Fish futures

INDIVIDUAL TRANSFERABLE QUOTAS IN FISHERIES

Barry Kaufmann,
Gerry Geen and
Sevaly Sen

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ACRONYMS

AFMA	Australian Fisheries Management Authority
CCAMLR	Convention for the Conservation of Antarctic Marine Living Resources
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CPUE	Catch per unit effort
CSIRO	Commonwealth Scientific Industrial Research Organisation
EEZ	Exclusive Economic Zone
EQMS	Electronic Quota Monitoring System
ESD	Ecologically Sustainable Development
FAO	Food and Agriculture Organisation
FERM	Fisheries Economics, Research and Management Ltd.
FRDC	Fisheries Research and Development Corporation
GPS	Global Positioning System
ICES	International Council for the Exploration of the Sea
INMARSAT	International Maritime Satellite Organisation
ITQ	Individual Transferable Quota
LES	Land Earth Station
NMFS	National Marine Fisheries Service, USA
NRC	National Research Council, USA
OECD	Organisation for Economic Cooperation and Development
QFMA	Queensland Fisheries Management Authority
QMS	Quota Management System
SBT	southern bluefin tuna
SENT	south east non-trawl
SET	south east trawl
SFR	Statutory Fishing Rights
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TAE	Total Allowable Effort
VMS	Vessel Monitoring System

FOREWORD

This book is aimed at providing reference material for persons interested in exploring how an ITQ system might work in practice. The target audience is fishery managers, industry and others involved in day-to-day fisheries management. The main purpose is to describe ITQ implementation options and provide, where possible, examples of how effective these options have been in various fisheries jurisdictions. The aim is not to identify and prescribe the most effective approaches to quota allocation, compliance or other operational matters, but rather to identify the ways that these issues have been tackled by various fisheries management agencies. Numerous references are provided in order to allow the interested reader to follow up on various topics.

In attempting to deal with a subject as broad as ITQ implementation, it is inevitable that certain topics are covered less thoroughly than others, and some barely at all. The choices of where to focus our attention have been largely driven by our experience of which issues cause problems to fishery managers and industry when designing and implementing ITQ systems. In highly technical areas, such as the chapters on Property Rights, Quota Allocation and TAC Setting, we have drawn on the knowledge of experts in the respective fields of law (Jane Knowler, Associate Lecturer in Law at Flinders University) and stock assessment (Andre Punt, Senior Resource Modeller in the CSIRO Division of Marine Research) to help us. However, we have attempted to keep the discussion fairly user-friendly so that anyone interested in the subject areas should be able to understand and digest the information.

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20 October 1999

1 INTRODUCTION

Worldwide, there is increasing concern about the apparent inability of traditional fisheries management to meet almost any reasonable set of objectives. Many fisheries are experiencing stock depletion, user-group conflicts, low profitability, and social disruption (frequently followed by government financial assistance). As a result, greater attention is being paid to the use of alternative rights-based management measures, especially individual transferable quotas (ITQs), as a potentially more effective approach to ensuring resource sustainability while stemming the growth of fishing capacity.

Although much has been written on the theoretical merits of ITQs compared to effort-based management measures, suprisingly little has been published on the operational aspects of the ITQ management system. This book is an attempt to, at least partly, fill this gap. Most of the material presented is meant to be of practical value to fisheries managers, the fishing industry and others involved in designing and implementing ITQ systems.

Individual quota management involves setting a total allowable catch (TAC) for a given fish stock and allocating the TAC to each of the various participants within the fishery. There are a number of important variations on this basic theme. For example, allocations may be transferable or non-transferable; issued to individuals, vessels or communities; denoted in terms of a percentage share of the TAC or as an absolute quantity of fish; and issued for a fixed period or indefinitely. In line with these variations, individual quota regimes have been referred to by various names, including individual vessel quotas, individual fishing quotas, individual transferable quotas, individual quotas, community development quotas, enterprise allocations, and fisherman quotas. Throughout this book the generic term individual transferable quota or ITQ is used. However, it is important to remember that ITQs introduced into various fisheries differ in a number of important details.

While conceptually simple, the move to ITQs as the main management instrument is a major challenge and implementation failure a real risk. Since it is sometimes difficult to disentangle implementation failure from any inherent weaknesses in ITQs, there is a tendency for fishers, managers and others to sometimes attribute all difficulties to the ITQ instrument itself.

The purpose of the book is to provide information on options relating to the design and implementation of ITQ systems, rather than as a vehicle to promote the use of such systems. The structure of the book reflects our personal experience with the issues and obstacles that often emerge both when introducing ITQ regimes and in debates about whether ITQs are an appropriate management system for any particular fishery. Although we have tried to make the book as accessible as possible to most readers, many of the chapters are necessarily quite technical. An exception is Chapter 2 on Why and

How Governments Manage Fisheries which provides readers with a broader context within which to view ITQ management systems.

The remaining chapters address common issues of concern with ITQ regimes, namely: the nature of property rights, quota allocation, compliance, discarding, management costs, TAC-setting and the social impact of ITQs. Throughout the book, examples are given on how ITQs have been handled in practice.

Finally, it will not be difficult for readers to identify that we lean toward the use of ITQs, which is consistent with our observations concerning the impacts of ITQs and alternative management systems in practice. However, as noted above, ITQ regimes cannot be expected to deliver their potential if they are poorly designed or implemented. We hope that the information presented here will help prospective fisheries managers and industry to avoid some of the mistakes of the past.

2 WHY AND HOW DO GOVERNMENTS MANAGE FISHERIES?

Stock depletion, gross overcapacity of fishing fleets, low profitability and social disruption have become defining features of many fisheries worldwide. Such failures have focused attention on the need for more effective resource management instruments. Consequently, fisheries management agencies have, over the last 15 years or so, increasingly turned from traditional limited entry and competitive quota systems toward approaches based on the assignment to fishers of individual quota rights.

The purpose of this chapter is to provide a broader context within which this widespread move toward the use of ITQs can be viewed, prior to expanding on various technical and operational aspects of their use later in the book.

WHY DO GOVERNMENTS MANAGE FISHERIES?

Unlike most sectors in market economies, governments tend to play a significant hands-on role in the day-to-day management of the commercial fishing industry. Fisheries management agencies often determine who may fish, and when, where and with what vessels and equipment.

Of course government intervention is not unique to the fisheries sector. Many governments around the world play a significant role in the protection, subsidisation and regulation of a number of goods and services producing industries in the economy. However, most people probably do not realise the extent to which government regulations control the day-to-day business activities of commercial fishers, or the degree to which governments directly supply taxpayer-funded management services.

The following quote from Bevan (1965) provides an example of what fisheries regulations might look like if applied to a second natural resource based sector — forestry:

> If, for example, logging were conducted under rules similar to fishing, the state would publish a series of regulations every year similar to the following:
>
> Logging will begin at 6:00 A.M. June 15 and close October 1 at 6:00 P.M. in even-numbered townships and sections.
>
> Logging will be permitted on Tuesdays and Fridays, subject to extension or restriction by field announcement.
>
> A logging licence to cost $25.00 must be purchased prior to April 1.
>
> It shall be unlawful for any person, firm, or corporation to use, employ, or operate a power-driven saw for the purpose of removing timber.
>
> Hand axes must have a blade less than 4 inches but more than 3 inches with a handle to exceed 18 inches. No logger shall have in his possession more than one axe.
>
> Each axe shall be legibly marked with the registration number and initials of the operator. No axe shall be placed or operated less than 600 feet from any other axe.

> No logging truck shall be longer than 30 feet overall, except trucks that logged prior to January 1, 1960.
>
> Trees with cones can be taken only prior to July 31.

The above analogy is not provided to suggest necessarily that government should not play a dominant role in the day-to-day operations of the commercial fishing industry, but rather to help illustrate the extent of government regulation.

To help understand why government agencies are so heavily involved in the management of this sector, it is useful to consider the forces that come into play when commercial harvesting is unfettered.

Open access fisheries: Over-exploitation and over-capacity

In order to appreciate the need for some form of government involvement in fisheries, it is helpful to consider the likely consequences of removing all government regulation with respect to fishing activities. This situation is usually referred to as 'open access'. Under open access, everyone is allowed unlimited access to harvest as much fish by whatever means as desired. Until recently, much fishing worldwide took place on an open access basis.

Initially, when stocks are large and lightly exploited, and vessels and gear are unsophisticated, the situation of open access (i.e. no formal or informal fisheries regulations) is unlikely to cause many problems. However, over time, circumstances change. Initially, or at some later point, catches and profitability are high, and this often induces new participants to enter the fishery. In addition, existing operators individually face a profit incentive to employ better harvesting techniques/equipment in order to increase their catch. As more and more resources (e.g. capital, labour, fuel, and gear) are moved into the fishing industry, and as harvesting technology improves (e.g. fish-finding sonar and vessel positioning systems), the fish stock and the economic returns to the industry often begin to deteriorate.

As with any animal population, fish stocks cannot withstand ever-increasing levels of exploitation. As more and more fish are harvested, the ability of fish stocks to accommodate additional harvesting or unexpected environmental change is reduced. At some point, increases in current harvests come at the cost of lower sustainable harvests in the future. Reducing a stock's reproductive ability is often referred to as 'recruitment overfishing'. Other conservation-type issues related to unregulated fishing include environmental damage, fish discarding and reduced biodiversity.

Economic damage may also occur. As more fishers enter a fishery, increases in vessel numbers, gear and other harvesting inputs places upward pressure on everyone's harvesting costs as competition to find and harvest the fish grows, and this in turn has a negative impact on profits. Over time, as stock size and sustainable harvest levels fall, profits are reduced further. Additionally, the competitive 'race for the fish' can result in market gluts and the supply of small and poor quality fish. In economic jargon, a number of these considerations are a reflection of economic inefficiency. Although technically a different concept, a frequently used alternative term is 'over-capacity', which is generally used throughout this report.

Pearse (1982) outlines the process and consequences of open access, with particular reference to Canadian fisheries, as follows:

> The perverse tendency for fishing fleets to overexpand is rooted in the way the commercial fisheries have traditionally been organized. Until very recently, fisheries throughout most of the world were open to unrestricted numbers of fishermen and fishing enterprises. Harvesting was, and still is, based on the "rule of capture"; that is unlike other natural resources, fish in the sea are not assigned through property rights or licences to any particular user; each user competes directly with all the others for a share of the catch, and has no right to any particular quantity until he has landed it.
>
> In these circumstances, temporary profits will stimulate fishermen to expand their vessels' fishing capacity in order to increase their catch, and will attract new entrants into the fishery. So the fleet will expand even if it is already capable of taking the entire harvest. Thus, as we have seen repeatedly on the Pacific coast, an increase in the price of fish will set off a wave of investment in vessels and gear even when there are no more fish to catch. The result is the excess fishing capacity we observe in all of our major fisheries.
>
> Several effects of this phenomenon should be noted. First, it threatens the stocks because constraining over-expanded fleets to the yield capabilities of the resource is difficult... Second, the redundant capacity raises the capital, labour and operating costs involved in fishing, and so erodes the net returns the fishery could otherwise generate... Third, such fisheries are unstable. Any increase in the available catch, or rise in the price of fish, or technological development that lowers the costs of fishing effort, induces fleet expansion; opposite changes force painful contradiction through financial failures.

A study of open access in the US New England groundfish fishery estimated that a 70% reduction in the number of days fished by the otter trawl fleet would eventually result in a 40% increase in catch and an annual improvement in the net economic value of the fishery equivalent to US$150 million (Edwards and Murawski, 1993).

The above discussion on open access and the tendency towards over-exploitation and over-capacity is purposely brief and simplified. A great deal has been written outlining the process by which open access tends to produce undesirable economic and conservation outcomes and those interested in greater detail should consult Gordon (1954), Scott (1955), Munroe and Scott (1985), Crutchfield (1978), Anderson (1986), and Hannesson (1993b).

In an attempt to overcome problems associated with open access a number of governments have established fisheries management agencies. These agencies have introduced various management regulations aimed at eliminating open access and controlling over-exploitation and over-capacity. The following section provides a brief discussion of the main management instruments currently in use.

HOW DO GOVERNMENTS MANAGE FISHERIES?

The purpose of this section is to outline briefly the major tools used by fisheries management agencies to deal with open access symptoms of over-capitalisation and resource over-exploitation: effort or input controls and output controls[1].

Effort controls

The first and most commonly used policy tool to control over-exploitation and over-capacity is the control of fishing effort[2]. Fishing vessels, gear, fuel, crew, and skippers are all elements of harvesting capacity that combine to produce total fishing effort, and in turn fish. Therefore, if open access gives rise to concerns about fish stocks[3] then one option is to introduce restrictions on vessel numbers, gear, crew numbers or a variety of other fishing inputs. These forms of restrictions are referred to as 'effort controls' and since restrictions are often centred on harvesting inputs, they also go by the name of 'input controls'.

There are many different types of effort controls in use today, including:

- gear regulations on size and number of nets/hook/pots;
- limits on the number of fishing permits (limited entry);
- restrictions on certain harvesting techniques such as pair trawling;
- limits on vessel numbers and restrictions on vessel length, under-deck volume, tonnage, hold capacity and engine horsepower;
- vessel-replacement restrictions;
- owner-operator conditions;
- restrictions on licence transferability; and
- area and seasonal closures.

Problems with effort controls

Effort controls remain the most pervasive management regime used in fisheries. However, growing concerns over over-exploitation and over-capacity raise doubts about the efficacy of this management instrument[4]. One of the major problems of controlling over-exploitation through effort controls is that in most fisheries it is extremely difficult to control every facet of fishing effort. Restrictions placed on particular inputs to fishing tend to stimulate fishers to expand their use of other uncontrolled dimensions of fishing effort in order to maintain their catch. Even if the effort "lid" can be screwed down tightly, unexpected technical innovations, such as global positioning systems, will act to pry it open, resulting in increased catches in the short term.

The difficulty of controlling every component of fishing effort also has negative implications for over-capacity. In a review of the long-run impact of limited entry and buyback in the Canadian west coast salmon fishery, Munro and Scott (1985) note that:

> By 1980 the limited entry program had apparently achieved some considerable measure of success. The total number of vessels had declined by 20 percent [Canada, Commission on Pacific Fisheries Policy (1982)]. The success was illusory, however. It is estimated that by the late 1970s the amount of capital employed in the industry may in fact have increased by as much as 50 percent [Fraser (1979)] over the previous decade.

Effort controls can also have additional negative implications for profitability and safety. For example, vessel replacement and gear restrictions can result in an aging fleet[5] that harvests with increasingly inefficient gear. Aging technology, when confronted with stable fish prices and increasing fuel, labour and insurance costs, has negative consequences for industry profitability.

Effort controls have been the subject of a number of additional criticisms; however as this book is not directly aimed at evaluating management options, the interested reader should pursue this topic separately.

In an attempt to provide industry with greater flexibility and to reduce over-capacity, individual transferable effort controls, which are a modified form of the effort controls discussed above, have been introduced into some fisheries.

Individual transferable effort controls

Under individual transferable effort (ITE) controls, an explicit total allowable effort limit (TAE) is specified and individual fishers are allocated transferable shares of the effort limit. The total allowable effort limit may be specified in various ways, such as:

- a limit on the total number of days that can be fished;
- a maximum number of nets allowed in a fishery; or
- a maximum weighted combination of effort categories allowed in the fishery (e.g., a maximum aggregate weighted index of underdeck volume and engine horsepower).

The Australian northern prawn fishery is an example of an ITE managed fishery. In 1985, each operator was allocated units of effort that were based on under-deck volume and main engine power of each fisher's vessel. The sum of all operators' effort units was used as a measure of total allowable effort in the fishery. Subject to various restrictions effort units were transferable. Since 1985, concerns about excess fishing effort have been mainly addressed through policies that reduced the TAE in the fishery[6].

Output controls

Regulations directly stipulating the amount, sex or size of fish that may be harvested are generally referred to as output controls. Examples of output controls include a competitive total allowable catch (TAC), vessel catch limits on a per day or per trip basis, minimum and maximum fish size regulations and individual catch quotas. Our focus here is on competitive TACs, vessel catch limits and individual catch quotas. Minimum size regulations tend to be used to capture economic benefits associated with maximising yield per recruit[7], as opposed to controlling the overall catch.

If open access leads to concerns about too many fish being harvested, then, as opposed to reducing fishing effort, one output control option is to set an explicit TAC. Fishers are allowed to compete until the TAC is harvested, whereupon the fishery is closed. Not surprisingly, as fishers attempt to catch all they can before the fishery is closed, competitive TACs tend to result in market gluts, poor fish quality and low fish prices. In an attempt to reduce market gluts and spread out harvesting, competitive TACs are frequently accompanied by another output control – limits on the amount of fish that may be landed per trip, per day or per some other unit of time.

Competitive TACs, even when associated with trip or seasonal catch limits, do little to control over-capacity. If TACs are dramatically reduced then large segments of the fleet might become financially unviable, and capital and labour might leave the industry (thereby reducing over-capacity). However, existing fishers still face an incentive to

invest in better/more vessels and gear in an effort to increase their share of the TAC. Since it is not possible for everyone to increase his or her share, this competitive behaviour often results in increased over-capacity.

Individual quota management attempts to mitigate the over-capacity problem associated with competitive TACs by directly reducing the associated investment incentive. Specifically, by allocating a share of the TAC to participants, there is less to be gained by increasing investment in harvesting inputs. Fishers are limited in the amount they can land by their quota allocation, and therefore the incentive now turns to harvesting their quota as cost effectively as possible and maximising the value of fish landed. If quota is tradeable, there are further incentives to reducing over-capacity as less profitable fishers sell to more profitable fishers.

Problems with individual transferable quotas

As with effort controls, individual transferable quota (ITQ) regimes are not without problems. Copes (1986), Pauly (1996), Greer (1995), and Walters and Pearse (1996) outline a number of criticisms of individual quota systems. The main problems with ITQ systems can be sorted into the following six categories: quota monitoring, data corruption, TAC setting, socioeconomic impacts, highgrading, and management costs. Under ITQs, fishers have a financial incentive not to report their catch and therefore it is important to have an effective quota monitoring system in place. If fishers' landings are not closely monitored against their quota allocations, then ITQs degenerate towards open access fishing. Quota monitoring is more difficult in fisheries that have many domestic marketing channels, are geographically disperse, have a large fleet of small vessels, and are located near other fisheries where the same species are harvested but which are not managed through quota limits.

If it is possible for fishers to avoid the quota monitoring system, then they are also likely to misreport catch and effort data, and cost and earnings data. In turn, this corrupted data would have an impact on the reliability of stock assessment and socio-economic studies.

ITQs require that TACs be set. Copes (1986) suggests that setting TACs in fisheries harvested over a short period or managed under fixed escapement policies is "patently absurd". It has also been suggested (Walters and Pearse, 1996) that ITQs require more accurate and timely stock assessments relative to effort controls.

A number of socio-economic concerns have been raised with regard to ITQs. For example, quota allocations often only go to vessel owners, with crew and others being left out. In addition, quota transferability might result in lost employment and other negative community impacts if quota systems result in a rationalisation of harvesting capacity. Transferability may also result in quota becoming concentrated in the hands of large corporations, which might provide them with unacceptable bargaining power. In addition, if quota is transferable, current fishers may capture all of the gains with no long-run improvement in incomes of future fishers.

In order to maximise the value of their catch, fishers may discard small, damaged or otherwise low-value fish. Discarding is often considered a waste and if not accounted

for can increase uncertainty surrounding stock assessments. Finally, management costs might increase under ITQs due to heightened requirements related to stock assessment, enforcement, and quota monitoring. There are additional criticisms of ITQs, however those interested in more information should consult the above references.

SUMMARY

The economy of any country can be thought of as consisting of five major types of goods and service producing industries: manufacturing, construction, utilities, services and industries that 'harvest' natural resources (e.g., agriculture, fishing, mining, forestry and oil/gas). Many governments play a role in the protection, subsidisation and regulation of all of these major industry sectors. However, governments are generally not involved in either the provision or funding of day-to-day management in most agriculture, mining, oil/gas, forestry and manufacturing, construction and service industries. The situation is different in the commercial harvesting sector of the fishing industry. In many countries, including New Zealand, Canada, Australia, and the United States, governments have established management institutions and processes that play a significant role in provision and funding of fisheries management services.

The rationale for government involvement in the fishing industry flows from over-exploitation and over-capacity problems that can arise if everyone is allowed unfettered or open access to fish resources. In managing fisheries, government institutions often employ various effort and output regulations. Effort controls have been the preferred management option to date but output controls are now being increasingly used. Neither effort controls nor output controls are perfect, and each management option comes with its own set of difficulties.

As noted earlier, it is not our purpose to contrast ITQs with input controls; this has been done many times in many different fora. Rather, it is to provide technical information on a range of key ITQ implementation options, the choice of which will affect how successfully ITQ systems work in practice. Before doing so, we turn first to a brief examination of ITQ fisheries in Australia and elsewhere.

ENDNOTES

1 In addition to effort and output controls, it is theoretically possible to manage fisheries through taxes. However, this management option is seldom, if ever, used as the major management option for the control of over-exploitation and over-capacity, and is therefore not discussed in this report. For more information on the taxation option see Grafton (1992, 1995).

2 For a detailed discussion of effort controls see Anderson (1986).

3 For example, stock levels are too low relative to unexploitated levels, fishing mortality is too high, and/or sustainable catch is falling.

4 For additional information on the effectiveness of effort controls see Townsend (1995) and Dupont (1996).

5 In Queensland, Australia, the Trawl Fishery Management Advisory Committee (1996) estimates that the average age of the fleet is roughly 20 years old. In addition to safety issues, older vessels are apparently having difficulties in acquiring insurance.

6 Effort units in the northern prawn fishery are currently based on the under-deck volume and engine power of vessels. The units are to be redefined as amounts of fishing gear; specifically, as meters of headline length of prawn trawl nets.
7 The meaning of yield per recruit is discussed in Chapter 10.

3 A BRIEF OVERVIEW OF ITQ FISHERIES

This section provides an overview of ITQ fisheries in Australia and in a number of other countries. The main purpose is to provide a brief description of the current status of each fishery, the reasons why an ITQ system was introduced and the way the management system operates. Readers interested in greater detail should consult the references provided for each fishery.

AUSTRALIAN ITQ FISHERIES

As illustrated in Table 1, Australia has twenty ITQ fisheries which account for approximately 26 per cent of Australia's total landings by weight and 22 per cent of total landed value.

In Commonwealth-managed fisheries, ITQs have been introduced into tuna, shark, scallop and finfish fisheries. In state-managed fisheries, ITQs have been largely limited to the higher value, single species fisheries such as abalone and rock lobster. The absence of sedentary, high value single species fisheries in Commonwealth fisheries is due to the fact that generally speaking, Commonwealth jurisdiction extends from 3 nautical miles (~ 5km) to 200 nautical miles (320km), while state jurisdiction is from the low-water mark to the 3 nautical mile limit. The main characteristics of each fishery are summarised in Table 2. Of the twenty ITQ managed fisheries listed in Table 2, twelve are single species fisheries, five are dual species fisheries, two are three-species fisheries and one has sixteen species under quota.

TABLE 1
VALUE OF PRODUCTION IN AUSTRALIAN ITQ-MANAGED FISHERIES, 1997–98

Fishery	Landed Tonnage	Landed Value (A$'000)	Unit Value (A$/tonne)
Commonwealth southern bluefin tuna	4,783	40,812	8,533
Commonwealth south east trawl fishery	25,382	57,701	2,273
Commonwealth south east non-trawl fishery	1,907	7,077	3,711
Commonwealth southern shark	3,465	11,742	3,338
Commonwealth Bass Strait central zone scallop	3,505	7,009	2,000
New South Wales abalone	333	9,990	30,000
New South Wales rock lobster	107	3,938	36,804
Queensland spanner crab (1996 figures)	2,800	9,000	3,214
South Australia southern zone rock lobster	1,635	47,003	28,748
South Australia abalone	812	26,883	33,107
South Australia blue swimmer crab	464	2,057	4,433
Tasmania abalone	2,360	77,923	33,018
Tasmania rock lobster	1,485	46,223	31,127
Tasmania giant crab	52	960	18,480
Victoria abalone	1,442	50,858	35,269
Victoria scallop	288	578	2,007
Western Australia pink snapper	564	1,804	3,200
Western Australia south coast purse seine	6,874	3,781	550
Western Australia abalone	326	10,703	32,831
Western Australia pearl oyster	…	…	…
Total ITQ fisheries	**58,584**	**416,042**	**7,102**
Total Australian fisheries[1]	**222,837**	**1,859,860**	**8,346**

1 Excludes aquaculture production. Source ABARE (1998b)

TABLE 2
SUMMARY OF AUSTRALIAN ITQ FISHERY MAIN CHARACTERISTICS

Fishery	No. of quota species	Main market	Landing sites	Gear types	Number of operators (1998)	Recreation and indigenous catch	By-catches in other fisheries	Commercial non-quota species	Onboard processing	Year ITQs introduced
C'wealth southern bluefin tuna	One	Initially domestic, now export	Few	LL, PS, PL, TRL	80	Small	Limited	Few	None	1984
C'wealth SE trawl	Sixteen	Domestic	Many	TRW, DS	120	Small	Small or limited by bycatch limits	Large number	Blue grenadier only	1992
C'wealth SE non trawl	Three	Domestic	Many	DL, LL, GN, TP	135	Small	Small or limited by bycatch limits	Large number	None	1998
C'wealth southern shark	Two	Domestic	Many	GN, LL, TRW	140	Small	Limited	Few, minor	None	1999
C'wealth scallop	Two	Domestic	Many	DR	155	None	None	None	None	1999
NSW rock lobster	One	Domestic	Many	TRP	185	Substantial	Small	Some	None	1994
NSW abalone	One	Export	Many	DV	37	Substantial	None	None	None	1989
Queensland spanner crab	One	Export	Many	TRP	244 (Area A) 306 (Area B)	Small	Small	Minor	None	1999
S. Australia abalone	Two	Export	Many	DV	35	Small	None	None	Shucking	1985
S. Australia blue crab	One	Domestic	Many	TRP, GN	6 potters, 32 GN	Significant (40%)	Nil	Crab	None	1998

Key: LL=longline; PS=purse seine; PL=pole and line; TRL= Trolling; TRW=trawl; DS=Danish Seine; GN=Gillnet; DL=Dropline; TRP=Trap/Pot; DR=Dredge; DV=Diving.

TABLE 2 (CONT.)
SUMMARY OF AUSTRALIAN ITQ FISHERY MAIN CHARACTERISTICS

Fishery	No. of quota species	Main market	Landing sites	Gear types	Number of operators (1998)	Recreation and indige-nous catch	By-catches in other fisheries	Commercial non-quota species	Onboard processing	Year ITQs introduced
S. Australia s. zone rock lobster	One	Export	Designated	TRP	185	5–8% of total catch	Nil	Crab	None	1993/94
Tasmania abalone	Two	Export	Many	DV	130	Small	None	None	None	1985
Tasmania rock lobster	One	Export	Designated	TRP	315	Some	Small	Crab	None	1998
Tasmania giant crab	One	Export	Designated	TRP	104	None	Small but limited by by-catch limits limits	None	None	1999
Victoria abalone	Two	Export	Many	DV	71	Some	None	None	None	1988
Victoria scallop	One	Domestic	Few	DR	94	None	None	One	None	…
W. Australia pearl oyster	One	Domestic	Few	DV	16	None	None	None	None	1982
W. Australia pink snapper	One	Export and Domestic	Few	LL,TRW	72	Substantial	Small	Minor	None	1987
W. Australia south coast purse seine	One	Domestic	Few	PS	29	None	None	None	None	1992
W. Australia abalone	Three	Export	Few	DV	26	Substantial	None	None	None	1985/1987

Key: LL=longline; PS=purse seine; PL=pole and line; TRL= Trolling; TRW=trawl; DS=Danish Seine; GN=Gillnet; DL=Dropline; TRP=Trap/Pot; DR=Dredge; DV=Diving.

COMMONWEALTH FISHERIES

The Commonwealth was the first in Australia to introduce ITQs, beginning with the southern bluefin tuna fishery in 1984. This fishery was considered well suited to ITQ management being single species in nature with little bycatch, and centred round a few key ports.

In 1989 the Commonwealth Government released a policy document (DPIE, 1989) that identified ITQs as its preferred management approach. Since 1989 ITQ management has been introduced in the south east trawl and south east non-trawl fisheries and is about to be introduced the Bass Strait scallop and southern shark fisheries.

The south east trawl fishery was the second fishery to be managed with ITQs starting with one species (gemfish) in 1989, and followed by another 15 species in 1992. The south east trawl fishery is unique in Australian quota fisheries in that it includes sixteen low-value species landed at a large number of ports. In 1998, ITQs were introduced for the three main species in the south east non-trawl fishery, species that are also subject to ITQ management in the trawl sector.

An ITQ system was to be introduced into the Bass Strait scallop fishery in 1999 but was deferred as the fishery is closed for the year due to low stock abundance. An ITQ system is planned to be introduced into the southern shark fishery in early 2000.

Southern bluefin tuna fishery

Southern bluefin tuna (SBT) are a long-lived, slow growing and highly migratory species that are distributed widely in southern oceans. SBT is mainly harvested by Australian, Japanese and New Zealand fishers, however catches by Indonesian, Taiwanese and Korean operators are increasing. Australian, Japanese and New Zealand catches of SBT are managed through the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) with each country receiving annual allocations. In 1997/98, Australian catches of SBT were 4,783 tonnes, valued at A$40.8 million.

In the early 1980s concern was expressed over the status of SBT stocks and the deteriorating financial performance of the Australian industry. In 1983, Japan, Australia and New Zealand agreed to a global TAC and annual country allocations of SBT. Initially, the Australian catch limit was managed under a competitive TAC. Following a Commonwealth Government inquiry on SBT fishery management, ITQs were introduced in 1984.

The quota allocation formula was based on catch history and investment. Quota eligibility was based on either a minimum catch of 15 metric tonnes of SBT in any one year over a specified period, or evidence of an irrevocable financial commitment to the fishery (e.g. through the purchase or construction of a vessel). Some operators argued that the use of investment in the allocation formula unfairly rewarded late entrants at the expense of pioneers. Quota appeals continued for five years and led to the introduction of legislation in 1989 to put a stop to further appeals. Quotas are freely transferable and all sales, transfers and third party interests are recorded by AFMA on a computerised register.

In 1995 a new management plan was introduced into the SBT fishery. The major change involved issuance of quota through delegated legislation. Existing quotas were converted into statutory fishing rights (SFRs) which last for the duration of the management plan and thus do not have to be renewed annually. Prior to the introduction of SFRs, quota was simply a condition on an annual fishing permit.

The introduction of ITQs has induced a number of profound changes in the harvesting and processing sectors. The focus of the industry has changed from supplying low grade tuna to the canning market to catching and supplying live fish for "grow-out" in sea cages. After three to six months, the fattened SBT are sold to the high-valued Japanese sashimi market.

For additional information on the introduction of ITQs in this fishery, see Franklin (1987), Robinson (1986), Geen and Nayar (1989) and Exel and Kaufmann (1997).

South east trawl fishery

The south east trawl fishery is a multi-species fishery that extends from north of Sydney, around Tasmania to Kangaroo Island in South Australia. Of roughly 100 species harvested in the fishery predominantly for the domestic market, 16 are under quota. In 1997/98 total landings of 25,382 tonnes were valued at A$57.7 million. There are three major vessel and gear types operating in the fishery – Danish seiners that target whiting and flathead, offshore orange roughy trawlers, and multi-species inshore trawlers.

In 1985 a limited entry management programme was introduced and the fleet limited to 150 vessels. Later, in 1986 an individual transferable effort scheme was implemented. Specifically, transferable boat units based on vessel hull size and main engine power were assigned to each vessel. The total number of boat units in the fishery was frozen and a boat replacement policy was also introduced in an effort to control growth in harvesting capacity. Maximum vessel size and mesh size restrictions were also put in place.

Concern over increasing catches resulted in the setting of competitive TACs for orange roughy (1987) and eastern gemfish (1988). In 1989 concerns over market gluts and increased inefficiency resulted in the introduction of ITQs for gemfish. In the same year a government review of management options concluded that the transferable effort regime had failed to control over-exploitation and over-capacity. As a result the Commonwealth Government took the decision to manage the fishery using ITQs. In early 1992, twenty months after the formal decision had been taken, an ITQ system was introduced.

Species with a landed value amounting to at least 5% of total landed value were put under quota. Even though gemfish were already under quota, a complete reallocation of gemfish quota was undertaken in 1992. The quota formula was based on effort unit holdings and catch history. Industry dissatisfaction with the quota allocation formula resulted in a number of legal challenges which will be discussed in more detail in Chapter 5 but the main outcome was that the Federal Court found the allocation formula to be "capricious and irrational" and declared it void. As a result of this

decision, the component of the allocation formula dealing with catch history was changed and quotas were reallocated.

Quotas can be permanently and seasonally transferred among licence holders. Sales, seasonal transfers and third party interests are all recorded by AFMA on a computerised register and any third party interests do not take effect unless they have been recorded on this register.

In 1998 a new management plan was brought in to the fishery. Under the management plan, which up until 1999 appeared as a condition on an annual permit, which is one of delegated legislation, statutory fishing rights (SFRs) replace annual fishing permits. This means that rather than quota being a condition on an annual permit, SFRs with quota attached will be allocated for the duration of the plan.

The south east trawl fishery offers up a number of important lessons with regard to ITQ management in a multi-species fishery, for more detail see Geen et al. (1990a and 1990), Pascoe (1993), and Exel and Kaufmann (1997).

South east non-trawl fishery

The south east non-trawl fishery is a multi-species fishery encompassing Commonwealth-managed species of demersal scalefish off south eastern Australia caught by methods other than trawl or Danish seine. The vast majority of the catch is of three species, blue-eye trevalla, blue warehou and pink ling that are sold mainly on the domestic market. In 1997/98, 1,907 tonnes were landed, valued at just over A$7 million. There are currently 135 boats operating in the fishery.

In 1985, a freeze was put on the issuance of new licences in an attempt to control the large amount of latent effort in the fishery. Fishery access criteria were developed in 1993. Discussions with industry about the introduction of ITQs began in 1994. By January 1998, ITQs were introduced for these species as conditions on annual permits.

Allocation of quota was based on the verified catch history of fishers (logbook data verified by other information, such as invoices and receipts). This was the first fishery in which the Commonwealth used an independent allocation panel to recommend an allocation formula.

Quotas are fully transferable between operators in the non-trawl fishery. Although the trawl and non-trawl sectors of the south east fishery are currently managed as separate fisheries, inter-sectoral leasing of ling and blue warehou quota is permitted while permanent quota sales are not[1]. Formal integration of the sectors under a single management plan is planned.

Further information on the south east non-trawl fishery can be found in AFMA (1997).

Southern shark fishery

The southern shark fishery is located in Commonwealth waters adjacent to the states of Victoria, Tasmania and South Australia. Although the fishery covers all species of demersal shark, it is largely based on the harvest of school and gummy shark caught by hooks and demersal gill nets and sold on the domestic market. In 1997/98, total catches

of shark amounted to 3,465 tonnes valued at A$11.7 million. There are roughly 140 boats operating in the Commonwealth managed section of the fishery.

The history of management arrangements in the fishery includes limited entry, bycatch limits, area and seasonal closures and vessel/gear restrictions. Management has been complicated by the existence of at least five state and Commonwealth management bodies responsible for management of catches from the shark stocks. Currently, the main management instruments used by the Commonwealth are limited entry and non-transferable hook and net entitlements implemented as a condition on annual permits. Reductions in net entitlements were implemented in 1987 and 1991 in order to reduce exploitation and over-capacity.

Industry dissatisfaction with the non-transferability of net and hook entitlements, combined with concern over school shark stocks and over-capacity in the industry led to an examination of alternative management options. In June 1997 the Southern Shark Management Advisory Committee recommended the introduction of ITQs. In 1999, AFMA established an independent allocation advisory panel to recommend an allocation formula. The panel recommended that quota should be allocated based on catch history. This has been accepted by AFMA. Furthermore, the Commonwealth and various state governments have agreed in principle that the harvest of school and gummy shark is to be placed solely under Commonwealth jurisdiction. AFMA expects to implement an ITQ system in early 2000.

For additional information on the management of this fishery, see FERM (1997a), Pascoe et al. (1992) and ABARE (1998a).

Bass Strait central zone scallop fishery

The Bass Strait central zone scallop fishery is located in Commonwealth waters between Victoria and Tasmania. Almost the entire catch consists of southern (or king) scallops, although some doughboy scallops are also taken. In 1997/98 the fishery accounted for 3,505 tonnes shell weight, valued at A$7 million. Most product is sold in the domestic market. There are 155 boats operating in the fishery. The scallop fishery experiences high natural variability in abundance, growth, mortality and meat yield.

Limited entry controls were introduced in 1986. Scallop abundance collapsed in 1990 and the fishery was closed. When the fishery reopened in 1991, a preliminary management plan was implemented based on a combination of input and output controls. Entry was limited to 155 entitlements, area and seasonal closures and a minimum shell size was introduced, and each vessel was allowed to catch up to a maximum number of bags of scallops per trip.

In 1997 the Bass Strait Scallop Consultative Committee proposed that an ITQ system should be introduced in place of per trip bag limits. The following year AFMA appointed an independent allocation advisory panel, which recommended that the TAC should be assigned equally across all licence holders. However, the implementation of ITQs has been delayed due to poor recruitment and the resulting closure of the fishery in 1999. It is anticipated that the ITQ management plan will come into effect in the 2000 season.

For more detailed information on the Bass Strait scallop fishery, see Young and Martin (1989), McLoughlin (1994), Zacharin (1994), Bass Strait Scallop Consultative Committee (1997), ABARE (1998a) and FERM (1998a).

NEW SOUTH WALES

There are only two quota managed fisheries in New South Wales, the abalone and rock lobster fisheries. These fisheries are currently being converted into "share management fisheries", as set out in the 1994 *Fisheries Management Act*. In a share management fishery, shareholders are allocated a percentage of the TAC (in the form of quota) calculated in proportion to their shareholding. Each share has the same amount of quota attached. The introduction of a share management fishery is a four stage process beginning with consultation, identification of the fishery and shareholders, followed by limiting access to the fishery to shareholders and the provisional issuing of shares, and finally full implementation of a share management fishery. At this final stage shareholders may be required to pay a community contribution (resource rent) calculated as a percentage of the total value of their catch. Shares are issued for an initial period of 10 years. All transfers of shares and quotas must be recorded on a register maintained by the New South Wales Department of Fisheries. Third party interests are also recorded, and do not take effect unless the interest is recorded on the register.

Both the abalone and rock lobster fisheries were declared share management fisheries in 1996, and are currently in the third stage of the process where provisional shares have been issued.

Abalone fishery

In 1997/98, the fishery for blacklip abalone landed 333 tonnes, valued at just under A$10 million. Most abalone is exported to south east Asia. There are 37 licence holders in the fishery.

In 1979, as a result of concern about the state of the abalone resource, the fishery became subject to limited entry controls. Out of the 100 participating divers only 59 were granted access to the fishery, although this number was still considered too high. Concerns over illegal fishing and increasing fishing effort led to the introduction of an ITQ in 1989 with each diver being allocated 10 tonnes of quota.

In 1995 the fishery was designated a share management fishery under the 1994 *Fisheries Management Act* and entered the limited access stage in 1996. Each of the existing entitlement holders was issued with 100 equal shares on a provisional basis. During this stage, shareholders could permanently transfer all their shares but only to an individual who holds no other shares in the fishery. Quota (a minimum of 100kg) can be seasonally, but not permanently, transferred. After the management plan is gazetted and the fishery becomes a share management fishery, the permanent transfer of shares and seasonal transfers of quota are allowed, subject to restrictions including minimum and maximum quota holdings and a ban on foreign ownership. In addition, shareholders must not acquire (through quota transfer) more than twice the amount of their actual allocation in any one year.

A court case, *Consolidated Abalone Divers Group Inc. v The Department of Fisheries of NSW*, discussed in Chapter 4, provides a detailed background to the fishery. A general description of the fishery can be found in New South Wales Fisheries (1999a).

Rock lobster fishery

In 1997/8, 107 tonnes of rock lobster were caught, valued at approximately A$4 million. Most of the rock lobster is sold in domestic markets. There are 185 licence holders in the fishery.

Management of the fishery began in 1984 when the number of vessels permitted to operate was frozen. In an effort to reduce latent effort, the fishery was declared a restricted (limited entry) fishery in 1993, with access criteria being based on historical participation. Continuing concern about over-exploitation led to the introduction of ITQs in 1994. Individual quotas were allocated to fishers based on catch history. Verified catch history was a tradeable commodity, allowing fishers to buy or sell 'history' to meet minimum entry criteria.

In 1995 the fishery was declared a share management fishery under the 1994 *Fisheries Management Act* and entry criteria were established. One hundred and eighty one restricted-fishery endorsement holders were granted provisional shares on the basis of their catch history. There are currently 187 fishers who hold shares on a provisional basis; shareholdings range from 12 to 218 shares. Shareholders may nominate another commercial fisher to take rock lobster on their behalf, although only one fisher can be nominated per shareholding and nominated fishers can only work for one shareholder at a time. During this stage, shareholders can permanently transfer all their shares but only to persons who are commercial fishers. However, no single person can hold more than 5% of the total available shares in the fishery. Quota can be seasonally, but not permanently, transferred, although shareholders must not acquire (through quota transfer) more than twice the amount of their actual allocation. After the management plan is gazetted and the fishery becomes a share management fishery, the permanent transfer of shares and seasonal transfer of quota will be allowed, subject to restrictions, including minimum and maximum quota holdings and a ban on foreign ownership.

A general description of this fishery can be found in NSW Fisheries (1999b).

QUEENSLAND

The spanner crab fishery in Queensland is the state's only ITQ-managed fishery. ITQs were introduced into the fishery in 1999.

Spanner crab fishery

The spanner crab fishery is centred in southern Queensland waters and extends into waters off northern New South Wales. Nearly all of the commercial catch is exported to markets in south east Asia. The 1996 catch of around 2,800 tonnes was worth around A$9 million. There are 244 operators in the area under quota fisheries (Area A).

In the early 1990s the fishery was managed by limited entry and gear restrictions. Over this period increasing demand and rising prices led to rapid expansion. Catches

increased from around 880 tonnes in 1991 to almost 2,400 tonnes in 1993, and the number of vessels active in the fishery more than doubled from 75 to 171. Concurrent with the increase in vessel numbers was an increase in the average size of individual catches and a substantial expansion of the fishery, with new grounds being exploited.

In response to concerns about resource sustainability and over-capacity, a number of effort and output restrictions were introduced during 1995-1997 including: a reduction in the number of licences issued, closures, daily catch limits and a TAC. Numerous problems associated with the competitive TAC resulted in the introduction of an ITQ system in 1999.

An independent allocation panel was established to recommend the quota allocation formula. A minimum equal allocation of quota was made to each of the 213 licence holders, topped up with an amount based on each fisher's catch history. The allocation was made under a management plan for the fishery. The Queensland Fisheries Management Authority (QFMA) issues annually each ITQ unit holder with a new certificate stating the amount of quota units held. This means that quota is issued as a condition on an annual entitlement. Quota is transferable, provided a minimum quota holding is not breached and that transferees hold a relevant fishing licence. A QFMA quota register records sales, transfers and third party interests. Third party interests must be registered to take effect.

For additional information on this fishery, see FERM (1997b) and the Fisheries (Spanner Crab) Management Plan 1999.

SOUTH AUSTRALIA

There are currently three ITQ-managed fisheries in South Australia. With the exception of the dual-species abalone fishery, all the fisheries are single species fisheries. An ITQ system was first introduced into the abalone fishery in 1985. ITQs were introduced into the two other fisheries in the early 1990s, starting with the rock lobster fishery in 1993/94, and followed by blue swimmer crab fishery in 1998. There are plans to introduce ITQs into the pilchard fishery in the near future.

Abalone fishery

Two species of abalone, blacklip and greenlip, are harvested in this fishery. In 1997/98, 812 tonnes of abalone were landed, valued at around A$26.9 million. Most abalone is exported to south east Asia. There are 35 licence holders in the fishery.

Historically the fishery has been managed through a limited entry program with transferable licences, seasonal closures and minimum landing sizes. Despite these restrictions, increases in fishing effort and catches during the 1980s threatened stocks, particularly of greenlip abalone. There was also concern that further tightening of input restrictions would result in increased risk-taking and consequent safety problems for divers as existing restrictions had already led to increased competition amongst divers and more frequent diving injuries.

In 1985 ITQs were introduced for both blacklip and greenlip abalone. Quotas were allocated equally among existing licence holders. ITQs were denominated in units of

meat weight for each species. Quotas for each zone in the fishery can be transferred with the sale of the associated licence for that zone but cannot be split from the licence; in other words they are a condition on the licence. Furthermore, an individual cannot have an interest in more than one abalone licence. Quota can be leased seasonally but not transferred permanently. Information on sales and transfers is recorded on a computerised register. Third party interests are recorded on the licence and the register but are not available for public inspection.

Southern zone rock lobster fishery

The southern zone rock lobster fishery extends from the mouth of the Murray River south to the Victorian border. In 1997–98, catches of 1,635 tonnes by 185 licensed operators were valued at A$47million. Nearly all lobsters are exported.

In 1980, the fishery was managed by limited entry and pot limits but later, a seasonal closure was introduced. A further pot reduction of 15 per cent was implemented in 1984 which was later assessed as having had only a small effect on fishing effort as fishers worked their remaining pots more intensively. As a result, the pot reduction failed to induce significant rationalisation within the fishery (Stanisford 1987). To redress this, in 1987 a 'buy-back program' was established which removed 41 licences and 2,455 pots from the fishery. However, the remaining fishers continued to increase their effort by spending more time at sea.

Concern about the sustainability of this catch level resulted in a competitive TAC being implemented in 1992–93. After consultation with industry, an ITQ system was introduced in 1993–94 through delegated legislation. In the first year of quota management, allocation was based on the fishers' greatest relative share of either pots or catch history. Following a review of the system at the end of the season, the allocation formula was changed to an equal share of the TAC being allocated per pot. After an unsuccessful legal challenge (see Chapter 5) the formula was adopted and applied in the 1994/95 fishing season. Quota is a condition on the annual licence and there are minimum and maximum limits on the number of pots that can be held by a licence holder.

Up until 1998 licence transferability was limited to family members only. However, pots and their quota entitlements can now be transferred amongst licensees provided the maximum pot holding limits are not exceeded. Seasonal leasing of quota is also permitted. Transfers of licences and pots are recorded on a computerised register. Third party interests are also recorded but not available for public inspection.

A general description of the fishery can be found in Zacharin (1997).

Blue swimmer crab fishery

South Australia has two blue swimmer crab fisheries. One is a deepwater pot fishery operating in the Gulf of St. Vincent and Spencer Gulf. The other is part of a marine scalefish fishery where crab is caught using set nets. In 1997/98 catches totaled 464 tonnes, valued at just over A$2 million. Most crabs are sold in domestic markets.

In the mid-1990s the deepwater fishery began as a developmental fishery, using pots, while in the marine scalefish fishery, blue swimmer crab is harvested with nets. ITQs were introduced into both fisheries in 1998 by delegated legislation. Most of the TAC is allocated to the deepwater pot fishery where licence holders must have a minimum holding of 50 pots; only six fishers operate in this fishery. Quota is allocated according to catch history and can be transferred seasonally but not permanently. As quota is a condition on a licence, quota cannot be transferred without also transferring the associated pot entitlements.

In the diversified marine scale fishery, quota was also allocated on the basis of catch history. As with the rock lobster fishery, all transfers and third party interests are recorded on a computerised register but third party interests are not available for public inspection.

TASMANIA

There are three quota fisheries in Tasmania for abalone, rock lobster and giant crab. An ITQ system was introduced into the dual-species abalone fishery in 1985, and into the rock lobster fishery in 1998 following extensive consultations with stakeholders over an eight year period. As giant crab is taken as a by-catch in the rock lobster fishery, ITQs have also recently been introduced into this fishery.

Abalone fishery

The Tasmanian abalone fishery comprises blacklip and greenlip abalone and provides 25% of the world's abalone harvest. In 1997/8, 2,360 tonnes were landed, worth just under A$78 million. Abalone is exported to markets in south east Asia.

The fishery became subject to limited entry in 1969. Continued concern about the status of stocks resulted in various management changes from 1969 to 1980, and in 1985 an ITQ system was introduced. A TAC of 3,800 tonnes was set and each diver allocated 28 abalone quota units. There was limited transferability, with divers being able to transfer up to 12 units seasonally. In 1991 the abalone diving licence was separated from the abalone quota licence and both became freely transferable. Abalone divers with small or no quota holdings could dive for other quota holders on either a fixed fee per kilo basis or for a share of the beach price.

In 1994, a contractual agreement was implemented — the Abalone Deed of Agreement (DoA). The Deed is delegated legislation. Under the Deed, quota unit entitlements that were held before the DoA are converted into shares under the DoA. Unlike quota unit entitlements that were granted for a year at a time, shares under the DoA are granted for ten years and carry with them an automatic option to renew at the end of ten years. Holders of abalone licences were offered the choice of either staying with an annual licence or moving to a DoA. Currently over 95% of the quota units are held under the DoA.

Under the DoA, the abalone quota licence is identified as 'property', which can be assigned (transferred) wholly or partially with the prior approval of the Director of

Fisheries. Entitlements and quota are held on a computerised register that also records third party interests.

For more information on this fishery, see Department of Primary Industry and Fishery, Tasmania (1997b).

Rock lobster fishery

In 1997/98 the Tasmanian rock lobster fishery landed 1,485 tonnes valued at A$46.2 million. The Tasmanian rock lobster fishing fleet is made up of 315 vessels, ranging from 6–21 metres in length. Most of the rock lobster catch is exported.

Prior to the introduction of ITQs the fishery was managed by limited entry and pot allocations based on either vessel length or tonnage. In the early 1990s, stock assessments indicated that the fishery was overfished. After a six-year consultation process with industry an ITQ system was implemented in 1998.

Quotas were implemented through delegated legislation. The allocation was mainly on an equal amount per pot basis, with a small percentage of the TAC allocated on the basis of catch history. These additional catch history quota units are to be phased out over a three-year period. There are maximum and minimum quota holdings and a maximum total holding by a single company or beneficial owner of 200 pots on up to seven licences. Quotas are permanently and seasonally transferable but only to individuals who hold a rock lobster fishing licence. Quotas are granted annually as a condition on licences.

Licence holders are able to separate pots from quota units by transferring quota units without pots on a seasonal transfer basis. Transferring quota units without pots does not entitle the transferee to use additional pots. All transfers are recorded on a computerised register together with third party interests.

More information on this fishery can be found in Department of Primary Industry and Fishery (1997a).

Giant crab fishery

The Tasmanian giant crab fishery developed rapidly in the early 1990s. In 1997/8 catches of 52 tonnes were valued at just under A$1 million. Giant crab is exported to markets in south east Asia. The fishery was managed through limited entry and other effort restrictions but a rapid decline in catches over the period 1994 to 1997 led to a review of its management. Concern about stock size was compounded by the introduction of quotas in the rock lobster fishery, leading to increased targeting of giant crab by rock lobster fishers. Entry to the fishery for giant crab was closed in 1998, and ITQs were introduced in 1999 by delegated legislation.

Due to a lack of scientific information on the giant crab stock the TAC is set at 85% of the average catch in 1997 and 1998. Allocation was based mainly on catch history, although a minimum allocation of five quota units was given to all licence holders. The maximum allocation to an individual was 35 units, and there is a maximum quota holding of 150 quota units. Giant crab licences are permanently transferable to holders of giant crab fishing licences or to holders of rock lobster fishing licences provided there

is at least one quota unit on the licence. Giant crab quota units are seasonally and permanently transferable between holders of giant crab fishing licences. However, quota units cannot be transferred permanently if they are the only quota unit on the licence, unless the licence is surrendered. All transfers are recorded on a computerised register, together with third party interests.

More information on the giant crab fishery can be found in Department of Primary Industry, Water and the Environment (1999).

VICTORIA

There are two ITQ-managed fisheries in Victoria, the abalone and scallop fisheries. Quotas were first introduced into the dual-species abalone fishery in 1988, with each of the 71 licence holders allocated an equal annual quota. In 1995, the new *Fisheries Act* formally allowed for the establishment of quota fisheries in Victoria, enabling the transfer and leasing of quota independent of licences.

Abalone fishery

Both blacklip and greenlip abalone are harvested in this fishery with blacklip abalone being the most abundant species. In 1997/98, catches of 1,422 tonnes were valued at A$50.9 million were mostly exported to south east Asian markets. Historically the fishery has been managed through a limited entry program with transferable licences, seasonal closures and minimum landing sizes.

In 1988, ITQs were introduced into the fishery by administrative decision, rather than delegated legislation. Each of the 71 licence holders was allocated an annual quota of 20 tonnes. Although quotas may be transferred independently of licences, minimum and maximum quota holdings apply. All seasonal and permanent transfers of quota are recorded on a computerised register that includes registration of third party interests. All licenses are now company owned.

Scallop fishery

Victoria's scallop fishery is based on southern (or king) scallops. The fishery was originally centred on Port Phillip Bay but, following the closure of the Bay, the fishery now operates from Lakes Entrance out to 10 nautical miles. The 1997/98 catch of 288 tonnes was valued at just under A$600,000 and sold mainly on the domestic market. There are 71 licence holders in the fishery.

Historically this fishery has been one of the most valuable in the state, accounting for up to 25% of the total value of all fish landed. The Port Phillip Bay fishery first collapsed in 1968. Harvesting of scallop in Port Phillip Bay continued throughout the 1970s and 1980s despite falling average production and dramatic fluctuations in catches. During this time limited entry and other effort controls, such as seasonal closures and minimum size regulations were used to manage the fishery. In 1996, a 'buy-back scheme' was introduced for Port Phillip Bay licences and the fishery has since been closed.

The quota management system was implemented in the oceanic scallop fishery by administrative decision, pending the finalisation of a management plan for the fishery. Equal allocations were made to licence holders as a condition on their annual licences. The quotas are seasonally transferable.

WESTERN AUSTRALIA

There are four ITQ-managed fisheries in Western Australia: the abalone, Shark Bay pink snapper, south coast purse seine and pearl oyster fisheries. With the exception of the south coast purse seine fishery, all produce high unit value catches.

Abalone fishery

Three species of abalone are commercially exploited in Western Australian waters: greenlip, blacklip and Roe's abalone. In 1997/98, the fishery landed 326 tonnes valued at A$10.7 million. Abalone is exported to markets in south east Asia. There are 26 licence holders in the fishery.

The commercial fishery began in the late 1960s and rapidly expanded in the 1970s. Zone-based management was introduced in 1975, along with closures and various effort controls to conserve stocks. An ITQ system was introduced in the mid-1980s in order to encourage orderly harvesting practices. Licensees were authorised to take an equal portion of the TAC in the zone for which they held a licence. Roe's abalone could only be taken in zone 3, while all three species could be taken in zones 1 and 2.

In 1992 a new management plan was introduced as delegated legislation. This maintained the quota management system and introduced minimum unit holdings for new entrants in response to concern about enforcement costs in a fishery with a large number of minor operators. Abalone licences and quota units are transferable seasonally and permanently within zones, although minimum and maximum quota holdings apply and quota units can only be transferred to a licence holder entitled to take abalone. However, quota units cannot be broken down into smaller sub-units. Quota is a condition on a licence that is annually renewable. A computerised register records quota sales and transfers, as well as third party interests. However, registration of third party interests is not compulsory and therefore is not necessary for such an interest to take effect.

More information on this fishery can be found in Fisheries Western Australia (1998) and (1999b).

Shark Bay pink snapper fishery

Pink snapper is a long-lived, slow growing species, sold on both domestic and export markets. In 1997/98 catches of 564 tonnes were valued at A$1.8 million. There are 29 licence holders in the fishery. Some 43 trawlers are also entitled to take a small bycatch of pink snapper.

In 1987 an ITQ system was introduced with licences being divided into two classes. 'A' class licences had 20 units of quota attached to them and enabled holders to fish the main fishing grounds in Shark Bay. These were allocated to fishers with a catch

history of at least 8 tonnes per annum over a four year period. Additional non-transferable units were allocated to licence holders with large catch histories.

'B' class licences had 10 units of quota attached to them and enabled holders to fish the outer areas of Shark Bay. These licences were allocated to fishers who had taken catches of less than 4 tonnes over the same four year period. In 1988 a split season was introduced and licence holders could nominate to fish during the peak season when quotas applied, or in the off-peak season when no quota restrictions were in place. Various additional management measures have also been introduced.

Under the management plan, which is delegated legislation, quota can be transferred permanently or seasonally but only to existing licence holders unless the licence is sold with the quota. A computerised register records quota sales and transfers as well as third party interests. As with the abalone fishery, registration of third party interests is not compulsory and therefore is not necessary for such an interest to take effect.

Plans are currently being discussed to simplify the system by introducing an annual quota management system that will make it unnecessary for fishers to nominate the season in which they wish to fish. In order to increase flexibility, existing units will be multiplied by a factor of ten that will allow for the transfer of units smaller than was previously permitted. A minimum ITQ holding has also been proposed for new entrants to the fishery in order to promote commitment and deter marginal operators.

More information on this fishery can be found in Fisheries Western Australia (1999a) and (1999c).

South coast purse seine

The south coast purse seine fishery covers the taking of small pelagic fish by purse seine in all waters between Cape Leeuwin and the South Australian border. The most productive area is King George's Sound and the main target species is pilchard. Most of the catch is sold as feed to the southern bluefin tuna mariculture industry in South Australia. In 1997/98, 6,874 tonnes were caught, valued at just under $3.8 million.

Following the introduction of ITQs into the southern bluefin tuna fishery and the expansion of the pet food market in the early 1980s, fishing effort increased and catches almost doubled. To curb fishing effort, in 1988 different classes of licences were introduced. 'A' class licences were allocated to the most active vessels which had caught more than 50 tonnes per annum over a three year period. These licences permitted year round access to King George's Sound. 'B' class licences were granted to vessels that had caught less than 50 tonnes per year over the same three year period. Access to King George's Sound was only permitted on a seasonal basis. 'C' class licences permitted holders to fish in the Albany Development Zone outside King George's Sound. Only 'A' class licences were transferable.

High effort levels and falling catches led to a review of management options by the Purse Seine Management Advisory Committee. On their recommendation, an ITQ system was introduced through delegated legislation, into two zones of the fishery (the Albany Development Zone and Bremer Bay) in 1992. ITQs of 200 tonnes were issued

to all licence holders operating within these zones, with extra quota provided to fishers who had caught more than 400 tonnes in 1989 and 1990. As an incentive to encourage all 'C' class licence holders to fish in Bremer Bay (a development zone) they also received a non-transferable pool quota for fishing in the Bay which was divided equally among all 'C' class licence holders.

Quota is a condition on an annual licence and can only be seasonally transferred, although permanent transfer can take place if the licence is also transferred. A computerised register records quota sales and transfers as well as third party interests.

A general description of this fishery can be found in Fowler et al. (1997).

Pearl oyster fishery

The pearl oyster fishery underpins the pearl mariculture industry in Western Australia. Unlike other fisheries in Western Australia, the pearl oyster fishery is governed by its own Act, the 1990 *Pearling Act*. Pearl oysters are collected from the wild, seeded, and then grown in cages on the seabed. One wild pearl oyster can be seeded up to four times. In 1997/98 the pearl industry was valued at around A$189 million. The industry is the world's largest producer of "south sea" pearls, most of which are exported.

In response to concerns about over-exploitation, wild stock pearl oyster quotas were first introduced in 1982, with quota allocations being based on licence holder requirements rather than the setting of a TAC. Provision was made to vary the quota if wild stocks were under threat, but such a situation has not yet occurred. Licence holders were able to apply for extra quota if needed for their business. Following a review of the industry in 1988[2], it was recommended that quotas were allocated to all existing licence holders based on the ongoing commitment of the participating companies to the industry, their traditional catching ability and investment in infrastructure. In 1993 three new pearling licences were granted to new entrants. Selection of the new entrants was based on their level of expertise and the support of regional development initiatives. New entrants received a minimum quota allocation while two existing licence holders received extra quota. Effort controls in the fishery are minimal, however there are minimum and maximum limits for quota holdings. Foreign ownership of licences is limited to 49% of each licence.

Quotas are fully transferable provided each licence holder maintains a minimum of 15 quota units. Leasing is not mentioned under the Act although it has been known to occur. A computerised register records information on the transfer of quotas, although third party interests are not recorded.

More detailed information on the pearl oyster fishery can be found in Fisheries Western Australia (1996) and (1999d).

INTERNATIONAL ITQ-MANAGED FISHERIES

This section provides a very brief review of, and details available literature on, ITQ-managed fisheries in New Zealand, the United States, Canada and several other countries. ICES (1996, 1997a) are a good source for the available literature on ITQ

fisheries. For a comparative review of ITQ-managed fisheries in various countries, see Arnason (1996), NRC (1999b), Muse (1989), OECD (1993) and Grafton (1996b).

NEW ZEALAND

Prior to the introduction of ITQs, fisheries in New Zealand were managed with input controls such as limited entry, gear and seasonal restrictions. In 1983 enterprise allocations (individual non-transferable company quotas) were introduced for seven deepwater trawl fisheries due to concerns about overfishing and over-capitalisation in the sector. After extensive discussions with industry on ways to improve the conservation of fish stocks and the economic efficiency of the sector, in 1986 the *Fisheries Amendment Act* was passed. This enabled a national Quota Management System (QMS) to be implemented. Under this Act enterprise allocations were converted into ITQs and inshore fisheries were brought into the QMS.

The quota system covers multi-species and multi-gear fisheries. There are currently 33 species or species groups managed under the QMS in 179 separate species/area TACs (Clement & Associates, 1997). The TAC for each fishstock is set and then a total allowable commercial catch (TACC) is set after taking into account the recreational and non-commercial (mainly Maori) interests in the fishery.

Foreign ownership of quota rights is not permitted, and there are various minimum and maximum limits on ITQ holdings. Resource rent payments that were introduced earlier were abolished in 1994 and the government introduced a management cost recovery programme from the commercial sector.

Over the next three years, the government intends to move all commercially harvested species into the QMS with 20% of the new quota allocated to the Maori under the *Treaty of Waitangi (Fisheries Claims) Settlement Act*. There is also the suggestion of introducing a quota management system into the recreational sector.

A great deal has been written on the introduction of ITQs in New Zealand and those interested in additional information should see the following references: Clark and Duncan (1986), Clark et al. (1988), Crothers (1988), Dewees (1989), Ackroyd et al. (1990), Macgillivrary (1990), Pearse (1991), Annala et al. (1991), Lindner et al. (1992), Boyd and Dewees (1992), Davies (1992), Sissenwine and Mace (1992), Clark (1993), Annala (1996), Sharp (1997), Branson (1997), Major (1997), Batstone and Sharp (1999) and NRC (1999b).

UNITED STATES OF AMERICA

There are four federal fisheries in the United States that are managed by ITQs: the East Coast surf clam/ocean quahog fishery, the South Atlantic wreckfish fishery, and the Alaskan halibut and sablefish fisheries. With the passing of the 1996 *Sustainable Fisheries Act*, the US Congress declared a moratorium on new management programs pending an evaluation of the ITQ management system. This review (NRC, 1999b) has been completed and has recommended that the moratorium be lifted.

Prior to the introduction of ITQs in 1990, the surf clam fishery was managed through a TAC and fishing time limits per fishing vessel, and a limit on fishing vessel numbers. The ocean quahog fishery was also managed with a competitive TAC. Effort management in the surf clam fishery was seen as burdensome and inflexible by industry as it resulted in drastic reductions in allowable fishing time and did not control over-capitalisation (NRC, 1999b). To address these problems ITQs were introduced into the fishery in 1990. Depending on the fishery and area, allocations were based either on catch history alone or catch history and vessel capacity. There are two components to the ITQ, the quota share which is a percentage of the TAC, and an annual allocation permit that is issued in the form of cage-tags (one cage contains 32 bushels of clams). Quota shares can be leased and sold permanently, whereas cage-tags, because they are valid only for one year can only be sold or leased during that period (NRC, 1999b). There is a minimum quota holding and restrictions on foreign ownership.

The South Atlantic deepwater wreckfish fishery began in 1987 and grew rapidly over the following three years, with an increase in vessel numbers from 2 to 80, and an increase in catch from 29,000 pounds to 4 million pounds (NRC, 1999b). Prior to the introduction of an ITQ the fishery was managed through a TAC and effort controls such as trip limits and seasonal closures. Due to concerns about growing capacity, increased catches and shorter seasons, an ITQ was introduced in 1992. Subject to a minimum landing requirement, 50% of the quota allocation was based on catch history, with the remaining 50% allocated equally. ITQs take the form of percentage shares of the TAC, and coupons are issued yearly based on the poundage associated with an individual's quota share. ITQs are transferable but coupons that may be transferred separately can only be transferred to other permit holders.

The Alaskan halibut and sablefish fisheries were managed by a competitive TAC, and various combinations of area, season and gear restrictions. The NRC (1999b) details a number of problems with the effort control regime including allocation and gear conflicts; ghost fishing; discarding; market gluts; over-capacity; safety; and short seasons. An ITQ system was introduced in 1995 with allocations based on catch history. For halibut, ITQs apply to all commercial hook and line harvests in state and federal waters off Alaska. For sablefish, ITQs are limited to longline and pot fisheries in the federal waters off Alaska. ITQs are issued as a percentage of the TAC for a particular region. There are various transferability restrictions in place: for example transferability is restricted across vessel sizes and categories. Quota holders who are fishers can only transfer quota to certain qualified buyers whilst catcher-processor vessel quota shares are transferable to any individual.

For information relating to the use of ITQs in United States' fisheries, see Muse and Schelle (1989), Muse (1991), NMFS (1992), Gauvin et al. (1994), Buck (1995), McCay et al. (1995), Squires and Kirkley (1995), Wang (1995), Knapp (1996), Gilroy et al. (1996), Knapp (1997), Adelaja et al. (1998) and NRC (1999b).

CANADA

Canada first introduced ITQs into the Scotia-Fundy herring purse seine fishery in 1976. Since then, Canada has introduced various forms of ITQ management into both freshwater and ocean fisheries. In ocean fisheries, ITQs have been implemented in the groundfish, pelagic and shellfish fisheries. In some cases quotas were allocated to companies (termed enterprise allocations) as opposed to individuals.

Given the large number of fisheries into which ITQs have been introduced and the use of different ITQ arrangements in each fishery, it is difficult to meaningfully summarise Canada's ITQ-managed fisheries. For example, various transferability restrictions apply in the different fisheries. However one commonality is that ITQ rights are relatively weak, with quota generally issued as a condition on an annual permit that is reissued at the discretion of the Fisheries Minister.

Information on Canada's ITQ-managed fisheries is available in Haxell (1986), Cowan (1986), Gardner (1988), Anonymous (1990a), Anonymous (1990b), Crowley and Palsson (1992), Stephenson et al. (1993), Burke et al. (1994), Casey et al. (1995) and Grafton (1996a and 1996b).

ICELAND

ITQs were introduced at different times and in slightly different forms into the Icelandic herring, capelin and demersal fisheries during the mid-1970s to early 1980s. The main reason for introducing ITQs was to improve conservation and increase economic efficiency. In 1990 the quota management regime was rationalised and harmonised by the *Fisheries Management Act*. Annual quotas are transferable subject to the restriction that must be transferred between vessels in the same geographical region unless the fishermen's union and the local authorities concerned approve the transfer. In practice approval is usually given (Arnason, 1993). Although quota can also be leased, leasing cannot be repeated indefinitely. To retain allocations, quota holders must fish at least half their quota every second year (NRC, 1999b).

As a result of a Supreme Court decision in *Jóhannesson v the State* described in Chapter 5, fisheries legislation has recently been amended so that fishing licences are no longer only issued to vessel owners with a specific fishing history. Any vessel is eligible to apply for a licence provided it satisfies certain standard conditions. However these 'new' licence holders are not entitled to either TAC-shares or annual allocations and thus have to buy or lease quota.

For more detailed information on Iceland's ITQ management systems, see Arnason (1993b, 1995b, 1996), Palsson and Helgason (1995) and Eythorsson (1996).

OTHER COUNTRIES

ITQs have also been introduced into other countries' fisheries including those of the United Kingdom, Netherlands, Norway and Greenland.

In the United Kingdom, sectoral quotas are allocated to Fish Producer Organisations. These organisations were originally set up under the Common Fisheries Policy as marketing organisations, but have become increasingly involved in fisheries management and now manage 95% of the UK's national quota. Each of the nineteen Fish Producer Organisations is allocated a sectoral quota based on the catch histories of its members over a specified period. The allocation of this sectoral quota amongst individual members is left to the Fish Producer Organisations concerned, with each developing a slightly different strategy depending on it's particular circumstances. For demersal species, quota is usually allocated equally to all licence holders, although in some cases it is allocated according to vessel size. More recently individual vessel quotas have been allocated based on the catch history of individual vessels, as is the case for pelagic fish quotas (Goodlad, 1996).

Quota can be transferred within and between Fish Producer Organisations. The most common transfers involve "fish for fish" arrangements. Permanent sales of quota by Fish Producer Organisations are rare.

In the Netherlands the national quota is divided into individual fishing rights. In the North Sea roundfish (cod, haddock and whiting) and flatfish fisheries, fishers have pooled their ITQs within Producer Organisations. The Producer Organisations are responsible for managing the quotas under a fishing plan, although ITQs are still individually owned. Producer Organisations were given legal status and fishers were given incentives to join them in the form of 10% more days at sea and the possibility of renting or hiring quota. By 1993, owners of 93% of the fleet (measured in horsepower) had joined a Producer Organisation; and by 1994 quotas became fully transferable (not tied to particular vessels).

In Norway most commercial fish stocks are shared with other countries and TACs are set by international agreement. In the case of fish stocks shared with Russia (Arctic cod, herring and capelin) individual vessel quotas were introduced in the 1980s (OECD, 1996). Quotas are not transferable except in the situation where a licensed vessel is bought, then scrapped and the scrapped vessel's quota is then added to an existing vessel. However the amount of quota which can be retained is conditional on the "direction of the sale". For example if a vessel is sold from northern to southern Norway, only 50% of the quota can be retained but if the vessel is sold from southern to northern Norway, 95% of the quota can be retained (NRC, 1999).

Arnason (1996), OECD (1993), NRC (199b) and Goodlad (1996) provide information on a number of these countries' ITQ programs. Arnason (1996) and Arnason and Friis (1995) also provide a review of ITQ management in Greenland.

ENDNOTES

1 Blue-eye trevalla is not transferable as a result of an agreement between Tasmania and the Commonwealth under the OCS.

2 Final Report of the Pearling Industry Review Committee, February 1988

4 FISHING ENTITLEMENTS AND PROPERTY LAW

As discussed earlier, economists have generally argued that open access fishing tends to result in over-capacity and over-exploitation (Gordon, 1954; Scott 1955). In an attempt to control these problems, governments have created and allocated various types of fishing 'entitlements' to fishers. The issuance of entitlements acts to limit the number of individuals that may harvest fish resources and to provide a vehicle to restrict how and where harvesting may take place. Fishing entitlements are referred to by various names, including permits, licences, and authorities. Creating a limited number of fishing entitlements, establishing conditions on entitlements (e.g., maximum vessel size), and allocating entitlements to a select group of individuals is an example of rights-based management.

In general, the more clearly defined the user rights, the lower the likelihood that fishers will, from society's viewpoint, have perverse incentives to increase fishing effort and catches to the detriment of the fish stock and the overall economic performance of the industry. Because each fisher is limited to a certain amount of catch, ITQs are seen as providing relatively well-defined rights compared to those assigned under effort controls that allow fishers to compete for increased catch shares. Instead, it is argued that fishers with ITQs pay greater attention to the increasing the value of their catch through improved marketing or processing and on reducing their fishing costs.

Other positive incentives are often created by the assignment of ITQs. In particular, fishers have been observed to take a stronger interest in the long-term health of the resource to which they have been assigned harvesting rights. Abalone fishers in the Chatham Islands in New Zealand were, for example, characterised as changing from plunderers to custodians of the resource following the introduction of ITQs (Ackroyd et al 1990). A number of similar examples of fishers adopting more responsible fishing practices under the New Zealand quota management system are provided by Annala (1996).

In view of outcomes such as these, economists have continued to advocate the use of management measures such as ITQs that provide a clearer definition of the rights and responsibilities of fishers. However, in describing ITQs and other rights-based management schemes economists have tended to use the terms 'use rights' and 'property rights' interchangeably. Arnason (1996) notes that:

> there has been a clear trend toward the adoption world-wide of fisheries management systems that are based on property rights. Several types of property rights have been tried, including exclusive user rights, access licences, capacity licences, and various types of harvesting quotas.

Arnason notes that access licences tend to be "low-quality" property rights, while:

> If ITQs are permanent, they constitute a relatively high-quality property right, not unlike the private ownership of a building or piece of land.

This is essentially an extension of the idea discussed above that the assignment of more clearly defined rights to fishers can be expected to create incentives for more efficient and responsible harvesting. Many economists have argued that "high quality" property rights, such as individual transferable quotas, have the best chance of mitigating the problems of over-capacity and over-exploitation.

The relationship between property and ITQs is important to fisheries managers, governments, fishers and conservation groups. Given the abundance of economic rhetoric on this subject, it is not surprising that fishers often consider ITQ entitlements to be similar to private property. Governments and fisheries managers are at times concerned that ITQs will be considered property by the courts, and that this could raise the possibility of compensation claims if ITQ arrangements are subsequently modified or extinguished, or if TACs are reduced. At other times, particularly during the initial consultation period with industry about the possible introduction of ITQs, fishery managers have been known to espouse the benefits to fishers of long-term property rights. Some conservation groups, recreational fishers and others see ITQs as the privatisation of fish stocks into the hands of big business.

The discussion on property rights, the quality and definition of fishing entitlements and the comparison of ITQs with private ownership of a building or piece of land raises a number of questions. First, what exactly is 'property' and what are 'property rights'? Second, what position have courts taken with respect to the issue of whether fishing entitlements (including ITQs) are property or not? Third, what are the implications of fishing entitlements being considered property? The remainder of this chapter explores various aspects of these questions and, as these are essentially legal issues, it has a strong legal focus.

WHAT ARE PROPERTY RIGHTS?

BACKGROUND

It is useful to outline briefly some of the legal concepts and terms that appear in this section. There are two basic sources of law in Australia — namely statute law (otherwise known as Acts of Parliament and legislation) and common law (otherwise known as judge-made law). Statute law is written law developed by elected members of parliament. Common law[1] is that body of law developed by judges in the course of deciding disputes between parties. Statutes are used to introduce new laws, repeal existing statute or common law rules that is, combine previous legislation and common law principles into one comprehensive statement of law. Where a statute and the common law deal with the same subject matter then, to the extent that there is an inconsistency between them, the statute prevails. The regulation, management and control of fisheries in Australia are dealt with by statute law, enacted at both the state and federal level.

PROPERTY CHARACTERISTICS

There is much more to the terms 'property' and 'property rights' than first meets the eye. To most individuals, the term 'property' is popularly used to specify an object that a person owns and is generally articulated in terms like "this house, car or money in my savings account is my property." Using the term property in this way emphasises that property relates to possession of an object and that it has to do with a unique relationship between a person and that object. Thus with respect to their property, most people would probably argue that they are free to do with their property what they like and that no one has the right to take their property away from them.

In terms of day-to-day living, the above understanding of property rights is sufficient. However, at both a conceptual and legal level, the terms 'property' and 'property rights' are far more complex. There exists a vast amount of material related to property and property law. Those interested in this area, as it relates to fisheries, can read Scott (1986, 1989, 1998) and Brubaker (1996); for a more legal perspective see Ziff (1996), Bradbrook et al. (1996), Hepburn (1998) and Fisher (1997). Our purpose here is only to provide a broad and simple outline of the topic.

Hughes and Leane (1997) state that:

> Property law is concerned with issues such as the types of property which the legal system recognises, the particular interests which can be created in relation to property and the manner in which property interests might be dealt with by those who lay claim to them.

This statement raises a number of issues that are useful to keep in mind, especially when considering the issue of whether fishing entitlements (including quota) may be considered to be property. First, legal systems usually only recognise certain types of property. Second, even if the legal system recognises a right as a property right, the interests created are not necessarily the same for all types of property. Third, the manner in which property interests are dealt with may vary for different types of property. It is important to remember, that when it comes to legal rights, law ultimately defines property[2], and not all property recognised by law is treated the same.

The issue of property can be viewed through a number of different perspectives. For example, one can speak of different types of property, identify various types of rights, and examine the various characteristics that property can possess.

TYPES OF PROPERTY

With respect to types of property, law divides property into real property and personal property. Real property concerns land and the wide set of interests or rights that can be created in relation to land. Personal property includes rights over all other types of property and is broken down into "choses in possession" (goods or tangible personal property) and "choses in action" (rights that are enforceable by action such as rights to debts, copyright, patents, rights of action on a contract or a right to damages for its breach).

PROPERTY AS A BUNDLE OF RIGHTS

In addition to the various types of property, property rights can be viewed through the relationship a person has with a particular object, be it real or personal property. This relationship is often referred to as 'a bundle of rights'. It is important to understand, from this perspective, that property is not the thing or object itself but rather the rights that a person has in relation to the thing or object. Ziff (1996) identifies property as a collection of the following rights: possession, management and control; income and capital; transferability; and protection under law (from such actions as expropriation).

Similarly, Hepburn (1998) states that:

> Ownership rights focus upon rights of use, control and possession over an object and include:
>
> - the right to exclusive physical control of the property;
> - the right to possess the property;
> - the right to use and enjoy the property;
> - and the right to alienate (that is transmit, devise or bequeath) the property.

The definitive right in private property relationships is the right of the owner to the use, possession and enjoyment of the object to the exclusion of the rest of the world.

PROPERTY AS A BUNDLE OF CHARACTERISTICS

Property can also be examined with respect to various characteristics, including exclusivity, durability, security and transferability. Scott (1989, 1998) provides a more in-depth discussion of these characteristics. Exclusivity refers to the right to exclude others from using or enjoying the property in question. A farmer who has freehold ownership over land can exclude others from using the land, and therefore the right carries with it a high degree of exclusivity. Durability concerns the time span over which the owner can exercise control. Freehold title over land is perpetual, and therefore exhibits a high degree of durability. Security is related to the quality of title — ownership that can be 'taken away' indiscriminately as a result of a bureaucratic decision would possess a low level of security. The final characteristic is transferability. Generally, freehold title over land is highly transferable, whereas a lease agreement between a landlord and tenant may not allow for any transfer of the lease agreement. The quality of a property right can be judged by the degree to which it possesses each of these characteristics. A perfect property right would be fully transferable, completely secure, of infinite duration and totally exclusive.

OTHER CONSIDERATIONS RELATED TO PROPERTY

Two additional observations are worth noting at this point. Firstly, ownership rights are rarely absolute. Legislation and courts can place restrictions on the way rights can be exercised. A good example of this is found in planning laws that place restrictions on land use in urban areas or in environmental laws that similarly restrict land use in rural areas.

Secondly, fishing entitlements as a right to fish are derived from government statutes (otherwise known as legislation or acts of parliament), rather than being a proprietary right that exists under common law. A good example of a statutory property right is found in the realm of intellectual property law. In Australia, copyright is a personal property right created under the *Copyright Act 1968 (Cth)*. Exclusive rights in new inventions are given to people under the *Patents Act 1990 (Cth)*. Protection of other specific subject matter is regulated by statutes such as the *Plant Breeder's Rights Act 1994 (Cth)* and the *Circuit Layouts Act 1989 (Cth)*. Where rights are created and regulated by the terms of the statute, the remedies[3] available are also usually contained in the statute.

WHAT PROPERTY RIGHT CHARACTERISTICS DO ITQs POSSESS?

Most fisheries legislation that enables the introduction of ITQs does not expressly describe ITQs as a proprietary right. The known exceptions are the abalone Deed of Agreement in Tasmania and quotas in New Zealand. If there is no express recognition of the proprietary status of ITQs by the statute and the issue is raised in legal proceedings, a court might examine whether ITQs have the characteristics of property as defined by the common law. In doing so, a court might ask the following questions[4]:

- Does the right holder have exclusive use of the right?
- Can the right be clearly defined?
- Can third parties identify the right?
- Can the right be transferred to third parties?
- Does the right have some degree of permanence or stability?

Not surprisingly these characteristics are similar to the exclusivity, durability, security and transferability characteristics outlined earlier.

At one level, the different quota regimes around the world are quite similar — specifically, ITQ regimes involve the allocation of a portion of the TAC (usually as a percentage of the TAC) to some entity (be it an individual, vessel or community). For most fisheries, the right is clearly definable (a certain proportion of the TAC), and for some fisheries third parties are able to identify the right through the existence of some form of register of quota holders.

Notwithstanding basic similarities in quota regimes, quota rights vary significantly amongst fisheries with regard to transferability, security and the degree of permanence and stability. It could be argued that the highest 'quality' quota rights are those that are: fully transferable, defined in government statute, and can be modified only through a change to the statute — that is, the right does not depend on a renewal process involving administrative decision.

Concerning transferability, not all ITQ fisheries allow transfer of quota permanently, although seasonal transfers are often allowed (occasionally subject to various restrictions). Some fisheries, such as New Zealand, have foreign ownership restrictions, while others, such as Australian Commonwealth fisheries, have no such restriction.

For present purposes, the security of quota relates to the legal mechanism by which quota is created, allocated, and modified. As discussed in more detail in Chapter 5,

quota regimes (including the allocation formula) can be implemented through government statute (i.e., a formal government law), delegated legislation (a lesser form of legislation than a statute, such as a management plan) or government policy. The most secure form of quota right exists: when the quota regime and quota formula are implemented through a government statute, where no additional administrative decision is required for the continued existence of quota, and where government or management changes to quota allocations require a formal change to the statute. Examples of ITQ fisheries that come close to fitting this description include those in New Zealand and the Tasmanian abalone fishery. The next most secure form of quota right involves delegated legislation, as changes to quota regimes so established require a degree of parliamentary scrutiny. The legally least secure form of quota right involves quota issued as a discretionary administrative decision. A discussion on the differences between statutes, delegated legislation and administrative decision is provided in Chapter 5.

In Canada, quota is issued annually as a condition on a licence, and the issuance of licences is an administrative decision at the complete discretion of the Minister. At the other extreme, in New Zealand quota is issued in perpetuity (although, as will be discussed later, this should not be confused with 'forever'). The situation in Australian fisheries is mixed. In the Australian southern bluefin tuna fishery, quota is allocated through delegated legislation and exists until the legislation is changed. In the south east trawl, south east non-trawl and Bass Strait scallop fisheries, quota is allocated as a condition on an annual licence; however, the introduction of delegated legislation is expected for these fisheries.

The situation in Australian State fisheries is also quite varied. In some fisheries quota is issued as an administrative decision and appears as a condition on a licence, whereas in other cases quota is allocated through delegated legislation for a fixed term.

In summary, from a legal perspective, property and property rights are complex terms. While a number of ITQ regimes possess many of the characteristics of property, it would be a mistake to conclude that ITQs offer title that is comparable to ownership of land or a house. Fishing entitlements are created through government legislation, and do not exist outside of that legislation. Some ITQ fisheries provide relatively 'strong' rights, while in other fisheries, rights exist for only a year and are re-issued at the complete discretion of the fisheries minister.

To provide a more complete appreciation of the legal status of fishing entitlements in general, and ITQs in particular, we now turn to an examination of various court cases relating to fishing entitlements. As it is not uncommon for fishers to pay a lot of money for these entitlements it is important to know whether they are buying 'property'. Also, if the government modifies or extinguishes the purchased fishing entitlement, will the courts act to protect the interests of the fisher?

AUSTRALIAN CASE LAW

Two separate, but related, issues are examined with respect to Australian case law. The first issue is whether fishing entitlements are considered to be property, and if so, what kind of property. The second issue concerns questions related to the modification and

extinguishment of fishing entitlements, including the question of compensation. This review also examines two cases on mining leases that provide for interesting comparisons with fishing entitlements.

ARE FISHING ENTITLEMENTS PROPERTY?

This section examines six legal decisions that provide opinions on the question of fishing entitlements and their status as property rights: *Pennington v McGovern*[5], *Kelly v Kelly*[6], *Austell Pty Ltd v Commissioner of State Taxation*[7], *Pyke v Duncan*[8], *Harper v Minister for Sea Fisheries and Others*[9], and *Bienke v. The Minister for Primary Industries and Energy*[10].

In *Pennington v McGovern* the South Australian Supreme Court held that:

> A fishing licence held pursuant to the Fisheries Act 1982 and regulations is a proprietary interest, is capable of being the subject-matter of a trust, and is capable of being transferred. (King CJ)

This case involved a fishing licence in the effort-control managed South Australian central zone abalone fishery. Fishing licences could only be transferred with the consent of the Director of Fisheries. In considering whether to consent to a transfer, the Director was to consider the personal suitability of the proposed transferee, compliance with regulations, the one person/one licence policy, and the absence of suspension of the licence or proceedings against the licence holder. In other words, the licences were not freely transferable, and transfer required official consent. Nonetheless, the Court stated that:

> The provisions of the regulations to which I have referred as to the contemplated value and transferability of the licence and as to the right to hold it notwithstanding that its exercise is subject to the direction and instructions of another [Director of Fisheries], are all, to my mind, indicia of rights of property and I have no difficulty in reaching the conclusion that the rights conferred by the licence are proprietary in character. All forms of property may be the subject of a trust unless the policy of the law or any statutory enactment has made particular property inalienable. (King CJ)

The issue in *Kelly v Kelly* was whether two authorities endorsed on fishing licences issued under the *Fisheries Act 1971 (SA)*, namely a rock lobster authority and an abalone authority, were capable in law of being partnership property. The court held that the fishing licences and the endorsed authorities conferred valuable rights, capable of transfer with the consent of the Director of Fisheries, which possessed a proprietary as well as a personal character, and were capable of becoming partnership assets.

The decision in *Austell Pty Ltd v Commissioner of State Taxation* was similar in effect to that reached in both *Pennington and Kelly*. This case concerned the payment of stamp duty on the transfer of crayfishing licences. Justice Brinsden in the Western Australian Supreme Court held that a licence was of value and capable of being transferred, albeit that the ability to transfer was not one of right but subject to the Minister's consent. In His Honour's view the fact that the transfer of the licence was subject to consent was not an obstacle to the licence and the rights conferred on it being proprietary in nature and coming within the definition of property in the *Stamp Act 1921 (WA)*.

In contrast with the above decisions is a decision by Justice Nathan in the Victorian Supreme Court. In *Pyke v Duncan* the issue was whether licences to dredge for scallops were 'property' which could be seized and sold by the Sheriff to satisfy judgments of the Court issued against Pyke, the holder of the licences. Justice Nathan answered the question in the negative and held that:

> although fishing licences may give proprietorial rights or amount to property for other purposes, these licences did not possess or have inherent within them those characteristics which enabled them to be seized as 'property' by the Sheriff.

The next case is *Harper v Minister for Sea Fisheries and others*. In *Harper* the issue was whether licence fees collected in the Tasmanian abalone fishery represented an excise tax (which if true would have been invalid, as under section 90 of the Australian Constitution only the federal parliament has the power to impose an excise tax). The Court found in this case that the licence fees were not an excise tax.

While this case is largely about commercial licence fees and taxation, it is discussed here because of one of the issues raised in the case was whether licences were a *profit à prendre*[11]. A *profit à prendre* is a form of common law property right. Specifically, the State contended that licence fees were not a tax, but represent a payment for a *profit à prendre*. In other words, a payment for the right to harvest fish from waters over which the state has fisheries jurisdiction. Although the Court had no need to address this argument, having accepted that the licence fee was a royalty, the judgments include observations on the concept of *profit à prendre* in fisheries. Justice Brennan made the following two observations on the *profit à prendre* issue:

> When a natural resource is limited so that it is liable to damage, exhaustion or destruction by uncontrolled exploitation by the public, a statute which prohibits the public from exercising a common law right to exploit the resource and confers statutory rights on licensees to exploit the resource to a limited extent confers on those licensees a privilege analogous to a profit à prendre in or over the property of another.
>
> A fee paid to obtain such a privilege is analogous to the price of a *profit à prendre*; it is a charge for the acquisition of a right akin to property. Such a fee may be distinguished from a fee exacted for a licence merely to do some act which is otherwise prohibited (for example, a fee for a licence to sell liquor) where there is no resource to which a right of access is obtained by payment of the fee.

The three remaining judges were more circumspect in their joint judgment, noting that:

> The right of commercial exploitation of a public resource for personal profit has become a privilege confined to those who hold commercial licences. This privilege can be compared to a *profit à prendre*. In truth, however, it is an entitlement of a new kind created as part of a system for preserving a limited public natural resource in a society which is coming to recognize that, in so far as such resources are concerned, to fail to protect may destroy and to preserve the right of everyone to take what he or she will may eventually deprive that right of all content. (Mason CJ, Deane and Gaudron JJ)

McCamish (1994) commenting on *Harper*, suggests that the Court is much more likely to avoid the issue of *profit à prendre* if it can, noting that:

> It is possible that concepts like "analogy" and "akin to" were used solely to avoid the significant problems which … arise in considering whether a profit à prendre can exist in tidal waters and sea fisheries, especially when there was an easier solution to the issue at hand. But the general tenor of Brennan J's judgment, and more particularly that of Mason CJ, Deane and Gaudron JJ's joint judgment, suggests that the Court will be wary of applying, to modern resource regulation, concepts of a outdated common law.

Finally, consider *Bienke v. The Minister for Primary Industries and Energy*[12]. In *Bienke*,[13] it was argued that a fishing boat licence was analogous to a *profit à prendre* or to a cause of action. Both of these terms refer to types of property rights under common law. However the court did not agree with this argument, and made the following observations:

> a fishing boat licence granted under s.9(2) of the Fisheries Act does not vest in the holder a cause of action under the general law, nor does it create an interest based on antecedent rights recognised by the general law.
>
> Legislation which prohibits the public from exercising a common law right, so as to prevent uncontrolled exploitation of a resource and confers statutory rights on licensees to exploit that resource to a limited extent, might be regarded in one sense as creating a right analogous to a profit à prendre: Harper, at 335. However, the right is not a common law right, but rather a new species of statutory entitlement, the nature of which depends entirely on the terms of the legislation… Thus the fact that the holder of a boat licence, on one view, might have a privilege comparable to a profit à prendre, does not mean that he or she has an entitlement based on antecedent proprietary rights recognised by the general law. (Mason CJ, Davies and Sackville JJ)

In summary, the above cases illustrate two important points with respect to the relationship between property and fishing entitlements. First, for some purposes fishing entitlements have been considered property — for example, as the subject of a trust, as partnership property, and as property as defined in the *Stamp Act 1921 (WA)*. However, as noted in *Pyke*, fishing entitlements may not be considered property for all purposes. Therefore, instead of asking whether fishing entitlements are property or not, it is probably more appropriate to view entitlements as generally proprietary in nature. However, whether these entitlements are considered property by the courts will depend very much on the issues and the wording of the fisheries legislation involved.

Second, one must be careful in making too much of cases that have considered fishing entitlements to be property. As discussed earlier, there are many different types of property, and it would be a mistake to assume that the rights attached are all the same. "Owning" a fishing entitlement is not like owning a piece of land. The decision in *Bienke* did not support the position that fishing entitlements are equivalent to antecedent proprietary rights (such as a *profit à prendre*) recognised by the common law. Fishing entitlements are rights created by government statute, and are best considered a new type of statutory entitlement, the nature of which depends entirely on the terms of the legislation.

To help provide a fuller perspective on the nature of statutory fishing entitlements, the following section examines a number of cases that have involved the modification or extinguishment of fishing entitlements. The related question of compensation is also considered.

MODIFICATION, EXTINGUISHMENT AND ACQUISITION OF FISHING ENTITLEMENTS

AUSTRALIAN FEDERAL CASE LAW

The preceding section showed that Australian courts consider that fishing entitlements, under certain circumstances, are proprietary in nature. Does this mean that they cannot be modified or extinguished by government? Moreover, if entitlements are modified or extinguished, does the common law or a constitutional protection of property rights require government to pay compensation?

Before discussing specific cases, a little legal background is needed. Under section 51(xxxi) of the Australian Constitution, the Commonwealth Parliament has powers to make law with respect to:

> The acquisition of property on just terms from any State or person for any purpose in respect of which the Parliament has power to make laws.

The overwhelming majority of court decisions involving section 51(xxxi) have concerned the acquisition of land or property rights at common law. However, the issue of acquisition of property rights created by statute has received increasing attention, examples include *Tape Manufacturers Association Ltd v The Commonwealth*[14] and *Australian Capital Television Pty Ltd v The Commonwealth*[15].

The first important Australian Commonwealth fisheries case on this issue was *Minister for Primary Industry and Energy v Davey*[16] where the Full Bench of the Federal Court of Australia considered three appeals concerning the Northern Prawn Fishery Management Plan. We will only be concerned with two of the appeals. By way of background, new management arrangements introduced into the northern prawn fishery in 1985 resulted in operators being allocated units of fishing capacity. These units were known as 'Class A' units, and were based on a vessel's underdeck volume and main engine horsepower. A certain number of Class A units were required to use a vessel in the fishery. In addition, to operate a vessel in the fishery an operator also had to have a boat licence which was referred to as a 'Class B' unit. Both types of units were tradeable. A boat replacement and buy-back policy was introduced to remove capacity from the fishery. However, continued concerns over tiger prawn stocks and industry profitability prompted the Commonwealth Government to implement a compulsory 30.76% reduction in the number of Class A units held by each fishery on 1 April 1993. After the compulsory reduction, fishers would hold insufficient A units to use their vessel in the fishery and would therefore need to (1) purchase additional A units (2) if they held more than one vessel, assign A units from one vessel to another (3) reduce the vessels engine power and/or (4) sell their remaining A units and cease fishing.

The compulsory reduction was challenged in court[17], which found that the compulsory reduction constituted an acquisition of property other than on just terms, and was therefore contrary to the limitation on the Commonwealth's power contained in section 51 (xxxi) of the Constitution. The Commonwealth appealed the decision[18], claiming (amongst other things) that there was no acquisition of property because no

person obtained any units or any other form of property, and secondly, that the rights in the units were always subject to the Northern Prawn Management Plan, as amended from time to time.

With regard to the first argument, Chief Justice Black and Justice Gummow assumed that the units were 'property' for the purposes of section 51 (xxxi), and then argued that for an acquisition to have taken place:

> It is necessary, therefore, to identify the proprietary benefit enjoyed either by the Commonwealth or by a third party as a consequence of the acquisition.

A number of court decisions were provided to suggest that the mere extinction or diminution of a property right does not necessarily result in acquisition — the Commonwealth or others must acquire an interest in property (even if only by means of a "circuitous device"). In this case, Chief Justice Black and Justice Gummow were not able to identify a proprietary benefit enjoyed either by the Commonwealth or by a third party as a consequence of the compulsory reduction in units, arguing that:

> All the fishermen are in the same position. It may be the case, (and it should be emphasised that what was urged here by the respondents was but a forecast as to economic consequences), that after the compulsory restructuring, and subsequent market rationalisation of units, some operators, in particular the larger corporate operators, will end up with a larger share of the fishery's capacity. Nevertheless, this advantage would arise principally from the survivors' greater ability to purchase extra units, effectively buying-out their competitors, and would stem from their own initiative, and market forces, rather than any acquisition by means of the Commonwealth law.

The second submission by the Commonwealth was that no rights were taken away from fishers because the rights to units were always subject to amendments to the management plan. This argument is somewhat more fundamental than the first submission. Clearly, if units are found to be subject to alteration by the Minister, then no acquisition could have occurred in the first place. The decision noted that:

> units may be transferred, leased and otherwise dealt with as articles of commerce. Nevertheless, they confer only a defeasible[19] interest, subject to valid amendments to the N.P.F. Plan under which they are issued. The making of such amendments is not dealing with the property; it is the exercise of powers inherent at the time of its creation and integral to the property itself. Paragraph 20B of the N.P.F. Plan [the compulsory reduction paragraph] confers no proprietary benefit upon the Commonwealth or a third party. And instead of taking away something the fishermen possessed, it merely alters the statutory creatures in accordance with the statutory scheme creating and sustaining them. (Black CJ and Gummow J)

The NPF restructuring plan was revisited by the Federal Court in *Bienke v the Minister for Primary Industries and Energy*[20]. Similar to *Davey*, Bienke claimed that the compulsory restructuring program embodied in the NPF Management Plan was a device for compulsorily acquiring property, not on just terms. In this case, it was the compulsory reduction of the Class B unit (the boat licence) rather than the Class A units that were the subject of acquisition. The court reaffirmed the Davey decision, finding that neither the Commonwealth nor a third party had acquired any proprietary interest, and noted that:

> In short, the permission granted by the fishing boat licence… was inherently susceptible of modification or even extinguishment, depending upon amendments to the NPF Plan.

AUSTRALIAN STATE CASE LAW

This section examines three cases heard in the State courts relating to fishing entitlements and property acquisition.

In *Gasparinatos v The State of Tasmania*[21], the Tasmanian Supreme Court considered the issue of whether there had been an acquisition of property in the Tasmanian abalone fishery. The Tasmanian abalone fishery is managed by individual quotas issued through Deeds of Agreement authorised under the *Fisheries Act 1959*. Under his Deed of Agreement, the plaintiff (Gasparinatos), could take 34 abalone quota units a year for commercial purposes. Each unit was worth 1/3500th of the TAC.

Subsequent to the establishment of the Deeds of Agreement, the Minister established a new, temporary fishery for 'undersized' abalone in specific areas of State waters (where abalone experienced much slower growth rates). New licences were issued for the temporary fishery. Although the case concerned a number of issues, one of the claims Gasparinatos made was that there had been an acquisition of his property without compensation. His argument was that the Deed of Agreement granted him the right to take a fixed proportion of the TAC for all abalone taken lawfully in State fishing waters. Gasparinatos argued that the Minister had, in effect, increased the total allowable catch by allowing a temporary fishery for "stunted" abalone. He claimed that failure to grant him a portion of this increased TAC amounted to an acquisition of his property and therefore compensation should be paid. The court held that there was no acquisition as the Deed of Agreement gave Gasparinatos a proprietary interest in a fixed proportion of the abalone TAC as stated in Regulation 39D (2,100 tonnes) but not a proprietary interest in *all* abalone lawfully taken in state waters. Thus it was possible that abalone could be taken in addition to the TAC.

In Consolidated *Abalone Divers Group Inc v The Department of Fisheries of NSW*[22], the Australian Supreme Court of New South Wales (Administrative Law Division) examined whether the introduction of new management arrangements in the New South Wales abalone fishery, and the consequent allocation of quota shares involved an acquisition of property without compensation. The facts of the case are as follows. In 1985, a two-for-one scheme was introduced which required any new entrant into the fishery to obtain two 'original' permits. In turn both original permits were surrendered and the new entrant was issued with a consolidated permit. A new entrant could also enter the fishery by purchasing a consolidated permit. The consolidated permits were twice the value of the original permits. Management arrangements were changed with the introduction of the 1994 *Fisheries Management Act*. Specifically, the abalone fishery was termed a Commercial Share Management Fishery and permit holders would, after a four stage process, become shareholders each allocated 100 provisional shares. The two-for-one scheme was scrapped.

In response to the management changes, the Divers Group claimed that allocation of shares should have taken into account existing entitlements (which included the ability of consolidated permit holders to sell their permits for twice as much as original permit holders) and their expectation that as the number of permit holders decreased through the two-for-one scheme their quota shares would increase. The court found that, because there were a limited number of endorsements, this was a semi-monopoly such that an endorsement could be considered a proprietary right. However, the decision to abolish the two-for-one scheme was not considered to be a destruction of proprietary rights without compensation because:

> The consolidated licensees do not lose their endorsements or their right to fish for a quota of the TAC. Their capital asset (right to sell their endorsement) is likewise not lost, it can still be sold as previously. The plaintiffs' argument amounts to no more than that its value is reduced, but there are a number of other factors that may lead to its value being reduced. (Dunford J)

Finally consider *Alesios & Ors v Stockdale & Anor*[23] which involves compensation for scallop licences that were cancelled in order to close Port Phillip Bay to scallop fishing. The decision noted that:

> It has long been established that a statute will not be construed to take away property without compensation unless the statute says so unequivocally… …The purpose of the common law principle of compensation is to protect the rights of subjects and the principle is to be scrupulously defended" by the courts… …Such principle, however, will not avail the plaintiffs unless the licence is proprietary in nature (Cummins J)

After reviewing a number of cases (including *Harper*, *Pennington*, *Bienke*, and *Davey*) and examining the *Fisheries Act 1968*, Justice Cummins concluded that:

> I consider that s.14(1)(b) licence for dredging for or taking scallops for sale is proprietary in nature. It thus attracts the basal common law principle of full compensation upon cancellation.

In summary, most of the above Australian Commonwealth and State cases suggest that while fishing entitlements may be considered proprietary in nature, the very nature of the legislation creating these entitlements explicitly recognises that such entitlements are subject to modification and extinguishment. As noted by Justices Black and Gummow with respect to the reduction of capacity units in the NPF restructuring:

> instead of taking away something the fishermen possessed, it [the compulsory reduction] merely alters the statutory creatures in accordance with the statutory scheme creating and sustaining them.

Other than *Alesios*, most of the above decisions raise serious questions about the ability of fishers to successfully demand compensation if fishing entitlements (including ITQs) are modified or extinguished. This issue will be discussed further after a review of Australian court cases involving mining leases (that are similar in a number of ways to fishing entitlements), and a review of a few international court cases concerning fisheries.

MINING AND PETROLEUM CASES: ACQUISITION ON JUST TERMS

There are two Australian mining cases on property acquisition on just terms that may be relevant to ITQ fisheries. These cases have been selected because, at least from a lay person's perspective, there are many similarities between government regulation with respect to the exploitation of mineral, petroleum and fisheries resources. Consequently, it is interesting to view court decisions concerning the acquisition of mining and petroleum entitlements.

Newcrest Mining (WA) Ltd v The Commonwealth[24] concerns losses associated with mining leases due to the creation of Kakadu National Park. The facts of the case are as follows. Newcrest held mining leases which were affected by two proclamations made under the *National Parks and Wildlife Conservation Act 1975 (Cth)*. Under the proclamations, the areas of the Company's mining leases were added to and included in Kakadu National Park. Prior to the making of these proclamations, the *National Parks and Wildlife Conservation Amendment Act 1987 (Cth)* had amended the Act by banning mining operations in the National Park.

In a majority decision, the Australian High Court found that with respect to a number of Newcrest's mining leases, the proclamations made under the Conservation Act were invalid:

> to the extent it effected acquisitions of property from Newcrest Mining (WA) Limited other than on just terms within the meaning of s.51(xxxi) of the Constitution of the Commonwealth.

In other words, the legislative amendments affecting Newcrest's mining leases were found to involve an acquisition of property.

In light of other court decisions outlined in this chapter which suggest that statutory entitlements are inherently subject to modification and extinguishment, it is interesting to review the decision of Justice Gummow, as it explicitly refers to fishing entitlements. Justice Gummow noted that this [*Newcrest*] was not a case involving:

> rights derived purely from statute and of their very nature inherently susceptible to the variation or extinguishment which had come to pass… …The Commonwealth had acquired radical title in the sense known to the common law and thereafter the Commonwealth dealt with the subject land in exercise of its rights of dominion over it. This involved the use of statute to carve out interests from the particular species of ownership enjoyed by the Commonwealth… It is not correct, for the purposes of the application of s.51(xxxi), to identify the property held by Newcrest as no more than a statutory privilege under a licensing system such as that considered in such decisions as *Minister for Primary Industry and Energy v Davey*[363] and *Bienke v Minister for Primary Industries and Energy*.

In other words, Justice Gummow felt that a mining lease, which is a statutory entitlement that allows for the extraction of mineral resources, is different from a fishing statutory entitlement permitting the extraction of fish resources, because the mining lease is based on the government holding a fee simple title over the land. By comparison

a fishing entitlement is a licensing system created by federal legislation, where no property interest previously existed.

Commonwealth of Australia v WMC Resources[25] is similar to Newcrest in that it involves the modification of petroleum exploration leases that resulted in a reduction in the size of the area that could be explored. This case concerned petroleum exploration permits issued to Western Mining Corporation (WMC) in the area of the East Timor Sea, known as the Timor Gap. Exploration permits allowed the holder to explore for petroleum, and to carry on such operations and execute such works as are necessary for that purpose, in the permit area. The leases were valuable and transferable. In 1991, Australia and Indonesia signed a treaty concerning the Timor Gap. While each country maintained its sovereign rights over the area, the Treaty designated the Timor Gap as a Zone of Cooperation, and divided the Gap into Areas A, B and C. Australia and Indonesia exercised joint control over petroleum exploration and exploitation in Area A. As a result of legislative changes needed to implement the Treaty, WMC's permit was modified, so exploration within Area A was no longer permitted.

WMC argued that there had been an acquisition of property and wanted compensation. The Federal Court[26] and a majority of the Full Court of the Federal Court[27] found that there had been an acquisition of property with respect to section 51(xxxi). However on appeal, a majority (four to three) of the High Court found that, while exploration permits issued under the *Petroleum (Submerged Lands) Act 1967 (Cth)* were proprietary rights, the modification or extinguishment of these permits did not result in an acquisition of property under section 51(xxxi) of the Constitution.

Justice Gaudron found that although the legislation had deprived WMC Resources Ltd of a valuable right of exploration it had not conferred any advantage on the Commonwealth or any other person. Justice Gummow similarly found that the scope and incidents of the exploration permit were subject to the legislation in whatever form it assumed and that any proprietary rights created in respect of the permit were liable to defeasance.

Justice McHugh went further to say that:

> A property interest that is created by federal legislation, where no property interest previously existed, is necessarily of an inherently determinable character and is always liable to modification or extinguishment by a subsequent federal enactment. Section 51(xxxi) therefore does not ordinarily withdraw from the Parliament the authority to use another s.51 power to revoke or amend legislation that has been passed under that power, even when the legislation has created a property right. The fact that the Commonwealth or some other person might be viewed as benefiting from the alteration or revocation is irrelevant.

Notwithstanding these comments, some of the judges' comments are worth noting. First, Chief Justice Brennan did not rule out the possibility that section 51(xxxi) could apply to statutory rights that have no basis in common law, stating:

> I agree that, where a purely statutory right is by nature susceptible of modification or extinguishment, its modification or extinguishment works no acquisition of property. But, in my respectful opinion, it does not follow that a law of the Commonwealth which extinguishes purely statutory rights having no basis in the general law can never effect

> an "acquisition of property" within s.51(xxxi). If statutory rights were conferred on A and a reciprocal liability were imposed on B and the rights were proprietary in nature, a law extinguishing A's rights could effect an acquisition of property of B. In the present case, where the rights of the permittee and of WMC, though created by statute, are properly to be regarded as proprietary in nature, a Commonwealth law which purported to effect a compulsory transfer of those rights to a third party would be a law for the acquisition of property.

Secondly, Justice Gaudron noted that:

> It may well be that if, after the discovery of petroleum, an exploration permit were extinguished or modified with the consequence that the right to apply for a lease or production licence was destroyed or otherwise negated, that would constitute an acquisition for the purposes of s.51 (xxxi) of the Constitution. In that situation, some benefit with respect to that petroleum would accrue to the Commonwealth or, perhaps, to the authority charged with the grant of leases and production licences. And that would also be the case if an exploration permit were modified or extinguished with the consequence that the holder of a permit were denied a lease or production licence to which it was otherwise entitled. But none of those considerations apply in this case.

These quotes suggest that there are still a number of important and unresolved questions with regard to the legal standing of statutory fishing entitlements.

CASE LAW FROM OTHER COUNTRIES

The following court cases from New Zealand, the United States and Canada examine issues related to fishing entitlements, property rights and acquisition.

NEW ZEALAND

New Zealand Fishing Industry Association and Others v Minister of Fisheries and Others[28] was heard by the Court of Appeal of New Zealand and involved a number of issues related to commercial fishing for snapper. A primary issue dealt with an appeal by industry over a 39% reduction in the total allowable commercial catch (TACC) for the 'Snapper 1' management area.

In this case, the court noted that:

> While quota are undoubtedly a species of property and a valuable one at that, the rights inherent in that property are not absolute. They are subject to the provisions of the legislation establishing them. That legislation contains the capacity for quota to be reduced. If such reduction is otherwise lawfully made, the fact that quota are a "property right", to use the appellants' expression, cannot save them from reduction... Of course, if the Minister is considering any reduction in TACC with a consequential reduction in quota, he must carefully weigh the economic impact of what he proposes to do both on individual quota holders and on the QMS [quota monitoring system] generally. That is a given, but it would not be consistent with the capacity to reduce quota to hold that the property rights inherent in the QMS afford any kind of absolute protection from reduction. Thus the Minister was not in our judgment acting unlawfully simply by dint of the fact that his decision reduced the property rights inherent in the quota system.

The court decision also provides some insight into the possibility that the value of the commercial sector's ITQ entitlements could be eroded over time through reductions in commercial TACs required to satisfy recreational demand:

> If over time a greater recreational demand arises it would be strange if the Minister was precluded by some proportional rule from giving some extra allowance to cover it, subject always to his obligation carefully to weigh all the competing demands on the TAC before deciding how much should be allocated to each interest group.

CANADA

Under Canadian fisheries legislation the Minister of Fisheries has absolute discretion with respect to the issuance of fishing entitlements. In both effort and ITQ managed fisheries, entitlements are generally annual permits, with no guarantee of renewal. Quota is a condition on this annual permit.

In *Joliffe et al. v The Queen*[29] the plaintiffs, in 1979, owned a fishing trawler that had the following fishing licences: Salmon "A" licence, a Groundfish Trawl licence and a West Coast Shrimp licence. In the autumn of 1979 they commissioned construction of a new vessel designed primarily for purse-seine salmon fishing, and requested that the Department of Fisheries transfer their licences to the new vessel under construction. On November 19, 1979 the Department notified the plaintiffs that their request had been approved. However on January 18, 1980 new regulations were adopted which restricted the harvest of salmon by purse-seining to vessels that had a catch history of salmon purse-seining during 1975 and 1976 and before July 28, 1977.

As the plaintiffs had not landed salmon by purse seine with their vessel over the qualifying period, the Department notified them that their new vessel would be licensed for "salmon by other than seine". The plaintiffs submitted an application for their three licences to be issued to their new vessel, and in both 1980 and in 1981 the plaintiffs were issued a Salmon "A" licence that contained no express limitations with respect to purse-seine fishing. However, the 1982 licence did expressly restrict purse-seining for salmon.

The plaintiffs argued that their fishing licence was in the nature of intangible property which has a commercial value and which cannot be altered or revoked except for reasons stated in the *Fisheries Act* or in the Regulations (and that those conditions were not relevant in the case). In addition, they argued that the January 18, 1980 regulation could not take away rights already vested by the prior issuance of a licence. In his decision, Judge Strayer found that:

> By sections 34 and 37 of the Regulations, licences are valid for one year only and expire each year as of March 31. By section 7 [of the Fisheries Act] the Minister has an "absolute discretion" in the issuance of new licences. Therefore there is no legal underpinning for the "vesting" of a licence beyond the rights which it gives for the year in which it was issued. The interest vested in a licence-holder is subject to modification by validly enacted laws. This is similar to the application of municipal building by-laws in a way which impairs rights previously enjoyed by land owners.

A similar conclusion was reached in *Bennett v Bennett*[30] a case that involved the determination of whether a roe herring licence was property as defined in the *Bankruptcy Act*. The court held that a fishing licence was property within the definition of property in the Act, but that the property interest only lasted for the year that the licence was issued. Furthermore, the court held that there was no automatic right of renewal and that granting of new licences was purely discretionary, although for historical reasons Mr Bennett may have a better chance to obtain a licence, this did not give him a "higher legal right" *vis à vis* anyone else.

The decision was reaffirmed in *Smith v. Humchitt Estate*[31] although the facts were different. Humchitt had agreed to lease his Category "H" roe herring licence to Smith, automatically, for 99 years in return for C$15,000. Under a power of attorney, Smith was authorised to apply for the licence each year on Humchitt's behalf. When Humchitt died, both Smith and Humchitt's son applied for a herring licence. The Minister issued the licence to Humchitt's son, and Smith took the matter to court. The court found that the lease agreement and power of attorney were unenforceable. Specifically, Judge Hinds ruled that:

> A category H roe herring gill net licence is personal to the holder of the licence and cannot be transferred, although an agreement to lease such a licence is a legal agreement. The licence expires at the end of the calendar year for which it is issued regardless of whether the licence holder is dead or alive on that date. There is no legal right of renewal. The issuance of a licence by the Department of Fisheries is a purely discretionary matter, with an absolute discretion being vested in the minister under s.7 of the Fisheries Act. Any "beneficial interest" in L.'s licence ceased to exist after 1986 because there was no vested right of renewal. Once the minister authorized the issuance of a 1988 licence to L.'s son, the subject matter of the lease agreement ceased to exist and the agreement became unenforceable.

The final case to be considered is *Timothy Joys v. Minister of National Revenue*[32]. Although the details of the case are not relevant, the following quote from the Canadian Federal Court of Appeal is worth noting:

> It is clear law that a fishing licence is a privilege granted by the Minister and in the renewal of which the licence holder has no vested right.

UNITED STATES

Sea Watch International et al. v Mosbacher[33] only obliquely refers to modification and extinguishment of ITQ entitlements, and is discussed in more detail in Chapter 5 on Quota Allocation. The case concerns quota allocation in the Mid-Atlantic and New England surf clam and ocean quahog fishery. While the judgment does not explicitly deal with the issue of whether ITQs are property, the court decision does state that ITQ rights exist only as long as the statute which created the right, and that these rights are subject to modification or extinguishment:

> Plaintiffs have selected excerpts from statements made during the administrative proceedings in which defendants themselves have applied the term "property right" or similar labels to the ITQs...When examined in full, most of these quotations indicate

> that the property analogy was employed with an appropriate qualification. E.g., AR 1759 ("Amendment 8 implies that [ITQs] are property in that they are 'owned' and can be sold, similar to a share of stock, at least so long as the management scheme creating the rights is in place.") Further, the Council's mere expressions of hope that the Amendment 8 regime would provide a lasting solution do not in themselves exclude the possibility of later re-evaluation and revision of the regulations.

The court made another interesting point:

> If the Council and the Secretary determine that the quotas are not being used, nothing prevents them from altering the present regime to allow distribution and use of any unused quotas.

In contrast, the second US case to be examined is *Foss v National Marine Fisheries*[34]. This case involves the introduction of ITQs into the halibut and sablefish fishery. While the details of the case are not relevant for present purposes, the appeals court made the following notable comments:

> The threshold question is whether Foss has a constitutionally protectible property interest in acquiring an IFQ permit, i.e., "a legitimate claim of entitlement" as opposed to a "unilateral expectation" or an "abstract need or desire for it." Roth, 408 US at 577 (1972). There can be no doubt that the IFQ permit is property. It is subject to sale, transfer, lease, inheritance, and division as marital property in a dissolution… …We hold that, for procedural due process purposes, Foss has a protectible property interest in receiving the IFQ permit.

In summary, it is difficult to generalise about fishing entitlements and their relationship to issues such as property rights, modification, extinguishment and compensation. Fishing entitlements are created through government legislation, and therefore their identity is very much defined by the wording in the statute through which they came into existence. Different statutes create different entitlements. Nonetheless, as there are commonalities that flow through many of the cases discussed the objective of this section is to explore a few of these common threads.

ARE FISHING ENTITLEMENTS PROPERTY RIGHTS?

As noted earlier, the economic literature on fisheries contains numerous references to the argument that a lack of property rights in fisheries is the underlying problem that generates the open access symptoms of overcapacity and overexploitation. Not surprisingly, a number of economists have suggested that the elimination of open access through the allocation of 'strong property rights' in fisheries would serve to mitigate these two negative concerns. The allocation of transferable quota in perpetuity is seen as proffering on fishers a strong right that has, in many cases, resulted in more efficient harvesting and the adoption of more responsible fishing practices.

However, when one uses terms such as 'property rights' and 'in perpetuity' it is best to move away from economics, and examine the relationship between fishing entitlements and property from a legal perspective. Debates amongst economists, conservationists, fisheries managers, fishers and others concerning ITQs, property rights and the privatisation of fisheries are frequently, at least from a legal perspective,

uninformed. It is law that is of central importance in understanding the legal implications of ITQ systems.

Some forms of fishing entitlements, including some ITQ regimes, have many of the characteristics of property, and a number of judgements have considered fishing entitlements to be proprietary in nature. However, it would be a mistake to conclude that fishing entitlements entail a spectrum of rights that fall anywhere close to the ownership rights that apply to one's land or personal property. Fishing entitlements are rights created by government as means of regulating the fishing industry. By removing the legislation creating the entitlement , the entitlement no longer exists. By modifying the legislation, the entitlement is redefined. In addition, most fisheries legislation we have examined is written to allow administrators substantial discretion with respect to modifying entitlements even without a change in legislation. All of the court cases examined above accept this position.

Of course, at the end of the day, governments can introduce legislation or change constitutions in order to extinguish or modify rights with respect to any form of property. However, the modification of statutory fishing entitlements is an everyday practice, not a theoretical possibility. Fishing entitlements that are issued annually (and modified even more frequently) at the discretion of a government minister or fisheries manager are, from a legal perspective, very weak rights.

Notwithstanding their vulnerability to be modified or extinguished, fishing entitlements are legally considered 'property' for some purposes. For example, once an annual fishing licence is issued, and before it expires, it may be deemed to be proprietary in nature with respect to some property-related legislation (e.g. stamp duties), and it may be possible to enter into enforceable commercial transactions with the licence (see *Pennington*). However, as illustrated in *Humchitt*, the right might only lasts for the duration of the licence. This means that commercial transactions involving the licence may not be enforceable after the licence expires. This would likely be the case in ITQ fisheries were the quota is merely a condition on an annual licence. In fisheries where quota is created and allocated by means of delegated legislation or by an act of Parliament, the quota entitlement is a stronger right because it requires more than administrative discretion to extinguish the right. However, as noted in the US and New Zealand cases, even quota created and allocated through legislation may be subject to a great deal of administrative discretion.

While fishing entitlements are often legally 'weak' rights, fishers often place a high value on their entitlements. In some sense this is not surprising. Entitlements are often renewed automatically, and if entitlement numbers need to be reduced, government sponsored buy-back schemes are frequently used, rather than using ministerial discretion to not renew all entitlements. Therefore, governments often treat fishing rights as if they are strong property rights[35]. However, this is more a case of politics than law. Fishers need take into consideration what the legislation and courts say, and not base their expectations solely on what has been practised historically.

ARE FISHING LICENCES COMPARABLE TO OTHER FORMS OF STATUTORY ENTITLEMENTS?

Most governments create various forms of statutory entitlements such as taxi licences, petroleum exploration permits, mining leases, patents, and fishing licences. In many cases these entitlements are transferable and acquire considerable value. The underlying rationale for the creation of such entitlements is not always the same, and the legislation defining entitlements varies. Nonetheless it is interesting to briefly examine how the Australian courts have differentiated fishing entitlements from mining and petroleum entitlements.

From one perspective, fishing, petroleum and mining entitlements are similar — they are rights-based instruments created by government, through statute, to solve problems that arise from unregulated harvesting of open-access natural resources. When everyone is allowed unfettered access to harvest natural resources, there exist inherent pressures for the creation of over-capacity and over-exploitation. Of course, governments could harvest fish, petroleum and mineral resources directly, without the aid of the private sector. But in most cases, governments play a management and enforcement role over public natural resources, and restrict access through the issuance of licences, permits or leases. Access entitlements are generally for a fixed period, sometimes they are renewable, and often they acquire value (especially if transferable). After being granted an entitlement, holders frequently invest substantial funds in order to explore for and extract resources.

However, a number of court decisions discussed in this chapter have concluded that fishing entitlements are different to petroleum exploration permits and mining leases. In *Newcrest*, the Australian High Court considered a mineral lease to be proprietary in nature with respect to section 51(xxxi) of the Australian Constitution, with their acquisition (at least under the circumstances of that case) attracting "just terms". The next section explores this issue in more detail.

DO HOLDERS RECEIVE COMPENSATION IF FISHING ENTITLEMENTS ARE MODIFIED OR EXTINGUISHED?

We are not aware of a successful court case involving the claim by fishers of government (or third party) acquisition as a result of government modification or extinguishment of their fishing entitlements. Most, if not all, fisheries legislation allows for the modification and extinguishment of licences under certain circumstances, and as indicated earlier, many fishing entitlements lapse after a fixed period.

However, would the common law or a constitutional guarantee require compensation payments if a fishing entitlement were modified or extinguished during the period prior to the entitlement's termination date? Of course, one cannot know the answer to this question until it is tested in the courts. The answer would likely depend on the circumstances and legislation surrounding the case. However, *Newcrest* and *WMC Resources Ltd* raise some interesting issues.

In *Newcrest*, the modification of mining leases was seen to involve an acquisition of property on other than just terms. While mining and fishing entitlements have many similarities, Justice Gummow saw a difference, arguing that it was not correct to identify Newcrest's property interest as no more than a statutory privilege under a licensing system as in the fisheries cases of *Davey* and *Bienke*. Mining leases in Newcrest, unlike fishing entitlements, were carved out of radical title known to the common law. However, this raises questions related to *WMC Resources Ltd*. In *WMC Resources Ltd* the petroleum leases involved not land, but waters beyond Australia's territorial sea (which is the same as for many fishing entitlements).

While a majority of the Court argued that there had been no acquisition in *WMC Resources Ltd*, three of the seven opinions argued for acquisition, and one of the no-acquisition opinions (Justice Gaudron) stated that:

> It may well be that if, after the discovery of petroleum, an exploration permit were extinguished or modified with the consequence that the right to apply for a lease or production licence was destroyed or otherwise negated, that would constitute an acquisition for the purposes of s.51(xxxi) of the Constitution.

Additionally, with respect to acquisition of statutory entitlements that have no basis in the common law, another of the no-acquisition opinions (Justice Brennan) is worth repeating:

> I agree that, where a purely statutory right is by nature susceptible of modification or extinguishment, its modification or extinguishment works no acquisition of property. But, in my respectful opinion, it does not follow that a law of the Commonwealth which extinguishes purely statutory rights having no basis in the general law can never effect an "acquisition of property" within s.51(xxxi). If statutory rights were conferred on A and a reciprocal liability were imposed on B and the rights were proprietary in nature, a law extinguishing A's rights could effect an acquisition of property of B.

This raises the possibility of challenging a move from effort controls to ITQs if the allocation formula results in a *significant* and *avoidable* redistribution of wealth. Consider the case of a fishery that is managed by transferable effort units (that acquire value and are basically the currency of the fishery). Assume that it is decided to move to ITQs because the individual transferable effort (ITE) regime is not working. Suppose that there were three fishers in the fishery and that the value of transferable effort units held by fishers A, B and C were $200,000, $500,000 and $1 million, respectively, on the day prior to the introduction of ITQs. The next day when quota is allocated assume that the value of the quota entitlements held by A, B and C were respectively $800,000, $500,000 and $400,000. Appealing to the logic in the above quote by Justice Brennan, one could argue that there had been a third-party acquisition of property — specifically, A's gain was at the direct expense of C's loss. Would this situation involve a third-party acquisition of property even though the fishing entitlements were created by statute? This issue is picked up again in the discussion on quota allocation in the following chapter.

The case that modifications to effort-control regimes also can result in third party acquisition is much weaker. Effort-control management, by its very nature, frequently

results in incidental and unavoidable transfers of wealth amongst fishers. For example, in a fishery comprised of both trawl and hook licences, it may be decided to close specific areas to fishing in order to protect the spawning biomass. If the trawl sector previously concentrated its harvest in the closed area, then its catches would fall and the catch in the hook sector would probably increase. The change in management policy has increased the wealth of one sector, and correspondingly reduced economic well-being in the other. Effort controls by their nature often have significant incidental impacts on the relative wealth position of licence holders. This is analogous to changes in taxes or interest rate policy, both of which can incidentally impact on the relative economic standing of various sectors and individuals within the economy. The 'wealth' impact of these various policy changes is incidental to government achieving various social or economic objectives.

When it comes to ITQs, the story is rather different. Under ITQs, if there is concern about the impact of a particular gear sector, on say the spawning biomass, then areas can be closed or the amount of the offending gear in the water can be reduced. However, licence holders in the offending gear sector still hold their quota. In addition, they may have the option of selling their quota or changing the gear that they use. In this case the underlying problems can be dealt with by means other than directly impacting on relative entitlement holdings.

This illustrates a major difference between effort controls and ITQs. Changes in wealth distribution under effort controls are a fact of life. Under ITQs, such redistribution becomes less necessary (for economic efficiency and ecological reasons) and more transparent (when implemented for vested-interest motives).

Statutory compensation

The preceding section has discussed how the courts have viewed the issue of compensation if a fishing entitlement is extinguished or modified. However there may also be provisions in fisheries and non-fisheries statutes which allow for compensation to be payable if a fishing entitlement is modified or extinguished because, for example, a marine park is declared.

Fisheries legislation itself might detail circumstances where compensation might be payable. For example, in Victoria, under s.63 of the *Fisheries Act 1995*, compensation is payable for any financial loss suffered as a consequence of the cancellation of an access licence by the Minister (excluding cancellation for non-compliance reasons). The Act also makes provision for compensation to be payable to scallop licence holders in Port Phillip Bay, when this was closed to scallop dredging. Under the Commonwealth *Fisheries Management Act 1991*, if a management plan is revoked, and for example, the area of the fishery is reduced, there is no provision for compensation. Instead, the holders of Statutory Fishing Rights (SFRs) under the revoked management plan are entitled to a Statutory Fishing Right option (s.31A). This entitles the holder to be granted statutory fishing rights under any new plan, based on the number of SFRs they held under the old plan.

Non-fisheries legislation may also have important implications for fishing entitlements. For example, environment legislation could create marine parks where fishing is not permitted, or where fishers are required to apply for new entitlements. Under s.8 of the Commonwealth *National Parks and Wildlife Conservation Act 1975*, regulations can be made to control fishing in areas proclaimed a marine park or reserve. In practice, this has meant that fishers are required to obtain a permit from Environment Australia in addition to any permits required by AFMA.

In Western Australia, there is specific legislation to deal with the situation where, rather than requiring an additional permit, fishers are prohibited from fishing in areas declared as marine parks or reserves. The objective of the *Fishing and Related Industries Compensation (Marine Reserves) Act 1997* is to provide compensation to holders of leases, licence and permit holders granted under the *Fish Resources Management Act 1994* and the *Pearling Act 1990* if a marine nature reserve or marine park is created under the *Conservation and Management Act 1984*.

ENDNOTES

1 Common law is also known as the general law.
2 As stated by Bentham (1931) "property and law were born and die together. Before laws were made there was no property; take away laws and property ceases."
3 Although a simplification, remedies can be thought of as the legal actions one can take to 'protect' one's property.
4 The leading cases are *National and Provincial Bank v Ainsworth* [1965] AC 1175 at 1247–48 and *R v Toohey; Ex parte Meneling Station Pty Ltd* (1982) 158 CLR 327
5 (1987) 45 SASR 27
6 (1989) 50 SASR 477
7 (1991) 4 WAR 235
8 (1989) VR 149)
9 (1989) 168 CLR 314
10 *Bienke v Minister for Primary Industries and Energy* (1995) 63 FCR 567
11 A *profit à prendre* is a right to take part of the soil, minerals, natural produce including fish and wild animals. The person does not own the subject of the thing gathered whilst it is on the land, but has a right to gather it. Usually a licence is granted to the holder of a *profit à prendre* to allow the person to enter the land (Gray, 1991).
12 (1995) 63 FCR 567
13 More details of the case can be found later in this chapter under the section: *Modification, extinguishment and acquisition of fishing entitlements: Australian federal case law*
14 (1993) 176 CLR 480
15 (1992) 177 CLR 106
16 (1993) 47 FCR 151
17 *Davey v The Minister for Primary Industries and Energy* (1993) 40 FCR 286
18 (1993) 47 FCR 151
19 A defeasible interest is an interest which can be defeated, revoked or annulled.
20 *Bienke v Minister for Primary Industries and Energy* (1995) 63 FCR 567
21 (1995) 5 TAS R 301
22 BC9801814, 15 May 1998
23 No. 6197 of 1997, unreported 15 April (1998)
24 (1997) 71 ALJR 1346
25 *The Commonwealth v WMC Resources Limited* (1998) 194 CLR 1

26 *Western Mining Corporation Ltd v The Commonwealth* (1994) 50 FCR 305
27 *The Commonwealth v Western Mining Corporation Ltd* (1996) 67 FCR 153
28 CA82/97
29 (1986) 1 F.C. 511 (F.C.T.D)
30 (1988) 24 B.C.L.R. (2nd) 346 (B.C.S.C.)
31 (1990) 48 B.C.L.R. (2nd) 361 (B.C.S.C)
32 (A-467-94)
33 762 F. Supp. 370 (D.D.C. 1991)
34 US 9th Circuit Court of Appeals, No. 97-36097
35 However, examples of "use it or lose it" policies are also not difficult to find with respect to government's attitudes to fishing entitlements.

5 QUOTA ALLOCATION

Quota allocation to individual fishers is probably the most contentious issue facing managers and industry when introducing ITQ management. The allocation formula selected has a major economic impact on pre-ITQ entitlement holders and possibly others directly and indirectly involved with the fishery, such as harvesting crew, the processing sector, and fishing communities. Fisheries management is often probably more about "who gets what" than is it about over-capacity and over-exploitation issues. The move to ITQ, which requires an explicit and transparent allocation of wealth, brings this vested-interest aspect plainly to the surface.

As an introduction to the topic of quota allocation, this chapter illustrates the various types of allocation formulæ used in a number of different fisheries. This is followed by an examination of various court cases that have arisen in response to the introduction of ITQs, including challenges to allocation formulæ.

ALLOCATION FORMULÆ

As illustrated in the examples given in Table 3, there is no standard quota allocation formula. In some fisheries, equal allocations were made to all participants, while in other fisheries, allocations were based solely on catch history or various combinations of catch history, fishing days, vessel size, investment, and vessel capacity.

TABLE 3
EXAMPLES OF ALLOCATION FORMULÆ USED IN VARIOUS FISHERIES

Country and fishery	Components of allocation formulæ
Australian southern bluefin tuna	Catch history and vessel investment
Australian south east trawl	Catch history and effort unit entitlements
South Australian rock lobster	Pot holdings
Canadian west coast halibut	Catch history and vessel length
Icelandic demersal, lobster and deep-sea shrimp	Catch history
Icelandic herring and inshore shrimp	Equal shares
Icelandic capelin	Equal base allocations and vessel holding capacity
New Zealand deep-water offshore	Catch history, vessel investment and processing plant investment
New Zealand inshore	Catch history

It is not surprising that allocation formulæ differ. Management objectives, policy commitments, and management arrangements surrounding pre-ITQ allocations differ

amongst fisheries, and these differences can have an impact on quota allocation formulæ. However, it is not clear that all differences in allocation formulæ can be explained by a logical examination of pre-ITQ circumstances. Rather, they may have more to do with the effects of lobbying of politicians and fisheries administrators by vested-interest groups during the determination of the quota formula. In addition, as the use of ITQs in fisheries is relatively new, a consistent set of underlying principles for quota allocation will take time to develop.

The reallocation of fishing entitlements in the form of ITQs may have a large impact on the economic position of individual fishers. Considerable changes in wealth amongst fishers may be expected to prompt those fishers dissatisfied with their quota allocations to take the government to court. This tendency suggests that fisheries administrators should take a cautious and considered approach to the development of allocation formulæ. Principles and processes pertinent to developing allocation formulæ are discussed in Chapter 6. However, to provide a background to the discussion and to emphasise the importance of quota allocation in ITQ implementation, the remainder of this chapter examines a number of court cases related to the introduction of ITQs and quota allocations.

The implementation of ITQs, including the adoption of a particular quota formula and the subsequent allocation of quota to individual fishers, can be handled in a number of different ways. For example, a government minister might decide to introduce ITQs and determine the allocation formula as a matter of government policy. Quotas may be implemented as a condition on a fishing licence. It is also possible to implement quotas by an Act of Parliament or by delegated legislation (a fishery management plan may be delegated legislation). It is important to understand the different ways of implementing ITQs (including the allocation of quota), as in some jurisdictions, the grounds and avenues for appealing the ITQ system and quota allocations are related to the manner in which quota allocations are implemented. Therefore, before proceeding, a brief discussion is provided on the differences between statute law, delegated legislation, policy, and administrative decision.

LEGAL BACKGROUND

STATUTE LAW

In Australia, the Federal Constitution confers the Federal Parliament with power to make laws in specific areas only (other sections of the Constitution limit or place prohibitions on the power to make laws) whilst the Australian States have general law making powers. Any member of the Federal Parliament may introduce a Bill, which is a proposed law, into Parliament. Most Bills are introduced in the Lower House. The process for turning a Bill into an Act of Parliament involves a number of stages, including: first reading, second reading, committee stage, and third reading. Following third reading, the Bill is forwarded to the Upper House, where the Lower House process is repeated. After the Bill is passed by the Upper House, it is sent to the Governor-

General for assent, and thereafter, the Bill becomes an Act of Parliament. Federal and State Acts of Parliament are known as statute law.

The *Fisheries Administration Act 1991* and the *Fisheries Management Act 1991* are examples of statutes passed by the Australian Federal Parliament. These Acts are often referred to as enabling legislation, in that they set up the broad regulatory framework upon which Commonwealth fisheries in Australia are managed. The *Fisheries Administration Act 1991* establishes the Australian Fisheries Management Authority (AFMA) and the Fishing Industry Policy Council, and details objectives, functions, powers and duties of both entities. The *Fisheries Management Act 1991* details various provisions related to: the regulation of fishing (e.g., establishment of management plans, granting of statutory fishing rights, and fishing permits); establishment of a statutory fishing rights register; surveillance and enforcement; collection of levies and charges; and review by the statutory fishing rights allocation review panel.

It is possible to implement an ITQ management regime, including the quota allocation formula, by statute.

DELEGATED LEGISLATION

The second option for introducing ITQs is through delegated legislation. Compared to an Act of Parliament, delegated legislation is a lesser form of legislation. The reasons for delegated legislation are described by Meek (1994):

> The pressure on parliamentary time is great and Parliament could not possibly make the detailed rules which spell out what is required by some of the Acts that it passes. Much of the legislation that is passed is of a technical or specialised nature and often it is more appropriate for persons who have expertise on a technical subject or the necessary local knowledge, with for instance, local government legislation, to fill out the specific details rather than the parliament itself. To overcome this problem parliament often passes Acts which set out in general terms what is required and then delegates or gives power to a subordinate body to make the detailed rules.

Rules and regulations that are made by such bodies are referred to as delegated or subordinate legislation. As a general observation, the process of making delegated legislation is far less onerous than creating an Act. However, this is not to say that Parliament is not involved. For example, Commonwealth delegated legislation is subject to being disallowed by either House of the Australian Federal Parliament. In Federal and State governments, parliamentary control over delegated legislation is also exercised through the establishment of parliamentary committees that scrutinise delegated legislation.

In the case of Australian Commonwealth-managed fisheries, section 114 of the *Fisheries Administration Act 1991* and section 168 of the *Fisheries Management Act 1991* enable the Governor-General to make various fisheries regulations by delegated legislation. An example of such delegated legislation is the *Fisheries Management Regulations 1991*. These regulations contain much more operational detail than does the enabling legislation, *Fisheries Management Act 1991*. For example, Part 9 of the *Fisheries Management Regulations 1991* provides details concerning the establishment and use of

logbooks. In some cases, plans of management, enacted under division 2 of the *Fisheries Management Act 1991*, have also been considered by the courts as examples of delegated legislation. The introduction of ITQs, including the allocation formula, may be handled through delegated legislation.

POLICY AND GUIDELINES

The third way to implement ITQs is by government policy. Policies, unlike Acts and delegated legislation, are non-statutory rules. Policies represent guidelines developed by administrators that are used as an aid in exercising discretion. Fisheries management agencies world-wide develop, publish and distribute policies on a number of issues, such as discarding, quota allocation policy and cost recovery.

Fisheries statutes are often written in very broad terms, and frequently provide fisheries administrators with a wide degree of discretion in determining how a fishery is to be managed (see Box 1). In using this discretion, a fisheries administrator (or government minister) might decide to implement ITQs in a fishery as a matter of policy. The allocation formula might also be determined through policy. In other words, parliament is not directly involved in either the decision to move to ITQs or in the approval of the allocation formula. In this scenario, the involvement of the legislative branch of government is limited to the establishment of the Fisheries Act (often referred to as the primary Act or enabling legislation) that allows a minister or fisheries administrator to use their discretion when introducing ITQs and allocating quota.

ADMINISTRATIVE DECISION

Fisheries Acts often provide fisheries administrators with the authority to make certain decisions. Assuming that the quota allocation formula fisheries managers must make is to allocate quota to individual fishers. If the procedure by which quota is to be allocated (i.e. the allocation formula) is specified in an Act or in delegated legislation, then a fisheries administrator has no discretion in applying the allocation formula to all eligible candidates.

However, if the quota allocation formula is implemented through policy, then the fisheries administrator will need to exercise a degree of discretion when applying the allocation formula to those claiming a right to receive quota. A number of court cases have involved individual fishers challenging their allocations on the grounds that the fisheries manager did not exercise sufficient discretion when applying the allocation formula (i.e. a policy) to their allegedly exceptional circumstances.

The difference between policy and administrative decision is not clear-cut. However, as Justice Lochart noted in *Hamblin v Duffy*[1], although the phrase "decision of an administrative character" is incapable of precise definition, it includes:

> the application of a general policy or rule to particular cases; the making of individual decisions.

BOX 1
WHAT IS DISCRETION?

Discretion covers decisions, such as quota allocation, which have no "right" answer and more than one reasonable answer between which the decision-maker must choose. The advantages of discretion is that it is flexible, allowing the merits of individual cases to be taken into account. Another advantage is that it allows policies to be more effectively implemented because administrators are able to deal with new and changing circumstances. The disadvantage of discretion is that inconsistent decisions may be made and an individual citizen is much more at the mercy of an administrator. Another disadvantage is that discretion often requires a higher level of care and attention by the administrator who exercises it. Administrative discretion can also be used as a political technique to offload difficult and potentially contentious policy choices onto administrators in order to avoid political debate (Cane, 1996). Given these disadvantages, the control of discretion is central to administrative law. One of the basic tenets of administrative law is that discretion must be controlled in order to control the activities of decision-makers. If a decision-maker is acting within the limits of their discretionary power they are said to be acting within power of *intra vires*. If a decision-maker is said to have stepped outside the limits of discretion then they are said to have acted outside their power or *ultra vires*.

There are many aspects to the control of discretion and interested readers in Australian administrative law are referred to Allars (1990).

IMPLEMENTATION OPTIONS: A COMPARISON

A number of court cases have followed the introduction of ITQs. Legal challenges have been made to the introduction of ITQs, the allocation formula, and to an individual's allocation. The legal avenue of appeal, the possible grounds of appeal, and probability of success associated with a legal challenges are related to how ITQs are implemented.

It is very difficult to use the courts to overturn allocations that have been implemented by statute. Provided the Act is properly implemented and is not unconstitutional, ITQ management and quota allocations are generally the 'law of the land'.

As a general rule, it is a little easier to appeal quota implemented through delegated legislation than an Act because, unlike statute law, the use of delegated legislation implies a degree of discretion on the part of the fisheries administrator introducing ITQs. If a fisheries administrator is acting within the limits of their discretionary power they are said to be acting within power or *intra vires*. If an administrator steps outside of the limits of discretion, then they are said to have acted outside their power or *ultra vires*.

In Australia, Meek (1994) suggests that delegated legislation may be considered outside of the power delegated by Parliament in the following situations: if the body or person making the regulation has exceeded the power given under the enabling Act;

where a regulation is inconsistent with statute or general law; where in making the delegated legislation there is a failure to comply with a mandatory procedural requirement; improper sub-delegation; and where the delegated legislation is made for an improper purpose, uncertain or unreasonable.

As will be detailed below, a number of court cases have involved challenges to the ITQ system and/or allocation formulæ that were implemented through government policy. In addition, a number of fishers have challenged their allocations on the basis of exceptional circumstances. Allars (1990) notes that:

> an administrator exercising discretionary power acts *ultra vires* if the discretion is exercised inflexibly, by application of a policy without regard to the merits of a particular case.

CASE LAW ON QUOTA ALLOCATION

This section examines a number of court cases involving appeals by fishers related to the introduction of ITQs, the allocation formula and an individual fisher's allocation. With the exception of Iceland, the cases are drawn exclusively from countries that have legal systems based on common law such as Australia, the United States, Canada and New Zealand. The focus of attention is on Australia.

AUSTRALIAN CASE LAW

With regard to ITQ-managed fisheries, Australian case law is grouped into three categories. The first category concerns cases where either the ITQ regime or the ITQ formula was found to be beyond the powers of the decision-maker (in legal terms, *ultra vires*). The second category examines cases where either the ITQ regime or ITQ formula was found to be within the powers of the decision-maker (or *intra vires*). The third category involves appeals by individuals of their individual allocation, as opposed to challenges of the allocation formula or ITQ regime.

ITQ challenges found to be beyond the powers of the decision-maker

There are two important Australian Commonwealth cases where the allocation formula was found to be beyond the powers of the decision-maker, and therefore *ultra vires*. The first case is *Austral Fisheries Pty Ltd v Minister for Primary Industries and Energy*[2] and the subsequent appeal, *Minister for Primary Industries and Energy v Austral Fisheries Pty Ltd*[3]. The second case is *Simon Crean, Minister for Primary Industries and Energy and AFMA v Musumeci and Others*[4]. Both cases involve the Australian south east trawl fishery.

As outlined Chapter 3, on 1 January 1992 ITQs were introduced for 16 species in the south east trawl fishery. ITQs were implemented through the *South East Fishery (Individual Transferable Quota) Management Plan 1991* (the management plan). The management plan was determined by the Minister under section 7B of the *Fisheries Act 1952* (Cth.).

In *Austral*, Austral Fisheries Pty Ltd appealed against its quota allocation (of orange roughy) and attacked the management plan on the following grounds: the allocation formula was statistically flawed, and consequently produced an irrational result; the applicant [Austral] was denied natural justice; and the new management plan was not properly made available, therefore breaching the *Fisheries Act 1952* (Cth). The natural justice and document-availability grounds were not upheld. However, Justice O'Loughlin did find that the allocation formula contained a statistical fallacy that produced an irrational result, which was void in law.

However, the judgement was appealed by government (*Minister for Primary Industries and Energy v Austral Fisheries Pty Ltd*). The Federal Court dismissed the appeal and upheld the earlier judgment stating that:

> In substance, the Judge held that the relevant provisions of the Plan were capricious and irrational, such that no reasonable person could ever have devised it. This was an extreme conclusion. but it was justified on the expert evidence of Dr Nicholls. We are not persuaded that, in principle, his Honour was wrong in that conclusion. In the absence of evidence or a process of reasoning to propound any rational basis to warrant the adoption of a statistically flawed formula for the calculation of catch history over the five year period, it was, we think, reasonably open to his Honour to conclude that the relevant provisions of the Plan were beyond power and thus void. No case for interfering with that conclusion has, in our view, been made out. (Beaumont and Hill JJ)

The second case involving a challenge to the south east trawl fishery quota allocation formula is *La Macchia and Others v Simon Crean, The Minister of Primary Industries and Others*, and the decision was appealed as *Crean, Minister for Primary Industries and Energy and AFMA v Musumeci and Others*[5]. Just as Austral had appealed its allocation of orange roughy, a number of other fishers appealed their allocation of gemfish. The expert witness and arguments are the same as in Austral, and therefore will not be repeated. Once again the allocation formula was found to be irrational and void in both the initial decision and on appeal. The following quote from the initial decision is worth noting:

> Where a statute provides for an allocation of a scarce resource amongst participants in the relevant industry, in general, and failing some clear indication to the contrary, the statute should be understood as authorising a method of allocation in accordance with some intelligible principle appropriate to achieve a reasonable division as between those participants. On the expert evidence before me, the principle upon which the method here in question was selected is not intelligible (and if there was some intelligible basis the respondents were in a position to prove it in detail, so that I am entitled to give full weight to the inferences arising from the evidence of Dr Nicholls. (Burette J)

It could be argued that the problem with the original south east trawl quota formula was not that the formula was statistically flawed, but because there no rational basis provided (such as rewarding pioneers) that would explain away perceived abnormalities. As discussed in Chapter 6, this is an important ITQ implementation issue.

In what sense was the quota formula "irrational"?

According to the management authority, allocations were to be based on the following three considerations: the process should be as fair and as equitable as possible; it should most effectively reflect the market share for a species over the catch history period; and, it should minimise disruption to the fishery.

The final allocation formula, presumably based on the above three considerations, used both catch history and 'investment' to determine individual allocations for the 16 quota species. Since the statistical fallacy and consequent irrationality concerned the catch history component of the formula, we focus on the formula's use of catch history.

The catch history component was calculated as follows. First, for each year over the six-year period 1984–89, each operator's verified catch of a particular species was divided by the total catch of all operators and multiplied by 100 to give a percentage representation of that operator's 'market share' of that species in that year. This calculation was made for each operator, and the best five years were used in the catch history calculation. An operator's market share for each year was given equal weighting, therefore with a total of five years which could be included in the catch history component of the formula, each year's market share was weighted by 0.2 (or one fifth). An operator's catch history was simply the sum of the weighted market shares.

In the initial appeal decision, Justice O'Loughlin, referred to Austral's expert witness testimony that maintained the allocation formula contained a "statistical fallacy" that produced an "irrational result", and concluded that since the mathematical conclusions of the expert witness had not been challenged:

> I must say that I do not readily comprehend how a statistical fallacy that produces an irrational result could be said to be synonymous with fairness, equity and maintenance of market share.

The expert witness provided the following example that served as an analogy to help illustrate the alleged statistical fallacy and irrationality inherent in the catch history component of the allocation formula:

> To illustrate the fallacy, let it be assumed that the road deaths over Easter in two successive years are as set out in the following table.

	NSW	VIC	SA	QLD	WA	TAS	ACT	TOTAL
Year 1	20	25	10	10	5	3	1	74
Year 2	25	20	10	15	6	3	4	83
% change	25	20	0	50	20	0	300	12.2

> In this hypothetical example, the overall percentage increase in road deaths between the two years is 12.2%. If, however, one averages the percentage increase figures, there is an increase of 53.6%. The figure of 53.6% is quite meaningless. It has no mathematical significance and it has no practical purpose or use whatsoever. Anyone suggesting that the figure of 53.6% was relevant to any question associated with road safety would be relying on a statistical fallacy.

As an aid to understanding and discussing a number of these issues, the results of a simplified version of the south east trawl fishery allocation formula is given in Table 4. For simplicity it is assumed that there are only two operators in the fishery, A and B.

Each operator's catch for each year over the 1990–1993 period is detailed in Table 4, along with the total catch for each operator over the entire period. Table 4 also shows the total industry catch for each year.

TABLE 4
A SIMPLIFIED EXAMPLE OF THE SOUTH EAST TRAWL FISHERY ALLOCATION FORMULA

Operator catch (tonnes)	1990	1991	1992	1993	Total operator catch
A	10	20	20	30	80
B	0	5	100	200	305
Total catch	**10**	**25**	**120**	**230**	**385**
Operator's market share					
A	100%	80%	16.7%	13.0%	52.4%
B	0%	20%	83.3%	87.0%	47.6%

The allocation formula used in the south east fishery (which was later declared legally void) would calculate the market share over the entire 1990–1993 period for operator A as 25% (there are four years, and each is weighted equally) of his/her 1990 market share (.25 x 100% = 25%), plus 25% of the 1991 market share (.25 x 80% = 20%), plus the corresponding calculations for 1992 and 1993. Adding the weighted market shares produces a catch history share of 52.4% for operator A and 47.6% for operator B. For the south east trawl fishery, the courts ruled that the result was irrational, and was based on a statistical fallacy.

Applying the 'logic' of Austral's expert witness road-death example to the data in Table 4, it would be argued that operator A only harvested 80 tonnes out of the 385 tonnes harvested over the entire period, or 20.7%; however under the allocation formula, operator A would be allocated 52.4% of the quota. According to the argument outlined in the expert witness' example, the 52.4% figure "…has no mathematical significance and it has no practical purpose or use whatsoever." However, this is not true. One can easily think of reasoning upon which this allocation procedure could be justified. If the Minister decided to reward fishers who 'pioneered' the fishery, then one possible way of doing this would be to use the original south east trawl quota formula, and calculate market share on a yearly basis. In the above example, while total industry harvest was low in the first two years, the market share for pioneers was high, and as a consequence the pioneer (operator A) receives a higher overall allocation. In fact it has been argued by some that the rewarding of pioneers was part of the reasoning behind the adoption of the allocation formula used, although this was never argued in court. If this argument, along with evidence, had been submitted at trial, this might have gone a long way in addressing Justice O'Loughlin's concern that:

> there does not appear to be any reason for the adoption of options 25 [the quota formula used]. When, as here, it produces such an absurd result, doubling one man's quota and

> giving him 18% of the TAC whilst reducing everybody else's, there is justification for judicial intervention to redress an understandable sense of injustice.

ITQ challenges found to be within the powers of the decision-maker

This section examines court challenges to the allocation formula used in the South Australia southern zone rock lobster fishery. In contrast to the judgments concerning the allocation formula in the south east trawl fishery, the judgment in the southern rock lobster quota allocation went the other way, although the issues were very similar.

In 1993/94 ITQs were introduced into the southern zone rock lobster fishery. Under the allocation formula (called the Presser model), each fisher was allowed to select either catch history or pot holdings as the determinant of their quota allocation. Catch history was calculated on the basis of the average of the two best years catch between July 1988 and June 1991, inclusive. Pot allocations were based on pot holdings as at 26 July 1993. A result of the allocation formula was that the sum of individual quotas exceeded the TAC by roughly 11 percent, and consequently individual quota holdings were reduced by an equivalent percent. Therefore, for the start of the 1993/94 season each licence was issued a maximum number of pots and a maximum weight of rock lobster that could be caught.

However, in August 1994 the Management Committee recommended that the allocation formula be changed. Specifically, it was recommended that quota allocation should be based solely on pot holdings. For the 1994/95 season, the Department of Fisheries introduced the APACHE (adjusting pots and catch history for equality) model of quota allocation. According to the APACHE model, over the four years commencing with the 1994/95 season, individual quota holdings would be adjusted up or down by one-quarter of a licence holder's existing allocation per pot and the average allocation per pot. After four years, all quota holders would receive the same kilogram allocation per pot held. In other words, the 1993/94 Presser allocation model was to be transformed into allocations based solely on pot holdings. The APACHE allocation formula was implemented by way of a regulation (Regulation No. 166 of 1994) made pursuant to the *Fisheries Act 1982* (SA).

The effect of the move to the APACHE formula was to allocate quota away from highliners (who had higher catches per pot than the average) towards low-catch fishers (who had below average catches per pot).

The move to the APACHE formula was appealed in the South Australian State Court. Justice Millhouse found:

> Regulation No. 166 of 1994 made pursuant to the Act is invalid, void and of no effect in that it is *ultra vires* the regulation making power in the Act.

Justice Millhouse described the APACHE system as one designed "…to rob Peter to pay Paul" stating that:

> It looks to me as though a majority of have nots has ganged up on a minority of haves and worked out a scheme to take away from the haves for their own benefit… …The real sticking point for me is not that some fishers lose but others gain at the expense of

> those who lose. The detriment to the losers is out of all proportion to the object to be achieved.

The decision was appealed to the South Australian Supreme Court[6]. The Supreme Court allowed the appeal, and therefore the APACHE formula was allowed to stand. Justice Lander (with Justices Cox and Prior agreeing) argued that:

> The regulation incorporates one of three options [i.e., allocation solely by catch history, allocation solely by pot holdings, or allocation based on both catch history and pot holdings]. It [the APACHE model] was the option that had the support of industry as demonstrated in the vote taken. The regulation preserves the economic unit in the industry. It is directed, more importantly, to preserving the resource. I do not believe it can be said that the regulation could not have been adopted as a means of attaining the ends of power. In those circumstances it seems to me that the regulation is a reasonable means of attaining the purposes contained in s46 and reasonably proportionate those purposes. The regulation, in my opinion, is within power.

The above quote appears to justify, at least in part, the APACHE formula because (*i*) it had the support of industry, (*ii*) it was directed at preserving the resource and (*iii*) it preserved the 'economic unit' of the fishery.

Consider the 'support of industry' argument. The Supreme Court decision makes the following three observations:

> There was thus strong support for the pot allocation method. The explanation for the strong support for the 'pot allocation' is that (option B) favours those who had reported low to average catches per pot over the years, because it is arrived at by simply dividing the TAC by the total number of pots in the industry. Further, it is said that there are more low to average catch fishers than high catch fishers.
>
> The catch history allocation method (option C) proposed using catch history reported by licensed fishers over the years 1988–89, 1989–90, and 1990–91. This method, of course, favored those who had, within those three years, caught higher than the average pot.
>
> I think it can be safely assumed that each of the fishers would have elected for a system of allocation consistent with that individual fisher's best position.

These quotes make it clear that the fact the APACHE formula had the support of the majority of industry was not likely to represent objective evidence in support of the equity or fairness of the formula. A fisher was likely to vote for the allocation formula that was best for him/her, and not what was necessarily fair or equitable.

Next consider the argument that the APACHE formula was directed at preserving the resource. The introduction of ITQs involves setting a total allowable catch (TAC) and allocating the TAC to individual fishers. Setting the TAC is aimed at preserving the resource, and this is achieved regardless of how the quota is allocated. Therefore, there does not appear to be any relationship between the formula and preservation of the resource.

Finally, it is suggested that the APACHE formula preserves the 'economic unit' of the fishery. This point is important, in that the Court is making a link between the economic position of fishers before and after the introduction of ITQs. Does in fact an

allocation based solely on pots maintain the economic unit of the fishery? There is no record of a debate on this issue in the judgment.

Appeals against individual quota allocations in Australia

This section examines a number of quota allocation appeals in the Commonwealth southern bluefin tuna (SBT) fishery. Initially, quota was implemented as a matter of policy (as opposed to through primary or delegated legislation), and the allocation to individuals, under the formula, was accomplished through administrative decision.

As discussed earlier, there is a difference between challenging the allocation formula itself and challenging an individual's allocation. Challenging an individual's allocation is not a claim that the policy itself is unlawful, but involves a claim that the application of the policy to an individual was wrong because the decision-maker applied the quota formula too rigidly and without regard to the particular circumstances of an individual.

Quota in the SBT fishery was allocated on the basis of catch history and investment. The allocation process was as follows. On 8 March 1984 a letter was sent to all participants in the SBT fishery (by the Commonwealth Department of Primary Industries, DPI) stating that:

> If you operated a boat in the SBT fishery between 1 April 1980 and 31 October 1983 and wish to express interest in participating in the fishery under future management arrangements, you should complete the attached boat registration form. If you did not operate a boat in the fishery between 1 April 1980 and 31 October 1983 but feel you can demonstrate special circumstances as to why your boat should be included in the SBT boat register, you should lodge a registration form for consideration.

On 22 August 1984, DPI sent fishers on the boat register an application form with which to apply for SBT quota. The attached letter stated quota would be allocated to applicants who have a significant dependence on the SBT fishery and who meet one of the eligibility criteria outlined in the attached application form. The eligibility criteria were:

> (A) The applicant is the current holder of a Commonwealth Boat Licence for a commercial fishing boat and was the licensee of a boat which was used to take at least 15 tonnes of southern bluefin tuna in any one season during the period 1 October 1980 to 31 September 1983;
>
> (B) The applicant was the holder of a Commonwealth Boat Licence for a boat which operated in the southern bluefin fishery before 30 September 1983 and who would have qualified under (A) above had the boat not been sold or otherwise disposed of but who can demonstrate that contracts were signed and monies (e.g. deposits) were paid prior to 7 September 1984 for the purposes of acquiring another boat for which quota is sought with the express intention of using it to resume fishing for southern bluefin tuna;
>
> (C) The applicant is a bona fide southern bluefin tuna fisherman who purchased a commercial fishing boat before 6 July 1984 with the express intention of also using it in the southern bluefin tuna fishery. A bona fide fishermen is a person who is the licensee of a boat used to take SBT before 6 July 1984 and is a person who derived income from a minimum of two complete fishing seasons during the period 1 October 1980 –

> 30 September 1983, as an operator skipper or deckhand on a boat which was used to take at least 15 tonnes of SBT in any one season during that period.

The eligibility criteria were not formalised in regulation or proclamation, but were incorporated into the application form. Therefore in this case we have a situation where the allocation formula was "implemented" through a policy decision, which was enunciated in a resolution of the Australian Fisheries Council (28 July 1984), and further detailed in the DPI letter (and attached quota application form) of 22 August 1984. The administrative decisions (made pursuant to discretion under section 9 of the *Fisheries Act 1952*) with respect to individual allocations were based on the allocation policy.

Applicants dissatisfied with their quota allocation could discuss their claims with the Southern Bluefin Tuna Review Panel. The Panel, comprised of federal and state representatives, was to ensure that all relevant information was available to the decision-maker charged with conducting reviews of the initial allocation decisions. The First Assistant Secretary of DPI was the decision-maker empowered to reconsider appeals. A number of fishers dissatisfied with the outcome from internal appeals, applied to the Administrative Appeals Tribunal (AAT) for further review.

Table 5 provides details on AAT appeals. None of the AAT decisions overrode the quota formula. However, there were a number of cases where application of the quota formula to certain individuals was found to produce an unjust situation due to unusual or special circumstances.

It is worth examining in more detail one of the appeals that was not considered to represent exceptional circumstances, and one case that was considered to represent an unique exception (and therefore remitted back to the Department for an increase in quota allocation).

In *Aston and Aston and the Secretary, Department of Primary Industry*[7] the Astons sought additional quota or compensation for the imposition of the quota regime. The Astons sold their vessel, the Almonta, in 1979 and arranged to have a new vessel built, the Empris Lady, that was launched in 1981. Therefore the Aston's developed a SBT catch history for only two of the three qualifying years, and were allocated quota of 224.133 tonnes. The Astons appealed for a higher quota, and following a SBT Panel Review, the estimated dollar value of their vessel and gear was increased, and, as quota allocations depended on investment, their quota was increased by an additional 12.757 tonnes. As the final quota was not sufficient to operate the new vessel, the Astons sold their boat and quota, and appealed to the Administrative Appeals Tribunal.

The Tribunal did not find in favour of the Astons, arguing that they were not unusually or specially disadvantaged by the adoption of the denominator in the formula, by the valuation placed upon their vessel, or by the fact that they had only fished for two of the three qualifying years. The Tribunal also noted that it had no authority to compensate Mr and Mrs Aston for any loss they may have suffered by virtue of the introduction of the quota scheme.

The AAT did find circumstances sufficiently unique to warrant an increase in an individual's quota in the case of *Michael v Secretary, Department of Primary Industry*[8].

TABLE 5
SOUTHERN BLUEFIN TUNA QUOTA APPEALS

Administrative Appeals Tribunal Case	Appeal Grounds	Appeal Decision
Hans Spengler and Secretary, Department of Primary Industry No. W85/73	*Exceptional circumstances:* low catch history in qualifying period due to engine troubles, installation of refrigeration, and family illness.	Initial allocation decision affirmed.
E.R. Aston and Y. Aston and Secretary, Department of Primary Industry No. S.85/27	*Exceptional circumstances:* purchased new vessel at beginning of qualifying period, and allocation was insufficient to allow for profitable operation.	Initial allocation decision affirmed.
Rosa S Pty Ltd and Secretary, Department of Primary Industry No. S.85/36	*Exceptional circumstances:* illness in qualifying period and allocation did not allow for a profitable operation.	Initial allocation decision affirmed.
Neil Frederick Buckland and Department of Primary Industry No. N85/140	*Exceptional circumstances:* was encouraged by the Commonwealth to harvest skipjack and yellowfin tuna, therefore limiting southern bluefin tuna catch, wrong catch history period used in formula, and other irregularities concerning quota issued to sunk, overvalued, and under-construction vessels	Initial allocation decision affirmed.
Bronwyn and Secretary, Department of Primary Industry No. S85/30	*Exceptional circumstances:* lost fishing time during qualifying period due to loss of deck-hand overboard and damage and subsequent repairs to vessel.	Initial allocation decision affirmed.
L.H. Michael and Secretary, Department of Primary Industry No. W85/50	*Exceptional circumstances:* built his own boat during qualifying period.	Remit the decision to the Department for increase in quota allocation.
Kennedy and Secretary, Department of Primary Industry No. W85/46	*Exceptional circumstances:* built boat during qualifying period.	Remit the decision to the Department for increase in quota allocation.
N. Mansted and Secretary, Department of Primary Industry No. W86/123	*Exceptional circumstances:* purchased a larger vessel.	Remit the decision to the Department for increase in quota allocation.
Dinjerra Nominees Pty Ltd and Secretary, Department of Primary Industry No. S85/53	*Exceptional circumstances:* purchased a vessel just outside of the deadline time period.	Remit the decision to the Department for increase in quota allocation.

Initially, the Mr Michael did not qualify under Criteria A or B as he was the licensee of a boat that took 15 tonnes over the qualifying period. However, he was allocated 6.913 tonnes of quota under Criterion C, as he had worked as a deckhand and skipper over qualifying period. While Mr Michael did not 'purchase' a boat prior to 6 July 1984, he had built a boat over the January 1982 to June 1983 period, and the term 'purchase' was interpreted to include building a boat.

However, the applicant argued his quota allocation was too low, and that due to exceptional circumstances (the fact that he was building a boat over part of the qualifying period) his allocation should be increased. Criterion C allowed a skipper or deckhand who purchased a boat prior to 6 July 1984 to use the best catch of the previous owner as the qualifying best catch. However, if the boat purchased had not operated in the SBT fishery during the qualifying period, the best catch was set equal to zero. Therefore, it was argued by the Department of Primary Industry that the applicant was entitled to use his catch history (8.262 tonnes) over the three-month period from July to September 1983 in the allocation formula. A deckhand or skipper who purchased a boat that had only an 8.262 tonne catch over the qualifying period would have been handled in exactly the same manner.

The Tribunal agreed with the applicant, arguing that there was a difference between a deckhand or skipper who acquired a boat with a low or zero qualifying catch and an individual who built their own boat over the qualifying period. Specifically, the Tribunal said:

> A boat without a qualifying catch purchased at the time the building of the "Cinderford" commenced in January or (sic) 1982 or, indeed, at any time before the end of 1982, could immediately have set about establishing one. The applicant, on the other hand, committed himself to a capital expenditure of $40,000 in January 1982 but was unable to commence establishing a qualifying catch until 18 months later in July 1983. Once the applicant committed himself to the capital expenditure involved in building the boat, he was for all practical purposes unable to purchase a boat with a qualifying catch, or, to have a season's fishing as a licensee in which to establish a season's catch during the qualifying period… The very fact which demonstrated his commitment to and dependence on the SBT fishery, the building of an SBT boat, prevented his qualifying for a reasonable catch. I think his is an anomalous situation similar to that examined in Kennedy. I see it as one where the criteria adopted for the calculation of the quota, whilst generally effective, do not provide in a particular case an adequate measure of the intended qualification, namely the extent of personal and financial commitment to the fishery and dependency on it.

The Tribunal's decision was to remit the decision back to the Department, with the recommendation that the applicant's quota be increased.

NEW ZEALAND CASE LAW

The case law from New Zealand concerns challenges to quota allocation between the commercial and non-commercial sectors in the snapper fishery. In 1997 the New Zealand Court of Appeal heard the following three cases: *New Zealand Fishing Industry*

Association (Inc) et al. v Minister of Fisheries et al.; *Treaty of Waitangi Fisheries Commission v Minister of Fisheries et al.* and; *Area 1 Maori Fishing Consortium and NGAPUHI Fisheries Limited v Minister of Fisheries et al.*

The primary issue dealt with by the Court was a challenge by the commercial sector to a decision made by the Minister to reduce the total allowable commercial catch (TACC) for the Snapper 1 management area by 39%. Our interest here is to consider the Court's discussion on a secondary issue related to inter-sectoral quota allocations between the commercial and the non-commercial sectors.

Commercial harvesting interests argued that if a TACC reduction was required, then the recreational sector should bear their proportionate share of the reduction. The Court of Appeal noted that the current legislation in force was the *Fisheries Act 1996*, in combination with parts of the 1982 *Fisheries Act*. Under both Acts, when setting or varying the TACC the Minister must have regard to the TAC. Under the 1982 Act, the Minister is required to "allow for": (*i*) non-commercial interests in the fishery and (*ii*) the catch allowed for foreign craft. Under the 1996 Act, when setting the TACC, the Minister is required to "allow for: (*i*) the following non-commercial fishing interests in the stock, namely, Maori customary non-commercial fishing interests, and recreational interests, and (*ii*) all other mortality to that stock caused by fishing.

The Court noted that neither Act explicitly requires a proportional sacrifice between commercial and recreational sectors. The Court also found that the Minister must make the allowances he thinks are appropriate for non-commercial sectors *before* he sets the total allowable commercial catch, and these allowances are not quotas. The 'allowance' for the recreational sector is simply the Minister's 'best estimate' of the recreational catch (in light of recreational bag-limit and other restrictions).

The Court's interpretation of the legislation was that:

> In summary, it is our conclusion that neither the specific sections (28D and 21) nor the Acts when viewed as a whole contain any implied duty requiring the Minister to fix or vary the recreational allowance at or to any particular proportion of the TACC or for that matter the TAC. What the proportion should be, if that is the way the Minister looks at it from time to time, is a matter for the Minister's assessment bearing in mind all relevant consideration… Once one retreats from the proposition that strict proportionality is required, there can be no satisfactory solution other than that the Minister must act reasonably to seek to stop the saving resulting from TACC reductions being lost to recreational fishing.

UNITED STATES CASE LAW

In the United States, the National Marine Fisheries Service (NMFS) is vested with exclusive federal management authority with respect to U.S fisheries. Buck (1995) provides a brief summary of the major laws implemented by the NMFS. The *Magnuson-Stevens Fishery Conservation and Management Act* ("Magnuson Act") is the major fisheries management Act with respect to fisheries resources within the 200-mile US exclusive economic zone (EEZ); however nearshore territorial waters are under State jurisdiction. Under the Magnuson Act, eight Regional Fishery Management

Councils have been created (New England, Mid-Atlantic, South Atlantic, Caribbean, Gulf of Mexico, Pacific, Western Pacific and North Pacific). The Regional Councils develop, administer and revise fisheries management plans that regulate fishing. Councils must follow certain procedures detailed in the Magnuson Act when adopting management plans, and must comply with provisions governing the content of management plans. Management plans must be consistent with a number of national standards outlined in the Magnuson Act. Fisheries management plans are implemented as regulations, and therefore are delegated legislation.

Concerning the issue of quota allocation, section 301 of the Magnuson Act outlines a number of national standards for fishery conservation and management. Management plans, and any regulation promulgated to implement any such plan, are to be consistent with these standards. One of the standards, National Standard 4, requires that:

> Conservation and management measures shall not discriminate between residents of different States. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocations shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

Section 303 (Contents of Fishery Management Plans) states that on or after October 1, 2000, the Councils and the Secretary shall ensure that any ITQ program:

> provides for a fair and equitable initial allocation of individual fishing quotas, prevents any person from acquiring an excessive share of the individual fishing quotas issues, and considers the allocation of a portion of the annual harvest in the fishery for entry-level fishermen, small vessel owners, and crew members who do not hold or qualify for individual fishing quotas.

Section 305(f) of the Magnuson Act specifies Congress' mandate for judicial review of the implementation of fishery management plans. Courts may set aside decisions that are found to be (A) arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law; (B) contrary to constitutional right, power, privilege, or immunity; (C) in excess of statutory jurisdiction, authority, or limitations, or short of statutory right; and (D) without observance of procedure required by law.

This section examines two US court cases. The first case is *Alliance Against IFQs v Brown*[9]. The Secretary of Commerce, under the 1982 *North Pacific Halibut Act* is authorised to enforce the *Convention between the United States and Canada for the Preservation of the Halibut Fishery of the Northern Pacific Ocean and Bering Sea*. In 1993, the Secretary implemented by regulation a management plan, based on individual transferable quotas, for the sablefish and halibut fisheries in portions of Gulf of Alaska, Bering Sea, and waters off the Aleutian Islands area.

Under the management plan, the regional director of the NMFS assigned to each owner or lessee of a vessel (that landed halibut or sablefish during 1988 to 1990 inclusive) a quota share based on their highest total halibut and sablefish landings over the 1984–90 period. Subject to certain restrictions, quota shares are transferable.

A challenge to the ITQ management plan failed in District Court, but an appeal was allowed to the US 9th Circuit Court of Appeals. The appeals court made it clear that it would not look at the merits of the case stating that:

> We determine only if the Secretary acted in an arbitrary and capricious manner in promulgating such regulations… We cannot substitute our judgment of what might be a better regulatory scheme, or overturn a regulation because we disagree with it, if the Secretary's reasons for adopting it were not arbitrary and capricious.

One of the grounds for appeal was that the allocation violated the Magnuson Act, in that it did not take into account "present participation in the fishery." The plaintiffs argued that the qualifying years to receive a quota share were 1988–90, but that the final regulation was not promulgated until 9 November, 1993. Therefore a person who last fished in 1988 would receive a quota, but someone who only fished in 1991, 1992 or 1993 would not. The appeal found that:

> while the length of time between the end of the participation period considered and the promulgation of the rule pushed the limits of reasonableness, we are unable to characterize use of a 1988 through 1990 period as so far from 'present participation' when the regulation was promulgated in 1993 as to be 'arbitrary or capricious'.

Secondly, the plaintiffs argued that the allocation to vessel owners and lessees violated the Magnuson Act requirement that allocations be fair and equitable to all fishermen. Specifically, since crew are also fishers, and since they were not eligible to receive quota shares, the plaintiffs maintained that the fairness and equity requirement to 'all' fishermen was violated. The rationale given by the regional council for excluding crew was the practical difficulty in documenting crew shares and the fact that vessel owners and lease holders are the participants who supply the means to harvest fish, and suffer the financial and liability risks.

The appeal decision concluded that:

> Although the Secretary's approval of the plan sacrificed the interest of non-owning crew members to boat owners and lessees, the Secretary had a reason for doing that which was consistent with the statutory standards… Despite the hardness to the fishermen who were left out there is no way we can conclude on this record that the Secretary lacked a rational basis for leaving them out.

There were two other grounds upon which the plaintiffs challenged the management plan, however they were not upheld. In summary, the appeal court stated that:

> This is a troubling case. Perfectly innocent people going about their legitimate business in a productive industry have suffered great economic harm because the federal regulatory scheme changed. Alternative schemes can easily be imagined… But we are not the regulators of the north Pacific halibut and sablefish industry. The Secretary of Commerce is. We cannot overturn the Secretary's decision on the ground that some parties are injured. Government regulation of an industry necessarily transfers economic rewards from some who are more efficient and hardworking to others who are favored by the regulatory scheme. We have authority to overturn the Secretary's decisions only if they are arbitrary and capricious, or contrary to law. In this case, they are not.

The second US case to be considered is *Sea Watch International et al. v Mosbacher*[10]. In 1990 the Fishery Management Plan for Surf Clams and Ocean Quahogs was amended. The amendment brought together the mid-Atlantic surf clam fishery, the New England surf clam fishery and quahog fishery under a single ITQs scheme.

For the mid-Atlantic surf clam fishery, allocations were based on catch history and vessel length (as a proxy for the owner's capital investment), weighted respectively 80% and 20%. Specifically, a vessel's average catch history from 1979 to 1988 was calculated (with the last four years counted twice, and the lowest two years deleted), and this was expressed as a percentage of the sum of all vessels' catch history, and the result was given a 80% weight. Likewise each vessel's length was expressed as a percentage of the sum of all vessels' length, and weighted 20%. For the New England surf clam and ocean quahog fisheries, each allocation was calculated by expressing a vessel's catch history for every year between 1979 and 1988 (excluding the lowest year for vessels that participated for more than one year), which was then expressed as a percentage of the sum of all individual vessel average catch histories.

In 1990 the introduction of ITQs was challenged in the United States District Court, District of Columbia. We will not go into all of the details of the challenge, but rather focus on a few issues. The first line of attack was on the ITQ regime itself. To quote from Justice Boudin's opinion:

> The gist of the plaintiffs' claim on this point is that an ITQ system 'amount[s] to privatization of the surf clam and quahog resource,' and that such a 'transfer of private ownership interests in a fishery' is both unauthorized by the Magnuson Act and in conflict with an express prohibition on the assessment of fees in excess of costs.

Justice Boudin did not agree with the privatisation challenge, arguing that:

> The new quotas do not become permanent possessions of those who hold them, any more than landing rights at slot-constrained airports become the property of airlines, or radio frequencies become the property of broadcasters. These interests remain subject to the control of the federal government which, in the exercise of its regulatory authority, can alter and revise such schemes, just as the Council and the Secretary have done in this instance.

In a second line of argument, the plaintiffs' contended that the ITQ system was contrary to National Standard 4 as described above[11]. The plaintiffs claimed that Standard 4(A) was violated as: similarly situated fishers were treated unequally; violators of regulations were rewarded; and owners of smaller fishing vessels were discriminated against. Since quota allocations were based on vessel catch history, as opposed to the catch history of individuals, fishers who recently sold their vessel would receive no allocation, while the vessel purchaser would receive a windfall gain. This was claimed to be unfair and inequitable. Justice Boudin found that Standard 4 does require the use of individual catch history, and that previous regulations in the Mid-Atlantic surf clam fishery were also based on vessel catch history. He therefore concluded that the decision to use vessel catch history:

> …reflects not mere administrative convenience, but a consistent and reasonable regulatory scheme.

The plaintiffs argued that Standard 4 was also violated because fishers who illegally fished longer than they were supposed to, ended up with a larger catch history, and provided they had not sold the vessel, would also receive a larger quota than honest fishers. This they argued was inequitable. The judge agreed with the counter arguments that: there is no way to correct for this unfortunate result; the majority of fishers probably cheated to some extent; catch history was only weighted 80%; and, there was no way to detect who had actually cheated. It was concluded that the use of past catch histories was not irrational and did not violate the Magnuson Act.

The final argument regarding National Standard 4 concerns the contention that small vessel owners suffered relative to larger vessel owners as a result of allocations. Small vessel owners were argued to be disadvantaged as they would incur larger average harvesting costs, and that because smaller vessel owners did not have access to capital to purchase quota (and therefore run their vessels at full capacity), they would be driven out of business. The judge noted that while there may be economic advantages to harvesting with larger vessels, the small fleet sector may receive substantial allocations, and there were other ways in which this sector could mitigate any damages (including selling their quota). With respect to this issue, the judge found that there was:

> nothing intentionally invidious or inherently unfair in the plan adopted by the Council and Secretary.

In addition to the above general challenges to the ITQ scheme, there were a number of specific challenges to the decision to introduce limited access to the quahog fishery and bring it under the same management scheme as the two surf clam fisheries. We will only go into the detail of one of these challenges. The plaintiffs argued that the ITQ system resulted in an "excessive share" of quota being held by two fishers, which was contrary to National Standard 4. Standard 4 requires that allocations should be "carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges." It was alleged that two fishers held ITQs totalling 40% of the annual quahog TAC. The court rejected this argument arguing that there was no definition of "excessive share", and therefore the Secretary's judgement of what is excessive should be given weight, especially in situations where regulations can be changed without the permission of ITQ holders.

ICELANDIC CASE LAW

An Icelandic case, *Jóhannesson v the State*[12], concerns a challenge to the constitutionality of ITQ allocation as contained in statute law. The facts of the case are as follows. Jóhannesson, who had not yet acquired a vessel, applied to the Ministry of Fisheries for both a licence to fish and quota in all the major species exploited. The Ministry of Fisheries rejected his application because licences were only issued to vessels, not to individuals. Jóhannesson decided to contest this decision claiming that although the decision was in accordance with existing fisheries laws, the laws violated constitutional clauses about equal rights and the freedom to work. The Court found that an individual could only request a resolution regarding the constitutionality of a particular law if it

could show that his/her rights and interests differed from those of other citizens (i.e. he had legal standing). They then dismissed his claim on the grounds that he did not have these rights and interests.

Jóhannesson appealed to the Supreme Court, which then requested the local court to reconsider. The local court again dismissed his claim arguing that Jóhannesson had failed to show how his rights and interests differed from those of other citizens, and further holding that the refusal by the Ministry was consistent with fisheries policy not to damage the reproductive potential of the stocks and that the policy "applied equally to all citizens in a similar position." Therefore the law did not violate constitutional clauses about equal rights and the freedom to work. Jóhannesson then appealed again to the Supreme Court.

In 1998, the Supreme Court unanimously concluded that the clause in existing fisheries laws (Art. 5, 38/1990) which granted ITQ rights in relation to ownership of vessels during a specific period (three years prior to the establishment of the ITQ system) was unconstitutional. The Court held that the Article violated two articles of the Constitution: Article 65 on discrimination and Article 75 on the right to work. The Court found that temporary measures to limit fishing effort and restrictions to the right to work may have been justifiable and in the public interest given the threat of collapse of fishing stocks, but the indefinite legalisation of this discrimination was not justified. The Court concluded that, in principle, Article 5, 38/1990 prevented the public from enjoying the right to work in fishing and receiving a relative share of the common property resource to which they are entitled (the 1990 Fisheries Act describes fisheries as the "public property of the nation"). In light of this, the Court upheld the appeal. The response by the government was to amend the legislation to enable individuals to apply for licences, although they would have to buy quota if they wanted to fish.

CANADIAN CASE LAW

The Canadian case law on quota allocation concerns the British Columbia halibut fishery. In 1991 Canada implemented a two-year experimental non-transferable quota system in the halibut fishery. Two years later, the quota system was permanent and limited transferability was introduced. Quota was allocated to individual fishers on the basis of catch history (over 1986–89) and vessel length. Under a condition known as the current owner restriction, the relevant catch history used in quota calculation was that of the current licence holder. In other words, if an individual purchased a halibut licence in 1989, then only the catch history for that year was used for allocation purposes. However, if a licence was purchased after the start of the 1989 season (therefore providing the licence holder with no relevant catch history), then the catch history of the previous owner of the licence was used for allocation calculations. Quota was implemented through policy (as opposed to regulation), and was allocated to fishers as a condition on their licences.

The current owner restriction was challenged in court (*Carpenter Fishing Corporation et al. v Her Majesty the Queen et al.*[13]). The plaintiffs claimed that the Current Owner Restriction (which was part of the allocation formula) was unlawful, a claim that

the judge agreed with. The Court held that the current owner restriction was not an administrative decision that was legislative in nature, and therefore plaintiffs were entitled to procedural fairness. The judge found that the consultation process was undemocratic, and that the Minister acted for an improper motive by endorsing a discriminatory policy. The Minister appealed to the Federal Court.

The decision was overturned on appeal (*Carpenter Fishing Corporation et al. v Her Majesty the Queen et al.*[14]). In the Federal Court of Appeal decision, Justice Decary (Justices Pratte and Linden concurring) overturned the initial decision that the current owner restriction was unlawful. Justice Decary stated that:

> In my view, the Trial Judge erred in hearing and assessing the evidence on the basis that what was in issue was not legislative action. That error led him to impose adherence to rules of natural justice that did not apply and to examine the evidence as if he was entitled to second-guess the propriety of the quota attributed by the Minister.

Justice Decary argued that the imposition of quota policy (which included the current owner restriction), as opposed to granting a specific licence, is a discretionary decision in the nature of legislative action. Further, it was argued that discretionary policy guidelines were not subject to judicial review, except in situations of bad faith, non-conformity with the principles of natural justice (when required by statute), and when irrelevant or extraneous factors are relied upon. None of these exceptions were found to hold in this case, and therefore the initial decision that the current owner restriction was unlawful was overruled.

SUMMARY

One must be extremely careful when generalising with respect to the implications of quota-related court cases. The grounds for and avenues of appeal depend significantly on the wording contained in fisheries acts, fisheries regulations and non-fisheries legislation. However, there are a few common implementation issues that flow through a number of the court cases discussed.

Given the wording of most fisheries Acts, it appears to be very difficult to challenge successfully either the introduction of ITQs or the quota formula in courts. Implementing ITQs through an Act provides the safest legal avenue, followed by delegated legislation and policy. The only known successful challenge to ITQs implemented through statute was in Iceland (*Jóhannesson*), where the statute was considered unconstitutional.

It has also proven difficult to overturn ITQ regimes or allocation formulæ implemented by delegated legislation or policy. In only one fishery, the Australian south east trawl fishery, was an allocation formula contained in delegated legislation ruled beyond the power of the decision-maker (i.e. *ultra vires*) because it was considered irrational, unreasonable and capricious. As noted above with respect to one of the south east trawl fishery decisions:

> Where a statute provides for an allocation of a scarce resource amongst participants in the relevant industry, in general, and failing some clear indication to the contrary, the statute should be understood as authorising a method of allocation in accordance with

> some intelligible principle appropriate to achieve a reasonable division as between those participants.

However, the south east fishery case represents the exception to the rule. A more representative position taken by the courts to date concerning allocation formulæ is found in the appeal decision in the Canadian *Carpenter* case:

> Perhaps the formula adopted is not the best one, or the wisest one, or the most logical one, but the Minister is not bound to pick the best, the wisest or the most logical one and it is certainly not the function of the courts to question his judgment as to whether a quota policy is good or bad. (Decary J)

Nonetheless, prudence suggests that if allocations (except for those implemented by an Act) have a significant and differential impact on fishers, such that a comparison of pre-ITQ and ITQ entitlements would demonstrate large gains and losses amongst fishers, a rationale should be developed (consistent with the enabling legislation) that supports this outcome. It does not appear that the rationale needs to be very profound, the most important thing is that there exists a rationale.

If quota is allocated through policy, then it is necessary to exercise discretion when applying the policy to individuals. Exceptional circumstances should normally be taken into account in applying the formula to individuals. This is certainly illustrated with respect to Australian case law.

The issue of quota allocation is likely to receive increasing attention, especially as ITQ regimes are becoming more widely used and, in some cases, the preferred management approach by government. The need for administrators to have a transparent basis for allocation decision-making is clear from a legal perspective. However, what is not apparent from the preceding discussion of court cases is the uncertainty and unrest created amongst fishers as a result of litigation and the restraint on industry adjustment to the ITQ system while the future of the management regime and quota allocations hang in the balance. The adverse fisheries management consequences of quota related litigation can be substantial and long-lasting, reinforcing the need for administrators to carefully consider the process by which quota allocations are decided.

The next section examines various principles and processes that may be of relevance when devising quota allocations in the future.

ENDNOTES

1 (1981) 34 ALR 333
2 (1992) 37 FCR 463
3 (1993) 40 FCR 381
4 *NG701 to 703 of 1992*
5 (1992) 110 ALR 201.
6 (1994) 64 SASR 359
7 AAT No. S.85/27
8 AAT No. W85/50.
9 84 F.3d 343 (9th Cir. 1996)
10 762 F. Supp. 370 (D.D.C. 1991)

11 Note that while the above Standard is taken from the 1996 Act, it is the same as the Standard that is contained in the version of the Act that was alive during the case.
12 Discussed in Palsson,G. Individual transferable quotas: unconstitutional regimes? Common Property Digest, 1999
13 14 November 1996
14 23 December 1997 A-941-96 Fed. C.A.

6 QUOTA ALLOCATION: PRINCIPLES AND PROCESS

This chapter explores two issues related to quota allocation. The first issue concerns the principles underlying quota allocation formulæ, and the second concerns the process by which the allocation formula is determined[1].

PRINCIPLES UNDERLYING QUOTA ALLOCATION

It is evident from the amount of litigation surrounding quota allocation (some of which was examined in the previous chapter) that the choice of quota formula has a major economic impact on participants in a fishery. Given the importance of allocation and the negative consequences for fisheries management of prolonged litigation, it is reasonable to suggest that fisheries administrators set out explicit principles upon which the allocation formula is to be determined. In so doing, from a legal perspective, fisheries administrators should first seek guidance from the primary legislation that gives them decision-making authority to allocate quota. A number of court challenges, based on the argument that the quota formula was not consistent with legislated fisheries objectives, give further weight to the argument that it would be prudent to consider the role of management objectives when devising the allocation formula.

To explore this issue, we examine primary fisheries legislation in Australia and New Zealand. The task is to consider whether any of the objectives specified in fisheries legislation are relevant to quota allocation and if so, how they might be applied. Table 6 details the management objectives found within Australia and New Zealand fisheries legislation. The various objectives in Table 6 can be roughly allocated into one of the following four categories: economic efficiency; ecological sustainability; community and social benefits; and fairness and equity in determining access.

THE ROLE OF ECONOMIC EFFICIENCY

One of the objectives in Australian Commonwealth fisheries is the maximisation of economic efficiency in the exploitation of fisheries resources. As far as we are aware, no other jurisdiction has such a clear mission statement with respect to economics. Other legislation refers to economics in terms of the promotion of a viable commercial fishing sector, optimum economic benefits, and optimum utilisation. However, in discussing the relationship between economics and quota allocation, we will focus on the term economic efficiency, as this term is a well-studied concept in economics. The issue of why economic inefficiency (or to use a simpler term, overcapacity) is a problem in fisheries was discussed in Chapter 2.

In fisheries with economic-efficiency type objectives, should fisheries administrators take this objective into consideration when devising the allocation formula? Specifically,

TABLE 6
FISHERIES MANAGEMENT OBJECTIVES IN PRIMARY LEGISLATION

Australian Commonwealth: Fisheries Management Act 1991

The following objectives must be pursued by the Minster in the administration of this Act and by AFMA in the performance of its functions:

1. implementing efficient and cost-effective fisheries management on behalf of the Commonwealth; and
2. ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development and the exercise of the precautionary principle, in particular, the need to have regard to the impact of fishing activities on non-target species and the long-term sustainability of the marine environment; and
3. maximising economic efficiency in the exploitation of fisheries resources; and
4. ensuring accountability to the fishing industry and the Australian community in AFMA's management of fisheries resources; and
5. achieving government targets in relation to the recovery of the costs of AFMA.

New South Wales: Fisheries Management Act 1994

1. The objects of this Act are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations.
2. In particular, the objects of this Act include:
   (a) to conserve fish stocks and key fish habitats, and
   (b) to conserve threatened species, populations and ecological communities of fish and marine vegetation, and
   (c) to promote ecologically sustainable development, including the conservation of biological diversity,

   and, consistently with those objects:
   (d) to promote viable commercial fishing and aquaculture industries, and
   (e) to promote quality recreational fishing opportunities, and
   (f) to appropriately share fisheries resources between users of those resources.

Queensland: Fisheries Act 1994

The objectives of this Act include:

(a) ensuring fisheries resources are used in an ecologically sustainable way; and
(b) achieving optimum community, economic and other benefits from fisheries resources; and
(c) ensuring access to fisheries resources is fair

TABLE 6 (CONT.)
FISHERIES MANAGEMENT OBJECTIVES IN PRIMARY LEGISLATION

South Australia: Fisheries Act 1982

In the administration of this Act the Minister, the Director and management committees have as their principal objectives:

(a) ensuring, through proper conservation, preservation and fisheries management measures, that the living resources of the waters to which this Act applies are not endangered or overexploited; and

(b) achieving the optimum utilisation and equitable distribution of those resources.

Tasmania: Living Marine Resources Management Act 1995

The purpose of this Act is to achieve sustainable development of living marine resources having regard to the need to –

(a) increase the community's understanding of the integrity of the ecosystem upon which fisheries depend; and

(b) provide and maintain sustainability of living marine resources; and

(c) take account of a corresponding law; and

(d) take account of the community's needs in respect of living marine resources; and

(e) take account of the community's interests in living marine resources

Victoria: Fisheries Act 1995

The objectives of this Act are –

(a) to provide for the management, development and use of Victoria's fisheries, aquaculture industries and associated aquatic biological resources in an efficient, effective and ecologically sustainable manner;

(b) to protect and conserve fisheries resources, habitats and ecosystems including the maintenance of aquatic ecological processes and genetic diversity;

(c) to promote sustainable commercial fishing and viable aquaculture industries and quality recreational fishing opportunities for the benefit of present and future generations;

(d) to facilitate access to fisheries resources for commercial, recreational, traditional and non-consumptive uses;

(e) to promote the welfare of persons engaged in the commercial fishing industry and to facilitate rationalisation and restructuring of the industry;

(f) to encourage the participation of resource users and the community in fisheries management

TABLE 6 (CONT.)
FISHERIES MANAGEMENT OBJECTIVES IN PRIMARY LEGISLATION

Western Australia: Fish Resources Management Act 1991

(1) The objects of this Act are to conserve, develop and share the fish resources of the State for the benefit of present and future generations.

(2) In particular, this Act has the following objects –

(a) to conserve fish and to protect their environment;

(b) to ensure that the exploitation of fish resources is carried out in a sustainable manner;

(c) to enable the management of fishing, aquaculture and associated industries and aquatic eco-tourism;

(d) to foster the development of commercial and recreational fishing and aquaculture;

(e) to achieve the optimum economic, social and other benefits from the use of fish resources;

(f) to enable the allocation of fish resources between users of those resources;

(g) to provide for the control of foreign interest in fishing, aquaculture and associated industries;

(h) to enable the management of fish habitat protection areas and Abrolhos Islands reserve.

New Zealand: Fisheries Act 1996

(1) The purpose of this Act is to provide for the utilisation of fisheries resources while ensuring sustainability.

(2) In this Act –

"Ensuring sustainability" means –

(a) Maintaining the potential of fisheries resources to meet the reasonably foreseeable needs of future generations; and

(b) Avoiding, remedying, or mitigating any adverse effects on 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.

should an attempt be made to calculate the economic efficiency of each fisher, and allocate more quota to the most efficient operators? From a theoretical perspective this is not necessary. Montgomery (1972) notes that the initial distribution of quota only affects the allocation of wealth, and it does not affect the level of efficiency after allowing for quota trading.

One of the objectives in Australian Commonwealth fisheries is the maximisation of economic efficiency in the exploitation of fisheries resources. As far as we are aware, no other jurisdiction has such a clear mission statement with respect to economics. Other legislation refers to economics in terms of the promotion of a viable commercial fishing sector, optimum economic benefits, and optimum utilisation. However, in discussing the relationship between economics and quota allocation, we will focus on the term economic efficiency, as this term is a well-studied concept in economics. The issue of why economic inefficiency (or to use a simpler term, overcapacity) is a problem in fisheries was discussed in Chapter 2.

In fisheries with economic-efficiency type objectives, should fisheries administrators take this objective into consideration when devising the allocation formula? Specifically, should an attempt be made to calculate the economic efficiency of each fisher, and allocate more quota to the most efficient operators? From a theoretical perspective this is not necessary. Montgomery (1972) notes that the initial distribution of quota only affects the allocation of wealth, and it does not affect the level of efficiency after allowing for quota trading.

On a practical level, the operational difficulties associated with attempting to calculate the economic efficiency of each operator are enormous. Few would argue that government attempts to manage even broad sectors of the economy in China, Cuba, and the former Soviet Union produced an economically efficient outcome. It is very unlikely that the centralised allocation of scarce fish resources amongst individual harvesters on the basis of bureaucratic determination of relative individual economic efficiency would be any more successful. One would imagine that the cost and earnings data supplied by fishers and used by government to estimate their relative individual efficiencies and, hence quota allocations, might be somewhat less than accurate.

Nevertheless, it is worthwhile to examine legal challenges in Commonwealth fisheries that were based on the premise that quota allocations (and other management decisions) required an explicit recognition of individual operator economic efficiency (due to the legislated economic efficiency objective). In *PW Adams Pty Ltd v Australian Fisheries Management Authority*[2], it was argued that quota allocations were flawed because the allocation formula did not explicitly consider the economic efficiency of individual fishers. Specifically, it was contended that the maximum economic efficiency objective required individual operator economic efficiency to be explicitly taken into account when determining quota allocations. In this case, the Court ruled that the fact that the quota formula was not in whole, or in part, based on estimates of individual operator economic efficiency was not an error in law.

This opinion was given further support in *Bannister Quest Pty Ltd v Australian Fisheries Management Authority*[3], where Justice Drummond argued that:

> In my opinion, this means that it is out of place for AFMA to have regard to the efficiency of an individual fisherman's operation relative to that of other fishermen or to social or equity considerations, in taking any action which will have an impact on whether economic efficiency in the exploitation of the resources of a particular fishery is likely to be maximised or hindered by that action. It is clear that the duty to pursue the efficiency objective does not require AFMA to protect or enhance the financial position of each operator…

Therefore in Australian Commonwealth fisheries, courts have taken the position that the Commonwealth's economic efficiency objective refers to the efficiency of the entire fleet, and that the efficiency objective in ITQ fisheries is pursued through the introduction of the management system itself. It is, therefore, unnecessary to allocate quota based on an estimate of the economic efficiency of each individual operator.

In summary, the argument that economic efficiency considerations should play a role in determining the allocation formula is conceptually, operationally and legally weak.

THE ROLE OF ECOLOGICALLY SUSTAINABLE DEVELOPMENT

A second fisheries management objective that is common in Table 6 relates to the concept of ecological sustainability. Objectives in Table 6 that fall under the broad heading of ecological sustainability include: conservation of fish stocks, conservation of key fish habitats, protection of threatened species, conservation of ecological communities, promotion of genetic diversity, and maintenance of biological diversity.

As with economic efficiency, it could also be argued that an ecologically sustainable development objective is relevant to quota allocation. For example, in fisheries with multiple gear sectors, if one gear sector produces high discards, unacceptable damage to biological diversity/genetic diversity, or excessive damage to the marine physical environment, then it could be argued that the 'environmentally unfriendly' gear sector should be allocated less quota when moving from effort controls to ITQs.

This type of argument was made with respect to inter-sectoral quota allocations between the trawl and hookline sectors in the Canadian west coast groundfish fishery (Halvorson, 1997). Specifically, each gear sector argued that it was more 'environmentally friendly' than the other, and therefore should be favoured in the allocation process. The arbitrator appointed to make quota allocation recommendations found that there was "a lack of cogent evidence" to favour one sector over another on these grounds.

However, even if there was cogent evidence to support the position that a particular gear sector (relative to others) was environmentally unfriendly, it is not clear that it is either necessary or equitable to use this evidence to reduce that sector's quota allocation. As an alternative to reducing the offending gear-sector's quota allocation, that sector could be required to use alternative gear, or could be allowed to sell or lease their quota. In other words, it is possible to manage the environmental concern by means other than by redistributing quota away from one sector to another. This would achieve the

environmental objective, and at the same time mitigate the economic costs otherwise imposed on operators in the offending gear sector.

With regard to economic efficiency, the *Bannister Quest* case discussed above also offers an interesting perspective on management decision-making and ecological sustainable development (ESD) in Australian Commonwealth fisheries. While the case is not about quota allocation, it is applicable to quota allocation decisions. One of the considerations in the case was the meaning of the Commonwealth's ESD objective outlined in Table 6. Specifically, the Commonwealth developed a *National Strategy for Ecologically Sustainable Development* (Commonwealth of Australia, 1992) that states one of the "guiding principles of ecologically sustainable development", decision-making should be to effectively integrate both long and short-term economic, environmental, social and equity considerations. The Strategy was endorsed on 7 December 1992 by the Council of Australian Governments, which agreed that:

> the future development of all relevant policies and programs, particularly those which are national in character, should take place within the framework of the ESD strategy on the environment…

It is important to note that the National Strategy, unlike the Commonwealth's ESD fisheries management objective, explicitly identifies social, economic and equity considerations within the meaning of ESD. This raises the question of whether in making decisions (including quota allocation), the Commonwealth's fisheries management agency (AFMA) may or should take into consideration social and economic factors. Justice Drummond stated in his decision that the National Strategy was a policy of the executive branch of government, whereas AFMA's ESD objective was legislation by the Parliament, and therefore the Strategy could not "be used to illuminate the meaning" of AFMA's ESD objective. Justice Drummond argued that AFMA may not have regard to the social and community components of the National Strategy in decision-making, and that AFMA's ESD objective was:

> concerned only with the need to ensure that the fisheries resources themselves are exploited only to the extent that the sustainability of the fish stocks over the long term is not impaired and with the need to ensure that the marine environment, in which those fish stocks exist, is similarly not subjected to irreparable damage.

THE ROLE OF COMMUNITY AND SOCIAL OBJECTIVES

A number of the management objectives in Table 6 relate to community and social concerns, such as intergenerational equity, cultural well-being, optimum community benefits, achieving community needs and interests, and promoting quality recreational fishing opportunities.

Unlike economic efficiency and ESD, a stronger case could be made for the assertion that fisheries management agencies must take into consideration social and community considerations when allocating quota. Of course, concepts such as social and community benefits are so general that they could allow fisheries agencies almost complete discretion in devising the quota formula. In moving from effort controls to

ITQs, it could be decided that all current effort-control entitlement holders would receive no quota, with all quota being allocated to crew members, new fishers, communities or other groups. Alternatively, it could be decided that, regardless of the catch history or the relative value of existing entitlements, only existing entitlement holders would be allocated quota, but they would be allocated equal amounts of quota (in an effort to help out smaller fishers for social reasons).

Whether it is prudent to ask a management agency, tasked with the rather specific responsibility of fisheries management, to manage fisheries in order to attain social objectives is an open question. Arguably, it would be better for government to further such social objectives directly, as opposed to using the fishing industry as a vehicle for wealth redistribution. Nonetheless, the existence of social objectives in some fisheries legislation does raise the possibility that quota will be allocated wholly or partially on social grounds. If this is the case then in order to minimise the possibility of successful legal challenges, it might be useful to state up front that the reallocation of entitlements is in part based on social or community considerations.

THE ROLE OF EQUITY

The final category of management objectives outlined in Table 6 concerns equity. Specific references include: the appropriate sharing of fisheries resources, ensuring access to fisheries resources is fair, and achieving equitable distribution. The objective that access rights should be allocated in a fair and equitable manner certainly seems relevant when reallocating fishing entitlements.

Understanding how fairness and equity might play a role in quota allocation is best described by an example. Consider the case of a fishery that is managed by limited entry (i.e. only a limited number of individuals possess an entitlement to fish). Assume that the management agency considers that its economic efficiency and ecologically sustainable development objectives are not being reasonably satisfied and decides to replace the current management regime with ITQs. It is decided to allocate quota shares to operators who currently hold licences, and the allocation is to be fair and equitable, as required by the management objectives. How are the rather general concepts of fairness and equity to be made operational?

Huppert (1987) provides the following suggestions, outlining an explicit link between 'equity' and the minimisation of wealth distribution:

> Everyone agrees that fishing regulations should entail an "equitable" distribution of benefits. Although there is no widely recognized definition of equity, there are clear patterns in management practice. In a recent study of twelve government programs that allocate property rights, Rolph (1983) found that policy makers deal with the equity issue by designing regulations to minimize any redistribution of wealth. Where established resource users enjoy benefits of a communal resource (such as in land development, air pollution, air pollution, groundwater pumping) 'the judicial, the legislative, and the executive branches have uniformly supported the claims of historic users when allocating rights.' This principle seems to be honored as well by the existing fishery limited-access system.

However, minimising differential economic impacts on fishers when reallocating access entitlements requires the identification and measurement of the relevant components of wealth before the new regime is put in place. Possible wealth-type considerations include the value of fishing entitlements, vessels, fishing gear, onshore processing facilities, and income dependence (possibly measured by catch history). To explore how a policy of attempting to not redistribute wealth might work in practice we will consider two types of pre-ITQ scenarios, one where fishing entitlements are not transferable and one where they are.

Non-transferable rights prior to ITQs

Consider a fishery where individuals have non-transferable rights to harvest fish prior to the introduction of ITQs. How does one determine the relevant pre-ITQ wealth position of each operator? Since the entitlements cannot be sold or leased, their economic value to the operator is measured by what can be earned from fishing. The income earned by each operator will depend on a number of factors including harvesting skill, investment in vessel, gear and other equipment, the amount of time spent fishing, marketing skills, and their overall ability to run a business and manage crew.

Therefore, one possible option is to allocate quota on the basis of each operator's share of total profits in the fishery. However, there are a number of difficulties associated with this option. First, at an operational level, it would be difficult to obtain 'meaningful' profit data from each operator. Fishers are often involved in more than one fishery, and this complicates the profit calculation if only one of the fisheries is moving to ITQs. While fishers could be asked to provide profit data, the incentive for misreporting is great and the ability to verify is weak.

Secondly, it is not clear that governments should be concerned with the individual business decisions that operators make. The transformation of catch into profits (the cost and marketing side of the equation) involve private business decisions that should perhaps be left out of the allocation process. Rather, it is the catches alone that are relevant indicators of the initial value of the entitlement.

Another possible allocation consideration is the investment that fishers make. However, this option exhibits many of the same difficulties associated with the profit-based option. Specifically, there are significant incentives for fishers to provide biased information, and the inclusion of an individual's business decision-making in allocations can produce difficult-to-rationalise redistribution consequences. For example, consider the case of two operators who each harvested 1,000 tonnes of fish. Operator A operates a cost-effective business and only spent $500,000 on a vessel and other fishing-related equipment, while operator B invests $1 million in a larger vessel and additional harvesting equipment. Splitting the quota according to investment in vessels would leave operator A worse off and operator B better off, as compared to their situation prior to ITQs.

In summary, if one equates equity with minimising wealth redistribution, then in a situation where pre-ITQ entitlements are non-transferable, a case can be made for allocations to be based solely on catch history.

Transferable rights prior to ITQs

Next consider the situation where prior to the introduction of ITQs, individual operators held transferable fishing entitlements. In this situation, a number of operators might have purchased their entitlement from other fishers. The entitlement has value as an asset, regardless of whether the entitlement was used to earn income from fishing or not. Since holders of similar entitlements[4] would have similar asset values, it could be argued that equal quota allocations to all entitlement holders would minimise wealth redistribution.

However, it is likely that fishers (highliners) who have harvested above average catches would feel aggrieved by equal allocations to all fishers. For example, highliners might argue that while their fishing entitlement has the same resale value as those who caught fewer fish, their catch history in the fishery entitles them to a greater share of the TAC.

On the other side of the argument, if quota was allocated solely on the basis of catch history, fishers who purchased expensive effort entitlements but, for one reason or another, did not fish would feel aggrieved, as they would receive no quota. With respect to this possibility, Halvorson (1997) argues that:

> Inactive licenses should receive some quota to recognize the capital asset and the right to fish. An analogy may be drawn to a landlord who does not rent his apartments. His withdrawal from the market leaves more tenants for other landlords. These landlords should not complain when he then makes his apartments available at a time when competition for tenants is great.

However, it could be argued that the landlord in question, who may have paid a substantial sum for the apartments, should receive something more than 'some' recognition for the price paid for the asset.

One option to deal with this situation is to provide all entitlement holders with a base allocation of quota estimated to have the same value as a no-catch-history effort entitlement, and then allocate additional quota based on catch history. Different circumstances may require different approaches. In our opinion, what is important is that if equity and fairness are objectives in the allocation process, then a principled and transparent approach to allocation based on an explicit consideration of the value of pre-ITQ entitlements should be followed.

This approach is followed in Australian Commonwealth fisheries[63], where a policy paper (AFMA, 1997) related to the reallocation of fishing concessions when management regimes change states that:

> AFMA will ensure that: such changes are consistent with and support the pursuit of AFMA's legislated objectives; and any differential economic impacts of allocations on individual concession holders are minimised unless there are reasons, justifiable with respect to AFMA's legislative objectives, that dictate otherwise.

In summary, it does not appear that economic or ESD objectives are relevant considerations to guide the development of quota allocation formulæ. However, fisheries managers should fully expect that various interest groups will appeal to these management objectives in order to increase their share of the TAC. However, the

objectives of fairness and equity would certainly appear to be relevant considerations when determining quota allocations. In keeping with fairness and equity, it would be prudent for fisheries managers to examine the wealth redistribution consequences of alternative allocation formulæ.

However, where fisheries legislation stipulates various social and community objectives, it might be possible to move away from individual fairness and equity considerations when allocating quota. Whether it is prudent to ask a fisheries management agency to use quota allocations as a means to redistribute wealth in order to meet social objectives is an interesting question. If this is to be done, the redistribution consequences should be identified explicitly and directly linked to desired social outcomes. Of course, if allocations are to be implemented through an Act, then it is not necessary (at least for legal reasons) to develop any explicit rationale for the quota formula.

INSTITUTIONAL OPTIONS FOR DETERMINING QUOTA ALLOCATION

The quota allocation formula is often developed by the fisheries management agency in consultation with various user groups. However, there may be advantages in removing the management agency and fishers from direct involvement in developing the recommended allocation formula. First, this reduces the potential for conflict between managers and fishers following the allocation. The level of trust between managers and fishers is often not high, and claims by some fishers that others unfairly influenced the development of the allocation formula often follow allocations. Managers must work with industry after quota allocations have been announced, and this can be made more difficult if segments of industry think that other fishers unduly influenced the manager, or that the manager was biased against certain individuals.

A second reason to exclude fisheries managers from developing a recommended quota allocation formula is that they generally do not possess the appropriate training in law or economics that might be useful in identifying allocation options. It is not clear that knowledge of biology or fisheries management is helpful in determining how to transform effort-control entitlements into ITQ entitlements.

Third, when it comes to quota allocation, fishers have a significant vested-interest bias. Involving industry in fisheries management is a positive move, however involving industry representatives in the direct determination of quota allocation is fraught with difficulties. It has been our experience that fishers pursue allocation formulæ directly related to their vested interests. Low-catch fishers prefer equal allocations, or allocations where catch history is given little weight. There is a tendency for low-catch fishers to argue that they have not taken many fish, and that they should therefore not be penalised for their 'conservation-oriented' behaviour. Another argument of low-catch fishers is that they have targeted on low-volume, high value fishing, and that they would be made relatively worse off with catch-history based allocations.

Highliners usually think catch history should be the most important factor in allocations. Highliners tend to argue that they have been full-time fishers in the fishery in question, have invested substantially in vessels and gear, and have worked hard to

earn their catch history. This is usually followed by the assertion that low-catch fishers have been involved in other fisheries or have just not bothered to fish (which explains their low catch), and therefore high-catch fishers cannot see why low-catch fishers should receive equal allocations. We have heard similar arguments in different fisheries and in different countries. It is not that all fishers just manufacture their logic to suit their interests, many fishers strongly believe in the justice of their arguments. However, we have rarely seen a case where an individual fisher's position with respect to quota allocation is inconsistent with his or her self-interest.

So, if fishers and managers are not to be directly involved in determining the allocation formula, how is the task to be accomplished? The remainder of this section describes an alternative approach being used by some fisheries management agencies.

ESTABLISHMENT OF INDEPENDENT ALLOCATION PANELS

Recently there has been a move to seek independent recommendations with regard to the determination of quota allocation formulæ. For example, in 1996, the Canadian Department of Fisheries and Oceans appointed an independent arbitrator (a former Justice of the Court of Queen's Bench for Saskatchewan) to consult with industry and recommend both individual and intersectoral quota allocations in the west coast trawl groundfish fishery (see Halvorson, 1997).

In Australia, the Australian Fisheries Management Authority (AFMA) has developed a process for determining quota allocation that involves a policy of minimising wealth distribution (see FERM, 1997c for additional information on the AFMA allocation policy and process) and the establishment of independent allocation advisory panels. The panels operate at arm's length from AFMA and comprise a retired judge, an economist and a fisher (not associated with the fishery in question). The allocation advisory panels advise AFMA on the most appropriate basis for allocating fishing entitlements in a fishery or amongst fisheries. Panels are also tasked with the identification of any exceptional circumstances that should be taken into account. In carrying out their functions, allocation panels must:

- consult widely with stakeholders and relevant parties and any person/s or organisations with appropriate knowledge or experience;
- identify the information necessary to implement the quota formula;
- identify the most cost effective and appropriate methods for collection and verification of this information;
- explain and justify recommendations to AFMA;
- provide advice to AFMA officers appearing before tribunals or courts; and
- maintain full records of all activities undertaken by the panel.

The first allocation panel was established in 1997, and was asked to advise AFMA on the apportionment of the total allowable catch of blue-eye trevalla, blue warehou, and pink ling between the non-trawl and trawl sectors of the south east fishery. In addition the panel was asked to recommend an appropriate formula for allocating ITQs in the non-trawl sector.

Since the creation of the first panel, AFMA has established independent advisory panels for quota allocation in the southern shark fishery and the Bass Strait scallop fishery. Allocation panels have also been created to recommend transferable effort allocations in the east coast tuna and billfish fishery and the northern prawn fishery. The northern prawn fishery is moving from a management system based on individual transferable effort units of (engine and underdeck) capacity, to effort units that are based on an amount of fishing gear. The east coast tuna and billfish fishery is currently managed by limited entry, vessel and gear restrictions, and area closures, and the proposed new management regime is also gear-based individual transferable effort units.

In Queensland, an allocation panel comprised of three individuals with legal, economic and industry expertise was established to make individual quota recommendations in the spanner crab fishery. A similar panel was established to advise the South Australian fisheries authority on the allocation of giant crabs.

A number of points are worth noting with respect to the above independent allocation panels established in Australia.

- Although still relatively early days, no recommended allocation formula has been overturned in the courts.
- Fisheries managers indicate that they prefer the independent allocation panel process, and would not want to go back to the process where they recommend the allocation formula.
- It should be remembered that under existing legislation, management agencies are usually ultimately responsible for determining the allocation formula — i.e., panels only recommend.
- A number of fishers will oppose a panel process, especially those that think they can influence politicians or management agencies more easily than they can influence an independent panel.
- It will not be easy for a management agency to deal with the situation where they think that a panel's recommendation is fundamentally flawed.

The latter point is worth thinking about. Given that an important aspect of the independent panel process is to keep the allocation discussions and recommendation-making at arms-length from the management agency, it would be politically difficult for the agency to dismiss the recommendations of the panel — however, legally the management agency must not blindly accept a panel's recommendations. This fact strongly suggests that careful thought should be given to both selecting an expert panel and to ensuring that the allocation policy of the fisheries management agency is unambiguous. The experience so far is that panels have attracted quite valuable talent; for example, the panel for the northern prawn fishery has a retired High Court judge. It is, however, too early to judge the relative success of the independent panel process in Australia.

ENDNOTES

1 Much of the following discussion is based on Kaufmann and Geen (1998).
2 (1997) 24 AAR 435
3 VG 268 of 1996
4 Entitlement values for the same fishery may vary because of differing restrictions (e.g., area, vessel or gear limitations) placed on entitlements. Expectations that catch history will play a role in quota allocation can also affect the value of individual entitlements.
5 This approach is also used in Queensland fisheries.

7 COMPLIANCE AND ENFORCEMENT

Perceived difficulties in enforcing compliance often provide a focal point for industry and bureaucratic opposition to the introduction of ITQ systems. Sources of probable quota leakage from the system are usually identified, drawing on the geographic peculiarities of the fishery and the ingenuity of fishers in overcoming all forms of management regulations. This is normally followed by assertions from fishers that the size of compliance expenditures needed to subdue the tendencies of their peers to cheat would be enormous, and would certainly bankrupt the industry. Scientists often add to the chorus by pointing out that fishers' efforts to evade the quota monitoring system and to highgrade their catches are likely to have adverse knock-on effects on the integrity of catch and effort logbook data, and that such 'data fouling' could have dire consequences for the accuracy of stock assessments.

The difficult task for a fisheries management authority proposing to introduce ITQs is to design a quota compliance program that will not only be effective, but will instill confidence in fishers, scientists and the general public, without causing management costs to soar.

With these issues in mind, this chapter reviews the main approaches used in Australia and to a limited extent, in other countries, to achieve compliance with ITQ management regulations (the main features of ITQ compliance regimes in Australia are detailed in Table 7). Alternative 'paper trail' and dockside quota monitoring systems are described and some observations on their likely effectiveness in deterring and detecting non-compliance are provided based on the practical experiences of a number of fisheries management agencies. These observations are supplemented by a comparison of the costs of a simple paper trail system and a proposed dockside monitoring system in five southeastern Australian quota-managed fisheries.

Communications technologies, such as pager reporting and vessel monitoring systems (VMS) are increasingly being used to enhance the effectiveness of both paper trail and dockside quota-monitoring systems. The integration of these supporting systems and their roles in tightening Australian compliance regimes are also described. The chapter concludes with a brief summary of the main administrative and judicial sanctions used in the enforcement process.

QUOTA MONITORING: THE PAPER TRAIL APPROACH

The simplest quota monitoring system involves the completion by fishers of catch logbooks that are submitted to the management authority on a weekly or monthly basis. There is no independent verification of landing details. This form of paper trail is sometimes used in small, low value fisheries or as an interim measure for fisheries in which management arrangements have not been fully developed. Such logbook based quota monitoring is used in the South Australian fisheries for mulloway and Australian salmon that are managed by non-transferable quotas.

TABLE 7
SUMMARY OF MAIN FEATURES OF QUOTA MONITORING AND COMPLIANCE REGIMES IN AUSTRALIA

Agency	Fishery	Paper trail	Dockside monitoring	Paging		VMS	Designated ports	Product identification
				Fishers	Processors			
Commonwealth	Southern bluefin tuna	Yes	No	Yes	No	No	No	No
Commonwealth	South east trawl	Yes	Pilot dockside weighing	Yes	No	Some vessels	No	No
Commonwealth	South east non-trawl	Yes	Pilot dockside weighing	Yes	No	Some vessels	No	No
Commonwealth	Shark	Yes	Pilot dockside weighing	Yes	No	Some vessels	No	No
Commonwealth	Bass Strait scallop	Yes	Pilot dockside weighing	Yes	No	All vessels	No	No
New South Wales	Abalone	Yes	No	No	No	No	No	No
New South Wales	Rock lobster	Yes	No	No	No	No	No	Horn tag
Queensland	Spanner crab	Yes	No	Yes	No	No?	No	No
South Australia	Southern zone rock lobster	Yes	Pilot voice response system	No	No	No	Yes	No, except bait tails
South Australia	Abalone	Yes	No	Yes	No	No	No	Sealed containers of shucked abalone
South Australia	Blue swimmer crab	Yes	No	No	No	No	No	No

Note: Aquaculture producers of abalone also have to provide pager reports when moving abalone on and off the farm

TABLE 7 (CONT.)
SUMMARY OF MAIN FEATURES OF QUOTA MONITORING AND COMPLIANCE REGIMES IN AUSTRALIA

Agency	Fishery	Paper trail	Dockside monitoring	Paging		VMS	Designated ports	Product identification
				Fishers	Processors			
Tasmania	Rock lobster	Yes	No	Yes	Yes	Some vessels	Yes	Horn tag on lobster for domestic sale.
Tasmania	Abalone	Yes	No	Yes	Yes1	No	No	No
Tasmania	Giant crab	Yes	No	Yes	Yes	Most vessels	Yes	No
Victoria	Abalone	Yes	No	No	No	No	No	Sealed bins with bin tags
Victoria	Scallop	Yes	No	No	No	No	No	Crates sealed with crate tags
Western Australia	Pink snapper	Yes	No	No	No	No	No	No
Western Australia	Abalone	Yes	No	No	No	No	No	Consignments numbered and crates numbered.
Western Australia	South Coast purse seine	Yes	No	No	No	No	No	No
Western Australia	Pearl oyster	Yes	No	No	No	No	No	Shell tags

Note: Aquaculture producers of abalone also have to provide pager reports when moving abalone on and off the farm

The most commonly used form of quota monitoring system involves the use of a paper trail of catch landing, transit and processor receival documentation — what we will call the "Fisher & Fish Receiver" model. In some fisheries, this paper trail is extended to account for the quantities of products sold by processors and exporters to facilitate thorough audits of processor/exporter transactions and, hence, deter collusion with fishers to under-report catches (an Extended Paper-Trail model).

Fisher & Fish Receiver model

The basic information set includes the following — a catch disposal record completed by fishers, a transit form completed by the transporter, and a catch receival record completed by an authorised fish receiver (see Box 2). The catch disposal and receival documentation is sent independently to the fisheries management authority that checks for discrepancies and, if the data are consistent, decrements the fisher's quota holding by the verified quantity of fish landed. Random checking by compliance officers of completed documentation against actual unloading at wharves, and fish receivals at processing establishments usually supports this system.

The quota monitoring paper trails used by the Australian Fisheries Management Authority (AFMA) are based on the completion of catch disposal records by fishers and their subsequent validation by authorised fish receivers. Following each unloading, and before the fish is moved more than 50 metres from the boat, or before the fish enters the premises of a fish receiver, the fisher must complete one section of a catch disposal record with the estimated weight[1] of the catch.

The record must be sent to AFMA within 24 hours of dispatch of the consignment. If more than one truck is used to carry a consignment of fish to a receiver, each truck must have a completed transit form, cross-referenced to the catch disposal record, that details the fish carried by that truck, and the last truck must carry copies of the catch disposal record.

The fish receivers fill in another part of the catch disposal form. The fish receiver verifies the species and weights of fish received, signs one copy of the catch disposal record and posts it to AFMA by the first Monday following the day the fish were received. The fish receiver retains one copy of the catch disposal record. AFMA decrements the fisher's quota on the basis of the verified weight supplied by the fish receiver. Reports on catches against quota holdings are sent periodically to each quota holder[2].

BOX 2
FISH RECEIVERS

Fish receivers are individuals or firms licensed under a Fisheries Act to purchase fish directly from fishers. Fish receivers are usually required to maintain purchase and sales records, to forward verified fish receival records to the fisheries management authority and to allow fisheries officers to enter and search their premises. Fish receivers may also be required to maintain detailed records of stock in hand.

Compliance problems: Fisher & Fish Receiver model

Collusion between fishers and authorised fish receivers to mis-declare landings is a primary source of non-compliance with the Fisher & Fish Receiver system. Landings of unrecorded catches to unregistered fish receivers may also be a significant problem in some fisheries.

The Tasmanian abalone fishery operated with a Fisher & Fish Receiver paper trail from 1985 until 1998 when ITQs were introduced. The system was based on the completion of a catch-landing docket by the abalone diver, which was subsequently verified by the processor who received the catch. As stated in a draft management plan for the fishery (Tasmanian Department of Primary Industry and Fisheries, 1997):

> problems with the [then] current system are indicated by anecdotal and hard evidence of illegal catches entering the processing sector and unexplained differences in processing recovery rates between and within processors. Currently, leaks of illegal abalone out of the processing stream are untraceable, especially when the abalone is moved into the domestic market. This is because processors do not have to match their inputs with their outputs. The level of compliance by divers and processors in the past has been impossible to verify, as have estimates of the amount of abalone illegally entering the processing system.

Making the case for an improved reporting system, the Tasmanian Department of Primary Industry and Fisheries also states that:

> It is possible for illegally taken abalone to be landed and introduced into the processing stream with few checks before, and none after, entering the processing system. To reduce the opportunity of illegal abalone entering a processing operation, there needs to be more detailed and timely information about abalone catches, and the processing and subsequent movements of abalone or abalone product, both within and out of the state.

The development in Tasmania and Victoria of an abalone farming industry adds further to compliance difficulties by creating a potential market for illegal and often under-size abalone, and additional complexity in relation to input/output ratios in the processing sector.

A Fisher & Fish Receiver paper trail system has been in place in the AFMA managed southeast trawl fishery since 1993. As in the Tasmanian abalone fishery, this approach to monitoring, coupled with a relatively low level of random inspections by fisheries officers of unloadings and weighings, provided ample scope for collusion between fishers and processors to not report or under-report catches. To date, there has been only one successful prosecution of fishers and fish receivers for collusive mis-declarations of catches, although charges have been laid in several other cases. The deterrent effect on other fishers of the jail sentences, fines and administrative sanctions (suspensions of double the quantity of quota that was over-caught) incurred by these offenders may have been eroded somewhat because of the four year time lag between the detection of these offences and convictions.

A 1996 review of compliance in the south east trawl fishery indicated three main avenues of non-compliance: non-reporting of landings of fish; mis-reporting of fish caught in Commonwealth waters as being caught in state managed waters where quotas are not in force; and, mis-reporting of fish caught in Commonwealth waters as being

taken in adjacent fisheries or by other gear types not subject to quota (SETMAC Compliance Working Group, 1996).

The subsequent implementation by state fisheries authorities of trip catch limits in state waters on many AFMA managed trawl species, the introduction of VMS and a requirement that multiple-licensed vessels could fish in only one jurisdiction per trip reduced significantly the latter types of mis-reporting[3].

Extended Paper-Trail model

This approach to quota monitoring is aimed at developing a picture of product flow through the production and marketing system so that illegal activities can be detected. A number of Australian jurisdictions, namely South Australia, Tasmania, Victoria and New South Wales have adopted variants of this system for one or more fisheries. The system was initially developed in New Zealand, where the vertically integrated structure of a large part of the industry would provide ample scope for mis-reporting of catches under a Fisher & Fish Receiver system. A simple version of an extended paper trail is used in Alaskan ITQ fisheries for halibut and sablefish. The Alaskan system also incorporates electronic transmission of landings data by fishers to the US National Marine Fisheries Service. The main features of the Alaskan quota monitoring system are described in Box 3.

BOX 3
KEY FEATURES OF THE ALASKAN QUOTA MONITORING SYSTEM

Deliveries of halibut and sable fish can only be made to registered buyers.

Landings are recorded using swipe cards through transaction terminals located in the premises of registered buyers. The cards display the name of the fisher, permit and vessel (in the case of hired skippers). When the card is swiped through the terminal, a connection is made with the central computer database. The fisher enters landings details, including species and weight, and the terminal prints out a "receipt" that is signed by the fisher. The swipe card can be used to check the balance of the quota holdings.

The reported weights of halibut and sablefish are adjusted to the standard management weight by correcting for processing (for example, halibut head on or off) and for ice and slime.

Registered buyers must file shipment reports to the National marine Fisheries Service to enable product to be tracked from point of landing to its first destination.

The system is supported by random at-sea and dockside inspections. In 1997, 11,000 landings (14% of total) were inspected and 153 boardings were carried out by the US Coast Guard. These inspections resulted in 179 confiscations of catch where the landing exceeded the fisher's remaining quota balance by more than 10% (National Marine Fisheries Service, 1998).

The extended paper trail system used by the Fisheries Department in South Australia for monitoring catches from the southern zone rock lobster fishery is more comprehensive in coverage than the Alaskan system, and is described in detail below. The requirements of fishers and first fish receivers, with respect to the completion of catch disposal records, are similar to those described above under the Fisher & Fish Receiver model.

Fishers have to complete Section A of a catch disposal record prior to landing, which includes an accurate number of rock lobsters caught and their estimated weight. One copy of this stays on board the vessel. A significant difference from the AFMA system is that rock lobster fishers have to weigh their catches on the wharf, using scales provided by the South Australian Fisheries Department. Scales are sited at all major ports around the fishery. Fishers landing at minor ports have to transport their catch to the nearest authorised scales for weighing. The South Australian fishers then complete Part B of the catch disposal record with the accurate weight of their catch and post the completed catch disposal record in a locked box adjacent to the scales. The catch disposal records in the locked box are collected daily and fisher's quotas decremented using these records (see Figure 1, a reporting flow chart for South Australian Southern Zone rock lobster fishers). The South Australian Fisheries Department is currently implementing electronic catch reporting for fishers to replace the 'paper' catch disposal record system (see Box 4). This system is similar in concept to that used in Alaskan fisheries.

Subsequent paperwork completed by processors is for the purpose of developing a detailed picture of product flow through the processing and marketing system. This is to enable authorities to detect by audit illegal sales of lobster to processors by licensed fishers, unlicensed fishers or recreational and indigenous fishers (see Figure 2, a reporting flow chart for fish receivers of southern zone rock lobster). Processors are required to submit monthly returns detailing sales, purchases, processing, storage and movement of lobsters. Compliance officers conduct random inspections of landings and receivals at processing premises.

Similar extended paper trail systems were introduced in 1998 in Tasmania for monitoring compliance in the rock lobster and abalone fisheries. These systems have been further tightened compared to the South Australian version by the addition of real time telephone reporting requirements on fishers and fish processors at various control points in the production, processing and marketing chain[4]. These requirements are described in detail in the section on pager reports later in this chapter.

The overall reporting requirements of Tasmanian fishers and processors of rock lobster are summarised on "compliance checklists" distributed by the Tasmanian Department of Primary Industries, Water and Environment. The compliance checklists for fishers and processors in the Tasmanian rock lobster fishery are reproduced in Figure 3 and Figure 4.

BOX 4
ELECTRONIC CATCH REPORTING —
SOUTH AUSTRALIAN "TELEPHONE BANKING" TYPE SYSTEM

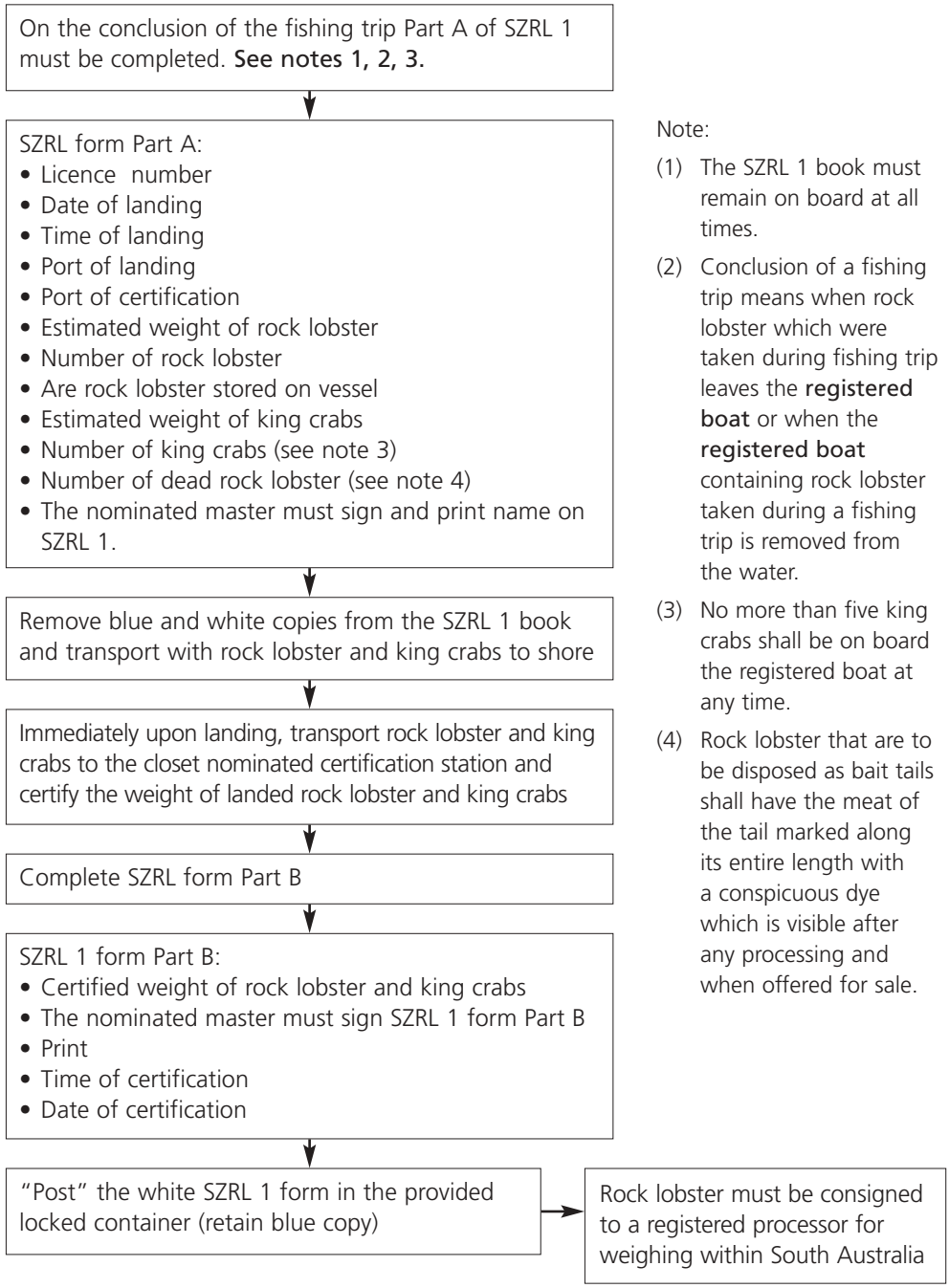
The South Australian Department of Fisheries carried out a successful trial, during the 1997–98 season, of an electronic catch reporting system in four ports in order to monitor landings from the southern zone rock lobster fishery. The system is aimed at achieving cost savings through reduced data entry and improving the effectiveness of compliance (FERM, 1998b). The system is to be implemented throughout the fishery in 1998–99.

The system is similar in concept to telephone banking — that is, an integrated voice response system. Fishers input their landings data on the keypad of a telephone in response to a series of automated questions. Fishers weigh their rock lobster catch on a set of scales located on the wharf in a designated port. The scales are "clock" type, belonging to the South Australian Department of Fisheries. The telephone is located in a cabinet or shed adjacent to the scales. Fishers punch in their personal identification number and are asked a series of questions on the number and weight of their catches of rock lobster and king crab and the quantities still on board the vessel. When the "transaction" is confirmed, the fisher's quota holding is decremented and the fisher is provided with his/her new quota balance.

Overall, it would appear that the integrated voice response system will result in significant cost savings (estimated at around $100,000 per year), mostly as a result of the elimination of the costs of the catch disposal record "postman" and data entry of fisher catch disposal records. A lot of paperwork remains in the system, with the requirements on fish receivers being unchanged. As unloadings and weighings continue to be monitored only on a random basis by compliance officers, there appear to be few, if any, additional compliance benefits from the system except, perhaps, any benefits that might flow from the fisher being automatically provided information at each weighing on the amount of his/her quota remaining uncaught. On a practical front, the integrated voice response approach is most appropriate for fisheries in which there are few species. Such a system is unlikely to be useful for a multi-species fishery, as questions would be numerous and time consuming.

FIGURE 1
SOUTH AUSTRALIAN SOUTHERN ZONE ROCK LOBSTER FISHERY
REPORTING FLOW CHART FOR FISHERS

(Reproduced from Primary Industries and Resources, South Australia,1998)



Note:

(1) The SZRL 1 book must remain on board at all times.

(2) Conclusion of a fishing trip means when rock lobster which were taken during fishing trip leaves the **registered boat** or when the **registered boat** containing rock lobster taken during a fishing trip is removed from the water.

(3) No more than five king crabs shall be on board the registered boat at any time.

(4) Rock lobster that are to be disposed as bait tails shall have the meat of the tail marked along its entire length with a conspicuous dye which is visible after any processing and when offered for sale.

FIGURE 2
EXAMPLE OF AN EXTENDED PAPER TRAIL SYSTEM: SOUTH AUSTRALIAN SOUTHERN ZONE ROCK LOBSTER FISHERY FISH PROCESSOR FLOW CHART

Reproduced from Primary Industries and Resources, South Australia, 1998.

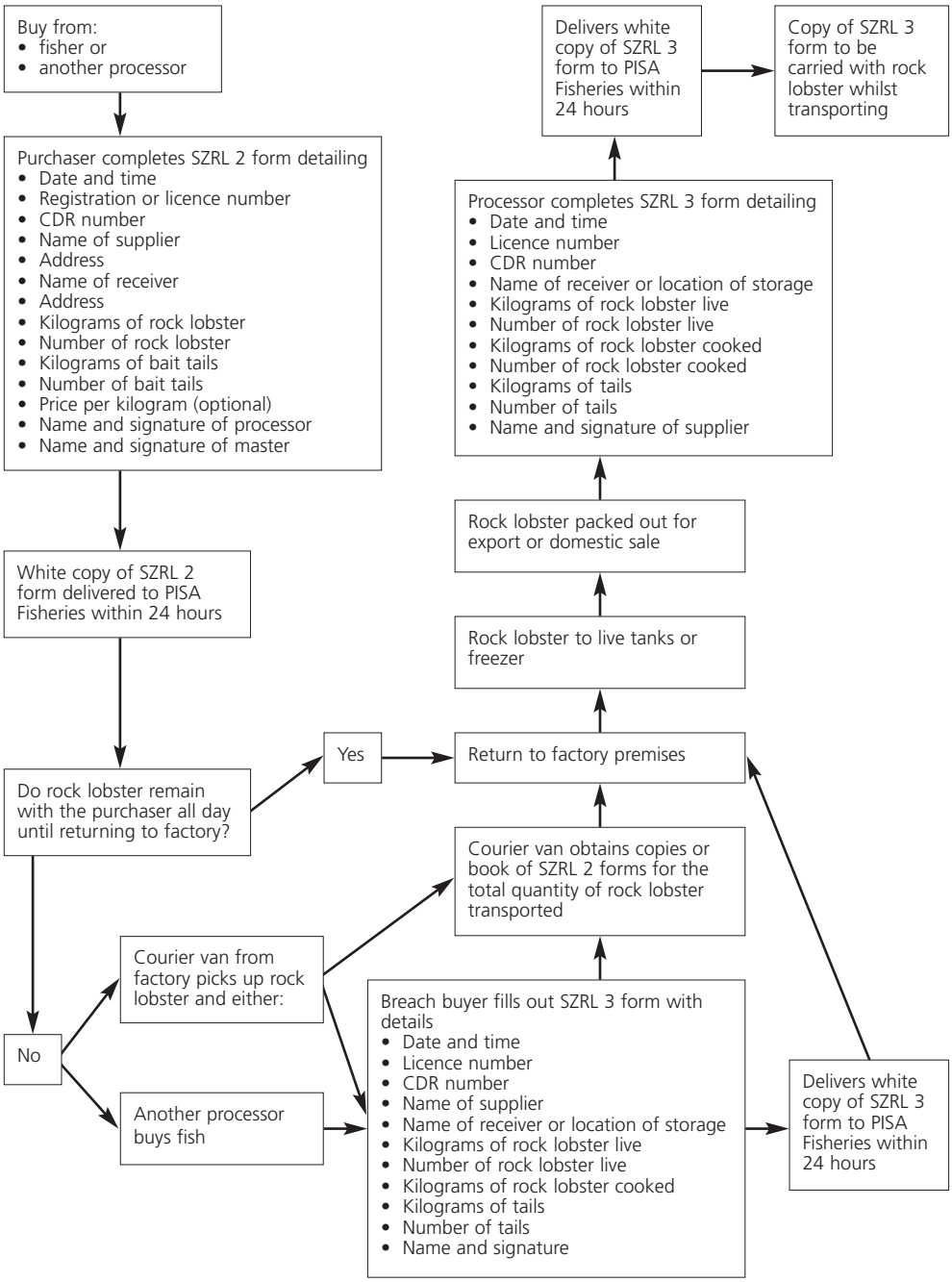


FIGURE 3
ROCK LOBSTER FISHERS COMPLIANCE CHECKLIST (TASMANIA)

Tasmania

Rock Lobster Fisher's Compliance Checklist

If you	You must **have**			You must make a **telephone report**					You must have **filled in**					You **must**
	Current fishing and boat licences	Unfished quota	An endorsed licence	> 2 hours before leaving port	> 2 hours before unloading	Before the fish leave the site of unloading	> 2 hours before dispatching lobster	> 1 hour before using a cauf	Part A of a quota docket	Your Catch Record Book	Part B of a quota Docket*	Transfer Certificate (Leaving)	A Sales Receipt	Tag all lobster sold
Take lobster	●	●								●				
Leave port with lobster on board after a part unloading				●										
Land lobster					●				●	●	●			
Sell more than 5 lobster direct			■		●	●	◆		●	●	■	◆	●	✪
Sell 5 or less lobster direct										●			●	●
Put lobster in a cauf			●					●		●				
Take lobster out of a cauf			●		●					●				
Store lobster in a holding tank			●		●				●	●	■			
Take lobster from holding tank			●				◆					◆	●	✪
Make an emergency landing					▼				●	●	●			
Land lobster interstate			■		■	■	■		■	●	■			

■ Special conditions apply

▼ Within 30 mins of unloading

✪ Only if you sell directly for Tasmanian market

◆ Only if selling interstate

* You must not complete Part B of the Docket yourself.

TELEPHONE REPORT LINE NUMBER 1800 067 470 OR (03) 9883 3335

THIS CHECKLIST IS NOT A LEGAL DOCUMENT – FOR ADDITIONAL INFORMATION TELEPHONE DPIF ON 6233 6514

FIGURE 4
ROCK LOBSTER PROCESSOR'S COMPLIANCE CHECKLIST (TASMANIA)

Tasmania

Rock Lobster Processor's Compliance Checklist

If you	You must make a **telephone report**					You must **fill in**			**And** you must			
	Before fish leave the unloading site	Within 15 mins of receipt at the premises	Immediately the fish are weighed and counted at premises	> 2 hours before accepting delivery	> 2 hours before sending lobster interstate	Part B of the Fishers Docket **(Signature only)**	Transfer Certificate (receipt)	Transfer Certificate (Leaving)	Fax copy of Transfer Certificate (Leaving) to DPIF before the lobster leave	Issue a receipt	Tag the lobster	Mail the Transfer Certificate (receipt) to DPIF at COB on the day of receipt
Receive lobster from a licenced fisher for transport to your premises	●					●						
Receive lobster at a premises		●					●					●
Transport lobster	●				●			●	●			
Export lobster which has not been firstly taken to a premises listed on your licence					●	●		●	●			
Sell to the Local Tasmanian Market										✉	●	
Receive lobster from someone other than a licenced fisher		●		●			●					●

■ Both processors and handlers

✉ For more than 5 lobsters

✪ Handlers transporting directly out of the State

TELEPHONE REPORT LINE NUMBER 1800 067 470 OR (03) 9883 3335

THIS CHECKLIST IS NOT A LEGAL DOCUMENT – FOR ADDITIONAL INFORMATION TELEPHONE DPIF ON 6233 6514

The quota of Tasmanian rock lobster fishers is decremented using the data provided by fishers in the catch disposal record. The catch disposal record also contains the verified weight of lobsters purchased by the fish receiver. Licensed fish handlers or fish processors who purchase the catch must verify the weight of catch and both parts of the catch disposal record must be completed before the lobster leave the wharf or enter the premises of a processor. One copy of the catch disposal record is sent by the fisher to the Tasmanian fisheries authority within 48 hours, one copy is retained by the fisher and the remaining copy travels with the rock lobster during transport.

Rock lobster transfer dockets are used to record all receivals and dispatches of rock lobster from processing factories. Information collected on the docket includes the number and weight of rock lobster received and dispatched, vehicle registration details and destination. The docket must be completed immediately after receipt and weighing and sent by post to the fisheries authority on the same day. Similarly, a docket must be completed prior to dispatching any rock lobster and faxed to the fisheries authority prior to any lobster leaving the premises. The holder of a fish handling licence must complete the transfer docket prior to dispatching any rock lobster from the state.

Holders of a rock lobster processing licence or fish handling licence are required to maintain records of the amount of stock on hand on any given day, processed weights of rock lobster, ownership of rock lobster on the premises and details of consignments of rock lobster that have entered or left the premises. Holders of rock lobster processing and fish handling licences are also subject to annual audits. This is also the case under the New Zealand Extended Paper Trail system, the main features of which are shown in Box 5 (for a more detailed description of documentary requirements under the New Zealand quota management system, see Clement and Associates, 1998). A recent addition to the New Zealand system is a requirement for fish receivers to undertake an annual systems audit to ensure that their record keeping complies with regulations.

Fishery management authorities also use a variety of other catch monitoring mechanisms to support the paper trail system. Fishers are sometimes required to use sealed crates or individual marker tags to identify the origin of catches once they enter the marketing chain. For example, in the South Australian southern zone abalone fishery, boxes must be sealed using a special tag. In Tasmania, the abalone or rock lobster catch of each fisher must be held in separate crates until dispatched for processing. If the rock lobsters are destined for sale on the domestic market, each must have a plastic tag attached to its horn, as an impediment to black market sales of commercial, illegal and recreational catches. It is an offence in Tasmania for a person to possess or offer for sale untagged rock lobsters. This does not apply to holders of recreational fishing licences who are, though, required to punch a hole through the tail fans or clip the tail fans of recreationally caught lobsters; or to persons taking part in an Aboriginal Cultural Activity (as specified under the *Living Marine Resources Management Act 1995*).

In South Australia, recreational rock lobster fishers are required to register their pots and are subject to a daily bag limit, as are recreational divers. However, there is no requirement to mark the lobsters. Rather, the onus is on processors to account for all the lobsters that they purchase.

BOX 5
DOCUMENTARY REQUIREMENTS OF THE
NEW ZEALAND QUOTA MONITORING SYSTEM

1. Catch, Effort and Landing Return. This is completed by the skipper of the fishing vessel when the catch is landed, providing an on-site record. It is not submitted, but must be available on demand from a compliance officer. It records fishing activities and sales of fish. For trawlers 28 metres and over, a daily fish processing summary is included.
2. Quota Management Report. This is completed by the quota owner and submitted to the Ministry of Fisheries monthly. It records the quantities of each quota species caught in each fishing area.
3. Licensed Fish Receivers Return. This is submitted monthly to the Ministry of Fisheries by licensed fish receivers. It identifies the name of each quota holder from whom fish is received and the species and weights of fish.

In addition to these three main channels of reporting, there are a number of supplementary documentary requirements placed on *licensed fish receivers*. These are to *maintain*:

a) Unloading dockets and purchase invoices;
b) Stock transfer documents and internal retail transfer records;
c) Retail sales documents and sales invoices; and *submit*
d) Annual inventory returns; and
e) Annual systems audit (to ensure compliance with record keeping regulations).

Other *"dealers in fish"*, such as owners of retail outlets or any persons who purchase fish products for sale, are required to keep purchase, sales and inventory records.

Compliance problems: Extended Paper-Trail Model

The more comprehensive reporting system under the Extended Paper-Trail model is likely to narrow the bounds of non-compliance compared to the problems experienced under the Fisher & Fish Receiver model. The effectiveness of the extended paper trail system depends on the ability of the fisheries management authority to detect and prove, mainly through cross checking of documentary evidence and audit, the entry of illegal fish into the processing and marketing chain. This is a complex task. Special investigative or audit units have been established in the Tasmanian and South Australian fisheries authorities, in addition to the normal compliance/policing units, to identify and investigate possible offences, particularly in relation to fraudulent reporting by fishers and processors. The departmental officers recruited to these units are often trained as investigative accountants.

The enormity of the cross-checking task clearly identifies the need for automation. Each landing of fish and its subsequent passage along the processing chain generates a substantial number of reports, the data from which must be collated, stored and cross-checked. A typical landing of rock lobster in Tasmania, for example, would be likely to generate at least seven separate reports from the fisher and processor. The development of software for the automatic cross-checking of reports is planned in both Tasmania and South Australia.

Part of the software development involves the estimation of input/output ratios or conversion factors for fish products being processed. Scope for under-reporting of catches of abalone, for example, will remain until a large range of credible conversion factors is estimated that accounts for each abalone species, area of capture, season, water loss and final product type. Until such time, discrepancies between average input and output rates may be explained by processors by reference to, for example, differences in product quality and yield on a temporal or geographic basis. Similar difficulties in identifying clearly mis-reporting activities have also been experienced in the South Australian rock lobster fishery. The need for additional data entry staff, computer systems support and development personnel, accountants and investigative field officers to staff audit units points to the fact that establishing and operating audit units to support an extended paper trail system is relatively expensive. In New Zealand, there have been a number of successful prosecutions of collusive mis-reporting of landings by fishers and processors, based largely on evidence provided by audits[5]. Annala (1996) reports several prosecutions that resulted in heavy penalties, including loss of quotas, vessels, and plant and equipment.

Notwithstanding, a survey report on fisher's attitudes to compliance, commissioned by the New Zealand Ministry of Fisheries, (CM Research, 1998) indicated that:

> skippers/quota owners do not feel that their chances of being caught undertaking these [illegal] activities are high. There is a feeling among many that the Ministry of Fisheries does not have enough staff to undertake this auditing or enforcement work.

The survey did, however, suggest that the heavy penalties for quota offences specified in the Fisheries Act influences fishers to be compliant, and if caught committing an offence most fishers believed they would be prosecuted.

Rather than use extensive and complex paper trail systems to attempt to deter or detect illegal catches entering the processing/marketing system, several fisheries authorities around the world are focusing their compliance resources on dockside monitoring of landings.

QUOTA MONITORING: THE DOCKSIDE MODEL

Frustrations with the difficulties of tracking product after it has left the wharf, and high costs of traditional compliance activities have led some fisheries management authorities to focus their compliance resources at the dock where fish are landed, and to use new communications technologies to assist their compliance efforts. The thrust of dockside monitoring is to simplify compliance by accounting for all commercial catches of quota

species before they leave the docks. Much of the discussion in this section is based on a benefit/cost analysis undertaken of the development of a dockside quota monitoring system for AFMA by FERM (1998b).

Dockside monitoring has been used in a number of ITQ managed fisheries on the west coast of Canada, namely the groundfish hook and line, groundfish trawl, and sablefish fisheries. A private company, contracted by the Canadian Department of Fisheries and Oceans to carry out the monitoring, has trained and contracted at-port observers to monitor the weighing of quota species. The observers manually record the catch data (the fish are weighed by operators) and forward the information to company headquarters where it is entered in an electronic database (which is in turn provided to the Department of Fisheries). The observers do not have any compliance authority, but contact compliance officers if they detect irregularities.

The National Marine Fisheries Service is also proposing to upgrade its dockside monitoring presence in Alaskan ITQ fisheries by placing weighmasters in a number of major Alaskan ports (National Marine Fisheries Service, 1998). The success of the Canadian system, combined with a US political imperative to downsize government and contract out services where possible were influential factors underpinning this shift toward increased dockside monitoring (Matthews, 1997).

The basic dockside monitoring system, as used in Canada, is being modified and pilot tested by AFMA for the monitoring of five ITQ managed fisheries in southeast Australia. The modified system features electronic weighing and capture of landings data and electronic transmission of the data from the dockside to AFMA.

AN ELECTRONIC QUOTA MONITORING SYSTEM (EQMS)

Concerns by operators in the south east trawl fishery over the amount of paperwork involved in quota monitoring have been evident since the introduction in 1992 of the ITQ system, and were noted in a 1996 report from the SETMAC Southeast Fishery Compliance Review Group. In an effort to reduce the amount of paperwork, AFMA and the Review Group established a trial for an 'integrated electronic weighing scales' in a Fishermen's Cooperative in New South Wales. This was to prove to be the first phase in the development and implementation of an electronic dockside monitoring system.

The stated objectives of the phase one project were to:

- provide for automated production of all records relating to the transportation and marketing of fish;
- provide for automated production of all relevant government records such as the catch disposal records, and in the longer term to replace all paperwork by transferring verified catch data direct by modem;
- remove duplication of effort by the fishing industry, markets and government relating to data entry and completion of paper records; and
- enhance current monitoring and compliance arrangements in the south east trawl fishery (and other fisheries as the system expands).

The centrepiece of initial development was a keypad that interfaced with digital scales and a personal computer (PC). The keypad allowed for electronic capture of data on the weights of boxes of fish weighed on digital scales, transfer of this information to a local PC, and printing of various quota monitoring and market related documents. The approximate costs of the various components of the hardware are given in Table 8.

TABLE 8
APPROXIMATE HARDWARE COSTS TO THE FISH RECEIVER OF THE PHASE ONE ELECTRONIC WEIGHING SYSTEM

Item	Cost
Keyboard and data logging software	$4,300
Digital scales	$2,075
Fish bin ticket printer	$3,099
PC	$1,500
Printer	$500
Modem	$400
Total	$11,874

Source: FERM, 1998b

The system works as follows. To access the keyboard, the user first enters a personal identification number. Once entered, the user's boat name and distinguishing symbol are displayed on the screen and the prior report number of the landing requested. The user then places a bin of fish onto the scales for weighing, and enters the following information: species of fish; process state (for example, headed and gutted); grade; ice allowance; destination of fish; and the type of fisheries management documentation that is required (for example, a catch disposal record). Subsequent bins of the same species (with the same product form and destination) are simply placed on the scales to allow the weight to be recorded; no additional data entry by the operator is needed.

On completion of weighing, the information is forwarded to the local PC. The PC contains the quota monitoring software that accepts the information and allows the following reports to be generated:

- tally sheets (a form given to fishers by the fish receiver or co-op, which acts as a receipt for fish unloaded);
- consignment sheets (a form that accompanies the fish to market on a truck, and details the total weight of fish and name/identification of owner);
- bin dockets (a small card that is attached to each bin of fish, giving species, weight and owner details); and
- AFMA catch disposal records.

The quota monitoring software was also designed to allow fish receivers to forward catch data to AFMA electronically, in a pre-determined format and at pre-determined intervals. This would replace the need for catch disposal records to be manually entered

on AFMA databases. This capability of the equipment was not operationalised during phase one of EQMS development.

The Phase One trial successfully demonstrated to fishers, other Fishermen's Cooperatives and AFMA some of the potential benefits of electronic quota monitoring. In particular, the paperwork burden on fishers and fish receivers related to filling in catch disposal records and fish transport documentation was eliminated. Also, the automated printing of bin tickets resulted in significant labour cost savings, equivalent to one person year in the Fishermen's Cooperative, while the automated printing of tally sheets and consignment notes was estimated to reduce overall weighing times by up to 30 per cent. The potential labour savings were sufficient to encourage the purchase of the EQMS equipment by another Fishermen's Cooperative in New South Wales. Some additional cost savings to fishers from the elimination of manual entry by AFMA of quota monitoring data would also have been achievable if data had been transferred electronically to AFMA.

Although the trial was successful in reducing paperwork for fishers and fish receivers, and reducing labour costs in the Fishermen's Cooperatives, it did little to improve the overall effectiveness of compliance arrangements in the fishery.

A subsequent benefit/cost study of the system (FERM, 1998b) concluded:

> although there are some potential cost savings through the implementation of this form of EQMS across all quota managed fisheries, the benefits are modest. And, furthermore they are unlikely to be accompanied by significant improvements in the effectiveness of fisheries compliance activities. The main benefits from this form of EQMS are likely to be derived by fish receivers in the form of commercial gains from the replacement of some casual labour on fish weighing lines, and by those fishers who land their catches to "exempt" fish receivers and who, as a result, do not need to fill in SEF2 [catch disposal record] documentation. Wider implementation of this form of electronic quota monitoring system does not appear particularly worthwhile for AFMA or fishers.

The report recommended an alternative approach to the use of the electronic quota monitoring equipment, the primary objective being to improve the effectiveness of the compliance regime. This involved using the electronic scales technology in a dockside monitoring application. That is, the electronic quota monitoring equipment would be sited in the ports and combined with on-site monitoring by observers.

Electronic dockside monitoring: pilot program

AFMA is currently implementing a pilot program of electronic dockside monitoring in five ports in south east Australia. The in-port EQMS is being used by AFMA to facilitate a restructuring of compliance activities to achieve an improvement in the effectiveness of compliance, without increasing total compliance expenditures.

The in-port EQMS involves use, with modifications, of the Phase One electronic scales and keypad, as well as in-port observer personnel to monitor that catches are correctly weighed. The observer is also likely to be responsible for transmitting catch data to AFMA. Unlike Phase One where the onus was on fish receivers to supply quota monitoring data in electronic form to AFMA, with an in-port EQMS the responsibility

for supplying electronic data would be on fishers, effected through a condition on their fishing permits/licences.

The basic equipment components of an in-port EQMS are digital scales, a keypad with integrated docket printer and a modem (radio or standard depending on location). There are options in relation to the siting and mobility of the EQMS equipment. The keypad can be mobile and enclosed in a waterproof cabinet, sited either on the wharf or, perhaps, in the premises of a fish receiver near the wharf. If on the wharf, an additional system component is another radio modem attached to a telephone line, within 500 metres of the scales. Alternatively, the equipment can be constructed as two or more portable components that are set up where and when required. Table 9 provides indicative costs for the equipment components.

TABLE 9
APPROXIMATE COSTS OF EQMS COMPONENTS AT THE WHARF

Component	Cost
Keyboard and data logging software	4,300
Digital scales	2,075
Integrated printer (Seiko)	500
Radio modem	600
Enclosure	1,000
Phone line installation	173
Total	$8,648

Source: FERM, 1998b

The functions of the in-port EQMS equipment are, for each vessel landing; to weigh, aggregate (sum the weights of boxes of each species) and record for each quota species the total quantity landed; store the aggregate data by fisher; generate a printout of vessel and landing details; and transmit the data to AFMA.

The other important aspect of the in-port EQMS is the associated on-site monitoring service. That is, observers are employed to monitor unloadings and operate the EQMS equipment on AFMA's behalf. The observers are likely to be supplied by the private sector (for example, security providers) under contract to AFMA. Although they would not have any enforcement powers, such as those held by state fisheries officers, the EQMS observers are tasked to report any breaches of permit/licence conditions to AFMA or state fisheries officers. The EQMS observer and the fisher both sign the printout to certify that the data being transmitted to AFMA is correct, and each retains a copy of the printout. This hard copy is stored for possible use in any future court cases.

Dockside monitoring: Implications for compliance

The current compliance regimes for AFMA's ITQ managed fisheries are based on the monitoring of a paper trail of documentation from the vessel to the first fish receiver (a Fisher & Fish Receiver model, as described earlier). This quota monitoring system is supported by the employment of state fisheries and police officers to check on compliance by fishers and fish receivers with the requirements of the system.

The effectiveness of current paper trail compliance arrangements in deterring and detecting illegal activities in many Australian quota managed fisheries is probably quite limited. Changing the nature of compliance activities in quota fisheries through the introduction of new technologies, coupled with in-port monitoring services, has the potential to substantially 'tighten' compliance regimes and shift the focus from prosecution to prevention. Better adherence to the quota regimes would reduce the likelihood of stock declines from overfishing.

Improvements in compliance effectiveness under an in-port EQMS stem from the monitoring of all vessel unloadings in ports with EQMS equipment, rather than a small sample as under the current arrangements. A substantial increase in the extent of official presence on the wharves is also likely to deter many operators from attempting to off-load part of their catch prior to a pre-arranged unloading time, as specified in their 'prior-to-landing' telephone report to the fisheries management authority (see Section on Pager Reporting). Moreover, because the EQMS monitor would be fully involved in the weighing activities, it is more likely that smaller scale rorting of the quota system, such as layering different species in the same box, would be detected or deterred.

Fitting vessels with VMS, to track their positions (see Section on VMS), is also a key component of the strategy. Adequate monitoring of activity in the 65 ports in southeastern Australia recorded as being used (many on a very occasional basis) for the landing of various quota managed species, is most unlikely under current arrangements, providing ample opportunity for fishers to make unrecorded landings. The implementation of VMS on all vessels in these fisheries would probably deter many operators from risking illegal landings. Without VMS, a higher level of random inspections of minor ports would be necessary to attain the same degree of confidence in the integrity of the system. There are also likely to be cost savings in aerial and at sea surveillance activities attributable to having VMS on board vessels.

Achieving these improvements in compliance effectiveness involves restructuring compliance activities and expenditures. A number of compliance activities would become largely or wholly redundant, with the result that current compliance expenditures would fall. However, these reductions in expenditures on state fisheries and police officers are offset by increases in costs associated with the purchase and installation of electronic quota monitoring equipment and by the costs of labour services required to monitor landings[6]. Table 10 provides a comparison of the costs of AFMA's Fisher & Fish Receiver paper trail and the estimated costs of an electronic quota monitoring system.

As can be seen from Table 10 the costs of an EQMS across the 30 busiest ports servicing five AFMA managed quota fisheries are estimated to be broadly similar to

those of the existing paper trail system[7]. It is noteworthy that these 30 ports accounted for more than 95% of the total catch landings in the mid-1990s. The remainder was spread across an additional 35 ports.

The cost estimates in Table 10 reflect the likelihood that AFMA's requirements for certain compliance activities will be reduced with the implementation of an in-port EQMS. The extent to which they are reduced will depend, among other things, on the number of ports that have EQMS installed, the associated coverage of landings, and the compliance arrangements for those ports outside of the system. Ports outside of the EQMS that retain the existing paper based arrangements are likely to become increasingly attractive for those operators intending to circumvent the quota monitoring system.

There would appear to be three main ways to deal with this potential problem: ignore it on the basis that it may be minor; designate a reduced set of ports at which landings can take place, all of which have EQMS equipment; or introduce "grandfather" provisions by which operators would only be allowed to land in minor ports if they have a recent history of landing in those ports.

TABLE 10
COMPARISON OF THE COSTS TO AFMA OF THE CURRENT "FISHER & FISH RECEIVER" PAPER TRAIL SYSTEM AND THE ESTIMATED COSTS OF AN EQMS IN 30 MAJOR PORTS

	Paper-trail	EQMS
Data entry and printing	102,087	6,490
In port boat inspections	205,053	41,011
Extension	185,689	37,138
Inspect processors	199,027	0
Fishery situation reports	36,789	8,094
Observe landings	146,503	0
Covert operations	74,997	74,997
EQMS hardware	0	132,328
Transmission/other costs	0	24,074
EQMS observers	0	555,369
Total	$950,145	$879,500

Source: FERM, 1998b

The latter option would cater for those vessels which are based at minor ports, and which have a history of landings therein, but would prevent a 'blow-out' of landings by other operators.

With VMS on all boats in quota managed fisheries and either 'grandfathering' or designation of a limited set of ports, there is a lesser need for in-port boat inspections, which are largely aimed at ensuring compliance with quota monitoring paperwork.

Similarly, extension activities in quota managed fisheries are targeted heavily on ensuring that fishers understand the quota monitoring paperwork requirements. These extension expenditures become unnecessary under an EQMS.

Other potential compliance cost savings are in the activity areas of inspections of processors and overt observation of landings. These activities are likely to become unnecessary as all landings would be monitored at the dock. The removal of the requirement of fish receivers to submit quota monitoring documentation would also generate significant data entry and printing savings. Fish receivers would, though, continue to be licensed and maintain records of purchases, sales and inventories. This would be necessary to allow compliance inspections of processors and random audits, to help ensure that some landings, or parts of landings, do not circumvent the in-port EQMS. However, this is a much more limited problem than that which currently exists. Furthermore, given the increased presence of observers on the wharves, the risks to fishers of unrecorded landings being detected should be substantially greater. These risks are further increased if all vessels are fitted with VMS so that any unscheduled vessel entry into a port is likely to be noticed.

Conversely, it could be argued that tightening up compliance around landings would result in an increase in trans-shipments of catches of quota species by licensed to unlicensed vessels. This is possible. However, it seems unlikely that the scale of this problem would warrant the retention of the full fish receiver based quota monitoring and compliance regime with all its attendant costs.

Covert observations of landings are required under the EQMS. This is because covert observation would be required to identify instances of unrecorded landings (as under the current compliance arrangements), and to identify or deter collusion between fishers and EQMS monitors to defraud the system. Clearly, there will be incentive for fishers to attempt to corrupt EQMS monitors, some of whom may be known on a personal basis. Covert observation of weighings by state fisheries or police officers would appear to be a useful precaution against such occurrences.

The roles of the compliance officers in ports where an EQMS is installed would be reduced to the covert activities mentioned above, and, essentially, being on call to follow up possible breaches of licence conditions detected by EQMS monitors. In minor ports without an EQMS, state fisheries officers continue to carry out the normal range of paper trail based activities.

Compliance problems: electronic quota monitoring system

A range of compliance problems will remain under an EQMS. Tightening compliance with EQMS in the main ports will inevitably lead to minor ports, where a paper trail system would continue to operate, becoming more attractive to some operators. Although designating a limited set of permissible landing ports, or "grandfathering" the use of minor ports would reduce the scope for illegal landings, considerable pressure from industry and local/state governments to keep isolated ports open for landings can be anticipated. Failure to tighten compliance arrangements in minor ports would create a substantial compliance loophole.

The heavy emphasis on the monitoring of landings and the probable lack of any secondary checking of compliance beyond the wharf makes the EQMS vulnerable to collusion between fishers and observers. Corrupt observers could turn a blind eye to certain landings or parts thereof, or more subtly to mis-identification of fish species. For example, a highly prized quota species such as blue eye trevalla could be recorded as groper, a non-quota species or as a relatively low-value quota species such as blue grenadier. Although there is a strong likelihood of such practices occurring, two main factors potentially mitigate against this form of collusion becoming widespread and highly problematic. First, if the task of monitoring landings is privatised, stiff penalty clauses can be included in the service contract in the event of proven collusion between the company's observers and fishers. This will create an incentive for the contracting company to take measures to reduce the likelihood of corruption such as preventing observers working in their home town and frequent rotation through ports. Secondly, state-based fishery or police officers will continue to be tasked with covert surveillance of landings, with a view to identifying collusion between fishers and observers.

Covert observation of landings is also necessary to deter fishers from attempting partial unloadings prior to the arrival of the observer at the unloading time nominated in their pre-landing report. Although this practice could be a problem under an EQMS, it is likely to be substantially less acute than under the paper trail systems where the official presence on wharves is substantially lower and the opportunities for illegal landings more frequent.

Another remaining potential loophole is through trans-shipment of catches at sea from licensed to unlicensed vessels. Despite these potential areas of quota 'leakage', AFMA compliance staff suggest that expenditures on traditional compliance activities would have to at least double to achieve an increase in compliance effectiveness comparable to that expected under an EQMS.

ADDITIONAL COMPLIANCE TOOLS

There are a number of compliance tools that can be used in association with either paper trail or dockside monitoring of quotas to enhance the effectiveness of the compliance regime. These include pre-departure and prior-landing reporting using pager technologies, and vessel monitoring systems.

PAGER REPORTING

Throughout Australia and elsewhere there is a growing use of real time reporting by fishers and processors to reduce the opportunities for quota evasion and to increase the cost effectiveness of compliance services. The reporting system provides "control points" between the vessel and the processor (and the exporter in some cases) at which landings can be verified on a random spot-check basis by compliance officers.

Specifically, fishers are required to make telephone reports to a commercial paging service when they undertake or intend to undertake certain activities, such as leaving port and returning to port to unload. Processors may be required to make reports on

the transfer of landed catch from the wharf to a processing factory, on the on-sale of the catch to another processor and on interstate dispatch or export of product. As shown in Table 11 most Australian fisheries under ITQ management now have some form of real time reporting requirements in place.

Since 1994 AFMA managed fishers in the south east trawl fishery have been required, by a condition on their fishing permits, to use a telephone reporting system to make real time activity reports. The aims of the system are firstly to reduce the incidence of unreported and under-reported landings in each fishery by providing fisheries officers with prior warning of the time and location of all unloadings, a proportion of which are selected randomly for inspection. Secondly, getting fishers to commit in advance to specify which fishery they intend to operate in on a particular trip is important, if the operator has the authority to fish in waters under different jurisdictions which are subject to different management rules. For example, a fisher with entitlements to operate in both Commonwealth and state managed waters may be subject to ITQs in one jurisdiction only, but capable of catching the quota-controlled species in both areas. Clearly this situation provides scope for fishers to evade quota controls by mis-declaring some or all of their catches as being taken in the input controlled jurisdiction. Getting the fisher to commit in advance to fishing in only one jurisdiction on each trip reduces the potential for this mis-reporting problem to occur.

The AFMA pager system is based on fishers reporting when they are leaving port and, subsequently, where and when they expect to unload. The fisher sends the messages by telephone or radio to a central paging service that operates 24 hours per day. The pager system operator logs the call and asks the caller a particular series of questions depending on whether it is a pre-departure or 'prior landing' report (the pre-departure and prior landing questions asked of fishers in the south east non-trawl fishery are shown in Boxes 6 and 7). The pager system operator provides the fisher with a receipt number for each report that is recorded as proof of having made the call.

The central paging service then sends a pager message containing the report details, to the nearest fisheries office to the port of unloading and to AFMA where each message is recorded on a database. The pager message includes the receipt number given to the fisher.

For each unloading the fisher includes his/her prior report receipt number on Part A of the associated catch disposal record and on the relevant catch and effort logsheet. A fisheries officer inspecting an unloading can crosscheck the size of the catch as reported by the fisher to the pager service with the actual unloading. Also, if a fisheries officer inspects a vessel unloading and the operator does not have a prior landing report number, the operator is in breach of his/her permit conditions.

The costs of the pager system are modest, ranging from around A$6,000 to A$14,000 per year for individual AFMA managed fisheries, but excluding transmission costs that are paid directly by fishers.

In 1998 a pager system was introduced into the Tasmanian rock lobster fishery. In keeping with the extended paper trail system used to document purchases and sales of rock lobster, processors and fish handlers are required to report a number of transactions via the pager system. Specifically processors and fish handlers have to report:

BOX 6
AFMA: SENTF 2 HOURS PRE-DEPARTURE REPORT

What is your vessel name?

Distinguishing symbol?

What is your intended port of departure?

What is your intended date and time of departure?

Will you be fishing in state or Commonwealth waters?

What is your intended fishing method?

- their intent to transport rock lobster before their vehicle leaves the wharf (movement report),
- their receipt of rock lobster at the processing or storage premises (receipt report),
- the dispatch of rock lobster from the state by fish handlers (dispatch report), and
- the delivery of rock lobster from a non-quota holder such as another processor (delivery report).

If the factory or premises of the processor or fish handler is within 1km of the wharf, a pager report is made on the completion of the weighing and counting process at the premises (short distance movement report). The pager reports required by each management authority are shown in Table 11.

BOX 7
AFMA: SENTF 2 HOURS PRIOR-LANDING REPORT

What is your vessel name?

Distinguishing symbol?

Which port are you heading for?

Number of school shark (if any) on board the boat?

Number of gummy shark (if any) on board the boat?

Estimated total live weight of blue warehou on board?

Estimated total live weight of blue-eye trevalla on board?

Estimated total live weight of pink ling on board?

Estimated total live weight of all fish species on board?

What port, or other place is it intended that the fish will be unloaded (if more than one you must give details of all ports or other places of unloading?

What is your estimated time of arrival in the port or other place?

What date and estimated time will unloading commence?

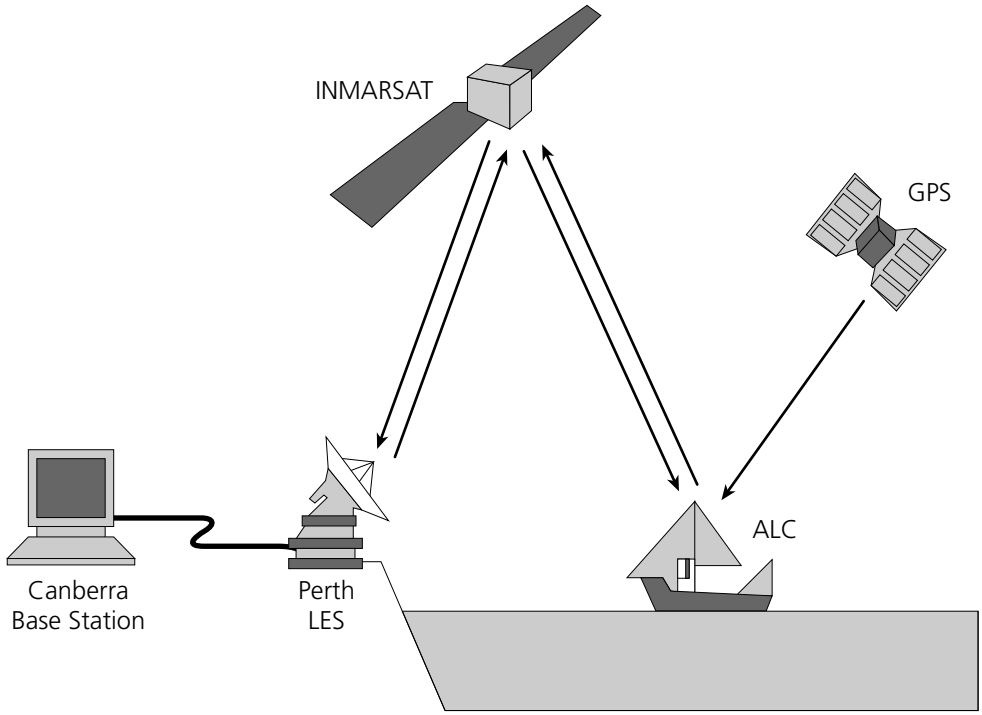
TABLE 11
TYPES OF PAGER REPORTS REQUIRED FROM EITHER FISHERS OR PROCESSORS IN VARIOUS FISHERIES

Agency	Fishery	Pre-departure	Pre-unloading	On wharf	Factory receival	Dispatch interstate or to another processor	Delivery from another processor or imported
AFMA	All quota fisheries	Fisher	Fisher				
New South Wales	Abalone					Processor	Processor
Queensland	Spanner crab		Fisher				
South Australia	Abalone	Fisher (southern zone only)		Fisher			Processor
South Australia	Blue swimmer crab		Fisher				
Tasmania	Rock lobster	Only if partial unloading has taken place	Fisher	Licensed fish handler or processor, unless exempted	Licensed fish handler or processor, unless exempted	Licensed fish handler. (Processor faxes DPIW&E)	Processor
Tasmania	Giant crab	Only if partial unloading has taken place	Fisher	Processor			Processor
Tasmania	Abalone	Fisher		Fisher	Processor	(Processor faxes DPIW&E)	
Western Australia	Abalone	Fisher		Fisher			Processor
Western Australia	Pearl oyster	Fisher					

VESSEL MONITORING SYSTEMS

VMS is being used increasingly in Australia as part of the compliance arrangements for both quota managed and effort controlled fisheries. A basic component of a VMS is the satellite transponder unit or automatic location communicator (ALC) that is fitted to vessels. The unit is linked to a global positioning system (GPS) and transmits position data to a satellite, which in turn relays the data to a "land earth station" or LES. The LES relays the data in real time from the vessel, using normal communication networks, to a VMS base station at the fisheries management authority. A schematic representation of the operation of the AFMA Inmarsat-based system is given in Figure 5.

FIGURE 5
MAIN FEATURES OF AFMA'S VESSEL MONITORING



Main features of AFMA's vessel monitoring system

A graphics/mapping package is used to translate the position data into an individual vessel track on the computer screen at the fisheries management authority. Closed areas and fishery boundaries can be identified and the software programmed to automatically generate an 'exception report' to monitoring or compliance officers (often by e-mail) if a vessel enters an area into which it is not permitted. In the context of quota monitoring, the main purpose of a VMS is to ensure that vessels do not transgress fishery or zonal boundaries, and do not attempt to make unreported landings at isolated locations.

In AFMA, VMS systems have been implemented in the Heard and McDonald Island fishery, the orange roughy sector of the south east trawl fishery, the northern prawn fishery and the Bass Strait scallop fishery. They are also required to be fitted to vessels in the south east trawl and non-trawl fisheries that declare catches of Commonwealth quota species in state or international waters.

In Tasmania VMS must be fitted to rock lobster vessels whose operators:

- are dual endorsed rock lobster fishers (holding Victorian or South Australian rock lobster licences;
- hold a giant crab licence with more than 10 quota units;
- operate or transit waters outside Tasmanian jurisdiction for the rock lobster fishery or;
- have been convicted of a serious fisheries offence under any state or Commonwealth law.

Once implemented, the activities of monitoring staff in fisheries management authorities in relation to the operation of the VMS systems are limited primarily to following up exceptions reports. Monitoring personnel are also normally involved in the process of VMS implementation and subsequent follow-ups to ensure that the equipment installed is fully functional.

The costs of purchasing and installing a transceiver on a vessel are usually borne directly by the vessel owner. Details of VMS costs are included in Table 12 in the section on electronic logbooks.

Compliance implications of VMS

In a recent Administrative Appeals Tribunal hearing, *Bagnato and Australian Fisheries Management Authority*[8], the Tribunal affirmed AFMA's decision to implement VMS as a permit condition for some vessels. It also stated that the AFMA's ESD and economic efficiency objectives are to be pursued by the introduction of VMS. Similar sentiments have been expressed previously by parliamentary committees when examining fisheries management issues. The House of Representatives Standing Committee on Primary Industries (1997) recommended that AFMA:

> undertake a phased in installation of VMS in all Commonwealth fisheries. AFMA should determine an order of priority for the introduction of VMS in the Commonwealth fisheries." The Senate Standing Committee on Industry, Science, Technology, Transport, Communications and Infrastructure (1993) stated that, "The Committee seeks to reduce the overall costs of compliance by measures such as the mandatory fitting of location transponders. The Committee recommends that AFMA consult with the Management Committees concerning the desirability of requiring transponders to be fitted.

The introduction of VMS across AFMA managed quota fisheries is integral to the realisation of improvements in compliance effectiveness expected under an electronic dockside monitoring program. Specifically, it would deter vessel operators from attempting to make unrecorded landings in minor ports and as a result, reduce the risk of compliance resources having to be spread thinly over many potential landing sites. Also, VMS would reduce or eliminate the need for at-sea compliance activities in quota

managed fisheries depending on what input based controls are retained under the ITQ system and would reduce the requirement for aerial surveillance. Only a tactical aerial capability would be retained to respond to vessels being identified from the VMS as transgressing closed areas or fishery boundaries.

The use of VMS can provide fisheries management authorities with greater confidence in their compliance regimes. For example, AFMA has been able in real time, to warn vessel operators in the northern prawn fishery that they are getting too close to closed areas, potentially preventing offences from being committed.

In Tasmania a VMS supports the compliance regime by making it easier to detect vessels that attempt to unload rock lobster in non-designated landing ports and to track vessels believed to be involved in illegal activities. To date fisheries management authorities have not relied on VMS data to prove that fisheries offences have been committed, but have used the VMS data to target surveillance resources toward vessels that behave in a suspicious manner. This is the main attribute of VMS; facilitating more cost effective use of compliance resources.

However Queensland has revised its fisheries Act to reverse the burden of proof in relation to violations identified through VMS. That is, VMS data becomes more akin to a photograph taken by a roadside speed camera; with the onus being on the offender to prove his or her innocence.

Catch and effort monitoring using VMS

Although the quota monitoring system also provides data on the landed catch of quota species, it normally omits the catches of non-quota species and discards, and provides no information as to where catches were taken and with how much fishing effort. This data is often essential for accurate fish stock assessments to be undertaken.

Fishers may mis-report their fishing positions in order to claim that catches were taken in areas outside the quota-controlled fishery or simply to protect the confidentiality of hot spots.

There are two traditional approaches to the collection of catch and effort data: placing observers on vessels (discussed in Chapter 8, *Discarding*), and/or requiring fishers to fill out logbooks. A novel electronic approach to catch and effort reporting that has the potential to partly overcome some of the data fouling problems is described in this section.

Paper catch and effort logbooks

To date, paper logbooks have been the mainstays of catch and effort monitoring in most fisheries. Fishers are normally required to fill in their logsheets immediately on the completion of each fishing operation, providing estimates of catches of all species and quantities discarded, as well as data on fishing locations and fishing effort.

There are often incentives for fishers to mis-report this data. These incentives may arise because of:

- a perceived lack of confidentiality of fishing position data (with regard to other fishers getting hold of information on hot-spot locations);

- the existence of fishing grounds not subject to quota controls but where quota managed species can be caught;
- the existence of areas closed to fishing;
- regulations that prohibit discarding and highgrading; and
- regulations that limit the amount of by-catch per set of particular species and require the fisher to change location if catch rates exceed the threshold.

In fisheries where some or all of these incentives exist, the veracity of fisher-provided logbook data is questionable. Also, if fishers under-report their catches through the quota monitoring system they will also be inclined to falsify their catch and effort data to ensure no discrepancies are apparent to the fisheries management authority. Scientists often raise concerns about the introduction of ITQs because of such 'data fouling' on the quality of catch and effort data and its knock-on effects of poor data on stock assessment.

Checking the validity of fishers' logbook records is difficult and costly, usually requiring both at-sea and in-port surveillance activities. Specifically, compliance officers may sometimes board vessels to check whether logbooks have been completed and to check logbook records against catches on board. Although providing some indication of whether the fisher is filling in logsheets when required and estimating with reasonable accuracy the amount of fish on board, such inspections reveal little if anything about the accuracy of logbook data on fishing effort and fishing locations. For vessels that are fitted with VMS, the introduction of electronic logbooks may solve some of these mis-reporting problems.

Electronic catch and effort logbooks

An integrated electronic logbook and VMS system would consist of the following hardware and software on board fishing vessels: a satellite transreceiver, a communication device (such as a personal computer or a message terminal) and catch and effort logbook software.

Instead of manually completing catch and effort logbooks at sea, fishers would use the personal computer or message terminal on board the vessel to complete an electronic version of the relevant logbook, and would in turn forward the logbook data (using the satellite transreceiver) to the management authority concerned. The software within the message terminal would allow the transmission of the logsheet to the management authority only when the fisher had completed all fields (with some fields having been automatically subject to error checking). This would reduce the subsequent need for management authority staff to follow up missing or erroneous data. Fishing location data may be entered manually by fishers or by fishers pressing a button and automatically recording their location when setting and hauling their fishing gear.

In addition to the on-board vessel requirements, the management authority would need a personal computer (PC) and communications and application software (to accept and forward data to the appropriate database or other destination). In addition, there would be other resource operating costs associated with data transmission and administration.

The benefits associated with replacing the current paper system with electronic logbooks include:

- lower costs associated with elimination of manual data entry;
- more timely and accurate data for stock assessment;
- lower expenditures on aerial and at-sea compliance; and
- improvements in the effectiveness of compliance activities.

In a recent Administrative Appeals Tribunal hearing[9] on whether the use of VMS could be required by AFMA as a condition on a fisher's permit, the Deputy President stated that:

> In addition to providing the geographical position of the vessel, the VMS has a capacity for conveying data. For example, catch data entered and transmitted at sea immediately after each fishing operation, commits the vessel operator to a specific estimate of catch without knowing whether the vessel will be subject to a landing or at-sea boarding inspection. This is not presently proposed but if implemented, would be useful in a number of situations. In Commonwealth fisheries, operators are required to fill out a log book declaring catch as it is caught. The communications capability of the VMS would make the requirements to keep log books and the associated random inspections more effective by enabling vessel operators to declare electronically directly to fisheries agency each catch as it is made. This would tend to obviate mis-reporting.

The estimated costs and benefits of an electronic logbook system in AFMA, including compliance benefits from VMS, AFMA are compared in Table 12 to the current costs of running a paper logbook system.

The data presented above indicates that the introduction of VMS and electronic logbooks may be somewhat more expensive than traditional paper-based logbook systems in these fisheries. However, no estimate is included of the expected benefits of more timely and accurate data on stock assessments although for some fisheries these benefits may be substantial. It should also be noted that many fisheries authorities are introducing VMS for compliance reasons, based on an anticipated increase in deterrence and compliance effectiveness, rather than simply on expected cost savings on at-sea and aerial surveillance. If VMS is already in place for compliance reasons, the difference in costs between a paper and electronic-based logbook system becomes marginal, while the electronic system offers a range of additional benefits.

AN INTEGRATED SYSTEM FOR CATCH AND EFFORT REPORTING

So far electronic dockside monitoring, VMS and electronic logbooks have been considered separately. However if VMS is to be introduced as a component of a dockside monitoring program (or for other reasons), it would be worthwhile to investigate whether there would be net benefits from also developing electronic logbooks.

Clearly the costs of developing and operating electronic systems as described above, will vary depending on the characteristics of the fishery and the specifications of the systems being implemented. Furthermore, whether it makes sense to restructure compliance and data collection systems will depend in large measure on the costs of these systems compared to the projected costs of their electronic counterparts.

TABLE 12
COMPARISON OF THE ESTIMATED COSTS OF A PAPER LOGBOOK SYSTEM AND A VMS-BASED ELECTRONIC LOGBOOK SYSTEM FOR FIVE AFMA QUOTA-MANAGED FISHERIES

	BENEFITS				COSTS		
Fishery	Net benefits	Reduced data entry costs	Reduction in compliance costs	Vessel equip't, software & installation[1]	Transmittal costs	AFMA hard- & software costs	AFMA admin. costs
South east trawl	-$29,663	$44,499	$79,504	$119,338	$25,220	$775	$8,333
South east non-trawl	-$46,419	$23,262	$16,025	$56,838	$19,760	$775	$8,333
Southern shark	-$1,073	$22,237	$119,843	$101,805	$32,240	$775	$8,333
Scallop[2]	-$46,655	$2,025	0	$33,905	$14,000	$775	0

1. Amortised over three years.
2. Vessels in the Bass Strait scallop fishery are already required to have VMS so any reductions in compliance costs have already been realised and administrative costs in AFMA already incurred.

Source: FERM, 1998b

For the five AFMA quota-managed fisheries that we have examined the estimated costs of implementing an electronic dockside monitoring scheme and electronic logbook using VMS would be similar to the costs of the existing systems (see Table 13).

TABLE 13
CURRENT AND ESTIMATED COSTS OF AN INTEGRATED DATA MANAGEMENT SYSTEM ACROSS AFMA-MANAGED QUOTA FISHERIES

Fishery	Current[1]	Integrated	% change
South east trawl fishery	2,965,287	2,921,588	-1%
South east non-trawl & shark	2,314,576	2,217,112	-4%
South east non-trawl & shark	2,314,576	2,217,112	-4%
SENT/shark	2,314,576	2,217,112	-4%
Bass Strait scallop	518,519	568,724	10%
S. bluefin tuna	1,245,473	1,295,394	4%
Total	*7,043,855*	*7,002,818*	*-0.6%*

1989–99 costs, Source: FERM, 1998b

However as noted previously, this is only one part of the appropriate comparison. The other must rest on judgements of how the effectiveness of compliance and catch and effort data collection is likely to be influenced by the use of integrated electronic systems.

ENFORCEMENT

Violations of quota regulations are enforced either administratively or by the judicial system. Administrative sanctions may be imposed by the fisheries management authority concerned in circumstances where a fisher is being investigated, when charges have been laid under the relevant fisheries legislation or where a fisher is in breach of licence conditions by failing to cover over-quota catches. Judicial penalties are those imposed by the courts, guided by the penalties specified in the relevant fisheries or crimes-type legislation.

ADMINISTRATIVE PENALTIES FOR 'QUOTA BUSTING'

Fishers who exceed their quota may be subject to administrative penalties in the form of deductions from their quota in the following year or years. For example in the Tasmanian rock lobster and giant crab fisheries, the administrator deducts the quantity of over-catch or a multiple thereof from the fisher's allocation in subsequent years[10]. A similar system of administrative penalties also applies in the Victoria and South Australia quota-managed fisheries. In New South Wales quota holders who exceed their quotas have to pay the market value of the over-quota fish to the Director of Fisheries[11]. Failure to pay this amount results in prosecution and the initiation of judicial proceedings.

AFMA has the authority to refuse to transfer fishing concessions and suspend or cancel fishing permits if it has grounds for believing that an offence has been committed. In one case of over-quota fishing, the offenders had their quota entitlement to catch 16 tonnes of orange roughy (the amount of over-catch) suspended for a period of two years (P. Venslovas, pers. comm.). Following an amendment in 1997 to the *1991 Fisheries Management Act*, the courts also have the power to order fishing concessions to be suspended or cancelled.

Apart from the administrative penalties directly associated with quota busting, there may also be administrative sanctions imposed on a fisher following a conviction of a fisheries offence. For example in Tasmania, Western Australia, Queensland and New South Wales the issue of licence renewal following a conviction is discretionary. Similarly, licences may not be issued or renewed in Victoria if the applicant is not considered a "fit and proper person" or has previously had a licence cancelled or suspended (e.g. in Queensland). In South Australia, the Director has the discretion to remove a licence from the fishery if the holder is convicted of three separate offences (a 'three strikes and you're out' policy).

There may also be 'knock-on' penalties such as that found under Australian Commonwealth legislation where if a fisher is convicted of a Commonwealth fisheries offence, he or she could lose their export registration. This is because the legislation underpinning the Australian Quarantine and Inspection Service requires that the holders of such registrations be fit and proper individuals.

JUDICIAL PENALTIES

In all Australian states penalties for serious offences are laid down in fisheries legislation. The intention of legislators is probably to limit the discretion of courts due to their perceived leniency in punishing fisheries offenders. Sutinen (1996) has observed that:

> Even where not constrained by statute, the courts usually limit the size of the penalty to reflect the amount of social harm done by, or amount of illegal gain realised from, the violations for which the individual is convicted

However Sutinen also observes that in practice courts have often imposed penalties that are modest relative to the illegal gains.

Penalties prescribed in legislation for quota violations are often tiered, starting with administrative penalties and moving on to judicial penalties for more serious violations. For example in South Australia's blue swimmer crab fishery, over-catches of quota that exceed 50kg are liable for prosecution. If the fisher is convicted the court "must" make an order that reduces the quota on the licence for three licence periods by one kilogram for each kilogram in excess of the quota for the licence period during which the offence was committed[12]. In addition, each offence under the South Australian legislation is assigned a divisional penalty that identifies a maximum and a minimum (the maximum of the next lowest divisional penalty) term of imprisonment and fine.

In Victoria fishers that over-catch their quotas are subject to fines and the forfeiture of quota equal to the excess catch. For a second offence, fines increase and double the

quota is forfeited. For a third offence, the quota is cancelled for the following year and fines are also incurred. For any subsequent offence the quota holder may be given 12 months imprisonment (and/or fines) and their access licence and quota will be cancelled[13]. In Western Australia the court "must" order a permanent reduction in entitlement by the amount by which that entitlement is exceeded[14].

However in some states (New South Wales and Queensland) and under Commonwealth fisheries legislation, only a maximum penalty for each offence is specified and some discretion is to left to the court to decide the amount and also whether the licence or the quota entitlement should be forfeited, suspended or cancelled. For example, under the New South Wales *Fisheries Management Act 1994*, management plans for shareholder fisheries can specify that a court that convicts a shareholder for a share forfeiture offence "may" order that all or some of the shares are forfeited and "may" also order that the holder cannot hold shares for a period specified by the court[15].

In New Zealand, under the *Fisheries Act 1996* there are three types of judicial penalties that may be imposed on a person convicted of a fisheries offence: fines, forfeiture of property, quota and proceeds from sale of fish, and exclusion from the fishery. If no other penalty is prescribed, fines are imposed not exceeding NZ$250,000 per offence. A new category of serious "intentional" offences, directed at high-value black market and fraud offences incur severe penalties, including imprisonment of up to five years and/or a fine[16]. Unless the court finds special reasons not to do so, quota will also be forfeited for serious "intentional" offences as well as other offences, such as providing false information or contravention of aggregation limits or foreign ownership constraints[17]. The severity of these penalties has been found to influence fishers' compliance with regulations (CM Research, 1998).

SUMMARY

Compliance programs for ITQ fisheries are based either on paper trails supported by random inspections of landings and product flow and by audits, or on large scale dockside monitoring of landings.

Traditionally, reliance has been placed on paper trail systems. Over time these systems have been enhanced by the use of pager reporting by fishers to forewarn compliance officers of their arrival in ports, and by the use of various electronic communications systems through which fishers input their landings data and receive updates on their quota balances. In some cases pager reporting has been extended to processors who have to report receivals and dispatches of products.

A key criticism of the paper trail approach is that it is complex. It requires specialised and additional investigative audit resources and sophisticated computer systems to keep track of product flow and detect irregularities. The level of conventional compliance resources is usually maintained to carry out inspections at docks and at the premises of processors, as well as other activities. This is costly.

Dockside monitoring of landings is an alternative path. It simplifies the compliance regime by focusing compliance on inspection of landings before they leave the wharf.

The success of the Canadian system of dockside monitoring has encouraged the Alaskan authorities to propose a similar system. A modified system is under development for Australian Commonwealth-managed fisheries. Enhancements to the system include the use at the dock of electronic scales and communication technology to capture and transfer landings data directly to the management authority concerned, and the use of a vessel monitoring system (VMS) to discourage fishers from attempting unreported landings. Compliance officers suggest that expenditures on upgrading existing paper trail systems would need to double to achieve the same degree of tightening of the compliance regime.

The expected costs of the electronic quota monitoring system (EQMS), including the costs of dockside observers and the vessel monitoring system, are similar to those of a Fisher & Fish Receiver paper trail system. The costs are likely to be substantially lower than those of an Extended Paper-Trail system. Perhaps the greatest benefit of a dockside monitoring system is that the emphasis of compliance activities is shifted, from prosecution to prevention of offences — one that is likely to engender greater cooperation from industry and result in fewer management resources being tied up in costly investigations. As noted by Sutinen (1995):

> Keeping regulations simple with a clear connection to conservation goals, and the equitable application of regulations and enforcement is believed to be important for securing industry support.

The implementation of a VMS also provides an opportunity for fisheries agencies to overcome some of the mis-reporting problems encountered with fishers' catch and effort logbooks. An electronic logbook can be developed using the communications capability of the VMS combined with an onboard PC or data terminal to give near real time catch and effort information. This would require fishers to commit to the size of their catch following each haul and provide an accurate location of fishing effort. The combination of dockside monitoring and a vessel monitoring system could provide scientists with set of data less prone to the hazards of data fouling, although onboard observers would still be needed to monitor discarding practices.

ENDNOTES

1 A condition on fishers' permits/licences states that this must be an accurate weight although there is no requirement to use scales Fish receivers may apply for an exemption that extends the 50 metre rule to 500 metres and allows the fisher to complete the catch disposal record at the completion of the weighing procedure by the fish receiver.

2 It is, however, the responsibility of the quota holder to ensure that catches do not exceed their holdings.

3 In the absence of a single management jurisdiction for the fishery as a whole, potential remains for the quota system to be circumvented by south east trawl fishers transhipping their catches to operators licensed in state waters only.

4 Tasmanian marine farmers of abalone are required to report movements of abalone into and out of the farm, conduct an inventory of abalone greater than 60mm shell length and are prohibited from possessing any abalone greater than 110mm (the commercial minimum size) unless they are individually marked.

5 See for example, *Kennedy v Ministry of Agriculture and Fisheries* 1994, High Court Dunedin, New Zealand (AP117-119/93).

6 Labour monitoring costs per unit are substantially lower than those for police or fishery officers, allowing greater use of labour services for the same overall cost.
7 AFMA personnel have suggested that the budget for covert compliance under an EQMS should be increased to allow for adequate covert investigation of possible offences. However, given that most landings would be monitored under an EQMS, the necessary scope of covert activities would be more limited than under the existing compliance regime. Unless current expenditures are inadequate, it is unclear why expenditures on covert activities should increase.
8 AAT No. 12568 (1998)
9 *Bagnato and Australian Fisheries Management Authority* AAT No. 12568, 1998
10 s.42 *Fisheries (Rock Lobster) Rules* 1997; s.27 *Fisheries (Giant Crab) Rules* 1999
11 s.81, *Fisheries Management Act* 1994
12 s.15, *Scheme of Management (Blue Crab Fishery) Regulations* 1998
13 s.66, *Fisheries Act* 1995
14 s.76, *Fish Resources Management Act* 1994
15 s.75, *Fisheries Management Act* 1994
16 s.252, *Fisheries Act* 1996
17 s.255, *Fisheries Act* 1996

8 DISCARDING

Unreported discarding of fish is sometimes seen as major impediment to the introduction of ITQs. Discarding may result in TACs being exceeded by an unknown quantity that would, in turn, result in increased uncertainty about the accuracy of stock assessments and the validity of TACs. If thought to be a substantial and widespread practice, discarding may seriously undermine public and industry confidence in the ITQ management system. Public perceptions of resource wastage by the fishing industry, coupled with concerns about unsustainable fishing practices, may drive political decision-making on the management of the fishery.

It is therefore important to estimate the extent of discarding under an ITQ system and to identify any specific management regulations that may be necessary to minimise the problem. However, in considering these issues it is important not to lose sight of the fact that discarding in fisheries is a widespread practice — irrespective of the form of management applied to the fishery (see Alverson et al., 1994 for a compilation of discard statistics from a wide range of fisheries throughout the world).

To illustrate this point, consider the following examples from the north east Atlantic fisheries of the European Community, the east coast of the USA and the south east of Australia. The north east Atlantic fisheries of the European Community are, or have been, managed predominantly using competitive TACs together with a range of restrictions aimed at reducing fishing effort. Crean and Symes (1995) cite an estimate by the European Commission that in 1985 some 500 million haddock were landed from the European Union's fishing grounds while 460 million were discarded. Similarly, in the Bay of Biscay and the Celtic Sea fishery for hake, discards of 130 million individuals actually exceeded the landed catch of 110 million individuals. Crean and Symes (1995) also state that:

> Minimum landing sizes and highgrading account for the very high levels of discards in the North Sea fishery for haddock.

Levels of discarding were substantial in the US east coast surf clam fishery during the 1980s when the fishery was managed using competitive TACs, minimum size limits and area closures (US National Research Council, 1999). The discarding was driven by the need to adhere to the size limits and by processors demanding large clams with high meat yields.

In the Australian south east trawl fishery, there was substantial discarding of certain species such as redfish while the fishery was managed under a mix of input controls. The discarding in this case was market-driven, fishers knowing that gluts often occurred when redfish supplies exceeded certain levels. Accidental catches were either discarded entirely or highgraded, with only a relatively small quantity of the largest fish marketed. This type of discarding has a long history in the fishery going back to at least 1915 when steam trawlers targeting tiger flathead were reported to discard most of their incidental catches of redfish (Smith, 1999).

The above examples illustrate that discarding is common in fisheries across various types of management arrangements. The point is that discarding in a fishery under ITQs should not be judged against a benchmark of no discarding, but rather against the likely level in that fishery under alternative management arrangements.

There are essentially three types of discarding under ITQ regimes. These are:

- discarding of non-commercial or uneconomic species;
- discarding of lower grade, quota-managed fish (highgrading) and;
- discarding of catches of quota species because of lack of quota (over-quota catches).

This chapter focuses on the latter two types of discarding that may be attributable to the introduction of an ITQ system.

HIGH-GRADING

Highgrading is the practice of discarding lower value fish of a particular species when a price premium is paid for higher grades of that species[1]. The greater the price differential between grades, the greater the incentive for fishers to high-grade their catches. Annala (1991) suggests that the incidence of highgrading in New Zealand increases as TACs for non-target species are approached, and that the practice is most prevalent amongst fishers with small quota holdings.

In effect, there can be three separate components to the highgraded catch, only one of which is attributable to the effects of an ITQ system. First, catches of juvenile fish that are simply too small to sell are often discarded either because there is no market for them or because there is a minimum landing size[2]. This form of discarding has nothing to do with an ITQ system. Second, there are grades of fish that are potentially saleable, however the net return to fishers after deducting the costs of onboard handling, marketing, crew wages and quota leasing[3] is zero or negative. Third, there are sizes of fish that could be expected to generate a net profit if sold but are still discarded when operators attempt to fill their quotas with larger-sized, more valuable fish or wish to delay filling their quotas until market prices become higher[4].

Highgrading is costly for fishers. The sorting and discarding of smaller fish, and repeat setting of the fishing gear to take additional hauls results in increased operating costs and may affect the market price received for the entire catch if landing is significantly delayed. Whether, for fishers, this is worthwhile in the end depends on the price differential between fish grades and on the estimated time and sums spent on catching replacement fish. This in turn will be based on expectations of the likely size and size composition of the catch from additional hauls. It is by no means clear that highgrading will be a profitable undertaking in many cases. According to the US National Research Council (1999):

> British Columbia [Canada] fishers say they can't afford to highgrade halibut. They plan deliveries, aim for maximum efficiency and don't want to increase operating costs by highgrading.

It was estimated that highgrading could increase a halibut fisher's revenue by around 4% but that the fisher would have to catch 24% more fish to make up for the discards. There

is, however, evidence to suggest that in certain fisheries quota-related highgrading is an economically viable practice for fishers. Case studies of the Australian south east trawl fishery and the Australian southern shark fishery, described later on in this chapter, suggest that quota-related highgrading occurs, or is likely to occur, in these fisheries.

OVER-QUOTA CATCHES

Fishers in multi-species fisheries will sometimes find themselves in a position where their quota for a particular species is exhausted. If the species in question is a bycatch of other target species, the fisher, if intending to continue fishing, faces either having to purchase or lease additional quota or discard. The availability of quota on the quota market and its price are critical factors which influence the decisions of fishers whether to trade or discard the bycatch species.

In theory, transferability of quota should be sufficient to deal with over-quota discards (Sissenwine and Mace, 1992). However, this conclusion is based on two strong assumptions, namely that TACs are set in accordance with fish availability within the fishery and that the quota market operates effectively. In practice, both are often of questionable validity.

First, the stock assessments underpinning TAC setting are based on estimates of fish abundance, not availability. The link between estimated abundance and availability is often weak, particularly in the short-term as availability of fish within the fishery fluctuates widely in response to a range of biological, hydrographic and other environmental factors. Moreover, the estimates of abundance used in the stock assessment are usually highly uncertain and tend to lag behind actual changes in abundance occurring in the fishery. This implies that at any given time significant differences between actual and estimated abundance are probable. Economic and political influences on TAC setting may cause further weakening of the link between TACs and actual fish availability to fishers. It is therefore highly probable that TACs will fail to respond adequately to changes in either fish abundance or availability. Squires (1998) makes a similar point stating that:

> there may exist a contradiction between individual species' TACs, determined on biological grounds, and harvest rates for the fishery as a whole, which are decided by the harvesting technology, biological, environmental and economic conditions, fishers' skill and luck.

Second, imperfections in the quota market may hinder fishers from trading. For example, with a relatively small number of operators in a fishery (as is the case in most Australian fisheries) the market may be quite 'thin'. This may have the effect of discouraging the emergence of quota-broking businesses, and limiting the availability of information on unused quota. Individual fishers may be forced to rely on their limited personal network to search for quota. In 'thin' markets, efficient pricing of quota is also problematic. These difficulties were noted by Baulch and Pascoe. (1992) in the period following the introduction of ITQs in the south east trawl fishery[5]. Also, given that most fisheries are highly over-capitalised when ITQs are introduced, a contraction in the

number of operators within a fishery can be anticipated. Industry adjustment may lead to quota holdings becoming concentrated in the hands of a relatively small number of operators with markets becoming prone to manipulation and uncompetitive practices[6].

The behaviour of fishers with regard to the trading of quota is also an important factor. For example, in the south east trawl fishery many fishers are unwilling to trade quota early in the year until they have a clearer idea of whether they are likely to need the quota later in the season. However, the resulting scarcity of quota available for leasing during the first half of the year has to some extent been ameliorated by inactive quota holders, or so-called 'absentee landlords' trading their holdings (SETMAC Working Group, 1998). But as noted by the Working Group:

> the problem comes down to the availability of quota — when a species is abundant, everyone is looking for the same species.

The effective operation of the quota market will have a strong influence on the ability of fishers to obtain or lease quotas to cover any over-catch. Fisheries authorities should ensure that there are no institutional impediments to the functioning of the quota market, and facilitate trade by regularly disseminating information on the quota holdings of individual fishers and their contact details (subject to any confidentiality constraints on the use of these data). The development of electronic quota trading systems may be another area in which government can play a facilitating role.

Considering the two issues of TAC setting and quota market effectiveness it seems reasonable to conclude that there will be years in which the availability of a particular species is high relative to its TAC, and that there will be inadequate quota available on the lease market to cover over-catches. Even in years when TACs are likely to be significantly under-caught, market imperfections may limit the availability of quota particularly early in the year, or the desirability of trading, if quotas are over-priced.

Overall, reliance on quota trading alone to mitigate or eliminate discarding problems arising because fishers over-catch their quotas is likely to be misplaced. Policies that introduce increased flexibility into the quota system, particularly in the case of multi-species fisheries, are likely to be required in order to deal with some discard problems (a range of possible policy responses to discarding are discussed later in this chapter).

EVIDENCE OF THE SIZE OF THE PROBLEM

In this section, summary information is provided on the extent of discarding in a number of fisheries in Canada, the US, New Zealand and Iceland, and two detailed case studies are presented of discarding in Australian fisheries. These case studies suggest that care is needed to review thoroughly the characteristics of a fishery before accepting commonly espoused views that the introduction of ITQs will lead automatically to large-scale discarding.

DISCARDING IN US, CANADIAN AND NEW ZEALAND FISHERIES

In the Alaskan halibut and sablefish fisheries, the degree of highgrading is thought to be modest. The US National Research Council (1999) states that:

> Although there is anecdotal evidence of highgrading, comparisons of halibut size composition data from Alaskan and Canadian commercial and from IPHC (Pacific Halibut Commission) surveys suggests that if highgrading occurs, it is not statistically significant", and, "preliminary comparisons of the size distribution of sablefish in the commercial landings and catches in the NMFS (National Marine Fisheries Service) sablefish longline survey suggests that highgrading, if it occurs, is not widespread.

Discards of halibut, caught as a bycatch in the sablefish fishery, are estimated to have decreased by 83% following the introduction of ITQs (Gilroy et al., 1996, cited in National Research Council, 1999b).

However, serious highgrading problems exist in some North American fisheries, including the Wisconsin lake trout and Ontario walleye fisheries, while highgrading is apparently minimal in the Gulf of St Lawrence trawl and San Francisco Bay herring roe fisheries (National Research Council, 1999b).

According to Annala (1991), discarding is known to occur in both the inshore multi-species trawl fishery and in deepwater trawl fisheries in New Zealand. In the inshore trawl fishery, fishers have been reported to discard catches of non-target quota species while trying to catch unfilled quotas of other species. In the deepwater fisheries, vessels carrying observers have reported larger quantities of retained non-target quota species than vessels fishing in the same area without observers, indicating that discarding is taking place. However, Annala (1991) suggests that the occurrence of highgrading in some fisheries has decreased with the adjustment of quota holdings of individual fishers. More recent information suggests that fishers, as they have gained experience with the quota system, have progressively adjusted their fishing operations to reduce the need to discard quota species (Annala, 1996). Increased familiarity with the large range of bycatch management programs available in New Zealand has probably also played a role in reducing discarding. Further details of the New Zealand approach to bycatch management are provided in the Policy Options section of this chapter.

Arnason (1994) states that opponents of the ITQ system implemented in Iceland assert that the system generates a great deal of waste through discarding of catches. He goes on to say:

> Measurements of discarding in the Icelandic multispecies demersal fisheries have not produced much evidence in support of this assertion. Thus a recently published study found no discernible increase in discards under the ITSQ [individual transferable share quota] system compared to the previous limited effort fisheries management system. Under both systems discards ranged from 1–6% of total catch volume depending on gear and vessel type.

Two case studies are now presented that illustrate the scale of actual and potential discarding problems in two Australian fisheries managed by the Australian Fisheries Management Authority (AFMA). The southern shark fishery is a demersal gill net fishery for school and gummy shark. The south east trawl fishery is a multi-species bottom trawl fishery.

The shark case study draws on research carried out prior to the introduction of ITQs in that fishery and was aimed at helping industry and the fisheries management authority to determine whether ITQs were an appropriate management system. The case study of

the south east trawl fishery on the other hand, under an ITQ system since 1992, draws on actual discard data, collected over a number of years by onboard observers on trawlers, and also examines evidence of industry adaptation to the ITQ system.

CASE STUDY ON THE AUSTRALIAN SOUTHERN SHARK FISHERY

Gummy and school sharks are the main species caught in the Australian southern shark fishery. These species are often caught together by fishers using bottom-set gillnets and longlines. A number of other species of shark are caught incidentally in small quantities. The fishery extends from Victoria around the coast of southeast Australia, around Tasmania to Western Australia.

Potential large-scale discarding of school and gummy shark under ITQs was seen by a number of government and industry representatives as a major impediment to the choice of ITQs as the long-term management approach for this fishery. The following discussion is taken largely from a study (FERM, 1997a) carried out to address these and other concerns. AFMA subsequently decided that ITQs would be implemented on the two main shark species in early 2000.

Discarding of school or gummy sharks may occur for two main reasons: fishers being unable to obtain sufficient quota to cover over-quota catches and through the high-grading of catches to ensure that individual quotas are filled by only the most valuable fish.

Over-quota catches

For most fishers there are likely to be occasions when their catch of a quota species exceeds their holding of quota for that species. These situations may occur because of:

- a large incidental catch at the end of a season;
- a 'mis-match' between an individual's holdings of two quota species which are caught together.

These problems will be aggravated in cases where TACs and individual allocations are lower than historic catches and where some redistribution of quotas, relative to recent catching patterns, takes place on initial allocation.

In the southern shark fishery, the main potential discarding problem is with school shark, a species that has been heavily fished and depleted to a relatively low stock size. Catches are being reduced substantially (from 835 tonnes in 1996 to 475 tonnes in 1999) to allow the stock to recover. This will generally result in individual quota allocations for school shark being smaller than previous catches. In contrast, allocations of gummy shark quota are likely to reflect recent catches fairly closely, as this stock appears to be in a healthy condition. Although school and gummy shark are caught predominantly in different areas of the fishery, there is an area of overlap in Bass Strait where they are often caught together. In this area of the fishery particularly, fishers are likely to face the prospect of a 'mis-match' between their school and gummy shark quotas. That is, their allocations of school and gummy shark will be in different proportions to the average proportions in which they have been caught in recent years. A decline in abundance of school shark in recent times is, however, likely to somewhat mitigate this problem.

With current fishing practices, mis-matches between individual school and gummy shark quota holdings would normally result in the school shark quotas of individual operators being used up before their gummy shark quotas. Subsequent fishing for gummy shark would be likely to result in incidental over-quota catches of school shark and lead to potential discarding. The transfer and leasing of school shark quotas could be expected to reduce this problem. However, trade in school shark quota may be limited for some time because of a probable industry-wide shortage of school shark quota. This is because the rate of TAC reductions implemented in recent years has exceeded the estimated rate at which school shark abundance is declining, implying that many fishers are likely to be constrained by their ITQ allocations and would, as a result, have little if any excess quota to trade. Also, there is likely to be an initial period in which the quota trading market will fail to function smoothly while operators adapt their business practices to the quota regime. This being the case, the extent to which discarding takes place is going to rest mainly on the ability of fishers to avoid catching unwanted school shark.

Targeting of school shark

Estimating the extent of potential discarding requires some understanding of the targeting behaviour of fishers. To the extent that school shark catches are targeted, they are avoidable. Operators could choose to not set their gear in places and at times when school shark catches are likely to be made. If on the other hand school shark catches are largely incidental to the capture of gummy shark, discarding of school shark is likely to be a more substantial problem.

Discussions with fishers indicate that sets made close inshore, in water less than 20 metres in depth, are usually targeted at large, pupping school sharks, while sets in depths greater than 75 metres are outside the main gummy shark habitat and are normally also aimed at catching school shark. Fishers also claimed that they had considerable flexibility to target (and thus avoid) school shark — even in Bass Strait where the fishery is predominantly for gummy shark and where school shark catches have often been assumed by scientists to be largely unavoidable.

Operators indicated that when fishing for gummy shark in Bass Strait, catches of school shark are usually not predicted. However, having had a 'sniff' of school shark, operators often "shoot back" their nets and try to catch them again. This is a matter of choice. These subsequent sets on school shark are targeted. The school shark catch from Bass Strait, at around 250 tonnes in 1995, constituted about 30% of the total school shark catch in the fishery for that year.

To estimate how much of the Bass Strait catch is targeted, including those caught in depths less than 20 metres and greater than 75 metres, analyses of catch and effort data were carried out. Based on information received from operators, targeted sets were defined as those that immediately followed a set resulting in 70kg or more of school shark and that contained as much, or more, school shark than gummy shark. That is, the first catch of school shark is assumed to be accidental and thus unavoidable.

The results of the most conservative scenario indicate that over the three-year period from 1993 to 1995, an average of 33% of the school shark catch in Bass Strait

taken between the depths of 20 metres and 75 metres was targeted (Taylor, 1997). The total quantities of school shark estimated to be targeted in Bass Strait, including those caught in depths less than 20 metres and greater than 75 metres, are shown in Table 14. This indicates that around two-thirds of the total Bass Strait school shark catch is targeted, contrary to previous perceptions of the nature of the fishery.

It is likely that this is an underestimate of targeted catch. The catch of pupping school shark in inshore waters is almost certainly under-reported in the logbook data. Also, there are probably occasions when the 'identification' set of the gillnets that takes a significant amount of school shark (assumed in the analyses to be non-targeted) is in fact targeted. This initial set might for example be targeted based on information about the school shark catch of another vessel in the area. Also, it is likely that some operators will know of times and places in Bass Strait when and where it is worth having an exploratory but targeted set for school shark.

TABLE 14
ESTIMATED TARGETED AND NON-TARGETED CATCHES OF SCHOOL SHARK IN BASS STRAIT

Depth	1993 *Catch (t)*	1994 *Catch (t)*	1995 *Catch (t)*
Targeted in depths less than 20 m	1	2	1
Targeted in depths greater than 75 m	131	105	88
Targeted between 20 m and 75 m	125	121	87
Total targeted catch	**257**	**228**	**176**
Non-targeted (20–75 m)	165	112	79
Total school shark catch in Bass Strait	422	340	255
Percentage targeted	**61%**	**67%**	**69%**

Table 15 shows the average composition of the initial 'identification' set, subsequent targeted sets and all sets in Bass Strait. This indicates that the average targeted set contained (by weight) around three times more school than gummy shark.

TABLE 15
COMPOSITION OF THE AVERAGE IDENTIFICATION (NON-TARGET) AND SUBSEQUENT TARGETED SETS IN 20–75 M DEPTHS, BASS STRAIT, 1993–95

Set type	School shark	Gummy shark
Identification set (kg)	338	102
Targeted set (kg)	279	103
Average of all sets (kg)[1]	*38*	*141*

1. Across all depths in Bass Strait.

The results also suggest that operators generally make two targeted sets before the school is lost. An important implication is that relatively modest amounts of gummy shark would be foregone if fishers choose not to shoot back on school shark after unexpectedly finding a 'patch'. In fact, Table 15 suggests that on average operators would catch more gummy sharks by shooting elsewhere.

In other parts of the fishery, logbooks do not provide data on catch by depth so it is not possible to carry out an analysis similar to that undertaken for Bass Strait. However, SharkFAG (1996) states that the school shark catches in western and central South Australian waters, which account for around half of the total school shark catch in the fishery, are 'mainly targeted'. Industry opinion appears to be that most of the catches from eastern and western Tasmania are also targeted. Over the fishery as a whole, it would appear that around 70% of the school shark catch is currently targeted and, therefore, potentially avoidable.

As a result, it may be inferred that operators have the ability to exercise a reasonable degree of control over the size of their annual shark catches. Therefore, depending on the response of fishers to the ITQ system, the potential discarding problem arising from over-quota catches of school shark may be less than expected at first glance.

Highgrading

There is likely to be incentive for fishers to highgrade their catches of school and gummy shark because of market price discounts for damaged and large-sized shark. In 1997–98, average prices for school and gummy sharks were around $6/kg. Prices for damaged sharks were discounted by $2–3/kg, while prices for large school shark were often 20 cents/kg – $1/kg lower than those for medium and small sizes of both species (FERM, 1997a).

Damaged sharks often make up a sizeable proportion of the catch. The sharks are damaged before the gear is hauled, having been eaten by invertebrates, fish, or other sharks and mammals. Also, in particular areas and at certain times of year, a proportion of the catch is 'green' — a discoloration treated as 'damaged' by the market. A scientific survey of the fishery, based on the use of commercial vessels and fishing gear, recorded catches of damaged sharks amounting to 13% of the total weight of the catch. Of these, 4% were unsaleable and 9% were devalued. These results accord with industry observations that overall damage rates vary between 2% and 15% by weight, depending mainly on location, lunar phase and soak time of the fishing gear.

Under an ITQ system, damaged sharks will be discarded if the extra revenue attainable by replacing damaged with undamaged sharks is expected to outweigh the extra costs incurred in catching additional undamaged sharks. If damaged sharks amount to, say, 10% of the catch and fishers set their nets an average of 20 times per trip, an operator who consistently discards all damaged carcasses would need, on average, to make more than two additional sets per trip to catch an equivalent amount of undamaged replacement sharks.

The direct costs of two or three extra sets of the gill nets per trip are relatively modest compared to the additional revenue expected from highgrading of damaged

sharks. Indirect costs may, however, be more substantial. Two or three additional sets per trip would result in the entire catch being stored for at least an additional day before sale. This could be expected to affect adversely the quality of the catch and market price, particularly for that portion taken early in the trip.

Perhaps more importantly, many shark fishers have licence packages that allow them to operate in a number of fisheries. Additional time spent shark fishing to replace high-graded catches means less time spent operating in other fisheries. The potential net profit foregone from using another licence to fish for say, scallops or rock lobster, would have to be taken into account by operators in deciding whether or not to highgrade damaged shark. Only if the additional returns from highgrading are greater than the potential returns from using that time in another fishery, would it be economic to highgrade.

It should also be noted that under the current effort control system there is a limited incentive to avoid actively catching damaged sharks — if it is at the expense of reasonable shots of undamaged sharks. The situation may be significantly different under ITQs. If the amount of damage to shark catches can be reduced by varying the timing, duration or location of shots — as has been suggested by industry — there will be greater incentive for operators to vary their fishing patterns accordingly. For many operators it is likely that taking steps to reduce the incidence of shark damage will be more cost effective than highgrading.

CASE STUDY ON THE AUSTRALIAN SOUTH EAST TRAWL FISHERY

The fishery is a complex mix of overlapping sub-fisheries on a large range of commercial species. It extends from mid New South Wales, around Tasmania to South Australia (see Figure 6). In 1992, 16 of the most important species became subject to ITQ management. Later that year, a review of the management plan in the fishery identified discarding as a major threat to the effectiveness of the plan (AFMA, 1992).

As in the southern shark fishery, the nature and scale of discarding is, in part, dependent on the ability of fishers to target individual species effectively. This case study is based on research that examined targeting behaviour in the fishery prior to the introduction of ITQs, onboard monitoring data on discarding collected since the introduction of the system, and research on adaptation of fishers to ITQs after five years of operating under quotas.

Pre-quota targeting practices

Amidst growing concerns about the amount of discarding in the fishery following the introduction of ITQs, initial research focused on the use of catch and effort logbook data in order to gain an understanding of the ability of fishers to target various species and species assemblages (Klaer et al., 1994). Amongst other matters, this was aimed at informing the discussion on appropriate bycatch management policies.

This research on targeting behaviour of fishers identified a number of sub-fisheries based on analyses of five years of catch and effort data for the period 1985–89, i.e. prior to the introduction of ITQs. A sub-fishery is defined as a particular region and time of

BOX 8
CASE STUDY OF DISCARDING IN THE AUSTRALIAN SOUTHERN SHARK FISHERY: SUMMARY OF KEY POINTS

Reports of the discarding of school sharks and highgrading of damaged shark carcasses are likely to follow the introduction of ITQs in the southern shark fishery. This will come at a time when catches of school shark are being reduced to allow the stock to rebuild in size.

A substantial share of the school shark catch is currently taken by fishers primarily targeting gummy shark, and appears at first glance to be an incidental bycatch that is likely to be discarded when ITQs are in place. In practice, around half the gummy shark-associated catches of school shark are incidental, the rest are targeted. Fishers often encounter school shark by accident, but once located waste no time in "shooting back" on the school. Catches taken in "shoot back" sets are targeted and avoidable, if fishers choose to move away. Also, catches taken close inshore and in deep offshore waters beyond gummy shark fishing grounds are targeted. Overall, more than two-thirds of the total school shark catch is probably targeted, and hence potentially avoidable if quotas are constraining.

Highgrading of damaged shark carcasses is probable as their is a significant price differential between damaged and undamaged shark. How much highgrading will take place is difficult to predict. However, fishers suggest that changes in fishing practices could substantially reduce damage rates and some believe that such changes may be more cost effective than highgrading. Also, many shark fishers with multiple licences may find highgrading financially unattractive. This is because the additional time needed to catch their quota of shark following the discarding of lower grade carcasses will reduce their time spent fishing for, say, rock lobster or scallops.

year in which a relatively predictable mix of fish species is available for capture. Some 16 sub-fisheries that remained relatively constant throughout the dataset were identified. The catch within each sub-fishery is usually composed of no more than three major species. The existence of these sub-fisheries is common knowledge amongst fishers, and seasonal targeting of the species groups comprising relatively discrete sub-fisheries is normal fishing practice (Klaer et al., 1994). There is an implication that fishers are able to modify the species composition of their total catch to a significant extent by switching between sub-fisheries.

Fine-scale analyses of the targeting patterns of fishers were based on the use of a rule to identify the key target species. The rule was that if 60% or more of the total catch value (catch *x* market price) taken in a week, in a particular depth/area stratum comprised a single species, all shots made in that 'site-week' were deemed to be targeted at that species[7].

FIGURE 6
MAP OF THE AUSTRALIAN SOUTH EAST TRAWL FISHERY

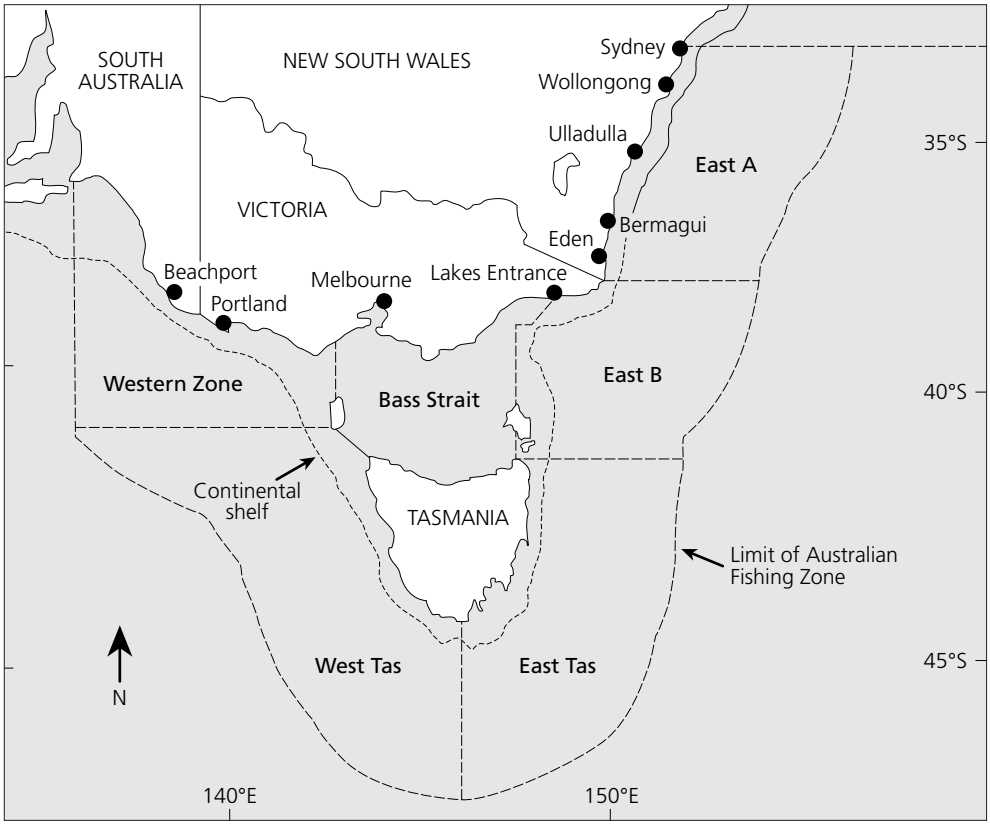


Table 16 shows the estimates of the targeted percentage of the catch for each quota species, and the targeting accuracy. That is, the average percentage of the target species in each of the trawl shots deemed to be targeted at that particular species[8].

It was concluded from the results shown in Table 16 that:

> Of the 16 [quota] species, only the first five have a targeted component of 66% or greater; suggesting that significant by-catch problems can be anticipated with the remaining 11 species. (Klaer et al., 1994).

Notwithstanding the need for cautious interpretation of the targeting results, the authors state:

> it is certain that there is potential for an increase in targeting accuracy and a consequent reduction in the bycatch component for most quota species… … The ongoing development of acoustic and navigation aids, together with improved knowledge of fish distributions, migrations and species assemblages, should also facilitate such an increase. However, it is obvious that such an increase in targeting will ultimately depend on the willingness of fishers to alter their fishing practices.

TABLE 16
ESTIMATES OF THE TARGETED PERCENTAGE OF THE CATCH OF EACH QUOTA SPECIES, AND THE TARGETING ACCURACY OF FISHERS

(reproduced from Klaer et al., 1994)

Species	Est'd percentage of total catch targeted	Accuracy of targeted shots (%)
Orange roughy	100	99
Gemfish	88	83
Royal red prawn	86	77
School whiting	86	86
Blue grenadier	69	83
Spotted warehou	53	81
Redfish	49	77
Tiger flathead	49	85
Blue-eye trevalla	47	68
Silver trevally	46	80
Blue warehou	36	75
Ling	35	57
Jackass morwong	32	75
Ocean perch	20	84
John dory	6	41
Mirror dory	4	74

Results of onboard monitoring

In 1993, concerns about the amounts of fish likely to be discarded in the south east trawl fishery led to the implementation of two complementary onboard monitoring projects; one on a sample of trawlers operating in the New South Wales area of the fishery and the other on trawlers operating out of Victoria. The New South Wales sector of the fishery is the most multi-species in nature. The results of the observer program in that sector indicated that on average 50% of the total catch of fish trawlers was discarded (Liggins, 1996).

The discarded catches were categorised into SEF quota species, commercial non-quota species and non-commercial species. Table 17 shows the average composition of retained and discarded catches of New South Wales-based trawlers over the three-year period of the study.

Although an ITQ system was in place throughout the course of the research, an overlap in fisheries jurisdictions between the Commonwealth and New South Wales governments effectively allowed fishers to catch fish in offshore Commonwealth-

managed waters (under an ITQ system), but to claim that the fish were caught inshore in waters under New South Wales jurisdiction where no quota system was in place. These catches were not subtracted from the Commonwealth ITQs held by the individual fishers. As a result, the ITQ system did not limit the catches of individual operators in New South Wales during most of the period monitored. Liggins (1996) concludes:

> It is considered unlikely that the existence of quotas influenced discarding of most quota species during this period.

TABLE 17
RETAINED AND DISCARDED PORTIONS OF THE TOTAL CATCH OF NSW-BASED FISH TRAWLERS, 1993–95

(from Liggins, 1996)

Catch composition	Share of total catch
Retained catch	*50%*
South east trawl fishery quota species	34%
Non-quota species	16%
Discarded catch	*50%*
South east trawl fishery quota species	15%
Non-quota species	8%
Non-commercial species	28%

However, observer data reveals that quantities of south east trawl fishery quota species were being discarded throughout the study period. Liggins suggests two main reasons for this. First, discards of two of the quota species were primarily driven by the existence of minimum legal sizes for the fish. The discards were predominantly smaller than the size limits. In fact, more generally across quota species it was observed that:

> sizes of fish discarded were generally smaller than the sizes of fish retained — the result of size-selective sorting.

This observation relates to the second suggestion as to why discarding of south east trawl fishery quota species and other commercial species occurred — i.e. for economic and marketing reasons. The implication is that the cost of boxing, icing, transporting and selling these, mainly small, fish were higher than the market prices expected from their sale.

However, in 1994 the impact of ITQs was felt when the New South Wales Department of Fisheries introduced a trip limit for redfish caught in state-managed waters. The trip limit, initially 300kg per day and subsequently increased to 500kg per day, reduced the capacity of fishers to exploit the jurisdictional loophole. The average amount of discarded redfish almost trebled compared to the previous year, from 141kg to 407kg per day. The retained catch dropped from an average of 839kg to

522kg per day. There was also an increase in the average size of the redfish discarded, consistent with the notion that the changes were ITQ, rather than market-driven.

In 1996, a fishery-wide, long-term program of onboard observation, in-port fish measuring and other scientific data collecting activities was implemented by AFMA. The results of the program indicated large variations in discarding rates between species, and between years for the same species. The availability of data on the size composition of retained and discarded catches by species provides scope for researchers to start to explain the various reasons for discarding in the south east trawl fishery — an important first step in designing appropriate policy instruments to address the problem.

Using mainly 1996 data on discarded catches, Hogan et al. (1999) estimated the lost short-term value to the industry of discards of quota species. Assuming that 50% of the total weight of discards of quota species were of an unmarketable size, and applying estimated price flexibilities to account for the likely market response to increased supplies, a gross value of A$2.1million was estimated. This lost revenue represents about 4–5% of the gross value of the fishery, and in profit terms, is equivalent to slightly over A$1 million or 8% of the total estimated fishery profit in 1996. This is a significant cost to the industry and indicates the potential value that may be derived from the implementation of additional bycatch management policies[9].

Although detailed analysis of the onboard observer data for the purpose of designing appropriate bycatch management policies has not yet been carried out, some initial observations can be made. Table 18 provides some tentative indications of the possible reasons for the discard of each species in each region of the fishery in 1998. These are based on the size composition of the discards relative to those of the retained catches, the extent to which TACs were under-caught, and industry information on quota and market influences[10]. Discarding is categorised as resulting from lack of quota or lack of adequate markets. Market-driven discarding is usually of either small-sized fish or species that are unusually abundant and are therefore being caught in large quantities.

Of the 54 area/species strata for which observations have been made of discarding, only in seven is it likely that lack of quota was a significant factor. For most of these seven strata, market-related factors are also likely to have contributed to the discarding and may in some have been the prime reason. It is also worth noting that in five out of the seven strata, the percentage of the catch discarded was low, between 2% and 7%. In only two strata, relating to catches of spotted warehou was discarding substantial (46% of the catch), and possibly attributable in part to lack of quota.

Highgrading is the most prevalent type of discarding in the south east trawl fishery. As seen in Table 18, in 1998 highgrading was evident for 11 of the 16 quota species. However, a large percentage of the highgrading appears to be of uneconomic sizes of fish. That is, fish that would often result in losses being incurred by fishers once handling and marketing charges are deducted from market prices. This form of highgrading certainly occurred prior to the introduction of ITQs and would take place under any management regime.

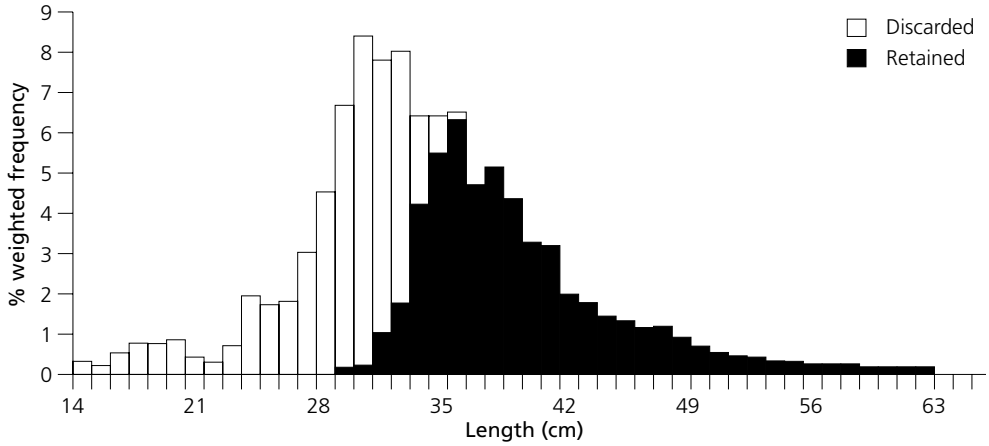
Brief commentaries are now provided on the main factors thought to be responsible for the discarding in 1998 of five of the species listed in Table 18: tiger flathead, blue grenadier, spotted warehou, redfish and eastern gemfish. These species were chosen to illustrate the effects of highgrading of small fish (tiger flathead), discarding following strong periodic recruitments (blue grenadier), discarding of saleable grades of fish as a result of market related factors (spotted warehou and redfish), and discarding due to insufficient quotas (gemfish).

Tiger flathead

The catch of tiger flathead forms one of the largest components of the overall catch from the continental shelf area of the eastern sector of the fishery. The 1998 TAC for tiger flathead (3,500 tonnes) was the third largest in the fishery after blue grenadier (10,000 tonnes) and orange roughy (4,800 tonnes).

Figure 7, based on onboard observer data on retained and discarded catches, shows the size composition of discards of tiger flathead in the eastern zone of the fishery in 1998. This clearly indicates that highgrading is occurring, although not for market reasons alone, as this species has a minimum landing size limit of 33cm in New South Wales (imposed for biological reasons). Relatively few flathead of saleable sizes are highgraded, and there is no evidence of discarding of larger size classes for quota or other market-related reasons.

FIGURE 7
RETAINED AND DISCARDED CATCHES OF TIGER FLATHEAD IN THE EASTERN ZONE OF THE SOUTH EAST TRAWL FISHERY,1998



Blue grenadier

Occasionally, environmental factors favour successful spawning and strong recruitments of juvenile fish to the fishery. When this occurs, an increased abundance of small fish inevitably leads to increased rates of highgrading. In 1995, 1996 and 1997 there were particularly strong recruitments of blue grenadier, estimated to be up to ten times higher than average (Punt, 1999).

TABLE 18
DISCARDING OF QUOTA SPECIES IN THE SOUTH EAST TRAWL FISHERY — TENTATIVE MAIN CHARACTERISTICS BY SPECIES AND REGION, 1998

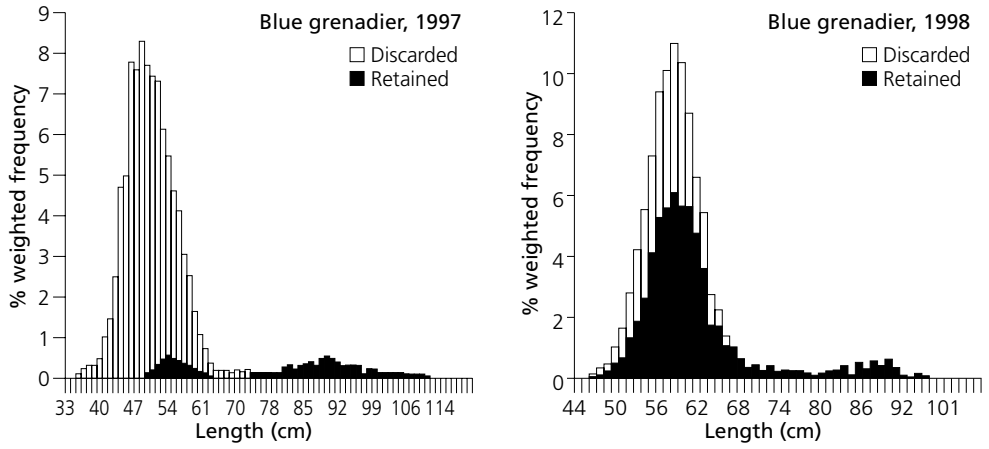
Species	Eastern A	Eastern B	E Tasmania	W Tasmania	Bass Strait	Western	Total discarded	Percentage of TAC caught
Blue grenadier	N	H	H, M	H, M	–	M	7%	46%
Ling	N	N	N	N	–	N	2%	86%
Orange roughy	–	H	–	–	–	H	1%	54%
Redfish	H, M	H	–	–	–	–	32%	86%
Mirror dory	H	H	H, M	–	–	N	20%	43%
John dory	N	N	–	–	–	–	4%	39%
Ocean perch	H, M	H, M	N	–	–	H	68%	60%
Tiger flathead	H	H	N	–	H	N	14%	63%
School whiting	H	N	–	–	N	–	12%	17%
Silver trevally	N	N	–	–	–	–	5%	16%
Jackass morwong	N	H	H	–	H	N	5%	49%
Gemfish east & west	H, Q	H, Q	N	–	H, Q	H	6%	103%
Blue eye trevalla	–	–	–	–	–	Q	2%	83%
Blue warehou	H	H	–	–	–	H, Q	7%	86%
Spotted warehou	–	H	N	Q, M	–	Q, M	46%	71%
Royal red prawn	M	–	–	–	–	–	7%	34%

KEY: N: Negligible, –: No data, H: Highgrading, Q: Discarding due to quota constraints, M: Discarding of larger size classes due to market conditions

There are two distinct components to the fishery for blue grenadier, a targeted winter fishery for large, spawning fish and a summer fishery in which juveniles are a bycatch of other species. In 1997, around 1,000 tonnes were landed from the summer fishery and around 2,600 tonnes from the winter fishery. The strongly recruited year classes were heavily discarded in the summer fishery in 1996 and 1997, as the juvenile fish were virtually unmarketable. The weight of discards in 1997 is estimated to have slightly exceeded the retained total catch[11]. Figure 8 illustrates that the number of mainly small fish discarded, dwarfed the number of generally larger fish in the retained catch. The discarding of significant numbers of fish in the larger size classes may be attributable to burst trawl bags resulting from large catches in the winter spawning fishery (Punt, 1999).

In 1998, discarding of the strong — but now larger and marketable — year classes continued, as indicated in Figure 8. Because blue grenadier spoils rapidly, it has to be processed on board within a couple of hours of capture. With fishers taking large catches, not all the fish could be headed and gutted between trawl shots, and residual quantities were discarded. Remarks by industry members of the south east Fishery Assessment Group (SEFAG) indicate that fishers are changing their fishing practices to take smaller catches per trawl to avoid discarding and to improve product quality (Smith, 1999). It was also noted that some operators were using larger mesh nets to try to avoid catching juvenile fish. Markets for blue grenadier are also said to have improved in 1998 compared to the previous year, allowing larger quantities of smaller size fish to be sold than in the previous year.

FIGURE 8
RETAINED AND DISCARDED CATCHES OF BLUE GRENADIER IN THE WESTERN ZONE OF THE AUSTRALIAN SOUTH EAST TRAWL FISHERY, 1997 AND 1998



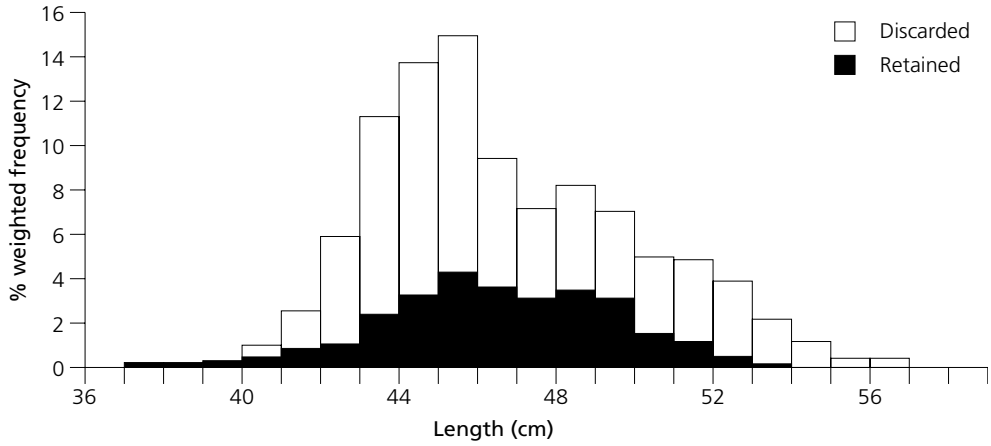
Spotted warehou

Spotted warehou is another species that was relatively abundant in 1998. The species was heavily discarded in the western parts of the fishery, with onboard monitoring data indicating that on average discards accounted for around two-thirds of the catch of each

trawl shot. Over the fishery as a whole about 15% of the catch was discarded (Smith, 1999). The size composition of discards matched that of the retained catch, suggesting that the discarding may have been quota related[12] (see Figure 9). Comments by fishers, reported in Smith (1999), to the effect that many operators found their quota holdings restrictive, supports this view.

Market-related factors may also have played an influential role as this species is relatively low-valued and auction prices on the Melbourne fish market are reportedly quick to fall when sizeable quantities of spotted warehou are sold (Smith, 1999)[93]. Spotted warehou is also exported to the Japanese market. In 1998, this market became less attractive, as depreciation of the Yen depressed Australian export prices. As a result, more fish was sold on the Melbourne market, adding to domestic marketing difficulties and giving credence to the suggestion that at least some of the discarding was market related. Again, this is supported by comments by fishers that landings in 1998 were often constrained by weak market demand, resulting in glut periods that led to discarding (Smith, 1999).

FIGURE 9
RETAINED AND DISCARDED CATCHES OF SPOTTED WAREHOU IN THE WESTERN ZONE OF THE AUSTRALIAN SOUTH EAST TRAWL FISHERY, 1998



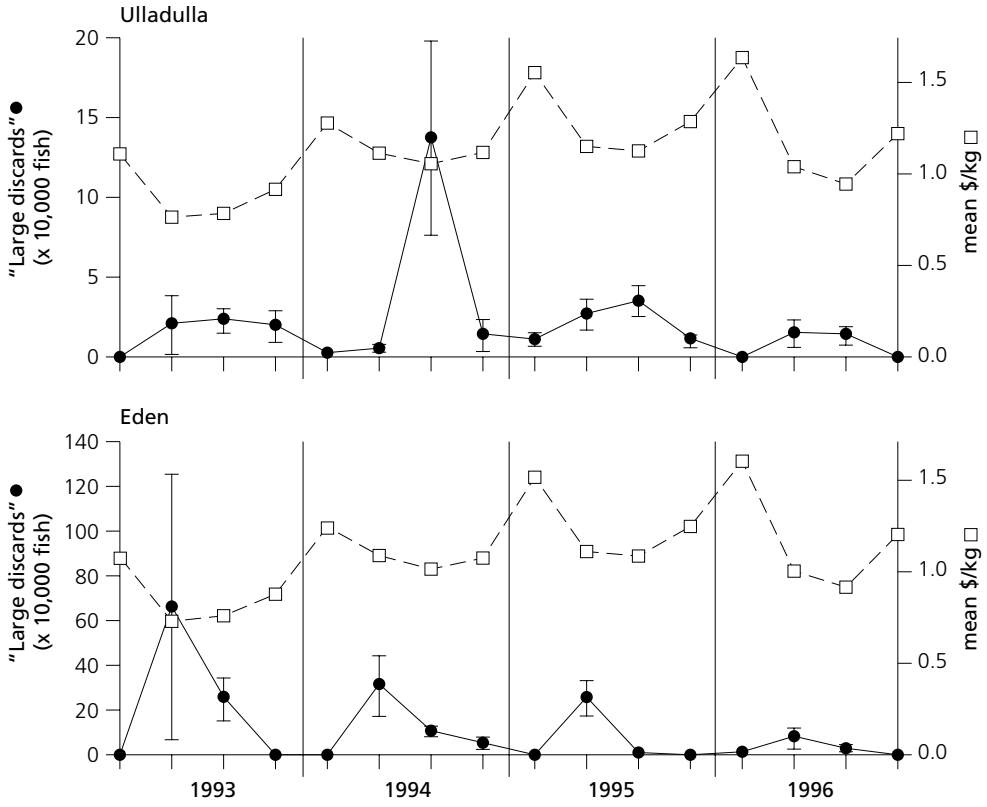
Redfish

Redfish is another species that is often discarded in response to changes in fish market conditions. The development during the late 1990s of a market for small redfish for processing into surimi[14] probably contributed to a halving of average discard rates, compared to the 1992–95 period. There remains a significant incentive for fishers to limit their supplies of redfish to the Sydney fish market and to discard small fish. This is because there is a strong price response to changes in the quantities supplied, particularly when supplies to the market are relatively large, and where the average price for medium-sized redfish is roughly double that for small redfish (Smith et al., 1998).

Liggins and Knuckey (1999) report that redfish between 15cm and 23cm in length were sometimes kept and sometimes discarded by the Ulladulla and Eden trawler fleets

over the period 1993–96. Figure 10 is a plot of mean quarterly prices for redfish on the Sydney fish market and quarterly estimates of quantities of "large" redfish[15] discarded by vessels operating out of two ports in the south east trawl fishery suggests that market prices influenced fishers' decisions to discard.

FIGURE 10
QUARTERLY MEAN PRICES FOR REDFISH ON THE SYDNEY FISH MARKET (WHITE SQUARES) AND MEAN NUMBER OF "LARGE" REDFISH DISCARDED PER VESSEL-DAY BY TRAWLERS FROM ULLADULLA AND EDEN (PORTS IN NEW SOUTH WALES), 1993–96



Source: Liggins and Knuckey (1999)

Eastern gemfish

Gemfish were also heavily discarded following the early implementation of the ITQ system. After taking catches of 2,000–3,000 tonnes per year in the late 1980s, TACs were scaled down to zero by 1993, following several years of poor recruitment, and were maintained at that level for most of the 1990s. Fishers were allowed a bycatch limit of 100–200kg per trip. Discarding in the eastern sector of the fishery was estimated at 72% of the total gemfish catch over the period 1993–95 (Liggins, 1996). Discarding of this species caused much conflict between industry and government and aroused intense

media interest. Fishers lobbied politicians to abolish the quota system and at one point protested against government inaction by dumping tonnes of gemfish on the steps of Parliament House. Following the initial protests, fishers began to actively avoid catching gemfish by not fishing in the depth range inhabited by the species during its annual spawning run — the time when the majority of the catch is taken. As shown in Table 18, in 1998 the level of discarding of gemfish was only 6%. While this may in part reflect the low relative abundance or availability of gemfish to the fishery, it seems probable that other economic and social factors were also at work.

Industry adaptation to ITQs

Fishers appear to be adapting their operations to the ITQ system, following a lengthy period in which controversy and litigation over the initial allocation of quotas created a deep mistrust of government and uncertainty about the future of the management system. A study undertaken in 1998, based on interviews with a large sample of trawler skippers in the south east trawl fishery, indicated that substantial changes in fishers' decision-making and operating practices are taking place in response to the ITQ system (Baelde, 1998). Baelde notes that for a fisher:

> making the right business decisions on what to catch and where, has become an essential part of fishing skills", and, "that fishers have to make such decisions based on a complex combination of information on market prices, quota holdings/availability/leasing prices, fish availability, and also based on information on other fishers' catches.

Although there is a strong suggestion that changing fishing patterns by individual operators in response to economic forces under the ITQ system may be responsible for reduced levels of discarding fishers are reportedly anxious to demonstrate that when market fishing[16], they are unable to effectively target particular fish species (Baelde, 1998). This industry sensitivity relates to the public perception (as noted above in Tilzey's 1994 analysis of targeting in the south east trawl fishery) that:

> if fishers are able to target a species, then they should be able to avoid it and thus not take unwanted catches. (Baelde, 1998).

The degree of targeting precision appears to be the main point of contention, with fishers claiming that when market fishing they cannot control the species composition of the catch. Most shots catch a range of species and indeed are intended increasingly to do so. Baelde notes that fishers often seek to increase the diversity of species in their catches in order to avoid filling quickly any particular quota and hence allowing their landings to be spread throughout the year. This now appears to be a key fishing strategy in many parts of the south east trawl fishery.

It is apparent that a variety of changes in fishing practices have been adopted to vary the species composition of the catch of individual shots — a loose form of targeting behaviour. Baelde suggests that the:

> essential way for fishers to catch a mix of species is to travel more between grounds, catching different combinations of species in different shots.

In this way, fishers are targeting various species groups, or sub-fisheries, as envisaged by Klaer et al., 1994. It is also noted that communication between fishers seems to have

increased since the quota management system was put in place, and that they maintain a day-to-day knowledge of catches in various grounds. Information on the catches of other fishers is an important part of an operator's decision-making process as to which species to target and which grounds to fish, particularly with regard to fish market conditions.

Other fishing practices being used to increase the diversity of catches include:

- working at particular depths or in grounds where the distribution of several species are known to overlap;
- trawling over a wide range of depths in one shot and finishing shots over the edges of canyons to try to catch species particularly attracted to these areas and;
- using high lift trawls over hard, broken grounds.

Baelde (1998) also reported that for most fishers:

> it is now part of their fishing practices to 'run away' from concentrations of some quota species to avoid unwanted catches," but that significant accidental catches were often taken prior to moving away (Baelde, 1998).

Fishers stated that the need to 'run away' happens more frequently in the second half of the year when a large proportion of some of their quotas has been caught. Also, the increasing use of net monitors is providing fishers with information on the amount of fish in the mouth of the net and gives a better idea of the likely size of catches. In these circumstances, the duration of trawl shots can be varied in an attempt to avoid over-catching particular quota species.

Overall, anecdotal and observer evidence has been collected that supports the idea that fishers are adapting their fishing practices to make more profitable use of their individual quotas. In this process, market fishers have sought to increase the mix of species in their daily catches and, by so doing, avoid situations where large catches of individual species absorb too quickly their annual quotas, creating over-quota difficulties later in the year.

There is little doubt that inter-annual changes in the relative abundance of particular species result in some over-catches for fishers, and in circumstances where quotas are unavailable on the lease market, in the discarding of these catches. This problem will continue to occur as stock assessment and TAC setting tends to lag behind changes in the relative abundance of species. However, the extent of problems of over-quota discarding in the south east trawl fishery, and the associated need for policy intervention to deal with them, appear to be lessening as fishers adapt to the ITQ system.

MONITORING OF DISCARDING

There is a variety of Australian legislation on fisheries and environmental management, at both the state and federal government level, that refers to the need to ensure that fishing is conducted in a manner consistent with the principles of ecologically sustainable development and the effective management of bycatches.

A lack of information on the extent of discarding would jeopardise the attainment of such objectives. In particular, unrecorded harvests of a species may result in TACs

BOX 9
DISCARDING IN THE AUSTRALIAN SOUTH EAST TRAWL FISHERY: SUMMARY OF KEY POINTS

The south east trawl fishery is multi-species in nature. Sixteen species are subject to quota management, Many of the quota species are routinely caught together in differing combinations and proportions, depending in part on fishing ground, time of year and depth. As might be expected, there has been a substantial amount of discarding over the years.

A defining feature of the fishery over its first seven years under ITQs has been ongoing litigation and controversy over initial quota allocations. The ensuing resistance of sections of industry to the ITQ system and an associated unwillingness to change fishing practices did little to reduce bycatch problems and discarding. An onboard observer program introduced in 1993 and based on the voluntary participation of fishers has provided a wealth of data on the retained and discarded proportions of the catch throughout the fishery.

Although significant amounts of quota species are still being discarded, fishers are increasingly adapting to the ITQ system and seeking to avoid taking over-quota catches. Changes in fishing behaviour include 'running away' from concentrations of particular species, and seeking to vary the species composition of catches by moving more frequently between grounds, fishing depths where species distribution overlap and towing over a range of depths in each trawl shot.

The main reasons for discarding in recent years have been the occurrence of very strong year classes of certain species, resulting in either large hauls of unmarketable juveniles or situations in which many fishers have fully caught their quotas and have been unable to obtain additional quotas on the lease market. When a species is highly abundant, substantial price responses on the fish market may discourage fishers from landing their entire catch. The most common form of discarding in the south east trawl fishery is highgrading. Preliminary analysis of data on the size composition of discards suggests that most of these fish are unmarketable and would have been discarded under any management regime.

being over-caught, to the detriment of the stock. Also, as most stock assessment methods are based on analysis of catch per unit effort (CPUE) data, unrecorded discards would have the effect of lowering the CPUE (if discards increase under ITQs); an outcome that could lead to overly pessimistic conclusions about the state of the stock. Clearly, realistic estimates of total catches of quota species are required for effective management.

Federal legislation also requires that management arrangements for the exploitation of fisheries resources "have regard to the impact of fishing activities on non-target species". Catches of such non-target species tend to be poorly reported on fishers'

logbooks. This is especially true for those species that are not commercially valuable and which are, as a result, routinely discarded.

Onboard observer programs have been implemented to monitor the extent of discarding in multi-species ITQ-managed fisheries in both Australia and New Zealand. Although the two programs aim to collect the same kind of data, they differ significantly in that the Australian program in the SET is regarded as "scientific", while the New Zealand program has a dual science and compliance role. As a result, the Australian program is voluntary, relying on the goodwill of fishers for the placement of observers[17]. Although the principal role of onboard observers is often seen to be stock assessment-related, the underlying reason for their presence on fishing vessels is the lack of compliance by fishers with logbook or other regulatory requirements. This may be particularly acute under ITQs because of the additional incentives for fishers to highgrade components of their catches.

AFMA only requires that observers be placed on vessels that are processing their catches on board. In contrast, New Zealand trawl operators are required to cooperate in the placement of observers.

The objective of the Integrated Scientific Monitoring Program (ISMP) in the south east trawl fishery is to collect information on the quantity, species composition, size and age structure of the retained and discarded catch of trawlers. In addition to onboard observers, this program involves in-port fish measuring. A primary purpose of in-port measuring is to check whether the onboard observer data is biased by unrepresentative sampling procedures or because fishers change their fishing practices when observers are present. For a detailed description of the program, including statistical design considerations, see NIWA (1997). Results of the program are provided in Knuckey et al. (1998).

In contrast to the Australian program that measures discarding directly, the New Zealand observer program is used to estimate the extent of discarding by comparing the catch composition of vessels with and without observers on board. Because discarding of quota species is illegal in New Zealand and observers have compliance responsibilities, fishers are obliged to land their entire catches of quota species when observers are present.

POLICY OPTIONS

Discarding is an emotive issue for fishers, fishery managers and the general public. As a result, there is often considerable pressure from various quarters on the fisheries authority concerned to act quickly to reduce known or perceived problems. However, policies to address discarding are likely to increase the administrative complexity and cost of the system and perhaps discourage the effective development of the quota market, so it is important that an objective assessment of the need for additional flexibility in the system is carried out prior to implementation.

Earlier discussion in this chapter concluded that mis-matches between actual fish availability to fishers and TACs are likely to occur in any ITQ system, and lead to

difficulties for fishers in leasing or purchasing additional quotas to cover bycatches. If the quota market is poorly developed or 'thin', these difficulties will be exacerbated.

The implication is that increased flexibility may be needed in the quota system to provide an economic incentive for fishers to land over quota catches that might otherwise be discarded. A number of policy measures, including allowing fishers some time to lease-in quotas, 'carry-unders and overs', quota substitution, deemed values and surrender provisions have been implemented in various jurisdictions to try to tackle this issue. These policy measures will be defined and discussed later in the chapter. Their main purpose is to reduce both the amount of over-quota catch and to ensure that any over-catch is recorded. The different bycatch policies used in various jurisdictions are shown in Table 19.

Highgrading is problematic from a policy perspective. Two main approaches have been suggested to mitigate the incentives to highgrade: setting quotas for different grades of each species[18] and using value-based quotas. Both options raise difficult practical issues, and neither appears to have yet been used in practice.

TABLE 19
POLICIES USED TO AVOID OVER-CATCHES AND DISCARDING IN VARIOUS JURISDICTIONS

Policy	Australia	New Zealand	Canada	United States
Quota balancing flexibility	Not permitted to be more than 20% over-quota at any time (SET and SENT)[19].	Fisher has until 15th of the following month to cover over-catch.	Fisher has 30 days to lease in quota.	Not permitted to be more than 10% over-quota at any time in Alaskan fisheries.
Carry-unders & overs	20% for most SET species. Fixed number of kgs. in state fisheries, if at all.	10%	…	10% in Alaskan fisheries.
Deemed value	None	For all quota species.	None	None
Substitution	None	Inshore species with strong associations.	Three species in the Scotia-Fundy groundfish fishery.	None
Surrender	None	Available for all quota species.	If insufficient quota available for substitution.	None
Basket quotas	Two species of ocean perch grouped in the SET.	Flatfish species grouped together.	None	None

CARRY-UNDER AND OVERS

Carry-under is an arrangement that allows fishers a permissible over-catch of quota in one year that is deducted from their following year's quota holding. Similarly, carry-over arrangements allow fishers to carry forward to next year's quota an amount which is uncaught this year. Carry-unders and overs are permitted in the SET and SENT under AFMA management, in New Zealand and in a more limited way, in some Australian state-managed fisheries[20].

As well as providing increased scope for fishers to avoid discarding species that are highly catchable or available, relative to their TACs, carry-under and carry-over offer fishers the economic advantage of timing their harvests to better suit current or expected market conditions. Fishers also report an advantage of being able to avoid "exorbitant leasing prices at the end of the year" to cover end of season over-catches (South East Trawl Management Advisory Committee, 1994). However, if high fish availability and relatively low TACs persist for several years, fishers that took early advantage of carry-under may face increased difficulties in dealing with future over-quota catches. Carry-over of uncaught quota does not address the discarding problem directly, except, perhaps, by serendipitously allowing increased catches next year if it turns out to be a year of unexpectedly high fish availability.

One argument against carry-over is that if the TAC is erroneously set too high, and fishers are unable to catch their quotas, allowing carry-over of the uncaught quotas will exacerbate potential stock problems by allowing increased future catches. For this reason it has been suggested that carry-overs should be discouraged (Tilzey, 1994). Recognising that there are a range of economic and environmental reasons, unrelated to fish abundance, that may result in TACs being under-caught, AFMA decided to allow carry-under and carry-over at a maximum rate of 20% of an individual's quota holding[21]. However, this general approach is tempered in practice by disallowing carry-under or over for stocks assessed to be over-exploited. A rate of 10% for carry-over and under is allowed in New Zealand fisheries.

The maximum permissible over-run of quota (carry-under), and whether or not carry-over of uncaught quota should be allowed, are issues that have generated considerable debate between fishers, scientists and fishery managers in Australia. The primary issue is whether carry-unders and overs would have an adverse impact on the stock by allowing TACs to be exceeded. A simple numerical example in Table 20 illustrates the effect on the total catch of a fisher using a maximum 20% carry-over of under-caught quota initially and, thereafter, taking the maximum permissible 20% over-catch.

After catching 20 tonnes less than his/her 100 tonne allocation in year one, the fisher is able to carry-over 20 tonnes to year two, giving an available quota of 120 tonnes. Using carry-under, the fisher can now exceed this quota by up to 20% and catch a maximum of 144 tonnes. The 24 tonnes carry-under is then debited from the fisher's allocation to give, in year three, a fishable quota of 76 tonnes. Again, using the full carry-under provision, the fisher can catch up to 91 tonnes with a carry-over debit of 15 tonnes in year four.

TABLE 20
EXAMPLE OF THE POSSIBLE EFFECT OF A 20% CARRY-UNDER AND CARRY-OVER RATE ON A FISHER'S CATCH

Year	1	2	3	4	5
Allocation	100	100	100	100	100
Carry-under/over	-	+20	-24	-15	-17
Available quota	100	120	76	85	83
Catch	80	144	91	102	100

Source: SETMAC Over-quota Harvest Working Group (1994)

The fisher would, after five years, be constrained to catch no more than his/her allocated quota. The maximum total catch taken over the five-year period is around 3.5% greater than if the allocated quota had been taken fully each year. The maximum catch using a 10% carry-under and over rate would be around 1.8% larger than the allocated quota over the same five-year period. So, although carry-under and carry-over do allow potentially more catch to be taken, it is one-off' in nature and the increment is of a relatively small magnitude.

Because of the variety of circumstances faced by individual fishers, it is highly unlikely that the full extent of carry-under and carry-over provisions would be used. Over the seven years that the scheme has been in operation in the south east trawl fishery, there have been only seven occasions (out of a possible 133) when the total fishery catch has exceeded the allocated TAC.

In AFMA, individual carry-unders and carry-overs are routinely computed as part of the catch monitoring system. If for example, a fisher under-catches a quota by up to 20%, this amount is added automatically to the fisher's quota for the following year. Reports are automatically generated and sent to fishers on a two-monthly basis in the first half of the year, and monthly in the latter half, showing their net quota position. This is their permanent allocation minus carry-under (or plus carry-over) adjusted for quota purchases and sales, quota leases in and out and decremented by the quantities of fish landed. As a result, the system requires little input from quota monitoring staff.

DEEMED VALUES

The purpose of a deemed value system is to give fishers an economic incentive to land and sell over-quota catches that would otherwise be discarded. The majority of the revenue from the sale of the catch is subsequently recovered from the fisher by government. Fishers are billed for the deemed value of the fish. The difference between the market price received by the fisher and the deemed value paid to the government is known as the incentive price. As its name suggests, this is a payment designed to provide fishers with an incentive to land rather than discard the incidental catches. The incentive price is aimed at providing fishers with a sufficient return to cover the costs

associated with icing, boxing, marketing and paying the crew, but without providing the incentive to actively target and over-catch their quotas.

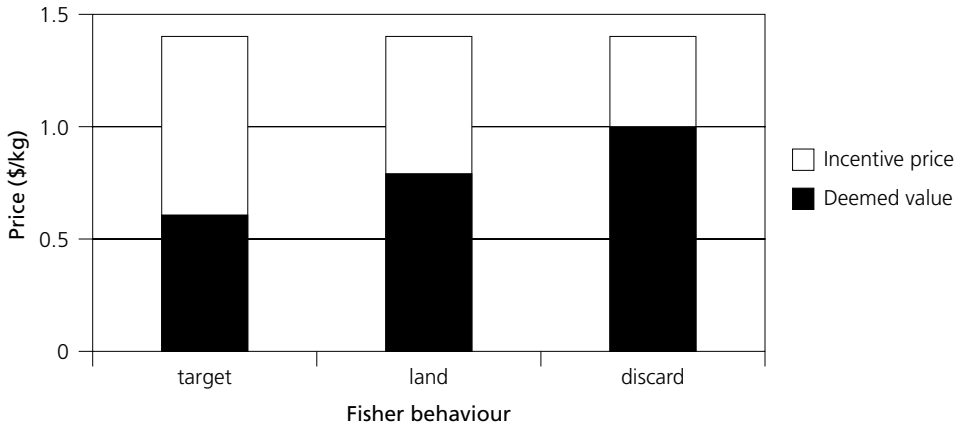
Deemed values are used in New Zealand as part of the bycatch management system. The process of setting deemed values in New Zealand is described in Baulch et al. (1992). There are two stages to determining a deemed value. First, a base price is set that is the average of the port price and the export price for each fishstock[22]. Deemed values are then calculated as a proportion of the base price. The proportions vary by species, product form and fishstock, and are based on subjective probabilities of any particular species or stock being discarded. The higher the perceived likelihood of catches from a fishstock being discarded, the lower is the deemed value that is placed on the fish. This increases the share of the market price retained by the fisher, providing a greater incentive to land the fish.

A number of limitations of the deemed value system, as used in New Zealand, have been identified by Baulch et al. (1992). Foremost, is the difficulty of administratively setting deemed values at the correct level that will provide fishers with an incentive to land incidental over-quota catches.

Figure 11 illustrates the likely effects of differing levels of deemed value for a particular fishstock.

If a deemed value is too high and the corresponding incentive price to fishers too low, quota species will be discarded. If the deemed values are too low, it will be profitable for fishers to target species for which they have no quota. Because deemed values are fixed for certain periods, it is inevitable that fluctuations in market and export prices will result in changes to the incentive price, causing changes in discarding and targeting behaviour.

FIGURE 11
POSTULATED EFFECTS OF DEEMED VALUES ON FISHER BEHAVIOUR



The vertically integrated nature of the New Zealand finfish fishery also creates difficulties for the effective operation of a deemed value system. In particular, the profits generated by maintaining throughput of fish through processing factories may act to

reduce the incentive price needed to land over-quota fish, and encourage targeting. It has been noted that high value adding during processing may act as additional inducement to land over-quota fish and pay the deemed value (Sissenwine and Mace, 1992).

The delay between fishers being paid by the market for over-quota catches and receiving a bill from the ministry is another potential pitfall that may create incentive for fishers with short term liquidity problems to intentionally catch high value species for which they lack quota (Baulch et al., 1992).

Another key concern about a deemed value system is that it could have a distorting effect on the quota market. If the deemed value for a species is set lower than the quota lease price, it would be more profitable for fishers to pay the deemed value to the government rather than lease quota to cover their over-catch. In effect, the deemed value places an upper bound on the quota lease price.

An alternative approach to the use of deemed values is to set the incentive price directly, rather than as a residual. In New Zealand, the primary focus is on setting the deemed value, with the result that the incentive price fluctuates with changes in market prices, with unwanted consequences, as identified above. Setting the incentive price directly would involve estimating the additional costs faced by fishers associated with landing rather than discarding incidental catches. Although the incentive price will vary by port, due to differences in distance and hence transport costs to markets, it is not apparent that there should be significant cost differences between species being sent from the same port to the same market (Geen et al., 1992). The costs associated with landing a box of flathead and sending it to market should be very much the same as those for a box of snapper. The benefit of directly estimating incentive prices is that if set correctly, fishers will land their bycatches irrespective of fluctuations in the market price.

Baulch et al. (1992) have estimated the incentive price necessary for fishers in the Australian south east trawl fishery to land their catches and sell them on the Sydney fish market. As a starting point, a review of market prices revealed that quantities of trawl species were consistently landed at a price of around 80 cents/kg. This price was used to estimate the labour costs associated with landing the fish, based on a percentage share of the value of catch. The costs of market commission, ice and transport (assuming a landing point close to the market) and administration were estimated directly. The total cost of paying the crew, landing and marketing the incidental catch amounted to 32 cents/kg. This is therefore the estimated incentive price for fishers landing catches close to the market. An increment for additional transport costs would have to be added to the incentive price for more distant landing sites.

However, Baulch states that this estimate is an upper limit on the true incentive price, as discussions with fishers indicate that under some circumstances they would target fish at this price. So, although fixed incentive prices may be an improvement over varying incentive prices, as used in New Zealand, discarding and targeting problems are still likely to emerge due to administrative errors in price setting. It is also interesting to compare the 32 cents/kg base level incentive price for the south east trawl fishery

estimated by Baulch et al. (1992) with the apparently high level of incentive prices used in the New Zealand deemed value system. For example, incentive prices of NZ$2.01/kg and NZ$1.08/kg were provided to New Zealand fishers in 1991 to land over-quota flatfish and gemfish, respectively. Incentive prices in New Zealand in recent years have been generally much lower.

A deemed value system is likely to be expensive to administer. In New Zealand, deemed values are adjusted periodically to account for changes in market prices and in response to information on the degree of use by fishers of the system; with heavy use perhaps indicating targeting behaviour. Setting and adjusting deemed values, collecting and analysing fish price and industry information, invoicing fishers, and following up non-payments are activities likely to result in a sizeable and costly bureaucracy. Deemed value payments to government would, however, offset these costs to some extent.

QUOTA SUBSTITUTION

Quota substitution is a mechanism that allows a fisher who over-catches a quota of a species to forfeit the use of uncaught quota of another species to cover the over-catch. The fisheries management authority sets the rates at which species can be substituted. Provided that the sale value of the over-caught fish is at least equal to that of the quota species exchanged, there will be no incentive to discard.

Quota substitution systems are used in New Zealand and Canada. The New Zealand system is known as the 'Bycatch trade-off scheme' and is limited to inshore species caught in conjunction with one another. The Ministry of Fisheries sets the exchange rates between species, based on the expected quota over-run of the bycatch species and the extent to which the TAC of the target species would need to be reduced to prevent this over-run (Baulch et al., 1992). The exchange rates differ by catching method and quota area.

Table 21 shows the bycatch trade-off exchange rates for one quota management area in early 1998. If a fisher bottom trawling for barracouta in area 7 takes a bycatch of stargazer for which he or she has no quota, then rather than pay a deemed value for stargazer the fisher may decide to offer to lease to the Ministry of Fisheries an equivalent value of barracouta quota. In this case, 6.37 tonnes of uncaught barracouta quota would be offered for each tonne of stargazer over-catch.

TABLE 21
BYCATCH TRADE-OFF SCHEDULE FOR QUOTA MANAGEMENT AREA 7, NEW ZEALAND, JANUARY 1998

	Target species	
Bycatch species	Flatfish (bottom trawl)	Barracouta (bottom trawl)
Red cod	0.19	–
Stargazer	–	6.37
Tarwhine	–	4.37

Each offer by fishers is assessed individually to consider the potential for the TAC to be exceeded, and to check whether there are any economic incentives prompting the offer of exchange. This would, presumably, relate to circumstances where relative quota lease prices differ significantly from the target/bycatch exchange rate. If the Ministry rejects a lease offer, the fisher is instead required to pay the deemed value of the over-catch.

In Canada, quota substitution has been implemented as the main bycatch management program in the Scotia-Fundy groundfish fishery (Baulch et al., 1992). The system is relatively simple and is confined to the three major species in the fishery. The conversion rates between the species are based on relative port prices and estimated catching costs, and are fixed for the season. Although the Canadian approach is probably less costly to operate than the New Zealand system, it is likely to provide incentives to either target or discard if fish prices vary through the season.

The principal advantage of quota substitution is that it may result in a lower over-run of TACs than other policy options. By using the quota of a target species to cover the over-run on an associated bycatch species, the quota for the target species is effectively filled earlier. When an operator reaches his/her target species quota, the operator ceases to target that species and in turn ceases catching bycatch species for which no quota is held. In contrast, a deemed value system would allow an operator to keep paying the deemed value of over-catches of the bycatch species while continuing to catch their full allocation of the target species. This results in higher catches of both the target and bycatch species, relative to the catches that could be taken under a quota substitution scheme.

SURRENDER OF CATCH

In New Zealand, fishers have the option of surrendering ownership of their over-quota catch to the Crown. This requires that the fisher advise the Ministry of his/her intention to surrender a catch as soon as practicable after it is taken and prior to landing. The Ministry will then advise the fisher to supply the fish to a particular licensed fish receiver. No payment is made to the fisher for the catch. In effect, this is equivalent to a deemed value for the fish of the full market price. Presumably, fishers would only surrender their catch, in preference to paying a deemed value, if they believed that the deemed value exceeded the market price. However, it appears that the surrender mechanism is used to a significant extent in New Zealand.

Annala (1991) reports that in 1987–88 use of the bycatch trade-off scheme and surrender provisions led to 24 TACs being exceeded. Of these over-runs, 18 were of more than 10% and several were in excess of 60%. The species for which TACs were substantially exceeded were predominantly bycatch species in the large-scale hoki fishery. Over-catches of these species were mainly surrendered to the Crown. Annala notes that:

> the surrender provisions have allowed hoki allocations to be fully caught without any constraint from the level of bycatch of silver warehou. This strategy, however, will not

> guarantee the sustainability of silver warehou stock if recommended catch levels are exceeded every year.

By 1993–94 the number of TAC over-runs due to the use of surrender and bycatch trade-off provisions was down to ten. Annala suggests that this reduction is the result of fishers changing their fishing practices, and points to the adoption of voluntary industry codes of conduct as contributing to the improvement, particularly in relation to reduced bycatch of silver warehou, ling and hake in the hoki fishery.

CLOSURES AND TECHNICAL MEASURES

One technical measure often implemented to try to reduce the catch of small fish in a single species fishery is an increase in the minimum mesh size for nets. For multi-species fisheries, identification of an appropriate minimum mesh size is not straightforward, involving consideration of trade-offs between lower catches of saleable fish of some species and fewer discards of others. In the south east trawl fishery, some fishers have voluntarily adopted larger mesh sizes in trawl nets to reduce their catches of juvenile fish.

Under certain circumstances other fishing gear modifications have been shown to reduce the amount of juvenile fish in the catch. Options include the use of separator panels, square mesh cod-ends and ground-gear modifications. For a review of possible modifications to bottom trawls to assist in improving fish selectivity, see Eayrs (1998).

Discarding of small-sized fish may also be affected by the closure of certain nursery grounds to fishing. This is a useful measure routinely used under all forms of management. Crean and Symes (1994) suggest that:

> Possibly the only effective regulatory method to reduce discards available to resource managers in either control system [input or output controls] is the use of ground closures or limited access. They may be permanent, as in the case of the Shetland and Irish Sea 'boxes' designed to exclude fishing methods that put at risk large populations of juvenile food fish, or they may be temporary, as with the emergency closure procedures in Icelandic waters activated when sample catches reveal dangerously high levels of small fish.

Area closures have also been suggested by a number of other authors as a means to reduce the bycatch of unwanted species. Adlerstein and Trumble (1992, cited in Alverson et al., 1994) suggest that

> time/area management can work under proper circumstances. It is most effective if a species (or complex) will clearly be absent from an area.

An alternative view is provided by Hughes (1992, cited in Alverson et al., 1994), who suggests that:

> More often than not, in Alaska, regulations which close chunks of fishing grounds to address some bycatch problem one or two years previously have created a multitude of new bycatch problems as a result of forced changes in fishery effort and normal yearly/seasonal changes in distribution and abundance of both target and bycatch species.

According to Alverson et al. (1994), most authors on such issues support the view that it is difficult to establish time/area closures that consistently meet bycatch management objectives. Alverson et al. also notes that although closed areas are used in many parts of the world to control bycatch mortalities they are seldom evaluated. Two evaluations, cited in Alverson et al. (1994), suggested that the closures under review had either little impact on bycatches (in the Bering Sea) or unintended results, such as an increase in the survival of soles from a closure directed at reducing juvenile plaice catches in the North Sea.

Taking a broader view of the effects of closures, Murawski (1992, cited in Alverson et al., 1994) states:

> Any bycatch reduction plans involving time/area manipulation of the fishery must address the following considerations: (1) Will the proposed solution be economically viable? i.e., the bycatch problems may be mitigated, but the fishery may not be profitable. (2) Does the proposed solution result in consistently lower bycatch rates? (3) Can the program be effectively implemented and enforced?

VALUE-BASED QUOTAS

To overcome highgrading problems, the use of value-based quotas has been suggested (see Turner, 1996 and Hogan et al., 1999). Rather than being allocated a right to harvest a certain quantity of fish, operators would receive a right to harvest up to a certain total value of fish. Fishers would have no incentive to highgrade their catch as there would be no addition to total annual revenue to be gained from landing more valuable sizes of fish. Rather, profits would be maximised by keeping fishing costs to a minimum. However, small or damaged fish that are uneconomic to land would still be discarded.

Practical difficulties are likely to be encountered with the use of this approach. Enforcing value-based quotas depends on the fisheries authority being able to obtain accurate data on the gross values of the catches landed by each fisher. As noted in Hogan et al. (1999), the existence of transfer pricing in vertically integrated companies or collusion between buyers and sellers to reduce reported prices would undermine the effectiveness of the system. This system has not apparently been implemented anywhere to date.

SUMMARY

Discarding occurs in many fisheries under a wide variety of management arrangements. A need to adhere to minimum size limits, market or processor demands or stay within bycatch limits often leads fishers to discard their catches. Under ITQs, fishers may have an incentive to highgrade the marketable portion of their catches or discard catches for which they have no quota.

The extent of discarding under ITQs particularly in multi-species fisheries will be heavily influenced by the ability of fishers to target individual species, the size of TACs in relation to fish availability, the functioning of the quota market and the price differentials between fish grades. In the Australian southern shark fishery in which

school and gummy shark are often caught together, research suggests that despite a halving of the school shark TAC, fishers if willing, should be able to largely avoid catching and discarding school shark. However, highgrading of damaged sharks is probable, as there is a sizeable price discount on these carcasses.

Discarding for market-related reasons has a long history in the Australian south east trawl fishery. The introduction of ITQs in 1992 provided fishers with additional incentives for discarding. Mistrust of government by fishers, following the initial quota allocation did little to encourage changes in fishing practices to avoid discarding. Despite the acrimony, fishers agreed to a voluntary onboard observer program to monitor for scientific purposes the size and composition of retained and discarded catches. In the late 1990s fishers are increasingly adapting their behaviour to make the most of their quotas and avoid the need to discard. Most discarding is now market rather than quota-driven, and would occur under any management regime, not just ITQs. Fishing practices are being modified to increase the species diversity in each haul, and new trawl designs and technology are being used to help avoid unwanted catches. A similar response by industry has been observed in New Zealand fisheries where the discarding of bycatch species has been substantially reduced through adherence to voluntary codes of fishing conduct.

Although important, gaining the good will of fishers is not usually enough to eliminate discarding in multi-species fisheries. Targeted policies that introduce flexibility into the quota balancing process are needed to help fishers deal with unintended over-quota catches. Fisheries management authorities have introduced policies that range from simply giving fishers a period of time to lease quota to cover their over-catch or allowing a certain amount of over-catch to be deducted from the following year's quota, to more complex deemed value and quota substitution schemes. Although potentially useful in helping to avoid discarding, all these measures also have the potential to stimulate additional targeting of fish when no quotas are held. The more complex the system, the more likely it is that fishers will take advantage of administrative blunders to intentionally over-catch their quotas.

It is likely that fisheries management authorities will need to implement a combination of policies to adequately address the problems of discarding in multi-species fisheries. Although no particular policy is clearly superior to others, quota substitution, by using quota of target species to cover bycatch species, does offer the advantage of smaller quota over-runs than do deemed value or surrender schemes.

Bycatch management systems can be complex and costly. If administered poorly, they can aggravate the problems they are intended to cure. As indicated by the case studies presented in this chapter, the ability of fishers to avoid over-quota catches is a matter that demands careful consideration by fisheries management authorities as a foundation for the development of appropriate bycatch management policies.

ENDNOTES

1 For an economic analysis of highgrading under ITQ systems, see for example Arnason (1994) and Anderson (1994).

2 For example, in 1998 in the eastern sector (Zone B) of the south east trawl fishery the average weight of discards of flathead in a trawl shot was around 10% of the total weight of flathead caught. These discards were of fish smaller than the minimum size limit for landings imposed by the New South Wales Government.

3 Fishers will take into account the opportunity costs of quota in the decision of whether to retain or discard catches. If quota could be more profitably leased out to other fishers rather than used to land a catch of say, small fish, then the catch is likely to be discarded. Similarly, if a fisher doesn't hold quota for an incidental catch and the expected profit from sale of the catch is less than the cost of leasing in quota to cover it, then these fish are also likely to be discarded.

4 The same applies to damaged or lower quality fish (for example, fish in poor condition following spawning).

5 The volume of lease-trading in quotas more than doubled between 1992 and 1997, from around 6,000t to over 14,000t per year (Hogan et al., 1999). In 1997 this was equivalent to 44% of the total allocated quota.

6 A recent study of the quota market in the south east trawl fishery noted a trend towards greater market concentration for most species but identified that concentration ratios have remained low, implying that market power is unlikely to represent an impediment to efficient quota trade (Hogan et al., 1999).

7 This form of analysis is subject to a number of potential biases. Specifically, so-called "targeted shots" containing more than 60% by weight of a particular species may in fact have been the result of speculative trawling. Conversely, actual targeted shots that failed to result in significant catches of the target species are omitted or wrongly classified as being targeted at other species, which by chance comprised the majority of the catch.

8 Note that estimates of target percentage and accuracy are based on landed catch, and biases are therefore introduced by discarding

9 AFMA already has in place a policy that allows fishers to over-catch their quotas by up to 20% in a year and deduct the same amount from their following year's quota, a move that may help avert some discarding.

10 From onboard monitoring data obtained from Knuckey et al. (1998), personal communications with fishers and industry observations in SEFAG (1999).

11 The total catch, including discards, was substantially below the allocated TAC of 10,000 tonnes.

12 Unlike blue grenadier, spotted warehou is not usually processed on board.

13 This observation is consistent with an analysis of price fluctuations for south east trawl fishery quota species on the Sydney fish market (Smith et al., 1998) which indicated that prices for species that have the highest market throughput are most responsive to changes in supply. Spotted warehou is a high throughput species on the Melbourne fish market, while only a moderate throughput species on the Sydney fish market. Nevertheless, a 10% increase in volume on the Sydney fish market is estimated to result in a 4–5% price reduction.

14 A type of fish 'mince' used as an ingredient in products such as 'crabsticks'.

15 "Large" redfish discards are defined as those discards greater than the length at which 33% of the catch was retained. For Eden trawlers, for example, the minimum size for "large" discards varied from 18cm to 21cm between years. Accordingly, the mean price on the Sydney fish market used for the analysis was for small, medium and ungraded redfish.

16 This refers to the practice of mixed species fishing on continental shelf and upper slope fishing grounds.

17 In 1998, it was reported that observers could be placed on 60–80% of the south east trawl vessels operating from the ports in which the program is sited (Knuckey et al., 1998).

18 Setting quotas on different grades would incur the same difficulties as fixed quota packages where fishers would be required to hold a certain amount of bycatch species quota for each tonne of target species held. As species and size composition of catches vary over time and spatially, such a policy is not likely

to reduce discarding. Also, fishers are locked in to their previous fishing behaviour by the fixed quota mix. This backward-looking aspect to this policy makes it undesirable (Baulch et al., 1992).

19 In practice, operators are allowed some time to lease-in quota before prosecution procedures are commenced.

20 A limited form of 'carry-under' is allowed in the South Australian rock lobster fishery. If fishers exceed their quota by 20kg or less, this quantity is simply deducted from their next year's quota. Larger over-quota catches incur penalties. There are similar arrangements for the Tasmanian rock lobster and giant crab fisheries and for the South Australia abalone and blue crab fisheries.

21 Carry-unders and overs are not allowed for species that are assessed as over-exploited, such as Eastern gemfish. Conversely, in 1998 a carry under and over rate of 40% was allowed as a short-term measure for spotted warehou in response to high abundance and catches following the setting of the TAC. The TAC was raised the following year and the carry-under and over rate dropped to 20%.

22 The fishery for each species in the New Zealand quota management system is divided into a number of different management units, officially designated as "fishstocks".

9 MANAGEMENT COSTS

The issues of fisheries management costs and cost recovery are gaining increasing attention. Recent articles and reports by Geen et al. (1991), Industry Commission (1992), Kaufmann and Geen (1997), Andersen et al. (1998), Arnason and Hannesson (1999) and Schrank and Skoda (1999) detail the costs of management in a number of fisheries and/or provide various arguments in support of cost recovery and out-sourcing of management services. Fisheries management costs are not insignificant, for example, Arnason and Hannesson (1999) suggest that management costs in Iceland, Norway and Newfoundland are respectively 3%, 10% and 15–25% of landed value.

The purpose of this section is to focus on the costs of management in ITQ fisheries as these are often claimed to be higher than for other management regimes. For example, a proposal to introduce ITQs into the Tasmanian rock lobster fishery resulted in the establishment of a Legislative Council Select Committee of the Parliament of Tasmania to review the recommended management change. The Committee raised a number of concerns relating to the ITQ option (Parliament of Tasmania, 1997). One of the Committee's conclusions was that the cost of management under an ITQ system was much higher than management costs under an input control system.

The US National Research Council (NRC, 1999b) takes a similar position:

> Both the literature and the experiences of other nations indicate that the implementation of IFQ[1] programs may increase the cost of managing a given fishery.

In a number of countries, fisheries management activities are funded by taxpayers and supplied by government management and research agencies. Management and research agency budgets are usually limited, and therefore the impact of ITQs on management costs is an important operational issue. In a few countries, a significant portion of management costs is recovered from the commercial harvesting sector, and a proposed move to ITQs can generate industry concerns about increased cost-recovery payments[2].

Regardless of whether fisheries management is funded by taxpayers or industry, it would appear self-evident that fisheries managers should undertake a pre-ITQ implementation analysis of the likely impact of ITQs on management costs. This section examines a pre-implementation analysis of ITQ management costs undertaken for the Queensland spanner crab fishery, and provides a comparison of management costs in seven Australian Commonwealth ITQ and effort control managed fisheries.

Management costs represent only one component of the costs and benefits of introducing ITQ management, and consequently this section also briefly considers the issue of undertaking a cost benefit analysis of all major management options prior to the introduction of ITQs.

IMPACT OF ITQS ON MANAGEMENT COSTS

ITQ management could impact on management costs in a number of ways. First, one-off implementation activities such as developing new regulations, industry consultations and quota appeals serve to increase short-term management costs. Second, the creation of new management services related to quota registry and quota monitoring activities would act to increase costs. Third, existing services might be increased or modified; for example, enforcement activity may increase and (see Chapter 7) it has been argued by some that ITQs require more timely and accurate stock assessments, and therefore research costs could increase.

The US National Research Council (NRC 1999b) notes that enforcement costs increased under ITQs in the US halibut and sablefish fisheries. The report also quotes a survey by the Organization for Economic Cooperation and Development (OECD, 1997a) that found enforcement costs and/or enforcement problems increased in 18 out of 23 ITQ fisheries.

The issue of management costs is pursued by a brief examination of two case studies. First, an example is given of a pre-ITQ analysis of management costs in the Queensland spanner crab fishery. Second, ITQ and effort control costs are compared in Australian Commonwealth-managed fisheries.

Pre-ITQ analysis of management costs: Queensland's spanner crab fishery

In Australia, the Queensland Fisheries Management Authority manages the spanner crab fishery on behalf of the Queensland State Government. In 1996 the value of the spanner crab catch was approximately $9 million, and landings were roughly 2,800 tonnes. Increases in vessel numbers and harvest levels over the mid-1990s led to concerns regarding resource sustainability and over-capacity. In response to these concerns, interim management arrangements based on a competitive TAC and various effort controls were introduced in 1994. Problems associated with competitive TAC arrangements (such as market gluts, increasingly shorter seasons, low prices and profits, and poor weather fishing) resulted in a management proposal to introduce ITQs.

Concern over the proposal to introduce ITQs resulted in the demand by a large number of industry operators for a review of the strengths and weaknesses of all management options. In response, government and industry commissioned an independent report (FERM, 1997b) into future management options. A committee of industry representatives (the Future Management Options Group) was established to oversee preparation of the report. One of industry's major concerns with ITQs (in light of the introduction of cost recovery) related to the possibility of increased management costs. Given this concern, part of the consultant's report estimated the management costs associated with both ITQ and effort control management options.

Table 22 details the costs of managing the fishery in 1996–97 and provides estimated future costs of management under four management options: daily catch limits and removal of the TAC; competitive TAC; individual transferable effort units (ITEs); and ITQs. The ITQ option was estimated to be the most expensive, with ITQ costs at least $60,000 higher than the daily catch limit and competitive TAC options.

The ITQ option would imply an approximate $170 per year increase in yearly licence fees for individual fishers.

A number of points should be noted about Table 22. First, in 1996/97 roughly 57% of management costs were being recovered from industry. This was assumed to remain constant when calculating the licence fee increase under the ITQ option. Second, the $60,000 increase in management costs under ITQ (over the less expensive management options) is related to increased expenditures associated with logbooks, quota registry and surveillance under ITQs.

TABLE 22
ESTIMATED MANAGEMENT COSTS OF FUTURE MANAGEMENT OPTIONS FOR THE QUEENSLAND SPANNER CRAB FISHERY (AUS. $)

Management Service	1996–97 Costs	Future Management Options			
		No TAC, Daily Catch Limit	Competitive TAC	ITE	ITQ
Fisheries Manager	50,400	50,400	50,400	50,400	50,400
Management Plan Development	47,392	25,000	25,000	25,000	25,000
Surveillance	130,000	130,000	130,000	160,000	160,000
Prior Reporting		21,000	21,000	21,000	21,000
Logbook	63,302	63,000	63,000	63,000	78,000
Research	30,000	30,000	30,000	30,000	30,000
Licensing	12,215	13,000	13,000	13,000	13,000
Quota Registry				10,000	15,000
Management Advisory Committee	18,180	18,180	18,180	18,180	18,180
Other	18,200	7,300	7,300	7,300	7,300
TOTAL	369,689	357,880	357,880	397,880	417,880

Source: FERM (1997b)

Concerning quota monitoring, it was concluded that the current logbook system would form the basis of a 'no-frills' catch monitoring system; however an extra 'half of a person' year ($15,000) would be needed to carry out additional activities, such as checking and comparing fisher and processor catch data, and issuing quota reports. Increases in catch monitoring costs were mitigated to some extent by the fact that catch monitoring was required under existing daily-trip-limit management arrangements, and a prior-reporting system was to be introduced under all possible management arrangements.

With regard to the quota registry, it was estimated that an additional 'half of a person year' ($15,000) would be needed to run the registry. Finally, compliance expenditures were estimated to increase by $30,000 due to additional enforcement time required for the observation of weekend and night unloading (which were not permitted under a competitive TAC and effort controls).

An additional issue that should be noted concerning estimated cost increases under ITQ management relates to research expenditures. Research funding by industry, at $30,000, was held constant over all management options, and the impact of ITQs on research funded by outside agencies was unknown.

ITQs were introduced into the spanner crab fishery in 1999, and the current management budget is roughly $440,000 which is approximately 5% of landed value and roughly $20,000 higher than the pre-implementation estimate of ITQ costs.

The pre-ITQ analysis of management costs was useful in facilitating industry and government discussions concerning ITQs. The introduction of ITQs in the spanner crab fishery was a hotly contested issue. Only months before quota was to be introduced the vast majority of industry lobbied government against their deployment. The independent report (steered by an industry committee), which examined the likely consequences (including the impact on management costs) of all management options, facilitated a more fact-based debate on the various issues. Following the completion of the report, industry overwhelmingly voted for ITQs.

A comparison of ITQ and effort control management costs in Australian Commonwealth-managed fisheries

Table 23 and Table 24 provide information relating to management cost in a number of Australian Commonwealth-managed fisheries. Table 23 details management costs for seven fisheries managed by the Australian Fisheries Management Authority (AFMA). Four of the fisheries, southern bluefin tuna, south east non-trawl, south east trawl and Bass Strait scallop are managed with ITQs. Southern shark is to be managed by ITQs in early 2000 and management costs in Table 23 are estimated ITQ costs. Both northern prawn and eastern tuna & billfish are managed with effort controls.

Table 23 contains projected 1999–2000 fisheries management expenditures by the Australian Fisheries Management Authority. Research expenditures by the Fisheries Research and Development Corporation (FRDC) are an average of 1998/99 actual expenditures and budgeted 1999/00 costs. The majority of research in Commonwealth-managed fisheries is funded by the FRDC. The FRDC is a separate statutory authority that is funded by both government and industry. Although the FRDC data are for an earlier period, relative to AFMA management costs, the FRDC cost data are included in order to provide an estimate of total management expenditures for each fishery[3].

Projected 1999–2000 management costs vary from roughly $440,000 in the Bass Strait scallop fishery to approximately $3.9 million in the south east trawl fishery. As a percentage of landed value, management costs are lowest in the effort controlled northern prawn fishery (1.75%), followed by one ITQ fishery, southern bluefin tuna (4.6%), an effort controlled fishery, eastern tuna & billfish (5.2%), and the remaining

TABLE 23
MANAGEMENT COSTS IN AUSTRALIAN COMMONWEALTH FISHERIES (AUSTRALIAN DOLLARS)

	S'thern blue-fin tuna	SE non-trawl	SE trawl	S'thern shark	Bass Strait scallop	N'thern prawn	Eastern tuna & billfish
AFMA Costs							
Direct Costs[1]							
Salaries & on-costs	82,670	189,068	348,936	217,652	90,092	109,744	216,849
Consultants	0	0	5,000	0	0	15,000	5,000
Travel	16,600	14,344	19,555	7,400	7,741	8,160	29,519
Other admin.	11,484	2,120	8,050	5,420	1,000	9,460	20,134
Total direct costs	**110,754**	**205,532**	**381,541**	**230,472**	**98,833**	**142,364**	**271,502**
Overheads	**91,895**	**218,530**	**414,361**	**243,393**	**83,722**	**123,919**	**260,052**
Research							
Industry initiated research	225,000	41,892	522,058	100,000	0	20,000	225,000
ARF[2] research	172,091	0	487,818	174,952	3,642	79,200	60,503
Indirect Costs							
Management advisory committee	164,506	48,746	181,462	114,914	35,652	156,246	226,255
Logbook	40,400	99,792	117,134	98,874	2,369	150,014	168,449
Licensing & registers	57,387	87,729	92,347	102,901	46,833	60,289	77,439
Compliance	628,626	219,674	1,285,238	503,878	155,618	707,674	204,854
Total indirect costs	**890,919**	**455,941**	**1,676,181**	**820,567**	**240,472**	**1,074,233**	**676,997**
Total AFMA Costs	**1,490,659**	**921,895**	**3,220,930**	**1,569,384**	**426,669**	**1,439,706**	**1,494,054**
FRDC Costs	**375,913**	**0**	**743,425**	**155,578**	**17,517**	**657,924**	**287,969**
TOTAL COSTS	**1,866,572**	**921,895**	**3,964,355**	**1,724,962**	**444,186**	**2,097,630**	**1,782,023**

Source: AFMA. ARF stands for the AFMA Research Fund, which contains $1 million in yearly funding from the federal government. FRDC refers to the Australian Fisheries Research and Development Corporation.

ITQ fisheries, Bass Strait scallop (6.3%), south east trawl (6.9%), south east non-trawl (13.0%) and southern shark (14.7%).

A second perspective from which to view the relative size of management costs is on a per vessel basis. Fisheries with a larger number of vessels could result in higher management costs regardless of how they are managed. Table 24 provides an estimate of the number of vessels in each fishery and estimated management costs on a per vessel basis. Management costs per vessel are lowest in the ITQ managed Bass Strait scallop fishery ($2,865), followed by eastern tuna & billfish ($5,748), south east non-trawl ($6,828), southern shark ($12,321), northern prawn ($15,891), southern bluefin tuna ($23,332) and south east trawl ($33,036). While management costs are lowest in the effort controlled northern prawn fishery when expressed as a per cent of landed value, management costs in this fishery are the third highest when expressed on a per vessel basis. This finding is no doubt related to the fact that prawns are a high valued species relative to the species in some of the finfish ITQ fisheries.

As a third perspective on management costs the data in Table 23 can be aggregated to show costs for the following three basic management categories: rule-making activities (i.e., fisheries managers, consultants, administration, and management advisory committees), rule-enforcing activities (logbook, licensing, registers and compliance) and research. As a per cent of total management costs, average rule-making costs in ITQ fisheries are 20% in southern bluefin tuna, 25% in south east trawl, 34% in southern shark, 49% in Bass Strait scallop and 51% in south east non-trawl. Rule-making costs in northern prawn and eastern tuna & billfish are 20% and 43% of total management costs respectively. Rule-enforcing costs range between 38% to 46% of management costs in ITQ fisheries, and are 44% and 25% of management costs in northern prawn and eastern tuna & billfish. Finally, research costs as a per cent of total costs are 41% in southern shark, 5% in Bass Strait scallop, 38% in south east trawl, 25% in southern shark and 5% in south east non-trawl. The south east non-trawl figure is biased downwards as much of the research associated with quota species in this fishery is picked up under the south east trawl fishery. Research costs in effort control fisheries are 36% and 32% of total costs in northern prawn and eastern tuna & billfish, respectively.

Arnason (1999) provides evidence that administration, enforcement and research costs (as a percentage of total management costs) in Newfoundland, Iceland and Norway average, respectively, 7%, 59% and 34%. Without further analysis it is difficult to explain these differences in the relative importance of rule-making and rule-enforcing costs. However, it should be noted that overhead costs (e.g. building rent) account for a significant proportion of rule-making costs in AFMA fisheries. The extent to which overhead costs are included in the Arnason data is not clear (especially for Newfoundland).

One must be careful about drawing conclusions with respect to the relative management costs of ITQ versus effort control fisheries from the data provided above. Additional work is required in this area before anything substantial can be said. For example, it would be interesting to undertake an analysis of pre- and post-ITQ management costs in various fisheries, combined with a careful consideration of

whether service levels were being increased (or decreased) under ITQs. However, a snap shot picture of AFMA fisheries suggests that management costs when viewed as a percentage of landed value are higher in AFMA's ITQ fisheries (averaging 7% of landed value) and lower in effort fisheries (at 3% of landed value); on a per vessel basis, ITQ management costs are roughly $14,000 per vessel and effort management costs are approximately $9,000.

TABLE 24
AUSTRALIAN COMMONWEALTH MANAGEMENT COSTS:
LANDED VALUE, VESSEL NUMBER AND INDUSTRY CONTRIBUTIONS

	Total landed value ($,000)	Vessel numbers	Total management cost as % of landed value	Total management costs per vessel ($)
ITQ Fisheries				
Southern bluefin tuna	40,812	80	4.6%	23,332
Southern shark	11,742	140	14.7%	12,321
Bass Strait scallop	7,009	155	6.3%	2,865
South east trawl	57,701	120	6.9%	33,036
South east non-trawl	7,077	135	13.0%	6,800
Effort Control Fisheries				
Northern prawn	119,365	132	1.75%	15,891
Eastern tuna & billfish	34,424	310	5.2%	5,748

Source: ABARE (1998)

THE NEED FOR COST BENEFIT ANALYSIS

While the focus of this section is on management costs, it is important to bear in mind that management costs represent only one component of the various costs and benefits associated with fisheries management. For example a pre-implementation analysis of the estimated impact of ITQs in the US halibut and sablefish fisheries by the North Pacific Fishery Management Council (1997) identified a number of potential costs and benefits from ITQs, including higher fish prices, lower harvesting, processing and marketing costs, reduced fishing mortality (due to less lost gear) and decreased discarding.

Therefore, in addition to examining the impact of ITQs on management costs, a cost benefit analysis should probably be undertaken on all aspects of ITQs prior to implementing quotas. The cost benefit analysis should also include an examination of the costs and benefits associated with major effort control alternatives to ITQs. This approach is taken in a recent US evaluation of ITQs (NRC, 1999b), which recommends that:

> Councils [US regional fisheries management councils] should give high planning priority to the question of social, economic, and biologic consequences of an IFQ program or alternatives to it.

The US report goes on to suggest that:

> At a minimum, the regional councils and the Secretary of Commerce should ensure that a preliminary study of the relevant socioeconomic aspects of a fishery being considered for IFQs be done prior to the design of the management program, that alternative limited access management programs be considered, and that a monitoring and evaluation program be part of the initial design…

A cost benefit analysis of management options would serve a couple of purposes. First, it would provide a transparent and quantitative framework through which to debate and discuss the various costs and benefits of management options. Second, issues such as the possibility of increased management costs under quotas could be estimated and examined in a more complete context. For example, in a move to ITQs, increased management costs could be compared to likely increases in the value of fishing entitlements. In the Australian south east trawl fishery the value of transferable effort entitlements prior to ITQs was estimated to be $89.9 million (25,695 effort units valued at $3,500 per unit); however the estimated value of quota in the year ITQs were introduced (1992) was roughly $145 million, an increase of approximately $55 million[4]. It is more difficult for industry to argue against increased management costs if asset values (i.e., quota entitlements versus effort entitlements) are likely to increase substantially reflecting, presumably, fishers' expectations of higher profits — despite higher management costs.

SUMMARY

It is difficult to generalise about the net impact of ITQs on management costs. Little empirical analysis has been undertaken on this issue. Fortunately, analysis of management costs under various management regimes is a research programme that is receiving increasing attention. Evidence to date suggests that management costs under ITQs might be higher. The net impact on management costs will vary from fishery to fishery, depending on a number of factors such as the type of pre-ITQ management arrangements in place, the type of quota monitoring regime implemented, and whether existing effort controls are reduced or eliminated.

In light of uncertainties surrounding the management cost implications of ITQs, it is important to undertake a pre-ITQ implementation analysis on this issue. However, this analysis should not be restricted to ITQs. Specifically, managers would be well advised to examine *all of the costs and benefits* of introducing both ITQs *and* the major effort control alternatives prior to embarking on a new management regime. Simply looking at estimated ITQ management costs or undertaking cost benefit analysis on the ITQ option is not sufficient. There is a tendency for ITQs to be compared to some ideal management regime, as opposed to being compared to the 'less-than-perfect' effort control management alternatives. Cost benefit analysis on this issue would help create a more level playing field.

ENDNOTES

1 IFQ refers to individual fishing quotas.

2 In Australia, the Commonwealth and some state governments practice cost recovery of management services. In the United States, in ITQ and community development quota fisheries fees (up to 3% of the ex-vessel value of landed fish) are to be collected to recovery the actual costs directly related to management and enforcement; and there is an additional 0.5% registration and transfer fee on the value of quota traded. In Canada, ITQ-managed fisheries are expected to pay certain costs, such as those associated with catch monitoring. New Zealand has moved from a regime of rent recovery to the recovery of management costs.

3 The Bureau of Rural Sciences and ABARE also undertake fisheries related research.

4 National Research Council (1999b) estimates the asset value of quota in the US halibut and sablefish ITQ fisheries to be US$2–3 billion and US$3–4 billion, respectively.

10 SETTING THE TOTAL ALLOWABLE CATCH

Management through individual quota regimes requires the setting of a total allowable catch (TAC) for species that are to be placed under quota management. TAC setting is not unique to ITQ management. A number of non-ITQ fisheries around the world are managed through TACs, usually in combination with various effort controls. However, TAC setting is mandatory for ITQ fisheries and optional for effort-controlled fisheries.

This section examines a number of TAC-related issues. The first concerns stock assessment requirements under ITQs. Second, the impact of ITQs on catch and effort data (which is often used in stock assessment and in turn in TAC setting) is considered. Third, an overview of various TAC-setting techniques is provided.

STOCK ASSESSMENT REQUIREMENTS UNDER OUTPUT CONTROLS

The first issue to be discussed is the stock assessment requirements under ITQs and effort controls. Walters and Pearse (1996) suggest that:

> Economic inefficiency and other problems associated with managing fisheries through restrictions on fishing times, places and gear have led to development of management systems based on individual fishers' quotas. But this shift from input controls to output controls calls for much more accurate and timely stock assessments.

A recent report of the US National Research Council (NRC 1998b) echoes much the same sentiment. A second and related observation made by Walters and Pearse is that uncertainty surrounding stock-size estimates (that are required under ITQs) will significantly lower the TAC. The purpose of this section is to explain the various arguments underpinning these suggestions, and to provide an alternative perspective. Because the various Walters and Pearse (1996) arguments concerning ITQs and stock assessment are based on the use of constant harvest rate strategies, it is important to first explain these concepts as a foundation for a discussion on the impact of ITQs on stock assessment.

The relationship between constant harvest rates and management regimes

For present purposes one may think of a harvest rate as the proportion of a fish stock that is harvested. Under a constant harvest rate strategy, the goal is to take a constant percent of the fish stock. For example, if it were determined that the optimal[1] harvest rate was 20%, this would mean that 20% of the stock should be harvested each year. Constant harvest rate strategies are also referred to as 'constant exploitation' and 'constant fishing mortality' strategies. It should be noted that there are important technical differences between exploitation and fishing mortality rates, however for our

purposes these differences are not important[2]. Alternatives to the constant harvest rate strategy exist (and are briefly discussed later in the section), however Walters and Pearse suggest that constant harvest rate strategies have gained increasing favour in recent years, and therefore their analysis focuses on this particular strategy.

Suppose that it was agreed that a fishery should be managed to achieve a harvest rate of 20%. The next step is to determine whether to use output or effort controls *as the main management instrument* to achieve this harvesting target. According to Walters and Pearse (1996), an important consideration in making this determination is the assertion that ITQs require "much more accurate and timely stock assessments". In order to examine this statement further, consider how one would go about achieving an optimal harvest rate under both management options.

Achieving optimal harvest rates with ITQs

Although a simplification, under ITQs one would determine the optimal TAC by multiplying the 'optimal' harvest rate by the biomass. For example, if there were 100,000 tonnes of fish in a stock, and if the desired harvest rate were 20%, then the desired TAC would be set at 20,000 tonnes. Unfortunately, as Walters and Pearse (1996) note, "stock size estimates are rarely accurate", which leads them to the following conclusion:

> As fisheries agencies are pressured to adopt low-risk management policies, uncertainty about stock size estimates will significantly lower the allowable catch levels that meet the more stringent safety criteria. The consequent reduction in yields could eliminate the economic gains from more efficient fishing under individual quota management.

Therefore, it is argued that a major disadvantage of ITQs is that under a constant harvest rate strategy one needs an estimate of stock biomass. Furthermore, since stock size estimates are highly uncertain, Walters and Pearse suggest that this uncertainty should be taken into account by lowering the optimal harvest rate (which in turn reduces the TAC).

In other words, the inevitable error in estimating biomass means one is unlikely to hit the intended target — the optimal harvesting rate. For years in which the biomass estimate turns out to be overly optimistic, the TAC will turn out to have been too high, and the actual harvest rate will be greater than the optimal harvest rate. Estimates of biomass from stock assessments are usually highly correlated. Therefore, errors in biomass estimates may persist for many years leading to the actual harvest rate being greater than the optimal rate for several years; thus, the need to adjust the optimal harvest rate downward to account for this stock uncertainty. If one wishes to return to the initially higher optimal harvest rate (and higher TAC), it is necessary to undertake additional research in order to reduce the uncertainty surrounding the stock size estimates.

Achieving optimal harvest rates with effort controls

Naturally, this raises the question of how effort controls manage to eliminate the need to estimate stock size (and avoid the downward uncertainty adjustments to the optimal harvest rate). Walters and Pearse (1996) state that:

> Historically, fisheries managers avoided the problem [errors in stock size estimates] entirely by depending on controls on fishing inputs rather than outputs. The fishing rate was regulated by restricting gear and fishing technology, and the area fished relative to the area of fish distribution: F = (area swept)/(area of fish distribution), assuming random search and constant area of distribution of the stock (Beverton and Holt, 1957). With random search and fixed fishing technology, the area swept is proportional to fishing effort, so the same effort each year produces a constant fishing rate.

Although expressed in terms of difficulties associated with TAC setting, the same idea is contained in the following quote from Kirkley et al. (1995) concerning the US mid-Atlantic sea scallop fishery:

> Information from the New England Fishery Management Council (1993) indicates that it may not be possible to adequately determine a total allowable catch (TAC) for implementing individual transferable quotas (ITQs). The concern is that there is additional imprecision or uncertainty about using catch to control fishing mortality, rather than using effort, because it is necessary to go from the fishing mortality-fishing effort relationship to a catch-effort and fishing mortality relationship.

We will try to simplify the above arguments. The question we are trying to examine is how effort controls allow managers to achieve a predetermined 'optimal' harvesting rate without the need to know stock size. The answer is based on a common assumption in the fisheries biology literature that there exists a well-defined and stable relationship between fishing mortality (for our purposes, the harvest rate) and fishing effort. Gulland (1974) states this perspective as follows:

> while no available effort unit is entirely perfect, and many depart quite widely from perfection, for nearly all fisheries there exists some effort unit which will give a reasonable measure of fishing mortality.

In other words, the harvest rate and fishing effort are directly related to one other. Therefore, once one has determined the optimal harvesting rate, it is then possible to simply use the relationship between harvesting rates and fishing effort to determine the optimal level of fishing effort. There is no need for estimating stock size. And consequently, there is also no need to adjust the optimal harvest rate downward to account for uncertainty surrounding biomass estimates.

This is the essence of the argument that ITQ management is more demanding in terms of stock information. The following two sections examine challenges to the position that ITQs require more stock information *and* also require lower uncertainty-adjusted harvest rates.

DO ITQs REQUIRE LOWER UNCERTAINTY-ADJUSTED HARVEST RATES?

First consider management error and ITQs. Under ITQ management, it was assumed that the management instrument, the TAC, is perfectly achieved (i.e., total catch will be equal to the TAC). ITQ management is not perfect, and unrecorded discarding at sea and unreported landings are likely to result in actual catches being different from the TAC. This source of management error[3] could be handled through a further adjustment to the uncertainty-adjusted optimal harvest rate, or by explicitly incorporating

(appropriately precautionary) estimates of unrecorded harvests when undertaking stock assessment.

The possibility of management error also has significant implications for effort controls. Under effort controls it is assumed that having determined the optimal harvesting rate, all managers need to do is to develop regulations that will deliver the corresponding optimal level of fishing effort. The optimal effort level comes from the assumed, error-free relationship between fishing effort and harvest rates. Management is assumed to be perfect in the sense that the management instrument, regulated fishing effort, hits the target optimal fishing effort level *and* that the optimal level of fishing effort, in turn, produces the optimal harvesting rate.

Unfortunately it is not reasonable to assume that actual fishing effort will equal optimal fishing effort. Even if fishing effort regulations were capable of achieving the optimal effort level, it is clearly unreasonable to assume that the management instrument (restrictions on fishing effort) will produce the optimal harvest rate. How many managers think that they could put effort regulations in place that would exactly produce, say, a 20% harvest rate? Taking this management uncertainty into account would dictate a downward adjustment to the optimal harvest rate when employing effort controls in the same way that uncertainty about biomass estimates under ITQs causes downward pressure on TACs.

There are a number of reasons to expect management uncertainty under effort controls. As noted by the US National Research Council (NRC, 1998b):

> fixing effort is no guarantee of a safe F [for our purposes you can think of F as the harvest rate F]; F can increase substantially as stock declines if the geographic range used by the fish shrinks and fishers are able to track this contraction so as to target remaining fish concentrations efficiently.

Walters and Pearse (1996) suggest that two of the underlying assumptions of effort controls, random search and fixed fishing technology, are "untenable", and consequently effort controls may not deliver the target harvest rate. Concerning random search, they argue:

> In other words, shrinkage in the distribution of the stock can result in dangerous increase in the fishing rate even if effort is constant. As a stock shrinks, fishers do not randomly search the original area, but concentrate on the smaller aggregation. Such changes undermine attempts to control fishing rates by limiting effort.

Even if geographical range does not decline with stock size there are a number of other reasons to expect management error under effort controls. In reality, fishing effort is comprised of a number of physical attributes, and it is difficult if not impossible to control every element of fishing effort through effort regulations. A number of factors outside the control of managers, such as changes in fish prices, labour costs, interest rates, gear and fuel costs can act to increase profitability, and in turn, result in unwanted effort expansion and increases in the harvest rate. Even restrictions aimed at reducing fishing effort (and the harvesting rate) could have a contrary effect if fishers, in order to maintain profits, respond by increasing uncontrolled elements of fishing effort. This

in turn would negatively impact on management's ability to deliver the desired reduction in the harvest rate.

Hilborn and Walters (1992) suggest that when stock abundance is low (and presumably profits are also low), fishers will withdraw from fishing (assuming alternative employment opportunities exist) and fishing mortality may decline. If stock abundance is unusually high, fishers will fish more and the fishing mortality rate could be higher than expected. They argue,

> In this situation, there would be a desirable relationship between realized exploitation rate and the stock size; if the stock size was high it would be harvested harder. This is just the opposite of what would be obtained by using TACS.

Perhaps, as mentioned above, there is a different view. Fishing is often an employer of last resort. It may be overly optimistic to assume that fishers will find alternative employment *in years of poor abundance*. To the contrary, fishers may not have immediate access to alternative employment, and many of the costs associated with fishing are fixed costs that must be paid regardless of whether one fishes or not (e.g., interest payments on the vessel). Faced with mortgages and other living costs, it would not be surprising to see fishers fish even harder when stock abundance declines. In *years of high abundance*, the increased supply of fish on the market could result in reduced fish prices, which in turn could have a negative impact on fishing mortality. In other words, the Walters and Pearse assumption of a "desirable relationship" between the fixed fishing mortality rate and stock size is only one possibility.

In summary, while Walters and Pearse (1996) state that ITQs require lower uncertainty-adjusted harvest rates than effort controls, they do not appear to provide either theoretical or empirical evidence to support this assertion. Much of their discussion with respect to this issue is predicated on a faulty assumption that effort controls are implemented without management error. Allowing for management error under both ITQ and effort controls leaves this issue both theoretically and empirically unresolved.

DO ITQs REQUIRE MORE TIMELY AND ACCURATE STOCK ASSESSMENTS?

As outlined earlier, this position rests on the assertion that TAC setting requires biomass estimates and effort controls do not. However, what exactly are the biological information requirements of effort controls? And why does stock-assessment information need to be "much less accurate and timely"?

Since fisheries managers are assumed to control fishing effort in an attempt to achieve some optimal harvesting rate, it is necessary to have data on past harvesting rates in order to estimate the fishing effort/harvesting rate relationship, and on current harvesting rates in order to evaluate management performance. Harvest rates (or to use a related concept, fishing mortalities) can be estimated from tagging experiments and through other stock assessment techniques (Hilborn and Walters, 1992). However, most of these techniques also generate information on stock size. Therefore the information

requirements associated with constant harvest rate management may provide much of the data needed to estimate biomass. And it is not clear why this information, under effort controls, needs to be captured in a less timely and accurate manner when compared to ITQ management. As Eggars (1993) notes:

> Because the monitoring of harvest rate requires monitoring of both catch and escapement, or total run, the fishery management system necessary to achieve a constant harvest rate with variable fishing power and catchability would be identical to that required to achieve constant escapement.

Once again, Walters and Pearse (1996) do not provide a convincing case, on either a theoretical or empirical basis, that ITQ management requires much more accurate and timely stock assessments.

In summary, Walters and Pearse (1996) do not provide clear theoretical or empirical evidence to support their assertion that ITQ management (relative to effort controls) requires much more timely and accurate stock assessments and that ITQ management results in lower harvest rates.

However, this is not to say that ITQs may not be associated with increased pressure from industry and others to improve stock assessments. Under effort controls, a fisher's catch might be less dependent on the results of stock assessment than is the case under ITQs. For example, even if the assessment deteriorates and effort controls are tightened, a fisher can always attempt to maintain catch by expanding uncontrolled elements of fishing effort. However, under ITQs, changes to the estimated status of stocks will have a direct impact on the catch associated with an individual's quota holdings (assuming that the management authority changes TACs in response to significant changes in assessments). This could act to increase the focus on stock assessment under ITQs — not because more data are needed, but because more data are demanded. Of course, even under effort controls, if effort controls finally do 'bite', industry may likewise respond with increased research demands.

This focus on TAC setting under ITQs has raised concerns that fishers will use the uncertainty surrounding stock assessment as an excuse to avoid reductions in TACs (just as fishers attempt to avoid the impact of effort reductions on harvesting by increasing uncontrolled elements of effort). In our experience this certainly has happened. However, we have also seen fisher's accept the results of adverse assessments when they have been given the opportunity to be involved meaningfully in the stock assessment process. Generally, it is likely that ITQs will result in an increased focus on stock assessment (relative to effort controls), and an argument could be made that this is actually one of the advantages of ITQ management.

ITQ MANAGEMENT AND DATA FOULING

The second major issue to be discussed in this section is the impact of ITQs on catch and effort data that is often supplied by fishers to fisheries managers and research agencies. It has been suggested that the move to ITQ management has had a negative

impact on the reliability of catch and effort data (which is often used in stock assessment). Copes (1986) states that:

> Fisheries managers require reasonably accurate reports on catch and effort from vessel operators as a basis for their estimation of stock strengths and optimal exploitation rates. But if the individual quota system results in fishermen taking catches in excess of their quotas, they are almost certain to underreport their catches in order to evade detection. They may also falsify their reports on effort in order to make these appear compatible with their incorrect catch reports. It has already been observed by fisheries scientists that the introduction of quotas in some places has led to severe deterioration in the quality of data that fisheries managers have to work with (Gulland 1985).

The National Research Council (NRC, 1999b) observes that cheating and data fouling could make the TAC-setting process even more difficult. It also notes that there were increased difficulties in obtaining accurate fishing effort estimates after ITQs were introduced in New Zealand and increased discarding in other ITQ fisheries.

Tilzey and Klaer (1994) observe that there was significant misreporting in the first year ITQs were introduced in the Australian south east trawl fishery. In this fishery, any data problems inherent in a switch to quotas were exacerbated by complex State/Commonwealth management arrangements. Specifically, quota species were not managed by ITQs in State waters, and therefore fishers endorsed to fish in both jurisdictions faced an incentive to report catches of quota species in Commonwealth waters, as State water catches.

In addition to misreported catch and effort data, ITQs can cause problems related to the accuracy of data if fleet rationalisation results in a reduction of the spatial distribution of effort. Specifically, if fewer areas of the ocean are fished, then there will be no data from unfished areas to feed into the stock assessment process, which may create additional uncertainty surrounding assessments. In fisheries with both quota and non-quota species, increased targeting of non-quota species can also act to reduce the comparability of the new catch and effort data with earlier information. As observed in a case study of the south east trawl fishery (see Chapter 8, Discarding), post-ITQ effort data may also be difficult to interpret because fishers change their fishing practices in a variety of ways in adapting to the ITQ system.

The following points may be worth noting when it comes to the issue of data fouling following ITQ implementation. First, ITQs are often introduced into fisheries that are suffering from the effects of severe management failure. As a result, even if ITQs were not implemented, it is likely that profound changes in effort policy would be required. These effort changes could have a significant and unwanted impact on catch and effort data. For example the introduction of area/seasonal closures will reduce the amount of spatial data on catch and effort. As another example, the move from management based on vessel restrictions to a regime based on transferable gear units can have a negative impact on the comparability of the catch and effort time series. It is likely that any fundamental change in management will produce behavioural changes in fishers that impact on catch and effort data. Of course, if only marginal changes are made to current effort arrangements, then catch and effort data are less likely to be compromised.

In the end, if effort management is not able to control effectively harvesting capacity, then, it is not clear that the alleged consistency of catch and effort data under effort control management is of any real value. As noted by Mace (1997):

> For capture fisheries, overcapacity (including both amounts of gear and number of participants) is the single most important factor threatening the long-term viability of exploited fish stocks and the fisheries that depend on them.

Second, as discussed in Chapter 7, Compliance and Enforcement, technological advances related to vessel monitoring systems, at-sea electronic reporting of catch and effort data, and electronic at-port catch reporting offer the potential for improved monitoring of catch and effort data under ITQs. The potential for ITQ systems to deliver significant improvements in the quantity and quality of spatial-oriented data could have important implications for stock assessment, and should not be overlooked.

However, the potential impact of management regime shifts, including ITQs, on stock assessment should not be underestimated, and it would be prudent to develop a research program to investigate this issue prior to introducing ITQs. To expand on this, the following section briefly examines some of the research undertaken prior to the introduction of ITQs in the Australian southern shark fishery.

ITQs in the Australian southern shark fishery: stock assessment response

Australia's southern shark fishery is based on two species: school and gummy shark. School shark is currently over-exploited while the fishery for gummy shark appears to be sustainable. Stock assessments for both species are currently primarily based on analysis of catch and effort data (catch rate data). Recently it was decided to replace input control management with ITQs. It was acknowledged by advisory groups established by the Australian Fisheries Management Authority (the Southern Shark Management Advisory Committee and the Southern Shark Fisheries Assessment Group) that there was a high probability that the move to ITQs would have an impact on the reliability of catch rates as an index of relative abundance. This was particularly the case for school shark, which is facing catch reductions. The Southern Shark Fisheries Assessment Group considered a range of alternative approaches for developing a fisheries-independent index of abundance for school and gummy shark (e.g., tagging, surveys of nursery grounds, and fishery independent fixed-station surveys). It was concluded that a programme based on fixed-station sampling using gillnets would probably be the most cost-effective and successful option.

A cost benefit analysis was undertaken to determine the most appropriate level of survey intensity. To this end, a pilot fixed-station survey was conducted at two sites in the fishery and a model of the resource, the surveying process, and how future TACs would be set, was developed. The analysis indicated that roughly seven sites should be sampled quarterly to achieve the same precision as catch rates would under ideal conditions (ideal in the sense that that effort efficiency would remain constant). If implemented, the use of a fisheries-independent (survey) index of abundance under ITQs would provide an improvement over the use of a fishery-dependent (catch rates)

abundance index under effort controls — as the fishery-dependent index would be impacted by unaccounted increases in effort efficiency and changes in fishing practices as fishers adapt to the ITQ system.

In summary, the move from effort controls to ITQs will probably affect the usefulness for stock assessment of catch and effort data, and this possibility should be addressed explicitly before ITQs are introduced. However, this problem is not unique to ITQs. Any major change in management arrangements is likely to impact on data comparability. While the issue of data fouling must be addressed when changing management regimes, not introducing ITQs because of data concerns is a case of letting the 'tail wag the dog'. If current management arrangements cannot control over-exploitation and over-capacity, there is only cold comfort in knowing that stock assessments are not being weakened by the introduction of new management arrangements.

SETTING THE TAC

The third and final issue to be addressed in this section is TAC setting under ITQ management. Fisheries managed through ITQs require some method for determining the TAC. The process of TAC setting is not simple and the literature on the issue is technically complex. Terms such as harvesting strategies, biological reference points, target reference points, limit reference points and threshold limits are interrelated concepts that are relevant to the issue of how to set TACs. This section divides the discussion of TAC setting into three basic perspectives: TAC setting from a biological perspective, TAC setting from a bioeconomic perspective and a market-based approach to TAC setting.

TAC SETTING FROM A BIOLOGICAL PERSPECTIVE

Biologists tend to view TAC setting through the concept of harvesting strategies. The issue of harvesting strategies has received a great deal of attention although many of the articles written on this issue are couched in mathematics, and consequently are not transparent to many fisheries managers or other user groups. The purpose of this section is to provide a brief non-technical description of what is meant by harvesting strategies and to show how they are used in TAC setting.

Examples of harvest strategies include constant harvest rates, constant catch and fixed escapement. The concept of constant harvesting rates was discussed earlier. Under a constant harvest rate strategy, a fixed percentage of the stock is harvested each year. The total catch increases if the stock increases, and if stock size declines, so does the catch. With the constant catch strategy, the objective is to take a constant catch each year. Under a fixed escapement strategy, the goal is to ensure that a fixed number of fish escape harvesting each year, with the remaining fish available for harvest.

Conceptually, all of the above harvesting strategy options can be used in TAC setting. With the constant harvest rate strategy, the 'optimal' harvesting rate must be determined. If it were decided that only 20% of the stock should be harvested each year,

and if stock stood at 100,000 tonnes, then the TAC would be set at 20,000 tonnes[4]. Under this option, the TAC varies with stock size. With the constant catch strategy the TAC would be set at some level, say 20,000 tonnes, and the TAC would not vary, even if the stock size changed. The fixed escapement strategy would set escapement at a specific level, say 1,000,000 fish, and if 1,200,000 fish were available, the catch would be 200,000 fish. If stock size is estimated prior to fishing, it is possible to set a TAC under the fixed escapement strategy. In this example, the TAC would be 200,000 fish. Under this strategy, escapement can be seen as a strategy to ensure that a threshold number of fish escape harvesting.

The focus of our discussion is on constant harvest rate strategies. The following quote from as noted a recent US National Research Council report (NRC, 1998b) explains our focus on constant harvest rate strategies:

> Constant exploitation rate or constant-F strategies are in principle very simple and have been shown to be nearly optimal in cases where the primary management objective is risk adverse (Deriso, 1985), and in situations where long-term changes in carrying capacity of marine ecosystems cannot be anticipated significantly in advance (Walters and Parma, 1996). These policies are robust to underestimation of the optimum F; using an F value lower than optimal for a given stock, although it will result in lower catches, can actually lead to higher biomass than optimum, and this increase in biomass partially balances the effect of using a lower-than-optimum F because the spawning stock is overprotected and gains will be achieved in later years.

After discussing constant harvest rate strategies, we turn to an examination of threshold strategies.

Constant harvesting rate strategies

The aim of a constant harvesting rate strategy is to take a constant fraction of the stock each year. It is important to remember that for our purposes, harvesting rate and fishing mortality can be thought of as interchangeable terms. Constant harvesting rate strategies are often referred to as constant F policies, where F stands for the fishing mortality rate. But what fraction of the stock should be harvested? In other words, what should F be set at?

F_{max} and $F_{0.1}$ harvesting strategies

A number of candidate fishing harvest rates have been proposed. Two examples include F_{max} (Beverton and Holt 1957) and $F_{0.1}$ (Gulland and Boerema 1973). Both of these harvest rates rely on the concept of yield per recruit. Consider the fate of 1,000 fish born in 1990. Over time some fish will die of natural causes, while others will live and increase in weight. The total biomass of the 1990-year class will initially increase in weight (as growth exceeds natural mortality) and then eventually decline (as the rate of natural mortality exceeds the growth rate). An F_{max} harvesting strategy is based on the objective of maximising the weight of fish that can be harvested from a year-class of fish over its lifetime.

By way of analogy, think of a fish farmer that has 100 newly hatched fish in his/her backyard pond. As each individual fish has little weight, the total weight of all fish is

low. A certain percentage of the fish will die in the first year, but the remaining fish will substantially increase in weight. At the end of the first year it is likely that the total weight of all fish living would be greater than the weight of the initial 100 at birth. After a number of years, the fish will stop putting on much weight and some will die. Eventually, the total weight (or biomass) will begin to fall.

Assume that the farmer only wants to maximise the tonnage of fish that can be harvested. With knowledge of the natural mortality rate and growth rate of the fish, the farmer could calculate the total tonnage that could be harvested at different times during the life of the fish. Under a F_{max} strategy, the farmer would calculate the age of first harvest that maximised the tonnage harvested, and then harvest all of the fish of that age. To calculate the 'yield per recruit', you simply calculate the tonnage that could be harvested assuming that the fish were harvested after one year two years, three years (and so on) and then divide this by the initial number of fish (100 in this example). In this simple example, F_{max} is infinitely high because all the fish are killed. The situation is more complicated in ocean fisheries, in which it is generally impossible to select (or for that matter find) all fish of a given age. Ocean fisheries can (and do) have partial recruitment whereby some age-classes are less than perfectly vulnerable to the gear. Thus the age-at-recruitment is replaced by the probability (for each age) of being harvested, given a unit of fishing mortality (a certain amount of fishing effort). Nonetheless, the fish farming example does provide a simple conceptual framework to help to understand the basic principle behind an F_{max} strategy.

$F_{0.1}$ is another example of a yield-per-recruit based harvest strategy. Under the $F_{0.1}$ strategy, the harvest rate is set equal to the value of F where the slope of the yield-per-recruit curve is 10% of the slope of the curve at its origin. The $F_{0.1}$ strategy has been employed in a number of Canadian fisheries (Rivard and Maguire, 1993), and it is worth trying to understand what this strategy really entails. Assume that we move from a position of no fishing to a harvest rate of 1% (i.e., we take 1% of the stock). Assume that the corresponding increase in total catch is 10 tonnes (i.e., we move from 0 tonnes harvested to 10 tonnes harvested). In other words, the first small increase in fishing mortality 'bought' us 10 tonnes of fish. Under a $F_{0.1}$ harvest strategy, we would continue to increase the harvest rate (i.e., fishing mortality rate) by small amounts and re-calculate the additional catch tonnage forthcoming. At some point in this example an additional increase in the harvest rate would only produce a one tonne increase in the total harvest. This one tonne increase in the total harvest would only represent 10% of what the initial increase in the harvest rate bought us (i.e., 10 tonnes). The harvest rate that produces this result is called $F_{0.1}$.

It may be easier to grasp the $F_{0.1}$ strategy if it is explained in terms of nominal fishing effort. As discussed earlier it is frequently assumed that fishing effort (e.g., the number of vessel days fished) and the harvest rate are related in a simple manner, such that a 1% change in fishing effort produces a 1% change in fishing mortality. Assume that we start fishing on a previously unexploited stock, and then allow a small increase in fishing days. Assume that the introduction of a small amount of fishing effort produces 10 tonnes of fish. Next, assume the fisheries manager again allows a small increase in

the number of fishing days, and again we calculate the increase in catch associated with the increase in fishing effort. The point where the additional increase in fishing effort only increases catch by one tonne (i.e., 10% of the initial increase in catch when fishing started) would represent the $F_{0.1}$ harvesting rate.

This raises a number of issues. First, why not stop before 10% or why not stop after? Since the $F_{0.1}$ harvest rate is less than the F_{max} it could be argued that the $F_{0.1}$ harvest rate offers a bit of a buffer against growth overfishing[5]. However, there are an infinite number of harvest levels below F_{max}, and the buffer logic does not really explain why the 10% figure is appropriate. The original logic given for $F_{0.1}$ by Gulland and Boerema (1973) is, unexpectedly, related to economics. Basically it is asserted that it would be uneconomic to fish beyond $F_{0.1}$. A somewhat surprising assertion given that prices, cost and market conditions play no role in the $F_{0.1}$ strategy. The Gulland and Boerema figure outlining the $F_{0.1}$ concept (Figure 3 in their paper) is labelled "Determination of an economic optimum position at which the marginal yield is 10% of the initial catch per unit of effort." They say that:

> The limiting point beyond which any increase in fishing would certainly not be worthwhile — assuming a marginal yield of 10% of the initial catch per unit of effort — is where the tangent to curve is parallel to this 10% line. The selection of 10% is arbitrary but once the 10% figure is accepted the corresponding catch can be calculated objectively. Thus it can be used to provide a Commission or other management body objective guidance based on scientific grounds.

For many species the yield-per-recruit curve is flat near its maximum so that $F_{0.1}$ may be much lower than F_{max} (Deriso, 1987). The essential pseudo-economic argument in this case is that the increase in yield at F_{max} compared to $F_{0.1}$ is not worth the additional fishing effort (even though effort has not been explicitly costed). The idea that $F_{0.1}$ offers economic virtues is still alive. Hilborn and Walters (1992) consider that $F_{0.1}$ will always be less than F_{max}, and consequently a little more economically efficient. A report of the National Research Council (NRC 1998b) states that:

> $F_{0.1}$ also has some basis in bioeconomics because it is the point at which each additional unit of fishing mortality achieves less than 10% of the yield per recruit obtainable from a unit of fishing mortality applied to a previously unexploited stock; that is, the return (in units of catch biomass per recruit) on investment in a unit of fishing mortality is 10% of the return obtainable from the stock when it was in an unexploited condition.

Notwithstanding these quotes, it is unlikely that most economists would assert that $F_{0.1}$ is built on any clear and explicit economic principles (Lane 1989). The issue of explicitly incorporating economics into harvesting strategies is dealt with later in this chapter.

F_{max} and $F_{0.1}$ harvesting strategies are often referred to as *biological reference points*[6]. They are biological reference points in that the determination of how much fish to harvest (or what per cent of the stock to harvest) is based solely on biological information. The objective implicit in F_{max} is to maximise the total tonnage harvested. Assuming that the price of fish does not vary with the amount of fish landed, F_{max} is equivalent to the objective of maximising the total harvesting landed revenue. $F_{0.1}$ is a

harvesting strategy that produces a landed tonnage somewhat less than F_{max}. Other than the fact that F_{max} is equivalent to maximising landed tonnage (and total revenue if fish prices remain constant), neither the F_{max} nor the $F_{0.1}$ harvesting strategy explicitly incorporates economic or market considerations. More crucial than the absence of economics, yield-per-recruit analysis, upon which both of these reference points are based, assumes that recruitment is independent of stock size — an assumption of questionable validity, particularly at low stock sizes. We now turn to a group of constant harvest rate strategies that do explicitly recognise stock size and/or recruitment.

F_{msy}, F_{rep}, F_{low}, F_{med}, and F_{high} harvesting strategies

F_{max} and $F_{0.1}$ are not the only harvesting strategies in existence. This section briefly outlines a number of alternative harvesting-rate biological reference points that have been developed. One of the problems with using the above yield per recruit analysis to set TACs is that it is assumed that the number of fish produced from a given parent stock is independent of the size of the stock. To return to the fish farming example, if farmers could not purchase fish from outside, it would be prudent in determining his/her harvesting strategy to keep an eye on what was happening to the spawning stock. A spawning stock that is too low might run the risk of not being capable of reproducing sufficient fish over time to replenish the stock.

The F_{msy}, F_{rep}, F_{low}, F_{med}, and F_{high} harvesting strategies attempt to overcome this limitation by explicitly considering how fish populations change over time and how future populations respond to harvesting today. This requires a more fundamental understanding of population dynamics that does the simple growth and mortality model employed in yield per recruit analysis. Hilborn and Walters (1992) outline a number of models of fish population dynamics. In examining the issue of harvesting strategies within the context of population models, it is not necessary that we go into the detail behind any of the population models. Our interest is only to examine the issue of harvesting strategies within the context of more complete models of fish population dynamics.

With a population model for a fish stock, it is possible to provide fisheries managers with advice on various harvesting strategies. One of the first constant harvest rate strategies developed within a population-dynamics context was F_{msy}. F_{msy} corresponds to the harvest rate that produces the maximum sustainable yield (MSY). F_{msy} is similar to F_{max} in that both harvesting strategies involve the objective of maximising the tonnage harvested[7]. However, F_{msy} takes into account the impact of fishing on recruitment as well as yield per recruit considerations; however, the exact manner in which this is done depends on the population model that is specified. Once again, if fish prices do not vary with tonnage landed, both strategies are also consistent with the financial objective of maximising harvesting revenue. Larkin (1977) provides the following summary of the F_{msy} strategy when applied in the context of setting TACs equal to MSY:

> Briefly, the dogma was this: any species each year produces a harvestable surplus, and if you take that much, and no more, you can go on getting it forever and ever (Amen). You only need to have as much effort as is necessary to catch this magic amount, so to use more is wasteful of effort; to use less is wasteful of food.

Notwithstanding Larkin's concern over maximum sustainable yield (MSY) strategies, MSY continues to be used as a primary target in a number of fisheries around the world. However, as noted in Caddy and McGarvey (1996) it may be more appropriate to consider F_{msy} as a biological reference point that sets a harvest rate limit, as opposed to a target. It should also be noted that it is possible to resurrect $F_{0.1}$ (often referred to as $f_{0.1}$ when expressed in terms of fishing effort rather than fishing mortality) in a more complete population model context. In fact, according to Hilborn and Walters (1992):

> $F_{0.1}$ policies may be one of the most significant changes in fisheries harvesting practice since the earlier widespread acceptance of MSY. They are significant not because of any theoretical breakthrough, or any intrinsic elegance, but simply because they provide a replacement for F_{max} and MSY and appear to often be robust.

Next consider F_{rep}, F_{low}, F_{med}, and F_{high} harvesting-rate biological reference points. While the number of F harvesting strategies being discussed is mounting, it is important to keep in mind that F simply refers roughly to the per cent of the stock harvested. $F_{0.1}$ and F_{msy} harvesting strategies are largely focused on how much is harvested, while F_{rep}, F_{low}, F_{med}, and F_{high} pay explicit consideration to how much fish is left behind after harvesting. A number of F-type harvesting strategies have been developed to capture the principle that sufficient spawning stock must be left unfished if the stock is to replace itself (Shepherd, 1982; Sissenwine and Shepherd, 1987). F_{rep} refers to the replacement fishing mortality rate. F_{rep} is more a concept than an operational harvesting rate. F_{rep} refers to harvest rates that allow sufficient recruits to survive and to replace the spawning stock that produced them.

But how does one actually calculate this 'replacement' harvesting rate? One example is F_{med}. F_{med} estimates F_{rep} by using historical spawning stock and recruitment data to calculate the harvest rate (F_{med}). Although not strictly accurate, for our purposes it is sufficient to think of F_{med} as an attempt to determine a harvest rate that will allow the stock to replace itself 'on average'. F_{low} and F_{high}, like F_{med}, are also estimates of F_{rep}. F_{low} is associated with a higher probability that the parent spawning stock will be replaced. The opposite is true for F_{high}[8].

In summary, a number of F-based biological reference points have been discussed above. There are other F-based biological reference points, such as F_{pa} (where pa stands for the precautionary approach) that were not outlined[9]. While the issue of constant harvest rates is complex, it is important to remember that a constant harvest rate strategy simply means that a constant percentage of the fishable stock is harvested each year. The discussion surrounding different constant harvest rate options is often quite technical (and is frequently built on various population dynamics assumptions) but at its heart the concept is quite simple. In light of all of the difficulties associated with actually implementing management arrangements that will achieve any pre-specified fishing mortality rate, it is not clear that the ongoing search to find the 'right' F offers much in terms of operational value for fisheries managers.

Threshold strategies and constant harvesting rates

There are general two points worth noting about constant harvesting rate strategies. First, when examined in the context of a population model that allows for an explicit relationship between recruitment and spawning stock, constant harvesting rates can be seen as a single 'policy' aimed at achieving a degree of compromise amongst competing catch maximisation, catch stability and conservation-related stock-size considerations. In other words, constant fishing mortality strategies represent one instrument trying to achieve three 'objectives' — a difficult task, not to mention the potential objective of economic efficiency. Second, under constant harvesting rate strategies, harvesting is still allowed to continue regardless of how low the stock size falls — a questionable strategy when applied to low spawning stock sizes.

In light of these difficulties, a number of biologists have also examined the use of threshold reference points, which would act as a harvesting limit when setting TACs. Constant harvesting rate strategies such as $F_{0.1}$ and F_{med} have been referred to as 'target' biological reference points, as the desired fishing mortality rate is the target one is trying to achieve. As noted by Macguire and Mace (1993), one of the problems with target biological reference points, such as constant harvest rates, is that:

> the consequences of not achieving the target in a given year may be difficult to evaluate, and the need and degree of urgency for remedial action may not be clear. For example, fishing mortalities that exceed a target such as $F_{0.1}$ for a few years may not jeopardize the stock during periods of favourable environmental conditions resulting in high survival and high recruitment, but may seriously deplete the stock if conditions are poor.

Threshold management strategies are an attempt to consider explicitly the threat of recruitment overfishing[10]. Although somewhat of a simplification, under a threshold strategy, harvesting is either stopped or substantially curtailed once the population falls below some predetermined threshold. A number of biological reference points have been suggested as thresholds. It is worth noting that this type of biological reference point is also referred to as a limit reference point. F_{med} and F_{msy} have both been suggested as possible threshold reference points.

Not all threshold reference points are stated in terms of fishing mortality rates. Some threshold reference points are stated in terms of spawning stock size (Quinn et al., 1990; Zheng et al., 1993). For example, it may be determined that the risk of recruitment overfishing is unacceptable if the spawning stock is fished down to 20% of its pre-fishing (or unexploited) level[11]. Mace (1994) suggests two alternative threshold reference points, one that is F-based, and the other is related to the spawning stock biomass. "Conservation-related" stock limits have also been referred to as minimum biologically acceptable limits (MBALs[12]).

Both target and limit reference points can be used as components of a TAC-related harvest strategy. As noted by Macguire and Mace (1993):

> The advantage of specifying thresholds (either as maximum F or minimum biomass or both) in addition to targets is that the degree of urgency for action can be judged by the proximity of the current stock condition to the threshold relative to the target.

One of the advantages of using both target and limit biological reference points is that it becomes easier to develop a rationale for the target harvesting strategy that is more 'divorced' from conservation concerns. To help develop this idea a little further, first think about conservation objectives. One conservation concern with any animal population is extinction. As Shaffer (1981) notes, one of the

> most pressing need[s] facing conservation is development of predictive understanding of the relationship between a population's size and its chances of extinction.

This has led to the development of the minimum viable population concept in the conservation biology literature. As Foose et al. (1995) note:

> A critical characteristic of a viable population strategy is that is provides explicit and quantitative objectives, for example:
>
> 99% probability of survival over, and recovery of evolutionary potential by the end of, the next 100 years; or
>
> 99% probability of survival and 95% preservation of diversity for the next 100 years; and,
>
> consequently, populations of a quantitatively specified size and distribution to achieve these objectives.
>
> There are at least two major reasons to be as numerate or as quantitative as possible. Actions plans (for captive and wild populations) ultimately must establish numerical objectives for population sizes and distribution as countermeasures to the stochastic problems if populations are to be viable. Numbers also provide for more objectivity, less ambiguity, more comparability, better communication and, hence, cooperation.

Of course, extinction is not the only, let alone the major, concern in most commercial fisheries, and in keeping with the above quantitative approach to extinction, it would be useful to develop similar explicit performance criteria with respect to recruitment overfishing and less well understood concepts such as preventing disturbance to ecosystem functioning. Once one or more threshold biological reference points have been established with respect to defining an acceptable degree of risk of endangering the future status of a stock, then economic and social considerations can come into play when determining the target harvesting trajectory over time.

We have heard the argument that the problem with limit reference points is that the fishing industry will always fish to the limit. If this were a concern, it would appear to imply that the limit reference points were set too low. If the limit (or limits) were constructed using conservation-related bottom lines that explicitly consider the issue of acceptable risk, then it is not clear why there would be a concern if fishing took place at the limits. It could be argued that the dynamics of fish stocks at low population size are even less well understood than those close to MSY; however this does not argue against limit reference points, but only suggests that this uncertainty should be built into setting the limits. Depending on the type of concern (e.g. biological extinction, ecosystem functioning, retaining the original spatial distribution), the conservation-related bottom line could either be extremely low or close to the unfished population size. For example, CCAMLR set 75% of the unfished biomass as a target for key prey species to ensure that predators have adequate food. However, this also is not an

argument against limit reference points. If society places value in certain conservation objectives, and if this 'value' is consciously evaluated against lost harvests, then it is not clear why bottom-line type reference points should be ignored, (via a sole focus on target reference points).

Once limit reference points are specified, then it would be easier to incorporate economic considerations (related to catch stability, prices, market conditions, or yield-per-recruit considerations) into the target reference point. Under this scenario, limit reference points are truly *biological* reference points, in that the economic status of the industry is not relevant, and the reference point is only a function of biological information. Target reference points could then be developed to reflect economic and possibly other non-biological concerns.

Evaluation of constant harvest rate and threshold strategies

A number of studies have evaluated various constant harvest rate and threshold strategies (for example, see Curse et al., 1992; and Smith et al., 1993). In general, a population model is specified for the stock under consideration, and then one or more harvest strategies are evaluated with respect to their impact on a number of 'objectives' including, catch, catch stability, spawning biomass size and recruitment. The robustness of alternative harvesting strategies has also been examined by changing stock/recruitment and other behavioural relationships, and introducing uncertainty around the data used for assessment purposes. Then the impact of the changes in the performance of the harvesting strategy is examined (with respect to catch, catch stability, etc.). In some studies the optimal harvest rate and/or optimal threshold are/is estimated (as opposed to being imposed, as when using $F_{0.1}$ or F_{msy}) by determining the strategy the best meets some harvesting objective, such as: maximising catch; maximising a weighted combination of catch and catch stability (e.g., Zheng et al., 1993); or maximising catch while protecting the stock at low abundance (Hollowed and Megrey, 1993).

In summary, there is a great deal of literature available related to the issue of harvesting strategies and their use in setting TACs. One of the most frequently used harvesting strategies involves setting the TAC by multiplying an estimate of the stock size by some predetermined constant harvesting rate. A great deal of effort has gone into determining what the appropriate harvest rate should be — specifically, should 10%, 13%, 20% or some other percentage of the fishable stock be harvested? Another approach has been to specify limits or thresholds that the harvest rate should not be allowed to exceed or below which the stock should not be permitted to fall.

We would like to complete the summary of this section by examining the following quote from Schmidt and Pengilly (1993):

> Optimal biological harvest strategies often get entwined with optimal economic policies; the latter frequently have major allocation ramifications. Economic policies usually require identification of specific benefactors (objective function) before analysis can proceed… We prefer to leave the definition of objective functions to the elected or appointed fisheries managers and their consulting economists and limit our discussion

> of optimal harvest strategies to average annual biomass yield and its interannual variation.

This quote appears to imply that biological reference point harvesting strategies that are limited to yield and catch variation fall within the domain of biology, and that managers, economists and others are required to become involved at the next stage. It is our opinion that many 'optimal' harvest strategies developed around fixed-harvest-rate biological reference points are implicitly based on ad hoc economic objectives such as maximising catch and/or minimising inter-annual variation in catch[13]. It is important that fisheries managers and others user groups fully appreciate that a number of biological reference points are not just about 'conservation', but rather, have at their foundation implicit and poorly defined economic objectives.

Two alternative (to biological reference points) approaches to setting TACs are examined next. The first involves bioeconomic models as opposed to the above strictly biological approach.

TAC SETTING FROM A BIOECONOMIC PERSPECTIVE

As noted above, most TAC-setting techniques are based solely on biological information and use biological reference points. While infrequently employed in practice, there have been attempts to incorporate explicitly economic information in the TAC-setting process. The purpose of this section is to outline briefly why economics may be relevant in TAC setting, and to provide examples of how economic considerations may be factored into the process.

An economic model of TAC setting

Most fishers have experienced the fact that when landings increase, the price of fish declines (and vice versa). If the percentage increase in landings is high, but the percentage fall in price is small, total revenue will increase; however, if the response is a substantial fall in price, total revenue may fall. Therefore the impact of changing TACs on the economic performance of the industry (at both ex-vessel and wholesale levels) depends not only on the direct change in the TAC, but also on the price response in the market. TACs set on the basis of biological reference points almost always exclude any consideration of price, or at best, assume price is independent of the size of the TAC.

Herrman et al. (1996) developed an economic model to examine the potential revenue effects from changes in the TAC for Alaskan pollock. It is important to note that this model does not include the population dynamics of the fish. Alaskan pollock is used principally in surimi production, the bulk of the United States production of which is sold to Japan, where it is further produced into a variety of seafood products.

The Alaskan pollock economic model is developed to 'explain': Japanese demand for imported United States surimi, United States supply of surimi to Japan, inventory holdings of surimi, and the exvessel price of United States Alaskan pollock. For example, the price of United States surimi imported into Japan is hypothesised to depend on the quantity imported, Japanese income, the price of substitutes and other

factors. We will not go into the detail of model specification or estimation, our only interest is to outline the potential use of this type of model for TAC setting.

The results of the Alaskan pollock model suggest that:

> under market conditions that prevailed in 1993, pollock exvessel revenues increase at a decreasing rate as landings increase until harvests increase by 24% above the mean (or 333,000 metric tons). At this level, the exvessel revenue gains reach a maximum of $9.1 million. Subsequent increases in landings lead to revenue declines. That is, the model indicated that management actions to maximize catch will only be economically sensible up to 1.7 million metric tons. Any additional increase (whether sustainable or not) will reduce revenues.

Such considerations are highly relevant to the economic performance of the industry and should be examined in the TAC setting process.

TAC setting and bioeconomic models

As noted above, strictly economic models suffer from the same failure as strictly biological models in terms of TAC setting — both ignore either the over-exploitation or economic efficiency problems. Not surprisingly, a number of integrated bioeconomic models have been developed in an attempt to overcome this problem[14]. For example, Palsson et al. (1993) examine the use of bioeconomic methods for determining TACs. Conrad (1989) has developed a bioeconomic model for the western Arctic bowhead whale which he argues can be used for determining optimal Eskimo harvest for alternative rates of discounts and weights on the bowhead population.

Bioeconomic models have been developed for other fisheries, such as the Hawaiian Island lobster fishery (Clarke et al., 1992), the Texas Shrimp fishery (Onal et al., 1991), the Canadian northern cod fishery (Lane and Kaufmann, 1993), to mention just a few. However, most of these bioeconomic models have focused on issues other than TAC setting.

Bioeconomic models represent attempts to integrate models of population dynamics with various economic considerations such as price determination, market considerations, harvesting and processing costs, and entry and exit of fishers. One can use such models to examine the impact of alternative harvesting strategies (e.g. pre-specified time series of future TACs or decision rules based on future data to set TACs) on profits, employment, economic efficiency, and current and future stock status. If properly specified these models can also be used to determine the harvest strategies that maximise economic and social objectives subject to various conservation constraints. Bioeconomic models should not be seen as instruments to provide the 'right' answer, rather, they provide a framework through which managers, industry, conservationists and others can examine the likely consequences of various policy options, including TAC setting. However, to date, bioeconomic models have played little part in TAC setting, and the TAC focus has been largely on biological models and biological reference points.

Criticisms of introducing economics into TAC setting

There are a number of possible concerns relating to the introduction of economics into TAC setting. One problem associated with most bioeconomic models developed by economists is that they tend to assume that the underlying economic and biological models (and associated parameters) are known with certainty, and that overly simple biological models are often employed. However, it *is* possible to introduce model uncertainty and more realistic biological models into a bioeconomic framework (Lane and Kaufmann, 1993).

Fishers and managers have also argued that economic behavioural relationships are too complex to be captured within a modelling context, and that the data required by such models are subject to major errors. This holds equally true for population-dynamics models that are an attempt to simplify complex, dynamic ecosystems. Similarly, economic models are simplifications of complex, dynamic economic systems.

Whether these simplifications render both model types useless for policy analysis is an interesting question. However, if both structured approaches to decision-making are rejected, it is unclear how TAC setting (involving complex biological and economic systems) can be handled 'in the heads' of fisheries managers. As mentioned earlier, this is not to say that TACs should just 'pop out' of the models, rather that the models may be useful tools with which decision-makers can examine TAC setting options in an internally consistent fashion. However, if used in this manner, models require an institutional framework, involving fishers, managers and scientists, within which the model can be properly employed[15]. The next section briefly examines this issue in more detail.

An institutional structure to support bioeconomic TAC setting

The integration of economic considerations into population dynamic models (i.e., bioeconomic models) offers policy-makers a more complete set of information upon which to base their evaluation of alternative TAC setting strategies. However, this framework still suffers from a number of drawbacks. First, it is difficult to 'sell' results that are simply generated from bioeconomic models. There is a tendency for some to see model results as naive simplifications, that are often based on faulty data, and are built without an understanding of what is happening 'at sea' or in markets. Second, it is difficult for models to produce reasonable forecasts if markets or populations dynamics have undergone recent changes that are not reflected in the historical data with which the models were constructed.

In order to accommodate these concerns, and in turn improve the usefulness of bioeconomic models as an aid into developing TAC setting strategies, user groups can be involved in both the development of bioeconomic models and in their use to examine alternative TAC harvesting strategies. This would allow their concerns to be aired and tested. Additional information is incorporated into the harvesting strategy evaluation process and greater transparency in the stock assessment process increases the probability that results will be ultimately accepted. Smith (1997) provides an outline of the harvesting strategy evaluation process for school shark in the Australian southern

shark fishery and eastern gemfish in the Australian south east trawl fishery. A brief description of the school shark process is given below.

In managing school shark the Australian Fisheries Management Authority (AFMA) has established the Southern Shark Fisheries Management Advisory Committee (SharkMAC) and the Southern Shark Fisheries Assessment Group (SharkFAG). SharkMAC provides management advice to AFMA, and is comprised of an independent chair, a fisheries scientist, an AFMA manager, five members with industry expertise and a conservation member. SharkFAG provides SharkMAC and AFMA with independent stock assessment and management advice, including advice on harvesting strategies. SharkFAG membership includes fisheries biologists, a manager, an economist and fishers. SharkFAG has developed a population model for school shark. At present, model development has not explicitly incorporated economic considerations, rather economic advice is introduced into the selection of alternative harvesting strategies through the input of an economist and industry participants.

The current harvest strategy for school shark is based on setting TACs to achieve a management goal of an 80% probability that the mature biomass at the start of 2011 exceeds that at the start of 1996. The biological status of the resource is represented by 22 scenarios (not unlike sensitivity tests) related to biological parameters/processes and selections for data to use in the assessment. These scenarios were selected jointly by the members of the assessment group. Some of the scenarios were not considered likely by some industry members while others were not considered likely by some scientific members. Nevertheless, all scenarios were considered plausible by all members. The agreed harvest strategy is based on a five-year phased reduction in catch. SharkMAC selected this harvest strategy after it was presented with a range of alternatives, all of which were predicted to satisfy the management objective.

MARKET-BASED TAC SETTING

One of the difficulties with all the approaches to TAC setting discussed so far is that the fisheries management agency is required to collect significant and costly amounts of biological, and in some cases economic, information. In a series of papers, Arnason (1989, 1990 and 1993) has developed a theoretical market-based approach to determining the 'optimal' time trajectory for TACs under transferable ITQ management. Unlike the various approaches to TAC setting discussed above, the market-based approach does not require a central management agency to collect any information about the fishery in order to set TACs.

Arnason's analysis is quite mathematical, and we will only provide a rough outline of his reasoning and the assumptions upon which his argument is based. To understand Arnason's logic, we first have to start out by assuming that fisheries management agencies are interested in maximising resource rent. With some simplification, this implies that the minimum amount of capital, labour, fuel and other resources should be employed to take the harvest. Note that this is different from the implicit objective associated with F_{msy}, which assumes an objective of maximising the tonnage harvested regardless of the economic costs associated with harvesting. To meet this economic

efficiency or resource rent objective, the management agency would need to collect biological information about the current and expected status of fish stocks, and a great deal of economic information about markets and harvesting costs. This information would then be incorporated into a bioeconomic model of the fishery, which in turn could be used to determine the optimal trajectory of TACs.

Arnason suggests that it would be difficult and costly for a centralised management agency to collect the required amount and type of information, and to carry out the necessary analysis to determine correctly the optimal time trajectory for TACs. Moreover, he argues that individual fishers already possess the information that the management agency seeks, and therefore it would be more appropriate to set up a market mechanism to determine TACs that would, in essence, use existing information more effectively. Clearly, individual fishing firms understand their cost and harvesting relationships at least as well as could the most determined management agency. Although fishers will not possess the required stock assessment information, they are interested in future stock status from a future profitability viewpoint and have incentive to ensure that an assessment is undertaken to determine the impact of alternative TAC scenarios on future stock status.

But how does Arnason suggest transforming the assumed information knowledge of fishers, along with their profit-motivated desire to acquire need information, into TACs? Arnason (1993) states:

> The fundamental idea is that the prices in the share quota market reflect all relevant information about current and future conditions in the fishery available to the fishing firms or, for that matter, any participant in the quota market. It follows that the quota authority only has to monitor the quota market price to become privy to the same information.

Since the market value of quota is assumed to equal the present value of expected future resource rent, Arnason (1993) suggests that all the management agency needs to do is:

> merely to monitor the share quota price in the quota market and adjust the total quota so as to maximize the total value of the share quotas.

He refers to this as the Minimum Information Management method.

But how would this process actually be carried out by management agencies? According to Arnason (1993) it would not be necessary to announce the future time path of the TAC, rather it would only be necessary to announce the long-term objective for setting future TACs, and then select the TAC for the current year. The current year TAC could be determined:

> by iteratively announcing the total quota and checking the response of the quota price. Presumably, for most fisheries, this could be carried out in a modified stock exchange setting.

Of course, Arnason's analysis and the subsequent conclusions are based on a number of strong assumptions, including:

- The existence of a perfectly competitive quota market exists — i.e., the quota market is open to everyone interested in trading, and no individual or group of individuals

are in a position to influence the quota price (this usually implies that they are a large number of independent quota traders);

- quota shares are issued in perpetuity;
- there exists no uncertainty with respect to current and future stock status, fish prices and harvesting costs;
- the sole management objective is to maximise resource rents; and
- instantaneous availability and processing of information by fishers.

Copes (1989) offers a number of criticisms of Arnason's market-based approach that largely amount to the rejection of a number of the assumptions listed above. In general, as discussed earlier, shares allocated to fishers in most ITQ fisheries are not strong property rights, and at least in an operational sense, it may be inappropriate to consider that they are issued in perpetuity. Therefore it is not clear that fishers currently hold the long-term harvesting incentives required under the market-based TAC approach. In addition, as far as a number of Australian ITQ-type fisheries are concerned, the quota market may be less than efficient — the number of participants is small and there may be potential for large quota holders to influence quota prices. Quota holders in New Zealand and Australia have avoided either the use or establishment of formal quota markets, and in Australian Commonwealth fisheries, industry has not been willing to make all quota trading prices public. It could also be argued that for slow growing, unproductive stocks, the quota market might place a very high premium on current harvests, at the cost of substantial recruitment overfishing. However, this could be remedied by establishing a threshold biological reference point that would limit the available TAC setting options open to industry.

In response to Arnason's minimum information management approach, Walters and Pearse (1996) state that:

> The basic presumption here is that all the information used for formal assessment is already available to fishers (most of it comes from the them in the first place), and they will use it as wisely as any scientist could in making the stock size assessments and predictions that are implicit in deciding how much a quota holding is worth. This presumption might indeed have some merit if commercial CPUE were proportional to abundance or if fishers were willing to share the spatial details of their fishing information… But that is a reckless presumption in a world of changing technology, accurate spatial targeting of fishing technology on whatever stock aggregations remain, and continuing incentives to be secretive about the best fishing locations. Under these circumstances, the entire industry is as likely to be misled in their investment decisions as was the Canadian government when its assessment staff used CPUE data in their northern cod assessments (Figs 3, 4). There is no simple economic 'magic bullet' for avoiding substantial care and investment in gathering information for stock assessment.

Although there seems to be little operational value in this market-based approach to TAC setting, the Walters and Pearse criticism may be exaggerated. Even as Walters and Pearse concede, the centralised data collection and stock assessment approach followed in Canada was itself no guarantee of effective stock assessment.

MULTI-SPECIES CONSIDERATIONS

The preceding discussion on TAC setting is predicated on the assumption that a single species is fished or at least that a single species dominates the catch and is of prime conservation concern. Unfortunately, this is seldom the case and many fisheries are highly multi-species. For example, the Australian south east fishery takes over 100 different species of which 16 constitute the bulk of the catch and have consequently been placed under quotas (Klaer and Tilzey, 1994). Problems relating to both output and input control become more severe if the fishery targets multiple species. This is because the species are unlikely to be equally productive so that the more susceptible species may be driven below their limit reference point while other species are under-utilised.

The issue of TAC setting in multi-species fisheries is an important question, however this topic is far beyond the scope of this book. For additional information on multi-species analysis see Hilborn and Walters (1992), Mercer (1982), Davis and Baldwin (1993), and Daan (1987).

ENDNOTES

1 One must be cautious with terms such as 'optimal' when discussing harvest rates. If one assumes an objective of maximising the tonnage of fish harvested, then the harvest rate that achieves this objective could be referred to as the 'optimal' rate. However, the harvest rate is only optimal with respect to a rather simple objective.

2 The terminology in this area can be quite confusing. Terms such as harvest rate, exploitation rate, instantaneous fishing mortality rate, fishing mortality rate, real fishing effort and nominal fishing effort are often related concepts, some of which are occasionally used interchangeably. To keep matters as simple as possible, when we use the term 'harvest rate' we mean the catch (over, say, a year) as a percentage of the fishable stock of a particular species. An alternative expression for harvest rate is the exploitation rate. The exploitation rate is often referred to by the symbol 'h'. Biologists frequently refer to the instantaneous fishing mortality rate, which is denoted by F. F is a measure of the mortality imposed by fishing at a point in time, whereas the exploitation rate refers to mortality imposed over a period of time. See Squires (1987), Cunningham and Whitmarsh (1980), Rothschild (1972), and Hilborn and Walters (1992) for additional information on these various terms.

3 In the biological literature, management error is also referred to as 'implementation uncertainty'.

4 In this example, as an alternative to using the term harvest rate, it could be stated that the *exploitation rate* is set at 20% of the stock. It is important to note that the 20% figure actually refers to the fraction of the *fishable*, as opposed to total, stock harvested; fishing mortality is an instantaneous rate that refers to harvesting at a point in time, as opposed to harvest rates which refer to harvesting over a period of time.

5 Growth overfishing occurs if fish are harvested at a younger age than that which could generate the highest total yield.

6 For a discussion of these and other biological reference points see Caddy and Mahon (1995).

7 While the underlying objective of both of these harvest rate strategies is similar (to maximise tonnage harvested), F_{msy} and F_{max} are based on different population model assumptions.

8 F_{med} uses the median survival ratio and F_{low} and F_{high} use the lower 10th and 90th percentiles, respectively.

9 See ICES (1997, 1998), Richards et al. (1997) and NAFO (1998) for more information on precautionary F-setting policies.

10 Recruitment overfishing occurs when the spawning stock is reduced by fishing to a level at which it is unable to produce enough recruits to replace itself.

11 See Hilborn (1997) for a criticism of 'x% of unexploitated biomass' limit reference points.
12 See Marchal and Horwood (1995) and Corten (1993) for a discussion of minimum biological levels.
13 For an economic analysis of constant catch and other harvesting strategies see Hannesson and Steinshamn (1991), Hannesson (1993a), and Steinshamn (1993).
14 For additional information on bioeconomic analysis see Clark (1985), Hannesson (1993b), Lane and Stephenson (1996, 1998), and OECD (1997b).
15 For a discussion related to the incorporation of fishers, managers, scientists and others into the management decision process see Hilborn and Luedke (1987).

11 SOCIAL CONSIDERATIONS

One concern frequently raised with respect to ITQs is the potential for negative social impacts. Two points are worth noting from the beginning. First, there are few in-depth empirical studies on the social impact of ITQs. As the National Research Council (1999) notes:

> The extensive literature and testimony received indicated that insufficient attention and resources have been devoted to socioeconomic impact assessments prior to decisions about IFQs, and to monitoring and evaluating the performance and consequences of IFQ programs once in place.

Second, notwithstanding the need for pre- and post-impact studies of ITQs, it is not sufficient to undertake studies that only focus on the social impact of ITQs. Studies are also needed on the likely social impact of the alternative effort-control options. In light of past experience with effort controls, it is inappropriate to assume that the alternative to ITQs is the social 'status quo' with respect to employment, community benefits and other social-type considerations. In a report on the social and cultural aspects of the US east coast multispecies groundfish fishery (which is not managed by ITQs), Aguirre International (1996) make the following observations:

> Families that depend on fishing and the seafood industry along the eastern seaboard of the United States are economically, socially and psychologically stressed because of declining fish stocks, increased state and federal government regulation, coastal development and gentrification, and conflicts between different populations of fishers. During 1995, for example, gill nets were banned in Florida waters and moratoria on licenses were put into effect in North Carolina and for fishers in the multispecies groundfish fishery of the Northeast and Mid-Atlantic regions (from the Gulf of Maine to Cape Hatteras). Several other states have been experimenting with new fishing licensing systems, limited entry or other kinds of reduced access programs, and various closures of fishing regions for environmental or biological reasons (e.g., designated nursery areas). Even as ground fishers witness fishing stocks dwindling and habitats continuing to shrink or become polluted, fishing interests in other states and other countries are considering or putting into place measures to restrict access to fisheries which displaced ground fishers might enter.

In other words, effort controls also have significant social impacts. If effort controls are ineffective at controlling catch or fishing mortality levels, then declining stock abundance will eventually impact on harvesting, processing and community employment. In addition, if effort controls reduce harvesting and effort (through area closures and vessel and gear reductions) then losses in employment and other negative community impacts are also likely. A one-sided evaluation of the social impact of ITQs is biased and misleading.

POTENTIAL NEGATIVE SOCIAL IMPACTS OF ITQS

The major purpose of this section is to expose the various arguments related to how ITQs have the potential to produce negative social consequences.

QUOTA ALLOCATION

In many fisheries, hired skippers and crew are co-adventures who are paid on a share basis. Since they face financial and physical risk associated with fishing (but not the financial risk associated with vessels and harvesting equipment), it has been argued that they should, but usually do not, receive quota allocations. This concern is not an inherent problem with ITQs and could be addressed by including hired skippers and crew in the initial allocation process. It is worth noting that under an effort-control program aimed at limiting the number of fishing licenses, one is confronted with a similar 'who's in and who's out' problem. Fishing licenses in effort-controlled fisheries are often reallocated to the same group of fishers, even though they frequently expire on a yearly basis. One rarely hears the argument that shares of these licenses should be reallocated to crew or hired skippers.

HARVESTING AND PROCESSING EMPLOYMENT, AND COMMUNITY IMPACTS

A major concern with individual quota regimes, especially if the quota is transferable and there are no limits on quota holdings, is that rationalisation in the fishery will result in a loss of harvesting and processing jobs. In a sense this should not be surprising. As discussed earlier, one of the major purposes behind the development of ITQs was the construction of a policy instrument that more effectively controls over-capacity and overfishing. Reductions in vessel numbers, and in turn harvesting employment, may be unavoidable consequences of introducing effective management into over-exploited fisheries.

ITQs may also impact processing employment. For example, management by seasonal closures can result in bursts of harvesting activity, accompanied by high seasonal demand for processing labour to process and freeze large quantities of fish. Some communities can become dependent on and develop around this particular structure of fishing activity. The introduction ITQs may change various structural aspects of harvesting and processing, and in turn impose various negative social adjustment costs on these communities while generating business and income-earning opportunities in others. If fishers sell their quota to fishers in different communities then processing employment may fall. Processing employment may fall if ITQs result in a more even distribution of harvesting throughout the year (therefore reducing total employment but increasing the number of full-time jobs). The production and marketing of fresh as opposed to frozen fish may also create community adjustment costs.

Any significant decline in direct harvesting and processing employment could also have additional negative implications for communities through flow-on indirect impacts.

This would especially be the case for isolated regions that were heavily dependent on fishing and have high unemployment and few alternative employment options.

OTHER SOCIAL CONCERNS

A number of additional social objections have been raised with respect to ITQs. Copes (1986) suggests that only the first generation of fishers will benefits from ITQs. Specifically, because new fishers must pay for quota, there will not be a permanent increase in fishing incomes.

Greer (1995) in a Greenpeace report suggests that large corporations have the financial strength to outbid smaller competitors and eventually take a dominant role in terms of quota holdings. Additional concerns related to the take over of fisheries by 'big business' include, foreign ownership, price-fixing, reduced crew bargaining power, monopolistic control, and collusion.

POLICY OPTIONS TO MINIMISE NEGATIVE SOCIAL IMPACTS

A number of policies have been introduced in order to order to mitigate the potential negative social impacts of ITQs. Specific policies include restrictions on transferability, maximum quota holding limits, limitations on the duration of quota rights, allocation of quota to non-vessel owners (including communities, crew, skippers and processors), foreign ownership restrictions, and owner-operator restrictions.

Concerning quota transferability, NRC (1999a) recommends that:

> Leasing of quota should generally be permitted but with restrictions as needed to avoid undesirable side effects such as absentee ownership.

In contrast to this view, fishers in the Australian south east trawl fishery have a more positive view of the presence of "absentee landlords" in the quota market, as noted in Chapter 8 on Discarding. This is because the "absentee landlords" are willing to trade quotas early in the year when most fishers are reluctant to do so, allowing fishers with incidental over-catches to land rather than discard these catches.

NRC's second recommendation on quota transferability is that:

> Permanent transfers of quota should generally be allowed without any restriction among eligible quota holders. However, if there is a desire is to promote an owner-operated fishery or to conserve geographic or other structural features of the industry, it may be necessary to restrict long-term transfers of quota shares to bona fide fishermen or to prohibit transfers of quota shares to bona fide fishermen or to prohibit transfers away from certain areas or between different vessel categories.

However, care should be taken in implementing such transferability restrictions. Vested interests, promoted under the guise of social considerations, can play a large role in determining the new rules of the game under ITQ management. It may be worthwhile to indicate from the beginning that the need and consequences of transferability restrictions will be *independently* re-evaluated on an ongoing basis.

A number of ITQ programs deal with concerns over the concentration of quota in the hands of a small number of players through the introduction of limits on maximum

quota holdings. The fear is that significant concentration of quota in the hands of a few companies or individuals could strengthen their bargaining power and consequently lower crew and skipper wages (especially in isolated communities). For US fisheries, NRC (1999a) recommends that Congress require the establishment of concentration limits for all new ITQ fisheries (rather than rely on federal antitrust law).

One attempt to address concerns over negative community impacts in isolated fishing communities is the US Community Development Quota (CDQ) program. The CDQ program was implemented in December 1992 in Alaska by the North Pacific Fishery Management Council. The CDQ program allocates quota (a percentage of the total allowable catch) for a number of species directly to a number of isolated communities in Alaska. For a recent review of the CDQ program see NRC (1999b).

For evidence on the actual social impacts of ITQs see NRC (1999), McCay and Creed (1994), Charles (1988) and, Palsson and Petursdottir (1997). The following section provides a broader context within which to consider the various social criticisms of ITQs.

CAN THE FISHING SECTOR REMAIN FROZEN IN TIME?

Countries, regions, communities and individuals in most market-based economies are continually forced to adjust to changes in technology, competition, and demand for various goods and services. In the 1940s, agriculture was a major source of employment in Australia, Canada, the United States and Europe. Over time, manufacturing replaced agriculture as the dominant sector, and manufacturing was in turn later replaced by the service sector. This transformation is illustrated in Table 25 that illustrates the relative shift of employment in a six sector breakdown of the economies of Canada, United States and West Germany. In 1956, the primary sector (agriculture, forestry and fishing) accounted for roughly 16% of employment in Canada and West Germany and 11% of US employment. However, by 1981 the percentage of employment in the primary sector had fallen significantly in all three countries, while the share of employment in the service sector substantially increased.

TABLE 25
PERCENTAGE OF EMPLOYMENT IN VARIOUS SECTORS OF FOUR COUNTRIES

Sector	Canada		United States		West Germany	
Year	1956	1981	1956	1981	1956	1981
Primary	16.4	5.5	11.2	3.7	16.9	5.5
Mining	2.1	1.8	1.4	1.1	3.1	1.4
Manufacturing	25.7	19.4	29.2	21.3	36.5	33.6
Construction	7.4	5.9	5.1	4.4	7.6	7.5
Utilities	8.9	8.3	7.2	5.5	8.7	7.0
Services	39.5	59.1	45.9	64.0	27.2	45.0

Source: Extracted from information in Table 2–3 Charette et al. (1986)

In response to the perceived social adjustment costs associated in the dynamic evolution of market economies, many governments have played a role in both *protecting* various sectors of the economy from immediate adjustment pressures and providing adjustment *assistance* to industries, regions, communities and individuals.

To help appreciate the issue of adjustment, consider the case of the agricultural sector. The agricultural sector in most countries has faced adjustment pressures from significant technological/structural change and substantial foreign competition. The introduction of technological improvements such as tractors and automatic harvesting equipment negatively impacted directly on agricultural employment and indirectly on the economic foundation of many rural communities. Governments could have responded to the negative social consequences of improved harvesting technology through even greater regulation of the agricultural sector. For example, the use of new harvesting equipment could have been restricted. If the sale of land by small-scale farmers to 'big corporate' farming operations led to a reduction in agricultural employment, then regulations could have been introduced to limit the size of a farm or owner-operator restrictions could have been introduced requiring land owners to drive their tractors. It doesn't take much imagination to believe that such actions would have resulted in industrial and economic stagnation and dire social consequences.

Of course, in most developed countries (with exceptions such as Iceland) the fishing sector is a small component of the national economy, and it is unlikely that over-capacity in fisheries would have much of a negative impact on national wealth generation and overall income levels. However, the high degree of hands-on management by government of the fisheries sector required by effort controls and consequent maintenance of significant 'politics' in the decision-making process may not in the end offer much relief from social adjustment in fisheries.

The fishing sector is not really very different from agriculture, car manufacturing, or banking. In our view it is illusory to think that government departments can successfully manage any of these sectors, particularly fisheries, to achieve long-term social objectives.

This is not to say that immediate adjustment in fisheries is prudent, nor does it suggest that free-market arrangements are always warranted. Displacement of labour in isolated communities that cannot readily find alternative employment is bad economics. While it is not frequently appreciated, economists have long argued that there is no economic gain from releasing labour from employment when it cannot, for one reason or another, be productively employed elsewhere in the economy. Clearly, social adjustment costs should be considered in the development of alternative fisheries management programs and thought given to how such impacts could be ameliorated. However, in the end, it may not be possible to continually isolate the fishing industry from structural adjustment.

12 OTHER ISSUES

There is a range of other issues that could be usefully discussed in relation to the implementation of ITQ systems. Only three were chosen for brief consideration, the operation of quota registries, the impact of the taxation system and the management of non-quota species.

QUOTA REGISTRIES: OPERATIONAL ISSUES

The basic functions of a quota registry are to issue and transfer licences, permits and quota rights and to maintain an up-to-date register of fishing entitlements. Records of quota leasing and sales transactions of each quota holder are maintained on the register, providing a balance of current quota entitlements. In fisheries where carry-over and carry-under of quota is allowed, the balance of individual operator quota entitlements on the register are credited or debited accordingly. Individual quota holders are normally provided with regular statements of quota balances.

Other information kept on the register often includes convictions or pending prosecutions of entitlement holders and third party interests in the fishing entitlements. When applications are made to transfer quota, registry staff check that the transferee is eligible to hold quota. Various conditions may exist relating to foreign ownership, maximum and minimum quota holding limits, previous convictions and the holding of other necessary fishing entitlements. For example in the south east trawl fishery, the transferee must hold a valid vessel permit (there is a limit on the number of vessels allowed to operate) or a non-fishing permit (which allows entities such as banks to hold quota).

Indicative registry checks include the following:

- Has the entitlement been suspended?
- Are there grounds for suspension or cancellation of the entitlement?
- Are there court proceedings against the transferor?
- Are there any third party interests registered?
- Has each person/entity with an interest in the entitlement agreed to the transfer?
- Is the transferee an eligible person to hold quota entitlements?
- Does the transferee hold any necessary additional fishing entitlements?
- Will the transfer result in the quota holding of the transferee exceeding a specified maximum quota holding?

Other functions that may be associated with the quota registry include the entry and checking of quota monitoring data, follow-ups of late or incorrectly filled out catch disposal records and of discrepancies between the parts of catch disposal records completed by fishers and fish receivers. Registers are usually open for public inspection, on payment of a fee.

Third party interests

The register normally includes third party interests in entitlements. For example, mortgages held by banks or finance companies. In some jurisdictions, such as the Australian Commonwealth and New South Wales, an interest has no effect unless it is registered. In other jurisdictions, such as Western Australia and Victoria, registration is not compulsory. As a result, registration does not "legally perfect" the interest. That is, there may be other third party interests that have not been registered. In this situation, it is unclear whether registration of third party interests actually gives the interest holder any stronger title than a person whose interests are unregistered.

Generally, once an interest is recorded on the register, the management authority is under a duty to notify interest holders of any application to transfer or change the entitlement and whether the holder has been convicted of an offence. The interest holder then has a certain period of time, generally 21 days, to take any action. Of most concern to third party interest holders are the consequences of having the entitlement revoked, cancelled or forfeited by the fisheries management authority or the courts. In some states, there is provision for compensation if a licence is cancelled by the fisheries management authority for other than a fisheries offence. For example, in Victoria, if a transferable licence is cancelled for a fisheries management reason, both the entitlement holder and holders of registered interests are entitled to compensation for any financial loss suffered[1].

With regard to forfeiture of quota, in many fisheries it is not clear whether third party interest holders are entitled to any of the proceeds of sale of forfeited quotas or what legal action interest holders may take to mitigate their losses. An exception to this uncertainty is found under the Tasmanian Deed of Agreement[2] for abalone, where third party interest holders, such as mortgagees, have a power of sale that they are allowed to exercise for three months before the Director of Fisheries exercises the government's power of sale. The difference between sale price and the amount of the mortgage is then paid to the Director of Fisheries. In New South Wales, provision has been made in the *Fisheries Management Act 1994* for regulations to be made to pay part of the revenues of forfeited shares[3] to a third party interest holder. In New Zealand, if quota is forfeited, lenders can make applications to the court for relief but their rights are subject to the overriding purpose of the Act (Findlay, 1997).

Whether registration of third party interests is compulsory or not, registration does offer benefits to third parties. This is because management authorities notify interest holders of any proposed changes to the entitlement. Furthermore, from a potential lenders perspective, an incomplete register of third party interests means it is more difficult to trace existing security interests.

TAX CONSIDERATIONS

The treatment by the taxation system of income derived from fishing using quotas and from their lease or sale is, of course, of vital interest to fishers from a financial viewpoint. There may also be implications from a broader fisheries management perspective if

taxes on transfers of ownership or on the realisation of capital gains discourage trade in quotas. The treatment of depreciation of the quota asset may also affect the desirability of holding quota as an investment asset. The most relevant taxes in Australia are capital gains tax and income tax[125].

CAPITAL GAINS TAX

In general, leases of quota on a non-permanent basis (such as seasonally) would be considered for income tax purposes as receipts or expenditures and assessable as ordinary income or deductible as business expenses. Capital gains tax is payable when there has been a sale of an asset — defined as an essential part of the income-earning apparatus of the fisher and being either real or personal property.

If quota is considered to be an asset by the taxation authorities and the quota holder only holds quota for one species, any sale of that quota would affect the income-earning ability of the fisher. Provided there had been a capital gain, that gain would be subject to payment of capital gains tax.

The difficulty arises in multi-species quota fisheries such as in the Australian south east trawl fishery, where a fisher owns a bundle of quota for different species and may simply wish to adjust the species composition of his/her holdings, rather than sell off assets. Here the question is "what is a single asset for capital gains tax purposes?" Alternatives are the bundle of quota or each separate species quota. If the quota bundle is considered one asset, permanent sales of quotas that are components of the bundle would not be subject to capital gains tax provided the total value of the quota bundle remained the same through corresponding quota purchases and sales. If there has been a net increase in the value of the bundle, capital gains tax would be payable. However, if each individual quota was considered an asset, then capital gains tax would be payable on any capital gains made from the sale of that particular quota.

Before the introduction of the 1997 *Income Tax Assessment Act* (Cth), the South east trawl Fishing Industry Association lobbied for specific provisions to treat quota bundles as one asset rather than multiple assets for CGT purposes (see AFMA and SETFIA [undated]). The Act dealt with these proposals indirectly by making roll-over relief available for small businesses (defined as having assets of less than $5 million). This relief allows small businesses to dispose of some or all of their assets and reinvest the proceeds without being liable for capital gains tax. As the Act considers statutory licences (which includes fishing licences and quota) as business assets, roll-over relief applies to fishers with assets of less than $5 million — including the majority of the operators in the SET. No capital gains tax is payable on permanent quota sales if the proceeds of such sales are reinvested in the business either by purchasing different quotas or other assets.

INCOME TAX: DEPRECIATION OF THE QUOTA ASSET

In Australia, fishing licences and quotas are treated as non-depreciable assets. In contrast, Icelandic law allows quota assets to be depreciated by 20 per cent per year,

significantly increasing the desirability of holding such assets. The decision, in 1993, of the Icelandic Supreme Court to allow fishers to depreciate their quotas was argued to compensate for the insecure character of the assets (Eythorsson, 1996).

Similarly, purchased quota shares are considered in the US as depreciable assets. The quota shares are depreciated at a rate of 1/15th of their purchase price each year (National Research Council, 1999). However, quota shares assigned to fishers (at no cost) in the original allocation are not depreciable.

MANAGEMENT OF NON-QUOTA SPECIES

Relatively few fisheries are based on single species with no bycatches, with the exception of fisheries for sessile species such as abalone. Most fisheries have target species and a range of bycatch species. Typically, when ITQs are first introduced they cover only the main target species.

If bycatches are relatively small, this omission may be of no consequence. However, if catches of non-quota species are significant, or the species lend themselves to target fishing, new incentives may be created for a competitive expansion of fishing capacity that may erode the economic gains from the introduction of the ITQ system and lead to depletion of these species.

A number of management approaches may be to used to attempt to address these concerns. These include using input controls or competitive TACs to manage this sector of the fishery, or introducing "basket quotas" that combine a number of species within a single TAC. Alternatively, all commercial species could be progressively brought under the ITQ system. This approach is used in New Zealand.

INPUT CONTROLS AND COMPETITIVE TACS

Input controls on vessel numbers, length and areas of operation were used in the Australian south east trawl fishery to attempt to control catches of non-quota species. However, operators were concerned that these measures were inadequate to prevent a potential "blow-out" of fishing effort on these species (SETMAC Management of Non-quota Species Working Group, 1995). Catches of non-quota species have not, however, risen substantially since the early days of the ITQ system, remaining around 20% of the total catch weight (SEFAG, 1999). Whether this is a result of input controls or other factors is unclear. However, using input controls for this purpose may have negative spill-over effects on the quota managed fishery by denying fishers the opportunity to use the most efficient vessels to take their quotas.

Competitive TACs could be set for individual non-quota species that can be targeted by fishers. However, it would probably be better to allocate these TACs as ITQs to avoid promoting wasteful, competitive fishing practices often seen under this form of management.

BASKET QUOTAS

This concept is similar to quota substitution (described in Chapter 8, Discarding) but with all species within the basket being substitutable on a one for one basis. That is, fishers could fill their basket quota with catches of a range of species, or with only one species, provided the total does not exceed their basket quota holding.

Basket quotas are used in New Zealand to manage the flatfish fishery. Within a single TAC for flatfish, fishers are able to catch up to eight species of flounders, sole, brill and turbot (Annala et al., 1991). Flatfish grow rapidly, have a short lifespan and are subject to highly variable recruitment, factors that would make individual species quotas highly variable from year to year causing difficulties for both fishers and stock assessment scientists. According to Annala et al., these species were included in the quota system primarily to put a ceiling on fishing effort in these fisheries and to minimise conflict between fishing units.

If a particular species within a basket becomes increasingly targeted, and/or there are concerns for its sustainability, the species could be withdrawn from the basket and allocated as ITQs.

ENDNOTES

1 S.63, *Fisheries Act 1995 Victoria.*

2 Explain what this is and how it differs from other instruments for holding quota.

3 Explain share managed fisheries concept

4 Stamp duty may also be relevant. This is a state tax in Australia payable on sales of real property. To become subject to this tax, quota would therefore have to be considered as real, as opposed to personal, property under the relevant legislation.

BIBLIOGRAPHY

Abalone Management Plan 1992 (Western Australia).

ABARE, 1998b. *Australian Fisheries Statistics 1998*. Australian Bureau of Agricultural and Resource Economics, Canberra.

ABARE, 1998a. *Australian Fisheries Surveys Report*. Australian Bureau of Agricultural and Resource Economics, Canberra.

Ackroyd, P., Hide, R. and Sharp, B. 1990. *New Zealand's ITQ System: Prospect for the Evolution of Sole Ownership Corporations*. Report to MAF Fisheries, Wellington.

Adelaja, A., McCay, B. and Menzo, J. 1998. 'Market share, capacity utilization, resource conservation, and tradable quotas', *Marine Resource Economics*, vol. 13.

AFMA and SENTFCC, 1997. *Discussion Paper on ITQ Management for the Southeast Non-Trawl Fishery*. Paper prepared by the South East Non-Trawl Consultative Committee.

AFMA and SETFIA, (undated). *Submission on Behalf of the South East trawl Fishing Industry Association (SETFIA) and the Australian Fisheries Management Authority for the Amendment of the Capital Gains Tax Provision in Part IIIA of the Income Tax Assessment Act.*

AFMA, 1992. *Review of the South East Fishery Management Plan*. Australian Fisheries Management Authority, Canberra.

AFMA, 1997b. *Southeast Non-Trawl Fishery Management Arrangements 1998.*

Aguirre International, 1996. *An appraisal of the social and cultural aspects of the multispecies groundfish fishery in New England and the Mid-Atlantic regions*. Report prepared for the National Oceanographic and Atmospheric Administration, Contract Number 50-DGNF-5-00008.

Allars, M. 1996. *An Introduction to Australian Administrative Law*. Butterworths, Australia.

Alverson, D.L., Freeberg, M.H., Pope, J.G. and Murawski, S.A. 1994. 'A global assessment of fisheries bycatch and discards', *FAO Fisheries Technical Paper*, no. 339, Rome.

Andersen, P., Sutinen, J. and Cochran, K. 1998. *Paying for fisheries management*. Paper presented at the IXth Conference of the International Institute of Fisheries Economics and Trade, Tromso, Norway, 8–11 July 1998.

Anderson, L.G. 1992. *Consideration of the potential use of individual transferable quotas in US fisheries*. National ITQ Study Report to the National Marine Fisheries Service, vol. 1.

Annala, J. 1996. 'New Zealand's ITQ system: Have the first eight years been a success or a failure?', *Reviews in Fish Biology and Fisheries*, vol. 6, pp. 43–62.

Annala, J., Sullivan, K. and Hore, A. 1991. 'Management of multispecies fisheries in New Zealand by individual transferable quotas', *ICES Mar. Sci. Symp.*, 193, pp. 321–29.

Anonymous, 1990. *Individual Quota Management in Canadian Fisheries: Taking Stock and Future Directions*. A report prepared by a Canadian Department of Fisheries and Oceans working group.

Anonymous, 1990. *Review of Canadian Enterprise Allocation Programs*. Report prepared by the Canadian Department of Fisheries and Oceans.

Anonymous, 1992. 'Cost Recovery for Managing Fisheries', *Industry Commission Report,* no. 17. Australian Government Publishing Service, Canberra.

Arnason, R. and Hannesson, R. 1999. 'The Costs of Fisheries Management', *Papers on Fisheries Economics*, no. 38. Centre for Fisheries Economics, Bergen.

Arnason, R. 1996. 'Property rights as an organizational framework in fisheries: The cases of six fishing nations' in B.L. Crowley (ed.), *Taking Ownership: Property Rights and Fishery*

Management ion the Atlantic Coast. Atlantic Institute for Market Studies, Halifax, Nova Scotia, Canada, pp. 99–144.

Arnason, R. and Friis, P. 1995a. 'The Greenland Fisheries: Developing a Modern Fishing Industry', in R. Arnason and L. Felt (eds), *The North Atlantic Fisheries: Successes, Failures and Challenges*. Charlottetown: Institute of Island Studies.

Arnason, R. 1995b. *The Icelandic fisheries. Evolution and Management of a Fishing Industry*. Fishing News Books, UK.

Arnason, R. 1994. 'On catch discarding in fisheries', *Marine Resource Economics*, vol. 9, pp. 189–208.

Arnason, R. 1993a. 'ITQ Based Fisheries Management' in S. Smith, J. Hunt and D. Rivard (eds), *Risk Evaluation and Biological Reference Points for Fisheries Management*. Canadian Journal of Fisheries and Aquatic Science (Special Publication), vol. 120, pp. 345–56.

Arnason, R. 1993b, 'The Icelandic Individual Transferable Quota System: A Descriptive Account', *Marine Resource Economics*, vol. 8, pp. 201–18.

Arnason, R. 1990. 'Minimum information management in fisheries', *Canadian Journal of Economics*, vol. 23, pp. 630–53.

Arnason, R. 1989. 'Minimum information management with the help of catch quotas' in P. Neher, R. Arnason and N. Mollett (eds), *Rights Based Fishing*. vol. 169 NATO ASI series, Series E: Applied Sciences. Netherlands: Kluwer Academic Publishers, pp. 215–24.

Baelde, P. 1998. 'Synthesis of industry information on fishing practices and their effects on catch rate analysis (bottom trawl sector)', in J. Prince, P. Baelde and G. Wright (eds), *Synthesis of industry information on fishing patterns, technological change and the influence of oceanographic effects on SEF fish stocks*. FRDC project no. 97/114, Canberra.

Bass Strait Scallop Consultative Committee, 1997. *Discussion Paper: Future Management of the Bass Strait Central Zone Scallop Fishery*.

Batstone, C.J. and Sharp, B.M.H. 1999. 'New Zealand's quota management system: the first ten years', *Marine Policy*, vol. 23, no. 2, pp. 177–90.

Baulch, K. and Pascoe, S. 1992. 'Bycatch management options in the south east fishery', *ABARE Research Report 92.18*. Canberra.

Bentham, J. 1931. *The Theory of Legislation*.

Beverton and Holt, 1957. 'On the dynamics of exploited fish populations', *Fishery Investigations, Series II, Marine Fisheries*. Great Britain Ministry of Agriculture, Fisheries and Food.

Boyce, J. 1992. 'Individual transferable quotas and production externalities in a fishery', *Natural Resource Modeling*, vol. 6, pp. 358–408.

Boyce, J. 1996. 'An economic analysis of the fisheries bycatch problem', *Journal of Environmental Economics and Management*, vol. 31, pp. 314–36.

Boyd, R. and Dewees, C. 1992. 'Putting theory into practice: individual transferable quotas in New Zealand's fisheries', *Soc. Nat Res.*, vol. 5, pp. 179–98.

Bradbrook A., MacCallum, S. and Moore, A. 1996. *Australian Property Law: Cases and Materials*. LBC Information Services, NSW, Australia.

Branson, A. 1997. 'An industry perspective on New Zealand's experience with ITQs', in E. Pikitch, D. Huppert and M. Sissenwine (eds), *Global Trends: Fisheries Management. American Fisheries Society Symposium 20*, Seattle, Washington, USA, 14–16 June 1994, pp. 270–74.

Bromley, D.W. 1993. *Environment and Economy: Property Rights and Public Policy*. Blackwell.

Brubaker, E. 1996. 'The ecological implications of establishing property rights in Atlantic fisheries', in B.L. Crowley (ed.), *Taking Ownership: Property Rights and Fishery Management in the Atlantic Coast*. Atlantic Institute for Market Studies, Halifax, Nova Scotia, Canada. pp. 221–51.

Buck, E. 1995. *Individual Transferable Quotas in Fisheries Management*. Congressional Research Service Report for US Congress.

Bureau of Resource Sciences, 1997. *Fishery Status Reports: Resource Assessments of Australian Commonwealth Fisheries*. Canberra, Australia.

Burke, L., Annand, C., Barbara, R., Brander, L., Etter, M-A., Liew, D., O'Boyle, R. and Peacock, G. 1994. 'The Scotia-Fundy inshore dragger fleet ITQ Program: background, implementation, and results to date', *ICES C.M. 1994/T:35*.

Caddy, J. and McGarvey, R. 1996. 'Targets or limits for management of fisheries?', *North American Journal of Fisheries Management*, vol. 16, pp. 479–87.

Caddy, J. and Mahon, R. 1995. 'Reference points for fisheries management', *FAO Fisheries Technical Paper 347*. Rome, Italy.

Casey, K., Dewees, C., Turris, B. and Wilen, J. 1995. 'The effects of individual vessel quotas in the British Columbia halibut fishery', *Marine Resource Economics*, vol. 10, pp. 211–30.

Charette, M., Henry, R. and Kaufmann, B. 1986. 'The evolution of the Canadian industrial structure: an international perspective', in D. McFetridge (Research Coordinator), *Canadian Industry in Transition*. University of Toronto Press, pp. 61–133.

Charles, A. 1988. 'Fishery Socio-economics: A Survey', *Land Economics*, vol. 64, no. 3. pp. 276–95.

Chesson, J., and Clayton, H. 1998. *A framework for assessing fisheries with respect to ecological sustainable development*. Bureau of Rural Sciences, Canberra.

Christy, F. 1973. 'Fisherman quotas: a tentative suggestion for domestic management', *Occasional Paper no. 19*. Law of the Sea Institute, University of Rhode Island.

Clark, I. 1993. 'Individual transferable quotas: the New Zealand experience', *Marine Policy*, vol. 17, pp. 340–42.

Clark, I. and Duncan, A. 1986. 'New Zealand's fisheries management policies, past, present and future: the implementation of an ITQ-based management system', in N. Mollett (ed.), *Fishery Access Control Programs Worldwide: Proceedings of the Workshop on Management Options for the North Pacific Longline Fisheries. Alaska Sea Grant College Program Report*, no. 86, pp. 107–40.

Clark, I., Major, P. and Mollett, N. 1988. 'Development and implementation of New Zealand's ITQ management system', *Marine Resource Economics*, vol. 5, pp. 325–50.

Clarke, R., Yoshimoto, S. and Pooley, S. 1992. 'A bioeconomic analysis of the Northwestern Hawaiian Islands lobster fishery', *Marine Resource Economics*, vol. 7, pp. 115–40.

Clement and Associates, 1997. *New Zealand Commercial Fisheries: The Guide to the Quota Management System*. Tauranga, New Zealand.

CM Research, 1998. Compliance survey research report. Prepared for Ministry of Fisheries, Wellington, New Zealand.

Commonwealth of Australia, 1992. *National Strategy for Ecologically Sustainable Development*. Australian Government Publishing Service, Canberra.

Conrad, J. 1989. 'Bioeconomics and the bowhead whale', *Journal of Political Economy*, vol. 97, no. 4, pp. 974–87.

Cooter and Ulen, 1997. *Law and Economics*, Second edition. Addison-Wesley.

Copes, P. 1986. 'A critical review of the individual quota as a device in fisheries management', *Land Economics*, vol. 62, pp. 278–91.

Copes, P. 1995. *Problems with ITQs in Fisheries Management with Tentative Comments on Relevance for Faroe Islands Fisheries*. Presented to the Nordic Council of Ministers.

Corten, A. 1993. 'The use of the MBAL concept in management advice', *ICES CM1993/H:19* (mimeo).

Cowan, T. 1986. 'Recent adjustments in Ontario's Fisheries', in N. Mollett (ed.), *Fishery Access Control Programs Worldwide: Proceedings of the Workshop on Management Options for the North Pacific Longline Fisheries*. Orcas Island, Washington, pp. 245–55.

Crean, K. and Symes, D. 1994. 'The discards problem: towards a European solution', *Marine Policy*, vol. 18, no. 5, pp. 422–34.

Crothers, S. 1988. 'Development and implementation of New Zealand's ITQ management system', *Marine Resource Economics*, vol. 5, pp. 325–49.

Crowley, R.W. and Palsson, H. 1992. 'Rights Based Fisheries Management in Canada', *Marine Resource Economics*, vol. 7, pp. 1–21.

Cunningham S. (ed.) 1993. *The Use of Individual Quotas in Fisheries Management*. Organization for Economic Cooperation and Development, Paris, France.

Cunningham, S. and Whitmarsh, D. 1980. 'Fishing effort and fisheries policy', *Marine Policy*, vol. 4, pp. 309–16.

Daan, N. 1987. 'Multispecies versus single-species assessment of North Sea fish stocks', *Canadian Journal of Fisheries and Aquatic Sciences*, vol. 44 (Supplement 2), pp. 360–70.

Davies, N. 1992. 'Fisheries management: a New Zealand perspective', *South Africa Journal of Marine Science*, vol. 12, pp. 1069–77.

Davis, S. and Baldwin, R. 1993. 'Multispecies management: A key to unlocking flatfish resources?', in G. Kruse, D. Eggars, R. Marasco, C. Pautzke and T. Quinn (eds), *International Symposium on Management Strategies for Exploited Fish Populations*. Alaska Sea Grant College Program Report, no. 93-02, University of Alaska, Fairbanks, pp. 529–44.

Deed Pursuant to Section 7 of the Fisheries Act 1959 in Relation to a Right to Take Abalone in Tasmanian State Fishing Waters.

Department of Primary Industries, Water and the Environment, Tasmania, 1999. *Giant Crab Fishery Policy Document*.

Department of Primary Industry and Fishery, Tasmania, 1997a. *Rock Lobster Fishery Policy Document*.

Department of Primary Industry and Fishery, Tasmania, 1997b. *Policy Document for the Tasmanian Abalone Fishery from 1/1/98 – 31/12/99 (Draft)*.

Deriso, R.B. 1987. 'Optimal $F_{0.1}$ criteria and their relationship to maximum sustainable yield', *Canadian Journal of Fisheries and Aquatic Science*, vol. 44 (Supplement 2), pp. 339–48.

Dewees, C. 1989. 'Assessment of the implementation of individual transferable quotas in New Zealand's inshore fishery', *North American Journal of Fisheries Management*, vol. 9, no. 2, pp. 131–39.

DPIE (Department of Primary Industries), 1989. *New Directions for Commonwealth Fisheries Management in the 1990s: A Government Policy Statement*. Canberra.

Dubbink, W. and van Vliet, M. 1996. 'Market regulation versus co-management?', *Marine Policy*, vol. 20, no. 6, pp. 499–516.

Dupont, D. 1996. 'Limited Entry Fishing Programmes: Theory and Canadian Practice', in D. Gordon and G. Munro (eds), *Fisheries and Uncertainty: A Precautionary Approach to Resource Management*. Calgary: University of Calgary Press, pp. 107–28.

Eayrs, S. 1998. *Options for gear modifications to increase the selectivity of demersal fish trawls in the SET*. Paper presented to the Fisheries Research and Development Corporation Workshop on Maximising Yield and Reducing Discards in the South East trawl Fishery, 30–31 July, Canberra.

Edwards, S. and Murawski, S. 1993. 'Potential economic benefits from efficient harvest of New England groundfish', *North American Journal of Fisheries Management*, vol. 13, pp. 437–49.

Eggars, D. 1993. 'Robust harvest policies for Pacific Salmon fisheries', in G. Kruse, D. Eggars, R. Marasco, C. Pautzke and T. Quinn (eds), *International Symposium on Management*

Strategies for Exploited Fish Populations. Alaska Sea Grant College Program Report, no. 93-02, University of Alaska Fairbanks, pp. 85–106.

Exel, M. and Kaufmann, B. 1997. 'Allocation of fishing rights: implementation issues in Australia', in E. Pikitch, D. Huppert, and M. Sissenwine (eds), *Global Trends: Fisheries Management. American Fisheries Society Symposium 20*, Seattle, Washington, USA, 14–16 June 1994, pp. 246–55.

Eythorsson, E. 1996. 'Theory and prices of ITQs in Iceland', *Marine Policy*, vol. 20, no. 3, pp. 269–81.

FAO, 1993. *Marine Fisheries and the Law of the Sea: A Decade of Change*, Food and Agriculture Organization, Rome, Italy.

FERM (Fisheries Economics, Research and Management Ltd), 1998a. *Cost and Operational Considerations of Introducing ITQs into the Central Zone Bass Strait Scallop Fishery*. Prepared by Fisheries Economics, Research and Management Consultants for the Australian Fisheries Management Authority, Canberra.

FERM, 1998b. *An Integrated Electronic Data Management System for the Australian Fisheries Management Authority*. Prepared by Fisheries Economics, Research and Management Consultants for the Australian Fisheries Management Authority, Canberra.

FERM, 1998c. *A Cost/Benefit Analysis of an Integrated Electronic Data Management System*. Report to the Australian Fisheries Management Authority, Canberra.

FERM, 1997a. *Future Management Options for the Southern Shark Fishery*. Report prepared by Fisheries Economics, Research and Management Consultants for the Australian Fisheries Management Authority, Canberra.

FERM, 1997b. *Future Management Options for the Queensland Spanner Crab Fishery*. Report prepared by Fisheries Economics, Research and Management Consultants for the Queensland Fisheries Management Authority, the Queensland Department of Primary Industry, and the Queensland Commercial Fisherman's Association, Australia.

FERM, 1997c. *Re-allocation of Fishing Concession where Management Arrangements Have Changed*. Prepared for the Australian Fisheries Management Authority, Canberra.

Findlay, B. 1997, 'Quota as Loan Security', *Seafood New Zealand*, December 1997.

Fisher, S. 1997. *Commercial and personal property law*. Butterworths, Sydney.

Fisheries Act (Queensland) 1994.

Fisheries (Abalone) Rules (Tasmania) 1997 and amendments.

Fisheries (Giant Crab) Rules (Tasmania) 1999.

Fisheries (Rock Lobster) Rules (Tasmania) 1997 and amendments.

Fisheries (Spanner Crab) Management Plan (Queensland) 1999.

Fisheries Act (Northern Territory) 1996.

Fisheries Act (South Australia) 1982.

Fisheries Administration Act (Commonwealth) 1991.

Fisheries Department of Western Australia, 1988. *Final Report of the Pearling Industry Review Committee. Fisheries Management Paper*, no. 17.

Fisheries Department of Western Australia, 1996. *Pearl Oyster Fishery. Ministerial Policy Guidelines*.

Fisheries Management (South east trawl) Regulations (Commonwealth) 1998.

Fisheries Management (Southern Bluefin Tuna) Regulations (Commonwealth) 1995.

Fisheries Management Act (Commonwealth) 1991.

Fisheries Management Act (New South Wales) 1994.

Fisheries Management Regulations (Commonwealth) 1992.

Fisheries Management Regulations (New South Wales) 1994.

Fisheries Regulations (NT) 1996.

Fisheries Western Australia, 1998. 'Abalone Managed Fishery', *Fisheries Overview*, no. 1.
Fisheries Western Australia, 1999a. 'Draft Shark Bay Pink Snapper Management Plan 1999', *Fisheries Management Paper*, no. 128.
Fisheries Western Australia, 1999b. 'The Abalone Managed Fishery in Western', *Ministerial Policy Guidelines*, no. 10.
Fisheries Western Australia, 1999c. *Shark Bay Snapper Managed Fishery – Overview 1998*.
Fisheries Western Australia, 1999d. *Commercial Fisheries: Pearling*.
Fishing and Related Industries Compensation (Marine Reserves) Act (Western Australia) 1997.
Fishing and Related Industries Compensation (Marine Reserves) Act 1997.
Fishing Levy Act (Commonwealth) 1991.
Foose, T., de Boer, l., Seal, U. and Lande, R. 1995. 'Conservation management strategies based on viable populations', in J. Ballou, M. Gilpin, and T. Foose (eds), *Population Management for Survival and Recovery: Analytical Methods and Strategies in Small Population Conservation*. Columbia University Press, New York, pp. 273–94.
Fowler, J. et al, 1997, 'Management of the South Coast Purse Seine Fishery', *Fisheries Management Paper*, no. 99, Fisheries Western Australia.
Franklin, P. 1987. *Australian southern bluefin tuna fishery*. Paper presented at the Indo-Pacific Fishery Commission Symposium on the Exploitation and Management of Marine Fishery Resources in South-East Asia, Darwin, 16–19 February.
Gardner, M. 1988. 'Enterprise allocation system in the offshore groundfish sector in Atlantic Canada', *Marine Resource Economics*, vol. 5, pp. 389–454.
Gauvin, J., Ward, J. and Burgess, E. 1994. 'Description and evaluation of the wreckfish (*Polyprion Americanus*) Fishery under Individual transferable quotas', *Marine Resource Economics*, vol. 9, pp. 99–118.
Geen, G. and Nayar, M. 1988. 'Individual transferable quotas in the southern bluefin tuna fishery: an economic appraisal', *Marine Resource Economics*, vol. 5, pp. 365–87.
Geen, G. and Nayar, M. 1989. 'Individual transferable quotas and the southern bluefin tuna fishery', *Australian Bureau of Agricultural and Resource Economics Occasional Paper*, no. 105, AGPS, Canberra, Australia.
Geen, G., Nielander, W. and Meany, T.F. 1993. 'Australian experience with individual transferable quota systems', in OECD (ed.), *The Use of Individual Quotas in Fisheries Management*. Organization for Economic Cooperation and Development, Paris, France.
Geen, G., Brown, D. and Pascoe, S. 1990a. 'Restructuring the south east fishery', in BRS (ed.), *Australian and New Zealand Southern Trawl Fisheries Conference: Issues and Opportunities. Bureau of Rural Resources Proceedings*, no. 10, Canberra, pp. 129–41.
Geen, G., Brown, D. and Pascoe, S. 1990b. 'Management Policies for the south east trawl fishery: An economic analysis'. Invited paper, Australian Agricultural Economics Society Conference, Brisbane, 13–15 February 1990.
Geen, G., Kingston, T. and Brown, D. 1991. *Cost Recovery for Managing Fisheries. Industry Commission submission 91-4*. Australian Bureau of Agricultural and Resource Economics, Canberra.
Gilroy, H., Sullivan, P., Lowe, S. and Terry, J. 1996. *Preliminary Assessment of the Halibut and Sablefish IFQ Programs in Terms of Nine Potential Conservation Effects*. International Pacific Halibut Commission, Seattle, Washington, and Alaska Fisheries Science Center, National Marine Fisheries Service, Seattle, Washington.
Gordon, J. 1954. 'Economic theory of a common property resource: the fishery', *Journal of Political Economy*, vol. 62, pp. 124–42.
Grafton, R. 1992. 'Rent capture in an individual transferable quota fishery', *Canadian Journal of Fisheries and Aquatic Sciences*, vol. 49, pp. 497–503.

Grafton, R. 1995. 'Rent capture in a rights based fishery', *Journal of Environmental Economics and Management*, vol. 28, pp. 48–67.

Grafton, R. 1996a. 'Individual transferable quotas: theory and practice', *Reviews in Fish Biology and Fisheries*, vol. 6, pp. 5–20.

Grafton, R. 1996b. 'Performance of and prospects for rights-based fisheries management in Atlantic Canada', in B.L. Crowley (ed.), *Taking Ownership: Property Rights and Fishery Management ion the Atlantic Coast*. Atlantic Institute for Market Studies, Halifax, Nova Scotia, Canada, pp. 145–81.

Grafton, R., Squires, D. and Kirkley, J. 1996. 'Private property rights and crises in world fisheries: Turning the tide?', *Contemporary Economic Policy*, vol. 14, pp. 90–99.

Gray, K. 1993. *Elements of Land Law*, Second edition. Butterworths.

Greer, J. 1995. *The big business takeover of US fisheries: privatizing the oceans through individual transferable quotas (ITQs)*. A Greenpeace publication.

Griffin, W.L., Roberts, K., Lamberte, A.B., Ward, J.M. and Hendrickson, H.M. 1992. 'Considerations for the potential use of individual transferable quotas in the Gulf of Mexico shrimp fishery', *National ITQ Study Report to the National Marine Fisheries Service*, vol. 3.

Gulland, J. 1974. *The Management of Marine Fisheries*. Scientechnica Publishers, Bristol, UK.

Gulland, J.A. and Boerema, L.K. 1973. 'Scientific advice on catch levels', *Fisheries Bulletin, US*, vol. 71, pp. 325–35.

Halvorson, K. 1997. *Recommendations for the Allocation of Commercial Groundfish Between Trawl and Hook and Line Gear Sectors, and Recommendations for a Groundfish Trawl Individual Vessel Quota Program*. Report prepared for the Minister of Fisheries and Oceans, Canada.

Hanks, P. 1996. *Constitutional Law in Australia*. Butterworths, Australia.

Hannesson, R. 1993a. 'Strategies for stabilization: Constant catch or constant fishing effort', in G. Kruse, D. Eggars, R. Marasco, C. Pautzke and T. Quinn (eds), *International Symposium on Management Strategies for Exploited Fish Populations*. Alaska Sea Grant College Program Report, no. 93-02, University of Alaska Fairbanks, pp. 665–82.

Hannesson, R. 1993b. *Bioeconomic Analysis of Fisheries*. FAP, Fishing News Books, UK.

Hannesson, R. 1996. 'On ITQs: an essay for the Special Issue of Reviews in Fish Biology and Fisheries', *Reviews in Fish Biology and Fisheries*, vol. 6, no. 1, pp. 91–96.

Hannesson, R. and Steinshamn, S. 1991. 'How to set catch quotas: Constant effort or constant catch?', *Journal of Environmental Economics and Management*, vol. 20, pp. 71–91.

Haxell, C. 1986. 'Management measures to control commercial fish harvest: the Ontario experience', in N. Mollett (ed.), *Fishery Access Control Programs Worldwide: Proceedings of the Workshop on Management Options for the North Pacific Longline Fisheries*, Orcas Island, Washington, pp. 231–44.

Hepburn, S. 1998. *Principles of Property Law*, Cavendish Publishing Pty Ltd, Sydney.

Herrmann, M., Criddle, K., Feller, E. and Greenberg, J. 'Estimated economic impacts of potential policy changes affecting the total allowable catch for walleye pollock', *North American Journal of Fisheries Management*, vol. 16, pp. 770–82.

Hilborn, R. 1997. 'Uncertainty, risk, and the precautionary principle', in E. Pikitch, D. Huppert and M. Sissenwine (eds), *Global trends: Fisheries management. American Fisheries Society Symposium 20*, Bethesda, Maryland, pp. 100–6.

Hilborn, R. and Walters, C. 1992. *Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty*. Chapman and Hill.

Hilborn, R. and Luedke, W. 1987. 'Rationalizing the irrational: A case study in user group participation in Pacific salmon management', *Canadian Journal of Fisheries and Aquatic Sciences*, vol. 44, pp. 1796–1805.

Hogan, L., Thorpe, S. and Timcke, D. 1999. *Tradable Quotas in Fisheries Management: Implications for Australia's South East Fishery*. ABARE report to the Fisheries Resources Research Fund, Canberra.

Hollowed, A. and Megrey, B. 1993. 'Evaluation of risks associated with application of alternative harvest strategies for Gulf of Alaska Walleye Pollock', in G. Kruse, D. Eggars, R. Marasco, C. Pautzke and T. Quinn (eds), *International Symposium on Management Strategies for Exploited Fish Populations. Alaska Sea Grant College Program Report*, no. 93-02, University of Alaska, Fairbanks, pp. 291–320.

House of Representatives Standing Committee on Primary Industries, Resources and Rural and Regional Affairs, 1997. *Managing Commonwealth Fisheries: The Last Frontier*. Parliament House, Canberra.

Hughes R. and Leane, G. 1997. *Australian Legal Institutions: Principles, Structure and Organisation*. JL Law and Tax, NSW, Australia.

Huppert, D. 1987. 'Introduction: Limited Access, what is it and why? Limited Access Alternatives for the Pacific Groundfish Fishery', in D. Huppert (ed.), *NOAA Technical Report NMFS 52*, US Department of Commerce.

Huppert, D.D., Anderson, L.G. and Haring, R. 1992. 'Consideration of the potential use of individual transferable quotas in the North Pacific groundfish trawl fishery', *National ITQ Study Report to the National Marine Fisheries Service*, vol. 2, USA.

Industries Assistance Commission, 1984. *Southern bluefin tuna*. Industries Assistance Commission Report. AGPS, Canberra.

Industry Commission, 1992. 'Cost Recovery for Managing Fisheries', *Industry Commission Report*, no. 17. AGPS, Canberra.

International Council for the Exploration of the Sea (ICES), 1996. *Report by Correspondence of the ICES Study Group on the Management Performance of Individual Transferable Quota (ITQ) Systems*. September, ICES. C.M. 1996.

ICES, 1997a. *Report of the ICES Study Group on the Management Performance of Individual Transferable Quota (ITQ) Systems*. ICES. C.M. 1997/H:2.

ICES, 1997b. *Report of the Study Group on the Precautionary Approach to Fisheries Management*. Advisory Committee on Fisheries Management. ICES CM 1998/ACFM:10.D. 3–6 February, ICES Headquarters, Copenhagen.

ICES, 1998. *Report of the Study Group on the Precautionary Approach to Fisheries Management*. Advisory Committee on Fisheries Management. ICES CM 1997/Assess:7.

Kaufmann, B. and Geen, G. 1997. 'Cost recovery as a fisheries management tool', *Marine Resource Economics*, vol. 12, no. 1, pp. 56–66.

Kaufmann, B. and Geen, G. 1998. 'Quota allocation and litigation: and economic perspective', *Marine Resource Economics*, vol. 13, no. 2, pp. 143–57.

Kirkely J., Squires, D. and Strand, I. 1995. 'Assessing technical efficiency in commercial fisheries: the mid-Atlantic sea scallop fishery', *American Journal of Agricultural Economics*, vol. 77, pp. 686–97.

Klaer, N. and Tilzey, R. 1994. 'The multi-species structure of the fishery', in R. Tilzey (ed.), *The South East Fishery. A Scientific Review with Reference to Quota Management*. AGPS, Canberra.

Knapp, G. 1996. 'Alaska halibut captains' attitudes towards IFQs', *Marine Resource Economics*, vol. 11, pp. 43–55.

Knapp, G. 1997. 'Initial effects of the Alaska halibut IFQ program: survey comments of Alaskan fishermen', *Marine Resource Economics*, vol. 12, pp. 239–48.

Knuckey, I. 1998. *Catch composition and discarding in the south east trawl fishery from observer surveys*. Paper presented to the Fisheries Research and Development Corporation Workshop

on 'Maximising yield and reducing discards in the south east trawl fishery', 30–31 July, Canberra.

Knuckey, I. and Sporcic, M. 1998. *South East Fishery Integrated Scientific Monitoring Program: 1998 Industry Report*. Marine and Freshwater Resources Institute, Queenscliffe.

Kruse, G., Eggars, D., Marasco, R., Pautzke, C. and Quinn, T. (eds), 1993. *International Symposium on Management Strategies for Exploited Fish Populations. Alaska Sea Grant College Program Report*, no. 93-02, University of Alaska, Fairbanks.

Lal, P., Haque, M. and Battaglene, T. 1994. *Benefits and Costs of the Joint Venture Agreement in the Southern Bluefin Tuna Fishery*. ABARE report to the Fisheries Policy Branch, Department of Primary Industries and Energy. Canberra, Australia.

Lane, D. 1989. 'Economics of $F_{0.1}$', *Economic and Commercial Analysis Report*, no. 18, Department of Fisheries and Oceans, Ottawa.

Lane, D. and Kaufmann, B. 1993. 'Bioeconomic impacts of TAC adjustment strategies: a model applied to northern cod', in S. Smith, J. Hunt and D. Rivard (eds), *Risk Evaluation and Biological Reference Points for Fisheries Management*, Canadian Journal of Fisheries and Aquatic Science (Special Publication), vol. 120, pp. 387–402.

Lane, D. and Stephenson, R. 1996. 'SATURN: A framework for integrated analysis in fisheries management', *INFOR*, vol. 34, no. 3, pp. 156–80.

Lane, D. and Stephenson, R. 1998. 'Toward a framework for risk analysis in fisheries decision making', *ICES Journal of Marine Science*, vol. 55, no. 1, pp. 1–13.

Larkin, P.A. 1977. 'An epitaph for the concept of Maximum Sustainable Yield', *Transactions of the American Fisheries Society*, vol. 106, pp. 1–11.

Liggins, G. 1996. *The interaction between fish trawling (in NSW) and other commercial and recreational fisheries*. NSW Fisheries Research Institute, Sydney.

Liggins, G.W. and Knuckey, I.A. 1999. 'Factors affecting discarding in the south east fishery – implications for stock assessment and bycatch reduction', in C.D. Buxton and S.E. Eayrs (eds), *Establishing meaningful targets for bycatch reduction in Australian fisheries. Australian Society for Fish Biology Workshop Proceedings*, Hobart, September 1998.

Lindner, R., Campbell, H. and Bevin, G. 1992. 'Rent generation during the transition to a managed fishery: the case of the New Zealand ITQ system', *Marine Resource Economics*, vol. 7, pp. 229–48.

Living Resources Management Act (Tasmania) 1995.

Mace, P. 1994. 'Relationships between common biological reference points used as thresholds and targets of fisheries management strategies', *Canadian Journal of Fisheries and Aquatic Science*, vol. 51, pp. 110–22.

Mace, P. 1997. 'Developing and sustaining world fisheries resources: the state of the science and management', in D. Hancock, D. Smith, A. Grant and J. Beumer (eds), *Developing and Sustaining World Fisheries Resources: The State of the Science and Management*. 2nd World Fisheries Congress, CSIRO Publishing, Australia, pp. 1–20.

Macgillivray, P. 1990. 'Assessment of New Zealand's Individual Transferable Quota', *Fisheries Management Report*, no. 75. Economic and Commercial Analysis Branch, Department of Fisheries and Oceans.

Macguire, J.J. and Mace, P. 1993. 'Biological reference points for Canadian Atlantic gadoid stocks', in S. Smith, J. Hunt and D. Rivard (eds), *Risk Evaluation and Biological Reference Points for Fisheries Management*. Canadian Journal of Fisheries and Aquatic Science (Special Publication), vol. 120, pp. 321–32.

Major, P. 1997. 'A government perspective on New Zealand's experience with ITQs', in E. Pikitch, D. Huppert and M. Sissenwine (eds), *Global Trends: Fisheries Management. American Fisheries Society Symposium 20*, Seattle, Washington, USA, 14–16 June 1994, pp. 264–69.

Marchal, P. and Horwood, J. 1995. 'Multi-annual TACs and minimum biological levels', *ICES Journal of Marine Science*, vol. 52, pp. 797–807.

Matthews, D. 1997. *Beyond IFQ Implementation: A Study of Enforcement Issues in the Alaska Individual Fishing Quota Program*. Report to the National Marine Fisheries Service Office of Enforcement, Silver Spring.

Matthiasson, T. 1996. *Local governments in the Icelandic ITQ market. Will they sell?* Institute of Economic Studies Working Paper, University of Iceland.

Matulich, S., Mittelhammer, R. and Reberte, C. 1996. 'Toward a more complete model of individual transferable fishing quotas: Implications of incorporating the processing sector', *Journal of Environmental Economics and Management*, vol. 31, no. 1, pp. 112–28.

McCamish, C. 1994. 'Fisheries Management Act 1991: Are ITQs property?', *Federal Law Review*, vol. 22, no. 2, pp. 375–401.

McCay, B. and Creed, C. 1994. *Social impacts of ITQs in the sea clam fishery*. Final Report to the New Jersey Sea Grant College Program, New Jersey Marine Sciences Consortium. Fort Hancock, New Jersey.

McCay, B., Gatewood, J. and Creed, C. 1989. 'Labor and the labor process in a limited entry in a limited entry fishery', *Marine Resource Economics*, vol. 6, pp. 311–30.

McCay, B., Apostle, R., Creed, C., Finlayson, A. and Mikalsen, K. 1995. 'Individual transferable quotas (ITQs) in Canadian and US fisheries', *Ocean and Coastal Management*, vol. 28, no. 3, pp. 85–116.

McLoughlin, R. 1994. 'Sustainable management of Bass Strait Scallops', *Mem. Queensland Mus.*, vol. 36, no. 2.

Mercer, M. (ed.) 1982. *Multispecies approaches to fisheries management advice*. Canadian Special Publications on Fisheries and Aquatic Sciences, no. 59.

Milon, W., Wellman, K. and Gauvin, J. 1992. 'Consideration of the potential use of individual transferable quotas in the South Atlantic mackerel fishery', *National ITQ Study Report to the National Marine Fisheries Service*, vol. 4.

Montgomery, W. 1972. 'Markets in licenses and efficient pollution control programs', *Journal of Economic Theory*, vol. 5, pp. 395–418.

Muse, B. 1991. *Survey of individual quota programs*. Alaska Limited Entry Commission.

Muse, B. and Schelle, K. 1989. 'Individual Fisherman's Quotas: A Preliminary Review of Some Recent Programs', *Alaska Commercial Fisheries Entry Commission paper 89-1*.

National Parks and Wildlife Conservation Act 1975.

NIWA (National Institute of Water and Atmospheric Research), 1997. *Design of an integrated scientific monitoring programme for the south east fishery*. Final report to the Australian Fisheries Management Authority, Canberra.

NMFS (National Marine Fisheries Service), 1998. *The IFQ Program*. 1998 Report to the Fleet, USA.

North Atlantic Fisheries Organization (NAFO), 1998. 'Report of the Scientific Council Workshop on the Precautionary Approach to Fisheries Management', *NAFO SCR Doc. 98/76*. Series no. N3069.

North Pacific Fishery Management Council, 1997. *Development of the Individual Fishing Quota Program for Sablefish and Halibut Longline Fisheries off Alaska*. North Pacific Fishery Management Council, Anchorage, Alaska.

NRC (National Research Council), 1998a. *Sustaining Marine Fisheries*. National Academy Press, Washington D.C.

NRC, 1998b. *Improving Fish Stock Assessments*. National Academy Press, Washington, D.C.

NRC, 1999a. *The Community Development Quota Program in Alaska*. Committee to Review the Community Development Quota Program. National Academy Press, Washington D.C.

NRC, 1999b. *Sharing the Fish: Towards a National Policy on Individual Fishing Quotas*. National Research Council.

NSW Fisheries, 1999a. Commercial Fisheries Profile – Abalone.

NSW Fisheries, 1999b. Commercial Fisheries Profile – Rock Lobster.

OECD, 1993. *The Use of Individual Quotas in Fisheries Management*. Organization for Economic Cooperation and Development, Paris, France.

OECD, 1996. *Synthesis Report for the Study on the Economic Aspects of Management of Marine Living Resources*. Organization for Economic Cooperation and Development, Paris, France.

OECD, 1997a. *Towards Sustainable Fisheries: Economic Aspects of the Management of Living Marine Resources*. Organization for Economic Cooperation and Development, Paris, France.

OECD, 1997b. *Evaluation of the potential Gains and Costs of the Transition to Responsible Fisheries: Model for Analysis*. Organization for Economic Cooperation and Development Fisheries Committee Report, September, AGR/FI(97)10/PART1, Paris, France.

Onal, H., McCarl, B., Griffin, W., Matlock, G. and Clark, J. 1991. 'A bioeconomic analysis of the Texas shrimp fishery and its optimal management', *American Journal of Agricultural Economics*, vol. 73, pp. 1161–70.

Palsson, G. and Helgason, A. 1995. 'Figuring fish and measuring men: The individual transferable quota system in the Icelandic cod fishery', *Ocean and Coastal Management*, vol. 28(1–3), pp. 117–46.

Palsson, G. and Petursdottir, G. (eds) 1997. *Social Implications of Quota Systems in Fisheries*. Nordic Council of Ministers, Copenhagen.

Palsson, H., Lane, D. and Kaufmann, B. 1993. 'Bioeconomic methods for determining TAC's', in S. Smith, J. Hunt and D. Rivard (eds), *Risk Evaluation and Biological Reference Points for Fisheries Management*. Canadian Journal of Fisheries and Aquatic Science (Special Publication), vol. 120, pp. 357–72.

Parliament of Tasmania, Legislative Council Select Committee, 1997. *Report on the Tasmanian Rock Lobster Fishery*.

Pascoe S., Battaglene, T. and Campbell, D. 1992. 'A bioeconomic model of the southern shark fishery', *ABARE Research Report 92.1*. AGPS, Canberra.

Pascoe, P. 1993. 'ITQs in the Australian south east fishery', *Marine Resource Economics*, vol. 8, pp. 395–401.

Pearse, P. 1982. *Turning the Tide: A New Policy for Canada's Pacific Fisheries*. Final Report of the Commission on Pacific Fisheries Policy. Department of Fisheries and Oceans, Vancouver, Canada.

Pearse, P. 1991. *Building on Progress – Fisheries Policy Development in New Zealand*. A report prepared for the Minister of Fisheries. Wellington, NZ: MAF Policy.

Primary Industries South Australia, 1997. *Management Plan for the South Australian Southern Zone Rock Lobster Fishery*. Adelaide, South Australia.

Punt, A.E. 1999. An assessment of the blue grenadier (*Macruronus novaezelandiae*) resource off southern Australia. Unpublished report to the Australian Fisheries Management Authority, Canberra.

QFMA, 1998. *Draft Management Plan and Regulatory Impact Statement: Queensland Spanner Crab Fishery*.

Quinn, T.J. II, Fagen, R. and Zheng, J. 1990. 'Threshold management policies for exploited populations', *Canadian Journal of Fisheries and Aquatic Sciences*, vol. 4, pp. 2016–29.

Richards, L., Schnute, J. and Olsen, N. 1997. 'Quantifying risk in precautionary stock assessments', *ICES CM 1997/V:01*.

Rivard, D. and Maguire, J.-J. 1993. 'Reference points for fisheries management: the eastern Canadian experience', in S. Smith, J. Hunt and D. Rivard (eds), *Risk Evaluation and Biological*

Reference Points for Fisheries Management. Canadian Journal of Fisheries and Aquatic Science (Special Publication), vol. 120, pp. 31–58.

Robins, C., Caton, A., Ward, P. and Williams, K. 1998. *Australia's 1996–97 and 1997–98 Southern Bluefin Tuna fishing seasons*. Working paper, Bureau of Resource Sciences, Canberra, Australia.

Robinson, W. 1986. 'Individual transferable quotas in the Australian southern bluefin tuna fishery', in N. Mollett (ed.), *Fishery Access Control Programs Worldwide: Proceedings of the Workshop on Management Options in the North Pacific Longline Fishery*. Alaska Sea Grant College Program Report, vol. 86, no. 4, pp.189–205.

Rolph, E. 1983. 'Government Allocation of Property Rights: Who Gets What?', *Journal of Policy Analysis Management*, vol. 3, no. 1.

Scheme of Management (Blue Crab Fishery) Regulations (South Australia) 1998.

Scheme of Management (Marine Scalefish Fisheries) Regulations (South Australia) 1991.

Scheme of Management (Rock Lobster Fisheries) Regulations (South Australia) 1991.

Schmidt, D. and Pengilly, D. 1993. 'Review of harvest strategies used in the management of Lithodid Crab in Alaska', in G. Kruse, D. Eggars, R. Marasco, C. Pautzke and T. Quinn (eds), *International Symposium on Management Strategies for Exploited Fish Populations. Alaska Sea Grant College Program Report*, no. 93-02, University of Alaska, Fairbanks, pp. 385–408.

Schrank, W. and Skoda, B. 1999. The costs of marine fisheries management in eastern Canada: Newfoundland 1989/90 to 1997/98. Unpublished manuscript. Memorial University of Newfoundland, Department of Economics.

Scott, A. 1989. 'Conceptual origins of rights based fishing', in P. Neher, R. Arnason, and N. Mollett (eds). *Rights Based Fishing: Proceedings of a Workshop on the Scientific Foundations for Rights Based Fishing. Reykjavik, Iceland, June 27–July 1, 1988*. Netherlands: Kluwer Academic Publishers, pp. 11–38.

Scott, A. 1955. 'The fishery: the objectives of sole ownership', *Journal of Political Economy*, vol. 6, pp. 116–24.

Scott, A. 1986. 'Catch quotas and shares in the fishstock as property rights', in E. Miles, R. Pealy and R. Stokes (eds), *Natural Resource Economics and Policy Applications: Essays in Honor of James A. Crutchfield*. University of Washington Press, Seattle, Washington.

Scott, A. 1998. 'The ITQ as a Property Right: Where it came from, how it works, and where it is going', in B.L. Crowley (ed), *Taking Ownership: Property Rights and Fishery Management in the Atlantic Coast*. Atlantic Institute for Market Studies, Halifax, Nova Scotia, Canada, pp. 31–98.

Senate Standing Committee on Industry, Science, Technology, Transport, Communications and Infrastructure, 1993. *Fisheries Reviewed*. Parliament House, Canberra.

SETMAC Compliance Working Group, 1996.

Shaffer M. 1981. 'Minimum population sizes for species conservation', *BioScience*, vol. 31, no. 2, pp. 131–34.

Shepherd, J. 1982. 'A versatile new stock-recruitment relationship of fisheries and construction of sustainable yield curves', *J. Cons. Int. Explor. Mer.*, vol. 40, pp. 67–75.

Sissenwine, M. and Mace, P. 1992. 'ITQs in New Zealand: the era of fixed quota in perpetuity', *Fishery Bulletin*, vol. 90, no. 1, pp. 147–60.

Sissenwine, M.P. and Shepherd, J.G. 1987. 'An alternative perspective on recruitment overfishing and biological reference points', *Canadian Journal of Fisheries and Aquatic Sciences*, vol. 44, pp. 913–18.

Smith, A. 1997. 'Quantification of objectives, strategies and performance criteria for fishery management plans – an Australian perspective', in D. Hancock, D. Smith, A. Grant and J.

Beumer (eds), *Developing and Sustaining World Fisheries Resources: The State of the Science and Management*. 2nd World Fisheries Congress, CSIRO Publishing, Australia, pp. 291–95.

Smith, A.D.M. (ed.) 1999. *The South East Fishery 1999*, Fishery Assessment Report. Compiled by the south east Fishery Assessment Group. Australian Fisheries Management Authority, Canberra.

Smith, P., Griffiths, G. and Ruello, N. 1998. 'Price formation on the Sydney Fish Market', *ABARE Research Report 98.8*, Canberra.

Smith, S.J., Hunt, J.J. and Rivard, D. (eds) 1993. 'Risk Evaluation and Biological Reference Points for Fisheries Management', *Canadian Journal of Fisheries and Aquatic Science (Special Publication)*, vol. 120.

South Coast Purse Seine Limited Entry Fishery Notice 1992, Notice no. 636 (Western Australia).

South East Trawl Fishery Management Plan 1998.

South East Trawl Management Advisory Committee, 1994. *Over-quota Harvest Working Group*. Report of discussions on over-quota harvest, 20 April and 10 May, Canberra.

South East Trawl Management Advisory Committee Working Group, 1998. *Options for Introducing Flexibility into the ITQ System in the Trawl Sector of the SEF*. Discussion paper for the Australian Fisheries Management Authority's 1998 SEF Workshop, Canberra.

Southern Bluefin Tuna Fishery Management Plan 1995.

Southern Shark Fishery Assessment Group, 1996. *School shark assessment*. Report to SharkMAC, November.

Southern Zone Rock Lobster Fishery Management Plan 1997, South Australia.

Squires, D. et al., 1998. 'Individual transferable quotas in multispecies fisheries', *Marine Policy*, vol. 22, no. 2, pp. 135–59.

Squires, D. 1987. 'Fishing effort: Its testing, specification, and internal structure in fisheries economics and management', *Journal of Environmental Economics and Management*, vol. 14, pp. 268–82.

Squires, D. and Kirkley, J. 1995. 'Resource rents from single and multispecies individual transferable quota programs', *ICES Journal of Marine Science*, vol. 52, pp. 153–64.

Squires, D. et al. 1998, 'Individual transferable quotas in multispecies fisheries', *Marine Policy*, vol. 22, no. 2, pp. 135–59.

Squires, D., Kirkley, J. and Tisdell, C. 1995. 'Individual transferable quotas as a fishery management tool', *Review of Fisheries Science*, vol. 3, pp. 141–69.

Stanisford, A. 1987. *The effects of the pot reduction in the southern zone rock lobster fishery*. Paper presented to the 31st Annual Conference of the Australian Agricultural Economics Society, Adelaide, Australia, 10–12 February 1987.

Steinshamn, S. 1993. 'Management strategies: Fixed or variable catch quotas' in S. Smith, J. Hunt and D. Rivard (eds), *Risk Evaluation and Biological Reference Points for Fisheries Management*. Canadian Journal of Fisheries and Aquatic Sciences, vol. 44, pp. 373–85.

Stephenson, R., Lane, D., Aldous, D. and Nowak, R. 1993. 'Management of the 4WX Atlantic Herring (Clupea harengus) fishery: an evaluation of recent events', *Canadian Journal of Fisheries and Aquatic Sciences*, vol. 50, pp. 2742–57.

Sutinen, J. 1995. *Summary and Conclusion of the Workshop on Enforcement Measures. Fisheries Enforcement Issues*. OECD, Paris.

Sutinen, J. 1996. *Fisheries Compliance and Management: Assessing Performance*. Report to the Australian Fisheries Management Authority, Canberra.

Sutinen, J.G., Mace, P., Kirkley, J., DuPaul, W. and Edwards, S. 1992. 'Consideration of the potential use of individual transferable quotas in the Atlantic sea scallop fishery', *National ITQ Study Report to the National Marine Fisheries Service*, vol. 5.

Symes, D. and Crean, K. 1995. 'Privatisation of the commons: the introduction of individual transferable quotas in developed fisheries', *Geoforum*, vol. 26, no. 2, pp. 175–85.

Taylor, B. 1997. *Targeting of the school shark (*Galeorhinus galeus*) in Bass Strait (1993–95)*. Southern Shark Fishery Assessment Group Working Paper. Australian Fisheries Management Authority, Canberra, Australia.

Tilzey, R. and Klaer, N. 1994. 'Catch and Effort Summary', in R. Tilzey (ed.), *The south east Fishery: A Scientific Review with Particular Reference to Quota Management*, pp. 46-71.

Tilzey, R.D.J. (ed.) 1994. *The south east Fishery. A Scientific Review with Particular Reference to Quota Management*. Bureau of Resource Sciences, Canberra.

Townsend, R.E. 1995. 'Transferable dynamic stock rights', *Marine Policy*, vol. 19, no. 2, pp. 153–58.

Trawl Fishery Management Advisory Committee, 1996. *Queensland Trawl Fishery. Discussion Paper*, no. 5. Prepared for the Queensland Fisheries Management Authority, Queensland, Australia.

Underwood, P. 1995. 'To manage quotas or manage fisheries? The root cause of mismanagement of Canada's groundfish fishery'. *Dalhousie Law Journal*, vol. 18, pp. 7–43.

Van Vliet, M. 1995. *Co-management of the Dutch North Sea fishery: between 'catch' and 'market'*. Paper presented to the International Sustainable Development Research Conference, Manchester.

Walters, C. and Pearse, P.H. 1996. 'Stock information requirements for quota management systems in commercial fisheries', *Reviews in Fish Biology and Fisheries*, vol. 6, pp. 21–42.

Wang, S. 1995. 'The surf clam ITQ management: an evaluation', *Marine Resource Economics*, vol. 10, pp. 93–98.

Young, P. and Martin, R. 1989. 'The scallop fisheries of Australia and their management', *Rev. Aquat. Sci.*, vol. 1, no. 4.

Zacharin, W. 1994. 'Scallop fisheries management: the Australian experience', *Mem. Queensland Mus.*, vol. 36, no. 2.

Zacharin, W. (ed.) 1997. 'Management Plan for the South Australian Southern Zone Rock Lobster Fishery, South Australian', *Fisheries Management Series*, no. 29, South Australian Rock Lobster Fishery Management Committee in association with Primary Industries and Resources South Australia.

Zheng, J., Funk, F., Kruse, G. and Fagen, R. 1993. 'Evaluation of threshold management strategies for Pacific Herring in Alaska', in G. Kruse, D. Eggars, R. Marasco, C. Pautzke and T. Quinn (eds), *International Symposium on Management Strategies for Exploited Fish Populations*. Alaska Sea1, pp. 41–166.

Ziff, B. 1996. *Principles of Property Law*, Second edition, Carswell Thomson Professional Publishing, Toronto, Canada.

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Fish futures

INDIVIDUAL TRANSFERABLE QUOTAS IN FISHERIES

Fish stock depletion and gross overcapacity of fishing fleets worldwide has prompted fisheries agencies to reconsider their approaches to the management of commercial fisheries. The use of individual transferable catch quotas is becoming increasingly popular as a means of forestalling or reversing this trend. However, there are many obstacles to successful implementation of this quota management approach, including the initial quota allocation to fishers and the prevention of 'quota busting' and fish discarding — actions that can threaten the sustainability of the fish stocks and seriously undermine public and fishing industry confidence in the management system.

This book draws together the growing body of practical experiences of quota systems both in Australia and internationally with the aim of helping fisheries managers, fishers and others take informed decisions on how to make quota systems work in practice.