EVALUATING THE NEW ZEALAND INDIVIDUAL TRANSFERABLE QUOTA MARKET FOR FISHERIES MANAGEMENT

Suzi Kerr Motu Economic and Public Policy Research Trust
Richard G Newell Resources for the Future
James N Sanchirico Resources for the Future
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Suzi Kerr (suzi.kerr@motu.org.nz) is Director and a Senior Fellow of Motu. Richard Newell (newell@rff.org) and James Sanchirico (Sanchirico@rff.org) are Fellows at Resources for the Future in Washington, DC and members of the Motu Affiliate Programme. The OECD funded this paper. Resources for the Future and the New Zealand Ministry of Fisheries funded previous work that this paper draws on heavily. Thank you to Gina Straker and Jo Hendy for research assistance. All opinions expressed are those of the authors.

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ABSTRACT

The New Zealand ITQ system is a dynamic institution that has had many refinements since its inception more than 15 years ago. Nonetheless, the basic tenets of the system - setting a total allowable catch and leaving the market to determine the most profitable allocation of fishing effort - have remained intact.

This paper assesses the New Zealand system to identify areas of success and/or possible improvement or expansion within it. The reasons for doing so are to highlight beneficial features and to identify features of the New Zealand ITQ system that are relevant to other potential tradable permit markets.

Beneficial features include simple standardized rules for quota definition and trading across species and areas; very few restrictions on quota trading and holding; relative stability in the rules over time; and low levels of government involvement in the trading process.

We find evidence that supports the assertion that fishers behave in a reasonably rational fashion and that the markets are relatively efficient. We do not find major changes in participation in these fisheries as a result of the system. We find evidence that suggests that the ITQ system is improving the profitability of fisheries in New Zealand. In general the evidence thus far suggests that the market is operating in a reasonably efficient manner and is providing significant economic gains.

These factors suggest that New Zealand would want to have non-economic justifications for any significant changes to the system.

1 INTRODUCTION

Inshore fisheries' depletion, the development of the quota-based program for offshore fisheries, and the general orientation of the New Zealand government in the 1980s toward deregulation, combined to create an atmosphere conducive to fundamental change in New Zealand fisheries management. After several years of consultation with industry, the Fisheries Amendment Act of 1986 was passed, creating New Zealand's individual transferable quota (ITQ) system. Several amendments to the original legislation have since been passed, but the basic structure of the system has remained intact.

The system has been evaluated many times since its inception. Most evaluations have been qualitative in nature, with the emphasis on identifying problems and improving the design of the regulations. The state of the fish stocks is reviewed regularly, though significant uncertainty remains. This report presents results from the first systematic assessment of the economic efficiency of the system. We assess only the likely efficiency of the ITQ market. We do not assess the environmental effects of the system, and hence cannot comment on the overall efficiency of the regulation. We begin by giving a brief description of the ITQ system. We then discuss our motivation and the institutional framework for the evaluation. We discuss our methodology and basic results, and then compare these with other evaluations of ITQ fisheries programs, and some other economic research on the New Zealand system.

2 OVERVIEW OF THE TRADABLE PERMIT REGIME

The environmental objective of the NZ ITQ system is primarily to ensure that catches are limited to levels that can be sustained in the long term. The total allowable catches are intended to be set to achieve Maximum Sustainable Yield (MSY). The ITQ system is part of a broader Quota Management System (QMS) that includes direct controls on fishing areas, techniques and seasons.

The basic objective of the new legislation and its associated set of regulations was to manage the fisheries as an economic resource in a sustainable and efficient way. The regulations were seen as a service to the fishing industry, and there was a strong push to ensure that the costs and risks of management were borne by the fishers who are the main beneficiaries of the system. Early on, the government planned to extract the rent from the industry on behalf of taxpayers in general, but although resource rentals continue to be

collected, they are not a major revenue source. In contrast to many international fisheries, regulators were not concerned about protecting small fishers or fishing communities. This had to be revisited with regard to Maori fishing rights but had important impacts on the design of the system.

Quotas are defined in terms of species and location. The ITQ system covered 33 species by 1998. The New Zealand EEZ is geographically delineated into quota management regions for each species, based on the location of major fish populations. In 1998, the total number of fishing quota markets stood at 157, with the number of markets per species ranging from one market for hoki (*Macruronus novaezelandiae*) to ten for paua (abalone). As of 1996, the species managed under the ITQ system accounted for more than 85% of the total commercial catch taken from New Zealand's EEZ.

Each year, the Minister of Fisheries sets an annual total allowable catch (TAC) for each fish stock based on a biological assessment as well as other relevant environmental, social, and economic factors. The process for setting these TACs involves scientists, the Ministry, industry, and environmental groups. The TACs are intended to be set with a goal of moving the fish population toward a level that will support the largest possible annual catch (that is, maximum sustainable yield) after an allowance has been made for recreational and other non-commercial fishing.

Individual quotas were initially allocated to fishermen as fixed annual tonnages in perpetuity, based on their average catch-level over two of the previous three years.[2] By denominating quotas as fixed tonnages, the government was counting on its ability to purchase quotas on the open market, if it wanted to reduce the total catch from a fishery. After several years of high costs and faced with the prospect of spending NZ$100 million to reduce TACs (Sissenwine and Mace 1992) for orange roughy alone, after prolonged negotiations the government switched from quota rights based on fixed tonnages, to denominating the quotas as a share of the TAC (beginning with the 1990 fishing year). In doing so, the burden of risk associated with uncertainty over future TAC levels was moved from the government to the industry. Most TACs have not been altered since this change, so for most fishers the effect has been potential, not actual.

Fishing quotas are generally tradable only within the same fish stock, and not across regions, species, or years, although there are some minor exceptions.[3] They are traded one for one. The quota rights can be broken up and sold in smaller quantities, and any amount may be leased and subleased. As of October 1, 2001, annual quota leases were supplanted by sales of "Annual Catch Entitlements" or ACEs. These are issued annually by the government and are equal to each quota owner's annual quota allocation. Thus there are now two quota instruments: the ACE, and the right to the perpetual stream of ACEs. There is no centralized trading platform. The government initially created one, but bilateral trading and brokers quickly replaced it.[4] High levels of trade (see later) suggest that transaction costs are relatively low, and the introduction of ACE aims to reduce the legal costs of trading even further.

There are legislative limits on aggregation for particular stocks and regions, and limitations on foreign quota holdings.[5] No pre-trade approval is required. All trades must be reported to the Ministry before the buyer can use the quota. Harvested fish must be matched against quota when they are sold to a licensed fish receiver. Compliance and enforcement are undertaken through a detailed set of reporting procedures that track the flow of fish from a vessel to a licensed fish receiver (on land) through to export records, along with an at-sea surveillance program that includes military aircraft and on-board observers (Boyd and Dewees 1992).[6] Misreporting is a criminal offence.

[2] Since 1996 if a new ITQ fishery can support a TAC greater than the fishers' histories returned (plus 20% for Maori), the government can auction the excess quota by competitive or closed tender.

[3] Given the uncertainty around quantity and composition of catch, additional flexibility was introduced into the system in four ways (Clement & Associates 1997). First, a by-catch trade-off exemption allows fishermen who incidentally take non target fish to offset the catch by using quota from a predetermined list of target species. Second, quota owners can carry forward to or borrow from the next year up to 10% of their quota; this right does not apply to leases. A third option is to enter into a non-monetary agreement to fish against another's quota. Finally, a fisherman can surrender the catch to the government or pay a "deemed value," which is set based on the nominal port price to discourage discarding of catch at sea and targeting stocks without sufficient quota (Annala 1996).

[4] The electronic system was closed in 1988 due to insufficient volume (Dewees 1996:339).

[5] Initially, the aggregation limits were on *holding* quota. Substantial changes were written into the 1996 Fisheries Act, one of which was changing the limits on holdings to *ownership* levels. The 1996 legislation also relaxed the aggregation limits for particular species and region combinations.

[6] In a survey of fishermen operating under the New Zealand ITQ system in 1987, Dewees (1998) found that 40% thought enforcement and 66% thought highgrading were potential problems with an ITQ management system. Highgrading is the practice of maximizing the quality of the catch to be counted against one's quota by dumping less valuable fish over board. These numbers dropped to 21% and 25% respectively in 1995 (Dewees 1998).

The New Zealand system has a large number of participants, averaging more than 1,500 over the history of the program, with more than 1,400 in 1998. The scope of the system ensured that the markets had the potential for liquidity. Although many small players were excluded when the system was initially created, a healthy number remained in every important market. Individual markets have had a median of 45 quota owners.

Up to 1998, the number of participants in the offshore fishery had been barely affected by the ITQ system, partly because the offshore fishery already had a quota system before 1986, and partly because those involved were large players. The number of participants in the inshore fishery has gradually declined since 1986. This could indicate consolidation of quota ownership. (The number of owners of shellfish stocks rose in 1990 primarily because of the addition of new stocks to the system.) The Treaty of Waitangi Fisheries Commission is currently the sole representative of Maori collective quota owners (by 2002 they held more than one third of all quotas). The Commission manages the quotas on behalf of all Maori. When these quotas are allocated to individual iwi (tribes) in the near future, the number of participants will rise further.

The New Zealand ITQ system is a dynamic institution that has had many refinements since its inception more than 15 years ago. Nonetheless, the basic tenets of the system - setting a total allowable catch and leaving the market to determine the most profitable allocation of fishing effort - have remained intact.

3 CONTEXT OF EVALUATION

3.1 Motivations

Our motivations for the study discussed here and our ongoing research are three-fold. First, we are assessing the New Zealand system to identify areas of success and/or possible improvement or expansion within the New Zealand system. Such evidence can help protect the strong features of the system against pressure for change, and offer evidence in support of beneficial changes.

Second, and perhaps more important, we are seeking to provide evidence that is useful for other countries considering using individual tradable quota systems. We have been particularly motivated by the intense debate in the United States where some systems have

been created (and even evaluated; Grafton et al 2000), but where there is also fierce opposition to the more widespread implementation of ITQ systems.

Finally, we are motivated by the ability to provide evidence understanding tradable permit markets more broadly. The New Zealand ITQ system has some features that are relevant to other potential tradable permit markets.

3.1.1 ITQ markets and other tradable permit markets

The spatial specificity of fisheries markets is analogous to non-uniformly-distributed pollutants (e.g. ground-level ozone). The existence of some very thin markets and high degrees of vertical integration are relevant for situations where there are concerns about market power. The joint harvesting process, where several species are caught simultaneously, is similar to the multi-pollutant problem where one source produces several pollutants simultaneously. In both cases, the need to balance a portfolio of quota across species (pollutants) and locations creates complexity that potentially raises transaction costs. These interrelationships also create difficulties, and additional opportunities, for evaluation, which we have not yet addressed. Quota prices of interrelated species should also be interrelated. Both production interrelationships and ecological relationships (e.g. predator-prey) also make evaluation of the environmental implications of the program more complex.

The ITQ system is only a partial solution to the fisheries management problem. Localized 'hot spots' with local over-exploitation can occur for species like shellfish or lobster, as the timing of harvesting is critical with regard to breeding cycles. This is similar to problems with situations where a pollutant can be highly toxic if it is emitted in large concentrations or in the wrong place (e.g. near a school). This is partially addressed through separate regulations on fishing seasons, closed areas and marine reserves that directly avoid 'hot spots'. Using separate controls, rather than trying to achieve this aim through limitations on trade, keeps the ITQ system simple and 'clean'. Some also argue that greater concentration of quota ownership would provide a greater incentive for fishers to internalize local environmental effects, because each owner would feel they had a direct stake in the future value of the resource.

In response to fiscal risk to the government, the NZ ITQ system defines quotas as shares of a shifting cap. This approach is relevant to quota systems where the government bears some fiscal risk (e.g. where some allowances are auctioned, or where the government

needs to buy back allowances to reduce the cap). The different risk-sharing characteristics of this approach might be particularly relevant for design of a greenhouse gas market, where the scale of the market might have significant fiscal and even macroeconomic effects.[7] The NZ fisheries case provides extremely rich information from which to explore these issues. We have only begun to tap it. Assessments of specific tradable permit systems can be more valuable if they can be designed to yield results of general interest beyond the immediate system and even beyond the specific issue. This is especially true given the limited opportunities for empirical evaluation.

3.2 Institutional framework

To date our analysis has been done in two stages. Resources for the Future and Motu funded the first stage out of internal funds. During this phase we negotiated a confidentiality agreement with the Ministry of Fisheries to provide us with access to some of their confidential data, for which we paid relatively low extraction costs. The Ministry provided us with considerable indirect support through access to staff. It was relatively easy for us to get the information we needed, even as independent researchers, partly because of the constructive attitude of the Ministry; partly because of the excellent reputation of Resources for the Future and the individual researchers; and partly because New Zealand is very small.

The fact that the Ministry of Fisheries did not initially fund us made it easier for us to gain the confidence of both industry actors and the environmental community. Again, RFF's reputation for objectivity and independence was helpful. It also helped that the issues we chose to study were the least contentious (at least in New Zealand) because they were not directly associated with ongoing policy reform. Finally, the policy itself is widely perceived to be a success and most of the players involved are quite proud of it. This made them very supportive of research that could rigorously show the value of the program.

We now receive some funding from the Ministry of Fisheries. This is a process with relatively loose oversight. We have the right to publish our findings regardless of the outcome and we maintain our independence. Our closer relationship has enhanced our access to data, and we no longer pay even nominal sums for data. Our research methods and findings are open to public and academic review. All our research is available as working

[7] For more discussion of this issue see Kerr (2003).

papers published on our website. We have presented our research at a large number of conferences and seminars throughout the United States and in New Zealand. We are committed to making some of our data available for other researchers after we have published our results. This situation will still subject to confidentiality requirements, so that most data requests will still need to be referred to the Ministry of Fisheries.

4 DESCRIPTION OF ASSESSMENT METHODOLOGY

Our evaluation framework is based in economics. To date a large part of our work has involved documenting the history of the program (Straker et al 2002) and developing and "cleaning" the databases that can be used for empirical evaluation. We are now beginning to analyze those data. Newell et al (2002) combine descriptive statistics motivated by economic hypotheses, with econometric work on the determinants of quota prices. A data appendix that describes our current data in some detail is also included.

Our empirical work is focused on assessing the economic efficiency of the quota market. We do not consider the overall efficiency of the program, including environmental gains. We assess economic efficiency indirectly by testing whether we observe patterns we would expect to see in an efficient market. This avoids the need for a baseline, but clearly has the limitation that we cannot give absolute numbers for the economic gains relative to the baseline.

The design of the New Zealand system facilitated our evaluation in some ways. A key element was the relative simplicity of the system. The rules are simple, consistent across species and areas, and have changed little over the history of the program. This makes it relatively easy to model optimal fisher behavior when faced with these rules, and reduces idiosyncratic features of the data. The stability of the rules allows us to look for time-series effects, without worrying significantly about regime shifts.

The administrative requirements of the system have resulted in a comprehensive database of ownership and trades. Although these data had not previously been used for research (except at an aggregate level) they were available in consistent computerized format. The reporting system also requires the price of each trade. Many people have claimed that prices that are voluntarily reported in tradable permit markets are unreliable. To a certain extent we found this to be true; there were many trades with a price of either $1 or very high

prices (e.g. including a boat in the trade). We were able to clean up the data however and produce useful, robust results.

Using information obtained from New Zealand government agencies and other sources, we assembled a comprehensive panel database of information on the New Zealand individual transferable quota (ITQ) system over the period 1986–1999. The data include information on the name of each fish stock; quota transactions (i.e. prices and quantities of quota leases and sales); the export prices of fish species covered by the ITQ system; quota ownership; the total allowable commercial catch (TAC) and actual catch for each fish stock; biological information on fish species; climatic variation and interest rates.

5 MAIN RESULTS

5.1 Do the market conditions support efficiency?

All results discussed in this and the next section are presented in much more detail in Newell et al (2002). As discussed earlier, the number of participants in most markets suggests that the markets are potentially very liquid. Transaction costs appear to be low and the markets are very active. The quota sale markets were most active in years when quotas were allocated with a high of 3,250 trades in 1986. This likely reflects rationalization of quota portfolios. The 1990 sales peak partly reflects adjustment to new allocations of shellfish quota, but also reflects allocation of quota to Maori, and possibly some response to the redefinition of quota as shares. In recent years around 4% of quota are sold each year in the median market. The lease market has developed considerably, from only 2,000 trades in 1986, up to 14,500 by 1998. In the median market, the percentage of quota leased has risen consistently to about 40% annually. Some markets are relatively inactive, but they tend to be economically unimportant. This high level of participation and activity suggests that the markets might be operating well.

The degree of price dispersion also suggests that these markets operate well. We measure price dispersion as the mean absolute percentage price difference between individual trade prices and the monthly mean price for that stock. We find that price dispersion is lower for sale prices than leases, which one would expect given that leases have quality differences for which we cannot control, such as agreements to provide the caught fish to the lease owners. We also find that dispersion falls over time, which is consistent with a period of

market learning and development. The dispersion appears to be in a range compatible with many other products and tradable permit systems that are typically thought to have well-functioning markets, although direct comparisons are difficult. Further work is exploring this issue in more detail.

5.2 Do quota prices reflect fundamentals?

A one-year quota lease should be worth the expected annual profit from one tonne of fish, or the difference between the price of fish and the marginal cost of catching fish. Simply mapping either lease or sale prices against fish export prices, we find a strong relationship between the two. This however does not control for the cost of catching fish, or for whether the TAC is actually binding (if it is never binding, the quota price might be expected to be close to zero as there is no scarcity).

We use a reduced form approach to relate export prices, and factors that affect costs, to lease prices.[8] We find that we can explain around 95% of the variation in lease prices over time. Export prices have a strong positive relationship with quota prices. Higher fishing costs are associated with lower quota lease prices. Higher quota demand (more binding TACs) pushes quota prices up. Greater ecological uncertainty (measured in terms of weather variability and natural mortality rate of the species, which implies more catch and hence cost uncertainty) lowers the value of quota. Prices also rise when the economy is doing well in general.

Finally, after controlling for all other factors, we find an upward trend in quota prices in general. One of the justifications for a quota system is that it will improve the efficiency of the fishing industry and hence its profitability. This should lead to higher quota prices. This effect will be most marked where stocks were being over-fished, but are now more sustainable because of the regulation. In the New Zealand system some stocks were initially over-fished while others were at sustainable levels. All of these might have been over-fished if the system had not been introduced, but we expect the initially over-fished stocks to benefit most. We observe a significantly higher quota price trend for stocks that had their catch

[8] We use Feasible Generalised Least Squares, with and without fixed effects for each fish stock, to econometrically estimate the relationships across all time periods and species.

levels cut when they were introduced to the ITQ system. This suggests growing fishing profitability as a result of rebuilding stocks.

The price to buy a quota in perpetuity should be the discounted value of future profits, i.e. the sale price should be the lease price divided by the discount or interest rate. If fishers expect lease prices to rise or fall, the current sale price would also incorporate these expectations. The sale price should then be roughly equal to the lease price divided by the discount rate minus the lease price growth rate.

Empirically, the sale prices respond to fundamentals in a similar way to lease prices. One notable difference is that the effects of transitory factors, fishing cost changes and short-term ecological uncertainty (from weather variability) are lower as we would expect. We find that the implicit discount rate inferred by the relationship between sale and lease prices is broadly consistent with the level and trend in real interest rates in New Zealand in this period. Our results do not suggest that fishers, or at least owners of quota, have unusually high discount rates. We might also expect that sale prices would incorporate uncertainty about the expected length of the regulatory program, and about the security of the property rights. After issues with Maori quota, and the issue of moving from tonnage to percentages of TACC were resolved, the value of quota might be expected to rise. These effects cannot be easily distinguished in the time series.

Overall the evidence suggests a reasonable level of economic sophistication, implying that market-based quota systems are potentially cost-effective instruments for fisheries management. Anecdotal evidence (and some studies, see below) suggests that the industry structure, technology used, behavior and product quality have changed substantially since the system was initiated. Many of these changes might have occurred in the absence of the ITQ program, particularly with the more general economic reforms in New Zealand. Because the ITQ system was introduced before over-fishing was a problem for many stocks, the distortions created by command and control regulation in many countries are not as much of a feature of the New Zealand industry. These distortions may well have arisen if the fishery had been regulated by command and control during its rapid development phase, but assessing this would require a complex counterfactual.

6 COMPARISON OF RESULTS

6.1 Comparison with other assessments of the NZ ITQ

Many evaluations of the NZ ITQ system have been qualitative in nature, supported by a few descriptive statistics. Pearse (1991) offers the first key report with his independent review of the state of New Zealand's fisheries management five years after the introduction of the QMS. However he and most other early reviews concentrate on direct analysis of the regulations and anecdotal opinion. Straker et al (2001) give a more complete list of studies relating to the New Zealand system. Here we focus on studies relating to economic efficiency.

Several studies have addressed the efficiency effects of the move to the QMS with varying degrees of empirical analysis. Dewees (1989), who carries out extensive industry surveys, finds that fishers were changing behavior in response to the ITQ system. In particular they were changing on-board methods for handling individual fish that could then be sold to lucrative markets in Japan. Sissenwine and Mace (1992) also give some concrete indications of economic change including consolidation of quota ownership, and changes in fishing practices to maximize the market value of catch. Annala (1996) confirms both of these. For example Annala states that the catch for hoki (Macruronus novaezelandiae) is now spread across the year, rather than concentrated in the spawning ground during the spawning season, with small catches per tow.

Batstone and Sharp (1999) provide some evidence on overall economic performance. They show that fishing employment has grown overall since the ITQ system was introduced. They show that profit levels in 1992 range from a 4.1 to a 19.9 per cent return on assets across fishing activities. They also show that the total value of the catch has risen considerably between 1986 and 1995. They are unable to compare to previous trends or an estimated counterfactual.

Four studies use more detailed empirical analysis. Using two years of data on quota sale and lease prices from the New Zealand ITQ system, Lindner et al. (1992) attempt to measure economic rents, but conclude that a more thorough analysis of the determinants of quota prices is needed to properly assess market performance and rents. Akroyd et al (1999) consider the time-series relationships in lease and sale prices for two species, snapper and

orange roughy.[9] They suggest that quota price information could be used to inform TAC setting but their conclusions are mostly based on theory not derived from empirical evidence. Batstone and Sharp (2000) analyze the effects of market power on lease prices in the snapper fishery and find that some large players have the power to affect the prices they pay or receive when trading quota.

Connor (2000 and 2001a) present valuable analysis of the changes in quota holdings concentration and fleet (vessel) capacity since the introduction of the QMS in New Zealand. He finds that the major changes in the fishing industry were in ownership of quota rather than ownership of the fishing fleet. He concludes that in New Zealand, the main gains in efficiency were in processing; export marketing; security of supply; and synergies between inshore and expanding offshore operations; rather than in improvements in harvest efficiency.

6.2 Comparisons with other international evaluations

ITQ systems are now used in many countries. Wallis (1999) summarizes some of the systems and evaluations of those systems. Here we simply focus on a few papers that have done detailed empirical analyses similar to ours.

One significant previous empirical study of the efficiency of a similar market is Grafton et al (2000) who studied the Canadian Individual Vessel Quota (IVQ) system for Halibut in British Columbia. They use firm level data on costs, earnings, equipment (gear used and vessel size), and fish landings, for 107 vessels each observed at one of three points in time, 1988, 1991 or 1994. They compare actual efficiency to an estimate of 'best practice' efficiency. They conclude that benefits may take a few years to materialize and can be critically compromised by restrictions on the property right and its transferability. They emphasize the importance of pre-existing regulations and the bundling of property rights. They also find that benefits arise from changes in the quality and price received for fish as well as reductions in cost.

Their approach is quite different from ours. They benefit from detailed vessel-specific data while we benefit from a much broader dataset with many species, stocks and years as well as a much simpler regulatory system.

[9] As cited in Clarke et al (2001).

Casey et al (1995) show that in the same IVQ system the timing of fishing changed from being highly concentrated in two months and with the product sold frozen, to being spread across the season and largely sold in the higher-value fresh market. They find significant revenue gains relative to the counterfactual of US halibut fishers. On the whole their study is more qualitative and uses only one year (two separate surveys in 1993 and 1994) of survey data.

Connor and Alden (2001) explore some proxies for efficiency in the South East Trawl Fishery of Australia. They find high levels of activity in the leasing market, but low levels of sales. They also find that the number of participants rises over time. They find levels of quota concentration similar to those in New Zealand.[10] They also explore how unused quotas are distributed across fishers. They have no price data.

6.3 Other issues: environmental and social effects

6.3.1 Environmental effects

We analyze only the efficiency of the market, or the cost-effectiveness of the ITQ system. We do not judge its environmental efficacy. However well a market works, the regulation is not efficient unless it achieves its primary goal. In the New Zealand case it seems highly likely that the environmental outcome is better than it would have been without the ITQ system. Available evidence indicates that the biological health of the fish populations within the ITQ system is almost never worse off,[11] in some cases shows clear signs of recovery, and in other cases is likely to be improving given current TAC levels (Annala et al 2000).[12] Even if these estimates were based on excellent data, however, they are not sufficient to say that the fish stocks and TACs are at efficient levels. That would require data and modeling that is beyond the resources of the New Zealand researchers. Partly because of the scientific uncertainty about sustainable TAC levels, the process of setting TACs is a negotiated one. This raises the risk that industry may effectively resist TAC reductions even

[10] We are exploring concentration in the New Zealand market in other research.

[11] One exception is for some geographically specific stocks of Orange Roughy. There are 8 different QMA for orange roughy, stock ORH3B is divided into 6 sub regions, and both ORH2A and ORH1 are divided into 2 subregions (Clement, 2002). A zero catch limit was set for the Puysegur sub-region of ORH3B in 1997/98 (MFish 2001b). ORH10 now has effectively a zero catch limit, of 10 tonnes.

[12] There are, however, some important caveats. First, for over half of the fish stocks, sufficient data to measure changes in fish populations over the course of the program do not exist. Second, the duration of the program is

when they would be environmentally justified. It is an ongoing challenge to maintain balance. Anecdotal evidence suggests that industry pressure to increase or at least maintain TACs has reduced somewhat as the system has matured and fishers are becoming more committed to the long-term sustainability of their stocks.

TAC levels are only environmentally effective if they are monitored and enforced. In New Zealand, the extensive formal enforcement system is complemented by a certain amount of self-monitoring within companies that want to avoid legal action and by other fishers using the same ports and fishing grounds. Despite this, some enforcement problems remain. These are more pronounced in species such as Paua (abalone), which has very high value, where fishing requires little equipment or skill and can be done from many parts of the coastline.

Setting the correct TAC and enforcing it is necessary for environmental sustainability but is not sufficient. Many other environmental issues are directly addressed through regulations on seasons, closed areas, and fishing technology. The ITQ system actually creates other concerns but might also offer a partial solution.

When the quota system limits total catch, fishers have an incentive to increase the value of that catch by 'high grading' or discarding low value fish and low margin species even if the discards would not survive. This can be partly addressed through the use of on-board inspectors. However the bycatch ratios on inspected versus uninspected boats appear to be somewhat different, so discards are probably not avoided altogether.[13] Inspectors may also be 'captured' by the fishermen or simply deceived by them.

Quota systems can also encourage increased catch in non-quota species, thus simply moving the environmental problem from one species to another. This apparently did occur to a certain extent in New Zealand but the problem is limited by the very wide scope of the system. As new species become commercially significant, and therefore under threat of over-exploitation, they are added to the quota system.

too short to assess whether measures taken to improve fish stocks with very long lifespans (e.g., orange roughy) are succeeding.

[13] In the deep-water trawl fisheries, vessels carrying observers have reported larger quantities of non-target QMS species than vessels fishing in the same area that do not carry observers, indicating that discarding has occurred. (Annala 1996).

It is possible that the changes in fleet composition and fishing techniques induced by the quota system could have negative (or positive) environmental impacts. The effects would depend on how behavior changes and to what extent the environment is protected by separate regulations. This would need more exploration.

Finally, it is likely that the quota system enhances incentives and opportunities for internalizing the complex externalities involved in exactly how fish are harvested. By changing the fishery from an open-access resource to having limited-access rights (through the TAC and individual allocation), the group which needs to cooperate on optimal management is limited and clearly defined. In at least one case - the Challenger Scallop fishery - this has led to local cooperation and voluntary controls that go beyond the government regulation. Greater concentration in the fisheries could make incentives to cooperate even stronger, though concentration may also have negative economic and social implications.

6.3.2 Social implications

Protecting artisanal fishers and fishing communities was not an objective during the creation of the New Zealand system. In part this reflected the general liberalization of the New Zealand economy at that time. Artisanal fishers also did not have an effective lobby group. Small and part-time fishers were excluded from the system from the beginning by being denied fishing permits. This made the system more manageable administratively.

Some smaller fishers who did receive allocations may still have been a little disadvantaged by the likely greater variability in their catch history (and, anecdotally, a tendency to under-report catch for tax reasons). There were years of litigation over the initial allocations. Smaller fishers might also have suffered more from the initial adjustment period as the rules were established and monitoring systems were made more user-friendly.

Our analysis thus far shows that there has been net exit of ITQ owners under the ITQ program, but there are still very many small fisherman active in the industry and new owners do enter. While it appears that exit is oriented more toward smaller owners (as efficiency would suggest is likely to be the case), we have not yet investigated this thoroughly. Also, it is unclear to what degree any consolidation is due to the ITQ program or to other forces. Yandle and Dewees (2000) find some evidence that, at least in the Auckland area, quota

owners and companies are more positive and optimistic about the benefits of the quota system than small fishers and those who lease quota.

Many of the smaller, part-time and artisanal fishers were Maori (indigenous New Zealanders). Their initial exclusion from the fisheries, combined with wider Treaty of Waitangi concerns about who actually 'owned' the fishery, led to a prolonged negotiation with government over Maori fishing rights. This issue has been addressed in two ways: allocation of quota to Maori, and establishment of customary fishing rights to provide iwi (tribes) with access to and control over their local fishing resources.

Maori now own more than one third of all quota. The Treaty of Waitangi Fisheries Commission (Te Ohu Kai Moana) currently holds these quotas on behalf of all Maori. Negotiations among Maori about their ultimate allocation to individual iwi are ongoing. The final decisions are not yet made, but it seems likely that sales of quota from Maori to non-Maori will be restricted to ensure that Maori ownership levels are maintained. Maori are able to use their quota in the same way as anyone else including leasing it to non-Maori. They are not required to fish using customary methods.

Customary catch refers to the traditional Maori right to harvest and gather seafood. Customary fishing regulations, introduced in the Fisheries Act 1996 govern non-commercial customary fishing only, and the harvest cannot be traded. Traditional customary fishing areas are those of special significance to *iwi* (tribe) or *hapu* (sub-tribe) as a source of food or for spiritual or cultural reasons. Provision for management of customary areas was first recognized by the Maori Fisheries Act (1989), and then re-affirmed by the 1996 Fisheries Act. *Taiapure* (local coastal or estuarine fisheries) can be formally declared by lodging a proposal to the Crown.

Iwi or trust groups can establish (through the Crown) *mahinga maitaitai* in larger areas important to customary food gathering. Commercial fishing is generally excluded from these areas.[14] The *maitaitai* is managed by a Tangata Kiaki/Kaitiaki (in the South Island), a Tangata Kaitiaki/Tiaki (in the North Island): *iwi* representatives nominated by the *tangata*

[14] To date only two maitaitai have been established: Koukourarata, December 2000 (for management of Banks Peninsula cockle beds); and Rapaki Maitaitai, December 1998 (Lyttelton Harbour). These maitaitai were established under the Fisheries (South Island Customary Fishing) Regulations (1999) (Ministry of Fisheries (2001e).

whenua (local Maori) and appointed by the Minister. They authorize customary and/or commercial fishing within their *maitaitai*, but are under no obligation to do so if the proposal is inconsistent with the *tikanga* (protocol and practices) of that area.

7 POTENTIAL IMPLICATIONS FOR POLICY REFORM

Overall our results confirm those of earlier studies. We find evidence that supports the assertion that fishers behave in a reasonably rational fashion and that the markets are relatively efficient. We do not find major changes in participation in these fisheries as a result of the system. We find evidence that suggests that the ITQ system is improving the profitability of fisheries in New Zealand. These factors suggest that New Zealand would want to have non-economic justifications for any significant changes to the system. It also suggests that countries considering adopting an ITQ system might not only be optimistic about the potential economic gains, but may also want to imitate some of the features of the New Zealand system that are likely have led to market efficiency. These features include simple standardized rules for quota definition and trading across species and areas; very few restrictions on quota trading and –holding; relative stability in the rules over time; and low levels of government involvement in the trading process.

To date, our study is very incomplete. We will be able to study many more detailed issues with our rich data: bycatch; changes in timing and quality of product; causes and effects of concentration of quota, among other things. Our evidence thus far suggests that the market is operating in a reasonably efficient manner and is providing significant economic gains. We need to explore the finer details of the market operation more closely to assess efficiency more fully.

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