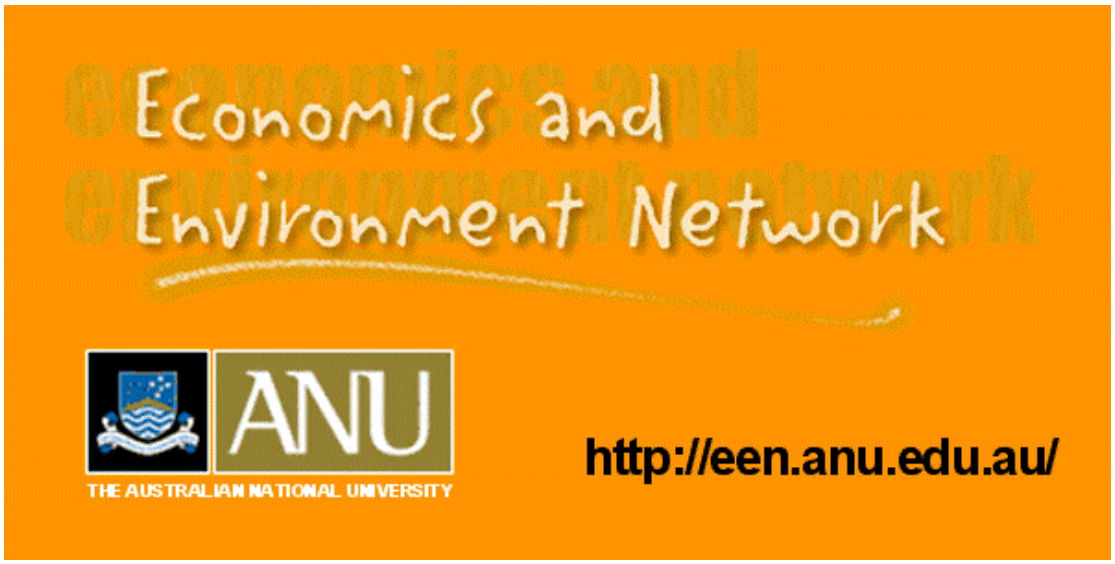

How to Resolve the Class II Common Property Problem? The Case of British Columbia's Multi-Species Groundfish Trawl Fishery

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Australian National University
Economics and Environment Network Working Paper
EEN0506

4 August 2005

How to Resolve the Class II Common Property Problem? The Case of British Columbia's Multi-Species Groundfish Trawl Fishery

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ABSTRACT

It is 20 years since Munro and Scott identified the causes and possible remedies for the dissipation of rents in fisheries. We analyse one of the solutions proposed by Munro and Scott by using insights from the British Columbia multi-species groundfish trawl fishery that has used ITQs since 1997. The history of this fishery shows that even the most difficult management problems including by-catch, equity concerns, concentration of quota holdings and vessel overages can be mitigated with the appropriate mix of incentives, monitoring and enforcement.

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~: the authors are grateful for helpful comments and suggestions provided by two anonymous referees and also Trond Bjørndal.

Revised February 2005

The market sends out incorrect signals to the participants in the fishery. Input controls constitute an attempt to address the problem by making it difficult for participants to respond to incorrect market signals. Output controls, on the other hand, change the market signals themselves.

G.R. Munro and A.D. Scott (1985, p 661)

1. Introduction

In what is now a classic in the fisheries economics literature, Munro and Scott (1985) divided the economic problems of fisheries into class I problems, where the absence of regulation results in dissipation of rent, and class II problems where authorities set a total allowable catch (TAC), but fail to prevent crowding and the race to fish that result in rent dissipation. After reviewing the outcomes of fisheries regulations, especially in Canada, their insight was to suggest the use of individual transferable quotas (ITQs) that they foresaw would both change the incentives of fishers and help prevent rent dissipation.

In the 20 years since their work, ITQs have been applied in a large number of fisheries in several different countries, including Canada (Kaufmann *et al.* 1999), New Zealand and Iceland (Hannesson 2004). Despite the apparent success of ITQs in delivering substantial economic benefits (Fox *et al.* 2003; Grafton 1996; Grafton *et al.* 2000; Shotton 2001; Weninger 1997) these advantages have largely been identified in so-called 'single-species' fisheries, where fishers are able to target particularly species of fish. What is less clear is whether the difficulties and complexities of managing multi-species fisheries (Holland and Maguire 2003) mean that ITQs can not be adopted for such fisheries (Boyce 1996) with similar success.

One of the perceived problems associated with multispecies fisheries includes discarding at sea (Anderson 1994; Arnason 1994; Boyce 1996). Although this problem also exists even in the absence of ITQs, quota systems can also induce discarding at sea (Copes 1986; Turner 1997). Indeed, even in so-called single species fisheries this problem exists, although the regulatory system simply ignores the issue by excluding bycatch and discards from the management regime. Perhaps more problematic is that *if* fishers have a jointness-in-inputs technology (Kohli 1983), such that they have no ability to separately target species, their catch mix may not match their quota allocation. A limited ability to target individual species could also contribute to undesirable quota underages and overages, and may severely constrain economic returns if total harvests are limited to protect vulnerable species, or lead to unsustainable harvesting of some stocks if managers ignore the bycatch or discarding

issues (Squires *et al.* 1998). Although some types of technology or gear, such as longlines, provide greater flexibility in catching individual species than other types of gear, such as trawls (Squires and Kirkley 1991), all fishers can to some extent adjust their fishing behaviour to increase their ability to target fish.

Using insights from the British Columbia (BC) groundfish trawl fishery, managed by ITQs since 1997, we show that with the appropriate incentives fisher behaviour can be modified to meet the twin goals of sustainability and economic efficiency. We also argue that an ITQ system can be effectively implemented in a multi-species fishery that includes over 55 distinct quotas while also addressing the discarding issue, equity issues and improving economic returns and sustainability. The experience of the BC groundfish trawl fishery demonstrates that the common property problem can be overcome if the incentives can be changed. The approach adopted in this fishery has been to change the incentives that, in turn, modify fisher behaviour. The end result has been a transformation from a 'race to the fish' mentality towards one oriented towards reducing costs, maximising value, and improving management.

The implications for multi-species fisheries management are significant. If the basic management approaches used in the BC groundfish trawl industry can be effectively applied elsewhere they have the potential to both mitigate sustainability challenges and raise resource rent. More generally, we argue that the lessons learned apply to single-species fisheries as well, and that the issue of discards and bycatches should be incorporated into the management regime to improve both the sustainability as well as the economic performance of the fishery.

The chapter is divided as follows. First, a description of the BC groundfish trawl fishery and the management regime in place prior to the introduction of the ITQs in 1997 is provided. This is followed with a detailed discussion of the current ITQ system and how the management program has helped to develop the 'right' incentives for promoting sustainability and enhanced economic benefits from fishing. The experiences of this fishery show that ITQs have contributed to conservation objectives, led to substantially improved profitability, and improved the collection of scientific information to help regulate the fishery. Several unique features of the ITQ system designed to address concerns over concentration of quota ownership and the associated distributional effects on processors, coastal communities, and crewmembers are also reviewed.

2. The BC Groundfish Trawl Fishery

To understand what the incentive approach to fisheries management has achieved in the Groundfish Trawl Fishery (GTF) we first review the major features of the fishery and its history.

Background

The GTF is the largest wild fishery in terms of both the value and total catch in British Columbia (Gislason 2004) that lands about 100,000 metric tonnes of fish per year worth some CDN$ 60-70 million (see Table 1). The harvest consists of dozens of different species caught exclusively off the BC Coast. Important species in terms of catch are rockfish, hake, Pacific cod, thornyheads, sole and lingcod (halibut are excluded as they fall under a separate licensed fishery). In terms of volume, the single largest species caught is hake that accounts for about twice as much in terms of landed weight than the catch of all other species combined. However, its price of 7 to 10 cents per pound is much less than the average 50-60 cents per pound received for other species. Other fish harvested by the trawl fleet also include sablefish, dogfish, turbot, skate, flounder and other groundfish. Management is also complicated by the fact that many species caught in the fishery have location–specific populations although some, such as sablefish and hake, can be harvested over the entire BC Coast.[1]

Fish are caught in trawl nets that may extend as much as 1500 metres behind the vessel. Depending upon the species, fishers may harvest along the ocean floor for many rockfish and other groundfish, while hake, pollock, and some rockfish species (i.e., greenies and brownies) are targeted with mid-water trawls. All species can be harvested year round, although there can be seasonal variations as well as annual fluctuations in relative abundance.

The large number of species that can be caught poses various difficulties for the industry. First, there is the complexity inherent in determining stock sizes and abundance for dozens of species. Second, the challenge exists to reconcile, within an ITQ system, the actual catches to initial fisher allocations plus net trades. Third, the problem of ensuring stocks are protected from unreported discarding, while at the same time allowing fishers to harvest up to the sustainable catch levels.

Historical Development of the Fishery

A commercial groundfish trawl fishery has existed in BC for over 60 years. In the early 1960s the fishery consisted of 80 trawlers, of which about half were operated on a full-time basis. In the mid-1960s foreign fleets arrived in BC waters, initially targeting Pacific Ocean Perch, and then hake. By the early 1970s, the catch of foreign fleets was significantly higher than the Canadian harvest for a number of key species. In 1977 Canada extended its fisheries jurisdiction to 200 miles, and since then foreign fishing has been phased out.

In 1960 a key report was released on the state of BC fisheries that recommended the use of vessel licensing to help prevent the further expansion of fishing effort (Sinclair 1960). In 1969 limited entry licensing was implemented in the commercial salmon fishery. In 1976 limited licensing was introduced into the GTF in the form of groundfish trawl *T* licenses. *T* licenses were allocated to 142 vessels that were allowed harvest multiple species, and permitted fishers to catch groundfish anywhere along the Canadian west coast. The licenses also created categories of prohibited species (halibut, salmon and herring) that fishers were not allowed to keep, as well as permitted species. A limited entry *L* license (by hook & line gear) for halibut was implemented in 1979 followed by limited entry *K* licenses (by hook & line and trap gear) in 1981 for sablefish. The groundfish trawl fleet was allocated 8.75% of the annual sablefish TAC. During the late 1970s the fishing fleet experienced a significant expansion due to favourable tax treatment and price subsidies designed to replace the effort formerly undertaken by foreign vessels in Canada's exclusive economic zone.

Despite the significant increase in landings in the 1970s, low prices, persistent unprofitability, and a significant amount of idle capacity characterised the GTF. The proposed remedy was given in a 1982 Royal Commission Report that recommended that 10 year quotas be established for groundfish species, individually where they were targeted separately, and issued by zone, with temporary permits issued on a year-to-year basis to handle fluctuations in stock abundance (Pearse 1982, 130-132). Unfortunately, none of the recommendations were implemented, and the groundfish trawl fleet continued to expand its harvesting capacity and overall harvest levels as

[1] For example, there are five distinct stocks of Pacific Ocean perch fished; one on the lower West Coast of Vancouver Island and another on the Upper West Coast, Hecate Strait, the West Coast of Queen Charlottes and Queen Charlotte Sound.

predicted by Munro and Scott in their description of the class II common property problem.

Prior to the establishment of ITQs in the fishery in 1997, the TACs for individual species in the fishery were specified for the whole of BC by adding individual sub-stock TACs together. The annual species TACs were also divided into four quarters, corresponding to a 12-month fishing season. Within the overall season were monthly fishing periods, and vessels could choose different fishing options (2, 4 or 15 trips per month) with vessel trip limits for each species. The trip limits were calculated by estimating fishing effort for the quarter and were reduced accordingly as the total landed catch approached the quarterly TAC. The trip limit was also related to the fishing option chosen by fishers such that more trips per month option had smaller trip limits. These individual trip allocations were non-transferable. Indeed, the incentives for misreporting and discarding were magnified by the fact there were individual species limits and, thus, fishers were obliged to curtail their trip if they exceeded just one of their individual limits out of the many species harvested on a trip. As trip limits were reduced, the problems of misreporting and discarding worsened.

In addition to trip limits and TACs on individual species, each fisher also faced various vessel and gear restrictions that included regulations on vessel size, gear and the ability to combine multiple *T* licenses on one vessel. Fishers were also required to maintain daily fishing logs recording their catch, and the regulator introduced 100% monitoring of all landed catch by independent dockside monitors.

Despite these controls harvests consistently exceeded coast-wide TACs for a number of species in the 1990s, and fisheries managers increasingly had to specify shorter trip limits in order to control effort. As fishing trip duration declined, the ability of fishers to modify their fishing operations to avoid reaching individual species limits diminished, magnifying the incentive to discard overages and bycatch. In addition to the impact on the sustainability of some stocks, the costs of fishing were also rising and increased the 'race to fish'. Moreover, the landed value of fish declined because of reduced quality and because an increased proportion of fish were sold as a frozen product due to the ever shortening fishing season.

The key difficulty faced by fishery managers was how to manage the stocks in the absence of reliable information on stock specific harvesting at sea and the level of discarding (Walters and Bonfil 1998). One of the principal problems identified at the time was that stocks could not be managed on a stock specific basis as reporting by fishers had little or no credibility. Moreover, there was no ability to assess whether or

not harvests were being taken out of a specific area, potentially endangering vulnerable sub-stocks. Given the lack of information, there was also much uncertainty over stock assessments, and in response to this uncertainty, fishery managers increasingly took a precautionary approach to management by setting lower TACs in the belief that the current TACs were likely to be exceeded. By 1995, the official catch exceeded the coastwide TACs for several species. As a result, fishery managers took the unprecedented action of closing the entire GTF in September 1995. [2]

The groundfish trawl fishery reopened in February of 1996 with 100% at-sea observer coverage.[3] This addressed the concerns of stock specific management and discarding as fisheries managers now had, for the first time, a reliable means of quantifying discards and identifying where the fish were coming from, reducing the main sources of uncertainty in managing within TACs. The fishery could now be managed on a stock specific basis rather than on a coast-wide basis.

3. Establishment of ITQs in the BC Groundfish Trawl Fishery

To address the economic problems of the fishery, fishers agreed to implement what was initially a trial of ITQs in April 1997. As part of the negotiations over allocation of quota that included a range of interests (crew, shoreworkers, processors, fishing communities and licence holders) only 80% of the species TACs were allocated to *T* licence holders. The remaining 20% was placed under the purview of a newly created non-profit society called the Groundfish Development Authority (GDA) charged with promoting regional development, market and employment objectives, sustainable fishing practices and fair and safe treatment of fishing crews.

Allocation and Transferability

[2] It should be noted that other high profile fisheries in Canada, most noticeably the East Coast cod fishery and the West Coast salmon fishery, had recently run into highly publicised problems with low returns and in fact, the Fraser River sockeye salmon run (the most important in the province) had been shut down in August, only a month earlier.

[3] Some fisheries have only partial observer at sea coverage, such as halibut, sablefish, schedule II fisheries and a localised in-shore fishery within the trawl fishery (Option B fishery).

The TACs were first divided between trawl and hook and line gear for rockfish, lingcod, and dogfish. The allocation of ITQ within the TACs for trawlers was then made on the basis of catch history and vessel length. All groundfish were converted into groundfish equivalents (GFEs) in order to make different species comparable.[4] Trawlers then received proportionate shares across all species and stock combinations.[5] This resulted in 55 different ITQ allocations all expressed as a percentage of the respective stock TAC (Department of Fisheries and Oceans 2004).

Under the ITQ rules, vessels are permitted to fish up to their allocation (which can also include carryover from the previous year) of a species within an area for stock specific allocations. If they exceed their allocation for the area they will not be permitted to continue fishing unless additional ITQs for that species are transferred onto the vessel to cover the overage. If the species in question is delineated as a coast-wide ITQ then the vessel is not permitted to bottom trawl anywhere and for any species until enough quota for the species in question is transferred to cover the overage.

Individual vessels are also permitted to retain fish caught in excess of their allocation and apply it to their next year's ITQ, although there are annual overage limits. They may also carry over underages into the next year. However, this underage expires at the end of the next year, and thus cannot be accumulated. The maximum underage and overage is 37.5% for all groundfish species other than hake and halibut for which the limit is 15%. There are also overall individual species cap set (between 4 and 10%) and a total holdings cap set limiting the amount of quota (based on groundfish equivalents) any vessel owner can accumulate in a particular species or in general on the vessel.[6]

Fishers also have individual halibut bycatch quotas even though they are not permitted to retain halibut. There is an overall mortality bycatch cap assigned to the fishery of one million lbs for which each individual vessel owner receives a proportionate share. This is freely transferable although no license holder can accumulate more than 4% of the total and, as is the case for individual species

[4] Pacific Ocean Perch (POP) was used to establish the baseline (so the price of POP is set to equal 1.0).
[5] Hake were excluded, but followed the same principles although the weighting-70% history for catch and 30% for vessel length was the same (although it was for hake vessels only).
[6] The total holding cap is determined using groundfish equivalents to compare different stock-species allocations.

allocations, fishers cannot continue fishing bottom trawl when they have exceeded their cap until they acquire more. In addition to the halibut bycatch, fish discarded at sea that are considered marketable are deducted from each vessel allocation, while non-marketable fish are recorded, but not counted against the ITQ. Mortality rates for fish caught and discarded are calculated based on the species and other factors, such as towing time.

There is an active market in transferring quota with over 2700 trades made among 70 boats annually. The transferability rules are determined on an ongoing basis and are reviewed every three years. The main concern addressed in designing the transferability rules has been the prevention of concentration of quota and an expressed desire to see quota stay on 'active' vessels. Quota can only be transferred between licensed trawl vessels. While quota is freely transferable, there are restrictions on how much can be transferred between vessels because of limits on how much can be accumulated on any one boat due to the individual species caps and total holdings limit.

The current rules require that 25% of the ITQ be 'locked' on to the vessel for three years (2004-2006) unless permanently transferred off, while 75% of the ITQ is freely transferable on a temporary basis within the year (this quota returns to the vessel owner at the start on the next fishing season). Each vessel license is allowed 2 one-way permanent transfers of locked on ITQ during a 3-year period. As is the case for total holdings cap, this is measured using groundfish equivalents to make different species quotas comparable.

Addressing distributional concerns

In addition to quota concentration, there were also concerns expressed about the impact of quota trading on both crew members and those communities that were either home ports to fishers or had processing facilities. These concerns were addressed through the development of the Code of Conduct Quota (CCQ) and the Groundfish Development Quota (GDQ).

The CCQ consists of the 10% of each TAC that is automatically allocated to individual trawl licensed vessels based on the ITQ allocation formula, provided the Groundfish Development Authority (GDA) has not been advised that a specific vessel receive less than their full CCQ allocation. The CCQ is designed to shelter crewmembers from unfairly absorbing any of the costs associated with the

introduction of the ITQ system and to limit, to some extent, the ability of vessel owners to reduce crew size. In addition, licence owners of vessels are required to satisfy 'safe vessel' criteria to prevent changes in crew size or maintenance due to ITQs that might compromise the safety of the vessel. Any crew member who feels that their rights have been violated can complain to the GDA, but to date there have been no complaints filed. The lack of complaints, however, may be partially explained by the fact that crew members who report a vessel owner will also suffer financially as the total allocation for the vessel will be reduced by 10%, thereby reducing their crew share.

The GDQ has also 10% of each groundfish trawl TAC allocated by the Groundfish Development Authority (GDA) based on proposals jointly prepared by processors and trawl licensed vessel owners. The GDA administers both the CCQ and GDQ. The GDA was the compromise negotiated in response to requests by processors, unions and coastal communities for direct ITQ allocations. Its Board of Directors is drawn from those stakeholder groups, but vessel owners active in the fishery are excluded. There is also a steering group that provides information and expertise to the board made up of processors, vessel owners, a government representative, and a First Nations representative

The GDQ is allocated based on the amount of ITQ fish in the proposal, processor production history, and the rating of the proposal. Criteria used for evaluation include market stabilisation, maintenance of existing processing capacity, employment stabilisation, benefits to local communities, increasing the value of groundfish production, job-training and sustainable fishing practice.

Financial Responsibilities & Rent Capture

The shift towards the ITQ system has also seen a change in the roles and obligations of industry and government. Overall direct costs to industry of managing the fishery are approximately $CDN 4 million annually (this excludes government expenditures on management, enforcement and science), or about 6% of the total landed value of fish harvested in the GTF. The government currently picks up one-third of the cost of data management with the industry paying two-thirds of the cost. The expense of maintaining on-board observers at sea, approximately CDN$300/day, is paid for by vessel owners. The annual cost of at-sea and dockside monitoring is approximately CDN$3 million while annual industry-funded science activities cost CDN$800,000, and GDA expenses are CDN$80,000 per year. The federal government also collects

license fees worth, in total, some CDN$800,000 annually while prior to ITQs the government annually collected CDN$1,420 in license fees (DFO 2004).

4. Economic and Sustainability Effects of ITQs

The potential economic benefits of ITQs include fresh fish year round, increased values, less loss of gear, lower quota overage and bycatch discards, and increased safety at sea (Dupont and Grafton 2001). Offsetting these benefits are increased management and enforcement costs and distributional concerns around the reduction in crew sizes. In their study of the Alaska sablefish fishery in which ITQs were introduced, Sigler and Lunson (2001) found that the fishing season lengthened and that catching efficiency improved. As well, selective fishing techniques were introduced, reducing bottom damage, and there was a reduction in catching of smaller immature fish and related discards.

As yet, there has not been a detailed economic assessment of the impact of ITQs on the BC groundfish trawl fishery. The available evidence, however, points to both improved profitability and changed fishing patterns and effort. Prior to the introduction of ITQs there were 142 limited entry licenses of which 115 to 135 boats would be active, depending upon the year. After the introduction of the ITQs, there still remain 142 *T* license holders, but there are now only about 60-70 boats operating. Both the very small boats (under 50 feet) and larger boats have exited the fishery. The smaller boats exited because of the cost of an observer at sea meant smaller-scale fishing was no longer profitable, while the larger boats exited because they had been designed for larger volumes and longer trips, but were not as profitable operating with smaller volumes taken over a long period of time.

The most significant change with the advent of ITQs has been in terms of fisher behaviour. This has manifested itself in several different ways. First, under the earlier regime, in order to maximise their catch fishers were forced to fish in all areas. This occurred because there was no incentive to individually withhold effort from an area given the possibility of the area TAC being reached and then closed to fishing. Thus harvesters would try to fish every area to ensure that they gained some catch before the limit was reached. Under the ITQ system, however, fishers have chosen to specialise both in regions and species. Figure 1 illustrates the significant reduction in nominal effort (total hours fished at sea) that has taken place since the introduction of the quota. There has also been the development of customised ‘shopping lists’, based

on market demand, and fishers have been making shorter trips to improve the quality of the fish.

Sustainability

One of the most important changes in terms of sustainability has been the change in fishing practices. Prior to the ITQ system, there was no reliable data on discards. Under the new management system the presence of on-board monitors, introduced independently of ITQs, ensures that discards are reliably estimated. As a result, stock assessments and the setting of TACs can be made with much more accurate data.

In addition to improved information, mortality rates on quota species are also assessed on fish released at sea that are considered marketable, and these count against the quota owned or leased by fishers. As a result fishers now face an economic disincentive to discard catch, and economic incentives to minimise bycatch and avoid ITQ overages. Fishers have several alternatives when they do exceed their limits — they can purchase quota, borrow from their quota next year, or shut down, but all of these cost money that provide an economic signal to avoid catching unwanted species. This policy of counting discards against quota allocations has given fishers the impetus to be much more selective in their fishing practices. For example, many fishers no longer target Pacific Ocean perch, sablefish, silvergray, and canary rockfish as such species are caught incidentally when targeting other species. Consequently, fishers reserve their fishing effort and quota for preferred species that can be targeted effectively.

Table 2 shows discard ratios for selected species that are the at-sea releases (both marketable and unmarketable) divided by the landed weight. For all five species shown, this ratio drops as fishers have learned over time to fish more selectively. In some cases the drop in at-sea releases to retained catch is dramatic such as for spiny dogfish where discards as a proportion of the retained catch were in 2003/04 about 5% of what they were in 1997/98. This change is *not* because of the observer monitoring at sea as full monitoring began in 1996, but is a direct result of adjustments by fishers as to when, where, and for how long they trawl so as to ensure that bycatches of non-targeted species do not prevent them from fishing. However, the at-sea monitoring is critical to ensure that the proper economic incentives are in place.

In addition to helping the sustainability of the groundfish species that fall within the GTF management system, changed fishing practices in response to economic incentives, have also reduced the annual bycatch mortality for halibut to about 15% of

it previous level, dropping from around 900 MT to a little over 100 MT since the introduction of ITQs.[7]

Fishers have been able to more selectively harvest in several different ways. First, there is greater communication between vessels advising each other not to fish in certain areas where there is a high incidence of unwanted species.[8] Second, fishers have changed their behaviour, using shorter tows and more frequent checking of the net, as well as test tows to see what they encounter before actually fishing. Third, fishers have also invested in technology (electronic equipment that allows them to vary the net opening while trawling) as well as net mensuration gear (remote sensors that transmit what is being caught and how much is in the net). Finally, harvesters are experimenting with their gear (nets, bridles, footropes, headropes, lengthening pieces, doors, and codends) to improve selectivity.

The better information generated by the industry in terms of discard mortality also provides for improved stock assessments that, in turn, feed backs into better management. For example, the BC longspine thornyhead quota was initially established at an unsustainable level because of insufficient information regarding the status of the fish stocks. Since the introduction of ITQs, however, managers have been able to work closely with industry to collect improved information that has allowed managers to redo their stock assessments and reduce the TAC to sustainable levels. Indeed, the ability to use better information to improve the management is one of the most important outcomes of the ITQ system, and is recognised as such by fishers (Haigh and Shute 2003).

Economic Outcomes

The introduction of ITQs into the fishery has allowed more profitable fishers to purchase quota from less profitable operators. This has led to a consolidation in quota holdings and catches per vessel as shown in Table 3 along with about a 50% reduction in 'active' fishing vessels.

[7] We note here, however, that despite the presence of another market for halibut quota, that this halibut is discarded, forgoing potential revenues, suggesting that there is still room for improvement in terms of integrating the two quota systems.
[8] This information sharing also appears in other fisheries (Platteau and Seki 2002). It is interesting to speculate to what extent such co-operation emerges in response to changes in incentives from moving to different management regimes.

In addition to a change in the overall number of vessels, the composition of the fleet has also changed with the smallest and largest vessels exiting and greater specialisation for remaining vessels in terms of their use of mid or bottom trawls, harvesting in deep or shallow water, landing fresh versus frozen fish, and choice of fishing locales.

Greater specialisation and quota consolidation has led to improved economic outcomes for vessels within the fleet. These benefits are manifested in a number of ways, such as increased output prices, because fish is now landed over a much longer period of time and in better quality or form (fresh rather than frozen). Figure 2 shows the significant difference in trends between landed values and volumes after the introduction of quota, with overall fleet revenues increasing despite the reduced harvest. The market has recognised these increased returns with a doubling in the average lease price for quota and in quota values over the period 1997/98 to 2003/2004, as shown in Table 4. These increases have come despite a fully funded at-sea and dockside monitoring program and increased license fees. In addition, the 10% set aside of the TACs each for Code of Conduct Quota and Groundfish Development Quota has allowed some of the benefits of ITQs to accrue to crew, some of whom own quota, as well as processors.

5. Concluding Remarks

It is some twenty years since Munro and Scott identified the key factors in successful fisheries management as the market signals and incentives faced by fishers. Their insight has been adopted and applied in a wide range of fisheries with the use of individual output controls.

Using the experiences of the British Columbia groundfish trawl fishery — a multispecies fishery with 55 separate quotas — it is clear that the 'incentive principle' of Munro and Scott can help address some of the most vexatious problems in fisheries management: discarding at sea, overages of bycatch species, and how to obtain reliable catch information for stock assessment purposes. By creating a quota for bycatch, even though the species have no or little market value, fisheries managers did give them an economic value. Fishers have then responded to the economic incentives that were created. Under an effective monitoring system, they have adjusted their behaviour as to when, where and how they use their fishing gear to mitigate the discard problem. As a result, the fishery is much better managed than prior to the introduction of individual harvesting rights. Equally as important,

transferability of individual quota has allowed more profitable operators to increase their share of the total catch. It has also allowed for greater specialisation by fishers that has contributed to a doubling in quota values since the introduction of incentive-based management in 1997.

The key lesson from the experiences of the British Columbia groundfish trawl fishery is to adaptively manage fisheries and set incentives such that fisher behaviour matches the goals required for a profitable and sustainable industry. The experiences of the British Columbia groundfish trawl fishery show that the insights of Munro and Scott regarding incentive-based management, implemented with adequate monitoring and operational tools, provides a powerful combination to help resolve the class II common property problem and the challenges of multi-species fisheries management.

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Table 1: Quantity (thousands of tonnes) and Value of Landings (nominal values in Canadian dollars) in the British Columbia Trawl Fishery 1993-2002

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Landings (000 MT)	122.6	164.6	121.3	138.0	129.3	129.5	124.0	58.3	92.9	98.1
Landed Value (CDN$ millions)	42	50	45	42	48	57	62	58	57	66

Source: G. S. Gislason & Associates

Table 2: Proportion of At-Sea Releases to Retained Catch for TAC Managed Species in the BC Groundfish Trawl Fishery, Selected Species for years 1997-2004

	Year						
Species	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04
Pacific Ocean Perch	0.028	0.024	0.016	0.010	0.008	0.007	0.012
Yellowmouth	0.008	0.008	0.003	0.003	0.003	0.002	0.002
Redstripe Rockfish	0.316	0.342	0.206	0.122	0.113	0.097	0.132
Shortspine Thornyheads	0.065	0.062	0.049	0.049	0.043	0.042	0.030
Spiny Dogfish	0.46	0.123	0.30	0.09	0.044	0.034	0.025

N.B.:
The 2003/2004 data only includes reports up to February 3, 2004.

Table 3: Landings Per Vessel, Selected Years 1994-2000

Landings per Vessel (lbs)	1994	1998	2000
> 1 million	53%	68%	82%
0.5-1.0 million	36%	21%	13%
< 0.5 million	11%	11%	5%

Table 4: Lease and Quota Prices in British Columbia Trawl Fishery

Year	**Lease Price** (CDN$ per lb)	**Quota Price** (CDN$ per lb)
1997/98	$0.10	$1.50
1998/99	$0.12	$1.50
1999/2000	$0.14	$1.75
2000/2001	$0.20	$2.00
2001/2002	$0.18-0.20	$2.00-$2.50
2002/2003	$.20	n.a.
2003/2004	$.20	$3.00

N.B.:
n.a = not available

Figure 1. Groundfish harvest (000 tonnes) and Effort (thousand hours) in the BC Groundfish Trawl Fishery 1980-2002.

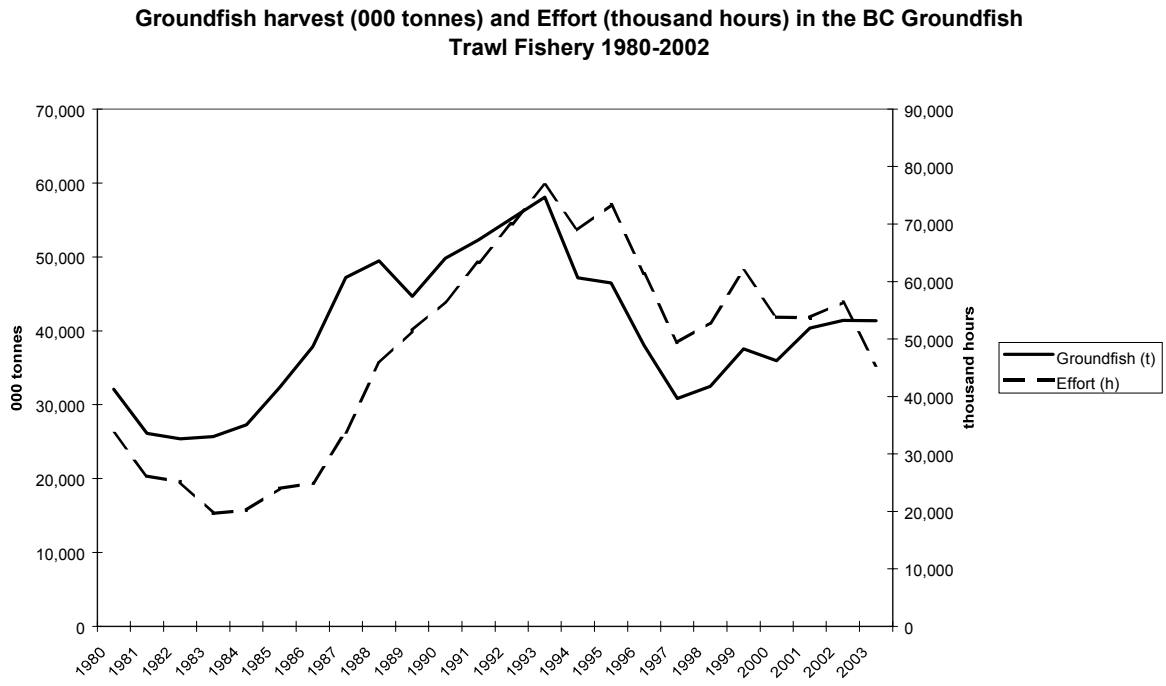

Figure 2. Groundfish Harvest (tonnes) by the Trawl Fishery and Landed Value (Nominal CDN$ millions), 1993-2002