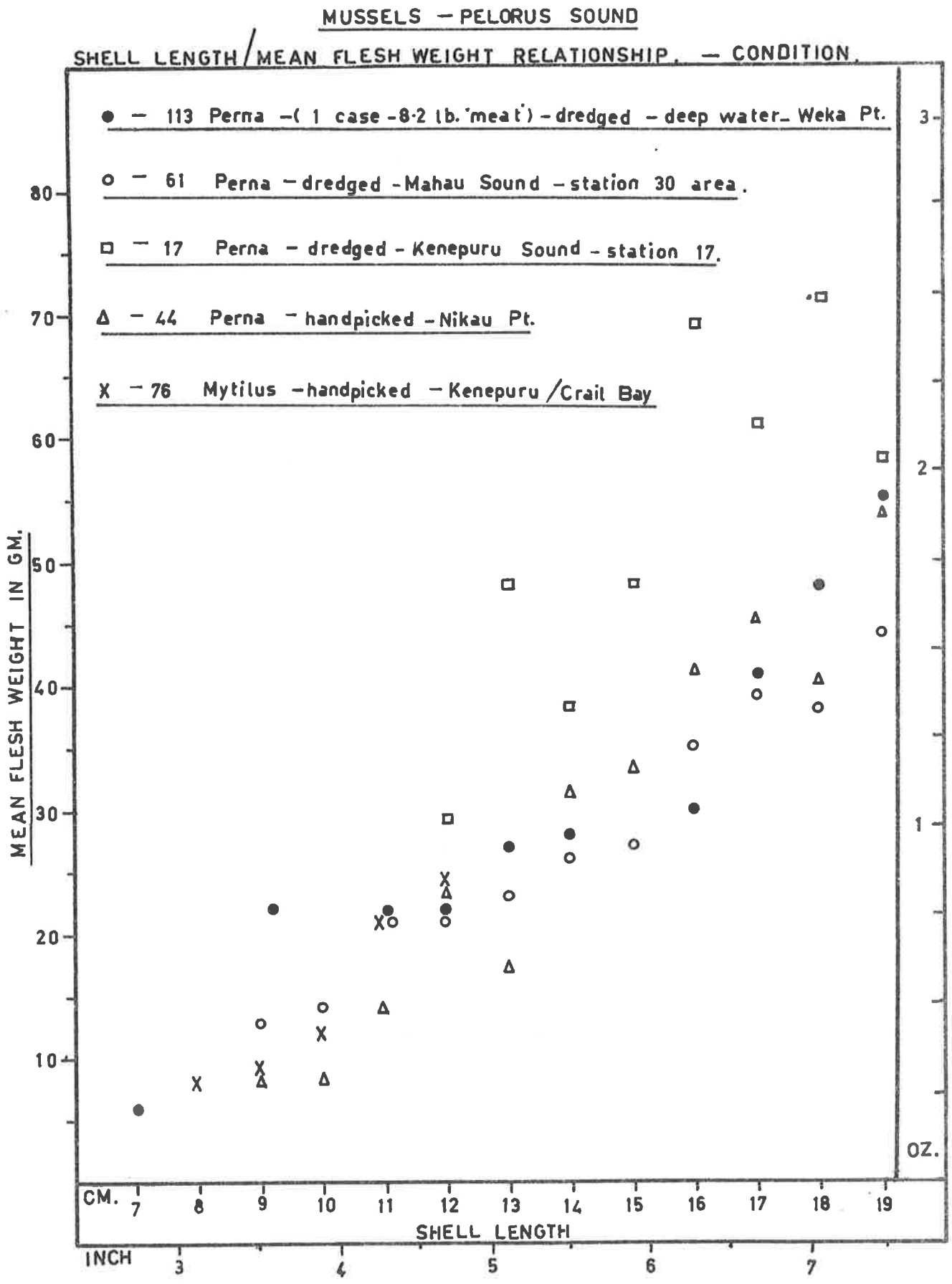

MUSSELS — PELORUS SOUND
SHELL LENGTH / MEAN FLESH WEIGHT RELATIONSHIP. — CONDITION.
● — 113 Perna —(1 case - 8·2 lb. 'meat') - dredged - deep water - Weka Pt.
○ — 61 Perna — dredged - Mahau Sound - station 30 area.
□ — 17 Perna - dredged - Kenepuru Sound - station 17.
Δ — 44 Perna — handpicked - Nikau Pt.
X — 76 Mytilus — handpicked — Kenepuru / Crail Bay
MEAN FLESH WEIGHT IN GM.
80
70
60
50
40
30
20
10
3
2
1
OZ.
CM. 7 8 9 10 11 12 13 14 15 16 17 18 19
SHELL LENGTH
INCH 3 4 5 6 7

FIG. 8

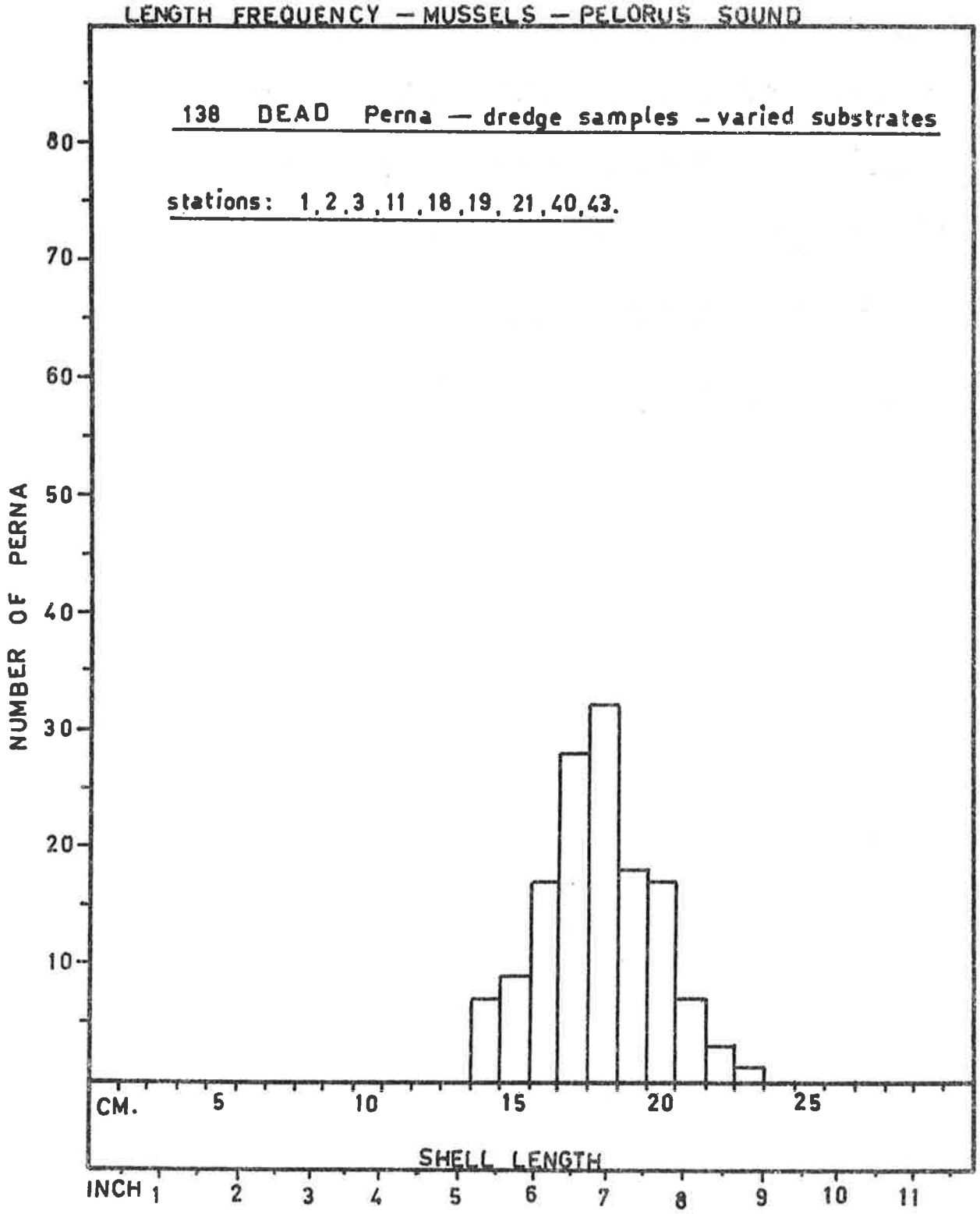
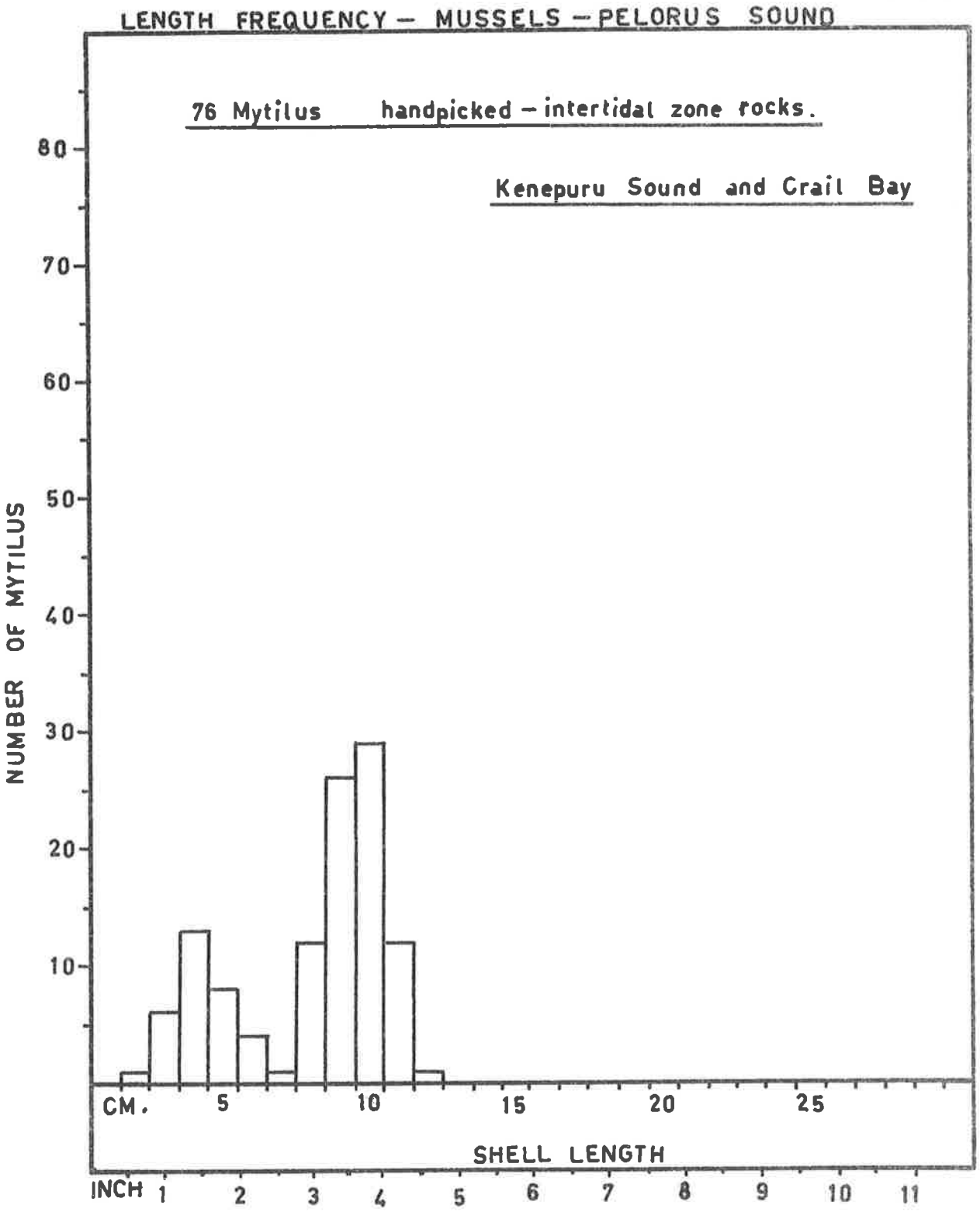

LENGTH FREQUENCY — MUSSELS — PELORUS SOUND
138 DEAD Perna — dredge samples — varied substrates
stations: 1, 2, 3, 11, 18, 19, 21, 40, 43.
NUMBER OF PERNA
80
70
60
50
40
30
20
10
CM. 5 10 15 20 25
SHELL LENGTH
INCH 1 2 3 4 5 6 7 8 9 10 11

FIG. 9


LENGTH FREQUENCY – MUSSELS – PELORUS SOUND
76 Mytilus handpicked – intertidal zone rocks.
Kenepuru Sound and Crail Bay
NUMBER OF MYTILUS
80
70
60
50
40
30
20
10
CM.
5
10
15
20
25
SHELL LENGTH
INCH
1
2
3
4
5
6
7
8
9
10
11

NEW ZEALAND MARINE DEPARTMENT

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WELLINGTON, NEW ZEALAND
1971