Pergamon

Marine Policy, Vol. 23, No. 2, pp. 177–190, 1999

Printed in Great Britain
0308-597X/98 $19.00 + 0.00

PII: S0308-597X(98)00036-0

New Zealand's quota management system: the first ten years

C J Batstone and B M H Sharp[1]

This paper has two aims. First, New Zealand's quota management system is analysed using a simple analytical economic model. Second, the paper describes how the system has evolved in response to pressures since implementation. The quota management system has provided a remarkably robust platform for addressing fisheries management problems during its first ten years of operation. It also provided the government with an instrument for settling Maori fishing claims. In 1996, the unsubsidised New Zealand fishing industry exported most of its harvest to highly competitive international markets. The paper concludes with a discussion of contemporary challenges.

Keywords—tradeable rights, institutional analysis

C J Batstone and B M H Sharp, Department of Economics, The University of Auckland, Private Bag 92019, Auckland New Zealand. Tel: 64-9-373 7599; Fax: 64-9-373 7000; E-mail: b.sharp@auckland.ac.nz.

[1]We would like to thank Dan Bromley, Jonathan Peacey, and Bruce Rettig for comments on an earlier draft. We are grateful for continued support from the New Zealand Seafood Industry Council and the Ministry of Fisheries.

In 1986 a quota management system (QMS) based on transferable harvesting rights, operating within the constraints of sustainability, was implemented (Sharp, 1997). In this paper we provide an assessment of New Zealand's experience with transferable rights in terms of three questions: (1) is the QMS economically efficient? (2) is the mechanism decentralised? (3) does the QMS capture the broad range of values associated with harvesting and conservation of fisheries assets? A simple economic model is described before proceeding with an analysis of the structure of property rights. We then describe and discuss the economic performance of the QMS. Two case studies illustrate how the QMS operates. The paper concludes with a discussion of contemporary challenges.

Quota management framework

The QMS is a rights-based system of management with two key structural pillars. First there is the total allowable catch (TAC). The second component is a set of individual transferable quota (ITQ) rights. In the context of economic efficiency, we must determine the optimal harvest (Q^*) and allocate rights to Q^* across fishers in a way that maximises net present value. Provided rights are well-defined and transferable, we can rely on the market mechanism to determine who gets the rights to fish. The price that attaches to quota is determined endogenously. Thus, active firms buy (sell) quota as long as the additional value to the firm is greater than (less than) market price. Two important results follow. First, total quota will be caught by the most efficient firms. Second, the market value of quota provides summary information about current and future conditions — biological and economic — in the fishery. Full economic efficiency holds if the TAC is set at Q^*. In practice, a fisheries management agency sets the harvest — say at Q^+ — and claims about the economic efficiency of rights-based fishing hinge on whether $Q^+ = Q^*$. Nonetheless, given Q^+, we can rely on the market to allocate rights to relatively more profitable firms.

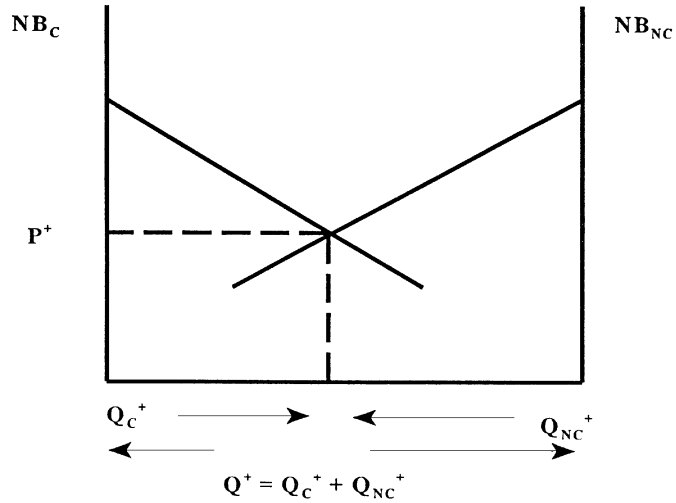

Figure 1. Optimal allocation of total allowable catch.

We now turn to the problem of allocating the TAC between commercial and non-commercial fishers. Net benefit to the two groups is given by NB_C and NB_{NC}, respectively. To simplify things, let us use a simple static framework and assume that the marginal cost of supplying a harvesting right to either group is the same. Figure 1 shows that the TAC should be allocated in such a way that net benefits are equalised, provided the allocation remains within the TAC. If the right to harvest is not differentiated, then competition will result in a uniform price P^+. Commercial fishers will harvest Q_c^+ and the non-commercial Q_{NC}^+.

The QMS approaches the problem of allocating Q^+ somewhat differently. Rather than creating specific recreational harvesting rights, Q^+ is partitioned into quantities available for commercial (TACC) and non-commercial (TANC) harvest. That is, TAC = TACC + TANC. Two case studies will illustrate the difference. In the deep-water orange roughy fishery there is no recreational interest, thus TACC = TAC. Whereas in the snapper fishery, recreational fishers harvest a sizeable percentage of the TAC, thus TACC < TAC.

Analysis

The above model provides a micro-economic foundation for analysing the QMS.

Total allowable catch

From the above model it is clear that the TAC is a decision variable of economic and biological significance. A consultative process underpins the TAC-setting process, including its allocation to commercial and non-commercial sectors. The TAC-setting mechanism uses information from research and catch records. At the beginning of each calendar year, the Ministry convenes a series of meetings to review stock assessment information. Representatives from the Ministry, the Seafood Industry Council, Maori, and conservation groups, attend the meetings. The Ministry discusses the assessment with commercial and non-commercial groups, and then forwards its recommendations to the Minister for declaration of any changes.

In 1986, when the QMS was introduced, ITQ were defined in terms of a given tonnage of fish. The original adjustment mechanism had government entering the market as a seller of rights to tonnage quota if stock assessments warranted increasing the TACC and as a buyer of excessive quota rights if the TACC exceeded sustainable harvest levels. For example, in 1987 the sale of rights to harvest hoki and orange roughy yielded $83.5 million. By 1989 the cost of effecting reductions to the TACC was considered unmanageable. A review of fisheries legislation concluded that this mechanism created incentives to fully harvest the TACC because government would provide compensation — through its buying activities in the quota market — for any reductions (Fisheries Task Force, 1992).

In 1990 legislation redefined quota rights as a percentage of the TACC. Any changes to the TACC were pro-rated across ITQ owners. For TACC increases, existing ITQ owners enjoy the benefits of extra harvest at no cost. For TACC decreases, an 'Accord' was negotiated between government and industry to provide compensation payments over a transition period to 1994. During this period, resource rentals were set aside to compensate quota owners for TACC reductions (Boyle, 1993). The change to proportional ITQ shifts the distribution of stock adjustment risk from government to industry. Re-establishing incentive compatibility into the TACC adjustment mechanism hinged to a large degree on the involvement of industry in future catches through stock assessment research (Pearse, 1991).

The 1996 Fisheries Act makes it clear that the Minister must set both a TAC and a TACC for each stock. Recreational and customary interests — summarised as TANC in our model — are not given explicit priority in allocation. For most stocks, the bench mark to be used when setting the TAC is the requirement to achieve a stock that will produce the maximum sustainable yield (MSY). The Minister can only take into account social, cultural and economic factors to alter the rate at which the fish stock is moved toward the MSY. The TACC for most species in the QMS has been adjusted at some time. Coefficients of variation, which summarise the relative dispersion of allowable catch around the mean allowable catch for each species, range from 1.9% to 37.5%. A number of reasons can be given for this variation across species, including by-catch, relative profitability, variable recruitment success, and different levels of stock knowledge.

A net-benefit maximising allocation of the TAC, as illustrated in Figure 1, requires a balancing of net benefits between commercial and non-commercial allocations. The existing institutional structure cannot produce the information necessary for net-benefit maximisation. Furthermore, the allocation of rights to the TAC is not decentralised. It is highly unlikely that the existing mechanism can optimally allocate a fixed TAC. The snapper case study, presented below, illustrates the issue.

Rights of Maori

Traditional fishing interests of Maori were guaranteed under the Treaty of Waitangi 1840 and have been acknowledged in fisheries legislation since 1877. In 1983 the Fisheries Act stated that "nothing in this Act shall affect any Maori fishing right". Three years later, when the QMS was introduced, the strength of this provision was tested in the High Court, which found that the Fisheries Act did not affect the exercise of customary rights. Although Maori agreed with the conservation functions of the new QMS they saw the allocation of quota as inconsistent with the Treaty and the section in the Fisheries Act protecting their rights (Te Puni Kokiri, 1993).

The High Court found that the QMS had been developed without taking into account Maori rights in fisheries and that it was possible that the system may breach these rights. Negotiations between Maori and the Crown culminated in a Deed of Settlement in 1992. The Deed did not, however, extinguish the right of Maori to have customary non-commercial claims considered.

The Deed of Settlement provided the basis for the Treaty of Waitangi (Fishery Claims) Settlement Act 1992. The Act provided for the full settlement of all Maori commercial fishing claims. It also provided a basis for non-commercial customary food gathering and the protection by Maori of places of customary food gathering importance. Taiapure provisions of the Fisheries Act 1983, and the maitaitai reserves of the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992, together seek to provide a Maori management role and to recognise Maori food gathering interests (Ministry of Agriculture and Fisheries, 1993).

Harvesting rights

Beyond transferability, the value of a tradeable right is influenced by its duration in years, the unit used to measure the right, and the scope for transforming the primary right into derivative forms. Quota rights are held in perpetuity, they are transferable, and can be transformed into derivative rights such as a lease. In law, quota rights are property and may be used as security.

A permit is necessary to commercially harvest fish controlled by the QMS. Foreign ownership of rights is prohibited. To be eligible for a permit, commercial fishers must hold quota, either owned or leased. Minimum quota holdings are: 3 t for rock lobster and shellfish in each quota management area (QMA); 5 t for southern scallops; and, 5 t for everything else in one or more QMAs. Aggregation limits apply to quota and range from: rock lobster 10% of any one QMA; to, deep water species — such as orange roughy — 45% of the combined orange roughy TACCs.

The Minister may set quota on any fishery outside the QMS and allocate the TACC as quota to specified commercial fishers, usually on the basis of previous catch history. The Treaty of Waitangi Fisheries Commission is allocated the first 20% of the TACC. Customary Maori fishing rights are recognised and traditional institutional structures are evolving to govern the exercise of customary rights. The right of amateurs to harvest fish is provided through regulations which specify daily bag limits; there is no upper bound on the total recreational harvest.

Species covered

It does not make economic sense to enclose all species within the QMS. Stock uncertainty, unproven profitability, and relatively high monitoring and enforcement costs, suggest that complete coverage is not necessary for efficiency. Initially, 27 species or groups of species were included within the QMS. In 1996, 32 species were controlled by the QMS. In addition to the annual commercial harvest, approximately 100 000 t of additional harvest is spread over some 50 non-ITQ species (Clement and Associates, 1995).

A permit is required to harvest non-ITQ species. Prior to 1992 there was an incentive to harvest non-ITQ stocks because catch history is used to establish initial allocations under the QMS. Government invited industry to consider a proposal to auction rights to species to be included within the QMS. Although an auction mechanism would solve the problem of fishing for quota it would result in existing operators bidding away some

of their return on asset-specific investments (Ackroyd and Hide, 1992). In 1992 government closed entry to non-ITQ fisheries in an attempt to limit fishing pressure.

By-catch

The possession of quota does not entitle fishers to target species without regard to other species they might take as by-catch. It is illegal to target species without an ACE. However, despite advances in technology, fishers exercising their legal rights can accidentally catch species not covered by their quota entitlements. Four options are available to those who accidentally exceed their entitlement: (1) the fish can be landed, directed to a specified processor, and the fisher receives no payment; (2) the fish are landed and the harvest is traded-off against holdings of other species; (3) additional quota necessary to cover the by-catch can be acquired, within a set period of time; or (4) pay a deemed value, based on port prices, which may be refunded if additional quota rights are acquired. The first two options are not frequently used. Of the remaining two options, use varies depending on relative profitability.

Geographic boundaries

Quota management area boundaries have economic and biological implications for management and industry. From a manager's perspective, spatial flexibility offers benefits in terms of being able to better manage fisheries where there are significant spatial and temporal variations in the stock. Spatial flexibility also provides fishers with an opportunity to hold a portfolio of rights — often, for a single species — across a number QMAs. Portfolio holdings reduce exposure to adverse TACC adjustments. Few changes have been made to the number of QMAs. The orange roughy case study illustrates how the Minister can specify separate TACCs for defined areas within a QMA. The benefits of further subdividing management areas do however need to be balanced against: the additional costs of producing rights to the TACC; the additional costs of monitoring, enforcement and quota trading; and, any efficiency losses associated with thinner quota markets.

Agency

At the time the tradeable rights were being introduced the new Labour government set about restructuring the public sector (Sharp, 1996). In 1987, fisheries activities within the Ministry of Agriculture and Fisheries (MAF) were restructured as a business group with primary functions of research, management and policy advice. In an annual contract, the Minister specifies a set of broad outcomes, and government provides the revenue to buy the outputs (Table 1). Revenue and expenditures outside this agreement, for example resource rentals and settlement of Maori claims, are handled separately.

Government was committed to resource rentals when the QMS was introduced. From the outset, government made it clear that it intended to increase resource rentals until the value of annual traded quota approached zero. Payment was based on ITQ holdings, regardless of whether fish were harvested. The rental varied across species and was not paid on quota held by government. The Minister had the right to vary — up to 20% increase — resource rentals each year. In setting the rental the Minister was required to have regard to the value of quota, the impact on net commercial returns, and relevant changes to TACC. Resource

Table 1. Output class expenditures 10^3, Ministry of Fisheries, 1991–1997

Outputs	1991	1992	1993	1994	1995	1996	1997
Policy advice	21136[a]	23285[a]	24215[a]	2065	3155	6300	9035
Stock assessment	–	–	–	20037	19189	b	b
Management	14222	13874	12655	11725	11117	9013[c]	8245[c]
Enforcement	10548	11921	10059	10803	11007	12387	13712
Prosecution	–	–	2257	2257	2521	1648	1907
Other[d]	2190	1876	539	588	755	1919	1437
TOTAL	48096	50956	49725	47475	47744	31367	34336

Source: Various MAF Reports to the House of Representatives.
[a]Includes fisheries research costs of $18–19 million.
[b]Stock assessment research administered by Ministry from 1996.
[c]Output class restructured in 1996 as Services.
[d]Includes contract management and other administration expenses.

rentals were to be paid into the Fisheries Fund which was to be used to finance management and research activities. The fund was never established, and rentals were paid into government's consolidated fund.

Resource rentals were one of the most contentious elements of government's fisheries policy. Industry vigorously opposed resource rentals. Even if tradeable rights create an economic surplus in the fishery, the problem of determining government's share of the surplus is not straightforward. Property legislation produces rents elsewhere in the economy and it is not clear why rents in the fishery should be singled out for taxation. Each year significant resources were allocated — by industry and government — to present convincing arguments, for and against, changes to resource rentals. Resource rentals contributed to commercial uncertainty in the fishery.

In 1994, a separate Ministry of Fisheries was created with the primary focus of utilisation of fishery resources while ensuring sustainability. Resource rentals were abolished, and the Fisheries Act was amended to enable government to recover the costs of management. Government continues to buy policy advice, and fisheries compliance services, from the Ministry. From 1997, the provision of research services — around $16 m annually — are now fully contestable by open tender. Quota owning companies are now beginning to contract directly with research providers. The Ministry is responsible for monitoring fisheries research.

Economic performance

In this section we present trends in industry profitability, the increase in harvest by domestic vessels, an export growth, to illustrate changes in productive efficiency.

Industry

The top three quota owning firms has increased slightly since 1991, from 52 to 56%. Concentration of ownership is greater in the deepwater fishery reflecting the capital needed to harvest deepwater species.

Table 2 shows how the structure of the domestic full-time fleet has changed relative to 1987. Full-time vessels are defined as those landing more than 7 t of finfish or 2 t of rock lobster during the fishing season. The structure of the domestic fleet reflects *inter alia* capital stock and opportunities for profit in the fishery. For example, the number of lining vessels — that seek to sell high-value species, such as snapper, in niche markets — has almost doubled. Vessels less than 12 m account for the largest

Table 2. Domestic full-time fleet

	1987	1990	1991	1992	1993	1994	1995
Danish seining	10	22	25	26	26	23	21
Dredging	124	113	117	115	110	99	120
Lining	146	193	189	195	215	214	249
Lobster potting	566	380	442	436	459	393	436
Purse seining	6	7	7	8	8	9	9
Set netting	212	225	211	194	212	206	268
Trawling (pair)	35	9	7	6	7	7	5
Trawling (single)	244	293	279	282	303	301	299
Troll/Polling	37	49	6	6	7	66	60
Other methods[a]	134	262	186	230	247	207	209
Total	1514	1553	1469	1498	1594	1525	1766

Source: New Zealand Fishing Industry Board (1996).
[a]Includes diving, hand gathering, traps, beach seining and ring nets.

Table 3. Industry full time equivalent employment 1990–95

	1990	1991	1992	1993	1994	1995
Catching sector	4425	4370	4540	4545	4600	4845
Processing	3560	3770	4190	4030	5140	5110
Total	7985	8140	8730	8575	9740	9955
Catching sector (%)	55	54	52	53	47	49
Within catching (%)						
Trawling	30	30	30	29	29	31
Static gear	48	46	44	44	39	37
Other	22	24	26	27	33	32
Total	100	100	100	100	100	100

Source: Statistics New Zealand.

proportion of the domestic fleet. By volume, most fish are landed by single trawlers. A wide range of harvesting and processing capacity exists within the trawler fleet. Some trawlers have the capacity to remain at sea for 45 days and fully process their harvest for export. During 1994–1995 the number of vessels over 30 m increased by about 10% reflecting a trend towards replacing foreign charter vessels with New Zealand owned vessels (New Zealand Fishing Industry Board, 1996).

Since 1990 total employment has grown. Although employment growth is evident in both harvesting and processing most of the growth has occurred in the processing sector (Table 3). This trend is consistent with the rights-based model, viz. rights provide an incentive to add value to harvest.

Data obtained from the Annual Enterprise Survey, yield some insights into the relative performance of activities within the fishing industry (Table 4). Trawling, which accounts for the largest share of the volume harvested in New Zealand's EEZ, has the lowest return on assets. Costs per full time equivalent (FTE) unit of labour are the highest, reflecting the relatively high capital intensity and operating costs. Potting, primarily rock lobster, is more labour intensive and operating costs per FTE are relatively low. This cost structure coupled with high unit revenue results in a relatively high return on assets. Processing is a large employer and posts a return on assets of 14.2%.

Production and export growth

Under the Law of the Sea Convention, sovereign nations may exclude foreign vessels only if they have the capacity to sustainably harvest the

stocks within its EEZ. Table 5 shows the foreign licensed fleet's share of total production has consistently fallen since 1986. This fleet, predominantly from Japan, only has a significant presence in the tuna fishery. However, charter vessels are still used by New Zealand companies. The share of annual harvest landed by domestic boats has increased from 37% in 1988 to 56% in 1995. The increase in landings by the domestic fleet is the result of investment in large deepwater vessels aimed at replacing charter effort. From 1990 the percentage of catch landed in New Zealand for further processing or distribution has increased. These trends in harvesting and processing are consistent with the growth in employment (Table 3).

Table 5 shows that the total value of production has increased. In 1986, five major species — orange roughy, squid, rock lobster, snapper and hoki — accounted for 88% of the exports by value. In 1986, the USA and Japan accounted for 40 and 35% of total export receipts, respectively. In 1991, industry posted a 23% increase in the volume which combined with a 4% increase in the average value of exports to result in the total value of exports increasing by 28% to $961m. Although the USA and Japan

Table 4. Within industry performance ($000) 1992

	Trawling	Potting[a]	Lining	Shell fish farming	Processing
Total Revenue	487 769	96 892	56 940	30 720	988 685
Total Costs	475 898	75 193	50 339	28 878	880 347
Profit[b]	15 346	25 183	8 184	3 485	110 924
Assets[c]	369 399	126 526	60 773	46 091	778 948
No. enterprises	230	406	445	189	127
FTE[d]	929	910	820	400	4810
Costs per FTE	512.2	82.6	61.4	72.2	183.0
Profit per FTE	16.5	27.6	10.0	8.7	23.1
Return on assets (%)	4.1	19.9	13.5	7.6	14.2

Source: Annual Business Directory, Statistics New Zealand.
[a]1993 data.
[b]Profit before salaries and wages paid to working proprietors, and tax.
[c]Book value.
[d]Full time equivalent.

Table 5. Economic performance 1986–1995

	1986	1987	1988	1989[a]	1990	1991	1992	1993	1994	1995
Production (t)										
Domestic	144 960	151 599	214 159		221 041	243 806	250 439	285 190	317 687	372 536
Charter	193 156	287 591	325 576		354 383	346 358	405 530	307 277	284 116	282 080
Foreign licensed	74 304	45 980	31 714		2 929	1 721	1 295	400	26	37
Total	412 420	485 170	571 449		578 353	591 885	657 264	592 867	601 829	654 653
Value of production										
Export										
Japan	222	281	336	331	280	290	409	347	351	329
USA	261	241	213	227	208	254	291	317	260	252
Australia	72	64	78	77	86	102	122	127	131	137
Other	101	90	96	159	175	315	396	409	427	520
Total ($ m f.o.b.)	657	676	722	794	749	961	1 218	1 199	1 169	1 238
Total value of exports	657	676	721	797	749	961	1 217	1 201	1 166	1 238
Domestic sales ($ m)	124	136	127	118	134	138	121	121	123	125
Total	781	812	848	915	883	1099	1 338	1 322	1 289	1 363

Source: New Zealand Fishing Industry Board.
[a]1989 production data not available.

remain New Zealand's main export markets, the value of exports to other countries such as Korea, Hong Kong, Singapore and Europe is increasing.

Case studies

Two case studies illustrate the operation of the QMS. Each highlights the processes used to set the TACC and the range of interests that converge on this key variable.

Orange roughy

Orange roughy is one of New Zealand's most valuable fisheries accounting for around 15–20% of the value of fisheries exports. The Chatham Islands Orange Roughy Fishery (ORH 3B) is one of eight orange roughy QMAs. Orange roughy are thought to be slow-growing, long-lived, fish. Recent estimates — which are highly uncertain — put the 1994 biomass (B_{94}) relative in that necessary to support MSY (B_{MSY}) at 0.45 (Francis, 1995).

Orange roughy is only harvested by commercial fishers, therefore the TACC equals the TAC. Table 6 shows the reported catches and TACCs from ORH 3B since 1982 when harvest was first controlled. A trawl survey in 1982 provided the basis for an increase in the 1984 TACC to 30 000 t where it remained until the QMS was introduced. In 1986 survey results suggested that the population was decreasing more rapidly than previously estimated. In 1987 the Ministry recommended a large reduction in the TACC to 17 340 t, about 45% of the previous season's TACC. The Ministry, after consultation with industry, proposed a quota-swap where industry agreed to give up 12 000 t of harvest from ORH 3B in exchange for an equivalent amount of orange roughy from neighbouring QMAs. In 1989, further scientific information prompted the Ministry to recommend reductions to the TACC. Stock uncertainty and the impact of sudden reductions on industry led the Ministry to recommend phased reductions. In August 1989, an agreement was reached to phase-in reductions over the next 4 years. The first reduction in 1989/90 was achieved by cancelling Crown quota. In 1990, new information led to further reductions, the TACC was reduced by 9000 to 23 787 t for the 1990/91 fishing year.

From 1992, the distribution of the catch within ORH 3B has been determined by a series of agreements negotiated between the Minister and industry. Table 6 also illustrates changes in the distribution of catch and

Table 6. Harvest, TACC and distribution of harvest within ORH 3B

Year	Catch (t)	TACC (t)	Nwest %	South %	Box %	East %	Other %
1982	28 200	23 000	28	2	67	3	0
1983	32 605	23 000	35	31	30	4	0
1984	32 535	30 000	13	21	61	6	0
1985	29 340	30 000	6	27	63	4	0
1986	30 075	29 865	12	18	56	13	0
1987	30 689	38 065	10	16	66	8	0
1988	24 214	38 065	7	28	56	10	0
1989	32 785	38 300	12	28	51	9	0
1990	31 669	32 787	10	35	51	3	1
1991	21 521	23 787	7	32	28	29	4
1992	23 269	23 787	1	9	4	52	34
1993	20 048	21 300	20	26	0	22	32
1994	16 960	21 300	21	30	0	29	20
1995	11 756	14 000	20	13	5	30	32

Source: Annala and Sullivan (1996).

the areas to which the negotiated limits apply. From 1982 to 1990 over 90% of the catch was taken from the Northwest, South and Spawning Box areas within ORH 3B. From 1991 the distribution of catch has shifted toward the East and non-Chatham sub-areas. In 1993, the Ministry and the fishing industry agreed to adopt a long-term management strategy that specified risk criteria against which catches of orange roughy could be evaluated.

The Minister's approach to exercising government's rights was challenged by Greenpeace New Zealand Inc. Greenpeace first expressed concern to the Parliamentary Commissioner for the Environment. Greenpeace then challenged the Minister's interpretation of the Fisheries Act 1983, the TACC level and the legality of phased reductions (Parliamentary Commissioner for the Environment, 1992). Legal opinion obtained by the Commissioner alleged that there were errors in the Minister's 1992 TACC-setting decision. In particular, the legal opinion claimed that the Minister did not have the right to adjust the TACC, relative to MSY, in stages over time. Greenpeace then initiated proceedings against the Minister of Fisheries, the New Zealand Fishing Industry Association, the Exploratory Fishing Company (ORH 3B) and the New Zealand Fishing Industry Board. The court found that the Minister may rely *inter alia* on economic and environmental factors in setting the TAC which may or may not move the fish stock toward the MSY but the TAC must not have the effect of preventing the attainment of the MSY over a reasonable period.

Snapper fishery

The snapper fishery is one of New Zealand's largest and most valuable coastal fisheries. There are six QMAs for snapper, area SNA1 is used in this case study. Snapper are a demersal fish occupying a wide range of habitats and are most abundant in the Hauraki Gulf, an area within SNA1. A relatively large, and growing, urban population lies in close proximity to SNA1. By the mid-1980s commercial catches had declined and the stock showed signs of overfishing (Sharp, 1997). The fishery had become more dependent on recruiting year classes as stock size decreased (Annala and Sullivan, 1996). Biomass estimates (B_{1996}: B_{MSY}) are in the order of 0.78. In contrast to the Orange Roughy, the TAC must be allocated between commercial fishers as TACC and non-commercial fishers as TANC.

Table 7 shows reported landings, the TACC and traded quota prices for SNA1. When the QMS was introduced in 1986 the TACC for SNA1 was set at 4 710 t which was 55% of the established catch history to allow for

Table 7. Landings, total allowable catch, and quota prices for SNA1

Year	Landings (t)	TACC (t)	Vol. ratio L : S (%)	Lease price ($)	Sale price ($)	Price ratio L : S (%)
1987	4016	4710	60.4	2237	13388	16.7
1988	5061	5098	194.1	1490	13657	10.9
1989	5793	5614	160.2	1692	16247	10.4
1990	5826	5981	74.5	1696	9420	18.0
1991	5315	6002	94.7	2349	20615	11.4
1992	6191	6010	241.9	3011	25523	11.8
1993	5423	4904	236.5	4133	42982	9.6
1994	4846	4928	441.9	3914	57227	6.8
1995	4831	4938	340.7	4696	60197	7.8

Source: Annala and Sullivan, (1996).

Table 8. Relative non-commercial harvest of snapper in SNA1

	Commercial catch (t)	Recreational catch (t)	Recreational catch %
1974	7 635	Unknown	
1984	7 141	1 600	22
1994	4 846	2 800	57

Source: Annala and Sullivan (1996).

stock rebuilding. Subsequent decisions by the Quota Appeal Authority saw the TACC increase to 6010 t in 1992. The TACC was exceeded by over 500 t in the 1993 fishing year. Some of this was the result of quota holders carrying forward up to 10% of underruns from previous years. Three observations can be made about the SNA1 quota market. First, the ratio of lease trades (L) to outright sales (S) suggests a reasonably well developed market for derivative rights. Second, the ratio of average lease-to-sale price has generally been declining since 1986. Interestingly, the 1992 L:S price ratio of 11.8% compares reasonably well against the 1992 13.5% return on assets for lining shown in Table 4. In other words, the ratio of lease-to-sale price may yield a useful summary indicator of profitability within the fishery, including industry's assessment of the stock's condition. Third, as suggested by our simple economic model, changes in the TACC appear to have an impact on sale price. We are currently undertaking more detailed econometric analysis of the SNA1 quota market.

Snapper is the most important fin-fish species sought by recreational fishers: It is also important to Maori. Table 8 shows the estimated growth in recreational harvest. Estimates of the recreational harvest range from 1600 t based on tagging programmes to 2850–3250 t derived from telephone and diary surveys. Expressed as a percentage of the TACC, the recreational harvest has increased from 22% in 1984 to 57% in 1994. Recreational fishers, including charter boat operators, are limited to nine snapper per head per day. Fish can be caught at any time in the year. A 1994 survey by the Recreational Fishers Council found that the average catch per day for each person is 1.9. The estimated 1996 recreational catch allowed for growth in recreational fishing effort arising from growth in population, improved fishing technology, changes in the biomass, and changes in the minimum size and daily bag limit.

The Minister's proposal to reduce the 1996 TACC by almost 40% to 3 000 t was prevented by an injunction granted to the fishing industry. Even if the TAC is consistent with B_{MSY} it is obvious that growth in non-commercial catch cannot be satisfactorily handled. In terms of Figure 1, the problem of intra-TAC allocation has yet to be solved. The pricing mechanism only operates within the market for rights to the TACC. Managers have no information on the relative value of SNA1 quota.

Contemporary challenges

We have identified reasons behind various changes to the QMS and it now remains to discuss future challenges.

Devolution and cost recovery

Rights-based fisheries management unleashes an incentive to form stakeholder organisations. Twenty-one organisations, many adopting

corporate structures, had been formed by 1997. Their individual charters vary, and may include quota management, stock assessment research, enhancement, and TACC negotiation. Current policy on research is based on devolution to stakeholders. It is now possible for stakeholder organisations to directly contract and fund biological research, subject to oversight by the Ministry.

As noted earlier, cost recovery was introduced in 1994 and applies only to the commercial fishery. The government pays the costs associated with non-commercial fishing and any joint costs shared by these two broad groups. Cost-recovery is based on the notion of avoidable cost, a principle that does not fit within the economist's model of efficient pricing. In operation, the mechanism has two major short-comings. First, as a monopoly provider, the Ministry does not face competition over the cost of service supply. Second, there is little, if any, scope for industry funders to balance the benefits of management against the costs.

Recreational harvest

Incorporating the interests of recreational fishers is one of the most vexatious issues facing fisheries policymakers. Recreational catch is regulated by bag limits, minimum fish length and mesh size, closed areas and other gear restrictions (Sutinen, 1996). Marine recreational harvesters number nearly 400 000; two-thirds live in the more populated northern region of New Zealand (Teirney et al., 1995). Attempts to quantify recreational harvest and to bring this source of fishing mortality under the ambit of the stock assessment process are a recent innovation. Table 9 lists the estimated recreational catch for some species alongside the commercial value that attaches to quota rights in perpetuity.

The snapper case study illustrates the problem. In 1995, the TAC was set at some 7800 t and allocated as: 4900 t to commercial harvesters; 2600 t to non-commercial fishers; and, 300 t to Maori customary harvest. Any move to limit catches with the long-run view of rebuilding stocks toward B_{MSY} must raise efficiency and equity issues in respect of the allocation between interests. Returning to Figure 1, the efficiency criterion suggests that maximum net-benefits in a fishery occurs when the marginal net benefit functions are equal. It is difficult to imagine a government agency achieving, or even approximating, this result. Decentralised decision making, within quota markets, offers an institutional vehicle which could be used to this end. This is a fundamental weakness and there have been suggestions to extend the QMS to recreationalists,

Table 9. Some estimates of recreational harvest 1995

Species	Commercial catch (t)	Recreation catch (t)	Average quota price[a] ($ per t)	Opportunity cost of recreational harvest ($ m)
Snapper SNA1	4 859	3 050	56 356	171.8
Rock lobster CRA2	240	135	175 212	23.6
Paua PAU2	125	80	83 899	6.7
Tarakihi TAR1	1 433	310	13 662	4.2
Gurnard GUR1	1 160	195	4 094	0.8
Trevally TRE1	1 162	255	6 647	1.7
Blue cod BCO8	250	135	3 783	0.5

Source: Teirney *et al.* (1995).
[a]Weighted average price for trade in perpetuity, year ending 1995.

configuring the non-commercial harvest as explicit quota (Pearse, 1991; Sutinen, 1996).

Other rights

Numerous interests intersect in the marine environment, especially in proximate coastal areas, and it should be no surprise that competition with respect to rights is keen in these areas. Relatively new structures of property rights have been introduced in the form of coastal policy, marine eserves, taiapure, and maitaitai fisheries. It is too early to predict their impact on the QMS. They may have the effect of excluding, to varying degrees, commercial fishing. From the quota holders point of view, spatial exclusion can impose costs and reduce profits. In some situations, a marine reserve would have little economic impact on those holding quota rights. However, this may not be the case if a marine reserve reduces the feasible fishing area for a prime inshore species. Similarly, exclusion from seamounts could reduce industry profitability. Particular care will be needed to balance the costs of attenuating commercial fishing rights against the benefits — information on commercial opportunity cost is signalled in the market, not so the benefits of customary rights, marine reserves, and local fisheries.

Conclusions

As an allocation mechanism, the QMS easily out-performs its predecessor (Sharp, 1997). Since 1986, components of the QMS have changed according to biological and economic conditions in the fishery. The QMS has successfully withstood litigation. Rights to the TACC are decided in the quota market. Tradeable rights provided government with an instrument for addressing Maori fishing rights. Tradeable quota have also provided a basis for new industry organisations to evolve. These developments should enhance the stability of the QMS. Commercial fishing within the New Zealand's EEZ is unsubsidised and based on the notion of sustainability. Economic performance relative to 1986 is impressive. It now remains to answer the three questions that were directed at the QMS.

First, it is highly likely that the mechanism is not economically efficient. To achieve economic efficiency, the mechanism must provide a basis for pricing all rights. Without information on non-commercial benefits it is not possible to arrive at a conclusion. This result is, of course, common to many environmental management problems.

The second question — concerning decentralised decision making — is answered at two levels. At the level of individual fisher, quota is privately owned and freely transferable up to individual aggregation limits. The mechanism is decentralised, rights to harvest are determined in the quota market, and price provides the incentive necessary for efficient use. However, the degree of decentralisation decreases at the level where the TACC is decided. As noted above, there are signs of innovative cooperative mechanisms developing. But it is the duty of the Minister of Fisheries to set the TACC and the TAC, benchmarked against MSY, at the beginning of each fishing year. Exercising this right is transparent and therefore contestable in a court of law.

The third question asked if the QMS captured the broad range of values associated with the harvesting and conservation of fisheries assets. It is along this dimension that rights-based fisheries management is most

exposed to the attenuating influences of politics which can threaten the stability of the mechanism. The snapper case study illustrates the economic, social and environmental problems that can arise when a quota market becomes politically contentious.

References

P Ackroyd and R Hide Establishing quota in non-QMS fisheries: problems with tendering', *Report to the New Zealand Fishing Industry Board*, December 1992.

J H Annala and K J Sullivan Stock assessments and yield estimates, *Report from the fishery assessment plenary*, April-May 1996; Ministry of Agriculture and Fisheries, Wellington, May 1996.

D P Boyle New Zealand Commercial Fisheries: The Fisherman's Guide to the Quota Management System 1993/94, Clement and Associates, Tauranga, 1993.

Clement and Associates, *New Zealand Commercial Fisheries: The Atlas of Area Codes and TACCs, 1995/1996*, Clement and Associates, Tauranga, 1995.

Fisheries Task Force, 'Sustainable fisheries/Tiakina nga Taonga a Tangaroa', *Report of the Fisheries Task Force to the Minister of Fisheries on the Review of Fisheries Legislation*, Ministry of Agriculture and Fisheries, Government of New Zealand, Wellington, 1992.

M P Francis, *et al*., *Assessment of the ORH3B Orange Roughy Fishery for the 1994/95 Year*, New Zealand Fisheries Research Document 95/4, 1995.

Ministry of Agriculture and Fisheries, Taitiaki o Kaimoaona, *Treaty of Waitangi* (*Fisheries Claims*) *Settlement Regulations*, Wellington, 1993.

New Zealand Fishing Industry Board. *The New Zealand Seafood Industry Economic Review*, Wellington, 1996.

Parliamentary Commissioner for the Environment, *Sustainable Management of the Chatham Rise Orange Roughy Fishery*, Office of the Parliamentary Commissioner for the Environment, Wellington, 1992.

P H Pearse 'Building on progress, Fisheries Policy Development in New Zealand', *A Report prepared for the Minister of Fisheries*, Wellington, 1991.

Sharp, B M H 'Natural Resource Reforms, In A Bollard, R Lattimore and B Silverstone, eds., *A Study of Reform*: *The Case of New Zealand*, North Holland, Amsterdam, 1996.

B M H Sharp 'From regulated access to transferable harvesting rights: lessons from New Zealand', *Marine Policy*, Vol 21, No 6, 1997, pp. 501–517.

J G Sutinen, 'Recreational entitlements: integrating recreational fisheries into New Zealand's quota management system', *A Report prepared for the Minister of Fisheries*, Government of New Zealand: Wellington, 1996.

Te Puni Kokiri, Ministry of Maori Development, *Customary Fisheries*, *Philosophy and Practices*, *Legislation and Change*, Wellington, 1993.

L Teirney, A Kilner, E Bradford, J Bell, R Millar *Marine Recreational Fisheries Working Group Draft Report*, May 1995.