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**Best Practice in the Use of
Rights-based Management
to Reduce Discards in
Mixed Fisheries**

IN-DEPTH ANALYSIS





DIRECTORATE-GENERAL FOR INTERNAL POLICIES
POLICY DEPARTMENT B: STRUCTURAL AND COHESION POLICIES

FISHERIES

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Management to Reduce Discards in
Mixed Fisheries**

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This document was requested by the European Parliament's on Committee on Fisheries.

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DIRECTORATE-GENERAL FOR INTERNAL POLICIES
POLICY DEPARTMENT B: STRUCTURAL AND COHESION POLICIES

FISHERIES

Best Practice in the Use of Rights-based Management to Reduce Discards in Mixed Fisheries

IN-DEPTH ANALYSIS

Abstract

Rights-based fisheries management systems alter the incentives for discarding and harvesting selectivity compared to the alternatives. Nations that have adopted individual transferable quotas (ITQs) in their fisheries generally have comparatively low discard rates. This is partly due to the attributes of the ITQ system and partly due to clever methods adopted by these nations in order to reduce discards in their fisheries.

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LIST OF ABBREVIATIONS

- EEZ** Exclusive economic zone
- ITQs** Individual transferable quotas
- IQs** Individual quotas
- MCS** Monitoring, control and surveillance
- MRI** Icelandic Marine Research Institute
- NA** Not available
- RB** Right-based
- RBF** Rights-based fisheries
- RBFM** Rights-based fisheries management
- RBM** Rights-based management
- TAC** Total allowable catch
- TOR** Terms of reference

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EXECUTIVE SUMMARY

- Considerable albeit incomplete theoretical and empirical knowledge on the discarding of catch it is available. This inventory of knowledge suggests inter alia certain effective measures to reduce discards in various types of fisheries.
- Discarding of catch is an activity undertaken by fishers to maximize their benefits.
- It follows that to reduce discards it is necessary to alter the incentives facing the fisher.
- Discarding can be reduced by three ways; (i) increase harvesting selectivity and thus reduce unwanted catch that might be discarded, (ii) increase the cost of discarding fish and thus discourage discards (iii) increase the net value of retaining fish that would otherwise be discarded and thus encourage retention.
- There are many ways to increase harvesting selectivity including fishing gear restrictions, time-area restrictions and supports for the development of more selective fishing gear.
- Harvesting selectivity and catch discarding are substitute activities. If harvesting selectivity is increased, the volume of fish discarded is reduced and vice versa.
- One way to increase the cost of discards is to strengthen the enforcement of non-discarding rules. This can be done by increased enforcement effort and higher penalties for infractions or both.
- Only economically inferior catch is discarded. Therefore, if the value of retaining catch is adequately increased it will not be discarded.
- In fisheries based on individual catch rights such as IQ/ITQs there are both added incentives to discard catch and to engage in more selective fishing.
- To counter the added incentives to discard it is helpful to:
 - Make quotas as easily transferable as possible
 - Allow some flexibility in the individual quota constraint
 - Define to the extent possible quotas by grades of fish
- Five countries employing IQ/ITQ-based management systems were studied; Iceland, Namibia, New Zealand, Norway and the USA.
- All five countries have imposed discarding restrictions. Iceland and Norway have a virtually complete discarding ban. Namibia and New-Zealand ban the discarding of quota-managed species. The USA only bans discarding of some species.
- All enforce their discard-bans by multiple means.
 - All use on-board observers but to a very different extent. Namibia and the USA have a very high on-board observer coverage (80% or higher) in their fisheries. The other three countries have very low on-board observer coverage (5% or less).
 - Iceland and New Zealand have built considerable flexibilities into their ITQ systems to reduce ITQ-generated incentives for discarding.
 - Iceland, Norway and to a certain extent New Zealand rely primarily on indirect evidence of discarding by e.g. comparing catch distributions of vessels with and without observers.
 - Iceland has conducted an awareness campaign to discourage discarding.
 - None of the countries relies on VMS or video evidence to monitor discards.

- All five countries have imposed relatively heavy penalties for illegal discarding. However, it is not clear to what extent these penalties are actually applied.
- Only in Iceland are there reliable time series estimates of the levels of discards. According to these estimates discards are low (under 3% of landed volumes) and have been falling over time. Discards seem to be higher in the other countries but still comparatively low (i.e. well under 10%)
- In none of the countries is discarding now seen to be a major or even a significant problem although it was perceived so in the past. It appears that with time, probably partly due to the measures taken, discards have been reduced
- The study suggests a set of recommendations for reducing discards in IQ/ITQ-managed fisheries
 1. Quotas should be tradable and trading as easy as possible.
 2. The quota constraint should have a degree of flexibility.
 - a. Possibility to exceed the quota constraint to a certain (relatively small) extent against a corresponding reduction in next year's quota.
 - b. Possibility to move some unused quota to next year.
 - c. Possibility to move quotas between species to some extent.
 - d. Possibility to land unwanted fish without quota subtraction provided the fishing firm cannot gain by this.
 3. There should be sufficiently strong enforcement of the discarding restrictions.
 4. Enforcement of discarding restrictions should be economical
 - a. It should rely to the extent possible on heavy penalties, law burden of proof and comparatively little monitoring.
 5. Awareness/information campaign may be undertaken, preferably in co-operation with industry, in order to instil anti-discarding sentiments.
 6. Increased harvesting selectivity should be promoted by
 - a. Judicious imposition of area-time-gear-fishery restrictions.
 - b. Promotion of the use of fish selectors.
 - c. Promotion of the development of more selective fishing gear and techniques.
 - d. Various other supports for increased selectivity.
 7. No two fisheries are identical. Therefore, the various measures to reduce discarding should be selected and applied with due regard for the specifics of the fishery in question.
 8. The various measures selected to reduce discarding must be cost effective. Therefore, a proper cost-benefit study be conducted in each case.

1. INTRODUCTION

This report is concerned with best practices in dealing with discards of catch in fisheries managed by rights-based methods (RBM). It reviews a collection of methods for reducing discards and attempts to assess their efficacy in reducing discards. The methods reviewed are partly those that have actually been used in real rights-based fisheries (RBF) and partly those suggested by theory.

Discarding is dumping of unwanted catch back into the ocean (or water body) from where it was harvested. Unwanted catch is always the result of imperfect harvesting selectivity. Therefore, the amount of discarding is strongly related to harvesting selectivity; the greater the latter, the smaller the former, everything else being the same. Catch discarding and harvesting selectivity thus exhibit a strong inverse relationship. For this reason, this report will to a certain extent deal with selectivity although this is not required by the TOR.

Since discarding is generally not costless, fishers generally have some incentive to employ selective fishing methods. This, however, is also costly. Therefore, it may be taken for granted that fishers always attempt to strike the most favourable balance, from their perspective, between selectivity and discarding. Of course it is usually not known beforehand exactly what harvests the fishing gear will yield. Therefore, the balance is in terms of expected results. Actual discarding will adjust to actually realized harvests.

If discarding is subject to regulatory restrictions or bans, engaging in discarding generally entails the corresponding additional costs. This tilts the a priori balance between selectivity and discarding toward more selectivity and encourages the retention of some fish that would otherwise have been discarded. The size of this impact, however, depends on the nature and enforcement of the discarding restrictions. With perfect enforcement of a discard ban, there will be no discards. Conversely, a discard ban with no enforcement will have a comparatively small, possibly negligible impact on the volume of fish discarded. Thus, the volume of discards is also closely related to both discarding regulations as well as their enforcement.

2. THEORETICAL FINDINGS

KEY FINDINGS

- Discarding of catch is an activity undertaken by the fisher to maximize his benefits. It follows that to reduce discards it is necessary to alter the incentives facing the fisher.
- Harvesting selectivity and catch discarding are substitutes.
- One way to reduce discarding is to improve harvesting selectivity.
- In rights-based fisheries based on individual catch constraints, such as IQ/ITQs, there are both added incentives to discard catch and to engage in more selective fishing methods.
- To counter the added incentive to discard it is helpful to:
 - Make quotas as easily transferable as possible
 - Build some flexibility into the quota constraint

This can be done in several ways including permissions to:

 - Transfer some fraction of quotas between species
 - Move some quota use between fishing years
 - Forfeit unwanted catch to the authorities without it being counted against quota.
 - Have quotas by grades of fish

Discarding catch is a human behaviour determined by behavioural laws. The elements of the relevant theory were developed in the mid-1990s (see e.g. Anderson 1994, Arnason 1994 and 1995, Boyce 1996, Turner 1997) and summarized in Pasco 1997. Since then, theoretical progress has primarily been in terms of extending the basic theory to a more complicated setting and adapting it to special cases (see e.g. Ward et al. 2012). Nevertheless, in the opinion of this writer, the theory is underdeveloped and in need of further improvements.

In spite of its limitations, the existing theory contains many important findings which throw considerable light on, among other things, the practical question of which methods are likely to reduce discarding and which are not. The theory is somewhat technical and not easily accessible to the layman. Fortunately, however, most of the key practical results can be stated in a reasonably non-technical way and are, moreover, reasonably intuitive.

In what follows a summary of the most pertinent results from the perspective of this work will be presented. The analytical basis for the results can be found in the above references:

1. Some discarding of catch may be socially optimal. This happens when the social costs of retaining the catch exceed the social benefits.
2. It follows from 1. that an absolute discard ban is not necessarily socially optimal. This holds a fortiori when imposing the discard ban is in itself costly e.g. because of enforcement costs.

3. Discarding of catch is undertaken by fishers to maximize their net benefits which are usually profits (or net income).
4. These net benefits do not normally coincide with true social net benefits. There are primarily two main reasons for this:
 - a. The fisher acts with respect to distorted signals (often, but not always, distorted prices) which are for instance generated by fisheries management controls.
 - b. Discarding has an external effect on other stakeholders (e.g. via the ecosystem, data generation etc.).
5. It follows that the discarding of catch undertaken by fishers is normally not socially optimal.
6. Discarding of any given catch is encouraged by low price of landed catch, high landings costs, high on-board processing and handling costs, low cost of discarding and limited vessel capacity.
7. The cost of discarding to the fisher includes (i) the physical work of dumping the fish, (ii) the expected penalty of the act when discarding is illegal and (iii) an imputed cost that stems from (a) any negative stock and ecosystem consequences, (b) loss of reputation and (c) the feeling of having done something unethical.
8. Harvesting selectivity and discarding of catch are substitute activities. The higher the former, the lower the latter and vice versa. This is because inferior fish (in terms of landing price, landing costs etc.) is discarded. If there are fewer such fish because of harvesting selectivity, the volume of discards is obviously reduced.
9. Harvesting selectivity is encouraged by anything that discourages discarding of unwanted fish (such as high cost of discarding) as well as low cost of engaging in harvesting selectivity.
10. The cost of increased harvesting selectivity typically involves (i) equipment investment costs, (ii) crew training costs, (iii) the cost of modified fishing methods, (iv) the cost of reduced harvest of wanted fish etc.
11. It follows from the above, that the volume of illegal discarding out of a given volume of catch can be reduced by:
 - a. Increasing the landed price of fish that would otherwise be discarded.
 - b. Reducing landing costs of fish that would otherwise be discarded.
 - c. Reducing on-board processing and handling costs.
 - d. Increasing the costs of discarding, e.g. by increasing the expected penalty of discarding. This may be done by:
 - i. Increased enforcement effort (monitoring etc.).
 - ii. Increased penalties for discarding violations.
 - iii. Less legal requirements for establishing that discarding violations occurred.
 - iv. Increasing the social stigma for discarding.
 - e. Providing crew members (not fishing companies) with sufficient incentives to retain catch that would otherwise be discarded. This exploits the separation between vessel owners and crew members which is stronger on large vessels.

- f. Encouraging harvesting selectivity. This may be done in many ways:
 - i. Support the adoption of selective fishing methods.
 - ii. Support the installation of more selective fishing gear.
 - iii. Support the development of more selective fishing gear and of fish selectors specifically.
 - iv. Impose time-area-gear restrictions that promote more selective fishing. For instance, close fishing grounds when they have high density of small fish etc.
 - v. Penalize the use of nonselective harvesting methods. This can be done in many ways some of which may be taxes or other surcharges on the use of non-selective gear.
12. Note that there are many other ways to influence the main determinants of discarding and hence the volume of discarding.
13. Many fisheries management systems alter the incentives for discarding and selectivity. This is because the constraints or other features involved in these fisheries management systems alter the costs and benefits of discarding and selectivity as seen by the fishers.
14. In open access fisheries or fisheries managed by total allowable catches (TACs) implemented by closures once the TAC is reached, the incentives for harvesting selectivity are usually reduced. This is because harvesting selectivity typically reduces the volume of wanted catch obtainable over a given period of time, thus representing a disincentive for using selective fishing methods. This leads to a corresponding increase in discarding as more unwanted fish is caught (along with more wanted fish).
15. In fisheries where fishers hold individual harvesting rights, such as IQs and ITQs, there is normally an added incentive for discarding catch. This is because with the individual harvesting volume fixed, profits can be increased by increasing the value of this fixed volume. One way to do this is to land only the most valuable fish or, more precisely, the fish that when landed covers the cost of reduced quota. In other words; the individual quota constraint is equivalent to a lower net price of fish (or increased landings costs). Clearly this extra cost is particularly relevant in fisheries with many grades of fish (e.g. large and small) and multi-species fisheries where one quota constraint becomes binding before the others.
16. In ITQ fisheries, i.e. tradable quota fisheries, this extra cost of not discarding is represented exactly by the rental price of quota.
17. In IQ fisheries, i.e. non-tradable quota fisheries this extra cost is the shadow value (imputed price) of running out of quota calculated by the fisher.
18. In ITQ fisheries, individual fishers are really only constrained by the overall TAC for they can purchase (or sell) quotas as long as the TAC has not been reached. Thus, the imputed quota price is generally lower in ITQ fisheries than it is in IQ fisheries.
19. It immediately follows that the incentive to discard catch is greater in IQ fisheries than in ITQ fisheries.
20. It is important to realize that the added incentive for discarding under IQ/ITQ fisheries due to the quota price disappears, if the quotas are by grades (e.g. sizes) of fish, i.e., there is one TAC for each grade of fish. However, this is usually not practical.

21. While, there is a greater incentive to discard catch in IQ/ITQ fisheries compared to open access and TAC restricted fisheries, there is also a greater incentive for catch selectivity in IQ/ITQ fisheries. The reason is that with a fixed quantity of harvest, it pays to avoid catch that has to be discarded. As a result, in IQ/ITQ fisheries, there will be less unwanted catch to discard.
22. From these opposing forces, it follows that under IQ/ITQs discarding may either increase or decrease compared to the alternative of open access or TAC restricted fishery.
23. Measures to reduce discards lead to costs for both the fishing firms, which have to adjust to the new measures, and the fisheries authorities, which have to design and enforce the discarding regulations usually at considerable costs. Thus any benefits from reduced discards have to be compared to these costs in order to determine the net benefits.
24. If only because the cost of enforcing discarding restrictions the optimal level of discarding would normally not be zero.
25. It may not be very practical to attempt to enforce a nonzero optimal level of discards.

3. DISCARDING IN COUNTRIES EMPLOYING RIGHTS-BASED MANAGEMENT SYSTEMS

KEY FINDINGS

- Five countries employing rights-based management systems were studied; Iceland, Namibia, New Zealand, Norway and the USA.
- All five countries have imposed discarding restrictions. Iceland and Norway have a virtually complete discarding ban. Namibia and New-Zealand ban the discarding of quota-managed species. The USA only bans discarding of some species.
- All enforce their discard-bans by multiple means.
 - All use on-board observers but to a very different extent. Namibia and the USA have a very high on-board observer coverage (80% or higher) in their fisheries. The other three countries have very low on-board observer coverage (5% or less).
 - Iceland and New Zealand have built considerable flexibilities into their ITQ systems to reduce ITQ-generated incentives for discarding.
 - Iceland, Norway and to a certain extent New Zealand rely primarily on indirect evidence of discarding by e.g. comparing catch distributions of vessels with and without observers.
 - Iceland has conducted an awareness campaign to discourage discarding.
 - None of the countries relies on VMS or video evidence to monitor discards.
 - All five countries have imposed relatively heavy penalties for illegal discarding. However, it is not clear to what extent these penalties are actually applied.
- Levels of discards
 - Only in Iceland are there relatively reliable time series estimates of the levels of discards. According to these estimates discards are low (under 3% of landed volumes) and have been falling over time.
 - The patchy evidence from other countries suggests somewhat higher discards although not substantial ones (i.e. they seem to be under 10% of landed volumes).
- Success/failure
 - In none of the countries surveyed is discarding now seen to be a major or even a significant problem although it was perceived so in the past. It appears that with time, probably partly due to the measures taken, discards have been reduced.

A large number of fishing nations has introduced RBM in their fisheries (Arnason 2013). Some of these countries have also imposed restrictions or bans on catch discarding in their fisheries. The following gives an account of how five of these countries, namely Iceland, Namibia, Norway, New Zealand and the United States, have dealt with discards in the operation of their RB fisheries management systems.

3.1. Iceland

The Icelandic fisheries may be divided into two separable components; (i) the pelagic fisheries which tend to be single species, homogenous catch fisheries with very little incentives for and negligible discarding and (ii) demersal fisheries which are generally mixed species fisheries with quite heterogeneous catch with respect to size and quality and a considerable incentive for discarding. Since discards in the pelagic fisheries are believed to be negligible, the following will primarily consider the demersal fisheries.

3.1.1. Discards in the demersal fisheries

The demersal fisheries are the mainstay of the Icelandic fisheries with over 80% of the value of landings compared to under 20% for the pelagic fisheries. The demersal fisheries are a mixed species, mixed gear fisheries. There are about 30 demersal species of commercial significance the most important of which are cod, haddock, saithe, redfish and turbot. The main fishing gear are bottom trawl, mid-water trawl, gillnets and long-line. The first, bottom trawl is often associated with high levels of discards around the world. The fishery has produced high rates of catch during the last 100 years or more – recent catches have between 400 and 500 thousand metric tonnes annually. Comparable fisheries, in terms of fishing gear and catch composition, are found in a number fishing areas within the EU community, e.g., in the North Sea and the Irish Sea.

Discarding of catch has historically been a feature of the Icelandic demersal fisheries. Most of this discarding has been of species and fish sizes of market value insufficient to cover the expenses of landing the catch. Occasionally discarding of valuable catch occurred because of vessel capacity limitations.

With the progress of fisheries management in Iceland from 1970 onward, various measures were undertaken to reduce the harvest of undesired catch and thus discards. These methods initially consisted of mesh-size regulations and time-area closures to reduce the catch of small fish which tended to be discarded. These methods probably had some impacts, but apparently high levels of discarding continued. In 1976 a ban on discarding the most important demersal species was introduced. This ban, however, was not strictly enforced.

Following the introduction of the ITQ system in the demersal fisheries in 1984, a new type of discarding was observed. This was the discarding of valuable fish for the purpose of maximizing the net value of the ITQs held by fishers. In order to reduce that kind of discarding, measures allowing the landing of undersized fish without being fully counted against quota were introduced with apparently some effects.

A complete ban on fish discarding at sea was introduced in Icelandic fisheries in 1996. This discard ban covered all commercial fisheries and all species of fish including pelagic species.

Discards of Cod and Haddock in the Icelandic Demersal Trawl Fishery

Since the early 1990s, the Icelandic Marine Research Institute, has put great effort into estimating the volume of discards in the Icelandic fisheries. Several methods have been used for this purpose. The one regarded as most reliable is to compare the size distribution of landings from vessels with no observers with the size distribution of catches by vessels fishing in the same area at the same time but with observers on board. The difference is assumed to represent discards by the former group.

The following table contains estimates of discards of cod and haddock in the Icelandic demersal trawl fishery by volume (metric tonnes) and as a proportion (%) of landings in the respective fishery. These estimates are based on data collected by the Marine Research Institute and the Fisheries Directorate.

Table 1: Iceland: Estimates of discards in cod and haddock fisheries (Percent of landed weight. Estimates before 2001 are less reliable).

Year	Cod, % of weight	Haddock, % of weight
1982	3.5	NA
.	.	.
1987	4.5	NA
1988	NA	3.8
1989	NA	3.4
1990	NA	0.8
1991	NA	9.7
1992	NA	13.3
1993	NA	8.0
1994	NA	10.7
1995	NA	19.6
1996	NA	11.6
1997	NA	22.3
1998	NA	10.3
1999	NA	5.2
2000	NA	8.4
2001	2.4	1.0
2002	0.8	1.6
2003	0.2	4.8
2004	0.8	1.8
2005	1.1	3.8
2006	0.9	1.9
2007	1.4	1.4
2008	0.5	1.2
2009	0.4	1.6
2010	0.4	1.1
Average 2001-10	0.9	2.0

Sources: Pálsson et. al 2012, European commission 2007

According to table 1, discard ratios for cod and haddock are not great. Even long before the discard ban in 1996 and the associated measures to reduce discards, discards of cod seem to have been quite modest, perhaps 3-5% of the landed volume. After 2000, discards of cod have hovered around 1% which must be regarded as small. Discards of haddock have been larger. This seems to be partly due to the fact that small and large herring are often mingled on the same grounds. Partly this seems to be caused by the comparatively greater use of indiscriminate fishing gear in the haddock fishery, namely small bottom trawl and Danish seine. Discards of herring were very high in 1992-1998, around 15% on average. Since then they have fallen drastically being only 2% on average between 2001 and 2010. For both species there is a strong and statically significant declining trend in discarding ratios.

Discards of other demersal species are thought to be much less or non-existent and have not been systematically collected. Some species of flatfish which are often caught by

Danish seine and for which there is a significant incentive to discard small individuals, may be an exception to this rule.

3.1.2. Measures to reduce discards

Imperfect catch selectivity and discarding of unwanted fish has been of concern to the Icelandic fisheries management authorities for many decades prompting them to undertake various measures to increase selectivity and reduce discarding. Before the advent of the ITQ system, these measures were mainly direct restrictions (i.e, commands and controls). Under the ITQ system, various additional measures of the incentive modifying type have been adopted.

Direct restrictions

The most important direct restrictions are:

(1) Fishing gear restrictions

These consist of:

- (i) Minimum (and sometimes maximum) mesh sizes
- (ii) Bans on the use of certain types of fishing gear, sometimes only in certain areas and times
- (iii) The requirement to fit the fishing gear with fish selectors in certain fisheries (shrimp)

(2) Time-area-gear closures

These are of various types. Sometimes they only apply to certain fishing gears.

- (i) Long term area closures (lasting years)
- (ii) Short term area closures (e.g. seasonal)
- (iii) Temporary area closures (These are immediately imposed based on observed small fish catches. They last only for a week at a time, usually covering small areas, often a few km²).

(3) Bans on landing undersized fish

Minimum landing sizes have been imposed on many species. The intention is to reduce the harvest of small fish, but will obviously increase discards.

(4) Discard bans

Bans on discards of certain species have been in effect for a considerable time. A general ban on discarding of catch was imposed in 1996 as already mentioned.

Incentive modifying measures

In the 1990s it was recognized that the ITQ system had certain built-in incentives for catch discarding (Arnason 1994, Anderson 1994). These incentives are basically of two kinds: First fishers do not want to land fish whose market value is less than the price of the quota. Second, in a multispecies fishery, it is difficult for the fisher to fill his quotas for different species simultaneously generating an incentive to discard species for which he had no more quota (see other parts of this report). With transferable quotas and well-functioning quota market, the second incentive, obviously, is the same as the first. However, with limited quota tradability, it may be seen as being separate incentive.

To counter this, the following measures were introduced at various times.

(1) Tradability of quotas

Quota trading was made easier. Thus, trading of permanent quota-shares was explicitly allowed and special trading exchange was set up and operated for some years.

(2) **Landing undersized fish outside of quota**

Landing of undersized fish of certain species was allowed at no cost or benefit to the fishing operation. This meant that the quantity of fish in question was basically forfeited to the fisheries authorities. They paid for the cost of landing and a small amount to the crew for handling of the catch and the quantity landed was not subtracted from the vessels' quota. The idea was to give the vessel owner no incentive to either target or discard undersized catch and give the crew a small incentive to retain it keep it.

(3) **Transfer between species**

Quota-holders are allowed to move some of change some of their quotas in one species to quotas in other species. The percentages in question were not high (3-5%) and some species restrictions applied. The rationale of this measure is to make the quota constraint more flexible.

(4) **Transfer between years**

Quota-holders are allowed to transfer up to 15% of the quota of most species to the next fishing year and fish up to 5% above quota for many species to be subtracted from next year's quotas. Thus, in a sense, quota-holders can "bank" their quota holdings in this way. As above, the idea is to make the quota constraint more flexible.

(5) **Landings above quota**

Under certain circumstances, it is allowed to land non-targeted catch outside of quota up to 5% of the targeted catch. In that case the value of the landings are forfeited. This stipulation is primarily designed for by-catch and will only be effective when the quota price of the by-catch is high.

Other incentive altering measures that were adopted are:

(1) **Enforcement**

Enforcement of the discard ban has been substantially beefed-up over time. This is both in terms of monitoring (on-board observers, comparing landings, VMS etc.) and, especially penalties, which have been greatly increased.

(2) **Persuasion and propaganda**

The authorities (which great voluntary help from the media) have run educational and awareness campaigns explaining to fishermen and fishing companies the detrimental effects of discarding managing to brand it a virtually amoral behaviour on par with stealing.

It appears that these incentive-modifying measures have, taken together, had a substantial impact toward reducing discarding and, by the same token, increase selectivity. The relative impact of each of them is unclear however. There are some indications that items (1) and (2) above, easy tradability and the ability to land undersized fish outside of quota may have had the greatest impact.

3.1.3. Enforcement

As mentioned above, the enforcement of discarding restrictions (now an absolute ban) has been substantially increased over the past 15 years. Most importantly, the method of comparing the catch distribution of vessels with observers aboard with that of vessels in the same area and time and fishing with the same fishing gear and drawing inferences from this about the discards of the latter has been greatly expanded. This indirect observation has proven effective because courts have been willing to accept this as satisfactory evidence.

There is an on-board observer programme in place, but the total number of observers is small relative to the size of the fleet, — approximately 30 observers for about 700 large scale (over 10 m.) vessels.

More importantly, the penalties for discarding have been increased both in the statute and in practice. The Fisheries Directorate (the agency in charge of running the fisheries management system) is mandated to issue administrative penalties. These include fines and the temporary revoking of fishing licences. These penalties are often applied. If a case is submitted to the legal process, penalties may involve fines, temporary or permanent revoking of fishing licence and even jail time up to six years.

In the case of discarding violations, it is thought that although the likelihood of violations being observed is not very high, the penalties are sufficiently high to create a real deterrence.

3.1.4. Outcomes

It seems that the implementation and enforcement of Iceland's non-discarding policy has been quite effective. As indicated in table 1, discards seem to (i) be small and (ii) have declined over time. Comparable statistics are not available from other fishing nations, but the indications are that discards of catch in Iceland's mixed fisheries are among the lowest that exist.

3.2. Namibia¹

Namibia has a short history of ocean fisheries and no artisanal fisheries sector. Fisheries in Namibia have always been and still are large and medium scale industrial fisheries (Sumaila et al. 2004).

Prior to independence in 1990, fisheries off Namibia were controlled by South Africa. A part of the fishery was operated by South African vessels another part was operated by foreign fishing fleets in which Soviet Union vessels played a major role (Sumaila and Vasconcellos 2000). In the years prior to 1990, hake and pilchard fisheries were managed on the basis of individual quotas.

After independence, the new government continued with essentially the same fisheries management system, but embarked on a policy of Namibianization of the fishery (Sumaila et al. 2004. Armstrong et al. 2004). The essence of this policy was to employ Namibians in the fishing industry and bring the fishing companies under Namibian, preferably indigenous, ownership. This policy, which has been in effect now for over 20 years, has been quite successful.

Namibia's 200 nautical mile Exclusive Economic Zone (EEZ) contains about 20 commercially exploited fish species consisting primarily of small pelagic species such as pilchard, anchovy and horse mackerel and demersal species such as hake, monkfish and kingklip. In addition there are substantial stocks of lobster in shallower waters as well as other species of crabs.

¹ Much of the information contained in this section and not explicitly referenced was provided by Mr. Filimon Shiimi at the Namibian Ministry of Fisheries and Marine Resources.

3.2.1. Fisheries management system

Namibia's are managed by a variant of the ITQ system (Marine Resources Act no. 27 of 2000). The government sets TAC for eight of the most important commercial species. The companies hold ITQ-shares which, once the TAC is set, are translated into individual quotas for the fishing year. The ITQ-shares explicitly have a duration of several years. There is some, but far from perfect, tradability of ITQ-shares. The annual quotas also have somewhat limited tradability.

3.2.2. The Discard Ban

The Marine Resources Act of 2000 (No: 27 of 2000) provides for restrictions on discards. This provision in the law forms the legal basis for subsidiary regulations.

According to Marine Resources Regulation 24, species of fish that are harvested under quota is forbidden as is the catch of by-catch species. The discarding of other species is not forbidden but must such discards are required to be weighed and recorded. There are reports of large quantities of such discards taking place without the recording requirements being met.

This discard ban applies only to whole fish. Discarding of heads and fins and fish entrails is not forbidden. Discards of whole fish may be allowed by officials present (e.g. on-board observers) under certain circumstances.

3.2.3. Enforcement of the Ban

The discard ban is primarily enforced by on-board observers and fishery inspectors. The on-board observer programme is extensive in Namibia. Larger fishing vessels have observers on board most of the time and many of the smaller ones as well. The smallest vessels that operate in the rock lobster and hook and line fishery are exempted from observer coverage. These observers are supposed to record fishing activities including discards. It is not clear how effective they are in this task. They are not required to prevent such activities but their presence is clearly a strong deterrent.

The fisheries inspectors are employed by the Ministry of Fisheries and Marine Resources. They carry out systematic sea patrols, largely directed at ensuring compliance with fishing regulations and carry out at-sea inspections. Air patrols are also employed primarily to detect and deter unlicensed fishing vessels and monitor the movement and operations of the licensed fleet. This activity is not well suited to enforce the discard ban, but it probably has some deterrence impact nevertheless. It is not clear to what extent this activity acts.

Discarding of fish is a criminal offence that is punishable by law. Penalties are fines and possible temporary cancellation of the fishing rights held by the offender.

If discarding is recorded by a fisheries observer, the vessel (vessel owner) is liable to prosecution once ashore. If discarding is observed by fisheries inspectors (which is rare), the licence of the vessel may be suspended and the vessel summoned to port for investigation.

The Minister of Fisheries is empowered by the Marine Resources Act (2000) to cancel the fishing rights of the rights holder that contravenes any provisions of the Act. It is a common practice that the offenders are fined N\$ 1 million (approximately 90,000 US\$) for contravention of the Marine Resources Act.

These administrative penalties may be referred to the court system. This is rare, however, because in the legal penalties are heavy and the offending vessel may be forfeited to the state.

3.2.4. Effectiveness of the Ban

It is difficult to gauge the effectiveness of the discard ban in Namibia. No systematic studies of discard quantities seem to be available. There are stories of the observer programme being subverted and substantial discards still taking place. No doubt there is some truth in this. The extent of these failures, however, is impossible to assess. In a horse mackerel fishing vessel was arrested for dumping fish and five years ago, seven horse mackerel vessels were recalled from the fishing grounds after allegations of fish dumping.

My impression is that the discard ban has substantially reduced discards and is reasonably effective. The enforcement cost, especially in terms of the observer programme is very high, however. Moreover, the contribution of the observer programme to the reduced discards relative to other enforcement activities and the high penalties is not clear. Thus, there are questions about the net benefits of the discard ban and its enforcement.

3.2.5. Main Problems Associated with the Ban

There are reportedly wide-spread complains from fishermen that low value species which may not be discarded, take up too much space in the fishing vessels reducing the space for valuable quota and by-catch species. To the extent that this is true, this represents costs associated with the discard ban which have to be added to the cost of enforcing the ban.

3.3. New Zealand

Most New Zealand fisheries are subject to the so-called Quota Management System (QMS) instituted in 1983 (Fisheries Act of 1983). The QMS is an ITQ system under which individual vessels are subject to a quota constraint on their catch volume of all QMS-managed species. Catch is defined the amount of fish caught and brought aboard the vessel and not merely landed fish. This means that fish subject to the QMS that is discarded is in principle counted against quota.

Until 1990, discarding of catch was not forbidden. This was changed in 1990, with an amendment to the basic Fisheries Act of 1983. According to this amendment (the Fisheries Amendment Act 1990) discarding of all species subject to the QMS was prohibited. Fish not subject to the QMS could, however, still be discarded.

The discarding ban on QMS-managed species was subject to some exceptions as follows:

- (1) Catch of 24 species, of which 13 were shellfish, which were believed to exhibit high survival rates following discarding could still place provided the discarded individuals were viable. Catch discarded under this rule was not counted against quota but had to be reported.
- (2) Eleven species are subject to minimum landing sizes. Undersize catch of these species must be discarded alive or dead. Thus this stipulation actually demands discards. Undersized fish discarded under this provision are not counted against quota and do not have to reported.
- (3) Fisheries officials including on-board observers may authorize discards of any fish. These discards, however, are counted against quota and must be reported.

3.3.1. Quota flexibility

As is well known (Arnason 1994), ITQ systems generate certain new incentives for discarding (as well as reducing others). These special incentives stem from the market value of the quota which represents a cost to fishers when fish is landed. To counter these incentives, the New Zealand quota system contains two important provisions:

- (1) It is possible to carry over to the next year up to 10% of uncaught quota.
This reduces the need to fulfil the quota constraint each year and, therefore, also the danger of exceeding the quota and having to purchase additional quota possibly at high prices.
- (2) If catches exceed quota it is possible to land these excess catches and pay the government a deemed-value for the excess catch.
This limits the discarding incentive generated by high quota prices to the deemed-value number.

3.3.2. Enforcement

The discarding rules are enforced on the one hand by monitoring of fishing activities and penalties for violations on the other hand. The monitoring activity is modest compared to that of many other fishing nations. For discarding at sea, monitoring and surveillance is primarily undertaken by military vessel inspections, aircraft surveillance and on-board observers. In addition, some experiments of on-board video monitoring have been undertaken.

The number of at-sea inspections is not high. Thus, in 2006/7 the Ministry only conducted 1567 vessel inspections for over 1500 licenced vessels (MRAG 2007). The observer programme likewise is not extensive. Observer coverage seems to be well within 10% of the vessels (MRAG 2007). At-sea observers have no coercive powers but can report on discards they observe. Responding to increasing concerns about discarding, the Ministry of Fisheries has apparently recently adopted a plan to install video-cameras in all fishing vessels by October 2015.

3.3.3. Level of discards

Comprehensive estimates of the volume of discards in New Zealand fisheries discards are not readily available (FAO 2005). A report published in 2005 (Anderson and Smith 2005) about discards in the hoki fishery, New Zealand's largest fishery and mainly conducted by trawl which has high bycatch rates, indicates (a) high levels of by-catch of $\frac{1}{4}$ to $\frac{1}{3}$ of the hoki catch, with discarding of bycatch of some 20 to 25% and discarding of hoki amounting to less than 1% of the hoki catch. There are further indications that discards of hoki have substantially decreased compared to earlier periods (Anderson and Smith 2005, MRAG 2007).

3.4. Norway²

Norway is one of the more important fishing nations in the world. We usually find her just below the 10th place in the league of nations, ranked according the volume of fish production, roughly on par with Russia and South Korea.

² Most of the material in this chapter was provided by professor Rognvaldur Hannesson at the Norwegian School of Economics.

Most of the landings are taken by large boats (trawlers and purse seiners), but there is also a large and politically important fleet of coastal boats that vary greatly in size. According to Norges Fiskerier, published by the Directorate of Fisheries (www.fiskeridir.no), the landings in 2012 were as follows:

Table 2 Norwegian fisheries: Main statistics.

	1,000 metric tonnes	Million NOK
Pelagic fisheries	1,235	5,738
Capelin	269	461
Blue whiting	118	277
Mackerel	176	1,290
Herring	611	3,561
Demersal fisheries	729	6,843
Cod	358	3,843
Haddock	161	1,317
Saithe	176	1,356
Crustaceans	119	773
Shrimp	19	510
King crab	1	117
Antarctic krill	93	47
Grand total	2,140	14,202

3.4.1. The Discard Ban

There is a discard ban on fish caught in Norwegian waters. This discard ban pertains to virtually all fish caught within the Norwegian economic zone and the special fish protection zones around Svalbard and Jan Mayen.

The Marine Resources Act that entered into force on January 1, 2009, established the discard ban as the legal norm (Gullestad, undated). Originally the discard ban was introduced for cod and haddock in the Barents Sea in 1987. The purpose was to protect the strong 1983-year class of cod, which at that time was turning up in trawl catches as undersized fish and being thrown away as such. It was feared that unlimited discards would jeopardize the survival of this year class and prevent it from supporting a more profitable fishery in the years to come (see Gullestad, undated). Gradually the discard ban was extended, and it has now become the general rule.

3.4.2. Enforcement of the Ban

The discard ban is enforced mainly by at-sea inspection. Most of these inspections are carried out by coast guard vessels, but a few inspectors from the Directorate of Fisheries are placed onboard vessels for an entire trip. Inspectors from coast guard vessels are placed onboard boats while fishing and remain onboard for some time and monitor the catches. They compare the size and species composition of catches taken after their boarding with those that were taken before they boarded. Discrepancies are reported to the judicial

authorities and pursued through the court system. The inspectors also monitor whether the crew engages in discarding while the former are onboard, which in fact has been reported to have happened often enough to indicate that discards are a matter of routine (Kommissjonen for tiltak mot utkast av fisk, 2004). The inspectors have reported equipment installed on board for the apparent purpose of facilitating discards (same source). The coast guard also monitor fishing activities without necessarily boarding the vessels, in some cases from helicopters, and film illegal activities that might be going on.

Another indication of discards is discrepancy between the share of undersized fish in catches of boats with inspectors on board versus boats with no inspectors but fishing in the same area. Such discrepancies can be uncovered when analyzing the landings from such boats, as all boats must report where and when their catches were taken.

The punishments for discarding could include withdrawal of fishing licenses, but this has never been applied, only fines of NOK 15,000 – 25,000 (US\$ 2400-4000) for the skipper and up to NOK 150,000 (US\$ 24,000) for the company owning the vessel (the law allows for jail sentences). In severe cases the value of the catch, of which the discards were a part, can be confiscated. One reason why license withdrawals are not applied is a goal of applying the same punishments for Norwegians as for foreigners (Kommissjonen for tiltak mot utkast av fisk, 2004); the Norwegian authorities are not in a position to withdraw fishing licenses of foreigners, except, of course, for fishing in the Norwegian zone.

3.4.3. Effectiveness of the Ban

There is much uncertainty surrounding the effectiveness of the ban. Very few cases of violations have been detected and successfully prosecuted through the courts—approximately half a dozen per year (Gullestad, undated; see also Kommissjonen for tiltak mot utkast av fisk, 2004). It is, however, widely believed that this is only the tip of the iceberg. Needless to say, an illegal activity such as discarding fish at sea is notoriously difficult to detect, and even more so is providing evidence acceptable to the courts that this has actually happened. Early this century, John Willy Valdemarsen and Odd Nakken, at the Marine Research Institute in Bergen tried to assess the magnitude of discards in the Norwegian fisheries and concluded that it was 2-8 percent of the catch volume, varying greatly between fisheries. They identified 55 different fisheries for this purpose. Their report is published in a volume entitled Report from a workshop on discarding in Nordic fisheries and is quoted at some length in Kommissjonen for tiltak mot utkast av fisk (2004), which however does not provide a detailed reference. The highest discards, in relative terms, occurred in the shrimp fishery in the North Sea and Skagerack, possibly as much as three times the retained catches of shrimp. The largest discards in volume occurred in the purse seine fishery for herring, possibly as much as 60,000 tonnes.

There does not appear to exist any assessment of whether or not the discard ban has improved the situation from what it was in the early 2000s. The said publication from 2004 indicates that discarding was widespread and apparently condoned, and possibly even encouraged, in wide circles in the industry at that time. That said, knowledgeable people in the Directorate of Fisheries think that the attitude in the industry towards discarding has much improved over the years (personal communication); they regard the discard ban and the admittedly incomplete inspections as an educational effort that will work, and has worked, over the long haul.

3.4.4. Main Problems Associated with the Ban

It is possible to identify three different purposes of the discard ban:

1. Discourage incidental captures of juveniles (cod, haddock, for example; this was the purpose of the original discard ban).
2. Avoid highgrading.
3. Improve the catch data that enter into stock assessment.

Incidental captures of juveniles of cod and haddock, as well as other fish, occur both in trawling for shrimp and trawling for cod and haddock of marketable size. Over time some portion of these juveniles would grow to marketable size and sustain targeted fisheries. For the industry as a whole it would most likely be profitable to avoid capturing the juveniles, but for the individual fisherman discards could be more profitable; it is the industry that collectively gains from not discarding juvenile fish while the individual firm only gets a small share of these gains. The ultimate purpose of the discard ban is to discourage the captures of these juveniles, not their retention as such. The discard ban is supplemented by area closures—too high a share of juveniles in landings from an area leads to the closure of the area. The discard ban is regarded as having provided incentives to develop more selective fishing equipment that avoids the capture of juveniles.

As more and more fisheries came to be regulated by vessel quotas the discard ban acquired the purpose of preventing highgrading of catches (discards of juveniles can be considered a form of highgrading). Highgrading is a logical consequence of a vessel quota system when the price of the fish caught differs between specimens, typically because of size; fishermen have an obvious incentive to throw away specimens that fetch a low price in order to make room for more highly priced specimens and so get the most out of their allotted quota. A similar phenomenon occurs in the purse seine fishery for mackerel and other species. Large shoals that fill up the seine can harm the quality of the fish so that it is no longer marketable for direct consumption but instead has to be sold to the fishmeal industry at a much lower price. Skippers that see this coming are tempted to release the fish so as not to waste their quota on a low-priced product, but the problem is that the fish have at that point been sufficiently harmed to not survive even if released. At this point it may be noted that the discard ban pertains to fish that have been harmed sufficiently to be unlikely to survive; releasing fish that is able to survive is not banned.

An important argument for the discard ban is that unreported landings skew the data fisheries biologists use in their stock assessment. Such unreported catches constitute unreported and unknown fish mortality. Landing this fish would make the catch statistics more accurate and improve the factual basis of fish stock assessment.

Making it compulsory to land unwanted fish imposes additional costs on the industry; this is one reason that it wants to throw the fish away. Therefore, fishermen retain 20 percent of the value of the fish caught in excess of their fish quotas, while the sales organizations that have an exclusive right to first-hand sales of fish retain the remaining 80 percent and are allowed to use it to defray their monitoring expenses (these organizations play an important role in collecting catch statistics and monitoring of fish quotas).

3.5. United States of America³

The US as a whole has no formal bans on discards. As a result there is very little available information on discard problems and even less on enforcement costs of discard bans.

The fundamental US legislation on fisheries management is the Magnuson-Stevens Fisheries Conservation and Management Act (hereafter "the Act"). This act does not impose any restrictions or set rules regarding discards of catch. The part of the Act that comes closest to deal with discarding is National Standard no. 9 which stipulates:

"Conservation and management measures shall to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch."

The Act defines bycatch as being fish that are harvested, but not retained either for sale or personal use.⁴ In other words, bycatch is equivalent to discards and the Act requires discards to be minimized subject to practicability and its mortality minimized.

Although country-wide general legislation says little about discarding and certainly does not forbid it, management rules applying in certain specific fisheries may go further. However, as far I have been able to establish, there are no US fisheries where discarding of all fish caught is banned. However, in certain fisheries there are some retention requirements (i.e., discard bans) for some species. These cases include (i) retention requirements of sablefish for IFQ (Individual Fishing Quotas) holders, (ii) full retention of Pacific cod and pollock in both the Bering Sea and Aleutian Islands (BSAI) groundfish fisheries and the Gulf of Alaska (GOA) groundfish fishery and (iii) full retention of all Chinook salmon caught in both the Bering Sea and the GOA pollock fishery is required. The following provides a synopsis of these programs.

Interestingly, certain stipulations in US fisheries management rules for individual fisheries demand discarding of some species.

3.5.1. Sablefish

Sablefish targeted with fixed gears (pots and longline in the BSAI and longline gear in the GOA) has been managed with an IFQ (Individual Vessel Quotas) since 1995. Total annual landings in this fishery averaged 12,152 metric tons valued at \$78.5 million (US) from 2006 to 2010. Landings and value in 2011 were 10,905 metric tons and \$119.2 million (US) respectively.

Sablefish harvest can only be retained by persons holding sablefish IFQ provided the season has not been closed and the individual quota held by the person exceeds zero. This means that any sablefish caught by individuals that do not have sablefish IFQ or while the season is closed must be discarded!

Monitoring and enforcement of the retention requirement is done by a combination of at-sea observer, by at-sea enforcement and inspections at catch buying stations on land.

³ This section was put together with the assistance of Eric Thunberg and his staff at the US National Oceanic and Atmospheric Administration (NOAA).

⁴ This definition of bycatch does not include fish released alive under a recreational catch and release management program.

Available discard data for sablefish is based on all sources of discards including the IFQ fishery as well as fisheries where sablefish are a prohibited species and must be discarded. During 2010 an estimated 374 mt of sablefish were discarded compared to 11,339 mt of landings yielding a bycatch ratio of 0.03 mt per landed mt of sablefish.⁵ Information is not available on the amount or cost of disposing of any sablefish that are retained but not sold.

3.5.2. BSAI and GOA Pacific Cod and Pollock

The BSAI and GOA groundfish fisheries are managed under separate Fishery Management Plans (FMP) developed by the North Pacific Fishery Management Council (NPFMC).⁶ A number of flatfish and rock fish species as well as sablefish, Pacific cod, and pollock, fisheries are managed under both FMPs. Of these, Pacific cod and pollock combined, account for about 75% of total BSAI and GOA groundfish catch (Fissel et. al, 2013⁷) and nearly two-thirds of total value (see Table 19 in Fissel et al., 2013). During 2012 the combined catch of all BSAI and GOA groundfish catch was 2.117 million metric tons valued at \$1.1 billion (US). Discarding in the BSAI and GOA groundfish fisheries were 12.5% of total catch during 1997, of which 40% were of Pacific cod and pollock (Fissel et al, 2013). These discard rates led to a prohibition on discarding of both Pacific cod and pollock which was implemented in 1998. However, the ban on discarding Pacific cod or pollock applies only when the directed fishery for pollock and Pacific cod is open. When directed fishing is not allowed possession of either Pacific cod or pollock is prohibited, in effect, demanding discards of accidental catches of these species.

This program resulted in a 53% reduction in total groundfish discards from 1997 (251.5 mt) to 2006 (118.4). During 2012, the discard rate was estimated to be 6% and 3% of total catch in the GOA and BSAI respectively (Fissel et al, 2013). In the GOA the discard rate for both Pacific cod and pollock was estimated to be 2% of total catch during 2012. The discard rate for BSAI Pacific cod was 1% of the total cod catch and discards of BSAI pollock was less than 0.5% of total pollock catch. Note that discards may not be zero because some cod and pollock are caught in other fisheries when the directed fishery is closed.

Full retention of Pacific cod and pollock is monitored through deployment of on-board observers. Information is not available on any specific costs or problems associated the Pacific cod and pollock retention requirements.

3.5.3. Salmon Retention Requirements

Salmon are incidentally caught in several BSAI and GOA fisheries. However, the overwhelming majority of salmon are caught in the directed pollock fishery. Salmon are a prohibited species in these fisheries and cannot be retained for commercial sale. However, discarding is also forbidden unless the salmon are viable.

Of particular concern in this connection is Chinook salmon in the GOA pollock fishery and the Bering Sea component of the BSAI pollock fishery. In each of these fisheries a Chinook salmon bycatch quota is set in terms of numbers of fish that would close the directed pollock

⁵ http://www.st.nmfs.noaa.gov/Assets/Observer-Program/bycatch-report/Table_5.2.pdf

⁶ See <http://www.npfmc.org/wp-content/PDFdocuments/fmp/BSAI/BSAIfmp613.pdf> for detailed information on the BSAI groundfish FMP. For detailed information on the GOA groundfish FMP see <http://www.npfmc.org/wp-content/PDFdocuments/fmp/GOA/GOAfp613.pdf>

⁷ <http://www.afsc.noaa.gov/refm/docs/2013/economic.pdf>

fishery, if exceeded. Retention is required to allow species identification and monitoring of the bycatch quota.

In the Bering Sea pollock fishery salmon identification is conducted by at-sea observers and salmon may be released alive if possible. In the GOA pollock fishery most pollock is delivered to shore-based processors so all Chinook salmon must be sorted and made available to an observer at the processor for identification and biological sampling. In both the Bering Sea and GOA pollock fisheries any salmon that are not released alive must be donated to authorized hunger relief agencies and food banks under a Prohibited Species Donation program.

Bycatch of Chinook salmon in the directed Bering Sea pollock fishery averaged 33,742 fish from 1992 to 2001.⁸ Chinook bycatch increased to an average of over 67,000 fish from 2002 to 2007 and was a high of 122,000 fish in 2007. An area-based management program was implemented in 2008 that provided incentives to avoid Chinook salmon by sharing information on bycatch hotspots. Bycatch was reduced to 21,000 fish in 2008 and declined in consecutive years to just under 10,000 fish in 2010.

Although the information sharing program reduced bycatch below what would otherwise be expected, the program still did not effectively place an upper limit on the amount of salmon bycatch that may occur. For this reason, a program that places an upper limit on total Chinook salmon catch coupled with specific sector allocations of Chinook salmon catch was introduced. Allocations were also made based on season (A and B) which may be transferred among sectors and season. This program was implemented in 2011 capping total catch between 49,000 and 60,000 fish. Chinook bycatch was 25,000 fish in 2011, but has been reduced to 11,000 fish in 2012 and about 13,000 fish in 2013.

From 1991 to 2003 Chinook salmon bycatch in the GOA pollock fishery averaged about 11,000 fish and ranged from a high of 26,000 fish in 1999 to a low of 4,400 fish in 2003. Chinook salmon bycatch from 2004 to 2010 was generally higher averaging about 21,500 fish and was a high of almost 45 thousand fish in 2010. Bycatch limits for Chinook salmon were implemented in 2011 that would close the directed pollock fishery in the GOA. The bycatch limits did not close the fishery as bycatch was reduced to about 14,000, 19,000, and 11,000 fish in 2011, 2012, and 2013 respectively.

3.5.4. Main items

Discarding of catch is generally not forbidden in US fisheries. However, it is for certain species in certain specific fisheries, most importantly salmon in the Bering Sea and Aleutian Island a (BSAI) and Gulf of Alaska (GoA) groundfish fisheries. In those fisheries the non-discard ban applies only to salmon that is not viable – viable salmon should be discarded. The discard ban is enforced primarily with the help of:

- On-board observers
- Special bycatch quotas for the sector

To discourage intentional catch of salmon, the fishing vessels cannot retain any of the landed value of retained salmon catches.

⁸ See <http://alaskafisheries.noaa.gov/sustainablefisheries/bycatch/default.htm> for Chinook salmon bycatch data for the Bering Sea and GOA pollock fisheries.

4. SUGGESTED BEST PRACTICE

The available theory of discarding and selectivity (see section 2 and references therein) suggests various ways to reduce discards in rights-based fisheries. Among the more pertinent of these suggestions are:

- Reductions in the price of quota
- Increasing the cost of discarding
- Increasing expected penalties of discarding
- Promoting harvesting selectivity

Explicit ways to achieve this are delineated in in section 2.

Another useful source of suggestions is the experience of fishing nations attempting to deal with discarding in rights-based fisheries. It is important to recognize, however, that real fisheries are complicated, involving numerous biological, technological and socio-economic variables. Moreover, for the same reason, each real fishery is unique; no two fisheries are the same. Because of the complexity, it is difficult to attribute certain observed discarding behaviour to specific management controls. Because of the uniqueness, there can be no assurance that what works in one fishery will work in another fishery.

With the warnings in mind, it appears from the five practical cases reviewed (see section 3) and other less specific empirical evidence that the following practices in IQ/ITQ fisheries contribute to reduced discards.

1. Strong enforcement of discarding restrictions.
2. Tradable quotas.
3. Flexible quota constraints.
4. Ability to land unwanted catch without it being counted against quota.
5. Awareness campaign to generate aversion to discarding.
6. Appropriate time-area-gear-fishery restrictions.

These empirical observations are in excellent conformance with the theoretical results. Items 1 and 5 increase the cost of discarding. Items 2, 3 and 4 reduce the price of quota. Item 6 serves to increase harvesting selectivity. Further details of the actual practices in the five countries reviewed are set out in section 3 above.

5. RECOMMENDATIONS

The theoretical and empirical evidence discussed in sections 2 and 3 and summarized in section 4 suggest certain principles that constitute good (or even "best") practice for reducing discards in rights-based, more precisely IQ/ITQ, fisheries. These principles can be summarized as follows:

1. Quotas should be tradable and trading as easy as possible.
2. The quota constraint should have a degree of flexibility.
 - a. Possibility to exceed the quota constraint to a certain (relatively small) extent against a corresponding reduction in next year's quota.
 - b. Possibility to move some unused quota to next year (banking quota).
 - c. Possibility to move quotas between species to some extent.
 - d. Possibility to land unwanted fish without quota subtraction (and no benefit to the fishing firm).
3. There should be sufficiently strong enforcement of the discarding restrictions.
4. Enforcement of discarding restrictions should be economical
 - a. It should rely to the extent possible on heavy penalties, law burden of proof and comparatively little monitoring.
 - b. Monitoring should be primarily based on on-board observers in relatively few vessels and the discards of other vessels (in the same area at the same time) inferred from comparison of their landed catches with the actual catches of the vessels with observers on board.(Obviously, for this to work, this indirect evidence must constitute a legally sufficient proof).
5. Awareness/information campaign may be undertaken, preferably in co-operation with industry, in order to instil anti-discarding sentiments.
6. Increased harvesting selectivity should be promoted by
 - a. Judicious imposition of area-time-gear-fishery restrictions.
 - b. Promotion of the use of fish selectors.
 - c. Promotion of the development of more selective fishing gear and techniques.
 - d. Various other supports for increased selectivity.

It is the recommendation of this study that these principles be applied in the implementation of the non-discarding policy. They should, however, be applied judiciously. No two fisheries are identical. Therefore, in applying these principles, due account should be taken of the specific biological, technical and socio-economic context of each fishery. Finally, the application of these principles should, of course, be cost effective. This suggests that a proper cost-benefit study be conducted in each case.

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