An Investigation of the Performance of Tangle Nets used off North Cornwall

MAFF Commission

Seafish Report No.391

April 1991

MAFF R&D Commission 1990/91

CONFIDENTIAL - NOT FOR GENERAL ISSUE

SEA FISH INDUSTRY AUTHORITY

Seafish Technology

AN INVESTIGATION OF THE PERFORMANCE OF TANGLE NETS USED OFF NORTH CORNWALL

Seafish Report No. 391
MAFF R&D Commission 1990/91
Project Code IBK 16

April 1991
J Swarbrick

Seafish would like to acknowledge the invaluable help of Skipper Caleb Munday BSc, MSc, and his crewman Tony Sawicz during the first part of the trials and who tragically lost their lives off St. Ives on the morning of September 14th 1990.

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SUMMARY

The tangle net fishery off the North Cornish Coast is targetted at certain species of whitefish, mainly turbot, monkfish, brill and rays and the high value lobster and crawfish. Tangle nets differ from other static nets in that the nylon monofilament netting panels are hung very loosely with hanging ratios of as much as 0.33. The footrope is weighted but the headline buoyancy is usually achieved by the inherent floatation in the polypropylene headrope. The nets thus lie loosely on the seabed and fish are caught by tangling rather than meshing as is the case with gill nets.

Most vessels in the Cornish fishery are between 25 and 40ft (7.6m and 12m) in length, less than 180h.p. and operate in inshore areas. There are a few vessels in excess of 12m which work the deeper water.

The purpose of these trials was to make a broad assessment of the performance of tangle nets in terms of selectivity and any loss of quality due to excessive soak times. The trials were carried out in the Summer of 1990 on the MARY AMELIA (SS84) and in the Autumn of 1990 on the PENDRIK (FH195). Nets from the vessels own gear were used together with variations in net design provided by Seafish (experimental nets).

Data from approximately 140 soak days was obtained with various net types.

The results are complex and it is not possible to draw firm conclusions but some very obvious trends are apparent. The most important of these is the wastage problem due to excessive soak times which results in spoiled fish. The excessive times were mostly due to bad weather preventing hauling. There is also the problem of brown crab by-catches, as it is virtually impossible to extract crabs without destroying them. Selectivity of tangle nets is however not as clear cut as with gill nets. This is to be expected because of the nature of these nets. One important observation was that during the trials no seabirds were caught in the nets contrary to the expectations of certain conservationist groups.

More trials work is needed to develop the technical knowledge about these nets.

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1 INTRODUCTION

Over the last three years, Seafish have carried out an extensive programme of trials investigating aspects of static net performance at sea. These trials have included investigations into by-catch reductions off North East England (Ref 4) and an evaluation of net selectivity in a trammel net fishery in South East England (Ref 5). This report describes a series of trials carried out in the tangle net fishery off North Cornwall. Tangle nets are another variant of the general 'static type' of fishing net and there is relatively little quantitative information on tangle net performance. In this series of trials, differing mesh sizes and hanging ratios were used to estimate the selectivity of the nets. Differing 'soak times' were used to establish the effect of increasing immersion time on catch spoilage whilst still in the net.

The tangle net fishery is based upon the use of monofilament static nets anchored on the seabed to target a variety of whitefish and shellfish species (Ref 1). Vessels engaged in the fishery usually fall within the size category 25-40ft (7.6-12m) in overall length with power capabilities of up to 180h.p. (134kW). However, there are several vessels fishing out of the ports of Newlyn and Mevagissey with overall lengths in excess of 12m and power capabilities of around 350h.p. (261kW). These vessels have a greater operating range than the inshore vessels (Ref 1).

The tangle net fishery in Cornwall is very extensive and there are a number of problems associated with it. Tangle nets are seen as "an environmental threat" by certain conservationist groups because of alleged risks to seabirds and marine mammals. The pressure on fishing grounds often leads to conflicts of interest between trawlermen and netters. By-catches of unwanted species - notably brown crabs (Cancer pagurus) and spider crabs (Maia squinado) - are often taken. These problems and others form the subject of discussion within this report.

This work and earlier work on the Northeast Coast and Southeast Coast with static nets forms part of the MAFF Commissioned programme of research into the performance and selectivity of these types of nets.

2 THE FISHERY

2.1 What is a Tangle Net?

A tangle net is a variety of static fishing gear which depends upon fish becoming completely entangled or meshed within the body of the net in order to be caught. Tangle nets usually do not have any extra flotation attached. Instead they rely on the inherent buoyancy of the polypropylene net headrope(s) for what little flotation they require. The footrope of the net usually consists only of a reinforced braided leadline of size number 2 or 3 (see Fig 2). However, a backing rope is used by some larger vessels to reinforce the leadline. This reduces the risk of parting the gear if any strain should be placed upon it, such as when hauling in a tideway.

Tangle nets are nearly always built with cheapness in mind and are usually constructed of nylon monofilament. They are not expected to last more than a season at most and there is also an increasing risk of gear being towed away by both foreign and U.K. trawlers.

Tangle nets differ from ordinary gill nets in that they are rigged so that the net sheet is hung very slack. For example, a 100 yard rigged net may be constructed from a 200 yard net sheet; the net is said to be "hung by one half". A 100 yard rigged net made from a 300 yard net sheet is said to be "hung by two-thirds", and is a lot slacker than in the first example. Highly prized shellfish such as crawfish (Palinurus elephas) and lobsters (Homarus gamarus) have many carapace projections that are easily entangled in a slack-hung tangle net. Unfortunately, other less highly valued species of shellfish, such as brown crabs (Cancer pagurus) and spider crabs (Maia squinado) are also easily entangled, and this effect can give rise to an unwanted by-catch.

Flatfish such as turbot (Scophthalmus maximus) and brill (Scophthalmus rhombus) entangle more effectively in a very slack net such as a hanging ratio of 0.33 ('hung by two thirds') would give. If unwanted shellfish are present on the grounds, or if the main catch is monkfish, then it may be more appropriate to use a net which is 'hung by one half' (a hanging ratio of 0.50).

2.2 Quantities of Nets Used

Nets are usually rigged so as to be 100 yards (91.4m) long and are joined together to form 'fleets' or 'tiers' of about 10 or 12 nets. The overall length of a typical fleet of nets ranges from 1000 yards to 1200 yards (914m to 1097m) for an inshore vessel. The limiting factor determining fleet length is usually the number of nets that can be fitted into commonly available plastic bins. Offshore vessels working the tangle net fishery usually shoot from net pounds and so the fleet length can be much greater.

The total amount of net fished varies with the size and capability of the vessel as can be expected. An inshore vessel of about 35ft in length operating up to 10 miles offshore will fish between 5000 and 15,000 yards (2.8 miles - 8.5 miles) of tangle nets, and haul them over a period of about 6 days. One large successful vessel of about 50ft (15.45m) in length from the port of Mevagissey fishes up to 50,000 yards (28.4 miles, 45.7km) of tangle nets and hauls up to 10,000 yards (5.7 miles, 9.1km) of net per day.

2.3 Mesh Sizes and Materials

Mesh sizes commonly used are as follows:-

(i) 5½in (11.4cm) - for sole.

(ii) 9in (22.9cm) - for brill.

(iii) 10½in (26.7cm) - widely used inshore in mixed species fisheries.

(iv) 12in (30.5cm) - used offshore by larger vessels - especially from the port of Newlyn in mixed species fisheries.

(v) 14in (35.6cm) - very unusual, but are sometimes used to target shellfish such as crawfish, lobsters and occasionally spider crabs.

The material most commonly used in Cornwall for the construction of tangle nets is nylon monofilament with a filament diameter of 0.65mm. Multimonofilament and 'monofilament twine' (two strand mono) tangle nets are also available.

2.4 Target Species

With regard to the type of net used and the species being targetted, the Cornish Peninsula can be divided into a northern half and a southern half. This division arises chiefly from the dramatic difference in bottom topography of the local seabed between North and South coasts. Different bottom topography gives rise to a different species mix.

The North coast has a very rugged characteristic, with dramatic cliffs and jutting rocks. This leads to a seabed with alternating bands of hard rock and sand. The rocky areas form an ideal habitat for benthic (bottom living) animals such as the crawfish (Palinurus elephas), the lobster (Homarus gamarus) and the monkfish (Lophius piscatorius).

Spotted ray (Raia montagui) and blonde ray (Raia brachyura) are frequently encountered on the soft ground between the rocky outcrops. Turbot (Scophthalmus maximus) and brill (Scophthalmus rhombus) are encountered in small numbers on the North coast, but much further offshore (30-60 miles) they occur in greater numbers.

Ranking these species in order of importance as a catch to the fishermen (not individual values or frequency) gives the following list for the North coast:-

(1) Crawfish
(2) Monkfish
(3) Lobster
(4) Turbot
(5) Brill
(6) Blonde ray
(7) Spotted ray

2.5 Seasonality

Tangle nets are used from early April until November all around the Cornish peninsula. Turbot are the main target species in June; this is especially important for ports on the South coast. White fish - mainly monkfish - are the target species in April and May, but are caught in small quantities at other times of the year. Shellfish, comprising crawfish (Palinurus elephas) and lobsters (Homarus gamarus) form part of the catch from March to April, but they gradually become a larger proportion of the catch until October-November when they form 100% of the targetted catch. In July however, many of the crustaceans caught are soft. A summary is given below:-

Monkfish : March to September, peaking from May to July.
Turbot : May to July, peaking in June.
Brill : As Turbot.
Crawfish : April to November, peaking in October.

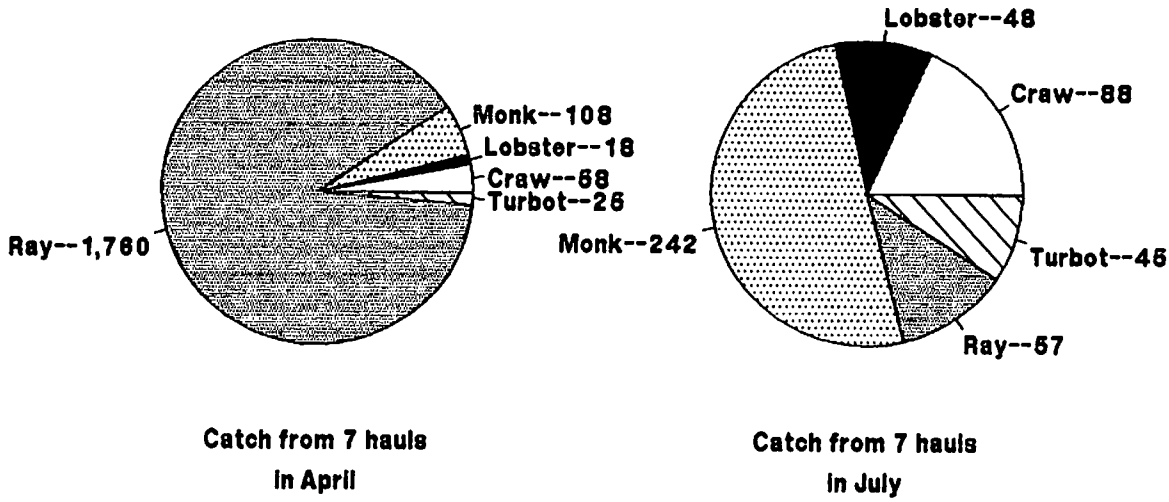
Note: Crawfish are present all year round, but in Winter, weather usually prevents efficient netting of them.

2.6 Species Occurrence

Figure 1 shows typical landings by a 10m vessel engaged in tangle netting and illustrates some of the seasonal variations in catches. The relative value of the main species is also given (Ref 1).

Landings by a 10m Tangle netter showing seasonal variation in catches

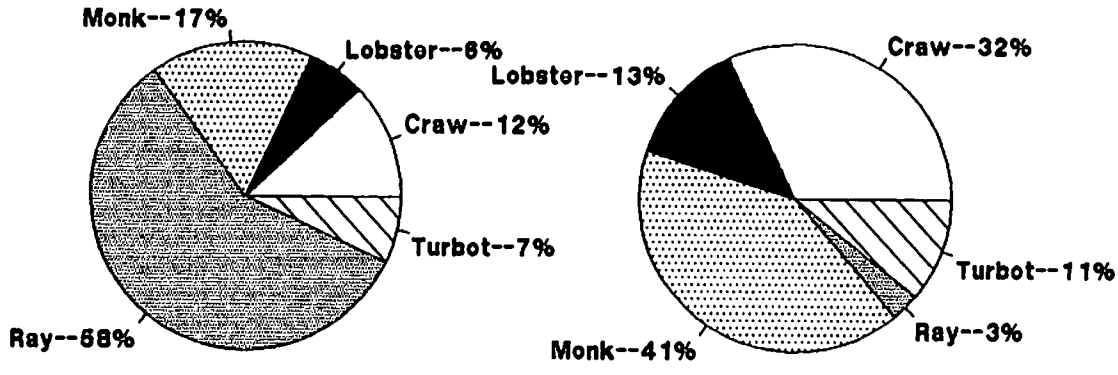
(a) Weight of main species (kg)



Catch from 7 hauls in April

Catch from 7 hauls in July

(b) Relative values of main species



Catch from 7 hauls in April

Catch from 7 hauls in July

From Munday, KC "Gill net and other set net fisheries in Cornwall", SEAFISH 1990 (21pp).

FIG 1

3 AIMS AND OBJECTIVES OF THE TRIALS

Following discussions with MAFF and after considering information provided by local fishing skippers in Cornwall, it was decided that sea trials should include a broad assessment of the performance of tangle nets in terms of (i) selectivity and (ii) catch quantity and state with varying soak time. As tangle netting involves leaving the nets to fish for a period of time (soak time - usually 2-5 days), then a proportion of the catch will inevitably be rotten on hauling. Because of this, it was decided to monitor the quality of fish on hauling.

The term "Selectivity" includes selectivity for species and selectivity for size, therefore both species and size were monitored for all animals caught in the nets.

3.1 Objectives

(1) For each of the main species of fish encountered, to establish the degree of net selectivity.

(2) To compare the selectivity of the experimental nets with that of the vessel's own nets which were used as a control.

(3) To establish a relationship between fish spoilage and soak time.

(4) To establish a relationship between catch and soak time.

(5) To determine the extent of any by-catch by species and size.

(6) To monitor any incidental mortalities.

3.2 Attributes to be Monitored

(a) Fish species
(b) Fish length/shellfish carapace dimension
(c) Fish quality state

Item (c) - Fish quality state - this was assessed by devising a very subjective five point scale A to E as follows:-

A = Strong alive
B = Weak alive
C = Dead, with no obvious loss of freshness
D = Unmarketable dead fish
E = Totally putrid/skeletal remains

Net damage to the fish was coded by a number on a four point scale:-

0 = Perfect, no net damage
1 = Minimal net damage
2 = Net damage
3 = Severe net damage

Subscript 'p' denotes evidence of predation/scavenging.
Thus, 'Monk A0 45' indicates a monkfish in strong alive condition with no net damage and of length 45cm. 'Monk Ep3 62' indicates a monkfish that is totally putrid with evidence of predation/scavenging, with severe net damage and of length 62cm. 'Monk Ep3 0' describes a rotten monkfish of indeterminable length.

Because the method of assessing fish quality followed the fishermens' subjective estimates of quality, the percentages of unmarketable fish for each day were an accurate reflection of what the fishermen could market.

4 THE TRIALS VARIABLES

(a) Mesh sizes : 10½in (26.7cm) and 12in (30.5cm)

(b) Hanging ratios : 0.50 and 0.33 (all nets 100 yards long, 91.4m)

(c) 'Soak' time : Ideally 10 days, 8 days, 6 days, 4 days, 2 days

5 THE EXPERIMENTAL GEAR

5.1 Tangle Net Construction

Four fleets A, B, C, and D, of twelve 100 yard (91.4m) nets were used in this set of trials. They consisted of 10½in and 12in mesh sizes (26.7cm and 30.5cm) with hanging ratios of 0.50 (hung by half) and 0.33 (hung in by two-thirds - see 2.1). All the experimental tangle nets were constructed of nylon monofilament with a filament diameter of 0.65mm.

Type Number	Mesh Size	Mesh Deep	Panel Length	Hanging Ratio	Set Length	Set Depth
1	10.5in	10.5	200yds	0.50	100yds	94in
2	10.5in	10.5	300yds	0.33	100yds	94in
3	12in	8.5	200yds	0.50	100yds	89in
4	12in	8.5	300yds	0.33	100yds	89in

Table 1 - The Experimental Gear

In summary, there were four fleets, A, B, C, D, each of 12 nets. A1-A4, A5-A8 and A9-A12 are sequences of the above four nets in fleet A. In addition, four fleets of the vessel's own nets were also fished as a control. These four control fleets were of the same length as the experimental fleets of nets and were also constructed of 0.65mm nylon monofilament.

5.1.1 Headropes and Flotation

All the 10½in (26.7cm) nets had an 8mm and a 6mm polypropylene rope laid together to form the headrope. This gave just enough buoyancy for the net to stand up at slack water with no extra flotation. Buoyancy of the combined 8mm and 6mm p.p. headrope is 0.4311kg/100m - a very small amount indeed.

The 12in (30.5cm) nets had twin 6mm polypropylene ropes laid together to form the headrope. This gave a buoyancy of 0.3103kg/100m.

Both buoyancy figures are for stretched rope that has been 'aged' in seawater, so as to eliminate trapped air within the rope.

5.1.2 **Leadline**

All nets were rigged with a number 2.5 leadline which has a runnage of 5.8kg/100m.

5.1.3 **Netting Panel**

Two lengths of netting panel were used; 200 yards and 300 yards. Both of these lengths when rigged onto 100 yard ropes gave hanging ratios of 0.50 and 0.33 respectively (see Table 1). The netting panels made out of 0.65mm diameter monofilament were finished at the top and bottom with a row of nylon twine loops. These loops were attached by means of twine staples to the head and footropes. Fig 2 shows a generalised tangle net with a hanging ratio of 0.50.

5.2 **Dahn Ropes, Anchors and Bridles**

The exact method of rigging the bridles and dahn ropes inevitably varies with different fishermen. However, it is usual to use a line-to-depth ratio of about 3:1 with the portion of line immediately below the dahn float itself of leaded rope. This reduces the chances of fouling on vessel propellers.

Fig 3 shows the arrangement of bridles and dahn lines used in the Seafish trials. Some vessels prefer to work chain weights rather than anchors, as anchors are notoriously difficult to stow on board a vessel and present safety problems when a vessel is rolling in a seaway.

It is important to use a good quality stretched rope to make up the bridles. Poor quality rope will quickly twist up and can become abraded on the seabed.

Diagram of a tangle net, showing construction of 10.5 inch (267mm) mesh monofilament with 10.5 meshes vertically. Rigged length of net is 100 yards (91.4m)

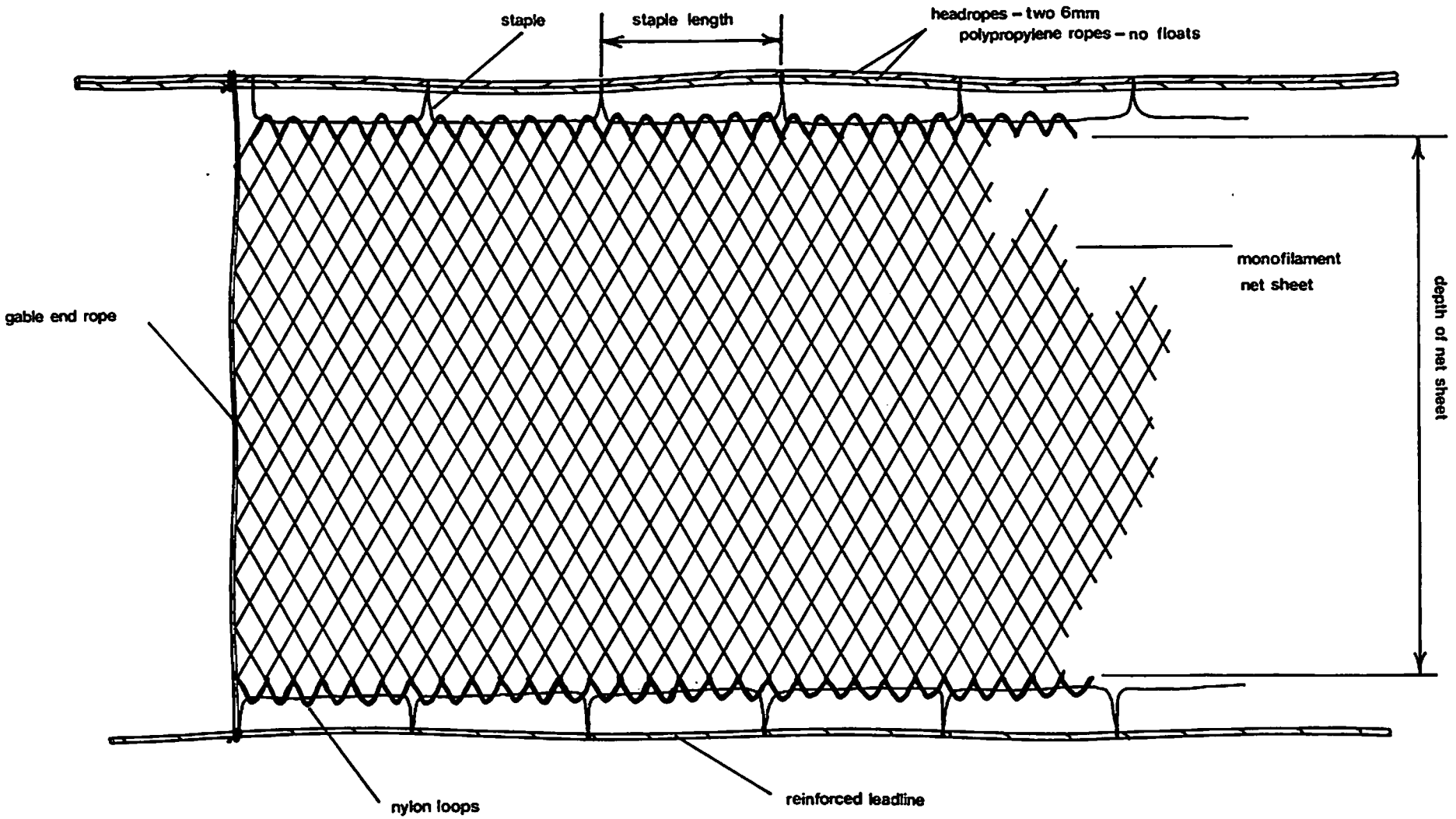


FIG 2

Showing arrangements of bridles and dahn ropes.

1 fathom (f) = 1.8288 metres (m)

Polypropylene rope = pp

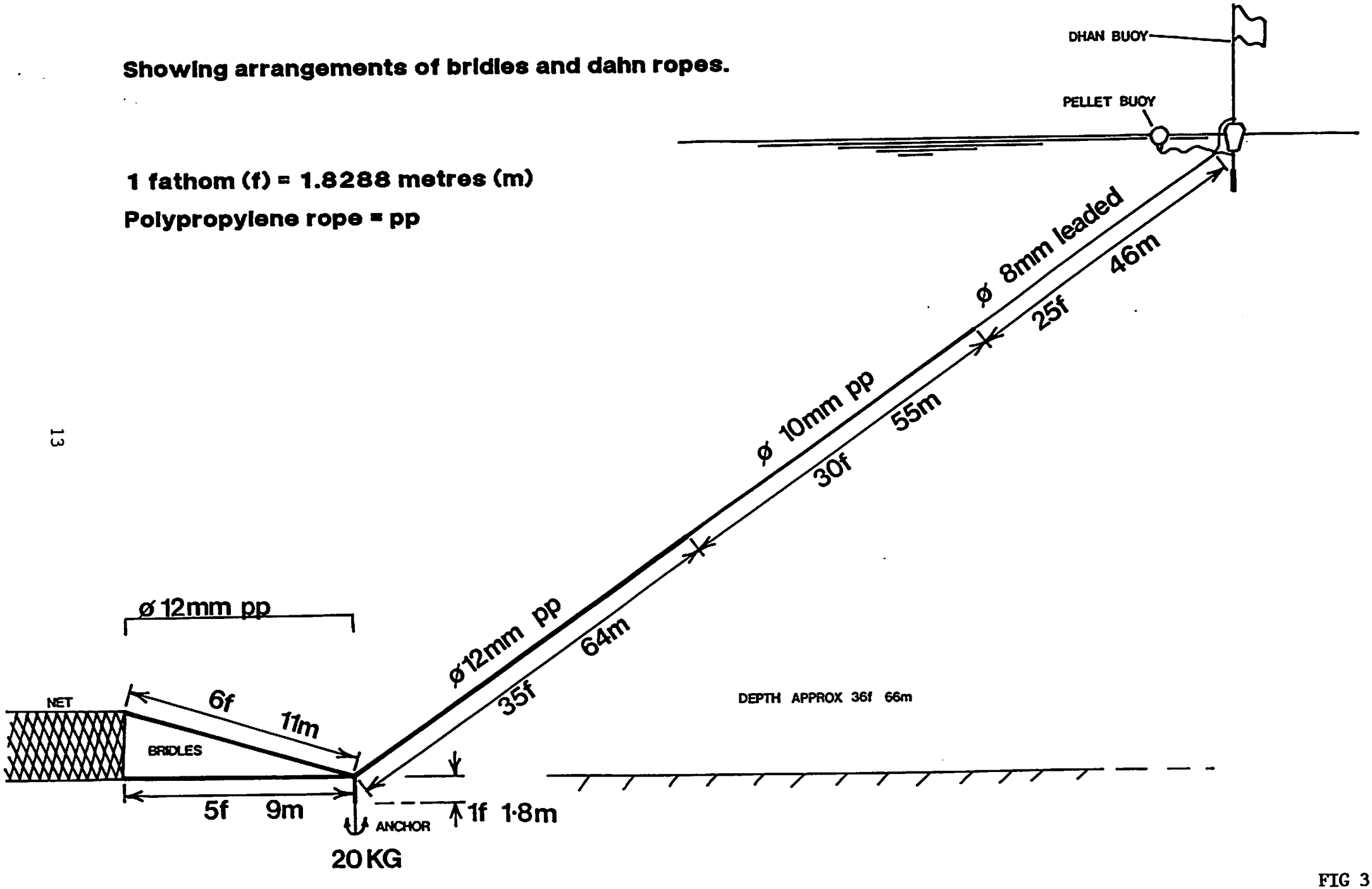


FIG 3

The dahn float is made to the typical pattern; a 10ft (3.1m) bamboo pole with 18in (45.7cm) of scaffolding tube on one end to act as a weight, a 20kg buoyancy float about one-third of the way up the pole and a flag fixed to the top end for identificaton.

A pellet buoy of no more than 10in (25.4cm) diameter is usually used on the North coast. Because of the fast tidal flows associated with the region, loss of the dahn float due to tide and rough weather may occur. The pellet buoy is attached to the weighted leadline below the dahn and allows retrieval of the line if the dahn is missing.

6 THE CHARTER VESSELS

It was decided to perform two sets of sea trials over a period of one month each in Summer and Autumn. For the Summer trial, the Hayle vessel MARY AMELIA (SS84) skippered by (the late) Caleb Munday was chartered. Because this vessel became unavailable to continue the Autumn trial, a different Hayle vessel was used, the PENDRIK (FH195) skippered by Keith Pope.

6.1 MFV Mary Amelia (SS84) - June to July 1990

Overall Length	: 11.05m (36ft)
Beam	: 4.05m (13.3ft)
Depth	: 1.21m (4ft)
Gross Registered Tonnage	: 7.68 tons
Hull	: Freeward Marine GRP with forward wheelhouse and insulated fishroom, built 1989.
Engine	: Ford Sabre 179 h.p. (134kW) diesel turbo
Hauler	: Bandolier 'Compact' and pot hauler

6.2 MFV Pendrik (FH195) - September to November 1990

Overall Length	: 9.12m (30ft)
Beam	: 3.07m (10ft)
Depth	: 0.90m (3ft)
Gross Registered Tonnage	: 4.03 tons
Hull	: Aquarius GRP with forward wheelhouse of wood
Engine	: Ford 120 h.p. (89kW) diesel
Hauler	: Bandolier Compact

7 TRIALS PROCEDURES

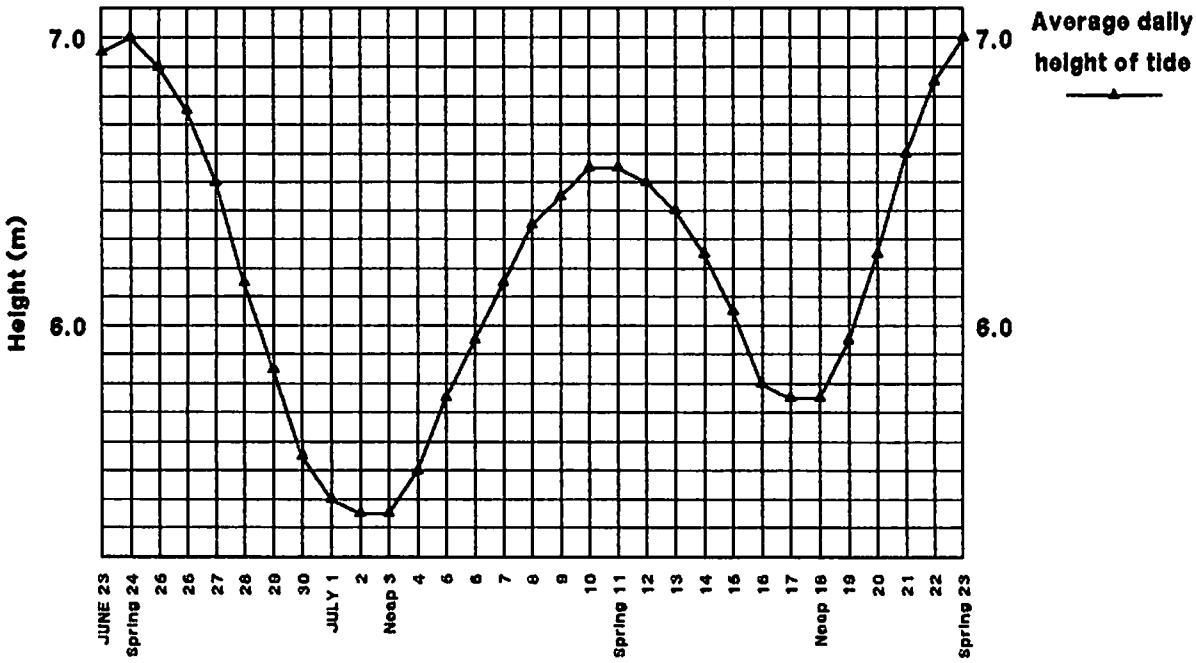
It was decided to carry out two sets of sea trials in the tangle net fishery, based at the port of Hayle near St. Ives. During the Summer trial (June 23rd to July 23rd) a complete tidal cycle was covered starting and finishing on a Spring tide. It was envisaged that the Autumn trial (September 30th to November 11th) would cover a complete tidal cycle starting and finishing on a neap tide, but bad weather extended the trial period and consequently the results for the Autumn trial are not as valid as those taken during the Summer. Fig 4 gives the daily average tidal height and the periods of Spring and Neap tides for the port of Hayle during both sets of trials.

7.1 Normal Daily Routine

During the course of a normal fishing day, the vessels left port as early as the tide would allow to catch the first period of slack water when they arrived on the fishing grounds. The trip to the grounds would take between two and three hours, depending on vessel capability. Most of the Hayle vessels were fishing an area approximately 10 miles north-west of the port. Two, three or sometimes four fleets of nets were then hauled - the number of fleets hauled depends on the state they were in and the length of slack water period. Badly tangled nets or nets with a dahn line (or "end") missing reduced the time available for hauling. Nets with large quantities of crabs enmeshed as by-catch inevitably took longer to clear.

Once the first period of slack water was over and the tide began to turn, the nets would be "turned over". This process involved clearing the nets of debris, mending where necessary and stowing them in bins neatly with dahn lines coiled in "bongoes" (cut-down plastic chemical drums) ready for shooting. The stowed nets were usually shot away before hauling further nets. Shooting was carried out in the direction of the tide, with the tide flow. This ensured that the nets paid away in a straight line.

Average heights of tide over the trial period
June 23rd to July 23rd 1990
for the port of Hayle, Cornwall



Average heights of tide for the period
September 30th to November 11th 1990
for the port of Hayle, Cornwall

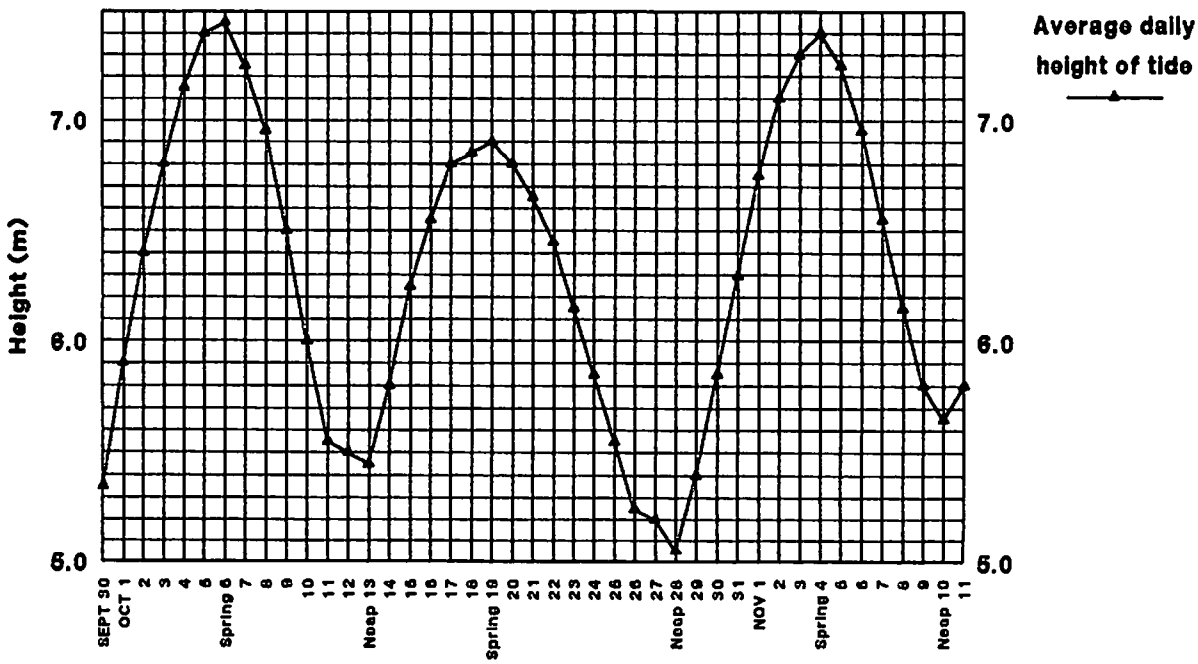


FIG 4

During the second period of slack water more nets were hauled, cleared and turned over. They were then shot away as before and then the vessel returned to port. The day's operations usually occupied 12-15 hours of time, including time spent running to and from the fishing grounds.

7.2 Trials Schedule

For both of the trials, it was decided to vary the soak times (i.e. the period of time the nets were left to fish) from 2 days to 10 days in increments of 2 days. This worked reasonably well in the Summer when every shot of the experimental gear (except the 2 day shot) was followed with a shot of the vessel's own gear - to act as a control. However, during the Autumn trials, progress was continually hampered by poor weather and so this 2 day incremental scheme was abandoned - the nets were recovered when the weather allowed.

7.2.1 Calendar of Operations - Summer Trial

Date	Gear	Soak Time
Saturday June 23rd	Shot experimental gear	
Sunday " 24th	Shot vessel's gear	
Wednesday " 27th	Haul and shoot experimental gear	4 days
Thursday " 28th	Haul and shoot vessel's gear	4 days
Tuesday July 3rd	Haul and shoot experimental gear	6 days
Friday " 6th	Haul and shoot vessel's gear	8 days
Wednesday " 11th	Haul and shoot experimental gear	8 days
Thursday " 12th	Haul and shoot vessel's gear	6 days
Friday " 13th	Haul and shoot experimental gear	2 days
Sunday " 22nd	Haul vessel's gear	10 days
Monday " 23rd	Haul experimental gear	10 days

7.2.2 Calendar of Operations - Autumn Trial

Date	Gear	Soak Time
Sunday September 30th	Shot experimental gear	
Monday October 1st	Shot vessel's gear	
Wednesday " 10th	Haul and shoot experimental gear	10 days
Thursday " 11th	Haul and shoot vessel's gear	10 days
Friday " 19th	Haul and shoot experimental gear	9 days
Saturday " 20th	Haul and shoot vessel's gear	9 days
Saturday November 10th	Haul experimental gear	22 days
Sunday " 11th	Haul vessel's gear	22 days

Trial abandoned due to bad weather.

7.2.3 Summary of Soak Times

Summer Trial

MFV MARY AMELIA (SS84)

Soak Time	Experimental Gear	Vessel's Gear
	2	-
	4	4
	6	6
	8	8
	10	10

Autumn Trial

MFV PENDRIK (FH195)

Soak Time	Experimental Gear	Vessel's Gear
	9	9
	10	10
	22	22

8 RESULTS

The results are presented on the following pages in a series of 9 diagrams (Figs 5-13) which have been condensed from the raw trials data. The raw data as collected at sea are contained in Appendices III and IV. Those data relating to the eight most frequent species have been coalesced from both the Summer and Autumn trials and ranked and totalled. They are given in Appendix V and it is these data which form the basis of the fish size distributions contained in this section.

Fig 5 Numbers of individual species netted over the entire trial period and the proportion of wasted edible crab (Cancer pagurus) by-catch.

Fig 6 Size distributions of edible crabs (cancer pagurus) caught as by-catch.

Fig 7 Size distributions for Crawfish (Palinurus elephas).

Fig 8 Size distributions for Lobsters (Homarus gamarus).

Fig 9 Size distributions for Monkfish (Lophius piscatorius).

Fig 10 Size distributions for Spotted Rays (Raia montagui).

Fig 11 Size distributions for Blonde Rays (Raia brachyura).

Fig 12 A comparison of catch quantity and soak time.

Fig 13 A comparison of whitefish degradation with increased soak time.

8.1 Conventions - The Identification of Net Types

All the size distributions have the same notation referring to the net type from which they were taken. For example, 12in x 0.50 indicates a tangle net of stretched mesh size 12in (30.5cm) with a hanging ratio of 0.50 (see Section 2.1). 'n = 26; mean = 133mm' denotes a sample size of 26 individuals with a mean size of 133mm.

The vessel's own fleets of nets were made up of a mixture of 10.5in and 12in (26.7cm and 30.5cm) nets. The majority of these nets were rigged with a hanging ratio of 0.33 but some were rigged with a ratio of 0.50. The proportion of 10.5in to 12in nets depended very much upon the "whatever was available at the time" principle. In view of this, it was decided not to break down the vessel's nets into types, but leave this attribute intact as a control as nets were frequently being replaced and interchanged.

For the size distributions shown in Figures 7 and 11, the upper graph depicts catches from the four types of experimental nets; the lower graph represents catches taken in the vessel's own nets. All percentage values other than frequencies are based on numbers of individuals, not weight, unless otherwise stated.

Numbers of individual species netted over the duration of the trial. Spider crabs and edible crabs are considered incidental.

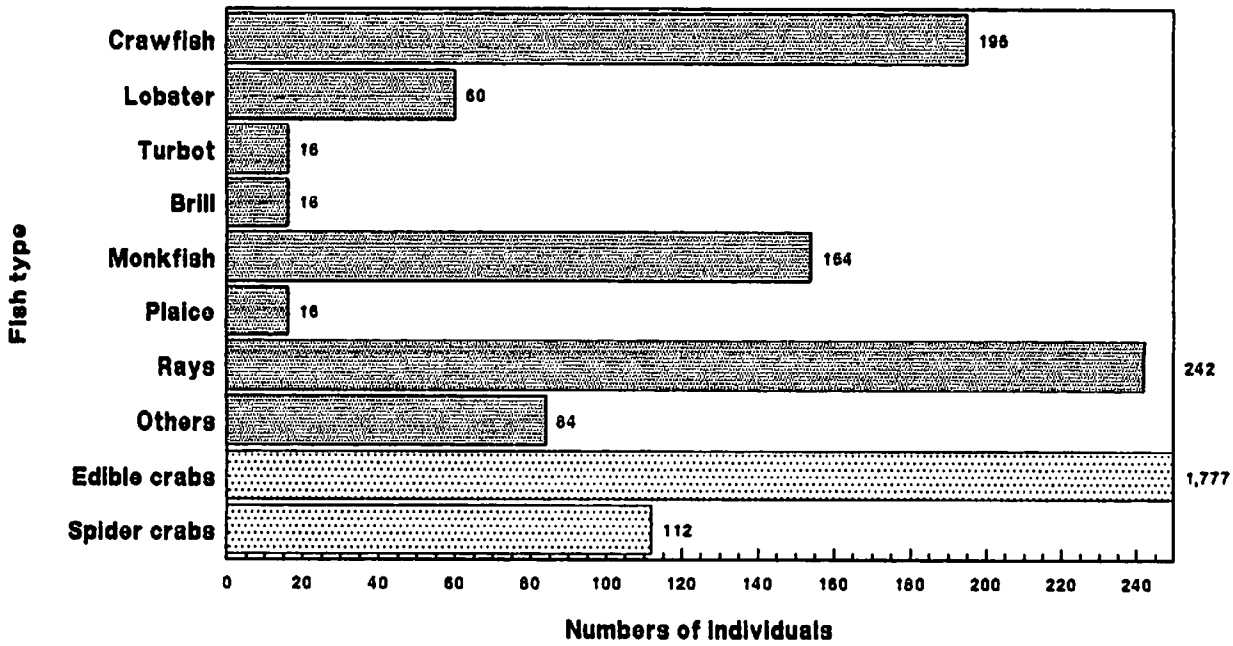
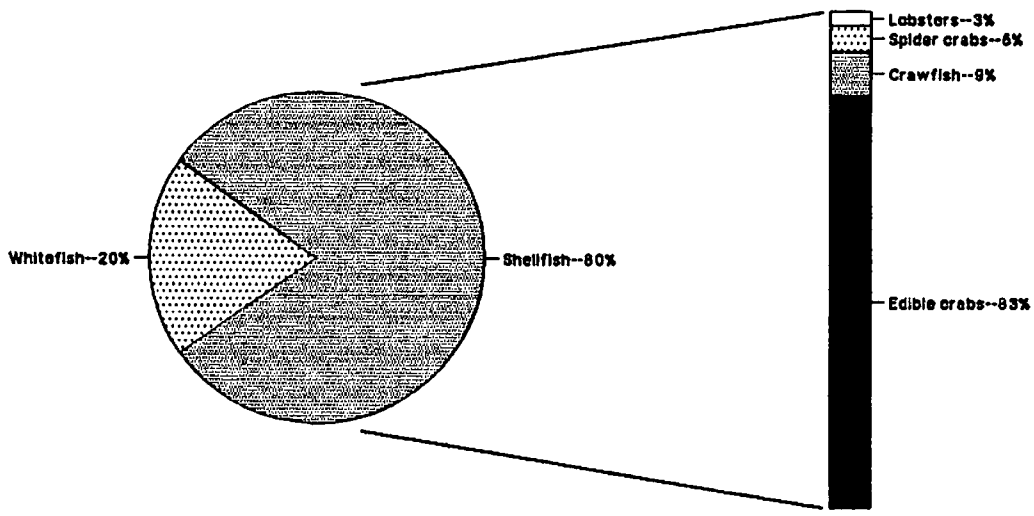


Diagram illustrating the proportion of wasted edible crab by-catch from the catches of all the nets used over the entire trial



Total catch for the trials

Breakdown of all shellfish caught

Trial periods June-July & Sept-Nov 1990
All edible crabs destroyed - claws landed

FIG 5

Size distributions of Brown Crabs (Cancer pagurus) caught as by-catch during Summer 1990 tangle net trials (period June-July)

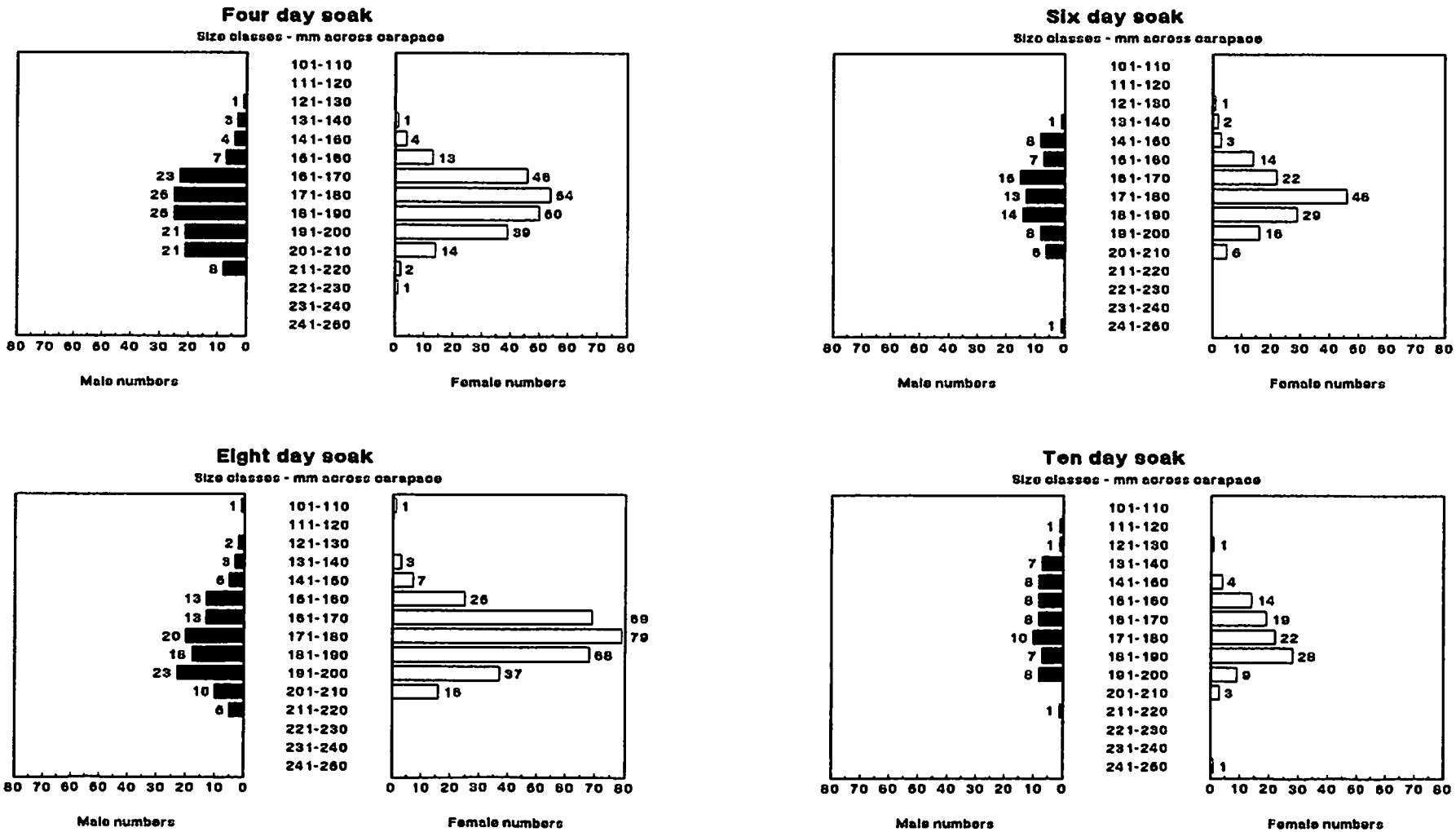
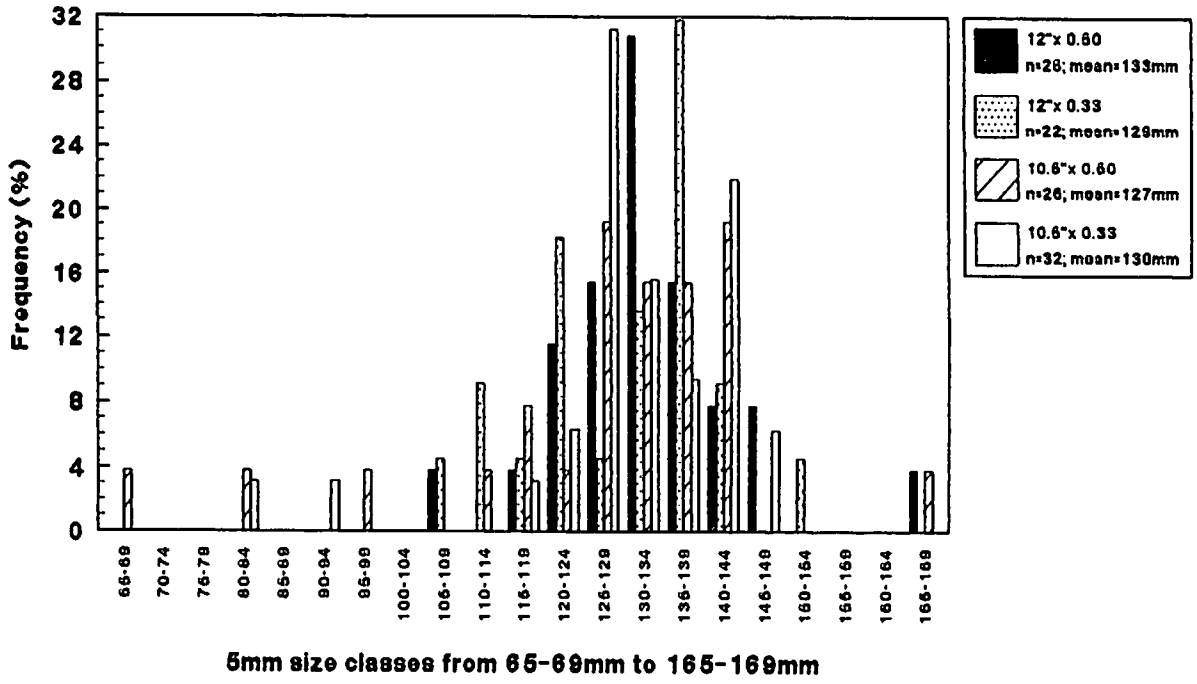


FIG 6

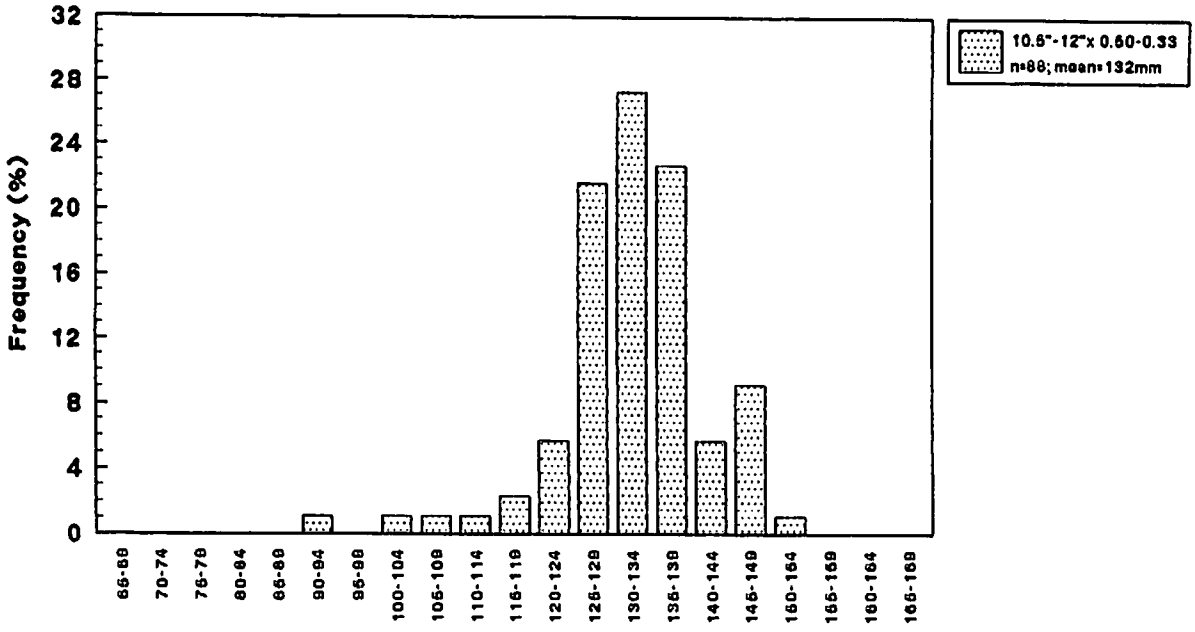
Size distributions of all crawfish (Palinurus elephas) caught with two different mesh sizes and two different hanging ratios



5mm size classes from 65-69mm to 165-169mm

Test nets - four specifications

Size distributions of all crawfish (Palinurus elephas) caught with two different mesh sizes and two different hanging ratios

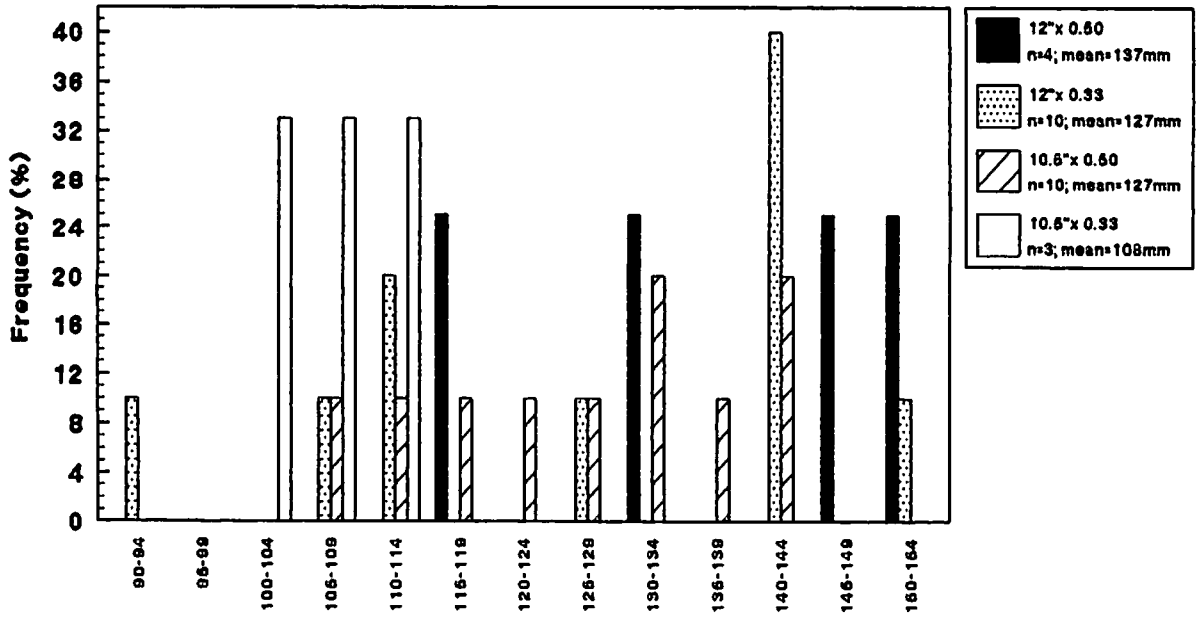


5mm size classes from 65-69mm to 165-169mm

Vessel's nets - mixture of specifications

FIG 7

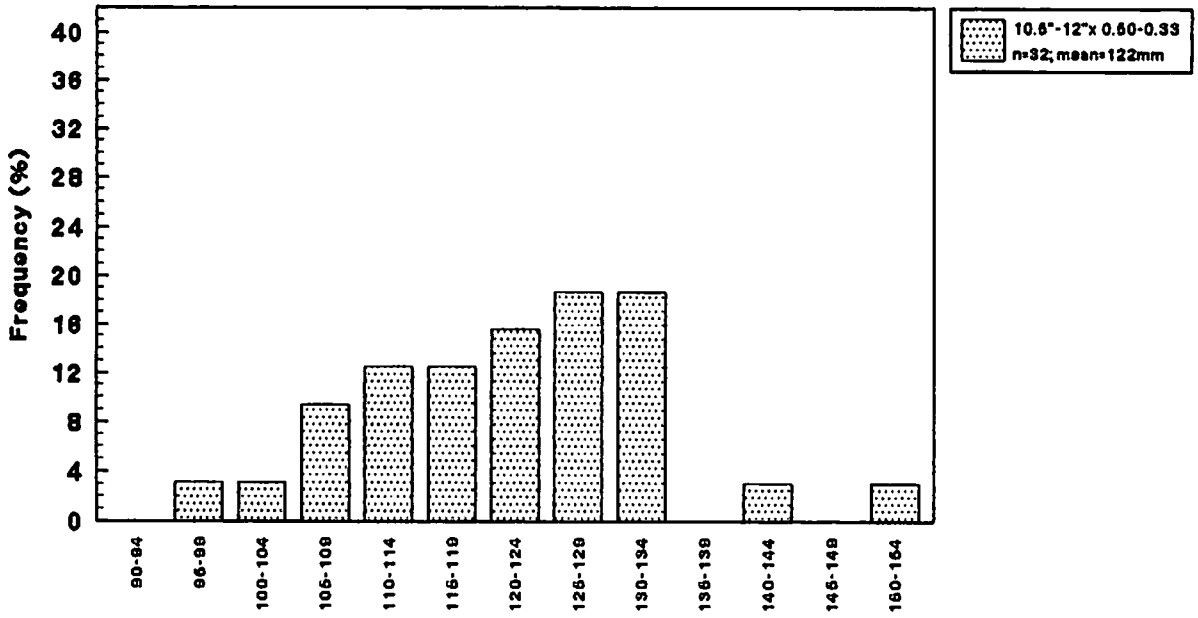
Size distributions of all lobsters (Homarus gamarus) caught with two different mesh sizes and two different hanging ratios



5mm size classes from 90-94mm to 150-154mm

Test nets - four specifications

Size distributions of all lobsters (Homarus gamarus) caught with two different mesh sizes and two different hanging ratios

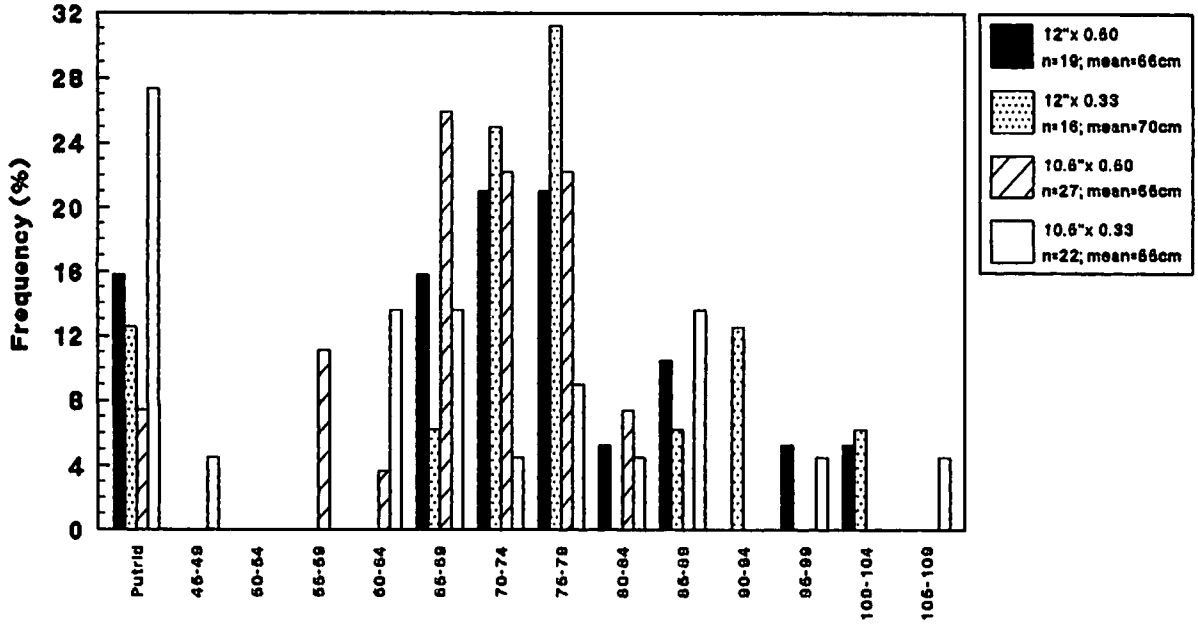


5mm size classes from 90-94mm to 150-154mm

Vessel's nets - mixture of specifications

FIG 8

Size distributions of all monkfish (Lophius piscatorius) caught with 2 different mesh sizes and two different hanging ratios

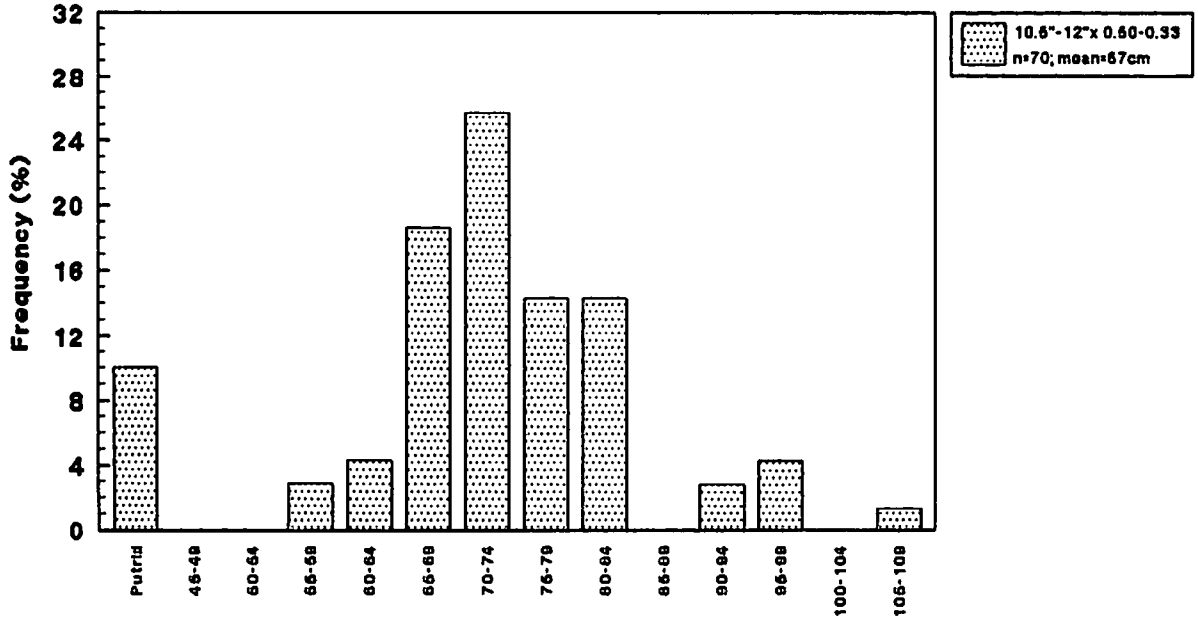


5cm size classes from 45-49cm to 105-109cm

Test nets - four specifications

Putrid = unmeasurable

Size distributions of all monkfish (Lophius piscatorius) caught with 2 different mesh sizes and two different hanging ratios



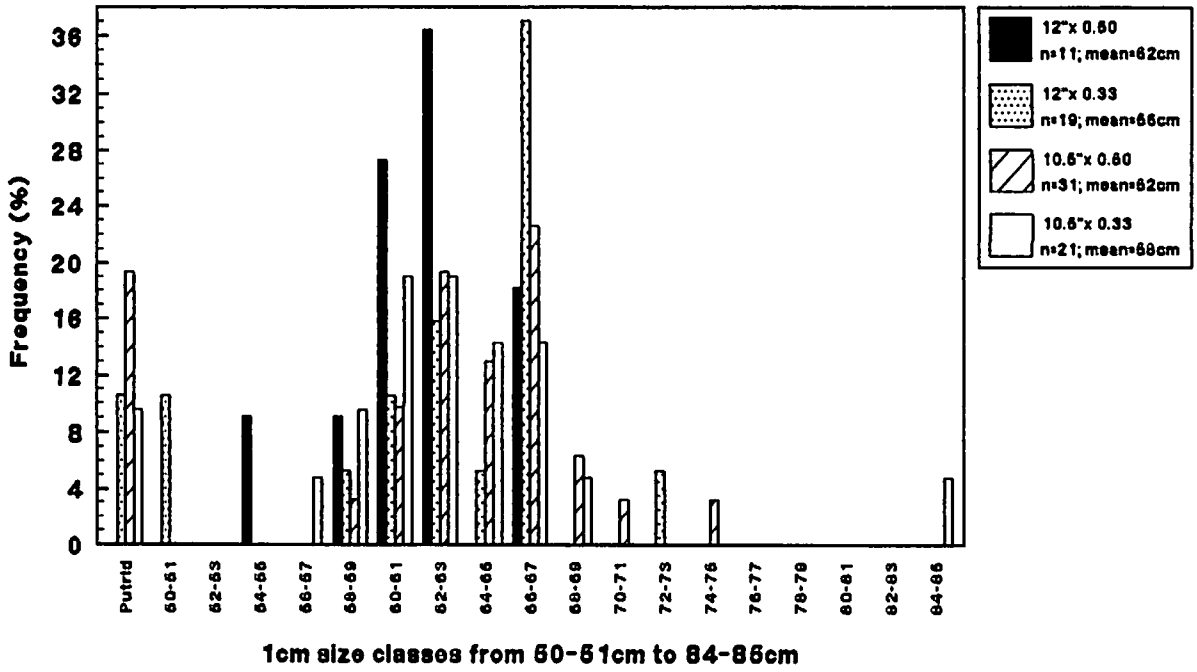
5cm size classes from 45-49cm to 105-109cm

Vessel's nets - mixture of specifications

Putrid = unmeasurable

FIG 9

Size distributions of all spotted rays (Raia montagui) caught with 2 different mesh sizes and two different hanging ratios

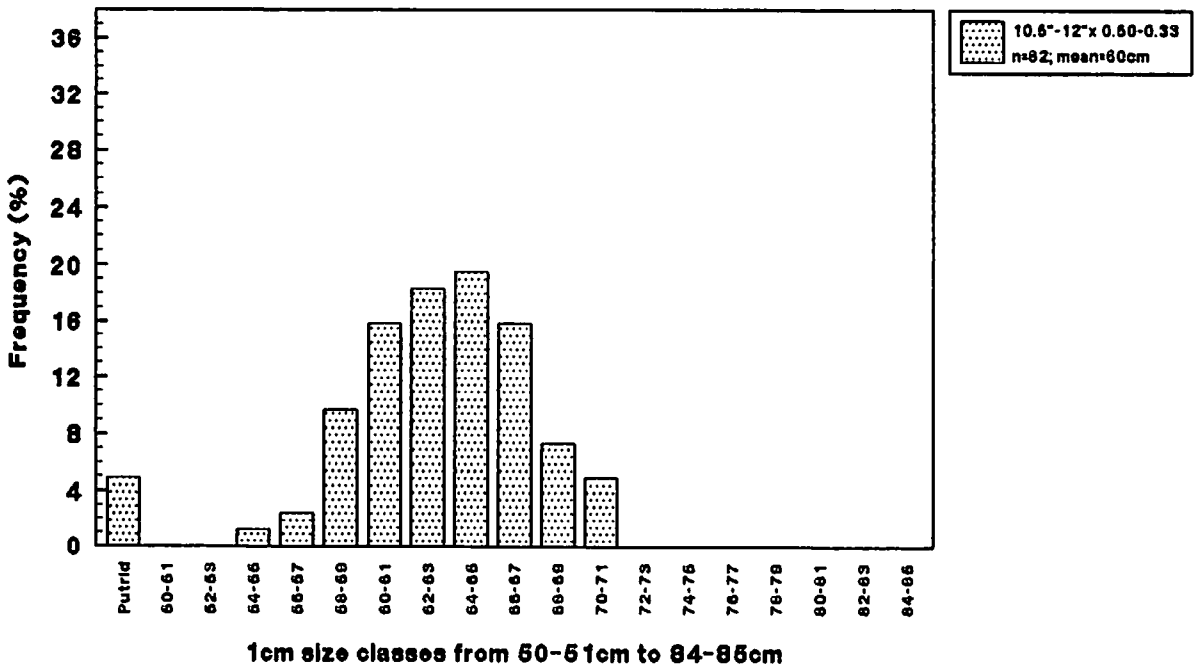


1cm size classes from 50-51cm to 84-85cm

Test nets - four specifications

Putrid = unmeasurable

Size distributions of all spotted rays (Raia montagui) caught with 2 different mesh sizes and two different hanging ratios



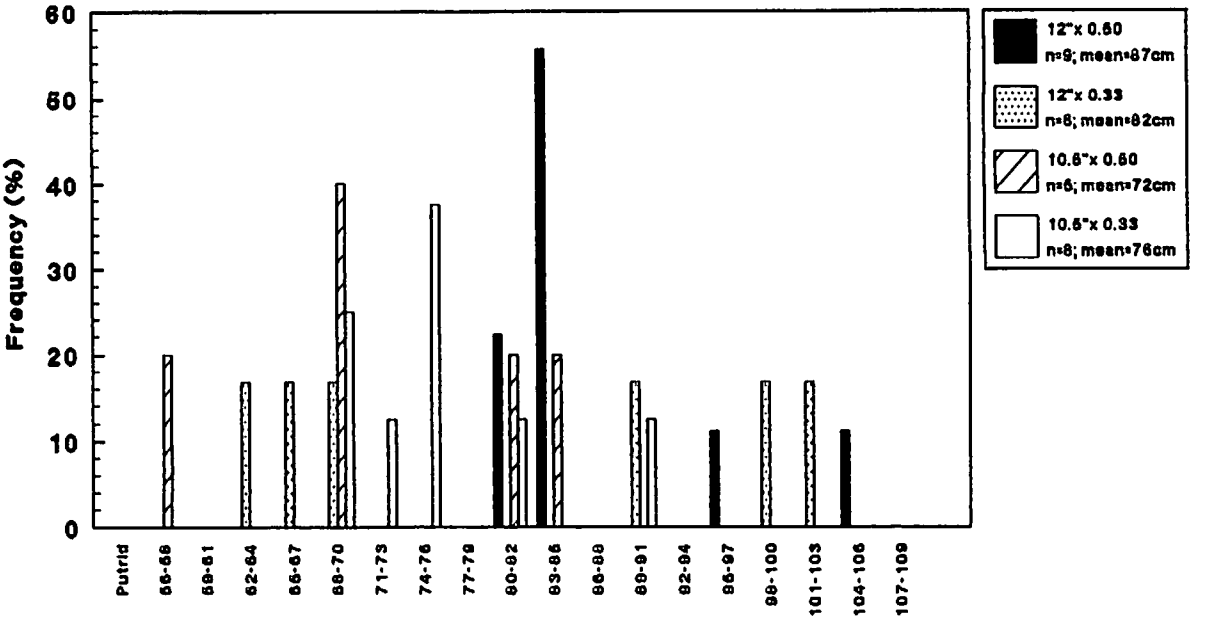
1cm size classes from 50-51cm to 84-85cm

Vessel's nets - mixture of specifications

Putrid = unmeasurable

FIG 10

Size distributions of all blond rays (Raia brachyura) caught with 2 different mesh sizes and two different hanging ratios

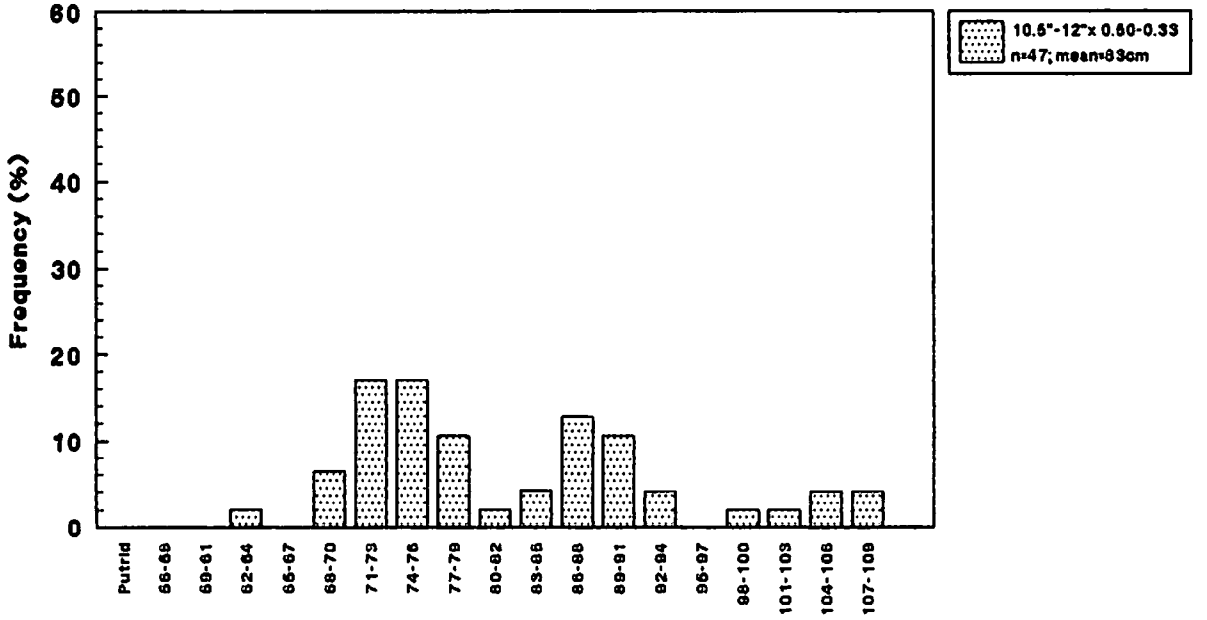


3cm size classes from 56-58cm to 107-109cm

Test nets - four specifications

Putrid = unmeasurable

Size distributions of all blond rays (Raia brachyura) caught with 2 different mesh sizes and two different hanging ratios



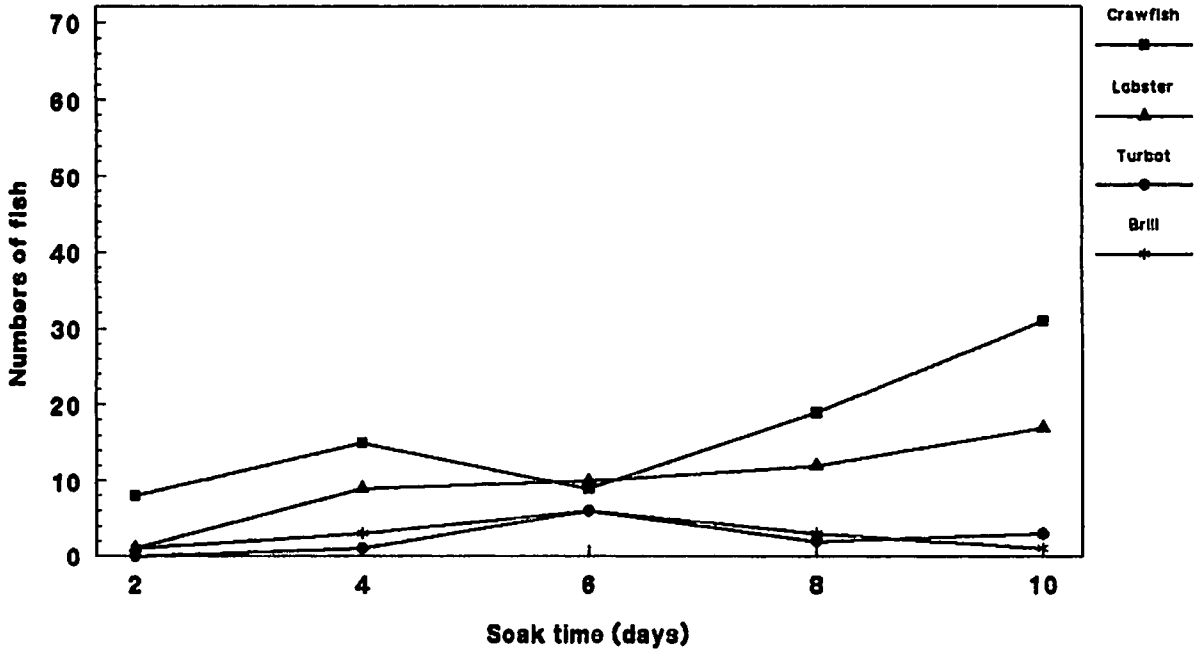
3cm size classes from 56-58cm to 107-109cm

Vessel nets - mixture of specifications

Putrid = unmeasurable

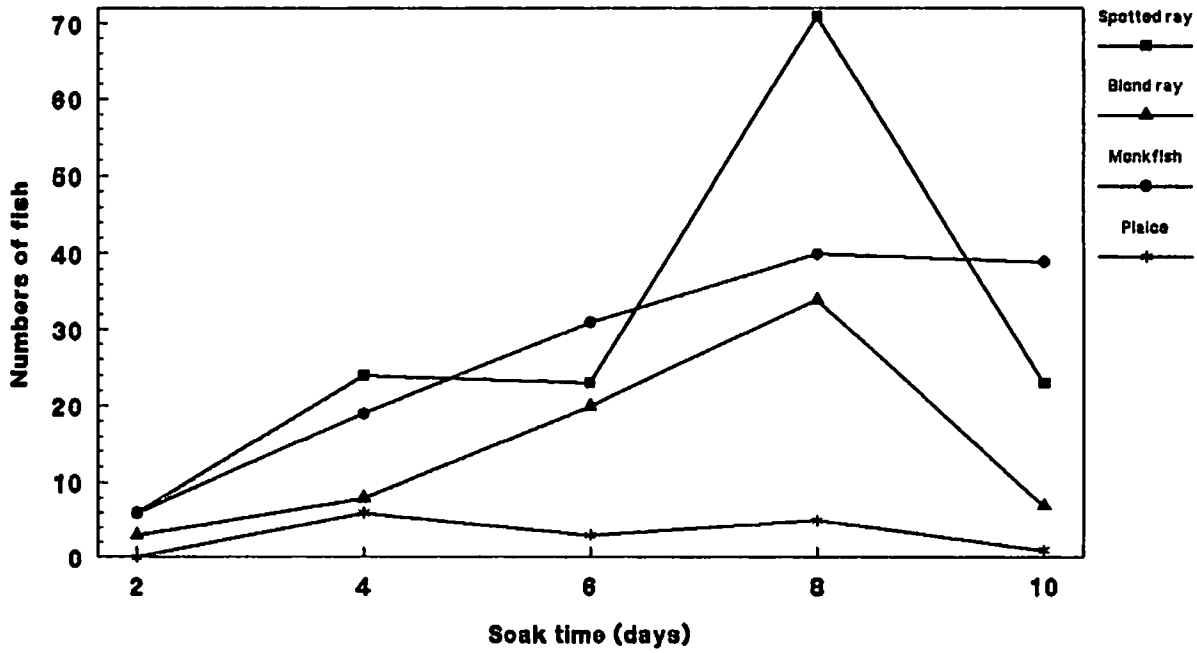
FIG 11

A comparison of catches with varying soak times
for Crawfish, Lobster,Turbot and Brill;
SUMMER TRIAL (June-July 1990)



Data from all net types combined

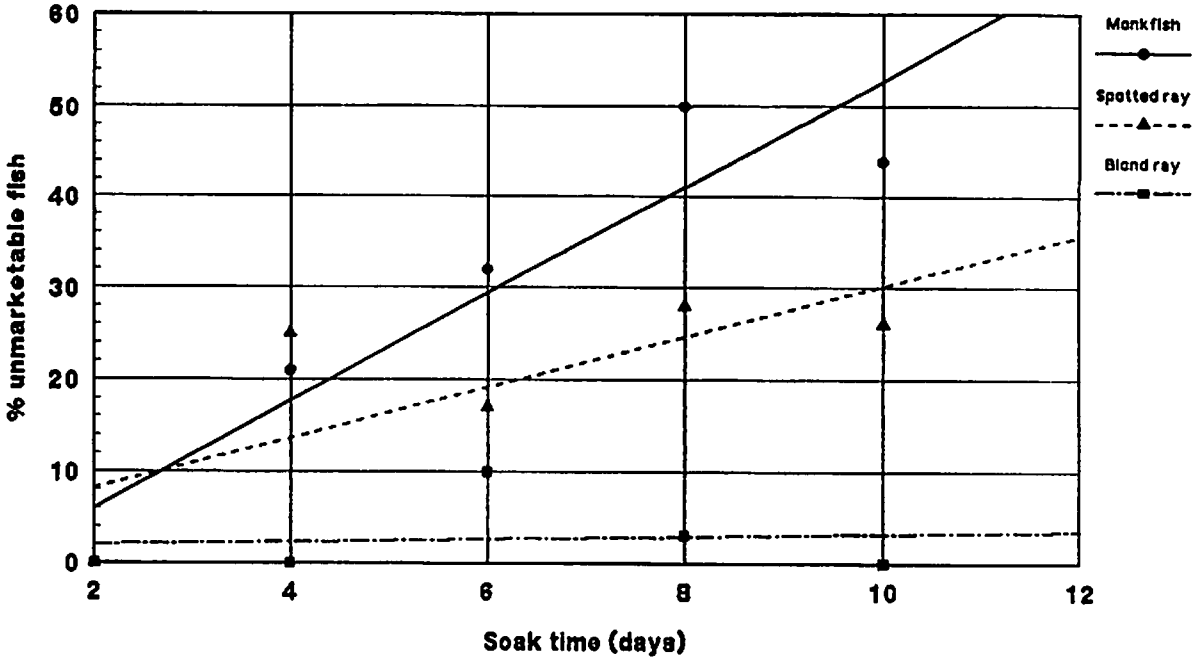
A comparison of catches with varying soak times
for Spotted ray, Blond ray, Monkfish and Plaice;
SUMMER TRIAL (June-July 1990)



Data from all net types combined

FIG 12

A comparison of white fish quality degradation (proportion of unmarketable fish) with increased soak time: SUMMER TRIAL (June-July 1990)



Data from all nets combined
Quality assessed using subjective grading

FIG 13

9 DISCUSSION

9.1 Selectivity of Tangle Nets

Selectivity describes how finely tuned a set of fishing gear is for catching fish of a certain size range or species. Selection (the process of selectivity) is defined as the alteration of the probability of fish capture depending on the characteristics of the fish (Ref 2). 'Selectivity' usually means selection by size, and 'size' is usually the total length of the individual fish.

For tangle nets, the selectivity attribute is somewhat different from other types of static nets and trawl gear. The gear does not rely solely upon fish becoming 'meshed' or 'gilled' (trapped by the opercula) - although this can happen. A tangle net relies upon the sheer volume of netting hung on the headropes and footropes to achieve a 'tangling' action. The length of the net sheet can be three times that of the rigged length of the net (see Section 2.1). Several individual meshes are usually found to be snagged on the body projections of a captured fish. Therefore, a tangle net is less selective for whitefish lengths than a net that has its meshes open wider (i.e. 'hung tighter') - for example, a gill net.

Tangle nets also differ from other types of static nets in that they are deliberately used to target shellfish as well as whitefish (see Section 2.3). The size range of captured crawfish (Palinurus elephas) - which are the most important shellfish target species - appears to be remarkably narrow for a net with relatively indiscriminate whitefish selectivity characteristics (see Fig 7). Whether this reflects the size distribution of crawfish on the grounds is not known. Crawfish are very spiny creatures and it was expected that individuals of any size would become quickly tangled in the strands of monofilament with equal effect. From the size distributions given in Fig 7, this was clearly not the case. There are two possibilities:-

(1) There is not a wide range of crawfish sizes occurring on the grounds (population size distribution).

(2) The nets exhibit a high degree of selectivity for crawfish only.

It is likely that the reason tangle nets appear to size-select crawfish better than whitefish is a combination of points (1) and (2).

There was not nearly a big enough sample size taken from these trials to say with any statistical certainty that 'one net fishes better than another'. What can be gained by looking at Figs 7 to 11 is an indication of how different mesh sizes and hanging ratios begin to affect the size distributions. There are too many uncontrollable variables to arrive at a scientifically valid conclusion, however. It would take many years of data collection to arrive at such a conclusion.

Observing Figs 9, 10 and 11, it can be seen that 12in mesh appears to catch fewer, larger fish than 10½in mesh - which catches greater numbers of smaller fish. This is exactly as one would expect. It is difficult to say with certainty, but there are indications that a slacker hung net (hanging ratio of 0.33) has better 'catching power' than a tighter hung net (hanging ratio of 0.50). These differences are minimal when compared to variables such as tide and ground type.

9.2 Tide

From observations made during hauling procedures and from the data contained in Appendices III and IV, it is apparent that the tide exerts influence on fish capture.

Observe Fig 14. This diagram is a graph illustrating the relationship between the month's tidal cycle from June 23rd to July 23rd 1990 and the occurrence of whitefish and brown crabs in the nets. 'Fish occurrence' information has been extracted from data relating to periods of time that the nets spent in the water - termed 'soak time'. As fish occurrence for a particular day represents an instantaneous value in time and the available data represents a long time period (soak time) then a certain amount of data interpretation was necessary to obtain these indices of fish occurrence. The main problem was that whitefish accumulating in a tangle net tended to spoil over the soak time period.

The only way to obtain a measure of the number of fish available to catch at the time at which the net was hauled is to count only fish that are strongly alive. Such fish fall into group 'A' on the subjective fish spoilage scale outlined in Section 3.1. The numbers obtained are then corrected to account for differences in the amount of nets fished. The resulting 'index of fish occurrence' represents numbers of strongly alive fish (group A) per 1200 yard fleet of nets.

This procedure cannot be applied to by-catches of brown crabs (Cancer pagurus) as these shellfish do not spoil in the same way as whitefish. They remain alive and healthy while trapped in the nets unless bad weather causes the nets to move about on the seabed (Section 9.3). The only means of obtaining a figure that reasonably represents the numbers of crabs available to catch at the time of hauling is to use the average catch rate over the soak time period and correct it to allow for differences in the amounts of net fished. Therefore, the 'index of crab occurrence' represents numbers of crabs per 1200 yard fleet per day.

Superimposing these two sets of figures on a tide graph for a one month tidal cycle reveals that there is a relationship between tide and whitefish/brown crab occurrence. Whitefish appear to be most frequent at neap tides. At these times there is about three times as many fish caught than at times of Spring tide. The curve for whitefish has been discontinued between July 13th and July 22nd as there were no hauls taken between these points in time. Indications are, however, that a maximum would occur near to the neap tide of July 18th.

It is known that the performance of tangle nets is linked to tide. During the periods of Spring tides, very fast tidal flows of up to five knots occured on the fishing grounds during the daily ebb and flood. The period of slack water was very short during Spring tides. This meant that the nets were fishing effectively for only a short period of time until the tidal flow forced the nets' headlines down onto the seabed. During periods of neap tides, these effects were much less marked. The variations in number of fish caught over the monthly tidal cycle during these trials was therefore likely to be a function of net performance rather than numbers of fish available on the grounds.

The occurrence of brown crabs sharply contrasts that of whitefish. Crabs appear most frequently in the nets at points just after a spring tide maximum. It is likely that the crabs are scavenging debris that has been stirred up by the strong tidal currents and being bottom-living animals they are easily caught in the net. Maximum occurrence of brown crabs features at points very close to minimum occurrence of whitefish. Avoiding these periods when using tangle nets would therefore seem a logical decision for a fisherman to make.

Average heights of tide and an index of the numbers of fish & crabs caught in the nets over the trials period June 23rd-July 23rd 1990

FIG 14

9.3 Soak Time and Spoilage

Figure 12 shows a comparison of catches with increasing soak time for the eight most frequent species. 'Soak time' is defined as the period of time between shooting the nets and hauling them. The two graphs in Figure 12 have been compiled using data from both the vessel's nets and the experimental nets during the Summer trial.

It is clear that generally the longer the nets are left, the more fish are caught. The relationships between catch and soak time vary. This variation is a function of fish spoilage and species behaviour/occurrence.

As the soak period gets longer, then more and more fish caught in the net will become spoiled (Ref 3). The rate of spoilage is dependant upon the fish species, water temperature, predation and weather conditions.

Based on observations taken during the trials period, the following is a list of the main species with provisional spoilage times:-

	Fish	Spoilage Time
(1)	Monkfish	2 days
(2)	Spotted ray	4 days
(3)	Blonde ray	4 days
(4)	Turbot/Brill	5-7 days
(5)	Lobsters	10 days
(6)	Crawfish	15 days

Note:-

'Spoilage time' here is defined as the time at which over half the fish caught were unmarketable.

Shellfish spoil in a different way from whitefish. They can survive long periods tangled in a net without access to food, but are susceptible to physical damage if, due to weather conditions, a heavy ground-sea is present. The nets then move about on the seabed and trapped shellfish are quickly damaged.

Soak Time and Spoilage

Figure 12 shows a comparison of catches with increasing soak time for the eight most frequent species. "Soak time" is defined as the period of time between shooting the nets and hauling them. The two graphs in figure [illegible] have been compiled using data from both the research nets and experimental nets during the [illegible] trial.

In [illegible] general, the longer the nets are left, the more fish are caught. The relationships between catch and soak time vary. This [illegible] the [illegible] of the species [illegible] concerned.

As the soak period gets longer, then more and more fish caught in the net will become spoilt (Fig 13). The rate of spoilage is dependent upon the fish species, water temperature, predation and weather conditions.

From observations taken during the trials period, the following is a list of the main species with approximate spoilage times:-

	Fish	Spoilage Time
(1)	Monkfish	2 days
(2)	Spotted ray	4 days
(3)	Blonde ray	4 days
(4)	Turbot/Brill	5-7 days
(5)	Lobsters	14 days
(6)	All fish	21 days

Notes:-

Spoilage times [illegible] as the time [illegible] which [illegible] half [illegible] [illegible].

[illegible] spoil [illegible] from [illegible]. They can survive [illegible] caught in a net [illegible], but are susceptible to physical damage, due to weather conditions; a heavy ground-sea is present. The nets then move about on the seabed and [illegible] are quickly damaged.

Water temperature at the seabed during the Summer trials was 12°C. The temperature has obvious links with bacteriological spoilage in dead fish trapped in the nets.

It is usually bad weather preventing vessels from going out to sea that leads to extended soak times. A good target soak time of five days can easily become a month or longer if the vessel cannot retrieve the nets. In one instance during the Autumn trial with MFV PENDRIK (FH195), an intended eight day shot became twenty-two days through bad weather. Long soak times are therefore not always a result of bad practice at sea.

9.3.1 Spoilage and Catch Dynamics

As fish that are caught in tangle nets are subject to spoilage, there is a dynamic situation with fish being accrued and lost continually. However, the number of marketable fish found in a net is not directly proportional to the soak time. A large increase in soak time usually results in only a small increase in the numbers of netted marketable fish and a big increase in the numbers of spoiled fish that are wasted. It is clearly a case of 'the law of diminishing returns'.

It can be shown mathematically that, in theory, the numbers of marketable fish caught in a tangle net will increase only up to a certain point with increasing soak time (personal communication; Seafish 1991).

9.4 By-catch

Tangle nets form a benthic (sea bed) means of static netting and as illustrated earlier in this report are usually used to target a wide range of species. Both shellfish and whitefish are targetted. The type of ground best suited to crawfish, which is a highly valued shellfish, is also ideal for brown crabs. This means that inevitably, large quantities of brown crabs (Cancer pagurus) are taken every day in tangle nets deployed around the Cornish coasts.

Fig 5 puts these 'by-catches' of brown crabs into perspective. During the Summer and Autumn Seafish trials, 80% of the catch taken was shellfish (by number). Of this 80%, 85% represented brown crabs (edible crabs); 9% represented the high value crawfish. Total numbers of brown crabs taken during the trials amounted to 1777 which were taken over 72 days fishing time with 2 x 4800 yards of net (2 x 4389m). This means that the average by-catch rates for brown crabs taken during the Seafish trials are as follows:-

25 crabs per day fished per 10,000 yards of net
(or 28 crabs per day fished per 10,000 metres of net).

The figure of 25 crabs per day per 10,000 yards of net (average) seems deceptively low, but when the time that the nets are fished for is taken into account, it becomes much more significant. The peak value for the rate of crab capture during the trials was 281 crabs taken in 4 days by 4800 yards of net. This represents 146 crabs per day per 10,000 yards of net.

Of all the brown crabs caught, 92% were above the minimum landing size. Landing size for brown crabs in Cornwall is 160mm across the carapace for males and 140mm for females.

It is difficult to see any way of avoiding such by-catches through the use of tangle nets. Crabs caught in this way have to be broken to remove them from the meshes of the net, and it is totally impractical to attempt to remove them whole. At the time of the trials the bodies were discarded but the claws were legally landed for processing into white crabmeat.

Most of the vessels engaged in tangle netting from the port of Hayle also fish inkwell pots for crabs. It is of interest to note that the crabs taken in the nets appeared to be consistently larger than those taken by pots - even when fishing on the same ground. Why this should be so is uncertain.

Spider crabs (Maia squinado) usually form part of the by-catch but not nearly to the extent of brown crabs. Of all the shellfish caught, spider crabs formed 5% by number (see Fig 5). Spider crabs are usually discarded, as the market for them is highly unreliable and short-lived, and the numbers encountered are usually low.

During the trials there were no instances of seabirds becoming trapped in the nets. The nets were being fished about 8 miles offshore in 30 fathoms (55m) of water. However, from information gained from local fishermen, birds were featured in net by-catches during late Winter and early Spring when nets are shot much closer to the shore.

The Royal Society for the Protection of Birds have acknowledged that the deployment of tangle nets in general poses no problems (with respect to seabirds), and that they consider problems to occur only in certain critical areas. These areas are where high densities of seabirds occur and tend to be well known. The RSPB therefore conclude that any bird/net interactions reflect a localised problem.

9.5 Conflicts

Conflicts arise in the inshore tangle net fishery between netters and potters and also between netters themselves.

Vessels shooting pots prefer to work across the direction of the tide, while vessels shooting nets must work closely in the direction of the tide (Ref 1). This can often lead to gear being 'shot down', that is, gear is laid over other gear. The risk of this happening in the inshore fishery is quite high.

Conflicts also arise between trawlers and both tangle netters and potters. Increasingly, trawlers of both U.K. and foreign origin are towing closer and closer inshore and are also towing on much rougher ground, so that now there are very few 'safe' waters anywhere. Tangle nets have to be built with cheapness in mind, as the risk of the nets being towed away by a trawl gear is ever present.

During the Summer trial with MFV MARY AMELIA (SS84), on 03/07/90, it was discovered that one of the trials nets (fleet D) was missing. A grapnel was deployed over the area to no avail. Our conclusion from this was that a trawler had towed away the entire fleet. (See Appendix I, 8 day soak : Experimental nets).

9.6 Summary of Problems in the Fishery

Below is a point-by-point list of various problems occurring in the Cornish tangle net fishery that have been identified in this report:-

(i) Wastage of whitefish due to excessive soak times.

(ii) Excessive brown crab mortalities due to method of net deployment and also through excessive soak times.

(iii) Conflicts of interest between tangle netters and trawlers of both U.K. and foreign origin.

(iv) Conflicts between different inshore vessels competing for space to shoot gear - both pots, lines and nets.

10 CONCLUSIONS AND RECOMMENDATIONS

(i) There is sufficient evidence to suggest that there is a considerable whitefish wastage problem. On one particular 8 day soak during the trials, 30% of the whitefish caught were unmarketable.

(ii) There is evidence to suggest that there is a considerable brown crab wastage problem in the tangle net fishery. On one particular 4 day soak (an ideal time in terms of minimum whitefish wastage) there were 281 crabs caught in 4800 yards of net. Of those crabs, 92% were above the minimum landing size. All were destroyed. Many of the vessels engaged in the tangle net fishery are also occupied with fishing for crabs and lobsters as a target species with inkwell pots.

(iii) It may be useful for fishermen to have access to a set of tangle net guidelines, so that ideal soak times for each target species can be regularly achieved.

(iv) There is a need to reassure conservationist organisations that there is apparently very little risk to birds or marine animals. During the entire Summer and Autumn trials no seabirds were found in any of the gear at any time.

(v) The trials highlighted the need to separate the use of different types of fishing gear (i.e. static and towed) if one type is not to be towed away by another. This is especially true in the inshore fisheries of Cornwall.

(vi) Selectivity for whitefish size in tangle nets is not as marked as it is in gill nets. On occasions, whitefish selectivity in the tangle nets appeared to be non-existent. Tangle nets appear to be far more size selective for shellfish than for whitefish, which is unusual.

(i) [illegible] is sufficient evidence to suggest that there is a considerable whitefish wastage problem. On one particular [illegible] and during the trials, 30% of the whitefish caught were unmarketable.

(ii) There is evidence to suggest that there is a considerable [illegible] crab wastage problem in the tangle net fishery. [illegible] in terms of [illegible] [illegible] 600 yards [illegible]. Of these crabs, 72% were above the minimum landing size. All [illegible]. Many of the vessels engaged in the tangle net fishery are also [illegible] with fishing [illegible] crews [illegible].

(iii) [illegible] or fishermen to have access to a set of [illegible] net [illegible] that [illegible] or each [illegible].

(iv) [illegible] is a need to measure conservation [illegible] there is apparently very little [illegible]. During the entire Summer and Autumn trials no [illegible] were found in any of the gear at any time.

(v) The trials highlighted the need to separate [illegible] of fishing gear (i.e. static and towed) [illegible] towed away by [illegible]. This is especially true [illegible] Cornwall.

(vi) [illegible] tangle nets is [illegible] in 1979 [illegible] annual.

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