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Evolution of User Rights Quality in the Icelandic Fisheries

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Abstract

User rights in fisheries refer to the rights of fishers to harvest from fish resources. In terms of exclusivity, security, duration and transferability these rights can be strong or they can be weak. For this a definition of and a measure of the strength of user rights is needed. We refer to strong and weak user rights, and by strong user rights in fisheries (SURFs), we mean fishing rights that score highly on the quality of property rights, or property rights quality index (Q-measure), which be explain in the paper. Weak user rights are fishing rights that score low on the quality of property rights.

We then explain how this approach can be applied to analyze and score the quality of actual user rights in fisheries. This we do first by relating the characteristics or attributes of property rights to harvesting rights or vessel quota systems in fisheries and we look at the case of Iceland which implemented an individual transferable quota system (ITQs) in its fisheries in the latter half of the 20th century. We recount the story of the implementation and score the different property rights attributes. We then relate this to the change in performance of the fisheries by comparing the quality score to the value of the fishing quotas, and indirectly to the profitability of the fisheries. It turns out that there is a high correlation between the quality score and the value of the quotas.

Keywords: User rights in fisheries, fisheries, property rights in fisheries, property rights, strong user rights, quality of user right sin fisheries, Q-measure, SURFs
JEL classification: B10, B25, D02, D72, K11, N54, P14, P48, Q20, Q22, Q28

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1. Introduction

A quick look through the social science literature will show that there is much discussion of property rights and systems. These concepts of property rights and systems are, however, used in a very wide variety of ways and are often rather inconsistent. Theorizing about ownership and property in the western world spans more than two millennia. An early contributor was Aristotle who in his *Politics* (around 330 B.C) argued that private property promoted prudence and other social virtues a topic taken up and extensively examined by T. Aquinas (1273) and the scholastics (see Waldron 2004; Dupont 2017). Early modern political economists, including Locke (1689), Hume (1739), Smith (1776) and Mill (1848), had similarly much to say about ownership and property using various and often different arguments for private property.[2] More recent authors, writing more strictly within the field of economic theory, include Coase (1960), Alchian (1965), Demsetz (1967), Cheung 1970, Libecap (1989), Pejovich (1990) and Scott (2008). A fundamental finding of modern property rights theory is that strong or high quality private or individual property rights are necessary for a high degree of economic efficiency and economic growth (Arnason 2000).

The subject of user rights in fisheries is a sub-part of this much wider topic of property rights in general. We refer to strong and weak user rights, and by strong user rights in fisheries (SURFs), we mean fishing rights that score highly on the quality of property rights, or property rights quality index (Q-measure), which be explain in the next section of the paper. Examples of strong user rights are (i) sole owner rights, (ii) individual catch quotas (IQs), individual transferable catch quotas (ITQs) and (iii) territorial user rights in fisheries (TURFs). Weak user rights are fishing rights that score low on the quality of property rights.[3]

In what follows, the user rights implied by these arrangements will often be our point of reference. For this we obviously need a definition of and, preferably, a measure of the strength of user rights. This kind of measure is suggested by Scott (1989, 1996, 2008) and rigorously defined by Arnason (2007). This will be clarified in the first two sections of this paper.

We then explain how this approach can be applied to analyze and score the quality of actual user rights in fisheries. This we do first by relating the characteristics or attributes of property rights to harvesting rights or vessel quota systems in fisheries. Then we look at the actual case of Iceland which implemented an individual transferable quota system in its fisheries in the latter half of the 20th century. We retell the story of this implementation and at the same time show how the score in the different property rights attributes developed and the quality of these user rights changed. We then relate this to the change in performance of the fisheries by comparing the quality score to the value of the fishing quotas, and indirectly to the profitability of the fisheries. It turns out that there is a high correlation between the quality score and the value of the quotas.

2. The economics of property rights

Economic exchange is usually depicted as the exchange of goods. A research program emerged in the 1960s, the property rights theory, of which Alchian and Demsetz (1973) are probably the most known representatives.[4] This approach depicts economic exchange as exchange of property rights and states that the value of a good depends on the specific design of the relevant

[2] In addition to Waldron (2004), on the contribution of each, Locke to Mill, see Furubotn and Richter (2010) and West (2003).

[3] Arnason and Runolfsson (2023) argue that a transition from weak to strong user rights in fisheries has a wide range of impacts and attempted to identify and describe some of the more prominent of these impacts.

[4] But see also Coase 1960, Cheung 1970, Barzel 1997, Libecap 1989)

property rights. Private property rights also increase gains from trade and facilitate resource conservation.

2.1 Development of theories of property in economics

Demsetz (1967) seminal article, "Toward a Theory of Property Rights," sought to explain the rise of private-individual property rights as a natural, evolutionary response to increasing demand for scarce natural resources. Eggertsson (1990) has referred to this theory as "the naïve theory of property rights," according to which (private) property rights develop if an internalization of externalities is associated with social net benefits.[5]

The evolution of actual property regimes applicable to natural resources do not seem to support the naïve theory, not even as a first approximation (see Cole and Ostrom 2010). There is a vast array of complex property systems, including various combinations of private, common, and public property rights that apply to natural resources. There are many other variables, including the structure of underlying institutions, both formal and informal, laws, and ecology

Reacting to Hardin (and indirectly to Demsetz) Elinor Ostrom claimed that arguments about the (mis)management of common-pool resources (CPRs) were impoverished by conflation of the resource system with the management or property system and failure to consider the possibility that in many cases local groups of resource users were managing CPRs successfully. Many property systems for various common-pool resources fail to exhibit some of the specific rights that legal scholars and economists emphasize. In broadly considering ownership rights in common-pool resources, including fishery resources, Ostrom has discerned five distinct operational level "property rights" in use (Cole and Ostrom 2010, 103):[6] Entry, Withdrawal, Management, Exclusion, and Alienation.

Although the approach that Ostrom et.al. put forth may help in clarifying her major point that governing the commons is not a simple choice between privatization and government regulation, or markets and states (the title of her noble lecture, see Ostrom 2010), it only underlines that things are more complicated.[7] Comparing property rights for different resources is difficult because property rights have many characteristics as mentioned. Simply saying that something is privately or communally owned is not sufficient to describe a property right. For example, in some traditional communities, goods that are privately owned can be "borrowed", based on need, without prior agreement by fellow members of the community (Devlin and Grafton 1998). This form of private ownership is less exclusive than the form of ownership that exists in the typical developed country.

Many types of property rights exist, each with their own set of characteristics. Sometimes property rights that have a similar set of characteristics may be referred to as *property-rights regimes* (Grafton and Devlin 1998). The nature of these regimes is determined by the institutional setting, technology, and the aspect of the environment over which they are held. For example, land previously owned communally by indigenous populations became privately-owned following colonization by European settlers in such places as the United States, Canada,

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5 Eggertsson (1990) refers to the theory as naive as it seeks to explain the development of exclusive property rights without explicitly modeling social and political institutions.

6 The five resource control rights they identify are cumulative in nature and available only in functionally meaningful combinations (Schlager and Ostrom 1992: 252). As they explain, "to hold some of these rights implies the possession of others. The exercise of withdrawal rights is not meaningful without the right of access; alienation rights depend upon having rights to be transferred". Their vision of property does not, then, contemplate a bundle that can be thrown together or pulled apart, in just any way.

7 Elinor Ostrom´s theory of property rights uses the categories of Authorized entrant, Authorized user, Authorized claimant, Proprietor, and Full owner (see Ostrom and Schlager 1996, 133, see also Cole and Ostrom 2010)). Each category of these is defined by a bundle of (cumulative) rights: Access, Withdrawal, Management, Exclusion, and Alienation.

Australia, New Zealand, and South Africa. This change in the property-right regime reflected differences in culture and institutions as well as different technologies and uses for the land.

2.2 The characteristics or attributes of property rights

Eggertsson (1990) distinguishes between three categories of property rights: First, the right to use an asset (user rights). Second, the right to earn income from an asset and contract terms. And third, the right to transfer permanently rights over an asset, to alienate or sell an asset.[8] Although they do capture important aspects of "property rights", which may be useful for analysis, a more detailed description of the attributes or characteristics of "property" is needed and ones that are also measurable or quantifiable.

A more fruitful approach is to follow Anthony Scott (2006, 5) who refers to a set of characteristics that compose property rights, especially those held by individuals who use and manage natural resources. He refers to these as the characteristics of the right. Although some of these characteristics may seem familiar from standard economic literature on the efficient allocation of resources, Scott is not primarily interested in deriving solutions to an optimal property holding problem.[9]

Scott (2006, 6), as Arnason (2008), assumes that the characteristics are quantifiable and treats them as though they are continuous, measurable, and changeable (rather than dichotomous, amorphous, and fixed). But his aim is not the one in which the resource holder has a property right with full and complete liberty to transfer the right to another person, or to avoid interference and spillovers from neighbours. While such simplifications can be useful, for his purpose, they assume away situations in which a holder may have existent but insufficient amounts of a characteristic, inducing him to understand the need for, and hence make a demand for, more.

Any property right consists of a collection of different 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:[10] Duration, Quality (or security) of title[11], Exclusivity, and Transferability. We now turn to a more thorough description of the characteristics (attributes) and their sub-attributes.

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[8] Four components of ownership are often identified as (Voigt 2019) states:

1. The right to use a good (usus).
2. The right to modify a good (abusus).
3. The right to enjoy the fruits from the use of a good (usus fructus).
4. The right to transfer property rights of a good to other persons (venditio).

These are often referred to as a "bundle" of rights.

[9] Scott (2008, 13): "[I] do not share the Victorian notion that society's laws and institutions, like nature's mechanisms, are not only perfectible but are constantly in the process of perfecting themselves and, in so doing, are bringing to the service of humankind (and of God) more specialization, more economies of scale, and more diversity. At least, such a belief does not fit the historical evidence on the development of property rights…. This is not my concern. I seek to learn how and why the characteristics of property rights have changed, not—at least as a general principle—whether the changes were a good or a bad thing."
Scott (1996, 37) also states that we may look at the powers of ownership (to manage, dispose of, and take its yield) as outputs of property rights while the characteristics are more like inputs. Scott (2008, 5) refers to the characteristics as the "set of elements that compose individual property rights".

[10] Scott (1996; 2000) refers to the four characteristics; exclusivity, duration, security, and transferability. In other of his writings (1989a, 1989b, 1999, 2007, 2008) the characteristics are six; flexibility and divisibility in addition the beforementioned four. On each occasion he does suggest that there are at least four to six characteristics (1996,37; 1989a, 291).

[11] Scott (1989a) states that: "Quality of title is an idea close to enforceability". See endnote 4 in Scott (1989a).

2.2.1 Security

The attribute of security refers to the ability of the holder of a property right to withstand challenges to his property right. It is best thought of as the probability that the owner will be able to hold on to his property rights, where the probabilities range from zero to one. A measure of unity means that the owner will hold his property with complete certainty and a measure of zero means that the owner will certainly lose his property.

2.2.2 Duration

Another important characteristic is the duration or permanence of the property right. In some countries with a British tradition of property rights, land can be "owned" in 99-year leases or as freehold or fee-simple tenure with no fixed term of ownership.

Duration 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. The term 'ownership' usually represents a property right in perpetuity or for as long as the owner wants. There is a difference between an indefinite duration, which does not stipulate the duration of the property right, and a property right in perpetuity, which stipulates that the property right lasts forever. Perpetuity therefore requires that the government must buy or compensate if a right is recalled or revoked, while indefinite rights might be revoked altogether without compensation.

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 but of limited duration.

2.2.3 Exclusivity

Exclusivity refers to the ability of a holder to use his property without outside interference. Exclusivity may therefore refer to the physical interference with use of resource by other users. Such physical interference amounts to having to share a resource. No interference and full exclusivity would only be expected in the case of a very large or isolated property (Scott 2008). Such a situation would be very special indeed. At the other extreme we have much interference and very low exclusivity. And as many resources have multiple uses, some or even much interference would be the norm and a lower level of exclusivity. Where a holder's property has multiple uses, each use could be said to refer to a specific right and a separate measure of exclusivity.[12]

Exclusivity also refers to a holder's freedom from government regulation that restricts ways in which the resource is utilized. The government might restrict use in ways to promote a public good or for its own ends (Scott 2008).

2.2.4 Transferability (alienability)

In most countries, land can be transferred through purchase or inheritance. In some places like the Cook Islands in the South Pacific, however, foreigners are not permitted to own land while

[12] This is in some ways like Alchian (1965, 819): "What are the effects of various partitioning of use rights? By this I refer to the fact that at the same time several people may each possess some portion of the rights to use the land. « A » may possess the right to grow wheat on it. « B » may possess the right to walk across it. « C » may possess the right to dump ashes and smoke on it. « D » may possess the right to fly an air- plane over it. «E» may have the right to subject it to vibrations consequent to the use of some neighboring equipment. And each of these rights may be transferable. In sum, private property rights to various partitioned uses of the land are « owned » by different persons".

in other countries no restrictions are placed on the transferability of residential property (Devlin and Grafton 1998).

Scott (2008, 9) states that the standard of property right's transferability determines the extent to which a holder may bequeath, trade, or sell his interest in a resource. Some of the economics literature describes transferability as an indispensable aspect of ownership rights.[13] Increased or complete transferability, "total freedom to transfer any part of ownership", could therefore be considered a sign of more perfect property rights. In the real world the right of complete transferability is rare.

Property rights may also be described in terms of divisibility. Land ownership could, for instance, be split among different owners into surface rights for building and farming or other uses and sub-surface rights or mineral rights. Arnason (2007) claims that perfect transferability implies both no restrictions on transfers and perfect divisibility.

Instead of divisibility, in the literature this is sometimes referred to as "partibility", "fragmentability", or "separability". Scott (2008) emphasizes that divisibility is not the same as transferability in parts, divisibility can be much more complicated. Scott in fact distinguishes between three kinds of divisibility: Horizontal, vertical, and multiple-use divisibility.

First, horizontal divisibility allows a holder to subdivide his resource into rights over smaller "parcels" or pieces that may be leased, gifted, willed, or sold. The horizontal divisibility may be the most familiar, as it is readily seen in subdividing land in history. Such sub-diving of land and resources has not always been permitted in some places and at times. A less familiar horizontal divisibility is the creation of co-ownership, whether of share type or "common ownership", where the joint owner vanishes on death.

Vertical divisibility refers to overlapping temporal claims, where each right exists today, even if some holders can only exercise their right in the future. The holder of these rights may be permitted to trade, mortgage, or further divide them today.

The third, multiple-use divisibility, allows a right holder to create a separate right to each of the uses of a resource or property. Subdividing multi-use might involve allowing fishing, hunting, logging, and mining to separate parties. In fact, this is exactly what Alchian was referring to as partitioning land (see footnote 10).

2.3 The Quality of property rights

Arnason (2000, 2007) attempts to measure property right "perfection" based on these characteristics. Building on Scott's approach he refers to attributes instead of characteristics, and there are four of these attributes: Durability, Exclusivity, Transferability, and Security (Arnason 2007, 34).[14]

2.3.1 Measuring attributes

The different attributes mentioned above are measured on a scale from 0 to 1. An attribute's measure of zero means that the property right holds none of that attribute, and a measure of unity means that the property right or holds that attribute completely. On this basis a map may

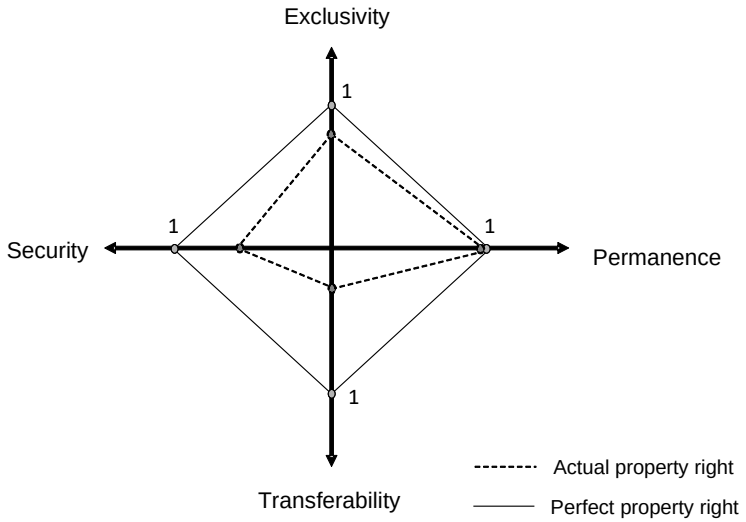
[13] Scott (2008, 9): "Transferability, and its variants, is mentioned by some writers (particularly in the allocational economics literature….) as the indispensable aspect of ownership rights for good land and resource use — more so even than quality of title. It is the characteristic that allows for markets in property rights, with perfect transferability a prerequisite for the 'perfect' market. These authors, of course, advocate complete transferability — total freedom to transfer any part of ownership of a property right to any outside party in return for fair compensation."

[14] Arnason (2007: 34) states: "It should be noted that enforceability, i.e. the ability to enforce the exclusive right, is an important aspect of exclusivity". Scott has enforceability under Quality of title.

be drawn of a perfect property right, holding all four attributes completely. Other less perfect property rights will have other characteristic footprints.

As for the measurability he explains that it may be most appropriate to use numerical values between 0 and 1 and then suggests a functional form (see below in a later section) for calculating a combined value of property right quality, which Arnason calls the Q-value. Enforceability is incorporated in each characteristic such that poor enforcement results in lower score for the attribute. The arrows represent the dimensions of the property right, and do not imply interactions between the characteristics.[15]

Figure 1. The characteristic footprint of a property right



The characteristic footprint of a perfect property right represents the outer boundary for characteristic footprint of all property rights, and the corresponding characteristic footprint of any actual property right in the same space of attributes must be completely contained within this rectangle, as illustrated in Figure 1.

Given the multi-dimensional nature of property rights, it may be useful to have a unidimensional numerical measure of the quality of a property right. A ratio of the area of the characteristic footprint of the property right to that of a perfect property right discussed above is one such measure. This measure, however, would treat all the attributes of the property right equally, which may not seem a reasonable premise.

A more flexible numerical measure of property rights quality is the so-called *Q*-measure of property rights quality proposed by Arnason (2000). In the case of the above four property rights characteristics, his *Q*-measure is defined by the expression:

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

where *S* denotes security, *E* exclusivity, *D* duration and *T* transferability. α, β, γ, δ, w_1 and w_2 are parameters, where either w_2 or w_1 is independent.

[15] Scott (2008b) states: "Economists will understand that the measured dimensions are not necessarily independent". See Scott (1989a) footnote 6.

This *Q*-measure has some attractive properties. It is easy to verify that it is nonnegative and takes values in the interval [0,1]. Note also that 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 property right will in most cases still be valuable and its quality measure therefore positive.

A Q-value of zero means that the property right has no quality and is therefore worthless. A value of unity means that the property right is perfect.

To apply the *Q*-measure, the independent parameters need to be specified. The appropriate specification should reflect the relative contribution of the different attributes to the property rights quality, and this, clearly, depends on the researcher's conception of property rights quality and an empirical assessment.

Like Arnason (2006), we adopt the following specifications: $\alpha = \beta = \gamma = 1/3$ and $\delta = 1$. These basically give equal weight to all four attributes. And $w_1 = 0.6$ and $w_2 = 0.4$ gives slightly more weight to the three attributes other than transferability, as the latter are assumed non-essential.

2.3.2 Property rights quality and economic efficiency

Basic economic theory suggests a strong positive relationship between property rights quality and economic efficiency. Standard Walrasian microeconomics basically assumes that perfect property rights generate full economic efficiency (see e.g. Furubotn and Richter 2010; Barzel 1997). Simple economic logic indicates that zero quality property rights lead to very low economic efficiency: if no-one will be able to hold onto anything durable, he produces there will obviously be very little production. Based on economic theory Arnason (2000, 2008) has relates the relationship between these characteristics (in sum referred to as "quality" of) property rights and economic efficiency, in the sense that more of the characteristics may lead to better functioning property rights.[16]

Employing the above logic and assuming continuity it seems obvious that economic efficiency increases monotonically with the quality of property rights. This means that any strengthening of a property right, i.e. improvement along any of its characteristics, will increase economic efficiency. And vice versa, any weakening of a property right along any of its characteristics will lead to reduced economic efficiency. In the absence of empirical research, it appears most likely that this increase will be best hypothesized as a S-shaped curve, as in figure 2.[17]

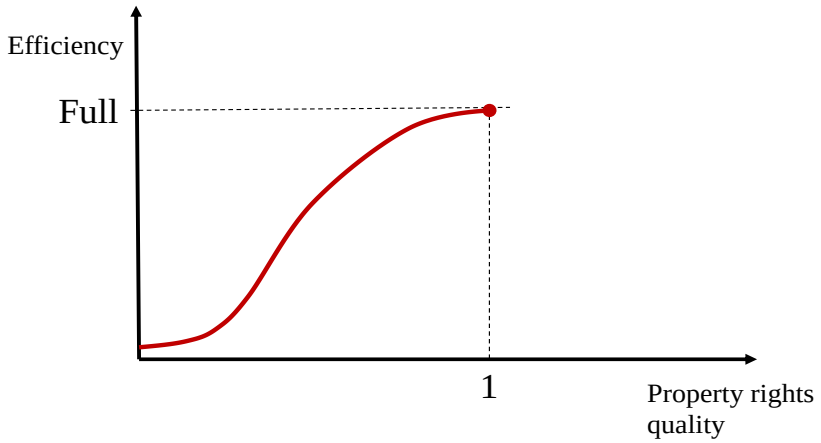
This is a hypothesized relationship between Q-values and economic efficiency. No claim is made that that the Q-value is a sufficient measure for property rights attributes. The depicted relationship is also subject to aggregation errors, just as a production function are as a function of K and/or L.

The expression "user rights in fisheries" coined by the FAO (see FAO 2016, 2018) refers to the specific rights of fishers (i.e. the users) to conduct their fishing. In terms of harvest and stock control, these rights can be weak (low quality) or strong (high quality). Strong or high-quality user rights in fisheries confer to the holder a high degree of control over the volume of harvest and other measures that affect the evolution of the fish stocks (Scott 2008).

[16] Arnason (2007, 33) states: "[T]he higher the quality of a property right, the more efficient is the associated economic activity ".

[17] Even so, the relationship between any one attribute and efficiency (increased value) may have different shape or be linear (but at a decreasing rate). See especially Arnason (2007).

Figure 2. Likely relationship between property rights quality and economic efficiency.



The *Q*-measure discussed above provides us with a straight-forward way to numerically assess the quality of common types of user rights in fisheries. We will refer to user rights with high property rights *Q*-value as strong and those with low *Q*-values as weak.

3. Application to the fishery

The relationship between the quality of property rights and efficiency in resource use applies also to fisheries. The effectiveness of fisheries governance systems in generating efficiency in fisheries depends on the quality of the property rights defined by the management system. This may be useful if it makes it easier to assess the changes in property rights quality associated with a proposed change in the governance system, rather than having to investigate the proposed system more directly (Arnason, 2012).

The quality of property rights index, the *Q*-measure above, provides us with a direct way to assess numerically the quality of user rights in fisheries. We now relate the attributes of the Q-measure to fisheries and fishing rights, and in particular IQs/ITQs.

3.1 Security

This attribute basically looks at what a fisher can expect at the start of the year or period concerning the security of access to a fishery or the right to catch a certain volume of fish or share of a TAC. The attribute should secure right holders both from other potential claimants and the government, and enforcement of the title.

Good security allows the holder of property right to receive payoff of improvements or increased value of the right, such as when the value of the underlying resource increases either due to higher prices, larger fish stocks or increased productivity.

Uncertain volume or share affects this.[18] If for example a fisher faces a decreasing share over the time of the rights duration that would manifest itself as weaker security of that right.

[18] The TAC for any species may of course increase or decrease from period to period (year to year) based on good scientific advice and other relevant knowledge. Such variations in the TAC(s) of course affect the volume of catch a holder of an IQ/ITQ may harvest but these should somewhat predictable.

3.2 Duration

Turning to the fisheries, the concept of duration may create some confusion between two meanings: the length of time during which the rules and specification will not be changed; and the length of the period until a particular harvest right holder's entitlement lapses. These concepts are slippery. For systems of IQs/ITQs, most governments' long-term quota rights convey an entitlement to a volume (share) of a total variable catch. A holder's *percentage* of the TAC would remain unchanged, but the TAC for all quota-holders may be reduced or increased periodically between fishing seasons (fishing years). By changing the TAC, the government administrators whose business, it is to manipulate the pressure on the stock can adjust the catch to which each holder is entitled without the hassle of introducing and disposing of new entitlements, i.e. new quotas.

Scott (2008) suggests that a different and second meaning of duration, raises a discussion about the distribution of jobs, income, and wealth among potential quota holders. Governments can issue quotas with limited duration and subject to a renewal fee. On expiry of an IQ/ITQ its holder could pay to renew it or allow it to be sold (or given) to the next person in line under whatever distribution policy is in place. But with transferability the owner of an expiring ITQ can also buy a replacement quota from another holder. Thus, one might conclude that ITQs are always 'permanent' in the sense that no fisher need go without quota because it has expired, so long as he is willing to pay the going market price to acquire a replacement. With this reasoning, the concept of duration is replaced by the concepts of TAC, renewal, and replacement, according to Scott (2008).

Duration therefore usually refers to the period or time within which the holder may carry on his resource use. Scott (2008) explains a second meaning that might refer to the period a second user must wait for the first user to finish his use. This might apply to a landlord who must wait before evicting a tenant. Duration can therefore range from indeterminate or permanent to being limited to months or years.

3.3 Exclusivity

The right of a fisher to go out fishing has exclusivity reciprocal to the number of other fishermen with the same right. A holder of an individual quota (IQ) has a right to a specified volume of harvest from a given stock of fish over a certain period. However, when it comes to the actual harvesting, exclusivity refers only to his ability take this harvest in the way he prefers and to prevent others from interfering with this ability. Any restricting government regulations on fishing would clearly also subtract from this ability. The same applies to the actions of other fishers that may interfere with his ability to harvest his quota in various ways.

Thus, an individual quota right generally provides some or even much exclusivity on harvesting but substantially less than full exclusivity to the relevant asset, the fish stock, and its marine environment. It should also be noted that the ability to enforce the exclusive right is important to exclusivity. In most cases it is the role of the government to manage the pressure and utilization of the fish stock(s) and the marine environment and enforce the exclusivity of harvesters' rights and the limits to their "property."[19]

At one extreme there is an open access fishery resource. Such open access has very little or no exclusivity, none if the stock is non-stationary or migratory and little if stationary. Most fisheries are no longer open access and at least have regulated access or even more restrictive

[19] This is an issue we will return to later, management and enforcement of resources. Depending on the nature of the resource and the property regime for its utilization, management and enforcement may be completely combined or separate.

access through special licensing, and in the less developed world there may be various common-pool arrangements. The level of exclusiveness therefore varies much and depends on the exact form of restrictions. On the other a "single owner" or TURF with a stationary stock (sedentary species) would be fully or near fully exclusive.

It is usually the role of the government to manage the fish stocks and the marine environment. In most countries this means that the government decides on the TACs for the various species, and it is also their task to enforce the TACs. The results of the governments decisions and enforcement can either reduce or increase the externalities for the holders of harvesting rights, both the externalities that result from the number of fishers sharing the same fish stocks and the externalities that result from the fact the various "fish species" feed off each other.

The TAC for any species may of course increase or decrease from period to period (year to year) based on good scientific advice and other relevant knowledge. Such variations in the TAC(s) only affect the volume of catch a holder of an IQ/ITQ may harvest. The "variations" discussed above are not based on that approach and affect not only the volume of fish a holder may harvest and not even his share of the TAC a particular group of holders may catch (such as the group of larger vessels) but his share in the overall TAC(s) is affected.

The constant percentage of an ITQ regime, the volume of fish a vessel may land as held down to the owner's quota, is perhaps the defining characteristic and major benefit of exclusivity. The individual quota right still does provide much exclusivity on harvesting a share, a certain volume of fish. But as detailed above, the individual quota provides substantially less exclusivity to the relevant asset; the fish stock(s). Fewer vessels make the fishery more exclusive and increased number of vessels does the opposite, reduce exclusivity. Loose enforcement of the TAC by the government lessens this exclusivity, beyond what it would otherwise be.

Lack of exclusivity may be described as a seizure of output (Arnason, 2007). One example of such "seizure of output" is in the form of special tax on quotas or landings. Sometimes governments attempt to capture "rents" from the more profitable fisheries that result from strong user rights. Such taxation, sometimes referred to as resource rent or fishing fee, seizes some of the catch value and thereby weakens exclusivity and user rights.

Some authors (Devlin and Grafton 1998, Scott 2008) refer to *flexibility* in ITQ systems in allowing fishers to land a catch in excess of their quota, sometimes up to 10% above their quota in any one year. The extra landings are then deducted from the following's year quota, and the same may apply to carryover of unused quota from one season to the next. Another flexibility, and an incentive at the same time, may be found in that fishers can land catch above quota and keep 50% of the value of those landings. Although these authors are (in)directly referring to the rules of the New Zealand fisheries management system, which is based on ITQs, the Icelandic system has some similar provisions, as detailed below.

3.4 Transferability

When rights become exclusive their transferability may be wanted. Transferability of exclusive fishing rights offers fishermen an opportunity to retire without losing all future income of staying in. It thereby offers opportunities to more qualified fisher, or newcomers. Restrictions on tradability of course can prevent this by distorting the price signal. The sale and leasing of quotas signals less catch for those selling and more catch for those buying. Transferability works as a selective process and creates incentives for cost savings in the fishery. It selects the productive ones and the ones with longer time horizons, a longer willingness to wait. A transferable quota system should thereby increase cost efficiency.

In a relatively small fishery transfers of quota may of course lead to concentration of quotas. This concentration can, in addition to the above-mentioned reasons, be the result of scale economies. Increased concentration may be economically feasible but meet opposition and restrictions being put in place.

How are the quotas divisible? They may be divisible if quota holders are allowed to trade portions of their quota shares of their long-term or permanent quota, or if they are allowed to trade portions of their annual quota volume. This is important because most trades are marginal, where sellers sell or lease a small portion of their quota and buyers have the same approach.

3.5 Fishing rights, user rights, and property rights

We refer here to the user rights with high property rights *Q*-value as strong user rights and those with low *Q*-values as weak user rights. In terms of harvest and stock control, these rights can be weak (low quality) or strong (high quality). Strong or high-quality user rights in fisheries confer to the holder a high degree of control over the volume of harvest and other measures that affect the evolution of the fish stocks. The more secure, durable, exclusive, and transferable the ITQs, the higher the Q-measure and the complete is the property right.

As such, ITQs are a usufruct right, a right to fish, not a right to the stock or the ocean habitat (Libecap 2008). The quota defines a property right in harvesting volume, a share of the total allowable catch (TAC). Being extraction rights, ITQs are only a very indirect property in underlying resources.

Scott (2008, 180) claims that ITQs may not fall under the law of property or provide a 'root' for a holder's title or even anything like registries of mining claims or land titles. These rights, Scott continues, may be rather like entitlements to use a resource,[20] and user rights or withdrawal rights may be the more appropriate wording.[21] Being entitlements means that it is therefore easier by law for the government to extend, reduce, or restrict these rights. Even though such rights, licenses, and individual quotas, become valuable in a well-organized fishery, they may not have features that most property has, such as allowing the "owner" to put the "property right" as collateral,[22] or being directly inheritable.

This description by Scott may be correct. But it may still be proper to refer to ITQs as a property right although this property right is not as strong or complete as a property right to the underlying asset.

4. Evolution of the Icelandic fisheries management system

Until the extension of the fisheries jurisdiction to 200 miles in 1976, the Icelandic fisheries were, for all intents and purposes, international, and common property fisheries. Large foreign fishing fleets featured prominently on the fishing grounds, taking almost half of the 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 fishers were concerned. They were still forced to compete for shares in the catch. Therefore,

[20] In his seminal article Scott (1955, 116) wrote: "[T]he mere existence of the institution of private property is not sufficient to insure the efficient management of natural re-sources; the property must be allocated on a scale sufficient to insure that one management has complete control of the asset." This was his definition of sole ownership.

[21] The expression "user rights in fisheries" coined by the FAO (see FAO 2016, 2018) refers to the specific rights of fishers (i.e., the users) to conduct their fishing.

[22] They are therefore an example of dead capital in de Soto's terminology (de Soto 2000).

not surprisingly, the development of the Icelandic fisheries in the post-war era closely followed the path predicted for common property fisheries exhibiting increasingly excessive fishing capital and effort compared to reproductive capacity of the fish stocks.

This long-term decline in the economic performance of the Icelandic fisheries did not go unnoticed. In fact, over the years, various measures were taken to reverse this trend. However, before the extension of the exclusive zone to 200 miles in 1976, effective management of the fisheries, especially the demersal ones, appeared impractical due to the presence of large foreign fleets on the fishing grounds. For this reason, fishery management before to the extension of the fishing limits to 200 miles was limited. With the *de facto* recognition of the exclusive 200-mile zone in 1976, the situation dramatically changed.

Following the extension of the exclusive fishing zone (EEZ) to 200 miles, the major demersal fishery, the cod fishery, was subjected to an overall catch quota (TAC). The annual quotas recommended by the marine biologists soon proved difficult to maintain. Hence, individual effort restrictions, taking the form of limited allowable fishing days for each vessel, were introduced in 1977. The demersal fleet, however, continued to grow both through improvement of existing vessels and with new entry as it was still possible for new vessels to be added to the fleet. The annual allowable fishing days, therefore, had to be reduced from year to year.

The value of fishing capital employed in the Icelandic fisheries increased 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 one-third of the output-capital ratio in 1945.

The authorities realized that the size of the fishing fleet, at least in terms of number of vessels and power, was already beyond the yield of the fishery. And, even if successive governments adopted a policy of "no new vessels", that policy was not enforced. The only restriction on the entry of additional vessels was access to finance, which was in that period heavily controlled by the government.[23]

After the moratorium in the herring fishery was lifted in 1975 vessels that had a catch history from the 1960s were eligible to apply for licenses. The larger vessels, using purse seine gear, could apply for a quota license, while the smaller vessels could apply for driftnet license.[24] The TAC was split, half for the purse seiners and half for the drift netters. The purse seiners share in the TAC was then allocated in equal size (volume) quotas to each licensed vessel, while there was a common TAC for the drift netters. In subsequent years the share in the TAC for the drift netters declined slowly and eventually to zero, mostly because interest disappeared as it became less profitable. During this decade from 1975 the catch was more than the TAC each season, for both the purse seiners and the drift Looking again to the history of fisheries management in Iceland in recent years, the laws and regulations that introduced licensed access and IQs essentially provided short duration of rights or entitlements. Licensing with an attached quota in the herring and capelin fisheries only had seasonal duration in the first decade or so, from the late 1970s to late 1980s. For the cod and bottom fish, the duration was for one year, then 2 years, and later 3 years, before they became "permanent" or indeterminate in duration in 1991. Despite the short duration, these IQs were made transferable (ITQs) within the fishing season/quota period in the 1980s. This short duration before 1991 most likely affected their

[23] For a more thorough description of the evolution of the fisheries management system in Iceland, see Runolfsson (2017) and Arnason (2005).

[24] Some of the smaller vessels used bottom set gillnets.

value, even though many vessel owners formed expectations rather quickly that the ITQs would eventually become permanent.

4.1 Vessel quotas in the fisheries

Despite the volatility of catches and increasing number of vessels, expectations may have seemed largely unchanged up until the Fall of 1983. The government marine biologists then issued another "black report" on the state of the demersal fisheries.[25] The recommendation of the biologists was to cut the TAC for cod by almost 50% in 1984 from previous years. This time there was a dramatic response, in that the government with the support of the association of vessel owners introduced a vessel quota system as a temporary measure to be applied for the fishing (calendar) year 1984. All fishing vessels larger than 10 GRT would receive an individual vessel quota based on their volume and share of the catch in 1981-1983. The fleet of small vessels, under 10 GRT, had been marginal in the fisheries, probably only averaging less than 3% of the cod catch in previous years, and less in others.

Table 1. *Chronology of key steps in the evolution of the fisheries management system in Iceland*

1975	The herring fishery: Individual vessel quotas (TAC)
1977	The demersal fisheries: Total cod quota (TAC) and individual effort restrictions
1980	The capelin industry: Individual vessel quotas (TAC)
1984	The demersal fisheries: Individual transferable vessel quotas for larger vessels
1985	The demersal fisheries: Effort quotas option introduced
1988	Transferable vessel quotas in all fisheries for larger vessels. Effort quota option retained
1991	A complete uniform system of transferable quotas in all fisheries for all but smaller vessels
2004	Separate ITQ system for smaller vessels, all major fisheries subject to ITQs
2004	Special taxation (fishing fee) on quotas (catch)
2009	Open access summer coastal fishery for smaller vessels (common TAC)
2010	Fishing fee increased considerably

In 1984 therefore, the main fleet of fishing vessels operated in a vessel quota system. This system was supposed to be temporary for one year only, and the score on durability is therefore quite low, but very secure for this short period. Note the high score on security. Leasing of the vessel quotas was allowed, with some restrictions, but transfers of quota shares were not allowed. Of course, the sale of a vessel or the company that owned the vessel resulted in the transfer of shares, but they were not divisible. The score on transferability is therefore rather high. Along with the introduction of vessel quotas for all but the small vessels, licensing was introduced. No entrance of new vessels was now possible unless a similar sized vessel was retired. This meant that no additional vessels were able to enter the quota system, and in fact regulations incentivized the retirement of vessels as the only way to bring in larger size vessels was to remove the same volume in GRT from the fleet.

[25] The first of these appeared in 1975, at the time of the extension to 200 miles.

Exclusivity in this vessel quota system was of course much more than in the previous open access system. Only licensed vessels with quota could catch cod and other major demersal species in 1984. But there was less perfect exclusivity on at least three fronts. First, the TAC was set above that recommended by the fisheries biologists. Second, it was assumed that the small vessels with their implicit low TAC would be limited to that volume. Neither TAC held, the total catch was beyond both TACs. The small vessel catch was higher than their TAC and the catch of larger vessels was also higher. Third, export of unprocessed catch was penalized by 25% of quota volume, which also decreases exclusivity. In addition, there was no change to other regulations concerning gear, areas, etc. that were in place in previous years.

The vessel quota system of 1984, which was supposed to be temporary for one year, was in fact extended, again and again. It was first extended for the year 1985, then for two years, 1986-1987, and finally for three years, 1988-1990. On each extension there were changes, especially concerning the offering for effort restrictions. These effort restrictions allowed a vessel to increase catch beyond their allocated quota, but with a cap. As a result, more than 25% of larger vessels chose effort restrictions in 1985, between 50-60% of vessel in 1986-1987, and close to 40% in 1988-1990.

In 1984-1990 the number of small vessels also continued to increase and so did their share in the total catch of all major demersal species. By the end of that decade their number went above 2000 from less than 1000 at the beginning of the 1980s. Their share in the cod catch had been estimated around 3% in 1981-1982 but was close to 15% in 1990.

4.2 Comprehensive ITQ system in 1991

The development described in the two paragraphs above led to the introduction of a somewhat comprehensive ITQ system in 1991.[26] The new legislation did not have a sunset clause, so in effect it introduced indefinite quotas. But there was an amendment in the legislation that required a review of the system within two years,[27] and that amendment tempered expectations regarding permanence. The new legislation also incorporated all vessels between 6-10 GRT in size into the ITQ system but leaving smaller vessels outside. Those vessels, smaller than 6 GRT, were restricted to hook-and-line gear and had a common TAC in cod. That TAC remained unenforced and in addition these vessels began seeking increased catches in other demersal species, especially haddock, ling, tusk, and catfish. The catches of these vessels over the next decade were therefore much higher than anticipated. The authorities met this more with accommodation rather than limiting their catch. This therefore both decreased security of the ITQs and exclusivity. Catches in most years were beyond the allowable TAC. Export of unprocessed catch continued to be penalized, although the decreasing to 20% of volume. There were still way too many vessels trying to catch a decreasing volume of fish, with shrinking stocks. Note the score on exclusivity.

In the government's role as manager of the utilization of the fish stock(s) it also sets regulations that lessen the exclusivity of the quotas, such as confining vessels to specific fishing areas (or excluding areas), fishing seasons (or closing sub-seasons for some species), gear, the size/age of fish (juvenile fish), and the handling and care of the catch.

The fisheries management legislation restricts export of raw unprocessed fish by penalizing up to 25% of volume exported.[28] Fishing firms that export unprocessed catch are automatically penalized by having their fishing quotas reduced by that volume.

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[26] Legislation was introduced in 1990, taking effect in 1991.

[27] The review was completed in 1993 and changes were made to the law with effective date in 1994.

[28] The penalty was 25% in 1984, 10% in 1985-1986, 15% in 1988-1990, 20% for cod and haddock but 15% for other species from 1991.

Transferability of shares was introduced in the new legislation, where ITQ shares were now divisible and transferable. There were some restrictions regarding sale of quotas/vessel between municipalities, but they rarely intervened.[29] A new restriction was introduced concerning the leasing of quota, as now all vessels had to utilize a minimum of 25% of their quota every other year.

In Iceland quotas can only be attached to vessels and no vessel should have more quota registered to its name than the vessel can reasonably catch during the fishing year. This limits the number of individuals and firms that quota holders can trade quota with.

Each vessel must utilize a minimum of 50% of his quota each year for his vessel to keep the quota share. This means that vessel must be operated and harvest half its quota each year. This restricts the ability of a vessel owner in leasing only half his quota each year. In the early days of the system this was less restrictive as the rule applied every other year.

A cap on the share of quota any individual or firm can own also reduces transferability. As quotas become more concentrated the number of potential traders diminishes and limits transfers.

The government and its agencies do look on the ITQs as valuable "assets" and treat them as such for tax purposes. And when it comes to collateral, financial institutions do assess the value of these rights when they look at the value of vessels as collateral for loans, and in divorce or inheritance cases the courts also look to the value of these rights. So indirectly at least, these rights seem to pass as property in above.[30]

4.3 The increasing share of smaller vessel

Looking at the recent history of the Icelandic fisheries and the IQs and ITQs in particular we see that the combined share of the fleet of larger fishing vessels was reduced continuously in the early days of the ITQ system. This declining share may be described as a lack security from government taking, although there was also encroachment from others, as total landings of many species were well above TACs for many years. The source of this overfishing lay in the lack of enforcement of property rights, resulting in less security of the rights of the ITQ holders.

At the outset of the IQ/ITQ system that evolved from 1984, the share of the main commercial fleet in the cod was 96% and the part-time small vessel fleet (spring and summer fishing) was 4%. No allowance was made in the other five species that were part of the early IQ/ITQ system, although it was common knowledge that the small vessels could not fish cod without by-catch. As access of small vessels was not restricted at the start and were then only gradually restricted based on vessel size and gear type (and even seasonal fishing) their numbers increased and their catch of bottom fish species cut into the share of the larger commercial vessels. As we look at the subsequent time periods of IQs in 1984-1990,[31] and the ITQ-system from 1991, where some of the small vessels were either incorporated into the main system at various times, as in 1988 and 1991, or in a separate and continuously evolving system for smaller vessels with restricted gear, as in 1991, 1996, 2001, and eventually in a separate "small vessel" ITQ system in 2004.[32] For most of this period the volume of catch of the small vessels in these species was

[29] Community pre-emption but rarely exercised.

[30] ITQ-shares bought before 1996 could be depreciate as other investment by 6%-8% per year, or the same as applies for the fishing vessels. ITQ shares bought in 1996 or later are not depreciated.

[31] In 1984-1990 there was also an effort quota option alongside the IQ system, and this reduced the share of the group of vessels that opted for the IQs for this whole period, especially in 1986-1987.

[32] The small vessel share of the cod TAC was in fact cut from 13.9% to 13.75% in 1997. But the TAC for cod was increased at the same time so the actual volume of cod that the small vessels were allowed to catch increased. And then again, their catch was more than their allocated share in the TAC.

way beyond their TAC, so there was not only a gradual decline in the share of the TAC that the main commercial fleet could catch but also a decline in the share the main commercial fleet would catch, as the enforcement was lacking in keeping the less restricted small fleet within their allowed TAC.

As major change in the legislation on fisheries management in the early 2000s requires all vessels to have ITQs.[33] In fact, there were now two almost separate systems, one for the larger vessels and one for the smaller.[34] Both systems had a share in a common TAC for each species, and all major fish species were part of the ITQ systems. By 2007 the total number of vessels had decreased in number by more than 50%, although they had increased in size and power[35]. The TAC was now enforceable, as all vessels had ITQs. Total catch was therefore more or less in line with the TAC. Note the higher score for exclusivity. Later, regional quotas, the summer coastal fishery (for small vessels that catch fish beyond and/or without quotas), and the smaller "tourist fishing" quota (very small, and very restricted gear) and the right of the public to fish (not many do, and there are restrictions on gear) that does not count towards the TAC, further cut into the share of the main commercial fishing fleet.[36]

Various rules to provide flexibility for fishers and incentives for behaviour that promotes landing of all catch have been adopted in the Icelandic management system. In the early days of the IQ/ITQ system for the demersal fishery this flexibility allowed fishers to land up to 5% above quota and carryover 10% between periods. This latter carryover was later increased to 20%, while landings of cod above quota was prohibited. Later changes also allowed limited interchange between species, counting landing of one quota species against unused quota in other species, although not cod. Similar but lesser volumes of landings and carryover were introduced for other non-demersal species.

4.4 Later developments

There is also flexibility regarding juvenile/undersize fish, to encourage vessels to land that catch instead of discarding it. The allowed volume or rather share of the total catch of a vessel each trip has been reduces as well as the financial incentive. This still provides flexibility, although less than before.

On the other hand, some rules may directly reduce flexibility. For a vessel to keep its quota share between periods, a vessel has to utilize a minimum of 50% of its quota, i.e. the vessel must be operated and harvest half its quota each year. In the earlier days of the system there was more flexibility, in that each vessel only had to harvest half its quota every other year.[37]

Another restriction on flexibility is the cap on the quota share any individual or firm can own. The first cap was introduced in the late 1990s. The original cap was 10% for cod, 20% for other species, and 8% of the total quota (in cod equivalent terms), or 12% for a firm where no owner has more than 20% of the company stock. For the small vessel quota system, instituted in 2004, the cap is 4% for cod, 5% for haddock, and 5% of the total.

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[33] Completed in 2007.

[34] The typical "small vessel" had of course changed very much from the early 1980s. At the outset these vessels were "small", slow, and rather manual in operation of gear. In the 1990s and 2000s the new vessels continued to measure "small" in GRT, had much more powerful engines and more automation in gear.

[35] From 2002 the size limit was increased from 6 GRT to 15 GRT and in 2013 to 30 GRT.

[36] Aside from these small vessels cutting into the share of the larger vessel in the TAC, the government also cut into their share in establishing the (temporary) Efficiency Fund 1991-1994.

[37] The rule allows exceptions: If the vessel is inoperable for a long period because of engine problems or damages, or if the vessel is being operated in distant fisheries, they are not required to use as much of their quota.

An additional restriction prevents foreign persons and firms from operating under the Icelandic system.[38] Foreigners can therefore not own or lease quotas, which of course limits the number or size of the group that Icelandic vessels can trade the quota to. Foreign persons and firms can in fact not own more than a 25% share of company stock of any company that owns quota or a company that owns a company that own quota.

In 2004 the government introduced a tax on the individual quotas (actually on harvesting the catch that the quota entitles). At the beginning they were low but later, in 2010, they increased sharply. It can be argued that this tax may be looked on as a restriction for a public good, as the justification for the special tax is to give the public its share in the resource.

On the other hand, there were still restrictions on export of unprocessed catch and the requirement for utilization of quota increased to 50% every other year (in 2000). Note that the exclusivity score does not increase all that much.

The durability score is unchanged as there has been no change affecting that characteristic. Security is a little higher as the authorities have accommodated the small vessels, dealt with regional issues, and the political opposition. Transferability score decreases as there are more restrictions concerning that characteristic. There is the increased harvest requirement, now 50% every other year. There is a cap on the volume of quota that can be attached to a vessel, no more than the vessel can reasonably catch in a year. And a cap on quota holding or consolidation of individual firms was introduced. All these limit transfers.

The government in power in 2009-2013 curtailed some of the attributes and therefore the Q-value of the ITQs. The only attribute that did increase was durability, and the reason was that the political parties in power abandoned the idea of shortening the duration by such methods as auctioning. Security was reduced by the meddling in the ITQ share in the TAC, as the legislation now cuts 5.3% into each vessel ITQ every year. The legislation opened a new derby style (common TAC, not IQs) Summer coastal fishery (strandveiðar) for small vessels using hook-gear, as well as increasing regional quotas. This also decreases the exclusivity of the ITQ system. This government also increased quota taxes substantially which also decreased exclusivity. Transferability was also reduced with a stricter harvest requirement, 50% every year for each vessel (in 2009).

5. Scoring the different attributes

How did the open access system of management score on the quality index? My assessment of the evolution of quality score for the different attributes of property rights in fisheries in Iceland in the period from 1978 to 2013 is illustrated in table 2. As for the attributes, we may say there was a high score on security, as it was almost certain that all vessels would continue to have access to the fishery. And durability would also score high, at least in the year 1978 when it seemed that it was indefinite. The score on exclusivity and transferability, on the other hand, was quite low, close to zero and zero respectfully, as there was open access and no tradability. The overall score for these years and the score on each characteristic is presented in table 1 for important selected years (Figure 3 then shows the evolution of Q-values for the whole period).

[38] This does not of course apply to mutual fishing rights that Iceland has made agreements on with other nations, where their vessels may catch a negotiated volume in Icelandic waters.

Table 2.	1978	1984	1991	2007	2013
Security	1,0	1,0	0,9	0,95	0,9
Exclusivity	0,01	0,6	0,7	0,8	0,65
Durability	0,9	0,25	0,9	0,9	0,95
Transferability	0	0,9	0,9	0,85	0,8
Q-value	***0,12***	***0,51***	***0,79***	***0,85***	***0,76***

The quality of the user right in the Icelandic ITQs system, as measured by the Q-value in the table, has therefore increased significantly in the period 1978-2007 but then decreased from then until 2013. It is of course no surprise that the Q-value increased much from 1978, when there was open access to the resource, to 1984, when licensing and vessel quotas were introduced. But the increase from 1984 to 1991 marks the change from a temporary, 1–3-year, intervention to a somewhat comprehensive and permanent system of rights. The changes from 1991 have in some ways strengthened these rights, increasing exclusivity on balance, while somewhat restricting the transferability of these rights. But in 2009-2013 there was some reversal.

5.1 Relation between the quality score and the market value of the ITQs

Above we have developed a measure of the quality of user rights in fisheries and applied that measure to the evolution of fisheries management in the Icelandic fisheries. We have seen how the score for the different attributes has changed with changes in the rights and how the Q-value has increased with those changes. How does this change in the Q-values correspond to the value of the fishery?

One way to see this is to compare the Q-value with the price of quotas, with the value of the fishing rights, the annual quotas. In figure 3 we show the value of the quotas in the Icelandic fisheries and the evolution of the Q-value in 1984-2013.[39]

The correlation between the Q-value and quota values, at annual prices, is 0.7, and 0.73 between the Q-value and the quota values at fixed 2013 prices. So, as expected, there is a strong relationship here. The Q-value alone does not explain in the quota values, other variables, such as the TACs, fish prices, profitability, capital costs, etc., all affect the quota values.[40] And some of these, of course, are highly correlated themselves.

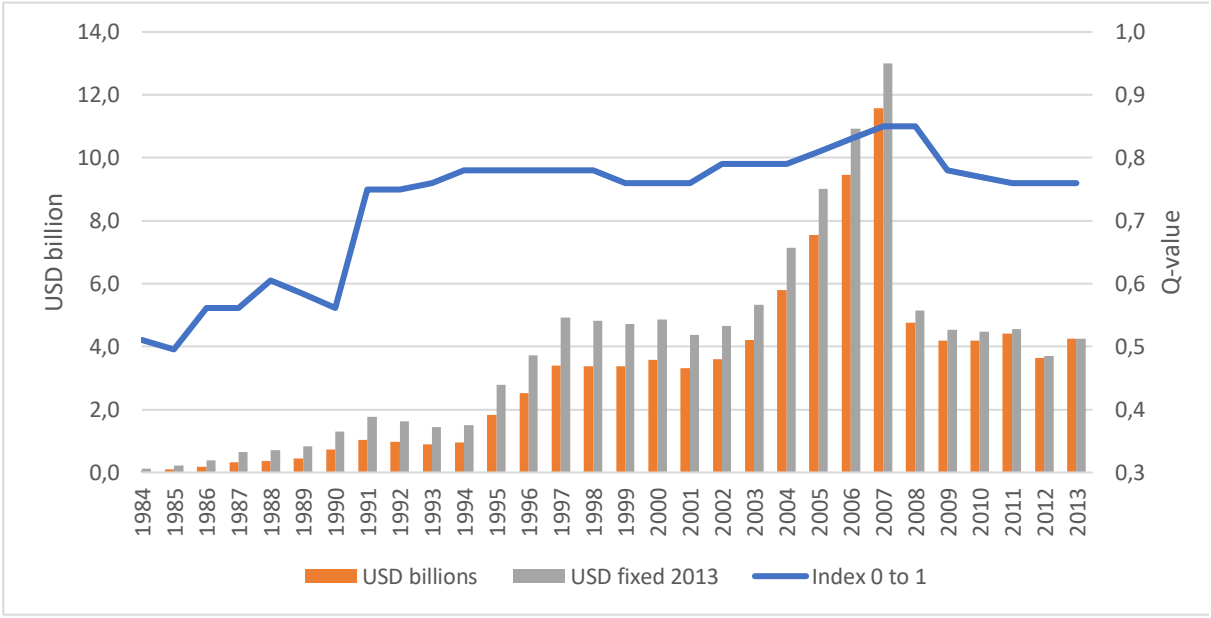
The reason for not showing the values for 1978-1983 is that there were no tradable rights and therefore no prices to measure the value of the open access rights. But from 1984 user rights to the vessel quotas had a price and we can then calculate the total value of these rights. As may be seen in figure 3 the quotas have little value early on. One reason is that they have very short

[39] The Q-values are based on the authors calculation as exemplified in the text above. The quota values are based on calculation by Professor Ragnar Arnason and by the author here.

[40] Similarly, the correlation between the Q-value and profits before taxes is 0.71 and EBITA profits is 0.73, for this same period.

duration, and the Q-value is relatively low. Overall, the value of the quotas corresponds rather well with the Q-value in this period 1984-2013.

Figure 3. Development of Q-value and quota values 1984-2013



There are of course other factors that affect the total value of the quotas, such as the volume of the TAC and expectations on future development of that volume, as well as fish prices and operational expenses. Conditions of financial markets and access to finance also have some effect, at least in 2004-2010. Nevertheless, the strength of the user right clearly is one of the factors that affect the value of the quotas.

6. Conclusion

The economic theory of property rights has certain clear applications to fisheries management. Fisheries governance based on strong user rights provides incentives to harvesters to improve efficiency and increase profitability and the value of their quotas. The better the property rights, as described by the four attributes in the above, are important inputs. The Q-measure, calculated on the score of the attributes, can provide a useful indicator on the efficiency of a fisheries management system. Improved, or as we refer to them, stronger user rights can be extremely valuable and important in improving the economics of resource use. Several countries have instituted user rights in their fisheries, often in the form of ITQs or other share systems. Such rights-based fisheries management has proven economically successful.

The problem of overfishing cod in Icelandic waters emerged in the 1970s and 1980s and the government regulated and restricted access to the cod fishery, and later the bottom fisheries more generally. The laws and regulations that introduced licensed access and IQs essentially provided short duration of rights or entitlements initially. For the cod and bottom fish, the duration was for one year, then 2 years, and later 3 years, before they became “permanent” or indeterminate in duration in 1991. Despite the short duration, these IQs were made transferable (ITQs) within the fishing season/quota period in the 1980s. This short duration before 1991

most likely affected their value, even though many vessel owners formed expectations rather quickly that the ITQs would eventually become permanent.

The experience with the ITQ system is generally favorable. Since 1991, when the comprehensive ITQ system went into effect, there have been substantial improvements in economic efficiency of the demersal fisheries. Total fishing effort went down more than 30 percent in the first 10-15 years after the ITQs were introduced (as compared with what it was in 1983). Fishing capital, which had increased by more than 400 percent in 1960-1990, has actually declined since 1990 to 2013, and the number of vessels has also declined substantially.[41] This reduction in the number of vessels, and increased quota concentration at the same time, is financed by the fishing industry itself. That is, the fishing firms buy each other out and improve their efficiency, without the state being directly involved or government subsidies.

The main purpose of the ITQ 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 was often highly negative (see graph). Since the introduction of ITQs the quality of the harvest and profits have improved significantly, and fishing effort has been reduced. Overall productivity and efficiency have therefore increased greatly.

The quality of the user right in the Icelandic ITQs system, as measured by the Q-value, increased significantly in the period 1978-2007 but then decreased from then until 2013. It is of course no surprise that the Q-value increased much from the late 1970s when there was open access, to the late 1980s when licensing and vessel quotas were introduced. The increase in the Q-value from 1980s to the 1990s marks the change from a temporary intervention to a somewhat comprehensive and permanent system of rights. The changes from 1991 have in some ways strengthened these user rights, increasing exclusivity on balance, while somewhat restricting the transferability of these rights. But in 2009-2013 there was some reversal in this trend.

There is a strong relationship between the Q-value and quota values in this period, as shown by the high correlation between the two. Clearly the stronger user rights in the form of ITQs are an important factor in increasing the value of the quotas, and the economic sustainability of the fisheries.

[41] In 1992/93, there were 1,265 vessels with ITQs and another 1,125 with hook-licenses, or 2,390 in total (there were some 162 additional vessels with commercial fishing licenses but without quota). In September 2012 only 603 vessels in total were allocated quotas (had ITQ shares), of which 261 were in the ITQ system for larger vessels and 342 in the small vessel ITQ section (the total number of fishing vessels in Iceland was 1690 in January 2012). See Runolfsson (2017).

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