MINISTRY OF AGRICULTURE FISHERIES AND FOOD
DIRECTORATE OF FISHERIES RESEARCH

# THE CRAB FISHERY OF SOUTH WEST ENGLAND

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LABORATORY LEAFLET No. 33
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CONTENTS

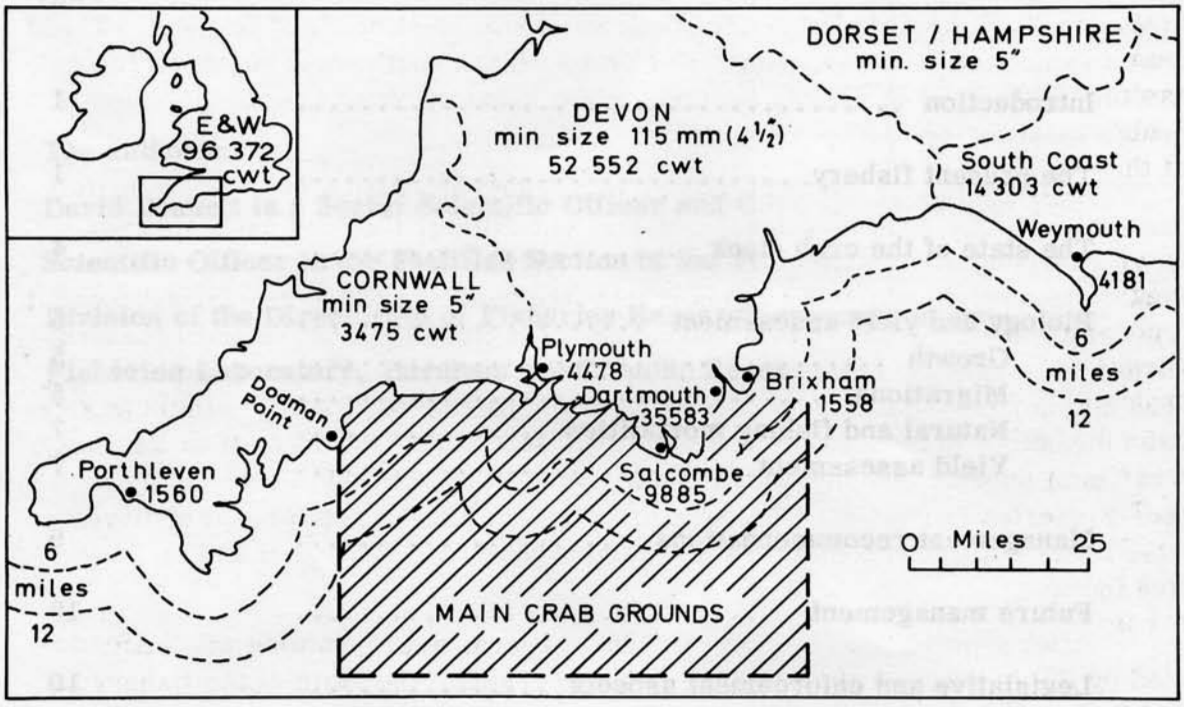


Figure 1 Crab landings (cwt) for 1975; main crab ports and grounds in the south-west.

Laboratory Leaflet No. 33

# THE CRAB FISHERY OF SOUTH-WEST ENGLAND - MANAGEMENT PROPOSALS

by D. B. Bennett and C. G. Brown

## INTRODUCTION

The England and Wales crab catch averaged 89 000 cwt (4 500 tonnes) during the five-year period 1971-75. A record 96 000 cwt (4 900 tonnes) of crabs, valued at £1.1 million was landed in 1975. Of this total nearly three-quarters (73%) was landed on the south and south-west coast of England. The rapid expansion in the exploitation of crabs off the south-west coast led to doubts on the part of certain sections of the industry about the effectiveness of the existing legislation.

Management of the crab fishery in England and Wales is achieved mainly by control of the minimum landing size. In addition, the landing of berried (egg-carrying) and soft recently moulted crabs is prohibited. Soft crabs have a poor meat yield which improves if they are returned to the sea for subsequent recapture after the shells have hardened. The Immature Crabs and Lobsters Order 1976 sets the national minimum landing size for crabs at a width of 115 mm across the broadest part of the back. Prior to 1976 the minimum size was measured in inches ($4\frac{1}{2}$). The national size limit is increased to 5 inches (127 mm) under a bye-law which applies to the Cornwall and to the Southern Sea Fisheries Districts. The main crab fishery off the south coast of Devon lies between these two districts and retains the national limit of 115 mm ($4\frac{1}{2}$ inches).

After a preliminary survey in 1967 a research programme was commenced by the Burnham Laboratory in order to evaluate the state of the fishery off south-west England, and in particular to determine the ideal minimum landing size for the area. It was decided to concentrate on the intensively fished and highly productive fishery off south Devon and east Cornwall, although some observations were also made along other parts of the south coast of England. The study included observations at sea aboard commercial vessels and at processing factories to examine the size composition and condition of the catch, tagging experiments to determine growth and migrations, general observations on the biology of the crab, and collection of catch and effort statistics. Contact was maintained with fishermen, merchants, processors, Sea Fishery Committee officers and the MAFF Inspectorate.

## THE PRESENT FISHERY

Crab fishing occurs along most of the south and south-west coast of England from Beachy Head to Land's End. Fishing effort is concentrated off south Devon and east Cornwall, between Brixham and Dodman Point (Figure 1).

The majority of crabs, over 70% of those caught in the south and south-west, are landed at Brixham, Dartmouth, Salcombe and Plymouth. The traditional fishing grounds were near the shore, but in recent years fishing has extended further and further offshore, the larger boats fishing up to 35 miles offshore.

The recent increase in the recorded landings from the south-west crab fishery, and hence the importance of this area now (Figure 2), is mainly due to the addition to the fishing fleet of larger boats up to 60 ft (18 m) in length, but partly to the improved collection of statistics. Such boats, operating up to 450 pots each, have on occasions each landed more than 2 tons of crabs in a day, and during the main season they frequently catch 1 ton per day.

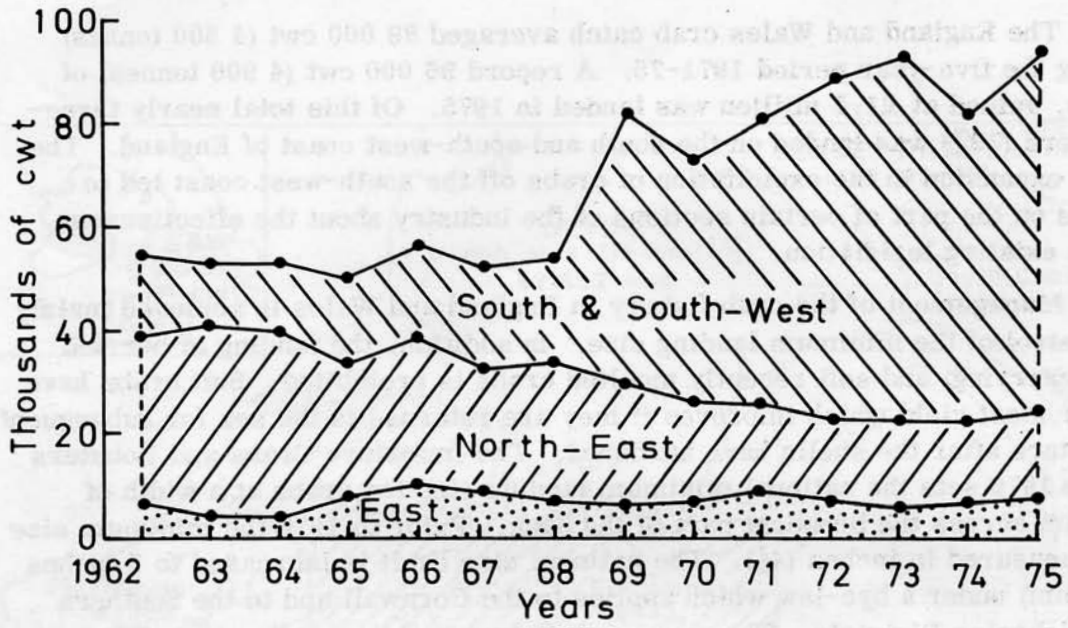


Figure 2 Crab landings for 1962-75 from the main fisheries. North-east = Northumberland to Lincolnshire; East = Norfolk to Essex; South and South-west = Kent to Land's End, Cornwall.

The analysis of catch and effort information recorded since 1971 by fishermen in log-books shows that peak crab landings occur in the autumn, with 80% of the catch being landed in the six months June to November (Figure 3). By comparison, peak landings on the north-east coast of England occur during the period April to June, and the crabs are caught mainly within 6 miles of the coast.

The autumn fishery in the south-west is based largely on large mature female (hen) crabs with developing or well developed ovaries (coral) caught on the offshore grounds. There is a seasonal increase of over ten times in the catch rate of hen crabs, from a minimum in the spring of about 50 lb/100 pots hauled to a maximum of about 600 lb/100 pots hauled in October. The seasonal nature of the main fishery for hen crabs creates problems for the marketing and processing side of the industry. Processing plant and staff are under-utilized during the first half of the year. Catches can be so large during the peak of the autumn

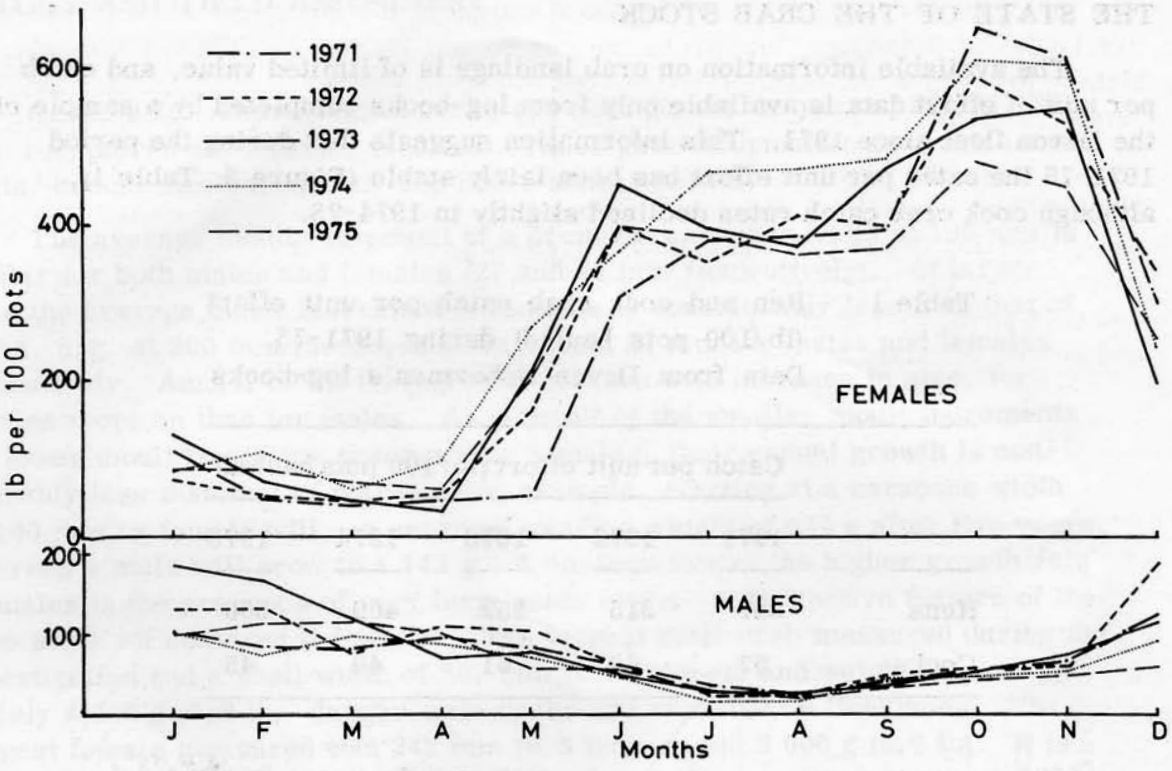


Figure 3 Catch per unit effort data (lb/100 pots hauled) from Devon fishermen's log-books, 1971-75.

season that voluntary limitation of catches is sometimes imposed. The majority of hen crabs are processed in local factories to produce catering packs of frozen white and brown meat. As there is more consumer demand for white muscle meat, much of the brown body meat is utilized by paste manufacturers. An export trade in frozen or chilled whole crab, mainly to Sweden, has been developed.

Peak male crab catch rates occur in the south-west during December and January (Figure 3) but the sustained high level of catch rates throughout the spring results in an important cock crab fishery on the inshore grounds, at a time when hen crabs are scarce. The larger male (cock) crabs which exceed approximately 7 inches (178 mm) and $2\frac{1}{4}$ lb weight (1 049 g) command a high price, up to five times that of females. Males smaller than this size and 'crippled' (i.e. incomplete) cock crabs are usually included with the females and sold as hens. Unlike the hen crabs, which are normally processed, cock crabs are sold as whole live crabs, usually being sent to the larger fish markets such as Billingsgate.

Although the minimum landing size is 115 mm (the equivalent was $4\frac{1}{2}$ inches before 1976) in Devon and Sussex, and 5 inches (127 mm) in Cornwall, Dorset and Hampshire, the market demand is for a larger crab. The average minimum size of crabs selected by fishermen is about 6 inches (152 mm); this is the effective minimum landing size in the Devon and Cornwall fishery. In Dorset, Hampshire and Sussex the average minimum size selected by fishermen is lower, about 5 inches (127 mm).

## THE STATE OF THE CRAB STOCK

The available information on crab landings is of limited value, and catch per unit of effort data is available only from log-books completed by a sample of the Devon fleet since 1971. This information suggests that during the period 1971-75 the catch per unit effort has been fairly stable (Figure 3, Table 1), although cock crab catch rates declined slightly in 1974-75.

Table 1 Hen and cock crab catch per unit effort (lb/100 pots hauled) during 1971-75. Data from Devon fishermen's log-books

| | Catch per unit effort (lb/100 pots hauled) | | | | |
|---|---|---|---|---|---|
| | 1971 | 1972 | 1973 | 1974 | 1975 |
| Hens | 357 | 315 | 352 | 409 | 360 |
| Cocks | 57 | 66 | 61 | 49 | 45 |

Observations on the unsorted crab catch show that the average size of crabs caught on the offshore grounds is greater than that on the inshore grounds. Undersized crabs, less than 115 mm ($4\frac{1}{2}$ inches), are rarely caught offshore. Large male (cock) crabs are, however, also caught on the inshore ground and in fact seem to be more abundant inshore during the spring. There is an increase in the average size of crabs, particularly females, on both inshore and offshore grounds in the autumn. The average size of crabs in the south-west is greater than in the other main fisheries off the east and north-east coasts of England.

The average size of female crabs landed in both the spring and autumn has varied little in the period 1967-75, averaging about 167 mm (6.6 inches) in the spring and about 179 mm (7.0 inches) in the autumn from the offshore grounds. The average size of the male (cock) crabs landed appears to have varied between 180 mm (7.1 inches) and 204 mm (8.0 inches), but most of this variability is probably the result of sampling variation. (For comparison, the average size in Yorkshire is 145 mm (5.7 inches) for females and 137 mm (5.4 inches) for males.) These observations, bearing in mind the problems of obtaining comparable samples, suggest that the present level of exploitation is having little effect on the size composition of the stock. Fishermen have, however, said that they catch fewer very large cock crabs now than a few years ago. This may well be so and would not be apparent from our sampling of cock crabs because of the large sampling errors involved.

The tagging results (see later) suggest that the exploitation rate is variable and appears to be relatively low in this fishery. However, certain grounds are heavily fished both by British and French boats. No information on the catch or effort of the French boats is available. It is unlikely that the areas at present supporting large numbers of pots (e.g. Start Point) could sustain an increase in exploitation.

## BIOLOGY AND YIELD ASSESSMENT

### Growth

Of the 9 497 suture-tagged crabs released during the years 1968-71, 321 were recaptured after having moulted. These gave information on moult increments, annual moult frequency and hence annual growth.

The average moult increment at a premoult carapace width of 100 mm is similar for both males and females (27 and 28 mm respectively). At larger sizes the average moult increment of females is considerably less than that of males, e.g. at 200 mm increments are 45 and 31 mm for males and females respectively. Annual moult frequency decreases with increase in size, for females more so than for males. As a result of the smaller moult increments and lower moult frequency observed for females, their annual growth is considerably less than that of males. For example, starting at a carapace width of 100 mm, a female will, on average, reach a weight of 644 g after five years, whereas a male will grow to 1 142 g. A consequence of the higher growth rate of males is the presence of very large male crabs - a distinctive feature of the crab stock off south-west England. The largest male crab measured during the investigation had a shell width of 267 mm (10.5 inches) and weighed approximately 4 200 g (9.3 lb): larger male crabs are reported by fishermen. The largest female measured was 242 mm (9.5 inches) and 2 000 g (4.4 lb). It is impossible to age crabs directly but the larger crabs encountered are probably in excess of fifteen years old.

### Migrations

Recaptures from both inshore and offshore tagging experiments have shown that some crabs, particularly females, make extensive movements, mainly west or south-west down the English Channel (Figure 4). Of those recaptured, between 10 and 32% moved 10 miles or more, and the majority of these (58 to 80%) moved westwards or south-westwards down the Channel. Although a few males made movements over 10 miles, the majority of movements were made by female crabs. The maximum distance moved was 155 miles. The concentration of female crabs, with developing or well developed ovaries, in the autumn off south Devon may well be the result of a breeding migration. There is probably a large, but possibly diffuse, stock consisting mainly of females over a large area of the English Channel, and extensive migratory movements, mainly down the Channel produce complex stock relationships. The movement of male crabs is limited and stocks of cock crabs are therefore probably localized and dependent upon recruitment from local sources.

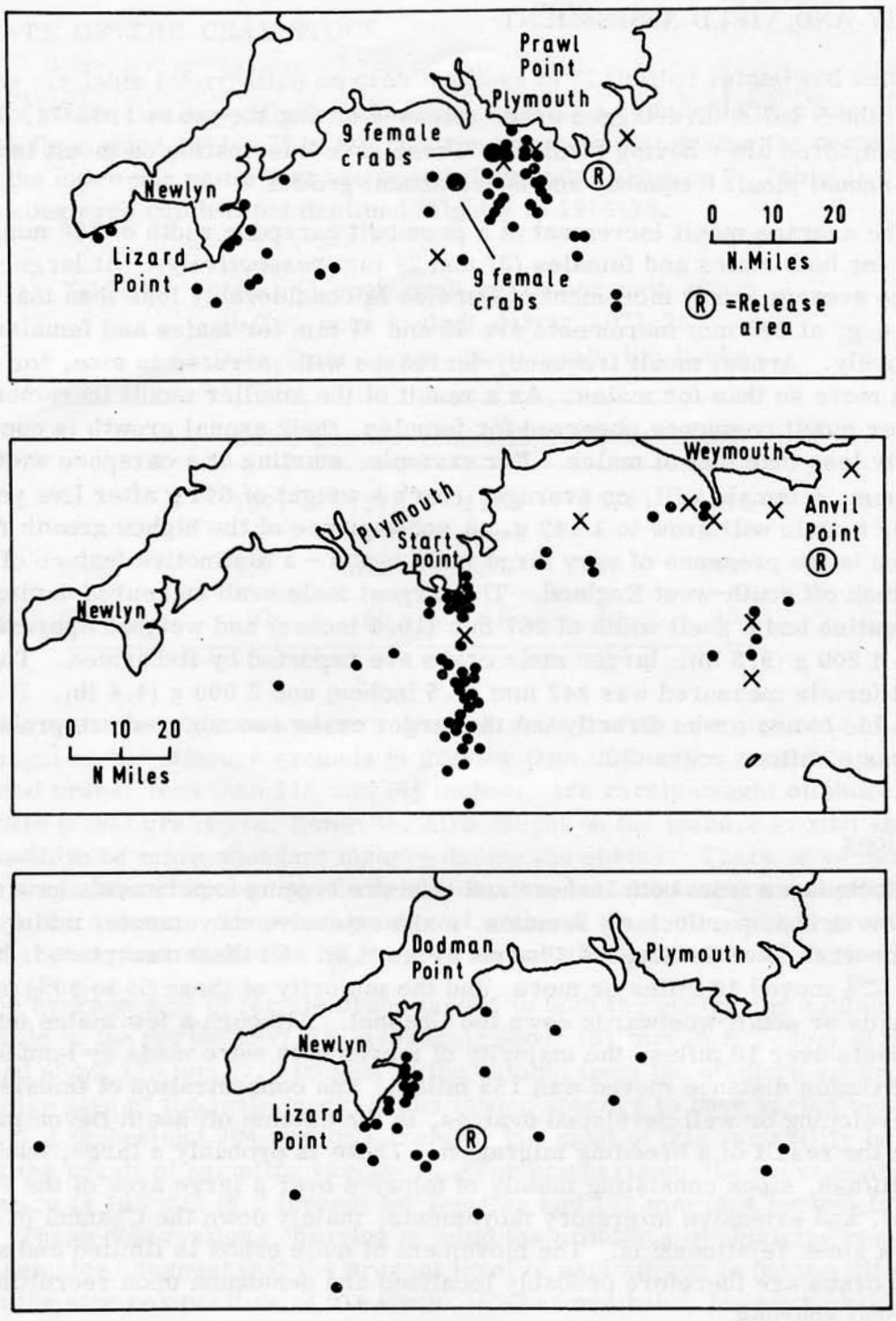


Figure 4 Recapture positions of male (x) and female (•) crabs which moved 10 or more miles from the release areas: (A) Prawle Point, October 1971; (B) 12 miles south of Anvil Point, July 1973; (C) 20 miles south of Dodman Point, July 1973. R = release position.

Natural and fishing mortalities

Estimates of the proportions of deaths due to natural causes and to fishing are necessary to enable predictions to be made about the effects of changing minimum sizes.

Our inability to age large crustaceans, such as crabs, makes the estimation of mortality parameters extremely difficult. Using the annual growth curves calculated for male and female crabs, together with size composition data, it has been possible to estimate total (fishing and natural) mortality rates. These data suggest a total annual mortality rate of about 45% for males and 40% for females off the south and south-west coast of England.

An indication of the level of fishing mortality can be obtained from the recapture rates in tagging experiments. Recapture rates have varied from area to area, from a high value of 31% in the twelve months beginning four weeks after release for females off Start Point, to a low value of 2% off Portland Bill. These recapture rates indicate that fishing mortality is variable and appears to be relatively low in this fishery. Rates of between 20 and 30% are more typical of the main fishing areas. However, these recapture rates have probably been reduced by tag losses, non-reporting and emigration, and therefore only provide a minimum estimate of fishing mortality.

Assuming some tag losses and non-reporting of recaptures, fishing mortality in the main fishery is assessed at about 35%. Natural mortality would therefore appear to be low, less than 18%.

Although too much reliance should not be placed upon these mortality estimates, they appear consistent with other known characteristics of the population and may be incorporated into the yield assessment model.

Yield assessment

An increase in the minimum landing size for crabs would only be worth while if a sustained increase in the yield of the fishery were achieved. This would occur if the loss of crabs due to natural mortality during the time period taken to grow from an old to a new minimum size was less than the increase in weight achieved by the growth of those crabs remaining in the stock and later caught.

It has been possible, using likely values for mortality parameters, to determine the probable effect on yields of various increased minimum sizes. As the growth rates of male and female crabs are so different it is essential to consider the sexes separately.

The yield assessments (Figure 5) suggest that the maximum yield of females is not being obtained, even under the present bye-laws of the Cornwall and Southern Sea Fisheries Districts (5 inches, 127 mm carapace width). If natural

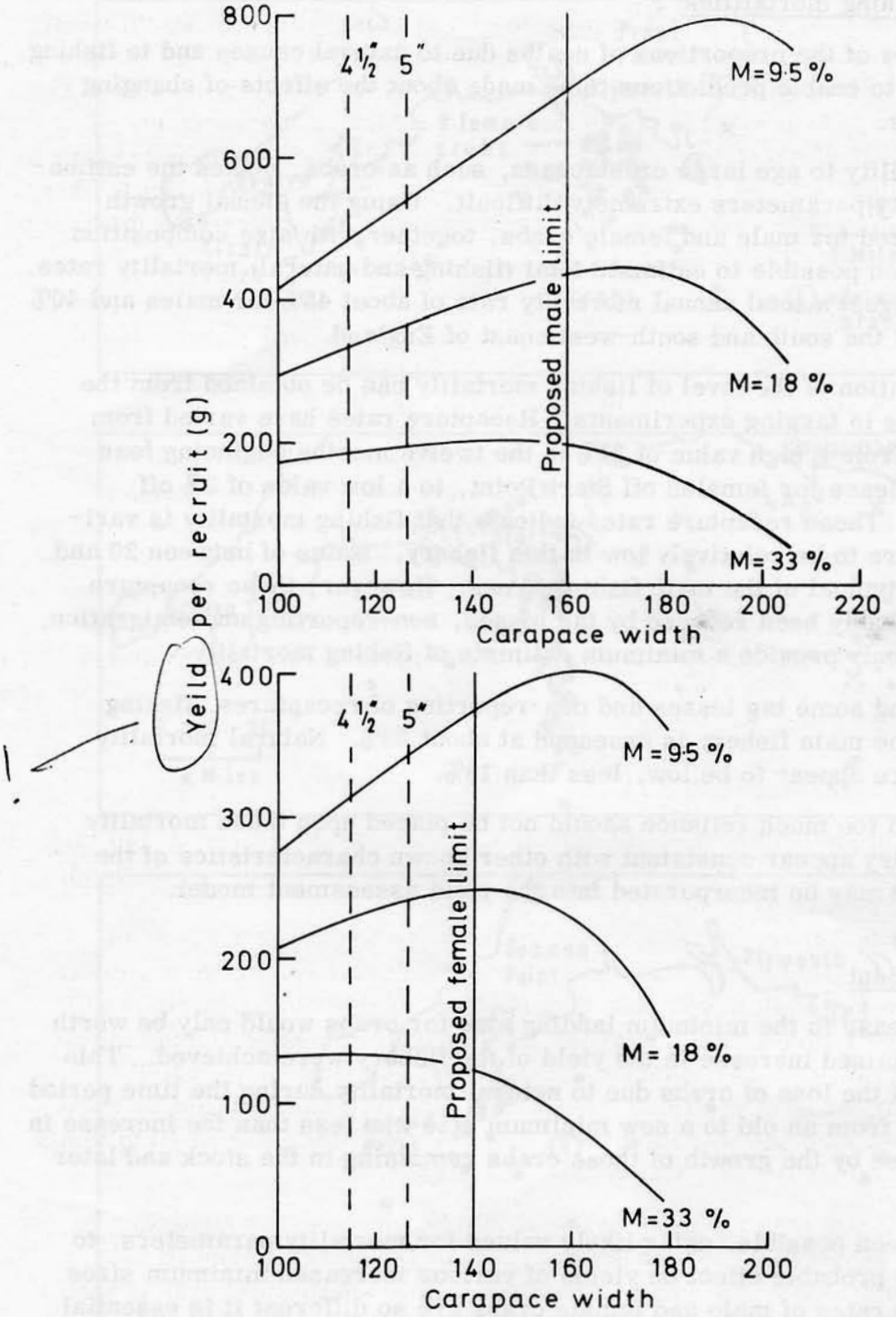


Figure 5 Yield curves for male and female crabs showing the yield at different minimum sizes for three levels of natural mortality (M = 9.5, 18, 33%) when fishing mortality is 33%. The proposed size limits are shown.

mortality is less than 33%, a minimum size of 140 mm ($5\frac{1}{2}$ inches) would result in an increase in yield, compared with the national limit (115 mm, $4\frac{1}{2}$ inches) and the bye-law limit (5 inches, 127 mm). If natural mortality is less than 18% then a minimum size greater than 140 mm would achieve a higher yield. However, as the level of natural mortality is not accurately known it is necessary to err on the cautious side and to select 140 mm as the minimum size limit; this should result in an increased yield, but would possibly not achieve the maximum increase if natural mortality is less than about 18%.

Male crabs grow faster than females. Unless natural mortality exceeds 33% an increase in the minimum size for males to 160 mm ($6\frac{1}{4}$ inches) should achieve an increased yield (Figure 5). Higher yields could be obtained at larger minimum sizes if natural mortality is 18% or less.

All these predictions are made on a yield per recruit basis. This is because it has not been possible to quantify the recruitment of the younger crabs to the fishable stock. Therefore, where increases in yields are predicted, these are increases above the yield which would be obtained in a particular year at the previous minimum landing size. If recruitment is low in subsequent years the total yield from the fishery may well be lower than previous yields. The yield should, however, be higher than if the minimum size were not altered.

## MANAGEMENT RECOMMENDATIONS

(a) <u>The minimum landing size for female crabs should be raised to 140 mm ($5\frac{1}{2}$ inches)* for the whole of the south and south-west coast of England, from Dungeness to Land's End</u>

In the main fishery off Devon such an increase would not achieve an increase in yield as the fishermen already voluntarily impose a similar minimum size. However, the 'legalization' of this voluntary limit will ensure the future protection of the stock should excessive fishing mortality occur (e.g. if our inshore stocks were to become more heavily exploited), and, in addition, the average size of females would be maintained at a size suitable for processing. A small increase in yield would be expected off Dorset, Hampshire and Sussex.

(b) <u>The minimum size for male crabs should be increased immediately to 160 mm ($6\frac{1}{4}$ inches)* for the south coasts of Devon and Cornwall</u>

This would result in a small immediate loss of small male crabs, normally sold as hens, but should ultimately result in an increased yield of cock crabs.

(c) <u>The minimum size for male crabs should be increased immediately to 140 mm ($5\frac{1}{2}$ inches)*, and eventually to 160 mm ($6\frac{1}{4}$ inches)* for the coasts of Dorset, Hampshire and Sussex</u>

Because of the lower average size of crabs along these coasts, compared with Devon and Cornwall, and the presence of a greater proportion of male crabs in the landed catch, an immediate increase to 160 mm ($6\frac{1}{4}$ inches), as recommended for Devon and Cornwall, would, together

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*140 mm ($5\frac{1}{2}$ inches) is approximately a 1 lb crab, 160 mm ($6\frac{1}{4}$ inches) is a $1\frac{1}{2}$ lb crab.

with the small losses incurred from increasing the female size limit to 140 mm ($5\frac{1}{2}$ inches), result in unreasonably large immediate losses in catches. It is therefore proposed that the male limit in Dorset, Hampshire and Sussex should initially be raised to 140 mm ($5\frac{1}{2}$ inches), the same as for females, and that after two years at 140 mm it should be further raised to 160 mm ($6\frac{1}{4}$ inches). Together these increases should ultimately result in an increased yield of cock crabs.

## FUTURE MANAGEMENT

The collection of adequate catch and effort statistics will be essential to monitor the effects of implementing the proposed increases to 140 and 160 mm. If this information were to become available, consideration should be given to a further increase in the male minimum size, particularly off south Devon.

## LEGISLATIVE AND ENFORCEMENT ASPECTS

If the proposed fishery management actions were to be implemented two fundamental changes in the national legislation would be required:

(i) It would be necessary to consider the management of the crab fisheries of England and Wales on a regional basis, not a national one. The crab stock of the south and south-west coast of England is separate from that in the north-east of England and has certain characteristics which necessitates different legislation from that existing nationally. The average size of crabs in the south and south-west coast catch is higher than elsewhere in England and Wales, with large cock crabs being a characteristic feature. This may be the result of a faster growth rate than elsewhere. Our previous studies from 1958 to 1967 on the east and north-east coast showed that a minimum size of $4\frac{1}{2}$ inches (115 mm) was the most suitable for that area. However, it appears that to achieve the maximum sustainable yield on the south and south-west coast a higher minimum size is essential.

(ii) Differential minimum sizes would be required for male and female crabs if the maximum sustainable yield for each is to be achieved. In the south and south-west the growth rate of male crabs is greater than that of females and large male cock crabs are caught and marketed separately. Consequently there are, in effect, two fisheries, one for cock crabs and the other for hen crabs, each requiring its own minimum size to achieve its maximum yield.

## SUMMARY

(i) The rapid expansion in the exploitation of crabs off the south-west coast led to doubts on the part of certain sections of the industry about the effectiveness of the existing legislation (minimum landing size 115 mm ($4\frac{1}{2}$ inches), i.e. the national limit, in Devon and Sussex; 5 inches (127 mm) in Cornwall, Dorset and Hampshire).

(ii) The Burnham Laboratory's study included (a) observations at sea aboard commercial vessels and at processing factories to examine size composition and condition of the catch, (b) tagging experiments to determine growth and migrations, (c) general observations on the biology of the crab, (d) collection of catch and effort statistics.

(iii) Observations on the catches suggest that the present level of exploitation is having little effect on the size composition of the catch. Catch per unit effort (lbs/100 pots hauled) has been fairly stable. However, it is unlikely that certain areas, such as the Start Point grounds, could sustain an increase in exploitation. Tagging experiments have shown that male crabs grow faster than females, and that migrations of females occur mainly westwards and south-westwards down the English Channel. Using the growth information and a range of probable values for fishing and natural mortality it has been possible to determine the likely effects of increasing the minimum size.

(iv) The following management measures are proposed:

(a) The minimum landing size for female crabs should be raised to 140 mm ($5\frac{1}{2}$ inches) for the whole of the south and south-west coast from Dungeness to Land's End.

(b) For the south coasts of Devon and Cornwall the minimum size for male crabs should be increased immediately to 160 mm ($6\frac{1}{4}$ inches).

(c) In Dorset, Hampshire and Sussex the minimum size for male crabs should be increased immediately to 140 mm ($5\frac{1}{2}$ inches) and after two years should be increased further to 160 mm ($6\frac{1}{4}$ inches).

(v) If these proposed fishery management actions are implemented two fundamental changes in the national legislation are required in order to allow regional minimum sizes and different minimum sizes for male and female crabs.

LABORATORY LEAFLETS

No. 1 Newfoundland Fishing. December 1962
No. 2 Spotlight on the American Whelk Tingle. December 1962
No. 3 Yorkshire Crab Investigations 1962. May 1963
No. 4 Trawling Prospects off West Norway. September 1963
No. 5 Notes on Escallops, and Details of the Baird Sledge Dredge and its Handling. February 1965
No. 6 Studies with the Woodhead Sea-Bed Drifter in the Southern North Sea. February 1965
No. 7 The West Greenland Cod Fishery. March 1965
No. 8 Future Prospects in the Distant-Water Fisheries. May 1965
No. 9 The Cornish Pilchard and its Fishery. December 1965
No. 10 Protecting British Shell Fisheries. April 1966
No. 11 North Sea Plaice Stocks. April 1966
No. 12 The Norfolk Crab Fishery. July 1966
No. 13 Lobster Storage and Shellfish Purification. August 1966
No. 14 Tuna Fishing. October 1966
No. 15 Whelks. January 1967
No. 16 Spurdogs. May 1967
No. 17 Yorkshire Crab Stocks. September 1967
No. 18 The Torrey Canyon Disaster and Fisheries. February 1968
No. 19 Oyster Pests and their Control. May 1969
No. 20 The Production of Clean Shellfish. September 1969
No. 21 Fishing for Sandeels. March 1970
No. 22 Cornish Crawfish Investigations. March 1971
No. 23 Mackerel of the South-West. April 1971
No. 24 Marine Fish Farming: an examination of the factors to be considered in the choice of species. January 1972
No. 25 Genetics and Fish Farming. March 1972
No. 26 The Cockle and its Fisheries. April 1972
No. 27 Prawn Culture in the United Kingdom: its status and potential. June 1972
No. 28 The Fishery for the Pink Shrimp, Pandalus montagui, in the Wash. June 1973
No. 29 The Impact of Mechanical Harvesting on the Thames Estuary Cockle Fishery. November 1973
No. 30 Norfolk Crab Investigations, 1969-73. November 1975
No. 31 Oyster Fisheries of England and Wales. 1976
No. 32 Mackerel Research in the South-West of England. 1976

NOTE
Although the complete list of Laboratory Leaflets is given to show the scope of the series, it will be appreciated that many of these leaflets are topical and therefore of interest chiefly at the time when they are written. For this reason most of the earlier ones are being allowed to go out of print when present stocks are exhausted; few copies are available of those prior to No. 13.

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