This thesis contains no material which has been accepted for the award of any other degree or diploma in another university, and to the best of my knowledge contains no copy or paraphrase of material previously published or written by another person, except where due reference is made in the text.

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December, 1986.

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ABSTRACT

The past and present structure and management of the D'Entrecasteaux Channel scallop fishery is examined with a view to providing a basis for the future management of the fishery.

The fishery has suffered mixed fortunes since its beginnings in the early 1920's. Production has fluctuated markedly over the years, reaching a peak in 1961, and subsequently collapsing. The fishery was closed from 1970 - 1981, re-opened from 1982 - 1985, but closed again in 1986.

The causes of the fluctuations in scallop production, and its collapse in the 1960's, include changes in fishing technology, excessive fishing effort and the inherent variability in the annual recruitment of scallops. The 1986 closure was forced by evidence of over-fishing, and the sudden appearance of the toxic dinoflagellate alga Gymnodinium catenatum Graham in the Channel area.

There is a lack of a comprehensive management plan for the D'Entrecasteaux Channel scallop fishery, and this is a serious obstacle to the successful conservation and utilization of the resource, as many of the administrative and biological problems, such as excessive fishing effort and the variable spatfall of scallops, are difficult to overcome. Moreover, there have been unexpected developments since the re-opening of the fishery in 1982: a great many more amateur fishermen now participate in the fishery, and the doughboy scallop (Chlamys asperrimus Lamarck) is now more numerous than the commercial scallop (Pecten fumata Tate).

Theoretical and practical management techniques applied in other fisheries are examined and assessed. Because of its flexible nature,

the concept of Optimum Sustainable Yield appears most suitable for the Channel fishery, and practical management should continue to include catch quotas, gear limitations, area closures, seasons, and size limits, as they provide a degree of control over fishing effort.

Specific recommendations made are that the Channel scallop fishery should be amateur-only while scallop stocks remain low, that the level of enforcement and fines for breaches of fisheries regulations should be increased, and that research on scallops in the Channel, particularly the doughboy scallop, should be upgraded.

CONTENTS PAGE

1. INTRODUCTION

Increasingly marine environment scientists are becoming aware of the delicate balance of nature that sustains marine ecosystems. In recent times the escalation in the demand for and use of marine resources has destroyed the myth that the sea is a boundless provider, and in the case of a harvestable fish stock, such as scallops, it is now realised that severe depletion will occur unless there is some form of control over fishing effort. This has resulted in a greater dependence on careful resource management to ensure the conservation and continued utilization of the various fish species.

The D'Entrecasteaux Channel scallop fishery is of considerable importance to Tasmanians. At one time it was the third largest scallop fishery in the world (Anon 1962), and it has sustained many professional and part-time (amateur) fishermen over much of the last sixty years. Historically, the fishery has been plagued by recurrent collapses in production, resulting in long closures of scallop beds, sometimes for years on end: one such closure lasted from 1970 to 1981. Since 1982 the Channel fishery has attracted much interest from amateur fishermen, and a small "armada" of boats has fished for scallops during the short season. There are signs that the scallop stocks are again becoming depleted and the possibility of an extended closure of the fishery again looms in the not too distant future.

The major aims of this thesis are to document the history of the D'Entrecasteaux Channel scallop fishery, and to suggest a basis for the long-term management of the fishery, in order that the scallop stocks can be conserved and utilized for the greatest benefit to

Tasmanians. The biology of the three scallop species in the D'Entrecasteaux Channel is detailed, the past and present fishery is examined, and the present management difficulties are discussed. Various theoretical and practical tools used in fisheries management are described, and detailed recommendations are made concerning the future management of this important fishery.

2. THE D'ENTRECASTEAUX CHANNEL AND ITS SCALLOPS

2.1 Introduction

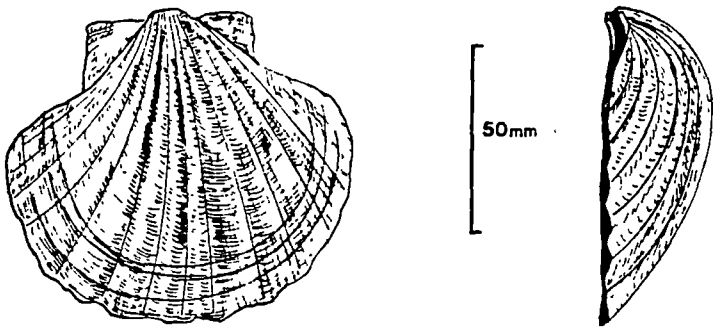
Scientific research on the three species of scallop in the D'Entrecasteaux Channel (the queen scallop, Equichlamys bifrons Lamarck, the doughboy scallop, Chlamys asperrimus Lamarck, and the commercial scallop,*Pecten fumata Tate -see Fig.1) began in 1910, when Dr Noetling and Mr A.Kirk were appointed by the Tasmanian Fisheries Board to examine the depleted Derwent River scallop beds (Commissioners of Fisheries 1910). From 1918-1920 Professor T.T.Flynn, Ralston Professor of Biology at the University of Tasmania, investigated the causes of depletion of the beds, making observations on scallop growth and reproduction, and assessing the environmental controls on scallop numbers (Commissioners of Fisheries 1918, 1919).

Further research on Tasmanian scallops included studies by Tubb(1946), Fairbridge(1953), and Olsen(1955), members of the Commonwealth Scientific Industrial Research Organization(C.S.I.R.O.) Division of Fisheries, and Harrison(1961), a B.Sc. Honours student at the University of Tasmania. These works concentrated on the D'Entrecasteaux Channel, and focussed particularly on the commercial scallop.

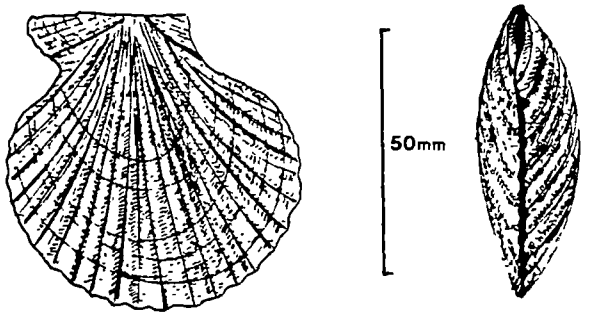
More recently Dr T.G.Dix and others have undertaken studies on larval and juvenile biology of each of the 3 species (Dix and Sjardin 1975, Dix 1976, Rose and Dix 1984). Most recently, two investigations have been carried out on spatfall, growth and survival of commercial scallops with a view to possible aquaculture and re-seeding projects (Hortle 1983a, Cropp 1985a).

*The taxonomy of Pecten fumata is currently under revision (Crawford, personal communication). It has previously been named Pecten medius (Tubb 1946), Notovola meridionalis (Fairbridge 1953), and Pecten meridionalis (Dix 1975).

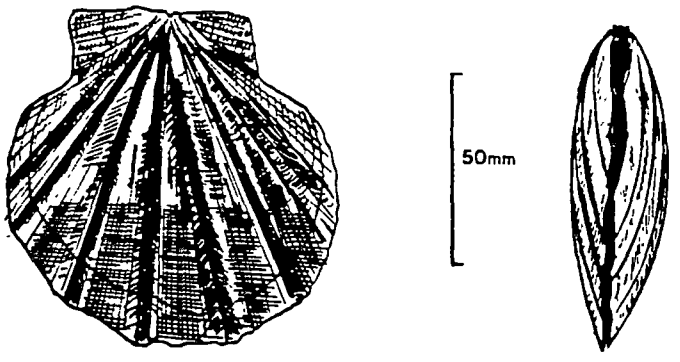
Figure1
Scallop species found in the D'Entrecasteaux Channel



Commercial Scallop - Pecten fumata Tate



Doughboy Scallop - Chlamys asperrimus Lamarck

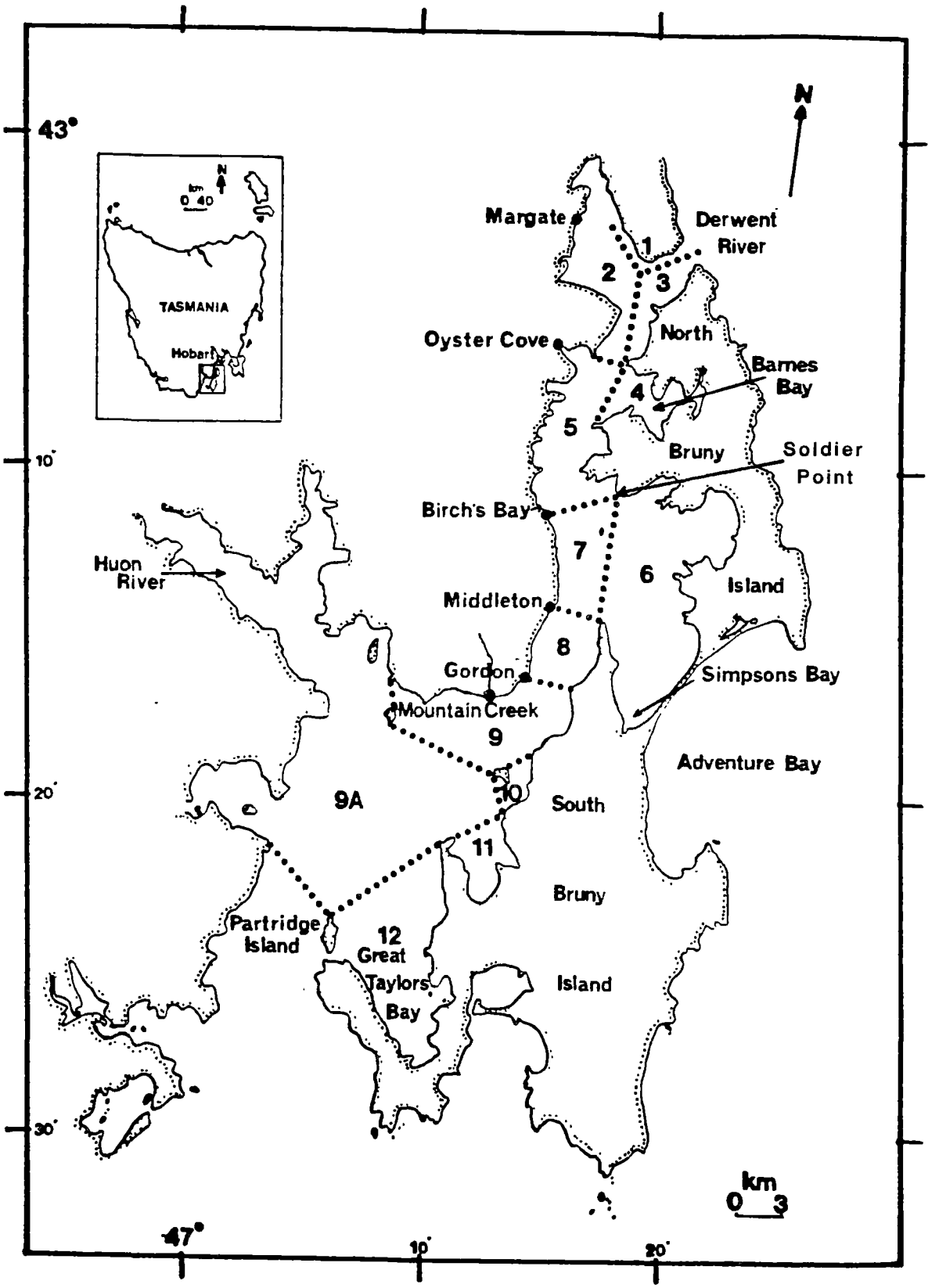


Queen Scallop - Equichlamys bifrons Lamarck

The northern extremity of the D'Entrecasteaux Channel is approximately 20 kilometres south of Hobart and the Channel runs south-south west for approximately 45 kilometres (Fig.2). In places, it is only a few kilometres across, but in its southern parts it is up to 15 kilometres wide. Olsen(1955) divided the Channel into 3 areas based on topography and bathymetry: a deep open southern entrance with an average depth of about 40 metres, an extensive shallow midsection with an average depth of about 14 metres, and a narrow northern channel, with an average depth of about 20 metres (Fig.3). The Derwent River to the north and the Huon River in the south both influence the hydrology of the Channel (Fairbridge 1953). On a rising tide, brackish water flows from the Huon River to the western shore of South Bruny Island and north along the Channel. There is an increasing salinity gradient, from south to north along the Channel after heavy rain (Langlois and Cooper 1978). The water temperature range in the Channel is from 7°C to 20°C (Fairbridge 1953).

Investigations on the bottom types in the Channel have been carried out by Olsen(1955) and the Sea Fisheries Division, Department of Agriculture (Sea Fisheries Division 1974, 1976). This work has shown that substratum types are highly variable, ranging from fine silt through to coarse sand and rock. In general, mud substrata are found in the deeper sections of the Channel and in the large bays, that is Northwest, Barnes, Simpsons, and Great Taylors Bays (Fig.4). There is a gradation from mud to fine sand to coarse sand with decreasing depth, particularly in the narrow parts of the mid section (Areas 7 and 8). Rock and weed substrata are normally found in shallow depths, fringing the coastline. The northern section of the Channel (Areas 1-5) has

Figure 2
D'Entrecasteaux Channel scallop areas *



* These areas were designated in 1947 (as part of an attempt to quantify scallop catches) and corresponded roughly with established scallop beds (Fairbridge 1953).

Figure 3

Bathymetry of the D'Entrecasteaux Channel

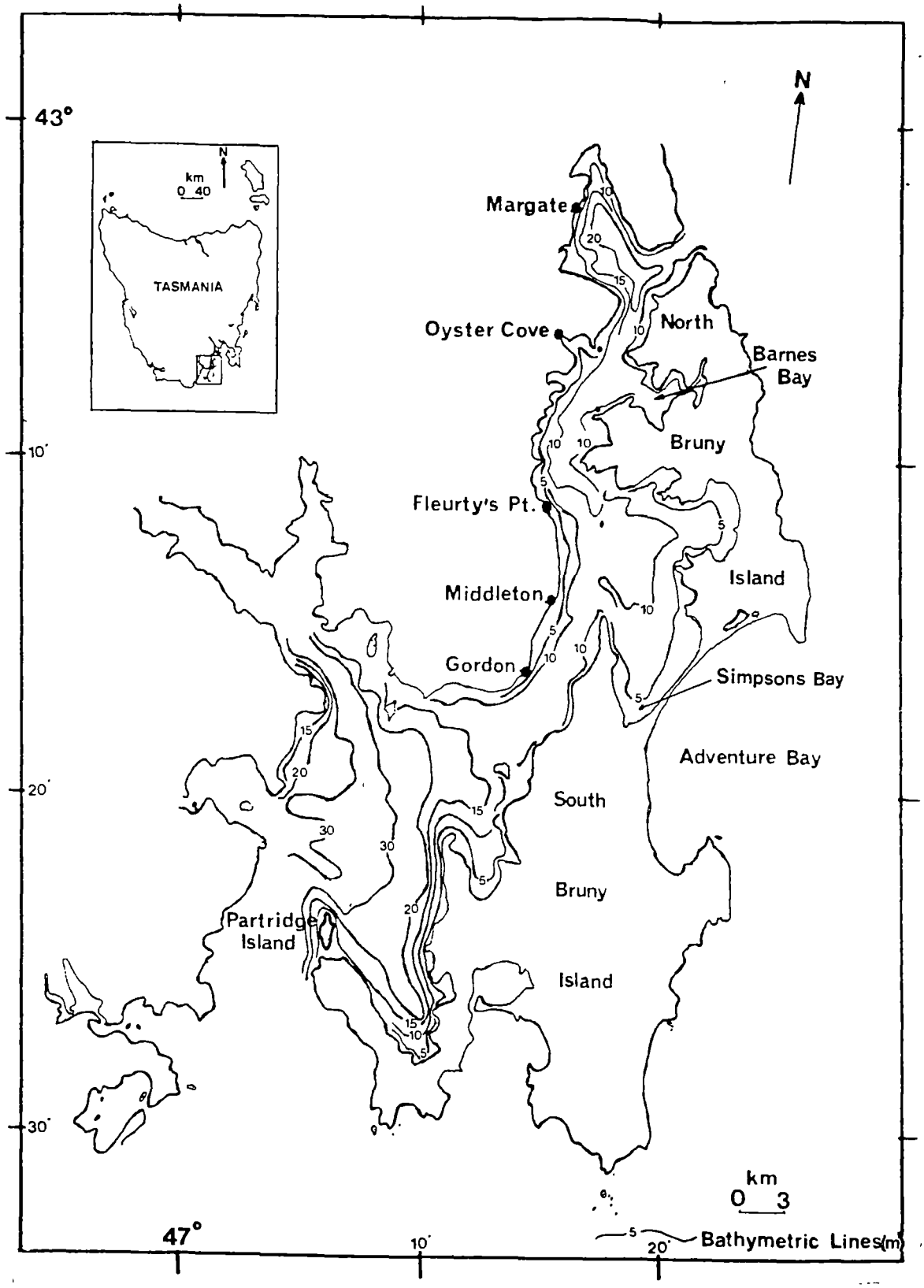
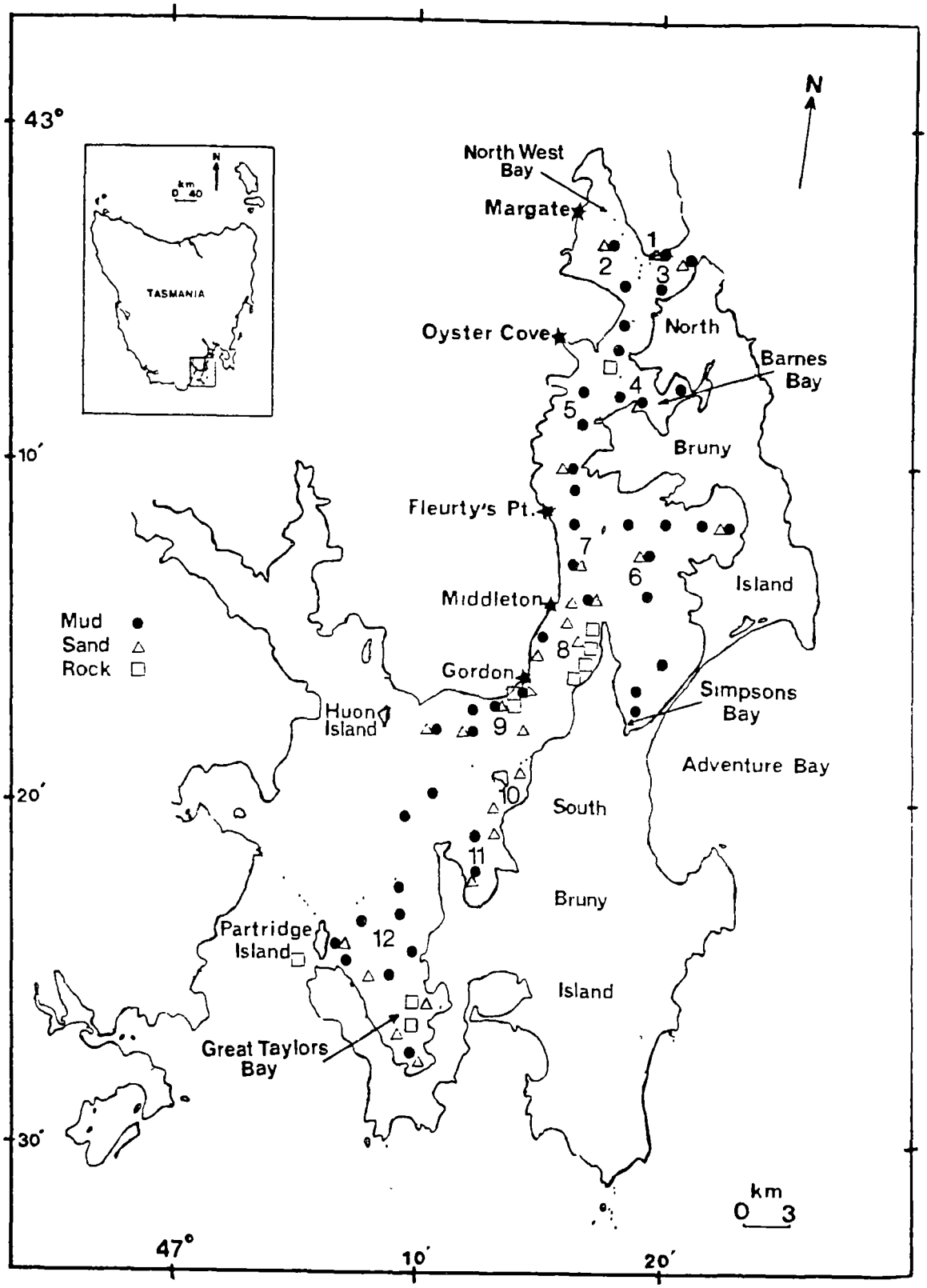


Figure 4

Bottom substratum types of the D'Entrecasteaux Channel



mostly a muddy bottom with sand fringes in the shallower areas. Outcrops of rocky bottoms do occur, for example east of Oyster Cove, but are rare. The mid section of the Channel (Areas 6-9) has many different bottom types. Area 6 is generally muddy while Areas 7, 8, and 9 contain areas of mud, shell and rock substrata. Olsen (1955) observed an area of coarse sand and fine shell located between Gordon and Middleton (Area 8), while below Gordon (Area 9) the fine sand covers all the substrata out to a depth of about 20 metres. Olsen's results are similar to those of the Sea Fisheries Division surveys, suggesting that bottom conditions had not changed markedly in the 20 years between the studies. In the southern section of the Channel (Areas 10-12), the substratum is again variable, Areas 10 and 11 having sandy bottoms and Area 12 having a muddy bottom in its deeper parts with sand, rock, weed, and shell in shallower sections.

Olsen(1955) is the only author to have published information on the distribution of the 3 species of scallops in the Channel. He found the commercial scallops to be most abundant over the mid section of the Channel (Fig.3) in a depth range of 8 to 16 metres. The commercial scallops were also found along the edges of the northern and southern ends of the Channel where they were aggregated into strips. The queen scallop was found to occupy a shallower range throughout the Channel, from 2 to 14 metres, often in association with rocky reefs and the seagrass Heterozostera tasmanica (Martens ex Aschers.) den Hartog, and rocky reefs. The doughboy scallops were found to have a similar depth range and horizontal distribution to the commercial scallops.

Olsen found that commercial scallops often occurred in high densities in beds or strips. Scallops were also present between the strips, but at low densities. The strips ranged in size from about a

metre to 30 metres or more in both length and width, and tended to lie with their long axes parallel to a flow or tide, or along contours in sheltered bays. Olsen concluded that tides had an important effect on the distribution of larvae and their settlement because in areas of strong tides scallop beds were found running parallel to the tide, but in areas where the tide was weaker the scallops were more evenly dispersed. His work also showed the importance of tides to scallop condition, as scallops in areas of strong current were found to have firmer, whiter adductor muscles than those from other areas. Olsen observed that the commercial scallop occurred on any type of substratum, from silt-sand through to coarse sand and shell. This observation has been confirmed by others who have dived extensively or fished on scallop beds in the Channel (Wolfe personal communication, Whayman personal communication).

Since the work of Olsen there have been no systematic studies on the horizontal distribution or depth ranges of scallops in the general Channel area. However, annual scallop surveys by the Department of Sea Fisheries contain information on scallop species and abundance in the major fishing areas of the Channel. The most recent surveys (Harris 1981, 1982, 1983, Smith 1984, Zacharin 1985, 1986) show that commercial scallops are no longer abundant in the mid section of the Channel, and doughboy scallops are the most abundant species overall, particularly in Areas 5, 6, 7, and 8 (Fig. 2). During these surveys the greatest catches of commercial scallops were taken in Areas 7, 8, and 12 and the largest numbers of queen scallops were in Areas 3, 7, and 8. However, catches of these two species were insignificant when compared with those of doughboy scallops.

2.3 Scallop Biology

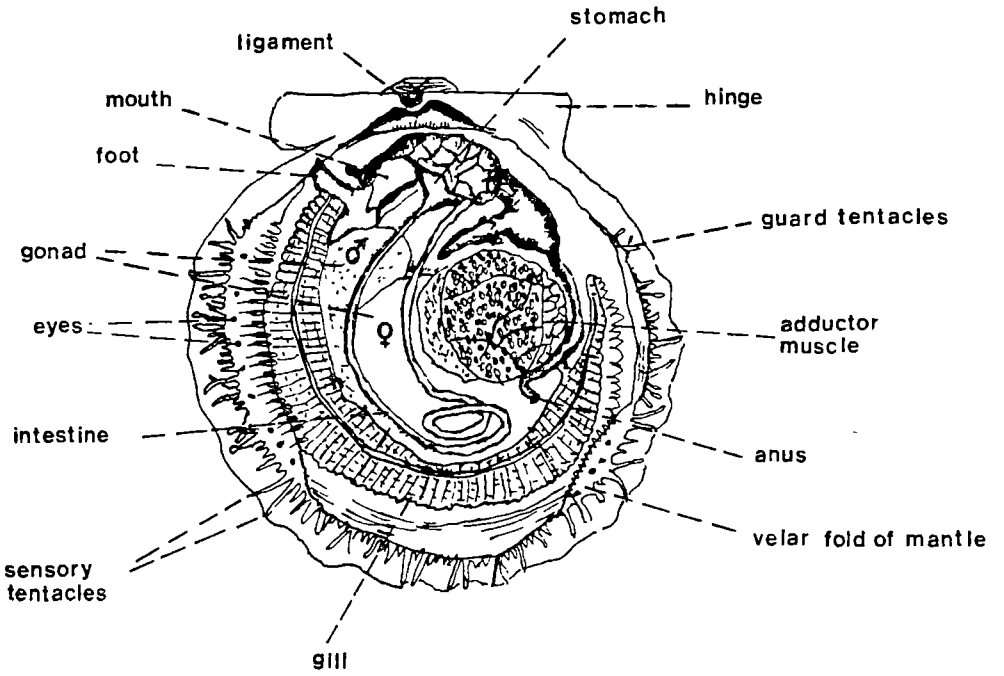
2.3.1 Adult Morphology and Anatomy

Adult scallops are considered here to be those scallops which have the capacity to reproduce. Scallops are bivalve molluscs, related to oysters and mussels. Unlike oysters and mussels however, the scallops are capable of swimming short distances and, with the exception of some doughboy scallops, are not attached to the substrate. The scallops' semicircular valves, with their fine ribs and colouration have caught the eye of many artists (eg. Mason 1983).

The three species of scallop found in the Channel are easily distinguished when seen together (Fig.1). Doughboy scallops are the smallest, adults normally reaching 80-90 mm in length. They are further distinguished by an unequal hinge, the red sponge encrustations often found on the valves, and the 25-30 closely set ribs which radiate from the hinge area (McPherson and Gabriel 1962). Commercial scallops are distinguished by their valve curvature, one valve being flat, the other highly convex with about 15 ribs radiating from the hinge (Olsen 1955). The queen scallops are the largest of the three species, some individuals being more than 150mm long. Both valves are slightly convex and have 7-8 narrow ribs which are much darker than the remainder of the shell. One valve is slightly smaller and is tightly clasped by the other and the interior surface of the valves is deep purple in colour (McPherson and Gabriel 1962).

The general anatomy of the three species of scallop is similar (Young personal communication) and is shown in Figure 5. The two

Figure 5
General anatomy of a scallop
(After Barnes, R.D., 1980)



valves are joined by a ligament at the hinge which allows the valves to open about 20 degrees. The valves are opened and closed by the large adductor muscle, which together with the gonad(s) forms the edible portion of the scallop (doughboy and queen scallop populations contain male and female individuals, while the commercial scallop is an hermaphrodite, that is both male and female gametes are found in each individual). Near the gonad(s) is the foot, used in early life when the scallop crawls about to select a suitable settlement site. It is thought that the foot is used in the adult to clear unwanted particles out of the shell (Franklin et al 1980). The internal organs of the scallop are enclosed in a thin membrane or mantle which secretes the shell (Mason 1983). Along the edge of the mantle are many well developed eyes and a number of sensory tentacles. The eyes are sensitive to light stimuli and perceive movements (Sanders 1970) enabling the scallop to react to such things as predators and towed dredges. The tentacles are used in detecting food and chemical changes in the surrounding environment (Franklin et al 1980).

2.3.2 Reproduction and Juvenile Development

Studies of the (hermaphrodite) commercial scallop have shown that the reproductive cycle is annual and normally begins in the second year of growth (Dix 1982). The work of Harrison in 1961 showed that the gonads begin to develop in early autumn, as water temperatures begin to fall. Gonad development proceeds until around early August, when spawning (release of eggs and sperm to the environment) commences. This is followed (depending upon temperatures) by a slight gonad regression before a partial spawning again around

September. In October, as the water temperature increases, the gonads begin to regress and this continues slowly until March when the animals are almost devoid of reproductive cells (Harrison 1961).

The eggs of the three species of scallop differ in size, the doughboy having the smallest and the queen having the largest (Dix 1976, Rose and Dix 1984). Fertilization occurs in the sea. In the case of the commercial scallop spawned in the laboratory, up to 10 million orange coloured eggs have been observed at spawning (Dix and Sjardin 1975) with an average diameter of just over 70 μm. After three days the larvae have grown to over 95 μm and have the ability to swim vigorously or drift in the water column. At approximately 180 μm the larvae develop a foot which is used for crawling, but still retain their swimming ability. Metamorphosis into the juvenile form begins at a length of 220-240 μm, some 31 days after fertilization (Dix and Sjardin 1975). The queen scallop, when spawned in the laboratory, produced fewer eggs (70,000 -900,000) but they were longer than those of the commercial scallop (120μm)(Dix 1976). Juvenile metamorphosis normally occurred 17-20 days after fertilization when the larvae were just longer than 200 μm. The doughboy scallop under laboratory conditions produced between 950,000-2,000,000 eggs which were smaller that those of the other species (62μm) (Rose and Dix 1984). Juvenile metamorphosis occurred 20-23 days after fertilization.

Fertilized eggs divide repeatedly and within a few hours form a trochophore. This first larval stage does not have a shell and is covered with cilia, enabling it to swim. After 2 or 3 days the trochophore develops into the veliger stage in which the larvae have a primitive digestive system and are positively phototactic, often swimming towards the sea surface to feed (Dix 1977). During this

planktonic phase the shells of the different species assume characteristic shapes and colours. The next stage is the pediveliger, which as the name suggests is a veliger with a small foot. The larvae sink to the bottom and use the foot to crawl about, searching for a suitable growing area. After selecting a site they undergo a metamorphosis in which the swimming organs and the foot are often modified or resorbed, and an adult-like shell begins to develop (Dix 1977). While in the early juvenile stage the young scallops are referred to as spat, and the process of settling out of the water column and selecting a site to grow is known as spatfall.

The time the larvae spend in the plankton is a crucial factor for successful settlement. For example, if the winds, currents and tides are such that the larvae are taken away from suitable settlement areas, then there will be no spatfall. The period spent in the plankton is probably a time of high mortality for scallop larvae as they are a food source for many animals (Robert 1978).

Once the scallops have selected a suitable settling site they secrete a byssal thread which cements them to the bottom (Dix 1977). The doughboy scallop often retains this thread throughout its life, while the other two species become detached and free living.

The growth of commercial scallops has been assessed at two sites in Tasmania, one on the east coast and one in Birchs Bay in the D'Entrecasteaux Channel (Fig.2). Growth was found to be greatest in the first year, and the scallops of the east coast site grew more rapidly than those in the Channel, apparently due to more favourable currents and food availability in the area (Cropp personal communication).

2.3.3 Adult Behaviour and Feeding

The behaviour of the commercial scallops in the Channel has been studied by Olsen (1955) and his findings form the basis of this subsection.

Adult scallops can be found on virtually any type of substratum, ranging from fine silt through to coarse sand (Wolfe personal communication). They are often found slightly recessed into the surface of the substratum with a fine layer of silt over their upper valve. Queen scallops form the largest depressions. Some doughboy scallops are attached to the substratum by a short byssal thread (personal observation). Commercial scallops are usually found with the edge of the mantle folded inwards so that the eyes and tentacles are fully displayed. In areas where tidal influence is low, the orientation of the valves is random, but in areas where tidal influence is strong the hinge faces into the tide. When disturbed, the commercial scallop swims by jerky, snapping motions of the two valves, with its hinge trailing. Propulsion is achieved by the jetting of water from either side of the hinge. Olsen rarely observed scallops swimming with the hinge foremost. He observed scallops swimming up to 2 metres from the bottom and a maximum horizontal distance of 5 metres. At the end of a swim the commercial scallop closes its valves and falls by a gentle zig-zag motion until it lays on the substratum on its curved valve. The commercial scallops are the most active swimmers, the doughboys the next and the queens the least active.

The swimming allows some avoidance of towed dredges. However, the adductor muscle, which is the muscle responsible for swimming,

tires quickly and the scallops are then taken. Fishermen have found that scallop beds need to be 'worked', that is a series of hauls needs to be made over a scallop bed before good catches of high quality scallops are made. It seems likely that the fishermen are tiring the scallops' adductor muscles so that they are unable to avoid capture. The high quality scallops are caught only after a number of hauls, since their muscles are in the best physical condition: scallops with poorer muscle condition will usually be caught first.

Scallops are filter feeders, actively passing seawater through their gills by the rhythmical contraction and relaxation of the large adductor muscle. Large particles are rejected, while those of edible size (e.g. phytoplankton, detritus, and bacteria) are passed into the mouth and through the digestive system (see Fig.5). There is evidence to suggest that scallops feed mostly on food matter close to the bottom (Broom 1976) and that shell flapping and suction from the gills takes food directly from the top of the substratum (Robert 1978). Scallops grown in culture survive well on unicellular algae (Dix 1976).

2.3.4 Predators

Scallops are preyed upon by a number of organisms but principally by the eleven armed starfish, Coscinasterias calamaria Gray and the large whelk Fasciolaria australasia Perry (Olsen 1955). Predation by starfish can be considerable: work done in the Channel on an area of seabed near Mountain Creek (Fig.2) suggested that predation by starfish resulted in an estimated 75 to 80 percent reduction in stock over a 4 year period (St. Leger 1964). The fish Platycephalus

bassensis Cuvier (Bay flathead) has been shown to feed on the remains of scallops attacked by starfish, but it does not attack scallops directly (Olsen 1955). In muddy environments scallops may be infested with the mud worm Polydora websteri Hartman. The worm burrows into the shell of the scallop, causing a blister which may become infected and kill the scallop (Commissioners of Fisheries 1918). There is some evidence for scallop predation by octopus (Cropp personal communication). Finally, growths of algae on the valves may result in scallops being pulled over in strong currents (Olsen 1955) and possibly being cast ashore.

2.4 Aquaculture

Scallop aquaculture is here defined as the intensive growing of scallops in a confined area, using artificial substrata, for the purposes of commercial harvesting.

Investigations into the potential of commercial scallops as an aquaculture species began in 1973 when the then Fisheries Division of the Tasmanian Department of Agriculture began conducting laboratory studies on commercial scallop larvae (Dix 1975). Preliminary experiments on the collection of wild spat (using onion bags stuffed with shark netting, see Fig. 1 p.19 in Dix 1981) and the ongrowing of juveniles were commenced in 1975 and continued in 1976 on Tasmania's east coast. However, low numbers of spat were caught and there was found to be a high mortality during the ongrowing phase. It was concluded that high mortality and spat collection problems would need to be resolved before scallop culture in Tasmania could become economically viable (Dix 1981).

In May 1978 trials on the potential for scallop culture were continued (Cuthbertson 1979). Juvenile scallops were obtained from the east coast and transplanted to the D'Entrecasteaux Channel. Growth rates of scallops grown in lantern shaped cages were compared to those of scallops glued to plastic tape. The scallops glued to the tape grew more quickly than those in the cages, probably because the flow of water around the cages was obstructed, inhibiting the filter feeding of the shellfish inside (Cuthbertson 1979).

The next step in the aquaculture of commercial scallops was a spat and larval sampling program begun in 1982 and designed to determine the factors influencing the timing and location of larval

settlement. Sampling of the water column for scallop larvae was undertaken at five sites around the Tasmanian coastline. Spat collectors were placed at seven coastal localities including one in the D'Entrecasteaux Channel at Soldier Point (see Fig.2). The larval sampling program foundered due to the low density of scallop larvae, and it was not possible to develop any prediction of spatfall from the results. However, the spat collection program proved successful, particularly for doughboy scallops at the Soldier Point site, where an average of 3291 scallop spat were recovered per collector (Hortle 1983b).

Some of the animals collected were re-located in upwellers (a form of holding pen with flowing sea water) at the Shellfish Culture Pty. Ltd. hatchery at Bicheno, so that growth rates of scallops in upwellers could be compared with those of scallops grown in the cages. It was found that scallops grew more slowly in the hatchery upwellers, largely because of higher densities (Cropp 1984).

A number of the scallops caught by the collectors were used to re-seed an area of Great Oyster Bay on the east coast and were released onto the area on two occasions: 1200 scallops were released in February 1984 and a further 7000 in May 1985. Seven weeks after the second release a search of the re-seeded area revealed 94 dead and 1 live scallop. The fate of the other scallops was not determined (Cropp personal communication). Recently over 400,000 scallops were released in Promise Bay on the east coast but the results of this reseeding attempt are, as yet, unknown (Cropp personal communication).

The re-seeding research is aimed at the repopulating of former scallop beds so that a viable scallop population might be restored. If it is successful, management authorities may be able to tell more

easily when a particular area could be opened and what the expected catch might be (Mercury 1985a). In May 1985, 12,000 juvenile commercial scallops were released in the D'Entrecasteaux Channel, in Northwest Bay. The results of this re-seeding are at present unknown, but are of vital interest to the future of the Channel fishery and the Tasmanian scallop fishery in general.

Recently, spawnings of scallops under hatchery conditions and the production of viable larvae and juveniles has been achieved at the Tasmanian Shellfish Company at Dunalley (Anon 1986a). This enhances the prospects of scallop reseeding and aquaculture, but at the present time the farming of scallops is uneconomical, due largely to the high price of the Japanese-made cages used for growing them. These cages have been estimated to constitute 83 percent of total capital costs for a potential scallop farmer, and alternative forms of culture such as glueing scallops onto tapes and hanging them from a longline need to be examined (Cropp 1985b).

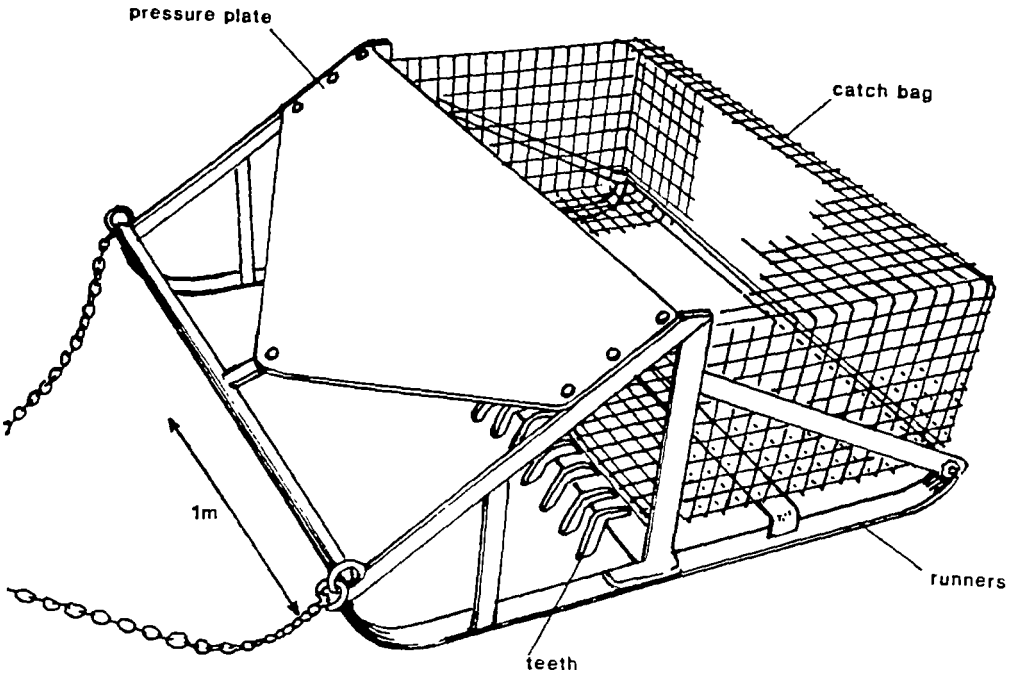
2.5 Fishing Techniques

Scallop fishing techniques in the Channel have changed greatly since the beginning of the fishery in the early 1900's. In those early times a rowing or sailing boat was used to tow a dredge, which was then hand-hauled onboard for the sorting of the catch (Harrison 1965). The hand-hauling was replaced by the use of a windlass, and later in the 1940's, by an engine driven winch (Lynch 1963). The dredge used was known as a lip dredge (Fig.6). Its major features were a flat iron blade which formed the lower lip of the dredge, and a collapsible chain mesh catch bag. The bar was set at such an angle that, when it was drawn over the seabed, it passed under the scallops, weed and debris and forced them up and through the mouth of the dredge into a catch bag. This had the unfortunate effect of crushing the scallops not picked up by the lip and smothering them with mud and sand disturbed by the bulldozing action of the dredge.

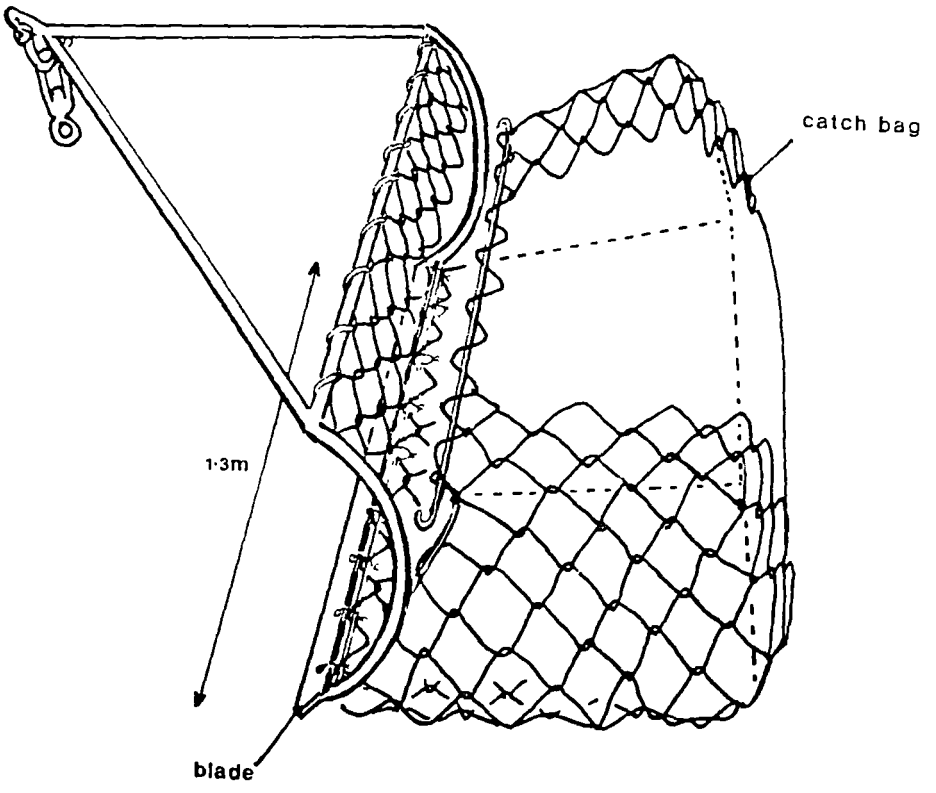
In 1958 a new dredge, the 'Sputnik' or Baird dredge (Fig.6), was introduced to Tasmanian waters by A.M.Olsen (Langford 1959). This dredge had runners to lift the bag or net above the bottom and a series of teeth projecting down from its lower lip. The teeth were designed to allow small scallops to pass through, while larger shells were passed up into the catch bag. Some of the dredges had a pressure plate attached, which acted to keep the mouth of the dredge on the substratum.

In the late 1950's there was much controversy concerning the use of the different dredges, and in 1960, as part of a Select Committee investigation into the scallop fishery of Tasmania, experiments were conducted to assess the amount of damage caused by each type of

Figure 6
Dredges used in the D'Entrecasteaux Channel scallop fishery



"Sputnik" dredge



Lip dredge

dredge. Although these experiments were inconclusive the lip dredge was purported to be the least damaging to the scallops and the 'sputnik' dredge the most damaging (Select Committee of the Legislative Council 1961).

The only dredge now allowed in the Channel is a 1.3 metre lip dredge. The fishing technique varies from boat to boat but follows a general pattern: the dredge is lowered into the water and enough line (usually about 4 times the depth of water) is let out to set the dredge at the correct angle; the dredge is towed at speeds up to 5 knots, depending on the concentrations of scallops; the dredge is then hauled into the boat and tipped out for sorting of the catch. There is some variation in the way in which the dredge is brought onboard: some boats have a self-tipping stern retrieval system, some use derricks to swing the dredge over the side, and some smaller boats still use the hand-hauling technique (Innes personal communication). The catch is sorted into doughboy and queen scallops of legal size (70mm and 90mm respectively) and bagged in plastic onion bags for return to port. The taking of commercial scallops from the Channel has been banned since 1984. If the boat is a commercial boat the catch is taken to one of several fish processors eg. SAFCOL Pty. Ltd. at Margate (McKenna personal communication). Amateur fishermen take the scallops for home consumption (the sale of scallops taken by amateurs is prohibited).

3. HISTORY OF THE FISHERY UP UNTIL 1982

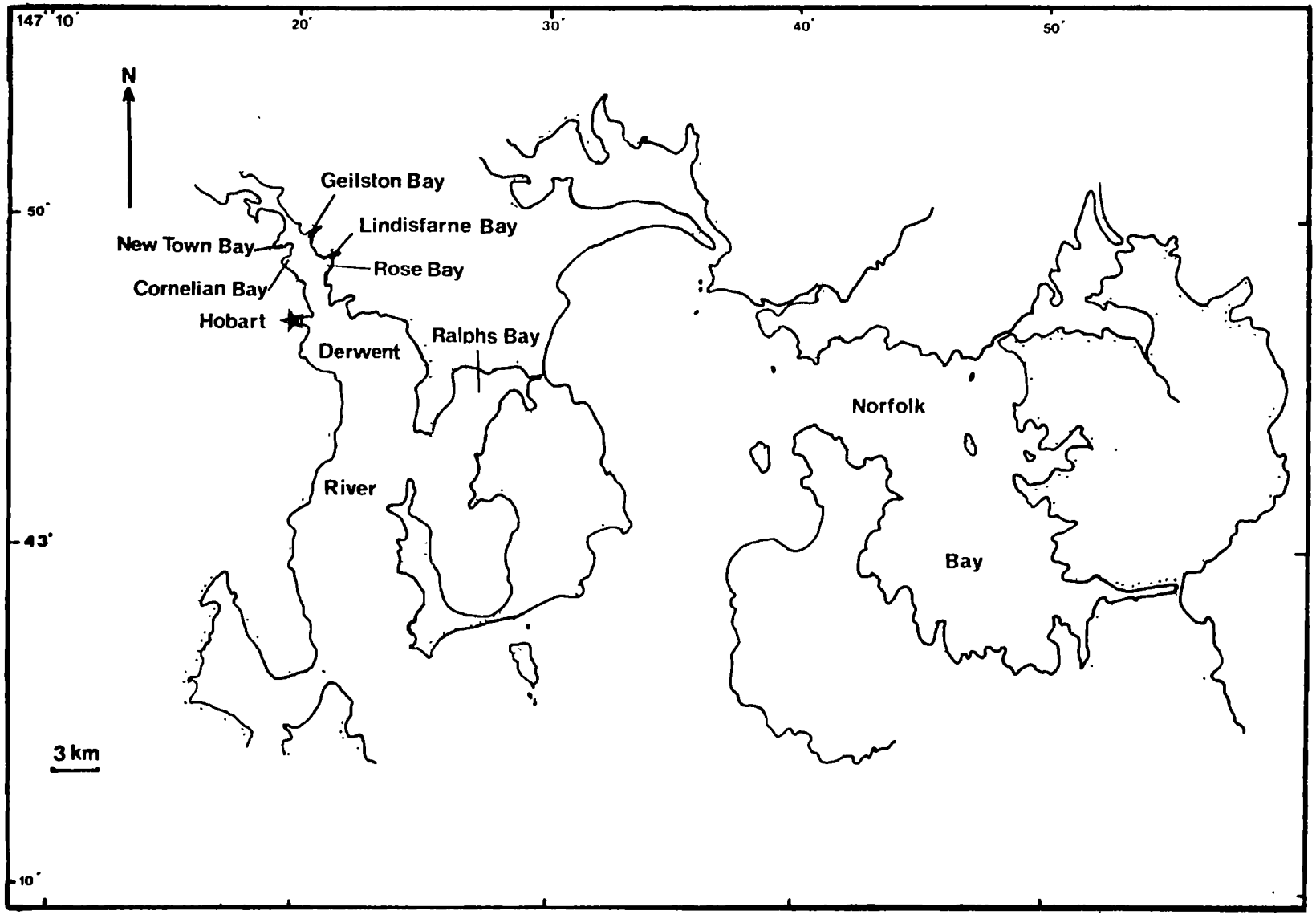
3.1 Scallop Fishing in the Derwent Estuary

Prior to European settlement in Tasmania, the environs of the Derwent Estuary and the D'Entrecasteaux Channel were inhabited by Aboriginals. However, there is no evidence of scallop shells in their kitchen middens, suggesting that scallops did not form a part of their diet (Brown personal communication). As late as 1882, a Royal Commission on Fisheries did not consider scallops to be significant commercially, though it did acknowledge that the common scallop Pecten fumata Reeve (sic) (the commercial scallop) was abundant in certain localities and was consumed locally (Seal et al 1883).

Significant numbers of scallops were available in the Hobart Market from 1905 (Anon 1980). These were caught in Rose Bay (Fairbridge 1953), from Cornelian and Geilston Bays, from near Lindisfarne and adjacent to the Domain (Mercury 1910), and from as far north as New Town Bay (Fig.7) (Guiler personal communication). The scallops were taken mostly by part-time operators for home consumption or sale to hotels.

Even at this early stage of the fishery, closures were enforced "owing to the serious depletion of the scallop beds in the Derwent by over-dredging" (Commissioners of Fisheries 1908). Investigations into the possible recovery of the scallop beds were conducted by Dr. Noetling and Mr A. Kirk, appointed by the Commissioners of Fisheries. They found virtually no young scallops growing on the western side of the Derwent, though there were reasonable numbers in the centre of the river and on its eastern side. They considered the factors contributing to the poor growth of scallops on the western side to be

Figure 7
Upper Derwent scallop areas
(including Ralphs Bay and Norfolk Bay)



the high incidence of a parasitic protozoan, the increasing silt load in the river, the discharge of sewage and the increase in growth of algae (Mercury 1910). A recommendation in 1910 that the scallop beds be re-opened was overuled by the Commissioners of Fisheries (Commissioners of Fisheries 1910).

In 1911-12 scallop fishing was again allowed, provided that scallops were taken using boats propelled only by oars and that a licence fee of 5 shillings was paid for each dredge used. Thirty two people applied for and were granted licences (Commissioners of Fisheries 1912).

Although a second Royal Commission on Tasmanian Fisheries in 1916 did not make any mention of scallop fishing (Flynn 1916), the Commissioners of Fisheries Report for 1915-16 showed that 20 pounds had been collected by the sale of scallop licences. This indicates considerable fishing effort, if it is assumed that the licence fee per dredge had not markedly increased (Commissioners of Fisheries 1916).

By 1918, however, fishermen reported that upstream beds of scallops had become practically nonexistent. A second investigation was made into the depletion of the scallop beds in the Derwent River, directed by Professor T. Thomson Flynn of the University of Tasmania. Flynn's preliminary report in 1918 indicated that the fishermens' reports were well founded as he could produce only a handful of scallops after intensive dredging over the known scallop beds. He postulated four factors contributing to the decline of the scallop population: increased silt and mud in the river, which either killed the scallops by smothering them or provided suitable conditions for the growth of organisms which attack scallops; increased numbers of parasitic protozoa; increased starfish attacks; and fluctuations in

salinity (Commissioners of Fisheries 1918).

In the Report of the Commissioners of Fisheries in 1919, it was stated that no scallop licences had been purchased, an indication that scallop fishing had virtually ceased in Tasmania. As an appendix to the Commissioners' Report of 1919, Flynn made his second and final report, noting that spatfall had been poor in the Upper Derwent and that no influx of larvae for settlement was occurring from the Gordon beds in the D'Entrecasteaux Channel (see Fig.2). He recommended the restocking of the Upper Derwent beds from fresh supplies brought up from Gordon. Flynn concluded by saying that the disappearance of the scallops from the Upper Derwent had been caused by unusual flooding, resulting in an increased silt load in the river and lethal fluctuations of river salinity (Commissioners of Fisheries 1919). In retrospect, this seems unlikely, as the salinity of the bottom waters of the Derwent changes very little, even during flooding (Guiler personal communication).

The depletion of the Derwent River scallop beds forced fishermen further downstream into Ralph's Bay (for doughboy scallops) and the D'Entrecasteaux Channel (for commercial scallops)(Fairbridge 1953).

3.2 Scallop Fishing in the D'Entrecasteaux Channel

The exact date of the commencement of scallop fishing in the D'Entrecasteaux Channel is not clear, but by 1920 a few fishermen had moved their operation downstream into the northern half of the Channel and into Ralphs' Bay. The Ralph's Bay fishery was short lived, closing in 1926 (Government Notice 113 1926) apparently due to restrictive legislation (Fairbridge 1953) and declining stock (Harrison 1965).

The first figures for the quantities of scallops passing through the Hobart Market were given in the 1923 Commissioners of Fisheries Report. At this time, scalloping was only a small scale industry and when it was suggested that scallops be obtained for export (by H.Jones and Company), the Commissioners of Fisheries stated that unfortunately the present known beds barely supplied the local requirements (Commissioners of Fisheries 1924).

Scallop production figures for 1921-1983 are plotted in Figure 8 and are derived from 5 sources: Commissioners of Fisheries (1923), Fairbridge (1953), Anon (1974), and Tasmanian Fisheries Development Authority (1982a, 1983). No figures are available for 1924-1928.

Boat numbers and the scallop season length for the D'Entrecasteaux Channel for the period 1933-1963 were given by the Sea Fisheries Advisory Board of Tasmania Subcommittee on the Scallop Fishery (1964). These are plotted in Figure 9. This figure also contains information from an unpublished report of the Council for Scientific and Industrial Research, Fisheries Division 1947. In Figure 10, scallop meat weights and price to the fishermen are plotted. This information was also derived from the Sea Fisheries Advisory Board of

Figure 8
Tasmanian scallop production 1921–1983

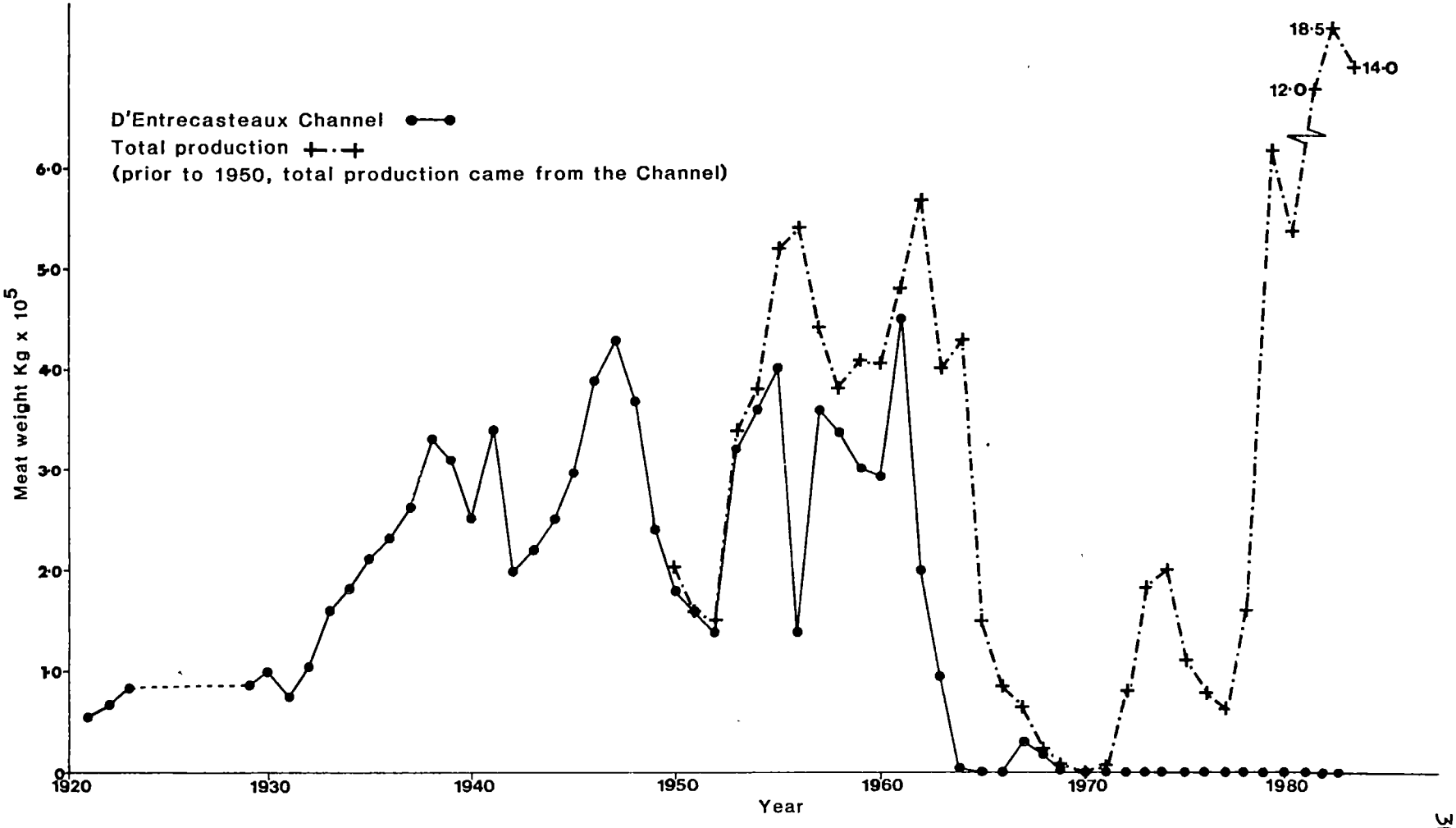


Figure 9

The number of boats and the season length

for the D'Entrecasteaux Channel scallop fishery

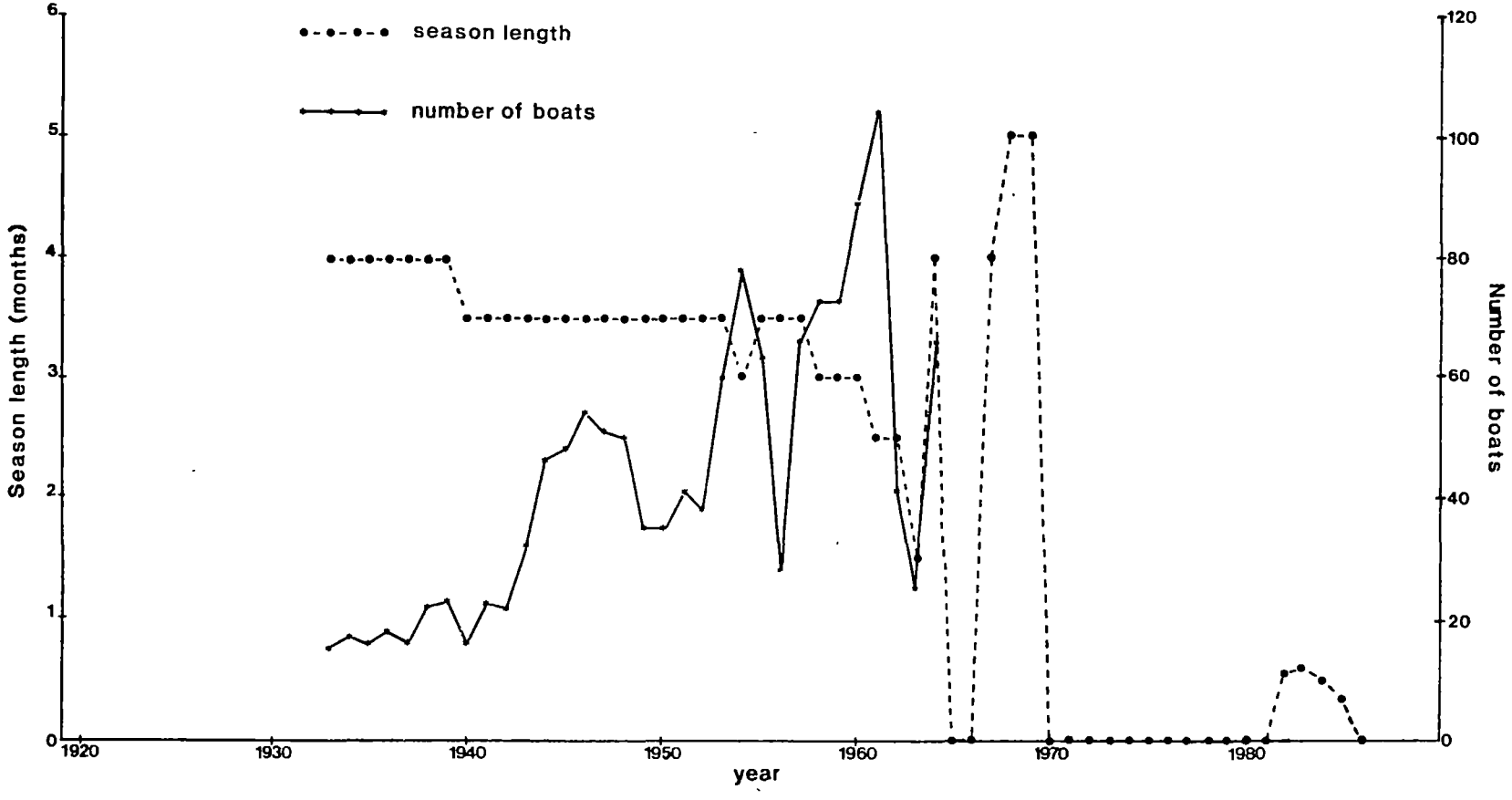
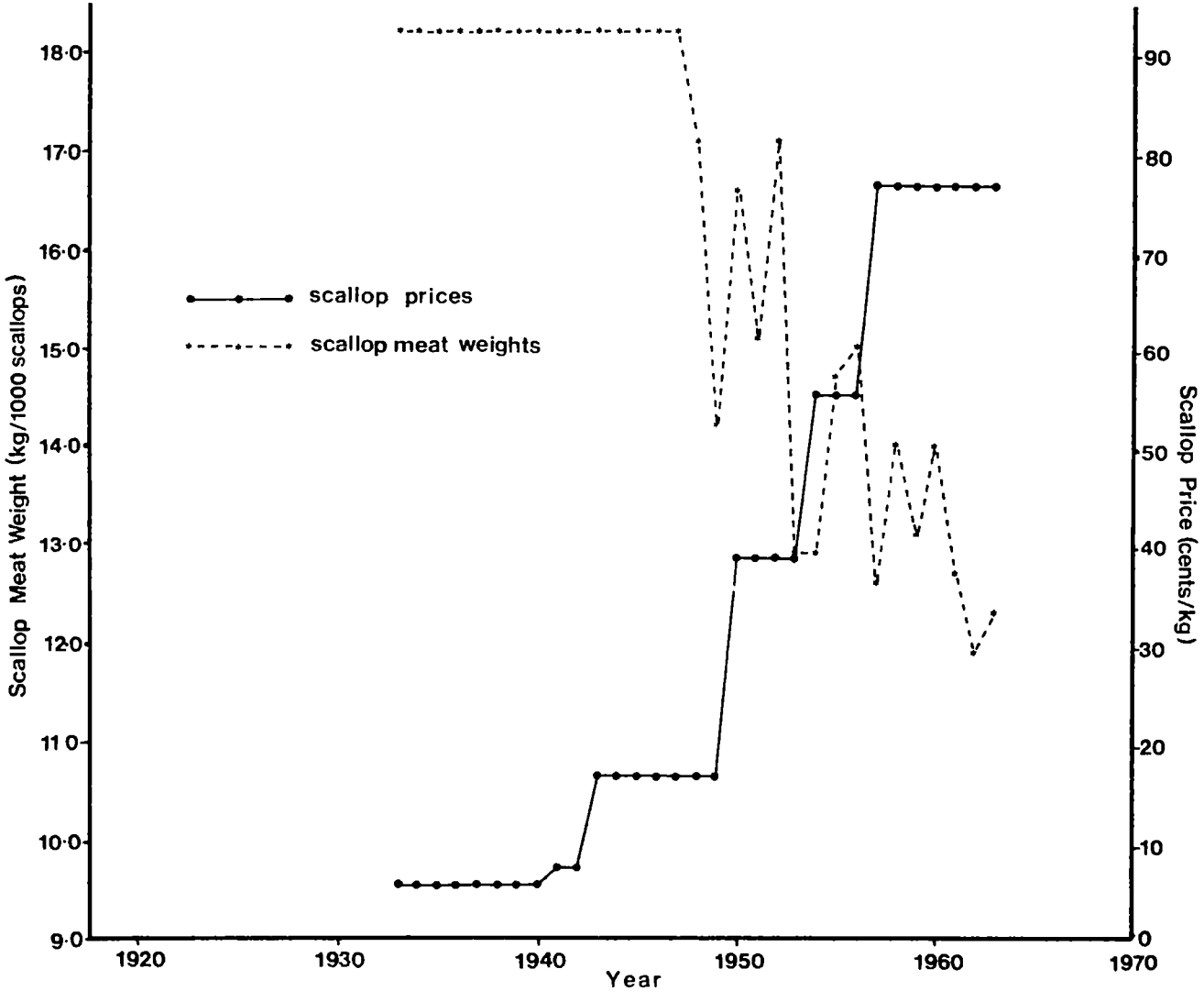


Figure 10
Scallop prices and scallop meat weights for the D'Entrecasteaux Channel
(No figures available after 1963)



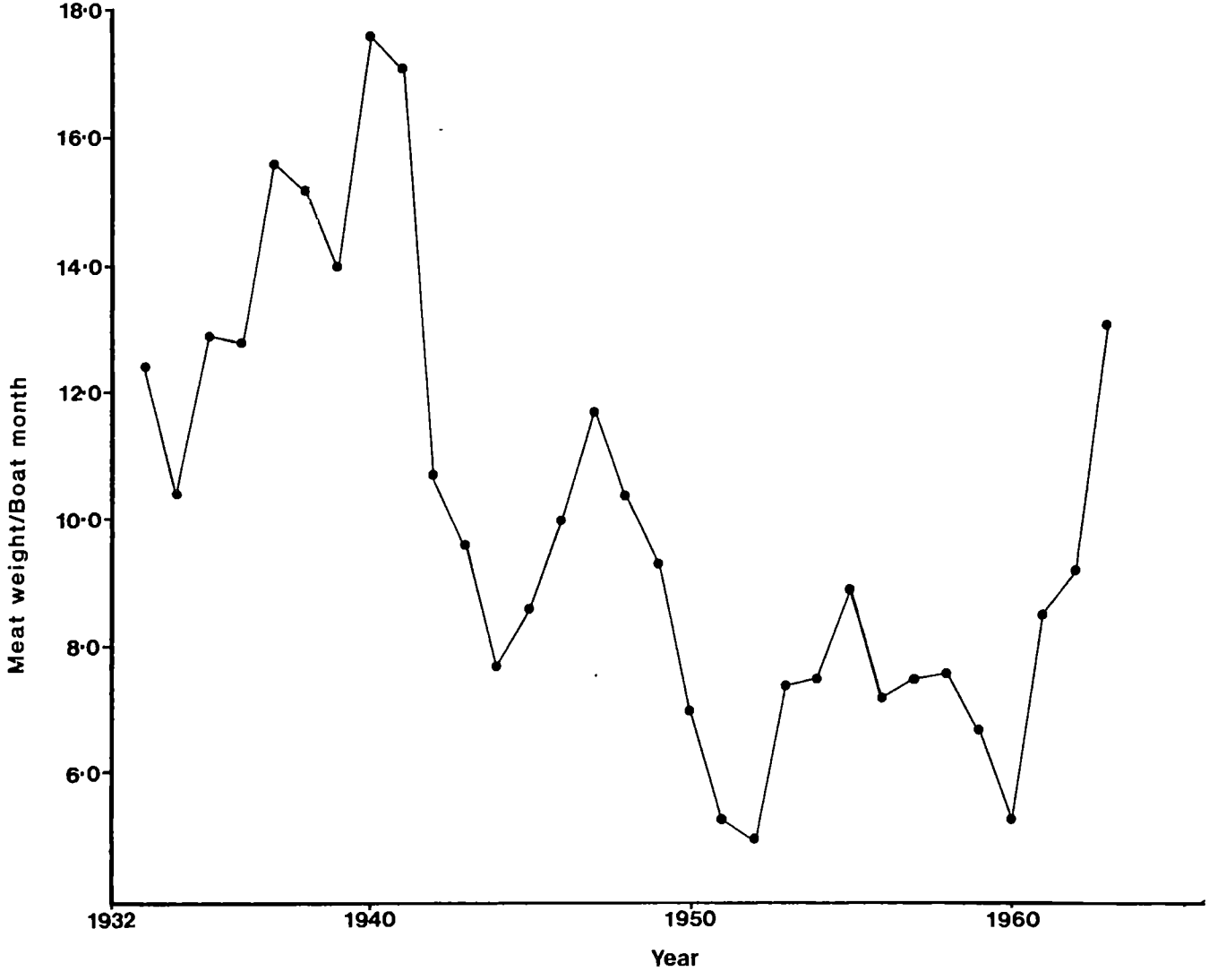
Tasmania Subcommittee on the Scallop Fishery (1964). As a rough approximation of catch per unit effort for the scallop fishery, the number of boats were multiplied by the season length (in months) to derive a boat-month figure for a particular year. The catch for that year was then divided by this figure to give catch per boat-month. This information is plotted in Figure 11.

Information on management measures such as fishery regulations for the period 1925-1941 has been derived from published and unpublished papers (Sea Fisheries Board Tasmania 1930, 1933, 1940, Anon 1947, Fairbridge 1953, Select Committee of the Legislative Council 1961, Harrison 1965) as no Annual Reports of the Sea Fisheries Board to Parliament were published for this period.

Careful conservation of scallop stocks was evident in the 1920's and 1930's. For example, a Committee of the Sea Fisheries Board continually monitored the scallop beds for signs of over-dredging (Sea Fisheries Board Tasmania 1933) and in 1925 over-fishing in the northern parts of the Channel resulted in a two year closure of the scallop beds "in the interest of conservation" (Select Committee of the Legislative Council 1960). In 1930 and 1931 scallop areas 1, 2, and 3 (Fig.2) were closed due to the depletionary effects of fishing (Sea Fisheries Board Tasmania 1930) and the splitting of scallops at sea was prohibited due to the numbers of starfish attracted to the scallop beds by the dead shells (Anon 1947).

Scallop production during the 1930's showed a steady growth rate (Fig.8) despite these restrictions on fishing effort.

Figure 11
Catch per unit effort for the D'Entrecasteaux Channel scallop fishery (No figures available after 1963)



The commercial scallop formed the bulk of the catch in the early 1920's (Fairbridge 1953) but during the late 1920's and 1930's the doughboy scallop became the most important constituent of the catch (Sea Fisheries Board Tasmania 1933). This change in species catch was probably due to the commercial scallop becoming rare in the Channel at this time (Harrison 1965) possibly due to starfish predation (Anon 1947). By 1939, however, 85 percent of scallops being caught were again commercial scallops (Sea Fisheries Board Tasmania 1938, Mercury 1940a)

Total scallop production increased from 153,000 Kg meat weight in 1933 to 327,000 Kg in 1938 (Fig.8) but the number of boats fishing for scallops did not increase rapidly, remaining at about 20 (Fig.9). It seems the rapid rise in catch per unit effort at this time (Fig.11) was due to the introduction of mechanical hauling of dredges replacing the former hand-hauling technique.

In 1934 the legal minimum size for commercial scallops was reduced from 3.5 inches (88mm) at its widest diameter to 3.5 inches at its smallest diameter (Anon 1947), while the doughboy scallop remained at 2.75 inches (69mm) at its smallest diameter as set in 1925 (Fairbridge 1953). In 1935 the width of scallop dredges was limited to four feet (1.3 metres) to protect the scallops from being crushed by the weight of the net being dragged over the bottom (Anon 1947). The meat weight per thousand scallops was stable around 40 pounds (18.2 Kg) per 1000 scallops, an indication that there was no trend towards smaller scallops as would be expected if recruitment overfishing was occurring (Sea Fisheries Advisory Board of Tasmania Subcommittee on the Scallop Fishery 1964)

In 1934 there were complaints to the Attorney General, Mr E.J.

Ogilvie, from the Tasmanian Fishermen, Fishworkers, and Scallop Dredger's Association about the rigid enforcement of scallop size restrictions being applied to fishermen, a further indication of the strict management regime being adhered to at this time (Sea Fisheries Board Tasmania 1935). There were also complaints in this year and again in 1939 of unfresh scallops being sent to the Hobart Market (Sea Fisheries Board Tasmania 1939) and in 1940 a Select Committee of Parliament, set up to investigate the management of Tasmanian fisheries, briefly examined the unfresh scallop claim. It recommended that local health inspectors at the Channel scallop splitting depots should examine the catch prior to despatch to the Hobart Market.

From 1938-1942 there were fluctuations in the scallop catch (Fig.8) and the catch per boat month (Fig.11). The fluctuations indicate that the fishery may have removed much of the accumulated stock of scallops and that fishing was now relying on annual recruitment (Harrison 1965). It is also likely that the catch was adversely affected by enlistments in the Australian Imperial Forces. For example, in 1939 there were 27 boats with 74 men working 52 dredges but in 1940 there were 20 boats with 45 men working 42 dredges (Mercury 1940b).

Concern was expressed about the possible depletion of the scallop beds in the Channel and in September 1944 J.Tubb of the Commonwealth Scientific Industrial Research (C.S.I.R.) Division of Fisheries, began biological and economic investigations into the scallop fishery. The biological investigations included the growth rate of scallops, migration, and the effect of fishing pressure on the scallop stocks (Tubb 1946). Tubb's work concentrated on scallop tagging experiments and he concluded that analysis of tag returns

together with the collection of fisheries catch data, organised by the Tasmanian State Fisheries Division, might form the basis for an assessment of the effects of the fishery on the scallop stocks in the D'Entrecasteaux Channel.

From 1942 to 1947 scallop production increased (Fig.8), as did the number of boats (Fig.9), but the catch per boat month varied (Fig.11). Harrison (1965) suggested the increase in production was due to four factors; an increase in the number of dredges carried by each boat, the change from doughboy to commercial scallop as the major species being caught, the development of the southern areas of the Channel for scallop fishing, and a good spawning of scallops in 1937-1940. Fairbridge (1953) believed the increase in catch from 1942-1947 was partly due to the increase in boat numbers (Fig.9) which resulted from generous treatment of boat owners by the **"authorities controlling manpower and other controls".** Some of the increase in the catch may also have been due to the return of ex-servicemen to the fishery.

From 1947-1952 total scallop production fell (Fig.8). The number of scallop boats during this period also fell, from 51 in 1947 to 38 in 1952 (Fig.9). The scallop meat weights per 1000 scallops began to fall after 1947 (Fig.10). The Sea Fisheries Advisory Board of Tasmania Subcommittee on the Scallop Fishery (1964) contended that in the period 1942-1946 the accumulated stocks of legal size commercial scallops were steadily reduced and after 1947 the size of the catch was dependent on the recruit brood. They cited the decrease in meat weights as possibly indicating the scallop catch was composed of smaller and younger scallops.

Further investigations by officers of the Commonwealth

Scientific Industrial Research Organization (C.S.I.R.O.) showed that scallop stocks were being depleted and a limit of two dredges per boat was enforced in 1949 (Department of Agriculture 1949).

This rapid decrease in scallop production resulted in speculation on the future of the scallop fishery. For example, one author suggested the season in the Channel might close early and that fishermen might be allowed to operate outside the defined scalloping areas, in the hope of locating new beds (Mercury 1950). Concern about the depletion of scallop beds in the Channel led to a transplantation of 90,000 2-3 year old scallops from the east coast (Whayman personal communication) to Area 2 (Fig.2)(Harrison 1965, Department of Agriculture 1953). The slump in Channel scallop production forced fishermen further afield into Norfolk Bay, Coles Bay and other areas on the east coast. The scallop catches from these areas have been combined with the Channel production in Figure 8 to give the the total scallop production for the state.

Research into the collapse of scallop production in the Channel was continued by A.M.Olsen, who used underwater breathing apparatus to study the scallops in situ. He stated that **"the successful spatfall and subsequent development of a strong year class is very sporadic and as yet, unpredictable"** (Olsen 1955). He found that there had been a heavy spatfall in about 1940 and another one in 1948, and it seemed the productive potential of the Channel's scallop stocks fluctuated around the success or otherwise of these spatfalls, if about 6 years for the scallops to enter the fishery is allowed (Sea Fisheries Advisory Board of Tasmania Subcommittee on the Scallop Fishery 1964).

The period 1952-1955 saw a rapid increase in scallop catch, boat numbers, and catch per boat month (Figs.8, 9, and 11) but scallop meat

weights began to decrease (Fig.10). Olsen's findings suggest that the 1948 year class had entered the fishery and was providing the bulk of the catch (Olsen 1955). In 1956 large catches of scallops were taken from Norfolk Bay and the Channel fishery catch dropped sharply, comprising only 27 percent of the total Tasmanian catch (Fig.8). The reasons for the low Channel catch are unknown to the author, but it seems likely that many boats which normally fished in the Channel began exploiting the Norfolk Bay beds. However, the Norfolk Bay beds did not produce many scallops in 1957 and by 1959 the catches there decreased to very low levels (Harrison 1965).

From 1956-1961 scallop catches increased again in the Channel and in 1961 the peak catch of 454,000 Kg meat weight was taken. Boat numbers steadily increased to a record 104 in 1961 but catch per boat month remained low. It seems that the high production level was achieved by increased fishing effort, and the low catch per boat month and decreasing meat returns per 1000 scallops suggests that the Channel scallop stock was being overfished. The season was shortened from 14 weeks in 1956 to 10 weeks in 1961.

One controversial alteration to fishing technique at this time was the introduction in 1958 of an English scallop dredge; the 'Baird' or 'Sputnik' dredge (Section 1.5, Fig.6). A majority of Channel fishermen believed this new dredge destroyed more scallops than the lip dredge (Langford 1959) but because the dredge was more efficient in deeper water and on hard substrata, many Channel fishermen used it (Mercury 1959). In 1958 the Licensed Fishermen's Association submitted a resolution to the Sea Fisheries Advisory Board asking that the dredge be banned from the Channel. This was accepted by the Board (Sea Fisheries Advisory Board of Tasmania 1959), but 'sputniks' were not

banned from the Channel until the 1962 scallop season.

Concern over the scallop industry's future, prompted by the controversy surrounding the 'sputnik' dredge, resulted in the appointment, in 1960, of a Select Committee of the Legislative Council to enquire into the scallop fishery of Tasmania. The Committee received submissions from 45 fishermen and took into account C.S.I.R.O. research on scallop dredge efficiency before concluding that spiked dredges, such as the 'sputnik', caused considerably more damage to the scallops than did the lip dredge. They also concluded that the major damage to scallops inflicted by spiked dredges was from the misuse of the dredge rather than any inherent design fault. The Committee recommended the banning of all spiked dredges from the Channel, subject only to further investigations by the C.S.I.R.O. (Select Committee of the Legislative Council 1961). The Committee also made recommendations on other aspects of the fishery but it seems many of these recommendations were not successfully implemented (Mercury 1961, Perrin and Hay in press).

Harrison (1965) believed the controversy surrounding the 'sputnik' dredge confused the issue of why scallop stocks in the Channel were at such low levels. He believed the decrease in catch per unit effort, the usual indicator of overfishing, was obscured by factors such as the rising price of scallops (Fig.10), the shift in exploitation focus to new beds around the state, and the 'sputnik' dredge controversy.

The Channel scallop catch fell dramatically from 1961-1964. This slump again forced some southern Tasmanian fishermen to look elsewhere for scallops, including Port Phillip Bay in Victoria, which began to be exploited in 1963. The Channel season was shortened to 6 weeks in

1963, the number of boats fell to 25, and the catch declined to 101,000 Kg meat weight.

This slump in the Channel fishery resulted in a subcommittee being appointed by the Sea Fisheries Advisory Board to give advice on the opening date and duration of the 1964 scallop season and on the scallop fishing operation in general. The committee reviewed the history of the Channel fishery, commented on the regulations in force, and recommended that the scallop season in the Channel be open for 6 months, from May 15 to November 15 (Sea Fisheries Advisory Board of Tasmania Subcommittee on the Scallop Fishery 1964). However, the fishery was opened for four months only, from May to August.

The arguments the Committee put forward for a 6 month season are worth examining in the light of later events. The Committee stated that the basis of the 2-3 month season was that scallop flesh weight fluctuated during the year and the season was set to maximize yield per scallop. It argued however, that the season brings little advantage by way of increased harvested meat, contending that weight loss due to year round harvesting would not exceed 27 percent. The Committee then listed the disadvantages of a short season, including the concentration of fishing effort resulting in inefficient use of equipment and labour, little regard for size regulations, and inefficiencies of splitting scallops. It concluded that the limited season made no contribution towards limiting catch or effort, and favoured a management policy which amongst other things placed no restriction on the time of fishing, with the provision that if fishing effort continued to the point where recruitment was endangered then the season should be closed (Sea Fisheries Advisory Board of Tasmania Subcommittee on the Scallop Fishery 1964).

Scallops are recorded as being taken from the Channel during only 3 months in 1964 (May-July) (Department of Agriculture 1965) and it seems they were rare and in poor condition (Mercury 1964).

The season was closed in 1965 and 1966. Scallop sampling undertaken every 3 months in 1965 revealed no signs of recovery of commercial scallop numbers, though doughboy scallops were plentiful in some places (Harrison 1966).

A survey in 1967, undertaken by officers of the Sea Fisheries Division, found that the commercial scallop numbers in the Channel were low but considerable recruitment of doughboy scallops had occurred due to spawning in 1962, 1963, and 1964 (Anon 1967a). The season was opened in 1967, from August to November, due largely to pressure from fishermen, scallop processors and a member of Parliament, Mr S.C.H. Frost (Anon 1967b) and 8 boats took 35,000Kg of scallop meat.

In 1968 the Channel produced 24,000 Kg of scallop meat and in 1969, just 6,800 Kg. The 1969 survey of the Channel showed that doughboy scallops were rare and the only juveniles present were those of queen scallops (Department of Agriculture 1970).

Speculation on the causes of the major collapse (after 1961) included changes in the marine environment brought about by natural processes and industrialisation (Harrison 1975), changes in the hydrological condition of the area which precluded commercial scallop settlement (Anon 1967a), and pollution from insecticide sprays used in orchards (Mercury 1969). It also seems likely that the extra long season of 1964, 1967, 1968, and 1969 (Fig.9), the disguised fall in catch per unit effort (Harrison 1965), and the introduction of the 'sputnik' dredge were contributing factors to this collapse.

For the next twelve years (1970-1981) the Channel scallop fishery was closed in an attempt to rebuild scallop numbers. Annual surveys of the scallop beds continued. The 1970 survey revealed small concentrations of doughboy scallops, while queen and commercial scallops were scarce (Department of Agriculture 1971). This was the pattern for the next 8 years, that is, an annual survey of the Channel beds and a report of few scallops. In 1979 and 1980 no surveys were done but in 1981 a survey revealed quantities of doughboy scallops in Great Bay and Simpsons Bay (Fig.2) . At this stage fishermen pressed for a limited opening of the area and a more comprehensive survey was undertaken to evaluate this possibility. This second survey revealed good settlement of doughboy scallops but commercial scallop numbers were still low. This work resulted in the recommendation that the Channel be closed in 1981 but that another survey be undertaken in 1982 with a view to opening the beds (Harris 1981).

In 1982 a joint government/industry body, the Scallop Industry Liaison Committee, recommended a short open season be allowed in Area 6. The short season that followed has been taken by the author as the commencement of the current fishery (Chapter 4).

3.3 Concluding Remarks

The D'Entrecasteaux Channel scallop fishery, like all scallop fisheries throughout the world, has undergone vast fluctuations in production levels. What began as a part-time industry in the Derwent Estuary expanded to become, at one stage, the third largest scallop producing industry in the world (Anon 1962) but subsequently collapsed. Although this variable production cannot be conclusively

tied to a single cause, it seems the annual variation in spatfall is critical to the fortunes of the fishery.

Attempts to conserve the Channel fishery by controlling effort have been undertaken by Government authorities from the fishery's beginning. By and large much foresight has been shown by the authorities and careful husbanding of the resource is evident at certain times in the Channel fishery's history. However, serious mistakes have occurred, in particular the failure to respond to falling catch per unit effort (Harrison 1965), the introduction of the 'sputnik' dredge, and the extra long scallop seasons of 1964, 1967, 1968,and 1969. These factors are considered largely responsible for the demise of the fishery.

4. THE CURRENT D'ENTRECASTEAUX CHANNEL SCALLOP FISHERY, 1982 ONWARDS

4.1 Survey Results

Table 1 summarizes the survey results from 1981-1986. No surveys were undertaken in 1979 or 1980 (Harris 1981). In 1981 there was considerable pressure from fishermen to open Area 6 (Fig.2) due to the apparent presence of significant quantities of doughboy scallops in the area. The Department of Sea Fisheries contracted a professional fisherman, Mr G.Innes, to undertake a survey of the scallop stocks of the Channel and Mr Innes, together with a Departmental Research officer, has subsequently conducted a similar survey each year. The results of these surveys are collated in Table 1. The 1981 survey was conducted between 12-14 May and showed that while there were large numbers of doughboy scallops in Area 6, most were undersize, and it was recommended that the Channel remain closed to scalloping but that a thorough survey should again be made in 1982 (Harris 1982).

The 1982 survey was limited to Areas 6, 7, and 8 and once again showed the presence of large numbers of doughboy scallops, most of which had reached commercial size. The Scallop Industry Liason Committee recommended that there be a short open season with fishing limited to Area 6 (Harris 1982). This is considered to be the beginning of the current fishery.

The 1983 survey was conducted from 18-20 April and concentrated on Areas 6, 7, and 8. It showed virtually no change in the distribution of scallops but a slight increase in the abundance of doughboy scallops (Table 1). Dredge tows undertaken in other parts of the Channel revealed no significant concentrations of scallops. The

TABLE 1

RESULTS OF D'ENTRECASTEAUX CHANNEL SCALLOP SURVEYS 1981 TO 1986

Numbers in the table represent average catch per 5 minute haul of a 2.4 m mud dredge with teeth. Dashes in the table represent no survey being undertaken. Numbers in left hand column refer to Figure 2 (Scallop Areas).

	DOUGHBOY					
	1981	1982	1983	1984	1985	1986
1	-	-	-	-	-	-
2	-	-	2	-	49	91
3	-	-	-	-	-	60
4	-	-	-	-	1.5	-
5	-	-	0	143	7.6	216
6	545	234	296	291	144	188
7	29	71	91	130	55	99.5
8	256	60	73	44	46	91
9	-	-	2.8	10	55.8	117
9A	-	-	0.3	-	-	-
10	-	-	-	96	124.6	59
11	-	-	10	115	227	45
12	-	-	0.2	4	0.33	1

	COMMERCIAL					
	1981	1982	1983	1984	1985	1986
1	-	-	-	-	-	-
2	-	-	0	-	0.33	1.7
3	-	-	-	-	-	5.0
4	-	-	-	-	1.5	-
5	-	-	0	0.75	3.0	3.7
6	1	1	1	1.3	3.7	10.5
7	3	5	8	4.4	7.2	6.7
8	4	7	6	5.2	3.1	6.1
9	-	-	1.6	1.0	2.9	3.9
9A	-	-	0	-	-	-
10	-	-	-	0	0.5	2.0
11	-	-	0.7	0.6	1.6	7.3
12	-	-	0.8	0.2	3.3	10.8

	QUEEN					
	1981	1982	1983	1984	1985	1986
1	-	-	-	-	-	-
2	-	-	0	-	0	0.7
3	-	-	-	-	-	15
4	-	-	-	-	0	-
5	-	-	0	0	0	0.8
6	-	-		0.8	2.2	2.6
7	-	-		19.1	18.6	15.5
8	-	-		7.4	5.1	8.6
9	-	-	0	0	0.6	5.1
9A	-	-	0	-	-	-
10	-	-	0	7.0	7.2	5.0
11	-	-	0	3.5	7.4	7.9
12	-	-	0	3.6	0	0.1

slight increase in doughboy scallop numbers from the 1982 to the 1983 survey resulted in a recommendation of a longer season of 4-6 weeks for the 1983 season in Area 6 only (Harris 1983).

The 1984 survey was conducted from 9-11 April. Once again doughboy scallop numbers were greatest in Area 6, while commercial and queen scallops were most abundant in Areas 7 and 8. The number of doughboy scallops had not decreased in Area 6, even though there had been two fishing seasons in this Area. No significant concentrations of scallops were found elsewhere in the Channel. The recommendations arising from this survey were that Area 6 be opened again, but Areas 7 and 8 should remain closed to protect the breeding stock of commercial and queen scallops (Smith 1984).

The 1985 survey was conducted from 29 April - 1 May and examined most areas of the Channel. Doughboy scallop numbers in Areas 6 and 7 had decreased markedly. The decrease in Area 6 was attributed to heavy fishing pressure during the 1984 season but no reason could be given for the decrease in Area 7 (Zacharin 1985). As the 1985 survey catch in Area 6 was less than 50 percent of the 1984 survey catch, and as there were many juvenile doughboy and commercial scallops present, it was recommended that Area 6 remain closed during 1985. Instead, Areas 8, 9, 10, and 11 (Fig.2) were opened for a limited season from July 6-15.

The 1986 survey was conducted from 28-30 April. It showed that Areas 5, 6, and 9 had the highest numbers of doughboy scallops, Area 7 had the highest numbers of queen scallops, and commercial scallops were increasing in abundance in a few areas of the Channel. The recommendations from this survey were that Areas 5 and 7 be opened for a 9 day season, if commercial vessel numbers were severely restricted,

and if the licensing arrangements for amateurs were changed, from one licence per boat to one licence per person (Zacharin 1986). However, the 1986 scallop season did not eventuate due to the sudden appearance of a toxic dinoflagellate and the overall desire to rest the scallop beds from fishing pressure (Mercury 1986a).

The surveys have all been undertaken using a 2.4 metre mud dredge, similar in design to the 'sputnik' dredge (Fig.6), thus there is consistency in the data regarding catch per unit effort. Variables such as towing speed and currents will have some effect on the catch but the survey data is sufficient to allow an analysis of trends in scallop abundance and distribution.

4.2 Channel Fishery Statistics, 1982-1985.

Table 2 summarizes the Channel scallop fishery statistics since 1982. The importance of the amateur component of the fishery is readily apparent: in 1984 there were 751 amateur scallop licences issued, about seven times the number of professional licences endorsed for the Channel.

The 1982 D'Entrecasteaux Channel scallop season opened with 160-200 boats fishing on the first day. All 3 species of scallop could be taken, and there was no bag limit except for divers. Most amateur fishermen reported good catches, and some of the professional boats in the fishery were taking up to 30 bags in a 7 hour period (Mercury 1982a). There were complaints from some amateur divers that their bag limit of 200 scallops per day was too low, especially when there was no bag limit for other amateur or professional fishermen (Tasmanian Fisheries Development Authority 1982b). Although fisheries inspectors reported a successful season from an enforcement viewpoint (Tasmanian Fisheries Development Authority 1983), isolated incidents of scallop dumping were alleged, apparently due to excessive catches of scallops (Mercury 1982b).

The scallop season was extended from 16 days in 1982 to 29 days in 1983, due to the encouraging survey results and following discussions with professional and amateur groups.

TABLE 2

D'ENTRECASTEAUX CHANNEL SCALLOP FISHERY STATISTICS 1982 TO 1985

YEAR	SEASON	AREA FISHED	LICENCES ISSUED		DAILY CATCH LIMITS (NUMBERS OF SCALLOPS)		**CATCH (KG MEAT WEIGHT)	**CATCH PER UNIT EFFORT (KG MEAT WEIGHT/ DREDGE HOUR)
			AMATEUR	PROFESSIONAL	AMATEUR	PROFESSIONAL		
1982	July 3-19	6	375	12	None*	None	2 302	30.5
1983	July 2-20	6	667	70	1000	15 000	32 585	14.1
1984	July 7-22	6	751	104	400	8 000	40 451	7.7
1985	July 6-15	8	734 (All areas)	87 (All areas)	400 (All areas)	6 000 (All areas)	663	2.4
"	"	9					1 360	2.6
"	"	10					58	1.9
"	"	11					64	1.3

* In 1982, amateur divers were limited to 200 scallops per day.
** Catch and catch per unit effort are for professional fishermen only.

Prior to the opening of the season, the Minister for Sea Fisheries, Mr Beswick, announced tighter controls on fishing effort, such as the introduction of bag limits, which were designed to discourage the participation of large scallop fishing vessels (Media Release from Minister for Sea Fisheries, R.J. Beswick 20.6.83). Opening day saw about 200 boats fishing in Area 6 (Mercury 1983) for all 3 species of scallop (Anon 1983a). After some 10 days, declining catch rates became obvious to Fisheries Inspectors of the Tasmanian Fisheries Development Authority and forced a recommendation from the Minister for Sea Fisheries that the Channel should close early, on July 20, on the grounds of excessive catches and the desire to leave some scallops for future breeding (Media Release from Minister for Sea Fisheries, I.M. Braid 14.7.83).

The 1984 Channel scallop season saw a further reduction in bag limits for amateurs and professionals, a shorter season, and the banning of the taking of commercial scallops. The opening day saw about 600 boats crowd Simpsons Bay (Area 6), 500 of them with amateur licences (Anon 1984a).

The 1985 season was run for 9 days only with further reductions on bag limits and the banning of onboard shucking and dumping of scallop shells in the Channel (an attempt to keep starfish away from the scallop beds). The opening day again saw 600 boats or more in the Channel but total catch and catch rates were low. Some boats returned without any catch (Anon 1985a). Most fishermen caught less than their daily bag quota and many said the catches were well down on the previous two years (Mercury 1985b). This is surprising when it is remembered that the preseason survey suggested high numbers of doughboy scallops in Area 11 in particular, yet low catch per unit

effort figures indicate that scallops were hard to find.

In April 1986 the Minister for Sea Fisheries, Mr R. Groom, approved arrangements to create a special licence for professional fishermen wishing to fish in the Channel, and in Storm and Norfolk Bays. However, the 1986 Channel fishery did not eventuate. This was due to two major factors: the sudden appearance of a toxic dinoflagellate in parts of the Channel, resulting in some scallops becoming contaminated to dangerous levels (see Section 6.2.2), and a desire on the part of management to rest the scallop beds.

Total catch and catch per unit effort data in Table 2 are for professional fishermen only as catch statistics for amateur fishermen are not kept by the Department of Sea Fisheries. Total scallop catch for the Channel fishery was small in 1982, rapidly expanded in 1983 and 1984 to approach the levels of production in 1967 and 1968 (Fig.8) but collapsed again in 1985. Since 1982 the catch per unit effort for professional fishermen has fallen dramatically, making it economically unviable for many to fish in the Channel (Innes personal communication).

4.3 Discussion

The Channel fishery has seen a marked reduction in season length and bag limits in an attempt to control the rapid increase in fishing effort. Over the period 1982-1985 the season has contracted from 16 days to 9 days, and bag limits for amateurs and professionals have declined from unlimited catch in 1982 to 400 scallops per day for amateurs and 6,000 per day for professional fishermen in 1985 (Table 2).

The Channel scallop beds appear to be suffering from overexploitation with the current fishing pressure. Evidence of this is seen in the total catch and catch per unit effort data in Table 2. The total catch in 1985 was particularly small, and catch per unit effort has decreased consistently since 1982.

Although the number of amateur fishermen has increased significantly, it is not possible to determine the impact of amateur fishermen on scallop stocks . Logically, it appears that the amateur fishing pressure is significant. However, it should be remembered that one professional fisherman catching 6,000 scallops per day is equivalent to 15 amateur fishermen catching 400 scallops per day, and if all licensed fishermen in 1985, both amateur and professional, took their daily catch quota, the professional fishermen would be catching almost twice as many scallops as the amateur fishermen.

Clearly then, there are problems of management and utilization of the Channel scallop resource which need to be examined. These problems are addressed in Chapter 5, which attempts to account for the scallop management and utilization groups who are involved in the Channel fishery.

5. RESOURCE MANAGEMENT AND UTILIZATION

5.1 Resource Management

5.1.1 Introduction

Management of the D'Entrecasteaux Channel scallop fishery is largely the responsibility of the Department of Sea Fisheries, with participation also by the Police Marine Division and the Marine Board of Hobart. The Department of Sea Fisheries conducts annual scallop surveys, issues licences to harvest the resource, liaises with fishermen and conducts a limited research program in the Channel. The Police Marine Division and the Marine Board of Hobart are responsible for enforcing the Sea Fisheries Regulations and the Port of Hobart Regulations respectively.

5.1.2 Department of Sea Fisheries

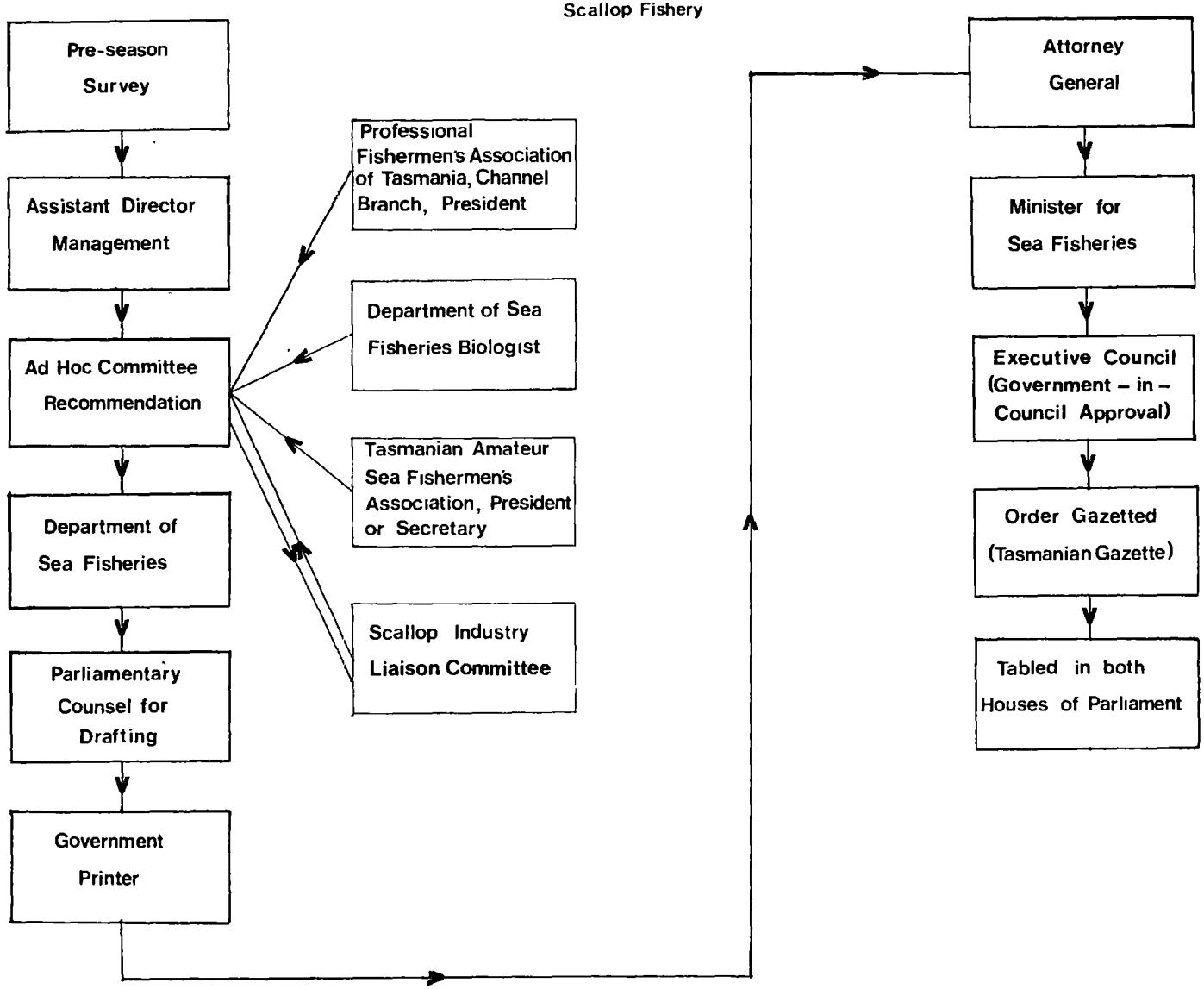
The Department of Sea Fisheries is the latest of a long line of official organizations charged with the overall management of Tasmania's fisheries (Perrin and Hay in press). The management of the D'Entrecasteaux Channel scallop fishery is the responsibility of the Management Division of the Department which receives input from the Research Division, other Government Departments, industry bodies and a special industry/Government committee, the Scallop Industry Liaison Committee. Under normal circumstances the Department undertakes an annual survey of the Channel scallop beds (Section 4.2). Research Division staff on the survey boat collate catch statistics and later

formulate a document which outlines the state of the various scallop areas and recommends a season length and areas to be fished (Harris 1981, 1982, 1983, Smith 1984, Zacharin 1985, 1986).

The decision making process for the opening of the Channel to scalloping is shown in Figure 12. Following the scallop survey the Assistant Director (Management) calls a meeting or contacts individually the President of the Channel Branch of the Professional Fishermen's Association of Tasmania (P.F.A.T.), the President or Secretary of the Tasmanian Amateur Sea Fishermen's Association (T.A.S.F.A), and a biologist from the Department's research laboratories at Taroona. Recommendations on season length, bag limits, licence costs, areas of opening, and participation by amateur and professional fishermen are made at this meeting (Thomson personal communication). The Scallop Industry Liaison Committee is informed of the meeting's recommendations and asked for comment. The recommendations are sent to the Director of Sea Fisheries who, if he is in agreement, forwards them in the form of a Scallop Seasons Order to the Parliamentary Counsel for drafting. The Parliamentary Counsel sends the Draft Scallop Seasons Order to the Government printer. The Order is then certified by the Attorney General, signed by the Minister for Sea Fisheries, and sent to the Executive Council for Government approval. The Order is then gazetted in the Tasmanian Gazette. Finally, the Minister for Sea Fisheries tables the Order in both houses of Parliament.

At present there is no formal written management policy for the D'Entrecasteaux Channel scallop fishery (Thomson personal communication). However, the 1985 Channel survey report suggested that the prime management objectives of the Department of Sea Fisheries

Figure 12
Decision making process for the D'Entrecasteaux Channel Scallop Fishery



concerning the scallop fishery in the D'Entrecasteaux Channel were as follows:

"to build up the populations of commercial scallops throughout the Channel and the protection of juvenile scallops, and to ensure the continuation of a limited annual fishing season for doughboy and queen scallops" (Zacharin 1985).

Research in the D'Entrecasteaux Channel by the Department of Sea Fisheries officers has concentrated on commercial scallop growth rates, reseeding, and aquaculture potential (Chapter 2). A number of scallops have been tagged and released to obtain growth rates and ring formation data for comparison with similar experiments elsewhere in Tasmania. A reseeding trial has recently been carried out in one area of the Channel (results of the experiment are not yet available) and investigations have also been made on spat settlement (Cropp personal communication).

5.1.3 Police Marine Division

Enforcement of the Sea Fisheries Regulations pertaining to scallops is undertaken by officers of the Police Marine Division. Under normal circumstances, the Marine Division maintains a 'watching brief' on the D'Entrecasteaux Channel scallop fishery, that is, surveillance patrols made to the west coast of Tasmania or to southern Bruny Island also inspect the D'Entrecasteaux Channel. About three weeks prior to the opening of the Channel, two boats make patrols of the Channel on a regular basis, and occasional night patrols are also made.

During the scallop season two or three boats are used to patrol the fishery. One boat (of sixteen metres with radar) is used as a mobile base and conducts night patrols (as daylight fishing only is permitted in the Channel), the others (faster runabouts) are used for inspectorial duties.

Checks are made by Marine Division officers on bag limits, gear, licences, and evidence of shucking scallops, and they ensure that all fishing is within the prescribed scallop areas. Marine Division officers also help to collate information on scallop catch rates.

According to the Divisional Inspector (Marine Division of the Police Department) amateur and professional fishermen transgress the regulations at about the same rate (Massie personal communication). Taken overall, the Channel has been free of many enforcement problems, and amateur and professional fishermen have usually cooperated with Police (Tasmanian Fisheries Development Authority 1983, 1984).

5.1.4. Marine Board of Hobart and Navigation and Survey Authority

Professional and amateur fishermen come under the jurisdiction of both the Marine Board of Hobart and the Navigation and Survey Authority with regard to the operations of boats. The enabling Act is the Marine Act 1976 which as amended stipulates many practices with which professional fishermen must comply. In particular, under the Marine (Examination and Certification of Competency) Regulations 1985 they must have a Certificate of Competency to use their boat, under the Marine (Survey and Certification of Survey) Regulations 1985 they must have an annual survey of their boat undertaken by the Navigation and Survey Authority, and under the Marine (Limits of Operation Areas) Regulations 1985 they must comply with regulations relating to areas of operation of their craft.

Marine Board Bylaws, under the Marine Act 1976, cover the activities of pleasure boat operators. The Bylaws state that if a boat has a motor of 4 horsepower or more it shall be registered, and if a boat exceeds 8 knots the operator must possess a speedboat driver's licence.

The Marine Board of Hobart Regulations and Bylaws affecting amateur and professional fishermen are enforced by Marine Board Inspectors. Penalties for transgressions by amateurs may include a fine of up to $200: commercial operators may receive much higher penalties (Collis personal communication).

5.2 Resource Utilization

5.2.1 Amateur Fishermen

Amateur fishermen have emerged as a major component of the D'Entrecasteaux Channel scallop fishery since it reopened in 1982. Prior to the closure of the Channel to scalloping in 1970, little mention was made of amateur fishermen. Since 1982, however, their numbers have swelled, and 751 amateur licences were issued in 1984 (Table 2).

Amateur fishermen, including divers, must obtain a non-commercial licence to fish for scallops in the Channel. The terms of the licence are similar to those for professional fishermen except in the areas of bag limits and licence fees . The equipment and the fishing techniques used by amateurs are similar to those described in Section 2.5 although the dredges used are often not as wide as 1.3 metres.

In the absence of any information on amateur fishermens' attitudes to the current management of the fishery, 10 amateur fishermen (including 2 divers) who fish in the Channel were interviewed by telephone in September 1986. Clearly interviewing 10 amateur fishermen (out of 734 licenced amateur fishermen in 1985) is not representative but does provide a first step towards an evaluation of current management practices. The interview questions pertained mostly to management measures, but socioeconomic factors were also included. These questions are detailed in Table 3 and the results of the survey are shown in Table 4.

Most of the amateur fishermen interviewed had fished the Channel

TABLE 3

Questions for Amateur Fishermen

1. How many years have you been fishing in the Channel?

2. Why do you go fishing?

3. How do you feel about the current size limit on scallops, that is, is it adequate or inadequate?

4. (As above) season length?

5. (As above) bag limits?

6. (As above) dredge type?

7. Should amateur fishermen be licenced per boat or per head?

8. How do you feel about the current fishing hours for scallops, that is, is it adequate or inadequate?

9. (As above) areas of opening?

10. How do you feel about the current level of enforcement by the Police Marine Division/

11. (As above) Marine Board Inspectors?

12. Do you believe fines for transgressions are adequate/inadequate?

13. Do you believe the preseason survey is adequate/inadequate?

14. Do you think amateur fishermen should have an area of their own?

15. (As above) amateur diver areas?

16. What do you believe is the future of the Channel fishery, amateur-only, amateur/professional, or professional-only?

17. Do you have a complaints mechanism to air any grievances you have concerning management?

18. What do you think of the potential for reseeding scallops in the Channel?

19. What do you think of the potential for aquaculture of scallops in the Channel?

TABLE 4

AMATEUR FISHERMEN SURVEY

FISHERMAN	QUESTIONS																		
	1	2*	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1982-85	A	OK	OK (but)	OK (but)	OK	NO	OK	OK	OK	NO	OK (but	OK	YES	NO	Am. (but)	YES	GOOD	N.C.
2	1983-85	A,B	OK (but)	NO	OK	OK (but)	NO	OK	NO	NO	NO	OK	OK (but)	YES	YES	Am.	YES	GOOD	N.C.
3	1982-85	A,B	OK	OK	OK	NO	NO	OK	OK	NO	NO	OK	NO	NO	YES	Am. (but)	NO	N.C.	GOOD
4	1982-84	A,B	OK	OK (but)	NO	OK	NO	OK	OK (but)	OK	NO	NO	NO	YES	YES	Am./Prof.	NO	GOOD	N.C.
5	1982-84	A,D,E	OK	NO	OK	OK	NO	OK	OK	OK	NO	OK (but)	NO	YES	NO	Am.	NO	GOOD	N.C.
6	1982-85	A,B	OK	NO	OK	OK	OK	OK	NO	OK	NO	NO	OK (but)	YES	YES	Am.	YES	GOOD	NO
7	1982-83((Am.) 1984 (Prof.)	A,C	OK	NO	OK	NO	OK	OK	OK	OK	NO	OK (but)	OK (but)	NO	YES	Am /Prof	NO	GOOD	GOOD
8	1982-85	B,C	OK	OK	OK	NO	NO	OK	OK	OK	NO	OK (but)	OK	YES	YES	Am. (but)	YES	GOOD	GOOD
9	1982-85	A,C	OK	OK	OK	OK	NO	OK	OK (but)	NO	NO	OK	NO	YES	NO	Am.	YES	GOOD	N.C.
10	1982-85	A,B	OK (but)	NO	OK (but)	OK (but)	NO	OK	OK	NO	NO	NO	OK (but)	YES	YES	Am. (but)	YES	MAYBE	NO

*A. Enjoyment/relaxation
B. Food source
C. Economics
D. Something different
E. Safety, proximity
N.C. No comment

scallop beds every year since 1982. The reasons given for going fishing included enjoyment, relaxation and the taking of scallops for food. One fisherman said he fished in the Channel because it was a safe and sheltered waterway, close to Hobart. Most fishermen found the costliest part of scalloping to be the initial furnishing of their boats with dredges, winches and other fishing gear, while the purchase of fuel for engines was the dearest maintenance cost. A number of fishermen mentioned a cost of $40-$60 for a weekend's scalloping, but this figure does not reflect capital costs, nor other maintenance costs.

Attitudes to the various fisheries regulations were sought and a number of trends emerged. The regulation governing the legal size for scallops (70mm for doughboy scallops and 90mm for queen scallops) was endorsed by all fishermen (the taking of commercial scallops from the Channel was banned in 1984). In the case of doughboy scallops, fishermen believed that if they were smaller than 70mm they would be difficult to split and possibly not have a chance to spawn. If the legal size for both species of scallop was increased, there existed the potential for resource wastage. There were differing views on season length: five fishermen thought the season length to date had been adequate; two fishermen thought the season too short; and one fisherman thought it was too long. Two fishermen thought it should be earlier, well before scallops are ready to spawn.

The bag limit for amateurs (400 scallops per person in 1985) was considered adequate by all but one fisherman, who felt it was too generous and resulted in the wastage of scallops by some people who could not be bothered splitting them. The use of the lip dredge was seen by most fishermen as being adequate but the two amateur divers

believed the dredge was causing serious harm to the Channel environment. One fisherman wanted to see more research done on the design and catching efficiency of different dredges, and another thought the dredges should be smaller for reasons of operator safety.

The current licensing of amateurs allows the licence holder to either dive or dredge for 400 scallops per day. Some concern was expressed that boats had often been overloaded with people putting the boat in danger of capsizing. All amateurs believed the hours for taking scallops (7 a.m.- 5 p.m.) were adequate, many expressing the view that from the safety and enforcement viewpoints it would be impractical to fish outside these hours. Eight of the ten fishermen thought the area system of opening the Channel was adequate. One of the objectors thought the areas were ill-defined and thus difficult to comply with, while the other questioned the validity of the area system because of the poor season in the areas opened in 1985.

When fishermen were asked whether they believed Sea Fisheries Regulations were adequately enforced, the majority thought they were. Those that disagreed thought enforcement levels could be higher and perhaps better deployed, for example by the checking of catches and equipment at boat ramps. All but one fisherman believed the level of enforcement by the Marine Board Inspectors to be inadequate. The usual comment was that the Inspectors were rarely seen during the scallop season and their enforcement levels could be increased.

Under the Fisheries (Scallop Seasons) Order 1986 Number 88, fines for transgressions of Sea Fisheries Regulations are as follows: $40-$1000 for the first offence, $100-$1500 for the second offence, and $200-$2000 for the third and subsequent offences. There is also a special fine of 50 cents per scallop under legal size. The fishermen

were asked if they thought the fines adequate. Most thought they were not: several felt the fines would be adequate if magistrates imposed the severest penalties possible, but indicated that this seldom occurs; some believed the fines were too lenient and did not act as a suitable deterrent; one thought the fines were too severe. Since these interviews were conducted the Tasmanian Cabinet has agreed to amend the Fisheries Act of 1959 to provide for jail terms of up to two years for multiple offenders (Mercury 1986b).

Some fishermen thought the preseason surveys were adequate but others felt they were not, particularly in 1984 and 1985 when poor catches of scallops were taken (Table 1). One fisherman believed the surveys should be undertaken using underwater television systems, while another objected to the use of the modified 'sputnik' dredge onboard the survey boat, stating that it gave unrealistic returns as everyone in the fishery is restricted to a lip dredge. A number of fishermen believed the survey results were not sufficiently publicised, resulting in unrealistic expectations of good catch returns.

Fishermen were questioned on the desirability of establishing amateur-only areas and diver-only areas. Nearly all fishermen agreed on the establishment of amateur-only areas, saying that the Channel fishery could not sustain a continuing professional fishery, and that professional boats endangered smaller boats when fishing in close proximity. Two people dissented: one believed amateurs should not be confined to one area, and the other believed the system would make no overall improvement to management. Seven out of the ten fishermen agreed with the idea of establishing a divers-only area on the grounds of safety. It was also felt that divers did less environmental damage

and a divers-only area would protect that part of the Channel environment from the ravages of dredging. Of those who disagreed, one believed divers should carry larger diving flags to announce their presence, and another believed accidents were unlikely to occur if the current fishing practices were continued.

Fishermen were presented with three possible future Channel fishery scenarios, an amateur-only fishery, an amateur/professional fishery, and a professional-only fishery, and were asked to choose which they thought should eventuate. Eight fishermen thought it should be an amateur-only fishery in the future and two thought it should be an amateur/professional fishery. Of those who thought it should be an amateur-only fishery, two fishermen qualified their remarks by saying that the fishery should be an amateur-only fishery while it was in its present depleted state but that if an increase in scallop stocks became evident then a limited professional fishery should be re-established under strict management guidelines. One problem raised was that of the small professional boat with a history of Channel fishing which may be unsuitable for fishing in the open waters of the State.

The majority of the fishermen believed they had a place to voice their opinion on the management measures currently employed in the Channel fishery: the Tasmanian Amateur Sea Fishermen's Association (T.A.S.F.A.). Two fishermen appeared to be unaware of the T.A.S.F.A., while one (a diver) didn't feel he had a place to have his say. When questioned on the importance of scallop reseeding the majority thought reseeding held much potential to boost the Channel's scallop production, although one fishermen questioned its economic viability. On the question of scallop aquaculture many responded that they didn't

know enough about it. One fisherman thought the influence of pollution and the slow growth rates of scallops in the Channel were two important factors working against the success of aquaculture. Three fishermen believed aquaculture has the potential to rejuvenate the Channel fishery and to lengthen the scallop season, if it is done with strict management measures.

In summary, the survey of amateur fishermen showed that most fishermen go scalloping for enjoyment, relaxation and to take scallops for food. Overall, the survey revealed that fishermen believe the D'Entrecasteaux Channel scallop fishery is being managed adequately, but that a number of areas of controversey exist. These areas can be broken into three major groups; regulations, enforcement, and stock assessment. Most of those interviewed could not agree about the adequacy of the Sea Fisheries Regulations concerning season length and dredge type. In the enforcement area, dissatisfaction with current arrangements was expressed particularly with regard to Marine Board Inspectorial work, and to a lesser extent with regard to the Police Marine Division officers. Fines for transgressions were also seen by many fishermen to be inadequate. Finally, the preseason survey was criticised, particularly for its lack of publicity, but also because of the use of scalloping gear which gives a false impression of catch returns.

The problems raised by this survey of amateur fishermen will be examined fully in Chapter 6.

5.2.2 Professional Fishermen

There are two categories of professional fishermen who work in the D'Entrecasteaux Channel scallop fishery: professional dredgers and professional divers. Nine professional dredgers and one professional diver, who have worked in at least one of the Channel scallop seasons since 1982, were interviewed by telephone during September 1986. The questions related to their attitudes towards the current management of the D'Entrecasteaux Channel scallop fishery and are detailed in Table 5. A summary of their answers is given in Table 6.

Questions were asked on the suitability of the current Sea Fisheries Regulations, enforcement, and fines, the annual surveys by the Department of Sea Fisheries, the future of the Channel scallop fis hery and the formal mechanism by which professional fishermen could put their views with regard to the management of the resource.

The legal size for taking scallops was seen as adequate by all but one fisherman. He believed the size limit for doughboy scallops was too small, resulting in problems for scallop splitters, who find them hard to handle, and thought if the size limit was increased the yield per scallop would improve. The majority of fishermen thought the season length was adequate, but three fishermen believed that the short season made fishing only marginally viable for them. One fisherman believed the season was too late in the year, occurring when scallops were about to spawn.

The daily limit for professional fishermen has contracted from no limit at all in 1982 to a total of 6,000 scallops (approximately 15 bags) in 1985. Most fishermen believed this limit was adequate and helped to control fishing effort.

TABLE 5

Questions for Professional Fishermen

1. How many years have you been fishing in the Channel?

2. How do you feel about the current size limits on scallops, that is, are they adequate/inadequate?

3. (As above) season length?

4. (As above) bag limits?

5. (As above) dredge type?

6. (As above) licence cost?

7. (As above) areas of opening?

8. (As above) hours of opening?

9. How do you feel about the current level of enforcement by the Police Marine Division?

10. Do you believe fines for transgressions are adequate/inadequate?

11. Do you believe the preseason survey is adequate/inadequate?

12. Do you think amateur fishermen and divers should have their own areas?

13. What is the future of the Channel fishery, professional-only, professional/amateur, or amateur-only?

14. Do you have a complaints mechanism to air any grievances you have concerning management?

15. What do you think of the potential for reseeding scallops in the Channel?

16. What do you think of the potential for aquaculture in the Channel?

TABLE 6

PROFESSIONAL FISHERMEN SURVEY

FISHERMAN	QUESTIONS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1982,83	OK	NO	OK	OK	OK	OK (but)	OK	OK (but)	OK (but)	OK	YES (but)	PROF/AM	PFAT + DIRECT	GOOD	GOOD (but)
2	1984,85	OK	OK	OK (but)	NO	OK	NO	OK	OK	NO	OK (but)	YES	PROF/AM	PFAT	GOOD	GOOD
3	1982-85	OK	N.C.	OK	NO	OK	OK	OK	OK	OK	OK	YES (but)	AM	DIRECT TO SEA FISH.	GOOD	GOOD
4	1982-85	OK	OK	OK (but)	OK	OK (but)	NO	OK	OK (but)	OK	NO	YES (but)	PROF/AM	PFAT	GOOD	GOOD
5	1983-85	OK	OK	OK (but)	OK	OK (but)	OK	OK	OK	OK (but)	OK (but)	YES (but)	PROF/AM	PFAT	GOOD	MAYBE
6	1983-85	OK	NO	OK	OK (but)	OK	NO	OK	OK	OK	OK	NO	PROF	PFAT	NO	NO COMMENT
7	1982-85	NO	OK (but)	OK	OK (but)	OK	OK (but)	OK	OK (but)	NO	OK	NO	PROF/AM	PFAT/DIRECT	GOOD	GOOD
8	1982-85	OK	NO	OK	OK	NO	NO	OK	OK	OK	NO	NO	PROF/AM	PFAT	GOOD	GOOD
9	982-85	OK	OK	OK	NO	OK	OK	OK	OK	OK	OK	NO	PROF/AM	PFAT + DIRECT	GOOD	GOOD (but)
10	1984	OK	NO	NO	NO	OK	OK	OK	OK	OK (but)	OK (but)	YES	PROF/AM (but)	NO	GOOD	GOOD

Complaints from two fishermen centred on the unreasonableness of the bag limits in 1984 and 1985, in the light of catch returns for these years. The professional diver felt the bag limits were too low for his operation to be economically viable.

The majority of fishermen saw the lip dredge as an adequate method of harvesting scallops but three fishermen felt it could be improved by research and development studies. The professional diver believed dredging wrecked the scallop beds and therefore should be banned. The cost of a licence to fish in the Channel ($25 in 1985) was seen to be adequate by all but one fisherman, who believed the cost was too small in view of the costs of management and enforcement.

The majority of fishermen felt the area system of opening and closing scallop beds was satisfactory but four fishermen objected, the major criticism being that resource wastage could occur if beds were ready for harvesting in several areas, but only one or two areas were opened. The hours of fishing, 7a.m.- 5p.m., were seen by all fishermen to be adequate.

Enforcement by the Police Marine Division was fully endorsed by all the professional fishermen interviewed, but two qualified their remarks by saying enforcement was adequate considering the level of manpower available, and one thought night patrols should be run prior to and just after the Channel scallop season. Fines were generally seen as adequate but two fishermen thought they should be more severe if they were to be an effective deterrent. One fisherman thought that delays between the time the offence took place and the subsequent court appearance were counter productive.

When questioned on the adequacy of the pre-season survey, seven fishermen thought it was sufficient, but two fishermen thought the use

of a 'sputnik' dredge on the survey boat gave a false indication of catch per unit effort and hence false expectations, while another thought the survey results could be more widely publicised.

The suggestion that a separate amateur fishery and/or diver area should be established was agreed to by seven of the ten fishermen, some provisionally, but three objected. The provisions were that the amateur activities should be carefully controlled and scallop stocks monitored for overexploitation due to divers. The three objectors thought that conflict between amateurs and professionals might arise if separate areas were granted. When the fishermen were presented with three options for the future of the Channel fishery, that is an amateur-only fishery, an amateur/professional fishery, or a professional-only fishery, eight chose the amateur/professional option, one the professional-only, and one the amateur-only. In support of the professional-only and amateur/professional fishery options, some believed they had a right to the scallop resource, others thought an amateur-only fishery might be 'locking up' the resource, and one fisherman thought there would be insufficient income derived from an amateur-only fishery to manage the scallop stocks.

When asked if they had a formal mechanism to have their say in the management process, most cited the Professional Fishermen's Association of Tasmania (P.F.A.T.) or said that direct representations to the Department of Sea Fisheries were possible. Only one fisherman, the professional diver, felt he didn't have a formal mechanism through which to air grievances.

Re-seeding and aquaculture were generally seen as positive steps for the successful long-term management of the Channel scallop fishery. Only one fisherman was pessimistic about re-seeding as he had

seen earlier attempts to re-seed areas in the Channel fail, and believed this could happen again.

The results of the survey show that taken overall, current management measures in force for the D'Entrecasteaux Channel scallop fishery are viewed favourably by the majority of professional fishermen. There was a similar attitude shown by professionals and amateurs to many of the regulations. For example, the legal size for the taking of doughboy scallops and queen scallops, the bag limit, the area system of opening and closing the Channel, and the permitted hours of fishing were generally endorsed by both groups. The professional fishermen surveyed had a high regard for the enforcement of the Sea Fisheries regulations, and endorsed more strongly than amateur fishermen the current fines for transgressions.

Not surprisingly, most of the professional fishermen did not want to see the Channel scallop fishery become an amateur-only fishery: most would prefer to see an amateur/professional fishery. The attitude of the professional fishermen to aquaculture and re-seeding was similar to that of the amateur fishermen in that they were generally positive about the benefits of both activities to the future of the D'Entrecasteaux Channel scallop fishery.

5.2.3 Scallop Processors

Although the D'Entrecasteaux Channel scallop fishery has not produced vast commercial quantities of scallops compared with the rest of the state since reopening in 1982, it is worth examining the processing sector of the fishery, particularly as it affects the size of the professional fishing fleet and influences resource utilization

rates. SAFCOL Pty. Ltd. at Margate takes the largest amount of scallops for processing from the Channel, while smaller amounts are processed at Tasmanian Marine Products Pty. Ltd., W.B. Industry Supply Pty. Ltd., and Tas Crays Pty. Ltd..

The scallops processed from the Channel since 1982 have been almost exclusively doughboy scallops. These present problems for processors, particularly as they are more difficult to split than commercial scallops. Splitters (people who split the scallops) are paid piecemeal rates depending on the numbers of adductor muscles and gonads per kilogram. The rates are higher for doughboy scallops and this offsets the greater difficulty in splitting them. Experienced doughboy splitters are rare (King personal communication).

Processing of scallops for an export market follows a general pattern. After unloading and trucking of the scallops to the processor, each boat's catch is marked so that it can be processed separately. Scallops are split, washed, and packed into a ten kilogram carton comprising four layers of 2.5 Kg each, and frozen. The cartons are usually slightly overpacked by an amount depending on their freshness on arrival so that on thawing they are still 10 Kg. Department of Primary Industry (D.P.I.) officers inspect them prior to export for faults such as incorrect weight (since scallops lose weight on thawing), damage to scallop meats (this must not exceed 5 percent of the total weight), fragments of shell amongst the meats, and attached viscera to the scallop meats and gonad (Collins personal communication).

Processing of scallops for the domestic market is similar, except that the overpacking of scallops is not as great, perhaps only 10.3-10.5 Kg for a 10 Kg carton (McKenna personal communication).

Scallop processors are faced with an array of Acts and Regulations with which they must comply. At the local council level, shellfish sheds need to be registered annually, as an Offensive Trade under the Local Government Act 1962, and as a Shellfish Shed under the Public Health (Food Hygiene) Regulations 1977, and the proprietor must also be licenced under the latter regulations to conduct the business therein. The scallop splitting sheds must also conform to the Public Health (Food Hygiene) Regulations 1977 as they pertain to the useage of shellfish sheds.

At the State Government level, scallop processors must be registered with the Department of Sea Fisheries and licenced by the Director of Environmental Control as a Scheduled Premise if they produce more than 100 tonnes of products per year. In so far as the Department of Environment is concerned the enabling legislation is the Environment Protection Act 1973 and the regulations contained within the Environment Protection (Water Pollution) Regulations 1974 and the Environment Protection (Waste Disposal) Regulations.

If processors wish to export scallops they must comply with the guidelines of the Department of Primary Industry as a Registered Export Establishment. The Department of Primary Industry officers operate under the Export Control Act 1982, the Export Control (Orders) Regulations, the Prescribed Goods (General) Orders 1985, and the Fish Orders Number 7 1985 Schedule 3 Part 8.

The scallop processors are represented on the Scallop Industry Liaison Committee, which reviews recommendations made on the Channel fishery before management decisions are reached.

6. PRESENT MANAGEMENT PROBLEMS

6.1 Introduction

Management of a living marine resource which has a variable fecundity, high palatability, and is within easy reach of amateur and commercial fishermen, is not an easy task. This is the situation faced by the managers of the D'Entrecasteaux Channel scallop fishery. As has been shown in the first five chapters there are a number of problems which are inherent to the Channel scallop fishery and these problems are discussed in this chapter.

6.2 Biological Problems

6.2.1 Variable Spatfall and Recruitment

Perhaps the single most important factor with which scallop managers must contend is the variability of the annual recruitment of scallops to the fishery. This variability in spatfall and consequent fluctuation in scallop production has been reported from scallop fisheries in Australia and throughout the world (e.g. Serchuk et al 1979, Franklin et al 1980, Gwyther and Sause 1985). Olsen (1955) considered its importance for the scallop fishery of the D'Entrecasteaux Channel, and found that the Channel fishery depended on occasional heavy spat settlement, which might sustain the fishery for up to nine years. He speculated that the successful settlement of spat was dependent on a delicate balance of environmental variables.

Others have proposed specific biological and physical variables as the controlling factors in scallop settlement. Among these are food availability (Franklin et al 1980), water temperature (Dow 1962 in Serchuk and Rak 1983) wind, current, and rainfall (Campbell 1984), and surface damage to scallop beds (Young personal communication).

Attempts have been made to minimize the adverse effects which variable spatfall and recruitment have on scallop fisheries. The management of many scallop fisheries relies heavily on data gained from preseason spat collection programs and/or dive surveys over scallop beds, such as in the Port Phillip Bay scallop fishery (Gwyther and Sause 1985) and the United Kingdom scallop fishery (Franklin et al 1980). Preseason dredge surveys over scallop beds are also undertaken in the U.S.A. and Canada (Serchuk et al 1979), similar to those made in the D'Entrecasteaux Channel (Section 4.2).

In Japan the routine collection of wild scallop spat for reseeding or aquaculture has resulted in a ten-fold increase in the total scallop catch, and according to Miller et al (in Campbell 1984) in the U.S.A. and France it has increased production and helped stabilize the scallop industries. In Golden Bay (New Zealand) reseeded areas are now increasing the availability of scallops for fishermen and consumers (Anon 1986b).

In Tasmania spat forecasting has been tried but proved unsuccessful (Section 2.4). Recent success with the production of hatchery reared scallop spat (Anon 1986a) suggests that improvements in total catch and an increasing degree of industry stability (via scallop aquaculture and reseeding) may be feasible in the D'Entrecasteaux Channel scallop fishery in the near future.

6.2.2 Toxic Dinoflagellates

Dinoflagellates are planktonic unicellular algae and are part of the food chain for many marine organisms. Some dinoflagellate species produce potent neurological toxins, and these may be accumulated in filter feeding organisms such as oysters, mussels, and scallops, posing a threat to humans who eat these molluscs. Of the 1500 or so known dinoflagellates, only 20 produce paralytic poisons (Hallegraeff and Sumner in press) but problems with these toxic dinoflagellates are world wide (Yentsch 1984).

In 1986 there was no Channel scallop season, partially due to the presence of high numbers (a "bloom") of the toxic dinoflagellate Gymnodinium catenatum Graham (Fig.13) in various parts of the Channel, and high levels of toxins in oysters, mussels, and scallops from these areas. This discovery resulted in the temporary closure of 14 aquaculture farms growing oysters and mussels in the Port Cygnet and lower Huon River area (Hallegraeff and Sumner in press).

A monitoring program was instigated to test for the dinoflagellates in the water column and toxins in the shellfish. Samples of scallops from the D'Entrecasteaux Channel were tested at the Institute of Medical and Veterinary Science in Adelaide and found to contain high toxin concentrations in the flesh and gonad, and low concentrations in the adductor muscle (Department of Sea Fisheries 1986).

The causes of the high populations of Gymnodinium catenatum were investigated by scientists from the Department of Sea Fisheries and C.S.I.R.O.. Dr G. Hallegraeff, research scientist with C.S.I.R.O., believes the bloom was caused by the heavy summer rains in 1986, which

Figure 13

Chains of the toxic dinoflagellate Gymnodinium catenatum Graham X 170 (Photograph courtesy of Dr. G. Hallegraeff, C.S.I.R.O.)

lowered salinities in inshore regions (which apparently favours some dinoflagellates), increased organic and inorganic runoff from agricultural land, and stabilized the water column due to freshwater inflows (Mercury 1986c, Hallegraeff and Sumner in press).

The importance of this dinoflagellate bloom in 1986 to the viability of the D'Entrecasteaux Channel scallop fishery cannot be overstated. The major question facing scallop managers at this stage is will these events prove to be an isolated incident or can these blooms be expected each year? It should be remembered that prior to a 1985-1986 C.S.I.R.O. plankton survey of Tasmanian waters (which

included the D'Entrecasteaux Channel), no work had been published on Channel phytoplankton. It is thus possible that Gymnodinium catenatum has been present each year with little apparent health risk. The answer to this question will not be known until a number of seasons have been monitored.

6.2.3 Changes in Species Abundance

There have been a number of changes in the relative abundance of scallop species taken in the D'Entrecasteaux Channel. In the 1920's and in the period 1940 to 1970 commercial scallops formed the bulk of the catch, but in the 1930's and since 1982 doughboy scallops have been more abundant.

The causes of the changes in species abundance are not known, but as far as the Channel is concerned, management policy needs to encompass all three species of scallop present, and research on scallop reseeding should be expanded to include the doughboy scallop, particularly if it is found that there has been some environmental change in the Channel which favours this species.

6.2.4 Pollution

Pollution by human waste such as agricultural runoff, sewage, and industrial effluents have been suggested as one of the causes of the declining scallop populations in the Derwent River and D'Entrecasteaux Channel (Mercury 1910, Harrison 1975, Mercury 1969). Although this is difficult to quantify due to the paucity of data, scallop sensitivity to pollution is great and is demonstrated by the

fact the United States Environmental Protection Agency now uses scallops as indicators of changing environmental conditions, such as eutrophication and siltation (Robert 1978).

With only a few exceptions (e.g. Newell 1969) there is a lack of data on pollution levels in the Channel. However, it seems reasonable that the increasing urbanization of the Channel environment might lead to increasing pollution levels, with consequent adverse affects on scallop stocks. Clearly more research needs to be done in this area.

6.3 Administrative Problems

6.3.1 Lack of a Management Policy

Carefully planned management of the D'Entrecasteaux Channel scallop fishery is essential if problems such as the overexploitation of scallop stocks, overcapitalization, and poor catches, all of which have occurred in the past, are to be avoided in the future.

At present there is no comprehensive management policy for the Channel fishery (Harrison personal communication, Thomson personal communication). Zacharin's survey report of 1985 contains three lines on management aims and objectives (Zacharin 1985). This apparently represents the sum total of written management aims and objectives for the Channel fishery.

6.3.2 Excessive Fishing Effort

Together with the variable recruitment of scallops, excessive fishing effort is considered here to be the most important problem facing managers of the Channel scallop fishery. It has been found that when common resources, such as scallops, are being utilized there is a tendency for the resources to become depleted (Hardin 1968). This is due to each individual who exploits the resource perceiving profits and increasing capital investment to maximize his share of the resource. This leads to overexploitation of the resource and overcapitalization, resulting in a depletion of the resource and poorer returns for utilizers (Crutchfield 1982).

The major problem arising from overuse of the resource is the

effect on the spawning stock level. There is evidence to suggest that scallop stocks in the Channel fluctuate independently of the parental spawning stocks (Sea Fisheries Advisory Board of Tasmania Subcommittee on the Scallop Fishery 1964, Olsen 1955) but that there may exist a critical population level below which recovery of a decimated population may not occur (Harrison 1965). Whatever the true case may be, it seems desirable to know the size of an adult spawning stock that is sufficient to ensure adequate recruitment (McKenzie et al 1978).

6.3.3 Dredge Damage to Scallop Beds

Recent work undertaken by the C.S.I.R.O. on dredge induced scallop shell breakage in Banks Strait has shown that at the end of a two week scallop season, over 50 percent of scallops caught in a survey were "recently killed", that is they still had viscera adhering to parts of the shell. "Old dead" shells, that is shells in which no viscera were adhering, increased from just over 20 percent at the end of the 2 week season to nearly 70 percent 6 weeks after the season had closed (Young personal communication). These results indicate the enormous impact dredging has on scallop populations and the apparent low efficiency of the current harvesting methods. The fact that most scallops caught in the survey six weeks after the season had closed were old dead shells, probably indicates that there was a continuing death rate amongst live scallops during and after the 2 week season. The dredge in use in this fishery is an enlarged version of the 'sputnik' dredge (Fig.6).

Overseas experience has shown that dredging can cause

considerable physical damage to benthic fauna (Caddy 1973, Dupouy 1983) while in Port Phillip Bay, Victoria, dredging has been implicated in the increase in levels of heavy metals in the water over scallop beds (Fabris 1981). Disturbance of the bottom by dredging and consequent destruction of the prawn habitat has resulted in all dredges being banned in the Shark Bay fishery in Western Australia (Rogers et al 1983). On the other hand, two studies have revealed that little damage is done by dredging to the marine environment (McShane 1981, Butcher et al 1981). This is surprising, but it should be remembered that destruction of the bottom is related to the sediment type, for example damage to open sandy bottoms, where species diversity is often low, may be minimal (Butcher et al 1981). The conclusion that dredging had no immediate effect on the macrobenthos of Port Phillip Bay (McShane 1981) is, however, difficult to understand.

Alternatives to scallop dredges include the Queensland style beam trawl which has been trialed off Table Cape in northern Tasmania. The results indicated that the beam trawl caught less by-products such as sponges, bryozoa etc., more legal size scallops, fewer undersize scallops, and fewer damaged scallops than the dredge (Wolfe 1986).

6.3.4 Survey Technique

There is little doubt that preseason scallop surveys are essential if a reasonable assessment of the health of the scallop stocks is to be made prior to a decision on opening or closing the fishery. Techniques used in scallop fisheries include dredge surveys, dive surveys, and spat forecasting programs (see for example McShane

1983, Serchuk et al 1979, McKoy et al 1982) while underwater video systems are still in the developmental stage (Franklin et al 1980, Young personal communication). In a review of methods of surveying scallop stocks in the United Kingdom, the underwater video system was found to be a useful compromise between the accuracy but costliness of diving surveys and the extensive coverage but inaccuracy of dredging (Mason et al 1982).

The D'Entrecasteaux Channel survey is made using a modified 'sputnik' dredge (Section 4.2) and this has led to some criticism by fishermen. The basis of the fishermens' criticisms is that the 'sputnik' dredge catches scallops more efficiently than the allowed lip dredge, and recommendations stemming from the survey results will thus be based on unrealistic catch returns (Section 5.3.1/2).

Given that the aims of the survey are to assess the distribution and abundance of scallops and to determine the effects of the fishing of previous years on stocks (Section 4.2) these criticisms may not be valid. The survey is not to give fishermen an indication of likely catch rates. Further, the same dredge has been used on all Channel scallop surveys since 1981 and to change the survey dredge to a lip dredge would seriously interfere with the consistency and value of catch data for the period 1981-1986.

6.3.5 Season Length

Scallop seasons are invoked for three major reasons: to maximize the yield per scallop, to protect scallop stock from excessive fishing effort (Rogers et al 1983), and to protect juvenile scallops.

The imposition of a scallop season has been criticised on the

grounds that the seasonal limitation on effort does not effectively restrict fishing pressure (Sea Fisheries Advisory Board of Tasmania Subcommittee on the Scallop Fishery 1964, Mason 1983). However, in the Channel fishery, where scallop stocks are subjected to large fishing pressure, the length of the scallop season has been one of the major management considerations for regulating fishing effort.

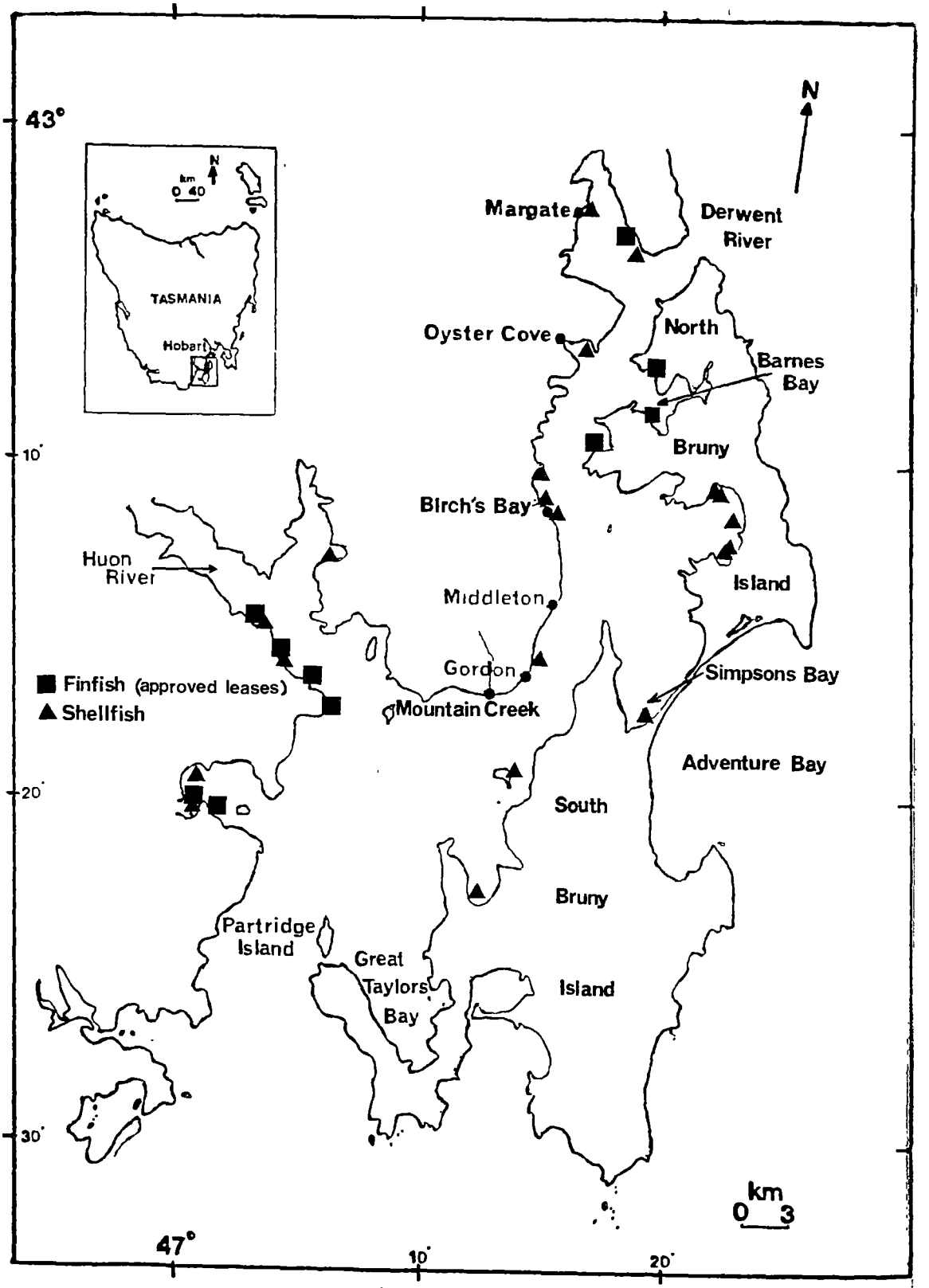
The survey of amateur and professional fishermen revealed some dissatisfaction with the present season lengths. A number of them (professionals) thought the season was too short for economic viability (Section 5.2). This is unfortunate for those individuals but should be seen in context with the wisest use of the scallop resource.

6.3.6 Aquaculture

Marine species currently being farmed in the D'Entrecasteaux Channel include Atlantic salmon (Salmo salar Linnaeus), rainbow trout (Salmo gairdnieri Richardson), oysters (Crassostrea gigas Thunberg), mussels (Mytilus eduiis planulatus Lamarck), and commercial scallops (Pecten fumata Tate), and there are now thirty aquaculture farms throughout the Channel (Figure 14) and several more about to begin operations (Hortle personal communication). Two main problems, for which there are no simple solutions, are posed by aquaculture for fisheries managers, the restriction on traditional anchorages and activities for recreational fishermen, and the potential damage to marine ecosystems by waste food and faecal matter from fish farms.

The majority of objections to the establishment of marine farms in the D'Entrecasteaux Channel which have been received by the

Figure 14
Aquaculture sites in the D'Entrecasteaux Channel



Department of Sea Fisheries have been on the grounds that safe anchorages and prime fishing locations are being taken over (Grant personal communication). For example, the recent application for a salmon farm lease near Partridge Island resulted in at least forty objections on the grounds that the farms would take away a protected anchorage and create a navigation hazard (Sunday Tasmanian 1986).

Secondly, the development of Atlantic salmon and sea trout farms may involve a significant increase in the nutrient load for the Channel. In Scotland, where these types of farms have been established for over a decade, significant changes to the marine ecosystem have been recorded in the vicinity of the farms. These have included the sediments beneath the fish farms becoming anoxic, the macrofauna becoming impoverished, and the occurrence of marine organisms characteristic of highly enriched sediments (Gowen et al 1985). While it is too early to predict the likely effects of fish farms on the Channel environment, the results here could be much the same. Thus the Department of Sea Fisheries plans to monitor the effects of the farms on the Channel environment by establishing an environmental monitoring section (Hortle personal communication).

CHAPTER 7 SCALLOP MANAGEMENT STRATEGIES

7.1 Introduction

The management of a scallop fishery is usually undertaken by a Government Department or similar controlling body, and includes such considerations as the protection of the resource, the welfare of fishery participants, the political and administrative feasibility of management schemes, and the social implications of management decisions (see for example Beddington and Rettig 1983, Anon 1984b, Winstanley 1985, East Coast Trawl Fishery Task Force 1985, Anon 1986b).

In the absence of a rational scallop management regime overexploitation of the resource is likely, resulting in hardships to industry participants and society. "The Tragedy of the Commons" (Hardin 1968) succinctly describes the results of open access to community goods, and the analogy used in Hardin's example seems valid for unmanaged or open-access scallop fisheries.

The D'Entrecasteaux Channel Scallop Fishery has been the subject of much management endeavour, with variable success (Chapter 3). Since reopening in 1982, its amateur and commercial components in particular (Chapters 4 and 5) have made it a difficult fishery to manage, but its importance to Tasmanians makes it imperative that the fishery be carefully husbanded. In this context, the lack of a comprehensive management policy (Chapter 6) is difficult to understand.

The aim of this chapter is to outline the management strategies generally used in scallop fisheries, and to relate these to the situation in the D'Entrecasteaux Channel. These include both theoretical and practical management tools.

7.2 Fishery Management Strategies

7.2.1 Theoretical Management Models

Developments in fisheries management have been evolving rapidly, due to escalating fishing pressure on what are now recognised as limited resources. As fisheries have increased in size and complexity so too has the need and scope for management. Most noticeably there has been an expansion of management criteria from those concerned solely with biological characters, to those which include economic, social and political factors. This has resulted in the construction and evolution of theoretical models of fisheries management to be used as guidelines for management strategies. The most widespread and well documented models are those of Maximum Sustainable Yield, Maximum Economic Yield, and Optimum Sustainable Yield.

7.2.1.1 Maximum Sustainable Yield

Maximum sustainable yield (M.S.Y.) has permeated most fisheries management schemes, particularly during the 1940's and 1950's (Larkin 1977). It was first used in the Norwegian Whaling Industry in the early 1900's to establish the relationship between stock levels and yield (Hjort et al 1933) and later refined by the work of Beverton and Holt (1957) who provided the mathematical framework for calculating the M.S.Y.. The M.S.Y. concept is linked to the natural rate of increase of a population of organisms. Initially, when the population is small relative to the carrying capacity of the environment, the

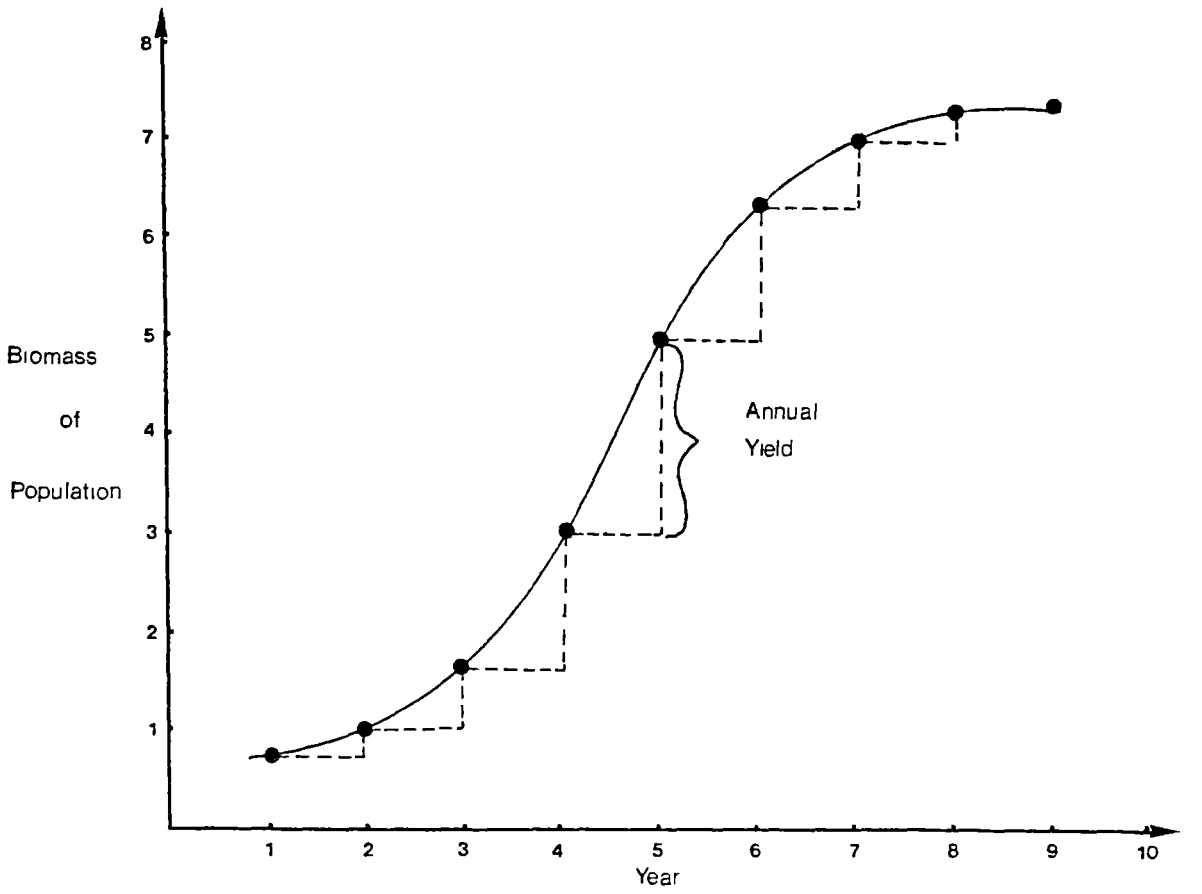
rate of increase of the weight of individuals is high, being greatest at some position along an 'S' shaped growth curve (see Fig.15a). If the growing population is cropped at the same rate as the natural rate of increase, then it should be sustainable. Further, if the cropping is undertaken when the rate is greatest (see Fig.15b), this will correspond to the M.S.Y. for this population.

Unfortunately, an M.S.Y. prediction is fraught with problems in most applied management situations (e.g. Kirkwood 1980). The greatest difficulty in many cases is the collection of the necessary reliable, consistent and meaningful data on parameters such as population size, growth rates, fishing effort, and natural mortalities. Clearly this is an extremly onerous and costly task and, as in the case of the Channel fishery, is beyond the means of many management bodies.

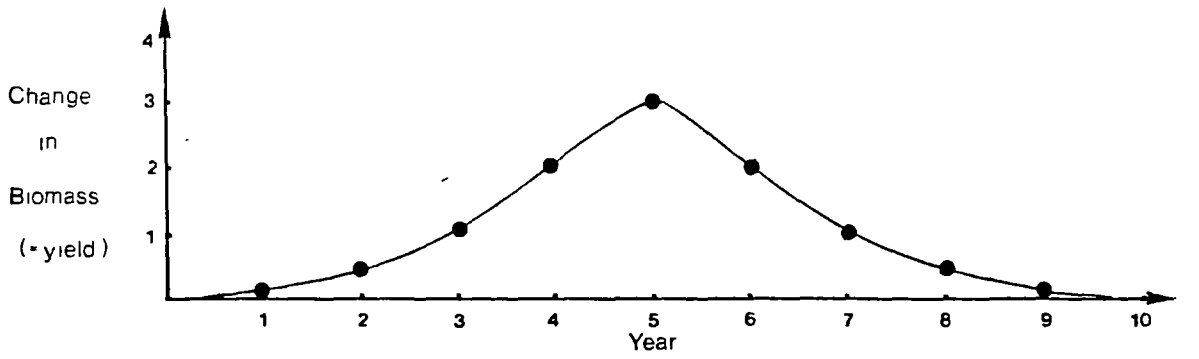
Another major problem is that M.S.Y. predictions must be made for each species in a multi-species fishery. This further increases the data requirements, creating problems for managers and imposing on fishermen who would be required to supply a lot of detailed information.

Finally, for most fish species (including scallops; Gwyther et al 1984), harvesting the resource along M.S.Y. guidelines means that young adults form the bulk of the catch, as their growth rate is maximal for the population. In the event of a natural catastrophe, or in the situation where recruitment is highly variable, the ability of the population to regenerate would be diminished by the lack of mature adults. In the case of scallops, where annual fluctuations in spatfall and recruitment are large, management along M.S.Y. guidelines could be disastrous.

Figure 15
Maximum Sustainable Yield



(a) Population growth curve



(b) Natural rate of increase

There are minor problems for M.S.Y. predictions for scallop stocks (see Larkin 1977) and it might seem that M.S.Y. has little to offer scallop fisheries managers. However, it is unwise to ignore the underlying rationale of managing a renewable resource, such as scallops, on a sustainable basis. If there is a demand from society for the utilization and conservation of a resource, then M.S.Y. could be used to form the upper limit of exploitation.

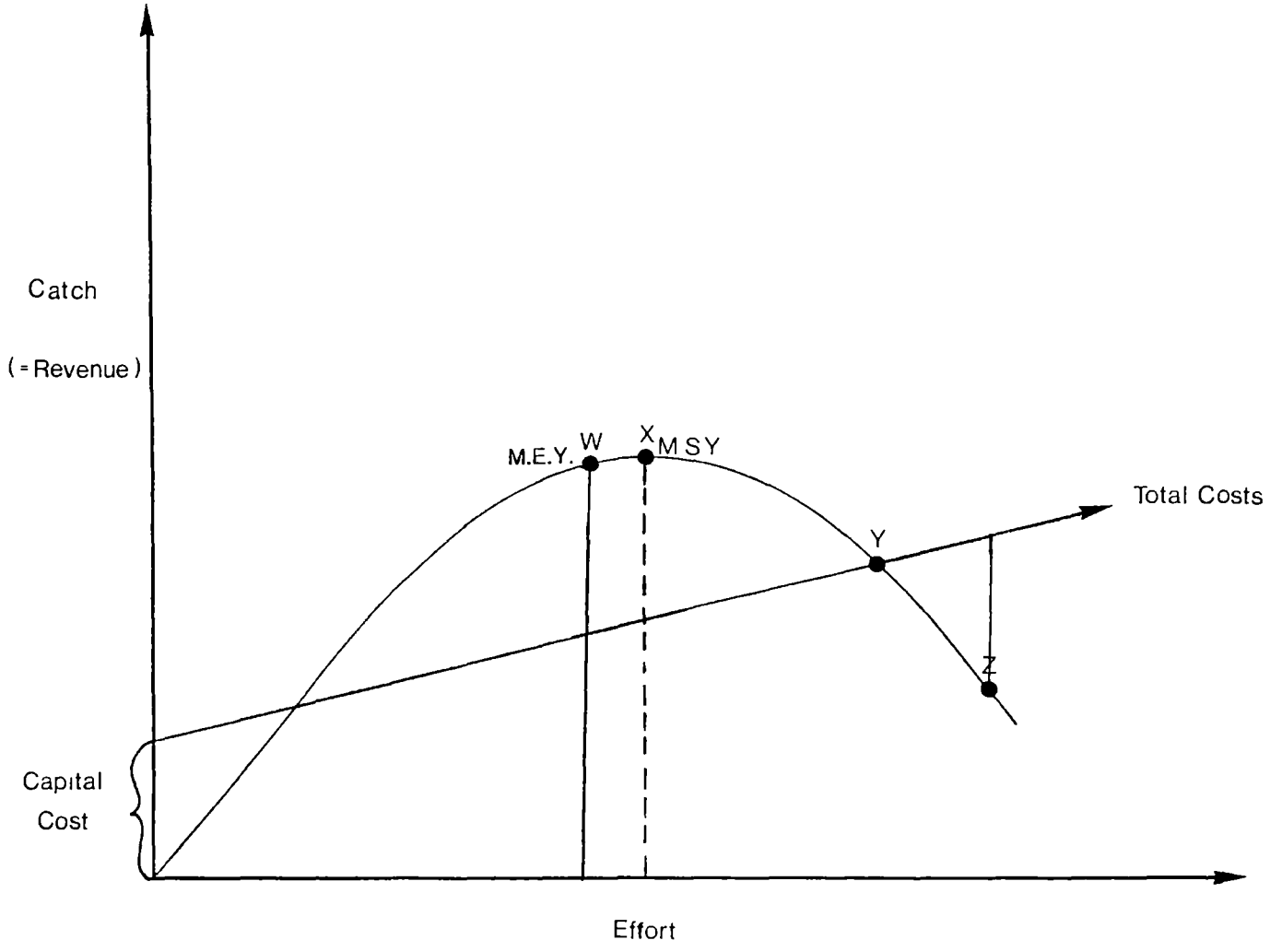
The above comments have been made within a biological framework. Fisheries managers, however, must contend with more than just biological factors (Perrin and Hay in press). In particular they must also consider the welfare of industry participants and their families. Thus some managers have embraced the concept of Maximum Economic Yield to account for some of the deficiencies in an M.S.Y. management strategy.

7.2.1.2 Maximum Economic Yield

In the past 30 years or so there has been a gradual increase in the accumulation of knowledge, interest, and ideas on the importance of economic criteria in the management of fisheries (Crutchfield 1980). This interest has been stimulated by the recurring problems of poor economic performance, overcapitalisation, and the depleted state of fisheries resources throughout the world.

The economist is interested in maximizing income while minimising total costs for the fishermen (Meany 1980). The level at which this occurs is the (M.E.Y.). In Figure 16, an attempt has been made to show the relationship between catch revenue and effort.

Figure 16
Maximum Economic Yield
Relationship between catch (or revenue) and effort



Two simplifying assumptions have been made: firstly, that the price of fish remains constant, and secondly, that the fishery is conducted by a fleet of similar vessels with standard costs of operation and standard catch effectiveness (this allows a straight line which represents total costs to be drawn, intersecting the catch/revenue abscissa. These assumptions are of course unrealistic due to variable scallop prices (Shield personal communication) and variable fuel, equipment, labour, and depreciation costs.

In Figure 16, W represents the point where there is a maximum difference between costs and revenue, that is the M.E.Y.. It is worth noting that this is reached before the Maximum Sustainable Yield at X. Most unregulated fisheries tend towards Y, where costs = revenue (Crutchfield 1982), and some overcapitalized and overexploited fisheries reach the point Z where costs are greater than revenue. In the latter case government subsidies and general return on capital are enough to artificially sustain participants.

In an unregulated fishery, capital will continue to be invested in the industry while profits are perceived, and the M.E.Y. position will often be passed. This leads to the need for external intervention to regulate fishing effort, with its associated political and administrative difficulties and costs.

A major problem with M.E.Y. (as already outlined for M.S.Y.) is the considerable volume of information needed to make an M.E.Y. prediction. Data on boat sizes, fishing effort, catch efficiency, operating costs, and market prices are needed and this imposes considerable costs on the fishery. Further, data gathering may well be hindered by the reluctance of some fishermen to divulge economic information. A second problem is the constant change in fishing

technology which, if unregulated, can easily result in an escalation of fishing effort beyond the M.E.Y.. Conversely, if technological change is regulated then account must be made of the economic inefficiencies created by such regulation and the associated problems for fishermen (Whitmarsh 1983).

Management of the D'Entrecasteaux Channel scallop fishery exclusively along M.E.Y. guidelines appears inappropriate on the basis of the problems listed above. It is also inappropriate because of the dual amateur/professional nature of the Channel fishery: M.E.Y. is hardly relevant to the amateur component of this fishery, in which the reasons for fishing are chiefly for relaxation and pleasure (Table 3). The M.E.Y. concept does, however, point out the dangers of unregulated fisheries and excessive fishing effort in economic terms. It is also a useful concept in so far as it has widened the scope of fisheries management to address the serious problems of economic hardships for fishermen due to unstable incomes.

7.2.1.3 Optimum Sustainable Yield

Optimum Sustainable Yield (O.S.Y.) first arose as a management concept during the 1958 United Nations Convention in Geneva (Stroud 1975). O.S.Y. is often discussed vaguely in terms of M.S.Y. and M.E.Y. and is difficult to define in precise terms, but is perhaps best stated as the sustainable yield from a fishery which fisheries decision makers perceive to be optimum in the light of biological, economic, social, and political considerations. It hinges on the value laden term 'optimum', and this gives it a lack of precision but a high degree of flexibility (Harville 1975). The concept is perhaps best

discussed in the proceedings of a symposium held in 1975 (see American Fisheries Society 1975).

In view of the dual amateur/professional nature of the D'Entrecasteaux Channel scallop fishery, and the required multi-objective management plan, the O.S.Y. concept, because of its flexibility, could hold most promise for effective management. Undoubtedly many problems would arise if the O.S.Y. concept was applied to the Channel fishery, but a detailed examination of these is seen to be beyond the scope of this present study.

7.2.2 Practical Management Techniques

There are a number of practical management techniques in use in scallop fisheries throughout the world which have been the vehicle for implementation of the theoretical management models. In this subsection, several practical mechanisms of fisheries management are described and related to the D'Entrecasteaux Channel scallop fishery.

7.2.2.1 Open Entry

'Open entry' management means that no restrictions are placed on the entry of fishermen or vessels to a fishery. Little effort is required for licencing and enforcement, and management costs are low. However, the eventual overcapitalisation of the industry and overexploitation of the resource that seems to accompany an open entry fishery are serious disadvantages (Berkes 1985).

The D'Entrecasteaux Channel fishery has been an open entry fishery in many ways until recently. Prior to the decision (in April

1986) that professional fishermen should have a special licence to fish in the Channel, any Tasmanian scallop fishermen with a Channel licence endorsement and not holding a Bass Strait licence endorsement could fish there. Further, the number of amateur fishermen has not been limited. This meant that in 1984, for example, 104 scallop boat owners were licenced to fish the Channel, and 757 amateur fishermen were able to do likewise. In the light of Chapters 3 and 4 this is clearly an overexploited fishery. Even the attraction of lower management/enforcement costs is not sufficient justification for ignoring the important social and economic benefits being foregone by this sort of management.

7.2.2.2 Limited Entry

'Limited entry' management involves the establishment of an upper limit on the number of boats permitted in a particular fishery, thereby gaining some control over total fishing effort.

The benefits of a limited entry scheme are that it enhances the conservation of a fish stock (Beddington and Rettig 1983), it involves the least disturbance to existing ways of operating and organizing a fishing venture (Crutchfield 1982), it can have an immediate effect in reducing fishing effort in an over exploited fishery, and it requires minimal monitoring (Scott 1984).

There are a number of problems which inhere to this management technique. These include equity considerations when establishing entry criteria (Dragun 1982), the escalation of fishing effort by licence holders who invest in larger vessels or more efficient catching gear (Beddington and Rettig 1983), and the loss of economic efficiency by

licence holders when controls are tightened on vessel modifications (Scott 1984).

It is the only management technique that has been tried on more than a limited basis in Australia (Dragun 1982) and throughout the world (Crutchfield 1982). In Canada's off-shore sea scallop fishery, limited entry has been used in conjunction with vessel trip limits and meat size restrictions (Serchuk et al 1979). Similarly, there is a limited entry management regime in place in New Zealand, with additional controls on the size of scallops, meat quotas, season restrictions and hours of operation (Anon 1986b).

In Western Australia there has been an apparent industry/Government desire to have a limited entry scheme introduced for scallop fisheries (Rogers et al 1983) and in 1985 a moratorium on the issue of licences to fish in the Abrolhos Islands (off the central west coast of Western Australia) was commenced as an aid to the introduction of a limited entry scheme (Anon 1984c). The Victorian scallop fisheries have been managed for a considerable time as a limited entry fishery (Sturgess et al 1982), and the Bass Strait scallop fishery in Commonwealth waters is also a limited entry fishery (Bass Strait Scallop Fishery Task Force 1984). In the Tasmanian scallop fishery (excluding the Bass Strait and the D'Entrecasteaux Channel areas), any Tasmanian resident could apply for a Tasmanian scallop licence until the imposition of a moratorium on the issue of licences in September 1985 and then the introduction of a limited entry scheme in April of 1986 (Thomson personal communication).

Given that a reduction in fishing effort is required in the Channel fishery, limited entry is an attractive proposition for achieving this goal. The introduction, in April 1986, of the special

licence to fish for scallops in southern Tasmanian waters is a form of limited entry pertaining to professional fishermen, but consideration may have to be given to a limited entry for amateur fishermen, if fishing pressure remains excessive.

7.2.2.3 Royalties/Taxes

The justification for the imposition of a royalty or tax on the harvesting of a fish resource is that the fishermen are, in effect, a privileged minority with a right of access to a scarce public good. A royalty should reflect the cost of the fishermens' actions to the society, and be used to help manage the resource in the best interests of the society. Royalties would be most applicable when used in an overcapitalised fishery, rather than a developing fishery, as the incentive to restrict fishing effort is greatest in the former (Crutchfield 1980).

A major problem in the use of taxes in fisheries management is the setting of the correct level of tax. On the one hand, variables such as the economic performance of fishermen and the state of the resource need to be assessed, so that the tax is a fair rental paid by fishermen for the use of a public resource. On the other, the costs of data gathering and processing have to be accounted for, so that the value of the tax is not undermined. Further, the taxation system needs to be reviewed and updated to account for fluctuations in these parameters. The flexibility required for such a system is difficult to achieve.

In New Zealand the Government considers the scallop fishing industry should pay a resource rental (or royalty) in recognition of

its commercial gain from a publicly owned resource (Anon 1986b) and is now enforcing royalties of $NZ 27.50 per tonne live weight on scallop landings. In Australia, however, there is a reluctance on the part of the Commonwealth and State Governments to impose taxes on scallop fishermen. For example, a recent major review of the Western Australian scallop fisheries did not mention royalties or taxes as a management option (Rogers et al 1983), and in a review of the management of the Victorian scallop fishery it was concluded that such taxes would not be viable due to resistance by fishermen, the costs of enforcement of such a system, and data collection difficulties (Victoria has two separate scallop fisheries, Port Phillip Bay and Lakes Entrance) (Sturgess et al 1982). In the Bass Strait scallop fishery the findings of the Bass Strait Scallop Fishery Task Force, appointed to report on management issues, did not mention royalties explicitly but argued that **"where individuals within industry enjoy a protected right to operate in that industry for profit and may accrue a capital gain, they should pay for that privilege"** (Bass Strait Scallop Fishery Task Force 1984).

In the D'Entrecasteaux Channel scallop fishery, the only direct tax currently imposed on amateur and professional fishermen is the cost of a fishing licence. A further tax on amateur fishermen hardly seems justified, but the mechanism does exist, that is the licence fee could be increased. For professional fishermen the licence fee is only a small portion of their overall costs, and a tax on professional landings of scallops from the Channel might have two important benefits. Firstly, it would increase the money available for management of the fishery, and secondly, it would discourage further accumulation of capital in an already overcapitalized and

overexploited fishery.

7.2.2.4 Catch Quotas

Management via 'catch quotas' refers to the establishment of a Total Allowable Catch (T.A.C.) of a fish resource, with some goals and objectives of management in mind, for example M.S.Y, M.E.Y., or O.S.Y.. A T.A.C. is based on the sampling and analysis of data from resource surveys and, once estimated, is divided amongst the resource users (subject to qualifying criteria) into individual quotas. If the quotas are made transferable (Individual Transferable Quotas, I.T.Q.) there then exists a "market good", and a form of property rights over the resource is established.

This management technique has been the subject of considerable attention in recent times (e.g. Crutchfield 1982, Rogers et al 1983, Beddington and Rettig 1983, Scott 1984). The advantages of such a system include the high level of control which can be achieved over fishing effort (Crutchfield 1980), the elimination of economically wasteful competition between fishermen (Scott 1979), and ownership of property rights, which provides a sounder basis for borrowing money and greater security for fishermen (Scott 1984).

The disadvantages, however, are considerable, particularly in the case of scallop fisheries. Firstly, the costs associated with a detailed resource survey are high. Secondly, the accuracy of the T.A.C. calculation is undermined by the variable recruitment of scallops. Thirdly, the administrative costs of regulating and enforcing such a system are probably higher than for any other management technique.

Finally, there exists the potential for a monopoly of transferable quotas to be established to the detriment of the fishermen and society in general.

The New Zealand Government, in considering the long term management options for the Nelson/Marlborough scallop fishery, has directed that the scallop managers examine the possibilities of introducing the I.T.Q. system for the 1987 season onwards (Anon 1986(b)). The adoption of the T.A.C./I.T.Q. system was also considered in the Western Australia scallop industry, but was not implemented: the difficulty of making an accurate estimate of total allowable catch was given as one of the reasons for this (Rogers et al 1983). In Victoria, scepticism was voiced concerning the costs of enforcement of such a system (Sturgess et al 1982). In Tasmania the system has been discussed with a view to its introduction (but excluding the D'Entrecasteaux Channel). It has not been introduced to date due to reluctance on the part of fishermen and lack of resources to administer the system (Harrison personal communication).

In the case of the D'Entrecasteaux Channel scallop fishery, the high cost of administration, enforcement, and data requirements make the catch quota system unfeasible for use as a regulatory tool. Further, the damage to scallop stocks by an inaccurate estimation of a T.A.C. would be exacerbated by the extremely high fishing pressure over the short scallop season. It should be remembered that a form of catch quota exists already in the Channel fishery, that is, the daily bag limit for amateur and professional fishermen. Judging by their responses to the interview (Section 5.3.1/2) it is a well accepted form of management control.

7.2.2.5 Other Output Controls

In this subsection the output controls of size limits, gear restrictions, area closures, seasons, and hours of fishing are considered.

Size limits on scallops are primarily aimed at ensuring the yield per scallop is maximized and that scallops can spawn at least once before they die, thereby adding a degree of protection to the scallop stocks. Acceptance of scallop size limits as a regulatory tool has by no means been universal. In the Canadian, New Zealand and some United Kingdom scallop fisheries, scallop sizes are enforced, but in the United States, Victorian, and Western Australian fisheries no size limits apply. New Zealand, for a short while, removed the size limit, but reinstated it in 1983, arguing that it aided the stability of the fishery (Anon 1986b). In Victoria size limits were applied to both the Lakes Entrance and Port Phillip Bay fisheries, but these were removed in 1976 and 1977 respectively on the grounds that their enforcement imposed excessive costs on fishermen and the likely damage to undersize scallops by dredging meant that throwing them back resulted in resource wastage (Sturgess et al 1982). Against this, however, is the evidence that scallops may have a higher rate of survival when returned to the sea than previously thought (Chapman et al 1977 in Mason 1983).

In the D'Entrecasteaux Channel fishery size limits have been applied since 1925 (Chapter 3) and seem to be well accepted by fishermen (Tables 4 and 6). The size limits are an important adjunct to other management tools and are valuable in protecting the long-term

viability of the Channel stocks including as a source of broodstock.

Gear restrictions can take many forms, such as dredge type or mesh size limitations. The aim of these restrictions is to reduce the catch of undersize fish, thereby enhancing the long-term prospects for the fishery. However, in the short term, overall catch rates may drop and fishermen may be reluctant to adhere to gear restriction strategies (Beddington and Rettig 1983).

Little mention is made of gear restrictions in reports from other scallop fisheries, suggesting that this is either an uncommon technique or it is considered unimportant by authors. In the Victorian and Tasmanian fisheries, gear restrictions are an important regulatory tool. For example the Port Phillip Bay and Lakes Entrance fisheries have limits on dredge size in accordance with the length of the boat. Further, in the Port Phillip Bay fishery dredges are not permitted to exceed 3.36 metres in width (Sturgess et al 1982). In the Bass Strait fishery restrictions are being mooted for equipment such as scallop sorting machines, should they prove too efficient in terms of increasing fishing pressure (Bass Strait Scallop Fishery Task Force 1984).

In the D'Entrecasteaux Channel scallop fishery the major gear restriction applying is that only the lip dredge may be used. Other dredges have been designed for use in the Channel (Brown personal communication) but, as yet, remain untried. Alternatives to dredging for scallops exist, such as the beam trawl (about which little detail is available), but early experiments suggest this technique may prove a valuable alternative to dredging (Wolfe 1986).

The closure of areas and the imposing of seasons represent conservation mechanisms for the resource in that they restrict fishing, ensuring maximum spawning and recruitment potential and increasing yield per fish. Administratively, they are relatively easy and cheap to implement and enforce, and are usually found in association with other regulatory measures such as limited entry or catch quotas (Anon 1983b).

From an economic viewpoint, area closures and regulation of seasons both represent a form of regulated inefficiency in that fishermen may be forced to stop fishing or turn to another, less profitable fishery. The imposition of a season may also lead to a disruption of marketing arrangements. Area closures and seasons are common regulatory tools in Australian scallop fisheries but, with the exception of New Zealand, most overseas fisheries do not employ such techniques.

7.3 The Future of the Channel Fishery: Amateur and/or Professional?

7.3.1 Amateur-Only Fishery

The importance of amateur fishing to Australians is only now becoming apparent. This has been facilitated by the results of the first national recreational fishing survey in 1983-84. In this study it was found that $2,200 million was spent on recreational fishing in Australia in the 1983/84 financial year, making it at least as large as the professional fishery (Anon 1986c). The importance of amateur fishing to the Tasmanian economy was revealed in a 1983 Australian Bureau of Statistics survey of non-commercial fishing activities (Australian Bureau of Statistics 1984). This survey showed that 49.9 percent of households surveyed owned fishing rods and reels, 23,713 boats were owned and used for fishing, and 107,000 Tasmanians who fish each year are spending approximately $49 million per annum on recreational fishing. This compares with a total commercial catch for 1983-84 of $38 million (Schaap 1986). Scalloping in the D'Entrecasteaux Channel has become an important amateur activity for many Tasmanian residents. Referring to the fishery as an event conducted in a small area over a very brief season, the president of the Tasmanian Amateur Sea Fishermen's Association (Mr D. Paton) it probably now rates as the biggest single recreational sea fishery in the country (Anon 1983a). The major attractions of the Channel for amateur fishermen are that it is within easy reach of Hobart, and it is a relatively sheltered and safe waterway for small boat usage. Whilst the survey of amateur fishermen in this report showed that some fishermen fished for economic reasons, most fished for enjoyment and relaxation (Table 4). This presents a number of difficulties for

scallop managers who must widen their aims and objectives of management to account for social objectives such as quality of experience and non-consumptive activities such as underwater photography.

In the absence of data on the value, in dollars, of the Channel scallop fishery to the Tasmanian economy, it is contended here that the value of the amateur component of the fishery far outweighs the professional component. This is because the ratio between amateur and professional licences issued since 1982 was at least 7:1 (Table 2). This suggests that the amount of petrol/diesel, oil, food and fishing gear, all of which indirectly contribute to the economy and employment, would have been much greater for amateur fishermen.

Given that the Channel is currently suffering from excessive fishing effort, it is contended here that an amateur-only fishery would result in a decrease in fishing pressure. Although the ratio of amateur to professional boats from the Channel is 7:1, it should be remembered that the individual permissible catch ratio is 1:15 (in 1985), that is the professional fisherman can take 15 times as many scallops as his amateur counterpart. Thus the professional component can exert around more than twice the fishing pressure of the amateur component. A restriction of the fishery to amateur-only could thus lead to a two thirds reduction in fishing effort.

7.3.2 Amateur/Professional Fishery

Support for the continuation of the amateur/professional fishery, much as it is now, came from nearly all professional fishermen interviewed (Table 6) but only two amateur fishermen (Table

4). This indicates that conflicts between fishermen, although not a serious problem in the current Channel fishery, could arise. This is not to say that conflict does not occur (Anon 1984a) rather that it could be avoided altogether, for example by the setting aside of areas for amateur use only, as is done in the New Zealand scallop fishery (McKoy et al 1983).

Two arguments for the continuation of the existing amateur/professional fishery are advanced and examined here. Firstly if the scallop stocks are capable of withstanding fishing pressure from both groups, it is difficult to rationalize an amateur only status for the fishery. This approach is taken in Victoria by the Commercial Fisheries Branch of the Department of Agriculture and Rural Affairs: their philosophy and policies of management require that the resource should be managed as harmoniously as possible where the resource can support both fisheries (Winstanley 1985). Secondly, the Channel fishery is an important winter living for some professional fishermen, providing a viable alternative to crayfishing for a short while. There are many professional boats with a long historical association with the Channel fishery, and scallop managers throughout the world have shown a tendency to regard historical association as grounds for a right of access to the resource (for example Sturgess et al 1982, Anon 1985b). These historical association rights, while not enshrined in legal respectability, would make it politically difficult to have an amateur-only fishery.

7.3.3 Professional-Only fishery

The establishment of a professional-only scallop fishery in the

Channel is difficult to justify and lacks support. This is evidenced by the views of the amateur and professional fishermen interviewed (Tables 4 and 6), with only 1 out of 20 fishermen believing the fishery should become a professional-only fishery. Firstly, the Channel stocks are in a depleted state, and most professional fishermen would find it unviable to fish here. Secondly, the mobilisation of recreational fishermen into a coherent unit via the Tasmanian Amateur Sea Fishermen's Association would mitigate against any moves to establish such a professional-only fishery. Finally, from the viewpoint of society in general, the benefits of allowing numerous Tasmanian residents access to a safe and sheltered waterway far outweigh the benefits of allowing a select few to extract a living from a depleted fishery.

CHAPTER 8 RECOMMENDATIONS FOR THE FUTURE

8.1 Overall Management

The primary management aim should be to ensure the long term viability of scallop stocks in the Channel in sufficient numbers to support at least an amateur fishery. Conservation of the entire Channel environment should be kept in mind and scallop stocks should be cropped in a way that sustains an optimum yield on an annual basis.

It is suggested that the D'Entrecasteaux Channel scallop fishery should be an amateur-only fishery while scallop stocks are low, the optimum sustainable yield being equated with the yield that guarantees amateur fishermen at least a short season, while protecting the scallop stocks. If stocks increase, a small-scale professional fishery could be allowed, and the small-boat owner who has a history of fishing in the Channel, who cannot fish safely elsewhere, and who relies on the Channel fishery for an important part of his livelihood should be given first option of fishing. If a professional fishery proved viable, a landings tax on scallops should be considered to assist in meeting management costs. Such a tax could be seen as reflecting the costs of the fishermens' actions to Tasmanian society in general.

Any proposed management plan will fail unless it is clearly understood and supported by fishery participants (at present there is reasonable harmony between the amateur and professional fishing components of the fishery and the Department of Sea Fisheries, indicating support for existing management practices). In particular,

the close liaison between the Department of Sea Fisheries and the Tasmanian Amateur Sea Fishermen's Association (T.A.S.F.A.) should be maintained, and the participation of the T.A.S.F.A. in the management process should be enhanced by wider publication of the reasons behind management decisions. In particular, the results of the preseason survey need to be widely communicated.

8.2 Regulations

The regulations concerning hours of fishing, scallop size limits, and the control of onboard shucking should remain. The present bag limits, which have provided scallop managers with a mechanism for maintaining close control over fishing effort, should also be maintained, and if fishing pressure is deemed excessive, perhaps by an in-season diving and/or dredging survey, they should be tightened. The present ban on the taking of commercial scallops is sensible: it too should be maintained and could be extended to include doughboy scallops if they become scarce.

The licence fee, which needs to be commensurate with management costs (such as those for preseason surveys, enforcement, and research) should be increased. The present bag limit of 400 scallops per day results in approximately 6Kg of scallop meat (Fehre personal communication), and at a conservative price of $8.00 per Kg this represents considerable reward to amateur fishermen (assuming they are taking the bag limit each day). An increase in licence fees (from $15.00 in 1986) could contribute towards the administration and enforcement costs of the fishery, and possibly towards the cost of reseeding depleted areas of the Channel. If licence fees are increased, the reasons for this should be clearly communicated to participants.

If the Channel fishery should become an amateur-only fishery, the length of the season should be increased to avoid the congestion which accompanies the present short season. This may result in a slight overall increase in fishing pressure, but this would probably be insignificant and not harm scallop resources. If the fishery

remains an amateur/professional then divers-only areas should be designated for the protection of the divers. The current system of opening and closing fishing areas seems reasonable, and provides a degree of protection to over-exploited and juvenile stocks. Consideration should be given to the permanent closure of one area, so that the effects of fishing on adjacent areas could be more easily assessed.

The lip dredge is conditionally recommended for continued use in the Channel fishery, pending further research on the damage done by the different types of scallop dredges.

The annual, preseason survey should continue and be enhanced by diving surveys (and possibly occasional underwater television monitoring of the scallop stocks ?). As well as examining the health and condition of the scallop stocks, these surveys should monitor the permanently closed area for signs of alteration in the relative abundances of doughboy, commercial, or queen scallops. The results of the survey should be published and distributed as widely as practicable prior to the opening of the season, possibly in conjunction with the sale of a licence.

8.3 Enforcement and Fines

It seems unlikely that enforcement levels in the Channel could be increased greatly owing to the shortages of resources, but some reassessment of enforcement activities is required. In particular, an increase in surveillance levels by the Marine Board Inspectors should be considered.

Penalties for transgressions need to be increased so that poachers and cheats (see Section 5.1.3) will be further dissuaded from breaching the law. Moves are already afoot to invoke jail terms for repeated offenders (Mercury 1986b) but the reluctance of judges to impose harsh penalties for breaches of the law undermines the value of these sterner penalties. Consideration should thus be given to having a Department of Sea Fisheries barrister present cases in court, as this may help to overcome the former shortcomings of low penalties, and bring about a greater realisation of the importance of protecting the fishery.

8.4 Research

Overall, research on scallops in the Channel should be upgraded.

A spatfall monitoring program should be implemented at strategic sites throughout the Channel. This would lead to a better understanding of the biology of the Channel scallops and the factors which influence spatfall, and may provide early estimates of recruitment, as well as of scallops for reseeding purposes.

Reseeding research should be increased and the possibilities of generating income by the sale of rights to fish a reseeded area should be examined. In Golden Bay the New Zealand Government, in conjunction with Japanese consultants, resowed an area of depleted scallop beds in 1984, and harvesting of the area was expected to commence in November 1986 (Anon 1986b). The establishment and harvesting of reseeded areas thus seems possible, and may be appropriate for the D'Entrecasteaux Channel. Income for the scheme could be generated from the sale of rights to fish the reseeded area.

Aquaculture of scallops in the Channel should be encouraged. There is already an experimental farm at Tinderbox (Squires personal communication) and such farms should be assisted as they would contribute directly to the strength of the annual scallop recruitment, and thereby enhance the Channel scallop stocks.

The development of new fishing techniques should be encouraged. This encouragement could take the form of special permits to trial dredges in the Channel, or help for applicants in obtaining research and development grants from sources such as the Fishing Industry Research Committee. There also needs to be instruction for fishermen,

to show the correct method of towing dredges. This would help offset the damage done by towing full or incorrectly set dredges, and could be achieved by distributing a leaflet with the scallop licence.

8.5 Concluding Comments

The recommendations made in this Chapter are based on the information presented in Chapters 1-7 and are suggested as the basis of a long-term management plan for the conservation and utilization of the D'Entrecasteaux Channel scallop resource. The recommendations are not radically different from existing management practices, but the emphasis on amateur fishermen is new and reflects the author's belief that in the light of past fishing practices this is the wisest path to take for the long-term benefit of the Channel fishery.

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