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Property rights in fisheries: Iceland's experience with ITQs

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Contents

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Abstract

The fundamental problem of economic inefficiency in fisheries, the so-called common property problem, may be seen to be caused by inadequate or lacking property rights in the underlying natural resources. The introduction of Individual Transferable Quotas (ITQs) into fisheries represents an attempt to correct this failure. ITQs, however, are not property rights in the relevant natural resources, i.e. the fish stocks and their

habitat. They are merely harvesting rights and thus far from ideal as property rights. Nevertheless, ITQs have been introduced in numerous fisheries around the world, apparently with generally, even consistently, good economic results. This paper outlines the basic theory of property rights and the strengths and weaknesses of ITQs as property rights in fisheries. The paper goes on to discuss the Icelandic ITQ system and compares its property rights value with that of the New Zealand ITQ system and the Norwegian IQ system. Finally, the paper reviews some measures of the economic outcomes of the ITQ system in Iceland.

Introduction

It is by now widely recognized (Scott, 1955; Neher et al., 1989; Shotton, 2000) that the basic problem of economic inefficiency in fisheries – often referred to as the common property problem (Gordon, 1954) and, more dramatically, the tragedy of the commons (Hardin, 1968) – stems fundamentally from inadequate or lacking property rights in the underlying natural resources, namely the fish stocks and their ocean habitat. Due to this lack of property rights, trades in the natural resources cannot occur. As a result markets cannot form and, consequently, there are no market forces to guide behavior to the common good in the way made famous by Adam Smith (1776). Indeed, as theory predicts (Gordon, 1954 and numerous later authors) and experience amply demonstrates (Gordon, 1954; Crutchfield and Zellner, 1962; and numerous later authors), common property fisheries generally exhibit an almost complete economic failure. All potential economic rents from the fishing activity are fritted away by investment in excessive fishing capital and fishing effort. Moreover, this economic waste is generally accompanied by an unjustifiable reduction in and, sometimes, even decimation of the biological capital, the fish stocks.

These well-documented observations seem to imply two things: First, common property fisheries should generally not be left to follow their own path of evolution. Fisheries management is needed; second, an obvious way to manage fisheries is by subjecting them to the appropriate system of property rights.

This paper is about property rights in fisheries. In particular, it focuses on one type of property rights that has become quite common in fisheries management around the world in recent years, namely individual transferable quotas or ITQs.

It is not always realized how widespread the use of ITQs has become. ITQs have been implemented in several hundred ocean fisheries around the world. With the recent addition of Chile to the fold of fishing nations using ITQs as the main management method for their fisheries, well over 10% of the total ocean fish harvest is currently taken under ITQs.[1]

The first ITQ systems were implemented in the 1970s. Currently, at least eight significant fishing nations – Australia, Canada, Greenland, Holland, Iceland, Namibia, Chile and New Zealand – employ ITQs as a major component of their fisheries management system (OECD, 1997; Hatcher et al., 2001). Several others, including Mosambique, Portugal, Mexico, Morocco and the United States use ITQs in some of their fisheries (OECD, 1997; Hatcher et al., 2001). Important fishing nations such as Peru and Argentina are preparing for the introduction of ITQs in some or all of their fisheries.

The experience with ITQs has generally been quite positive.[2] Fishing effort has usually decreased and fishing fleets contracted. Fish stock declines have generally been halted and some previously depleted stocks have been rebuilt.[3] The quality and value of landed catch has increased. In fact, due to the increased emphasis on product value and quality, total employment in the fishing industry has usually not been found to contract. Finally, and perhaps most importantly, economic

[1]Most important fishing nations employing ITQs are Chile with average catches of over 5 million metric tonnes, Iceland with some 2 million, New Zealand with about 0.6 million, Holland with some 0.5 million and Canada with some 1 million metric tonnes a large part of which is taken under ITQs.

[2]Evidence on the impact of ITQs in various fisheries can for instance be found be found in OECD (1997), National Academy of Sciences (1999), various papers in Shotton (2000), Arnason (2001) and Hatcher et al. (2001).

[3]One particularly dramatic case of stock rebuilding under ITQs is in the Icelandic summer spawning herring fishery. In this fishery, one of the first in the world to come under ITQs in 1979, the stock has increased about threefold and is currently (2004) larger than anytime before on record.

rents have generally greatly increased (Hatcher et al., 2001). It seems that ITQs are the only fisheries management system currently employed around the world that can claim this degree of general success.

Recently, interest in another type of property arrangements in fisheries, community fishing rights, has increased. Community fishing rights, under which communities or otherwise defined groups of fishermen are given certain exclusive fishing rights, seem particularly attractive in situations where other rights-based approaches (such as ITQs) cannot be applied for socio-political or technical (usually enforcement) reasons. It can be shown that under the right circumstances community fisheries management on the basis of community property rights will lead to efficient community fishing (Arnason, 2003a). Interestingly, in those cases, the communities tend to allocate their rights to individual fishers as IQs or ITQs (Valatin, 2000; Hatcher et al., 2001).

The paper is organized broadly as follows. First I will review the elements of property rights theory and introduce the concept of property rights value. In the following section, Section 2, I will consider the attributes of ITQs as property rights in fish stocks and the underlying natural habitat. Following this, I will go on to describe the features of the Icelandic ITQ system and compare its property rights value with those of the New Zealand's ITQ and Norway's IQ systems. In Section 4, I will present various measures of the economic and social outcomes of the Icelandic ITQ system. Finally, in Section 5, I will summarize the main results of the paper and speculate about the future of fisheries management.

The basic theory of property rights

Through the writings of Adam Smith (1776) to modern theory of economic growth Barro and Sala-i-Martin (1995) it has been well established that the two basic sources of economic growth, i.e. increased production of economic benefits per person, are:

(1) *Specialization*. Specialization, in this context, should be interpreted broadly. It comprises the division of labor between persons with each specializing in what he does best; specialization between firms with the most efficient firms carrying out the production of each commodity and specialization between countries with each producing the goods in which it has comparative advantage.
(2) *Accumulation of capital*. This should also be interpreted broadly. Capital here refers to all assets that contribute to production and well-being. This, obviously, includes physical as well as human and biological capital.

I will now argue that property rights, especially private property rights, are a fundamental prerequisite for specialization and accumulation of capital to occur.

Specialization obviously requires trade. If there is no trade, people will be forced to produce all their needs themselves. Specialization will not be possible. This, of course, is the typical situation in very primitive societies. Trade, in turn, requires property rights. This, of course, is obvious. After all, trade is nothing but a transfer of property rights. So, without property rights there can be no trade. Hence, we must conclude that without property rights, there can be very little economic specialization.

Accumulation of capital obviously requires property rights. Obviously, no one is going to save valuables in the form of physical capital, natural resources or even human capital unless he enjoys adequate property rights over his accumulation. There are two reasons for this. First, accumulation of capital necessarily means sacrifice of current consumption. Therefore, to accumulate one must be reasonably sure of not only retaining possession of the accumulated assets but also gaining from their existence.[4] Without property rights, this of course is not possible. Second, even if some people decided to accumulate nevertheless, this accumulation would be seized by others and, in order to avoid a similar fate, quickly consumed. So without property rights there will be (i) no accumulation and (ii) what capital there might exist will be quickly seized and squandered.

On the basis of these arguments, we conclude that property rights are a fundamental prerequisite for specialization and accumulation of capital to occur. Without property rights there can be no specialization or accumulation of capital.

[4]This, of course, assumes something less than perfectly altruistic individuals.

It is worth noting that the above arguments also establish one of the most a fundamental theorems of economics. This is the theorem that property rights are necessary for a high supply of goods and, indeed, what is regarded as economic progress in general.

All this is well- known. What is perhaps less well known is that property rights are fundamental to the operation of the market system. More precisely, property rights are both necessary and virtually sufficient for the operation of the market system.

The core of the market system is trades in the market place. Clearly, such trades presuppose property rights over the commodities that are traded. Hence, property rights are necessary for the operation of the market system. If a system of property rights is put in place, the opportunity for individuals to benefit from production specialization and trading will arise. Therefore, assuming only a minimal degree of individual enterprise, trading will commence and the market system is on its way. The reverse, however, is not true. The existence of markets does not lead to the creation of property rights. The causal relationship is from property rights to markets and trades not vice versa.

So, the property rights system is really more fundamental than markets. Assuming only that people look after their interests, markets will automatically arise if there are property rights. Moreover, the market cannot exist without property rights but the existence of property rights does not depend on the market. In this sense, property rights are more fundamental than the market.

A common problem with the market system is externalities. Externalities are for instance pervasive in fisheries. It is well known that the market system is only efficient if there are no externalities (Debreu, 1959; Arrow and Hahn, 1971). What is less well known is the close causal relationship between externalities and property rights. Basically, we may assert that lack of property rights causes externalities. How does this work?

If property rights are missing, people may simply take what they want, at least to the extent this is allowed by social custom.[5] If the resource is scarce, this causes an external effect. The act of "taking" simply leaves less of the resource to others. They are in other words adversely affect by the "taking". An externality (usually a negative one) is created. With property rights in place "taking" is not permissible. Consequently, as is easy to verify, with full and complete property rights, there can be no externalities.[6] Under that regime, any "taking" or in the case of positive externalities "giving" involves the exchange of property rights. With property rights in place the method of obtaining is buying. If the resource is scarce the purchase price will be positive. This means that the previous owner will be compensated for handing the property right over.

Characteristics of property rights

A property right is not a single variable. As Scott (1988, 1996) has informed us, any property right consists of a collection of different of attributes or characteristics. The number of distinguishable characteristics that make up a property rights is very high. However, according to Scott (1996, 2000) the most crucial property rights characteristics are:

- Security, or quality of title
- Exclusivity
- Permanence
- Transferability

Let us now briefly discuss the content of these characteristics.

Security or quality of title

A property right may be challenged by other individuals, institutes or the government. Security, here refers to the ability of the owner to withstand these challenges and maintain his property right. It is perhaps best thought of as the probability that the owner will be able to hold on to his property right. Probabilities range from zero to one. A security measure of one means that the owner will hold his property with complete certainty. A security measure of zero means that the owner will certainly lose his property.

Exclusivity

This characteristic refers to the ability of the property rights holder to utilize and manage the

[5]Actually, if "taking" is not allowed, we may say that property rights exist.

[6]This statement, of course, is not meant to imply that a system of full and complete property rights can be implemented or that such a system is necessarily desirable.

resource in question (his property) without outside interference. An individual's personal things such as his cloths, generally have a very high degree of exclusivity. A right to the enjoyment of a public park has almost zero exclusivity. An ITQ holder has a right to a specified volume of harvest from a given stock of fish over a certain time period. However, when it comes to the actual harvesting, the question of exclusivity refers to his ability take this harvest in the way he prefers and to prevent others from interfering with this ability. Any government fishing regulations clearly subtract from this ability. The same applies to the actions of other fishermen that may interfere with his ability to harvest his quota in various ways. Thus, an ITQ right generally provides substantially less than 100% exclusivity to the relevant asset, i.e. the quantity of harvest. It should be noted that *enforceability*, i.e., the ability to enforce the exclusive right, is an important aspect of exclusivity.

Permanence

Permanence refers to the time span of the property right. This can range from zero, in which case the property right is worth nothing, to infinite duration. Leases are examples of property rights of a finite duration. By verbal convention, the term "ownership" usually represents a property right in perpetuity or for as long as the owner wants. Note that there is an important difference between an indefinite duration, which doesn't stipulate the duration of the property right, and property right in perpetuity, which explicitly stipulates that the property right lasts forever. The duration of a property right may seem related to security; if a property right is lost then, in a sense, it has been terminated. Conceptually, however, the two characteristics are quite distinct. Thus, for instance, a rental agreement may provide a perfectly secure property right for a limited duration.

Transferability

This simply refers to the ability to transfer the property right to someone else. For any scarce (valuable) resource, this characteristic is economically important because it facilitates the optimal allocation of the resource to competing users as well as uses. An important feature of transferability is *divisibility*, the ability to subdivide the property right into smaller parts for the purpose of transfer. Perfect transferability implies both no restrictions on transfers and perfect divisibility.

Quality of property rights: The Q-measure

Following Scott (1988), it is helpful to visualize the above characteristics of property rights as measured along the axes in four-dimensional space. This is illustrated in Figure 1.

A given property right may exhibit all four characteristics and others to a greater or lesser extent. It is convenient to measure this on a scale from 0 to 1. A measure of zero means that the property right holds none of the characteristic. A measure of unity means that the property right holds the characteristic completely. Given this we can draw a picture of perfect property rights as a rectangle in the space of the four property rights characteristics illustrated in Figure 2.

We refer to the map of the property rights characteristics as in Figure 2, as the characteristic footprint of a property right. Obviously, the characteristic footprint of a perfect property right represents the outer limit for the quality of all property rights. It follows that the corresponding characteristic footprint of any actual property right in the same space of characteristics must be completely contained within this rectangle. This is illustrated in Figure 3.

Figure 3 illustrates the characteristic footprint of some actual property right within the characteristic footprint of a perfect property right. The ratio between the two areas enclosed by the two quality maps provide an idea of the relative quality of the actual property right. Henceforth, the term

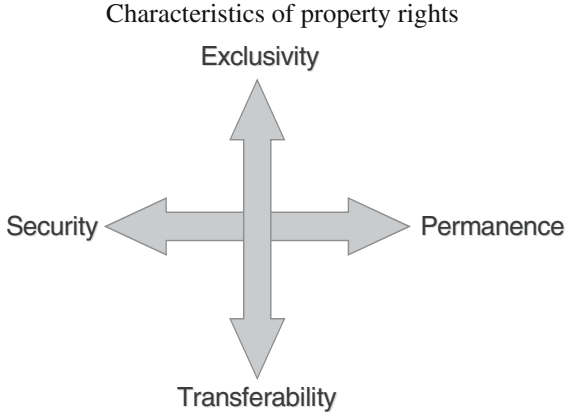

Figure 1. Characteristics of property rights.

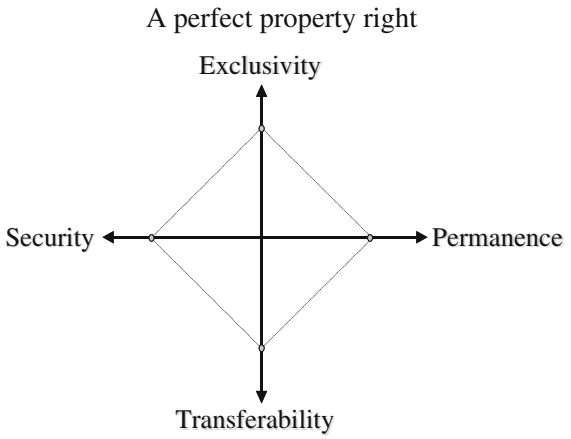

Figure 2. A perfect property right.

"quality of a property right" will refer to this ratio (which is always positive and less or equal to unity.). Obviously the closer the characteristic footprint of a property right is to that of a perfect property right, the higher is its quality.

Given the multi-dimensional nature of property rights, it is obviously useful to have a uni-dimensional numerical measure of the quality of a property right. One such measure is the so-called Q-measure for property rights (Arnason, 2000). In the case of the above four property rights characteristics, the Q-measure may be is defined by the expression

$$Q \equiv S^{\alpha} \cdot E^{\beta} \cdot P^{\gamma} \cdot (w_1 + \ w_2 \cdot T^{\delta}),$$
$$\alpha, \beta, \gamma, \delta, w_1, w_2 > 0 \quad \text{and} \quad w_1 + w_2 = 1 \quad (1)$$

where S denotes security, E denotes exclusivity, P denotes permanence and T denotes transferability.

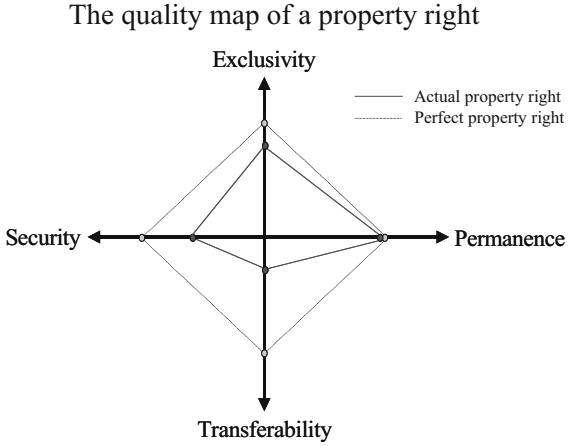

Figure 3. The quality map of a property right.

α, β, γ and δ are parameters and w_1 and w_2 are weights. The Q-measure takes values in the interval [0,1]. A value of zero means that the property right has no quality; it is worthless. A value of unity means that the property right is perfect. Note that in the formula in (1), the first three property rights characteristics are considered essential. If any one of them is zero, the overall property right quality is also zero. The fourth characteristic, transferability, by contrast, is not essential. Even when there is no transferability, the quality of the property right may still be positive.

ITQs as property rights

There are many property rights arrangements in fisheries. Among the more prominent are (i) sole ownerships, (ii) territorial use rights in fisheries or TURFs, (ii) individual nontransferable and transferable quotas, IQs and ITQs, (iv) community fishing rights and (v) access licenses.

Individual quotas define property rights in harvesting volume. If these rights are permanent, secure, exclusive and transferable (i.e. ITQs) then these property rights are of high quality. In that case, and barring other market imperfections, we may be reasonably sure that the harvesting will be conducted in the economically most efficient way. This means, among other things, that by adjustments in fishing capital and fishing effort the total allowable catch (TAC) will be taken at minimum cost[7], and that by adjustment of landings to demand and increased emphasis harvest preservation and quality the unit value of landings will be as high as is economically reasonable.

However, the underlying natural resource in question is not the volume of harvest, but the fish stocks and their ocean environment. Obviously, IQs and ITQs, being extraction rights, form only a very indirect property right in these underlying resources. Consequently, they provide the individual quota-holders with very little control over the fish stocks and the marine environment and equally small protection from the interference of others (quota holders, marine predators and other users of the marine environment such as mining companies, polluters, etc.) in these resources. In

[7]It is important to realize, however, that the institution of ITQs does not guarantee that the TAC will be set optimally.

terms of our analytical framework, this really means that the exclusivity, as far as these basic resources are concerned, is much reduced.

It immediately follows that as far as these underlying resources go, individual ITQ holders are subject to the common property problem. Consequently, they will be forced to use these resources for their own personal benefit without regard for the common good. In other words, ITQ holders, acting as individuals, will not have the appropriate incentives to maximize the overall flow of benefits from the fish stocks and their ocean environment. Only to the extent that it benefits them personally will they undertake acts that improve these underlying resources or avoid act that deteriorate them.

ITQ fishers are very much like hunters (or berry pickers) subject to a bag limit. They will of course be very interested in the general welfare of the fish stocks in which they hold quotas and therefore also their environment and will make this interest count in collective decision making. However, when acting individually they will not take these common (pubic good) benefits fully into account. Thus, ITQ fishers will still have an incentive to use environmentally damaging fishing gear (provided it is more harvest effective), release pollutants in the environment (if that is expedient) and discard valuable fish (if the quota value is high enough). Similarly, they will not individually have the appropriate incentive to feed the stock, protect it from predators, improve its yield by selective breeding, etc. (Copes, 1986).

Due to these limitations of ITQs as property rights in what really counts, the fish stocks and their ocean habitat, the ITQ system, as such, is not capable of fully maximizing the flow of benefits from these resources. Only to the extent that this benefits individual ITQ holders will these benefits be maximized. It should be noted, however, that when acting collectively, for instance through their formal Association, they would take their common interests into account and so overcome part of the common property problem. These collective decisions will, however, not generally take the appropriate account of non-fishing interests such as for instance the conservation interest.

The ideal property rights we would like in fisheries are similar to those farmers have on land. We would like our fishers to hold property in certain volume of ocean and the underlying ocean bottom with the ability to maintain their fish, or other crops, within this area. In that case they would control all the major factors affecting ocean productivity, very much as farmers do. In fact, as the experience from TURFs for shellfish (oysters) demonstrates, under those conditions fishers quickly become farmers. The problem is that we don't yet have the technology for this type of ocean enclosures. They are legally and perhaps even socially feasible but the technical ability to create and enforce them is still lacking. In this respect, most of the living resources of the ocean are still in a similar position to those on land some thousands of years ago.

What is the degree of sub-optimality implied by the limitations of ITQs as property rights? This is very hard to say. It clearly depends on the particulars of each situation. These include the prevailing fishing technology, the heterogeneity of the fish stock, the sensitivity of the ocean environment to harvesting and, not the least, the extent of collective decision-making concerning fishing practices. Comparing modern day farming with primitive agriculture just after land enclosures and, indeed, quota fisheries with fish farming suggests that the efficiency loss may be quite substantial.

Iceland's ITQ system

Iceland was among the first fishing nations in the world to adopt the ITQ fisheries management system. The earliest IQ/ITQ fisheries were initiated in the latter half of the 1970s following the extension of the fisheries jurisdiction to 200 miles. Since then, the ITQ system has expanded in several steps to comprise virtually all Icelandic fisheries. The most important steps in this evolution were taken in 1984, when ITQs were introduced in the demersal fisheries, and in 1991, when a uniform and fairly complete ITQ system was adopted for all Icelandic fisheries.

It is important to note that during the time period before 1991, many different fisheries management systems other than ITQs were tried in various fisheries including (i) overall catch quotas, (ii) fishery access licenses, (iii) fishing effort restrictions and (iv) investment controls and vessel buy-back programs. Iceland's experience

of the various fisheries management systems, however, has led to the adoption of the ITQ system in all fisheries. This progress, however, has differed substantially between the various fisheries.

The chronology of the development in Icelandic fisheries management is summarized in Table 1.

A brief account of the evolution of the ITQ fisheries management system in individual Icelandic fisheries is as follows.

The herring fishery

In 1969, 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 1975, when fishing from the Icelandic summer spawning herring stock was resumed, it was obvious that the whole fleet could not participate. Hence an individual vessel quota system with limited eligibility for quotas was introduced. These vessel quotas, however, were small and in spite of no explicit permission and certain bureaucratic obstacles, informal trading of these quotas soon emerged. In 1979, by a Ministerial decree and industry support, fairly unrestricted transfers of quotas between vessels were permitted. This, incidentally, is one of the first examples of an ITQ system in a major ocean fishery in the world. In 1991, this 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 1970s, was subjected to limited entry and individual vessel quotas for license holders in 1980 at a time when the stock was declining. The arguments were similar to the ones in the herring fishery previously; if the harvest had to be restricted it was most efficient to do so with the help of individual quotas. The positive experience with the vessel quota system in the herring fishery also proved a convincing argument for adopting the same type of system in the much more important capelin fishery. In 1986, in conjunction with increased transferability of demersal vessel quotas, capelin vessel quotas became partly transferable. In 1991, the capelin vessel quota system became a part of the general vessel quota fisheries management system.

The demersal fisheries

Following the extension of the exclusive fishing zone to 200 miles, the major demersal fishery, the cod fishery, was subjected to an overall catch quota. The annual quotas recommended by the

Table 1. Key steps in the evolution of the fisheries management system: a chronological overview

Pre 1965	Little fisheries management. Gear and area restrictions in some fisheries
1965–1975	Inshore shrimp and scallops fisheries. Mixture of access limitations, effort restrictions and, in scallops fisheries, processing plant quotas.
1969	The herring fishery: Total quota.
1972	The herring fishery: A harvesting moratorium
1976	The herring fishery: Individual vessel quotas
1976	The demersal fisheries: Total cod quota.
1977	The demersal fisheries: Individual effort restrictions
1979	The herring fishery: Vessel quotas made transferable
1980	The capelin fishery: Individual vessel quotas
1984	The demersal fisheries: Individual transferable vessel quotas. Small vessels exempted
1985	The demersal fisheries: Effort quota option introduced
1986	The capelin fishery: Vessel quotas made transferable
1988	A system of transferable vessel quotas in all fisheries. Effort quota option retained in demersal fisheries
1991	A fairly complete, uniform ITQ system in all fisheries. Small boats exemption retained
Post 1991	Various measures to control the expansion of the small vessels fleet. Modifications of the ITQ system

Source: Ministry of Fisheries: Fisheries laws and regulations.

marine biologists soon proved quite restrictive and thus difficult to maintain. Hence, individual effort restrictions, taking the form of limited allowable fishing days for each vessel, were introduced in 1977. However, due to technological progress and since the demersal fleet continued to grow[8], the annual allowable fishing days had to be reduced from year to year. Thus, at the beginning of the individual effort restriction regime in 1977, deep-sea trawlers were allowed to pursue the cod fishery for 323 days only. Four years later, in 1981 this number of allowable fishing days for cod had been reduced to 215 days. This system was obviously economically wasteful. Consequently, in 1984, following a sharp drop in the demersal stock and catch levels, a system of individual vessel quotas was introduced. Importantly, at this point, vessels under 10 GRT which were relatively numerous but accounted for only a small portion of the demersal catch, were exempt from the ITQ system.

Initially the Icelandic legislature, the Althing passed the ITQ legislation for one year only. In 1985, however, due to generally favorable results of the individual quotas, the system was extended for another year. However, an important provision was added. Vessels preferring effort restrictions could opt for that arrangement in place of the individual quota restriction. This system was extended, largely unchanged for an additional 2 years in 1986. In 1988, the Althing passed a general vessel quota legislation for all Icelandic fisheries to be effective for the period. 1988–1990. In 1990, a complete, uniform vessel quota system for all fisheries, the *Fisheries Management Act*, was enacted. This act, which became effective in 1991 and is of indefinite duration, abolished the limited effort option in the demersal fisheries. Moreover, in this act, vessels between 6 and 10 GRT were incorporated in the ITQ system. However, the exemption from the ITQ system for vessels under 6 GRT was retained with the provision they could only use fishing gear based on "hooks and line", i.e. fishing with any type of nets was forbidden to this fleet.

[8]Not only did vessel owners improve existing vessels but as new entry was possible new vessels were added to the fleet.

The shrimp and scallops fisheries

The inshore shrimp and scallop fisheries are relatively recent additions to the Icelandic fisheries. These fisheries were largely developed during the 1960s and 1970s and have, practically from the outset, been subject to extensive management consisting primarily of limited local entry as well as overall quotas. In the 1980s, most of the scallops and inshore shrimp fisheries went on ITQs. With the fisheries management legislation passed in 1988, the deep-sea shrimp fishery, the only remaining significant Icelandic fishery not closely managed, was also subjected to vessel quotas. The management of the shrimp and scallops fisheries is now a part of the general ITQ system according to the general Fisheries Management Act of 1990.

The current ITQ fisheries management system

The current fisheries management system is based on ITQs as stipulated in the *Fisheries Management Act* of 1990. The essential features of this system are as follows:

- All fisheries subject to a total allowable catch are managed on the basis of catch quotas.
- The quotas are assets of indefinite duration, perfectly divisible and transferable with minor restrictions.
- All commercial fishing, with the exception of a subset of the small vessel fleet, is subject to these quotas.
- The quotas were initially allocated on the basis of catch history prior to the institution of the quota system.
- The quotas are subject to a fee.

Currently, 19 species (and well over 30 substocks) that are found primarily within the Icelandic EEZ are subject to the ITQ system. These species account for over 97% of the value of harvest taken within the EEZ.

In addition to these domestic species, ITQs apply to a number of fisheries that take place outside the 200 mile EEZ, some in distant waters. These include for instance the shrimp fishery on the Flemish Cap, the Barents sea cod fishery, the Atlanto-Scandian herring fishery and the more recently developed blue whiting fishery. When an international agreement exists for the utilization of species outside the Icelandic EEZ, the Icelandic

share is allocated as ITQs. Even in cases where no international agreement concerning the utilization of the shared stock exists, Iceland frequently elects to impose a TAC on her vessels and allocate this TAC as ITQs.

It is worth noticing that in addition to the ITQ system, which together with the TAC imposition is the cornerstone of Iceland's fisheries management, there are a number of other measures designed to improve the sustainable yield of the stocks. There are rules concerning the type of fishing gear permitted, e.g. the minimum and maximum mesh size. Fishing with bottom trawl is generally prohibited 6–12 miles from the coast and in other areas, which serve as spawning and nursery areas. Sorting grids in fishing gear are obligatory in certain fisheries to prevent catches of juvenile fish. Extensive provisions are made for temporary closure of fishing areas to protect spawning fish from all fishing. Further to this, the Marine Research Institute has the authority, which it uses extensively, to temporarily close fishing areas if the proportion of immature fish in the catch is deemed to exceed acceptable limits.

The following describes Icelandic ITQ-system in further detail.

Total Allowable Catch (TAC)

The Ministry of Fisheries determines the Total Allowable Catch (TAC) for each species for which the Marine Research Institute feels a TAC is necessary. The TAC decision is made on the basis of recommendations from the Marine Research Institute. In recent years the Ministry of Fisheries has followed the recommendations of the Marine Research Institute quite closely.

TAC-shares

The basic asset in the Icelandic ITQ system is the right to a share in the annual TAC. These rights are of indefinite duration. They are denominated in percentage terms (of the TAC) and sum to 100%. Each licensed fishing vessel may hold permanent quota shares in the TAC for any species for which there is a TAC. These permanent quota shares, denominated as fractions, may be referred to as TAC-shares.

As already stated, the term or duration of the TAC- shares is not stipulated. However, it is clear that they are not explicitly in perpetuity although they may turn out to be so. More precisely, according to legal opinion, the ITQ system may be abolished and the TAC- shares withdrawn without compensation to the holders, provided a notice of several years is given (Auðlindanefnd, 2000). Therefore, this basic asset of the ITQ system must be regarded as being of uncertain duration. TAC-shares, however, are secure in the sense of being protected by law as any other asset and they exhibit certainty exclusivity over the corresponding harvests to be further discussed below.

Annual catch quotas

The size of each vessel's annual[9] catch quota in a specific fishery is a simple multiple of the TAC for that fishery and the vessel's TAC-share. Thus, the annual quota is denominated in volume terms.

It may be noted that the annual quota is a property right derived from the TAC-shares. It is highly secure, exclusive and tradable. Thus, apart from the limitation of duration it is a high quality property right.

Divisibility and transferability

Both the TAC-shares and the annual quotas are transferable subject to certain restrictions and perfectly divisible. Perfect divisibility means that any fraction of a given quota may be transferred.

Restrictions on quota transferability are relatively insignificant. Neither TAC-shares nor annual quotas may be transferred to non-Icelanders and the recipient of a transfer must be able to register the transfer to a licenced fishing vessel. Apart from this, TAC-shares are transferable without any restrictions whatsoever. Transfers of annual quotas, are more restricted. First, no more than 50% of the annual quota received at the beginning of the fishing year can be transferred from a vessel. This clearly imposes a significant constraint on quota trades and speculative quota holdings. Any quantity of purchased quotas can be re-traded, however. Second, no vessel may be associated with quota purchases that are clearly in excess of what it can reasonably harvest. Third, any vessel that does not

[9]In some cases, e.g. the capelin fishery and some inshore shrimp fisheries, where the biological management periods are less than a year, the quota periods are correspondingly shorter.

harvest 50% of its annual quota every second year will forfeit its permanent TAC-share. The effect and intention of these restrictions are to discourage speculative quota holdings and trades, restrict quota holdings to bona fide fishermen and to increase short term job security to fishermen and, to some extent, fish workers.

Apart from this, transfers of quotas are only subject to registration with the Fisheries Directorate. The particulars of the exchange are registered and listed on the Fisheries Directorate's web site.

Taken as a whole, the above restrictions on quota trades are relatively insignificant and have not, so far, seriously limited the ability of quota holders to engage in the quota trades they have sought. They, nevertheless, constitute a subtraction form the quality of the ITQ property rights.

Maximum quota holdings

The permanent TAC-shares held by any company or individual is subject to an upper bound that ranges from 12% of the TAC for cod up to 35% of the TAC for ocean redfish. Moreover, the individual companies must not control more than 12% of the value of all TACs.[10] These stipulations are explicitly to prevent what is regarded as excessive concentration in the fishing industry.

Initial allocation of permanent TAC-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 were essentially based on the vessel's historical catch record during certain base years. In the demersal fisheries this usually equaled 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 1981–1983 due e.g. to major repairs or having entered the fleet after 1981, the calculated share was 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 for all eligible vessels. Eligible vessels were generally those with a recent history of participation in the fishery. The same rule applied to the capelin fishery except that 1/3 of the TAC-shares were initially allocated on the basis of vessel hold capacity.

Needless to say, the initial allocation of the TAC-shares is formally irrelevant to their subsequent quality as property rights. However, the initial allocation may affect the perceived legitimacy and, consequently, the social support for the system and, thus, the security with which TAC-shares are held. In this sense the initial allocation process, or rather how it is perceived, and the property rights value of the TAC-shares are not independent.

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 *Law on Fisheries Monitoring Charges* of 2000, The *Fisheries Management Act* of 1990 and the *Development Fund Act* of 1994, the Fisheries Directorate is to collect a fee to pay for the cost of monitoring and enforcing the fisheries management system, contribute to fisheries research costs and to certain structural changes in the fishing. In total these charges amount to some 1.4% of the gross value of landings in 2002. In addition to these charges, vessel owners are required to pay a fixed daily charge for observers that may be placed on their vessels as well as providing them with food and board.

In 2002, the *Fisheries Management Act* was amended to include a special fisheries fee. This fee, which will become effective during the fisheries year 2004/2005 is imposed on annual quota allocations but is calculated as special fee on the calculated aggregate profits of the fishing industry amounting initially to 6% of these calculated profits and increasing to 9.5% in 2009. When fully in effect, this charge could, at current operating conditions, amount to an additional 2% of the gross revenues of the fishing sector.

[10]This aggregate value is calculated in cod equivalents using species exchange rates (essentially price ratios) set annually by the Ministry of Fisheries.

Taxation subtracts from the property rights value of assets. Basically it violates exclusivity – here the exclusivity to economic benefits of the asset. It is easy to show (see e.g. Johnson, 1995) that fishing fees generally affect the TACs which quota holders prefer.

Exemptions from the ITQ system: Small vessels

In the initial ITQ legislation in the demersal fisheries in 1984, vessels under 10 GRT were exempted. The main reason was that these vessels were relatively numerous and, consequently, administratively cumbersome to include. Also, in 1984, this fleet accounted for a very small part (about 2%) of the demersal catch. In subsequent years, however, both the size of the small vessel fleet and its harvest increased rapidly and it became a matter of some urgency to put a lid on this expansion. In 1991 this exemption from the ITQ system was restricted to vessels under 6 GRT and their allowable fishing gears to hook and line. Moreover, further expansion in the number of boats was curtailed and for those vessels that did not elect to enter the ITQ system a system of limited fishing days was introduced in order to constrain their total cod catch. As this system did not prove satisfactory, a number of additional restrictions were introduced in subsequent years.

In 1995, a special small boat ITQ system was offered as an option to the small boat fleet. A large number of small boats elected to go for this option. However, the small vessels that chose to remain in the limited fishing days system have continued to cause problems of higher than expected catches and thus the need for ever reduced allowable fishing days.[11]

Currently (beginning of 2004), the small vessel fleet, i.e. vessels under 6 GRT, is on three different types of fisheries management regimes. A few dozens of them are in the normal ITQ system, several (about 500) are in a special ITQ system for small boats and the remainder (about 300) are still in a system based on limited fishing days.[12]

In addition to these commercial exemptions from the ITQ system, it should be noted that both fishing for own consumption and recreational fishing is exempt from the ITQ fisheries management system altogether. These particular exceptions are thought to be of little consequence as both activities are believed to generate negligible harvests compared to the commercial activity.

All these exemptions from ITQ restrictions subtract from the property rights value of the ITQ property rights. More precisely, they reduce exclusivity as the exemptions reduce the fish stocks and thus reduce both current profitability of using quotas and future TACs without compensation to quota holders.

Comparison with the New Zealand ITQ and the Norwegian IQ system[13]

In Iceland and New Zealand fisheries management is based on fairly complete ITQ systems. Norway, by contrast, operates most of her fisheries on the basis of an IQ system, i.e. an individual quota system with very limited transferability of the quotas. In all three countries, the security of the property right is fairly high. However, in Norway, in certain fisheries, new vessels may be allocated quotas thus subtracting from the quota shares of the other fishing vessels. Clearly this reduces the security of the Norwegian property right. In all three countries the exclusivity of the harvesting right is pretty high, really only limited by government fisheries regulations which in the case of Iceland and in particular Norway are more extensive than those in New Zealand. Permanence of the property right differs greatly between the countries. In New Zealand, the quota rights are explicitly in perpetuity. In Iceland they are of indefinite duration but there are non-trivial socio-political threats to the continuation of the system. In Norway individual quota rights are explicitly non-permanent, allocated only for a year at a time. However, since quotas are customarily allocated to the previous recipients in more or less the same proportions, it may be claimed that the associated

[11]The number of allowable fishing days for cod in the limited fishing days system for small vessels is currently about 23 days a year.

[12]In 2004 the fisheries law was amended to bring all small vessels into the special small vessel ITQ system. This process will be completed in 2006.

[13]This comparison is primarily based on material in the following accounts: General: Hatcher et al. (2001), Arnason (2001), Country Specific: Iceland Arnason(1996ab), Runolfsson (1999), New Zealand Sharp (1996), Major (1999), Arnason (2001) and Norway Hannesson (1994).

Table 2. Estimated quality of quota property rights: Iceland, New Zealand and Norway: Q- values

Characteristics	Iceland	New Zealand	Norway
Security	1.00	1.00	0.90
Exclusivity	0.90	0.95	0.70
Permanence	0.80	1.00	0.50
Transferability	0.90	0.95	0.10
Q-values	0.86	0.96	0.44

Q-values calculated as:

$Q \equiv S^{\alpha} \cdot E^{\beta} \cdot P^{\gamma} \cdot (w_1 \cdot + w_2 \cdot T^{\delta})$, where $\alpha = \beta = \gamma = 1/3,\ \delta = 1,$ $w_1 = 0.6, w_2 = 0.4.$

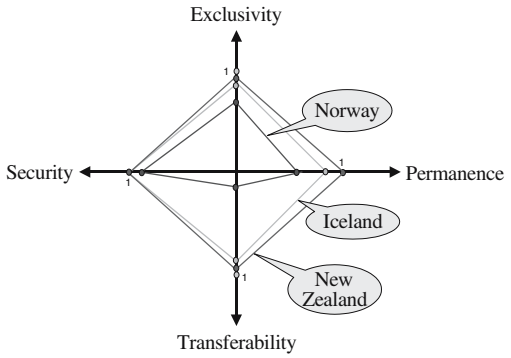

Figure 4. Iceland, New Zealand and Norway: The quality of quota property rights.

property right has gained a degree of permanence. Finally, transferability in New Zealand is close to perfect (only foreigners excluded). In Iceland, transferability is only slightly more restricted. In Norway, as mentioned above, there is virtually no transferability of the quotas.

A rough numerical estimate of the values of the property rights characteristics for these three countries is provided in Table 2. The corresponding characteristic footprints are illustrated in Figure 4.

According to the Q-values reported in Table 2, the quality of the New Zealand quota property right, $Q = 0.96$, is near perfect. The property rights quality of Iceland's quota rights, $Q = 0.86$, is considerably lower but still quite high. The property rights quality of Norway's fishing rights, $Q = 0.44$, is much lower than that of both New Zealand and Iceland. Thus, although by no means negligible, Norway's IQs must be regarded as comparatively weak property rights.

It may be helpful to compare these results with a corresponding assessment of the property rights quality of a typical, common property fishery employing the same methodology. This would typically be in the range of $Q = [0.05,0.2]$ depending on the ease of access and the number of participants.[14] Hence, compared to this, the Norwegian IQ system represents a substantial improvement.

Experience of the Icelandic ITQ system

The individual vessel quota system in Iceland seems to have yielded considerable economic benefits. New investment in fishing capital has been reduced and the fishing fleet has contracted. In some fisheries the number of operating vessels has dropped significantly. Fishing effort has also been significantly reduced. Finally, estimates of the actual economic rents generated by the system as well as analysis of quota values strongly indicate that very substantial economic benefits are already being generated by this management system.

To substantiate these claims let's briefly review the experience of Iceland's major fisheries.

The pelagic fisheries

The pelagic fisheries have until recently[15] been essentially based on two species; herring and capelin. The predominant fishing gear has been purse seine.[16] To a large extent the same boats pursue both fisheries. The herring fishery was subjected to IQs in 1975 and ITQs in 1979. The much larger capelin fishery came under IQs in 1980 with limited quota transferability[17] and full ITQs in 1986. So as far as the pelagic fisheries are concerned, the big change in fisheries management came in the 1980s.

[14]Thus, for instance, security = 0.95, permanence = 0.9, transferability = 0.0 and exclusivity = 0.005 yields, according to the same parameter values as in Table 2, $Q = 0.1$.

[15]Blue whiting fishing in mid-water trawl has become substantial fishery in the past few years.

[16]In recent years, mid-water trawling for herring has become more common.

[17]Two vessels could combine their TAC-shares.

Since 1980 there has been a dramatic decline in the number of fishing vessels and a smaller decline in the total tonnage (GRT) of the pelagic fleet.

Due to the resumption of harvesting from the previously huge and recently recovered Atlanto-Scandian herring in the late 1990s and the emergence of the blue whiting fishery a few years later, time series data on the pelagic fisheries to the present are not comparable. However, from about 1977 to about 1996, the Icelandic pelagic fisheries were based on the Icelandic summer-spawning herring stock and capelin almost exclusively. The history of the purse seine fishing fleet during this period is illustrated in Figure 5.

During the same period the pelagic catches increased, so there was a very substantial increase in the catch per unit of fleet (metric tons/GRT) as illustrated in Figure 6.

Now in pelagic purse seine fisheries, catch per unit of fleet is a good indicator of productivity. Hence the experience in the pelagic strongly suggests a dramatic increase in the technical efficiency in this fishery.

At the same time as these efficiency gains were being generated in the pelagic fisheries, the pelagic stocks improved considerably. The capelin stocks fluctuated around a constant average and the smaller herring stock expanded greatly. By the end of the period, the herring stock was the largest on record and well over two times bigger than at the beginning of the period. These trends have continued since.

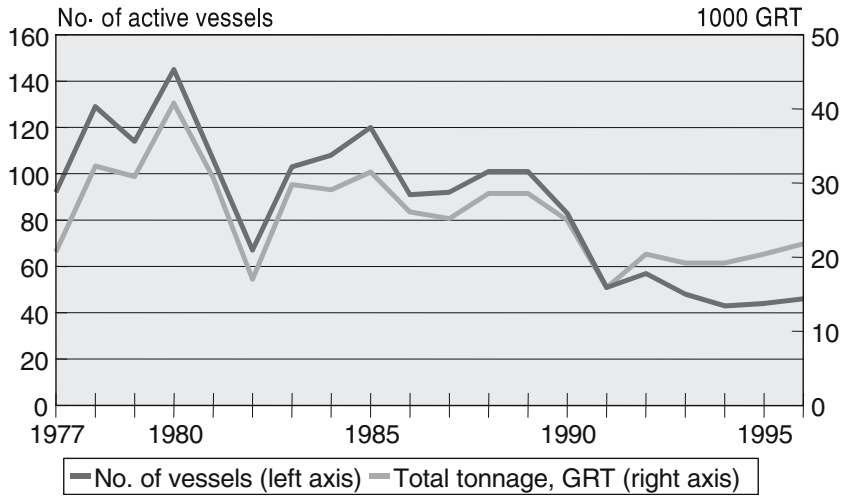

Figure 5. The Pelagic Fishery: Purse Seiners fleet developments (Purse seine vessels. Number counted as the maximum number active purse seiner in any one month of the year).

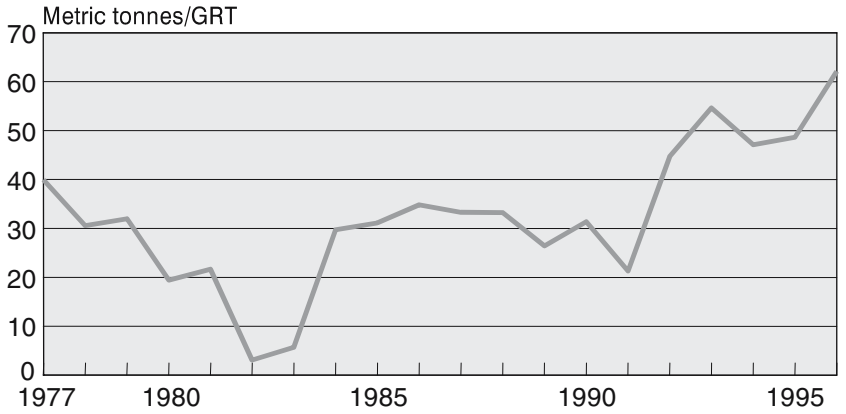

Figure 6. Pelagic Fishery: Catch per unit of fishing fleet (Metric tonnes/gross registered tonne).

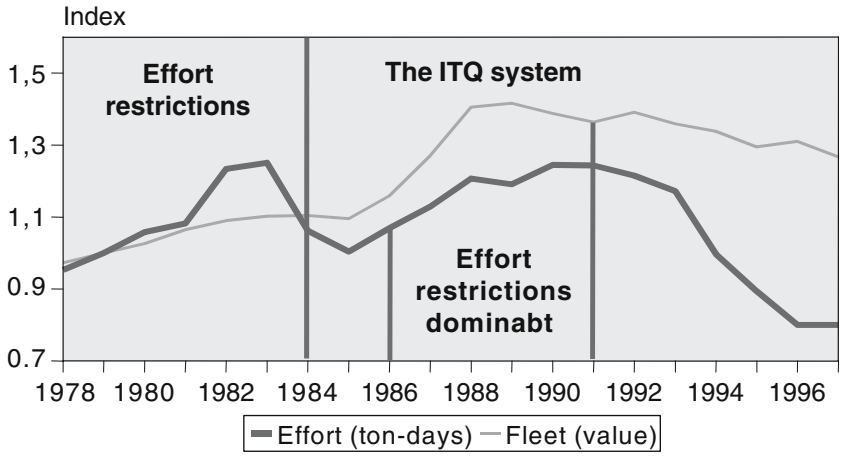

Figure 7. The evolution of the demersal fishing fleet and effort.

The demersal fisheries

The demersal fisheries are Iceland's most valuable fisheries by far. These fisheries are based on about 20 different species of which cod, haddock, saithe, redfish (ocean pearch), greenland halibut (turbot), ocean catfish (wolfish) and various species of flatfish are the most important. From 1978 to 1983, the Icelandic demersal fisheries were managed on the basis of effort restrictions in the form of limited fishing days for cod. An ITQ system was introduced in 1984. However in 1985 this was supplemented with an option to go for limited fishing days instead of a catch quota. As it turned out, a large number of vessels took this option with the result that from 1986 to 1990 more than half of the demersal catch was taken under effort restrictions rather than quota restrictions. The effort option was made less attractive in 1988 and abolished at the end of 1990. Since 1991 a fairly pure form of the ITQ system has been in operation in the Icelandic demersal fisheries.

The experience of this system is to a certain extent illustrated in the following Figure.[18]

The history illustrated in Figure 7 may be broadly divided into four periods. In the first period, 1978–1983, the demersal fisheries were managed by effort restrictions. During this period, fishing effort (measured as ton-days[19] of fleet on the fishing grounds) increased drastically and the fleet (measured in value terms) also increased considerably. At the same time, some of the most important demersal fish stocks (cod, haddock and saithe) declined substantially or by about 1/3. Catches, however, were about unchanged at the end of this period compared to its beginning. The second period covers the first 2 years of the ITQ system before effort restrictions became dominant. During this period fishing effort declines substantially and the increase in fleet size is halted. Stocks hardly change but catches improve slightly. In the third period, 1986–1990, the option to exit the ITQ system and go on limited fishing days is selected a high number of operators and the majority of the harvest is taken under a restricted effort regime. During this period, fishing effort rises again substantially and there is a drastic increase in the investment in new fishing vessels, the latter being at least partly motivated by the option of entering the ITQ system again with an improved historical catch record. During this period, there is a further significant decline in the most important demersal fish stocks but only a small increase in catch levels which peters out again toward the end of the period. The last period, from 1991 to 1997, is the period of a fairly complete ITQ system in the demersal fisheries – only small vessels (under 6 GRT) are exempt from the system. During this period, fishing effort declines very substantially and the fleet steadily declines, albeit at a slow rate. Over the period the most important demersal stocks improve slightly. Catches on the other hand are reduced quite substantially primarily because of the adoption of quite a restrictive TAC policy.

[18]Unfortunately due to alternation in statistical collection it has not been possible to obtain demersal fishing effort data beyond 1997.

[19]Fleet size measured in GRT multiplied by the total days of application to fishing.

To summarize: it appears from Figure 7 that periods where the fishery was managed on the basis of effort controls – a typical direct economic restriction – correspond to increasing fleet size and fishing effort. On the other hand, the periods of the ITQ management have been accompanied by substantially reduced fishing effort and a slowly reduced fishing fleet. Thus from 1990 to 1997, under the complete ITQ system, demersal fishing effort was reduced by over 30%. A similar speedy reduction in fishing effort occurred in 1984–1985 when ITQ restrictions were dominant. Thus, clearly, the ITQ system has brought the demersal fishery towards greater efficiency.

In spite of a quite restrictive TAC regime since 1991, the demersal fish stocks have responded quite sluggishly. This applies not the least to the cod stock, which according to the most recent estimates is now only about 10% larger than at the beginning of 1991, the first year of the complete ITQ system, although it has grown by almost 40% compared to its nadir in 1992. Recently, however the haddock and saithe stocks seem to have bounced back sharply and currently the size of these three most important demersal stocks is almost 50% larger than it was in 1991.

The fisheries as a whole

One of the major economic problems of common property fisheries is an excessive fishing fleet. Therefore, it is of great interest to examine how the fleet has developed prior to an under the ITQ system. Figure 8 illustrates the evolution of the aggregate replacement value of the Icelandic fishing fleet from 1970 to 2002. As shown in the figure the fishing fleet increased until 1998. Since 1990, however, the fleet has declined at an average rate of −2% annually compared to an average growth of +6% before. This, however, does not tell the complete story. Since the ITQ system became dominant, a number of fishing vessels while still being registered in the Icelandic fleet, have either engaged exclusively in distant water fishing, often under local licensing, or have become inactive. We may obtain a better idea about the actual fleet operating in the ITQ system by looking at number of vessels maintaining an icelandic fishing licence.

As illustrated in Figure 9, there has been a very substantial decrease in the number of licensed fishing vessels in Iceland since 1992. In 1992, the total number of these vessels was 2526. In 2002, licensed vessels numbered 1497. This represents a reduction of almost 42%. Looking exclusively at decked vessels, the mainstay of the Icelandic fishing fleet, the reduction is even greater or 52%. Needless to say, this reduction is entirely voluntary. It represents the response of fishing firms to the incentives they face under the ITQ system. It should be mentioned that as the fishing vessels have become larger, the reduction in total tonnage of licensed vessels is somewhat less than the reduction in their number. Nevertheless, the reduction in the licensed fleet is very considerable and, since harvests have increased and not

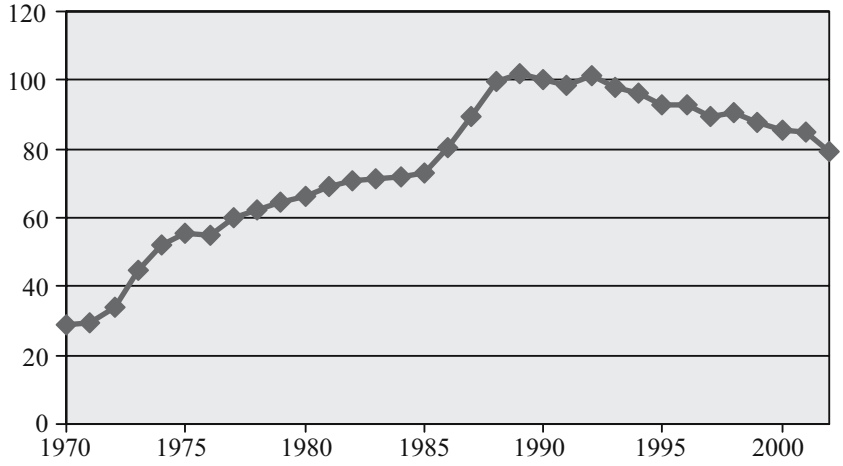

Figure 8. Total fishing fleet: replacement value. (Index)

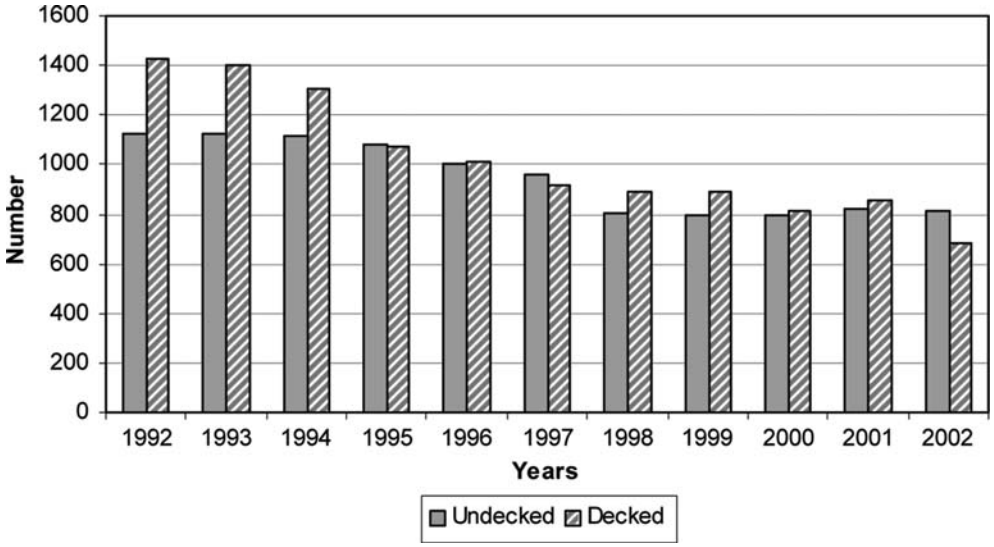

Figure 9. Number of licenced fishing vessels.

declined, represents a substantial gain in economic efficiency.

Another, and more direct way to assess the efficacy of the ITQ system fisheries is to look at quota values. As the quotas are transferable, an efficient market for trading them has evolved. According to standard economic theory (see e.g. Arnason, 1990), the total market value of quotas should provide us with a good measure of the net rents generated in the fishery.

The evolution of the annual quota values is illustrated in Figure 10. This figure, more precisely, describes the total annual rental value of quotas in all Icelandic fisheries.

As shown in Figure 10, the quota valuation of the Icelandic fisheries has greatly increased from 1984 onward. It is currently about USD 450 million per annum, almost 20 times what it was in 1984. This implies two things:

1. Since 1984, under the ITQ fisheries management system, the efficiency of the fisheries has increased dramatically.
2. Currently, the economic rents generated by the fisheries, as measured by the quota price evaluation, constitutes a substantial fraction of the average landed value.

These quota valuation results are confirmed by a couple of other statistics; (i) the operating results

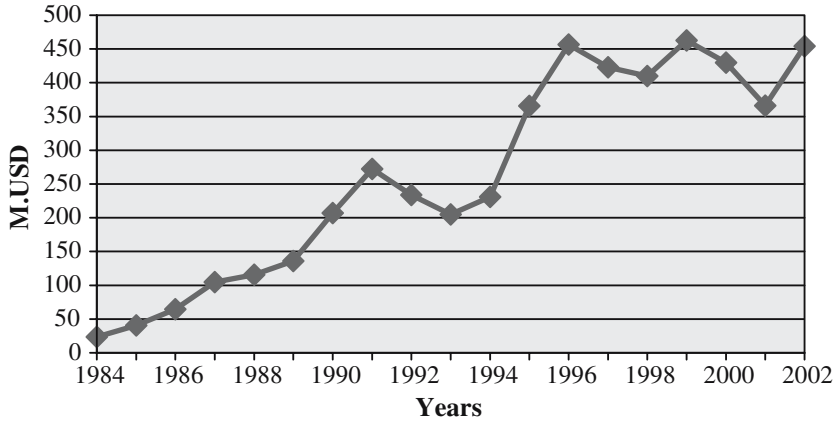

Figure 10. Annual quota rental values in the Icelandic Fisheries. (Million USD)

of the fishing companies and (ii) estimates of technical progress in the fishing industry.

Let us first look at the operating results of the fishing industry as reported by the National Economic Institute (2001). These estimates based on the examination of the operating accounts of a sample of fishing firms indicate a fairly dramatic upward shift in the profitability of the fishing industry since the introduction of the ITQ system in 1984 and the consolidation of the system in 1991. These results are illustrated in Figure 11.

A recent study (Ministry of Fisheries, 1999) attempted to estimate growth in the productivity of the Icelandic fisheries between 1974 and 1995. Productivity growth is as is well known often associated with technical progress (see e.g. Grosskopf, 1993). In the case of the fisheries, productivity growth or, for that matter, technical progress may stem from improved fisheries management (Arnason, 2003b). Thus, examination of the evolution of factor growth productivity in the Icelandic fisheries may throw light on the impact of the ITQ system.

The path of factor productivity in the Icelandic fisheries since 1974 until 1995 is illustrated in Figure 12. In interpreting this figure it is important to keep in mind that the big steps in the evolution of the Icelandic ITQ system were taken in 1984

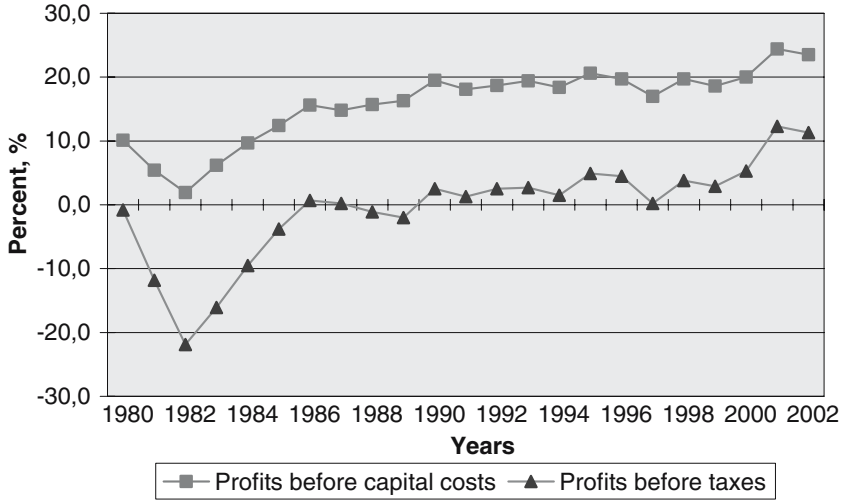

Figure 11. Profitability in the Icelandic Fisheries (Percent of revenues. *Sources*: National Economic Institute, 2001, and Statistics Iceland, 2003).

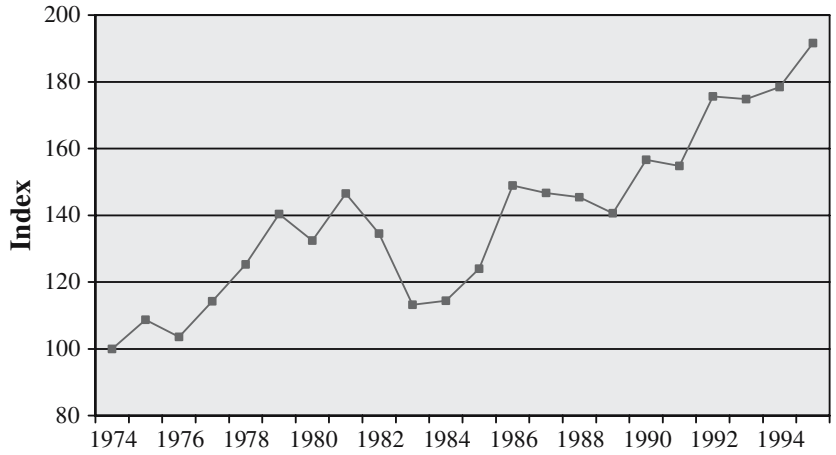

Figure 12. Total (three factor productivity for the Icelandic fisheries).

when the demersal fisheries were put on ITQs and in 1991when a fairly uniform ITQ system was established in all fisheries.

Figure 12 indicates a substantial growth in productivity in the Icelandic fisheries as measured by the total factor productivity measure (Arnason, 2003b). Over the data period as a whole (22 years), total factor productivity has increased by over 91%. The trend rate of productivity growth has been about 3.5%, which is much (about three times) higher than in any other major Icelandic industry and, indeed, in most major industries abroad. Moreover, it turns out, as is actually apparent from Figure 3 to 6, that most of this productivity growth occurred after 1994. Indeed, in spite of the extension of the fisheries jurisdiction to 200 miles in 1976, which is probably responsible for much of the productivity growth during the first part of the period, the growth rate since 1984 is significantly higher than in this earlier period. This may be taken as yet another evidence of the increased economic efficiency under the ITQ system.

Conclusions

Property rights are fundamental to economic growth and efficiency. Without them there can be no accumulation of capital and no markets and, therefore, no specialization in production. Many natural resources, including fisheries, are subject to inadequate or missing property rights. This leads to, often severe, problems of economic inefficiency. These problems are traditionally attributed to externalities but are better understood as missing or inadequate property rights.

ITQs represent one way to create property rights in fisheries and thus avoid their usual economic inefficiencies. ITQs, however, are harvesting rights and therefore only indirect property rights in the resources that really count, namely the fish stocks and their aquatic habitat. For these reasons, ITQs cannot generate full efficiency in fisheries in the way that, for instance, a farmer can in the management of his land.

In spite of these limitations, it appears that ITQs, when applied to ocean fisheries, can bring very substantial economic benefits. Thus, for instance, the experience of ITQs in Iceland strongly suggests that the system has led to very substantial increases in economic efficiency. Reports from the Netherlands, New Zealand and Australia where ITQs have been in operation for some years are similar. Positive outcomes seem, moreover to have been experienced in more recent ITQ systems as diverse as the Canadian groundfish and sablefish fishery (Turris, 2000), the US ocean quahog and wreckfish fisheries (Anderson, 1992) and the Greenland demersal and shrimp fishery (Arnason, 1996ab). Indeed, the outcome of the ITQ fisheries management system in Iceland seems to be in good conformity with the experience of similar systems around the world (Hatcher et al., 2001).

Given their proven economic superiority, it seems inevitable that the use of ITQs will continue to expand during the coming years. More fisheries in Canada and Mexico will come under ITQs. Following the end to the temporary moratorium on new ITQ systems in the USA, it appears highly likely more fisheries there will soon come under some form of ITQ management. ITQs are already being actively prepared in large Latin American fishing countries such as Peru and Argentina. The same applies to some important African fishing countries such as Mosambique, South Africa, Senegal, Gambia and Uganda. At the same time the creeping trend toward ITQs in European countries such as Britain and France is likely to continue. The notable laggard in this development is the inshore fisheries of South–east Asian fishing nations such as Japan, China, Indonesia, Thailand and India where artisanal type of operations fisheries are dominant.

Improvement of current ITQs

At the same time, we are likely to see improvements in the design and operation of existing ITQ systems. This will occur primarily to increase the efficiency of the system, a trend spurred on by the relentless push for increased efficiency in by profit maximizing fisherman. These improvements will take many forms. However, important among them will be:

(a) *More secure and long term individual quota rights*. This will lead to more efficiency in the use of the fish stocks and their habitat, the setting of TACs and investment in fishing capital.
(b) *Increased ITQ transferability*. This opens many doors including (i) international trading

of quotas just as any other commodity thus allowing global specialization in the fishing activity. (ii) trading harvesting rights between alternative users of living marine resources such as recreational fishermen, conservationists and the tourist industry, thus allowing a better overall use of ocean resources. The possibility of trading harvesting rights between fishermen and conservationists is particularly interesting. It offers the way to resolve a longstanding conflict of increasing intensity via market trades. If conservationists are more hurt by increased harvest than the fishermen benefit from it, they will simply buy the corresponding harvesting right from the fishermen and vice versa. In this way, the increased tradability of ITQ-rights between all sectors of the economy and, indeed, globally will facilitate the attainment of the overall optimal use of the scarce resources of the ocean.

(c) *More detailed quotas by grades*. One may also expect that the ITQs of the future will, in many cases, not be restricted to species of fish but subdivided according to grades or sizes of fish. Thus, for long-lived fish with significant price difference between fish sizes there may easily be separate TACs, and consequently ITQs, by size of fish. For instance, in the simplest case there would be one TAC set for large fish and another one for small fish. This accomplishes two objectives. First this makes it easier to control and tune the evolution of the stock biomass. Second, it reduces the problem of discarding inferior (most often smaller) fish because it is not sufficiently valuable to cover the quota price. If there is a separate TAC for small fish, that tends to be discarded, the quota price for that kind of fish will be correspondingly reduced. Hence the extra incentive to discard generated by the aggregate ITQ system will be eliminated and the problem of discarding correspondingly alleviated.

(d) *Co-management and self-management*. The ITQ system offers the opportunity for extensive co-management and self-management of the fishery that most fishing nations have yet to exploit. Co-management means that the management of the fishery – setting the TAC, carrying out research, enforcing quota restrictions fisheries etc. – is shared between the fisheries authorities and the fishing industry itself. Self-management means that the fishing industry itself takes these functions completely over. The key to this is that the ITQ system (assuming reasonably long lasting quotas) gives the quota holders a vested interest in the future of the fishery.[20] In other words, the ITQ system (with reasonably long lasting or permanent quotas) provides the industry with the right incentives to develop the fishery in the socially optimal way. The government, on the other hand, as is well known (Andersen et al., 1998), does not have these incentives. The other advantage is that since the incentives are right the industry as a whole can be relied on to do this in the most efficient manner and certainly less expensively than the government.

Community property rights

Community fisheries management based on community rights has attracted a good deal of attention in recent years (Hanna et al., 1996; Pitcher and Pauly, 1998; Arnason, 2001. The basic idea, as already discussed, is to allocate exclusive fishing rights to a community e.g. group of fishermen in the hope that this group will somehow find a way to manage its asset efficiently.

Although, in most cases, it would be overly optimistic to expect a speedy resolution to the fisheries problem on the basis of community fishing rights, the allocation of exclusive fisheries property rights to communities may actually be the best option in many situations where the implementation of individual quota property rights are simply not feasible. This actually seems to be the case in many fisheries in the world, not least many artisanal types of fisheries where there is a great number of participants and little social infrastructure. In addition, the devolution of fisheries management authority to communities

[20]ITQ-holders generally want to maximize the asset value of the fishery (Arnason, 1990). This normally implies a large stock of commercially valuable fish species and a desire to avoid stock and ecosystem irreversibilities. The perverse case of a privately profitable stock extinction discussed for instance by Clark (1973) would hardly arise unless there was either a major failure in the market system or extinction was indeed socially optimal.

may, in many cases, remove a thorny problem from the higher authority and thus be politically attractive. For these reasons one may expect a significant expansion in this form, or rather framework, of fisheries management in the future.

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