Using economic incentives to conserve CITES-listed species

A scoping study on ITQs for sturgeon in the Caspian Sea

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Contents

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1. Introduction

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an agreement between governments that aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. It currently has 166 parties or members and it encourages universal membership. CITES is regarded as one of the most important and successful legal international conservation instruments. It works to prevent illegal trade or trans-shipment through non-parties; promotes compliance with and enforcement of the requirements of the Convention; and facilitates action against non-compliance.

The species covered by CITES are listed in three appendices according to the degree of protection they need. Appendix I includes species threatened with extinction, and trade in these species is prohibited except in exceptional circumstances. Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled. Appendix III includes species that require protection within at least one member country (CITES 2004).

The value of annual trade in wildlife is estimated at $200bn and growing. The precise contribution by individual species is difficult to estimate owing to illegal trades and poor economic information along the trade chain. CITES is increasingly seeking guidance on economic factors and analysis to inform its decisions, implementation and enforcement.

This study is a product of the recommendations made by delegates at the first CITES meeting on ‘Economic incentives’ held in December 2003. Several economic incentives (EIs) were identified, one of which is the individual transferable quota (ITQ) system, which is the subject of this scoping paper. ITQs are increasingly being seen as a promising mechanism for achieving both conservation and socio-economic benefits.

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’. Furthermore, CITES ‘Strategic Vision Through 2005’ acknowledges the pressures of human populations and their development needs in developing countries, emphasising that for trade to be responsible, social and economic incentives are needed. One way in which CITES is seeking to deliver on this vision is through broadening its perspective to include economic approaches to pro-poor conservation, including investigating the use of economic incentives for commercially valuable species.

This study explores the applicability of ITQs to the Caspian sturgeon fishery. It introduces the broad concepts of an ITQ system and explores EI design, implementation, enforcement and compliance issues in the case of the sturgeon population in the Caspian Sea. Despite its Appendix II listing, anecdotal evidence indicates that the *in situ* sturgeon population remains threatened. Using information from a number of case studies where ITQs have been implemented, it highlights the limitations of ITQs and indicates research necessary to design and implement a sustainable system.

The paper is structured as follows. Section 2 reviews the theoretical underpinnings of fisheries and fisheries management. It also provides a general introduction to ITQ systems, how they can be established, 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 programme 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 programme 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 a fish stock is used and managed depends greatly upon its attendant property rights. In economic terms a fishery is a common property or open access resource. Open access rights exist when there are no clearly defined property rights, such that individuals can enter the fishery industry and exploit the fish stock without restrictions. Common property rights exist when a defined group of people own a resource.

Open access is not optimal since theoretically individuals have no incentives to conserve the resource into the future. Instead, the initial existence of profits in the industry attracts new entrants to the fishery, increasing the harvesting effort and making the resource scarcer. Catch per unit effort (CPUE) declines, raising the unit cost of catching fish. New entrants will increase 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 (see Box 1.1 for more detail).

To correct these market failures and achieve the optimal level of fishing effort and harvesting, governments must intervene in the fishing market. In the past, this was undertaken using traditional command-and-control approaches, whereby the regulating authority imposes input, output, or technological restrictions to control fishing effort and harvests. These have included restrictions on fishing gear (e.g., mesh size of nets and size and power of fishing vessels) and the number of days at sea, and the introduction of fishing quotas. These methods failed to alter the underlying behavioural incentives inherent in the fishing industry, and were largely ineffective.[1]

Economists tend to advocate the use of economic incentive methods (or market-based instruments) that can theoretically achieve a given harvest level at a minimum economic cost to society. Examples include taxes on resource rent, user fees and landing fees.[2] Another method that has more recently been applied in more than 75 fisheries (Tietenberg 2003) is an individual transferable quota (ITQ) system.

2.2 Individual transferable quotas

An ITQ programme can eliminate the open access nature of certain resources (including fisheries), promoting conservative harvesting and more efficient management of the resource. Under an ITQ programme, the regulating authority specifies a total allowable catch (TAC) and issues an equivalent number of quotas to reflect this (where one ITQ represents the right to harvest a predetermined number of tonnes 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 season or a year). The ITQs are then either distributed free of charge or auctioned off to fishermen. ITQ programmes guarantee a share of the current TAC and, under

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1 Fish stocks collapsed in the New England groundfish fishery and Atlantic Canada's cod fishery despite the application of such restrictions (PERC, 2002).

2 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).

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. This eliminates incentives for fishermen to 'race to fish' but creates incentives to adhere to their share of the TAC. ITQs also reduce overfishing by compensating participants for fishery exit in over-crowded fisheries. They also stimulate technological development by increasing the returns to licence holders on investments in research or improved fishing technology.

One crucial concern is the enforcement of quotas. Participants in the industry need to be confident that their rights to the resource are secure and exclusive. There is particular concern about CITES Appendix II-listed species because trade has previously been identified as a cause of population decline, and the associated species products often attract high values.

Box 2.1 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 or productive asset. For instance, personal savings are a renewable resource in the sense that savings earn interest, r, and accumulate over time at this rate. If this is the sole source of income then an individual has to decide their level of consumption over time: 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.

Decisions regarding consumption today have implications for future time periods. The problem is a dynamic one – one less Euro of savings today leads to lost interest on that Euro for all future periods. 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 one Euro of consumption today than tomorrow, and such impatience is reflected by the individual's 'discount rate', ρ. Higher levels of impatience or discounting of the future will tend to increase consumption now, and reduce savings. A range of external factors also influences the consumption/savings decision.

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. Also, in order to maximise welfare, returns from the fishery need to be compared with those of alternative options. This is similar to a consumer comparing bank rates; 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. Likewise with the external and individual effects that determine the harvesting decision; an individual or government managing the fishery that 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 features 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.

But there are important areas where the analogy with savings does not apply. 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.

Second, where consumption of savings is 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 will have three effects: 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 they must 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 accrue as profit to the resource owner.

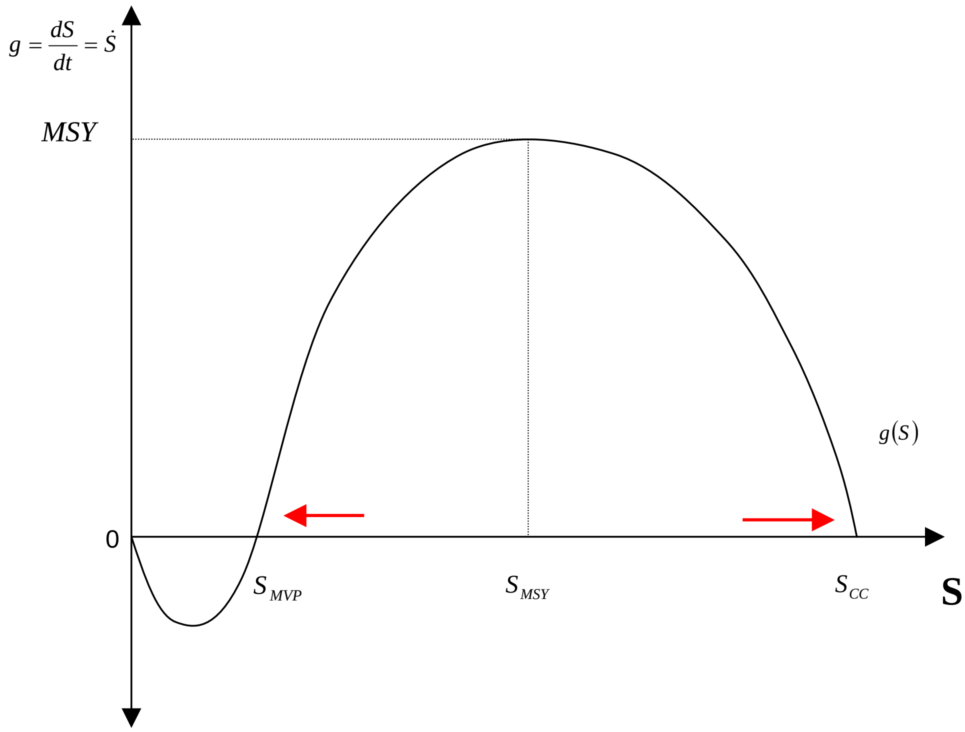
Third, where the stock of savings is a private resource, owned exclusively by the individual, fisheries are frequently owned either publicly by a sovereign state(s), commonly by regional communities, or are not subject to distinct property rights at all (open access).

Fishery dynamics: The fishery 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 problem is fully 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), 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. First, since the slope of the growth function is zero at S_{MSY}, maintaining the stock in order to harvest the maximum sustainable yield (MSY) does not maximise welfare over time, (i.e., is not efficient) where the interest rate is positive. Second, 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 level. 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 is illustrated in Figure 1.

Under 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*)[3] and the lower the growth rate of the fish population and the harvesting costs (*c*). The same can be said for optimal exhaustion**,** except that, in addition, high returns from outside options (*r*) will also increase the likelihood of exhaustion. Optimal exhaustion is less likely the higher the rate of price change 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.

[3] 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).

Figure 2.1 The logistic growth function, minimum viable population and maximum sustainable yield



Because quotas can be traded, an ITQ system can reduce fishing effort at a minimum cost, as the most efficient fishers purchase ITQs from the least efficient. Unlike conventional quotas, which require that each party or group is limited to a specific quantity, a market in ITQs is established for regulated vessels. This allows fishers to trade quotas with one another at a market price determined dynamically by the supply and demand for ITQs. Being a function of the level of the TAC and the marginal harvesting costs of the vessels, this market equilibrium links to the environmental characteristics of the fish stock,. The market creates genuine incentives to trade: regulated vessels will wish to purchase or lease additional ITQs if their marginal harvesting costs are higher than the prevailing ITQ price. Similarly, regulated vessels with marginal harvesting costs that are lower than the equilibrium ITQ price will wish to sell their excess ITQs.

Box 2.2 sets out a number of key factors underlying ITQ systems and guiding their success under different circumstances.

Box 2.2 The logistic growth function, carrying capacity and the maximum sustainable yield

i) The logistic growth function: The logistic growth function shown in Figure 2.1 characterises some essential features of biological resources. First, 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. Second, the growth function reflects the fact that growth at all 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) MSY 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 arrows in Figure 2.1 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. Box 2.I includes 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 specific 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)

For most fish stocks, the benchmark used to set the TAC is to achieve a stock that will produce the maximum sustainable yield (MSY) (see Figure 2.1 and Box 2.1). The size of a TAC is usually obtained on an annual basis by applying a target exploitation rate to an estimate of the current stock size. It is difficult to determine the target exploitation rate and to measure the stock size because of the variability in the relationship between stock size and the generation of subsequent offspring, and the difficulty in accurately measuring fish populations in the wild (NRC 1999). 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. Yet, the target fishing industry rarely welcomes conservative approaches.

Fish species are seldom caught individually. Setting TACs for multi-species fisheries entails additional innovation in ITQ design; examples include species aggregation into a single TAC and quota.[4]

[4] 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

A quota is often defined as a specific tonnage that may be harvested (e.g., one ITQ share equals one tonne) for a specific fishing season in a specific fishing ground. It can also be expressed as shares of the TAC, so that the harvests for a given share of quota fluctuate 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). The regulating authority will also need to determine the applicability of the programme, i.e., whether vessels of all sizes are affected by the ITQ programme.[5]

Allocating the ITQs

The initial quota allocation is one of the most contentious issues associated with an ITQ system. It can generate windfall benefits to the initial recipients and alter social and economic relationships among individuals and communities. Often, ITQ allocation is based on an average of a few years of historical harvests.[6] Alternatively, the ITQs can be auctioned off to the highest bidders.

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 programme for the indigenous population; and
- New Zealand's ITQ programme to benefit the Maori people.

For these allocations the community retains control over the transfers and is thus able to protect community interests (Tietenberg 2003). Other options include letting licence holders determine the initial quota allocation among themselves.

New entrants and monopoly power

ITQs that are initially distributed free of charge to existing fishers in the industry need to make provision for new entrants. Without this, future entrants will face a financial disadvantage because of the additional capital investment required to obtain ITQs. Allowing new entrants is key to both ensuring competition within the quota system and keeping existing quota holders efficient. Mechanisms such as annual auctions of ITQs help to ensure the process of quota allocation is relatively seamless.

One flaw in ITQ programme design, which can undermine the economic efficiency of the programme, is that it allows certain quota holders to corner the market, obtaining monopoly control over the landings as they purchase more and more quotas. Various design options have been introduced to restrict this (see Section 3.1 for examples from Iceland).

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

[6] One can also include a component for the use of 'clean' fishing techniques (i.e. minimal incidental by-catch) to reward those who have been more efficient in the past and to provide incentives to minimise incidental by-catch in the future.

Banking and borrowing of quotas

Banking refers to the ability of fishers to carry excess quotas over into the next year or fishing season. *Borrowing* of quotas enables fishers to harvest more in the current season by borrowing against future quotas. There are balanced arguments: the ability to bank and/or borrow quotas provides fishers with additional flexibility to adjust their harvest levels towards the economic optimum (PERC 2002). Yet, it can mean that total harvest (annual or season) exceeds the TAC. In practice, such flexibility can be an essential element of a multi-species fishery with volatile populations. However, there are attendant administrative and management implications that must be costed and factored in.

Monitoring and enforcement

Monitoring and enforcement are crucial for a well functioning ITQ programme, to help regulate internal abuse by licence holders and *external* abuse by non-licence holders. Internally, accurate and consistent measurement of fish catch will ensure that the total harvest adheres closely to the TAC. In addition, the price of an ITQ should reflect its true value.

High grading – that is, discarding lower valued fish in favour of higher valued fish – is a common problem that occurs when there is no monitoring. It is likely to be less of a problem if:

- there are minimal price differentials by fish size or quality;[7]
- 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).

To address the problem of high grading, 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 programme (Buck 1995).

Externally, monitoring and enforcement measures help reduce poaching and illegal harvesting. It is argued that ITQ programmes 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 are reduced and the price of quotas will fall. If all fishers adhere to the rules, all should benefit in line with the quota they hold. A system of financial penalties often provides fishers with extra incentive to comply with their quota restrictions.

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[7] Incentives to high-grade will tend to be greater the more dockside market prices are differentiated by size or quality of individual fish.

2.3 Some further considerations for use of an ITQ system

Sufficient operators

There should be a sufficiently large number of participants to ensure a competitive market for ITQs and reduce the possibility of monopolisation of resources. But the number should not be so large that it undermines the regulator's authority to manage and administer the programme.

Adequate authority

It is important to establish in advance whether the relevant government entity has sufficient jurisdiction over the geographic area where the programme 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 multi-country ITQs, such a programme 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 should be undertaken by an international authority since national governments would 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 programme 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:

- a developed system of private contracts and property rights;
- a private sector that makes business decisions based on the desire to lower costs and increase profits; and
- a government culture that allows private businesses to make decisions about 'how' to achieve objectives with minimum intervention (EPA 2003).

3. Case studies of ITQ systems for fisheries

This section details case studies of ITQ programmes for fisheries in operation in Iceland, New Zealand and the USA. These are not CITES-listed species but they are included to illustrate key points about the functioning of ITQ programmes that need to be borne in mind when developing appropriate economic instruments for CITES-listed species. Each case study is analysed using the characteristics explained in Section 2. Table 3.1 summarises information on the fisheries.

Table 3.1 Selected comparative statistics on the case studies

	Iceland	New Zealand	USA	Sturgeon, Caspian Sea
Number of vessels	2000	2000	<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 (2000) b) Raymakers (2002) c) Hersoug (2003)

3.1 Cod and the Quota Management Programme, Iceland

Background

In 1979 ITQs were first applied to a local herring fishery. In 1980 *vessel* quotas were introduced in the capelin fishery, and were made transferable in 1986. In 1982 an ITQ system was applied to the cod industry to alleviate the twin pressures of overfishing and overcapitalisation. Cod is one of the most important fisheries for Iceland's economy and there is an unwillingness to accept large short-term losses to achieve longer-term gains. Since 1990, the Quota Management Programme has incorporated most fisheries in Icelandic waters and included approximately 900 smaller vessels that had been fishing previously without restrictions. As a result, the total number of ITQ holders increased from 451 to 1,155. The duration of the ITQ programme is now indefinite, and ITQs are fully divisible and independently transferable.

The industry reports that ITQs have brought about a reduction in vessel numbers. For example, in the herring fishery, the number of vessels has fallen from 200 in 1980 to 29 in 1996 (NRC 1999), and between 1992 and 1999 the total number of vessels fishing under quota in all sectors decreased by 40 percent. Significantly, employment dropped by only one quarter between 1983 and 1997 (Runolfsson 1999).

Setting the TAC

Management of the Icelandic cod stock through the ITQ system has proved less successful than for herring and capelin. The cod population has apparently fallen because of an excessively high TAC. Indeed, the TAC set by the government in Iceland has consistently exceeded the recommendations of the Icelandic Marine Research Institute (NRC 1999). Cod was over-fished, and a record low stock was reported in 1992, although there was a subsequent recovery. In 1995, the TAC was set for the first time on the basis of a ‘TAC rule’, proposed in a bioeconomic study of the fishery, of either 25 per cent of the fishable stock or 155,000 metric tonnes, whichever is greater. Both are considered prudently conservative.

Defining the ITQs

The cod ITQ programme was initially established for one year only. It was seen by many as a temporary emergency measure for stock recovery. Quotas did not, therefore, constitute true private property rights. However, following successive two-year extensions, since 1990 there has been a regime of quotas of indefinite duration.

Initially, each fishing vessel over ten tonnes was allotted a fixed annual proportion of future TAC for cod and five other demersal fish species. Currently, the ITQ programme divides access to the resource among vessel owners based on their fishing record during the three years preceding implementation of the programme. 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.

Allocating the ITQs

- The ITQ rights are distributed free of charge, and are subject to annual renewal charges (currently approximately one per cent of fisheries' gross revenue) that have been increasing over time.
- Vessels of less than six gross registered tonnes (GRT) are subject to limits on the number of fishing days and an overall limit on catch.
- In order to hold quota shares, a person or company must have access to the vessel to which the quota shares are allocated and must fish at least half of their quotas every second year.
- Only one-half of the catch taken by vessels fishing with longlines in the winter months is counted against the quota.
- Quota shares are transferable and can be leased or permanently sold.

New entrants and monopoly power

Because of concern about the rapid concentration of ITQs in the hands of large vertically integrated companies, the Ministry of Fisheries set up an internal committee. This committee recommended limits for individual quota holders of 10 per cent for cod and haddock and 20 per cent for other species. In addition, 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.

Banking of quotas

For groundfish,[8] there is a certain flexibility built into the programme. Twenty per cent 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 harmful to stock conservation than it might appear. The exploitable stock of groundfish consists of ten year classes or more, which evens out the pattern of catches over time despite large variations in the size of year classes.

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[8] Groundfish include cod, haddock, halibut, redfish, saithe and account for 80 per cent of Iceland's wetfish value.

Monitoring and enforcement

Trading of quotas appears to be brisk; in the 'fishing year' 1993/4 the trading of cod and saithe quotas amounted to 44 per cent and 96 per cent, respectively, of the total catch. However, the same quota can be traded more than once. 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 usually a formality.

Other issues

Over-catch: 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. One reported impact is dead fish being discarded at sea – especially towards the end of the fishing year when ITQs are scarce and the lease price is inordinately high. This contributes to the waste of living resources and is ecologically irresponsible.

Employment: In fishing villages that have lost most or all of their quota, large-scale unemployment occurs, causing breakdown of communities. There are therefore demands for effective limits on quota transfers between regions and communities, to avoid employment uncertainty. Such limits are applied in Norwegian fisheries.

Allocation issues:

- **Quota duration.** Although quota allocations are of indefinite duration and could be revoked by the Icelandic Parliament at any time, the prices of quota shares suggest that the risk of this is low. In 1997, permanent quota shares for cod were trading at about eight times the cost of renting quota shares for a year.

- **Benefit distribution.** Prior to the programme, fishing was typically regarded as a 'co-venture' between vessel owners and crew. However, the initial allocation of quotas to vessel owners changed this symbiotic relationship, apparently favouring vessel owners over crew members. This has led to claims that vessel owners have become rich at the expense of crew members. There are similar claims in other fisheries, e.g., in Alaska's halibut and sablefish fisheries. But here practical difficulties, such as inadequate records on the fishing history of crew (a problem that does not exist in Iceland), were the main causes of the perverse or inefficient outcomes. However, this problem reflects a broader issue of a common bias in ITQ allocation toward capital ownership in both the theory and the practical design of ITQs.

Summary evaluation

This study highlights the implementation timeframe of an apparently successful ITQ programme, which has extended to all fisheries and all vessels. The strategy was to commence with larger vessels and the most significant and/or the most threatened or emblematic species or fisheries. It took several attempts to define an ITQ system that both supported the wild population and was acceptable to fishers. Careful and consistent monitoring has paid off; many of the innovations occurred ten years after the ITQ system was established.

3.2 Quota management system, New Zealand

Background

Since the exclusive economic zone (EEZ) was declared in 1978, the number of New Zealand's domestic operators has increased. The Fisheries Amendment Act of 1986 established the Quota Management System (QMS). A year later, it covered 30 species of the 140 commercial species in the EEZ, with each fishery for each species divided into a number of different fishery management units (officially designated as fishstocks). The number of fishstocks ranges from two to ten for any given species, with a total of 179 different fishstocks in the QMS. Its wide success has led to the government introducing plans to include all remaining commercially harvested species into the QMS. There has been no detailed investigation of changes in the fleet by sector owing to the QMS, but a recent study examined the whole fleet by size class and found significant declines in vessel numbers only in the ten-metre class. Most other vessel classes have expanded or remained static in terms of total tonnages, while catch volumes have increased at a greater rate (Connor and Alden, 2000; Arnason, 2002). Employment figures are inconsistent among reports, but the trends are clear. There has been a modest increase in employment in harvesting and a large increase in employment in the processing sector (Sissenwine and Mace 1992, Batstone and Sharp 1999, Dewees 1998).

Setting the TAC

TACs have been established since 1986, based, for most inshore stocks, on a largely qualitative assessment of average reported landings during periods when the catches were considered to be 'sustainable'. For a number of the prime inshore species, the initial TACs were set at levels of up to 75 per cent below the catches reported immediately prior to the introduction of ITQs. To smooth the economic impact of the likely alterations within the industry, the government provided adjustment assistance to the fishing industry in the form of a *buyback* of quota entitlements in certain fisheries. This provides some insurance to industry participants wishing to leave the fishery.

Defining the ITQ

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

Initial allocation of ITQs

Specific innovations include the following.

- The initial allocation of ITQs was made free of charge on the basis of catch history over a period of qualifying years.[9]
- ITQs were allocated in perpetuity and authorised the holders to take specified quantities of each species annually in each fishstock.
- Modifications were made following analysis of the buyback scheme and information generated by the ITQ programme.

[9] 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.

Monitoring and enforcement

The New Zealand ITQ monitoring and enforcement system is largely land based. It relies on documented product flow control that tracks a fish 'paper trail' through submissions to the Ministry of Fisheries. There are rules stipulating that all persons selling, transporting or storing fish must keep business records to verify that the product has been purchased from a licensed fish receiver, and that all fishermen must sell only to licensed fish receivers.

Fishery officers enforce product flow and fishery auditors examine business accounts and records to monitor quota compliance. In addition, cost-effective enforcement is enhanced by the use of sophisticated electronic monitoring and surveillance information and analytical systems. These include quota monitoring and reporting systems; catch and effort returns; and an observer programme and vessel monitoring system.

Penalties for non-compliance

Offences within the ITQ programme are not treated as traditional fishing violations but as commercial fraud, with penalties including 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 per cent over-runs 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 within the ITQ process.
- *Quota busting* is believed to occur in some fisheries, especially those for high-value species such as rock lobster, paua, snapper and orange roughy. Indeed, the illegal catch of rock lobsters in 1993 was estimated at about 25 per cent of the total New Zealand TAC (Annala 1994). To counter incentives for illegal fishing, recent well-publicised prosecutions, which resulted in heavy penalties, including loss of quota shares, vessels, and plant and equipment, have allegedly reduced 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. For example, 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 illegal fishing levels substantially. In addition, 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.

Summary and evaluation

The collection and use of relevant information has characterised the management approach in this quota management system. Information was key to analysis, design and implementation, and it guided monitoring and enforcement efforts. This case highlights the institutional requirements of a sustainable ITQ programme and the need for continuous assessment. The ITQ programme covers several species, which enables knowledge transfer.

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

Background

The surf clam and ocean quahog (SCOQ) fishery off the mid-Atlantic coast came under ITQs in 1990. Before 1990, the surf clam fishery was managed through limited entry, quarterly quotas and fishing time restrictions. However, these limits on effort, together with a growing strong year-class and increased vessel harvesting effectiveness led to such over-capacity that, by 1990, fishers were restricted to six six-hour trips per quarter. As a result, the Surf Clam and Ocean Quahog ITQ programme was adopted under Amendment 8 to the Fishery Management Plan in 1990.

A rapid decrease in vessels is reported in this fishery: from 180 vessels in 1990 to 80 in 1994, and 50 in 1997 (Adelaja et al. 1998: 590; NRC 1999: 64), with accompanying unemployment. This is lower than might be expected due to the practice, in the pre-ITQ period, of rotating crews among vessels restricted by numbers of allowable days at sea (McCay et al. 1995). Efforts to track the fate of redundant crew in this fishery revealed that ex-crew attempted to stay in fishing but found suitable work to be scarce (McCay et al. 1995).

Setting the TAC

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

Defining the ITQ

The ITQ has two components:

- the *quota share*, expressed in percentages of the TAC, which can be transferred permanently; and
- the *allocation permit*, which is in the form of a tag 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

Specific innovations include the following.

- The initial allocation of quota share was divided among owners of all regulated vessels[10] that harvested surf clams or ocean quahogs between 1979 and 1988.
- Replacement vessels were credited with the catch of vessels they replaced.
- The minimum holding of SCOQ ITQs is five cages, with no maximum holding and no limit to accumulation.[11]

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

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

- Anyone eligible to own a fishing vessel under US 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, but the National Marine and Forestry Service (NMFS) northeast regional director must approve all transfers.
- Cage tags are transferred only within a given calendar year and cannot be transferred between October 15 and December 31 of each year.

Monitoring and enforcement

Enforcement relies heavily on shore side surveillance, the cage tag system and cross-checking logbooks between vessels and processors. Transporters are not required to report, which can complicate enforcement effort.

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 Fishery Management Plan.

Other Issues

Cost recovery. No resource rents are collected from SCOQ ITQ fisheries. Instead, 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.

Summary and evaluation

Aligning industry and management incentives was crucial in this case. Government interaction with the industry was a key component of ITQ design and laid the groundwork for later financial devolution from the authorities to the industry. The ITQ programme is subject to a number of wider regulations, which complicates incentive structures and demands flexible solutions to species depletion.

4. Implications for ITQs for Sturgeon in the Caspian Sea

4.1 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 but the precise nature of the threat is unclear but a, number of social and environmental factors are blamed for the sturgeon population's decline.

Ninety per cent 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 (the Caspian littoral states). In the past, 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 the apparent breakdown of monitoring and enforcement led to an alleged rapid increase in illegal sturgeon fishing.

Figure 4.1 Map of the Caspian Sea littoral states

4.2 CITES and Caspian sturgeon

Background

CITES became involved in the sturgeon fisheries 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). In 1998, the Caspian sturgeon was placed on Appendix II of CITES.[12]

Most commentators – and, crucially, key industry participants – agree that bringing the international trade of sturgeons and sturgeon products under the well-established monitoring

[12] Some of the potential industrial and economic adjustments under a listing are reported in Box 4.1.

and regulatory system of CITES was a positive step for the long-term survival of wild sturgeon populations and their fishery. In addition to international trade regulation, the CITES Secretariat has promoted demand-side curbs on the caviar trade, through the development of labelling laws for caviar and enforcement efforts.

However, poaching and smuggling have apparently continued largely unabated despite these conservation measures. As a result, in 2000 the CITES Animals Committee included sturgeons in its Review of Significant Trade. The latter is a 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.

Following this Review, the CITES Standing Committee recommended at its 45th meeting in Paris in 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.

The Caspian Bioresources Commission (CBC) is the regional body under CITES that allocates the TAC among the Caspian littoral states. It was established in 1992 by the Caspian littoral states, minus Iran (who was an observer until she joined in 2002) (Anon., 2002f; Anon., 2002g; Anon., 2002h; Anon., 2002i).

Aggregate statistics on the quota system are available but the processes for determining and allocating quotas are not well documented in English. Therefore, this section relies on anecdotal information from key informants and literature available in popular press, on the internet and in hard copy.

Setting the TAC

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

Defining the ITQ

There is a general trend towards defining ITQs in terms of shares of the TAC as opposed to a specific tonnage, because of the greater administrative ease and inherent flexibility of the former.

Allocating the ITQs for the Caspian Sea

The proportion of TAC each country receives is complicated by debate and science. Negotiations on the allocation have traditionally taken into consideration a number of factors including hatchery release volume, volume of freshwater flow, available biomass of food resources, and historic spawning grounds. Quota allocations are agreed on by the CITES Secretariat before exports are permitted (Ivanov et al. 2001; Suciu 2004). The export quotas for caviar in previous years were 146 tonnes (2003), 140 tonnes (2002) and 153 tonnes (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 the previous year's level: Russia (429t sturgeon and 30.3t caviar), Kazakhstan (216t and 23.18t), Iran (676.4t and 78.8t) and Azerbaijan (109t and 9.2t).

Quota proportions and volumes continue to be hotly contested (see Anon., 2002j; Anon., 2002i; Ashirova, 2004). At the 21st meeting of CBC in March 2004, representatives of Russia and Azerbaijan (with the silent support of Kazakhstan) insisted on a new method of setting quotas for sturgeon catch and caviar export, which includes criteria required for sturgeon reproduction (Ashirova 2004) proxied by the number of fish farms in each state. The CITES Secretariat approved the commission's decision.

Allocating the TAC domestically

Industry participants are likely to be comfortable with an auction system for quotas because it is used in other fisheries. A first-price auction system for quotas operates in the Russian Federation[13] and appears to be thriving, attracting greater numbers of buyers and increasing prices. Price per tonne in 2000 was six times the 1998 price (Anon., 2000; Anon., 2002a). In Iran, the state monopoly limits catch based on its TAC (Moiseev, 2002), but there is little information on the allocative processes operating in the other states.

New entrants and monopoly power

The case studies above offer several options on how to address these issues; usually entailing the imposition of trading restrictions. However, a regulating authority will need to examine the trade-off between imposing such trading restrictions and minimising costs for the fishers, as restrictions on the trading of ITQs limits the ability to achieve the latter.

Monitoring and enforcement

The case studies in Section 3 highlight the central importance of this issue. It is probably the most challenging issue for an effective ITQ system for the sturgeon in the Caspian Sea. Although ITQs can provide the appropriate incentives for long-term sustainable management of the resource, factors such as corruption, the alleged mafia, poaching, low average wages relative to caviar values, and the existing poverty within the region could undermine these policy goals. Crucially, little is known about the nature of illegal harvesting and poaching, and there is little precise information on the 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. The CBC has 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).

Penalties for non-compliance

It is recommended that, in general, penalties for non-compliance should be approximately three to five times higher than the cost of purchasing an additional quota, to provide fishers with an adequate incentive to comply (EPA 2003). However, optimal penalties will vary depending on the monitoring and enforcement intensity as well as the probability of detection, and with the often high value of CITES Appendix II-listed species, these figures need to be determined on a case-by-case basis. To this end, more stringent penalties can include the forfeiture of quota shares, vessels and plant and other equipment.

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[13] Following Decree of the President of the Russian Federation from 08.04.97 № 305.

Box 4.1 Industry responses 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 stable legal supply of raw material;
- price rises in the short- to medium-term; and
- illegal trade routes to either evolve or disappear.

If this is the case, 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 responses, 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 programme design issues for sturgeon in Caspian littoral states

Section 4 highlighted key design aspects of a proposed ITQ system for sturgeon. However, design needs to 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 highlights some key issues that represent both opportunities and constraints for ITQ design, implementation and, ultimately, success. Better comprehension of these factors 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

Section 2.1 indicated that property rights are key to generating incentives to conserve wild populations. Because of the transboundary nature of the Caspian Sea, an ITQ system for Caspian sturgeon would have to include all five Caspian littoral states. No international ITQ systems exist for any fishery in the world. Hence, coordinating the interests and activities of the five Caspian littoral states over the sturgeon fishery would probably require an international or regional agreement, and issues such as flag-hopping and quota-hopping would need to be controlled. Prior conditions might include:

- collaboration between policy-makers and fishery scientists, as well as local stakeholder involvement;[14]
- appropriate political will, and domestic cooperation at different institutional levels (Aubry, 2001; Farvar, 2001) – see Box 5.1;
- harmonisation of certain design options of the ITQ across the different states to ensure that all fishers are subject to the same incentives and that the ITQs are fungible across national borders;
- consistent monitoring requirements and non-compliance penalties across all five states.

A regional programme does exist: namely, the Caspian Environment Program[15] and this could be the body to distribute fishing rights. Of course, the choice of allocation method of the ITQs could remain with individual states.[16] To inform this choice, we need to understand the functioning of the domestic quota system in the Russian Federation.[17]

The precise impact on each state will be different: Iran's state-managed monopoly will require a different implementation strategy to establish an ITQ system than the Russian Federation.

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[14]For instance, public participation and educational programmes will be required to ensure that participants involved understand how such a programme operates.

[15] See www.caspianenvironment.org.

[16] 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).

[17] The system in operation for sturgeon in the Lower Danube (Siucu 2004) might yield useful information to inform design of systems for the Caspian Sea.

Box 5.1 Specific property rights issues over the natural resources of the Caspian Sea

First, the countries differ in:

- national management;
- socio-economic development;
- geography and proximity to a range of natural resources; and
- investment climate.

Second, the countries cannot decide on ownership of their 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 Sea met for the first time to discuss the need to balance natural resource exploitation with biological sustainability. Several property rights options emerged.

- *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:* whereby the seabed would be divided into five sections, but the water above would be shared.
- *Column*: Azerbaijan, on the other hand, wants to see the agreement go further and divide the 'water-column'.

Until a decision is made about how the Caspian will be divided, the current arrangements and poor communication between states is likely to continue to hinder advances in responsible environmental management (Hicks 1999; Anon. 2001a; Suciu 2004). In addition to sturgeon, several other environmental issues require collaborative efforts, including pollution abatement and oil exploitation. Some geo-political cooperation is taking place (on regional stability and security) and more is expected in the future (shared concerns include transport infrastructure) (Anon. 2003a). Avoiding the risk of the *resource curse* is of paramount importance (where potentially high gains from abundant valuable natural resources transfer overwhelmingly negative burdens to the state and lead to inequity as elites capture the rents (see Murshed 2004). One appealing argument is to re-invest some of the resource rents from oil exploration and extraction to develop a sustainable sturgeon fishery.

5.2 Calculating the TAC

At the centre of an ITQ system is a scientifically calculated TAC. While there is 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). The population estimates of the beluga sturgeon presented in Table 5.1 illustrate a growing population and indicate the health of the total population.

Table 5.1 Estimated numbers of beluga sturgeon 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.

The CITES Secretariat believes that not only is the beluga sturgeon population expanding (see Table 5.1), but the commercial proportion of this population is also increasing. The following sections investigate some of the difficulties of calculating the TAC for sturgeon in the Caspian Sea.

Causality

To design an efficient and successful ITQ system, it is important to have evidence of the causality underlying population decline. For sturgeon populations, there are conflicting views on the significance of the following:

- oil pollution – it is unclear whether pollution is localised at the mouths of the Volga, Ural and Kura rivers (Werth, 2001, Dahl, 2003); or endemic (Hicks, 1999);
- overfishing;
- *Mnemiopsis ledyi* (jellyfish) – impacts on sturgeon food biomass from recent invasions in the Caspian Sea (Hicks 1999; Farvar 2001; Kirby 2002; Pearce 2004).

Hatcheries

The sturgeon population is maintained through two forms of recruitment: natural growth and artificial recruitment from hatcheries. This makes it difficult to identify of the root causes of low populations. The impact of the hatcheries, and the estimated 0.5 to 2 billion fingerlings released over the past 40 years, on population dynamics is a critical issue (De Meulenaer and Raymakers 1996; Anon. 2002b; Bennett 2004; Ivanov et al. 2001; Armstrong et al. 2003), as is their impact on future conservation strategies (Anon. 2002c; Anon. 2002d).

The economics are intriguing, yet uncertain. Further information is required on the following with regard to the functioning of hatcheries and the attendant incentives.

- *Hatchery ownership and funding*. Moiseev (2002) states that ‘funding for enhancement is derived from the revenues from legal harvesting and trade’.

- *Diversification of hatchery production* - the extent to which sturgeon juveniles are produced for export to captive-breeding establishments and for aquaculture in the Caspian Sea and its tributaries (Pala, 2002).

Box 5.2 Domestic consumption

Meat

– Domestic retail is illegal, and is therefore not systematically monitored.
– There is a large (but unquantified) domestic market for sturgeon meat. Raymakers (2002) indicates that it currently retails at about double the price of beef on most markets in Russia. The market for sturgeon meat within the Caspian Sea littoral states could be an important driver of harvest (both legal and illegal). 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 per cent and caviar prices by up to 10 per cent (Raymakers 2002).

Caviar

– Domestic retail is illegal, and is therefore not systematically monitored.
– There appears to be a large (but unquantified) domestic market for caviar within the Caspian Sea littoral states. So, international trade bans will prove ineffective for sturgeon populations (Anon. 2001b; Hamilton 2003).
– It has a luxury value in caviar-producing countries and internationally.

The flexible nature of ITQs offers opportunities to incorporate the hatchery issue, but financing for hatcheries will need to be sustainable. Options here might include bolt-on regulations and the use of other economic incentives (EIs).

Harvest rates

For sturgeon and other CITES Appendix II-listed species, total harvest levels are difficult to estimate because of illegal activity (see Box 5.1) and unreported domestic consumption (see Box 5.2). But estimates of the scale of these activities would be valuable for TAC calculation, although both require further research.

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

Understanding the industry is key to ITQ design, particularly its structure, relationships and incentives. Studies of other CITES Appendix II-listed species have shown that understanding industrial structure helps identify *levers* for conservation (MacGregor 2002).

There is evidence to suggest that the structure of the fishery trade chain for Caspian sturgeon is static: fishermen to processor to traders to retailers. But, the scale and significance of industry participation is uncertain. Furthermore, we lack the necessary information to expand this static structure into a dynamic 'model', which could anticipate changes brought about by ITQs (or other interventions).

Socio-economics

Sturgeon are important to local livelihoods. The majority of individual fishermen poaching sturgeon are believed to be poor with few alternative sources of income (see Box 5.3). Revenues from illegal sales of sturgeon form a significant portion of their earnings (Anon. 2001c; Raymakers 2002; Saffron 2002; Novruzov 2004). Furthermore, alleged links with organised crime groups (OCGs) make it difficult to address these complicated rural livelihood

issues. Clearly, EIs will require complementary measures such as rural credit, retraining and provision of extension services, to ensure that alternative livelihood options are available for fishermen.
ITQ allocation that aims to provide equitable benefits will need to take into account the incentives for participants. Potential innovations might be to divide the fishery into large and small vessels, as happens with artisenal fishery systems in many countries, including Chile and Cambodia.

The economic incentives for poor individuals are not easily incorporated into policy. Indeed, there is a *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 prevailing property rights. While ITQ systems can provide a compliant structure for this, understanding the current mix of incentives for these individual fishers is needed to inform and frame the ITQ design.

Box 5.3 Illegal trade and EIs

Although it is impractical to expect detailed data on the scale of illegal activities, an understanding of the *nature* of illegal trade will be crucial to informing design of an ITQ system. There is conflicting anecdotal evidence that before 1991, poaching of sturgeon was both limited (Søyland 2000) and excessive (Moiseev 2002). As the Soviet Union imploded organised crime groups (OCGs) increased (Hendley et al. 1999). They concentrated on a wide range of lucrative and foreign exchange-earning commodity chains, including caviar and sturgeon meat. Today, there is evidence that poaching takes place on a significant scale (Raymakers, 2002). It is often stated that the Russian mafia controls the illegal sturgeon fishery and caviar trade. Yet, there is little accessible literature discussing the mafia or OCGs in relation to sturgeon. Most of it is anecdotal. There is no information about the organisational aspects of these groups. Recent evidence suggests that the authorities were also involved in illegal activities, including assigning quotas to selected businesses (Anon. 2004d).

There are indications that OCGs operating in the former Soviet Union consist of many gangs, which control economic activities in specific locations. Connections and agreements exist between the 'leaders' of these geographical cells (Varese 2000). This neatly fits with global experience with OCG activity, in which OCGs:

- govern an underworld within defined borders;
- become monopoly suppliers of protection services; and,
- become monopoly buyers of certain commodities.

Certain services, such as gambling, money-lending and drug-dealing, are more suited than others to being supplied by a monopoly. The same is true for trade in certain commodities 'produced' by a region – including illegally traded goods, such as sturgeon and caviar. Sturgeon meat and the caviar are probably among several products and services controlled by an OCG.

Designing an EI for a species subject to considerable illegal activity
The success of any EI will often depend on whether the EI mechanism can generate sufficient incentives for the legal industry to begin enforcing itself. For the purposes of designing and implementing conservation-based EIs, it is useful to establish a simple framework for better understanding of the nature of illegal activity. In this way we might begin to understand some of its inherent incentives, and crucially whether and how these require realigning for efficient design and implementation of ITQs.

Activities
We do not know the extent of OCG involvement in any of these activities. But it is likely that an OCG will perform two roles with respect to sturgeon fishing and the caviar trade:
Protection – payment for a range of 'protection' services to the OCG by *legal* fishing companies –

Søyland (2000) estimates that up to one-third of the catch of the legal fishery fleet is unaccounted for in this way.

Sole buyer and sole seller – subcontracting individuals, 'gangs' or even entire village fishing fleets to supply caviar for domestic and international markets. Throughout the supply chain, Bennett (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.

Participants and location

It is unclear precisely who the participants are and whether 'gangs' (Anon. 2003b) or opportunistic individual fishers (Saffron 2002) are the more significant. Anecdotal evidence suggests that sturgeon poaching is devolved and that there are considerable financial incentives for individual fishers to poach.

If the above is true, it is significant because it suggests that illegal activity is not a parallel industry but rather opportunistic and potentially involves *all* individual fishermen. This would mean the *risks* of poaching are devolved to the individual fisherman and/or boat, making enforcement doubly difficult.

It seems clear that post-1991 and particularly post-CITES listing, the illegal trade changed and (potentially) narrowed. Of course, we must maintain the possibility that it is not a slick functioning activity but rather haphazard and random.

5.3 Financing conservation

EIs can generate significant revenue for a government or regulatory authority, which could be used to address equity issues, by:

- providing compensation for those who are unable to participate in the fishery (e.g., by providing re-training and education programmes for alternative employment opportunities);
- explicitly enabling local smaller fishers to participate, by setting-aside ITQs for those fishers (Borregaard et al. 2001), or to communities in general (Farvar 2001) as discussed in the case studies in Section 3.

Revenues from ITQ auctions will be earmarked for monitoring and enforcement costs that will probably be necessary to ensure an effective ITQ programme, as well as new administrative costs.

5.4 Demand for the final products

Demand analysis combined with supply analysis enables policy-makers and EI designers to understand the drivers of the trade. This includes the transmission of price signals throughout the supply chain and the associated risks. It can help forecast the effect of proposed changes or interventions impinging on EIs and conservation.

There are few analyses of the price and demand responses to a listing on CITES Appendices (see Box 4.1). In mature markets in agricultural products, scarcity is often inferred from spot prices. Markets for scarce wild species have peculiar characteristics. Not only is the supply level uncertain, but the nature of demand and its response under different conditions is also unclear.

Caviar is a luxury good and its demand profile is complex, peculiar and irregular (Armstrong et al. 2003):

- Consumer preferences do not obey conventional economic principles. For instance, rising retail prices might lead to increased demand.[18]
- Scarcity is key. Both ownership of distribution channels and supply levels help to explain high prices (Anon., 2004b; Anon., 2004c; Saffron, 2002).
- The demand for caviar by wealthier consumers is not well explained by conventional economic cycles; rather by events and cycles that impact on international travel
- Caviar in a store suggests high-quality merchandise throughout the store. One of the traditional reasons for stocking high-quality caviar is to sell other associated (and often cheaper) products. It is also said to create a reputation for quality for the retailer and generate repeat sales.

There are similarities with other luxury goods.

- Immense value is created along the supply chain; most of this value is attributable to the *brand*.[19]
- The challenge of maintaining *brand integrity* is a key concern.
- Sales are through exclusive retail outlets: boutiques, airports and flagship department stores throughout the world.

5.5 A brief history of demand for caviar from the Caspian Sea

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

- International trade was restricted by the state monopoly to 10 per cent of production to maintain a high price (Saffron 2002).
- This monopoly dealt mainly with a few wholesalers: Petrossian, France; D&H, Germany; Caviar House, Switzerland; Romanoff, USA; and Porimex, Switzerland.
- Wholesalers, in turn, 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 creates incentives for retailer-led cultivation of the *caché* of caviar, and is pivotal to development of an elite retail brand. Added to this are the product perishability, uncertain supply and a lack of access to the final consumers for potential new entrants.

The monopoly collapsed in 1991.

- Supply chain became complicated;
- Supply became more dispersed as new entrants edged into the caviar market

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

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

- Demand became more dispersed ; caviar stores opened in urban America (Saffron 2002).
- Consumers increased and became dispersed, which reduced their role in any effective future conservation solution. This re-emphasised the case for some form of EI at producer level.
- The relatively sudden collapse of the monopoly appears to have caught the larger buyers by surprise (Uldry 2001).

The illegal trade since 1991 is not surprising given the combination of:

- porous borders;
- unemployed fishermen;
- easily caught fish; and
- potential gains by participants from the trade.

Open access replaced the monopoly conditions, and caviar flooded the market. In spite of these changes, 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*. And the market is growing. The U.S. makes up about 80 per cent of the world's beluga caviar market, and imported an estimated $20 million (€20.6 million) of all types of caviar in 2001 (Horvath 2002). Consumers appear willing to pay for the best available quality. Theoretically, if well managed, Caspian Sea littoral states could turn this to their advantage.

Competition

Intra-market competition: Caviar consumers, their locations and their preferences are changing. The caviar industry, its supply chain and associated markets are also changing. Luxury markets are increasingly competitive and the design of an ITQ needs to take account of potential shocks emanating from changes in these markets, such as the risk of a brand or product losing market share to a newcomer.

Substitutes: Competition from other sturgeon, and cross-elasticities of demand between products associated with caviar should be better understood; since caviar is currently produced in a number of countries and substitution across these is possible. While supply from the Caspian Sea is unlikely to increase significantly in the near future, captive-bred sturgeon and non-sturgeon roes could upset the market with exponential growth through aquaculture development.

Ex situ propagation and production of caviar: There is a large and lucrative international trade in fertilised eggs and live specimens between range states and captive breeding centres (Animals Committee 2000; Anon. 2003c; Anon. 2003d). Experience shows captive breeding of wild species has a number of market impacts: greater supply, increased differentiation of and competition among final products, and lower unit prices (see MacGregor 2001, 2002, 2003).

Ranching: Advances in technology are increasing caviar production without the harvesting of sturgeon. This leads to a form of sturgeon ranching *in situ*, where sturgeon have restricted movement and are protected, and their eggs occasionally harvested.

- In Russia scientists have pioneered a safe way of manually extracting caviar without killing the fish, keeping them in pens (Armstrong 2004).
- In Kazakhstan scientists are testing a drug that induces sturgeon to expel eggs without an operation (Bennett 2004).

Competition from other roes: There are a host of other roes from other fish species on the market, some of which have economic interactions with caviar in final consumer markets. Varieties include local specialties from Iceland, Japan (*tobiko*), China (*keluga*) and the United States (whitefish, salmon, trout, lumpfish, and hackleback). There are also more widely available alternatives such as lobster roe, golden black herring roe, anchovy roe, and grey mullet roe. This wide range of qualities and types is said to have affected caviar's consumer acceptance and its caché. But this is not certain.

Conservation campaigns encouraging consumer boycotts of caviar

- The campaign, *Caviar Emptor: Let the Connoisseur Beware*[20] seeks a halt in international trade in beluga caviar as a means of protecting sturgeon, and is urging US consumers to consider domestic caviars as an alternative (Anon 2002e).
- 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 'success' of these campaigns is uncertain, but it is important for their impact to be analysed as this will help increase our understanding of the demand-side factors and particularly consumer preferences. Design of future interventions for conservation that target consumers will be better informed. Understanding these factors in the demand-side of the trade chain will help to forecast trends in attitudes. With better intelligence on the functioning of the trade chain under different conditions, this will in turn relate these trends back to the health of the resource. Specific trends that require better comprehension and monitoring include:

- *Buyer confidence:* Recent environmental campaigns have focused consumers and, more importantly, retail store buyers' attention on sturgeon conservation status. These buyers are increasingly larger corporate entities, anxious to avoid disruption due to their buying policies. While regulation has apparently instilled confidence in caviar products (Lang 1999), this factor warrants closer attention.
- *Buyer identity:* The profile of consumers of luxury goods is changing, particularly in the USA. Demand drivers for luxury goods are increasingly middle market consumers[21], as consumers from diverse socio-economic backgrounds experiment with luxury goods (Silverstein, Fiske and Butman 2003). If this is the case for caviar, are industry profit margins being squeezed?
- *Differentiation of product:* Caviar is appearing in all aspects of the menu, being served as a garnish, an ingredient, and an entrée (Moran 2000).
- *Timing:* Seasonal aspects of the caviar market remain significant, particularly Christmas and New Year celebrations (Moran 2000, 2002; Wolff 2001). However, whereas previously certain consumers would buy caviar in any economic cycle, consumption is becoming increasingly related to world economic cycles (Redmayne 2002).

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

[21] See also Schor (2002); Brooks (2000).

6. Conclusions and policy recommendations

Building on Bulte, Swanson and Van Kooten (2003), this scoping study has explored the potential for, pitfalls of, and ex-ante considerations for one type of economic incentive: an ITQ programme for sturgeon in the Caspian Sea.

Establishing ITQs throughout the Caspian Sea is a considerable challenge: there is currently no international ITQ system for any fishery; crucial information is either missing or incomplete; and wider but related geo-political issues take precedence. Yet, there are many initial conditions that favour ITQ development. Quota auctions are used to allocate quotas for other fisheries, and there is collaboration over other collective natural resources of the Caspian Sea. In addition, international demand for caviar appears sustainable at high prices, indicating large potential gains for all industry participants from the sustainable management of sturgeon. This demand-side characteristic is significant and could provide the economic foundation for a sustainable solution. Under the right conditions, regulation would be the preferred route of the majority of firms associated with the sturgeon resource, and ITQs can provide a suitable regulatory framework.

To enhance conditions for developing an ITQ system that can deliver pro-poor conservation, further clarity is required on:

- *economic questions*, including the nature of the illegal trade, structure of the trade chain, livelihoods issues and consumer preference;
- *biological questions*, specifically the relative significance of the various causes of depletion of sturgeon populations;
- *capacity building requirements* of resource managers, institutions and decision makers.

The findings of this study have broad resonance for other CITES-listed or scarce species, highlighting potential issues and opportunities for EIs. Solutions should build on the positive impacts of trade and use, while aiming to mitigate the costs.

In conclusion, in order to implement an effective ITQ system as an economic incentive to conserve wildlife, the following factors need to be considered.

- ***Integrated approach***: recognising that EIs are not a panacea. Instead, economic information needs to be collected and incorporated within a flexible system that incorporates social, political and biological information and that enables local conditions to be adequately reflected.
- ***Causality***: the variety of causes of wildlife loss need to be considered. In particular, a better understanding is required of the linkages between trade and use patterns, and habitat changes caused by other human activity.
- ***Time***: successful ITQs are the result of learning-by-doing, experimentation and innovation over considerable time periods.
- ***Economic information*** needs to be routinely collected to feed into decision-making, review and analysis.

- ***Resource managers'*** needs must be given due consideration to ensure economic signals are consistent with conservation objectives. Incentives for resource managers are often far from perfect and can generate outcomes that conflict with pro-poor conservation.
- ***Demand-side*** pressures that generate incentives for production need to be understood, particularly the nature of both legal and illegal demand, and the structure of the trade chain.
- ***Domestic support*** from legal, social and political frameworks to is required to encourage resource managers to promote conservation of target wildlife species.

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