TASMANIAN SMOKEHOUSE

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The Market Potential for jack mackerel

A report by

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C O N T E N T S

INTRODUCTION

During the twelve months from July 1979 to June 1980, Tasmanian Smokehouse undertook to determine the market potential for jack mackerel which would involve following a sequence from catching through to processing, packaging, consumer acceptability and marketing.

The emphasis being on secondary processing particularly with the object of producing a replacement for imported kippers and whole smoked mackerel.

PROCESSING TRIALS AND ASSESSMENTS

It is axiomatic that a first class smoked fish can only be obtained from fresh fish in good condition. Mackerel which is low in fat content, which has been stored too long at too high a temperature and is no longer fresh, or frozen fish which have been badly cold-stored and developed protein denaturation or fat rancidity, can only make an inferior smoked article irrespective of the care taken during the smoking process.

Fish, as distinct from other primary products is subject to little or no control before harvesting or killing. Most primary products can be genetically controlled for desirable characteristics, optimum conditions at slaughtering can be maintained and control of disease is ensured. Fishermen must merely accept or reject not only what the sea makes available but also when or where it is available. However, measures can be taken to ensure that the fish are in the best possible condition when they arrive at the processor.

Of all the flesh foods, fish is the most susceptible to autolysis, oxidation and hydrolysis of fats and microbial spoilage; as a result preservative methods must be undertaken on board the boat immediately after harvesting.

The mackerel handled by Tasmanian Smokehouse are held after catching in ice or refrigerated sea water on board ship, then delivered to the processor after a 4-5 hour journey. The fish are not gutted and as a result the digestive enzymes in the gut may continue to be active and may attack and perforate the gut wall and belly wall and viscera.

However the flesh of ungutted fish is not contaminated by intestinal bacteria but may develop odours due to the food in the gut decaying and the odours penetrating the flesh. Ungutted fish can be cooled rapidly and as a result many enzymes are inactivated. Most of the bacteria found on fish are on the surface and the type depends on the waters in which they are caught. Most bacteria on fish caught in Tasmanian waters would be psycholphiles and thus able to multiply at $0^{o}C$ but their activity is retarded at these temperatures and lower. Although a large number of bacteria may build up upon the skin of the fish this can be reduced by washing prior to processing. However, bacteria on the skin and in the storage water can be absorbed through the gills and via the vascular system be taken into the flesh where deterioration of the flesh can take place, and unpleasant odours and flavours develop and eventual spoilage.

Rigor mortis and the time taken to set in are very important in the preservation of fish and the quality of the smoked product, for they retard post mortem autolysis and bacterial decomposition and any procedure that lengthens rigor mortis lengthens keeping time. Rigor mortis is hastened by the fish struggling and a lack of oxygen and warm temperatures, and delayed by low pH and low temperatures. Struggling fish use up stored glycogen and increase the pH of the flesh. This can result in increased bacterial decomposition as this is retarded at low levels of pH. High pH can also result in tough, unpalatable flesh. Bacterial spoilage does not begin until after rigor mortis sets in for the released juices from the flesh fibres can provide a suitable environment for their growth. Consequently the longer rigor mortis is delayed

the longer the keeping time.

Mackerel have a high fat content and can develop oxidative rancidity if not stored and preserved in appropriate conditions. This is essential prior to smoking. The object is to prevent oxidation and hydrolysis of the unsaturated fats. During harvesting and processing the fish should be handled carefully to avoid bruising and tearing and damage to the flesh. This latter situation unfortunately tends to arise during the transport and delivery of mackerel and as a result some smoked mackerel is unsatisfactory and is wasted as consumers will not pay premium prices for inferior quality products.

Some mackerel were processed immediately after delivery to the processor and others were frozen and processed at a later date. This did not seem to greatly affect the quality of the finished product so long as the fish were snap frozen and stored at at least -30°C and that all fish in the blocks are frozen. If this is not ensured some bacter - ial types may continue to multiply and cause spoilage of the mackerel.

To begin processing, the mackerel are split, the gut removed and the fish washed. This removes surface bacteria but some may be left on the surface from the cleaning water. Guts, membranes and blood decompose more rapidly than fish flesh and the more speedily they are removed the better the keeping quality. Care must be taken during this operation to ensure damage to the fish does not occur.

The salting or brining is the next process and is a significant factor in determining if the smoked mackerel is to be acceptable to the consumer. In the past, salting was an essential part of the preservative process. However, the salt concentration has to be between 8 and 10 per cent before there is appreciable inhibition of moulds and bacteria. Consumers will not accept such high concentrations today and as a result the acceptable levels tend to be between 2 and 4 per cent and as a result its preservative effect is minimal and its main function nowadays is to confer a piquant flavour as well as to improve appearance. The addition of sodium chloride can provide a surface gloss which is noticeable after smoking and contributes to the desirable appearance of the fish. The brine also contains annatto dye to impart the requisite colour of smoked fish. This must be of the correct amount to ensure that the colour is not too bright and result in an unattractive and unappealing appearance.

It is extremely important to control the concentration of the brine to ensure the fish is not too salty. The time the fish are in the brine does not tend to influence the final concentration, but the concentration of the brine, the degree of uniformity of shape and the fat content of the fish, do, for the penetration of salt is retarded by the fat content and these factors all influence the final concentration. Mackerel, which have been split, are flat and thin with more surface area exposed to the brine and take up the salt relatively rapidly.

As the brine continues to be used, bacterial contamination

builds up in it which may lead to contamination of the fish with bacteria which can reduce its subsequent shelf life. To control this, the old brine should be discarded daily, the containers cleaned and fresh brine should be prepared.

When the fish are removed from the brine they are then placed on trolleys and smoked. Mackerel are cold smoked, the temperature does not exceed 30°C and the fish are not even partially cooked. During cold smoking two distinct processes occur, drying, which results in the characteristic texture, and the addition of smoke constituents, which result in the desirable and unique flavour of the fish. The rate of drying will depend on the rate of flow of air past the fish and its relative humidity. The rate of deposition of smoke on the fish depends, among other factors on the concentration of certain smoke constituents in the air, particularly vapours.

TRIALS

No. 1

Source : The frozen jack mackerel came from the "Petuna Endeavour" and were trawled off Lakes Entrance. Due to unexpected delays, the fish after being held on ice had to be frozen in 40kg blocks on board, and stored at -21°C.

The weight of each fish ranged between 300 and 600 g. with an average of 523 g. per fish.

Experimentation was carried out as follows -

Aim To process, smoke and package jack mackerel cutlets aimed at the Japamese market.

Method Frozen blocks were allowed to air thaw and sorted into two grades. Those above 500 g. were selected for smoking cutlets.

The fish were cut into 40 mm. widths and where the gut cavity remained on the cutlet it was scrubbed to remove blood and black deposits.

Brining was carried out in an 80% salt brine for two minutes, to achieve a desired 2 to 4% salt intake.

The cutlets were then placed on the smoking trolley racks and allowed to air dry for 6 hours.

Hot smoking was carried out for 2 hours at 63°C and ½ hour at 80°C after which the smoked cutlets were allowed to cool and then vacuum packed. However, it was noted that sharp bones remaining on the cutlets pierced the bags causing loss of vacuum.

Results Processing yields were as follows :

Original frozen weight of fish	17.45 kg.
Fresh processed weight	9.95 kg.
Smoked cutlets weight	8.10 kg.
Smoked yield	46.5 %

Assessment Although the raw fish was received in generally poor condition, the smoked cutlets appeared to have good gloss and colour, and the flavour when tasted by factory staff was agreeably pleasant.

No. 2

Source: "Petuna Endeavour " Catch.

Aim To process, smoke and package jack mackerel kippers for the local market.

Method The fish were graded from 300-500 gms. They were butterflied (Aberdeen cut) with the back bone and rib bones being removed. The kippers were then washed and brined in a 80% salt brine with the addition of 100g./litre of annatto dye.

After brining the kippers were placed skin down on trolley racks and allowed to air dry for 4 hours.

Cold smoking at 28°C was carried out for 3 hours.

Results

Original frozen weight of fish	59. 4 kg.
Fresh kippered weight	27. 65kg.
Smoked kippered weight	24. 45kg.
Smoked yield	41. 2%

Assessment The smoked mackerel kippers were sent to the C.S.I.R.O. division of food research for assessment.

C.S.I.R.O. comments :

1. No rancidity
2. Good colour , and gloss although maybe a little too dark.
3. A little over salted
4. Other than these comments, favourable acceptance.

No. 3

Source: "Kyeema" Catch

The fish from Kyeema had been purse seined and arrived at the factory iced down. The fish appeared fresh and in excellent condition. Eyes clear and no signs of gut burn.

They were held overnight iced and in the chiller at 2°C.

The following day 107 kg. of graded fish were processed and 140 kg. were frozen and glazed in 15 kg. blocks.

The weight of each fish varied between 130 and 300 g., averaging 173 g. per fish.

Aim To advance the processing procedure on kippers.(London cut).

Method The fish were first graded and those that averaged 300g. were kept for kippering. In this experiment the rib bones were left in the kipper which speeded up the processing of the fish.

Owing to the size of the fish the brining time was cut in half to one minute. As the colour of the fish in the last experiment was too dark the dye content was reduced to 50 gm/litre.

The fish were again dried on racks for the same period.

Finally the kippers were cold smoked at 28°C for 3 hours.

Results

Original frozen weight of fish	63 kg.
Fresh kippered weight	30. 24 kg.
Smoked kippered weight	26. 67 kg.
Smoked yield	42. 4 %

Assessment Although a slight increase in yield (1.2%) kippering fish by hand of this size appears to be unacceptable for the following reasons -

(1) Longer man hours needed to process and pack the kippers.

(2) Kippers are usually accepted at two per 500g. pack, however with this size the 500 g. packs were averaging 10 kippers.

(3) The fish tended to be drier resulting in a poorer quality product.

The reduced amount of dye gave a much more satisfactory colour.

No packaging problems were encountered from leaving in the backbone.

No. 4

Source: "Kyeema"Catch

Aim : To smoke the smaller size fish for pate and determine the market potential for this product.

Method: After allowing the fish to air thaw , they were gutted and brined in an 80% brine with no dye for 10 minutes. The whole fish

were then speared through the eyes with stainless steel rods and allowed to hang on the trolley.

The fish were hot smoked for 3 hours. After cooling the meat was removed from the bones by hand.

Using a silent cutter the meat was then blended with other ingredients into a fine paste.

The final product was packed in 100 g. and 500 g. plastic containers with a heat sealed aluminium foil lid and frozen.

Result

Original frozen weight of fish	107 kg.
Fresh gutted weight	100. 05 kg.
Smoked whole weight	87. 54 kg.
Smoked mackerel meat	28. 18 kg.
Smoked whole yield	82 %
Smoked meat yield	26. 34%
Pate yield (including cream cheese, butter and spices)	35. 24%

Assessment

This product was tried by a taste panel of six staff and the general conclusions were that the mix was a little too salty and oily and a coarser texture would be preferable. It was recommended tjat the salt and butter content be reduced and less time in the cutter.

The colour and general comments however, were most acceptable.

From a commercial point of view a larger size fish should be used.

No. 5

Source: Trawled fish from Geraldton

Due to lack of mackerel being caught in Tasmanian waters, a consignment of fish was ordered from Western Australia.

Quality Assessment : The order placed was for fish graded 300 to 600 gm., however on arrival the weight of these fish ranged between 56 and 200 g. averaging out at 120 g. per fish.

The fish were ungraded block frozen in 20 kg. cartons.

The condition of the cartons on arrival in Tasmania was estimated at more than 80% severely damaged.

The fish were too damaged, freezer burnt and with signs of rancidity for trials to be carried out.

The fish were finally sold for bait.

No. 6

Source: Trawled fish from City Fish Wholesalers.

These fish arrived at the factory frozen in 15 kg. cartons.

The wholesaler informed us that they had been caught 8 months previously off the Tasman Peninsular and stored at -20°C.

The weight of the fish ranged from 275g to 460 g. with an average of 420 g.

Aim To smoke kippers with head on rather than nobbing as before.

Method The frozen blocks were allowed to air thaw overnight and subsequently graded into sizes above and below 350g. Those above were kept for kipper fillets.

Instead of the head being removed it was split and the gills and guts removed.

The kippers after cooling were again vacuum packed with approx. 2 fillets per pack.

Results

Original frozen weight of fish	126 kg
Fresh kippered weight	71.82kg
Smoked kipper weight	62.90kg
Smoked kipper yield	49.93 %

Assessment

The experiment was to see if the longer time taken kippering the fish was in relation to the higher weight gained by leaving the head on.

The extra time taken was in splitting the head and removing the gills.

This process took 13.4 man hours/126 kg. of fish and it was concluded that there must be a faster method of doing this. However, the weight gained, approximately 13%, more than justified the extra time taken.

The Australian market acceptance is another facit to be looked at.

The same times and amounts of addatives were used in this experiment and we found the end result of the last batch of kippers justified no change.

Further trials were conducted from fish caught and supplied by the "Maria Louise" during the autumn of 1980. The results were the same as those described above.

CONSUMER ACCEPTABILITY & STORAGE TRIALS

The factors that may determine consumer acceptability of smoked mackerel have changed over the past two decades. Smoking, or smoke-curing, was used as a method of preservation, bought about by a combination of drying and the deposition of naturally produced chemicals resulting from the thermal breakdown of wood. The products became acceptable not only for their keeping qualities but also for their unique smoky flavour. The market for heavily salted and smoked products began to decline when a more reliable transport system was developed at the turn of the century. The widespread distribution of mildly cured, blander and more perishable products which had been subjected to less severe smoking treatments was possible. This trend has accelerated in recent years by the growth of freezing in consumer packs where preservation is taken care of by low temperatures and even more recently by vacuum packaging which provides atmospheric conditions which retard the growth of microorganisms.

The three criteria of acceptability consumers apply to all foods, appearance, odour and flavour are used when assessing the acceptability of smoked mackerel. Each one is not mutually exclusive as all three criteria must attain the consumer's level of acceptability to meet with approval. However, the assessment of acceptability by consumers is a very subjective evaluation and, as a result, it is extremely difficult to set down rigid criteria of acceptability in relation to appearance,

odour and especially flavour.

Despite this difficulty, the important aspects of quality in smoked fish are concerned with the freshness and manner of preparation of the raw material, the salting process, the smoking process and the storage, transportation and retailing of the product. All of these aspects influence the keeping quality of the smoked fish and ultimately the acceptability of the cooked product. The next section of this report will deal with how these aspects can affect the keeping quality of smoked mackerel.

The smoking process, although not the only factor determining quality is crucial if an excellent product is to be obtained. As a result of smoke deposition and drying the cold smoked, mild cured smoked mackerel can be preserved in first class condition for 2-3 days at ordinary room temperatures and can remain palatable for up to a week depending on the initial freshness of the fish and the amount of smoking and drying undergone. In smoked fish the bactericidal substances absorbed from the smoke are more effective than the slight degree of drying in inhibiting the growth of micro-organisms. The keeping quality, therefore, depends primarily on the extent of smoking. Very lightly smoked fish which will also usually be only slightly dried, although delectable in flavour when fresh, are almost as perishable as fresh fish and need to be kept thoroughly chilled, frozen or appropriately packaged, such as vacuum packed throughout transport and distribution to minimize spoilage.

Although freezing extends the storage life of frozen fish for

up to 4-5 months, if vacuum packaged, they can be stored at -30°C for 1 year. (reference). Vacuum packaging also significantly extends the time smoked mackerel can be stored at refrigerated temperature. Many consumers resist purchasing foods in the frozen form for they believe that upon thawing the fish will lose moisture and result in loss of flavour and moisture as well as nutrients. Also many domestic freezers do not hold frozen foods at sufficiently low enough temperatures to ensure the food item remains in first class condition.

Vacuum packaging increases the storage life of smoked mackerel by reducing the oxygen in the bag. This reduction does not affect normal spoilage organisms until the level falls below 0.8 per cent. The fear of food poisoning by Clostridium botulinum has often been raised. Experiments with vacuum packed fresh fish by Lindsay and Deibel, University of Winconsin, 1979, which were inoculated with activated botulism spores, have produced some interesting results. These showed that

1. At very high storage temperatures (50°F - 80°F) the fish deteriorated quickly, much too quickly for toxin growth to take place.
2. At lower temperatures 45°F and lower, the fish took longer to spoil, but it did spoil before the formation of botulism toxins. In other words, even after storage periods of up to 30 days at various temperatures, no botulism growth formed before the product had spoiled beyond palatability.

> "There was no Bot-toxin before the product became so absolutely unacceptable that no one would possibly ever eat it. " [1]

Thus the criteria of acceptable appearance and odour would not be met and the fish would not be consumed and no poisoning would take place.

However, there still seems to be some doubt as to how long and under what storage temperatures vacuum smoked mackerel can be stored before unacceptable odour, and flavour alterations take place. This is quite necessary information if date marking is to be used and also the processor needs to know how long his product will remain in acceptable condition at refrigerated temperatures. In the light of this uncertainty the following experiment was conducted at the Home Economics Department, Tasmanian College of Advanced Education, Newnham, Tasmania.

Aim To determine the length of time smoked mackerel can be stored at various temperatures to gain consumer acceptability.

Factors Affecting Methodology

The attributes of taste, odour and flavour are difficult, if not impossible to evaluate instrumentally and as a result these attributes are best measured by the method of using a taste panel and the subjective evaluation of individuals taste sensations.

These factors cannot be measured instrumentally as there is no understanding of the mechanism by which such sensations are stimulated in

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1 Lindsay, Deibel R.H. "Vacuum Packaging for fresh fish" in Food Engineering, January 1979.

the consumer. Because of the subjective nature of a taste panel using individual evaluations results can be influenced by human psychological factors and as a result statistical guides need to be used to counteract this bias.

The purpose of the taste panel in this experiment would be to detect the difference between a control sample and consecutive samples. As the product being tested in this experiment may not have been eaten by many of the subjects a training programme needed to be undertaken to ensure they were familiar with the characteristic flavour and texture of the product prior to storage.

As this method of assessment is subjective methods must be employed to attempt to make it as objective as possible and account for as many variables as possible. As a result each panellist must be provided with sufficient privacy to ensure the results are arrived at independantly and not influenced by the words or expressions of other panellists.

The panellists should not receive instructions that may indicate the identity of the product or the techniques it may have been subjected to. Nothing should be said that may lead the panel to conclude certain results are expected. Variations should be accounted for in preparation of the samples rather than overcome them

by instruction. The samples should be prepared in an identical manner for each panellist and at each session and that each panellist receive the sample from the same area of the fish at each session. Untreated samples should be tasted first if off flavours are to be detected. Plenty of time should be given to each panellist, a lapse of 2 minutes between samples should be given to prevent errors and indecision.

Care must be taken in coding the samples so that one sample is not given an advantage over the other. This applies particularly with company products but when comparing with an original sample this may not apply quite so much. Panellists should also be numbered to ensure that the experimentor does not know which panellist is scoring in a particular way and anticipate results.

Storate trials need to have a time at which the product becomes unacceptable and then withdrawn due to unacceptability. Due to time limitation if the products were stored at refrigeration temperatures only there may not be any significant results at the end of five weeks. However, if some products could be stored at $15^{o}C$ then room temperatures could be stimulated and accelerated reactions could be observed.

Bacterial contamination of the product will determine its acceptability after storage and tests may need to be conducted to assess the number and or types of micro-organisms in and on a particular

specimen to ascertain to what extent these increase during the time of the trial. However, as stated previously in this paper, in most instances the strong 'off odours' associated with deteriorating fish mitigate against the fish being consumed and food poisoning resulting. Also as the product is to be cooked prior to eating at temperatures above $60^{o}C$ spoilage bacteria would be destroyed, but of course spores are resistant to this temperature, which when the right conditions are provided will begin to multiply.

In the light of the above factors, the following Experimental Method was followed.

Method

Eleven panellists were selected from the student and staff population at the Tasmanian College of Advanced Education, Newnham Campus, the main criteria for selection being their ability to attend taste sessions regularly and their liking for smoked foods.

The taste sessions were conducted in the Applied Science Laboratory with each panellist being divided from the other panellists by a cardboard screen to ensure privacy and independant results obtained.

Each panellist was allocated a number and each service plate was correspondingly numbered to ensure each panellist received a sample from the same section of the fish each time. This was achieved by dividing the fish into sections and numbering them and then serving this section to the corresponding numbered panellist. See Appendix.

Bread and water were served to panellists at each session.

Ten vacuum packs of smoked mackerel processed on the same day at Tasmanian Smokehouse were stored in refrigerators in the laboratory. Five being stored at 5°C and five at 15°C. These temperatures were checked with thermometers and access to the refrigerators was restricted to the removal of the products once a week to ensure maintenance of correct temperatures.

Prior to serving, the mackerel was removed from the refrigerator and individually prepared by covering with boiling water and left to stand for five minutes. It was then drained and divided into coded pieces and served on coded pieces of paper to identify each sample. The mackerel stored at 5°C was coded and 15°C coded +. As other products were being tested at this taste panel they were also coded. See Appendix.

The testing instrument was designed so as to ascertain if off flavours developed what other textural changes occured at the same time. The characteristics were given a score ranging from 9 for 'Extremely Strong' to 1 for 'Extremely Weak' in flavour characteristics, 5 being characteristic quality, the subjects were not told the scoring method. Subjects were required to taste each sample in order and tick the appropriate box, comments could be made if desired.

As few of the panellists had experienced taste panels before

and had little experience of the product, training sessions were conducted. This was vital as the following samples had to be compared with the characteristic attributes of the product and memory had to be relied upon. Three training sessions were conducted where it was explained that this was an experiment being conducted for a Tasmanian manufacturer of high quality products - but the panellists were not told that this was a storage trial. The panellists were given samples identical to those they would receive in the trial and were given the opportunity to complete the form and become familiar with it.

Panellists were required to attend once a week, on Wednesday, at lunch time, to ensure they would be amenable to taste food at that time of day. Some people missed sessions, but eleven people were selected to overcome this.

The items were assessed prior to preparation by the experimentor for deterioration in odour and when the product reached an unacceptable level it was withdrawn from the panel.

Results

See Graph.

The smoked mackerel stored at both 5°C and 15°C both scored quite highly for acceptability on day 6 of the trial with a mean score of 7.6 for the 5°C and 7.2 for the 15°C. By day 14 the results for both samples were again almost the same but by day 22 there had been a marked variation in scores and acceptability. The 15°C sample had

dropped to a mean of 2.4 with a standard deviation of 2.2 and was withdrawn from the panel after that day. The samples stored at 5°C however continued to score highly at 6.8 on day 22 and 7.00 on day 36.

Both samples scored similar for off flavour at 1.4 mean for 5°C and 1.8 mean for the 15°C sample.

They both scored the same on day 14 at 2.3 but by day 22 the 15°C sample scored 7.2 mean for off flavour, whereas the 5°C sample dropped to 1.6 and on day 36 was scoring at 1.8. At day 22 the 15°C sample was removed from the panel.

Day 18 is the day that the 15°C sample drops below the level of acceptability.

Discussion

As the off flavours develop when smoked mackerel is stored at 15°C the level of acceptability declines. This is only minimal prior to day 14 but after that the off flavours increase dramatically and the acceptability shows a marked decline, to the extent that at day 22 it is almost impossible to eat.

When removed from the package the fish gave off a strong, putrid smell and a slightly sticky surface on the skin but the flesh side was relatively dry. The flavour of the cooked product was extremely strong with distinct off flavour and strong after taste.

Panellists comments included statements such as

'Bad after taste'
'Flavour too awful to assess texture'
'Worst food I have ever eaten'

However, prior to day 14 it met with a high degree of acceptability.

The samples stored at 5°C rated a high degree of acceptability right through the trial until day 36 when the trial was finished which would indicate this product could be stored at refrigerated temperatures for 4 weeks without any development of off flavours and maintain a high degree of acceptability.

These results cannot be taken as being valid for every pack of smoked mackerel as there will be product to product variation and bacterial contamination that may affect some items to a greater extent than others.

Recommendations

For smoked mackerel to reach the consumer in an A1 condition it must be caught and harvested without too much struggling to prevent toughening of the flesh and prevent bacterial activity setting in at an early stage. As all fish contain natural flora that will multiply if not stored correctly, once caught the fish should be stored under refrigeration or frozen to prevent deterioration. The fish should be handled carefully to prevent bruising and damaging and gutted and cleaned with care to prevent further damage.

As most panellists in the experiment expressed objections to over salty food the brining process must be carefully monitored to ensure excessive salt is not taken into the flesh. As the salt intake is intensified during smoking this also needs to be checked. The panellists also expressed a desire for a moist smoked fish so every endeavour must be made to ensure that the product is not excessively dry due to over salting or excessive smoking. The smoke flavour seemed to be very popular and this appeared to be at the correct degree.

To be able to purchase the smoked mackerel chilled seemed to be much more popular than purchasing frozen and as the result of the experiment indicated they could be kept under refrigeration for four weeks without development of off flavours. Room temperature storage does seem a possibility for up to 14 days but after that time marked deterioration takes place.

The marked advantage of vacuum packaging is that is keeps the product for increased time with no deterioration in acceptability if stored correctly at refrigerated temperature. Also the consumer can see the product and partly ascertain the quality visually. The vacuum bags currently used by Tasmanian Smokehouse are a lamination of 2 microns of nylon and 2 microns of sylon which would appear quite satisfactory for storage at 5°C. However a change of bag may improve the keeping time of smoked mackerel stored at 15°C. A bag which could

be a lamination of nylon, polyvinylidene Cl and polyethylene would give a bag that is :

Humidiproof

Ventproof

Oilproof

Waterproof

Boilingproof

Freezingproof

Transparent

Heat Sealing

- See Appendix 1.

These bags may be more expensive than those currently used but this may be outweighed by the advantage of being able to store at room temperatures for an extended period of time.

Taste testing cont...

ACCEPTABILITY	○	□	×	△	∅	+
9 Extremely acceptable						
8 Very acceptable						
7 Moderately acceptable						
6 Acceptable						
5 Just acceptable						
4 Moderately poor						
3 Poor						
2 Very poor						
1 Extremely poor						

Comments - optional

○

□

×

△

∅

+

Appendix 1

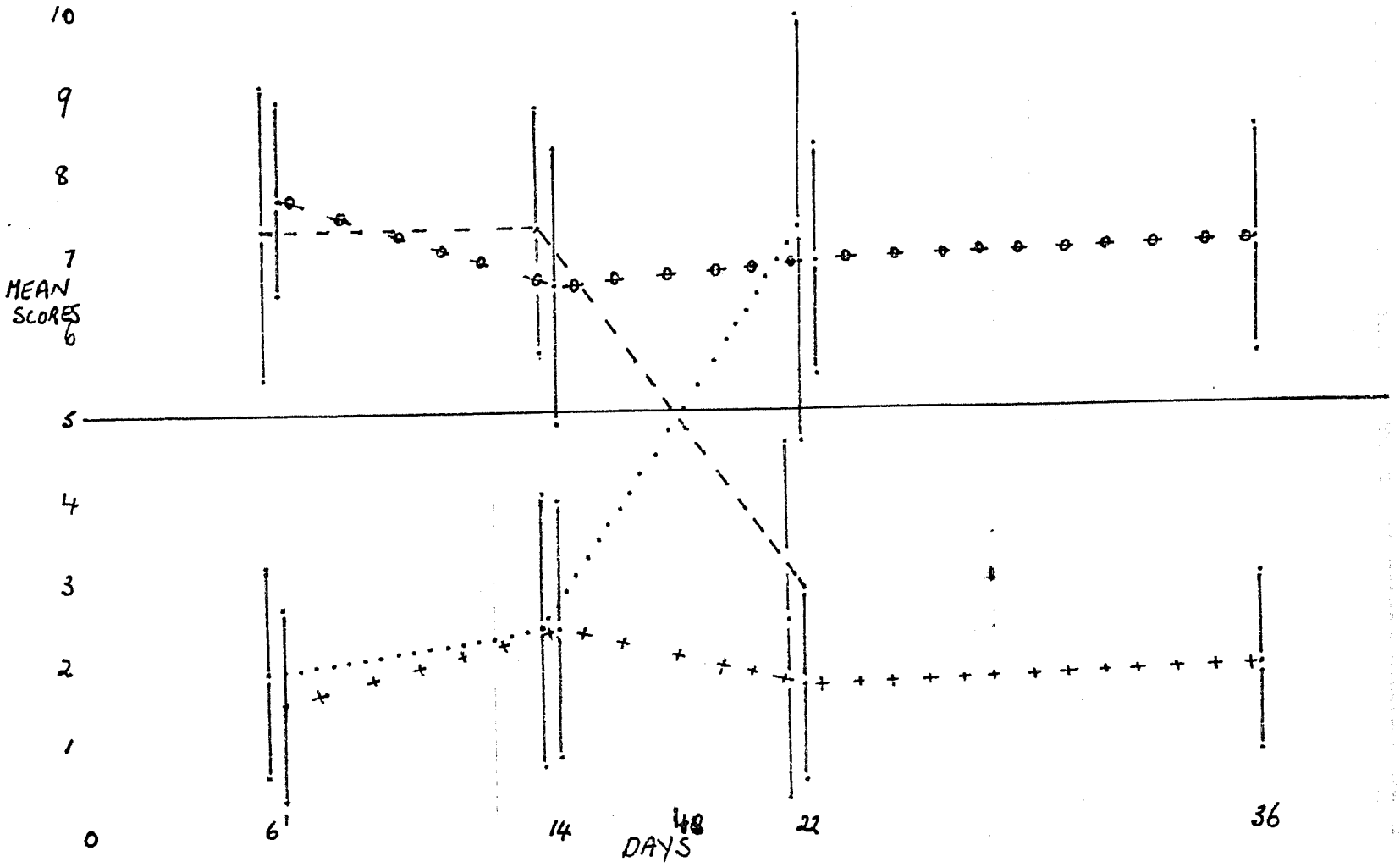
	Humidityproof	Ventroop	Oilproof	Waterproof	Boilingproof	Freezingproof	Transparency	Heat-Sealing	For
CPP/PVDC/PE	0	0	0	0	0	N	0	0	Cooked beef,soup,ham.sausage
PT/PE	0	0	N	X	X	X	0	0	Rice cracker, medicine
OPP/PE	0	N	N	0	0	0	0	0	Laver, frozen food
PVDC/PE	0	0	N	0	0	N	0	0	Ham, jam
CPP/CPP	0	N	0	0	N	N	0	0	Cookies,Peanuts,oilen items
PT/CPP	0	0	0	X	X	X	0	0	Cookies,Peanuts,oilen items
OPP/PT/DE	0	0	N	0	0	0	0	0	Cooked beans, food boiled down in soy
PET/PE	0	0	0	0	0	0	0	0	Powder Juice
PET/PVDC/PE	0	0	0	0	0	0	0	0	White peach, smoked items
N/PE	N	N	0	0	0	0	0	0	Rice cake, frozen items
N/PVDC/PE	0	0	0	0	0	0	0	0	Fish paste, frozen items
OPP/PVA/PE	0	0	0	0	N	N	0	0	Fruit cocktail
PC/PE	N	X	N	0	0	0	0	0	Sliced ham
AL/PE	0	0	0	0	N	N	0	0	Medicine, photographic
PT/AL/PE	0	0	0	X	X	X	X	0	Tea, instant food cookies
PET/AL/PE	0	0	0	0	0	0	0	0	Curry, stew
PT/PAPER/PVDC	0	0	0	X	X	N	X	0	Laver, tea, dried food
PT/AL/PAPER/PE	0	0	N	X	X	X	X	0	Tea, shampoo, powder milk

O = Good

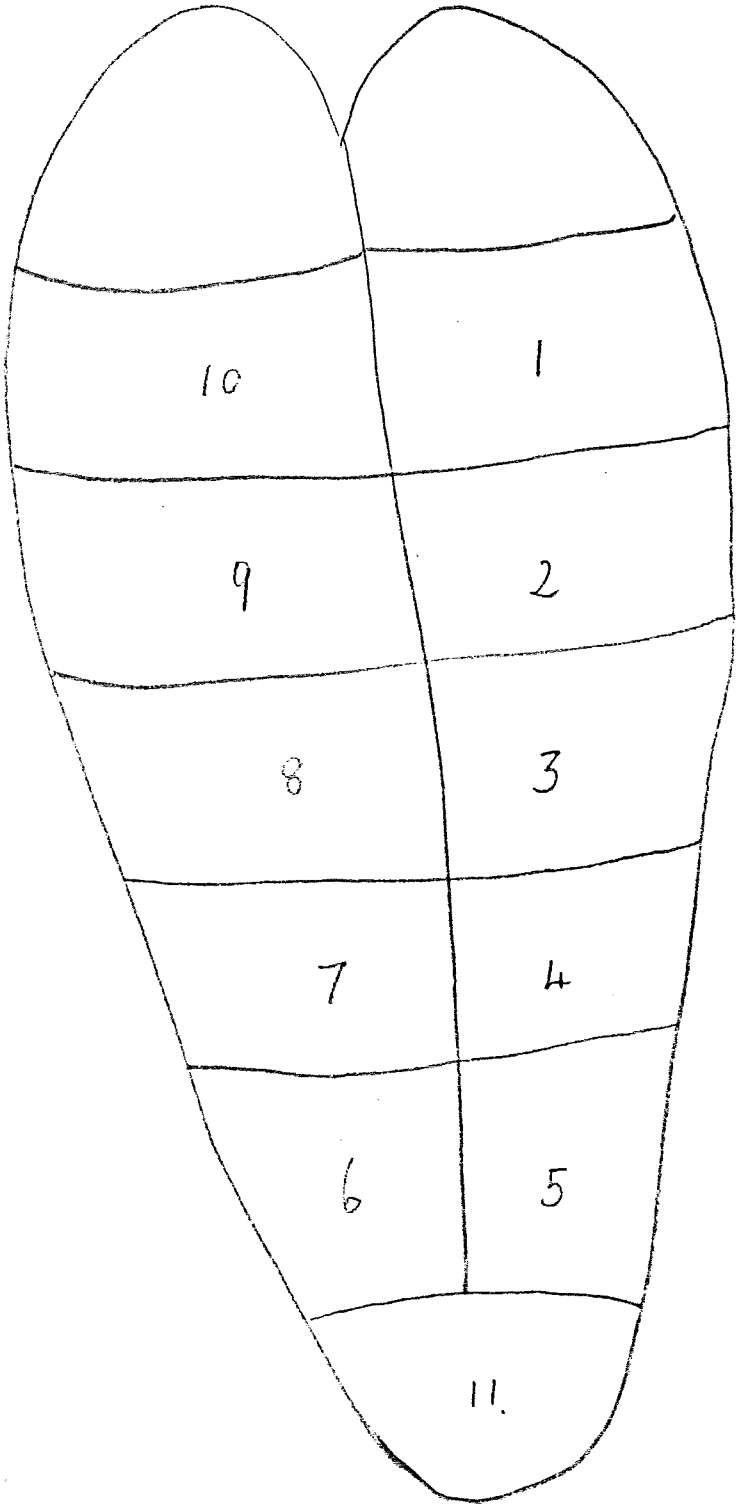
N = Normal

X = No good

PANEL SCORES - TASTE PANEL FOR SMOKED MACKEREL



DIVISION OF SMOKED MACKEREL FOR SERVING



TASTE TESTING OF SMOKED FOODS

Taste Order : _____ Taster number :

Please assess all samples for flavour variations from original samples.

Mark score sheet in all columns for all samples using appropriate symbols.

Feel free to state your comments concerning each sample.

FLAVOUR	○	□	X	△	∅	+
9 Extremely strong						
8 Very strong						
7 Strong						
6 Slightly strong						
5 Characteristic						
4 Moderately weak						
3 Weak						
2 Very Weak						
1 Extremely weak						

OFF FLAVOUR	○	□	X	△	∅	+
9 Extremely strong						
8 Very strong						
7 Strong						
6 Slightly strong						
5 Moderately weak						
4 Weak						
3 Very Weak						
2 Extremely weak						
1 None						

TEXTURE	○	□	X	△	∅	+
9 Extremely tough						
8 Very tough						
7 Tough						
6 Slightly tough						
5 Characteristic						
4 Slightly soft						
3 Soft						
2 Very soft						
1 Extremely soft						

TEXTURE	○	□	X	△	∅	+
0 Extremely dry						
8 Very dry						
7 Dry						
6 Slightly dry						
5 Characteristic						
4 Slightly moist						
3 Moist						
2 Very moist						
1 Extremely moist						

Continued over.....

Code for Graph

$5^{\circ}C$ Smoked mackerel "Off Flavour "

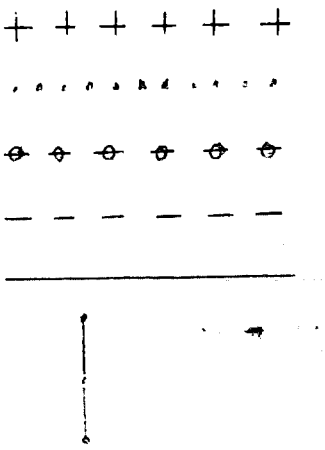
$15^{\circ}C$ Smoked mackerel "Off Flavour"

$5^{\circ}C$ Smoked mackerel 'Acceptability'

$15^{\circ}C$ Smoked Mackerel 'Acceptability'

Level of Acceptability

Standard Deviations are represented by vertical lines.



CONCLUSION

The major difficulty in trying to assess the production and market potential of jack mackerel has been with the catching and supply of raw material.

However, we believe sufficient material was received and processed to evaluate the future market potential of this specie.

In these trials, the flavour and texture of jack mackerel were found to be very acceptable, although in some instances bones were a slight problem. However, there was a substantial amount of meat which points towards a better product than the imported varieties, particularly as colour and quality are equal to the import. It is felt that the market for mackerel in Australia would be limited to whole hot smoked fish and cold smoked vacuum packed kippers. Further, those markets with large ethnic populations such as Adelaide, Melbourne and Brisbane tended to have a stronger demand than other areas where this type of product is not as well known. It was generally felt by distributors that so long as local product could be marketed at prices comparable to imported products then the potential for sales would inevitably increase.

Other forms of processing and marketing such as freezing whole, canning and salting were not evaluated mainly because of the lack of interest within the catching sector of the Fishing Industry at this time. Future developments of these processes would need to be examined when the necessary catching potential is available.

ACKNOWLEDGEMENTS

P. S. Helps - Home Economics Department, Tasmanian College of Advanced Education, Newnham, Tasmania.

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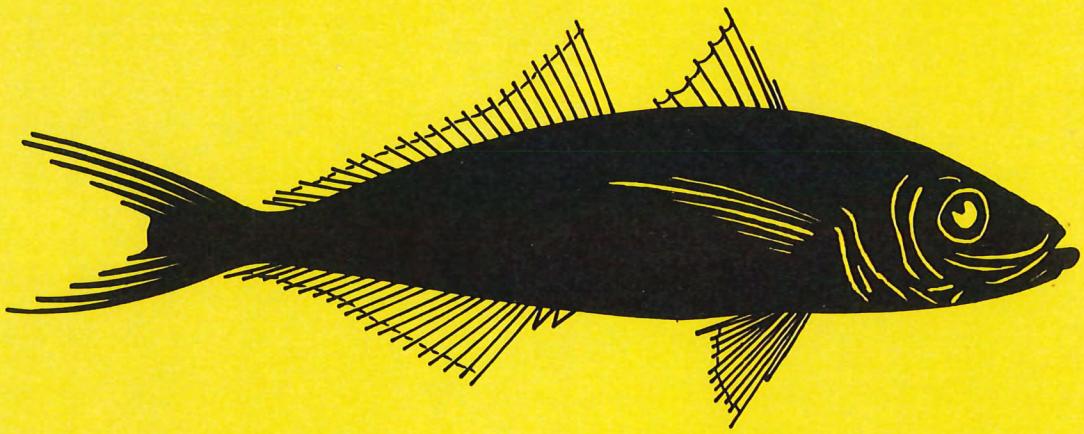
Jack Mackerel

Fishery situation report 2



J. G. H. Maxwell

FISHERY SITUATION REPORT 2. JACK MACKEREL

J. Garrey H. Maxwell

CSIRO Division of Fisheries and Oceanography

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FISHERY SITUATION REPORT - JACK MACKEREL

INDEX

1.0 INTRODUCTION

Over the years interest has been expressed in the potential of the jack mackerel (Trachurus declivis (Jenyns) 1841), (Blackburn and Olsen 1947; Blackburn and Rayner, 1951; Wolfe, 1967) as a commercial species and, despite a number of investigatory attempts to establish a fishery, none exists at the present time.

The family Carangidae to which the Australian jack mackerel belongs is of importance commercially around the world and landings from the genus Trachurus alone average over one million tonnes annually.

This report covers general features of the species relevant to future commercial exploitation.

1.1 Distribution

The jack mackerel is found around Tasmania, Victoria and north to the mid New South Wales coast. The range extends westward across the Great Australian Bight to Western Australia, where it was first described from a specimen taken in King George Sound (Jenyns, 1841).

Research has shown that there is a seasonality in the observed distribution in the waters of south-east Australia. Surface shoaling is evident in southern New South Wales waters in the late winter and early spring (Blackburn and Rayner, 1951), while Blackburn and Tubb (1950) reported that the densest concentrations occur in south-eastern Tasmanian waters during autumn and early winter. Hynd and Robins (1967) observed significant surface aggregations off eastern Tasmania, but found the schools concentrated in the north east rather than south east as reported by Blackburn and Tubb (1950). Surface sightings of fish while useful, can give a bias in any account of seasonal distribution. The distribution of all surface sightings from 1941-1966 (Anonymous, 1969) is given in Figure 1 and shows that the majority of reported sightings were between the months of February and May in the waters of south-eastern Tasmania. Recent sonar surveys (Wolfe, 1970, 1971, 1976) suggest that the distinct seasonality of occurrence in the south east indicated by surface observations may not be the real situation and that the mackerel may be present most times of the year. The seasonality of surface sightings by recent aerial observations are shown in Figure 2(a)-(c), confirming the concentrated period of surface sightings shown in Figure 1 for the autumn and early winter. The seasonal surface sightings noted by Blackburn and Rayner (1951) of jack mackerel in New South Wales during late winter and early spring is also confirmed. It is thought that a migration southwards out of New South Wales does occur as the summer progresses and the 17°C isotherm moves south. An offshore migration into deeper cooler water is also likely (see Section 1.2).

The abundance of the south eastern stocks for commercial exploitation has been reported as being between 10,000 to 100,000 tons. Hynd and Robins (1967) from their aerial survey work give 10,000 tons as a possible yield from eastern Tasmania. Butcher (1967) on the other hand reports:

> "During a recent aerial survey, surface shoals off the east and west coasts of Tasmania on March 6, 1966 were estimated by experienced spotters to be of the order of 100,000 tons."

This figure is not given as a potential yield to a fishery but as a total stock. The value of 100,000 tons potential yield appears in a number of reports and finally is reported by Gulland (1971). For south eastern Australia this value may be excessive and a more accurate value should be sought by conventional research techniques.

1.2 Biology

The jack mackerel like other species of the same genus, is an active pelagic predator. As mentioned above, the surface schooling behaviour appears to be correalated with the 17°C isotherm (Anon, 1975) and the principal pelagic and demersal concentrations inhabit water colder than this. Shuntov's (1969) observations of jack mackerel in the Great Australian Bight forming surface schooling concentrations in water temperatures of 19.5 to 21.5°C were not confirmed by a recent survey of that region (Maxwell and Brown, 1978) and any preference for water temperatures within these limits cannot be supported from observations in south-east Australian waters.

Measurements reported by Webb and Grant (1979) give a maximum theoretical length ($L\infty$) and value for (K) calculated from the von Bertalanffy growth equation of 46.3cm and 0.23 respectively.

From an analysis of stomach contents Webb (1966) reported a diet of 99.9% euphausids. During the investigations carried out by the CSIRO with the FV "Courageous" the diet was observed to be more catholic, consisting of euphausids and other zooplankton, molluscs and a number of fish species. The observed distribution of food items taken (Figures 3 and 4) indicates a pisciverous diet in deep water at the continental shelf edge while pelagic feeding on euphausids dominates the diet of fish on the continental shelf.

Spawning, as indicated by the presence of ripe fish, probably occurs slightly earlier in New South Wales (October to January) than off Tasmania (November to January).

2.0 THE FISHERY

There is no established Australian fishery at the present time. A purse seine vessel, the "Dageraad", owned by Lakes Entrance Processors Pty Ltd has been using the Commonwealth owned purse seine net to establish the feasibility of catching jack mackerel for processing as fish meal through the Lakes Entrance Processors Pty Ltd, in Victoria.

2.1 Fishing localities

The main concentrations of jack mackerel are found off eastern Tasmania. Quantities are also found along the New South Wales coast in early summer after which they move either southwards into Victoria or off shore into generally deeper water. Concentrations are also found in western Victoria from Cape Otway to Cape Northumberland.

2.2 Fishing methods

When specific commercial efforts are made in south-east Australia, the purse seine is used (Lorimer, 1968; Anonymous, 1975). Mid-water trawling is also possible with small boats (< 30m) (Gorman and Graham, 1977), but catch rates are highly variable on account of the species' behavioural characteristics. Where it is caught in New South Wales as an incidental catch component it is taken in conventional demersal trawl gear. It is worth noting that in New Zealand there is an active demersal trawl fishery by the Japanese, taking in the region of 20,000 tonnes annually.

2.3 Production and income

With the low status of jack mackerel as a fishery, detailed landing statistics are subject to error due to misidentification of the fish and 'lumping' landings with other incidental species. The present landings are trivial, and between 1969/70 and 1977/78 the total reported production in New South Wales was 537 tonnes, which after correction becomes 452 tonnes. The peak landings in 1973-74 for New South Wales (Table 1) when high landings were made at Twofold Bay (Table 3) illustrate the special case where a purse seine operation made a specific effort to land jack mackerel. The main landings during this period were made in Tasmania where four boats working for a six month period during the summer of 1973-74 landed over 6,000 tonnes at Triabunna in eastern Tasmania for reduction to fish protein concentrate (FPC) by the Fish Protein Concentrate (Tasmania) Pty Ltd. The collapse of this venture was in no way due to the lack of the resource but to problems relating to the land based component of the operation. A purse seine operation from Lakes Entrance in 1969-70 most likely explains Victorian landings in excess of 150 tonnes for that year.

At present Lakes Entrance Processors Pty Ltd expect $30/tonne for whole fish going to fish meal while in general the market landing price may vary between $30-60/tonne depending on how the fish is to be utilised.

2.4 The market

There is no specialised market for jack mackerel landed by Australian vessels at the present time. Such landings that are made in south eastern Australia as an incidental component of demersal trawl catches have been used as bait and pet food.

While jack mackerel is edible, especially if canned (Anon, 1977; Pownall, 1977), it is unlikely to become popular in Australia. A recent survey (Anon, 1979) identified Japan and Korea as potential specialised markets for high quality frozen fish capable of being processed for human consumption. Another major use for jack mackerel is in the production of fish-meal. An Australian resource capable of sustaining fish-meal production could have a useful home market as most fish-meal used at the present time has to be imported.

3.0 MANAGEMENT

At present no management measures are required. Future management could well be necessary with the present interest in developing a bait fishery in Tasmania. Such a fishery is likely to be in shallow water for both jack mackerel (T. declivis) and yellowtail (T. mccullochi). Juvenile jack mackerel which school inshore are therefore likely to form part of the catches made by a bait fishery.

While the reported annual production of yellowtail is higher, the difference in landings between the two species drops significantly (Tables 3 and 4) when ports where species identification for statistical returns are subject to error are removed from the analysis. A possible correlation exists between landings of the two species (Table 2).

Development of bait fisheries should be closely monitored to avoid damage to pre-recruitment stocks of jack mackerel, such as occurred with the South African Maasbanker (Trachurus trachurus) (Geldenhuys, 1973).

4.0 RESEARCH AND DEVELOPMENT

The potential for an Australian jack mackerel fishery has been noted many times (Blackburn and Olsen, 1947; Blackburn and Tubb, 1950; Blackburn and Rayner, 1951; Hynd and Robins, 1967; Wolfe, 1967; Gulland, 1971), but the requisite economic and marketing circumstances for its establishment do not appear to have existed.

Research on the biology and life history has continued from the 1947 work of Blackburn and Olsen to the present time, with State Fisheries Departments in both New South Wales and Tasmania and the Federal Government in the form of the Department of Primary Industry (Fisheries Division) and the CSIRO (Division of Fisheries and Oceanography) contributing to

the work. Knowledge has now been gained about the basic parameters influencing the species but more remains to be learned about environmental influences on distribution, population structure and population dynamics. An active fishery which could be monitored on a scientific basis would greatly assist and give impetus to a research effort.

Development of a fishery is likely in the first instance to centre around fish meal production. At present, the Commonwealth Government lends a purse seine to fishermen wishing to gain experience in its use for jack mackerel fishing. During the summer of 1977-78 the net was lent to Lakes Entrance Processors Pty Ltd who are running a pilot project for fish meal production at their Lakes Entrance plant. Adverse weather conditions (November-December 1977) and gear failure prevented any effective results.

5.0 PROSPECTS

The south eastern Australian jack mackerel resource is a potentially valuable one and worth developing. The present landings are negligible and can be expanded considerably, as has been shown when purse seine operations have been conducted. Development of a resource such as the jack mackerel should not however be viewed in isolation from other related species such as the yellowtail or those which are susceptible to similar fishing methods.

In realistic terms the development of a fishery is dependent on such a diversity of factors quite apart from the availability of the resource that the prospects for developing such a fishery are hard to predict.

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Figure 1. Reported jack mackerel surface sightings from 1941-1966 evaluated from fishing and research vessel log books (Anon, 1969). The estimated school sizes are given as a relative guide to compare reported sightings from five sectors on the Tasmanian east coast for each month.

Figure 2(a). Distribution of surface sightings by aerial observation from July 1973 to May 1974. July-October 1973.

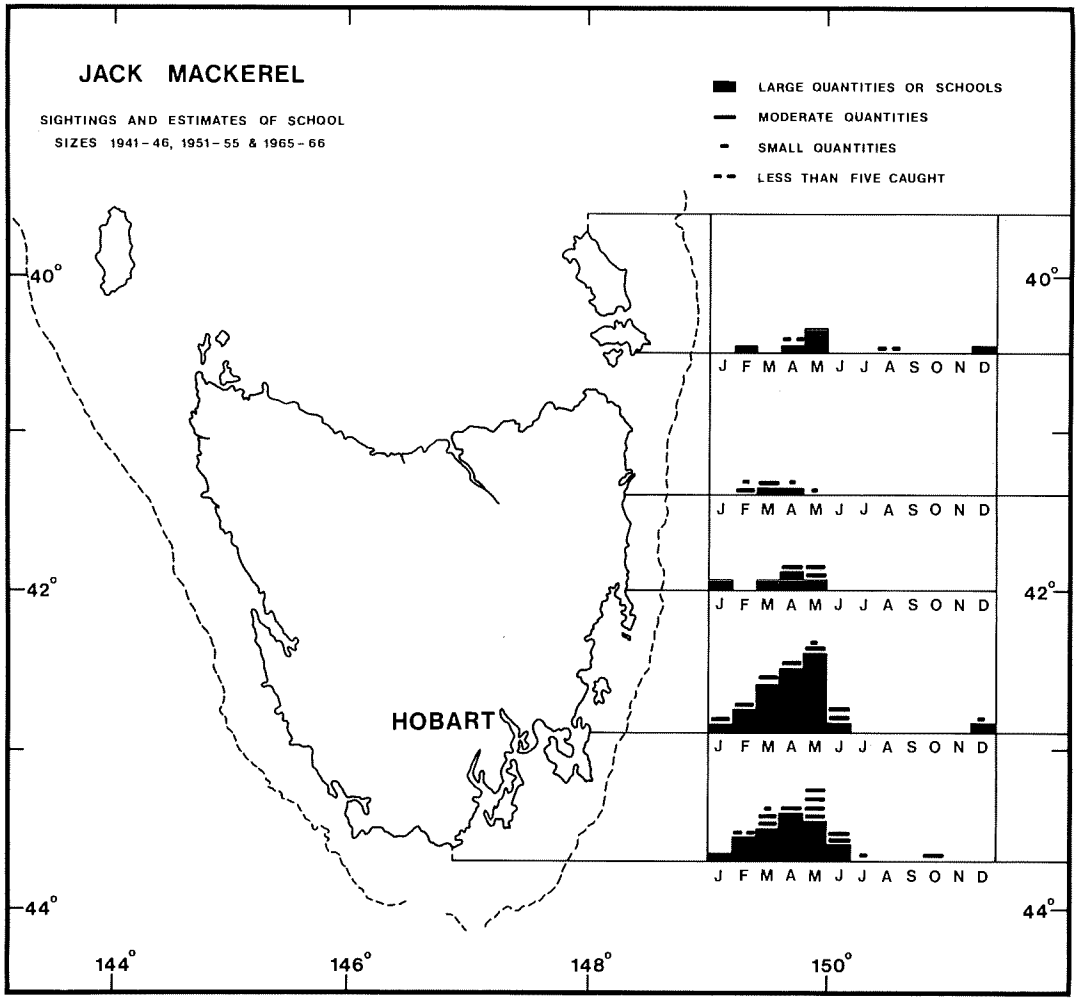
Figure 2(b). Distribution of surface sightings by aerial observation from July 1973 to May 1974. November 1973 - February 1974.

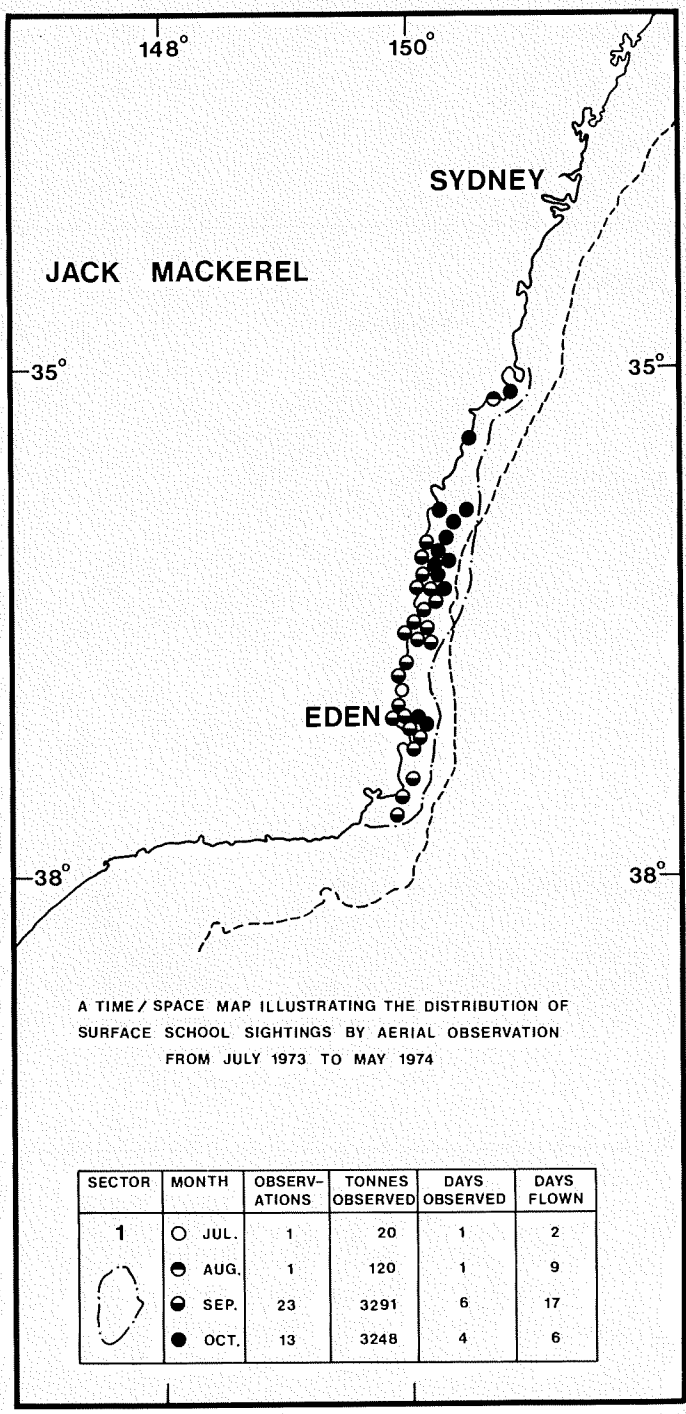
Figure 2(c). Distribution of surface sightings by aerial observation from July 1973 to May 1974. March-May 1974.

Figure 3. Observed distribution of principal food items from analysis of jack mackerel stomach contents.

Figure 4. Observed distribution of different fish components of the diet of jack mackerel.

Figure 1


JACK MACKEREL
SIGHTINGS AND ESTIMATES OF SCHOOL SIZES 1941-46, 1951-55 & 1965-66
LARGE QUANTITIES OR SCHOOLS
MODERATE QUANTITIES
SMALL QUANTITIES
LESS THAN FIVE CAUGHT
HOBART
40°
42°
44°
144°
146°
148°
150°
J F M A M J J A S O N D

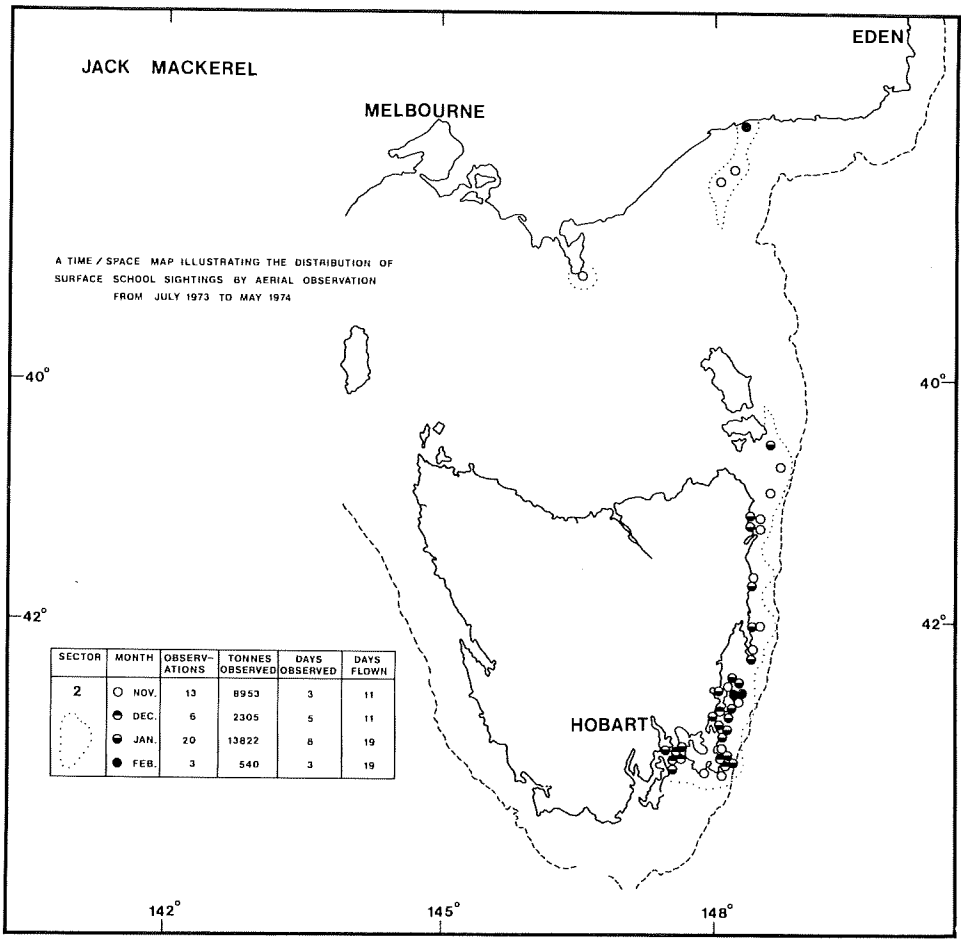


A TIME / SPACE MAP ILLUSTRATING THE DISTRIBUTION OF SURFACE SCHOOL SIGHTINGS BY AERIAL OBSERVATION FROM JULY 1973 TO MAY 1974

SECTOR	MONTH	OBSERV-ATIONS	TONNES OBSERVED	DAYS OBSERVED	DAYS FLOWN
1	○ JUL.	1	20	1	2
	◓ AUG.	1	120	1	9
	◒ SEP.	23	3291	6	17
	● OCT.	13	3248	4	6

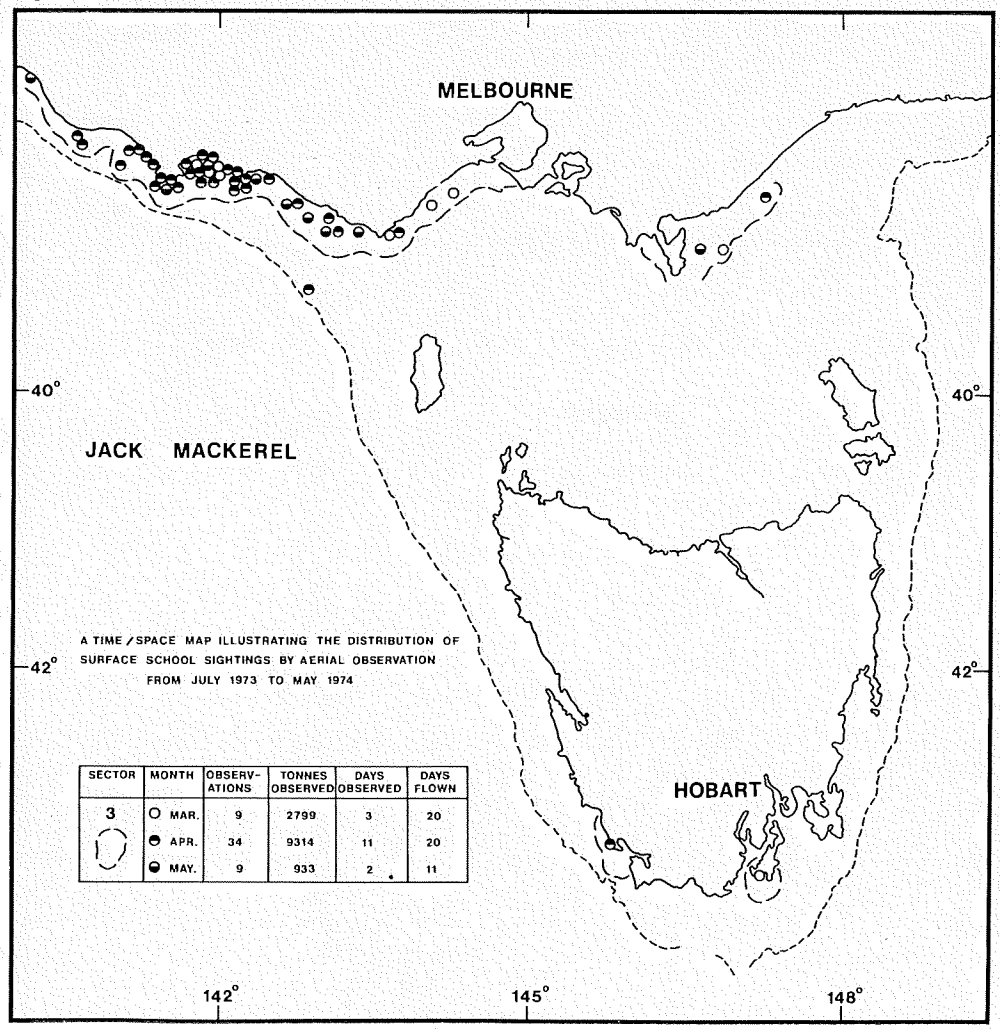
Figure 2a

Figure 2b



SECTOR	MONTH	OBSERV-ATIONS	TONNES OBSERVED	DAYS OBSERVED	DAYS FLOWN
2	NOV.	13	8953	3	11
	DEC.	6	2305	5	11
	JAN.	20	13822	8	19
	FEB.	3	540	3	19

Figure 2c



A TIME / SPACE MAP ILLUSTRATING THE DISTRIBUTION OF SURFACE SCHOOL SIGHTINGS BY AERIAL OBSERVATION FROM JULY 1973 TO MAY 1974

SECTOR	MONTH	OBSERV-ATIONS	TONNES OBSERVED	DAYS OBSERVED	DAYS FLOWN
3	MAR.	9	2799	3	20
	APR.	34	9314	11	20
	MAY.	9	933	2	11

Figure 3

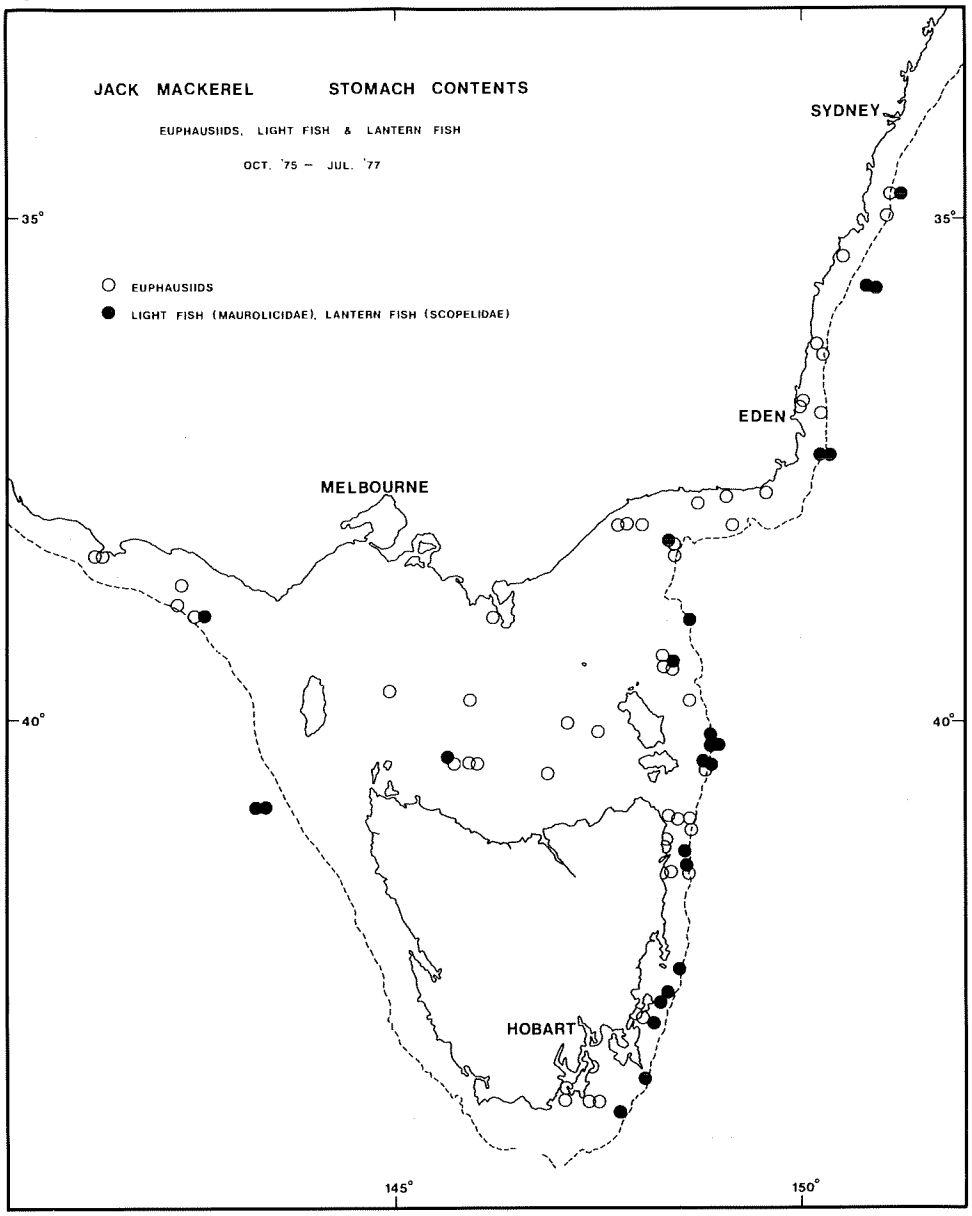

JACK MACKEREL STOMACH CONTENTS
EUPHAUSIIDS, LIGHT FISH & LANTERN FISH
OCT. '75 – JUL. '77
EUPHAUSIIDS
LIGHT FISH (MAUROLICIDAE), LANTERN FISH (SCOPELIDAE)
SYDNEY
EDEN
MELBOURNE
HOBART
35°
40°
145°
150°

Figure 4

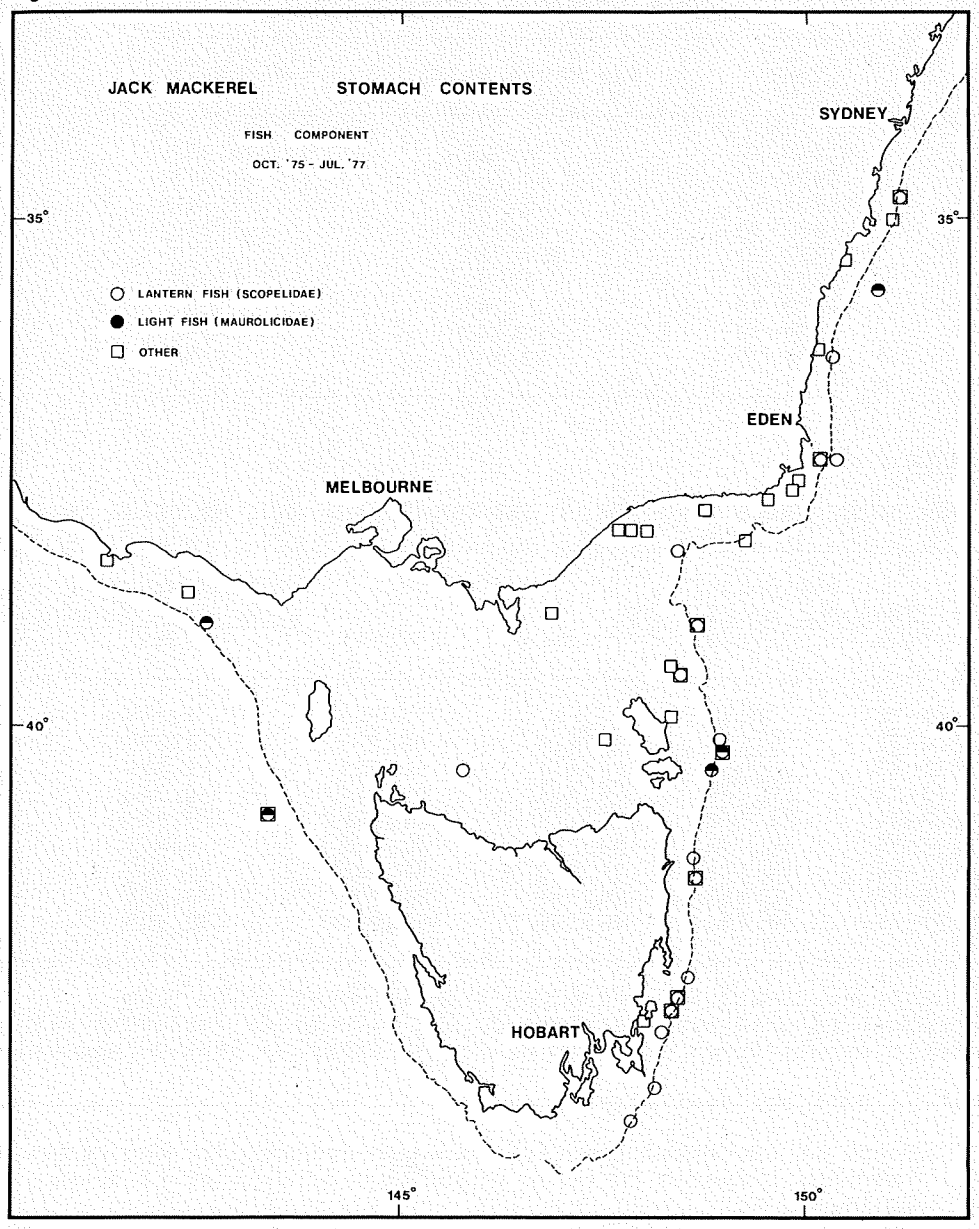

JACK MACKEREL STOMACH CONTENTS
FISH COMPONENT
OCT. '75 - JUL. '77
LANTERN FISH (SCOPELIDAE)
LIGHT FISH (MAUROLICIDAE)
OTHER
SYDNEY
EDEN
MELBOURNE
HOBART
35°
40°
145°
150°

TABLE 1

JACK MACKEREL LANDINGS (kg)

Year	New South Wales	Victoria
1969-70	8,316	150,935
1970-71	14,357	4,395
1971-72	19,529	7,348
1972-73	34,318	1,330
1973-74	365,787	2,757
1974-75	8,867	6,000
1975-76	21,547	N.A.
1976-77	33,559	N.A.
1977-78	30,499	N.A.

TABLE 2

NEW SOUTH WALES LANDINGS OF YELLOWTAIL AND JACK MACKEREL (kg)

	Yellowtail (Trachurus mccullochi)			Jack Mackerel (Trachurus declivis)
Year	Estuary	Ocean	Total	Total
1969-70	N.A.	N.A.	37,936	8,316
1970-71	5,853	32,819	38,754	14,357
1971-72	13,916	43,139	57,175	19,529
1972-73	14,748	69,726	84,474*	34,318
1973-74	31,448	77,178	108,626	365,787
1974-75	16,731	64,544	81,275	8,867
1975-76	14,343	71,603	85,946	21,547
1976-77	27,985	64,790	92,775	33,559
1977-78	40,464	48,576	89,040	30,499

Underlined totals are converted from imperial units from original reports and therefore do not give exact agreement with metric totals taken from N.S.W. State Fisheries 1975-76 Report.

N.A. = data not available

* Total of converted imperial measures for estuary and ocean landings compared to total production of yellowtail given as 65,849 kg.

TABLE 3

JACK MACKEREL (*Trachurus declivis*) LANDINGS AT PRINCIPAL PORTS IN NEW SOUTH WALES (kg)

Port	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	TOTAL
Port Jackson	259	75	538	816	4,117	10	699	104	259	6,877
Botany Bay						2	2			4
Wollongong	2,172	119	2	1,195	385	50	87	4,744	2,313	11,067
Greenwell Point			4	14	23	7	48			96
Jervis Bay				29						29
Ulladulla	895	611	779	1,857	180	1,236	7,573		495	13,626
Bateman's Bay					5					5
Narooma					76					76
Bermagui	49		615	1,247		391	485	2,036	32	4,855
Twofold Bay	71	9,988	8,731	12,632	347,654	3,135	7,222	14,661	11,986	416,080
Total	3,446	10,793	10,669	17,790	352,440	4,831	16,116	21,545	15,085	452,715
Reported total production	8,316	14,357	19,529	34,318	365,787	8,867	21,547	33,559	30,499	536,779

TABLE 4

YELLOWTAIL (Trachurus Mccullochi) LANDINGS AT PRINCIPAL PORTS IN NEW SOUTH WALES (kg)

Port	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	TOTAL
Port Jackson	16,209	12,216	22,213	17,162	5,851	28,565	18,240	16,124	21,814	158,394
Botany Bay	6,177	13,197	13,666	11,687	7,397	10,755	11,414	11,607	4,280	90,180
Wollongong	8,704	3,358	4,936	2,288	13,345	2,175	1,906	536		37,248
Lake Illawarra	9	2	99	43	1,453	43	1,787	46	21	3,503
Shoalhaven River	108	120	277	274	390	3,339	2,599	1,149		8,256
Greenwell Point	42	205	201	31	3,611	249	173	77		4,589
Jervis Bay		167	1,036	1,603	2,244	2,097	5,171	11,559	11,233	35,110
St Georges Basin	402	83	448	149	157	1,059	229	56		2,583
Ulladulla	210	239	701	3,740	9,948	3,862	11,910	5,274	1,969	37,853
Bateman's Bay	33		9			3	748	447		1,240
Narooma			32		59			3,070	2,618	5,779
Bermagui	21		1,370		32	4,425	979	633	18	7,478
Twofold Bay	3	10	825		382	1,463	18		34	2,735
Total	31,918	29,597	45,813	36,977	44,849	58,035	55,174	50,578	41,987	394,948
Reported total production	37,936	38,754	57,175	84,474	108,626	81,275	85,946	92,775	89,040	676,001

Underlined figures denote conversion from imperial to metric units from original values given in New South Wales Yearly Fisheries Report.

Only landing statistics from ports south of Port Jackson are included in Tables 3 and 4 to lessen the effect of confusion of jack mackerel with mackerel tuna, and yellowtail with yellowtail kingfish which may occur in landing returns from more northerly ports.