Economic Incentives and CITES Appendix II-listed Species –

Scoping paper on Individual Tranferable Quotas for Acipenseriformes spp. In the Caspian Sea

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Prepared by IIED on behalf of the CITES Secretariat
Authors: James Macgregor[1], Katia Karousakis and Ben Groom[2]

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EXECUTIVE SUMMARY

The motivation for this study came from the first CITES meeting on 'Economic incentives' (December 2003) where delegates recommended a review of the potential for several economic incentive measures (EIs) including individual transferable quotas (ITQs), the subject of this scoping paper. Strong theoretical and increasingly practical credentials back ITQs as a promising mechanism for achieving both conservation and socio-economic outcomes.

The purpose of this scoping paper is to introduce the general concepts of an ITQ system and the specific program design issues that need to be considered for its application to the sturgeon population in the Caspian Sea. These Caspian sturgeon species are listed on Appendix II of CITES. Anecdotal evidence indicates the *in situ* population might continue to be threatened although the factor causality is uncertain. To this end, this scoping study will explore the applicability of ITQs to the Caspian sturgeon fishery, highlight the limits of such an approach and indicate a ladder of research necessary to design and implement an efficient and sustainable system. This paper presents key issues that need to be considered to assess the viability and effectiveness of such a program, and presents lessons learned from a number of case studies where ITQs have been implemented.

This scoping paper builds on Bulte, Swanson and Van Kooten (2003) which notes that 'the challenge is somehow to bring all of the costs and benefits of wildlife exploitation and conservation together so that those making decisions about wildlife (whether wildlife managers, poachers or traders) take them all into account. If this is to occur, it will be necessary to develop appropriate economic instruments and incentives'.

Economic incentive measures

In essence, economic incentive measures (EIs) help democratise the regulation and enforcement of the management regime associated with a natural resource or an ecosystem, guiding resource users towards efficient and sustainable use of natural resources and industry participants towards enhanced self-regulation.

EIs can be more than a bolt-on to other regulation and legislation, and have been placed at the heart of solutions for commercially valuable and threatened species worldwide. It is precisely the ability to co-opt industry participants and guide their effort in concert with international regulations (such as CITES regulations) that makes an attractive package for tackling imminent conservation problems.

[1] *Environmental Economics Programme, IIED, London WC1H 0DD. Corresponding author: james.macgregor@iied.org. Tel: +44(0)2073882117.*

[2] *Department of Economics, University College London.*

Pragmatically speaking, the design of *efficient* EIs necessitates far better intelligence on the associated industry, industry participants and product markets than currently exists for many CITES Appendix II-listed species. Indeed, even the *direction* of response to certain events or regulations is unclear for many species listed on CITES. However, in the absence of hard data, there remains available information that might alert us to the opportunities and limits of EIs in the fight for species conservation.

The Individual Transferable Quota System

An ITQ system is an economic instrument that is, in theory, able to achieve a given level of stock conservation (or the sustainability of the resource) in the most efficient way (i.e. at a minimum economic cost to society). It is an efficient extension of traditional quota systems, as allowing trading ensures that the financial and natural resources will be allocated to more valuable uses, resulting in least-cost harvesting. In several countries, ITQ systems have met with substantial success in increasing fishing efficiency, reducing over-capitalization, and lessening the ecological impact of fishing operations. In addition, ITQs have encouraged fishers to exercise greater stewardship both *individually* over the resource and *collectively* over the long-term future of their fishery; individual fishers find new and often innovative ways of harvesting the target resource.

To set up a system of ITQs, the regulating authority must specify a Total Allowable Catch (TAC) and issue an equivalent number of quotas to reflect this. The TAC is the aggregate amount of fish that can be legally harvested over a specified time period and should be established so as to enable the fish stock to be maintained in perpetuity. The ITQ shares – where one ITQ represents the privilege to harvest a predetermined number of tons of fish, or alternatively, a share of the TAC – are then either distributed free of charge or auctioned off to the regulated fishers. Since ITQ programs *guarantee* a share of the current TAC and under appropriate conditions offer the *opportunity* to bid for a share of future TACs, incentives for fishers to 'race to fish' are eliminated, thereby reducing overcapitalisation and allowing them flexibility over the rate and timing of their fishing. Furthermore, it decentralises the cost minimisation decision giving each single owner of a portion of the resource incentives to manage her portion efficiently for the whole resource. This is what in effect promotes the *conservation* of stocks.

However, one crucial caveat concerns the *enforcement* of quotas; industry participants need be confident that their activity will be enforced. With CITES Appendix II-listed species this has added significance owing to the often high value of the associated products and derivatives from the species.

The *efficiency* of an ITQ program is ensured via the transferability of the quotas. This is because regulated fishers are able to purchase additional quotas if they would like to exceed their initial allocation of ITQ, or sell or lease their excess ITQ shares to other regulated individuals in the ITQ market. Assuming that fishers are profit maximisers, the decision to purchase or sell ITQs is determined by each individual's marginal cost of harvesting (MHC) an additional unit of fish. If the MHC is greater than the price of an ITQ, the regulated fisher will prefer to sell the excess quotas to others who are more efficient; alternatively, if the MHC is less than the price of an ITQ they will prefer to purchase additional quotas so as to catch more fish.

In common with regular quota systems based on TAC, ITQ systems are inherently flexible to environmental needs; TAC levels can be adjusted to account for fluctuations in stock levels. Indeed, there are examples of ITQ programs where TAC levels have been set to zero for a short period so as to allow the stock to recover from external factors (environmental conditions or pollution effects). In the knowledge that fishers will be able to resume their activities once the stock has recovered, they have incentives to comply with these restrictions.

Issues to Consider Prior to Implementing an ITQ System

Several factors are important in determining whether an ITQ program can be effective and program design in itself is also a crucial component for success. With regard to the former for example, there need to be a sufficiently large number of fishing vessels in the program to ensure that there is no monopoly power in the market for ITQs as this undermines the economic efficiency of the program. The regulating authority will need to maintain a balance between intervening in the trading mechanism and process – to ensure objectives such as equity are met – and the attainment of cost minimisation for the fishers as restrictions on the trading of ITQs limits the ability to attain the cost minimising outcome. Simultaneously, the number of fishing vessels in the program should not be so large as to undermine the regulating authority's ability to manage the ITQ program. Monitoring and enforcement capabilities are of utmost importance and fines and penalties need to be determined on a case-by-case basis, possibly related to the monitoring and enforcement intensity and industry perception of the probability of detection. Regarding program design, important aspects include the method of allocation of quotas e.g., based on historical levels or including a component for use of "clean" fishing techniques (i.e. minimal incidental by-catch); the maintenance of a registry; the application of appropriate penalties for non-compliance; measures to address new entrants into a fishery; and provisions that include incentives to minimise or prevent the prevalence of high-grading.

In addition for CITES Appendix II-listed species, there are additional uncertainties that require the greatest possible clarity to efficiently inform and seed ITQ design:

– *Biological scientific clarity*: Evidence of causality of biological harm through the action to be targeted: overfishing, international trade or pollution.
– *Economic clarity*: Evidence on the nature, inherent incentives and scale of: legal industry structure and dynamics, illegal fishing and trade, domestic consumption, demand dynamics and socio-economics of fishing.

Practically, the information gaps may be no more informationally intensive than required to design many other regulatory measures. A solutions-oriented approach often entails interrogating the available information and data using an incentives framework to reduce the risks of forwarding a course of action that runs counter to conservation objectives. From an economic viewpoint, the complexities of the interactions within ecosystems and among people and ecosystems often exceed the ability of rational analysis to forecast the outcome of any one decision. Indeed, such uncertainties may call for a sequential approach to management using a range of EIs complementary with regulation under CITES. Fortunately, ITQs do lend themselves easily to a risk-averse process of experimentation – progressing from short-term quotas to permanently tradable quotas.

Sturgeon fishery and caviar trade

There are no existing case studies on the potential of ITQ systems for sturgeon in the Caspian Sea, and significantly, no international ITQ systems exist for any fishery in the world. To this end, linking and coordinating the interests and activities of the five Caspian littoral States (Azerbaijan, Iran, Kazakhstan, the Russian Federation and Turkmenistan) which comprise the range states of *Acipenseriformes spp*. in the Caspian Sea over the sturgeon fishery will be vital and would likely require an International or Regional Agreement and attention paid to issues such as flag-hopping and quota-hopping. Equally, the current and future distribution of economic interests in sturgeon and caviar are different among these countries. A further complication is the significance of hatchery production for resident sturgeon populations – it has been argued that the Caspian sturgeon population approximates a "giant fish farm" (Pala, 2001).

There is optimism that the threats to a Caspian Sea-wide ITQ posed by, the need for international innovation, inter-Caspian Sea economic imbalances and hatchery-based population-recruitment uncertainties can be overcome.

Cooperation between the Caspian littoral States under the Caspian Bioresources Commission (CBC) bodes includes setting the TAC and catch quotas for sturgeon, and export quotas for caviar. Additionally, there are functioning systems to allocate and distribute quota in some of the Caspian littoral States, which might be applicable across the other countries. ITQs can deal with the different source of production entailed by reliance on hatcheries for sturgeon fingerlings. To this end, solutions using ITQs combined with other EIs or regulatory measures would seek to seek to ensure the sustainability of the full system, including hatcheries; ensuring both funding and the incentives facing industry participants are aligned with the full needs of the resource in perpetuity.

Cooperation is key and the process has apparently accelerated after the CITES Appendix II listing compounded by scrutiny by the Secretariat and external bodies, such as NGOs. Agreements reached on the Caspian Sea's resources will likely be stepwise and occur potentially over a prolonged time period. The integration of an ITQ system for the sturgeon fishery could run parallel to these wider processes. It is sensible not to be overly ambitious and to aim for quota to be traded domestically as an initial objective. The uncertainties over how any cooperative agreements that are brokered will transpire for the sturgeon fishery promote a stepwise approach to installing ITQ systems, building on the progress under the CBC. Information-gathering and analysis is crucial to guiding the pace of this stepwise development, with economic data and information key elements. One additional benefit of ITQ development is the access to new and vital information on the bio-economics of the target resource, which build into databases and resources that both guide future development and alert to potential risks.

Glossary of Terms

Common property: Property held collectively by a community or a particular group (two or more persons) within a community, owned and managed in common for the benefit of the community or that particular group. Excludes individual rights. Occurs where the rights to exploit a particular resource are held collectively by two or more persons. A resource to which no individual has exclusive rights to either the whole or a part; it can include an 'open access' resource.

Catch per unit effort (CPUE): The quantity of fish caught (in number or in weight) with one standard unit of fishing effort; e.g. number of fish taken per 1000 hooks per day or weight of fish, in tons, taken per hour of trawling. CPUE is often considered an index of fish biomass (or abundance). Sometimes referred to as catch rate. CPUE may be used as a measure of economic efficiency of fishing as well as an index of fish abundance. Also called: catch per effort, fishing success, availability.

Fish stock: The living resources in the community or population from which catches are taken in a fishery. Use of the term fish stock usually implies that the particular population is more or less isolated from other stocks of the same species and hence self-sustaining. In a particular fishery, the fish stock may be one or several species of fish but here is also intended to include commercial invertebrates and plants.

Flag-hopping: The practice of changing a vessel's flag to avoid conservation and management.

Fungibility: The ability to trade ITQs across national borders because the value of one ITQ from country x is identical to the value of an ITQ from country y.

High grading: The discarding of a portion of a vessel's legal catch that could have been sold to have a higher or larger grade of fish that brings higher prices. It may occur in quota and non-quota fisheries.

Maximum Sustainable Yield: A theoretical maximum tonnage of fish that can be harvested sustainably from year to year.

Open Access: A condition of a fishery in which anyone who wishes to fish may do so. Recreational fisheries are usually open access. Access to the resource is free to anyone who wants to use or harvest it because there is no ownership of the resource.

Population: A group of fish of one species, which shares common ecological and genetic features. The stocks defined for the purposes of stock assessment and management do not necessarily coincide with self-contained populations. Sometimes taken to mean a Stock.

Quota-hopping: Owners of one State who buy vessels in another State and use them to fish against the national fishing quota allocated to the latter State, after obtaining the right to fly the flag and being granted fishing licenses there.

Race to fish: A pattern of fishing characterized by an increasing number of highly efficient vessels fishing at an increasing pace, with season length becoming shorter and shorter.

Rent: In a fishery, difference between the total revenues obtained from the fishery resource and the total costs of production, i.e. capital and labour valued at their opportunity costs (see Opportunity costs). The total costs of production include a reasonable profit and the rent is often considered as a "surplus" profit, over and above what would be considered a "normal" rate of return. For this reason, the decision as to who gets the rent (e.g. the society, the management authority, or the fishermen) remains a key policy issue.

Source: FAO Fishery Glossary. http://www.fao.org/fi/glossary/default.asp.

1. Introduction

The paper is structured as follows: Section 2 provides a general introduction to ITQ systems, how they can be set up and some necessary institutional requirements for them to function effectively. Using case study evidence from Iceland, New Zealand and other countries, section 3 presents available options for ITQ program design and lessons learned from these experiences. Section 4 presents issues specific to the use of ITQs for the Sturgeon population in the Caspian Sea. Section 5 highlights some specific program design issues for sturgeon, and proposes a research agenda. Finally, section 6 concludes with some implications for policy.

2. A Review of Individual Transferable Quotas

2.1 The Economics of Fishing

The way in which a fishery is used and managed depends upon the property rights to the resource. The nature of a fishery is described as a common property or open access resource in economic terms. The situation of open-access occurs when there is a lack of clearly defined property rights (i.e. a market failure), such that individuals are able to enter a particular market and exploit the resource without restrictions. A common property resource is one that is owned by some defined group of people such as a community or a nation. Within the group, the property may either be regulated or unregulated which has significant implications for the types of rents than can be earned and the sustainability of the fishing regime. Theoretically, under an open-access situation, individuals do not have any incentive to conserve the resource into the future and instead, due to the initial existence of profits in the industry, will encourage more individuals to enter the fishery and increase the harvesting effort. As the scarcity of fish increases, catch per unit effort declines, thereby raising the unit cost of catching fewer fish. Entry will continue until total costs have increased and total revenue has fallen to the point where profits are zero (rent dissipation), and the stock of fish declines below the optimal level. This is the so-called 'tragedy of the commons' (see **Box I** for more detail).

In order to correct for these market failures and achieve the optimal level of fishing effort and harvesting, governments must intervene into the fishing market. In the past this has been undertaken via the application of more traditional command and control approaches, whereby the regulating authority imposes input, output, or technological restrictions so as to control the level of fishing effort. These have included restrictions on the use of particular fishing gear (e.g. the mesh size of nets), the number of days at sea, the size and power of fishing vessels, and the introduction of fishing quotas, among others. These methods however do not alter the underlying behavioural incentives inherent within the fishing industry and have therefore been largely ineffective (e.g. fish stocks collapsed in the New England groundfish fishery and Atlantic Canada's cod fishery despite the application of such restrictions [PERC, 2002]).

Instead, economists tend to advocate for the use of economic incentive methods (or market-based instruments) that are in theory able to achieve a given level of output (or in this case harvest level) at a minimum economic cost to society. Examples include taxes on resource rent, user fees and landing fees[3]. Another method that has more recently been applied to in excess of 75 fisheries (Tietenberg, N/A), is that of an Individual Transferable Quota (ITQ) system.

2.2 Individual Transferable Quotas

An ITQ system is able to eliminate the open-access nature of certain resources (including fisheries), thereby promoting conservative harvesting and thus more efficient management of the resource. Under such a program, the regulating authority specifies a Total Allowable Catch (TAC) and issues an equivalent number of quotas to reflect this (where one ITQ represents the privilege to harvest a predetermined number of tons of fish, or alternatively, a share of the TAC). The TAC is the aggregate amount of fish that is legally allowed to be harvested in a given time period (such as a particular season or on an annual basis). The ITQs are then either distributed free of charge or auctioned off to the fishers (e.g., either to the vessel owners or also to crew members). Since ITQ programs guarantee a share of the current TAC

[3] *Landing fees, whereby a Pigovian style tax on the catch is applied, are uncommon in practice. One example where this has been applied is Namibia, which has differential landing fees depending on ownership and land-based processing. For a theoretical comparison of landing fees vs ITQs, see Arnason (1991) and Weitzman (2002).*

and under the appropriate conditions, assure quota holders a share of (or the opportunity to bid for a share of) any increase in future harvests achieved through stock rebuilding, incentives for fishers to 'race to fish' are eliminated. However, one crucial caveat concerns the *enforcement* of quotas; industry participants need be confident that their activity will be enforced. With CITES Appendix II-listed species this has added significance owing to the often high value of the associated products and derivatives from the species. This in turn reduces the need for overcapitalisation (at sea and on land) and allows fishers the flexibility over the rate and timing of harvesting their share to reduce costs or to increase product value. Furthermore, an ITQ system reduces excessive fishing effort by providing a compensated exit strategy for license holders in over-crowded fisheries and stimulates technological progress by increasing the returns to license holders of investments in research or improved fishing technology.

Box I – The economic approach to fisheries management

Economists approach the management of a population or stock of fish in much the same way as they approach the management of any renewable/productive asset. Take a stock of savings for example. This is a renewable resource in the sense that savings earn interest, say r, and will accumulate over time exponentially at this rate. If this asset is the only source of income then an individual has to make a decision about their desired consumption over time. In any period the individual can choose to consume an amount less than, equal to or greater than the interest accrued, in which case savings will respectively increase, remain constant or decrease over time. In this sense it is important to note that where stocks of resources are involved, decisions regarding consumption today have implications for future time periods, i.e. this is a dynamic problem. For example, one less pound of savings today leads to lost interest on that pound for all future periods. The choice of consumption plan will depend upon a variety of individual characteristics and external factors.

With regard to the individual, the value of the well-being obtained from consumption may differ depending upon the time period in which the consumption takes place. In general people are impatient and will prefer £1 of consumption today than tomorrow, and such impatience is reflected by the individual's 'discount rate', say ρ. Higher levels of impatience/discounting of the future will tend to increase consumption now, and reduce saving. External factors are sometimes reflected in the discount rate. An extremely high discount rate would be expected if the individual does not expect her savings to be available in the future due to political uncertainty or the absence of the rule of law. In this case the incentives for the individual are to consume as much as possible now to avoid possible losses in the future. Other external factors, which influence the consumption/savings decision, include outside options for resources. For example, a savings account offering higher rates of interest, say $r' > r$, provide incentives for the individual to shift savings to this more lucrative account.

Economists think of fisheries in largely the same way, where the fish population, say S, is the stock of savings, the rate of growth/recruitment of the fish population is the rate of interest, and the harvest/catch is the consumption decision. Furthermore, in order to maximise welfare, returns from the fishery need to be compared with those of outside options. Analogous to a consumer comparing returns across banks, an entrepreneur wanting to maximise profits or a government wanting to maximise welfare will compare the return from fishing to the rate of return from alternative projects, e.g. health or education. Equally analogous is the external and individual effects that determine the harvesting decision; an individual or government managing the fishery which does not greatly value the future (be it welfare, consumption or profits) will tend to increase the current harvest rate. With savings, the value of both outside options and individual traits are generally captured by the rate of interest, r. Higher harvests allow greater transfer of profits to *alternative* high yielding projects and consequently lead to lower fish populations.

There are important areas where the analogy with savings is not complete however. Highlighting the differences is helpful in explaining the economic approach to fisheries management. First, biological resources differ dynamically to finance; they interact and compete for food, procreate, and have defensive strategies, for example. As a result of this, whereas the interest rate on savings remains constant regardless of the level of saving, the growth of the fish population, g, will generally vary with the size of the population, S. In algebraic terms: $g = g(S)$. Figure 1 shows a common stylisation of the relationship as a logistic growth function (Bulte and Van Kooten 1999). The features of Figure 1 are explained in **Box II**.

Furthermore, where consumption of savings was costless, fishing effort, E, is a costly activity. Total costs, C, are commonly related to search costs and, in the case of search fisheries, are dependent upon the resource stock: $C = c(S)E$ (Bulte and Van Kooten 1999). It is usual to assume that harvesting costs increase as the stock decreases, since fish will be harder to find. Similarly it is often assumed that the catch per unit of effort, E, is increasing in the stock. Where the harvesting costs, productivity of fishing and the growth of the resource are dependent upon the resource stock, current harvesting decisions invoke 3 effects in the future: i) changes in the growth rate of the stock; ii) increases in the costs of harvesting and; iii) decreases in the productivity of effort, in all future periods. Thus, when the resource manager or government wishes to maximise the value of the fishery over time it is necessary to consider all the future/dynamic effects of current harvesting. Economists call the value of such dynamic effects the '**resource rent**' or '**scarcity rent**', and it reflects **the value of leaving the fish in the sea**. The optimal management of a resource would include the resource rent as an additional cost of depletion, just as lost interest represents a cost of consuming one's savings. Resource rents therefore represent a divergence between the unit price and cost of harvesting and are accrued as profits to the resource owner.

Another difference in the case of fisheries is in the ownership of the asset. Whereas above the stock of savings is a private resource, owned exclusively by the individual, fisheries are frequently owned publicly by a sovereign state(s), commonly by regional communities, or are not subject to distinct property rights at all, in which case ownership is described as 'open access'. Just as property rights are important for the savings decision: an individual will not save if the banking system is corrupt, unreliable and insecure, the current harvesting decision and associated stock of fish will depend upon the prevailing ownership /property rights regime, and hence the security of the stock in the future.

Economists have frequently cited the ownership of or property rights to fisheries as the key reason underpinning depletion and exhaustion. The essence of this argument can be understood by considering two extremes of ownership: a single owner and open access. A single owner will endeavour to maximise resource rents, i.e. profits, and is able to maintain positive profits through the exclusion of other fishers (by virtue of her sole ownership). Under open access, positive profits attract additional fishers to the fishery and will therefore be gradually eroded until non-existent. This process of 'rent dissipation' through free entry to the resource leads to higher levels of effort than under single ownership and lower levels of the resource stock. Put simply, with insecure property rights each additional entrant to the fishery considers only the current gains from fishing, not those that accrue in the future. In this sense each entrant imposes external costs upon the other fishers since they ignore the dynamic costs that their actions impose upon all other fishers. On the other hand, secure property rights mean that the owners will choose today's harvest knowing that any returns from the saving the resource, e.g. resource growth, will be available in the future and will not be competed away.

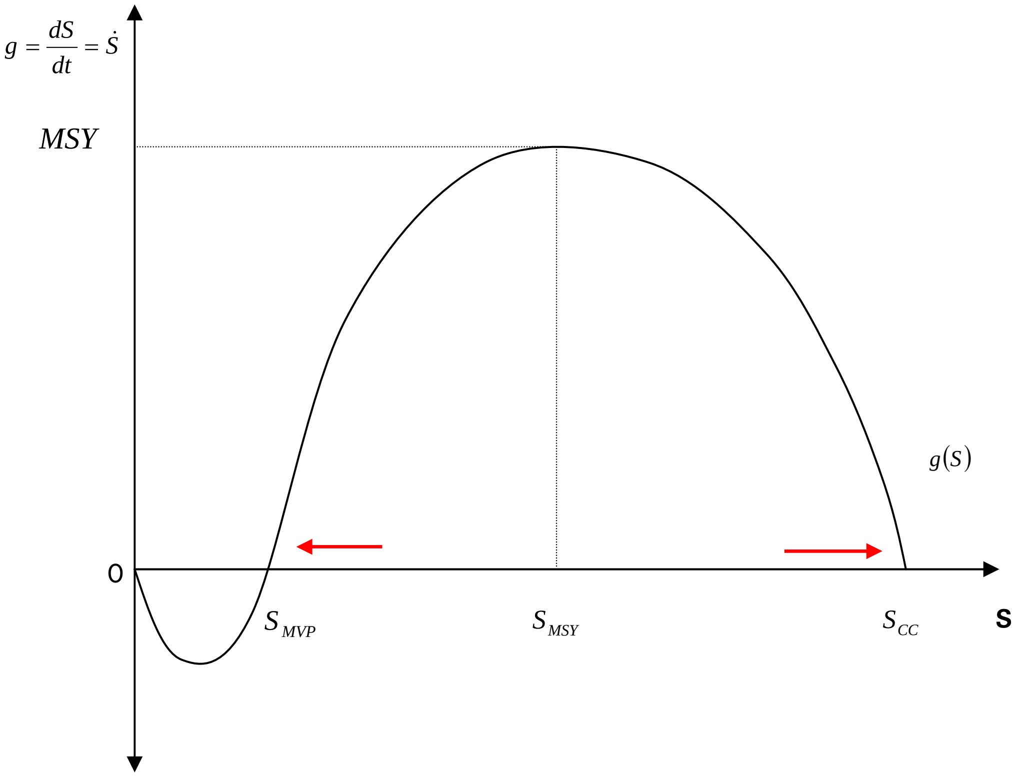
Fishery Dynamics: As we have described above the full management problem is dynamic, since decisions today affect future well being. Furthermore, the returns from the fishery must be compared to outside options. When the full problem is addressed, welfare maximisation requires that the rate of return from the fishery must be equated with that of outside options. For example, where costs of harvesting are **not** dependent upon the stock level (as would be the case for a schooling fishery for example), the outside options are represented by the interest rate, *r*, and the price of fish is constant over time, equating returns across assets requires that $r = g'(S)$. $g'(S)$ is the slope of the growth function in Figure 1 and reflects the growth rate of the fish population or the '**rate of interest**' for fish. There are a number of things to notice here. Firstly, since the slope of the growth function is zero at S_{MSY}, maintaining the stock in order to harvest the Maximum Sustainable Yield does not maximise welfare over time (is not efficient) where the interest rate is positive. Secondly, the efficient stock is lower than S_{MSY} since the slope of the growth function $(g'(S))$ is only positive at lower levels of the stock. The management rule then states that where the rate of return of the fishery is higher (lower) than for outside options: $g'(S) > r$ $(g'(S) < r)$, it is welfare enhancing to increase (decrease) harvesting and reduce (increase) the stock of fish until $r = g'(S)$. Where price of fish is changing over time at a rate ΔP, this increases the rate of interest for fish and optimality requires that $r = \Delta P + g'(S)$. By the same logic this means that if the resource is increasing in value over time, the rate of return from the fishery is equated with *r* where the rate of growth of the resource, $g'(S)$, is smaller and the stock therefore larger. Hence, with positive price growth, reducing harvests and increasing the stock increase welfare. Indeed, when a search fishery is considered, and harvest costs vary with the stock size, the effect of harvesting upon future harvesting costs must be considered in determining the optimal. With costs decreasing in the stock, this will tend to increase the optimal resource stock. In sum, the optimal stock can be higher or lower than S_{MSY}, but only equal by coincidence. This can be seen by reference to Figure 1.

Under the open access however, entrants to the fishery do not consider the full resource cost (they ignore the resource rent) and fishing effort per unit of harvest increases as these rents are dissipated compared to the efficient outcome. If, during this process, the stock under open access falls below S_{MVP} in Figure 1, ill-defined property rights lead to exhaustion of the fishery. Furthermore, the classical economic model predicts that extinction of the resource under open access is more likely to occur the higher the price **level** of fish (*p*)[4] and the lower the

[4] *It should be noted that some authors have suggested that a highly priced resource increases the likelihood that the resource will be monitored and hence may reduce the likelihood of exhaustion under open access (Hotte et al 2001)*

growth rate of the fish population and the harvesting costs (*c*). The same can be said for **optimal exhaustion** except in addition, high returns from outside options (*r*) will also increase the likelihood of exhaustion. Optimal exhaustion is less likely the higher is the rate change of prices over time (ΔP), the higher the increase in costs arising from reduced stocks, $c'(S)$, and the higher the physical growth rate of the resource, $g(S)$. These simple ideas form that basis of economic analysis of fisheries.

Figure 1 The Logistic Growth Function, Minimum Viable Population and Maximum Sustainable Yield



Due to the ability to transfer the quotas (i.e. trade), an ITQ system can achieve a reduction in the level of fishing effort at a minimum cost since the most efficient producers can purchase quotas from the least efficient, who leave the industry. Unlike conventional quotas, which require that each party or group is limited to a specific quantity, ITQs allow fishers to trade with one another within each time period on the basis of different harvesting costs. The going market price of an ITQ is determined by the supply and demand for ITQs, which is in turn a function of the level of the TAC and the marginal harvesting costs of the fishing vessel owners. Regulated vessels will wish to purchase or lease additional ITQs if their marginal harvesting costs are higher than the equilibrium ITQ price; analogously, regulated vessels with marginal harvesting costs that are lower than the equilibrium ITQ price will wish to sell their excess ITQs.

Box II. The Logistic Growth Function, Carrying Capacity and the Maximum Sustainable Yield

i) The Logistic Growth Function: The logistic growth function shown in Figure 1 characterises some essential features of biological resources. Firstly, the extreme points of the stock, S_{MVP} and S_{CC}, represent the Minimum Viable Population (MVP) and the Carrying Capacity of the resource respectively. Growth is assumed to be negative below S_{MVP}, reflecting the absence of sufficient females, genetic diversity etc. to maintain recruitment above natural losses. Below the MVP, negative growth leads to exhaustion. The stock reaches a maximum at S_{CC} as the natural resources available to maintain the stock, e.g. food, come under increasing competition. Secondly, the growth function reflects the fact that growth at low and high levels of the resource stock is low, reflecting e.g. the absence of females and the competition for resources respectively. At medium levels of the stock growth of the stock increases reaching a maximum of g_{MSY} at S_{MSY}. Growth at this level of the resource represents the Maximum Sustainable Yield (MSY), i.e. the maximum harvest that could be obtained from the resource without reducing the resource stock. Naturally, magnitudes of S_{CC}, S_{MVP}, S_{MSY} and g_{MSY} will vary from one fishery to the next, and the logistic function should be seen as a generalisation and a useful benchmark for analysis.

ii) Maximum Sustainable Yield as a Management Ideal: The maximum sustainable yield stock, S_{MSY}, has often been regarded as the level of harvesting at which fisheries should be managed since it represents the stock at which the maximum increment to the population occurs. However, there are several reasons why this strategy is considered to be flawed (Conrad and Clarke 1990): i) the MSY is not sustainable over the long run due to natural fluctuations; ii) MSY is unstable: if the sustainable yield in a given year declines then continued harvesting at the old MSY will deplete the stock over time. (This instability is represented by the red arrows in Figure 1 which imply that deviations from the sustainable harvest are unstable at or below the MSY stock, but stable above); iii) the MSY completely ignores all social and economic considerations of renewable resource management. In **Box I** there is a discussion about the economically efficient management of a renewable fishery resource. In this discussion is becomes clear that the MSY will only become the economically efficient stock level under very special circumstances. One of those is when the return from outside options or the social discount rate is equal to zero.

Setting the Total Allowable Catch (TAC)

As specified above, the most economically efficient level for setting the TAC is at the optimal harvest. For most stocks, the benchmark that is used to set the TAC is the requirement to achieve a stock that will produce the Maximum Sustainable Yield (MSY) (See Figure 1 and Box II).

The magnitude of a TAC is usually derived on an annual basis by applying a target exploitation rate to an estimate of the current stock size. Determining the target exploitation rate and measuring the stock size are both subject to considerable *uncertainty* because of large variability in the relationship between stock size and the generation of subsequent offspring and to general difficulty of accurately counting and measuring fish populations in the wild (NRC, 1998). Given the nature of the ITQ system, there is an inherent incentive for the regulator to opt for more conservative overall quotas in the knowledge that each quota holder will capture the benefits of conservation through higher catch limits in subsequent years.

Species are mostly caught complementarily with each other; to this end, setting TACs for multi-species fisheries entails some additional considerations for ITQ design. Some have been aggregated into a single TAC and quota – e.g. in the British Colombia individual quota trawl fishery, perch and redeye are treated as an aggregate species; in New Zealand, eight species of flatfish form an aggregate. The ability to conduct species aggregation will depend on biological criteria such as age structure, recruitment, and year class strength, though in most cases it is unlikely that this will be optimal (Squires *et al*, 1998).

Defining the ITQ

ITQs can be defined in a variety of ways and include elements of time, space and quantity. The most common approach is to define a quota in terms of a specific tonnage that may be harvested (e.g. 1 quota equals 1 ton) for a specified fishing season or year.

ITQs can also be expressed as shares of the TAC, so that the amount of fish that can be harvested for a given share of quota fluctuates with changes in the level of the TAC.

Less common are 'value-based' quotas, which *regulate* the value of harvested fish (for a discussion on this see Turner (1996)). Clearly, the aggregate number of ITQs should equal the TAC.

The ITQ should not necessarily reflect a property right *per se*. For example, the US Clean Air Act, which deals with the Sulphur Allowance Trading program states that "an allowance under this title is a limited authorization to emit sulphur dioxide … such allowance does not constitute a property right".[5] One motivation for this is common law doctrine, which implies that certain resources belong to the public (e.g. air and water) and that the government holds them in trust for their public, and should not be given away. Another concern was that if, for human health and environmental reasons, the US Environmental Protection Agency were required to reduce the aggregate emissions cap and hence issue fewer allowances, regulated sources would not be able to sue for compensation (Tietenberg, N/A).

Others argue, however, that the more akin ITQs are to property rights, the more incentives fishers have to optimally manage the resource. In New Zealand ITQs are in fact property rights (i.e. are granted in perpetuity) and evidence points to fishers taking an active role in enhancing the productivity of their ITQ fisheries (PERC, 2002).

<u>Allocating the ITQs</u>

In general, ITQ allocation can be based on historical levels or more commonly, an average of a few years of historical levels (to adjust for random fluctuations). One can also include a component for the use of "clean" fishing techniques (i.e. minimal incidental by-catch) to reward those that have been more efficient in the past and to provide incentives to minimise incidental by-catch in the future. Alternatively, the ITQs can be auctioned off to the highest bidders, in which case the government can use the revenues to further promote sustainable fisheries. The regulating authority will also need to determine the applicability of the program, i.e. whether vessels of all sizes are affected by the ITQ program[6].

The initial quota allocation is probably one of the most contentious issues associated with an ITQ system given its potential to generate windfall benefits to the initial recipients, the privileges that ITQs create and the potential for decreasing employment and altering social and economic relationships among individuals and communities.

One potential design option to reduce the adverse distributional effects that ITQs can have on communities is to allocate the quotas directly to communities. Experience here includes:

– Alaska's Bering Sea Community Development Quota Program for the indigenous population, and
– New Zealand's ITQ program to benefit the Maori people.

For these allocations the community retains control over the transfers and is thus able to protect community interests (Tietenberg, N/A).

An interesting option was employed in Canada's scallop fishery. License holders determined the initial quota allocation among themselves. The result was quota granted to nine enterprises (i.e. not individual vessels but to operating companies) – based largely on historical catch – and in the form of percentages of the annual TAC (Repetto, 2001). This innovative approach is restricted to cases involving small numbers of license holders.

<u>New entrants and monopoly power</u>

If quotas are distributed free of charge to existing fishers in the industry and there are no provisions for new entrants in the initial allocation process, then new entrants face a disadvantage because of the additional capital investment required to purchase or lease quota shares. Equally, incumbents face enormous advantages. Allowing new entrants is key to ensuring competitive nature to the quota system and to keeping existing quota holders efficient. When including provisions for new entrants, additional ITQs should come from *within* the TAC – using economic mechanisms such as annual auctions of ITQs helps to ensure the process of quota allocation is relatively seamless.

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[5] *104 Stat 2591.*

[6] *For further discussion, see FAO (1997).*

One flaw in ITQ design is to allow certain holders of quotas to corner the quota market, obtaining effective monopoly control over the landings as they purchase more and more quotas, as this can undermine the economic efficiency of the ITQ program. Various design options have been introduced to restrict this aspect of trading of quotas in attempt to control for this (e.g. Iceland, see case study section).

Banking and borrowing of quotas

Banking refers to the ability of fishers to carry excess quotas over into the next year or fishing season to be used at a future period. *Borrowing* of quotas enables fishers to catch more in the current season by borrowing against future quotas. The ability to bank and/or borrow quotas provides fishers with additional flexibility to adjust their harvest levels towards the economic optimum (PERC 2002). Introducing these types of provisions need to be carefully considered, however, as they may induce fish catch in a given year (or season) to exceed the critical dispensation level. Equally, it can be an essential element of a multi-species fishery with volatile populations.

Monitoring and enforcement

Monitoring and enforcement are crucial components of a well functioning ITQ program. Accurate and consistent measurement of fish catch will ensure that the total level of fish harvested adheres to the TAC, and that the price of an ITQs reflects the true value which allows for a well-functioning ITQ market. The potential for quota busting, by-catch dumping, price dumping, and data fouling will thereby be reduced (see Copes, 2000).

High-grading is a common problem that arises in the absence of monitoring – i.e. discarding lower valued fish in favour of higher valued fish. Incentive to high-grade will be greater the more ex-vessel prices are differentiated by size or quality of individual fish. To address this problem, on –board observers are used in the multi-species British Colombia ITQ trawl fishery (Squires *et al*, 1998) and on larger vessels in the Alaska ITQ program (Buck, 1995). In the absence of observers, high-grading is likely to be less of a problem if:

- There are minimal price differentials by fish size or quality;
- There are limited opportunities to catch the fish at another time;
- The gear employed effectively targets species of the preferred size; or
- There are mesh size or other gear restrictions, which limit the catch of small fish (Squires *et al*, 1998).

Monitoring and enforcement measures are also necessary to reduce poaching and illegal harvesting. It is argued that ITQ programs provide incentives for self-enforcement among fishers because the value of an ITQ depends on the *integrity* of both the system design and its practice. Although individuals stand to gain by exceeding their quota, they are adversely affected if other quota owners do likewise. In general if the fishery is overfished, the incomes of fishers is reduced and the price of quotas will fall. Note that monitoring and enforcement of course is not specific to the use of an ITQ system, but is necessary for any management approach to work effectively.

Penalties for non-compliance

ITQ programs should provide a system of penalties to provide fishers with the necessary incentives to comply with their quota constraints. Stiff penalties should be applied when fishers do not have sufficient quotas to cover their harvest. If there are no on-board observers, such penalties may encourage the dumping of fish at sea. The ability to use banked quotas provides additional flexibility for fishers to be in compliance.

2.3 Some further considerations for use of an ITQ system

Sufficient operators

The structure of industry should facilitate manageability in terms of control, reliability of catch statistics and enforcement costs. There should be a sufficiently large number of participants to ensure a competitive market for ITQs and reduce the possibility of monopolization of resources, while simultaneously not an excessively large number so as to undermine the regulator's authority to manage and administer the program.

Adequate authority

It is important to establish in advance whether the relevant government entity has sufficient jurisdiction over the geographic area where the program is to be implemented. If the quotas are to be traded across national jurisdictions, they will need to be consistent and fungible. Although there are no current examples of international ITQs; such a program would require common design elements, including standards for determining applicability, measurement and reporting, record-keeping, enforcement, and penalties for non-compliance (EPA, 2003). Clearly, monitoring and enforcement will have to be undertaken by an international authority since national governments will have incentives to under-report harvest levels if these exceed the national TAC so as to avoid the non-compliance penalties.

Adequate political and market institutions

Finally, for the trading element of the ITQ program to work, a country must have the same institutions and incentives in place as those required for any type of market to work. These include:

– Developed system of private contracts and property rights;
– Private sector that makes business decisions based on the desire to lower costs and raise profits; and
– Government culture that allows private businesses to make decisions about "how" to achieve objectives with a minimum intervention (EPA, 2003).

Building on the theory, key elements and some potential design options of an ITQ system, the next section describes examples of ITQs in practice. ITQ programs have been used to sustainably manage fisheries in a number of countries including Iceland, New Zealand, Australia, Canada, and the U.S. Section 3 details three of these case studies[7].

3. Case studies of ITQ systems for fisheries

Table 1 Selected comparative statistics on the case studies:

	Iceland	New Zealand	SCOQ, USA	Sturgeon, Caspian Sea
Number of vessels	2000	2000, of which 71 are greater than 28 meters + 80 charter. 4650 fishers	<50 - 140	
Number of ports	61[a]		Limited	
Seasonability of fishing		Varies according to fishery		Varies according to country[b]
Age to sexual maturity	Varies according to species	Varies according to species	1-2 years for surf clams	14-23 years for females

Sources: a) Eythorssen b) Raymakers, 2002 c) Norwegian presentation.

[7] *These case studies are derived from the NRC (1999).*

3.1 Quota Management Program, Iceland

Background

- According to the new fishing law in 1990, most fish stocks around Iceland were incorporated into the quota management program. At first, the quotas were not transferable, but due to the small size of the quotas and the difficulty of fishing them profitably, transfers were allowed from 1979 on.
- ITQs were first applied in the fishery for a local Icelandic herring stock.
- In 1980, *vessel* quotas were introduced in the capelin fishery, and were made transferable in 1986.
- Capelin is a short-lived species necessitating flexibility in quota system design; only one or two year classes allocated in quotas.
- Since the size of the year classes is highly volatile, the TAC is also very variable; there have been years when no fishing for capelin has been allowed.
- It is sometimes alleged that ITQs cannot be applied to highly volatile fisheries; this has not proven to be a problem here. As in other Icelandic fisheries, capelin ITQs are determined as shares of the TAC.
- Iceland’s most important fishery is the demersal or groundfish fishery (cod, haddock, saith, redfish, and Greenland halibut) accounting for over 80% of the total wetfish value in recent years.
- By 1982, two pressures that threatened the cod industry – overfishing and overcapitalisation – were brought to the attention of Icelandic politicians and interest groups and were tackled within an ITQ system enacted the following year.

Setting the TAC

- Management of the Icelandic cod stock has been much less successful than the management of herring, despite the fact that it is also part of the ITQ program and much more important for the Icelandic economy.
- The primary reason for the population decline is argued to have been an excessive TAC.
- The cod stock reached an all-time low in 1992 but has recovered somewhat since then.
- The TAC set by the government in Iceland has consistently exceeded the recommendations of the Icelandic Marine Research Institute (NRC, 1999), citing the importance of the cod stock for Iceland's economy and an unwillingness to accept large short-term losses to achieve longer-term gains.
- In 1995, the TAC was set for the first time on the basis of a ‘TAC Rule’, proposed in a bio-economic study of the fishery – either 25% of the fishable stock or 155,000 metric tons, whichever is greatest. Except for the minimum of 155,000 metric tons, this appears to be a prudently conservative rule for a long-lived and slow-growing species such as cod.

Defining and Allocating the ITQ

- The ITQ program was established initially for one year only and was seen by many as a temporary emergency measure for stock recovery.
- Quotas did not, therefore, constitute true private property rights.
- However, following successive extensions for two years at a time, since 1990 a regime of quotas of indefinite duration has existed.
- Initially each fishing vessel over 10 tons was allotted a fixed proportion of future TACs for cod and five other demersal fish species, allotted annually in metric tonnes on the basis of this permanent ITQ share.
- The ITQ program divided access to the resource among vessel owners on the basis of their fishing record during the three years preceding implementation of the program.
- Initially, ITQ shares were not fully divisible or independently tradable and could only be bought or sold *undivided* along with the fishing vessel to which they were originally allotted, although they could be leased relatively freely.
- With the Fisheries Law passed by Parliament in 1990, the program was reformed and extended – both to approximately 900 smaller vessels that had been fishing previously without restrictions and to include all major fisheries.
- By 1991, as a result, the number of ITQ holders increased from 451 to 1,155.
- Further, the ITQ program was made indefinite in duration, and ITQs became fully divisible and independently transferable, making them more akin to permanent property rights.

Allocating the ITQs

- Specific innovations:
  - vessels less than 6 GRT are subject to limitations in the number of fishing days and an overall limit on catch;
  - only one-half of the catch taken by vessels fishing with longlines in the winter months is counted against the quota.
- In order to retain their quota share allocations, quota shareholders must fish at least half of their quotas every second year.
- Quota shares can be leased or permanently sold.
- Quota allocations are of an indefinite duration and could be revoked by the Icelandic Parliament at any time, but the prices of permanent quota shares suggest that this is not considered a very high risk; in 1997, permanent quota shares for cod were trading at about eight times the cost of renting quota shares for a year.
- In order to hold quota shares, a person or company must have access to the vessel to which the quota shares are allocated.
- The ITQ rights are distributed free, and are subject to annual renewal charges – currently approximately 1% of fisheries gross revenue – that have been increasing over time.
- The initial allocation of quota to vessel owners apparently favoured vessel owners over crew members.
- Prior to the program, fishing was typically regarded as a 'co-venture' of vessel owners and crew.
- Allegations run that vessel owners have become rich and crew members disenfranchised.
- Similar problems exist in other fisheries – Alaska halibut and sablefish fisheries – but here disruptive practical difficulties (such as inadequate records on the fishing history of crew) – that do not exist in Iceland – caused perverse outcomes.
- The reason for crew members receiving poor returns under ITQs appear to stem from being omitted from the initial allocation. It appears to reflect a common bias toward capital ownership in the theorizing about and design of ITQs.

New entrants and monopoly power

- A new licensing scheme stipulated that new vessels could be introduced to the fisheries only if one or more existing vessels of equivalent size (in GRT) were eliminated in return.
- Concern about the rapid concentration of ITQs in the hands of large vertically integrated companies saw an internal committee appointed by the Ministry of Fisheries recommend limits be set for individual quota holders – at 10% for cod and haddock and 20% for other species.

Banking of quotas

- For groundfish, there is a certain flexibility built into the program; 20% of annual quota can be shifted to the subsequent year with one penalty – the volume of extended quota is subtracted from the subsequent year's quota allocation.
- This is less injurious to conservation of stocks than it might appear; the exploitable stock of groundfish consists of ten year classes or more, which smoothes the pattern of catches over time despite large variations in the size of year classes.

Monitoring and Enforcement

- If a quota is to be leased or sold to a vessel operating from a different place, the consent of the municipal government and the local fishermen's union must be obtained – although this is virtually automatic.
- Trading of quotas appears to be brisk; in the "fishing year" 1993/4 the trading of cod and saithe quotas amounted to 44% and 96%, respectively, of the total catch. Note, however, that the same quota can be traded more than once.

Other issues

- <u>Over-catch</u>: vessels must acquire an equivalent amount of cod ITQs to cover their over-catch to prevent loss of their fishing licenses.
  - The price of ITQs leased for this purpose tends to fluctuate considerably in relation to demand.

    - Apparently, this results in dead fish discarding at sea, especially toward the end of the fishing year when ITQs are scarce and the lease price is inordinately high.
    - ITQs may, therefore, contribute to the waste of living resources, resulting in the erosion of ecological responsibility.
- Municipal bankruptcy in fishing villages that have lost most or their entire quota is causing massive unemployment and dissolution of communities.
    - To this end, there are demands for effective limitations on quota transfers between regions and communities, to avoid extreme uncertainty in employment. Such limitations are applied in Norwegian fisheries, for example.

3.2 Quota Management System, New Zealand

Background

- Passing of the Fisheries Amendment Act 1986 established the ITQ program – the Quota Management System (QMS).
- One year later, there were 30 species covered by the QMS.
- The fishery for each species in the QMS is divided into a number of different fishery management units, officially designated as *Fishstocks.*
- The number of Fishstocks ranges from 2 to 10 for any given species, with a total of 179 different Fishstocks in the QMS.
- The government plans to introduce all remaining commercially harvested species into the QMS, which will inflate the number of Fishstocks by more than 100.

Setting the TAC

- TACs have been established since 1986.
- The initial TACs for most of the inshore finfish stocks were based on average reported landings during periods when the catches were considered to be sustainable – a largely qualitative assessment.
- For a number of the prime inshore species, the initial TACs were set at levels up to 75% below the catches reported immediately prior to the introduction of ITQs.
- To smooth the economic impact, the government provided adjustment assistance to the fishing industry in the form of a *buyback* of quota entitlements in certain fisheries.

Defining the ITQ

- Initially the ITQs were defined as a given tonnage of fish. Subsequent legislation in 1990 however redefined the quotas as a percentage of the TAC.

Initial Allocation of ITQs

- The initial allocation of ITQs was made free of charge. ITQs were allocated in perpetuity and authorized the holders to take specified quantities of each species annually in each quota area.
- Initial allocation was made on the basis of catch history over a period of qualifying years.
- Fishermen who held permits in May 1985 were advised in mid-1985 of their individual catch by species for the three years ending in September 1984. They were allowed to choose two of these three years, the average of which would form their ITQ.
- Modifications were informed by the results of the buyback scheme and administrative reductions made to match effort more closely to the available resource.

Monitoring and Enforcement

- The New Zealand ITQ monitoring and enforcement system is largely land-based, relying on documented product flow control that tracks a fish 'paper trail' through submissions to the Ministry of Fisheries.
- Fishermen must sell only to licensed *fish receivers*.
- All persons selling, transporting or storing fish must keep business records establishing that the product has been purchased from a licensed fish receiver.

- Fishery officers enforce product flow while fishery auditors examine business accounts and records to monitor quota compliance.
- Cost-effective enforcement is enhanced by the use of sophisticated electronic monitoring and surveillance information and analytical systems – including quota monitoring and reporting systems; catch and effort returns; observer programme and vessel monitoring system.

Penalties for Non-Compliance

- Offences against the ITQ program are treated not as traditional fishing violations but as commercial fraud.
- Penalties include significant fines and forfeiture of fish, vessel, and quota shares.

Other Issues

- Overfishing provisions require very complex computer systems to track catch against quota.
  - The inclusion of provisions such as 10% overruns and under-runs, 'fishing-on-behalf' arrangements, and the deemed value and by-catch trade-off systems have added complexities that have often strained computer systems. Late and sometimes inaccurate calculation compounds problems with the ITQ process.

- Quota busting is known to occur in some fisheries, especially those for *high-value* species such as rock lobster, paua, snapper, and orange roughy.
  - The illegal catch of rock lobsters in 1993 was estimated about 25% of the total New Zealand TAC (Annala, 1994).
  - It is alleged that recent well-publicized prosecutions – resulting in heavy penalties, including loss of quota shares, vessels, and plant and equipment – have suppressed quota busting substantially (NRC, 1999).

- Industry self-regulation: Industry is taking a more active role in helping to reduce illegal fishing, especially in the rock lobster and paua fisheries.
  - An industry-initiated management plan for the east coast North Island rock lobster fishery, which had the highest estimated level of illegal catch, has apparently reduced the level of illegal catch substantially.
  - The fishery is now closed during summer months, the traditional period of greatest illegal activity, and all pots must be removed from the water during the closure period to assist enforcement.

3.3 The Surf Clam and Ocean Quahog (SCOQ) Program, USA

Background

- The Surf Clam and Ocean Quahog ITQ program was adopted under Amendment 8 to the Fishery Management Plan in 1990.
- Prior to the adoption of the ITQ program, the surf clam fishery was managed through limited entry, quarterly quotas and fishing time restrictions.
- These effort limitations, together with a growing strong year-class and increased vessel harvesting effectiveness led to the problem of over-capacity to the extent that, prior to 1990, fishers were restricted to 6 six-hour trips per quarter.

Setting the TAC

- The annual quotas can be set 'at a level that would meet the estimated annual demand', within constraints set for biological and long-term industry reasons.
- This policy, adopted in 1992, reflects a lengthy history of discourse with the industry on reducing the quota below the level warranted by stock assessments, especially for ocean quahogs.

Defining the ITQ

- The ITQ has two components: (1) the *quota share* expressed in percentages of the TAC, which can be transferred permanently, and (2) the *allocation permit*, which are in the form of tags to be attached to the large steel cages used to hold the clams after they are harvested.
- Tags can be transferred only within a given calendar year.
- Annual individual quotas are calculated by multiplying the individual quota share by the TAC

Initial Allocation of ITQs

- The initial allocation of quota share was divided among owners of all permitted vessels[8] that harvested surf clams or ocean quahogs between 1 January 1979 and 31 December 1988. Replacement vessels were credited with the catch of vessels they replaced.
- Different formulas were used for allocations reflecting different levels of available information.

New entrants and monopoly power

- The minimum holding of SCOQ ITQs is five cages.
- There is no maximum holding and no limit to accumulation.[9]
- Anyone qualified to own a fishing vessel under U.S. law is entitled to purchase ITQs (irrespective of whether they own one), except entities with majority foreign ownership (McCay and Brandt, 2001).
- There are no limits on transfer of quota share.
- Cage tags are transferred only within a given calendar year and cannot be transferred between October 15 and December 31 of each year.
- The NMFS northeast regional director must approve all transfers.

Monitoring and Enforcement

- Monitoring the harvest of clams under the ITQ program is facilitated by the cage-tagging requirement and by mandatory reporting to NMFS by vessel owners and dealers of clams landed and purchased.
- Allocation permit numbers must be reported on both vessel logbook reports and dealer-processor reports.
- Dealers and processors must have annual permits but no reporting is required from truckers and other carriers.
- Enforcement relies heavily on shore side surveillance, the cage tag system, and cross-checking logbooks between vessels and processors.
- During seasons when state fisheries are open, at-sea and air surveillance is also required to reduce the possibility that vessels with state permits or cage tags may stray into federal waters.
- Allocation permits and dealer/processor permits may be suspended, revoked, or modified for violations of the FMP.

Other Issues

- No resource rents are collected from SCOQ ITQ fisheries; allocation permit fees are collected to help cover administrative costs, including the production and distribution of cage tags. In 1990, 128 vessels participated in the Mid-Atlantic Exclusive Economic Zone fishery for surf clams. This had fallen to 75 vessels in 1991 and 31 vessels by 1998.

4. Implications for ITQs for Sturgeon in the Caspian Sea

Background

Six species of sturgeon inhabit the Caspian Sea and its tributaries: Beluga (*Huso huso*), Russian sturgeon (*Acipenser gueldenstaedti*), stellate sturgeon (*A. stellatus*), ship sturgeon (*A. nudiventris*), Persian sturgeon (*A. persicus*), and sterlet (*A. ruthenus*). All sturgeon species are 'threatened' to some degree.

[8] *These were all commercial fishing vessels, mostly working the waters of the Mid-Atlantic region.*

[9] *Except as might be determined by application of U.S. antitrust law*

However, there are a number of social and environmental issues that are attributed responsibility for the sturgeon population's demise; the precise nature of the threat is unclear and is potentially composite.

Ninety percent of the world's sturgeon stocks *in situ* are in the Caspian Sea, which is bordered by Azerbaijan, Iran, Kazakhstan, the Russian Federation and Turkmenistan. For decades, the Soviet Government tightly regulated the harvest of caviar from spawning sturgeon. The Ministry of Fisheries in Moscow established quotas for the annual sturgeon catch and enforced these with the use of armed inspectors who contained the activities of poachers and illegal dealers. Since 1959, it also helped regulate available stock of sturgeon in the Caspian Sea through the establishment of hatcheries. In 1992, the emergence of four new independent states and two new autonomous regions along the spawning grounds of the sturgeons, together with the alleged breakdown of the chain of command out of the Kremlin, led to a marked decline in the enforcement of these quotas. The result was a rapid increase in illegal sturgeon fishing.

CITES and Caspian sturgeon

Background

- This involvement of CITES in the sturgeon fisheries arose because of concerns over the impact of unsustainable harvesting levels and the extent of illegal trade in wild specimens (Armstrong and Karpyuk, 2003; Armstrong *et al*, 2003).
- The Caspian sturgeon was placed on Appendix II of the Convention on International Trade of Endangered Species (CITES) list in 1998.
- Most commentators – and crucially key industry participants – believe that bringing the international trade of sturgeons and sturgeon products under the well-established monitoring and regulatory system of CITES was a major step forward to the long-term survival of sturgeon and its fishery.
- In addition to trade regulation, there has been extensive development of labelling laws and their enforcement agitated for by the CITES Secretariat as demand-side curbs on the ease of illegal trading in caviar. Some of the economic adjustments under a listing are reported in **Box III**.
- However, the worst fears of stakeholders have been realised as poaching and smuggling have allegedly continued largely unabated in the wake of these conservation measures.
- As a result, in 2000 the CITES Animals Committee was to include the Acipenseriformes (sturgeons and paddlefish) in its Review of Significant Trade – this is the Convention's mechanism for remedial action when there is reason to believe that CITES Appendix-II listed species are being traded at significant levels without adequate implementation of CITES provisions. In essence, when implemented correctly, this process acts as a safety net for the Convention by ensuring that species are harvested sustainably.
- As a result of the Significant Trade Review, the CITES Standing Committee recommended at its 45th meeting in Paris (June 2001) a Conservation Action Plan for the Caspian Sea sturgeon fisheries. This 'Paris Agreement' has helped extend the regulatory power of CITES to domestic trade and markets involving certain species threatened by international trade.
- Aggregate statistics on the quota system are available but the processes for determining and allocating quota is not well documented in English. To this end, this section relies on anecdotal information from key informants and literature available in popular press on the internet and in hard-copy. Further research is necessary to determine if the system operating in the Russian Federation provides a model that can be extended to other countries.

Setting the TAC

- TAC levels have been set for sturgeon in each of the Caspian littoral states but in slightly different ways, reflecting the management models and funding available for this calculation:
  - Since 2002 TAC levels submitted to the CBC are based on a cooperative survey and derived from sample trawling
  - Before this, Iran determined its TAC using a catch per unit effort (CPUE) stock assessment within an adaptive management approach (Armstrong *et al*, 2003; Moiseev, 2002).

Defining the ITQ

- There is a general trend towards defining ITQs in terms of shares of the TAC as opposed to a specific tonnage due to greater administrative ease.

Allocating the ITQs – for the Caspian Sea

- Under CITES, the Caspian Bioresources Commission (CBC) is the regional body charged with allocating the TAC between the Caspian littoral States. The CBC was established in 1992 by the Caspian littoral States excepting Iran, which joined in 2002 (Anon., 2002f; Anon., 2002g; Anon., 2002h; Anon, 2002i) where it had previously been an observer (Anon., 2002h)
- The proportion of TAC each country receives is complicated by debate and science; negotiations over the allocation has traditionally taken into consideration a number of factors including hatchery release volume, volume of freshwater flow, biomass of food resources available and historic spawning grounds.
- The quotas are communicated to and agreed on by the CITES Secretariat before exports are permitted (Ivanov *et al*, 2001; Siucu, 2004).
- The export quotas for caviar in previous years were 146t (2003), 140t (2002) and 153t (2001).
- In 2004, Turkmenistan's quota for sturgeon catch and black caviar export has been reduced by three tonnes: 56.25t sturgeon and 5.85t caviar. Except for Azerbaijan, the quotas of the other Caspian countries have remained near last year's level: Russia (429t and 30.3t, respectively), Kazakhstan (216t and 23.18t) and Iran (676.4t and 78.8t). Azerbaijan's quota has been increased over the past three years. In 2004, Azeri fishermen may catch 109t of sturgeon and 9.2t of caviar.
- Recently, at the 21st meeting in March 2004, representatives of Russia and Azerbaijan (with the silent support of Kazakh experts) insisted on a new method of setting quotas for sturgeon catch and black caviar export – which includes criteria required for sturgeon reproduction (Ashirova, 2004). The CITES Secretariat approved the commission's decision. Now the quotas are dependent on the volume of fodder resources, the availability of fresh water, and the number of fish farms in each Caspian country. Quota proportions and volumes continue to be hotly contested (see Anon, 2002j) Iran and Turkmenistan favour equal parts (Anon., 2002i). Turkmenistan supports the old approach to setting the quotas, given that the country has no fish farms (Ashirova, 2004).

Allocating the ITQs - domestically

- Caspian littoral States have a history of auctioning fishing licenses to the highest bidders and stakeholders involved are likely to be comfortable with this system.
- This system is followed only in the Russian Federation, where, following a Presidential Decree[10], in Astrakhan, the quota is split using an auction system which appears to be functioning well, attracting greater numbers of buyers and increasing prices – in 2000 the realised price per tonne was 194,000 roubles, six times the 1998 price (Anon, 2000; Anon, 2002a).
- In Iran, the state monopoly limits catch based on its TAC (Moiseev, 2002).

New entrants and monopoly power

- The case studies above present several options on how to address these issues and usually entail the imposition of trading restrictions.
- The regulating authority will need to examine the inherent trade-off between the imposition of such trading restrictions and the attainment of cost minimisation outcome for the fishers as restrictions on the trading of ITQs limits the ability to attain the latter.

Monitoring and enforcement

- This is probably the most challenging issue facing an effective ITQ system for the sturgeon in the Caspian Sea.
- Although ITQs can provide the appropriate incentives for the long-term and sustainable management of the resource, the alleged mafia, corruption, poaching and existing poverty within the region undermine the policy goals.

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[10] *Decree of the President of the Russian Federation from 08.04.97 № 305.*

- The CBC have been planning since 1995 to create a united force of law enforcement officials from the five countries to staff anti-poaching patrols in the Caspian Sea (Pala, 2001).
- Low average wages relative to caviar values compound this task. Little is known about the nature of illegal harvesting and poaching and precise information on economic, social, and institutional factors driving these.
- The apparently large number of participants in both legal and illegal fishing coupled with the extensive coastline further compound these problems.

Penalties for non-compliance

- It is recommended that in general, penalties for non-compliance should be approximately 3–5 times higher than the cost of purchasing an additional quota to provide fishers with the adequate incentives to comply (EPA, 2003). Optimal penalties will vary depending on the monitoring and enforcement intensity as well as the probability of detection.
- However, with the often high value of CITES Appendix II-listed species, these figures need to be determined on a case-by-case basis.
- More stringent penalties can include the forfeiture of quota shares, vessels, as well as plant and other equipment. The setting of efficient levels for such penalties requires a lot of information.

Box III – Industry adjustments to listing on CITES Appendix II

- Placing a species on Appendix II of CITES sends *signals* to the industry associated with trade in its derivatives that can be *translated* in economic terms. Outcomes of interventions depend on a variety of associated factors and prove difficult to predict. Broadly speaking, industry participants *might* anticipate:
  - More stability of legal raw material supply;
  - Price rises in the short- to medium-term;
  - Illegal trade routes to either evolve or disappear.
- To this end, a variety of adjustments will have occurred since 1998 in the sturgeon fishery and its associated markets and trades; industry participants have taken decisions based on dynamic shifts as they occur. While Raymakers (2002) presents an initial attempt at understanding the nature and scale of these adjustments, data have not been systematically collected, and such analysis remains a priority for designing and implementing future economic incentive mechanisms based on efficient and conservation outcomes.

5. Specific program design issues for sturgeon in Caspian littoral states

Section 4 highlights key design aspects of a proposed ITQ system for sturgeon. However, design should be informed more widely by economic, political, social and environmental aspects of the fishery as it currently stands and as it is anticipated to change under an ITQ system. This Section indicates some key issues that represent opportunity and constraint on ITQ design, implementation and ultimately success. Better comprehension of these factors, presumably within an economic framework will enable more efficient and sustainable solutions – particularly ITQs – to be promoted, designed and implemented for sturgeon populations in the Caspian Sea.

5.1 Property rights and the geo-political climate

- It has been stated that property rights are key to generating incentives to conserve wild populations – sturgeon in the Caspian Sea is a case in point.

Box IV Specific property rights issues over the natural resources of the Caspian Sea

First, the countries differ at to their absolute levels and their level of maturity of:

- National management
- Socio-economic development
- Geography and proximity to a range of natural resources
- Investment climate.

Second, the countries cannot decide ownership of its natural resources. From 1940 until the collapse of the Soviet Union, the sea was joint Soviet-Iranian property (Suciu, 2004). Then followed a confused period. In mid-1998, the five countries that border the Caspian met for the first time to discuss the need to balance natural resource exploitation with the biological sustainability of the region. Several property rights options have been forwarded and discussed:

- *share* – Russia and Iran want to see the five states share the resources since their immediate offshore waters do not contain significant reserves (Artyukov, 2002).
- *condominium approach* – whereby the seabed would be divided into five sections, but the water above shared.
- *column* – Azerbaijan, on the other hand, wants to see the agreement go further and divide the "water-column".

Until a determination is made about how the Caspian will be divided, the current arrangements and poor communication between States will likely continue to hinder and even discourage significant advances in responsible environmental management (Hicks, 1999; Anon., 2001a; Siucu, 2004). In addition to sturgeon, several additional environmental issues require collaborative efforts to successfully mitigate, including pollution abatement and oil exploitation; indeed, some geo-political cooperation is ongoing (on regional stability and security) and expected in the future (shared concerns include transport infrastructure development) (Anon., 2003a). The wish to avoid falling foul of the *resource curse* is of paramount importance – where potentially high gains from abundant valuable natural resources convey overwhelmingly negative burdens on the state; often inequity as elites capture the rents and sequester the gains (see Murshed, 2004). One appealing argument is to re-invest some of the rents from oil exploration and extraction in developing a sustainable sturgeon fishery.

Box V – Illegal trade

- Although it is impractical to expect detailed data on the scale of illegal activities, a comprehension of the *nature* of poaching will be crucial to informing design of an ITQ system. Equally, it will be key to comprehend the *nature and scale* of domestic consumption.
- There is some conflicting and unsubstantiated anecdotal evidence that pre-1991, poaching was limited (Søyland, 2000) and excessive (Moiseev, 2002). As the Soviet Union imploded, business strategies that rely on trust between partners became critical; and coupled with a weak law regime; organised crime groups (OCGs) rose in stature and significance (Hendley *et al*, 1999).
- It is often stated that the 'Russian mafia controls' the illegal sturgeon fishery and caviar trade; there is little accessible literature discussing the 'mafia' or OCG in relation to sturgeon and most is anecdotal or observational – the organisational aspects, most pertinent to an economic characterisation of this mafia, are unrecorded.
- However, significantly, recent evidence indicates that the authorities were also culpable in illegal activities, including assigning quotas to selected businesses (Anon., 2004d).
- In general, there are indications that OCGs operating in the former Soviet Union are not a single crime group, rather many entities or gangs with a grip on specific locations and economic activities – coupled with connections and agreements existing between the 'leaders' of these geographical cells (Varese, 2000). This neatly fits with global experience with OCG activity:
  - to govern an underworld within defined borders;
  - to become monopoly suppliers of protection services; and,
  - to become a monopoly buyer of certain commodities.
- Some services lend themselves to being supplied monopolistically than others – gambling, money-lending and drug-dealing; the same is true for certain commodities 'produced' by a region – including smugglable tangibles, such as sturgeon poaching and the illegal caviar trade.
- Sturgeon poaching and the caviar trade will likely be *one* of several products and services controlled by an OCG.
- For the purposes of designing and implementing conservation-based EIs, it is useful to establish a simple framework to enable better comprehension of the *nature* of illegal activity; in this way we might begin to understand some of its inherent incentives, and crucially whether these require realigning for efficient design and implementation of ITQs.
- Often the success of any EI will hinge on the ability of the EI mechanism to generate sufficient incentives for the legal industry to begin enforcing itself; one aspect of this is to use the legal industry to crush the illegal – this necessitates innovative design of the ITQ system *informed* by intelligence on the nature of the illegal poaching

and trade.

- In sum, it seems likely that any OCG will perform two roles with respect to sturgeon fishing and the caviar trade:
  - Protection – payment for a range of 'protection' services to *legal* fishing companies – Søyland (2000) reports that one-third of the catch of the legal fishery fleet is unaccounted for because criminal gangs *seize* it.
  - *Fishing, processing, retail* – subcontracting individuals, 'gangs' or localities to supply caviar for smuggling to domestic and international markets. There is little information on this – the nature of the pervasion of the OCG into any of these activities is a matter of debate. However, it seems sure that there are monopsonistic buying practices at key points in the supply chain that ensure governance is easily enacted over the trade (as indicated by Bennett, 2002).
- There is evidence that poaching is a clear and present activity (Raymakers, 2002). However, it is unclear who the participants are; the significance of the associated socio-economics, structure and power relationships of the illegal trade – for instance, the relative significance in harvesting of the 'gangs' (Anon., 2003b) and the opportunistic individual fishers (Saffron, 2002); interactions with the legal trade; and, the scale of how the illegal trade operates.
- From the limited evidence from the Caspian Sea but more specifically, international experience with OCGs, it is likely that the responsibility for sturgeon poaching is devolved and chiefly performed by individual local fishermen – for whom incentives will include relatively high financial benefits and may include fulfilling terms associated with informal credit for boat and fishing gear with repayment terms including monopsonistic buying of any caviar supplied. If this conjecture about the *nature* of the illegal trade holds true, it is important; it directs our conception of illegal activity – not as a parallel industry but rather an opportunistic trade potentially involving *all* individual fishermen. This would mean the *risks* of poaching are devolved to the individual fisherman and/or boat – making enforcement doubly difficult.
- Along the supply chain, Bennett (2002, 2004) describes how processors of small amounts of poached caviar need few tools and minimal capital investment to operate. For the OCG, it is simply a matter of monopolising buyer rights from a local community, ensuring rudimentary quality and storage standards, and finding a buyer for the aggregated stock.

It seems clear that post-1991 and particularly post-CITES listing, the illegal trade changed and (potentially) narrowed, as indicated earlier an industry participant might anticipate. Of course, we must maintain the possibility that it is not a slickly functioning institution and instead, haphazard and random.

- Pragmatically, due to the transboundary nature of the fishery resource, ideally an ITQ system would include all five states.
- Significantly, no international ITQ systems exist for any fishery in the world. Hence, linking and coordinating the interests and activities of the five Caspian littoral states over the sturgeon fishery would likely require an International or Regional Agreement and issues such as flag-hopping and quota-hopping would need to be controlled.
- Furthermore, determining how an ITQ program can be established for sturgeon will require collaboration between policy-makers and fishery scientists, as well as local stakeholder involvement[11]. In addition, it will rely on appropriate political will and require domestic interlinked and nested cooperation both at many and among many different institutional levels (Aubry, 2001; Farvar, 2001). Plus, more information on the *nature* of participants would be needed.
- Further, certain design options of the ITQ would need to be harmonized across the different states to ensure that all fishers are subject to the same incentives and that the ITQs are fungible across national borders. Particularly necessary is consistent monitoring requirements and non-compliance penalties across all five states.
- A regional program does exist – the Caspian Environment Program[12] – and could be a candidate for delegation of this task.
- While the choice of allocation method of the ITQs could arguably be left to the individual states[13] - it is sensible to initially obtain a better idea of the functioning of:
  - The domestic quota system in the Russia Federation.

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[11] *For instance, public participation and educational programs will be necessary to ensure that participants involved are familiar with how such a program operates.*

[12] *See www.caspianenvironment.org.*

[13] *These issues have been raised in the context of international emissions trading under the Kyoto Protocol of the UN Convention on Climate Change (see EC COM, 2000:87), and in the design of the OTC NOx Budget Training Program for the eastern states of the USA (see OTC, 1996).*

  - The system functioning for sturgeon in the Lower Danube (Siucu, 2004) might yield useful information to inform design of systems for the Caspian Sea.
- The precise impact on different Caspian littoral States will be different – Iran's state-managed monopoly will require different processes to establish an ITQ system than the Russia Federation.

5.2 Calculating the TAC

- At the cornerstone of ITQ systems is a scientifically calculated TAC.
- While there exists debate over the robustness of data used to calculate the TAC for the Caspian Sea sturgeon – indeed, the biological underpinnings have been criticised for being both too high and too low – the CITES Secretariat is convinced that the figures used are precise (Armstrong *et al*, 2003; Armstrong and Karpyuk, 2003). Data from 1998–2002 is presented in **Table 1**, indicating growing robustness and scale of the beluga sturgeon population of the Caspian Sea.
- In addition the interaction between the biological TAC and the fishery industry participants is poorly understood.

Table 1: Estimated numbers of *Huso huso* in the Caspian Sea and percentage of adults, based on summer trawl surveys

Year	1998	1999	2000	2001	2002
Numbers	7.6 mil.	9.3 mil.	5 mil.**	9.3 mil.	11.6 mil.
% adults	0 - 17.4%	8.7 - 10.0%	5.5%**	14.8 - 22.0%	20.6 - 42.9%
Number of spawners entering major* rivers	**6,090**	**5,272**	**5,355**	**5,695**	**5,524**
Number of spawners harvested	**2,118**	**1,454**	**1,182**	**1,059**	**1,121**
% of harvested specimens held for the hatcheries	**41%**	**72%**	**48%**	**69%**	**62%**

Source: CITES, 2002; Armstrong and Karpyuk, 2003.

* major rivers = Kura, Ural, Volga.

It is the view of the CITES Secretariat that not only is the beluga sturgeon population expanding (see Table 1), he commercial proportion of this population is increasing.

Causality

- To design an efficient and successful ITQ system, evidence of *causality* is key. Particularly, there is conflicting testament and conjecture on the significance of the following for sturgeon populations:
  - oil pollution – localised at the mouths of the Volga, Ural and Kura rivers (Werth, 2001, Dahl, 2003); or endemic (Hicks, 1999).
  - mnemiopsis *ledyi* jellyfish impacts on sturgeon food biomass and recently invaded the Caspian Sea (Hicks, 1999; Farvar, 2001; Kirby, 2002; Pearce, 2004).

Hatcheries

- *The problem* – the sturgeon population is maintained through two forms of recruitment – natural growth and artificial recruitment from hatcheries – making difficult identification of the root causes of allegedly low populations.
- The impact of the hatcheries and 0.5–2 billion fingerlings released over the past 40 years on population dynamics is a critical issue to be resolved (DeMuelenaur and Raymakers, 1996; Anon, 2002b; Bennett, 2004; Ivanov *et al*, 2001; Armstrong *et al*, 2003) and its impact on future conservation strategies (Anon, 2002c; Anon, 2002d).

The economics are intriguing, yet uncertain:

- Funding – Moiseev (2002) states that 'funding for enhancement is derived from the revenues from legal harvesting and trade', but further information on this funding mechanisms has been found;
- Hatchery ownership;
- The extent of diversification of hatchery production into producing sturgeon, juveniles for overseas captive-breeding establishments and fertilised eggs to captive breeding establishments in Europe?
- The significance and contribution of new techniques for farming or aquaculture in the Caspian Sea and its tributaries (Pala, 2002).

Box VI – Domestic consumption

Meat

- Domestic retail is illegal, and hence is not systematically monitored.
- There is a large (but unquantified) domestic market for sturgeon meat. Raymakers (2002) indicates that the market for sturgeon meat within the Caspian Sea littoral states could be an important driver of harvest (both legal and illegal) – it currently retails for about double the price of beef on most markets in Russia. However, the significance of this is unknown.
- There is some evidence that supply determines prices since during the sturgeon migration meat prices fall by up to 30% and caviar prices by up to 10% (Raymakers, 2002).

Caviar

- Domestic retail is illegal, and hence is not systematically monitored.
- There is a large (but unquantified) domestic market for caviar within the Caspian Sea littoral states. Hence, international trade bans will prove inefficient (Anon., 2001b; Hamilton, 2003).
- The luxury value is apparently felt, captured and realised in caviar-producing countries and internationally: within Russia, it is one of the few domestic products that carries a feeling of luxury and distinction (Bennett, 2002) and internationally, its cachet is well established.

- The flexibility of ITQs is a great ally in determining how best to deal with this non-natural recruitment issue. It will be necessary to understand better the financing mechanisms currently operating and how an envisaged ITQ system can be tweaked to ensure that financing is sustainable and that the incentives facing all industry participants are developed in such a way as to function with minimal intervention. Options here might include bolt-on regulations and the use of other EIs.

Harvest rates

- *The problem*: In general, for CITES Appendix II-listed species, total harvest levels are difficult to estimate owing to illegal activity (see **Box V**) and unreported domestic consumption (see **Box VI**).

Legal industry dynamics – industry structure, supply chains and market power

Equally key to ITQ design is comprehending the industry – its demographics, structure, relationships and incentives. Research into these "industrial economics" issues is rarely undertaken and these links are rarely drawn

- Understanding industrial structure can help identify *levers* for conservation as well as being key to framing the economic *limits* to quota management and enforcement.
- There is some evidence of the *static* structure of the fishery – fishermen to processor to traders to retailers. However, the position and significance of some players is uncertain – hatcheries, intermediaries, financial institutions, regulators, information brokers, local authorities, NGOs, government, oligarchs. Equally the demographics of the industry are unclear – the proportion of large to small, and their relative power to influence the industry and its practices.
- Equally, we are lacking the necessary information and data to expand this industry structure into a dynamic "model" with which to assess power relations and anticipate changes owing to ITQs – information such as contracts and negotiation techniques.

Socio-economics

- The majority of individual fishermen poaching sturgeon (see **Box V**) are believed to be poor with few alternative livelihood options and whose revenues from illegal sales of sturgeon form the vast part of their earnings (Anon., 2001c; Raymakers, 2002; Saffron, 2002; Novruzov, 2004).
- In addition, many are highly dependent on *informal credit* – often provided by economic agents associated with OCGs – which bodes poorly for any economic mechanism that does not incorporate solutions to this vast and complicated rural livelihood issue. As such, EIs will require complementary measures – such as rural credit, retraining, and extension – to ensure that the alternative livelihood options for fishermen are genuine options.
- Equally, ITQ allocation that aims to provide equitable benefits will need to take into account the incentives facing these participants. Potential innovations might be to divide the fishery into large and small vessels – as with artesenal fishery systems in many countries, including the Chilean toothfish industry.
- The incentives facing poor and/or rural individuals are complex and not easily forecast for policy options testing.
- *Theoretical gap* – there is a myth that if someone currently harvesting a species "makes more money" per unit of species, they will be keener to conserve the species and less likely to deplete it. This will depend on the nature of property rights that are prevalent and while ITQ systems can provide the correct structure for this, understanding the current mix of incentives facing these individual fishers is needed to inform and frame the ITQ design.

5.3 Financing conservation

- Revenues collected by the government could be used to address issues such as equity, for instance, by providing compensation for those who are unable to participate in the fishery (e.g., by providing re-training and education programs for alternative employment opportunities).
- Alternatively, to explicitly enable local smaller fishers to participate, some of the ITQs can be set-aside for those fishers alone (Borregaard *et al*, 2001) or to communities in general (Farvar, 2001) as discussed in the case studies above.
- Revenues from ITQ auctions are also key to financing additional monitoring and enforcement costs that are likely necessary in order to ensure an effective ITQ program, as well as other administrative costs.
- If alternatively the ITQs are distributed for free to fishers, the allocation rules need to be carefully constructed so as to ensure an equitable distribution of benefits – issues such as the identity of the fishers and the requirements of the current fleet.
- Equally, hatchery production needs to be scrutinised further – this essential element shaping recruitment to the sturgeon population will need to be assured sustainable under ITQs, possibly through hypothecated flows of revenue from rents captured elsewhere, for instance by government.

5.4 Demand for the final products

- Demand analysis enables policy-makers and EI designers to comprehend the location of the drivers of the trade – including the transmission of price signals throughout the supply chain; the associated risks and to help forecast the effect of proposed changes or interventions impinging on EIs and conservation.
- Little analysis has been undertaken on what happens to the price of species' products in response to a listing on CITES Appendices.
- Prices could increase as supply for the product has fallen. Note that higher prices for the product can induce increased poaching, which in turn calls for a tighter TAC, further reducing supply and increasing the price… This spiral effect is clearly counter-productive to the conservation goal.
- Alternatively prices could fall i.e., if it has been profitable to stockpile pre-CITES listing decision; speculation occurs throughout these supply chains since the species that are potentially endangered or threatened, trade is often a niche aspect of a larger trade.
- Recall however that under optimal management expected future increases in price increase the rate of return to fisheries and cause a reduction in harvests (see **Box I**). The effect under open access is likely to be different however.
- Caviar sells into the luxury goods market (Armstrong *et al*, 2003) with the following characteristics:

  - Consumer preferences do not obey conventional economic principles – for instance, rising retail prices might lead to increased demand.[14]
  - Scarcity and exclusivity are key – control of the brand through ownership of distribution channels helps to explain the vertiginous prices (Anon., 2004b; Anon., 2004c; Saffron, 2002).
  - Demand is from wealthier consumers and is not strictly fixed to economic cycles; rather events and cycles that impact on international travel dent luxury goods sales.
- As such, there are clear similarities with the business of retailing other luxury goods:
  - Immense value is created along the supply chain – and in keeping with most luxury goods – most of this value is attributable to the *brand*.[15]
  - The challenge of maintaining *brand integrity* is key to selling luxury goods.
  - It is sold in exclusive retail outlets, boutiques, airports and flagship department stores throughout the world.

Box VII A brief history of demand for caviar from the Caspian Sea

For sturgeon and caviar, during 70 years of Communist rule, a sophisticated and (apparently) efficient state monopoly linked the fishery with the international caviar retail trade. Furthermore, the supply chain was short and relatively simple:

- International trade was restricted by the state monopoly to 10% of production to maintain a high price (Saffron, 2002).
- This monopoly dealt mainly with a few wholesalers – Petrossian, France; D&H, Germany; Caviar House, Geneva; Romanoff, USA; Porimex, Zurich.
- These wholesalers dealt mainly with a few large volume buyers – airlines, hotels, cruise ships and small boutiques (Uldry, 2001; Saffron, 2002).

A marshalled supply chain with buyer concentration created the atmosphere for retailer-led cultivation of the *cache* of caviar, and its attaining and retaining the status of an elite retail brand. The pivotal position of these buyers was further shored up by the fortunate confluence of product perishability, uncertain supply and a lack of access to the final consumers for potential new entrants.

After the monopoly collapsed in 1991, the supply chains became complicated; supply and demand are more dispersed, and this limits the effectiveness of some interventions. For instance, caviar stores opened in urban America (Saffron, 2002). To this end, consumers are numerous and dispersed reducing their role in any effective future conservation solution. Re-emphasising the case for some form of EI at producer level.

Indeed, the relatively sudden collapse of these perfunctory monopoly conditions appears to have caught the larger buyers by surprise (Uldry, 2001). The unfortunate combination of porous borders, unemployed fishermen in the Caspian sea, easily caught fish, and the great gains to be made from the trade, saw open access replace the monopoly conditions and the market became flooded with caviar through new supply routes and industry structures.

Significantly, caviar products appear to have maintained their *brand integrity*. From an economic and conservation standpoint, this is positive – caviar has the attributes of an *enduring luxury*; people are willing to pay for "the real thing" or at least the best available quality. Theoretically, if well managed, suppliers of caviar can turn this feature to its brand advantage.

Currently, the U.S. makes up about 80% of the world's beluga caviar market, and imported an estimated $20 million (□20.6 million) of all types of caviar in 2001 (Horvath, 2001). America's appetite for caviar had only grown since CITES (Saffron, 2002).

Caviar signals quality of all the merchandise in a store. One of the traditional reasons for stocking good-quality caviar is to sell other associated (and often cheaper) products. Furthermore, it is thought to help create a retailer's reputation for quality and generate repeat sales.

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[14] *These goods are not true luxury goods or Veblen goods in an economic sense, but rather sold into markets that accentuate and promote the concept of prestige.*

[15] *The resilience of the brand is a key concept to comprehend when designing EIs. Brands resilient to adverse publicity and abrupt changes in demand and supply inspire industry confidence and are most likely to endure in the luxury goods market of the future.*

Competition

- Caviar consumers, their locations and their preferences are changing; plus the industry, its supply chain and associated markets are evolving.
- Markets are competitive and the design of an ITQ needs to take account of potential shocks and the risk associated with market changes; and the risk of an incumbent brand or product losing market share to a newcomer is ever-present.
- *Competition from* other *sturgeon*, and cross-elasticities of demand between products associated with caviar should be better understood
  - Caviar is currently produced in a number of countries and substitution across these is possible.
  - There is a wide and prosperous international trade in fertilised eggs and live specimens between range states and captive breeding centres (Animals Committee, 2000; Anon., 2003c; Anon., 2003d).
- Experience worldwide with captive breeding of wild species has a number of market impacts – greater supply, increased differentiation of and competition among final products, lower prices. The extent to which any (and more) of these impacts may already be occurring is unclear.
- Technology is also having an impact in the Caspian Sea.
  - Russian scientists have apparently pioneered a safe way of manually extracting caviar without killing the fish, keeping them in pens (Jim Armstrong *pers comm.*, 4/6/04).
  - Kazakhstan scientists are apparently testing a drug that induces sturgeon to expel eggs without an operation (Bennett, 2004).

  Both technologies lead to a form of sturgeon ranching *in situ*, where sturgeon have restricted movement and are protected, their eggs occasionally harvested.

- *Competition from other roes*: There are a host of other roes on the market – some of which have economic interactions with caviar. Varieties include local specialties from Iceland, Japan (*tobiko*), China (*keluga*) and the United States (whitefish, salmon, trout, lumpfish, and hackleback) as well as more widely available alternatives such as lobster roe, golden black herring roe, anchovy roe, and grey mullet roe. This widened range of qualities and types affected caviar's acceptance and its cachet in both retail and restaurant sectors.

- The extent of competition as opposed to complementary selling through the ladder of socio-economic consumer groups is uncertain.
- *From* conservation *campaigns encouraging consumer boycott of caviar:*
  - A campaign, *Caviar Emptor: Let the Connoisseur Beware*[16] seeks a halt to the international trade of beluga caviar as a key to the survival of sturgeon and is concomitantly urging US consumers to consider domestic caviars as an alternative (Anon, 2002e).
  - Plus, more recently, over 100 chefs and retailers in the USA have signed a letter to Interior Secretary Gail Norton supporting a beluga caviar import ban (Hamilton, 2003).
  - Both have been applauded by US caviar farmers and opposed by caviar importers (Simpson, 2004).
- The ability of these campaigns to succeed in encouraging a consumer boycott is moot; yet concerted campaigns should be monitored for their ability to create economic waves in the industry.

Understanding these factors internal to the supply chain will help to forecast trends. Specific trends that require better comprehension and monitoring include:

- *Buyer confidence* – Recent environmental campaigns have focused consumer and, more importantly, retail store buyer attention on its conservation status. These buyers are increasingly larger corporate entities, eager to avoid disruption owing to their buying policies. While regulation has apparently successfully instilled confidence in caviar products (Lang, 1999), this factor deserves closer attention.
- *Buyer identity* – The profile of consumers of luxury goods is changing – particularly in the USA – with demand drivers for luxury goods increasingly being middle market consumers[17] as consumers

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[16] *Run by SeaWeb, University of Miami's Pew Institute for Ocean Science and Natural Resources Defence Council.*

[17] *See also, Schor (2002); Brooks (2000).*

from diverse socio-economic backgrounds experiment with luxury goods (Silverstein and Fiske, 2003).

- *Differentiation of* product – caviar is infusing all aspects of the menu, and integrating across luxury goods; served as a garnish, an ingredient, and an entrée (Moran, 2000).
- *Timing* – Seasonal aspects to the caviar market remain significant – particularly Christmas and New Year celebrations (Moran, 2000, Moran, 2002; Wolff, 2001). However, whereas previously certain consumers would buy caviar in any economic cycle; increasingly consumption is a factor of world economic cycles (Redmayne, 2002).

6. Conclusions and Policy Recommendations

Building on Bulte, Swanson and Van Kooten (2003), this scoping study has indicated for sturgeon that the sculpting an appropriate international EI will be of great importance when it comes to habitat preservation through initially establishing (collectively) property rights as a first step towards efficient management of resources – both of land and the species it supports. It seems certain that this initial step must be complemented by additional EIs (such as ITQs) to arrive at a truly global optimum.

While there remain uncertainties, which, coupled with inadequate information, elevate the associated risks, a prudent and conservative quota system based around existing auction structures is the strongest recommendation that can be made. Experience from the Russian Federation's domestic quota allocation system should be scrutinised for the potential to extend this to other countries. Equally, ITQs do not exist in a vacuum and the extent and nature of additional complementary command-and-control measures requires further analysis.

Economic instruments enable policy-makers to be innovative and to design systems that are flexible to future social, economic, bionomic and environmental conditions. To this end, the sturgeon example demonstrates the importance of designing flexible systems. In sum, species will need to be considered on a case-by-case basis; 'blueprints' for designing EIs for conservation and development are not available.

The allocation of shares is crucial construct to get right – auctions appear most attractive owing to existing institutional mechanisms. Other key design options include ensuring social equity issues are considered – such as giving management rights and responsibilities to local communities and re-investment of any revenues from the ITQ system.

Establishing ITQs throughout the Caspian Sea entails a considerable challenge; currently, no international ITQ system exists, and would require significant political will to begin functioning. Positively, it was reported at the 50th Standing Committee of CITES that there is "no lack of political will" for sturgeon conservation among the Caspian littoral States.

Equally, further analysis is needed to establish the *nature* of:

- Causality – both biological (within the Caspian Sea ecosystem) and economic (among industry participants);;
- Incentives of political stakeholders;
- Incentives of industry participants – a key objective is to guide current harvesting strategies away from short-term over-harvesting and towards long-term sustainable harvesting. Strategies that promote industry self-regulation, emphasise and incentivise legality, will all be key;
- Demand drivers;
- Market structure and differentiation.

The importance of being prudent and conservative with EI design is important. In the long-term, and under the right conditions, regulation will be the preferred route of the majority of firms associated with the sturgeon resource – ITQs can provide a suitable framework for such regulation. Generating and sustaining economic benefits for industry has some key benefits:

- Increases the per unit profits for legal industry members
- Increases the incentives to being legal
- Increases the incentives to future membership of the legal industry
- Promotes *self-regulation* of the industry – effectively turning the legal trade on the illegal trade.

Hence the design of regulation needs to be informed, innovative and where possible flexible; importantly, industry need to perceive net benefits. Pragmatically, the fortunate confluence of industry confidence in future *persistent* supply coupled with a product that demonstrates *durable* demand, will increase the long-term benefits to being a legal industry participant, and increase the likelihood of sustainable use of the resource. Added to this is evidence that buyers appear to have confidence in caviar as a brand.

In determining how an ITQ program can be established for the Sturgeon in the Caspian Sea will require *collaboration* between policy-makers and fishery scientists, as well as local stakeholder involvement. Public participation and educational programs will be necessary to ensure that participants involved are familiar with how such a program works.

References

Animals Committee (2000). Implementation of Resolution Conf. 8.9 (Rev.). Sixteenth Meeting of the CITES Animals Committee, Shepherdstown, USA, 11/15 December. 139pp.

Anon. (2000). The quotes on fishing of sturgeon in 1999 have risen in price in 6 times in comparison with 1998. Avers On-line. http://www.caviar.ru/english/bissnes1.htm. Accessed 26/2/04.

Anon. (2001a). Caspian countries for joint moves to protect sturgeon. *Pravda*, 19 June http://english.pravda.ru/economics/2001/06/29/8957.html. Accessed 27/2/04.

Anon. (2001b). Export Quota Reductions May Endanger Caspian Sturgeon. IWMC – World Conservation Trust, August. http://www.iwmc.org/newsletter/2001/2001-08-03.htm. Accessed 19.02.04.

Anon. (2001c). Export Quota Reductions May Endanger Caspian Sturgeon. IWMC – World Conservation Trust, August. http://www.iwmc.org/newsletter/2001/2001-08-03.htm. Accessed 19.02.04.

Anon. (2002a). About the realization of auction tenders on sale of quotes on fishing the sturgeon fishes. Russian Caviar online. http://www.caviar.ru/main_eng.htm. Accessed 12/2/04.

Anon. (2002b). Volgograd sturgeon hatchery releases over four million fry into Volga, *Pravda* On-line, 31 July. http://english.pravda.ru/region/2002/07/31/33565.html. Accessed 27/2/04.

Anon. (2002c). Caspian Sea states to resume caviar trade. Press Release, 6 March, CITES Secretariat, Geneva.

Anon. (2002d). Caspian caviar ban lifted. 6 March. *BBC News* On-line. http://newsvote.bbc.co.uk/cgi-bin/emailthisstory/emailthisstory.pl. Accessed 25.2.04

Anon. (2002e). American Caviar: An Eco-Friendly Way to Celebrate Special Occasions. Caviar Emptor website. http://www.caviaremptor.com/holidays.html. Accessed 27/2/04.

Anon. (2002f). Iran admitted to commission on Caspian bioresources. *Azer News* on-line 14 (248). http://www.bakupages.com/pubs/azernews/7942_en.php. Accessed 2/6/04.

Anon. (2002g). Iran joins a commission on Caspian Sea. *Nimrooz*, 5 April. http://www.nimrooz.com/html/679/17298.htm. Accessed 2 June 2004.

Anon. (2002h). Iran joins the Commission on Caspian Bioresources. *Eurasia Net* (Turkmenistan Daily Digest), 1 April. http://www.eurasianet.org. Accessed 2/6/04.

Anon., (2002i). Iran joins Caspian resources commission. *IranMania* (on-line). 4 April.http://www.iranmania.com/news/ArticleView/Defaul...9598&NewsKind=CurrentAffairs. Accessed 6/6/04.

Anon. (2002j). Sturgeon fishing in the Azerbaijani sector of the Caspian Sea will be surged from 5.3% to 12.85%. *Caspinfo* (on-line), 10 November. http://www.caspinfo.ru/data/doc_e02/001476.HTM. Accessed 6/6/04.

Anon. (2003a). Iranian President Urges Countries of Central Asia and Caucasus to Develop Cooperation. *Pravda* On-line, 20 January. http://english.pravda.ru/world/2003/01/20/42263.html. Accessed 27/2/04.

Anon. (2003b). Anti-poaching squads tackle caviar crisis. BBC News Online, 25 June. http://news.bbc.co.uk/go/pr/fr/-/1/hi/world/europe/3020454.stm. Accessed 22/2/04.

Anon. (2003c). Wakefield to be caviar capital. BBC News Online, 6 December. http://news.bbc.co.uk/go/pr/fr/-/1/hi/england/west_yorkshire/3296727.stm. Accessed 22.02.04.

Anon. (2003d). Marky's is First to Import Live Sturgeon. *Gourmet Retailer*. http://www.gourmetretailer.com/gourmetretailer/search/search_display.jsp?vnu_content_id=1913574. Accessed 19.02.04.

Anon. (2003e). Putin does not rule out introduction of state monopoly on sturgeon fish and caviar. *Pravda*, 20 January. http://english.pravda.ru/world/2003/01/20/42263.html. Accessed 27/2/04.

Anon. (2004). Interpretation and implementation of the Convention: Sturgeons. SC50 Doc. 18. 50th meeting of the Standing Committee, Geneva, 15/19 March. XX

Anon. (2004b). Business sense. *The Economist*. 6 March.

Anon. (2004c). No end of luxury. *The Economist*. 6 March.

Anon. (2004d). Extortion by Fisheries Committee officials exposed. *Interfax* (on-line), 2 June. http://www.interfax.ru/e/B/0/0.html?id_issue=9707370. Accessed 3/6/04.

Armstrong, J.A. and Karpyuk, M.A (2003). Beluga sturgeon (*Huso huso*) in the Caspian Sea – a response to the proposal to list beluga sturgeon as endangered under the U.S. Endangered Species Act. CITES Secretariat, Geneva, September, 30pp.

Armstrong, J.A., Karpyuk, M.A, De Meulenaer, T., Nash, S.V. and Pourkazemi, M. (2003). The status of beluga sturgeon (*Huso huso*) in the Caspian Sea, since its listing in CITES in 1998. CITES Secretariat, Geneva, September, 47pp.

Arnason, (1991). Efficient Management of Ocean Fisheries. *European Economic Review*, 35: 408–417.
Artyukov, O. (2004). Putin and Aliyev to discuss status of the Caspian Sea and Karabakh. *Pravda* On-line, 24 January. http://english.pravda.ru/main/2002/01/24/25973.html. Accessed 27/2/04.
Ashirova, G. (2004). How to Save Caspian Sturgeon? *The Times of Central Asia*, 15 April. http://www.times.kg/news/?id=1106529.html. Accessed 2/6/04.
Aubry, D. (2001). The Caspian Sea at the crossroads. *Policy Matters* no. 8, October.
Batstone and Sharp (1999). New Zealand's quota management system: the first ten years. *Marine Policy* 23 (2): 77–190.
Bennett, V. (2004). *The taste and desire for Russia*. Headline Book Publishing, London.
Borregaard, Convery and Katz (2001). Applying Trade in Developing Countries –The Chilean Experience. Paper presented at FEEM Workshop, December 3/4.
Boyce, J.R. (2004). Instrument choice in a fishery. *Journal of Environmental Economics and Management* 47: 183–206.
Buck, E. (1995). Individual Transferable Quotas in Fishery Management. CRS Report for Congress.
Chew, K. (2002). Serge Doroshov & Sturgeon Aquaculture. Waterlines, Winter. Newsletter of the Western Regional Aquaculture Center. http://www.fish.washington.edu/wrac/images/WaterlinesWin2002.pdf. Accessed 22.2.04.
Churunov, V.N. (2003). To the problem of catchability determination of the investigation trawls. Unpublished, 15pp.
CITES (2002). Catch and Export quotas for specimens of Acipenseriformes species included in Appendix II for 2002.
Copes, P. (2000). Conservation and Fish Harvest Productivity. Institute of Fisheries Analysis and Department of Economics. Simon Fraser University. B.C. Canada
CRTC LREI (2001). Evaluation of legal and economic instruments to be used for the Caspian sea environmental protection. Third CRTC LREI Expert Meeting, Moscow, 22/23 August.
Doward, J. (2000). Roe rage as piracy rules. *The Observer* (UK), 21 May. http://www.guardian.co.uk/fish/story/0,7369,353224,00.html. Accessed 22.2.04
Duchene, L. (2001). Sturgeon's plight fuels alternate sources for caviar. *Seafood Business*. http://www.seafoodbusiness.com. Accessed 22/02/04.
EU Commission (2000). Green Paper on Greenhouse Gas Emissions Trading within the European Union COM (2000) 87. http://europa.eu.int/comm/environment/docum/0087_en.htm.
Eythorsson, E. (2000). A Decade of ITQ-management in Icelandic Fisheries- Consolidation without Consensus.
FAO (1997). Fisheries Technical Paper 371 - Individual Quota Management in Fisheries - Methodologies for Determining Catch Quotas and Initial Quota Allocation.
FAO (2001). Country Profile on Iran. http://www.fao.org/fi/fcp/en/IRN/profile.htm. FAO Fisheries Technical Paper. No. 412. Rome, FAO. 2001.
Farvar, M.T. (2001). On sturgeon and the new character of CEESP. *Policy Matters* no. 8, October.
Fischer, C. (2002). The Complex Interactions of Markets for Endangered Species Products. RFF Discussion Paper 02-21.
Hamilton, A. (2003). The beluga's blues. *Time* (Asia). 13 January. http://www.time.com/time/asia/magazine/article/0,13673,501030120-407380,00.html. Accessed 19.02.04.
Hicks, E.J. (1999). Environmental constraints on development of Caspian oil and gas resources: The Bosphorous and the Caspian Sea. WWS 401c.
Horvath, S. M. (2002). Caviar Industry Fights Efforts To Add Fish to Endangered List. *Wall Street Journal*. 12 August. http://www.fao.org/docrep/003/W7292E/w7292e00.htmContents.
Ivanov, V P, Vlasenko, A D, and Khodorevskaya, R P (2001). Status of Caspian sturgeon stocks and their conservation. *CITES World* 8, CITES Secretariat, Geneva, Switzerland, 16pp.
Jenkins, R. (2001). Management and use of Caspian sea sturgeons by the Islamic Republic of Iran. *Policy Matters* no. 8, October.
Kemper (2001). Markets for Tradable Water Rights. IFPGRI 2020 Focus 9 Brief 11 of 14.
Kirby, A. (2002). Farmed sturgeon 'only hope for caviar'. BBC News Online, 2 December. http://news.bbc.co.uk/1/hi/sci/tech/2528557.stm. Accessed 22.2.04.
Lang, J. M. (1999). Caviar: Treasured little eggs of luxury dining. *Seafood Business*. http://www.seafoodbusiness.com. Accessed 22/02/04.
McCay and Brandt, S. (2001). Changes in Fleet Capacity and Ownership of Harvesting Rights in the United States Surf Clam and Ocean Quahog Fishery, B.J. in Shotton, R. (ed.) *Case studies on the effects of transferable fishing rights on fleet capacity and concentration of quota ownership*.
Moiseev, A. (2002). TAC estimation for the Sturgeon species in the Caspian Sea. Report prepared by the Management Authority for Sturgeon of the Russian Federation, Moscow, 20pp.
Montgomery, D. R. (2003). *King of fish*. Westview Press, Oxford.
Moran, M. (2000). Buyer Scan: Caviar. *Gourmet Retailer*. 1 September. http://www.gourmetretailer.com/gourmetretailer/search/search_display.jsp?vnu_content_id=1050559. Accessed 19.02.04.
Moran, M. (2002). Truffles, Caviar & Foie Gras: Small Luxuries with Loyal Fans. *Gourmet Retailer*. http://www.gourmetretailer.com/gourmetretailer/search/search_display.jsp?vnu_content_id=1755294. Accessed 19.02.04.
Murshed S.M. (2004). *When does natural resource abundance lead to a resource curse?* IIED Environmental Economics Programme, Discussion Paper 04–01, March, 54pp.
Nash, S. (2004). Caspian sturgeon catch and caviar export quotas 2001-2003. CITES Secretariat, Geneva, 1pp.

National Research Council Committee to Review Individual Fishing Quotas (1999). Sharing the Fish: Toward a National Policy on Individual Fishing Quotas.
Newell *et al*, (2002). Fishing Quota Markets. RFF Discussion Paper 02–20.
Novruzov, M. (2004). Turkmenistan: Sturgeon stocks endangered. IWPR's *Reporting Central Asia* no. 269. 5 March. http://www.caspinfo.ru/data/2004_EN.HTM/001885.HTM. Accessed 6/6/04.
OTC (1996). NESCAUM/MARAMA Nox Budget Model Rule. http://www.epa.gov/airmarkets/otc.
Pala, C. (2002). Lift on Caspian Caviar Ban Renews Threat to Belugas. *St Petersburg Times* (Russia) (on-line), 12 March. http://www.sptimesrussia.com/archive/times/752/news/n_5928.htm. Accessed 6/6/04.
Pala, C. (2001). Is This Really the End of Caviar as We Know It? *St Petersburg Times* (Russia) (on-line), 3 July. http://www.sptimesrussia.com/archive/times/683/rest/r_3893.htm. Accessed 3/6/04.
Pearce, F. (2004). Attack of the killer jellyfish. *The Independent* (UK). 10 March.
PERC (2002). *Fencing the Fishery*. http://www.perc.org.
Raymakers, C. (2002). Study on the Social and Economic Aspects if the Illegal Fishing in the Caspian Sea. TRAFFIC Europe, Belgium, 48pp.
Redmayne, P. (2002). Caviar. *Seafood Business*, December. http://www.seafoodbusiness.com/archives/searchframe.asp. Accessed 21.02.04.
Robinson, F. (2003**)**. Owner of Miami caviar import firm establishes Sturgeon AquaFarms. *Seafood Business*. http://www.seafoodbusiness.com. Accessed 22/02/04.
Søyland, S. (2000). *Criminal Organisations and Crimes against the Environment - a desktop study.* http://www.unicri.it/pdf/cocae.pdf. United Nations Interregional Crime and Justice Research Institute, Turin, Italy, 80pp.
Squires *et al* (1998). Individual Transferable Quotas in Multispecies fisheries. *Marine Policy* 22(2): 135–159.
Suciu, R. (2004). The impacts and implications of listing commercially-exploited aquatic species on CITES Appendix II: a case study on the fisheries of sturgeons, with emphasis on fisheries of the Danube, Black Sea and Caspian Sea. Sturgeon Research Group, Danube Delta National Institute, Tulcea, Romania, 26pp.
Tietenberg, N/A. Tradable Permits Approach to Protecting the Commons: What have we learned? http://colby.edu/personal/thtieten.
Turner, K. (1996). Value-based ITQs. *Marine Resource Economics* 11: 59–69.
Turner, K. (1997). Quota-Induced Discarding in Heterogeneous Fisheries. *Journal of Environmental Economics and Environmental Management* 33: 186–195
Uldry, T. (2001). How is the private sector coping? *Policy Matters* no. 8, October.
Varese, F. (2001). *The Russian mafia*. Oxford University Press.
Weitzman (2002). Landing Fees vs Harvest Quotas with Uncertain Stocks. *Journal of Environmental Economics and Management* 43: 325–338.
Werth, A. (2001). Pollution in the Caspian Sea. *Policy Matters* no. 8, October.
Wolff, L. (2001). Fishing freeze targets illegal caviar trade. *Gourmet News*. http://www.gourmetnews.com/august2001/depts/gn/gnstory1.htm. Accessed 23.2.04.