The United Nations University
FISHERIES TRAINING PROGRAMME
PO Box 1390, Skulagata 4
120 Reykjavik, Iceland

Final Project 2000

Implementation of Individual Transferable Quota system in Fisheries Management: The case of the Icelandic Fisheries

Liu Xinshan
Dalian Fisheries University
China

Supervisor: Dr. Eyjolfur Gudmundsson, University of Akureyri

ABSTRACT

Since 1950s, the world marine fish resources have suffered the serious over-fishing. The marine resources subsequently have been in great danger. Quite diverse management regimes are used to regulate the fisheries globally. Among them, the individual transferable quota (ITQ) system is claimed to achieve the sustainable fisheries. The report is to explore the Icelandic ITQ system carefully.

This paper first compares the various management measures and reviews the ITQ theory. Then the growth and implementation of the Icelandic ITQ regime are examined carefully. And its performance and various controversies over the ITQ system are analysed on the fisheries and social-economic data. It is demonstrated that the effect of Icelandic ITQ is quite positive. A well-defined and enforced ITQ system can meet the biological and economic goals of fisheries management. Under the ITQ regime, the state of marine resources has been recovering and the economic efficiency has been improved largely. However, the current Icelandic ITQ system does not create a private property right over the fish stock. The ITQ system has not cause serious unemployment and destroyed the community economy in Iceland. The ITQ system is very promising, although there are some flaws in the current Icelandic ITQ regime. Finally, possible remedies of the flaws are discussed.

Keywords: ITQ, fisheries management, fisheries resources, fisheries economics, Iceland

TABLE OF CONTENTS

1. INTRODUCTION

This chapter is a brief introduction to the world fisheries, including the trend of world landings, the state of world fishery resource, and an urgent need of an efficient fisheries management regime.

Being one of the oldest economic activities, marine fisheries provide human beings with a source of high quality protein and meet the cultural and life needs. According to FAO, 1998 witnessed 86.3 million metric tons of fish, crustaceans, molluscs, etc. extracted from the broad sea and ocean. However, research work of biologist and official statistics have shown us the marine fish resources are suffering from serious depletion. As Figure 1 indicates, the world marine catches will likely reduce rather than increase in the future.

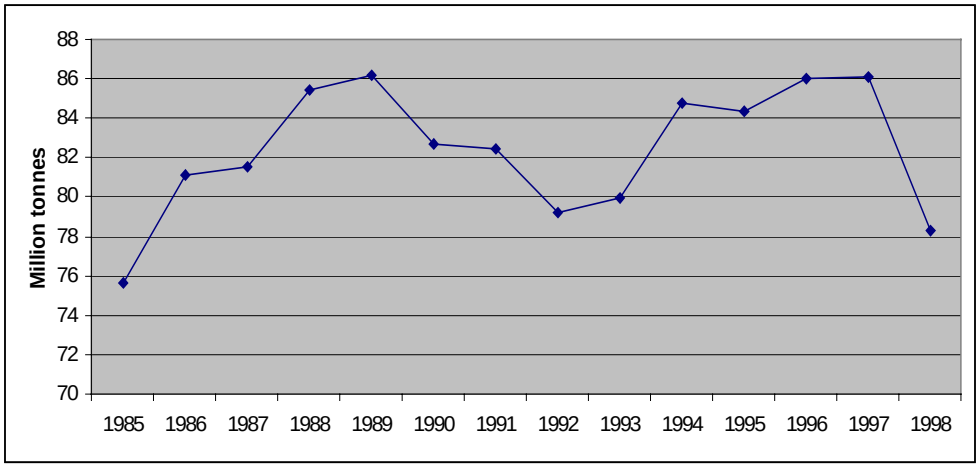


Figure 1: World total nominal catches in marine fishing areas 1985-1998 (FAO 2000).

The world ocean productivity is close to its limit. Also, two bitter facts are concealed that the low-valued fish is to take over the first position in species composition - in 1992 the miscellaneous category ranked third - and that human being have been suffering economic waste from fishing activities - very roughly estimated, $60 billion are wasted globally each year (Christy 1997). Low profitability and business failures have been occurring in the world fishing industry. It is partly the force of various subsidies that help the fishing company to operate profitably (Porter 1997).

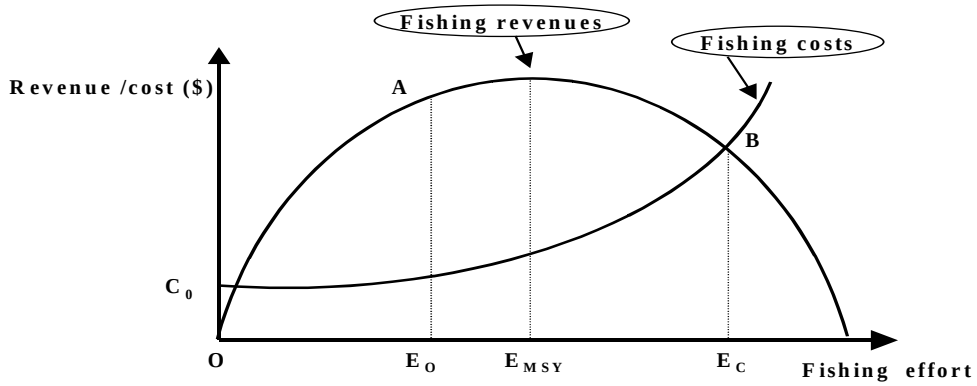
The problem of over-fishing has clearly general and now concerns all regions of the world. It is indicated that 70% of the fish resources are overexploited, depleted, or recovering from depletion (Garcia and Newton 1997).

2. WHAT IS AN INDIVIDUAL TRANSFERABLE QUOTA?

Since 1970s, the acronym ITQ has become more and more well known in the world. This chapter carefully examines the root of over-fishing and diverse fisheries management regimes used in the world, especially the ITQ system and its main characteristics.

2.1 Problem of over-fishing and choice faced by fishermen

Fish, as a source of food supply, is undoubtedly in great danger. Following the Second World War, the call for the conservation of fish stocks has grown louder. Concerns for marine life has caused some bitter conflicts between countries and even among fishermen of the same country (Hart 1976). Many biologists and economists have explored the reasons for these sufferings. The major root is attributed to the common property nature of fish swimming in the ocean (Warming 1911, Gordon 1954, Scott 1955, Hardin 1968, Hannesson 1993). Figure 2 gives a clear picture of economic incentives in fishing activity.



A: Optimal equilibrium point
B: Competitive equilibrium point
C_0:Necessary costs before fishing

Fig. 2 Fishery bio-economics model

Under common property, competitive fishery will reach an equilibrium only when the expansion in fishing effort has brought the stock size down to the point where marginal product is zero.

It is evident that common property has always driven fishermen into a dilemma. In the short term, a fisherman catching fish from a common bank reduces the availability of fish to other fishermen. It is obviously rational for a fisherman to expand his fishing effort to catch more fish. A fisherman, who always prefers prudent fishing, will run a quite high risk of suffering great loss.

Therefore, the problem of over-fishing is a tragedy of the common, the tragedy of the existing ocean order. It is not caused by ignorance of fishermen at all. All a fisherman thinks about is the fact that other fishermen's harvest would definitely reduce his harvest if he had not expanded his fishing effort. Under common property of fish, it is not reasonable to expect that a fisherman always take into account how his expansion of fishing effort affects fish growth and fish reproduction.

2.2 Common fisheries management regimes

In the half past century great effort and even fierce fighting to remove the common property of ocean led to three global conferences on the laws of the sea. A modern convention on the law of sea was generally accepted in 1982. Under this Sea Constitution, EEZ (exclusive economic zone) was established as a rule of

international law. This implies that more than 90% of marine fisheries resources can by controlled by individual coastal states (Laursen 1993).

Governments have been responding to the decline in fish stock. Quite diverse measures are employed in the world. Basically, these measures can be divided into two groups: direct command-control measures and indirect biological-economic measures. This also reveals two main objectives of fisheries management: sustainability of fish supply and high fishery economic efficiency.

2.2.1 Direct command-control fisheries management

Direct command-control measures mainly contains fishing gear and methods restriction (e.g. minimum mesh-size restrictions, small fish-release devices, sorting grid devices, etc.), fishing period closure (e.g. spawning season), fishing area closure (e.g. spawning area, nursery area, area quite close to shore, etc), and fish minimum size limits, etc. It is generally acknowledged that biological regulations can lessen the exploitation of fish stock, provided that the various limits are correctly set and efficiently enforced. However, they do not necessarily alleviate fishermen's eagerness to increase their fishing effort because they do not undermine the root of over-fishing i.e. the common property of fish stocks. Finally, intense competition among fishermen inevitably erodes the accomplishments of biological regulations to achieve conversation objectives.

2.2.2 Indirect biological-economic fisheries management

Economically oriented measures generally cover fishing licence/permit, resources tax or charge/royalties/fee, TURF (territorial use right in fisheries), IQ (individual quota), ITQ, etc.

Fishing licence may be the most common tool of fisheries regulation in the world. Under the fishing licence, a fisherman/fishing firm (In practice a fishing licence is always attached to a specified fishing vessel) must hold a certificate issued by fisheries administrative authority when fish is caught.

Depending on its characteristics and applying conditions, a fishing licence may have very different meanings. It is necessary to specify further:
1. Close licence/open licence. Close licence regime usually means fishing activity is limited entry, no entrant. Open licence indicates an entrant can apply for a permit and conduct fishing. Compared with the open licence, the former can obviously slow the race for fish.
2. Transferable license/non-transferable licence. Transferable licence regime implies the licence may be lent, leased, or sold. Transferable license can bring the flexibility and improve the economic efficiency to an extent provided it is closed to the new entrants.
3. Permanent licence/ short duration licence. Permanent licence can improve the security of fishing right on the condition that it is closed to new applicant. Usually the short term fishing licence may be renewed.
4. A fishing licence under IQ or ITQ system is employed as a purely administrative tool.

5. Measurable fishing licence / non-measurable fishing licence. In general, a licence is attached to a specified vessel when issued; it should match to the size of fishing vessel, e.g. horsepower or gross tonnage, etc.

A fishing licence was first introduced as a means of administrative management, like a driving licence. As such, it provided data and helped enforcement. It was usually seen as a certificate of fishing privilege by fisheries authority. It was what a fisherman needed to act legally on a wild fish stock. Depending on the diverse characteristics, evaluation of the fishing licence is mixed. Generally speaking, it is very reluctant to say that a fishing licence is an excellent regime alone because it does not restrict the total landings, unless it is completely closed to any new applicants and works together with TAC (total allowable catch) regime.

Under TURF, a fishing area is allocated to a fishing entity, which has exclusive right to the fish stock living in this fishing area. TURF is always regarded as the best method in which property right to fish stock could be implemented. Main objectives of fisheries management can be achieved completely. Unfortunately, it is only suitable to sedentary species such as oyster, mussels, scallop, and so on. Fish migration limits its wide application.

Fisheries regulation on the basis of taxation (or charge, royalties, fee) is quite attractive. The self-defeating competition among fishermen stems fundamentally from the fact that fishing appears more profitable to individual fisherman than it is for the fishing industry as a whole. By imposing tax on the fishing, fisheries authority can efficiently remedy each fisherman's fishing behaviour to protect fish resource. The influence on fishing activity by taxation is clearly revealed by Figure 3 and Figure 4 (Arnason 2000).

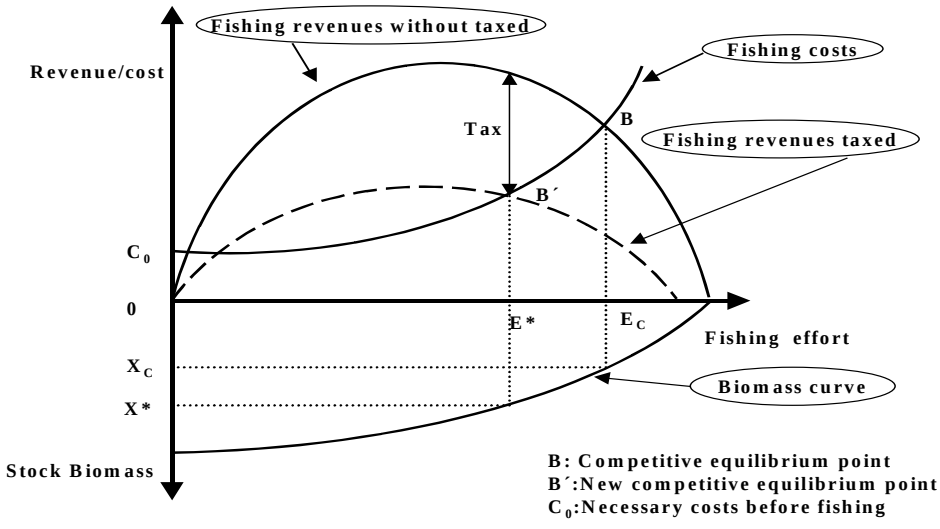


Fig. 3 Influence on fishing activity by taxation on landing-value

Figure 2: Influence on fishing activity by taxation on landing-value (Arnason 2000).

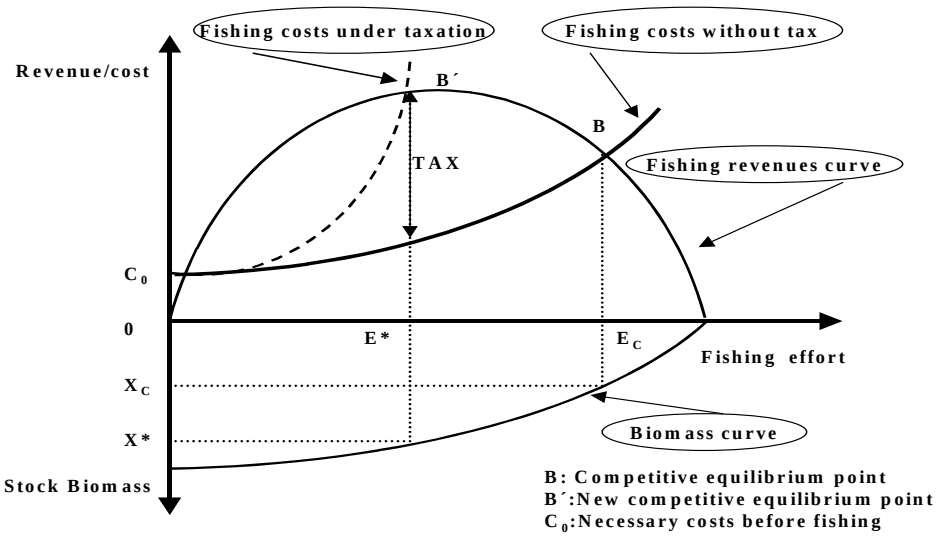


Fig. 4 Influence on fishing activity by taxation on input

Figure 3: Influence on fishing activity by taxation on input (Arnason 2000).

As indicated in Figures 3 and 4, tax on output or input will produce the same result. Before the tax is imposed, the competitive equilibrium is at fishing effort Ec, and biomass Xc. After the imposition of the tax, the final competitive equilibrium will be at a lower fishing effort E*, while the revenue curve moves downwards or the cost curve moves upwards. The corresponding biomass level is increased to X*. Thus the optimal equilibrium can be reached, whether the tax is imposed on input or output. It is apparent that taxation revenue is equivalent to fisheries rent in a fishery managed by tax.

Fisheries regulation by tax is quite effective and advantageous in theory, but there are some difficulties with this method in practice. For example, taxation on input will distort the input mix of industry because input is not an observable variable. It consists of many variables: boat tonnage, boat length, engine power, size of net, days at sea, number of crew, fish-finding equipment, type of fishing gear, deck equipment, fishing capital, and so on. This essentially brings it into the framework of direct fishing effort limit. Moreover, a taxation regime is usually unpopular in the society; a correct tax rate is very hard to determine; tax collecting requires a rather costly enforcement, etc. Like indirect biological measures, it does not alleviate the wasteful competition among fishermen (Arnason 2000).

Compared with fisheries management regimes discussed above, IQ and ITQ systems are the most successful ones in the world, although they are still in an early development stage (In fact IQ can be considered an early stage of an ITQ system). (Arnason 1990, 1999).

2.3 The ITQ system

Since mid-1970s, IQ/ITQ/IVQ has been invented and continuously modified as an instrument of fishery management. The ITQ regime is being implemented successfully, experimented with reasonably, or is gradually gaining acceptance as a management device in the world. In New Zealand, some 32 species fisheries in 10 management areas are now managed by ITQ institution, more than 90% of total

landings in terms of value. In USA, the ITQ system was first instituted for the Atlantic surf clam and ocean quahog fisheries in the waters of the mid-Atlantic states and New England waters in 1990, in the wreckfish fishery on the southern East Coast in 1992, and in March 1995, for halibut and sablefish (blackcod) fishing off Alaska. Italy has a clam ITQ programme. Australia has an ITQ programme regulating more than 15 species fisheries. South Africa manages its abalone fishery by the ITQ system. Canada has several fisheries that are managed by ITQ along both Atlantic and Pacific coasts and in the Great Lakes. ITQs also are used to manage the Netherlands' sole and plaice fishery. Although this is not a comprehensive list of all country fisheries under ITQ system, it indicates that the ITQ regime is widely used internationally (Wesney 1989, Pascoe 1993, Davides 1997, Arnason 1997, Major 1999).

Constructing an ITQ system basically has to contain the following four steps, although a uniform, unequivocal definition is not available.

1) Following the recommendations by fish biologists, fisheries authority annually determines and declares a TAC for each commercial species fishery;
2) Mainly depending on historical landings and size of boat, each fisherman/fishing firm is initially allocated a percentage of TAC for each species (Individual percentage share quota, TAC-share or quota share), where an ITQ is usually attached to a specified fishing vessel (also called IVQ). Allocation of TAC-share is conducted only once when ITQ is introduced. A newcomer must through quota market to obtain his quota. A fisherman/fishing firm can keep his TAC-share forever unless he actively transfers it to others.
3) The legal annual landing (LAL) from an individual fishing vessel is equal to the product of its permanent TAC-share times the annual national TAC. (Individual tonnage catches quotas, annual catch entitlements, ACE).
4) Individual Permanent TAC-share and individual annual catch quotas are unlimitedly divisible in theory and may be freely transferred on the quota market.

Under an ITQ system, the total annual landings are limited by limiting each fisherman's annual catch to his legal annual landings (LALs). Depending on the actual state of the fish stock, a TAC is biologically determined annually. Thus, the biological objective of the fishery regulation is achieved.
How does an ITQ system look from an economic point of view? Because a fisherman's catch is limited, competition among the fishermen will move from the amount of catch to fuel-saving, use of efficient fishing technology, quality of fish product, marketing system, price of product, etc. in order to increase their profits. This competition may be more intense than before, but it is beneficial to the whole fishing industry. The economic efficiency of the fishing industry will be improved as the result of this competition. Because the individual TAC-share is permanent and subsequently a fisherman has an interest in the future state of the fish stock, his enthusiasm to protect fish resources is increased. Because the ITQ system may be divisible and tradable and a new entrant has to obtain fishing rights through a quota market, fish will always be extracted by the most effective fishermen. Furthermore, a fisherman withdrawing from fishing industry can also sell his permanent share quota and get financial rewards from the quota market.
Therefore, it can be concluded that the ITQ system increases fishery economic efficiency to a large degree. The second objective of fishery management, the

sustainability of the resource, is also achieved. The reason for this is an ITQ system can successfully mitigate the common property nature of fish resource. An ITQ system gives fishermen incentives to make efficient use of the fish stock. Thus, the ITQ system is a quite powerful tool to achieve the objectives of fisheries management.
In summary, an ITQ system is a fishery management institution, under which a fisherman or fishing firm legally holds a defensible right to catch, land a certain quantity of fish, and this right is freely tradable in an asset market. The result is that fishermen try to generate the biggest possible return from their share of the catch, by increasing the value of landings, and reducing costs, and preferably co-operating with others to increase the future profitability. Because of its perpetuity, the security of access to fish stock of quota holders is guaranteed. Because of the limitation of the catch landed by individual fishing vessel, protection of a fish resource can be accomplished. Because of its divisibility and transferability, a market mechanism can work well and subsequently the optimal economic outcomes to the fishing industry is achieved.

3. HOW THE ITQ SYSTEM WORKS IN ICELAND?

The theory behind an ITQ system is one thing, how it works in practice is another. This chapter will explore how an ITQ regime has developed and functioned in Icelandic fisheries.

3.1 The role of fisheries in Icelandic economy

It is often stated by Icelandic economists that the Icelandic economy is heavily dependent on fisheries; fisheries form the backbone of the national economy; economic performance in Iceland is largely based on the performance of the fishing industry, its exports volume, and foreign market prices, etc. (Bjarnason 1996, Danielsson 1997). These assertions have been supported soundly by some economic statistics. In 1993, fishing and fish processing contributed 15.4% of the GDP and employed 11.3% of the working population; marine fish and fish products accounted for 79% of the commodities exported and 55% of foreign earnings. According to Arnason (1995), a 1% increase in the output value of the fishing industry will eventually lead to 0.45% increase in GDP. The significance of fisheries in the Icelandic economy also can be seen from its dominance in the national macroeconomic system, its influence on the growth of wages and exchange rates. Fish consumption per Icelander is over 90 kg annually (OECD 1997).
The importance of fisheries in the Icelandic economy means that any changes of fisheries policy and management regime have far-reaching effects on the Icelandic society.

3.2 The evolution of the fisheries management system

3.2.1 Establishment of EEZ

The history of Icelandic fisheries management may be a textbook example to mirror the development of the new world order of the sea in the late 20th century. It can be divided into three distinct phases. Fisheries in Icelandic waters were completely

international fisheries before 1948. The years between 1948 and 1976 saw an unyielding campaign for Icelanders to gain the jurisdiction over fish stock (Table 1). From 1976 to present is characterised by the growth of the ITQ system.

Table 1: Extension of Icelandic Jurisdiction over fisheries around Iceland (Jonsson 1982).

- 1948 Scientific Protection of the Fish Stocks on the Continental Shelf
- 1950, 1952 Extension to 4 miles, fishing area 43000 km^2
- 1958,1961 Extension to 12 miles, fishing area 75000 km^2
- July, 1972 Extension to 50 miles, fishing area 216000 km^2
- July, 1975 Extension to 200 miles, fishing area 758000 km^2
- 1982 UN Convention on the Law of the Sea was signed
- 1985 Iceland ratifies the UN Convention on the Law of the Sea, being the first state to do so
- 1994 UN Convention on the Law of the Sea entered into force

Having gained the complete jurisdiction over her fish stocks, Icelanders achieved the legal prerequisite to the establishment of an ITQ system in Icelandic waters.

3.2.2 Growth of the ITQ regime

The growth of Icelandic ITQ system is very much a slow and painful learning process. It came being by trial and errors rather than by academic design in the office. Table 2 exhibits its nearly 25-year development history.

Table 2: The chronology of the development of ITQ regime

- 1965 Inshore shrimp and scallop fisheries subjected to licences, effort restrictions and catch quotas.
- 1969 A TAC imposed on the summer-spawning herring fishery.
- 1972-1974 Herring fishery closure.
- 1973 A TAC in lobster was first set and vessel catch quotas issued.
- 1975 Legislation on processing and fishing of inshore shrimp and scallop passed. Seven inshore shrimp areas established. The TAC for summer-spawning herring divided into individual vessel quotas (IVQs), although not permanent.
- 1976 A special Fisheries Act passed, giving the Minister powers to restrict access to the fishing grounds. TAC for the major demersal fisheries.
- 1977 Individual effort restrictions on fishing days introduced in demersal fisheries, but new entry was possible.
- 1979 IVQs for herring fishery made transferable.
- 1980 IVQs introduced in the capelin fishery, limited entry into capelin fishery.
- 1984 Licensing and IVQ in lobster fishery. A comprehensive system of ITQs was introduced to the demersal fisheries. All vessels over 10 GRT were allotted a quota share based on their average catch Nov. 1981-Oct. 1983. The annual tonnage quotas were transferable, but the percentage share quotas were not transferable, except between the vessels owned by the same owner. The larger vessels closed to demersal fisheries unless as a replacement for withdrawing comparable vessels.
- 1985-1990 Effort restrictions in demersal fisheries. Vessels under effort restrictions may re-enter quota system based on the new track record. Vessels under 10 GRT open access until 1988 and boats between 10-6 GRT until 1990.

Table 2 (cont.)

- 1986 IVQs for capelin were made transferable.
- 1988 Deep-sea shrimp fishery was subjected to ITQ. More than 90% of landings by value was under ITQ.
- 1990 Fisheries Management Act passed. All vessels above 6 GRT and the important species covered by a uniform ITQ system. Effort quota option was eliminated. Both permanent TAC-share and ACE may be divisible and transferable. Boats under 6 GRT operating with long-lines and hand-lines were allowed a period of adjustment before being incorporated within the system. The permanent percentage share quota between vessels owned by different owners was allowed. Fees to cover enforcement cost collected by Authority.
- 1993 Supreme Court decided the transfer of TAC-share should be taxed as transfer of property, the transfer of ACE taxed as income for the seller and cost for buyer.
- 1995 Catch rule was made. Annual TAC for cod was set at 25% of the fishable biomass.
- 1998 only up to 50% of annual catch quota is freely transferable between different ownership. If a vessel catches less than 50% of its quotas (measured in cod equivalents) in two subsequent years, its quota is forfeited. A single firm is not allowed to hold more than 10% quota share of cod and haddock, 20% of saithe, redfish, Greenland halibut, herring, offshore shrimp, and capelin.
- 1998 ITQs were issued for the Atlanto-Scandian herring fishery.
- Sep. 1998 Quota Exchange established. All quota transfers must take place through the Quota Exchange except between vessels owned by the same firm.
- Dec. 1998 Supreme Court ruled that Art.5, Act 38/1990, which privileges those who derive their fishing rights from ownership of vessels during a specific period, is unconstitutional.
- Jan. 1999 Unconstitutional clause was revised. Any vessel can get a fishing permit as long as it satisfies standard conditions about seaworthiness and registration.
- June 2000 The TAC for cod should not vary by more than 30000 MT between 2 continuous fishing years.
- 2000 Supreme Court ruled that fishing without quota was illegal. The verdict strengthens the legal basis of the ITQ system.

As indicated in table 2, the evolution of ITQ regime showed several markedly characteristics. (1) It was first introduced in herring fishery in response to the collapse of stock and then extended to other dangerous fisheries. (2) It was extended from the slow-valued fisheries to the high value fisheries. (3) The significance of fishing effort restrictions gradually became weak. (4) The degree of exclusivity and transferability of quotas were gradually stronger and more freely. (5) There was a five year period (1985-1990) for fishermen to operate under two different management regimes in ground fisheries. (6) An ITQ system was gradually accepted by the traditional legal convention.
The 25-year development of the ITQ system may imply that a new fisheries management institution has been accepted gradually by Icelanders.

3.3 Icelandic ITQ system---its five pillars

A practical ITQ system must contain some necessary components. This section explores the major pillars of an ITQ system.

3.3.1 Recognition of EEZ international

That EEZ system was globally accepted as a rule of international law is the premise of successful implementation of an ITQ regime. In 1976, the international recognition of Icelandic 200-mile EEZ made it possible to create the ITQ system. While the UN

Convention on the Law of the Sea grants the exclusive jurisdiction to coastal states, it also emphasises the importance of international co-operative management because of fish migration. Effective co-operation between Iceland and her neighbour countries ensures the success of ITQ system in the Atlanto-Scandian herring fishery, oceanic redfish, capelin fishery, etc.

3.3.2 Setting of TAC

Setting of TAC in fact contains two steps - one is totally scientific advice from the Marine Research Institute (MRI) and the other is the final determination made by Ministry of Fisheries. This implies the combination of biological and social - economical objective that fisheries management seeks. When the ITQ was first introduced in demersal fisheries, the final TAC for cod determined by the Minister was usually higher than recommended by the MRI because the adverse effects on the economy had to be taken into account (Figure 5). In 1995 a special catch rule was adopted: TAC for cod should be 25% of the fishable biomass. In June 2000, this rule was amended so that the difference in the TAC for cod between two continuous years should not exceed 30000 MT in order to stabilise the harvesting sector.

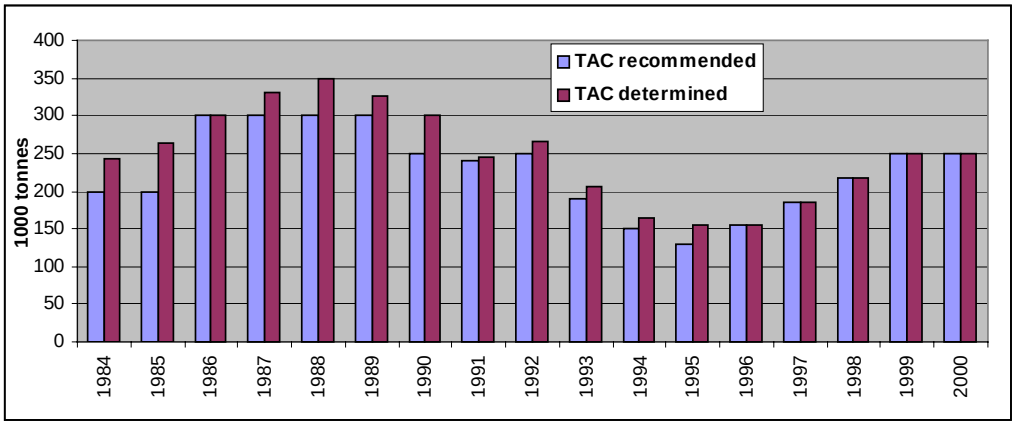


Figure 4: Comparison between the TAC determined for cod and that recommended (MRI 2000).

3.3.3 Surveillance of landings

The success of an ITQ system to a large degree depends on whether the landings of every fishing vessel are formally and exactly registered. To achieve this, every landing site has to be monitored effectively. TheDirectorate of Fisheries and local harbour authorities are responsible for the monitoring of landing activities. Figure 6 illustrates how an ITQ system is run in Iceland. In addition, a good juridical system is a necessary part of the support system.
The system also allows a good deal of flexibility of landing limit. (1) A vessel may exceed its ACE for any given demersal species (cod not included) by 5% subject to a corresponding reduction in the ACE of other demersal species based on value determined by Ministry. (2) Up to 20% of the ACE for each demersal species, deep-water shrimp, lobster and herring, 10% of ACE for scallops and 5% of ACE for offshore shrimp may be postponed to the next year. (3) Vessel may also fish up to 5% in excess of its ACE for each demersal species, herring, and deep-water shrimp and 3% for scallop and offshore shrimp subject to a corresponding reduction in the following year.

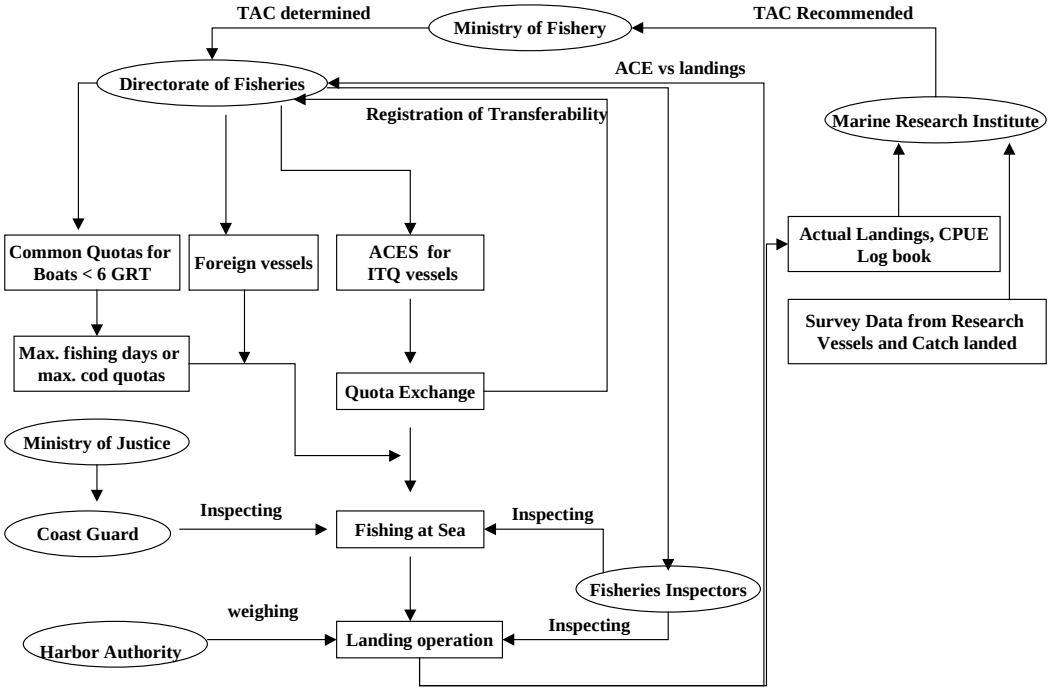


Fig. 6 Flow chart of Fisheries Management: Icelandic ITQ system

Figure 5: Flow chart of Fisheries Management - Icelandic ITQ system.

3.3.4 A perfect market of quota transferability

The ITQ system manages to define the quite special fishing rights, which make catch quota markets possible. Through voluntary quota exchange, the buyers and sellers can increase their economic security respectively. Usually having a comparative advantage in fishing operation, the buyers tend to specialise in fishing, while the sellers can get financial compensation. Mutual gain is achieved. A properly functioning quota market system should use the prices to co-ordinate the decisions of buyers and sellers. In September 1998, the Icelandic Quota Exchange (IQE) was established. IQE facilitates the bidders to get more complete information. However according to the Fisheries Management Act, owning a fishing vessel is a necessary condition to hold quota and only 50% of annual catch quota can be transferred. This restricts the market force.

3.3.5 Biological support measures of an ITQ system

A successful ITQ system also has to be strongly supported by some biological measures. These measures include permanent closed nursery areas, immediate temporary closure of areas with excessive juveniles, 12-mile limit for large trawlers, mesh size limit. And a sorting grid is mandatory to avoid by-catch of juvenile fish in the shrimp fisheries and devices for excluding juveniles in the demersal fisheries are also mandatory in certain areas. There are also some requirements that small fish, i,e. cod and saithe less 50 cm, haddock less than 45 cm and redfish shorter than 33 cm must be kept separate in the catch and must not exceed 7% of the cod catch and 10% of the saithe, haddock and redfish catch. They are not fully counted in calculations of the vessel used quota because of low value.

4. DISCUSSION AND CONCLUSION

This chapter explores the effects of ITQ regime, especially the various controversies over its effects.

4.1 The performance of the Icelandic ITQ system

The introduction of the ITQ system to fisheries management is to improve the economic efficiency of fishing industry and accomplish the sustainable supply of fish and fish product. Generally speaking, the 2 goals have been achieved in Iceland. The progress towards the common goals is, of course, not in the same step in the different fisheries because it was introduced at different times and in different forms, and more importantly, because each fishery has its own biological features.
In 1979, the herring fishery was first subject to an ITQ regime. Herring is harvested mainly in October to January. Figure 7 illustrates that the landings of herring have increased steadily since 1975. The stock of herring has recovered successfully (Jakobsson and Stefansson 1998). landings in 1999 are twice that of 1979. The spawning stock biomass (SSB) in 1999 is 2.38 larger than in 1984. The herring stock has been successfully rebuilt.

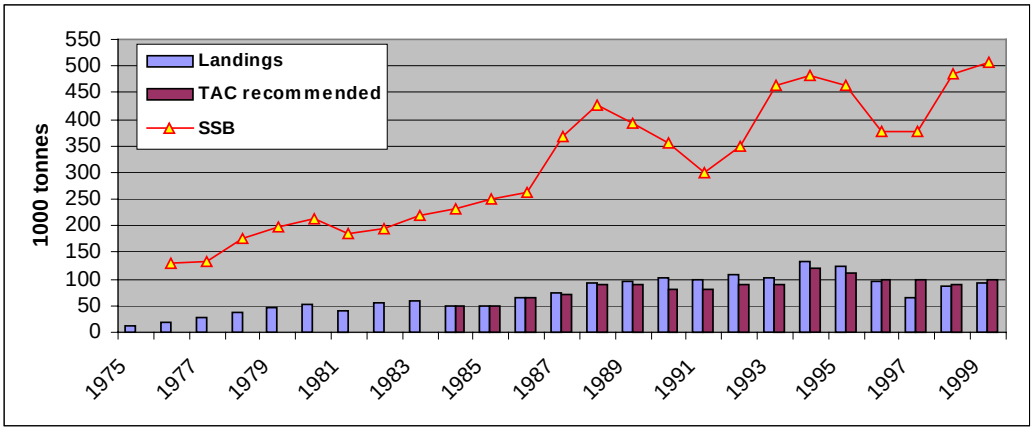


Figure 6: The trend of landings, TAC recommended and SSB for summer-spawning herring stock (MRI 1996, 1999,2000).

Cod is the most important of all marine stocks in Iceland and is caught throughout the year. In 1991, a comprehensive ITQ system was introduced in the cod fishery. As indicated in Figure 8, the effect of ITQ on the state of cod stock is not conclusive. Perhaps intrinsic flaws in the ITQ system for cod fishery, a short period of ITQ-employment and intrinsic ecological features of the cod stock are responsible for this. (1) The small boats under 6 GRT in cod fishery are not subject to the uniform ITQ regime. (2) Cod is a quite long-lived species so that it will take long time to recover. (3) There are noticeable differences between the TAC recommended and the TAC determined finally as a result of its economical importance. (4) The fishing intensity on demersal species from 1984 to 1990 increased too fast when an imperfect ITQ system was implemented (Figure 9). During this period, the average ratios of recommended TAC to FSB (fishable stock biomass) was 29% and the average ratio of actual landings to FSB was 35.4%. However the optimal ratio should be 25% according to the Catch Rule declared in 1995. Maybe the TAC recommended and actual landings for cod were too high. In June of 2000 year, the Catch Rule was

added: The TAC for cod should not vary by more than 30000 MT between 2 continuous fishing years. It suggests that in a quite short period it is very difficult to combine the biological considerations and economical considerations in demersal fisheries. Figure 8 also reveals the fishable stock of cod tends to increase slowly after it reached the lowest point in 1992. The recovery of cod may be expected in the future.

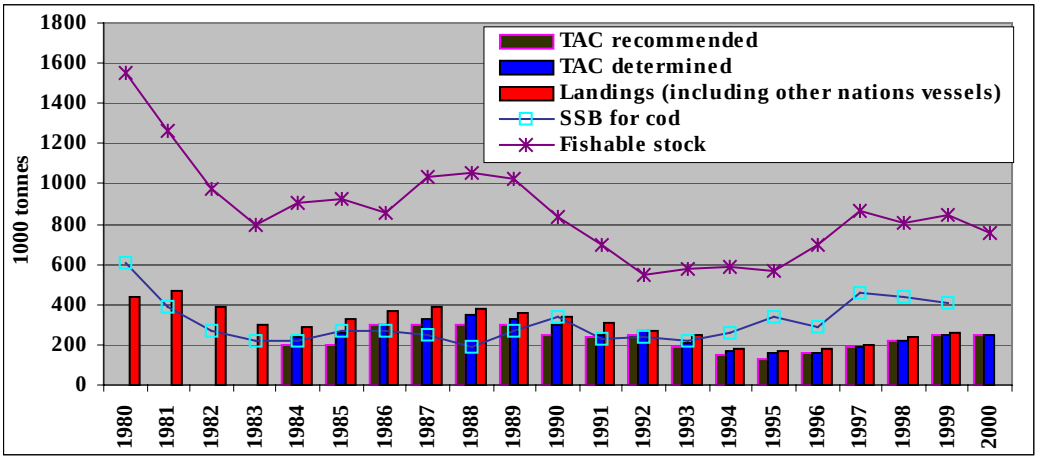


Figure 7: The trend of landings, TAC recommended, fishable stock and SSB for cod stock (MRI 2000).

One of primary purposes of an ITQ system is to provide an incentive to rationally manage the fishing capital by the fishing industry itself. Under the influence of the ITQ regime, the structure of Icelandic fishing fleet has changed largely. The number of fishing vessels, the number of average fishermen employed, and the total fishing days at sea tend to reduce gradually, while the average GRT of each vessel tends to increase slightly (Figure 9).

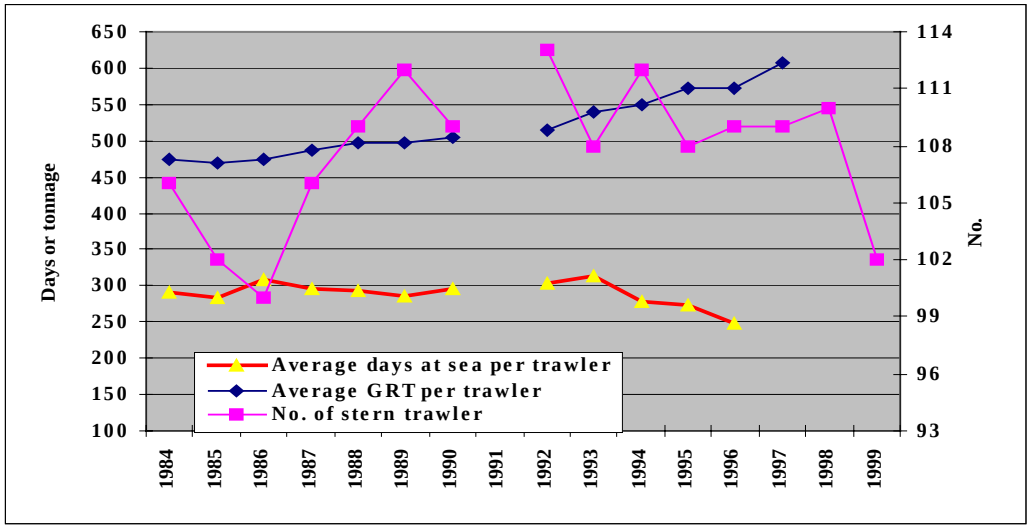


Figure 9 (a): the fleet of stern trawlers.

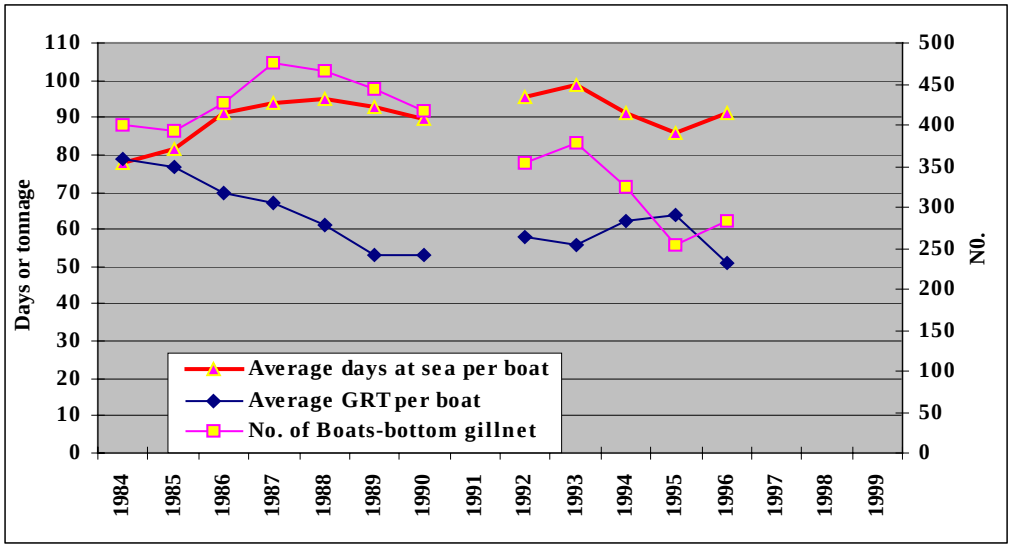


Figure 9 (b): the fleet of boats using gillnets.

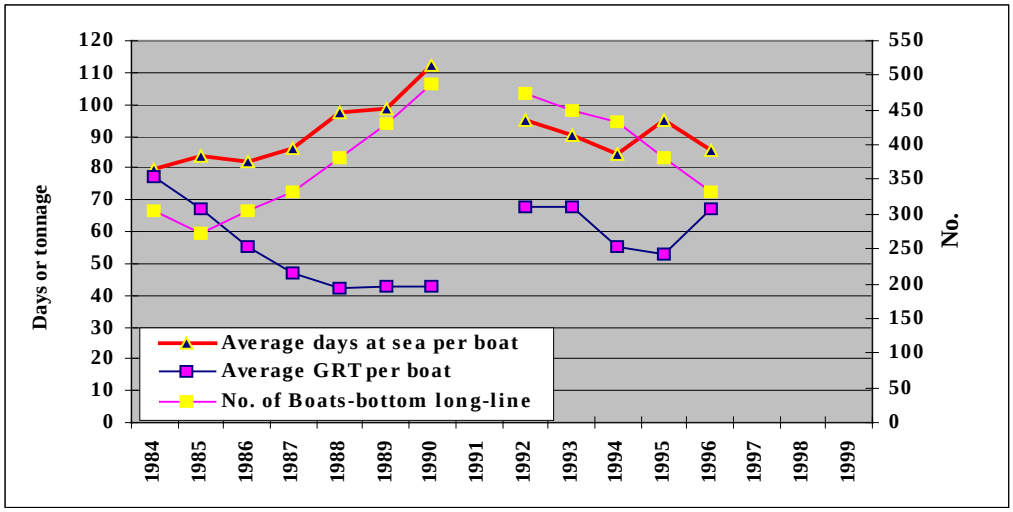


Figure 9 (c): the fleet of boats using long-line.

Figure 8: The change of fishing fleet structure and fishing days at sea in demersal fisheries (Statistic Iceland 2000).

Figure 9 shows the change of fishing fleet structure with different fishing methods in demersal fisheries. There were 106 stern trawlers of 473 GRT on average in 1984, and reached 113 stern trawlers in 1992 with 514 GRT on average. In 1997 the number of stern trawlers reduced to 109 with an average size of 607 GRT. Boats using longline show a similar trend but the GRT of boats using gillnets decrease as the number of boats decline. It is worth noting that the number of fishing boats in the demersal fisheries increased quickly in the early years of the ITQ system and then reduced. It is clear that many people entered the demersal fisheries from 1984 to1990 in order to get quota. Then some of them exited from the fishing industry and some small boats were gradually combined into big boats by 1992. This suggests that the speculation can not be avoided and an absolute allocation scheme of quotas is not available at all when the transition of fisheries management regime takes place.
The ITQ system can result in the rationalisation and modernisation of the fleets and encourage value-added fish processing. The mix of fisheries input becomes more rational and economic efficiency improves. Figure 9 also reveals the important fact

that the average fishing days at sea per vessel has reduced largely. It is suggested that under the ITQ system the fishing technology have been improved significantly. Figure 10 manifests that labour productivity is improved to a large degree. The economic efficiency of the whole fisheries industry has been made better. The landings per fisherman increased from 229.3 tons in 1990 to 380.8 tons in 1998. The export fob-value of marine fish and fish products per worker in the fishing and fish processing sector increased from 4.74 million ISK in 1990 to 7.30 million ISK in 1998.

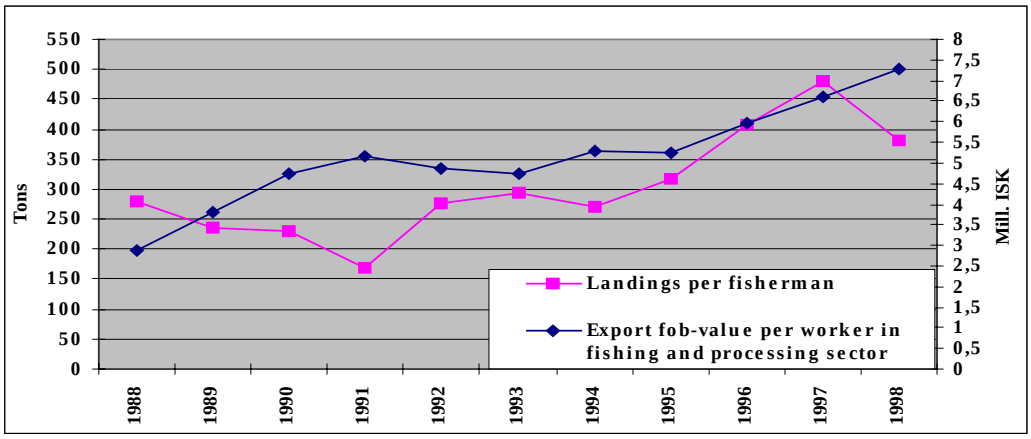


Figure 9: The trend of landings per fisherman and export for-value per worker in fishing and processing sector (Statistic Iceland 2000).

Therefore, the past near two decades witnessed an adjustment in the structure of the fishing fleet and the gradual recovery of some depleted stocks. More importantly, an increase in the economic rents has been seen. This is achieved to a large degree by market force, not by expansion of the administrative power of government. A well-defined and well-enforced ITQ regime can automatically balance the landings, the capacity of resources and fishing capital.

4.2 The controversies over the ITQ system

Although the outcome of the ITQ regime is quite positive, its introduction to fisheries management has caused the various controversies. This section attempts to pinpoint some of the concerns regarding the ITQ system.

4.2.1 The issue of initial permanent share allocation

Being a mixed concept of economics and biology, the ITQ system indeed provides no guidance regarding who has qualification to be allocated the permanent TAC-share and how many TAC-shares are given to every individual when it is initially introduced to a specific fishery. How to allocate the TAC initially is a social issue rather than an economic one. Table 3 lists some examples adopted in some countries.

Table 3: Initial allocation of permanent share in some countries (Arnason 1997, Gerry and Mark 1988, Casey and Dewees 1995, Gauvin et al. 1994).

- Iceland: In 1973-1975 vessel quotas were equally allocated in shrimp, scallop and lobster fisheries.
- Iceland: In 1975 the herring TAC was equally divided among the eligible vessels.
- Iceland: In 1984 the TACs for demersal species were allocated normally on the basis of catch history over 1981-1983 and an adjustment was also made owing to boat repairs or late entry into the fisheries. In 1985-1990 vessels under effort options may re-enter quota system based on the new track record.
- Iceland: In 1980 2/3 of quotas in the capelin fishery were allocated equally and 1/3 on the basis of the hold capacity.
- Netherlands: In 1975 sole and plaice fishery quotas were allocated on the basis of historic catch and the capacity of vessel (engine size).
- New Zealand: In 1982 deepwater trawl fisheries (for seven commercially important species) on the basis of their capital investment in the fishery.
- Australia: In October 1984 quota allocations were based on catch history (75%) and investment in the Southern Bluefin Tuna fishery (25%).
- Canada: In 1990 70% of an initial quotas for halibut were based on historic catch and 30% on the length of the vessel.
- USA: In 1990 ITQs for ocean quahogs were based on the average catch between 1979 and 1987.
- USA: In 1992 50% of quotas for wreckfish fishery were based on historic catch and 50% divided equally among all vessels.

As indicated in the table 3, the initial allocation of quotas was all bound to the active fishing vessels-----only an owner of fishing vessel was entitled to get quotas; the historic landings of each vessel and fishing capital were the only considerations and entitlements were given free of charge. No country allocated the quotas by auction market. It is obvious that the harvesting history and present investment are respected altogether as much as possible by all countries. When no the best fair methods are available, to respect history and reality is a quite civilised and practical choice. Perhaps the number of family members should also be a consideration when an ITQ system is introduced in a fishery with many small-scale fishers based on families. The initial allocation should allow small-scale fishers a better opportunity to participate in the competition in the future. The introduction of a new institution certainly causes disharmony in the whole society. Thus equity should be taken into account to increase social acceptance.
In addition, when allocating the TAC for cod annually according to the permanent TAC-share, the Minister is entitled to allocate a small special share to vessel owners who have suffered the most from the TAC reductions.

4.2.2 Prediction of TAC

One of the weaknesses of an ITQ system is the accuracy in the projection of TAC. The current biological methods and associated data used to provide advice for fishery management are heavily criticised since the current biological models do not address the complex dynamics of marine ecosystems (Macglade 1999). The critics are correct because the current knowledge and understanding of marine fish stock is clearly insufficient to determine a correct and safe TAC, although various biological models have been created and modified for nearly a century. Especially when dealing with the

multi-species fisheries and change of marine physical-chemistry environment, the current scientific methods of stock assessment are quite limited.
However it is the market force created by an ITQ system that can reduce the risk of biological-prediction uncertainty. Continuous adjustments of TAC are inevitable because of the inherent of biological variability in fish stocks and their ecological interrelationship. Whether the TAC is set too high or too low will not affect the statement that the ITQ will maximise the economic rents from the TAC. The understanding of marine ecosystem and ability to set a sustainable TAC will improve over time.

4.2.3 ITQ and private property right

Whether the ITQ system creates a new type of private property right is a very interesting topic, but quite meaningless in practice. On one hand, the catch quota (or TAC-share) is an attached to the fishing vessel, but on the other hand, it has its own monetary value and can be traded in the quota market and split like an ordinary asset in a divorce settlement. Thus it caused the serious debate on whether fish stock should be "common or private" and whether the TAC-share holders should pay extra tax or fee for utilisation of fish stocks.
Property rights are usually defined as the right to use, control, and obtain the benefits from a good or service. Private property rights exist when property rights are (1) exclusively held by one owner (or jointly by a group of owners) and (2) transferable to others at the owner's discretion (Gwartney and Stroup 1995). Anthony Scott (1999) attempted to visualise the combination of characteristics in a property right (Figure 11).

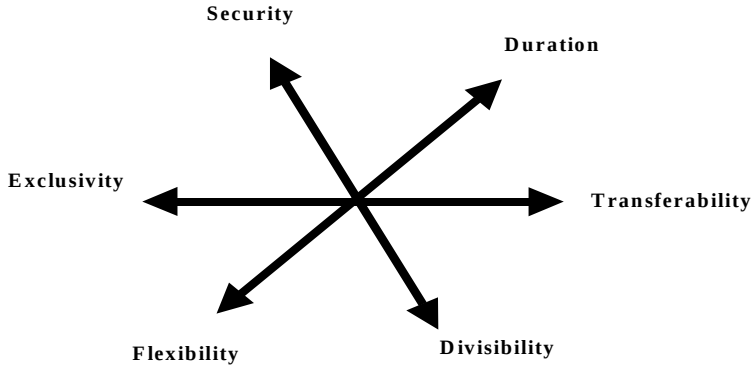


Fig. 11 The combination of characteristics in a property right

Figure 10: The combination of characteristics in property right

Careful observation suggests that the current Icelandic ITQ regime does not certainly create a new type of private property. Article 1 of Fisheries management Act 1990 states that the exploitable marine stocks of Icelandic fishing banks are the common property of the Icelandic nation. It only stands for a harvest privilege in fact. First, the price of ACE or TAC-share in the market does not only depend on the supply and demand. It is heavily up to the TAC-setting. Second, no matter how well an ITQ regime is defined, a quota-holders can never practically claim his right to a part of fish stock in waters, even when his share of fish stock is seriously harmed (it does not matter whatever reason) because the habitat of fish has many functions and fish may migrate. The purposes of fish habitat will absolutely increase with the improvements

in scientific technology. The idea of privatisation of marine fish stocks or ocean like land is only a romantic dream. Should the technology of fencing the oceans be created, fishing activities would be marine culture. Similarly the quota holders can never exercise their rights without any interferences, even when the boats below 6 GRT are subject to the ITQ regime. Third, the divisibility and transferability are not perfect because the quota is stringently attached to a fishing vessel. Much worse, 50% of ACE must be legally harvested in two consecutive fishing years. Otherwise quota share will be cancelled. Finally, according to the UN Convention on the Law of the Sea, the nature of a coastal state's sovereign right over fish stock is also not clear. Privatisation of ocean resources does not have strong legal grounds internationally.
In fact, attentive and time-consuming debate over private property in fisheries and discussion on enclosure the ocean have deviated from the primary purpose of creation of ITQ system. A cat, whether yellow or white, is a good cat as long as it can catch a mouse (by Deng Xiaoping). An institution is of course good as long as it can preserve the fish resources and maximise the economic rents. Whether the quotas certificate can be collateral for loan has not direct relationship with the goals of ITQ regime. It is only depends on the agreement between the given bank and the specific quota-holder. Like virtual population analysis in fish stock assessment, an ITQ regime seems to create a virtual private property over a virtual share of fish stock----just virtual private property.

4.2.4 Concentration of fishing concession, unemployment and community stability

The ITQ regime has been fiercely attacked in Iceland because it can encourage the concentration of quotas. Further, it will cause the high unemployment and destroy the economy of community.
Concentration of permanent TAC-share has very different measurements to assess and concentration of quotas accordingly suggests quite different outcomes. (1) The TAC-share per fishing vessel becomes higher; (2) the geological distribution of TAC-share (registered ports of fishing vessels) contracts; (3) the number of fishing companies and real quota-holders (including the vessel owners and stockholders of fishing corporation) reduce.
Under the ITQ system, the number of active fishing vessels absolutely reduces and finally reaches an economic equilibrium point. This is just one of goals for ITQ regime to seek. This will directly reduce the employment opportunities for fishermen (seamen) and indirectly affect the jobs in the whole fishing industry.
As Figure 12 indicates, the average number of fishermen and employment in fish processing has gradually reduced since 1990 and 1995. However there is strong evidence that the ITQ regime has not caused serious unemployment (Figures 13, 14 and 15).

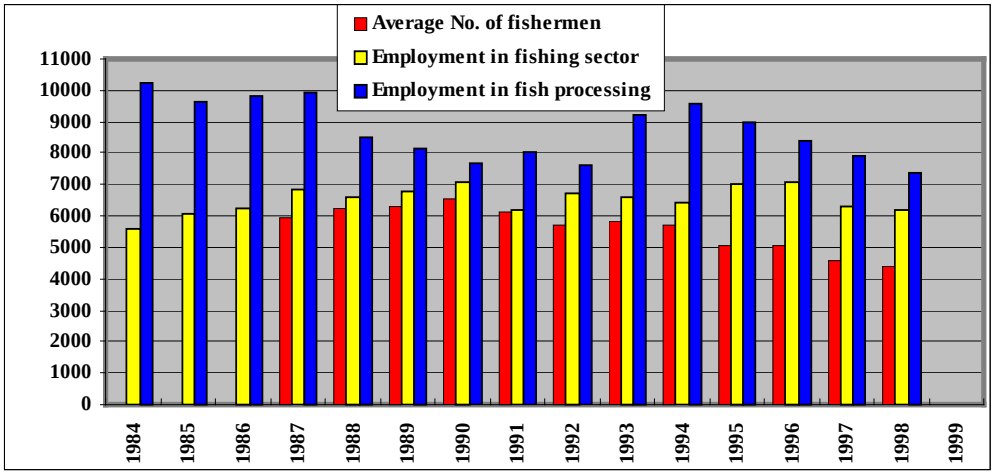


Figure 11: The average number of fishermen and employment in the fisheries (Statistic Iceland 2000).

Figure 13 shows the percentage of employment in fishing sector and fish processing sector has basically gone down since 1984. It is very interesting to note that the rate of registered unemployment and percentage of employment in fish processing industry exhibit a very similar tendency since 1992. It suggests that it is quite easy in Iceland to find new jobs in other industry for some workers who have to leave from fisheries.

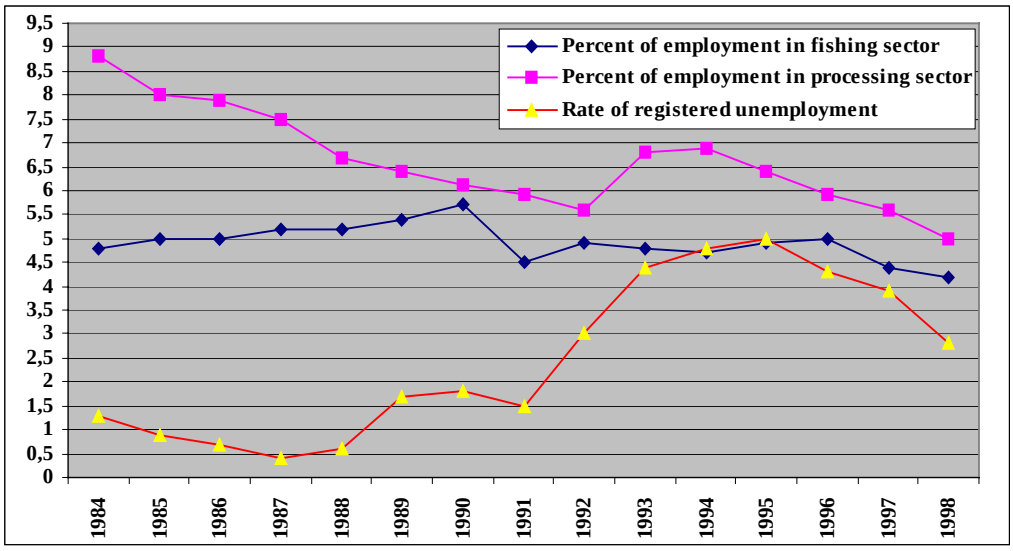


Figure 12: Comparison between the rate of registered unemployment and percentage of employment in the fishing sector and fish processing sector (Icelandic Statistics Yearbook 1984-1999).

Figure 14 shows that the geological distribution of quota holdings. A clear trend is noted that the quota holdings held in the Northeast have clearly increased and the quota holdings in Reykjavik and Western fjords have reduced since 1995. The trend of change of quotas held in other regions in not significant. Fig. 15 shows the geological distribution of registered unemployment. It reveals that the unemployment rate exhibits the quite similar tendency among all the regions. Compared with Figure 14, only in the Northeast region is there a close relationship between the quota

holdings and unemployment rate that the rate of registered unemployment went down, while the quota holdings went up. However there are no indications in other regions.

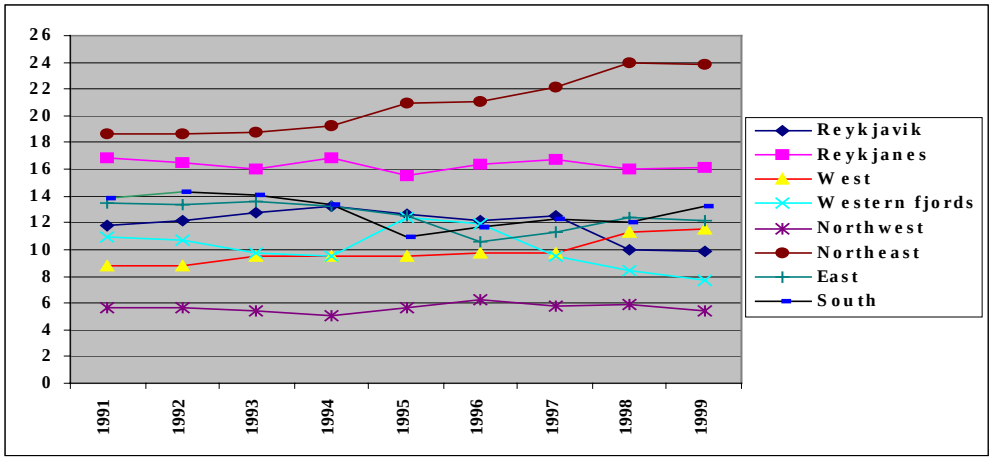


Figure 13: The geological distribution of quota holdings (Danielsson 2000).

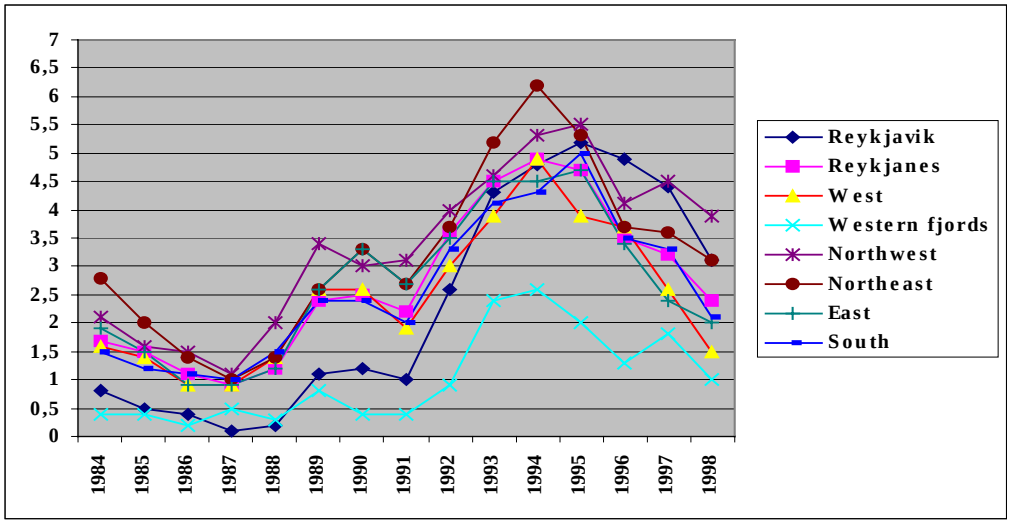


Figure 14: The geological distribution of registered unemployment (Statistic Iceland 2000).

It is not very reasonable and logical to directly link the employment opportunities in a specific region with its TAC-share holdings. First, fishing vessels may employ the seamen and land catch outside its region, even employ foreign workers and land its catch in foreign ports. Second, TAC-share is only a percentage based on quota value. The big TAC-share held in a special region does not necessarily mean more jobs available there. The unemployment problem is a complicated social issue. It is difficult to state what factors will have a seriously adverse impact on job opportunities. The assertion that the geological contract of TAC-shares definitely destroys the jobs is lack of strong ground. The whole Icelandic economy is quite strong. Employment shift is quite easy to achieve.

It is also revealed that the national employment does not have any close relationships with employment in fisheries. A contradictory relationship may be shown in Figures 14, 15, and 16 because of very small contribution from the fisheries to the national employment.

The fallacy that the ITQ system causes the serious unemployment stems from a failure to recognise its secondary effects. The number of active fishermen must decline

owing to ITQ. However the ITQ system will definitely lower the cost and improve the labour productivity, which will lead additional spending and jobs in other industries. For example, the ITQ system creates the new positions in the Icelandic Quota Exchange, some inspector positions, weighing officials, etc. Certainly in the short run, some people have to improve their employability to adapt new positions.
The invention of computers and internet does not destroy jobs. The ITQ regime results in the mass-production and improved fishing technology and will not deprive of employment in the long run. The purpose of ITQ system is to improve the economic efficiency by improving the catch per unit effort. This will be accomplished through reducing fishermen and fishing fleet. Even without the ITQ system, some communities may lose vessels and some communities may win vessels. Much worse, the depletion of fish stock may cause the complete closure of fishery. This can suddenly give rise to a serious unemployment and finally destroy the community stability.
In essence, the ITQ system does not necessarily cause the excessive concentration of fishing privilege because any Icelander can "catch fish" by investing in the stock market, not only by owning a fishing vessel. And no law prohibits more than one person owning one fishing vessel. Thus, analysing how many quota-shares one fishing company holds will misinterpret the concentration of fishing rights and further the notion that the rich will become richer.
The co-existence of quota market and stock market imply that the legal co-habitat of TAC-share holding and vessel-owning will produce negative rather than positive impact on the fisheries economy and fair distribution of wealth.
In order to reduce the economic oscillation in the community heavily based on fisheries, it is a wise choice to keep the small-operators free of the ITQ system. They can be allocated a common TAC-share according to their fishing history. However, this should be a closed fishing club. That the ITQ theory can improve the fishing efficiency is based on an important assumption: the quota-holders are willing to transfer their quotas when they feel their ratio of input and output is low enough. It is well known that the smaller the fishing operator, the further from the real world this economic assumption is. Thus, it would not have a significant impact on fishing productivity even when all small-operators had been driven to quota market. The only outcome is to hurt the fishermen feelings, destroy the traditional fisheries culture and disrupt community stability suddenly, and finally make it difficult to accept the powerful ITQ system.

4.2.5 Enforcement and administration cost

To function well, any fisheries regimes have to be enforced and monitored effectively. The ITQ system is criticised for leading to false reports and higher administration cost. How to keep the actual landings of a specified vessel consistent with its quotas held legally constitutes an important task of fisheries management indeed.
In Iceland there are about 70 landing ports. The Directorate of Fisheries issues the scale certificates and licenses the weighing operators (employees of fishing harbour authority) in each landing port. The licensed operators must weigh all landings on the certified scales. A computer system links all the landing ports to Directorate of Fisheries and Icelandic Quota Exchange. Actual landing data are transmitted twice a day. In addition, some fisheries inspectors from Directorate of Fisheries observe the fishing activity on board and travel between the landing ports to check the landing activity. Violations of fisheries laws and regulations are subject to fines, expropriation

of catch and gear, cancellation of fishing permit, and imprisonment depending on the seriousness.

Under any fisheries institution, whether good or bad, it is possible for fishermen to break the rules to get private interest because every person in essence is selfish. Enforcement of ITQ is not only the duty of government but also the responsibility of fishermen and quota holders. In practice it is not easy to misreport the landings because fishing and landing activity are always conducted by a group of people. Further the additional incentive to inspect and report each other can be created by rewarding quota shares revoked from cheaters to reporters or by reallocating them to remaining quota holders. It is also noteworthy that the ITQ regime increases the future interest in fishery. It can similarly increase the willingness for operators to observe the legal rules.

The introduction of any new regimes will definitely increase the administration cost. However it is absolutely absurd and unreasonable to oppose the ITQ system for this reason. Whether a new institution should be established should not at all depend upon its cost in practice. It should depend upon whether society needs this new institution in the long run.

Under the current Icelandic ITQ system, the quota-holder (the owner of active fishing vessel) must pay the following fees and taxes.

(1) Directorate of Fisheries annually collects a fishing inspection fee ISK242 per ton (cod equivalent) to fund the fishing inspection. The minimum is ISK 2700.
(2) Directorate of Fisheries annually collects a quota fee, ISK 1230 per ton (cod equivalent). This fee goes into the developing fund of fisheries.
(3) Directorate of Fisheries collects fees for a general fishing permit, ISK 15000 per year.
(4) Vessel owners supply the fishing inspector with meals and facilities.
(5) The seller of quota must pay a confirmation fee to the Directorate of Fisheries, ISK 1800.
(6) Weighing fee supports the weighing cost in landing ports.
(7) Registration fee of quota-transferability is used to finance Icelandic Quota Exchange, .13% of trade value.
(8) Various taxes collected by state and municipal tax authorities.
(9) Various harbour dues are collected by the harbour authorities.
(10) Charges for vessel registration are collected by Maritime Administration.

It is suggested that the current ITQ regime be run on a basis of “cost recovery”. In an extreme case it seems that quota holders should also finance the Ministry of Fisheries and other government organs relating to fisheries. As a result, the fishing industry will be isolated from the rest of society.

The concept of cost recovery is not a wise idea. It will potentially give rise to the division of social members, economical conflict between different occupational groups and political opposition. People live in a common society. In order to keep and improve social harmony, tax paying is an ideal choice instead of quota fees because nobody can clarify what expenditures should be recovered by quota-holders and what expenditures should be offered by all taxpayers. Since the current Acts stipulate that all citizens own the marine fish stocks, it is reasonable and logical to impose a special tax on quota holder to collect the resources rent. Weighing operators work for the State, not only for quota holders. Therefore, they should be supported by all taxpayers.

There is no difference between the administration cost of ITQ regime and other government expenditures.

4.2.6 ITQ and high grading/discarding

The concerns that ITQ system tends to cause serious high grading and discarding affect its acceptance very adversely. The ITQ system indeed creates an excessive incentive to grade highly and to discard more fish, usually too small and low valued fish (Arnason, 1994, Anderson 1994).
From economic point of view, it is rational for fishermen to discard the small fish in order to maximise their earnings. Even without ITQ, discarding may take place. No reliable method can be found to assess how serious the discarding the ITQ will give rise to. In order to reduce discarding, the practical means are to strengthen the direct biological measures by establishing temporary closure areas, strictly inspecting minimum mesh size, legally mounting special sorting devices, etc. The factory trawlers should be closely watched because the processing machines may select the raw materials too highly. Fishing gear with more biological selectivity should be the target, although the current laws and regulations stipulate that the small fish landed might be counted in the catch quota. Owing to the reduction of fishing effort, the adverse impact on the fish stock and its habitat caused by fishing activity might lessen.

5. DISCUSSION AND CONCLUSION

The uniform ITQ regime has been employed for over 10 years, since 1991. Its performance is generally positive and very promising. However some flaws can also be identified in the current ITQ system. Some of them are intrinsic such as stock assessment, discarding, misreporting etc., which can not be eliminated. Other flaws are due to either poor system design or have historical roots, which can be eliminated to make a better ITQ system in the future.
From a political point of view, the stipulation that a fishing vessel without a quota can not enter the quota market is discriminating against some citizens. From an economical point of view, this bridles the force of market mechanism. The fishing vessel is in fact a barrier of entry and exit to the quota market. As a result TAC-share (or ACE) becomes a special asset but with certain flaws. Subsequently its divisibility and transferability are impaired. The initial allocation of TAC-share respected fishing history. To liberate the TAC-share holding from the shackles of a specific fishing vessel in the future is to respect the equity. The Quota Exchange may combine with the Stock Exchange. The TAC-share for fish stock may be tradable like a special kind of stock.
In order to avoid the concentration of fishing concessions and attack the speculation, the Fisheries Management Act stipulates that (1) a vessel must harvest at least 50% of its ACE in 2 continuous fishing years, (2) the net transfer of ACE from any vessel within each year must not exceed 50%, and (3) no single fishing firm may hold more than a given fraction of TAC for each species. However, this arbitrary command and control subsequently restricts the scale of production. It will definitely generate an adverse impact on improving economic efficiency. Thus, to impose a special tax on the excessive TAC-share holding is an ideal alternative. Also, taxation on excessive TAC-share holders can distribute social wealth fairly like tax on individual income.

Instead of so-called cost recovery, a general tax may be imposed on all TAC-share holders like tax on individual consumption. A general tax on all TAC-share holders is to collect the resource rent because the marine fish stocks are absolutely owned by all Icelanders.

The stipulation that up to 20 %ACE of this fishing year may be harvested in the next year is not very necessary or appropriate. According to Catch Rule for cod, TAC is equal to 25% of fishable stock. It can infer that the actual landings may be 45%. Therefore in an extreme case the setting of biological TAC may be meaningless. In fact the ACE not caught may be transferred through the Quota Exchange.

Small operators with boats under 6 GRT may form a separate fishing club. They can enjoy a permanent, fixed and common TAC-share, or an equal individual TAC-share, but it should be a closed club. If they like, they can also make it possible trade their quotas within their club. To keep them free of the ITQ system is to respect the fisherman's culture and lifestyle.

Although the 10-year history of the Icelandic ITQ system is quite short to draw a convincing conclusion that the ITQ theory can save the world marine fish resource and bring about sustainability of the fish supply, its performance in Iceland has demonstrated it is the best fisheries management regime.

Regardless of whether ITQ represents a private property right or not, it has been used to protect the fish resource to a large degree and improve the fisheries' economic efficiency. It is completely impossible and unwise to reverse the process. In fact the objective of fisheries management is a mix of economic, biological and social goals. Three goals always co-exist in tension with the pendulum of fisheries management regime often swinging between the three goals. Fisheries management is as much an art as it is a science.

The sharp political debate on some controversies does not always benefit society as a whole and does not lead to a consensus in the short term. All people, whether economist, biologist, fishers, or politicians, have to take the time to see the success of the ITQ system for themselves. A perfect ITQ regime has to be built up both in theory and in practice.

ACKNOWLEDGEMENTS

Creating a project is always not an author's own effort. First I would like to express my many thanks to Dr. Eyjolfur Gudmundsson. Without his warm-hearted help, careful directions, and constructive comments, I would not have finished my project. My special thanks should also be given to Dr. Tumi Tomasson, whose pointed remarks gave an impetus to my ideas. I always feel indebted to Dr. Ragnar Arnason, whose valuable and wonderful teaching benefited my work on this report very much and even my future.

Here I would also like to express my appreciation to the following people for their friendly and generous help and directions: Thor Heidar Asgeirsson, Deputy director of UNU Fisheries Training Programme; Asgeir Danielsson, Economist of National Economic Institute; Sigurjon Adalsteinsson, Head of Dep. of Land-based Surveillance, Directorate of Fisheries; Gudmundur Kristmundsson, Project manager of Dep. of fisheries management of Directorate of Fisheries; Birgir and Sigurdur, two inspectors from Directorate of Fisheries; Höskuldur Steinarsson, an official from Dep. of fisheries management of Directorate of Fisheries; Arni Muli Jonasson, Assistant Director of Directorate of Fisheries; Petur Bjarnason, Chairman of Icelandic Fisheries Association; Hannes H. Gissurarson, politics professor of the University of Iceland. Finally I am grateful for the good studying facilities provided by the Marine Research Institute and University of Akureyri, Iceland.

REFERENCES

Anderson, L.G. 1994. An Economic Analysis of Highgrading in ITQ Fisheries Regulation Programmes. *Marine Resources Economics* 9:209-226.

Arnason, R. 1990. Minimum Information Management in Fisheries. *Canadian Journal of Economics* 3:630-653.

--- 1994. On catch discarding in Fisheries. *Marine Resources Economics* 9:189-207.

--- 1995. *The Icelandic Fisheries: Evolution and Management of a Fishing Industry*. London: Blackwell Science Ltd.

--- 1997. On the Icelandic ITQ System and its Consequences. In Petursdottir, G. ed. *Property Rights in the Fishing Industry*. Reykjavik: University of Iceland Press.

--- 1999. Advances in ITQ Fisheries Management. In Arnason, R. and Gissurarson, H.H. eds. *Individual Transferable Quotas in Theory and Practice*. Reykjavik: University of Iceland Press.

--- 2000. The Principles and Practice of Fisheries Management (in press).

Bjarnason, A. 1996. *Export or Die--Icelandic Fishing Industry: the Nature and Behaviour of its Export Sector*. Reykjavik: Fisheries Research, University of Iceland.

Casey K.E., Dewees, M.C. 1995. The effects of individual vessel quotas in the British Columbia Halibut Fishery. *Marine Resources Economics* 3:211-230.

Christy, F.T. 1997. Economic Waste in Fisheries: Impediments to Change and Conditions for Improvement. In Pikitch, E.K., Huppert, D.D. and Sissenwine, M.P. eds. *Global trends: Fisheries Management*. Bethesda: American Fisheries Society.

Danielsson, A. 1997. Fisheries Management in Iceland. *Ocean & Coastal Management* 35:121-135.

--- 2000. The quota transfers in Iceland: A descriptive 2000 (unpublished).

Davides, W. 1997. ITQs in the Netherlands. In Petursdottir, G. ed. *Property Rights in the Fishing Industry*. Reykjavik: University of Iceland Press.

FAO 2000. Yearbook: fishery statistics capture production 1998.

Garcia, S.M. and Newton, C. 1997. Current Situation, Trends, and Prospects in World Capture Fisheries In Pikitch, E.K., Huppert, D.D. and Sissenwine, M.P. eds. *Global trends: Fisheries Management*. Bethesda: American Fisheries Society.

Gauvin, J.R., et al. 1994. Description and evaluation of the wreckfish fishery under individual transferable quotas. *Marine Resources Economics* 2: 99-118.

Gerry. G. and Nayar, M. 1988. Individual Transferable Quotas in the Southern Tuna Fishery: An Economic Appraisal. *Marine Resources Economics* 4: 365-388.

Gissurarson, H.H. 1999. The Fishery: Agreeing on the Rules. In Arnason, R. and Gissurarson, H.H. eds. *Individual Transferable Quotas in Theory and Practice.* Reykjavik: University of Iceland Press.

--- 2000. When ideas conspire with circumstances: Introducing individual transferable quotas in fisheries. *Bilingual Journal of Interdisciplinary Studies* 2:285-314.

Gordon, H.S. 1954. The Economic Theory of a Common Property Resource: the Fisheries. *Journal of Political Economy* 62:124-142.

Gwartney, J.D. and Stroup, R.L. 1995. *Microeconomics: Private and Public Choice.* Fort Worth: The Dryden Press.

Hannesson, R. 1993. *Bioeconomic Analysis of Fisheries* London: Fishing News Books.

Hardin, G. 1968. The Tragedy of the commons. *Science* 162:1243-1247.

Hart, J.A. 1976. *The Anglo-Icelandic Cod War of 1972-1973: A case study of a fishery dispute.* Berkeley: Institute of International Studies, University of California.

Jakobsson, J. and Stefansson, G. 1998. Rational harvesting of the cod -capelin-shrimp complex in the Icelandic marine ecosystem. *Fisheries research* 37:7-21.

Jonsson, H. 1982. *Friends in Conflict: The Anglo-Icleandic Cod Wars and the Law and of the Sea.* London: C. Hurst and Co. (Publishers) Ltd.

Laursen, F. 1993. *Small powers at Sea*. Dordrecht: Martinus Nijhoff publishers.

Macglade, J. 1999. Bridging disciplines: The role of scientific advice, especially biological modelling. In Kooiman, J., van Vliet, M. and Jentoft, S. eds. *Creative governance---opportunities for fisheries in Europe.* Aldershot: Ashgate Publishing Limited.

Major, P. 1999. The Evolution of ITQs in New Zealand. In Arnason, R. and Gissurarson, H.H. eds. *Individual Transferable Quotas in Theory and Practice.* Reykjavik: University of Iceland Press.

MRI 1996. State of marine stocks in Icelandic waters 1999/2000.

MRI 1999. State of marine stocks in Icelandic waters 1999/2000.

MRI 2000. State of marine stocks in Icelandic waters 1999/2000.

OECD 1997. Towards Sustainable Fisheries: Economic Aspects of the Management of Living Marine Resources.

Palsson, G. 1999. Individual Transferable Quotas: Unconstitutional Regimes? *The Common Property Resource Digest* 48:1-4.

Pascoe S. 1993. ITQs in the Australian SouthEast Fishery. *Marine Resources Economics* 8:395-401.

Porter, G. 1997. Euro-African Fishing Agreements: subsidizing overfishing in African watrs. In *Subsidies and Depletion of World Fisheries*: case studies. Washington D.C.: World Wildlife Fund.

Runolfsson, B.Th. 1999. The Icelandic System of ITQs: its nature and performance. In Arnason, R. and Gissurarson, H.H. eds. *Individual Transferable Quotas in Theory and Practice*. Reykjavik: University of Iceland Press.

Scott, A. 1955. The History: The Objective of Sole Ownership. *Journal of Political Economy* 63:116-124.

--- 1999. Fishermen's Property Rights. In Arnason, R. and Gissurarson, H.H. eds. *Individual Transferable Quotas in Theory and Practice*. Reykjavik: University of Iceland Press.

Statistic Iceland 2000. Statistical Yearbook of Iceland 1990-1999. Reykjavík.

Warming, J. 1911. On Rent of Fishing Grounds. Translated by Peder Andersan and Kirsten Stentorft. *History of Political Economy* 1983 15 (3): 391-396. Duke University Press.

Wesney, D. 1989. Applied Fisheries Management Plans: Individual Transferable Quotas and Input Controls. In Neher, P.A., Arnason, R. and Mollett, N. eds. *Rights Based Fishing*. Dordrecht: Kluwer Academic Publishers.