A CHARACTERISATION OF FIORDLAND'S FISHERIES

Beneath the Reflections

Compiled by:
The Guardians of Fiordland's Fisheries

1999

Photo courtesy Nicole Goeble

Acknowledgements

The Guardians of Fiordland's Fisheries would like to gratefully acknowledge the following people for their contributions toward compiling this document.

Tony Brett
Geoff Clarke
Rose Grindley
John Jillett
Stephen Logie
Lesley Raj
Hayley Suter
Laurel Teirney

Contents

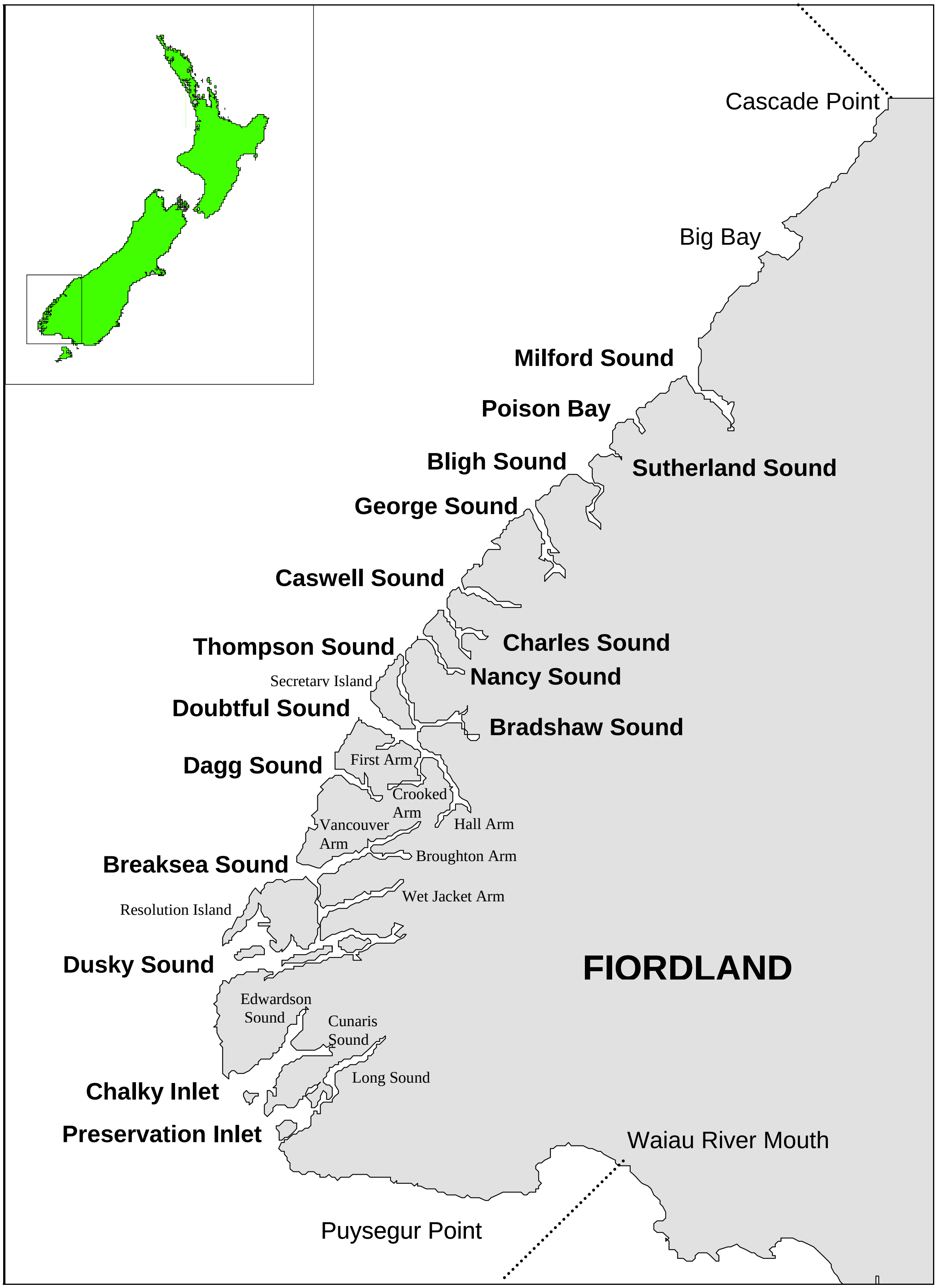


Figure 1: Map of Fiordland

1 INTRODUCTION

Beneath the reflections, the Fiordland marine environment is home to a vast range of life. This amazing, unspoiled world supports customary, recreational and commercial fisheries as well as ecotourism and other recreational ventures.

Traditionally, the fiords have been used extensively for commercial blue cod fishing, rock lobster fishing (cray fishing) and latterly, paua diving. The fiords are also renowned for recreational fishing, especially harvesting rock lobster and blue cod. The Fiordland coast supports the most important New Zealand rock lobster fishery, with approximately 20% of the national harvest coming from this region. In addition, the commercial paua fishery supports 12% of the national paua harvest. The recreational fishery for rock lobster and blue cod is superb, with an active charter boat industry continuing to develop around recreational fishing and ecotourism.

There is an increasing awareness among recreational fishers that Fiordland offers an exceptional fishing experience within a truly special boating and diving environment. As a consequence, Fiordland is attracting fishers from throughout New Zealand and overseas who are looking for a rare and exciting experience. Improved access to the area, in particular by road to Doubtful Sound via the Wilmot Pass, but also by way of larger boats, yachts, charter vessels, float planes, and helicopters, is also contributing to the increase in fishing effort in Fiordland.

Against this background, the Guardians of Fiordland's Fisheries (Tautiaki Ika O Atawhenua) was formed in 1995. The group's primary objective is to manage and conserve Fiordland's fisheries resources for the use and enjoyment of future generations.

To identify and understand potential issues, the Guardians require a comprehensive account of Fiordland's fisheries, their development history and possible future fisheries changes. While much has been written about various aspects of Fiordland, no attempt has been made to describe Fiordland's fisheries in one document. Faced with this situation, the Guardians decided to produce such a document; "*A Characterisation of Fiordland's Fisheries*".

This characterisation report brings together available information to provide a comprehensive and objective picture of Fiordland's fisheries. The information includes fisheries catch data, biological and physical data, plus the collective knowledge held by the Guardians themselves and those they represent. It is intended the characterisation will contribute to management decisions now and into the future.

2 THE GUARDIANS OF FIORDLAND'S FISHERIES

During the early 1990s, recreational and commercial fishery groups raised issues about the future of Fiordland's fisheries with the Ministry of Fisheries on a number of occasions. Tangata whenua, recreational and commercial harvesters and charter boat operators expressed a deep commitment towards conserving and managing Fiordland's marine resources. All harvesting groups felt that it was important to get together and share information and views about their fisheries. Accordingly, each sector selected representatives, who first met as the Guardians of Fiordland's Fisheries in December 1995.

At this first meeting, group members shared their visions for the future of Fiordland's fisheries. The Group adopted an overall vision for Fiordland:

"*that the current quality of Fiordland's marine environment and fisheries, including the wider fishery experience, be maintained for future generations to use and enjoy*."

Seven main points were adopted as terms of reference. These were:

- To ensure the sustainable utilisation of the finite fisheries resources, having regard to the special nature of the fiord marine environment
- To support the current fisheries management framework
- To ensure the rights of tangata whenua, recreational, charter operators, commercial and other user groups are identified and recognised and that these groups are involved in fisheries management decisions
- To ensure an equitable allocation of access to the fishery resource for harvesting groups
- To prevent uncontrolled expansion of effort/harvest by any one group
- To identify information requirements/research needs, and
- To adopt a cautious and responsible approach to developing any new fisheries.

The general area of interest for the Group was determined as being from Cascade Point in the north to the Waiau River in the south. However, different boundaries apply to individual fish species, these being determined by the various quota management areas (QMA) and statistical reporting area boundaries. Maps showing the boundaries of the QMAs and statistical reporting areas for the major fishery species are attached as Appendix 1.

In setting an appropriate off-shore boundary it was agreed that this should be determined on an issue basis but that in reality emphasis would fall on the coastal environment, within the 12 mile territorial limit. It should also be noted that some species require management on a wider scale (eg, pelagic species such as sharks and blue fin tuna as well as migratory species such as groper and moki)

The Group decided that education about Fiordland's special features was important to foster responsible fishing behaviour. As part of the first term of reference, the Group undertook the production of a code of responsible fishing practices entitled "*Beneath the Reflections: Caring For Fiordland's Fisheries*". The code focuses on encouraging appropriate fishing behaviour within the fiords and has been enthusiastically received. The code is available from Fiordland tourist and charter operators, sport shops, and Ministry of Fisheries offices.

During the process of compiling the characterisation, the Guardians identified several areas where information was incomplete or in some instances did not exist. Where this information was important for fisheries management decisions, the Guardians have proposed, promoted and supported a range of research projects. While some of these projects have now been completed, and the results included in this characterisation, others are ongoing and the results will be incorporated into a fisheries plan.

Following on from this characterisation of the Fiordland fisheries, the Guardians intend to produce a further document, *The Fiordland Fisheries Plan*. This will identify fisheries issues and future management options. It will be a living document, that will be updated and re-released as the issues facing Fiordland's fisheries change.

2.0 The Guardians of Fiordland's Fisheries 1999

Customary Representatives
Stewart Bull (Murihiku)
James Russell (Kati Waewae)

Charter Boat Representatives
Irene Barnes
Gordon Johnson
Paul Norris

Recreational Representatives
Charlie Barry
Alan Key
Wayne Neiman

Commercial Representatives
Ian Kennedy (paua)
Des King-Turner (wetfish)
Ian Leask (Bluff Fishermen)
John Steffans (northern rock lobster)
Peter Young (southern rock lobster)

Ministry of Fisheries (South) Staff who have provided advice and information
Laurel Teirney (Policy)
Tony Brett (Policy)
Rose Grindley (Policy)
Hayley Suter (Policy)
Geoff Clark (Compliance)
Ian Henderson (Compliance)

Past Members and Contributors

Malcolm Anderson	Charter Boat Representative
Kathy Jamieson	Charter Boat Representative
Paul Lindsay	Recreational Representative, Christchurch

3 PROCESS OF COMPILING INFORMATION

Groups involved with fisheries management require a sound information base, and the Guardians are no different. When first discussing the issues confronting Fiordland, the Guardians discovered that although there was a great deal of information about Fiordland, the available information was dispersed and incomplete. A *Characterisation of Fiordland's Fisheries* was compiled to bring all available information together into one document.

3.0 Map Exercise/Working Group Knowledge

Collectively members of the Guardians hold many years of first hand experience and knowledge of Fiordland's fisheries. This knowledge was largely brought together in two ways. The first of these was a map exercise, where group members worked with a detailed map of Fiordland and identified where various fisheries existed and the state of these. They also identified the distribution of harvesting by different groups (customary, recreational, or commercial) and the areas that were important to each group. This information is referred to throughout this document.

Secondly, Fiordland fisheries were categorised and discussed in four ways - the whole of Fiordland, by fiord, by fishery, and by harvest group. The Guardians considered the fisheries in each of these categories, identifying both generic and special features. This information is presented in sections 5, 8 and 9.

3.1 History of Fishing

Group members contributed a large amount of historical information and a search of published accounts of early Fiordland added to this. However, there were still some areas where knowledge was sparse, particularly pertaining to the pre-1960s.

3.1.0 Oral Histories

To fill these gaps, the Guardians identified key people who would be able to contribute valuable information on the history of Fiordland's fisheries. When contacted, these people were all happy to be interviewed. Questions asked covered the individuals' involvement in Fiordland, their knowledge of the early state of the fisheries, methods used, equipment available, factors influencing the development of Fiordland's fisheries, and so forth. Accordingly, we thank the following for generously sharing their experience and knowledge of Fiordland.

Cliff Barnes, Charlie Barry, Rex Bradshaw, George Burnby, Wallace Chilton, Pat Farry, Fred Flutey, Brian Harvey, Les Hutchins, Sonny Johnson, Des King-Turner, Dick Marquand, John McLellan, Jimmy Roderique, Les Ryan and Tup Stirling.

3.2 Bibliography

A great deal has been written about Fiordland and its fisheries, and many of these articles and books are referred to throughout this document. To assist those who would like greater detail, in addition to references, a bibliography is included listing relevant scientific papers, reports and popular accounts of visits and experiences in Fiordland. (Appendix III).

3.3 Identification of Research Needs

Following the compilation of information from the sources discussed above, the Guardians took a step back and identified gaps still remaining in their knowledge base of Fiordland's fisheries. These gaps largely related to the nature and extent of recreational fisheries within Fiordland. To gather this information, the Guardians advocated for research that would provide the necessary information. Thus, two surveys of recreational fishing within Fiordland, and two surveys of charter vessel based recreational fishing were conducted. The results of these projects are presented in section 8.2.

4 MAORI IN FIORDLAND

4.0 Creation

The following version of the creation of New Zealand was told to James Herries Beattie during his travels in the South Island. It is recounted here to demonstrate the connection Maori have with Fiordland - a connection going back as far as mythical times and continuing to the present.

Once upon a time there was no New Zealand. The heaving waters of the great sea of Kiwa rolled over the place now occupied by the North, South and Stewart Islands. No sign of this fair land existed on the breast of the ocean.

When Raki (the Sky Father) wedded Papa-Tua-Nuku (the Earth Mother) both already had children by other unions. After the marriage some of the sky children came down to inspect the new wife of their father, and some even married the earth daughters. Among these celestial visitors were four sons of Raki. Their names were Aoraki (cloud in the sky), Raki Roa (long Raki), Raki Rua (Raki the second) and Raraki-Roa (a long continuous line). They came down from the sky in a canoe, which was known as Te-Waka-a-Aoraki. The brothers proceeded to travel around Papa-Tua-Nuku, who lay as one huge continent, known as Hawaiki. The immense canoe left the shores of Earth Mother and boldly put out to sea. However, go where they would, the voyagers could find no land.

Then, disaster struck them and the karakia (invocation) which should have lifted their canoe skywards went wrong. Their craft sank onto an undersea ridge, turning to stone and earth in the process. Unfortunately it sank unevenly, with the western side being left much higher than the eastern side. The four voyagers clambered on to this high side, also turning to stone in the process. Thus the oldest of the voyagers, Aoraki, became Mt Cook, and his three younger brothers became the three peaks nearest. The canoe itself forms the South Island or Te-Waka-a-Aoraki, the oldest known name of the island.

Now, it must not be thought that Te Waka-a-Aoraki, the South Island, was then as we see it now. Much was required to make it fit for man's occupation. The benevolent god named Tu-Te-Rakikihanoa, or Tu, was given the task to see to this. Tu made an inspection of this Canoe of Aoraki and found things far from his liking. The high and elaborate prow had fallen and shattered, forming the Marlborough Sounds, and he left this as it was. The western side he found to be one long, high, unbroken line. He found the stern had sunk very irregularly, the stern post (Bluff Hill) being surrounded by water which encroached a long way inland. The eastern side was also seen as another unbroken line needing attention. Tu decided to start his work on the western side.

Tu looked at a long and high wall of rock running from north of Milford Sound down to Puysegur Point. It was an appalling sight and sufficient to daunt the stoutest heart. Tu decided to make a few openings in that unbroken line and so let the sea run in. He planted one foot on the cliff, with the other many miles further up, and began his heroic labours. He grasped his gigantic axe, Te Hamo, and set to work to chop into the great mountain wall.

The work was hard and to assist him he repeated karakia (prayers) called Tapatapa-Te-Tapahi, which commanded the rocky wall to split asunder. The work was left quite rough in parts, but the general effect was good, if on a grand and godlike scale, and calculated to inspire awe in human beings.

When Tu had gaps made in the outer wall and the sea began to flow in, he started to push and heave at the inland country to extend the length of the Sounds. In doing so, the straining caused the places where his feet rested to part from the rest, forming the two islands known as Resolution and Secretary Islands. When starting with the more southerly Sounds, Tu was inexperienced, and left far too many islands in them, but as he proceeded north he made the Sounds on more clear cut lines, and instead of leaving numerous islands, he stacked the material up in higher hills and mountains. During the forming of the many Sounds, Tu had the assistance of other gods and goddesses. From these came only some of the names of the Sounds; these being too numerous at this time for all to be named.

After Tu and his helpers had made the South Island into much the shape we see it now Polynesian navigators began to arrive. The most illustrious of these voyagers was Maui, his heroic feats being those of a demi-god. It is thought that he arrived at Bruce Bay and then voyaged south. During this voyage different places were named after those people aboard Maui's canoe. It is also told that many of the names in the fiords came from the actions of Maui and his crew.

From the Sounds, Maui proceeded round to a place now known as Omaui (the place of Maui) and, thinking the Canoe of Aoraki needed an anchor, he pulled up Stewart Island. He then voyaged up the eastern side of the island to Kaikoura, where he pulled up that big fish, the North Island. After this feat he returned to Hawaiki. After this notable journey to our land, the name of the South Island was changed from Te-Waka-a-Aoraki to Te-Waka-o-Maui.

There is hardly a nook or cranny of Fiordland that is not mentioned in Maori legends. The Maori partook of all the fisheries resources available in these places, while participating in the activities described in the stories told. It was commonly understood then, as it is now, that these resources were neither early Maori nor southern Maori to own, but to use for sustenance and other needs as required. In doing so, they understood that future generations must also have the opportunity to partake of the fisheries in the same manner. The concepts of Kaitiaki Tanga and Tikanga Tangata Katoa, an obligation of responsibility for upholding spiritual beliefs in Maori culture in relation to natural and physical resources, are therefore practised today as they were in days of old. Southern Maori believe that as long as they can hold onto and practice these concepts of Kaitiaki, then man can live in health and harmony with Papa-Tua-Nuku, mother earth.

4.1 Published Accounts of Maori History in Fiordland

Between 850 and 1500 AD, Maori arrived in the South Island and explored much of Fiordland. Waitaha appear to have arrived first and are said to have discovered Lakes Wakatipu, Te Anau and Manapouri before following the Waiau River south to Te Wae Wae Bay. Later expeditions explored the Fiordland coast. By the 15th century Kati Mamoe had arrived and settled in the south. They were later followed by Ngai Tahu who were to become the dominant South Island iwi.

The early Maori name for the Fiordland area, from Milford Sound to Preservation Inlet and east to the Waiau district was Moho-Kaherehere. Translated "moho" means fugitive, a person fleeing for his life and "kaherehere", is the old Maori name for forest (Cormack, Orwin, 1997).

Following Ngai Tahu victories in the South, the Kati Mamoe sought terms with their enemy at Kaiapoi and were successful in securing a peace accord. However some Kati Mamoe were not reconciled to these arrangements. A band of rebel Kati Mamoe warriors returned south looking to attack Ngai Tahu foes settled amongst the Kati Mamoe. After being decisively routed at Otago Heads, the rebels fled to Preservation Inlet and built Matauira Pa. Matauira Island is connected to the shore by a spit at low tide. The Ngai Tahu followed them round in three double canoes attacking Matauira Pa. The Kati Mamoe occupants were killed and the Pa burnt. In the meantime some Kati Mamoe had been fishing and eeling up at the head of the Sound. On seeing their Pa in enemy hands, the fishing party slipped out to sea past Gulches Head, retreating north into the depths of the Fiordland Sounds.

Southern Maori had a nomadic lifestyle and moved with the seasons to exploit the rich resources of Murihiku (referring to the lower part of the South Island below Milford Sound in the West, and the Nuggets in the East), spending summers foraging and hunting for food across the region. Winters were usually spent on the coast in villages with access to freshwater and kaimoana.

The log of Captain Cook's exploration of Dusky Sound aboard the *Resolution* (1773) details several interactions with Maori. To commemorate his expedition, Cook left medals in Dusky Sound, several of which were later found at Otakou, evidence of the distances travelled by southern Maori.

A major Maori settlement was reported at Martins Bay before 1800. Traditional accounts suggest that Martins Bay was an important settlement as it gave easy access by sea to Milford Sound to the south and to Awarua to the north. This naturally led to canoe building, an industry for which this settlement was famous.

The Fiordland sounds area was not penetrated by Maori living north of Big Bay (Awarua), (Cormack, Orwin 1997). Sealer John Boultbee, whose sealing gang was attacked in May 1826 at Arnotts Point South Westland, was later told by southern Murihiku Maori that his attackers came from the Canterbury area and were regarded as enemies by those living in Foveaux Strait. These Maori in South Westland were refugees or fugitives displaced by the Kaihuanga feud raging at the time among Ngai Tahu in the Banks Peninsula area. For a time the Open (Jacksons) Bay Maori led a life of predatory warfare wandering the South Westland coast (Boultbee, Starke, 1986).

During the second half of the 19th Century, Europeans began to explore Fiordland in more detail, with men like Caples following the length of the Hollyford River to emerge at Martins Bay on the West Coast. The journals of these explorers often contained mention of pa sites on the banks of rivers and lakes in Fiordland, especially around Lake Te Anau. Several Europeans encountered Maori living at Martins Bay, in particular an old West Coast chief, Tutoko, his wife and two daughters after whom the highest peak in Fiordland and two coastal hill ranges were named.

In a huge, dry cave on the West Coast, about a mile from the tip of Cape Providence, seal bones, paua shells and Maori middens have been found - evidence of occupation by Maori and their dependence on the bounty of the fiords.

This dependence has been highlighted in the material submitted to the Treaty of Waitangi Tribunal by Ngai Tahu as part of their WAI-27 claim.

Original sources of meat to Maori in the south were moa, seals and schooling barracouta (*Thyrsites atun*). At first harvesting efforts were focused upon these species, but later shifted to other fish and shellfish. This is thought to be due to the depletion of the larger species of terrestrial and marine game (Anderson 1983). Haast (1874) was the first to observe that Maori middens often contained moa bones overlaid with ‘beds’ of shellfish remains. Archaeologists later interpreted this as being a move from coastal to inland moa hunting, while coastal subsistence switched to fishing, sealing, and harvesting shellfish. There appeared to be a balance as to whether moa or seals made up the greater part of the flesh diet prior to the switch in subsistence style - rocky coastlines would have provided habitat for many seals, while other areas would have had an abundance of moas. It is presumed that Fiordland could cater to either subsistence style, dependent on where Maori were living (Anderson 1983).

The following species have been identified during excavation of Maori midden sites between Port Craig and Chalky Inlet: red cod, ling, sea perch (jock stewarts), hapuku (groper), tarakihi, wrasses, greenbone, blue cod, stargazer, barracouta (Coutts 1975). It was surprising that there was no trace of bones from kahawai, moki, marblefish, warehou, flatfish, or yellow-eyed mullet (Anderson 1986). These bones show up well in samples from other locations, and it is therefore likely that fishing methods were being employed that simply did not catch these species on a regular basis. These seldom-caught species are mostly caught in seine and set nets, so the scarcity of their bones is a strong indication that netting was seldom employed in these areas of New Zealand (Anderson 1986).

In support of this supposition, fishing nets were seldom mentioned in descriptions made by early European visitors to this region. Beyond a few cases where the methods used at specific locations are known (Otago and Canterbury), there is no early historical evidence of the use of nets in southern Maori sea fishing, in direct contrast to northern Maori (Anderson 1986). However, some scraps of nets and floats have been found in Fiordland rock shelters (Coutts 1975) and sinkers are also occasionally recovered (Anderson 1986). Further, Captain William Edwardson who visited Foveaux Strait aboard the *Snapper* in 1823 does mention seeing large nets made from flax fibre, “from one to two miles in length and between 10 to 12 feet in width.” (McNab, 1907), although this account may possibly be exaggerated.

It appears that the southern Maori did not use gill nets, and although they knew about seine nets, they did not appear to use them widely. Seine nets are fairly labour-intensive to make and use, and it could be that there simply weren’t enough people available. This small work force could also be the reason more seaworthy canoes were not constructed (Anderson 1986).

The conclusion of Atholl Anderson (1986) was that “selection in the fish catch of southern New Zealand owed a great deal to constraints upon technology imposed by insufficient labour.”.

Historical and current records bear proof to little open sea fishing in Fiordland, as conditions would have been too rough and unpredictable for the canoes in use by the Maori at the time. Double canoes (two dug-outs lashed together) were observed by Wales in 1773 in Dusky Sound. These craft could not be regarded as seaworthy in any conditions other than light winds and slight sea conditions (Anderson 1986).

In 1975 Coutts examined sites in Breaksea Sound, Dusky Sound, Chalky Inlet, Preservation Inlet and Sandhill Point and found that spotties were caught in addition to those species listed above. A great deal of fishing gear was excavated, including bone and shell fishhooks, stone sinkers, wooden net floats, fishhook shanks and spreaders and flax net fragments.

Given the species caught and the watercraft available, it is apparent that the inshore shallow area of the fiords was the principal marine zone fished by the Maori inhabitants. Eventually, contact with Europeans and European technology allowed Maori to take species that previously had only been caught in low numbers. Whaleboats also allowed Maori to fish areas previously only accessible on a periodic basis.

Geologist James Hector, at Preservation Inlet in July 1863, recounts being joined by a party of Maori from Riverton who caught hapuku and had probably gone there for seals. Steep-to Island, he was told, was the usual Maori camping place, with several fine caves affording comfortable shelter (Anderson 1998). Hector described the crayfish which lay in thousands on the sandy bar between Steep-to Island and Coal Island. With six strong Maori oarsmen, Hector explored Long Sound in their seal boat. On their return to Long Sound entrance, the Maori crew caught eleven large groper, of about 30 pounds (15 kg) each to replenish the expedition's food supply (AC & NC Begg). Traditionally, groper have been taken by Maori fishers and are a highly regarded seafood.

Fiordland was no doubt a rather wild and inhospitable area in pre-European times and, with the exception of the Martins Bay community, residents were seemingly those seeking refuge from the ire of others. Nevertheless, the available information encourages Anderson (1998) to conclude that Maori, mainly from Foveaux Strait, were probably frequent visitors to Fiordland to obtain seals and greenstone.

5 EUROPEAN ARRIVAL

The following information on the history of Fiordland's fisheries was obtained from published accounts of activity on the coast and from interviews with several people with long family and/or personal involvement in the area.

5.0 EARLY HISTORY

The earliest records of European presence in Fiordland come from the journal entries detailing Captain James Cook's first two expeditions to New Zealand in the early 1770s. On his first expedition in 1770, Cook sailed the *Endeavour* up the Fiordland coast. Abandoning his first attempt to enter the expansive fiord on dusk, he named Dusky Bay due to the failing light. Sailing north, he cautiously avoided entering Doubtful Sound, being "doubtful" there would be enough wind to sail back out of the steep walled fiord. The first European to describe the Fiordland coast, Cook recounted: "No country upon Earth can appear with a more rugged and barren aspect than this doth". He described wooded hills rising directly from the sea, backed by rugged mountains of barren rock, and prodigious height, "covered in large patches of snow which perhaps have lain there since the creation".

5.0.0 Cook Explores Dusky

Returning to Dusky Bay in the *Resolution*, Cook entered the fiord, dropping anchor off Anchor Island on the 26 March 1773. Next morning a superior anchorage was found in Pickersgill Harbour which was to become the base for activities over the next five weeks. After four months at sea in the stormy Antarctic, Cook wanted to give his crew a well-earned rest and sustenance. From this "snug little harbour" behind Crayfish Island, Cook refitted his ship. While Cook and his men explored and charted the fiord, his scientists carried out examination of the flora and fauna.

His first act on the ship being moored was to send out a boat party with hooks and lines to provide fresh fish for his men. He found that "the Sound teemed with fish, so that an hour or two of fishing per day, provided enough for the whole ship's company" which numbered 112 men.

Cook provides us with the very first fishing impressions by Europeans visiting the Fiordland coast, recording in his journal:-

> "What Dusky Bay most abounds with is fish; a boat with six or eight men, with hooks and lines, caught daily sufficient to serve the whole ship's company. Of this article, the variety is almost equal to the plenty; and of such kinds as are common to the more northern coast; but some are superior and in particular the *coal fish* (blue cod), as we called it, which is larger and finer flavoured than any I have seen before, and was in the opinion of most on board, the highest luxury the sea afforded us…The only amphibious animals are seals. These are to be found in great numbers, about this bay, on the small rocks and isles near the sea coast." (McNab, 1909)

On one occasion Cook's journal reported: "In the morning hauled the seine (net) for the first time but caught only four fish. Hooks and lines make up for these deficiency". (Beaglehole, 1961)

While in Dusky, Cook made mention of the abundance of rock lobster, still commonly called crayfish. Cook recounts:

> "I found…a very snug cove, on the south-east side of Anchor Island…sheltered from all winds, which we called Luncheon Cove, because we dined on *crawfish* on the side of a pleasant brook under the shade of trees". (Beaglehole, 1961)

While Cook is silent on how the *crawfish* were caught, it may be presumed they were caught with a baited line, as described later by Boultbee. Cook's journal makes further mention of the sounds rich bounty:

> "Every corner of the Bay abounds with fish, the *coal fish* (as we call it) is here in vast plenty, is larger and better flavoured than I have any where tasted, nor are there any want of *craw* and other shell fish". (Beaglehole, 1961)

Cook found the same lavish supply in waterfowl that abounded. Five species of duck including the "painted" (paradise) duck and the now rare "whistling" (blue) duck fell under the guns of the ships foraging parties. "The woodhen" wrote Cook, "eats very well in a pie of fricassee" and "the flesh of the poy bird (tui) is most delicious". (J Hall-Jones, 1976) While fresh fish and duck roasted on the embers, kegs of spruce beer was brewed to quench the thirst. The beer brewed from the leaves and branches of the rimu tree and manuka (tea) tree, to which molasses and yeast was added, was used to take the place of vegetables to ward off scurvy.

During the *Resolution's* extended six week stay, Dusky Sound was thoroughly explored and charted by Cook and his crew, with the ships botanists and zoologist being much in awe of the flora and fauna they examined. There had been several interactions with three or four small families of Maori during the exploration, all of which were friendly, and resulted in the European naming of physical features in the area, including Indian Cove, their first meeting place on Indian Island. Cook and his astronomer William Wales visited two Maori huts, as well as a cave shelter at Cascade Cove. They found "a canoe hauled upon the shore near two small mean huts where there were several fire places, some fishing nets, a few fish lying on the beach and some in the canoe". (Beaglehole, 1961) The Maori inhabitants of the camp remained absent during the short visit. Wales described the huts as round and vaulted, standing 4 or 5 feet high, being constructed of flax and bark and built strategically near the sea. Wales also described the fishing tackle used by the Maori in Dusky:

> "They had a variety of fish hooks in their canoes. Some made all of wood, others all of bone (whale and human) and others again, part wood and part bone, joined by tying them together. Their lines are made from hemp (flax) plant, some twisted as our cordage is with two, three or four strands or twists, and others platted like the lash of a whip". (A C & N C Begg, 1966)

Scientist Anders Sparrman was impressed by the speed the native (Maru) prepared a meal. “By rubbing two pieces of dry wood together they produced a fire with incredible rapidity, and immediately and ingeniously cooked a fish on the embers. Fellow scientist Johann Forster observed; “The inhabitants dress their fish with so much care, that a man with a good appetite would not refuse to eat with them.” The midden outside the hut was observed piled high with the shells of pipi, scallop, giant mussel (green-lip mussel), limpet and *earshell* (paua). (A C & N C Begg, 1966) This provides evidence of the Maori’s diet and their reliance on the outer fiord’s rich shellfish resources.

By the time the *Resolution* finally sailed north via “New Passage” (Acheron Passage) to Breaksea Sound and into the Tasman Sea, Cook had done much to stimulate European interest in this far-flung southern sanctuary. Historian Robert McNab (‘*Murihiku*’, 1909) credits the publishing of Cook’s fine chart of Dusky Sound and his glowing accounts of “teeming fish and numerous seals”, as doubtless the reason that brought the sealers to Dusky at the end of the eighteenth century; making it an important trade centre for many years to follow.

5.0.1 Vancouver’s Return

Eighteen years later, one of Cook’s midshipmen, George Vancouver, returned to Dusky Sound in command of two naval vessels, the *Discovery* and the *Chatham*. On the 2 November 1791 Captain Vancouver anchored in Facile Harbour. Vancouver did not intend to stay as long as Cook had done. Parties were at once employed cutting wood for fuel, and timber for spars and planks, brewing rimu beer and repairing sails, rigging and casks. “A boat with four men was constantly employed fishing”. (McNab, 1909).

During the next three weeks Vancouver visited many of the coves charted by Cook and completed what little work he had left undone, including the further exploring and charting of Breaksea Sound. In contrast to Cook’s visit, Vancouver’s Botanist Dr Menzies noted a “singular absence of Maori”. His journal records a few old huts were found abandoned, in and around Facile Harbour. The huts appeared no more than temporary shelter and bore no marks of being recently inhabited. Scattered around the fireplace they found a great number of *earshells* (paua) and limpets. While Maori were absent, Menzies journal confirms the fishing in Dusky had not deteriorated since Cook’s last observations. A boat deployed daily in fishing “was not long gone, when she returned with a sufficient quantity of fish for all the Ship’s company”. The *Chatham’s* log records: “Fish was in great plenty and excellent in their kind. The best are the *cole fish* (blue cod) and skip jack. Many of the former weighed 10 to 15 pound (5 to 7 kgs), and were equal in firmness and flavour to codd. We never caught any flat fish, and the only shell fish besides small mussels and limpets are cray fish.”. (McNab, 1909) On his departure, Vancouver paid tribute to Dusky as a marine sanatorium: “Thus we quitted Dusky Bay, greatly indebted to its most excellent refreshments, and its salubrity of its air. The good effects of a plentiful supply of fish and spruce beer, were evident in the appearance of every individual in our little society”.

5.0.2 The First Traders Arrive

The first recorded European trading visit into Dusky Sound, occurred on 6 November 1792 with the arrival of Captain William Raven, in the *Britannia*. Raven’s mission was to procure seal skins for the China market. From Facile Harbour Raven examined the Sound, selecting Luncheon Cove on the south side of Anchor Island as a suitable site to leave a shore based sealing gang. Sufficient provisions for a 12-month stay were sent ashore, and work commenced on erecting New Zealand's first European house. The 12-man gang was also directed to build a small wooden ocean going vessel, in case the *Britannia* didn't return (J. Hall-Jones, 1976).

On Raven's return on the 27 September 1793, Leith's men had almost completed the 16 metre (53 feet) long vessel, which was built on stocks. The building of this craft was at the time, the first vessel built in Australasia entirely from local timber. The vessel was left on its stocks, in Luncheon Cove, where it was destined to play a life saving role two years later. The weather during the sealer's stay had been very bad, with severe gales and heavy rains from the north-west often impeding labour. *Britannia* departed Dusky on the 21 October 1793. En-route to India, Captain Raven reported on the benefits of Dusky to the Norfolk Island authorities:

> "Fresh provisions are readily procured. *Coal-fish* (blue cod) are innumerable and may be caught with hooks and lines in almost any quantity, and have this peculiar excellence. My people (sealers) ate them without bread for many months twice a day, and were fond of them to the last." (McNab, 1909)

5.0.3 Spanish Explorers Visit Doubtful Sound

While Cook had named Doubtful Sound, the first Europeans to enter the Sound in February 1793 were a Spanish expedition under the command of an Italian, Alessandro Malaspina. Under his command two Spanish ships the *Decubierta* and *Altrevida*, spent a total of five years sailing round the world in exploration.

Attracted by Cook's accounts, Malaspina dispatched Don Felipe Bauza in an armed long boat to explore Doubtful Sound, while the two corvettes stood safely off the entrance, seaward of two prominent rocks, the Hare's Ears. Contrary to Cook's and others' experiences of Dusky Sound, Bauza saw only "a few birds, no seals, no shellfish save a few limpets and not a single sign, however remote of inhabitants". Malaspina concluded, "unless chance or dire necessity brings mariners to this port, it is destined to be perpetually deserted". As strong winds prevented Malaspina's expedition putting into Dusky, he decided to head for Sydney (J Hall-Jones, 1984). A sprinkling of Spanish names remain on the charts of Doubtful Sound to mark this early Spanish visit.

5.0.4 Dusky's First Shipwreck

The next visitors to the Fiordland coast were the ill-fated *Endeavour*, under Captain William Bampton and the brig *Fancy* under Captain E T Dell, sailing together from Sydney. Arriving in Dusky Sound in October 1795, both vessels put into Facile Harbour. The *Endeavour*, an East Indiaman of 816 t (800 t), (which is not to be confused with Cook's ship) arrived in a chronically leaking condition and on inspection was found to be unseaworthy. Having no alternative but to condemn the waterlogged *Endeavour*, she was stripped of all useful items, before foundering on rocks in Facile Harbour. (J Hall-Jones, 1976)

The total number of people now in Dusky from the two vessels numbered 244 persons, more than the rest of New Zealand's European population at the time. The *Endeavour's* log records fishing parties were daily employed to provide fresh fish for the shipwrecked community.

While hook and line were successful, one excursion by a boat “to haul a seine net in Goose Cove, returned without a fish”. (McNab, 1907)

Raven’s unfinished vessel in Luncheon Cove was eventually completed and commissioned as a schooner, named the *Providence* under Captain Dell, while Bampton took command of the *Fancy*. After three months of fitting out, the *Providence* with ninety persons aboard and the *Fancy* with 64 persons sailed for the convict settlement of Norfolk Island, which they reached safely on the 19 January 1796. (McNab, 1909)

Meanwhile, the balance of ninety persons remained in Dusky Sound to complete the lengthened longboat renamed the *Assistance*, which eventually sailed with 55 persons under first officer Waine. The *Assistance* reached Sydney on the 17 March 1796 in a distressed state having exhausted provisions the day before making land. As no suitable vessel was available in Sydney to retrieve the remaining 35 shipwrecked mariners, incredibly a year passed before the New South Wales Governor made arrangements for an American whaler the *Mercury*, to collect the *Endeavour* survivors. The *Mercury* sailed in mid May 1797 for Dusky Sound uplifting the remaining 35 marooned survivors who had been stranded a total of twenty months. (McNab, 1909) Miraculously the survivors abandoned by Bampton with critically low provisions had endured unimaginable hardship, sustained in great part for the twenty months by eating fish, seal meat and mussels.

The consistent message from the accounts of these early European explorers is that all had been sustained by fishing. The ships’ logs and journals record the mariner’s daily reliance on fishing the apparently abundant inshore fish stocks. This is notably so in the expansive water ways and maze of wooded islets of Dusky Sound. As the Spanish mariner Bauza, and later stranded sealers found, the steep walled depths of Doubtful Sound provided meagre sustenance from fish and shellfish, compared to the open fiords to the south.

5.0.5 Bass Proposes Southern Fisheries Monopoly

The intrepid navigator George Bass after whom Bass Strait is named, advanced a bold Fishery scheme to the New South Wales authorities, after making just one visit to Dusky Sound in November 1801. En-route for Tahiti aboard his brig *Venus*, Bass spent two weeks cutting timber for casks and salvaging iron from the *Endeavour* wreck. On his return to Sydney, Bass proposed to Governor King, that he supply salted fish to supplement the Public Stores reliance on imported beef and pork. In return Bass sought “exclusive rights to the South part of New Zealand, or that south of Dusky Bay, including the Bounty, Antipodes and Snares Islands”. With an eye to monopolising the seal trade, he speculatively advanced in a written proposal; “I have every proof, short of actual experiment, that fish may be caught in abundance near the South part of the South Island of New Zealand, or at the neighbouring Islands. And that a large quantity might be supplied annually to the Public Stores”. However before the seven-year lease, renewable to 21 years was granted, the intrepid Bass sailed once more for Dusky Sound en-route to Chile. Proposing to explore the Southern Islands in search of seals and fish to furnish a cargo for England, Bass never returned. Lost without trace, some have speculated his brig *Venus,* may not have escaped the uncharted reefs of Foveaux Strait. (McNab, 1909)

5.0.6 Sealers and Whalers

The next wave of visitors were the sealing gangs. Until the early years of the nineteenth century the great sealing ground of Australasia was Bass Strait between the Australian mainland and Tasmania. By 1803, seal numbers had declined to the point where sealers now eyed the southern islands and south coast of New Zealand in search of new grounds. The New Zealand seal trade commenced in earnest with the arrival of Sydney based sealing vessels, dropping off shore based sealing gangs along the remote Southland and Fiordland coasts in search of the fur seal (*Arctocephalus forsteri*).

In 1809 Captain John Grono aboard the *Governor Bligh* worked the Fiordland coast, returning twice to Sydney with 10,000 skins on each occasion. The following year he returned from Doubtful Sound with a further 10,000 skins. Grono the first recorded visitor since the Spaniard Bauza, named several features in Doubtful Sound including Thompson Sound. In the course of his expeditions he explored and named several of the northern fiords, including Caswell, Nancy, George and Bligh Sounds and notably the majestic Milford Sound, named after his Welsh birth place of Milford Haven.

In December 1813 Grono returned with 14,000 skins and a party of stranded sealers he had rescued off Secretary Island. The sealers had been dropped off three years earlier from the ill-fated *Active*, which sailed away and was never heard from again. After their dinghy was smashed and until rescued by Grono, the abandoned sealers had eked out an existence on seal meat in season and a species of fern root, which they roasted or boiled. (J Hall-Jones, 1976) Without a boat to cross the mile and a half to the mainland, fishing options were reduced. Low numbers of blue cod and shellfish in the deep walled waterway surrounding Secretary Island, may have added to the sealer's misery by denying them valuable sustenance.

Unlike the ill-fated *Active* gang, most shore based sealing gangs were reliant on a small whaleboat for access to the remote seal colonies and for fishing. The hardy sealers subsisted on fish, shellfish, and seal meat, in addition to bird's eggs, sea birds and woodhens, to augment their dry stores and salted pork rations. The success or not of a sealing party, not only depended on the number of skins taken, but also on the location's available food resource for survival.

The seal industry continued unabated until the mid 1820s. However, from this time, as sealing declined, the whaling industry began to focus on New Zealand waters.

Erected in 1829, the Port Bunn shore whaling station in Cuttle Cove, Preservation Inlet, was the first and undoubtedly one of the most remote shore whaling stations in Southern New Zealand. Captain Peter Williams built and managed the substantial station, employing up to sixty men, manning sixteen whaleboats during the season. Williams and his family put in several seasons at Cuttle Cove up until 1836. In 1835 the station was purchased by the then Sydney based merchant Johnny Jones in partnership with Edwin Palmer, who became the manager. The adjacent Fiordland sounds yielded plenty of whales during calving, and the station prospered until they were exterminated. (Evison, 1997) By 1838, the station had been abandoned by Jones for the more accessible site at Jacob's River (Aparima) in Foveaux Strait.

Sealing parties from Jacob's River continued to visit Cuttle Cove during the summer months in search of seals along the Fiordland coast. By the early 1840s, the decline in right whale numbers visiting Foveaux Strait necessitated the use of larger vessels and extended trips to the western fiords by the Jacob's River and Bluff whalers. In 1840 Captain John Howell, the founder of the successful Jacob's River (Aparima) shore whaling station, purchased the 71-ton schooner *Amazon*. With a crew of 16 to 17 men, the schooner carried two whaleboats that were each manned by six men; five oarsmen including the harpooner at the front and the headsman who steered the boat from the stern with a long oar (Richards, 1995).

In 1842 during a cruise around to the west-coast sounds, Howell's schooner put into Bligh Sound one night and dropped anchor. To the crew's surprise, fires were seen ashore. Early next morning a boat's crew landed to investigate. A Maori dwelling was found, and in it some mats, a whalebone patu paraoa (club) and other articles including fish hooks. The occupants of the whare had fled into the bush, leaving only footprints behind them. It is believed that these Maori, were remnants of the fugitive Kati Mamoe rebels, that many years earlier had fled their Ngai Tahu pursuers into the depths of Fiordland to become romantically known as the "Lost Tribe". (Roberts, 1913)

During the winter whaling season it was not uncommon for the *Amazon* to spend up to three months "hunting bay whales off the sounds on the west-side". An American Burr Osborn who crewed on the *Amazon* in 1846, recounted that during periods of bad weather (which occurred often), they would run into the sounds to fish and hunt wood-hens and ducks. "We fished and caught clams (called cockle by the English), craw-fish (rock lobster) etc. It must be remembered the greater part of our supplies came from the ocean". Osborn reported they also had good luck sealing, taking over 100 seal and 800 barrels of sperm oil. (Richards, 1995)

While the vessel owners turned from harvesting the sea to farming the land, their mixed crews of pakeha and Maori, all knew and appreciated the natural supply of fish and shellfish which could be obtained from the sounds to sustain them on their hunting forays. Amongst the most sought after fish was the groper (Hapuku) and the black footed paua, which the early Europeans called "*pawa*" or "*mutton fish*". Fishing for food was a natural and necessary part of each working day when around the coast. Fishing also provided sport and relaxation when weather and sea conditions prevented the mariners from venturing outside the Sounds. Beyond eating fish and shellfish "fresh", fish such as groper and barracouta were sometimes preserved by drying in the sun on racks in the old Maori way, or salted down in casks, while blue cod was suitable for smoking.

5.0.7 The Acheron Survey

In 1851, Captain John Lort Stokes of the HMS *Acheron* completed a coastal survey of all the West Coast Sounds. The *Acheron*, a wooden paddle steamer rigged as a barque was accompanied around the sounds by the whaling schooner *Otago* under Captain William Stevens, from Jacob's River. Stevens' brother George Stevens, along with another straits whaler Tommy Chasland using their local knowledge, piloted the *Acheron* up through the sounds, while the *Otago* operated as tender.

Commander Richards also leaves us with an excellent description of the Fiordland coast. "The only natural harbours along the whole West Coast are those truly remarkable sounds and inlets which penetrate its south-west shores. Approaching from seaward the smaller inlets have more the appearance of ravines between high and rugged mountains than entrances of harbours. The most remarkable feature, common to all (the sounds), is their great depth of water. Soundings can rarely be obtained under 80 or 100 fathoms (180 metres) and where a cove is reached where an anchor can be dropped, it will generally be necessary to secure to the trees also". On entering Milford Sound, considered "the most remarkable harbour" visited in New Zealand, "the *Acheron's* masts dwindled into nothing beneath the towering cliffs". (J Hall-Jones, 1980)

5.0.8 Gold Miners and Loggers

The final influx of people of historical note came with the Preservation gold rush and timber boom. With the decline in whaling and sealing, Preservation Inlet's next concentration of human endeavour was in the exploitation of minerals. Prospectors had long known gold probably existed in the area, but it was 1890 when the gold rush commenced after a 600-800 gram nugget was picked up on Coal Island. The 70 gold miners already working Coal Island were joined by a flood of miners, who initially landed at the old whaling station site in Cuttle Cove. The gold rush was on and two separate communities sprang up. The construction of a quartz crushing battery at the Golden Site mine led to the first settlement at Cromarty, which also supported a sawmill. The second settlement at nearby Te Oneroa was commenced after the discovery of the Morning Star reef. At the height of Preservation Inlet's gold rush, over 500 people populated the Inlet, with miners eventually concentrating on the two surveyed towns. The towns sported hotels, accommodation houses and stores. As with the sealers and whalers, there was a strong reliance on fishing as a food source by these isolated communities. By 1907 the gold mining had petered out and the last mines closed.

5.1 Commercial Fisheries

Before 1900, commercial fishing on the West Coast was limited. The fishing that did exist was centred on blue cod and hapuku. Of these, blue cod was more marketable and, given their smaller size, more blue cod than hapuku could be carried on board. In 1893, Bluff fish merchants Urwin and Roderique were shipping large quantities of fish, including blue cod, to Melbourne for the Australian fish markets.

After the turn of the century, fishing in Fiordland gradually increased, with more boats venturing around to the western coast. In the early 1900s blue cod was still being exported from Bluff for regular sale on the Melbourne fish market. By 1903, a fish shed and freezer was operating in North Port Chalky Inlet, managed by W. Thomson to process blue cod and groper landed by a fleet of small vessels from Bluff and Riverton (AC & NC Begg, 1973). With more markets for their fish, fishermen from Colac Bay and Riverton in particular, began making longer journeys to the West Coast grounds, remaining away from their homes for many days on end (MacIntosh, 1980). Trips became longer as advancements in technology increased safety and helped to ensure that a profitable catch would be returned to port many weeks later. Such developments included benzene and diesel powered engines to replace steam and sail, and the arrival of ammonia (and then later, freon) freezers. Despite the development of combustion engines, most craft continued to carry sails to ensure their return to port. Fiordland was, and is, a dangerous and rugged coast where vessel reliability is of paramount importance.

Blue cod was the main fishery until the end of the 1940s, with fish caught on hand-lines from tender dories. Using this method, catch rate was determined by how fast the lines could be hauled and returned. Other limiting factors were freezer size and fuel supplies. To overcome the obstacle of freezing facilities (not all boats had freezers until after the '40s), fishing stations were established, one in Dusky Sound, and a larger one based at North Port in Chalky Inlet. Here, 15-20 boats brought their catch to be frozen in a diesel-powered freezer. Fuel was also available from the station.

Other fisheries at the time were lining for hapuku and occasional set netting for moki and butterfish, although this was restricted almost entirely to 2-3 months of the year, when the main target was butterfish. As in the blue cod fishery, freezer space was limited and only the larger fish were taken to ensure a profitable operation.

During World War II, the blue cod fishery waned as fishers left to enter active service. Technology developed during the war years changed the nature of fishing in the late 1940s as radios and better trawling gear became available.

After the war, the blue cod fishery continued to wane as oystering in Foveaux Strait rapidly expanded and markets were found for trawl fish species such as rig and elephant fish. These fish could be caught close to port and yielded greater profits than blue cod. Trawling was largely carried out in Te Wae Wae Bay for flatfish species but when these were out of season some fishers set out around the coast to try their luck in Big Bay and Jackson Bay at the top of Fiordland. There, they were hampered at times in their attempts to catch flats by the large amount of rock lobster that were gathered by the nets.

5.1.0 Rock lobster fishery

Before the development of rock lobster export markets, rock lobsters were often caught in great quantities but they fetched a low price and were mainly consumed locally (Street, 1970). Local trawlermen returning to port would often deposit a sack of rock lobster on the wharf for the locals to take home a meal.

While there was a limited European market for the earliest lobster catches, it was the opening of the American market for frozen lobster tails during the late 1940s, that fuelled the rapid development of this fishery. Fishers began to target lobster with hoops and pots but those early attempts required refining to overcome the difficulties of fishing such exposed waters. Again, technology improved fishing effort with the development of steel pots, plastic buoys able to withstand the punishing conditions, and, very importantly, synthetic ropes. These were much lighter, less bulky and easier to handle than the heavy coir ropes, freeing up precious deck space to allow more pots to be fished. Because of the distance from port, the fishery was based on lobster tails, which took up less room and, importantly, could be frozen to maintain their quality during several weeks at sea.

By 1948 the rock lobster bonanza was beginning. Between July and February, the coastal stretch from Puysegur Point to Milford came alive with small fishing boats. "Shallow-draughted, seaworthy and well skippered, the boats deliberately worked the hazardous inshore grounds where the rock lobsters were considered more plentiful." (Powell, 1976). The '50s boom years saw boats coming to fish Fiordland's waters from as far away as Nelson, Westport, Greymouth, Lyttelton, Akaroa, Moeraki and Port Chalmers, joining the local Waikawa, Bluff, and Riverton boats. The big mercantile company *National Mortgage* as well as *Otakou Fisheries* of Dunedin sent several boats from Port Chalmers and developed a system where smaller boats would feed their catches into a mothership with large freezers. This was a virgin fishery and even though the techniques for harvesting fish had not yet been perfected, catches were initially very large. In these early years it was not uncommon for fishermen to be lifting full pots, with a groper feeding on the rock lobsters clinging to the outside of the pot. Total landings reached a peak of over 4,000 t in 1956. Thereafter, the landings declined in volume and size of individual fish taken as the accumulated stocks of large resident inshore rock lobster were fished down.

As time went on, equivalent catches required increased effort. Moving on from the early days of trawling and hooping, lobster pots were developed, boats became faster, freezers became larger and increasing numbers of boats entered the fishery despite the controlled licensing regime that was in place until 1963.

The opening of the Homer Tunnel in 1952 increased tourism in Milford Sound. The tourist fleet expanded and inevitably conflict grew over limited mooring space in Freshwater Basin. Commercial fishing and tourism were not considered to be compatible by the Tourist Hotel Corporation. The THC cited concerns over impaired visual aesthetics and navigation hazards posed by fishing gear set inside the Sound. As a result, regulations were introduced in 1954 prohibiting commercial fishing and the disposal of offal in Milford Sound (Annala, 1983).

The Homer Tunnel, the later completion of the Wilmot Pass road into Deep Cove in the late 1960s, plus the arrival of amphibious aircraft, greatly assisted the lobster fishery. These three events all made it easier to transport the lobster tails out of Fiordland and released many fishers from the constraints of having to return to their home port to land the harvest. Freighting tails directly from Fiordland also allowed fishers to conserve fuel and stay away from their home port for longer periods.

Importantly, in 1988 technology and markets were developed to allow a live export lobster fishery to supersede the "tailing at sea" fishery. The use of helicopters meant lobsters could be at the pack house within minutes of leaving the boat. The new live fishery based on Asian markets has today almost entirely replaced the North American frozen lobster tail market that drove the early fishery.

Growth of the rock lobster fishery eventually levelled off and remained fairly constant up to the species introduction into the QMS as a transferable term quota (TTQ) fishery in 1990. With the passing of the 1996 Fisheries Act, these transferable term quotas were replaced with individual transferable quotas (ITQs).

With the introduction of TTQ and ITQ, many small fishers left the fishery. There are presently fewer fishers working greater numbers of pots - from the 20-60 pots during the late '40s to around 200 pots today. This on-going restructuring has meant that over-all pot lifts are declining each season.

5.1.1 Paua Fishery

In more recent times a paua fishery has developed in Fiordland. The rapid development of the national fishery during the 60's and 70's did not reach Fiordland until the mid to late

1980s. The exposure and isolation of the coast mean only the best equipped fishers are able to access the area with less than a dozen fishing operations catching the bulk of the harvest. More fishing takes place in the south, but with fewer harvesting operators, spelling areas was able to evolve early in the Fiordland fishery.

One of the earliest attempts to export paua meat was reported in 1872. Two enterprising local Maori had harvested and preserved half a ton of “mutton fish” from Centre Island for shipping by wool ship to the London market (MacIntosh, 1980). Apart from these early trials, the national paua fishery began just after World War II and was based on paua shell used for making jewellery and souvenirs. The Customs Export Prohibition Order of 1946 banned the export of raw shell but allowed the export of manufactured items. Until the early 1960s the meat was often discarded because of its low value and the lack of markets.

Exploratory fishing in Fiordland by a large Nelson based company vessel in the early 1970s encouraged other new paua diving operations to extend their diving to around the Fiordland coast. During these years and up until the issue of individual quota in 1988, fishers were restricted to landing a maximum of one tonne of greenweight paua per vessel, per week. This was easily circumvented by registering multiple vessels, This included dinghies, inflatable craft, kayaks and in one case, it is rumoured that wooden pond board was registered. Apart from the one tonne per week and the prohibition on the use of under water breathing apparatus, the biggest restriction on paua fishing in Fiordland was the fish packhouse export regulation requirement to land paua alive in the shell to the packhouse. The cost of floatplane and helicopter transport discouraged large scale diving until the introduction of quota and higher export returns.

Following concern about Stewart Island paua stocks, legislation was introduced in 1995 sub-dividing PAU 5 into three quota management areas: Fiordland - PAU 5A, Stewart Island - PAU 5B and Southland/Catlins/Otago – PAU 5D. There was an even allocation of the TACC between the three areas with the PAU 5A TACC set at 147 t. Each quota holder was allocated 33% of their quota within each QMA. The sub-division was expected to divert divers with larger vessels to work the more distant Fiordland coast (Elvy, Grindley, Teirney, 1997). Another innovation that assisted harvesting of Fiordland paua stocks has been paua holding pots and vessel wet wells to keep paua alive until landing.

5.1.2 Wet Fishery

Blue cod remains an important target wet fishery in Fiordland, and is seeing a resurgence. There is an increasing trend for Bluff and Riverton blue cod fishing boats to fish the lower coast from Doubtful Sound south to Sandhill Point, to spread fishing effort and avoid competition on fishing grounds in Foveaux Strait and around Stewart Island.

In recent times fisheries for various offshore fish species such as shark, groper, tuna, and bluenose have grown and some exploratory fishing for kina (sea urchin), sea cucumber (*bêche de mer*) and scallops has been undertaken, but these have not developed into commercial fisheries to date.

5.2 Recreational Fisheries

As already stated, European explorers and sealers fished in Fiordland on a subsistence basis. Targeting finfish, their catches would have been consumed close to the time and place of capture. Even though early European fishing was for subsistence, at times it provided a significant population with a valued source of palatable protein.

Late in the 19th century a few settlers who became resident in Fiordland undoubtedly depended on fish as a source of food. These early activities include the Murrell's tourist facilities in Deep Cove, Doubtful Sound and the Gaer Arm of Bradshaw Sound, as well as the Milford Sound Hotel. Operating since the 1890s, these ventures illustrate that the attractions of Fiordland were evident from the earliest times. Subsistence fishing continued to be characteristic of Fiordland up until the early 1950s, mainly servicing the needs of the limited numbers of tourists, hunters and mariners. Numbers were limited by access being only by foot or by sea.

In 1953 the Homer Tunnel finally opened for road traffic. By this time the post-war rock lobster "bonanza" was well under way in Fiordland. Recreational fishing had long been recognised as part of the tourist experience at Milford but had remained limited to subsistence purposes. Road access opened up Milford Sound, although towing boats through the new tunnel was not allowed until it was widened 30 years later, around 1983.

In 1954, the Doubtful Sound Lodge again became a destination for tourists and fishing was a significant activity from the outset. The lodge relied on fresh fish and venison for the menu, supplies being brought in only twice a year. The capacity of the lodge was 40 people, plus staff, and it was always full over Christmas/New Year and at Easter time. Fishing was part of this tourist experience, fish being taken out only in small quantities as it had to be carried and was difficult to keep in good condition (Hutchins, 1998).

Development of Deep Cove as a base for fishing activity was further enhanced from the late 1950s by the advent of amphibious aircraft, this being the closest fiord destination, by air, from Te Anau. Rock lobster tails began to be flown out and supplies back-loaded.

In 1963, the Government took over the Deep Cove lodge and foreclosed on tourist activity while construction of the Manapouri power scheme took place. Over 500 men lived on the old trans-Tasman liner Wanganella at Deep Cove. At the peek of construction the power scheme employed over 1,800 men. Even before the Manapouri power scheme was completed, Doubtful Sound began to be recognised as the main focus of recreational fishing in Fiordland. Determined and enthusiastic amateur fishers prevailed on the authorities to permit them to tow boats across the new Wilmot Pass road. The attraction was the ready catches of finfish and rock lobster that could be made in central Fiordland and a growing awareness of game fishing opportunities for bluefin tuna, albacore and various sharks. When the power scheme was completed in 1971, the Wilmot Pass road became the main recreational fishing access to Fiordland, though it could only be reached after crossing Lake Manapouri by boat.

At about this time, some commercial fishers began to take friends and acquaintances away to enjoy the hunting and fishing opportunities of wild and remote Fiordland. At first these trips were usually combined with normal commercial fishing operations but they soon developed into informal charter arrangements.

The opening of the Wilmot Pass road to the public, coupled with a continuing ban on towing through the Homer Tunnel to Milford Sound, made Deep Cove the only practical entry point for trailer boats into Fiordland. The outer reaches of Doubtful and Thompson Sounds came to be recognised as the most favourable location for game fishing, especially for bluefin tuna. Here, it was thought, the continental shelf was narrower and warmer oceanic water came closer to shore. Extensive sheltered waters inside the entrances provided for a range of general fishing when conditions offshore were unsuitable, as they often were.

After the Manapouri power scheme was completed, various accommodation buildings and plant used during the construction were taken over by the Invercargill-based Deep Cove Outdoor Education Trust. The primary objects of this trust are educational, providing an opportunity for organised groups of school children to experience the wilderness and learn about the environment. Fishing has always been part of this experience, using rods, hand-lines and occasionally a long-line, to catch spotties, jock stewarts, spiny dogfish , sometimes blue cod and even groper.

Around 1972, the Fiordland Game Fishing Club was established and flourished for about 20 years. Each year, at least one, often two, expeditions into Doubtful Sound were organised. These mainly targeted bluefin tuna and sharks and took place from Christmas onwards, and always at Easter. Expeditions would involve up to 20 boats and 80 people, mainly from Invercargill, Gore and Queenstown. The fishing club largely financed the Dea's Cove hut. Use was also made of the Blanket Bay Hotel as a base for freezer facilities and occasionally for floatplane access. These expeditions were generally of 8–10 day's duration. Relations with commercial fishers were good and they often provided freezer facilities to hold catches. Fishing for the pot, hunting ashore for venison and later on, diving, were secondary activities on these expeditions.

The club maintained certified weighing scales and appointed official weigh-masters at Te Anau and Milford Sound. Many members used approved IGFA tackle suitable for claiming records. In 1978 the club won the National On-Base Fishing Contest. Although bluefin tuna were the main attraction, different members at times held national and world thresher shark records. Most game fishing took place on the open coast outside the fiords, up to several kilometres offshore. In the early years the only game fish brought out were those for which a record might be claimed. Later, bluefin tuna was eaten and sharks were tagged and released.

Up until 1984, safety constraints on small boats restricted most recreational fishing activities to the Doubtful/Thompson/Bradshaw Sound complex. Some fishing was undertaken from tourist boats in Milford Sound and, on an opportunistic basis, from commercial fishing boats elsewhere in Fiordland. A few brave souls travelled further afield, picking their opportunity in fast boats. This group fished outside on the open coast for bluefin tuna when weather allowed but spent about two thirds of their time inside the Sound fishing for groper, rock lobster and blue cod. Between them, collective daily catches of up to 7 or 8 bluefin tuna (each weighing 29 to 50 kg), 12 to 14 groper, and half a bag of rock lobster were not unusual. Blue cod were there for the taking.

Scuba diving activities were quite limited in the 1960s and early 1970s, mainly by a lack of compressed air supplies. Towards the late 1970s diving became more popular inside these Sounds prompting the beginning of dive-charter activity in Fiordland. Divers mainly target rock lobster, with a limit of 6 per day. Diving tourism has become increasingly popular.

Since the number of safe dives is restricted to two or three per day, normal operations also allow plenty of time for conventional fishing, mainly for the pot, targeting blue cod and groper.

In the early 1980s, following the widening of the Homer Tunnel, the ban on towing trailers into Milford Sound was lifted. Milford Sound became a major focus for recreational fishing, as it was then more conveniently accessible to trailer-boat owners than Doubtful Sound. The Fiordland Game Fishing Club, for example, gave up their major expeditions into Doubtful. They turned their attention to Milford Sound and even planned floating barge accommodation for which official permission was denied at the eleventh hour in 1992, creating significant debts. The club went into recess and has recently been wound up.

Nowadays, Milford Sound is characteristically a site for independent private boat owners engaged in recreational fishing and diving. The main advantage is seen to be convenient access, set against the disadvantages of restricted and relatively crowded waters. Milford Sound has only a limited area compared with Doubtful Sound.

The access, infrastructure and services available at Deep Cove have ensured Doubtful Sound continues to be an important base for recreational fishing, though on a more casual basis than in earlier times. Privately owned boats can be got in and out of Deep Cove more readily than ever before, there being some 28 Department of Conservation concession holders authorised to tow boats over the Wilmot Pass between West Arm and Deep Cove.

Rebuilding of the Deep Cove Hostel around 1980 provided accommodation used by Boating Clubs. At Easter 1998, there were some 20 boats from the Gore and Invercargill clubs based at the hostel and engaged in recreational fishing. This is a regular and popular Easter occurrence.

Fishing boat operators sometimes use their vessels for recreational trips with family or friends. There are also now a number of larger, non-commercial, privately owned boats that are based in Fiordland.

Over the last 7 or 8 years there has been a consistent increase in the charter industry spreading the pressure more widely into the less accessible areas of Fiordland, especially Dusky Sound. Fifteen years ago there were only one or two charter operators working out of Doubtful Sound. Today there are at least nine charter-vessels that either call regularly, or operate out of Deep Cove. Throughout January, 1998, 16 vessels were reported to be operating from these facilities. Vessels range throughout Fiordland, using Deep Cove and Milford Sound as points of access, but also fly clients in and out by helicopter, for example, from the otherwise remote upper reaches of Preservation Inlet. Several vessels used over summer for short day-trips are used in winter for extended cruises. Although not all of these operators specialise in fishing and diving, these activities are still significant components of most operations. There are at least two operators who offer charters on a strictly no-take basis.

Importantly, increasing ease of access has meant quantities of fish are now easier to keep and transport out. The availability of ice, freezers, the humble chilly bin, air transport and improved road access have all contributed.

Target species vary. Divers focus mainly on rock lobster and scallops. Enthusiast fishers tend to target game species, including blue fin tuna, albacore, thresher and blue sharks. But popular with all kinds of fishers are the “eating species” blue cod, groper and tarakihi. Eating freshly caught fish has always been seen as a highlight of the Fiordland experience.

There is concern that catches of the most popular species have deteriorated within both Milford and Doubtful Sounds. It is important to note that Milford Sound with its very steep sides has deceptively limited habitat. In the future, comparison of fish numbers and fishing effort on the fished southern side of the fiord with those in the Piopiotahi marine reserve may well shed light on fisheries management in Milford Sound.

Although many recreational fishers who have long experience of Doubtful Sound recollect that fishing was originally as good there as anywhere else, commercial fishers of the 50s and 60s remember Doubtful Sound as not ever supporting large numbers of blue cod, a popular target species. While at times fishing can be difficult almost anywhere in the Sounds, Doubtful Sound may be influenced by recruitment factors such that stocks don’t readily replenish. There is a need for a better understanding of seasonal migrations of fish in and out of the Sounds. In any case fishers nowadays recognise Doubtful Sound as having comparatively poor blue cod fishing. Fishers tend to equate an abundance of wrasse and jock stewarts as symptomatic of a location being too heavily fished.

Increasing numbers of people and fishing pressure on Doubtful and Milford Sounds has provided an incentive for recreational fishers and charter operators to range further afield, though the attractions of different scenery and remoter locations are also important. The outer sounds and the open coast are by far the preferred fishing sites though access for small boats is limited by weather. On the open coast, trolling for game fish can take place in more marginal weather conditions than can fishing from drifting or stationary boats.

As well as improving access, developments in technology are also leading to increases in fishing pressure. The advent of easily transported solid- and inflatable-pontoon trailer boats has greatly improved the capabilities of vessels in this size class. They have the potential to enable owners to be more adventurous. Such boats have opened up more of Fiordland to regular visits from recreational fishers, though much depends on the experience and skill of the operator. These boats have yet to make a serious impact in Fiordland. Mention is often made of the protection afforded by weather and isolation and while this is certainly true, over 90 years ago, Richard Henry considered the protection of isolation already lost.

Fish finders, echo sounders and GPS have become almost standard, even on trailer-boats. GPS and sounders are seen to be particularly useful in relocating favourable fishing spots and GPS is used as a matter of course to locate set long-lines or lobster pots. There is a possibility that sophistication of fishing effort on smaller craft may contribute to localised depletion which could serially expand from access points.

Radio communication in Fiordland was once somewhat haphazard but has recently been improved. In the 1970s, the Fiordland Game Fishing Club saw it as essential for their small boats to travel in convoy and use CB radios to keep in contact. Boats without CB sets were paired with other boats that did have radio. Recent improvements in VHF facilities have brought ready communication into Fiordland and assistance is seen to be close at hand in the event of emergency. The Maritime Service now routinely broadcasts the current maritime weather forecasts, which are perceived to be more reliable than was once the case. These changes give confidence to people who might not have formerly ventured into Fiordland at all.

5.3 Other Activities

5.3.0 Cruise Ship Visits

The first passenger cruise vessel to visit Fiordland was probably the Union Steam Ship Company *Wanaka* in 1877. Thereafter, the company ran popular tourist excursions from Dunedin to the West Coast Sounds until 1910, when their steamer *Waikare* struck an uncharted rock and sank in Dusky Sound.

Passing between Indian Island and Passage Islets on the morning of 4 January 1910, the 3,132 tonne *Waikare* struck and bumped over the uncharted rock. Listing heavily to starboard, the lifeboats were lowered to allow the passengers off. The stricken *Waikare* was then run aground on nearby Stop Island, before foundering and later sinking. The passengers "behaved with great coolness" and after coming ashore, many of them relaxed by fishing off the rocks with rods and handlines. While a hasty camp was rigged ashore, a launch was dispatched to Puysegur Point lighthouse some 30 miles away to alert the authorities by telegram. The 226 castaways were rescued the following day by the warship HMS *Pioneer*, which had fortunately been at Bluff when the news of the sinking reached port (J Hall-Jones, 1976). This mishap effectively brought cruising in the remote southern fiords to a standstill for over seventy years.

Following this Fiordland became a less frequent destination although some excursions were still made to Milford Sound, including ships of the Cunard Line in the 1930s. The exception to this was the *Water Lily*, first under George Cross, and later Harry Roderique. This 22 ton auxiliary ketch carried sightseers around Fiordland during the 1920s.

It took events on the other side of the world to revive Fiordland as a popular cruising destination. The terrorist seizing in 1985 of the Italian liner *Archille Lauro*, during a cruise in the Eastern Mediterranean, saw nervous American and European passengers cancelling their Mediterranean cruises in droves. In the search for a "safe" cruising area, many companies turned to the South Pacific and Fiordland has seen a dozen or more cruises annually since the *Archille Lauro* incident. Recent instability and conflict in Bosnia and Kosovo in the Adriatic has strengthened cruise vessel commitment to Fiordland. Voted the most spectacular destination in the world by one authoritative yachting magazine, Milford Sound remains the best known of Fiordland's scenic attractions. Most fiords are accessible to large ships but the tight scheduling of modern cruise liners generally restricts them to a circumnavigation of Resolution Island via Dusky and Breaksea Sounds and the Acheron Passage, along with cruising through Doubtful and Thompson Sounds and, of course Milford Sound itself (*Bluff Portsider*, 1991).

Recent information from the New Zealand Tourism Board indicates that more than half the cruise ships visiting New Zealand go to Fiordland. About 25 ships visited during 1998 with most visiting between December and March. In 1998, 22,000 cruise passengers visited the country, up from 18,500 in 1997 (*Southland Times*, 1999).

While direct impacts on Fiordland's fisheries from cruise liners or any large vessel are not considered a significant risk, the potential for environmental damage is of concern to all with an interest in Fiordland's marine environment. Oil spills, although considered unlikely would be most difficult to clean up and could have a devastating impact on all marine life. The possible introduction of foreign marine organisms from ships hulls and illegal ballast water discharges are of concern. While disturbance from the wake of large ships of the fiords river deltas, few beaches and the fragile rock wall habitat has also been raised. Already some local tourist operators consider some fiords, such as Doubtful Sound as being too overcrowded to offer the remote wilderness experience tourists desire (*Southland Times*, 1999).

6 THE FIORDLAND MARINE ECOSYSTEM

6.1 Physical Characteristics

There are 14 main fiords along the western coast of the South Island, extending from Milford Sound (44º 35'S) over 200 km south to Preservation Inlet (46^0 10'S) (Figure 1).

Although named as sounds, these waterways are technically fiords, which creates some confusion. A fiord is formed when the sea, following the disappearance of ice, invades the remaining glacial valley (Bishop & Forsyth). Sounds, on the other hand, are the result of drowned river valleys and are not generally excavated below sea level when formed. The characteristic sill of the New Zealand fiords verify that they are the result of glacial action, and are therefore fiords. Each has a typically steep-sided (~90°), u-shaped valley separated from the open ocean by a shallower sill of rock moraine.

There are marked differences between northern and southern fiords, as evidenced in Maori legend about their formation. The southern fiords, Dusky Sound, Chalky and Preservation Inlets, are less precipitous and more open, with many islands and stacks scattered throughout complex waterways.

By world standards, New Zealand fiords are not particularly numerous, nor are they particularly long. While the longest fiord is Dusky Sound at 42 km, the average length is 16 km. A further eight arms are greater than 10 km in length. The length of the coastline habitat enclosed within the fiords (including the larger islands) is approximately 1,450 km (Terralink 1998). The length of open coastline fishery habitat from Cascade Point to the Waiau River, the area of interest to the Guardians, is approximately 500 km.

The maximum depths of the fiords range from 169 m (Broughton Arm) to 421 m (Doubtful Sound), with entrance sill depths from 30 m (Preservation Inlet) to 145 m (Thompson Sound). Very shallow sills are rare, but depth profiles show that some fiords have inner sills shallower than the entrance sills (Stanton & Pickard 1981).

The outer coast of Fiordland is exposed. The continental shelf is narrow north of Dusky Sound and the continental slope descends rapidly to 4,500 m depth. With deep water just off the shore, the wave force is high. Fetch on this coast is unlimited and the entrances to the fiords are exposed to prevailing west and south-west storms. Swell waves average 3.5-4.5 m significant height (Pickerill and Mitchell 1979). In the narrow fiords, wave energy is absorbed within the entrance, but in the more open inlets, swells may travel several kilometres up the fiord.

Within the fiords there is limited development of beaches, shallow estuaries and shore platforms. Beaches and shallows are significantly more apparent in southern fiords than in northern fiords. Rivers are located mainly in the heads of fiords, many with deltas built up by river gravel and sand.

Fiordland is one of the wettest places on earth with average rainfall >600 mm/yr (Pickerill, 1987; Grange, 1990). Run-off during periods of high rainfall brings vast amounts of freshwater into the fiords. Freshwater inflow has profound effects on the physical oceanography, sedimentology and biology of these fiords by setting up estuarine circulation, causing sedimentation in the upper fiords, and supplying nutrients (Grange 1990). These fiords have typical fiord-estuary patterns of temperature and salinity. The high run-off of freshwater leads to the formation of an upper layer of low salinity moving seawards over a marked halocline at 5-10 m depth (Pickrill 1987). This upper layer of low salinity water entraps higher salinity water from below, inducing an inward flow of oceanic water to maintain the salt balance, a process known as estuarine circulation. The depth of this surface layer increases towards the heads of the fiords as the total circulation increases. Stream run-off maintains the lower salinity of the surface layer. Estuarine circulation may be important for larval retention within fiords, but might restrict larvae entering a fiord from the open ocean.

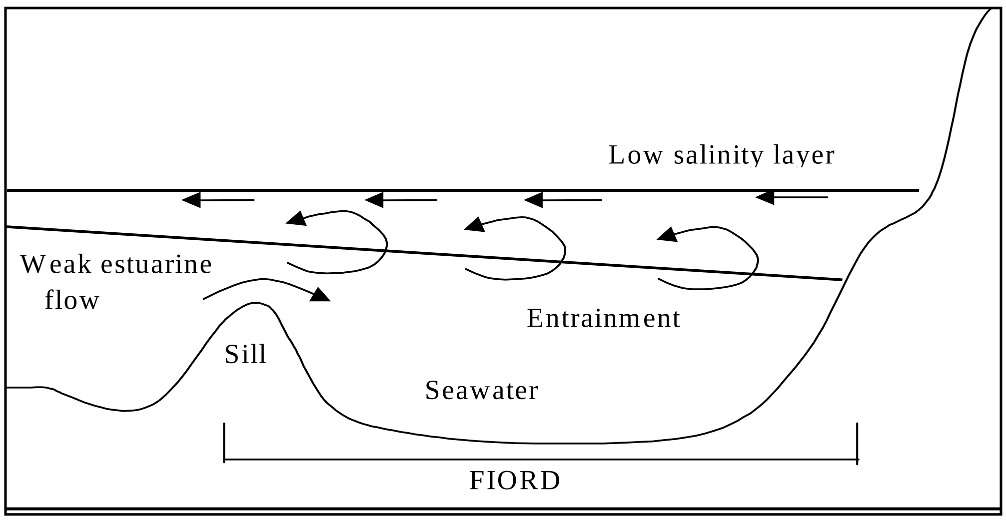


Figure 2: Estuarine circulation

Although the overall sedimentation rate is low, periods of high rainfall can wash considerable volumes of sediment into the fiords. The basins are generally covered with organic-rich sandy silts, the sediments becoming finer towards the centre of the fiord basins. Pebbly silts, gravels and sands are found on the sills (Bruun, *et al.* 1955; Stantin 1964; Glasby 1978).

The most notable physical feature stemming from the large freshwater input is the existence of a low-salinity layer, on average up to 4 m deep, but that may range from 1 m in drought to 12 m during high intensity rain fall. Freshwater entering the fiords contains humic substances picked up while passing through the surrounding forests. These compounds have the effect of staining the water a light-absorbing yellow-brown. Weak tidal currents and a lack of waves means there is little mixing of the less dense, low salinity upper layer with the underlying water of higher salinity. Low light, especially at the blue end of the spectrum, (U.V.), and a deep low salinity layer means that macro-algae are almost non-existent at the heads and within the body of the fiords. The formation of a freshwater layer is more pronounced in the narrow northern fiords than the wider southern type.

Landslides are another physical process that deserves mention. Because of the precipitous sides of the fiord valleys, large sections of vegetation clinging to the sheer rock cliffs breaks free and plummets into the fiord. This surprisingly regular occurrence has two consequences; it “wipes” the sessile rock wall communities away allowing for re-colonisation, and, it also contributes concentrations of organic material to the ecosystem. While this seems dramatic, it would appear to be part of the natural processes in the fiords.

The Guardians have highlighted a concern about this process. Invading possums have the capability to weaken the vegetation on the steep cliffs, with the possibility of accelerating the process beyond the recovery rate of the rock wall communities.

6.2 Biological Characteristics

With surface salinities inside the fiords less than 30% of the oceanic water outside the fiords, and in places below 1% of the oceanic salt concentration, the low salinity layer has a significant effect on inter-tidal communities, especially at the heads of the fiords. Shallow sub-tidal areas, down to about 4 m are subjected to fluctuating salinities depending on the state of the tide and the amount of runoff. Species at high tide level, when immersed, are usually in relatively fresh water, whereas those at low tide, although subject to greater extremes, are in relatively salty water much of the time. This effect is more or less pronounced between different fiords.

The Fiordland intertidal communities were compared to those of Otago by Batham in 1965. She found that Fiordland communities were impoverished, and that this was consistent with lowered salinities and lack of wave action, concluding that the high rainfall had profound effects on the intertidal communities.

Below the low salinity layer from approximately 4 m to 40 m, the steep rock walls of the fiords are covered with a profusion of species, forming diverse marine communities. The composition of these communities changes from the heads to the seaward entrances of the fiords. Seaweeds (macro algae) for example, tend to be absent at the head of the fiords but increase towards the fiord entrances where coastal characteristics begin to dominate. Not surprisingly, seaweed eating species follow a similar distribution.

The physical conditions of rock wall communities are relatively stable, with small temperature variation, often limited currents, little wave action, dim light and little suspended sediment (Grange 1991). With very limited seaweed present, these communities are dominated by slow growing, long-lived animal species. The majority of organisms are sessile suspension feeders and microcarnivores that rely on a steady supply of food being brought by the current. Many are profusely branched to collect as much plankton as possible. Dominant organisms include brachiopods (lamp shells), antipatharians (black corals), gorgonians (horny corals, including sea fans and red coral) and serpulid polychaete worms. Below 40 m, the diversity decreases due to the lack of light, although little research has been conducted at these depths.

The rock wall communities highlight an important feature of the fiords. Constrained by low salinity near the surface and restricted light at depth, a narrow band of growth forms the major fish habitat. Therefore, despite the wide expanses of water, the available fishery area is rather more restricted than would be expected.

Communities in the deep basins can be separated into two types; those on soft sediments and those on the sills. Within the muddy floor of the fiords, a large number of echinoderms, especially heart urchins, polychaete worms and various bivalve shellfish species are found. At times the water in the bottom of these deep basins can become anoxic greatly limiting the species able to survive in these extreme conditions. Consequently, there is very little fishing in the deeper water, except for groper and ling.

As well as the popular fishing species there is a vast array of marine organisms that are important components of the ecosystems found within fiords. Many of these species are intriguing either for their beauty, accessibility, life history or rarity. While these species have an intrinsic natural value in their own right, they also have an environmental, non-extractive value attracting ecotourists and divers and are a significant component of the "Fiordland experience".

Invertebrates can be divided into two broad groups. Firstly, those that are fairly widespread around the New Zealand coast, live in more exposed habitats, are quick growing and are likely to colonise new areas quickly. Secondly, those that are particularly sensitive to environmental change, are not widespread around New Zealand, and are found in the fiords because of the fiord environment characteristics.

The first type of species, for which there is little concern over the long-term viability of individuals, includes hydroids, ascidians, star fish, horse and blue mussels, bryozoans, sea urchins, brittle stars and possibly sea horses and soft coral. The second group of species contains the rare, protected and deepwater species that are slow growing, long-lived and some of which require very specialised habitat. For example, snake stars live in a symbiotic relationship with healthy black coral colonies. Many of the delicate species (eg, red and pink hydrocorals and cup corals) may have very narrow requirements for larval settlement, hence their restricted distributions. Both black and red coral are protected species under the Wildlife Act 1953.

One hundred and eighty species of finfish have been recorded in the fiords (Paulin, 1991). Most are associated with shallow, inshore reefs. The species composition of the shallow reef fish communities suggests that the fish life of Fiordland is essentially the same as Otago and southern New Zealand, although species diversity is generally low. It is probable that many of the species not recorded from Fiordland are in fact present, but in very low numbers. Markedly different fish communities exist in inner, middle and outer fiords. Herbivorous species such as butterfish and marble fish are scarce in the inner fiords because of the lack of algae.

The majority of species recorded are widespread in New Zealand waters, with a small component of sub-Antarctic species that are distributed only south of the Chatham Rise. There are a few 'northern' species that are normally found north of the Chatham Rise, but occasionally find their way into fiord waters. There are a number of species found in southern New Zealand that have not been recorded from Fiordland.

Fish diversity within the fiords is generally lowest near the heads of the fiords and increases seawards. The most common fishes are not the visually dominant demersal species such as the scarlet wrasse, girdled wrasse, blue cod or butterfly perch, but rather the small, benthic, cryptic species such as triplefins. The collections of fishes obtained from each fiord have produced a number of new records; specimens of several species new to science (which are also known from other regions in New Zealand) and one species that has to date only been recorded from Fiordland: the Fiordland brotula, *Fiordichthys slartibartfasti*.

Almost nothing is known about the distribution, abundance, biology or ecology of the cryptic and small species. Commercial species and species that prefer soft bottoms are largely unstudied (Francis 1991). The biological parameters of many fish species, including wrasses, show regional differences. Consequently, information obtained elsewhere cannot be assumed to apply in Fiordland. It is only in recent years that biodiversity surveys have established baseline records of the composition of the Fiordland fish community.

A notable biological feature of the fiords is the presence of species in apparently viable, shallow water (<40m) populations that are rare elsewhere or usually regarded as deep-water species (>100 m). This phenomenon is known as deep-water emergence and has been recorded for a variety of animals. These include the notable black coral (*antipathes fiordensis*) and cup sponges, as well as the fishes, common roughy (*paratrachichthys trailli:* trachichthyidae), spiny seadragon (*solegnathus spinossissimus*: syngnathidae), wavy line perch (*lepidoperca tasmanica*: serranidae), splendid perch (*callanthias allporti*: callanthiidae), banded giant stargazer (*kathetostoma* sp.: uranoscopidae), and yellow weever (*parapercis gilliesi*: pinguipedidae) (Grange, *et al.*. 1981; Grange 1985; Hardy 1985; Roberts 1989).

It is important to note the possibility of other emergent species or species currently unrecognised as emergent (eg, the Fiordland brotula inhabits crevices and boulder rubble and can only be collected by divers using specialised ichthyocides. The species may be more widespread in New Zealand waters at depths below normal diving limits).

Further research on fiord fishes and associated biota is essential to establish biodiversity baselines on which the scientific importance and natural heritage value of the fiords can be assessed.

7 FISHERIES MANAGEMENT FRAMEWORK

7.0 FISHERIES LEGISLATION

The 1998 fisheries management regime operates under two coexisting fisheries acts; the Fisheries Act 1983 and the Fisheries Act 1996, the latter of which is partially implemented and under review.

While the purpose and principles behind the Fisheries Act 1983 were the management and conservation of fisheries and fishery resources, the 1996 Act focuses more specifically on **providing for the utilisation of fisheries resources while ensuring sustainability**. "Ensuring sustainability" is defined in the Act as "maintaining the potential of fisheries resources to meet the reasonably foreseeable needs of future generations and avoiding, remedying, or mitigating any adverse effects of fishing on the aquatic environment". "Utilisation" means "conserving, using, enhancing, and developing fisheries resources to enable people to provide for their social, economic, and cultural well-being".

Following on from this dual purpose of sustainability and utilisation are a set of environmental principles and a set of information principles. The 1996 Fisheries Act requires that all persons performing functions under this Act shall take into account the following environmental principles:

- That associated or dependent species should be maintained above a level that ensures their long-term viability;
- That the biological diversity of the aquatic environment should be maintained; and
- That habitat of particular significance for fisheries management should be protected.

The information principles require:

- That decisions should be based on the best available information;
- That decision makers should consider any uncertainty in the information available;
- That decision makers should be cautious when information is uncertain, unreliable, or inadequate; and
- That the absence of, or uncertainty in, any information should not be used as a reason for postponing or failing to take any measure to achieve sustainable utilisation.

A further important provision in the 1996 Fisheries Act is the requirement to interpret the Act and to act in a manner consistent with New Zealand's international obligations relating to fishing.

7.1 Evolution and Definition of Fisheries Rights

In 1978, New Zealand declared its 200 mile Exclusive Economic Zone (EEZ) under the United Nations Convention on the Law of the Sea. The declaration gave New Zealand responsibility for sustainable management of its fisheries and the authority to address any over-exploitation of our waters by foreign nations at the time. (Territorial Sea, Contiguous Zone & Exclusive Economic Zone Act 1977)

7.1.0 Commercial Rights

The Quota Management System (QMS) was introduced in 1986 to manage the commercial harvest. The QMS is a management system based on property rights and not only limits commercial catches, but also prevents over-capitalisation of the fishing industry. It is set up as follows:

The New Zealand EEZ is divided into 10 Fisheries Management Areas. For each species in the QMS, fishstocks have been identified and each fishstock defined by its own Quota Management Area (QMA).

A Total Allowable Catch (TAC) is set for each fishstock managed under the QMS. Each TAC is determined by assessing the maximum sustainable yield from the fishstock (ie, the total annual allowable take by all groups including recreational, commercial and traditional users). Once the TAC has been determined, a Total Allowable Commercial Catch (TACC) is set for each fishstock. Each TACC is calculated from the TAC after making an allowance for customary Maori, recreational and other non-commercial interests in the fishery. Each TACC is allocated as Individual Transferable Quota (ITQ); the "property right".

An ITQ is the access right to catch a specified share of a quota species each fishing year within a QMA. ITQ are allocated in perpetuity and each owner has the rights to catch, sell, or to lease their quota.

7.1.1 Customary Maori Rights

Article 2 of the Treaty of Waitangi promised Maori the 'undisturbed possession' of their fisheries, thus confirming the aboriginal fishing rights of the Maori people. These were rights which aboriginal peoples retained even with their cessation of sovereignty to the colonising British. Aboriginal rights stood in common law as an encumbrance on the power of the new sovereign and could be extinguished only by legislation that specifically named them as extinguished. Although these customary fishing rights were largely ignored until recently, they have been preserved in Fisheries legislation since the late nineteenth century.

In 1985, Tom Te Weehi, in catching undersized paua, brought the issue of Maori fishing rights into the public spotlight. In *Te Weehi* v *Regional Fisheries Officer* (1986) Mr Justice Williamson ruled that Maori fishing rights had not been defined. No one knew exactly what the Maori legally could and could not do, did or did not own. The Court concluded that customary Maori fishing rights exercised in a customary way are exempt from regulations under the Fisheries Act, and that customary fishing rights continue until they are expressly taken away. Furthermore, consequent of the Muriwhenua claim, then Ngai Tahu, Waikato and others, the high court issued injunctions against the extension of the QMS on grounds that further ITQs might well be in breach of aboriginal rights and therefore the legal rights of the Maori. Therefore, the government would have to work towards clarifying the situation.

At a national hui in 1988 Maori negotiators were mandated to seek a settlement. A partial settlement occurred in 1989 when the Maori Fisheries Act provided for the establishment of the Maori Fisheries Commission and transferred 10% of all species in the QMS to the Commission until a method of allocation and distribution was determined.

However, the major difficulty reaching a settlement was that most of the quota had already been allocated. The proposed sale of *Sealords* (who held some 26% of the quota) provided the opportunity to overcome this problem. In 1992, the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992 agreed that the Crown would:

- pay $150 million to promote Maori commercial fishing thus assisting Maori in a joint venture purchase of Sealord Products Ltd;
- give Maori 20% of quota for further species entering the QMS (in addition to the 10% of previous quota as agreed in 1989);
- tangata whenua would have input into and participation in fisheries management decisions;
- the Maori Fisheries Commission would be restructured making it more accountable to Maori, giving it more input to fisheries management and reorganising its membership with appointments to be in consultation with Maori; and
- Maori customary fishing rights and management practices would be recognised.
- Allow the establishment of Taiapure-Local fisheries.

In return Maori agreed that the settlement "shall discharge and extinguish all commercial fishing rights and interests of Maori". It was also agreed that customary fishing rights would be replaced by regulations.

As a result of this agreement, the Fisheries Act 1996 requires the "input and participation" of Maori to a range of fisheries management processes and, in 1998, the Fisheries (South Island Customary Fishing) Regulations 1998 were enacted. These regulations provide for customary fishing rights for the South Island, including appointment of Tangata Tiaki, provision for customary gathering of kai moana for marae purposes and the gazetting of mataitai reserves. A similar set of customary fishing regulations was introduced for the North Island in February 1999.

7.1.2 Recreational Stakeholder Rights

Unlike commercial and customary fishers, the rights of recreational fishers are not well specified in statute. The recreational sector relies on the Minister, whose discretion is subject to competing demands from other sectors, to take into account their interests and to make an appropriate recreational allowance.

Prior to setting a Total Allowable Commercial Catch (TACC) for any species the Minister is required to make a quantifiable allowance for non-commercial interests in the stock. Customary is fully provided for when allocating the TAC between sectors. There is no provision to limit customary take unless sustainability is threatened. As such, customary fishing has priority over recreational and commercial fishing. Clear statements of the extent of the respective allowance for recreational and commercial interests, or the priority to be accorded them are absent from fisheries legislation. Therefore, while the right to fish recreationally may be secure, the ability to catch a reasonable share is less secure as local area depletion may mean that fish are not as easily accessible.

In practice, recreational fishing is managed by limiting the amount individuals can catch through the Fishing (Amateur Fishing) Regulations 1986. The regulations are enforced by a network of Fishery Officers and Honorary Fishery Officers. The regulations impose a variety of management controls on recreational harvesting (eg, bag limits, method and gear restrictions, closed areas and closed seasons). With a few exceptions, the controls are set and varied without explicit reference to maintaining the total recreational take within a specified 'allowance'. However, as pressure on key recreational fisheries continues to increase, explicit setting of controls to limit catch, and monitoring of those controls is increasing. Regular national diary surveys allow a close estimate of the recreational catch that can then be managed retrospectively.

Current recreational fisheries management does not empower recreational fishers to exercise any control in important recreational fishing areas. While recreational fishers remain a potentially powerful influence group, the legitimate actions of other fishing groups can adversely affect recreational fishing at the local level. Without a more active role for recreational fishers, there is a danger that recreational rights could be subject to a gradual unintended degradation.

7.1.3 Environmental

The 1996 Fisheries Act focuses the government on its core role of ensuring that fishing is sustainable and provides for more explicit environmental principles and standards. These environmental principles at the beginning of the Act give significant emphasis to ecosystem based management of the marine environment.

7.2 Stakeholder Management

In 1996, the Ministry of Fisheries released its document *Changing Course - Towards Fisheries 2010*. This document sets out the rationale for the future management of fisheries in New Zealand. The document outlines how *Fisheries 2010* will result from a collaborative process between stakeholders. People with a common interest in the sustainable management of fisheries will work together to ensure healthy fisheries for future generations. This will involve the active and informed contribution of fisheries stakeholders to processes of government and the community to establish fisheries law and policies that govern the management of the aquatic environment. There will be greater involvement of stakeholders in decisions concerning sustainability and use. There will also need to be new ways for stakeholders to take responsibility for managing access/allocation of rights and the obligations that go with them.

Commercial fishers are preparing to take on the management responsibilities that go with their rights. The Treaty of Waitangi (Fisheries Claims) Settlement Act 1992 signals the expanding role of Maori in managing their fishing interests and rights. One example of this is the contract that Ngai Tahu has with the Crown for the delivery of non-criminal compliance services for customary fishing.

However, perhaps even more exciting, is the evolution of mixed stakeholder groups such as the Guardians of Fiordland's Fisheries where stakeholders from all interest groups work together with a common interest in the sustainable management of their fisheries.

7.2.0 Overlap with Other Legislation

Although fisheries are primarily managed under the two Fisheries Acts (1983 & 1996), the Guardians have identified several other important pieces of legislation that could be used in managing Fiordland's fisheries and the marine environment. These include:

- Resource Management Act 1991 (Regional Council)
- Ngai Tahu Deed of Settlement (1997)
- Ngai Tahu Claims Settlement Act 1998
- Conservation Act 1987 (Department of Conservation) (Department of Conservation Management Strategy)
- Wildlife Act 1953 (Department of Conservation)
- Marine Reserves Act 1971 (Department of Conservation)
- Marine Mammal Protection Act
- Biosecurities Act
- Maritime Transport Act

The Guardians recognise the importance of producing a fisheries management plan that is complementary with the objectives of the Regional Coastal Plan produced by the Southland Regional Council, the Department of Conservation Management Strategy, and the Fiordland National Park Management Plan produced by the Southland Conservation Board.

8 COMPLIANCE

8.0 Compliance Objectives

High levels of voluntary compliance with fisheries laws are critical to the success of any fisheries management regime.

The Ministry of Fisheries Compliance business provides a range of services aimed at achieving optimal levels of compliance with fisheries laws by firstly, maximising voluntary compliance and, secondly, by creating an effective deterrent against illegal activity.

The rationale for the first goal of maximising voluntary compliance, is that fisheries stakeholders need to:-

- be involved in developing the rules
- understand and accept the rules as fair
- be involved in developing compliance strategies; and
- believe the rules are being administered fairly and equitably.

The rationale for the second goal of achieving an effective deterrent requires people to believe that:-

- there is a reasonable chance of being caught cheating
- there is a high probability of being successfully prosecuted
- the costs of being caught cheating outweigh the benefits.

8.1 Compliance Services

In terms of Fiordland's fisheries, compliance needs are serviced by a staff of eight Fishery Officers in Invercargill whose principal roles are:-

- Development and delivery of education programmes, material and brochures for all stakeholders.
- Answering queries and providing advice to non-commercial and commercial stakeholders.
- Detecting commercial and non-commercial offences against fisheries laws through monitoring and surveillance of fishing and fish product flows.
- Inspections of vessel and vehicles.
- Inspection of Licensed Fish Receivers and Dealers in Fish product.
- The audit and investigative examination of business records.
- The investigation of illegal fishing activities.
- Management of an Honorary Fishery Officer Network where volunteer members of the public assist enforcement in recreational fisheries through education, public relations and enforcement actions.

8.2 Geographic Considerations for Compliance

The large isolated coastline and access difficulty to Fiordland's commercial and non-commercial fisheries provides both advantages and disadvantages to fisheries enforcement.

The advantages are that access for the majority of recreational fishers and some commercial fishers is restricted to two locations, Manapouri/Deep Cove and Milford Sound. Both education and monitoring of catches can therefore be directed effectively to those landing points.

The disadvantages are the adaptation both commercial and non-commercial fishers have made to overcome the accessibility issues in Fiordland. Principally this has occurred through the use of helicopters and float-planes to fly both catches and crew out of the Fiordland coastal area. Given the range of landing points available, the inspection of catches and the detection of illegal landings difficult.

Those concerns aside, historically MFish staff have found a high level of compliance with fisheries legislation in Fiordland. It has been found that the fishers are protective towards their fishery and supportive of both the compliance efforts and management goals of sustainable utilisation.

8.3 Legislative Controls on Fishing in Fiordland

In the commercial sector Fisheries enforcement centres around the quota management system (ensuring fishermen hold quota and permits and report landings accurately to count against quota), minimum legal size (for rock lobster in particular), prohibited states (egg-bearing female rock lobsters in particular), fishing gear (marking of rock lobster pots and escape gaps) and prohibited methods (use of underwater breathing apparatus in paua fishery in particular).

Other relevant controls include the prohibition on commercial fishing within Milford Sound, marine reserves in Milford and Doubtful Sounds (enforced by Department of Conservation), an area closed to kina diving within Dusky Sound and a prohibition on trawling, seining, using set nets more than 1,000 m long or any other bulk net fishing method within the waters of any Sound.

Commercial fishermen operating in the Fiordland area were instrumental in initiating the move to more effective escape gaps in rock lobster pots and have also established voluntary enforcement initiatives and have used peer pressure to improve compliance with fisheries law and fishing and fish handling practices. This positive and supportive attitude towards fisheries management controls results from a widespread acceptance that fisheries management controls are in the best interests of the continued viability of their fishery and therefore have a positive impact on their fishing operations in the long term. Commercial fishermen who depend on illegal fishing practices for economic survival are unlikely to support enforcement activities aimed at eliminating those practices.

9 FISHSTOCKS AND FISHERIES

9.0 Customary non-commercial

Ngai Tahu embrace a holistic management approach to resources of which they consider themselves kaitiaki (guardians). This is illustrated by their concept of ki uta tai or 'Mountains to the Sea', where they will play a role in the co-ordinated management of land and marine fisheries resources.

Maori have traditionally managed fisheries in a holistic and sustainable manner, with mechanisms in place whereby stocks could be protected if put under pressure. In the last decade this philosophy has begun to be recognised in fisheries legislation: the 1989 Maori Fisheries Act, the 1992 Deed of Settlement Act, and recently, the development of the South Island Customary Regulations 1998 and other provisions contained within the Ngai Tahu Settlement including:

- a permitting system for customary harvesting through tangata tiaki,
- management responsibility for mataitai fishing areas of traditional/cultural significance to tangata whenua and
- management responsibility for taiapure-local fishery areas by way of a local community committee representative of tangata whenua interests.

These provisions enable Ngai Tahu to play a major part in the management of customary fisheries in Fiordland in the future. Although there has not been a high level of customary harvesting to date, it is possible that customary harvesting levels may increase over time. Very little is known about the current levels of customary non-commercial fisheries. Ngai Tahu have a significant interest in various commercial fisheries following the 1992 Deed of Settlement.

9.1 Commercial

Commercial fishing has been occurring in Fiordland for over a hundred years. The early blue cod fishery consisted of line fishing from dories, based from the fishing villages at North Port, Chalky Inlet and Dusky Sound. This fishery closed down at the outbreak of World War II as the participants were needed elsewhere.

After the war, new technological developments, especially refrigeration, and the opening up of the American market for rock lobster tails, sparked the beginning of the commercial rock lobster fishery. Float planes proved invaluable for transporting supplies into Fiordland, and frozen rock lobster tails out. As the live lobster market developed in Asia, float planes and helicopters have increasingly been used to transport the catch, overcoming access difficulties. The Fiordland rock lobster fishery represents about 25% of the national harvest.

With the liberalisation of paua export provisions during the 1980s, commercial harvesting of paua in Fiordland became economic. Currently, the Fiordland paua fishery represents about 12% of the national harvest.

A table of landings by species and statistical area for the 1996-97 fishing year are contained in Appendix II.

9.1.0 Rock lobster

The Fiordland coast supports New Zealand's most important rock lobster fishery. The Fiordland rock lobster fishery is contained within the Quota Management Area CRA 8, which contains the area from Long Point on the East Coast of the South Island around to Abut Head on the West Coast, including Stewart Island. Approximately 70% of the CRA 8 catch is taken from Fiordland. The 1997-98 lobster fishing year was particularly poor with only 778 t caught for CRA 8, 518 t coming from Fiordland.

9.1.1 Biology/Distribution

The red rock lobster, *Jasus edwardsii*, is found throughout New Zealand. Rock lobsters, particularly the small size groups, require habitat that provides cover, in crevices and guts. The softer, sedimentary rock reef formations in southern Fiordland, from Dusky Sound to Te Waewae Bay, are particularly important in providing nursery habitat. Being crepuscular scavengers, rock lobsters find food primarily by "smell", eating almost anything, including shellfish, crabs, fish, and sometimes seaweed

The rock lobster begins independent life first as a nauplius larva and then a phyllosoma, which grows for about 12-15 months adrift in the ocean currents tens to hundreds of kilometres offshore, until it is approximately 5 cm long. It then metamorphoses into the *puerulus* stage, which looks much like the adult rock lobster. It is transparent and using large pleopods under its tail is able to swim forwards (unlike the adult) to locate the coast for settlement. Given this juvenile life history, the place of settlement will most probably bare no relationship to the place that the individual was spawned.

Once settled, the puerulus moults into a pigmented juvenile rock lobster, losing its ability to swim forward, becoming a miniature version of the adult. At settlement, it measures about 10-13 mm. Settlement is seasonal, the season generally consistent from year to year for each site, but varying according to region. Settlement takes place mainly in winter in Fiordland and the numbers of pueruli settling is thought to be larger in La Nina weather pattern years.

To increase its size, the rock lobster has to shed its shell and grow a bigger one. During moulting periods, rock lobsters move into shallow inshore waters, become sluggish, cease to eat and are more often found alone. After shedding its shell, the rock lobster is very soft and vulnerable to predators, but within a few hours the shell begins to harden. Within a few days, the new shell is quite hard, although thin, and the rock lobster can begin feeding and move into deeper water. Moulting tends to be seasonal in mature animals. In Fiordland, mature male red spiny rock lobsters moult between August and November.

Male lobsters appear to reach the minimum legal size of 54 mm tail width (about 98 mm carapace length) about 5-7 years after settling as puerulus larvae. Mature females moult between February and July. The growth rate of females appears slow, and declines with increasing size. Females reach the average size at first breeding (about 85 mm carapace length) about 7-8 years after puerulus settlement and the national minimum legal size (60 mm tail width) after more than 10 years. It should be noted that research currently being undertaken by the CRA 8 Management Committee suggest that growth rates may in fact be significantly faster then this estimate.

At maturity, the female's tail becomes proportionally wider (relative to the carapace) while in the male the tail remains narrower and shorter. Each year after moulting, a mature female rock lobster can produce between 120 000 and 500 000 eggs determined largely by her size. The eggs are glued underneath her tail, and are carried for 3-6 months, depending on water temperature. Eggs hatch between August and November, and clouds of larvae are released into the water.

The southern fishery is known for periodic and sometimes spectacular lobster migrations. Tagging experiments (*Street 1997*) have shown that migrations of rock lobsters ('run fish') take place from the east coast to west coast around the bottom of the South and Stewart Islands. Rock lobsters can migrate considerable distances (straight line movements up to 5.5 km per day and up to 290 km in a year have been recorded). Further illustrating the magnitude of this endeavour, run fish can often be identified by the wear on the claws of their legs. These animals are either males or immature females. Once females mature, they tend to become relatively sedentary.

The reasons for and origins of these migrations are not known. The most common suggestion is that the migrations may be a means of compensating for the drift of larvae since most of the long distance movements observed have been in the opposite direction to the prevailing currents. Such migration is called contranatant, and in this case, moves against the Southland Current which flows in a northerly direction up the east coast and the Tasman Current which runs in a southerly direction down the West Coast. The migration results in a mixing of the population and means that Fiordland has two fisheries. Inshore stocks of predominantly mature animals, where females mature at a size well below the legal minimum size and the migration fishery. Fishers with experience follow the migration up the coast, continually setting their pots just in front of the migration. The migrating lobsters can disappear in the rugged sub-surface terrain and knowledge as to where they might re-appear is vital.

There is a high rate of puerulus settlement recorded in Chalky Inlet and observed in Preservation Inlet. Fishers also report seeing large migrations of sub-legal individuals in the area at times.

9.1.2 Development of the Fishery

A restrictive licensing system, originally introduced in 1937, limited the number of rock lobster boats to 105 until licensing control was lifted in 1963. The number of vessels increased substantially to reach 233 in 1969.

In 1952 regulations were passed prohibiting tailing at sea and dumping of rock lobster bodies. An exception was made for all waters between Bruce Bay, South Westland and Long Point off South Otago due to geographical remoteness. (Annala, 1983) This enabled Southland and Fiordland rock lobster fishers to continue tailing and freezing at sea, while elsewhere rock lobster had to be landed live to the packhouse.

Discovery of the seasonal contranatant migrations drew fishers from the fiord entrances out into deeper water. This required larger vessels, good electronics, experience and a large dose of good luck to capitalise on the big "runs". Working the edges of foul bottom for "run fish" became the norm during the 1970s. Pot design was by now perfected, with strong rectangular steel frames, laced with nylon trawl mesh and tarred to withstand the rigours of a hostile coast. Steel pots replaced the lighter wooden frame pots that were suitable for use inside the fiords.

A national moratorium on the issue of new rock lobster fishing permits was declared in December 1977, in response to concern about over-capitalisation and the sustainability of the national fishery.

In June 1980, Fiordland was included with Southland and Stewart Island in the Southern rock lobster controlled fishery. At the time the Southern area had 317 licensed vessels, the highest of any fishery (Annala, 1983). Over this period the main regulations governing the rock lobster fishery were the minimum 152 mm tail length size limit, a prohibition on the taking of berried females and soft-shell rock lobsters and certain method and gear restrictions.

In 1988 the tail length measurement was replaced with a new minimum tail width measurement, measured between the tips of the primary pleural spines on the second abdominal segment. The national setting of a minimum tail width size of 58 mm for females and 54 mm for males effectively excluded fishers from harvesting much of the market-preferred size rock lobsters, previously harvested. The tail width introduction saw strong protest from the local industry which cited serious economic hardship. Based on different growth rates and size at maturity of fish from the colder southern waters, a concession was introduced in 1989, enabling fishers to harvest females at 56 mm for one year, increasing to 57 mm in 1990. The concession was limited to export only and restricted landings to approved concession packhouses and depots. While the commercial female tail width was increased nationally, in 1992, to 60 mm, the CRA 8 female commercial concession has remained at 57 mm.

By 1984, the number of licensed vessels in the Southern controlled fishery had reduced to 238 with about 160 of these operating in Fiordland. While the total number of vessels had reduced, there was little real change in fishing effort with ever increasing numbers of pots being worked. While the industry called for a limit on pot numbers, a more lasting solution was sought by the government resulting in the introduction of the rock lobster fishery into the Quota Management System as transferable term quota (TTQ) in April, 1990. The QMS fishing year for rock lobsters is 1 April through 31 March.

During the last half of the 1980s, the live lobster fishery almost totally replaced the tailing-at-sea fishery. An important facet of the live trade is the use of large “coff” pots to hold fishers’ catches in the sea until there is a sufficient quantity fish for transport to packhouses.

The Southern area now became known as the CRA8 rock lobster management area, and a total allowable commercial catch (TACC) was set at 1,054.5 t. The new TACC was a significant decrease from the previous average annual landings, and this was decreased further in 1993 to 888 t. With the introduction of TTQ and ITQ, many small fishers left the fishery. There are 118 vessels operating in CRA 8 today, of which approximately 70 fish in Fiordland.

In 1992, following local industry initiatives and trials to cut down the handling of undersize fish, new regulations were introduced providing for improved rock lobster pot gap escapement. Rock lobster pots were now required to have two escape gaps on opposite sides of the pot measuring 54 mm in height and 200 mm in width, with the aperture not less than 80 per cent of the total height or length of the pot.

With the passing of the 1996 Fisheries Act, transferable term quotas were replaced with individual transferable quotas (ITQs). The CRA 8 TACC remained at 888 t until declining catches brought about a 20% reduction in quota to 711 t for the 1999 season. The 20% TACC cut received the unanimous support of quota owners, fishers and processors.

Today, the commercial fishery is managed by the CRA 8 Management Committee Incorporated, a group representative of quota owners and harvesters engaged in the commercial harvest of rock lobster in Southland and Fiordland. The committee has as an objective "to promote the sustainable harvest of CRA 8 lobster", and is an approved provider of rock lobster research to the Minister of Fisheries. The CRA 8 committee has representatives on the Guardians of Fiordland's Fisheries.

The CRA 8 Management Committee research includes individually tagging 20,000 lobsters. On recapture, tagged lobsters are re-measured and any changes in growth recorded along with the place of recapture. This new growth information will then be analysed and incorporated into the information base used to set safe harvest limits. The CRA 8 Committee has also been running a vessel logbook programme. This voluntary programme covers the whole fishery and requires fishermen to record detailed information on the catch from four designated pots each day. The data collected from this programme has become very important in monitoring the TACC and ensuring safe harvest limits and is now a required service by the Minister of Fisheries.

9.1.3 Fishing Methods

Nowdays, commercial fishers exclusively use pots for catching rock lobster. The most commonly used lobster pots consist of a steel rectangular box frame covered with meshing. In general pots measure 1 x 1.2 m with a depth of 600-800 mm. The neck is about 300 mm in diameter. Different sized pots may be used depending on the size and capability of the vessel. Commercial rock lobster fishers use an average of 150-200 lobster pots and lift productive pots once every 24 hours. Sometimes, due to poor weather, or poor catching, pots will be left for longer periods.

9.1.4 Harvest

The majority of lobster fishing occurs close in shore on the open coast, requiring expert seamanship and not a little courage. Within the fiords, rock lobsters are only targeted during specific parts of the fishing year, except Dusky and Doubtful Sounds, where rock lobsters are harvested throughout the fishing year. In some years up to 50% of the TACC can be caught from the offshore deepwater (60 m) fishery.

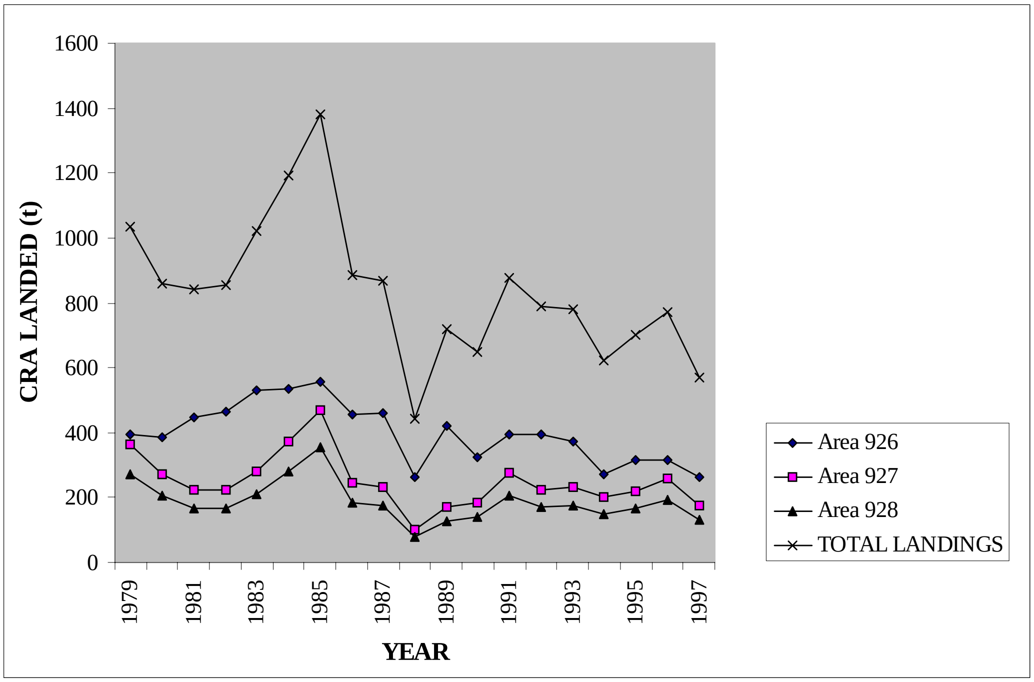


Figure 3: Annual logbook landings of rock lobster in the Fiordland fisheries areas

From 1979 to 1997 there appears to be a general decline in rock lobster landings in the Fiordland area (Fig. 3). The marked drop in the 1988 catch shown in this graph corresponds to the introduction of the tail-width measure. The large peak in 1985 co-insides with extra fishing effort to acquire "catch history" prior to the introduction of the QMS.

Table 1: Annual rock lobster landing data. (Note: Area 928 extends from Milford Sound to Cascade Point, therefore for the purposes of this report, landings given here represent 75% of total area 928 landings)

Year	Area 926 Landings (t)	Area 927 Landings (t)	Area 928 Landings (t)	Total Landings
1979	395.143	365.003	273.752	1033.898
1980	384.153	272.59	204.443	861.1855
1981	449.272	224.833	168.625	842.7298
1982	464.88	223.702	167.777	856.3585
1983	531.144	281.376	211.032	1023.552
1984	534.941	374.682	281.012	1190.635
1985	555.598	471.06	353.295	1379.953
1986	455.063	246.641	184.981	886.6848
1987	460.301	233.16	174.870	868.331
1988	264.966	102.482	76.862	444.3095
1989	419.514	171.852	128.889	720.255
1990	324.96	186.232	139.674	650.866
1991	395.023	274.374	205.781	875.1775
1992	395.429	225.726	169.295	790.4495
1993	372.742	233.796	175.347	781.885
1994	269.907	200.734	150.551	621.1915
1995	315.8	219.548	164.661	700.009
1996	316.12	259.198	194.399	769.7165
1997	263.303	173.932	130.449	567.684

Table 2: Fishers estimation of the annual harvest from within each sound

Location	Estimated Annual Catch (t)
Poison Bay	1.0
Sutherland Sound	1.0
Bligh Sound	4.0
George Sound	5.0
Caswell Sound	3.0
Charles Sound	3.0
Nancy Sound	2.0
Thompson Sound	5.0
Doubtful Sound	10.0
Dagg Sound	1.0
Breaksea Sound	15.0
Dusky Sound	30.0
Chalky Inlet	6.0
Preservation Inlet	4.0
Total	**90.0**

Landings from logbooks show that more rock lobster are caught in fisheries statistical area 926 (Sandhill Point to Dagg Sound) than in areas 927 (Dagg Sound to Milford Sound) and 928 (Milford Sound to Cascade Point – for the purpose of this report) (Table 1).

9.1.5 Paua (PAU)

Biology/Distribution

There are three species of abalone (paua) endemic to New Zealand; *Haliotis iris, H. australis* and *H. virginea.* The Fiordland paua fishery is based on the largest of these, *H. iris,* the blackfoot paua.

Haliotis iris is found on rocky substrate in both the intertidal and subtidal areas, with peak abundance at about 5 m depth, although they are found down to 18 m in some localities (Schiel, 1989), with a clear distinction between the habitats of juveniles and adults. Young *H. iris* (less than 100 mm long) occur in crevices and under stones, especially on boulder bottoms. Adults inhabit more stable and exposed sites on flat boulder bottoms, low rocky ridges, or close to the bottom of vertical surfaces where they receive an almost continuous supply of drift seaweed.

Paua are herbivores, with very young paua feeding on microscopic algae (diatoms) and larger juveniles and adults eat larger seaweeds. *Haliotis iris* do not actively forage for food, but feed on drift seaweed brought to them on the current.

Mature blackfoot paua are sedentary, moving very little although slightly more at night than during the day. As they do not forage for food, they move only when rough conditions disturb their habitat or food becomes extremely short. Migration must also occur when juveniles mature and their preferred habitat changes, especially in the case of intertidal juveniles which must move into deeper water as adults. This low rate of movement means that re-population of areas after fishing depends on growth of juveniles rather than adults moving in from other areas.

Growth rates are variable, but it usually takes about seven years for *Haliotis iris* to reach 127 mm (legal harvest length, 125 mm) and they grow to a maximum of 200 mm (approximately) in shell length (Poore, 1970b). No method of determining the age of paua has yet been developed, so accurate estimates of longevity are not possible.

Unlike most other animals, paua do not have a clotting mechanism in their blood. Combined with the fact that the major blood vessels are very close to the surface of the foot, this means that even a relatively small wound, particularly those inflicted by sharp instruments used to harvest paua, can cause a paua to bleed to death. When wounded paua are returned to the sea it is likely that they will die, either directly through blood loss and infection or indirectly from the inability to right themselves, clamp onto rocks, or crawl away. In 1994, the PAU 5 Management Group and MAF Fisheries produced a code of practice for the commercial fishery.

Spawning season is late summer to early autumn, but *H. iris* do not spawn every year. The reasons for this are unknown. *H. iris* first produce mature eggs at about 60 mm shell length and probably spawn substantially for the first time when four years old. Paua have a short larval life (12-15 days) after which they need to settle on suitable substrate - rock covered in coralline algae. The coralline algae is important as it releases a chemical substance which acts as a cue to settle for the paua larvae. The algae can be seen as "pink paint" on the rock. This also provides shelter, and perhaps some nutrients. The short larval life means that there is limited dispersal, partly explaining why parameters such as growth, morphometrics, mortality and recruitment vary over small distances. Recruitment for *H. iris* is low compared to other species of abalone and apparently varies independently of the abundance of paua. (McShane *et al.*,1995). There is a low abundance of juveniles in exposed habitats.

Paua was incorporated into the Quota Management System (QMS) in 1986/87. The Fiordland paua fishery came within the PAU 5 management area. Prior to 1 October 1995, PAU 5 was managed as one area. The large size of PAU 5 did not allow for the biological variability of paua between areas of different habitat quality. Growth rates, recruitment and density all depend upon local environmental conditions and vary greatly from one site to the next. As a result, a number of stocks within PAU 5 with different and distinct characteristics were all managed under a single TACC. Furthermore, the Stewart Island area was supporting up to 70% of the commercial PAU 5 harvest despite indications that paua abundance in less fished areas of PAU 5 was greater than around Stewart Island.

New legislation was passed on October 1 1995 to enable the sub-division of PAU 5 into three commercial areas; Fiordland - PAU 5A, Stewart Island - PAU 5B, and Catlins/Otago - PAU 5D. Further sub-division may be necessary to allow for differences in productivity within these areas. Both the new and old QMA boundaries and statistical reporting areas are contained in Appendix 1.

Size composition studies of paua off the West Coast of the South Island reveal an accumulation of large individuals with few pre-recruits. Recruitment (numbers of juveniles) apparently varies independently of the abundance of paua and is evidently low for wave exposed habitats. It is not known if recent catch levels or the current TACC are sustainable, or at levels which will allow the stock to move towards a size that will support the maximum sustainable yield (MSY) as required by the Fisheries Act.

Fishing Methods

The commercial paua fishery is a dive fishery and, as with recreational paua gatherers, underwater breathing apparatus is prohibited. A very small amount of shore picking is carried out. Commercial fishers use a trowel or hooking device to dislodge animals from the substrate into hand-held nets. These are either suspended from floating inner-tubes or deposited in a small tender which is kept near the diver. Paua are fished year round with no recognised season, but fishing depends on the weather and sea conditions, and on the current market price.

Harvest

The TACC for PAU 5 was originally set at 390 t in 1986, based on the average commercial paua landings between 1983 and 1986, but following quota appeals the TACC for this area had increased to 492 t by 1992. With the formation of the Otago Southland Paua Management Working Group, PAU 5 quota holders expressed their commitment to the resource by taking a voluntary 10% reduction in their quota, reducing the TACC to 443 t for the 1992/93 fishing year. Following subdivision of the PAU 5 area on 1 October 1995, the TACC for PAU 5A (Fiordland) was set at 147.7t. This has since risen to 148.8 t following a final successful quota appeal.

Table 3: Annual catch data by original fishery statistical area for PAU 5A

Year	Area 030	Area 031	Area 032	Total Pau 5A
1984	97.1	1.9	0.0	
1985	163.3	56.1	4.4	
1986	90.3	32.0	0.0	
1987	26.5	15.4	0.6	
1988	34.0	12.7	1.0	
1989	33.7	9.2	1.2	
1990	118.6	22.4	3.7	
1991	109.6	31.4	8.6	
1992	90.4	14.8	11.7	
1993	111.2	7.8	4.1	
1994	87.6	9.7	2.4	
1995	92.3	12.0	3.5	139.53
1996	99.9	18.2	6.0	141.91
1997	80.4	11.2	12.4	145.78

Catch data by statistical area for PAU 5A is difficult to reconcile with actual landings from Fiordland for two reasons, a significant portion of landings do not record the statistical area, and, a significant but changing proportion of area 030 is caught on the west coast of Stewart Island. However, landing data has been included in this report as it clearly shows the distribution of catch within Fiordland. The majority of the catch is caught in from the south coast and southern fiords, with an almost insignificant catch obtained from northern Fiordland. There does appear to be an increasing take from the northern Statistical area.

Virtually the entire commercial catch is blackfoot paua, *H. iris*. As with the amateur fishery, there is a minimum legal size limit of 125 mm shell length. The small amount of *H. australis* that is caught is included in a TACC covering both species. Although there are 55 quota holders in PAU 5A (1997 figures), only 13 of these hold more than 1 tonne of quota.

The commercial representatives on the PAU 5 Management Working Group identified Fiordland as an area of increasing interest to commercial paua divers. Areas commonly fished include the seaward entrances of Caswell Sound, Doubtful Sound, Dagg Sound, Breaksea Sound, Dusky Sound, Five Fingers Peninsula (Chalky Inlet), Preservation Inlet and the South Fiordland coast to Port Craig. In the1990/91 fishing year approximately 20% of the total paua catch for PAU 5 was harvested from Fiordland (Elvy, Grindley, Teirney, 1997).

The Guardians of Fiordland's Fisheries have also identified areas of importance to the commercial paua fishery, and estimated catches from each sound. (Table 4). These estimates are based on what fishers would harvest when fishing each sound, but it is important to note that, with the exception of the southernmost sounds, after being fished, an area is "spelled" or rested for up to 3 seasons. Therefore, each sound is not necessarily fished each and every year. In any year, the majority of the TACC is taken from the open coast.

Table 4: Estimated Paua Catches from Fiordland by Sound

	ESTIMATED ANNUAL HARVEST (T)	
Location	**Lower**	**Upper**
Sutherland Sound	3.0	4.0
Bligh Sound	3.0	4.0
George Sound	2.0	3.0
Caswell Sound	3.0	4.0
Charles Sound	2.0	3.0
Nancy Sound	3.0	4.0
Thomson Sound	3.0	4.0
Doubtful Sound	9.0	12.0
Dagg Sound	3.0	4.0
Breaksea Sound	4.0	6.0
Dusky Sound	9.0	12.0
Chalky/Preservation Inlets	18.0	24.0
Total	**62.0**	**84.0**

9.1.6 Scallops (SCA)

The southern scallop (*Pectin novaezelandiae akiura*) is found in modest numbers in nearly all the fiords. Southern scallops appear to live significantly longer and grow significantly larger than their northern counterpart.

Biology/Distribution

Scallops are found lying free-living on sand and mud bottoms, from low tide mark to depths of more than 80 metres. They are largely sedentary bottom dwellers, living in a depression in the seabed. They are most abundant on fine, silty mud substrates and are typically found in large sheltered bays with a gentle sloping or shelving bottom.

Natural predators of scallops include starfish, octopus and fishes. To escape predators, scallops are capable of swimming short distances using a kind of jet propulsion generated by violently clapping the two valves of the shell. When necessary, whole populations can migrate over large areas.

Scallop populations are noted for major fluctuations in abundance in any one area. These large fluctuations have been attributed to variations in larval settlement and recruitment, and are thus independent of fishing pressures on adult stocks. Scallops in the Southern Region usually reach legal size of 100 mm in length at between two and three years of age. However, in some areas, growth is slow and scallops may fail to reach legal size. Research undertaken in Paterson Inlet in 1990 by Michael and Cranfield (1992) revealed that scallop growth occurs mainly during November to April and ceases almost completely during winter. Paterson Inlet scallops grow to a size of 170+ mm at about 5-10 mm per year, and are long lived (7-10 years).

Scallops most likely attain sexual maturity during their first summer after settlement. Spawning can occur between October to April and appears to be reasonably consistent over this period. The larvae have a planktonic life of 3-4 weeks with a settlement peak during December and

January. Settlement sites are determined largely by the hydrology of the immediate area. Bottom types preferred for larval settlement are of a filamentous nature, usually algal or hydroid mats.

In 1963, divers discovered scallops in Harrison Cove (Milford Sound), Dea's Cove (Thompson Sound), and Duck Cove (Dusky Sound). In 1971, paua divers reported scallop densities of up to 30 m^{-2} in Isthmus Sound (Preservation Inlet). Results of a 1972 preliminary diving survey in Fiordland suggested the possibility of a commercial fishery. Scallop studies were carried out at some shallow anchorages in Fiordland from the "W.J. Scott. Diving revealed live scallops in Milford Sound, Breaksea Sound, Dusky Sound, Chalky Inlet and Preservation Inlet. Most scallops were seen on shallow, sub-littoral slopes in Isthmus Sound, Preservation Inlet. Dredging was carried out at 21 stations between Farewell Spit and Preservation Inlet. Live scallops were taken at only six stations and these were in Bligh Sound, Doubtful Sound, Dusky Sound and Preservation Inlet. Another diving and dredging survey was carried out from the "W.J. Scott" in July 1972. Although patches of good quality scallops occurred in commercial densities in some areas, there were apparently not enough to support a commercial fishery (Stead, 1972).

9.1.7 Kina (SUR)

Biology/Distribution

Kina (*Evechinus chloroticus*) are sea urchins. Endemic to New Zealand, they are common on shallow subtidal reefs, generally less than 10 metres in depth (Andrew, 1988). Kina are typically a rocky bottom dweller, but may be found on other substrates. Generally, abundance increases with increasing exposure to wave action. Juveniles are inconspicuous and found both inter-tidally and sub-tidally, in two habitats; under rocks, particularly those resting on pebbles, or tucked in small crevices and depressions in rocks, where they are usually extensively covered with debris (Dix, 1970).

Sea urchins have been shown to play a structuring role in subtidal benthic communities. The grazing of some species of sea urchin can have a profound effect on algal assemblages by keeping areas free of large seaweeds (Lawrence, 1975, Schiel & Foster, 1986, Andrew, 1988). Dix (1970) noted that kina might reach densities of 50 m^{-2}. However, kina are rarely distributed evenly over extensive areas. Instead, isolated clumps, or aggregations, are typical. Such clumping occurs at two levels. Firstly, high density populations (several thousand to many thousand urchins) within a given geographical area are usually separated by fairly extensive areas of low density, and, secondly, clumping occurs within these populations (20 to 500 urchins).

Dix (1972) found that kina lived at least 10 years. The annual increase in test diameter ranges between 1 and 2 cm per year. It is likely that growth rates of kina vary over small distances according to factors such as relative exposure and food availability. Kina will eat almost anything, but favour algae. During a shortage of preferred diet items, they will ingest bottom material and act as general scavengers.

The main predators of kina include rock lobsters and benthic reef fishes (eg, blue cod), but they are also eaten by some carnivorous gastropods and sea stars.

Kina are external spawners, with a relatively long free-swimming larval stage, thought to be about one month, depending on temperature and settlement conditions (Dix, 1969). Because of this relatively long larval life, most adult kina populations are probably rarely self-supporting (Dix, 1969). Recruitment processes are poorly understood. Settlement is irregular from year to year and some populations show a very restricted size range, perhaps representing a single intensive settlement.

A study by Lamare (1998) in Doubtful Sound indicated that there was high kina larval retention within the fiord. Larval densities were consistently higher within the fiord (330–2349 larvae.m^{-3}) compared to an outer site (10 larve.m^{-3}). This data suggests that recruitment of urchins into the Doubtful Sound population is by larvae that have originated, been retained, and complete development within the fiord.

Kina are apparently dominant in the subtidal reef communities off Fiordland (McShane and Naylor, 1991). A study by McShane and Naylor, in 1991, revealed abundant and widespread populations in Dusky Sound and Chalky Inlet with mean densities varying between 1.1 and 3.0 per m^2. Kina were observed at all four sites surveyed, and were associated with stands of dense seaweed. In kina-dominated areas of Dusky Sound, the habitat can be characterised by the presence of encrusting red seaweeds and a common large brown seaweed (*Carpophyllum flexuosum*). The encrusting red seaweeds are maintained by the grazing activities of kina, and when kina are removed, these seaweeds may become overgrown with other species such as large kelps (McShane *et al.* 1993). The seaweeds preferred as food by kina were commonly associated with kina populations.

Kina were also observed in dense aggregations down to 26 m depth. Few individuals smaller than 50 mm test diameter were recorded, but spatial variation in the number of small kina, indicative of recent settlement, was shown in Dusky Sound (McShane *et al.* 1994). While kina are abundant in Dusky Sound, the stock is an accumulated stock of larger, older individuals.

Fishing Methods

Kina may be gathered by diving and shore picking. Most are harvested by diving. The use of underwater breathing apparatus is illegal when harvesting kina.

Harvest

Kina are harvested for their roe (the gonad of the animal) and are sold mainly on the domestic market. Nation-wide, the commercial fishery is divided into eight fishstocks, and is managed under a competitive catch system. Permit holders do not have individual catch entitlements, but collectively can catch no more than the annual competitive catch limit. Within SUR 5 (which extends from Slope Point to Awarua Point and includes Stewart Island) there are 200 t of competitive quota, and 31 fishers with permits to harvest this species. Most of the kina harvested within SUR 5 are taken from Stewart Island.

Table 5: Reported landings (t) of kina in SUR 5 from 19983/84 to 1992/93 and actual competitive quota (t) from 1986/87 to 1992/93

Fishing Year	Landings (t)	Competitive Quota (t)
1983/84	2.60	-
1984/85	6.17	-
1985/86	0.22	-
1986/87	6.09	-
1987/88	4.01	-
1988/89	0.00	200.00
1989/90	13.37	200.00
1990/91	121.47	200.00
1991/92	227.88	200.00
1992/93	377.03[1]	200.00
1993/94	244.95	200.00
1994/95	187.52	200.00

[1] Includes experimental harvest, Dusky Sound (133 t).

A kina fishery development project was established in Dusky Sound in 1992 with two aims. The first was to gather information on kina biology and sustainable harvest levels for the Ministry of Fisheries, and the second was for those participating in the harvesting to develop export markets for kina roe.

The kina development programme proposal was for several local dive vessels to harvest 1,000 t of kina in the first year, from within a defined area in Dusky Sound. A kina processing factory was set up in Invercargill by Uni Fishing Company Limited, a Taiwanese joint-venture company with specialist experience in processing sea urchin for the Asian market. Low export prices and poor market acceptance saw the factory close within the first year. The programme was discontinued in 1995.

Results of harvesting showed that the removal of 133 t of kina from the Sound was insufficient to cause a measurable change in the density of kina or the seaweed composition. Attempts to establish export markets for roe were unsuccessful. A high proportion of the desired export sized roe had a particularly bitter taste, that was unappreciated by the Japanese market. The bitter taste perhaps related to the diet of the Dusky kina (McShane *et al*. 1994).

To undertake the kina development programme, a prohibition on kina fishing, unless specially authorised, was implemented under the *Fisheries (Southland and Sub-Antarctic Areas Commercial Fishing) Regulations 1986, Amendment No 15* that effectively closed kina fishing from Breaksea Sound to Puysegur Point. This area remains closed for the purpose of kina research and is unlikely to be re-opened. However, interest in re-establishing the kina fishery development programme persists.

With the exclusion of the important areas kina fishing areas by this regulation, the vast majority of kina harvested in SUR 5 is from Stewart Island.

9.1.8 Sea Cucumber (SCC)

Biology/Distribution

The common sea cucumber (*Stichopus molis*) is described as the characteristic holothurian species of central and southern New Zealand, including the Chatham Rise and the Snares Islands (Pawson, 1970; Sewell, 1987). *S. mollis* has also been recorded on the southern and western coasts of Australia (Pawson, 1907; Sewell, 1987), and in New Zealand along the north-east coast of Northland and throughout the Hauraki Gulf (Sewell, 1990). Its recorded depth range is 0-270 m (Pawson, 1970), although Dawbin (1949a) noted a maximum depth of 1,530 m at an undefined location.

Stichopus mollis is a large conspicuous sea cucumber, with a warty dorsal surface and a flattened creeping sole. It is elongate, with a soft tapering body. This species is assumed to be a deposit and/or surface detritus feeder (Barnes, 1987, Sewell, 1987; Archer, 1996; Mladenov & Campbell, 1998).

Live *Stichopus mollis* vary in colour, predominantly combinations of brown, yellow and cream with the occasional tinges of red in the tentacles and tube feet of some juvenile adults (Sewell, 1987). The colour usually graduates from the dorsal surface with dark warts, to the lighter ventral sole.

Fishing Methods

Many sea cucumbers are edible and are either eaten fresh, or gutted and their body wall dried to form a product known as trepang in Malaysia or, more commonly throughout the pacific, bêche-de-mer (Nichols, 1962; Conand, 1981; Stewart, 1993). Bêche-de-mer has been sought after for many centuries by the Chinese and South East Asians who value the product highly, both as a gastronomic delicacy and for the animals' supposed aphrodisiac properties (Stewart, 1993). There is also a market for a range of specialised products derived from the gut and gonads of some holothurian species (Mladenov & Gerring, 1991).

The market for bêche-de-mer is said to be expanding, due mainly to an increasing demand for cheaper species by the Peoples Republic of China (Mladenov & Gerring, 1991). Countries such as Australia, the United States of America and Canada are important newcomers due to this demand, introducing temperate species onto the market (Mladenov & Gerring, 1991).

Consequently, there has been recent interest in harvesting *Stichopus mollis* from New Zealand for overseas markets. A survey conducted in Fiordland in 1989, indicated *S. mollis* was present in commercial quantities in all fiords except Caswell and Nancy Sounds (Mladenov & Campbell, 1998). In 1990, a joint venture between the Te Anau based Fiordland Lobster Company Limited and Mount Manganui Seafoods Limited, a Tauranga fish export company, proposed the commercial harvest of sea cucumber from the fiords. They were subsequently granted a special permit by MAF Fisheries to collect *S. mollis*, using SCUBA. (Mladenov & Gerring, 1991). At the time, the approved harvest of 73 t amounted to between 0.2 and 2 percent of the estimated total sea cucumber population in Fiordland. Problems arose for the company when trying to process *S. mollis* in Fiordland as the characteristic high rainfall in the region meant sun drying the catch was very difficult.

Harvest

Continued interest in fishing *Stichopus mollis* from New Zealand waters (Mladenov & Campbell, 1998) lead to further research, based in Doubtful Sound, Fiordland (Raj, 1998). *S. mollis* is abundant in Doubtful Sound, but its reproductive characteristics mean that any commercial harvest would need to be carefully managed. If fishing for *Stichopus mollis* in Fiordland was allowed, an interim halt in fishing during the breeding season (October to January) would be advantageous to ensure sustainability (Raj, 1998). As fecundity, in relation to body size, is relatively low, capture of fertile individuals during the reproductive season would be disadvantageous (Raj, 1998). A minimum catch size limit would have to be set above 91g wet weight, or SAFSM (size at first sexual maturity) for the population, to ensure individuals are able to spawn at least once before capture (Raj, 1998). Fecundity was also shown to increase with size. *S. mollis* larvae are planktotrophic and remain in the water column for a period of up to two weeks (Archer, 1996). Restocking by local populations could be erratic and unreliable unless the larval recruitment processes for kina, as described by Lamare (1998), also apply to this species.

The relatively large size of *Stichopus mollis* at first sexual maturity in relation to maximum body size suggests it may be a slow growing and long lived species of holothurian, taking at least two years to reach sexual maturity (Raj, 1998). This is supported by length and preliminary growth studies which indicate *Stichopus mollis* are slow growing, reaching a maximum length of approximately 24 cm (Raj, 1998). This makes them one of the larger invertebrates in Doubtful Sound. The removal of large quantities of this important detrital feeder could impact on the ecosystem.

9.1.9 Blue Cod (BCO 5)

Biology/Distribution

Blue cod (*Parapercis colias*) are endemic to New Zealand. They are not a true cod but a member of the weaver family (Pinguipedidae), of which 43 species are described throughout the Indo-Pacific region. The blue cod is the only member of the family Pinguipedidae that supports a commercial fishery and its biology is not well understood. Parameters such as early life history, movement patterns, social structure and behaviours are not clear.

Blue cod are distributed from the shore to the shelf edge around New Zealand's entire coastline. Bottom dwelling carnivores, they are found on reef edges, shingle/gravel or sandy bottoms close to rocky outcrops. Although most commonly found to a depth of 150m, deepwater trawlers have reported catches of blue cod from depths of about 360 m (200 fathoms) off the Otago coastline.

Little is known about the early life history of blue cod, although fishers report catching juveniles at all depths. Sexually mature blue cod are often found in shallower water than small juveniles, and their distribution shows an inverse relationship with some kelps (Mutch, 1983). This observation is also supported by fishers who have reported that blue cod tend to 'shelter' from rough weather away from kelp covered reefs (Warren *et al*, 1997).

Large male blue cod may be territorial, holding large and rather loose territories (Mutch, 1983). Blue cod can reach up to 60 cm in length and weigh up to 4 kgs. Growth rates can vary within local areas (Rapson, 1956; Carter, 1992) and it has been suggested that growth may depend upon the availability of food (Rapson, 1956) or other localised environmental variables. It is estimated that blue cod live to a maximum age of between 12 and 17 years. As movement patterns of blue cod are unclear a study of blue cod movements within Southland has been commissioned. Preliminary results from this study suggest that most blue cod move less than 1 km (Carbines, 1998b), however, recent data shows individuals have travelled significant distances, up to 160 km in a straight line (Carbines, C. pers comm). Understanding whether blue cod are transitory or remain in one general location has important implications for the management of blue cod within the fiords.

While it has been observed that densities of adult blue cod on reefs show long term stability (Mutch, 1983), the abundance of blue cod may fluctuate naturally in some areas. Locations on the west coast of the South Island which supported good fishing grounds for many years no longer provide the catches they used to, despite the fact that cod potting has not been intense in recent years (Warren *et al*, 1997). On the other hand, some areas fished for many years are still proving to be good fishing sites today (Warren *et al*, 1997). It would appear that changes in environment such as food and habitat availability are major factors in determining the abundance of blue cod.

There is also anecdotal evidence of seasonal variation with blue cod fishing. Some fishing grounds may fish well during one season, whereas another location may be better during another season. As with other territorial reef dwelling species, which are non-migratory, blue cod appear to be susceptible to local depletion from fishing pressure. Results from the current Southland blue cod movement studies should clarify this (Carbines, 1998b).

It is generally accepted that blue cod change sex from females to males. This belief originates from experience with other members of the Pinguipedidae family which have been found to undergo this type of sex change (Stroud, 1984; Kobayashi *et al*, 1993). After presenting histological evidence, Carbines (1998a) defined blue cod as a diandric protogynous hermaphrodite, meaning that male blue cod can develop either directly from birth or indirectly from a previous female state.

Blue cod in Southland spawn in October, continuing through to January (Carbines, 1998a). Aggregations of what appear to be spawning blue cod have been observed in Foveaux Strait, in less than 55 m (Rapson, 1956; observations from local fishers). Both the eggs and the larvae of blue cod are pelagic for about 5 days before settling (Rapson, 1956; Robertson, 1973).

For a more detailed description of the biology of blue cod, refer to Carbines 1998a and the Southern Blue Cod Advisory Committee report “Characterisation of the Southland Blue Cod Fishery (1991-1996)”, compiled in association with the Ministry of Fisheries. The Guardians Working Group includes a representative from the Southern Blue Cod Advisory Committee.

Fishing Methods

Until the 1980s, the commercial blue cod fishery was primarily a line fishery. The use of specially designed cod pots replaced this method and since 1989/90, over 97% of the annual commercial blue cod catch has been caught by cod pots. Commercial blue cod fishers now use cod pots with a minimum 48 mm mesh size, to avoid catching undersize fish.

Cod pots are constructed of a steel frame covered with cyclone mesh. Fish are able to enter the pot through 3 or 4 funnel shaped 'spouts'. The number of spouts varies with the size of the pot. There are a variety of different sized cod pots; the use of which is often dependent upon the size and capability of the vessel. The two types most commonly used are 3’6” x 3’6” x 20” (1,050 mm x 1,050 mm x 500 mm) or 4’ x 4’ x 20” (1,200 mm x 1,200 mm x 500 mm). Generally, small vessels use the smaller sized cod pots.

Cod potting is carried out during the day and pots are usually baited with paua intestines and squid. The number of pots in the water at any one time varies between fishers and the time of the year. Blue cod fishers use, on average, seven cod pots (range 4-10) per fishing trip. The number of times each fisher lifts the pots during the day varies with the tide, number of pots in the water and with catch rates. Generally, each pot is lifted between 4 and 12 times per day. The amount of blue cod caught each day also varies greatly between fishers, location and the time of year. Catch is thought to be related to tidal movement.

To maximise the catch, experienced blue cod fishers may move their cod pots to another site after 1-2 days fishing. These areas will not usually be fished again (at least by that fisher) until the following season. This practice also has the effect of conserving the stocks, as localised areas are not entirely fished out and time is provided for the blue cod to grow in size and to re-stock the area for next year’s fishing. Once ‘takeable’ fish have been removed, undersize fish feeding in pots generally makes it to costly to continue fishing that area.

Blue cod are usually processed on board the boat, as the return to the fisher is much higher if the fish is landed processed. Fish are either head and gutted, or, more recently gilled and gutted for Asian markets. Currently, export certification regulations prevent fish-sheds from taking filleted cod. Fillets can only be sold on the local market.

Fishing is not as intensive now as it has been over the past few decades. This is largely a result of market demands that now require icing cod on the boats rather than freezing. This practice has led to four-day trips, 2 days of which are spent in transit. This is generally not as cost effective, and fishing pressure has therefore dropped.

The current regulations relating to the commercial blue cod fishery in BCO 5 Quota Management Area are contained in the *Fisheries (Southland and Sub-Antarctic Areas Commercial Fishing) Regulations 1986*. These include a minimum fish size of 33 cm, and a minimum mesh size of 48 mm for cod pots.

Harvest

Table 6: BCO 5 has three statistical areas encompassing Fiordland; 030, 031 and 032. Area 030 also includes the west coast of Stewart Island

Fishing Year	Annual Catch in Statistical Area 030 (t)	Annual Catch in Statistical Area 031 (t)	Annual Catch in Statistical Area 032 (t)	Total Annual Catch (t) from 030, 031, 032
1989/90	114.736	1.729	0.005	116.47
1990/91	103.443	0.030	0.679	104.152
1991/92	107.759	0.371	0.051	108.181
1992/93	161.224	3.369	5.174	169.767
1993/94	215.212	5.532	19.867	240.611
1994/95	203.448	19.893	0.780	224.121
1995/96	228.382	39.811	0.734	268.927
1996/97	178.027	22.102	6.200	206.329
1997/98	245.086	36.115	4.300	285.501

9.1.10 Groper (HPB, HAP, BAS)

Biology/Distribution

Two different species make up what is termed the groper fishery; the hapuku (*Polyprion oxygeneios*) and the bass (*Polyprion moeone*). The bass has a deeper body than the hapuku, with larger eyes and scales, a more symmetrical jaw (not undershot) and the first dorsal fin is not as high.

Research carried out on the biology of groper is extremely limited and life histories are poorly known. Both groper species are large fish and presumably powerful swimmers. Both species have proved difficult to age, but by analogy with similar species, it is assumed that they are slow-growing and at least moderately long-lived. The smallest juveniles are virtually unknown, but are mottled, pelagic and surface dwelling, perhaps schooling in association with drifting weed.

Hapuku and bass are widely distributed over the entire continental shelf from north to south. They generally inhabit rough ground from the central shelf (about 100m) to the shelf edge and down the upper slope. Their lower depth limits are ill-defined, but hapuku extends to at least 300 m and bass to 500 m. Commercial trawling and trawl survey data indicate sparse distribution of groper over smooth sea floor. Depending on the time of year, groper can also be found on rocky reefs as shallow as 5 m. Although bass and groper are closely related, they are seldom caught together as they generally inhabit different depths. Southern hapuku are quite abundant in shallow waters from 20-30 m during the summer months. It is thought that in June and July (winter) they migrate to deeper waters to spawn. By October/November, they begin to return.

The size range of commercially caught hapuku is 50-140 cm, with a maximum weight of 45 kg. Bass are slightly larger at 60-150 cm and much bulkier and heavier at equivalent lengths.

Groper are most abundant in steep and rocky habitats, possibly because their prey species concentrate on rough ground. When fishing, an error of a boat length in setting a line can make the difference between a good and poor catch. Therefore, it is likely that the groper lie against the rock faces and "ambush" their prey, very rarely leaving the face in search of food. Groper are carnivores and prey on a wide variety of fish and invertebrates, including red cod, tarakihi, blue cod, hoki, lanternfish, pilchard, ahuru, squid, krill, crabs, rock lobster and prawns. Groper probably have few predators themselves, but have been found in the stomachs of sperm whales.

It has been suggested that there are two types of hapuku fishery. One based on essentially migratory fish and the second on isolated, presumably resident, populations around island reefs and offshore pinnacles, or around the steep banks of offshore shelf-edge canyons.

Fishing Methods

Commercial groper fishers use drop-trotlines. These lines are set on the bottom (which may be mud or rock) at depths of 80-180 fathoms depending on the time of year and the area being fished. Each line consists of a length of braided or tarred line to which is attached 12-15 snoods with a hook on the end of each. A grapnel or weight at one end provides an anchorage and a long line with a buoy on the other end provides a marker and a means of retrieving the line. The lines are left on the bottom for several hours and are set with the tide and raised at slack water.

Harvest

Reported landings from ports from Taieri Mouth around to Milford, including Stewart Island, have been relatively small between 1930 and 1983, fluctuating around 50 tonne. This region may be relatively unexploited, due to the presence of more lucrative inshore fisheries and the amount of bad weather, making working the exposed groper grounds difficult (Paul, 1984). Paul, 1984, estimated that an increased yield of 200 t would be possible for this area.

Table 7: HPB5 has three statistical areas encompassing Fiordland; 030, 031 and 032. Area 030 also includes the west coast of Stewart Island

Fishing Year	Annual Catch in Statistical Area 030 (t)	Annual Catch in Statistical Area 031 (t)	Annual Catch in Statistical Area 032 (t)
1989/90	11.744	4.999	6.122
1990/91	28.728	7.851	4.541
1991/92	25.128	6.588	10.125
1992/93	36.579	8.719	3.092
1993/94	50.793	11.169	6.941
1994/95	35.150	13.659	10.457
1995/96	25.249	10.416	12.142
1996/97	21.150	13.244	27.498
1997/98	11.312	3.635	5.304

9.1.11 Tuna (STN, ALB, BTU, BIG)

Biology/Distribution

All tuna are highly mobile species, which migrate seasonally between tropical spawning grounds and subtropical and temperate feeding grounds. Tuna spend at least the juvenile phase of their life near the surface, where they are caught by trolling, purse seine and pole-and-line fishing. As tuna grow into adults, they tend to be found deeper, and are then caught by longline fishing.

Albacore tuna, *Thunnus alalunga,* is a moderately sized, relatively slender tuna that averages 55-65 cm in length, and can attain a maximum size of about 1.4 m, with a weight of 35 kg. Trolling surveys between 1968 and 1973 (Roberts 1974a, b, 1975, 1977, Slack, 1969) have shown that albacore tuna are seasonally present off the west and northeast coasts of New Zealand. Two different groups of albacore are found. During the winter, deep swimming adult fish are found off the edge of the continental shelf, and, in the summer months, surface swimming juvenile fish 50-60 cm long are found off the coast.

Albacore caught in the EEZ are part of a single South Pacific stock that ranges from the equator to about 45ºS and from the east coast of Australia to South America. Albacore are rarely caught by trolling in areas where sea surface temperatures are less than 15ºC (Roberts, 1980). In New Zealand waters in summer, this is the surface temperature associated with the boundary between the Subtropical and Subantarctic Surface Waters and the southward migration of albacore is limited by the position of the subtropical convergence. Off the West Coast, the convergence is poorly defined because of horizontal mixing and the dynamics of circulation in the area. Webb (1974) reported that albacore were landed in temperatures ranging from 17.2ºC-19º C along the western areas of the South Island.

Webb (1974) hypothesised that there were two distinct populations of albacore tuna along the western area of New Zealand: one off the North Island and one off the South Island. The southern population has an east-west migration through spring and autumn, while the northern albacore migrate north and south within the same periods.

Further, Webb (1974) concludes that most albacore breed in warmer waters away from New Zealand, although a few may breed in offshore New Zealand waters. Albacore tuna spawn in the western Pacific Ocean.

The major food sources for albacore tuna is plankton, including amphipods, however, they also feed on fish (ocean piper, pilchards, lantern fish, horse mackerel, whitebait - probably juvenile forms of pilchard, anchovy, and *Galaxias*), Euphausids, shrimps, salps, squid, and octopus.

Southern Bluefin Tuna (*Thunnus maccoyi)* is a large deep-bodied tuna and is one of the largest bony fish, attaining a maximum length of 2.5 m and a weight of over 400 kg. The southern bluefin is a powerful, rapid swimming migratory tuna found off the West Coast of the South Island during the summer, when schools are sometimes seen on the surface. Webb (1974) reports that southern blue fin tuna are found in water below 18.8ºC and at the confluence of upwelling and ocean water. Juvenile southern bluefin tuna migrate in single year class shoals (also of a single sex), and only mix with other year classes with the onset of maturity (130-150 cm).

Food includes plankton (crustacea), pilchards, lantern fish, and ocean piper. Southern bluefin spawn in the eastern Indian Ocean, south of Indonesia, and those caught in Fiordland are part of a single stock.

Japanese longliners have fished within what is now the New Zealand 200 nautical mile Exclusive Economic Zone (EEZ) since the 1950s. Foreign licensed Japanese, chartered and domestic longline vessels target southern bluefin tuna (SBT) south of latitude 35ºS.

During February and March of 1972, a polefishing survey, using the "*Hoko Maru* 15", was conducted along the west coast of New Zealand. One objective of the survey was to assess the tuna polefishing potential in the western areas of New Zealand, with special reference to the west coast of the South Island. It was found that although catches were not high, due to inadequate gear, the possibilities for future live bait fishing were good.

Southern bluefin tuna are the only tuna caught in New Zealand which are subject to a catch limit. This species is jointly managed by New Zealand, Australia, and Japan under the Commission for the Conservation of Southern Bluefin Tuna. Annual catch limits are set for each country. Southern bluefin tuna have been caught in the New Zealand area since the 1960s, mostly by Japanese longliners. New Zealand vessels began to target this tuna in 1982, developing a small fishery off the West Coast. However, by this time, the three nations were concerned about indications that the stock was being overfished. As a result, New Zealand agreed to restrain the expansion of its fishery, and Australia agreed to reduce its surface fishery. All parties agreed to abide by catch limits. Despite these efforts, the southern bluefin stock has continued to decline, and all parties agree that the parental stock is now 25-39% of what it was in the 1980s (Murray, 1996).

The Southern Bluefin Tuna fishery operates off the South Island in April, May, and June. Over the past 12 years, fishing effort by Japanese SBT longliners within the New Zealand EEZ has declined.

Local Fiordland fishers have started to develop a commercial bluefin tuna fishery using surface longline and trolling. They catch bluefin from late summer until early winter. In 1996, a Te Anau Licensed Fish Receiver (LFR) processed 50 t of local caught bluefin for the Japanese sashimi market. Japanese joint venture and New Zealand surface longline vessels now fish off Fiordland during these months with the larger vessels fishing up to 60 kms off shore.

Fishing Methods

Domestic longline vessels typically set a single longline during the night to avoid seabird capture. This line will be about 20-40 km long with no more than 1200 hooks. The bait is usually whole squid, jack mackerel, or other small fish (about 300 mm long), and the lines are generally set so that hooks are 80-180 m deep. The preferred depth varies with each species, the season, and geographical area. The line will be hauled in during mid to late morning, the hauling process taking 3 to 6 hours.

Bluefin is also the target for a growing charter fishing business through these months centred off the coast from Milford Sound and Doubtful Sound.

Table 8: Commercial Landings of Tuna by Statistical Area, 1996-97

TUNA				
		031+032	**030**	**TOTAL**
Albacore Tuna	ALB	6.819	0.092	6.911
Bigeye Tuna	BIG	0.09		0.09
Southern Bluefin Tuna	STN	24.141	2.687	26.828

9.1.12 Blueose (BNS)

Biology/Distribution

The available biological information on bluenose (*Hyperoglyphe antarctica*) is based on research undertaken in the QMA2 area (ie, off the east coast of the North Island). Bluenose is fast growing for the first two years of life, growing to 31 cm forked length (FL) within the first year, and 45 cm FL in the second year (Annala *et al*, 1998). At approximately 47 cm FL, juveniles recruit from a presumed pelagic lifestyle to a demersal one. The females' growth rate is faster than the males. Bluenose first spawn at ~62 cm FL at 4–5 years of age (Annala *et al*, 1998). The oldest recorded bluenose was a 15 year old female.

Little is known about the reproductive biology of bluenose. Spawning probably begins in late summer and lasts several months (Annala *et al*, 1998). No distinct spawning grounds are known, and it is not known whether more than one stock occurs in New Zealand waters.

Bluenose is often mistaken for groper and is a bycatch of line fishing and trawling. It may be resilient to fishing pressure due to its moderately fast growth, widespread distribution, occurrence in untrawlable areas, and presumed juvenile pelagic life-style (Annala *et al*, 1998). However, the apparent relatively sedentary nature of adults probably makes blue nose susceptible to localised depletion (Annala *et al*, 1998).

The QMA for BNS 3 is vast and contains the south east coast, the Chatham Islands and all sub-Antarctic waters around to the top of Fiordland. The distribution of quota is uneven and little is available for the Fiordland fishery to cover the inevitable bycatch from longlining. There has been some discussion about the possible sub-division of BNS 3. In the 1996/97 fishing year the TACC was exceeded by over 50%.

BNS 3 was put into an adaptive management programme (AMP) in the 1992/93 fishing year, when the TACC was increased from 175 t to 356.5 t.

Commercial landings of bluenose in the 1996-97 fishing year from Fiordland totalled 34.143 tonne.

9.1.13 School Shark (SCH)

Biology/Distribution

School shark (*Galeorhinus australis*) are generally found inshore during summer and offshore in the winter. Their habitat range extends from 0–600 m depth (Annala et al, 1998). School shark feed predominantly on small fish and cephalopods (octopus and squid). They are a slow growing, long-lived species, reaching approximately 50 years of age. School shark do not produce eggs, but give birth to fully developed young called “pups”. Growth is fast for the first few years, then slows between 5–15 years of age, with negligible growth after 20 years (Annala et al, 1998). Age at maturity is 12–17 years for females and 13–15 years for males (Annala et al, 1998). Breeding is assumed to be biennial, and perhaps even 3-yearly. Fecundity rates differ with age, with an average number of 5–10 pups (young) produced by small females, and ~40 pups by large females (Annala *et al*, 1998). Mating occurs in deep waters in winter, with pups released in spring and early summer (Annala *et al*, 1998). Nursery grounds include harbours, shallow bays, and sheltered coasts. Pups remain on the nursery grounds for 1–2 years (Annala *et al*, 1998).

Results from tagging studies indicate that school shark may move considerable distances. This could mean that there is only one single stock in New Zealand waters (Annala *et al*, 1998). In fact, individuals tagged in Foveaux Strait and southern Fiordland have been recaptured in south eastern Australia. This has significant implications for the management of the fishery.

School shark have a low productivity rate due to late maturity, slow growth, and low fecundity (Annala *et al*, 1998). Minimising fishing pressure on large mature females would help to maintain species productivity (Annala *et al*, 1998).

The commercial catch of school shark form Fiordland in the 1996-97 fishing year was 93.133 tonnes.

9.2 Recreational

Recreational fishing in Fiordland, with rugged wilderness values, spectacular scenery, and excellent fishing for a wide variety of species, is a special fishing adventure for people from all over New Zealand and abroad.

9.2.0 Recreational Fisheries

Rock lobster (Crayfish)

The MAF Fisheries South Region survey of Marine Recreational Fishers (Teirney *et al.*, 1992) found that rock lobster is the most popular recreational “shellfish” species in the South region, from the Clarence River above Kaikoura, around to Awarua Point above Milford Sound.

Diving, particularly SCUBA diving, is the most popular recreational rock lobster harvesting method in Fiordland. Potting is limited by the logistics of transporting the gear.

Recreational regulations for spiny rock lobster include a daily bag limit of 6 rock lobsters and a minimum tail width, measured in a straight line between the tips of the two large (primary) spines on the second segment of the tail. Recreational fishers may not take or possess male spiny rock lobster with a tail width of less than 54 mm or female spiny rock lobster with a tail width less than 60 mm. With a little practice, telling the difference between male and female rock lobster is quite easy. First, females have small pinchers on the rear pair of legs. Secondly, look at the underside of the tail. In the female the pleopods, or small fins are in pairs on each side of the tail but are in single form on the tail of a male.

It is illegal to harvest any female carrying external eggs or lobsters in the soft shell stage. It is also illegal to set a rock lobster pot unless it has two escape gaps of minimum inside dimensions 54 x 200 mm. Each aperture is required to be not less than 80% of the height or length of the pot. The float used is required to be marked with the owner's surname as well.

The 1991/92 recreational catch has been estimated at 40 t for all of CRA 8, which extends from Slope Point to Jackson Bay, including Stewart Island. The recreational harvest is only 4% of the commercial catch for CRA 8 for that fishing year. The recreational catch for CRA 8 for 1995/96 was estimated to be a point estimate of 16 t, ranging between 10-20 t (*Bradford 1998*). This figure represents 2% of that year's commercial take. While a figure for recreational take of rock lobster from Fiordland is not available at this time, it is reasonable to assume that it is small in comparison to the commercial catch.

Paua

The recreational paua fishery is managed by a daily bag limit of 10 blackfoot paua (*Haliotis iris*) and 10 yellowfoot paua (*Haliotis australis*) per person per day and also by size restrictions. The minimum legal size for the common blackfoot paua is 125 mm shell length. The yellowfoot paua has a minimum legal size of 80 mm shell length. Recreational fishers fish for paua either by shore gathering, or by free-diving. It is illegal to use underwater breathing apparatus (UBA) to harvest paua or to have UBA and paua together in a boat or vehicle. UBA includes SCUBA diving, or self contained underwater breathing apparatus.

In 1994, the Otago Southland Paua Management Working Group and MAF Fisheries produced a code of practice for amateur gatherers of paua. This code addressed issues such as harvesting techniques, measuring devices for use in the water, handling practices, and processing practices and quality control. This code of practice is available from any MFish office.

While a highly prized recreational species in Otago and Southland, the 1991/92 Marine Recreational Fishing Survey did not find paua an important recreational species in Fiordland. This is possibly because boats with SCUBA aboard are not allowed to also hold paua. As most divers going into Fiordland take SCUBA equipment, paua diving is not an option.

Blue cod

The current regulations relating to the recreational blue cod fishery in the Southland Fisheries Management Area are contained in the *Fisheries (Southland and Sub-Antarctic Areas Amateur Fishing) Regulations 1991*. These include a minimum fish size of 33 cm, and a maximum daily limit of 30 finfish (including blue cod).

Both the 1990 Survey of Marine Recreational Fishers (Teirney et. al., 1992) and the 1991/92 Marine Recreational Fishing Survey (Teirney and Kilner, 1999) showed that blue cod was by far the most popular recreational fish in the South region. It was targeted on more trips and caught in greater numbers than any other recreational fish.

In 1991/92, an estimated 5670 recreational fishers harvested 190 t of blue cod in BCO 5 which extends from Slope Point to Awarua Point. The 1991/92 Recreational Survey found that the main recreational fishing areas for blue cod in Fiordland were Doubtful Sound and Dusky Sound. This is supported by information collected by the Guardians of Fiordland's Fisheries.

The majority of recreational fishers use a rod or line to catch blue cod. Rod and line fishing from private and charter boats accounts for nearly 80% of recreational blue cod catch. Diving from both private and charter boats accounts for a further 18% of the catch. Due to increasing tourist numbers, charter boats will play an increasingly important part in the Fiordland recreational blue cod fishery. Over the period November 1997 to October 1998, 24,000 blue cod are estimated to have been caught from charter boats (James, G.D & Unwin, M.J. 1999). The 1990 Survey (Teirney *et. al.* 1992) reported that almost all recreational boat fishers harvest blue cod and about half of all recreational divers and shore fishers also catch this species.

Line fishing can result in the harvest of undersize blue cod. Carbines (1997) studied the survival rate of undersized blue cod returned to the water in the Marlborough Sounds. Eighty blue cod less than 33 cm length were caught by line and then released into holding pens. This study demonstrated that survival was directly linked to the site of the hook wound. There was a mortality rate of 25% overall, but only fish hooked in the gills or gut died. Furthermore, only fish caught with small hooks (size 1/0) were hooked in the gills or gut. The mortalities all occurred within 26 hours, indicating that death was caused by bleeding rather than infection.

From this study, it is clear that the use of small hooks should be discouraged in order to minimise the mortality of undersized blue cod that are returned to the water. It is recommended that only number 6/0 kahle hooks, or larger, should be used for blue cod fishing.

The current regulations relating to the Southland Fisheries Management Area include a minimum fish length of 33 cm and a maximum daily limit of 30 finfish (including blue cod).

Groper

Important commercial and recreational groper fisheries are found in the arms of Doubtful Sound. The 1991/92 Marine Recreational Fishing Survey found that Dusky and Milford Sounds were also important areas for recreational groper fishing in the South region (Teirney and Kilner, 1996). Groper are taken by non-commercial fishers using lines, and to a lesser extent, Dahn lines. Recreational fishers are restricted to a daily bag limit of 5 groper.

Scallops

Scallops are a very popular shellfish species and are sought after by recreational fishers throughout the South region. The 1991-92 revealed that over half of all divers surveyed listed scallops as one of the top six recreational species sought. Eighty percent of divers surveyed used SCUBA to collect scallops.

In Fiordland the current amateur regulations permit a daily bag limit of 10 scallops per person per day during a restricted season from 1 October to 15 March inclusive. There is also a minimum size regulation of 100 mm, measured across the greatest diameter of the shell.

Kina

Kina are accessible to both divers and shore gatherers. Currently, the size of the recreational fishery in Fiordland is considered to be small (McShane, *et al*., 1994). The daily bag limit for kina is 50 per person per day.

Other species

Species commonly caught but not so often targeted include sea perch (or as they are known colloquially in the south, jock stewarts), spotties, wrasses, trumpeter, moki, greenbone, gurnard, tarakihi, barracouta, stargazer, skates, sharks, rays and mussels. Sea perch/jock stewart, parrot fish, rig/dog fish and barracouta are the main bycatch species.

It is important to note that various daily bag and size limits that apply to Fiordland and the Southland FMA, may differ significantly from northern regulations or even south east regulations.

9.2.1 Recreational Activity Survey 1990-1995

Information on the Fiordland recreational fishery was obtained by a questionnaire survey conducted in 1995/96. The questionnaire was distributed by MAF Fisheries staff to anyone who could be identified as fishing in Fiordland. These people were found through recreational fishing meetings in Invercargill, Dunedin and Christchurch, and also through recreational fishing magazines. The questionnaire was also available at points of entry to the sounds. The questionnaire was in 3 parts: personal details of respondents, details on general recreational usage of Fiordland between 1990 and 1995 and more detailed questions relating to the respondent’s most recent trip to Fiordland.

The methods of obtaining respondents for the questionnaire mean that results are indicative of fishing patterns and trends, however, in the light of no information at all, this approach was deemed appropriate to establish if there was a recreational fishery of any significance in the first instance. Consequent to this, an independently contracted recreational fishing survey for the 1998-99 year is currently being completed.

One hundred and fifty eight questionnaires were completed. Respondents came from all over New Zealand, and ranged in age from 12 to 74. Of the 158 responses, only 9 were from females. There was a range of experience in terms of fishing Fiordland, with some respondents having first visited as long ago as 1950, others for the first time in 1995. The number of trips made by each respondent ranged from 1 to 2,000.

Table 9: Region of residence of respondents

Region	Respondents
Southland	60 (38%)
Canterbury	48 (30%)
Otago	33 (21%)
Fiordland	8 (5%)
Wellington	5 (3%)
Auckland	2 (1%)
Stewart Island	1 (1%)
Nelson	1 (1%)
Total	**158**

The respondents made a total of 1422 trips to Fiordland within the 1990-1994 period. Some, but not all respondents altered their questionnaires to include details from their 1995 trips. The 1995 information was therefore regarded as incomplete and is excluded from the following results.

The number of respondents visiting Fiordland rose from 73 in 1990 to 93 in 1994, while the total number of trips these respondents made rose from 259 in 1990 to 325 in 1994. When averaged, a consistent number of trips were made per respondent during this period. The average trip length during this period was also relatively constant at around 3.5 days.

Of the days spent in Fiordland for the different years, approximately 80% involved fishing, with an average of approximately 2.7-2.9 fishing days per trip between 1990 and 1994.

Table 10: Trip data 1990-1994

	1990	1991	1992	1993	1994
Number of Respondents	73	64	76	91	93
Number of Trips	259	260	278	300	325
Number of Days	924	902	978	1,107	1,090
Number of Fishing Days	742	727	800	877	885

Respondents were asked to indicate their primary reasons for visiting Fiordland each year between 1990 and 1994. Possible purposes included fishing, diving, sightseeing, hunting, tramping and working. There was also the opportunity to specify other reasons.

Most respondents listed more than one purpose during each year or visit. Follow up of respondents showed that those contacted sought to enjoy a variety of activities during a visit. The principal reason most commonly cited for entering the sounds was fishing. The next most popular activities were sightseeing and diving. The diving figures include fishing while diving in addition to non-extractive diving. Also popular was hunting, while respondents less commonly indicated tramping and working. Most respondents listed a "package" of activities which strongly suggests that fishing is a component activity that makes up a "Fiordland experience".

Table 11: Number of respondents participating in various activities in Fiordland, 1990-94

	1990	1991	1992	1993	1994
Fishing	68	63	72	81	85
Diving	32	29	32	40	48
Sightseeing	35	35	33	48	47
Hunting	22	18	21	23	24
Tramping	11	7	7	9	9
Working	5	7	9	10	11
Other	5	5	6	8	7

Between 1990 and 1994, Fiordland was most commonly entered at Doubtful Sound via Wilmot Pass and Milford Sound, with low numbers of respondents also recording entries via the South Coast and by other means. Respondents were asked to indicate what was the means by which they moved around Fiordland during each year, from 1990-94. Car, bus, charter boat, private boat, air or tramping were given as options. Many respondents used more than one form of transportation within the same year.

Cars were the most common form of transport used, followed by private boat. Travelling around Fiordland by private boat rose in popularity over the time period of the survey. Charter boats showed the biggest increase in use over the time period of the survey. Air transport fluctuated in popularity.

Fishing Details: most recent trip

The year in which the respondents most recently fished in Fiordland ranged from 1990 to 1996, although the majority (78%) fished most recently between 1994 and 1996.

Survey data indicates that April, followed by February, January and November, appear to be the most popular months for fishing Fiordland. The number of visits dropped off over winter before picking up again in spring. The period of highest use was January to April.

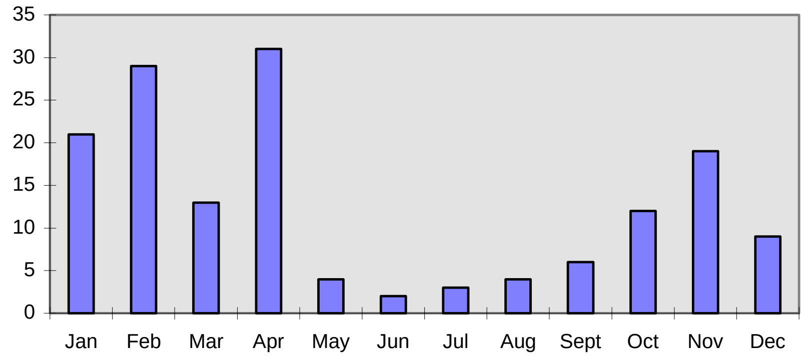


Figure 4: Month of most recent visit to Fiordland. (number of respondents vs mth)

The most popular fishing method used was line fishing from boats (142 respondents) followed by diving (99 respondents) and long lining (27 respondents). There was a small amount of potting, set netting, gathering and shore fishing also reported

The most commonly targeted species were blue cod, groper and rock lobster. (Table 12).

Table 12: Species targeted by respondents on their most recent trip

Species	Number of Respondents
Blue cod	122
Groper	90
Rock Lobster	76
Tuna	13
Scallops	10
Moki	5
Tarakihi	5
Greenbone	4
Sharks	4
Trumpeter	4
Ling	3
Paua	1

Respondents were asked to rate the abundance of species they caught or targeted. A species designated as ‘abundant’ was scored as a ‘1’, ‘moderately abundant’ as a ‘2’ and ‘scarce’ as ‘3’. If they were not sure of the status of any particular species, they indicated ‘4’ for ‘don’t know’. With the exception of game fish, abundance perception relates to within fiords.

Excluding the ‘don’t know’ category, scores were averaged to give an overall rating for each species. These are shown in Table 13. Of the most commonly targeted species, blue cod and rock lobster were considered abundant to moderately abundant, while groper, moki, greenbone, tuna and paua were considered moderately abundant to scarce.

Kilner and Teirney (1999) cite paua as the third most popular targeted recreational species in the south region, yet paua almost failed to get a response in this survey. One explanation for this anomaly is that being in possession of paua while having UBA equipment on board a vessel is an offence against the amateur fishing regulations. This posses a problem for those who wish to SCUBA dive, but are confined to their vessel.

Table 13: Abundance of different target species as perceived by respondents during their most recent fishing trip

Species	Mean 'Abundance'
Finfish	
Blue cod	1.92
Groper	2.19*
Greenbone	2.47*
Moki	2.34
Tuna	2.20
Trumpeter	2.00
Sharks	1.60
Tarakihi	1.80
Shellfish	
Rock lobster	1.67
Paua	2.47*

* few responses

Respondents were also asked to compare the perceived abundance of different species on their most recent trip with previous visits. A similar ranking system was used, with '1' being 'more plentiful', '2' as 'the same' and '3' as 'less plentiful'. Again, if respondents were unsure, they either did not answer or indicated a '4' for 'don't know'.

Table 14: Mean perceived relative abundance

Species	Mean 'Relative Abundance'
Finfish	
Blue cod	1.94
Groper	2.15
Greenbone	1.96
Moki	2.06
Tuna	1.75
Trumpeter	2.00
Tarakihi	1.50
Shellfish	
Rock Lobster	1.85
Paua	2.28

Tarakihi, tuna and rock lobster were considered to be more plentiful than on previous visits, blue cod was rated as being about the same abundance, while paua and groper were perceived to be less abundant.

Table 15: Percentage of most recent recreational fishing trips to fiords

Percentage of Most Recent Fishing Trips by Location			
Milford Sound	**19**		
Sutherland Sound	**0**		
Bligh Sound	**0**		
George Sound	**2**		
Caswell Sound	**0**		
Charles Sound	**0**		
Nancy Sound	**1**		
Doubtful Sound	**57**		
		Doubtful	**27**
		Thompson	**13**
		Bradshaw	**11**
		First Arm	**0**
		Crooked Arm	**3**
		Hall Arm	**3**
Dagg Sound	**0**		
Breaksea Sound	**5**		
Wet Jacket Arm	**0**		
Dusky Sound	**10**		
Chalky Inlet	**3**		
Preservation Inlet	**3**		

Where people fished on their most recent fishing trip strongly favours the points of access. If Breaksea and Dusky Sounds are combined as a complex and the same is applied to Doubtful, Thompson and Bradshaw Sounds, then 91% of respondents fishing trips occurred in just 3 discrete areas.

9.2.2 Fiordland Recreational Fishing Diary Survey 1997/98

J. Bell (Unpublished data), Research Progress Report to Ministry of Fisheries.

Table 16: Percentage of recreational fishing trips to fiords by location 1997/98

Percentage of Fishing Trips by Location			
Rod Fishing			
Milford Sound	**33**		
Sutherland Sound	**0**		
Bligh Sound	**2**		
George Sound	**2**		
Caswell Sound	**0**		
Charles Sound	**0**		
Nancy Sound	**1**		
Doubtful Sound	**37**		
		Doubtful	**11**
		Thompson	**9**
		Bradshaw	**8**
		First Arm	**4**
		Crooked Arm	**3**
		Hall Arm	**2**
Dagg Sound	**0**		
Breaksea Sound	**12**		
Wet Jacket Arm	**2**		
Dusky Sound	**10**		
Chalky Inlet	**0**		
Preservation Inlet	**1**		

Table 17: Percentage of recreational fishing trips to fiords by location 1997/98

Diving - Percentage of Trips by Location			
Milford	**26**		
Sutherland Sound	**0**		
Bligh Sound	**1**		
Caswell Sound	**0**		
George Sound	**2**		
Charles Sound	**1**		
Nancy Sound	**1**		
Doubtful Sound	**59**		
		Doubtful	25
		Thompson	15
		Bradshaw	6
		First Arm	1
		Crooked Arm	2
		Hall Arm	2
		Bauza Is.	8
Dagg Sound	**1**		
Breaksea Sound	**2**		
Wet Jacket Arm	**0**		
Dusky Sound	**6**		
Chalky Inlet	**0**		
Preservation Inlet	**1**		

Table 18: Percentage of recreational fishing trips to fiords by method 1997/98

Trolling - Number of trips (unscaled) (Open sea)	
Milford	**14**
Poison Bay	**1**
George Sound	**3**
Charles - Thompson	**5**
Doubtful Sound	**4**

It is evident from the above tables that Milford and Doubtful Sounds are the most regularly visited destinations by recreational fishers. It is important to note that these are also the most readily accessible areas.

The popularity of diving in Fiordland shown by these figures is also supported by the results of Bradford 1998, who concluded QMA 5 was second in importance for diving from a charter boat and most of this use was in Fiordland.

Table 19: Main target species of recreational fishers in Fiordland 1997/98

Main Target Species: number of times targeted		
Rock lobster	135	
Blue cod	101	
Hapuku/groper	35	
Tuna	22	(Southern bluefin - 9)
Trumpeter	21	
Tarakihi	7	

When compared with the list of most commonly targeted species from the previous survey, diving for rock lobster has become more popular and groper has slipped in popularity, but the top four species have remained the same. The surprise is trumpeter. Members of the Guardians and others consulted on Fiordland's fishing history recall that 20 years ago catching a trumpeter was rare and an occasion of note, but that since that time their numbers have flourished and trumpeter have become a common and popular Fiordland species.

9.2.3 Charter Boats

Charter boats play an important role in the recreational fishery in Fiordland, as shown by the results of the Fiordland Recreational Activity Questionnaire. For fishers who have no other way of accessing Fiordland's fisheries, charter boats provide a means of transport, allowing a wide range of recreational fishers to enjoy the experience. Some insight into the current charter boat fishery has been gained through a charter boat questionnaire survey conducted in 1995.

The Fiordland Charter Boat Questionnaire was issued to all charter boat owners and/or skippers operating in Fiordland. The questionnaire requested details about past and present charters - location, catch, method, frequency of trips and proportion of trips spent fishing, berth numbers, and so on.

Eleven questionnaires were returned, one of which was from an operator no longer in business, but which did provide some historical catch data. One operator did not fully complete the questionnaire.

The busiest time of the year for charter boats is between April and July. In contrast, the summer period (November to January) is the quietest time. Of the nine responses to the question of when they operated, three operated for the entire year, three for seven months, two for six months and one for three months.

The number of people carried on each of these trips varied from three to thirty, with an average of 10 clients per trip.

Charter boats cater for a number of client activities, from access to tramping areas, for sightseeing or a slice of Fiordland's rich history, to fishing charters. Charter operators were asked to detail the number of charter trips made each year over their years of operation up to 1995, and to state on how many charter trips clients fished.

Operators were also asked to state the number of fishing charters per year, the total number of days on the water, and the number of days clients fished. Some respondents provided the number of charters and no further details, so sample numbers in this section are reduced. Between 90-98% of days spent on the water involved clients fishing. This appeared to be fairly constant from year to year. The average length of charter trips ranged from seven day trips in 1991 for the one operator who gave details for this year, to 2.76 days in 1994 (n = 5). From 1992 to 1995 average trip length fell between two and three days on the water.

Table 20: Fishing charter details, 1991-95

	Year				
	1991	**1992**	**1993**	**1994**	**1995**
Number of charter trips	5	44	61	74	67
Number of days at sea per year	35	86	143	204	180
Mean trip length (days)	7	1.95	2.34	2.76	2.69
Number of days fishing (% of trips)	32 (90%)	83 (96.5%)	136 (95.1%)	196 (96.1%)	177 (98.3%)

Most operators who responded stated that fishing was their clients' primary interest. The primary purpose of the remainder was ecotourism and sightseeing.

Operators were asked to indicate on maps of Fiordland where they regularly fished, and what proportion of total fishing time was spent in those areas. Three operators completed this question. In all three cases, at least 50% of total fishing time was spent in the Thompson/Doubtful Sound area. Most fishing was conducted at the entrance to these fiords, with varying amounts taking place towards the heads of the fiords. The other popular fishing areas were at the entrance to Dusky and Breaksea Sounds.

Table 21 shows the fishing sites frequented by charter boats in 1991 and 1995. The most popular areas were Thompson, Doubtful, Breaksea and Dusky Sounds.

Table 21: Locations frequented by charter fishing boats in 1991 and 1995

	Number of Operators Fishing Each Location	
Location	**1991 (n = 4)**	**1995 (n = 10)**
Milford Sound	1	4
Poisson Bay	0	1
Sutherland Sound	0	0
Bligh Sound	0	0
George Sound	2	3
Caswell Sound	1	1
Charles Sound	0	2
Nancy Sound	0	1
Thompson Sound	3	6
Doubtful Sound	3	6
Dagg Sound	1	3
Breaksea Sound	3	5
Dusky Sound	3	5
Chalky Inlet	2	2
Preservation Inlet	2	2

The most commonly used fishing methods on charter boats were rod fishing and diving. Rod fishing was available from 10 of the operators, diving from eight. Long lining was also a potential method for some clients, available from seven of the operators. Other methods used infrequently were hand gathering and set netting.

The most preferred target species were blue cod, rock lobster, groper and scallops. Of these, blue cod, rock lobster and scallops were judged by the respondents to be abundant or moderately abundant within the areas their clients fish. Also frequently harvested in these areas were mussels and sea perch. Other species considered to be less abundant or scarce were greenbone, groper, moki, paua, tarakihi, trumpeter and tuna. When asked to recall the abundance of these species in their first year of operation in comparison with the 1995 stocks, blue cod, scallops, sea perch, tarakihi, trumpeter, moki, mussels, rock lobster and tuna were all thought to be present in larger or similar numbers as in earlier years. This was not the case for butterfish, groper and paua whose numbers were thought to have declined overall.

Another charter boat survey is currently underway, and is designed to provide estimates of the recreational harvest from charter boats operating in Fiordland.

10 FISHERIES OF THE FIORDS

For each fiord the Guardians identified the following:

What are the special values at present:

- Harvesting
- Support for fishing: anchorage, supplies, etc...
- Level of access
- Features
- Development

As a result, it became clear there are many features common to all the fiords, and these are discussed in section 9.1. Special features of each fiord are discussed in section 9.2.

10.0 The Generic Fiord

Certain features are common to all the fiords on the southern west coast. Generally, there is a wide range of marine species present: fish, invertebrates and plants typical of the southern region. Seals, dolphins and penguins are also found throughout many parts of Fiordland. Inside the fiords the waters are generally calm, with the fiord walls and islands providing shelter, although the fiords can funnel winds into a great intensity depending on direction. Most of the fiords and their arms ultimately shallow toward the head and culminate in estuarine areas at the mouths of extensive river systems.

Despite a wide range of fish species being found within the fiords, the fishing is generally not as good inside the fiords as on the outer coast. This is more pronounced towards the head of the fiords and may be associated with the paucity of seaweeds, both as food and cryptic habitat. The low salinity layer may also affect the primary productivity of phytoplankton, as could light intensity and complications in estuarine circulation.

Both recreational and commercial fishing takes place in most fiords, but the majority of commercial fishing is conducted outside the fiords. The commercial emphasis is on rock lobster and paua. Recreational fishing is concentrated on those areas that have road access, Milford Sound and the Doubtful Sound complex. Increasingly, charter boats, boats from other ports (including international), and privately owned larger vessels allow recreational fishing to take place within all the fiords.

Milford Sound typifies the public perception of a fiord, but in reality the nature of the fiords changes from north to south. The topography becomes less steep and fiords transform from narrow “ribbons” into complex configurations with numerous islands and rocky reefs. This difference is identified in Maori legend about the origins of Fiordland. Three general groupings can be identified.

Northern fiords are not complex. From Milford to Nancy Sound, the fiords are steep sided and narrow, very deep and with high precipitous mountains which create significant shade. They often have a shallow, well defined sill. This sill and the narrow width of the northern fiords can impede hydraulic and biological processes between the fiord and the open ocean.

Fiordland has a very high rainfall, and consequently substantial quantities of freshwater enter the fiords. The narrow width of these fiords assists the development of a thick low salinity layer over the surface. Humic compounds dissolve in the rainwater as it runs through the bush staining the low salinity layer a weak tea colour when the run-off enters the fiord. The stained low salinity layer reduces light penetration, which in turn restricts seaweed and phytoplankton growth. As a result of all these factors fishery habitat is limited. The steep sided fiords provide a fairly uniform rock wall habitat for species in the photic zone, except at the heads of the fiords. Communities are dominated by filter feeding animals with seaweed eating species becoming increasingly rare towards the head of this type of fiord.

The precipitous mountains mean that northern and central fiords are more prone to landslips than southern fiords. The edge of the continental shelf is extremely close to the entrances of northern and central fiords. This feature also influences both oceanic and ecological processes.

Between Thompson and Breaksea Sounds, the fiords tend to be more complex, characterised by interconnected systems of fiords and arms. The entrances to these fiords are wider and sills tend to be less defined, allowing greater oceanic exchange and hence algal growth. Islands within the fiords are more common. The middle fiords' open aspect to the ocean and wider expanses of water tend to reduce the light filtering low salinity layer as well as its effects towards the mouths of the fiords. Available habitat is less limited than northern fiords. In some places they are not as deep or as steep sided as the northern type. The surrounding mountains are not as steep or as towering, reducing the effect of shade in parts.

Dusky Sound, Chalky and Preservation Inlets are complex, with extensive, comparatively shallow areas and considerable numbers of rocky reefs and islands. Sills are poorly defined, with wide entrances allowing much greater interaction with the open ocean and its processes. This allows for a variety of habitats within these fiord systems. The surrounding landscape is lower and more "rolling". In places, these fiords are many kilometres wide. The lower salinity layer may be non existent in the outer third of southern fiords. The extensive habitat this provides contributes to a much wider diversity of species within these fiords, especially macro-algae. This difference is corroborated by McShane's (1997) observation that paua are abundant in Dusky Sound and in Chalky and Preservation Inlets but are rare in other fiords. Both central and southern fiords tend to be significantly longer than their northern counterparts, generally penetrating twice as far into the mountainous interior. Southern fiords are not as close to the continental shelf edge.

10.1 Features of Specific Fiords

Features specific to each fiord are described below. Although the Guardians posses detailed knowledge, the following descriptions have been condensed to provide an overview noting important features.

10.1.0 Northern Fiords

Milford Sound

Milford Sound was closed to all commercial fishing by a general fishing regulation in 1954. This closure reflected the importance of Milford Sound as a tourist destination, even at that time. Nevertheless, as it is the only fiord with direct road access, Milford Sound has remained important to the Fiordland commercial fishing fleet with current operations and mooring based at Deepwater Basin. Road access has also ensured Milford Sound is popular with recreational fishers and divers, as they can reach calm waters without needing to traverse the exposed West Coast.

Fish stocks within the fiord have not ever been reported as plentiful. Outside the fiord there are good stocks of blue cod, sea perch, spiny dogfish, groper, bluenose, tarakihi and moki which support both commercial and recreational fisheries. A commercial rock lobster fishery is also based off the coast of Milford, as is a big game fishery based largely around tuna species.

Milford is the most commercially developed of the fiords, and is now the base of a substantial tourist industry, catering for up to 5,000 visitors a day. In 1993, a marine reserve was established, which incorporates most of the northern side of the fiord. The reserve, with its underwater environment, has added another dimension to the tourism base and offers research opportunities to study the underwater environment the fiord. An underwater observatory gives non-divers the opportunity to view the fiord’s underwater environment. Video footage of most of the marine reserve has been made and the process of documenting the species found there is underway at the time of writing. There are anecdotal reports that the reserve has caused increased fishing pressure on the southern side of the fiord and this is of concern, however, interactions between the marine reserve and recreational fishing areas may become more clear over time.

Poison Bay

Poison Bay is about ten kilometres south of Milford Sound. Only accessible by boat, the area has many wilderness values and is relatively untouched when compared with Milford Sound. Although anchorages are available, they are not suitable for all weathers and care should be taken in this respect. A plateau that runs out of the bay supports significant fish stocks. These plentiful fish stocks support rock lobster, line and set net fisheries both off the entrance and on the plateau. The up-welling of ocean currents over this plateau offer good tuna fishing in the summer months.

The Bay provides good diving and a wide variety of species may be seen. Interestingly, sea horses are plentiful, especially large individuals. This bay will probably increase in popularity as tourist numbers and fishing pressure increases around the Milford Sound access point.

Sutherland Sound

Sutherland Sound is almost land-locked by a huge sill. This has caused the formation of an extensive estuarine area behind the sill with numerous logs trapped in the muddy fiord floor. Some areas of the Sound resemble an estuary with resident stocks of flatfish, spiky dogfish and stargazer. There is no commercial fishing in the Sound and because of this it is probably pristine. There are no rock lobster or paua inside the fiord due to periodic low salinity.

This Sound is difficult to enter because of the sill and, as a result, there has been limited tourism. The area is popular with hunters during the "roar". With sand hills on the northern side, the large estuary like area supporting good bird life, steep cliffs and spectacular scenery, this area is quite unique.

Bligh Sound

Bligh Sound has a wide entrance for a northern fiord and is relatively shallow (50 fathom) until Turn Round Point were it suddenly deepens to 100 fathom. Turn Round Point is renowned for its benthic fauna, especially black, red and pink coral and sponges, and has been identified as a significant area. It is thought that the strong local currents make this such a special place.

There are ample fish stocks, especially tarakihi and rock lobster, and it is one of the better Sounds for blue cod fishing. Despite this, there is little commercially fishing inland of Turn Round Point, limited charter boat activity, and it is not significantly fished recreationally.

The Sound is famous for its sand flies, even within Fiordland.

George Sound

An attractive and popular Sound, George Sound is described as comparatively shallow and is well known as an anchorage for both recreational and commercial fishers. The Sound is fished commercially for rock lobster up to Anchorage Cove, and has spots popular with recreational fishers for blue cod, hapuku and scallops. There is already a charter presence and the Sound is accessible to trampers via Lake Te Anau with a Department of Conservation hut available for accommodation. Special features include hot water springs at Anchorage Cove and sea pens on the south side of Cinch Cove.

Caswell Sound

Caswell Sound is a deep and narrow fiord with a very slim entrance as it is partially blocked by Entrance Island. These features tend to funnel the south-east wind which, when coupled with the precipitous and narrow geography of the fiord, means anchorages are few. The steep sides offer limited habitat so fishing is generally poor but commercial rock lobstering occurs in the outer Sound. Diving is described as not particularly good. Despite these draw-backs, the Sound did not escape human exploitation when at the turn of last century there was a marble mine on the northern side of the Sound.

Charles Sound

Charles Sound is within easy boating distance of Thompson Sound via the Doubtful Sound complex. It is considered one of the more attractive of the northern fiords with a picturesque island at the junction of Gold Arm and Emelius Arm, an estuary at the head of Gold Arm, while the Irene River in the Emelius Arm, navigable by small craft, has stocks of brown trout. The recreational fishery is good as is the recreational diving, but there is little charter activity. There is a good rock lobster fishery and some groper fishing also takes place. The supply of services is enhanced by a helicopter platform at the head of Gold Arm.

Nancy Sound

The mouth of this fiord is perched on the edge of the continental shelf. Consequently, there is no sand sill, presumably lost over the shelf, and the fiord is blocked by nugget-like rocks. This Sound conforms to the northern fiord type being deep, steep, and narrow affording very limited anchorages. It supports a variety of finfish species, but not in abundance, and blue cod fishing is reported as poor. However, the fiord possesses a useful rock lobster fishery. Tourist charters over-night in the Sound but this is not a regular occurrence despite there being good diving with black coral accessible at 3 metres depth. Soft mud at the Toe of Nancy Sound makes it inadvisable to anchor in a nor-west wind.

10.1.1 Central Fiords

Thompson Sound

Thompson Sound is connected to both Doubtful Sound and Bradshaw Sound by the Pendulo Reach. It has easy access for a range of craft via the Wilmot Pass and Doubtful Sound and, with sandy beaches and a northerly aspect, is a popular part of this waterway complex.

Thompson Sound is well known to recreational fishers with many staying at the Dea's Cove hut, not only lured by the promise of catching blue fin tuna and other big game fish, but general recreational fishing and diving. While there are not many blue cod to be caught, the groper fishing is good and migrating rock lobster or "run fish" are sometimes encountered between December and January inside Secretary Island. As these fish move through the Doubtful Sound system, some fish remain, replenishing stocks. It is unusual to see migrating lobster within the fiords. Thompson Sound is a designated shipping lane, accessible to all sizes of ships. Thompson Sound has several shallow bays and reef areas leading to an area of diverse marine habitat.

Bradshaw Sound

Bradshaw Sound is also a component of the greater Doubtful Sound waterways - connected by the Pendulo Reach. The Sound is very deep, right up to its head, where it divides into Precipice Cove and Gaer Arm. There is a good all weather anchorage at Precipice Cove. The Camelot River is accessible to small boats at high tide, useful to some users. The area offers good diving, especially in Precipice Cove.

This Sound has good fisheries and, possibly because of the depth, is particularly known for its ling fishery at the head of the Sound. This fishery is considered to be the best of all the fiords for this species. The area is also known for the less attractive hagfish. Bradshaw Sound also supports useful stocks of rock lobster well up into Gaer Arm and is an established component of the commercial fishery. There are also groper and scallops present.

Doubtful Sound

As mentioned, Doubtful Sound is part of a network of waterways. However, it is one of the larger fiords in its own right with a large entrance and three large arms: First Arm, Crooked Arm and Hall Arm. Secretary Island acts as a wedge, deflecting currents and tides either into Thompson or the Bauza water-way. As a result, this long fiord has significant tidal movement. The fiord also has some rocky outcrops and islands. There is vehicle access to the head of the fiord at Deep Cove, established over the Wilmot Pass in 1963 to service the Manapouri hydro-power scheme.

Both access and the power scheme have had significant implications for the fisheries in Doubtful Sound. Firstly, access has seen much greater use of this fiord than all others except Milford Sound. Access has also enabled quite extensive tourist development and recreational fishing.

Secondly, there is a substantial increase in the freshwater input into the Sound from the hydro-power scheme which increases the depth of the low salinity layer. Concerns about the environmental impacts of the increased volume of freshwater have resulted in the area becoming a focus for scientific study, largely funded by the hydro scheme owners.

While access makes the Sound a popular destination for recreational fishing and diving, it is not thought of as a prolific blue cod fishery as its stocks have traditionally been considered low. On the other hand groper, wrasses and jock stewarts are plentiful with the later popular catches for the children visiting the Deep Cove Outdoor Educational Trust hostel.

Commercially, there is some wetfish long lining and drop lining throughout the fiord, on a seasonal basis, especially for groper, as well as potting for rock lobster. The fiord offers numerous anchorages and shallow bays as well as including both the service areas of Deep Cove and Blanket Bay, which offer fuel, storage and helicopter facilities. With this range of infrastructure the fiord has become known as the “last resting place” of Fiordland fishers as they are able to contain their fishing wholly within the shelter of the Doubtful Sound complex.

The fiord has a range of conservation features including a marine reserve, Te Awaatu, at the “Gut”, a spectacular area renown for its yellow zooanthids and sea pens. Increasing numbers of seals, significant penguin colonies, especially of the Fiordland-crested penguin, and a resident pod of bottlenose dolphins top this off. When these attractions are coupled with the impressive Hall Arm, known as the “Sound of Silence”, plus ease of access, the popularity of this fiord with both fishers and the wider population is easy to understand.

On a cautionary note, the establishment of a possibly exotic sea weed, thought to be a species of either *Grateloupia* or *Rhodoglossum,* but commonly referred to as “Wanganella weed” because it arrived on the hull of the Wanganella, indicates the potential for ecological change from increased human activity.

Dagg Sound

Dagg Sound is a smaller fiord and is almost part of the Doubtful network via “Narrow Neck”, a link with Crooked Arm. Dagg Sound has a comparatively open entrance and therefore ocean swells penetrate quite some distance up the fiord. Nevertheless, it does offer some hospitality to mariners at the self-explanatory Anchorage Arm. The other arm is relatively shallow and terminates at Narrow Neck with quite an area of mud flats.

Wonderful underwater scenery and marine growth make for good diving which is further enhanced by large numbers of rock lobster, fished commercially up to Anchorage Arm. Despite this, some feature of the fiord must not suit blue cod, as the area is renowned for its lack of blue cod. Interestingly, it is also known for the presence of whales off the coast from the entrance.

Breaksea Sound

Breaksea Sound is the last of the central type of fiord, being part of a large waterway with two substantial terminal arms and numerous islands. It is connected via the Acheron Passage to a network of waterways. There are reasonable commercial rock lobster stocks within the fiord and some lining for groper also takes place. In general, recreational fishing is good with the added bonus of scallops for those who know where to look. Recreational fishers must employ larger boats than required for fishing in Doubtful Sound, as an open sea voyage is required to get to Breaksea, but there are good anchorages and friendly fishing bases. With spectacular scenery and access to Dusky Sound, tourism is on the increase.

Wet Jacket Arm

Branching off the Acheron Passage, which connects Breaksea and Dusky Sounds, lies Wet Jacket Arm. While it has ample fishing, especially blue cod and groper, the arm is long and isolated and attracts few visitors, usually hunters, looking for the mythical moose which were released at the head of the arm. This is really a fiord in its own right, being as big or bigger than many northern fiords. It is described as typical and has high wilderness values.

10.1.2 Southern Fiords

Dusky

At the southern end of the Acheron Passage is Dusky Sound. This fiord has pretty much everything. It has the features of a southern fiord. It is wide, with numerous rocks, shallow sandy bays and islands. In fact, folklore has it that there is an island for every day of the year. Further, as a warning to navigators, there is a submerged or tidal rock for every day of the year. The surrounding landscape is not as steep, nor as high as its northern counterparts. However, this only serves to make it different, not less spectacular.

Possessing a wide entrance that is also very close to the continental shelf, the outer fiord is exposed to the extremes of weather from the south and west and stories abound of the size of waves within the outer fiord. With this openness to the ocean and a wide variety of habitats, the area supports a wide range of fisheries. There are plentiful stocks of blue cod, tarakihi and trumpeter, which, once thought rare in Fiordland, are plentiful. Being more open to the ocean, the low salinity layer can be absent and seaweeds grow in abundance, supporting healthy stocks of kina and good numbers of paua.

An area of Dusky was set aside for an experimental kina fishing programme in the early 1990s, however, product quality did not meet market requirements and the experimental area currently remains closed to commercial fishing. Kelp-eating species of fish such as green bone are present. Rock lobster, which are quite prolific in the crevices and ledges of the Acheron Passage, breed within the fiord. The fiord is the longest of all the fiords, penetrating 42 km inland, yet, at the head of the fiord, Shark Cove is still appropriately named with surprising numbers of seven gill sharks present from time to time. The other cove at the head of the fiord is the terminus of a walking track and has two Department of Conservation huts.

The fiord offers many good anchorages and, as outlined earlier in this document, is steeped in history. There are excellent diving opportunities, including brilliant underwater scenery around Anchor Island, rock wall diving in the Acheron Passage, and two shipwrecks. With such a full basket of fishery and historic values, plus recreational opportunity and conservation interests, such as high seal numbers and abundant bird life, it is not surprising that tourism is developing rapidly in this fiord.

Chalky Inlet

Chalky Inlet has all the characteristics of a "southern fiord". It has a very wide double entrance of 7 to 8 km, excluding Chalky Island, and is approximately 24 km long. Chalky Inlet is a substantial body of water of over 60 km^2, excluding two complete sounds, Edwardson and Cunaris, at the head. In the body of the Inlet the low salinity layer is non existent. The land topography is comparatively low and the water correspondingly shallow with a number of islands and rocky reefs. It has many long beaches and sheltered bays. It is also important to note that the southern most fiords (Chalky and Preservation Inlet) are colder than their northern counterparts. The exposure to the open ocean assists the growth of significant quantities of seaweed, especially bladder kelp (*Macrocystis pyrifera*), which in turn support large paua and kina populations.

In recent times, these southern fiords have not attracted as much recreational attention as the more accessible fiords despite being rich in many species of fish and marine life. Chalky and Preservation Inlet both support commercial blue cod and rock lobster and paua fisheries. These fiords are known for big rock lobster in less than 10 m depth. Paua fishing is important within the Inlet, extending into the north side of Cunaris Sound. Of particular recreational interest, Chalky offers some of the best diving in Fiordland including access to scallops.

The old name for Chalky Inlet was the ominous 'Dark Cloud Inlet', so it is fortunate the Inlet offers sheltered anchorages - some famous over a hundred years of commercial fishing in the area, such as the not so imaginatively named North Port and South Port. There are freezer facilities and the wreck of the Stella at North Port.

Preservation Inlet

Preservation Inlet is similar to its immediate neighbour Chalky Inlet, with a wide, extensive, island-studded shallow area typical of the southern fiords. It also has two Sounds: the smallest of all Fiordland's Sounds, Isthmus Sound, and one of the larger Sounds, Long Sound. Preservation Inlet is approximately 32 km long, measured from Puysegur Point to the head of Long Sound. The area has similar fisheries to Chalky Inlet with important rock lobster and paua fisheries. Again, paua fishing occurs well into the Inlet. There is very good recreational diving, including sea pens and the "strawberry fields" holothurian beds. Preservation Inlet has a relatively rock free, sheltered inner fiord, with many anchorage's, and excellent recreational diving and fishing. The Inlet has a much stronger Maori history, especially at Spit Island, an early European history, and the only privately owned land within the Fiordland National Park boundaries, Kisbee lodge near the deserted gold town of Cromarty. The Inlet also has the site of the geologically oldest identified part of New Zealand, Coal Island, and possesses high wilderness values. Despite these many attractions, the area remains remote, having been described as the "last of the last frontier". This is probably because of the distance and the notorious waters of Foveaux Strait.

10.1.3 The Fiordland Coast

The coastal and littoral marine flora and fauna of the Fiordland outer coast is typical of the lower South Island, the species present and relative abundances' being similar to those of the coasts of Southland and Otago. The exception is the northerly current that moves down the Fiordland coast, raising the summer water temperature as high as 22^{o}C bringing with it some northern species, for example flying fish and snapper, the latter having been caught on occasion as far south as Vancouver Arm, Breaksea Sound.

The weather is the most significant factor controlling fishing opportunities outside the fiords. Rock lobster, paua, tarakihi and blue cod are fished along the entire Fiordland coast and inshore areas, (inshore is considered 50 fathom or less). Paua and especially blue cod are more prolific in the south.

Deepwater fisheries, (50 to 300 fathom), exist for bluenose, groper and bass. Except in isolated areas, "bulk" wetfish harvesting is limited because foul ground makes bottom trawling difficult.

Mid-water there are tuna, barracouta, kahawai, shark and mackerel but with limited catch histories for these species, there is little quota and few permits available for accessing these fisheries.

Closer inshore, there are good stocks of greenbone, moki tarakihi and trumpeter. These species are not common inside the fiords where kelp is limited, but greenbone and moki are more common in the south where kelp is more abundant. In the summer, squid are common on the western coast, including the occasional giant squid. Whales also frequent the coast, mainly in summer. On the open coast, coral banks occur from about 10 to 15 fathom, with black coral wide-spread out to and over the continental shelf. Red coral appears to respond to strong coastal currents and is common at deeps of 30 to 60 fathom. Encouragingly, recent information shows that red coral grows at a much faster rate than previously thought.

Having visited each fiord, north to south, we need to work our way back, starting with the Fiordland south coast. From Sandhill Point to Puysegur Point, the south coast is characterised by wave-cut rocky reefs with foul bottom all along the shoreline. Further out, the sea floor changes from rock to mud. These rock platforms are thought to be a good nursery area for rock lobster puerulus. The area is open and exposed to the southerly weather. This formation ends with an extensive off shore reef out from Puysegur Point at the entrance to Preservation Inlet. This whole stretch of coast is an important rock lobster and paua fishing ground. Potting for blue cod and netting for school shark are also regular fisheries. This pattern extends along past West Cape and Five Fingers Peninsula. Sea conditions from Sandhill Point to Breaksea are notoriously exposed and dangerous, however, they are said to improve the further north you go, but this by no means makes the northern conditions good.

Halfway between Breaksea and Coal River, and out to sea, is the first of the so called “magic mountains”. This is a cluster of pinnacles that suddenly raise “like undersea islands”, offering good fisheries on their upper reaches for blue nose, groper, bass and shark, as well as surface fishing for tuna in summer.

From this point up the coast the continental shelf is very close to the shore. This leaves little area available for inshore habitat and therefore constrains the inshore fisheries. Thus, coastal reef fish, paua and rock lobster fisheries predominate. On the other hand, aggregations of various species congregating to take advantage of up-welling food may be found on the edge of the steep continental slope.

The habitat pattern outlined above continues north until just south of Nancy Sound where there is a most curious formation. This consists of three or four pinnacles that rise from 100 fathom up to 2 or 3 fathom below the surface. The surface area of the top of each pinnacle is less than 100 m^2.

Next, in front of Caswell Sound, about 8 km out to sea, is the second “Magic Mountain”. This is in fact a ridge that runs out to sea directly in front of the mouth of Caswell Sound. Passing the famous Two Thumb Bay and Looking Glass Bay and the curious House Roof Rock, the continental shelf bulges - again affording a wider variety of good fishing. Between here and Sutherland Sound there is an important fishing bank.

The coast adjacent to Milford Sound has high fishery values. Off shore reefs offer good rock lobster fishing, and there are excellent quantities of blue cod north of Milford Sound. The Brig (a reef 4 km off the entrance to Milford Sound) is popular with recreational fishers and overnight charter trips. Kina are plentiful on this stretch of coast, while to the south of the entrance, Transit Beach affords excellent fishing.

Yates Point to the north is quite distinct from the terrain to the south. The shelf starts to expand creating sandy areas that allow easy trawling and a flatfish fishery. This is also an excellent rock lobster area. Martins Bay and Big Bay are large sand beaches with surf clams, tuatua, pipi, and cockles. Martins Bay and Big Bay are the largest northern areas for trawling and set netting.

11 REFERENCES

‘An Introduction to the Waitangi Tribunal - with reference to the Ngai Tahu Land Claim.’ Dunedin Community Law Centre, 1995.

Anderson, A.J. (1983). Analysis of fish remains from southern Fiordland and Stewart Island. New Zealand Archaeological Association Newsletter **26**: 264-270.

Anderson, A. (1986). Mahinga Ika O Te Moana: Selection in the pre-European fish catch of southern New Zealand. In: A. Anderson (ed.) *Traditional Fishing in the Pacific*, Pacific Anthropological Records **37,** Bishop Museum, Hawaii.

Andrew, N.L. (1988). Ecological aspects of the common sea urchin *Evechinus choloroticus* in northern New Zealand: a review. New Zealand Journal of Marine and Freshwater Research **22**: 415-426.

Andrew, N.L., MacDiarmid, A.B. (1999). Sea urchin fisheries and potential ecological interactions with a kina fishery in Fiordland: a review of the evidence. A report prepared for the Southland Conservency of the Department of Conservation. WLG 99/25

Annala, J.H., McKoy, J.L., Pike, R.B. (1980). Size at the onset of sexual maturity in female *Jasus edwadrsii* (Decapoda: Palinuridae) in New Zealand. N.Z. Journal of Marine and Freahwater Research 14 : 217-227.

Annala, J. *NZ Rock Lobsters, Biology and Fishery*, Fisheries Research Division Publication No. 42, History and Current State of the Fishery.

Annala, J.H., Sullivan, K.J., O’Brien, C.J. & Iball, S.D. (Comps.) (1998). Report from the Fishery Assessment Plenary, May 1998: stock assessments an yield estimates. 409 p. (Unpublished report held in NIWA library, Wellington).

Batham, E.J. (1965). Rocky shore ecology of a southern New Zealand fiord. Transactions of the Royal Society of New Zealand, Zoology, 6(21): 215-227.

Beaglehole, J.C. (1961). *The Journals of Captain James Cook*, Volume II, Cambridge.

Begg, A. C. & N. C. (1966). *Dusky Bay*, Whitcombe & Tombs, Christchurch, Part 2, page 118-119.

Begg, A. C. & N. C. (1969). *James Cook and New Zealand*, Government Printer, NZ.

Begg A. C. & N. C. (1973). *Port Preservation*, Whitcombe & Tombs, Christchurch.

Best, E. (1929). Fishing methods and devices of the Maori. Dominion Museum Bulletin No. 12.n pp230.

Bishop, G. & Forsyth, J. (1988). Vanishing ice: an introduction to glaciers based on a study of the Dart Glacier. John McIndoe and New Zealand Geological Survey, DSIR, Dunedin, New Zealand. pp 56.

Bradford, E. (1998). Harvest Estimates form the 1996 national marine recreational fishing surveys. New Zealand Fisheries Assessment Research document 98/16. Ministry of Fisheries, Wellington. pp 27.

Bradford, E. (1998b). Determining the contribution which diarists fishing from charter boats make to harvest estimates from the national diary survey. Research Report for Ministry of Fisheries. Ministry of Fisheries, Wellington. pp10.

Brosnan, B.C. (1999). Recovery of terrestrial and marine communities in a New Zealand fiord after large-scale disturbances. Unpublished MSc thesis. University of Otago. pp 137.

Carbines, G.D. (1997). The mortality of hooked and returned blue cod (*Parapercis colias*) in the Marlborough Sounds of New Zealand.

Carbines, G.D. (1998a). Blue Cod age validation, tagging feasibility and sex inversion. NIWA Research Report. pp 72.

Carbines, G.D. (1998b). Movement Studies of Blue Cod interim report

Carter, S.E. (1992). Latitudinal changes in growth patterns of two Teleost fishes within New Zealand. MSc Thesis, University of Auckland, Auckland, New Zealand.

Coutts, P.J.F. (1975). Marine fishing in Archaeological perspective: techniques for determining fishing strategies. In R.W. Casteel & G.I. Quimby (eds.) *Maritime Adaptations of the Pacific*. pp. 265-306. Mouton, The Hague.

Dix, T.G. (1969). Larval life span of the echinoid *Evechinus chloroticus* (Val.). New Zealand Journal of Marine and Freshwater Research **3** 13-16.

Dix, T.G. (1970). Biology of *Evechinus chloroticus* (Echinoidea: Echinometridae) from different localities 1 General. New Zealand Journal of Marine and Freshwater Research **4**(2): 91-116.

Dix, T.G. (1970b). Biology of *Evechinus chloroticus* (Echinoidea: Echinometridae) from different localities 3. Reproduction. New Zealand Journal of Marine and Freshwater Research **4**(4): 385-405.

Dix, T.G. (1972). Biology of *Evechinus chloroticus* (Echinoidea: Echinometridae) from different localities 4. Age, growth, and size. New Zealand Journal of Marine and Freshwater Research **6**(1&2): 48-68.

Duckworth, K. (1995). Analysis of factors which influence seabird bycatch in the Japanese southern bluefin tuna longline fishery in New Zealand waters, 1989-93. New Zealand Fisheries Assessment Research Document 95/26.

Elvy, D., Grindley, R., Teirney, L. (1997). Management Plan For Paua 5, MFish, Dunedin.

Evison, H. (1997). *The Long Dispute*, Canterbury University Press.

Fiordland Travel. (1998). *Discover Fiordland,* Manapouri.

Francis, M.P. (1991). Distribution and abundance of Fiordland reef fish. In: Report on Planning Workshop - Fiords Marine Research 26-27 August, 1991, Wellington. DSIR Marine & Freshwater &University of Otago.

Glasby, G.P. (Ed.) (1978). Fiord studies: Nancy and Caswell Sounds, New Zealand. N.Z. Oceanographic Memoir 79: 94 pp.

Grady, D. (1986). Sealers & Whalers in New Zealand Waters, Reed Methuen, Auckland.

Grange, K.R. (1985). New Zealand's southern fiords, a marine wonderland. DSIR Alpha 50.

Grange, K.R. (1990). Unique marine habitats in the New Zealand fiords: A case for preservation. N.Z. Department of Conservation, D.O.C. Project No. S1030/584.

Grange, K.R. (1991). Rock-wall ecology. In: Report on Planning Workshop - Fiords Marine Research 26-27 August, 1991, Wellington. DSIR Marine & Freshwater &University of Otago.

Grange, K.R., Singleton, R.J., Richardson, J.R., Hill, P.J., Main, W. Del, (1981). Shallow rock-wall biological associations of some southern fiords of New Zealand. N.Z. Journal of Zoology 8: 209-227.

Grange, K.R., Singleton, R.J., Richardson, J.R., Hill, P.J. & Main, W. deL., (1985). Shallow rock wall biological associations of some southern fiords of New Zealand. *New Zealand Journal of Zoology* **8**:209-227.

Grange, K.R. and Mladenov, P. (eds,.) (1991). Report on Planning Workshop - Fiords Marine Research 26-27 August, 1991, Wellington. DSIR Marine & Freshwater &University of Otago.

Hall-Jones, J. (1976). *Fiordland Explored*. A.H. & A.W. Reed, Wellington.

Hall-Jones, J. (1984). *Doubtful Harbour*, Craig Printing, Invercargill.

Hall-Jones, J. & White J. (1980). *Majestic Wilderness*, Orakau House, Auckland.

Hardy, G.S. (1985). *Fishes recorded from Fiordland waters*, 1984/85. Unpublished report, prepared for Fiordland National Park Board. pp10.

Hutchins L. (1998). *Making Waves,* Craig Printing, Invercargill.

Johnston, A.D. (1983). *The southern Cook Strait groper fishery*. Fisheries Technical Report No. 159. pp33.

Kobayashi, K., Suzuki, K. & Shiobara, Y. (1993). *Studies on the Gonadal Sex Succession in P snyderi (Teleostei, Parapercidae) in Suruga Bay, Central Japan*. Bulletin of the Institute of Oceanic Research & Development, Tokai University. 14, 83-91.

Lamare, M.D. (1998). Restricted larval transport in a population of the sea urchins, *Evechinus chloroticus* (Val.) in a New Zealand Fiord. In Echinoderms: San Francisco, R. Mooi & M. Telfor (Eds). Proceedings from the Ninth International Echinoderm Conference, San Francisco, August 1996: pp723.

Lawrence, J.M. (1975). On the relationships between marine plants and sea urchins. Oceanography and marine biology annual reviews **13**: 213-286.

MacIntosh, J. (1980). *Colac Bay* Gore Publishing Co. Ltd., Gore.

McNab, R. (1907). *Murihiku*, Wilson & Horton, Auckland.

McNab, R. (1909). *Murihiku*, Whitcombe & Tombs, Christchurch.

McNab, R. (1914). *Historical Records of New Zealand Vol. II*, Government Printer, Wellington.

McShane, P.E., Anderson, O., Gerring, P., and Stewart, R. (1993). Experimental fishing for sea urchins (kina) underway in Dusky Sound. Seafood New Zealand. August 1993. 42-44.

McShane, P.E., Anderson, O., Gerring, P., Stewart, R., and Naylor, J.R. (1994). Fisheries Biology of kina (*Evechinus chloroticus*). New Zealand Fisheries Research Document, 94/17.

McShane, P.E., Mercer, S.F., Naylor, J.R., and Notman, P.R. (1975). Paua (*H. iris*) fishery assessment 1995. New Zealand Fisheries Research Document 95/

McShane, P.E. and Naylor, J.R. (1991) A survey of kina popuations (*Evechinus chloroticus*) in Dusky Sound and Chalky Inlet, southwestern New Zealand. New Zealand Fisheries Assessment Research Document 91/17.

Michael. K.P. and Cranfield, H.J. (1992). The population size structure and relative abundance of the Scallop (*Pecten novaezelandiae*) at Paterson Inlet, Stewart Island. Unpublished data report.

Mladenov, P. V. & Campbell, A. (1998). Resources evaluation of the sea cucumber, *Stichopus mollis*, in the environmentally sensitive Fiordland region of New Zealand. In R. & T. Mooi M. (Ed.), Ninth International Echinoderm Conference, August 1996, (pp. 481-487). San Francisco, California, USA: A.A. Balkema, Rotterdam.

Mladenov, P. V. & Gerring, P. (1991). Resource Evaluation of the Sea Cucumber (*Stichopus mollis*) in Fiordland, New Zealand. Report of the Marine Science and Aquaculture Research Unit, University of Otago, 25pp.

Murray, T. (1996). Are there enough out there? Seafood New Zealand **4**(10): 54-56.

Mutch,P.G. (1983). Factors Influencing the Density and Distribution of Blue Cod (*Parapercis colias*) (Pisces: Mugiloides). M.Sc. Thesis, University of Auckland, Auckland New Zealand.

Olssen, E. (1984) *A History of Otago*. McIndoe Ltd, Dunedin, NZ.

Orwin J. (1997) *Four Generations From Maoridom*: The Memoirs of Sid Cormack, Kaumatua & Fisherman, University of Otago Press, Dunedin.

Orbell, M. (1985). "The Natural World of the Maori." David Bateman Ltd., Auckland. 230p.

Pantin, H.M. (1964). Sedimentation in Milford Sound. In : Skerman, T.M. ed., Studies of a southern fiord. N.Z. Oceanographic Institute Memoir 17: 35-47.

Paul, L.J. (1984). The estimation of Hapuku, Bass, and Bluenose yields. Fisheries Research Division Internal Report No. 7.

Paulin, C.D. (1991). In: Report on Planning Workshop - Fiords Marine Research 26-27 August, 1991, Wellington. DSIR Marine & Freshwater &University of Otago.

Paulin, C.D.(1991). The Fiordland fish fauna: a summary. In: Grange, K. & Mladenov, P. (Convenors), *Report on Planning Workshop - Fiords Marine Research*. DSIR Marine & Freshwater and University of Otago.

Pickrill, R.A. (1980). Beach and nearshore morphology and sedimentation in Fiordland, New Zealand: A comparison between fiords and glacial lakes. N.Z. Journal of Geology and Geophysics 23(4): 469-480.

Pickrill, R.A., and Mitchell, J.S. (1979). Ocean wave characteristics around New Zealand. New Zealand journal of Marine and Freshwater Research **13**: 501-520.

Poore, G.C.B. (1972a). Ecology of New Zealand Abalones, *Haliotis* species (Mollusca: Gastropoda). 1. Feeding. N.Z. Journal of Marine and Freshwater Research **6** (1&2) : 11-22.

Poore, G.C.B. (1972b). Ecology of New Zealand Abalones, *Haliotis* species (Mollusca: Gastropoda). 2. Seasonal and diurnal movement. N.Z. Journal of Marine and Freshwater Research **6** (3) : 246-58.

Poore, G.C.B. (1972c). Ecology of New Zealand Abalones, *Haliotis* species (Mollusca: Gastropoda). 3. Growth. N.Z. Journal of Marine and Freshwater Research **6** (4) : 534-59.

Poore, G.C.B. (1973). Ecology of New Zealand Abalones, *Haliotis* species (Mollusca: Gastropoda). 4. Reproduction. N.Z. Journal of Marine and Freshwater Research **7** (1&2) : 67-84.

Powell, P. (1976). *Fishermen of Fiordland*, A H & A W Reed, Wellington.

Raj, L. K. (1998). Reproductive Biology and the Use of Photoidentification to Study Growth in *Stichopus mollis* (Echinodermata: Holothuroidea) in Doubtful Sound, Fiordland, New Zealand. MSc, University of Otago.

Rapson, A.M. (1956) Biology of the Blue Cod (*Parapercis colias* Foster) of New Zealand. Ph.D Thesis, Victoria University, Wellington, New Zealand.

Richards, R. (1995). *The Foveaux Whaling Yarns of Yankee Jack*, Otago Heritage Books, Dunedin.

Roberts, P.E. (1974a). Selective feeding by albacore and skipjack tuna in the New Zealand region in spring. Pp. 461-469. In: Indo-Pacific Fisheries Council Proceedings, 15th session, Section 3: Symposium on Coastal and High Seas Pelagic Resources.

Roberts, P.E. (1974b). Albacore off the northwest coast of New Zealand, February 1972. New Zealand Journal of Marine and Freshwater Research **8**: 455-72.

Roberts, P.E. 1977. 1973 Tuna survey west coast South Island. New Zealand Ministry of Agriculture and Fisheries, Fisheries Research Division Occasional Publication 12.

Roberts, C.D. (1989). A revision of New Zealand and Australian orange perches (Teleostei Serranidae) previously referred to *Lepidoperca pulchella* (Waite) with description of a new species of *Lepidoperca* from New Zealand. Journal of Natural History **23**: 557-589.

Roberts, C.D. (1989). A revision of New Zealand orange perches (Teleostei: Serranidae) previosly referred to *Lepidoperca pulchella* (Waite) with description of a new species of *Leidoperca* from New Zealand. *Journal of Natural History* **23**:557-589.

Roberts, P.E. (1980). Surface distribution of albacore tuna, *Thunnus alalunga* Bonnaterre, in relation to the subtropical convergence zone east of New Zealand. New Zealand journal of Marine and Freshwater Research **14**(4): 373-380.

Roberts, W. H. S. (1913). *Place Names & Early History of Otago & Southland*, 1913.

Robertson, B.M. (1993). Southland water quality review. Southland Regional Council Report prepared by Robertson Ryder & Associates, Environmental Consultants, Dunedin.

Rock Lobster Fisheries Proposed Policy for Future Management. (1986). MAF, Wellington.

Ryan, P.A. and Paulin, C.D. (1998) Fiordland Underwater, New Zealand's Hidden Wilderness. Exisle Publishing Co Ltd, NZ.

Schiel, D.R. and Foster, M.S. (1986). The structure of subtidal algal stands in temperate waters. Oceanography and marine biology annual reviews **24**: 265-307.

Slack, E.B. (1969). A commercial catch of albacore (*Thunnus alalunga* Bonnaterre) in New Zealand. New Zealand Marine Department Fisheries Technical Report 46.

Smith, F. (1995). Structure of subtidal rock wall invertebrate communities of three reference sites in Doubtful Sound. Report to ECNZ. pp 33.

Stanton, B.R. and Pickard, G.L. (1980). Physical oceanography of the New Zealand fjords. NZ Oceanographic Institute Memoir 88: 37 p.

Starke J. (1986) *Journal of a Rambler: The Journal of John Boultbee*, Oxford University Press, Auckland.

Starke, J. (1986). *Journal of a Rambler*, *The Journal of John Boultbee*, Oxford University Press.

Stewart, B.G. (1993). Evidence for a marked decline of bêche-de-mer populations in the Suva and Bega areas of Fiji, and a preliminary description of a method of identifying bêche-de-mer individuals based on characteristic body wrinkles. University of the South Pacific Marine Studies Technical Report No 1/93. pp 20.

Stewart, B.G. (1998). Biological Monitoring of Doubtful Sound Ecosystem. Annual Report #1. Electricity Corporation of New Zealand. pp 60.

Stewart, B.G. (1999). Biological Monitoring of Doubtful Sound Ecosystem. Annual Report #2. Meridian Energy. pp 77.

Stead, D.H. (1972). Scallop surveys - Fiordland - 1972. Fisheries Technical Report No. 124. Wellington, New Zealand.

Street, R. (1970). *NZ Rock Lobster South Island Fisheries*, Fisheries Technical Report No. 54, Wellington.

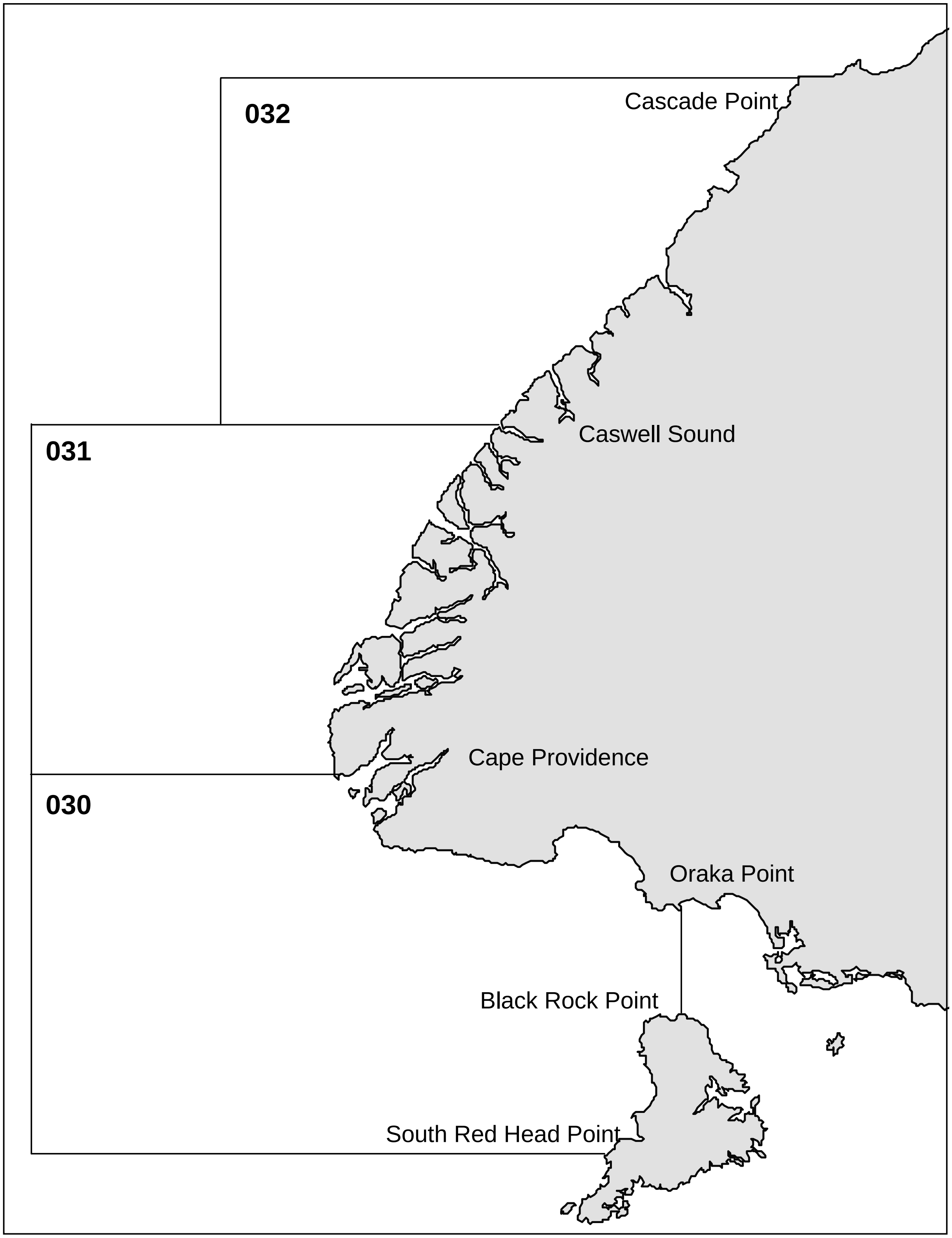
Street, R. (1970). *NZ Rock Lobster South Island Fisheries*, Fisheries Technical Report No. 54, Wellington.

Teirney, L. and Kilner, A. (in prep.) Marine Recreational Fishing Survey 1991/92 in Ministry of Fisheries South Region. New Zealand Fisheries Management: Regional Series.

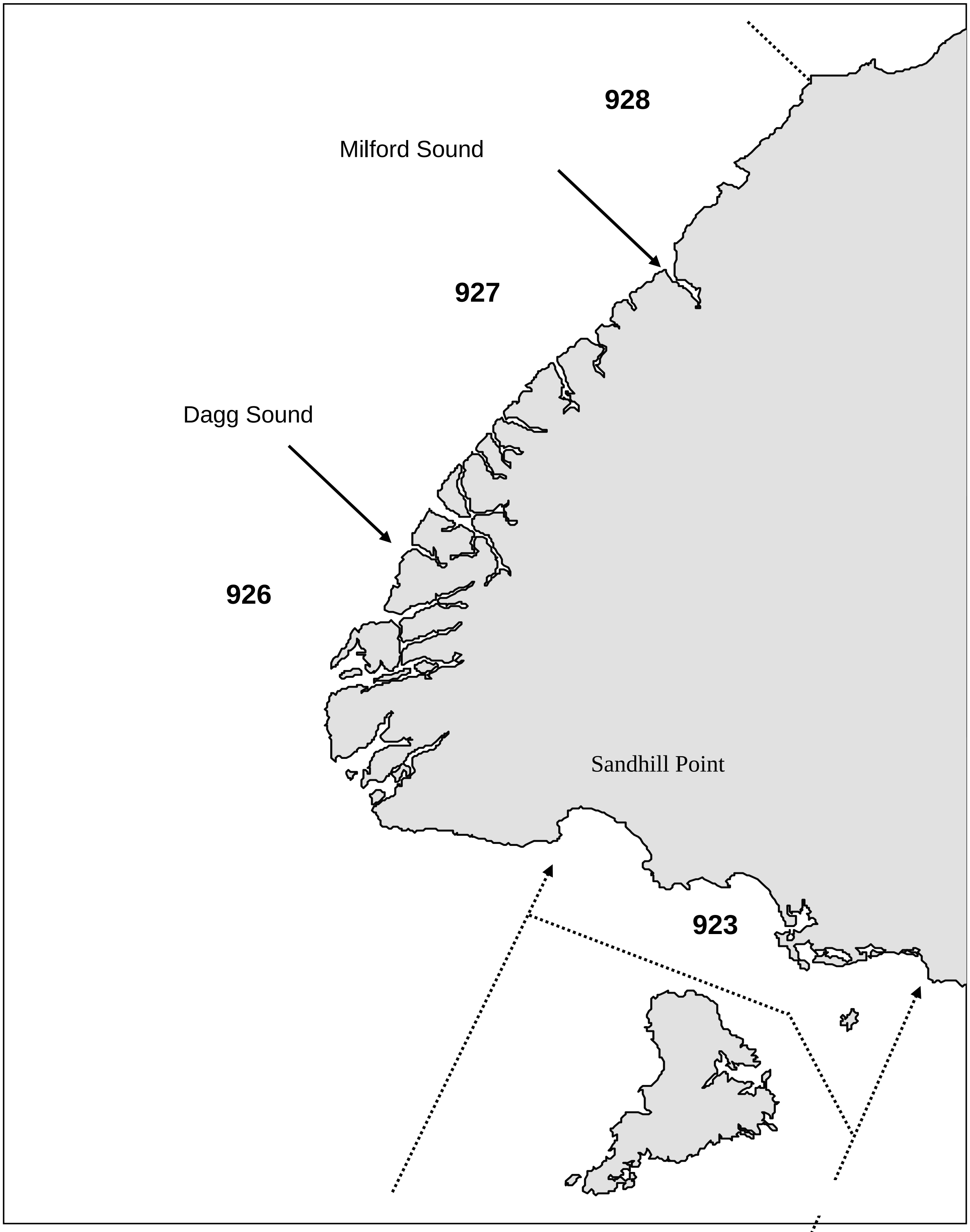
Webb, B.F. (1974). Report on a tuna polefishing and livebait venture “Hoko Maru 15” 8 February to 21 March 1972 Section 3: Polefishing, hydrology, and tuna analysis. New Zealand Ministry of Agriculture and Fisheries, Fisheries Technical Report 106.

APPENDIX I

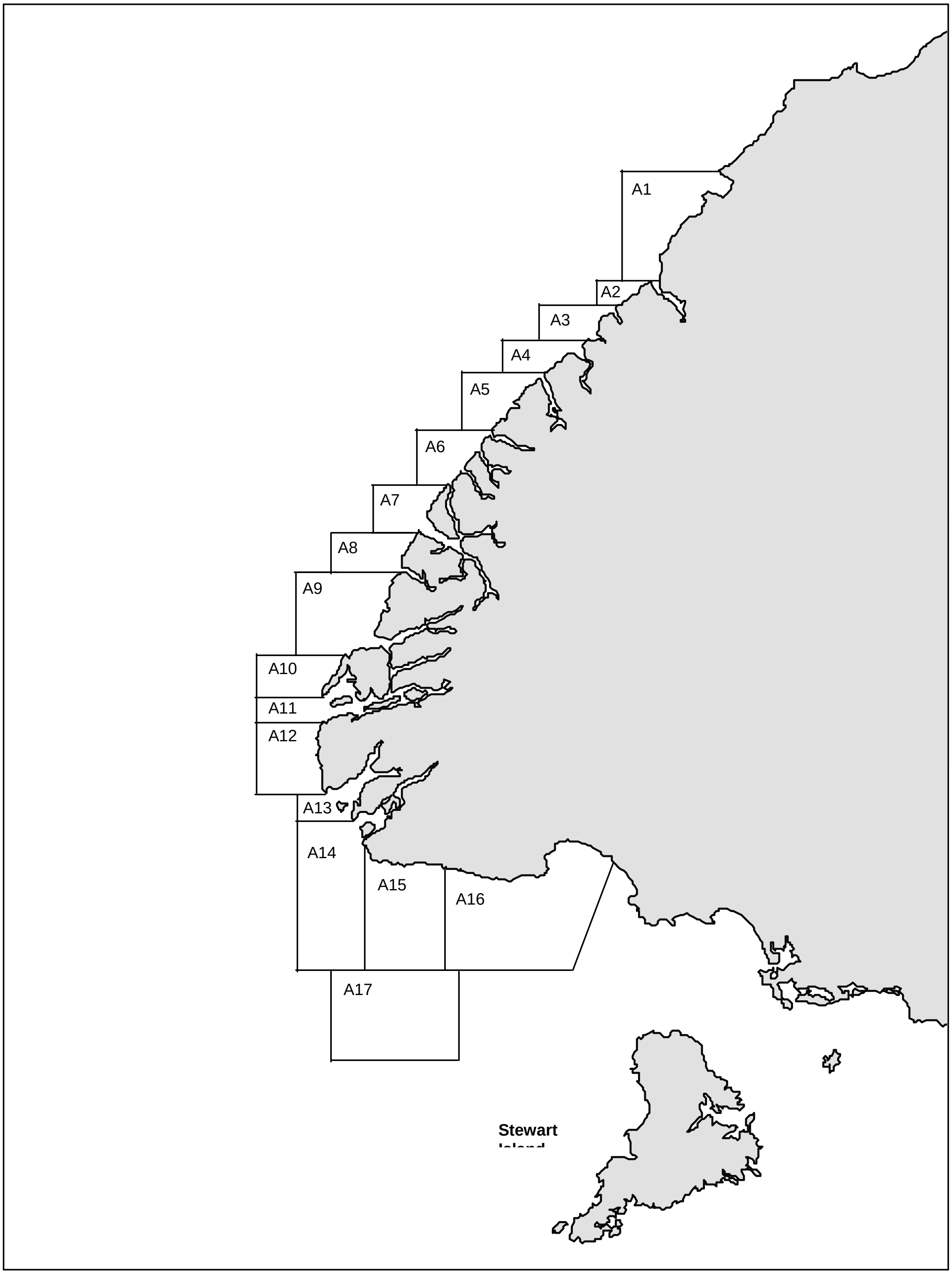
FIORDLAND GENERAL STATISTICAL AREAS



FIORDLAND ROCK LOBSTER STATISTICAL AREAS



Quota Management Area PAU 5A Statistical Areas



APPENDIX II

ESTIMATED COMMERCIAL CATCH OF SPECIES IN FIORDLAND FOR THE 1996/97 FISHING YEAR.
CRA DATA NOT INCLUDED.

ELASMOBRANCHS

SHARKS

Species	Code	31&32	30	TOTAL
Seal Shark	BSH	13.799		13.799
Blue Shark	BWS	4.101	0.118	4.219
Ghost Shark	GSH	1.1		1.1
Mako Shark	MAK	1.416	0.186	1.602
Other sharks and dogfish	OSD	6.183	29.496	35.679
Porgeagle Shark	POS	0.1639	0.003	0.1669
School Shark	SCH	20.224	72.909	93.133
Shark	SHA	0.0053		0.0053
Shark fins	SHF	0.033		0.033
Spiny dogfish	SPD	13.393	86.934	100.327
Rig	SPO	3.329	39.78	43.109
Thresher Shark	THR	2.634		2.634
		66.3812	**229.426**	**295.8072**

SKATES/RAYS

		31&32	30	TOTAL
Rough Skate	RSK	0.19	7.336	7.526
Smooth Skate	SKA	2.543	7.595	10.138
Skate	SSK	3.085	21.771	24.856
		5.818	**36.702**	**42.52**

TUNA

		31&32	30	TOTAL
Albacore Tuna	ALB	6.819	0.092	6.911
Bigeye Tuna	BIG	0.09		0.09
Southern Bluefin Tuna	STN	24.141	2.687	26.828
		31.05	**2.779**	**33.829**

IMPORTANT FINFISH SPECIES

		31&32	30	TOTAL
Banded Giant Stargazer	BGZ	0.4	9.42	9.82
Barrouta	BAR	1.086	73.13	74.216
Bluenose	BNS	23.017	11.126	34.143

Conger Eel	CON	8.337	0.948	9.285
Hoki	HOK	2.455	4596.517	4598.972
Ling	LIN	240.527	1629.095	1869.622
Lookdown Dory	LDO	0.705	2.235	2.94
Moki	MOK	0.583	0.075	0.658
Orea	OEO	10	1.5	11.5
Sea Perch	SPE	1.162	5.475	6.637
Silver Warehou	SWA	117.55	356.001	473.551
Smooth Orea	SSO	18	244.691	262.691
Giant Stargazer	STA	26.758	491.757	518.515
		512.68	**7457.53**	**7940.21**

OTHER SPECIES

		31&32	30	TOTAL
Octopus	OCT	14.029	4.317	18.346
Paua	PAU	19.896	115.519	135.415
Sea Urchin	SUR	9.92	37.852	47.772
		43.845	**187.688**	**201.533**

IMPORTANT RECREACTIONAL SPECIES

		31&32	30	TOTAL
Blue cod	BCO	64.5	178.027	242.527
Flatfish	FLA	3.087	135.822	138.909
Gurnard	GUR	5.169		5.169
Hapuku & Bass	HPB	27.568	21.14	48.708
Tarakihi	TAR	33.777	23.485	57.262
Trumpeter	TRU	0.925		0.925
		70.526	**180.447**	**250.973**

APPENDIX III

Bibliography.

Allan, H.H. (1946). The New Golden Hind Expedition to the fiords. Bulletin of the Wellington Botanical Society 14: 7-8.

Annala, J. & Bycroft, B. (1983). Fiordland rock lobster study. Catch 83, December: 28.

Annala, J.H. & Bycroft, B.L. (1988). Growth of rock lobsters *Jasus edwardsii* in Fiordland, New Zealand. Journal of Marine and Freshwater Research 22(1): 29-41.

Anon. (1987). Jaques Cousteau joins DSIR in Fiordland fiord. Science Scene, May 1987.

Austin, R.E.W. & McGowan, A.N. (1986). Milford Sound Development, Stage 1.

Author[Brodie, J.W. (1963). Milford Sound bathymetry, 1:32,750. N.Z. oceanographic Institute Chart, Miscellaneous Series 5.

Baker, A.N. (1980). Euryalinid Ophiuroidermata (Echinodermata) from Australia, New Zealand, and the south-west Pacific Ocean. N.Z. Journal of Zoology 7: 11-83.

Barker, P.H. (1967). Bathymetry of the Fiordland continental margin. N.Z. Journal of Science 101): 128-137.

Batham, E.J. (1965). Rocky shore ecology of a southern New Zealand fiord. Transactions of the Royal Society of N.Z., Zoology, 6(21): 215-227.

Begg, A.C. & Begg, N.C. (1973). Port Preservation Whitcombe & Tombs Ltd., Christchurch. 398 pp.

Begg, A.C. and Begg, N.C. (1966). Dusky Bay Whitcombe & Tombs Ltd., Christchurch. 240 pp.

Bell, J.D., Bell, S.M. & Teirney, L.D. (1992). MAF Fisheries South Region - Survey of marine recreational Fishers - Summary of findings. New Zealand Fisheries Management Regional Series No. 1

Bell, J.D., Bell, S.M. 7 Teirney, L.D. (1994). Results of the 1991-92 marine recreational fishing catch and effort survey MAF Fisheries South Region - New Zealand Fisheries Data Report

Bell, N. & Foster, P., (Eds.) (1994). A Boaties Guide to Fiordland. 2nd Ed. Mana Cruising Club, Wellington.

Benham, W.B. (1906). In a new species of pennatulid (*Sarcophyllum bollonsi*). Transactions of the Royal Society of N.Z. 39: 193-195.

Bennett, Q. (1986). Diving Fiordland New Zealand Dive Magazine 8 (4): 4-6, 44-45

Booth, J. (1984). Rock lobster fishery causes concern. Catch 84, March: 12, 21-23.

Bowman, M.J. & Dietrich, D.E. (1995). The effects of one year and ten year flood events on the circulation and mixing in Doubtful Sound: Numerical model simulations. Department of Marine Science, University of Otago Report to Electricity Corporation New Zealand. 15 Nov. 1995.

Bowman, M.J. & Dietrich, D.E. (1995). The influence of the Manapouri Power Station on the circulation of Doubtful Sound: Numerical model simulations. Department of Marine Science, University of Otago. Report to Electricity Corporation New Zealand. 22 February 1995.

Boyle, M.C., Jillett, J.B. & Mladenov, P.V. (1995). Intertidal Community Structure in Doubtful Sound. A Preliminary Report. Department of Marine Science, University of Otago Report prepared for Electricity Corporation of NZ, Dunedin. 16 Oct 1995.

Brodie, J. (1964). The Fiordland Shelf and Milford Sound. Pp 15-23 in Skerman, T.M. (ed.) Studies of a Southern Fiord. N.Z. Oceanographic Institute Memoir 17: 101p.

Campbell, H.J. & Fleming, C.A. (1981). Brachiopods from Fiordland, New Zealand, collected during the New Golden Hind Expedition, 1946. New Zealand Journal of Zoology 8 (2): 145-155.

Chapman, B.E. & Richardson, J.R. (1981). Recent species of *Neothyris* (Brachiopoda : Terebratellinae). Pp 157-161 in Recent Brachiopods from New Zealand. N.Z. Journal of Zoology 8: 133-248.

Cornforth, R., Thornton, M. & Ill, D. (1984). Triune Resources Corporation water export from Deep Cove: Environmental Impact Audit.

Cunningham, B.T. (1951). Preliminary report on fisheries in New Zealand-American Fiordland Expedition of 1949. In: Preliminary reports of the New Zealand-American Fiordland Expedition. Investigations of Fiordland, New Zealand, in 1949. N.Z. DSIR Bulletin 103.

Dawson, E.W. (1962). A West Coast, South Island, sea bird log in winter, 1961. Notornis 10(2): 77-80.

Dawson, E.W. (1971). A reference list and bibliography of the Recent Brachiopoda of New Zealand. Journal of the Royal Society of N.Z. 1(2): 159-174.

Dawson, S. & Slooten, E. (1986). Hector's dolphin: gradually unravelling the secrets. N.Z. Environment 51: 9-12.

Dell, R.K. (1956). The archibenthal Mollusca of New Zealand. Dominion Museum Bulletin 18: 1-235.

Dell, R.K. (1964.). A list of Mollusca and Brachiopoda collected by NZOI from Milford Sound. Pp 91-92 in Skerman, T.M. (ed.) Studies of a Southern Fiord. N.Z. Oceanographic Institute Memoir 17: 101 p.

Department of Conservation (1989). Nomination of South-West New Zealand (Te Wahipounamu) by the Government of New Zealand for inclusion in the World Heritage List. Department of Conservation, Wellington. 69 pp.

Department of Marine Science, University of Otago. (1994). Environmental impact assessment. Manapouri tailrace discharge into Doubtful Sound New Zealand. Progress Report No. 1. May 1994.

Department of Marine Science, University of Otago. (1994). Environmental impact assessment. Manapouri tailrace discharge into Doubtful Sound New Zealand. Progress Report No. 2. November 1994.

Doak, W.T. (1972). Fishes of the New Zealand Region. Hodder & Stoughton, Auckland. 132 p.

Estcourt, I.N. (1976). Bibliography of scientific studies of New Zealand mainland estuaries, inlets, lagoons' harbours and fiords. N.Z. Oceanographic Institute Miscellaneous Publication 75 : 40 p.

Fell, H.B. (1952). Echinoderms from southern New Zealand. Zoology Publications from Victoria University College, Wellington 18: 1-37.

Fell, H.B. (1947). *Ophiomyxa duskiensis*, a new ophiuroid from the southern fiords. Transactions and proceedings of the Royal Society of N.Z. 76(3) : 421-422.

Fell, H.B. (1964). A list of Echinodermata collected by NZOI from Milford Sound. P. 95 in Skerman, T.M. (ed.) Studies of a Southern Fiord. N.Z. Oceanographic Institute Memoir 17 : 101 p.

Fleming, C.A. (1950). The molluscan fauna of the fiords of western Southland. New Zealand Journal of Science and Technology B35(5): 378-389.

Francis, M.P., Hardy, G.S., Ward, C. and Williams, M.W. (1989). Survey of Fiordland reef fish populations, 1986-87. Unpublished Report, Leigh Marine Laboratory, July 1989 : 11 p., + app.

Francis, M.P., Ling, N. (1985). Abundance of reef fish in Doubtful and Thompson Sounds, Fiordland. Fisheries Research Division Internal Report 32 : 20 p.

Garner, D.M. (1964). The hydrology of Milford Sound pp 25-33 In: Skerman, T.M., (ed.), Studies of a southern Fiord. New Zealand Oceanographic Institute Memoir 17. 101pp.

Garner, D.M. (1969). The seasonal range of sea temperatures on the New Zealand shelf. N.Z. Journal of Marine and Freshwater Research 3(2) : 201-208.

Gaskin, D.E. (1972). Whales, Dolphins and Seals. Heinneman Educational Books, Auckland. 200 pp.

Glasby, G.P., (ed.) (1978). Fiord studies: Caswell and Nancy Sounds, New Zealand. New Zealand Oceanographic Memoir 79. 94 pp.

Goldberg, W.M., Grange, K.R., Taylor, G.T. and Zuniga, A.L. (1990). The structure of sweeper tentacles in the black coral *Antipathes fiordensis*. Biological Bulletin 79 : 96-104.

Goode, R.H. (1972). Quinnat salmon survey of the Seaforth River system, Dusky Sound.

Grange, K.R. (1980). *Antipathes fiordensis*, a new species of black coral (Coelenterata: Antipatharia) from New Zealand. New Zealand Journal of Zoology 17: 279-282.

Grange, K.R. (1985). Distribution, standing crop, population structure and growth rates of black coral in the southern fiords of New Zealand. New Zealand Journal of Marine and Freshwater Research 19 (4): 467-475.

Grange, K.R. (1988). Mutual protection in fiord waters. Resource Research 14:1.

Grange, K.R. (1990). Unique marine habitats in the New Zealand fiords: a case for preservation. New Zealand Oceanographic Report 1990/7 prepared for Department of Conservation. 70 pp.

Grange, K.R. (1985). Distribution, standing crop, population structure, and growth rates of an unexploited resource of black coral in the southern fiords of New Zealand. Proceedings of the 5th International Coral Reef Congress, Tahiti, 6 : 217-221.

Grange, K.R. (1985). New Zealand black coral. N.Z. Dive 7(4) : 24-26.

Grange, K.R. (1985). The intertidal ecology of the soft shores of Freshwater Basin, Milford Sound. Contract Report, prepared for the Department of Lands and Survey, Wellington. 12p.

Grange, K.R. (1986). The marine ecology of the head of Milford Sound. Contract Report, prepared for the Department of Lands and Survey, Wellington. 14 p.

Grange, K.R. (1986). Potential marine impacts of assembling a large concrete platform in Thompson and Bradshaw Sounds, Fiordland. Contract Report, prepared for Beca, Carter, Hollings & Ferner, Wellington. 14 p.

Grange, K.R. (1986). Life under a fiord. Pp 65-69 in Mountains of Water. The Story of Fiordland National Park. Department of Lands and Survey & Cobb / Harwood Publications, Auckland. 176 p.

Grange, K.R. (1986). The underwater world of Fiordland. Forest and Bird 17(3) : 10-13.

Grange, K.R. (1987). Diving deep to study black coral. Resource Research 8 : 2.

Grange, K.R. (1988). Redescription of *Antipathes aperta*, Totton (Coelenterata : Antipatharia), an ecological dominant in the southern fiords of New Zealand. N.Z. Journal of Zoology 15 : 55-61.

Grange, K.R. (in press). Mutualism between the antipatharian *Antipathes fiordensis* and the ophuroid *Astrobrachion constrictum* in the New Zealand fjords. Hydrobiologia.

Grange, K.R. (submitted). Demography of black coral populations in Doubtful Sound, New Zealand: results from a 7-year experiment. Proceedings 6th International Conference on Coelenterate Biology, The Netherlands.

Grange, K.R. (1993). Fragile marine communities, a case for cautious exploitation. Proceedings Marine Conservation and Wildlife Protection Conference, Auckland, May 1992. 66-73. N.Z. Conservation Authority, Wellington 1993.

Grange, K.R. (1994). Coelenterata. Pp 13-18. in McCrone, A. (ed.). A Draft Status List for New Zealand's Marine Flora and Fauna. Department of Conservation, Wellington. 59 p.

Grange, K.R. & Goldberg, W. (1992). Diving in Doubtful Sound. Sea Frontiers 38(4): 44-47.

Grange, K.R. & Goldberg, W. (1993). Fiords down under. Natural History 3/93: 60-68.

Grange, K.R. & Mladenov, P. (1991). Report on planning workshop - Fiords Marine Research. DSIR Marine & Freshwater and University of Otago.

Grange, K.R. & Singleton, R.J. (1988). The population structure of black coral, *Antipathes aperta*, in the southern fiords of New Zealand. N.Z. Journal of Zoology 15(4) : 481-489.

Grange, K.R. and Goldberg, W.M. (in prep.). Autoradiographic analysis of skeletal growth in the black coral *Antipathes fiordensis*. Journal of Experimental Marine Biology and Ecology.

Grange, K.R. and Goldberg, W.M. (1991). Growth-rate determination of the antipatharian *Antipathes fiordensis* using in situ 14C protein labelling of the growing skeleton. P 702 in Williams, R.B., Cornelius, P.F.S., Hughes, R.G. and Robson, E.A. (eds.) 1991: Coelenterate Biology: Recent research on Cnidaria and Ctenophora. Proceedings of the Fifth International Conference on Coelenterate Biology, 1989. Developments in Hydrobiology 66. Kluwer Academic Publishers, Dordrecht, xx + 742 pp.

Grange, K.R. and Goldberg, W.M. (1993). Fiords down under. Natural History 102(3): 60-70.

Grange, K.R. and Goldberg, W.M. (1993). Chronology of black coral growth bands: 300 years of environmental history? Pp 169-174 in Battershill, C.N., Shiel, D.R., Jones, G.P., Creese, R.G., and MacDiarmid, A.B.: Proceedings Second International Temperate Reef Symposium, 7-10 January 1992, Auckland. NIWA-Marine, Wellington. 252p.

Grange, K.R. and Newell, B.E. (1988). Marine outfall design in areas of particular ecological sensitivity and unusual hydrology. In : Proceedings of the International Conference on Marine Disposal of Wastewater, Wellington, 23-25 May 1988.

Grange, K.R., Singleton, R.J., Goldberg, W.M., Hill, P.J. (1991). The underwater environment of Doubtful Sound. Results from an instrument array moored from November 1987 to June 1989. N.Z. Oceanographic Institute Miscellaneous Publication 105 : 32 p.

Grange, K.R., Singleton, R.J., Richardson, J.R., Hill, P.J. & Main, W.deL. (1985). Shallow rock wall biological associations of some southern fiords of New Zealand. New Zealand Journal of Zoology 8: 209-227.

Grimmett, J. (1993). Water-based activities in the Fiordland coastal area. Unpublished Report, Royds Garden Dunedin. 8 inventories.

Habib, G. (1989). Ngai Tahu Claim to Mahinga Kai. Waitangi Tribunal, Department of Justice, Wellington.

Hall-Jones, J. (1968). Early Fiordland. A.H. & A.W. Reed, Wellington. 199 pp.

Hall-Jones, J. (1976). Fiordland Explored A.H. & A.W. Reed, Wellington. 148 pp.

Hardy, G.S. (1985). Fishes recorded from Fiordland waters. Unpublished Report, prepared for Fiordland National Park Board. 10 p.

Hare, J. (1991). The Coasts of the Southland Region: A report in the context of the Resource Management Act 1991 Department of Conservation: Southland Conservancy Technical Series No. 4.

Horning, D.S., Schuster, R.O., Grigaric, A.A. (1978). Tardigrada of New Zealand N.Z. Journal of Zoology 5(2): 185-280.

Hovell, K.J. (1994). Coastal Water Management for Southland Report prepared for the Coastal Working Party of the Southland Regional Council.

Hurley, D.E. (1964). Benthic ecology of Milford Sound. Pp 79-89. In: Skerman, T.M. (ed.) Studies of a southern Fiord. New Zealand Oceanographic Institute Memoir 17. 101 pp.

Jillett, J.B. & Mitchell, S.F. (1973). Hydrological and biological observations in Dusky Sound, southwestern New Zealand. Pp 419-428 in Fraser, R. (ed.) Oceanography of the South Pacific, 1972. N.Z. Commission for UNESCO, Wellington. 524 p.

Kenchington, R.A. & Agardy, M.T. (1990). Achieving marine conservation through biosphere reserve planning and management. Environmental Conservation 17: 39-44.

King, J.E. (1983). Seals of the World. Oxford University Press. 240 pp.

Knox, G.A. (1964). A list of Polychaeta collected by NZOI from Milford Sound. Pp 93-94 in Skerman, T.M. (ed.) Studies of a Southern Fiord. N.Z. Oceanographic Institute Memoir 17 : 101p.

Kustanowich, S. (1964). Forminifera of Milford Sound. Pp 49-63 in Skerman, T.M. (ed.) Studies of a Southern Fiord. N.Z. Oceanographic Institute Memoir 17 : 101p.

Lee, D.E., Carter, R.M.,King, R.P.,and Cooper, A.F. (1983). An Oligocene rocky shore community from Mt Luxmore, Fiordland. N.Z. Journal of Geology and Geophysics 26(1) :123-126.

Llewellyn, P. (1984). Black coral. Science Express, video. TVNZ, Private Bag, Lower Hutt.

Lyon, G.L, and Richardson, J.R. (1983). Non-terrestrial food source for Fiordland brachiopods : Carbon isotope evidence. Unpublished Report, N.Z. Institute of Nuclear Sciences INS-R-317 : 15p.

McCrone, A. (Ed.) (1994). A draft status list for New Zealands marine flora and fauna. Department of Conservation, Wellington. 59 pp.

McDowall, R.M. (1981). Freshwater fish in Fiordland National Park., Fisheries Environmental Report 12.

McKnight, D.G. (1968). Features of the benthic ecology of Chalky and preservation Inlets. N.Z. Journal of Marine and Freshwater Research 2(4) : 716-720.

McKnight, D.G. & Estcourt, I.N. (1978). Benthic ecology of Caswell and Nancy Sounds. Pp 85-90. In: Glasby, G.P. (ed.), 1978: Fiord studies: Caswell and Nancy Sounds, New Zealand. New Zealand Oceanographic Memoir 79. 94 pp.

McKoy, J.L. (1983). Movements of rock lobsters, *Jasus edwardsii* (Decapoda : Palinuridae), tagged near Stewart Island, New Zealand. N.Z. Journal of Marine and Freshwater Research 17(4) :

McShane, P. (1994). Evidence for localised recruitment failure in the New Zealand abalone *Haliotis iris* (Mollusca Gastropoda). Pp 145-150. In: Battershill, C.N. et. al., (eds.), Proceedings of the Second International Temperate Reef Symposium, 7-10 January 1992, Auckland, New Zealand. NIWA Marine, Wellington. 252 pp.

McShane, P., Mercer, S. & Naylor, R. (1992). Sea urchins in Dusky Sound - Prospects for a major Kina industry in New Zealand. New Zealand Professional Fisherman. December 1992: 34-40.

McShane, P., Stewart, R., Anderson, O. & Gerring, P. (1994). Failure of kna fishery leaves bitter taste. Seafood New Zealand 2(4): 33-34.

Meads, M. (1990). Forgotten Fauna. The rare, endangered, and protected invertebrates of New Zealand. DSIR Publishing, Wellington. 95 pp.

Mladenov, P. (1995). Monitoring possible future effects of increased freshwater discharge into the Doubtful Sound marine ecosystem. Finak Report. Department of Marine Science, University of Otago. Report prepared for Electricity Corporation of New Zealand, Dunedin. 20 October 1995

Mladenov, P. (1995). Overview of research on the Doubtful Sound Fiord System with an assessment of possible marine environmental impacts resulting from increased freshwater discharge. Final report. Department of Marine Science, University of Otago. Report prepared for Electricity Corporation of NZ, Dunedin. 14 July 1995.

Mladenov, P. (1996). Comparitive survey of the upper limit of black coral distribution in New Zealand fiords. Department of Marine Science, University of Otago. Final report to Electricity Corporation of New Zealand. 13 March 1996.

Mladenov, P. (1996). Community equilibrium in Doubtful Sound. Department of Marine Science, University of Otago. Final report to Electricity Corporation of New Zealand. 4 March 1996.

Mladenov, P.V. & Brewin, P.E. (1996). Tolerance of the black coral, Antipathes fiordensis, to lowered salinity. Department of Marine Science, University of Otago. Final report to Electricity Corporation of New Zealand. 12 March 1996.

Moore, D. (1980). Bibliography for Fiordland National Park. National Parks Series No. 15 :147p.

New Zealand Law Commission - PP9 (1989). The Treaty of Waitangi and Maori Fisheries New Zealand Law Commission Preliminary Papae No. 9. 182 pp.

Odell, N.E. (1952). Sutherland Sound, Southland, New Zealand. Geographical Journal 118(3) : 368-369.

Olsen, G. (1991). Fiordland Marine Reserves - A First? New Zealand Professional Fisherman 5(9): 36-38.

Parker, N. (1995). Reproductive biology of black coral *Antipathes fiordensis* in Doubtful Sound, Fiordland. Unpub. MSc thesis, University of Otago. 47 pp.

Paulin, C.D. (1994). Description of a new genus and two new species of bythitid fishes and a redescription of Bidenichthys consobrinus (Hutton)from New Zealand. Journal of Natural History 29: 249-258.

Paulin, C.D., Stewart, A.L., Roberts, C.D., and McMillan, P.J. (1989). New Zealand Fish : A complete guide. National Museum of New Zealand Miscellaneous Series No. 19 : 279 p.

Paulin, R. (1889). The Wild West Coast of New Zealand. A summer's cruise in the Rosa. Thoburn & Company, London. 121 pp.

Peat, N. (1989). Living marvels in fiord waters. The Press (Christchurch) : 21.

Peat, N., Patrick, B. (1996). Wild Fiordland, University of Otago Press. Dunedin

Pickrill, R.A. (1987). Circulation and sedimentation of suspended particulate matter in New Zealand fjords. Marine Geology 74: 21-39.

Pillai, A. (1991). Fiordland: Protecting the undersea world. Forest and Bird 22(3) : 34-41.

Powell, P. (1976). Fishermen of Fiordland. A.H. & A.W Reed, Wellington. 119 pp.

Richardson, J.R. (1981). Brachiopods in mud: Resolution of a dilemma. Science New York 211(4487): 1161-1163.

Richardson, J.R. (1981). Distribution and orientation of six articulate brachiopod species from New Zealand. N.Z. Journal of Zoology 8 : 189-196.

Richardson, J.R. (1981). Recent brachiopods from New Zealand - Background to the study cruises of 1977-79. N.Z. Journal of Zoology 8 : 133-143.

Richardson, J.R. (1981). Brachiopods and pedicles. Paleobiology 7(1) : 87-95.

Richardson, J.R. (1983). Brachiopods. Pp 72-73 in Brownsey, P.J. Baker, A.N. (eds) The New Zealand Biota - What do we know after 200 years. National Museum of N.Z. Miscellaneous Series 7.

Richardson, J.R. (1984). Evolution of brachiopods. National Geographic Society Research Report 17 : 751-760.

Richardson, J.R. (1985). Tropical life down under. Air New Zealand Pacific Way 1985(5) : 28-32.

Richardson, J.R. and Child, A. (1987). Proposed underwater observatory in Harrison Cove, Milford Sound. Environmental Impact Assessment.

Roberts, C.D. (1989). A revision of New Zealand orange perches (Teleostei: Serranidae) previously referred to Lepidoperca pulchella (Waite) with description of a new species of Lepidoperca from New Zealand. Journal of Natural History 23: 557-589.

Robertson, B.M. (1993). Southland Coastal Water Quality Review Southland Regional Council, December 1993. Report prepared by Robertson Ryder & Associates, Environmental Consultants, Dunedin.

Robertson, D.A. (1978). Spawning of Tarakihi (Pices : Cheilodactylidae) in New Zealand waters. N.Z. Journal of Marine and Freshwater Research 12(3) : 277-286.

Robertson, D.A. (1976). Planktonic stages of *Maurolicus muelleri* (Teleostei : Sternoptychidae) in New Zealand waters. N.Z. Journal of Marine and Freshwater Research 10(2) : 311-328.

Ross, J.O'C. (1969). This Stern Coast. A.H. & A.W. Reed, Wellington. 277p.

Singleton, R.J. (1991). The living brachiopod communities of the fiords of southern New Zealand : a pictorial survey. N.Z. Marine Sciences Society Newsletter 33.

Skerman, T.M. (1964). Microbiological studies in Sterling Basin, Milford Sound. Pp 65-71 in Skerman, T.M. (ed.) Studies of a Southern Fiord. N.Z. Oceanographic Memoir 17 : 101p.

Skerman. T.M. (Ed.) (1964). Studies of a Southern Fiord. N.Z. Oceanographic Memoir 17 : 101p.

Smith, A.M. (1996). Ecologically relevant estuarine salinity zones. Department of Marine Science, University of Otago. Report to Electricity Corporation of New Zealand. 23 February 1996.

Smith, A.M. & Mladenov, P.V. (1995). Suspended sediment discharge study. Manapouri Duplicate Tailrace Proposal. Final Report. Department of Marine Science, University of Otago. Report prepared for Electricity Corporation of New Zealand, Dunedin. 15 March 1995.

Smith, F. (1995). Structure of Subtidal Rock Wall Invertebrate Communities of Three Reference Sites in Doubtful Sound Department of Marine Science, University of Otago Progress Report. Report prepared for Electricity Corporation of New Zealand, Dunedin. 28 August, 1995.

Southland Regional Council (1993). Proposed Regional Policy Statement for Southland. Southland Regional Council Publication No. 49: 1-214.

Southland Regional Council (1994). Proposed Regional Coastal Plan, Consultative Draft. Draft 16. 10: 1-244.

Stead, D.H. (1973). Scallop surveys, Fiordland 1972. N.Z. Marine Department, Fisheries Technical Report 124.

Stewart, B.G. (1995). The biology of the Euryalid Snake Star Astrobrachion constrictum (Echinodermata: Ophiuroidea). University of Otago, Dunedin, New Zealand. Unpublished Ph.D theisis. 222 pp.

Waitangi Tribunal-22 (1988). Muriwhenua Fishing Report: Report of the Waitangi ribunal on the Muriwhenua Fishing Claim. Waitangi Tribunal, Department of Justice, Wellington. 371 pp.

Warham, J., Spurr, E.B., and Clark, W.C. (1986). Research on penguins in New Zealand. WRLG Research Review 8.

Webb, B.F. (1973). Cetaceans sighted off the west coast of the South Island, New Zealand, summer 1970. N.Z. Journal of Marine and Freshwater Research 7(1/2) : 179-182.

Williams, J.A. (1992). The abundance and distribution of Bottlenose dolphins (*Tursiops truncatus*) in Doubtful Sound. Unpublished M.Sc. Thesis, University of Otago, Dunedin. 58pp.

Witman, J.D. and Grange, K.R. (submitted). Links between climate and predation in a rocky subtidal community. Ecology

Witman, J.D. and Grange, K.R. (1994). Hydrography regulates predation intensity in subtidal rock wall communities of a New Zealand fiord. EOS Transactions of American Geophysical Union. 75(3): 215 (Abstract).

Wood, E.J.F. (1964). A note on diatoms occurring in Milford Sound. P. 97 in Skerman, T.M. (ed.) Studies of a Southern Fiord. N.Z. Oceanographic Memoir 17 : 101 p.