Tenure rights and stewardship of marine resources – A co-managed Swedish shrimp fishery in a marine reserve

H. Eggert
Department of Economics, Göteborg University
PO Box 640, SE 405 30 Göteborg, Sweden
Hakan.Eggert@economics.gu.se

M. Ulmestrand
Institute of Marine Research, Swedish Board of Fisheries
PO Box 4, SE 453 21 Lysekil, Sweden
mats.ulmestrand@fiskeriverket.se

1. INTRODUCTION

The problems related to open access marine fisheries lead fishers to avoid responsibilities for ensuring future benefit flows. In fact, theoretically, open-access fishery implies that fishers only care about their own catch today, but completely disregard their potential catch tomorrow and in the more distant future (Clark, 1973). It is sometimes held that wealth or the prospect of wealth leads to over exploitation of resources and that myopic behaviour of fishers is a result of the human nature (Ludwig, Hilborn and Walters, 1993). However, from an economics perspective, the problem is rather that poorly defined property rights lead to perverse economic incentives, which causes excessive effort and short-sightedness (Björndal and Munro, 1998).

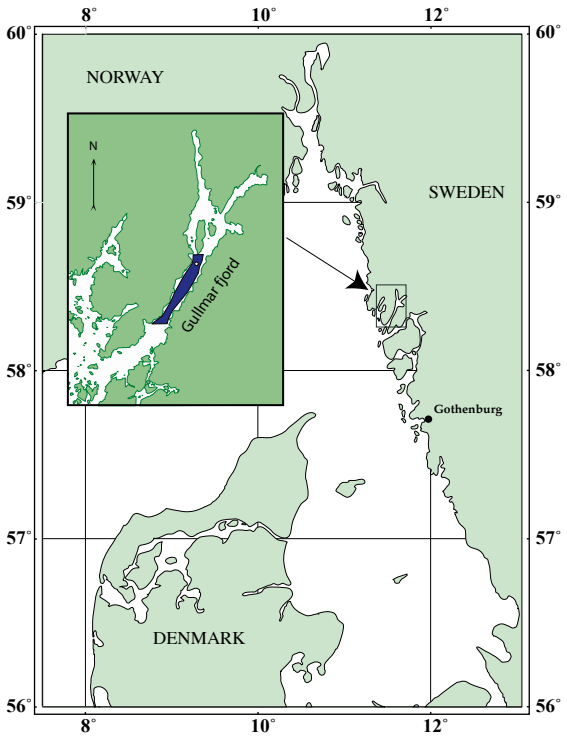
Hence, fishers can be made to behave in a more long-term responsible manner with respect to stocks and landings and the prospect of wealth will foster stewardship and prevent overfishing, given that property rights are improved and fishers are provided with sound incentives. Simply put, fishers should be willing to invest in fish stocks given that they know that there is a fair chance that abstaining from catching a fish today is rewarded in the future. In this study, we report the experiences from a co-managed fishery within the Gullmar Fjord, which is a marine reserve on the Swedish West coast.

2. THE GULLMAR FJORD SHRIMP FISHERY

A fjord is an inlet on the sea that results from marine inundation of a glaciated valley, often with a limited shelf depth at a narrow inlet and greater depths in the upper and middle reaches than on the seaward side. This limits the exchange of deep water within the fjord and the outside sea and provides a unique environment for marine flora and fauna. Hence, from a Swedish perspective the Gullmar Fjord is unique being the only fjord in Sweden (Figure 1).

Northern shrimp (*Pandalus borealis*) trawling in the Gullmar Fjord started in 1902 and three to four boats frequently trawled the fjord until 1960. In 1983, the fjord was made a marine reserve to preserve it as a valuable reference area for marine research. However, limited fishing activities were allowed but by 1990 a ban on trawling was

FIGURE 1
Map of the Gullmar Fjord



introduced in order to study the effects of trawling on the benthic community and on fish species. During 1996–97 a large-scale research experiment of trawling effects was carried out. The results from that project (Lindegarth *et al.*, 2000; Hansson *et al.*, 2000) indicated that trawling had a limited impact on the benthic community and based on these results the management authority, the County of Västra Götaland, decided to re-open the trawl fishery but with new and more strict regulation.

Boats in this fishery are typically small-scale trawlers with a length in the range 8–15 metres (Photo 1), which combine the shrimp trawling with coastal trawling for Norway lobster (*Nephrops norvegicus*). The small vessels benefit particularly from fishing in the fjord during windy conditions when the open sea is accessible only with considerable risk. Thanks to favourable prices, the landings are of value to the vessels concerned. In Table 1 we report aggregated price, landings and fishing effort data of the fishery.

The application fee for a commercial fishing licence is SEK 500, and this licence must be renewed every fifth year at a cost of SEK 300 (SEK 7 ≈ $US 1). The permission to enter a species-specific fishery is free of charge and the same applies for the fishing vessel licence. Indeed, there are no additional licence costs for Swedish fishermen and this applies for the small group of shrimp fishermen described in this study.

3. DEVELOPMENT OF CO-MANAGEMENT IN THE SHRIMP TRAWL FISHERY

In 1999 a new regulation on the requirements for fishing was inacted and the trawl fishery was re-opened. The fishery was opened to any fishers with a size-limited single trawl, minimum mesh size of 35 mm and equipped with a species selection grid (Isaksen *et al.*, 1992; Ulmestrand and Larsson, 2000). To minimize the effect on bottom fauna, a maximum size and weight for the trawl door, i.e. of the size used in the large-scale experiment, was decided upon. The total annual fishing effort was limited to 100

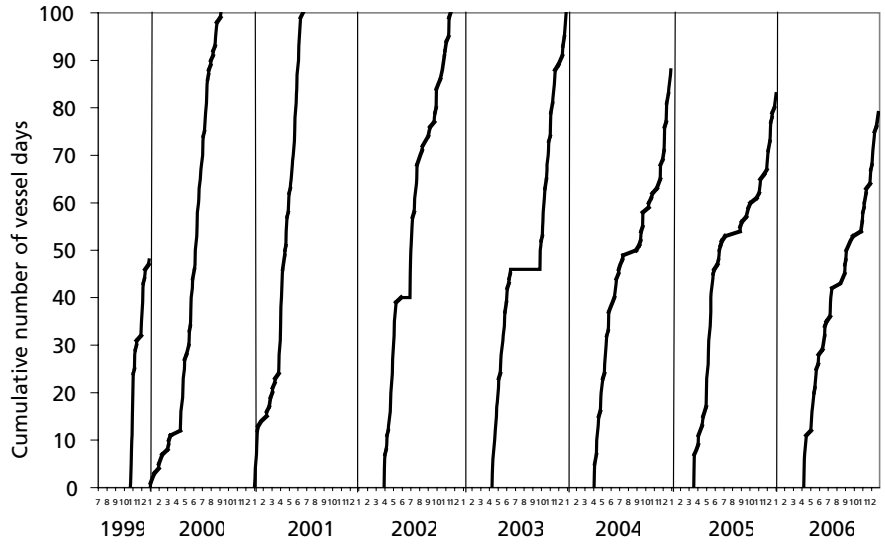
PHOTO 1
Typical shrimp trawler of the Gullmar Fjord Shrimp fishery

LAURA PIRIZ, SWEDISH BOARD OF FISHERIES

TABLE 1
Gullmar Fjord shrimp landings, real value and fishing effort 2000–2006

	Landings (kg)			Discards (kg)	Real price/kg	Fishing effort	
Year	Large	Medium	Small	Large	Medium	Hours	Days
2000	3 358	738	55	100 08	15 03	807	100
2001	5 201	1 252	297	93 27	15 59	998	100
2002	10 518	2 744	2 430	112 82	13 51	789	100
2003	11 953	5 756	473	103 09	13 24	945	100
2004	10 391	2 209	369	100 75	11 76	820	88
2005	5 807	5 355	2925	130 83	11 61	845	76
2006	5 377	3 115	831	137 86	12 09	628	71

FIGURE 2
Annual distribution of the 100 vessel days 1999–2006



vessel-days (as was used in the large-scale experiment) and could be distributed over the year during Mondays to Thursdays each week. Each vessel has to report to the Swedish coast guard when they want to enter the Fjord. Further, the allowed trawl area in the fjord was limited to roughly 30 percent of the total fjord area (Figure 1) to limit the effects in general and to avoid trawl activity close to hard bottoms with known rare and/or sensitive marine fauna in particular.

The first vessels were trawling the area by the end of 1999 and during 2000–2001 the allocation mechanism for vessel days was a "race to catch". As the catch per unit effort (CPUE) by that time was significantly higher in the off-shore shrimp fishery and no price difference between shrimp caught in the two areas existed, the major factor attracting fishers to the Fjord was avoidance of bad weather. In 2000, the 100 days were used by September 6 and during 2001 all days were consumed by June 20, and consequently the fishery shut down for that year. Figure 2 shows the distribution of vessel days for each year during 1999–2006. The "race to fish" in 2001 resulted in both lower price per kilo (Figure 3) and lower CPUE (Figure 4). Individual fishers who were disappointed with the early fishery closure contacted the Institute of Marine Research (IMR), which is the local representative of the Swedish Board of Fisheries. On several such occasions the second author of this article suggested that they should contact other fishers in order to reach an agreement, but the initial reaction to this suggestion was that most often the other fishers were not sensible enough to reach such

FIGURE 3
Annual percentage real price difference between offshore shrimp and Gullmar shrimp

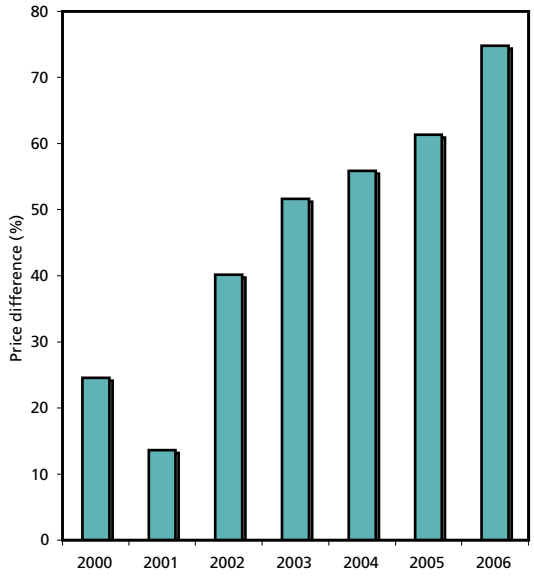
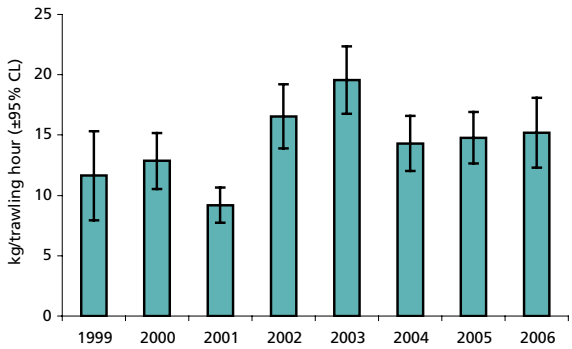


FIGURE 4
Annual average shrimp landing per trawling hour



Error bars represent 95 percent confidence limits.

an agreement. However, later on, the four most frequent trawlers commonly contacted the Institute of Marine Research to get help to reach a voluntary agreement on vessel day distribution, which led to a meeting. The first meeting was held at the end of 2001 and it was agreed that the fishery should open by April in 2002, and that the days should be distributed as 40, 40, and 20 for the second, third, and fourth quartile of the year, respectively. In addition, it was agreed that each vessel should not trawl the area more than twice a week.

In 2002, the five most frequent trawlers in the Fjord asked for a new meeting with the IMR staff, and reached a new voluntary agreement, that stated that the fishery should postpone the opening until 14 April 2003 and use 50 days until June 30, followed by a closure during July–August, and then use the remaining 50 days during September to December. The participating fishers agreed that each fisherman could only trawl the area one day a week. During 2002 eight different vessels had acquired the necessary equipment and tried trawling in the Fjord. Further, a price difference between off-shore shrimp and the Gullmar shrimp, due to superior quality, was established that was on average 34 percent higher for the Gullmar shrimp during 2002. In 2003 the average price difference was 50 percent more, which is likely due to the larger shrimp sizes and better quality of shrimp following the reduction of bycatch thanks to the species selective grid. A simple indicator of shrimp quality is the frequency of straight instead of curly specimens in a batch of cooked shrimp Photo 2 shows on the onboard cooking process. A straight specimen indicates that it was dead when it was thrown into boiling water, while a fresh cooked specimen has a characteristic u-shape indicating a high quality shrimp.

There were still eight trawlers that tried trawling within the area and these two factors led to concern among the most active trawlers and the authority. The first author of this article suggested to the authority that the days could be allocated on an auction basis with a maximum restriction on number of days that each fisherman could buy. This suggestion was ruled out by leading desk officers at the Swedish Board of Fisheries, as it would bear resemblance to Individual Transferable Quotas (ITQs), which at that time was regarded as an unacceptable regulatory instrument both among desk officers at the Board of Fisheries, and among individual fishers (Eggert and Ellegård 2003; Eggert and Martinsson 2004).

Instead of any market based approach, a co-management initiative was encouraged. Until 2002, exclusion of any fisherman was not possible under the prevailing legislation,

PHOTO 2
Shrimps are cooked fresh on board the trawler

but at that time a Governmental proposition on amendments to the *Act of Fisheries* (Anon., 2002) was ratified and it became possible to grant sovereign access rights to the Fjord for a limited number of fishers. Six vessels were granted permits to fish the area from 2004 to 2006 using an application procedure based on historical catches from the fishery. Experience with this system from that period would be evaluated by the end of 2006, followed by a renewed agreement for a three-year period, which in turn implied a high chance of a permanent system of sovereign access and withdrawal rights for the permit holders.

Property rights in economics are often described as a bundle of entitlements defining the owner's rights, privileges and limitations for use of the resource (Tietenberg, 1996). Schlager and Ostrom (1992) refer to five different types of rights relating to property rights listed below and hold that for common-pool resources the two most relevant are access and withdrawal rights.

i) Access: The right to enter a defined physical property.
ii) Withdrawal: The right to obtain the "products" of a resource (e.g. catch fish, appropriated water, etc.).
iii) Management: The right to regulate internal use patterns and transform the resource by making improvements.
iv) Exclusion: the right to determine who will have an access right and how that right may be transferred.
v) Alienation: The right to sell or lease either or both of the above collective-choice rights.

We note that for the standard setting of an ITQ fishery, where the governmental management sets an annual TAC, fishers buy and sell shares of that TAC, all but (iii) are to a large extent fulfilled. In the co-management setting for this particular fishery both exclusion and alienation rights are quite limited. On the other hand, management rights exist in the sense that our group of fishers can regulate internal use and transform the resource by making improvements.

4. EXPERIENCES FROM THE CO-MANAGED SHRIMP FISHERY

Granting the sovereign rights to fish the Fjord for six trawlers, all of them operated by a single crew member most of the time, immediately led to activity to increase the benefits from the fishery. Besides distribution of days over the year, the vessel operators were concerned about the large fraction of small and undersized shrimp in their catches. The Swedish regulations and the market for shrimp basically divide shrimp into three size classes. The largest ones, which we refer to as big shrimp, are big enough to be caught in a 10-mm sieve and earn a price in the range $10–20/kg depending on supply and demand variations over the year. The medium size are retained by a 8-mm sieve, and are sold to processing factories at a stable price of $2/kg. The smallest,

PHOTO 3
Cool end with liner visible

undersized shrimp are less than about 15 mm carapace length, go through 8-mm sieve and are discarded back to sea. All of the fishers used a 38 mm mesh size from the start, which is larger than the mandatory 35 mm, and agreed that the four remaining days in the season after each fished for 16 days would be used to test whether a 45-mm mesh size could be justified. A trawl has a retainment profile which follows an ogive curve. Hence, the larger shrimp the larger probability that it will be retained within the trawl. The net selection of shrimp is far from knife-edge and a substantial fraction of medium-sized and even undersized shrimp are caught, while some big shrimp pass through the mesh. Fishers are often critical about regulatory suggestions to increase the minimum mesh size to avoid capture of small shrimp, believing that they will lose too many mature specimens. Here, they eagerly gave up some of the smaller specimens with the objective of increasing the landings of high-valued larger shrimp caught 6–12 months later, instead of catching them as small low-value individuals.

Changing the mesh size from 38 mm to 45 mm implies a short time reduction of about 5 percent for the most valuable big shrimp. By 2006 all of the trawlers had voluntary converted to 45 mm minimum mesh size in trawl codend and extension piece, while most other Swedish fishers still used 35 mm mesh size in the off-shore shrimp fishery (Photo 3). The effect of the increase in mesh size cannot be determined on the basis of a few years of observation. The average proportion of shrimp sizes in the catch from the Gullmar Fjord, 2000–2006, is 67 percent, 25 percent, and 8 percent for big, medium and undersized, respectively, which is substantially below corresponding figures for the off-shore shrimp fishery. A similar co-management initiative for a shrimp fishery 100 km north of this fishery included 20–25 vessels where no one is excluded from the fishery. It is unclear in this fishery whether the fishers still use a minimum mesh size of 35 mm because of the higher number of fishers or because of open access to the fishery, or a combination of both.

In Sweden, monitoring and enforcement of daily fishing activities are carried out by the Swedish Coast Guard. Each skipper that wants to enter the reserve in the Gullmar Fjord calls the Coast Guard prior to entering the fjord. Random inspections at sea and at landing sites have so far, not reported any violation of the prevailing regulations. Marine researchers from Göteborg University using an underwater robot camera once detected traces of trawl activities outside the prescribed area, but that was before the sovereign rights were granted, and since 2004 no such trespassing has been revealed.

The Swedish offshore shrimp fishery has a long regulatory history. The industry had already agreed upon voluntary weekly quotas for each vessel in the fleet by the 1930s. The rationale was to prevent price decreases due to oversupply and a price insurance scheme was developed linked to this agreement that guarantees a minimum price for large shrimp. These measures also had the long-term result that Swedish shrimp trawlers were small compared to those from Denmark and Norway. Further, Swedish

landings were kept at a low level that was a small fraction of the quota when a TAC was introduced in 1992. Denmark, Norway, and Sweden share the Skagerrak stock, and while the Swedish area is 30 percent of the total Swedish fishers got 19 percent of the shrimp TAC based on historical landings. This has led to a fishery where the national quota never has been binding on Norwegian or Danish fishers, while Swedish fishers have fully used their quota each year during 1992–2005. The current regulation prescribes a 35 mm mesh size and the fishers also use a voluntary landing composition of 50 percent big and 50 percent medium shrimp. Given the price difference between big and medium shrimp, a factor of 5–10 to one, and the constraint on catches of the annual quota, there is a strong incentive to high grade catches for Swedish fishers, while the Danish and the Norwegians lack such incentive. Preliminary studies of length compositions for catches in the three countries 2003–04 indicate that Swedish offshore shrimp fishers discard (hi-grade) roughly 50 percent of their medium-sized shrimp to increase their landings of larger, more valuable, shrimp.

An immediate effect of the agreement on distributing annual effort was that the Gullmar fishers could aim at landing shrimp when prices are high. A positive effect of the larger mesh size combined with a species selective grid is less weight from bycatch and more live specimen when landing. These factors, combined with some marketing efforts to establish recognition of Gullmar shrimp, led to an increasing price difference compared to the shrimp caught offshore. In Figure 4 we show the price difference for Gullmar shrimp and offshore shrimp during 2000–2006, which confirms the finding by Homans and Wilen (2005) that revenue increases are the first improvement from introduction of rights-based fisheries.

As noted earlier, ITQs are still seen with great suspicion by Swedish fishers, Swedish fisheries managers and by managers at the European Union (EU) level. This negative view is probably the result of two major factors. First, the Common Fisheries Policy aims at maintaining communities with little alternative employment, and at the same time was applied to the previous Swedish national fisheries policy. In Sweden, many fishers fear that ITQ holders in remote areas will be tempted to sell their ITQs to fishers in urban areas. Second, there is a general fear of introducing transferability. A recent document on rights-based management (RBM) from the European Commission (EC) states: "The most controversial aspect of RBM systems is the transferability of rights. The reasoning behind the tradability of rights is primarily economic: the efficiency of fishing enterprises improves following the exit of economically weaker vessels from the fleet while the transfer of quotas from less profitable to more profitable vessels introduces a price for using the resource. The introduction of a resource price may lead to large-scale buying of rights, resulting in concentration of ownership of quotas, geographical distribution of fishing activity and fleet composition." (EC, 2007)

This view is pretty much shared by the fishers exploiting the reserve. In 2004 some of the allocated days were not used, and in 2005 and 2006 this trend was even greater. One important explanation for this was that one of the fishers found alternative job opportunities and only used a few, if any, of his allocation of 16 days. When the others realized this, an informal trading started whereby those who wanted to fish paid approximately US$150 a day to the non-fishing fishers who were willing to sell. Notwithstanding the low sum, this shows that transferability was accepted by these fishers and that some resource rent had already been re-established in the fishery. At the same time fishers within the group thought it was unfair that those who did not fish could enjoy additional income just by leasing their fishing days, and this was an important factor why not all days have been traded.

The issue of skipper skill is sometimes discussed in the literature (e.g. Pascoe and Coglan, 2002). The experience from the Gullmar Fjord shrimp trawling provides overwhelming evidence supporting the existence of skipper skill, where the best performing fisherman clearly stand out as highliners with an average daily income

of US$2 000 during 2002–2006, while the average daily income for the other fishers is about US$1 000 for the same period. Hence, in case the days were transferable we would expect this highliner to lease/buy a substantial amount of the fishing days from the other fishers.

5. DISCUSSION

The experiences from the co-management of the Gullmar Fjord trawl shrimp fishery indicate that the small number of fishers that gained rights to a fishing area in terms of access and withdrawal immediately adopted a longer-term perspective: These fishers proved willing to give up short term catches in order to increase long-term catches.

The rights granted to these fishers also included a substantial amount of influence over the management of the resource. The informal meetings between the fishers lead to negotiations whereby agreements on how to allocate days between individuals were reached quite rapidly. Days with expected high demand for shrimp were targeted and the fishers divided days between themselves in order to avoid congestion and get maximum returns. This led to dramatic improvements in price paid per kilogram of shrimp and increased revenues, just as predicted for the introduction of a rights-based fishery (Homans and Wilen, 2005). The meetings between the fishers did not only end the race to fish, distributing the fishing effort evenly over the year, but also meant that some fishers did not use all of their days. The daily comparison between the shrimp fishery and the coastal Norway lobster fishery was in favour of the lobster fishery to a large extent and so the total impact on the marine reserve for these years was below the target limit resulting from 100 days of fishing. Hence, the fishers could compensate themselves with equally rewarding fishery outside the reserve, which implies that eliminating the race to fishing days also entailed welfare improvements in terms of sustainability.

The rights granted to the fishers have been quite limited in terms of exclusivity and transferability. The fishers cannot formally transfer their fishing rights, nor can they expect any payment for abstaining from their rights, and in practice they have limited possibilities to influence who can and cannot fish. However, an informal practice of leasing days between fishers has partly evolved, where some of the non-fished days of one fisherman have been bought from one or two of the other fishers.

While the project appears successful in terms of conservation and sustainability, it is less clear how potentially necessary future reductions in harvest can be handled by the co-management agreement. During 2006, one fisherman left and the remaining fishers argued in favour of keeping the exploitation rate at 100 days, or even increasing it. Given the short time series of the biological data and the uncertainty concerning shrimp abundance, little can be said in favour of increasing, or decreasing, the exploitation rate. The fisherman who left did so because of the existence of attractive alternative employment opportunities, i.e. there were high opportunity costs to fishing. Increasing opportunity cost is probably the most important factor in the structural adjustment process of Swedish fisheries over the last 40 years. In terms of numbers, Swedish commercial fishers have been reduced by almost 90 percent since 1960, from 16 000 to less than 2 000, while the real GDP per capita income for Swedes has increased from US$11 000 to almost US$30 000 in 2000 (Eggert and Tveterås, 2007).

The project implies major improvements in efficiency since 2001. Still, efficiency is not an explicit objective of the CFP. The rights of exclusion and alienation are severely limited in the current regime. A fisherman who exits the fishery does not receive any reward for improving the status of the stock or vice versa. This may provide a distorted incentive during the last period prior exiting the fishery. The absence of an institutionalized right to sell or lease the right to fish clearly hampers efficiency development. The two best performing fishers can, according to their record, increase the aggregate landing value substantially and that could be done using less than the

allocated 100 days, which would guarantee less impact on the benthic community. Rendering possible such a reform would be strictly welfare improving, given that the other fishers can find alternative employment. The Swedish unemployment rate is below 6 percent and the same applies for the region where the fishers live, but those concerned still want to continue as fishers. This issue reflects the current perception of the new CFP among desk officers and commercial fishers. The new CFP should aim at supporting small-scale coastal fisheries, but the number of small-scale fishers is rapidly decreasing in Sweden and in other European countries. There is a concern that there exists a critical threshold level of fishers in remote areas, when the number of fishers becomes too low to support the land-based activities needed for the fishery to survive. If they cease operations, all commercial fisheries in the area ends. The current management regime, where five fishers are supported to stay in business is in this sense preferable to only two fishers that achieve full efficiency.

A general finding in economics is that a beneficial aspect of improved property rights is that, e.g. a farmer can use his land as collateral. This facilitates more investment and more efficient exploitation of the resource thanks to the possibility of taking a mortgage (Besley, 1995). A fully implemented ITQ system would imply that the ITQ holders could borrow money from the bank with the ITQs as security and improve the technical level of their vessels, but that would come at the expense of less employment opportunities among fishers. Swedish fisheries management has so far been reluctant to use ITQs. The general concern is that ITQs would lead to concentration and large-scale vessels with the loss of the cultural heritage of small-scale coastal fishing. In addition, the idea that an individual can buy or sell the right to fish and even earn money on increasing value for such fishing rights is often seen as unfair. During 2007 the Swedish pelagic fishery will introduce an ITQ system with several constraints aiming at controlling potential negative side effects of the system. Demersal fishing in Sweden remains within the realm of regulated open-access management (Homans and Wilen, 1997). Meanwhile, the co-management experiment with the Gullmar Fjord shrimp fishery provides a good example of how fishers can be induced to change their perspective to a longer term perspective when property rights are improved in a fishery.

6. ACKNOWLEDGEMENT

This work was sponsored by the Swedish Board of Fisheries. Financial support from the Swedish International Development Agency to the Environmental Economics Unit at Göteborg University is acknowledged. The views expressed in this article are those of the authors alone and do not necessarily reflect those of the Swedish Board of Fisheries.

7. REFERENCES

Besley, T. 1995. Property rights and investment incentives: theory and evidence from Ghana. *Journal of Political Economy*, 103(5): 903–937.

Björndal, T. & Munro, G.R. 1998/1999. The economics of fisheries management: a survey. *In* H. Folmer & T. Tietenberg, eds. *The international yearbook of environmental and resource economics: 1998/1999*, pp. 153–188. Cheltenham, UK, Elgar.

Clark, C.W. 1973. The economics of overexploitation. *Science* ,181: 630–634.

Eggert, H. & Ellegård, A. 2003 Fishery control and regulation compliance. A case for co-management in Swedish commercial fisheries. *Marine Policy,* 27(6): 525–533.

Eggert, H. & Martinsson, P. 2004. Are commercial fishers risk lovers? *Land Economics,* 80(4): 550–560.

Eggert, H. & Tveterås, R. 2007. *Productivity development in Icelandic, Norwegian and Swedish fisheries.* Paper presented at the XVIIIth Annual EAFE Conference, 9–11 July 2007, Reykjavik.

European Commission. 2007. *Communication from the Commission on rights-based management tools in fisheries {SEC(2007) 247}*. Commission of the European Communities.

European Commission. 2007. 2002 *Reform of the CFP* (available at http://ec.europa.eu/fisheries/cfp/2002_reform_en.htm).

European Commission. 2005. *Green Paper on the future of the Common Fisheries Policy*. Vol. I and II (available at http://ec.europa.eu/fisheries/publications/reform/green_paper_en.htm).

Homans, F.R., & Wilen, J.E. 2005.Markets and rent dissipation in regulated open access fisheries. *Journal of Environmental Economics and Management*, 49(2): 381–404.

Homans, F.R., & Wilen, J.E. 1997. A model of regulated open access resource use. *Journal of Environmental Economics and Management*, 32: 1–21.

Isaksen, B., Waldemarsen, J.W. Larsen, R.B. & Karlsen, L. 1992. Reduction of fish by-catch in shrimp trawl using a rigid separator grid in the aft belly. *Fisheries Research*, 13: 335–352.

Ludwig, D.R. Hilborn, & Walters, C. 1993. Uncertainty, resource exploitation, and conservation: lessons from history. *Science*, 260(2 April): 17–36.

Lindegarth, M., Valentinsson, D., Hansson, M. & Ulmestrand, M. 2000. Effects of trawl disturbances on temporal and spatial structure of benthic soft-sediment assemblages in Gullmarsfjorden, Sweden. *ICES Journal of Marine Science*, 57: 1369–1376.

Pascoe, S. & Coglan, L. 2002. The contribution of unmeasurable inputs to fisheries production: an analysis of technical efficiency of fishing vessels in the English Channel *American Journal of Agricultural Economics*, 84(3): 585–597.

Schlager, E. & Ostrom, E. 1992. Property-rights regimes and natural resources: a conceptual analysis. *Land Economics*, 68(3): 249–262.

Tietenberg, T.H. 1996. *Environmental and natural resource economics*. 4th ed. New York, NY, Harper Collins College Publishers.