

The Icelandic Individual Transferable Quota System: A Descriptive Account

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Abstract *This paper provides a brief description of the evolution and current structure of the individual quota system (IQ) in the Icelandic fisheries. This particular fisheries management system was introduced at different times in different fisheries—in the herring fisheries in 1976, in the capelin fishery in 1980 and the demersal fisheries in 1984. Since 1990 all Icelandic fisheries have been subject to a uniform system of individual transferable quotas (ITQs).*

The paper discusses the social and economic impetus for the initial adoption of the ITQ fisheries system in the various fisheries, sketches its subsequent development and describes the key elements of the current system. Assessments of the economic impact of the ITQ system are presented in the last part of the paper. Although a definitive study of this impact is not available, the various indicators presented generally indicate an improvement, sometimes substantial one, in the economic efficiency of the fisheries in question.

Keywords Individual transferable quotas, fishery management, economic impact and performance.

Introduction

One of the most interesting proposals for improved fisheries management generated by fisheries economics is the institution of individual transferable quotas (ITQs). Within the framework of simplified analytical models it is possible to show that an appropriately designed ITQ system is capable of producing full economic rents from fisheries.¹ These analytical models, however, represent at best an approximation to the economics of actual fisheries. In addition, they generally ignore the social environment in which the fisheries operate. It is therefore of great scientific as well as practical importance to study the socio-economic conditions that allow the actual introduction of an ITQ system and to monitor the subsequent course of fisheries.

This paper considers the ITQ system in the Icelandic fisheries. It describes the origin, evolution and the current structure of the system and presents indicators of its economic impact. The paper is organized roughly as follows: The first section contains a background description of the Icelandic fisheries. The origin and evolution of the ITQ fisheries management system is outlined in the second section. The structure of the current ITQ system is described in the third section. Finally, in the fourth section, the economic performance of the ITQ system to date is assessed.

¹ See e.g. Arnason 1990.

The Icelandic Fisheries: A Descriptive Background

The most important Icelandic fishery by far is the demersal or groundfish fishery. In recent years this fishery has usually generated between 75% and 80% of the total value of the catches. The most important demersal species are cod, haddock, redfish and saithe. Pelagic fisheries based exclusively on capelin and herring are also important, usually yielding 10–15% of the total catch value. In addition to demersal and pelagic fisheries, there are significant shrimp, lobster and scallop fisheries. A more detailed numerical description of these fisheries and their relative importance is provided in Table 1.

The fishing fleet consists of several vessel types. It is convenient, however, to decompose the fleet into four main classes:

1. Deep-sea Trawlers:

These are relatively large fishing vessels usually between 200 and 1200 GRT (gross registered tonnes) and 130 and 250 feet in length. They are engaged almost exclusively in the demersal fisheries employing bottom and occasionally mid-water

Table 1
Icelandic Fisheries: Catch and Value Data

	Average Catch 1981–90 (1000 MT)	Estimated Catch Values* (M.USD)	Estimated MSY (1000 MT)	Estimated MSY Values* (M.USD)
Demersal species				
Cod	356.0	367.8	400.0	412.7
Haddock	55.6	79.9	60.0	86.3
Saithe	68.3	41.8	85.0	52.0
Redfish	98.1	96.9	90.0	88.9
Other**	92.3	102.0	75.0	82.9
Total	670.3	688.4	710.0	722.8
Pelagic species				
Herring	67.6	10.4	110.0	16.9
Capelin***	662.1	42.2	750.0	47.8
Total	729.7	52.6	860.0	64.7
Crustaceans				
Shrimp	24.1	42.9	30.0	53.4
Lobster	2.4	11.6	3.0	14.5
Total	26.5	54.5	33.0	67.9
Shellfish				
Scallop	13.3	5.8	14.0	6.1
Grand Total	1439.8	801.3	1617.0	861.5

* At 1990 catch prices and USD values.

** Mainly Greenland halibut, catfish, plaice, tusk and ling.

*** MSY estimate represents the Icelandic share.

trawl. Due to their size, the deep sea trawlers have a wide operating range and are able to exploit practically any fishing ground off Iceland. Each trip usually lasts for about 5 to 15 days. A number of the deep-sea trawlers have recently been turned into freezer trawlers.

2. Specialized Purse Seiners:

From 200 GRT and up, these vessels are primarily engaged in the capelin fishery. Most also participate in other fisheries, particularly the deep sea shrimp fishery and the herring fishery. The specialized purse seiners usually follow the capelin schools over great distances and land their catches where it is most convenient.

3. Multipurpose Vessels:

The multipurpose vessels cover a wide size range. The typical multipurpose vessel is smaller than those previously discussed. Some, however, are quite large, *i.e.*, over 200 GRT. The multipurpose fleet is, for the most part, neither specialized with respect to fishing gear nor fishery. Most of the multipurpose fleet is designed as gillnetters or longliners although they are technically capable of employing trawl and purse seine as well. The geographical range of the smaller multipurpose vessels is limited and they are normally confined to one- to three-day fishing trips exploiting fishing grounds relatively close to their home port.

4. The Part Time Fleet

This class of fishing vessels covers numerous vessels of sizes up to 20 GRT although most are under 10 GRT. These vessels are typically owner operated and employed on a seasonal basis. This fleet employs handline, gillnets and longline. Depending on the fishery, the crew size is one to three persons. As the smaller of the part time fleet, namely vessels under 12 GRT and subsequently 10 GRT, were not subject to vessel quota restrictions until 1988, this component of the part time fleet has mushroomed in recent years.

Further details about the Icelandic fishing fleet are set out in Table 2 below. As shown in that table, the average age of the fishing fleet is rather high. This reflects *i.a.* the effects of more restrictive fishery management measures and official efforts in recent years to halt new investment in the fishing fleet.

The Origins and Evolution of the Fisheries Management System

Until the introduction of the vessel quota system in the demersal fisheries in 1984, the Icelandic fisheries were for the most part common property ones.² First, until the extension of the fisheries jurisdiction to 200 miles in 1976, the Icelandic fisheries were, for all intents and purposes, international fisheries. Large foreign fishing fleets featured prominently on the fishing grounds, taking almost half of the

² Due to the introduction of vessel quotas in the herring and capelin fisheries a few years earlier, the common property nature of these fisheries had been eliminated. These fisheries, however, only accounted for about 1/10 of the value of Icelandic fisheries.

Table 2
The Icelandic Fishing Fleet (December 1990)

	Number	Total Tonnage (1000 GRT)	Average Age (Years)
1. Deep-sea Trawlers	112	55.612	13.2
(i) Standard	84	NA	NA
(ii) Freezer	28	NA	NA
2. Purse Seiners	45	21.490	20.8
3. Multipurpose Fleet	344	38.603	21.6
(i) Over 200 GRT	48	11.676	20.4
(ii) 111–200 GRT	99	15.347	20.4
(iii) 51–110 GRT	115	8.982	25.1
(iv) 21–50 GRT	82	2.598	21.9
4. Part Time fleet	<u>495</u>	<u>4.451</u>	14.3
Grand Total	<u>996</u>	<u>120.156</u>	

Source: Utvegur (1991).

NA = Data not available.

demersal catch. The extension of the fisheries jurisdiction to 200 miles all but eliminated foreign participation in the Icelandic fisheries. However, the initial management measures taken in the demersal fisheries following the extension of the fisheries jurisdiction in 1976 were inadequate and therefore did not alter the common property nature of these fisheries as far as domestic fishermen were concerned. They were still forced to compete for shares in the catch. Therefore, not surprisingly, the development of the Icelandic fisheries in the post-war era closely followed the path predicted for common property fisheries (see *e.g.* Gordon, 1954) exhibiting increasingly excessive fishing capital and effort compared to the reproductive capacity of the fish stocks. The post-war development of fishing capital and catch values before the introduction of the demersal vessel quota system in 1984 is illustrated in Figure 1.

As Figure 1 indicates, the value of fishing capital employed in the Icelandic fisheries increased almost by well over 1200% from 1945–1983. Real catch values, on the other hand, only increased by 300% during the same period. Thus the growth in fishing capital exceeded the increase in catch values by a factor of more than four. This means that in 1983 the output-capital ratio in the Icelandic fisheries was less than 1/3 of the output-capital ratio in 1945.

This long-term decline in the economic performance of the Icelandic fisheries did not go unnoticed by the fisheries authorities. In fact, over the years, various measures were taken in an attempt to reverse this trend. However, before the extension of the exclusive fishing zone to 200 miles in 1976, effective management of the fisheries, especially the demersal ones, appeared impracticable due to the presence of large foreign fleets on the fishing grounds. For this reason, fishery management prior to the extension of the fishing limits to 200 miles was minimal.

With the *de facto* recognition of the exclusive 200 mile fishing zone in 1976, the situation was dramatically changed. Since that time the Icelandic fisheries have

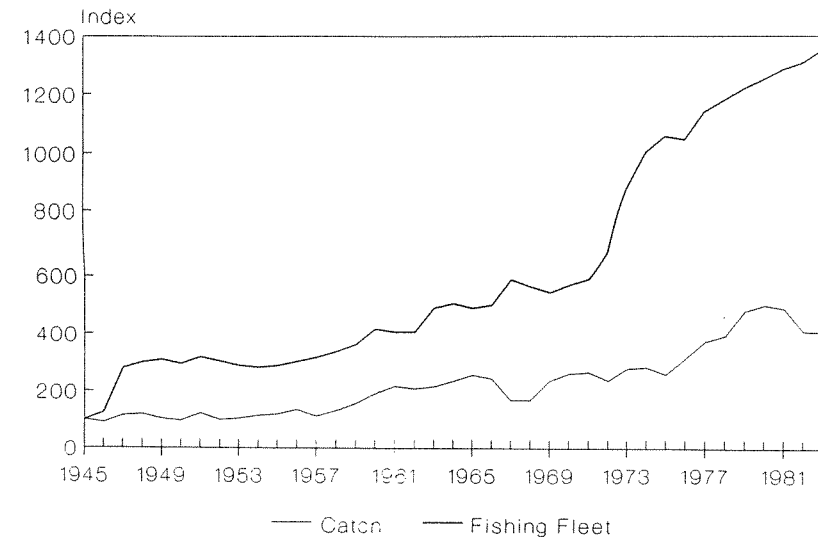


Figure 1. Fishing Capital and Catch Values 1945–1983: Constant prices. Indices (100 in 1945).

come under gradually increasing management, culminating in a uniform ITQ system in practically all fisheries since 1990. The chronology of this development is summarized in Table 3.

A more detailed review of the evolution of the ITQ fisheries management system in individual Icelandic fisheries is as follows:

The Herring Fishery

In 1966, due to an alarming decline in the herring stocks, an overall quota was imposed on this fishery. Since this did not halt the decline in the stocks, a complete herring moratorium was introduced in 1972. In 1976, when fishing from the Icelandic herring stocks was partly resumed, it was obvious that the whole fleet could not participate. Hence, an individual vessel quota system with limited eli-

Table 3
Key Steps in the Evolution of the ITQ Management System:
A Chronological Overview

1976	The herring fishery: Individual vessel quotas.
1979	The herring fishery: Vessel quotas made transferable.
1980	The capelin fishery: Individual vessel quotas.
1984	The demersal fisheries: Individual transferable vessel quotas.
1985	The demersal fisheries: Effort quotas option introduced.
1986	The capelin fishery: Vessel quotas made transferable.
1988	Transferable vessel quotas in all fisheries. Effort quota option retained.
1990	A complete uniform system of transferable vessel quotas in all fisheries.

gibility was introduced. Vessel quotas, however, were small and in 1979, by a Ministerial decree and industry support, fairly unrestricted transfers of quotas between vessels were permitted. In 1988, the vessel quota system in the herring fishery became part of the general fisheries vessel quota system.

The Capelin Fishery

The capelin fishery, which became very big in the seventies, was subjected to limited entry and individual vessel quotas for licence holders in 1980 at a time when the stock was seriously threatened with exhaustion. Again the arguments were the same as in the herring fishery previously. The positive experience with the vessel quota system in the herring fishery also proved a convincing argument for adopting a similar system in the much more important capelin fishery. In 1986, in conjunction with an increasing transferability of demersal vessel quotas, capelin vessel quotas became partly transferable. In 1988, the capelin vessel quota system became a part of the general fisheries vessel quota system with fairly unrestricted transfers of quotas.

The Demersal Fisheries

In connection with the extension of the exclusive fishing zone to 200 miles in 1976, the major demersal fisheries were subjected to overall catch quotas. The quotas recommended by the marine biologists soon proved quite restrictive and thus difficult to uphold. Therefore, individual effort restrictions, taking the form of limited allowed fishing days for each vessel, were introduced in 1978. However, as new entry remained possible and the demersal fleet continued to grow, the allowable fishing days had to be reduced from year to year. Thus, it became gradually obvious to everyone concerned that this system was economically wasteful. Consequently, in 1984, following a sharp drop in the demersal stock and catch levels, a system of individual vessel quotas was introduced. Initially regulations to this effect were issued for one year only. Due to generally favourable results of the system, it was extended. However, to ensure sufficient support for the system, a very important provision was added. Vessels were allowed to opt for effort restrictions instead of catch quotas. In 1988, the Icelandic Legislature, the Althing, enacted a general vessel quota legislation applying to all Icelandic fisheries effective for 1988–1990. This legislation retained the effort quota option but made it somewhat less attractive. In 1990 a complete, comprehensive ITQ legislation was passed by the Althing. This legislation abolished the effort quota option and closed certain other loopholes in the previous legislation, especially as regards the operation of vessels under 10 GRT. It, moreover, extended the ITQ system indefinitely albeit with a stipulation for a revision in 1993.

As may be inferred from this description, the course towards a complete ITQ fisheries management system in Iceland has evolved more by trial and error than by design. In most countries, and Iceland is no exception, there is strong social opposition to radical changes in the institutional framework of production and employment. A great deal of this opposition seems to derive from traditional values and vested interests rather than rational arguments. Therefore, in Iceland, it was probably unavoidable from a socio-political point of view to pass through an evolutionary process during which various management methods were tried in

different fisheries. The knowledge and understanding gained from these experiments were probably crucial for the eventual acceptance of the much more efficient ITQ system.

At the same time, it should be noted, that the key steps in the evolution of the ITQ system have usually only been taken in response to crises in the respective fisheries due to a sudden reduction in stock levels. Thus, individual vessel quotas were introduced in the herring fishery in 1976 following a collapse in the herring stocks and a prolonged moratorium on herring catches. Similarly, vessel quotas in the capelin fishery and the ITQ system in the demersal fisheries were introduced in the early 1980s in response to a perceived danger of a corresponding collapse in these fisheries.

This pattern reflects, above anything else, the reluctance of members of the fishing industry to accept changes in the traditional organization of the fisheries. Only when faced with a disaster in the form of a significant fall in income due to fish stock reductions or a drop in the world market price for fish products, have the interest groups been willing to consider changes in the institutional framework of the fisheries.

The passing of the comprehensive ITQ fisheries management legislations in 1988 and even more so in 1990 constitutes a break with this pattern. For the first time, the fishing industry has agreed to a significant improvement in the fisheries management system without being threatened with the alternative of a financial disaster. This, I think, must be attributed to the potentially immense economic benefits of the vessel quota system that have now become apparent to most of the participants in the fisheries.

The Current ITQ Fisheries Management System

Let us now turn to the description of the current ITQ fisheries management system in Iceland. Although this system was instituted at different times and in somewhat different form in the various fisheries, it was, as mentioned above, made uniform by the *Fisheries Management Legislation* passed in 1990.

The essential features of the current ITQ system are as follows: All fisheries are subject to vessel catch quotas. The quotas represent shares in the Total Allowable Catch (TAC). They are permanent, perfectly divisible and fairly freely transferable. They are issued subject to a small annual charge to cover enforcement costs.

It should be noted that the ITQ system was superimposed on an earlier management system designed mainly for the protection of juvenile fish. This system involving certain gear, area and fish size restrictions is still largely in place. The ITQ system has not, in other words, replaced these components of the earlier fisheries management system.

Further details of the ITQ-system in the Icelandic fisheries are given below:

(1) Total Allowable Catch (TAC)

The Ministry of Fisheries determines the Total Allowable Catch (TAC) for each of the most important species in the fisheries. This decision is made on the basis of recommendations from the Marine Research Institute. In the past the Ministry of

Fisheries has followed the recommendations of the Marine Research Institute quite closely.

Several species, i.e., those on which fishing pressure is regarded as slight, are not currently subject to TAC. This means that the corresponding fisheries can be pursued freely. These fisheries are, in most cases, commercially negligible.

(2) *Permanent Quota Shares*

Each eligible vessel is issued a permanent share in the TAC for every species for which there is a TAC. These permanent quota shares may be referred to as TAC-shares.

(3) *Initial Allocation of Permanent Quota Shares*

The initial allocation of TAC-shares to individual vessels varies somewhat over fisheries. In the demersal, lobster and deep-sea shrimp fisheries the TAC-shares are normally based on the vessel's historical catch record during certain base years. In the demersal fisheries this usually equals the vessel's average share in the total catch during the 3 years prior to the introduction of the vessel quota system in 1984. There are noteworthy exceptions to this rule, however. If, for instance, the vessel in question was not operating normally during 1981–3 due e.g. to major repairs or having entered the fleet after 1981, the calculated share is adjusted upwards. Also, during the years 1985–1987, it was possible to modify the TAC-shares by temporarily opting for effort restrictions instead of vessel quotas and demonstrating high catches during this period. In the herring and inshore shrimp fisheries the initial TAC-shares were equal. The same holds for the capelin fishery except that $\frac{1}{3}$ of the TAC-shares were initially allocated on the basis of vessel hold capacity.

(4) *Annual Vessel Quotas*

The size of each vessel's annual quota in a specific fishery is a simple multiple of the TAC for that fishery and the vessel's TAC-share.

(5) *Divisibility and Transferability*

Both the TAC-shares and the annual quotas are transferable and perfectly divisible. This means that any fraction of a given quota may be transferred to another vessel.

TAC-shares are transferable without any restrictions whatsoever. Transfers of annual vessels quotas, on the other hand, is subject to some restrictions. Annual vessel quotas are freely transferable between vessels within the same geographical region. Transfers of annual quotas between geographical regions are, on the other hand, subject to revision by the respective fishermen's unions and the local authorities. The rationale for this stipulation is to stabilize local employment in the short run. In practice, however, it appears that few inter-regional transfers are actually blocked.

Apart from this, transfers of quotas are only subject to registration with the

Ministry of Fisheries. The particulars of the exchange, including price, are not registered.

(6) *Restricted Access*

All commercial fishing vessels must hold valid fishing licences.³ Fishing licences, moreover, are issued only to vessels already in the fishery in 1990 and their replacements provided they are deemed comparable in terms of fishing power. The fishing licences are not transferable.

Thus, in addition to the ITQ-system, the Icelandic fisheries are subject to restricted access. One of the impacts of a well designed ITQ system is to provide the socially appropriate incentive for disinvestment (investment) in the fishing fleet. The fishing licence stipulation clearly adds a deterrent to investment in fishing vessels.

(7) *Exemptions from the ITQ System*

There are two minor exemptions from the current ITQ system—both in the demersal fisheries. The first concerns longline demersal fisheries in mid-winter. More precisely, 50% of the demersal catch of vessels employing longline during the months of November through February each winter is exempt from quota restrictions. The reason for this exception is primarily to support regional employment during this period.

Second, handline fisheries by vessels under 6 GRT are exempted from quota restrictions and subject to limited fishing days. This arrangement, however, is only temporary and is due to end in 1994, when according to the current legislation, this class of vessels is also supposed to become subject to the ITQ system.

(8) *Quota Fees*

The annual vessel quotas calculated in the above-described manner were initially issued by the Ministry of Fisheries free of charge. However, according to the *Fisheries Management Legislation* of 1990, the Ministry of Fisheries is to collect fees for catch quotas to cover the cost of monitoring and enforcing the ITQ regulations. The law imposes an upper bound on this fee amounting to 0.2% of the estimated catch value.

The Performance of the ITQ System

The main purpose of the vessel quota system is to improve the economic efficiency of the fisheries. The Icelandic fisheries are biologically very productive and should be able to generate high economic rents. Until the adoption of the vessel quota system, however, comparatively low rents were generated in the industry. In fact, during the years preceding the introduction of the vessel quota system in the various fisheries industry profits were often highly negative.

³ This is in addition to catch quotas.

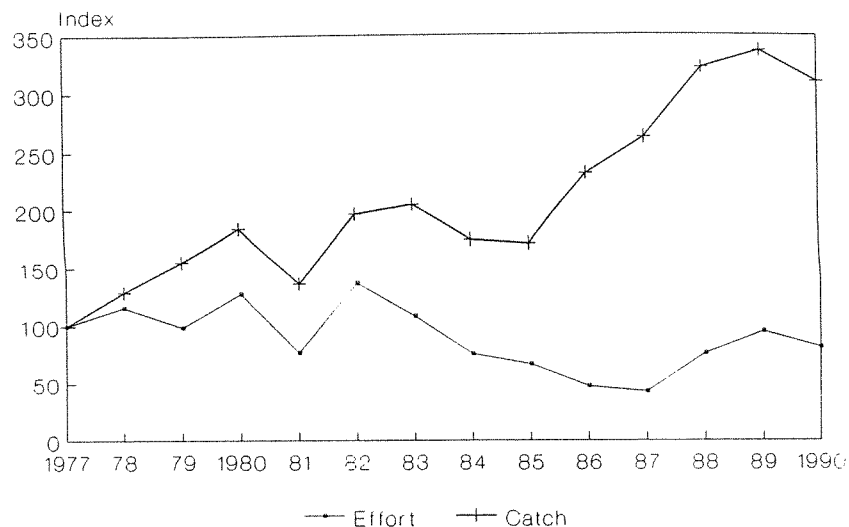


Figure 2. The Herring Fishery: Development of Catches and Fishing Effort.

The Herring Fishery

When the herring fishery was resumed in 1976, at the end of a three year fishing moratorium, a system of individual catch quotas was imposed. Due to the generally favourable experience with this system, the quotas were made perfectly divisible and transferable in 1979. In 1990, the herring fisheries management system was incorporated—largely unchanged—in the comprehensive fisheries management system for the Icelandic fisheries.

The individual transferable quota system in the herring fishery has been very successful. Since 1977 herring catches have tripled. Fishing effort,⁴ on the other hand has not increased. In fact it has declined by some 20%. This means that the technical efficiency in the herring fishery is now roughly 5 times higher than it was at the outset of the vessel quota system in the fishery 16 years ago.

The development of fishing effort and catches in the herring fishery is further described in Figure 2.

The Capelin Fishery

An individual vessel quota system was introduced in the capelin fishery in 1980. In 1986 the quotas were made transferable. In 1990 the capelin management system was incorporated in the overall Icelandic fisheries management system.

The capelin is a short lived species and the fishery, which depends on a single cohort each year, is very volatile. Since the introduction of the vessel quota system in 1980 there has been no trend in catch levels. Mean catches have re-

⁴ Fishing effort is here defined as the application of fishing capital to the fishery and is measured as a multiple of vessel tonnage and days fishing.

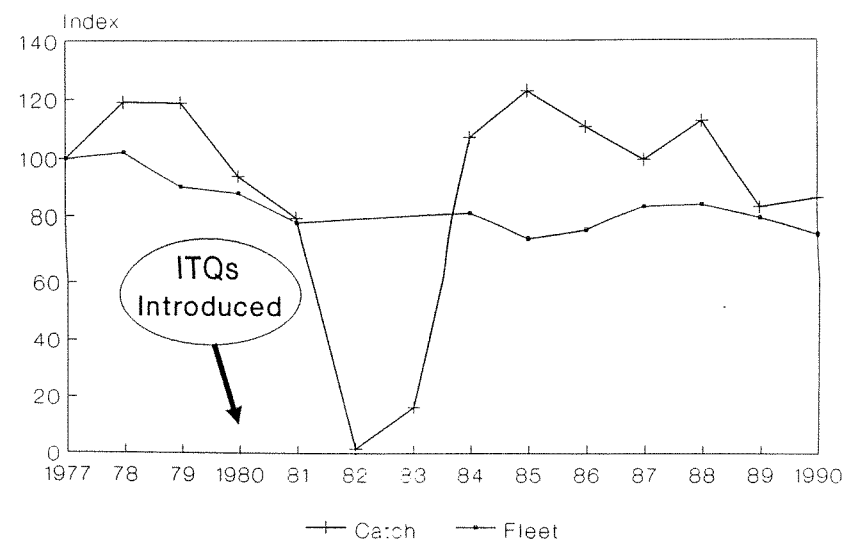


Figure 3. The Capelin Fishery: Development of Catches and Fishing Fleet.

mained roughly unchanged. The capelin fleet, on the other hand, has been substantially reduced. The number of vessels has declined by 40% and the total tonnage of the fleet has been reduced by about 20%. Thus, there are strong indications that the efficiency of the capelin fishery has been substantially increased since the introduction of the vessel quota system. The development of the catch and the fleet size in terms of tonnage is illustrated in Figure 3.

The Demersal Fisheries

The demersal fisheries are by far the most important Icelandic fisheries, accounting for over 75% of the total value of the catch. These fisheries were subjected to an individual transferable quota system in 1984. This system was subsequently under almost continuous revision until the adoption of the uniform fisheries management system in 1990.

The Trend in Fishing Capital and Fishing Effort

We have seen that one of the reasons for the dissipation of economic rents in the Icelandic fisheries has been overinvestment in fishing capital and excessive fishing effort. Therefore one of the tests of the efficacy of the vessel quota system is the development of fishing capital and aggregate fishing effort since the introduction of the system.

The trend in fishing capital and fishing effort⁵ in the demersal fisheries in recent years is illustrated in Figure 4.

As shown in Figure 4, the previous growth in the value of aggregate harvesting

⁵ Fishing effort in this context is estimated as a multiple of fleet tonnage and days at sea.

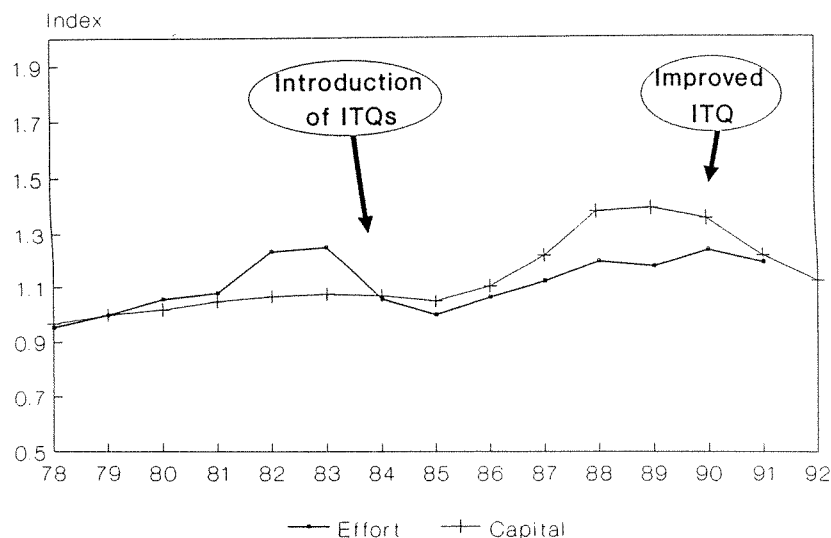


Figure 4. The Demersal Fisheries: Development of Fishing Capital and Effort.

capital halted abruptly in 1984 when the vessel quota system was introduced. In fact, fishing capital contracted 1984–85. This was the first time since 1969 that the value of the fishing fleet actually decreased. In the preceding 15 years this capital value had grown at an annual rate of over 6%. Thus, at this point, the vessel quota system seems to have generated beneficial results.⁶ In 1986, on the other hand, investment in fishing capital resumed at a high rate. This resumption of investment, should not, however, be interpreted as a failure of the vessel quota system as such. After all, the increase in the value of fishing capital since the inception of the ITQ system has amounted to just over 3% annually while during the preceding 15 years this annual increase was over 6%. Moreover, most of the investment since 1986 can be explained by factors extraneous to the ITQ system.

First, a good deal of the investment in fishing capital from 1986 onwards has consisted of the installation of freezing equipment and the corresponding modifications of several deep-sea trawlers.⁷ This part of the investment is, in other words, in fish processing capital employing new and profitable techniques. Second, a part of the investment was in specialized trawlers for the emerging and very valuable deep-sea prawn fishery which was not subject to vessel quotas until 1988. Third, by the mid 1980s a significant fraction of the deep-sea trawler fleet was due for replacement. As the years 1986 and 87 were unusually profitable for the harvesting sector, many firms took the opportunity to replace their aging vessels. Fourth, during this period there was a very significant investment in small vessels (under 12 and subsequently 10 GRT) that were not subject to the vessel quota

⁶ Note, however, that the years 1982–84 were periods of heavy losses for the fishing industry. Therefore the halt in investment in 1984–5 can hardly be attributed exclusively to the vessel quota system.

⁷ In 1983 there were 3 freezer trawlers. In 1990 they were 28.

system. Last but not least, the effort quota option in the demersal fisheries, introduced in 1985, undermined the efficiency incentives of the ITQ system inducing many vessel owners to upgrade or replace their vessels. The effort quota option was abolished in 1990 and, in fact, we see a significant reduction in fishing capital in that year. More importantly, this reduction continues in 1991 and 1992. In fact, during the three years, from 1990 to 1992, the value of fishing capital was reduced by almost 15%.

The course of demersal fishing effort tells a similar story. As indicated in Figure 4, fishing effort in the demersal fisheries dropped by some 15% in 1984, the first year of the vessel quota system, and by an additional 6% in 1985. Since 1986, on the other hand, fishing effort has increased considerably. This is no doubt primarily due to the widespread selection of the ill-advised effort quota option within the ITQ system during 1986–1990. Another important explanation for the increase in fishing effort in 1989 and 1990 is the decline in the demersal fish stocks without a commensurate reduction in the TACs thus requiring more fishing effort to fill the catch quotas. In 1991, demersal fishing effort appears to have declined somewhat again.

The main question, however, is not whether fishing effort has been reduced from its 1983 level. The crucial measure of the impact of the vessel quota system is the difference, if any, between the actual fishing effort 1984–1990 compared to the fishing effort level that would have prevailed during the period had the vessel quota system not been introduced.

Clearly, it is not at all straightforward to predict the course of fishing effort under the earlier management regime. However, in an attempt to provide a partial answer to this question, a simplistic model has been used to explain the path of fishing effort under the two different management regimes. Essentially, a simple trend model describing the path of fishing effort under the two management regimes was specified. Somewhat more precisely, it was hypothesized that during the 13 year period 1978–1990 fishing effort evolved over time according the relationship:

$$e(t) = (a \cdot D_1 + b \cdot D_2) \cdot \exp[(c \cdot D_1 + d \cdot D_2) \cdot t], \quad t = 0, 1, 2, \dots, 12,$$

where $e(t)$ represents fishing effort in year t and t represents the years measured from 0 to 12. D_1 and D_2 are dummy variables for the two management regimes. Thus $D_1 = 1$ during the years of restricted effort (e.g. 1978–1983) and 0 thereafter. $D_2 = 0$ in the years preceding 1984 and 1 thereafter. The coefficients a and b represent the intercepts and the coefficients c and d the growth rates of effort under the two management regimes.

The hypothesis that there is no structural break in the evolution of fishing effort between the two management regimes is resoundingly rejected. The relevant test statistic is $\chi^2(2) = 58.9$. Similarly the growth of fishing effort under the ITQ regime is significantly lower than under the previous fisheries management regime. The relevant test statistic is $\chi^2(1) = 6.9$.

Employing this estimated relationship we may predict the fishing effort assuming that the vessel quota system had not been introduced in 1984 and compare this to the actual fishing effort observed. The results of this exercise are illustrated in Figure 5.

According to the estimation results illustrated in Figure 5, fishing effort under

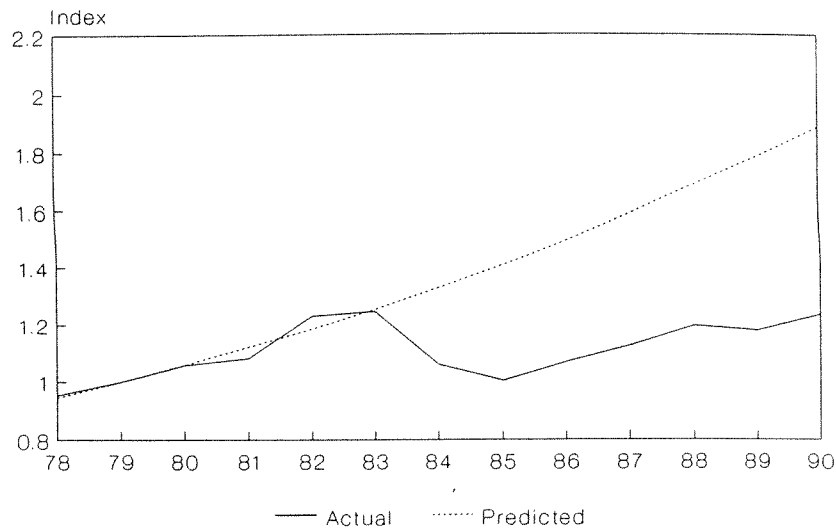


Figure 5. Actual vs. Predicted Fishing Effort Assuming no ITQ System.

the earlier fisheries management system would, in all likelihood, have continued to increase at a high rate after 1983. Judging from these estimates the vessel quota system appears to have reduced total demersal fishing effort by some 34% compared to the expected fishing effort under the previous management system. The financial benefits of this kind of an effort reduction are very substantial. In interpreting these results, however, the reader should be mindful of the extreme simplicity and mechanistic nature of the underlying model. In fact, the above results should be regarded as indicative only.

More Direct Estimates of Economic Benefits

Let us now turn to more direct estimates of the economic benefits generated under the vessel quota system. Unfortunately, little research has been done in this area and the available information is consequently rather scant.

From a theoretical point of view, the economic benefits of a vessel quota system should include the following items:

(1) A Reduction in Fishing Effort

Under the vessel quota system competition between vessels for a limited stock of fish is eliminated. Consequently, the fishing firms will attempt to catch their vessel quota with minimum fishing effort. It is important to realize, however, that aggregate fishing effort will not necessarily be reduced if the TAC is excessive.⁸

⁸ Given the size of the fish stocks, each TAC requires a certain minimum fishing effort. If the TAC is set high relative to the size of the fish stocks aggregate effort may actually increase under an ITQ system.

(2) Reduced Cost of Fishing Effort

Having secured private ownership of a certain volume of catch under the vessel quota system, the fishing firm can concentrate on taking that catch with minimal costs.

(3) Improved Quality of the Catch

Being bound by its vessel catch quotas, the fishing firms can only increase revenues by improving the quality of this catch.

In a study carried out in 1985, the National Economic Institute attempted to estimate the benefits of reduced fishing effort and improved quality of the catch in the demersal fisheries for the year 1984. The conclusion was that the benefits of reduced fishing effort amounted to some 14 M.USD and improved quality of the catch to some 6 M.USD. The total number, 20 M.USD, is about 8.5% of the value of the demersal fisheries in that year. These results were confirmed in a less comprehensive study done in 1987.

Another way to approach the problem of estimating the rents generated in the demersal fisheries as a result of the vessel quota system is to look at quota values. As the catch quotas are transferable, a market for quotas has developed. In this market, quotas are exchanged for other valuables such as money. Hence, applying standard economic theory and assuming that the market for quotas is reasonably effective, the value of the fishery should equal the total value of outstanding quotas.⁹

The extent of the quota market in the demersal fisheries is described in Table 4.

Table 4 shows that the extent of the demersal quota market is considerable. In 1984, the first year of the vessel quota system, about 11% of outstanding quotas were exchanged. Since 1986 this percentage has fluctuated between 20 and 30%. However, due to a contraction in the volume of outstanding quotas resulting from the widespread use of the effort quota option, the actual quantities exchanged in 1986–90 were not any greater than in 1984–85.

The economic rents generated in the demersal fisheries according to the quota evaluation are given in Table 5.

Judging from the fourth column of Table 5, it appears that the total value of outstanding quotas evaluated at the mid-point of the price range given, was some 46 M.USD in 1984 and 166 M.USD in 1990. However, these numbers almost certainly underestimate the true value of demersal catch rights. The reason is that they ignore the value of the nontradable catches which are mostly taken under effort quotas. If all the demersal catch is evaluated at the vessel quota prices, we obtain the valuation in the last column of Table 5. According to this column, the economic rents generated in the demersal fisheries are very considerable and constitute a significant fraction of the gross earnings of the fisheries.¹⁰

⁹ Notice, however, that this value will not necessarily equal bookkeeping results. Quotas will be bought on the market at a price up to their marginal variable profits. Fixed costs, e.g. those associated with harvesting capital, are irrelevant for these transactions. Therefore, a firm may buy quotas at a high price without being able to cover fixed costs.

¹⁰ Thus in 1989 the demersal quota values exceeded ¼ of total earnings in the demersal fisheries.

Table 4
The Extent of the Demersal Quota Market

Year	Total Transfers		Vessel Quotas as Fractions of Total Demersal Catch
	(1)	(2)	
1984	64.1	11.2%	98.1%
1985	81.0	19.2%	76.8%
1986	52.2	24.4%	36.0%
1987	40.1	21.1%	28.1%
1988	61.4	23.7%	43.8%
1989	72.2	29.8%	42.5%
1990*	78.9	22.6%	68.2%
1991			95.9%

(1) Quotas exchanged in 1000 MT.

(2) Quotas exchanged as a percentage of total outstanding vessel quotas.

NA Information not available.

* The new complete ITQ system took effect on Sept. 1 this year.

These estimates, however, must be interpreted with great care especially during the latter part of the period. During these years, demersal catches were good and fish prices extremely good. For this reason the quota prices for 1986-90 were probably higher than would otherwise have been the case, although considerably lower than in fully efficient equilibrium. More importantly, it must be realized that one of the first effects of a reasonably complete ITQ system is to make excessive fishing capital commercially redundant. This means that its market price falls drastically, the opportunity cost of its use is reduced and the market value of catch quotas is correspondingly increased. This, however, is a short term effect, that will be reversed in the long run when the level of fishing capital reaches a new equilibrium.

How does the economic performance of the demersal vessel quota system compare with optimal economic utilization? Comparing the above quota price valuation of fisheries rents with the maximum attainable rents according to an empirical study of the Icelandic demersal fisheries (see Arnason, 1984), it appears

Table 5
Economic Rents in Demersal Fisheries: Quota Price Valuation

Year	Annual Quota Price Range USD/MT		Total Quota Values M.USD	
	Cod	Other	All Quotas	Whole Fishery
	1984	55-87	24-40	36-57
1985	84-126	54-72	36-53	51-72
1986	127-176	79-109	23-32	66-91
1987	206-259	104-131	35-44	104-131
1988	208-277	154-205	49-65	108-144
1989	262-349	157-209	62-83	143-189
1990	428-514	256-308	151-182	222-267

that the realized economic rents in 1990 were well over 50% of the maximum attainable ones. Previous reservations concerning the probable upward bias of the quota values as estimators of sustainable rents in 1990 must, however, be stressed. Nevertheless, it is clear that significant benefits have been generated by the demersal vessel quota system. As fishing effort has been reduced only slightly, this must primarily be attributed to reduced harvesting costs per unit of catch and higher quality of the catch. In fact there is ample evidence that this has occurred.

The Problem of Discards

Discarding of catch or highgrading is an often cited problem with ITQ systems especially in mixed fisheries. (See *e.g.* Rettig, 1986 and Squires and Kirkley, 1991). The Icelandic demersal fisheries are certainly mixed fisheries. Nevertheless, there is little evidence of increased discarding under the ITQ system. According to measurements published in a recent report by a government commission (Nefnd um Motun Sjavarutvegsstefnu, 1993), demersal discards range from 1-6% of total catch volume depending on gear and vessel type. Moreover, according to this report there has been no detectable increase in discards since the introduction of the vessel quota system in 1984.

Regional Impacts

The Icelandic ITQ system does not appear to have had an adverse regional impact so far. In spite of a very substantial transfers of temporary and permanent quotas, their regional allocation has remained remarkably invariant as indicated in Table 6. In fact, the regional pattern of demersal landings show a much greater volatility than quota holdings both before and after the introduction of the ITQ system. The main discernible trend in Table 6 is some movement of quotas from the metropolitan and South-West regions to the Northern part of the country. This movement, incidentally, conforms nicely with the objectives of regional policy in Iceland.

Conclusion

Versions of the ITQ fisheries management system have been in operation in Icelandic fisheries since 1979. The evidence on the performance of this system is generally favourable although somewhat mixed.

Table 6
Regional Shares in Demersal Quotas (Cod Equivalents, Vessels over 10 GRT)

Regions	1984	1985	1986	1987	1988	1989	1990	1991	1991/2
South	13.5%	13.5%	13.8%	13.6%	14.0%	14.7%	15.2%	14.8%	14.4%
South-west	18.1%	18.0%	17.0%	15.0%	16.2%	14.9%	15.9%	15.8%	15.3%
Reykjavík	11.6%	11.35%	10.8%	9.9%	8.4%	7.9%	8.2%	7.9%	9.0%
West	9.0%	9.0%	9.7%	9.9%	9.6%	9.3%	9.0%	9.4%	9.3%
West-fjords	13.6%	13.6%	13.9%	14.1%	14.2%	14.7%	14.0%	13.9%	13.8%
North W.	6.1%	6.2%	6.3%	6.9%	7.4%	7.9%	7.6%	7.9%	7.2%
North E.	14.9%	15.1%	14.8%	16.9%	16.7%	17.6%	17.1%	17.7%	18.4%
East	13.2%	13.2%	13.7%	13.7%	13.5%	13.2%	12.9%	12.5%	12.7%

Source: Nefnd um Mótun Sjávarutvegsstefnu

The introduction of the ITQ system in the herring fishery appears to have produced a dramatic increase in efficiency. In the capelin fishery, the ITQ system also appears to have produced economic benefits although less dramatic than in the herring fishery. In the demersal fisheries, the evidence is less conclusive. On the one hand, the fishing fleet has increased and aggregate fishing effort has contracted only slightly. On the other hand, various indicators including quota values in the demersal fisheries strongly suggest that significant rents are being generated by the system.

However, when interpreting the development of the demersal fisheries since 1984, the imperfectness of the ITQ system employed during the early part of the period should be kept in mind. This applies especially to the wide-spread use of the effort quota option during 1985–90. In fact, as shown in Table 4, the fisheries management system was only partially an individual quota system in these years. For this reason, the upward trend in harvesting capital and demersal fishing effort during this period is hardly evidence of the failure of the ITQ system. In fact, as previously explained, since the abolition of the effort quota option and the consolidation of the ITQ system in 1990, demersal fishing capital has declined substantially.

In addition, there is no evidence that the vessel quota system has increased discarding of catch. Neither does it appear to have had an adverse impact on regional habitation. In fact, the opposite is probably closer to the truth.

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