Marine Policy 36 (2012) 1123–1130

Contents lists available at SciVerse ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Eco-labeling of seafood: Does it affect the harvesting patterns of Norwegian fishermen?

Kine Mari Karlsen*, Øystein Hermansen, Bent M. Dreyer

Norwegian Institute of Food, Fisheries and Aquaculture Research (Nofima), PO Box 6122, NO-9291 Tromsø, Norway

ARTICLE INFO

Article history:
Received 20 December 2011
Received in revised form
1 March 2012
Accepted 1 March 2012

Keywords:
Capture fisheries
Harvesting pattern
Eco-label
MSC
KRAV
Friend of the Sea

ABSTRACT

The aim of this paper is to compare the criteria for eco-labeling of wild-caught fish in the Norwegian eco-certified fisheries, and to study if these eco-labels affect the harvesting patterns of Norwegian fishermen. The eco-labels Marine Stewardship Council (MSC), KRAV and Friend of the Sea (FOS) as applied in 2009 were studied. In this study, the harvesting patterns are defined by using the following parameters: season, catch area, size of fishing vessel, gear type, bycatch, location of landing site and distance to the fishing ground. KRAV had more specific criteria than did MSC and FOS in specific fisheries regarding time of the fishing effort, catch area, size of fishing vessels, gear type (e.g. hook size, and the use of beam trawlers was not permitted) and distance to the fishing ground. The findings show that few of the eco-label requirements influenced these aspects in Norwegian fisheries.

1. Introduction

After the second World War it became clear that aquatic resources were not unlimited and needed to be properly managed [1]. In large part, this realization came as a result of high gains in productivity in the fishing fleet, resulting in increased fishing pressure. The early phase of fisheries management focused on utilization of the single stock itself. During the 1980s it became obvious that new approaches to fisheries management and environmental consideration were necessary [1]. Later, the scope was widened, and more attention was paid to indirect effects. Bycatch and discards are sought minimized, as is seafloor impact and ghost fishing [2]. Ecosystem-based management has become the goal, rather than single stock management. Energy consumption is another issue of concern due to climate change [3,4]. For harvesting operations, this is related to the fuel consumption and the corresponding greenhouse gas (GHG) emissions. In addition, illegal, unreported and unregulated (IUU) fishing is a problem for stocks management [5].

Several definitions of sustainability exist, and in many settings there are now distinctions between the two terms 'sustainability' and 'sustainable development' [6–8]. The Brundtland Commission's definition of sustainable development was one of the first definitions with a global perspective [9]. '*…development that meets the needs of the present without compromising the ability of future generations to meet their own needs*'. According to Omann [6], sustainability used to '*refer to the maintenance of the functions of the earth's system*', and sustainable development is the process of working towards this level. Sustainability is acknowledged as a potential basis for solving environmental problems [6]. In the following, Omann's approach to sustainability and sustainable development is used.

In fisheries, reproductive capacity and mortality are of prime importance. Monitoring and control of fisheries is costly and difficult. With strong economic incentives for overfishing and other non-sustainable harvesting practices, other control mechanisms have been sought.

Marked-based incentives have been employed to reduce environmental impacts [10,11], and promote the development of sustainable fisheries [12]. According to Kaiser and Edward-Jones [13], eco-labeling is one such instrument. Eco-labels require the fisheries to comply with a set of requirements designed to promote sustainability. In return, eco-labeled products normally achieve higher prices compared to other products [13]. Fulfilling the criteria to use an eco-label can thus constitute a competitive advantage in the market and be a driving force for the fisheries industry to eco-certify their products [14].

The aim of this study is to compare the criteria of the eco-labels 'Marine Stewardship Council' (MSC), 'KRAV' and 'Friend of the Sea' in the Norwegian eco-certified fisheries and to investigate if these criteria influence harvesting patterns among Norwegian fishermen. Harvesting pattern is a wide term used to describe many different aspects of the utilization of a fish stock. It

* Corresponding author. Tel.: +47 77 62 91 41; fax: +47 77 62 91 00.
E-mail address: kine.karlsen@nofima.no (K.M. Karlsen).

0308-597X/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.marpol.2012.03.003

encompasses aspects such as total fishing mortality, fleet composition, gear types, fishing areas, size distribution of catch, bycatch levels, landing sites, time of harvesting and distances to fishing grounds. Any harvesting pattern is mostly the result of fishermen trying to maximize profit from a trip or quota portfolio, restricted by the existing legal and control framework.

Other papers that study this topic have not been identified. The paper is organized as follows: first, the method used in the study is described. Second, the criteria of the eco-labels studied are presented. Finally, a discussion of how these criteria affect the harvesting patterns of Norwegian fishermen is carried out.

2. Method

The study was carried out in 2009. Fig. 1 outlines the different stages of the research method used in this study. The first step was to identify which parameters describe the harvesting pattern and determine which parameters to include in this study. As there are several eco-labels for wild-caught fish [2], the second step was thus to identify which eco-labels were relevant for Norwegian seafood producers. According to the Norwegian Seafood Export Council, Marine Stewardship Council (MSC), KRAV and Friend of the Sea (FOS) were the most important eco-labels for wild-caught fish caught by Norwegian fisherman in 2009. The third step was to identify which requirements the eco-labels placed on individual fisheries. Primary sources of data were assessments of each individual fishery (reports/documents) obtained from the Internet sites of MSC [15], KRAV [16] and FOS [17]. An analysis of how these criteria affected harvesting patterns was carried out in the fourth step. The basis for this analysis were the primary sources of data collected in step three, as well as interviews with the Norwegian Fishermen's Sales Organization, the Norwegian Fishing Vessel Owners Association and the Norwegian Seafood Export Council.

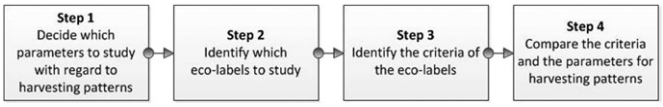

Fig. 1. Overview of research method used in this study.

3. Results

An overall comparison of MSC, KRAV and FOS is presented in Table 1. The superior criterion of these eco-labels was that the fishery must be sustainable. The major differences between these labels were related to which types of products were certifiable and the dissemination of the eco-labels throughout the world. The duration of the certification processes within these eco-labels varies; an MSC-assessment of a fishery could last fourteen months, whereas FOS-assessment and certification could take one day.

MSC, KRAV and FOS had different criteria with regard to the assessment of a fishery and the certification of involved companies (Table 2). The length of reports from these eco-certification processes varies; a MSC-assessment of a fishery could be documented with a report comprising approximately 200 pages, while reports from FOS and KRAV would be approximately 10 pages. This indicates that MSC puts considerably more work into an assessment of a fishery than FOS and KRAV.

3.1. Eco-certified fisheries

MSC had a higher number of certified fisheries on a global level, followed by FOS and KRAV (Fig. 2). In a Norwegian setting, KRAV had certified the highest number of fisheries, closely followed by MSC and FOS.

Two of the eco-certified species studied, harvested by Norwegian fishermen were pelagic (mackerel and herring), and three were bento-pelagic (cod, haddock and saithe) (Table 3).

Table 1
Overview of the eco-labels MSC, KRAV and FOS as applied in 2009.
Sources: [16,17,33].

	MSC	KRAV	FOS
Type of organization	International non-profit organization	Swedish association, non-governmental	Non-profit non-governmental organization
Established	1997	1985	2006
Type of products	Wild-caught fish and seafood, not farmed fish	Organic production of agricultural products and seafood products	Wild-caught fish and farmed fish
Dissemination	The whole world	Mainly in Sweden	The whole world High dissemination in Italy
Superior criteria	Sustainable fishery No rough gear types	Sustainable fishery No rough gear types Low content of contaminants or absence of eco-toxins in seafood	Sustainable fishery and aquaculture

Table 2
Eco-certified processes within MSC, KRAV and FOS.
Sources: [16,17,33].

	MSC	KRAV	FOS
Certification process	Two steps: 1. Assessment of the/fishery 2. Certification of the companies	Two steps: 1. Assessment of the fishery 2. Certification of the companies and the vessels	Assessment and certification
Duration of certification process	Step 1: 14 months Step 2: Varies greatly[a]	Step 1: 6 months Step 2: 2 weeks	The whole process: 1 day-2 weeks
Validity of endorsement for fishery stock[b]	5 years	3 years	5 years
Validity of endorsement for actors	3 years	The endorsement is valid until next revision.	3 years

[a] Depends on the size of the company, number of products, management system and level of the included process.
[b] Depends on the status of the fishery stock.

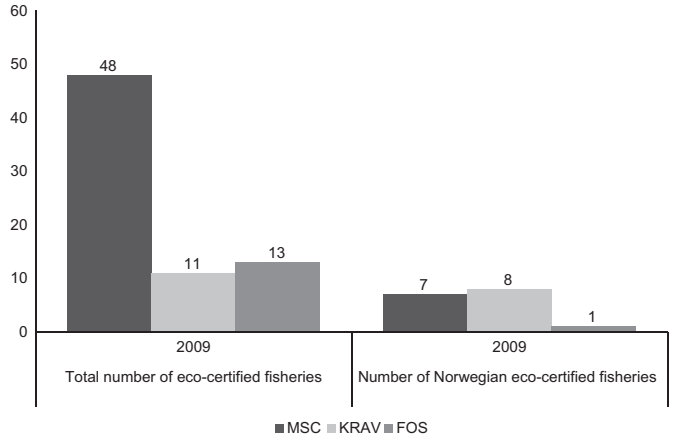

Fig.2. Number of the eco-certified fisheries in 2009.
Sources: [16,17,33].

Table 3
Eco-certified species harvested by Norwegian fishermen in 2009.
Sources: [16,17,33].

Species	MSC	KRAV	FOS
Shellfish		Shrimp (*Pandalus borealis*)	Shrimp (*Pandalus borealis*)
Pelagic	Mackerel (*Scomber scombrus*) Herring (*Clupea harengus*)		
Bento-pelagic	Cod (*Gadus morhua*) Haddock (*Melanogrammus aeglefinus*) Saithe (*Pollachius virens*)	Cod (*Gadus morhua*) Haddock (*Melanogrammus aeglefinus*) Saithe (*Pollachius virens*)	

Table 4
Eco-certified gear types in the Norwegian fisheries in 2009.
Sources: [16,17,33].

	MSC	KRAV	FOS
Active gear type	Trawl Danish seine Purse-seine	Trawl Danish-seine	Trawl
Passive gear type	Long-line Gill-net Hand line	Long-line Gill-net Jig	

Neither KRAV nor FOS had eco-certified pelagic species harvested by Norwegian fishermen.

MSC had the highest number of eco-certified gear types within Norwegian fisheries (Table 4). MSC was the only eco-label which has approved the use of purse-seine.

In general, there are no stringent restrictions with regard to catch areas in the Norwegian eco-certified fisheries studied. The majority of Norwegian MSC-certified and KRAV-certified fisheries had large approved catch areas (Tables 5 and 6): the Barents Sea and the Norwegian Sea, for example. FOS had eco-certified only one Norwegian fishery: catching shrimp in the Barents Sea (Table 7).

However several of the KRAV-certified Norwegian fisheries had more stringent restrictions on catch area—fishing was restricted to outside the baseline of Norway (hereafter called 12 nautical mile zone), and fishing inside fjord lines was only allowed for one fishery.

3.2. Catch operations

In addition to evaluating fisheries, species, gear type and catch area, as mentioned above, the eco-labels studied had different criteria for the catch operation. See Tables 5–7 for an in-depth description of these criteria or a link to the source of the criteria.

3.3. Eco-certified actors

Permission to use the eco-labels was given on different levels: single fishing vessel, specific producers, groups of fishing vessels, specific supply chains (fishing vessels and production plant), and specific fisheries (Tables 8 and 9).

4. Implications of harvesting patterns

The harvesting patterns of Norwegian fishermen can be described using the following parameters: season, catch area, size of fishing vessel, gear type, bycatch, location of the landing company and distance to the fishing ground. The following sections discuss how and if these parameters are affected.

4.1. Season

In terms of times for fishing efforts, the majority of eco-certified fisheries did not have more stringent conditions placed on them than those imposed by Norwegian legislation, with the exception of the KRAV-certified North East cod fishery, where the fishing period was restricted to January through April. This means that the KRAV-label cannot be used on cod caught from May through December. According to Hermansen and Dreyer [18], the majority of North East Arctic cod is caught from January to April. KRAVs criterion does thus not represent a problem for the Norwegian fishing fleet.

4.2. Catch area

KRAV had more specific criteria regarding catch area compared to Norwegian legislation, MSC and FOS. For several of the KRAV-certified fisheries, all fishing efforts must take place outside the 12 nautical mile zone to prevent bycatch of coastal cod. The certification body, Moody Marine, emphasized that bycatch of coastal cod in specific MSC-certified fisheries can happen if the fishing takes place inside the 12 nautical mile zone. None of the certified fisheries had this requirement imposed on them in 2009. If it had been imposed, however, it would not have affected the Norwegian fishing fleet, because the fishing activity is already carried out outside this zone.

4.3. Size of the fishing vessel

Only three of the eco-certified fisheries studied were restricted in terms of criteria regarding the size of the fishing vessels: KRAV-certified cod, haddock and saithe in the Norwegian Sea and the Barents Sea. The fishing efforts in these fisheries must be executed with offshore long line vessels outside the 12 nautical mile zone. The size of the vessel is important in terms of the ability to fish offshore, the ability to stand up to bad weather and having enough hold capacity. Consequently, many Norwegian vessels are excluded from participating in these eco-certified fisheries, which creates incentives for building larger vessels. This is, however, a trend in Norway already. Other factors than eco-certification are likely more important in this regard.

Table 5
Norwegian MCS-certified fisheries as per March 2009.

Nr.	Species	Gear type	Catch area	Criteria [Source]
1	Domstein Longliner Partners North East Arctic cod (*Gadus morhua*)	Long-line	Coast of Northern Norway, including spawning areas of the Lofoten islands, the southern part of the Barents Sea and in the Svalbard area	[34]
2	Domstein Longliner Partners North East Arctic haddock (*Melanogrammus aeglefinus*)	Long-line	Coast of Northern Norway, including spawning areas of the Lofoten islands, the southern part of the Barents Sea and in the Svalbard area	[35]
3	North East Atlantic mackerel (*Scomber scombrus*)	Offshore purse-seiners, mid-water trawlers and some smaller coastal vessels operating purse seines, hand lines	ICES areas II, III, IV, V, VI, VII	[36]
4	Norway North Sea and Skagerrak herring (Clupea harengus)	Pelagic trawl, pelagic purse-seine	North Sea and Skagerrak; ICES divisions IV and IIIa within EEZ of Norway	[37]
5	Norway spring spawning herring (Clupea harengus)	Purse-seine, pelagic trawl	North East Atlantic, EEZs of Norway, Russia, Iceland, EU and Faroe Islands. Jan Mayen Fisheries Zone and Svalbard Fisheries Protection Zone, International waters	[38]
6	Norway North Sea saithe (*Pollachius virens*)	Trawl, gill-net, purse-seine, Danish seine, handline	The North Sea, ICES area IV	[39]
7	Norway North East Arctic saithe (*Pollachius virens*)	Trawl, gill-net, purse-seine, Danish seine, handline	The Norwegian Sea, ICES Sub-areas I and II, within the Norwegian Exclusive Economic Zone	[39]

4.4. Use of gear type

Both MSC and KRAV allow both active gear types and passive gear types in the studied eco-certified fisheries. Beam trawlers were not permitted in KRAV-certified fisheries, presumably because of benthic impacts, rather than gear selectivity. In general, no gear type is currently excluded from any eco-certification process because it is less selective compared to another gear type. Selectivity is further discussed in the next section.

4.5. Bycatch

Bycatch is by many considered synonymous to 'waste' [19]. This negative approach to bycatch is common and a 'popular' understanding of the word. Behind this lie real problems related to the unwanted bycatch of juveniles and other species [20–22]. Such an interpretation is too narrow in many fisheries, as bycatches also may yield significant benefits to vessel economy and society. Bycatch can be desirable, as it may lead to a better utilization of fishing vessel capacity and increased profit from harvesting operations. If the harvested species are not overexploited and juveniles are not caught, bycatch may be desirable also from society's perspective. Taking into account the above, Alverson et al. [19] have identified three ways of using bycatch in the literature: using bycatch to identify (1) retained species, (2) discarded species and (3) retained non-target-species (Table 10).

Table 11 provides an overview of how the eco-labels studied use the term bycatch. MSC, KRAV and FOS all included discard in their use of the term bycatch. This is one of the ways of using bycatch identified by Alverson et al. [19]. MSC separated the species into retained species (usually commercial) and bycatch species (not retained and usually non-commercial) [23]. This is not in line with the identified use of bycatch presented by Alverson et al. [19], because 'retained non-target species' have a commercial value. Neither KRAV nor FOS separated bycatch into commercial and non-commercial species. The bycatch criteria applied by these two eco-labels were related to avoiding or reducing catch of non-target species. The commercial value was not emphasized, thus it is unclear if this way of using bycatch can be 'retained non-target-species' as presented by Alverson et al. [19].

The eco-labels had several criteria due to bycatch in the Norwegian eco-certified fisheries. Common for the eco-labels studied was the use of selective devices to reduce and record bycatch, and, in addition, the actors must comply with Norwegian regulations. Reduction of bycatch can be achieved by using specific gear types [24], but KRAV and MSC did not exclude less selective gear types from eco-certification, as discussed in Section 4.4. KRAV had more specific criteria than MSC and FOS, especially on the use of gear type (e.g. hook size) to prevent and reduce bycatch in the Norwegian eco-certified fisheries.

Reducing the bycatch of coastal cod is important for KRAV and MSC. The MSC eco-certification processes for North East Arctic cod and haddock are examples of what can happen if the population of non-target species is not within safe biological limits. These fisheries could not be certified in 2009 because of an increased risk of bycatch of coastal cod within the 12 nautical mile zone. When the certification processes started, coastal cod was a depleted stock [25], and the fisheries inside and outside the 12 nautical mile zone were thus assessed separately. Offshore North East Arctic cod and haddock were MSC-certified in April 2010 [25,26], and inshore North East Arctic cod and haddock were assessed under a separate time line and certified October 2011 [27]. It is unclear whether and how this will affect the Norwegian fishing fleet in the future.

4.6. Location of the landing site

The distance between the fishing ground and the landing site is important when fishermen decide on catch areas and landing site locations [18]. The fishermen must deliver the catch to an eco-certified landing site to qualify for eco-labeling of the fish. The question here is whether fisherman are willing to change their harvesting patterns to qualify for eco-labeling, or whether they will continue harvesting unaffected by this requirement. Parkers et al. [28] assume that fishermen can increase profit using certification schemes, but there is very little evidence supporting these supposed economic benefits. One key factor in deciding on landing sites is cost, and especially energy consumption. This is discussed in the next section.

Table 6
Norwegian KRAV-certified fisheries as per May 2009.

Nr.	Species	Gear type	Catch area	Criteria[a]								Criteria [Source]
				Season	Catch area	Use of gear	Bycatch	Biology	Reporting	Vessel	Working criterion	
1	North East Arctic cod (*Gadus morhua*)	Long-line	Vesterålen	January–April	Outside the fjord line in the Norwegian statistical areas 04, 05 and 00	Hook size: 5, 7 or 11	No increase in the catch of coastal cod in long-line fisheries	No changes to the status of the stock	Submit a catch report every six months			[40]
2	Haddock (*Melano-grammus aeglefinus*)	Long-line	Vesterålen	January–December	Outside the fjord line in the Norwegian statistical areas 04, 05 and 00	Hook size: 5, 7 or 11	No increase in the catch of coastal cod in long-line fisheries	No changes to the status of the stock	Submit a catch report every six months			[41]
3	Cod (*Gadus morhua*)											[42]
4	Haddock (*Melano-grammus aeglefinus*)	Long-line	The Norwegian Sea and Barents Sea		Outside the 12 nautical mile zone			No biological changes to the status of the stock	Submit a catch report every six months	Off-shore long-line vessels	Use scarecrow	[43]
5	Saithe (*Pollachius virens*)											[44]
6	Shrimp (*Pandalus borealis*)	Trawl	The Barents Sea			Bottom trawl		No changes to the status of the stock				[45]
7	Cod (*Gadus morhua*)	Trawl, Danish seine, gill-net, long-line, jig	The Norwegian Sea (62 degrees North) and Barents Sea	Cod caught outside the 12 nautical mile zone can be certified continually. Cod caught inside the 12 nautical mile zone can be certified from 1 January to 10 April in areas 03, 04, 00 and 05. Cod caught in the area 00 (the so-called 'Henningsvær-Svolvær' box) and inside fjord lines cannot be certified.	Use mesh size of minimum 156 mm in the gill-nets. The mesh size of trawl and Danish seine—minimum 135 mm.		No changes to the status of the stock	Submit a catch report every six months		Avoid trawling on hard bottom, especially near coral reef. Use bird-scaring devices.		[46]
8	Haddock (*Melano-grammus aeglefinus*)	Trawl, Danish seine, gill-net, long-line, jig	The Norwegian Sea (62 degrees north) and Barents Sea	Haddock caught outside the 12 nautical mile zone can be certified continually. Haddock caught inside the 12 nautical mile zone can be certified from 1 January to 10 April in areas 03, 04, 00 and 05. Haddock caught in the area 00 (the so-called 'Henningsvær-Svolvær' box) and inside fjord lines cannot be certified.	Use mesh size of minimum 156 mm in the gill-nets. The mesh size of trawl and Danish seine—minimum 135 mm.		No changes to the status of the stock	Submit a catch report every six months		Avoid trawling on hard bottom, especially near coral reef. Use bird-scaring devices.		[47]

[a] The criteria are only available in Swedish and have thus been translated into English.

4.7. Distance to the fishing ground

The distance to the fishing ground is an important factor with respect to the energy consumption during the harvesting stage, because good availability yields lower energy consumption [4]. In 2009, KRAV was the only eco-label with requirements related to distance to the fishing ground. Several of the KRAV-certified fisheries must be executed outside the 12 nautical mile zone to avoid bycatch of coastal cod. In 2010, two Norwegian MSC-certified fisheries (the offshore North East Arctic cod and haddock) introduced similar requirements [25,26].

Requirement of this kind may affect fuel consumption, depending on catch volume, catch rates and gear type. Energy consumption decreases as catch volumes increase [29], and high catch rates and the use of passive gear types also reduces energy consumption [4,29]. Other factors affecting energy consumption are vessel size, catch area, weather and temperature. The smallest vessels are more energy efficient than trawlers [30], less energy is consumed when fishing on banks [29], and energy consumption increases in bad weather and rough seas, low temperatures and icing [4].

Table 7
Norwegian FOS-certified fishery as per May 2009.

Species	Gear type	Catch area	Criteria [Source]
Shrimp (*Pandalus borealis*)	Trawl	The Barents Sea	[48]

Table 10
Identification of three ways of using the term bycatch.
Source [19].

Use of bycatch	Description
Retained species	*'Differentiate the target species from other species and caught'*. Some authors refer to this form of bycatch as '*by-product*'
Discarded species	*'Species and certain sizes of species discarded as a result of economic, legal, or personal considerations'*
Retained non-target-species	*'Non-target species retained and sold, plus all discard'*

Table 8
Number of actors within the Norwegian eco-certified cod fisheries, haddock fisheries and saithe fisheries as per 2009.
Sources: [16,17,33].

Species	Applicator	Number of eco-certified fishing vessels	Number of eco-certified landing sites[a]	Type of eco-label
Cod (*Gadus morhua*)				
North East Arctic cod-Domstein	Domstein Longliner Partners	10	1	MSC
North East Arctic cod	Domstein Longliner Partners	11	1	KRAV
Cod	Domstein Longliner Partners	9	1	KRAV
Cod	Norwegian Sea Food Export Council	9	1	KRAV
Haddock (*Melano-grammus aeglefinus*)				
North East Arctic haddock-Domstein	Domstein Longliner Partners	10	1	MSC
North East Arctic haddock	Domstein Longliner Partners	11	1	KRAV
Haddock	Domstein Longliner Partners	9	1	KRAV
Haddock	Norwegian Sea Food Export Council	9	1	KRAV
Saithe (*Pollachius virens*)				
North Sea saithe	Norwegian Fishing Vessel Owners Association	Norwegian vessels with permission to catch this species	6	MSC
North East Arctic saithe	Norwegian Fishing Vessel Owners Association	Norwegian vessels with permission to catch this species	6	MSC
Saithe	Domstein Longliner Partners	9	1	KRAV

[a] The number of MSC eco-certified actors is based on the MSC list. Some of these actors have several landing sites, but this is not represented in the numbers.

Table 9
Number of actors within the Norwegian eco-certified herring fisheries, mackerel fisheries and shrimp fisheries as per 2009.
Sources: [16,17,33]

Species	Applicator	Numbers of eco-certified fishing vessels	Numbers of eco-certified landing sites[a]	Type of eco-label
Herring (*Clupea harengus*)				
Norway spring-spawning herring	The Norwegian Fishermen's Sales Organization for pelagic fish	Norwegian vessels with permission to catch this species	13	MSC
North Sea and Skagerrak herring	The Norwegian Fishermen's Sales Organization for pelagic fish	Norwegian vessels with permission to catch this species	11	MSC
Mackerel (*Scomber scombrus*)				
North East Arctic mackerel	The Norwegian Fishermen's Sales Organization for pelagic fish	Norwegian vessels with permission to catch this species	13	MSC
Shrimp (*Pandalus borealis*)				
Shrimp	*Informasjonsutvalget for reker* (*Prawn information council*)	2	3	KRAV
Shrimp	Norway Prawns, The Norwegian Fishermen's Sales Organization	The Norwegian fishing fleet with permission to catch this species	4	FOS

[a] The number of MSC eco-certified actors is based on the MSC list. Some of these actors have several landing sites, but this is not represented in these numbers.

Table 11
Criteria of the eco-labels studied for avoiding or reducing bycatch.

Eco-labels	Definition of bycatch	General criteria	Specific criteria within the Norwegian fisheries
MSC	*'Organisms that have been taken incidentally and are not retained (usually because they have no commercial value)'* [23]	*'Measures and practices that make it unlikely that this fishery could seriously deplete the population or hinder recovery…'* [23]	Must comply with Norwegian regulations (e.g. discard, quota regulations) Estimates of bycatch of tusk, coastal cod, North Sea cod, seabirds and discarded small elasmobranches [34–39] Discards/slipping (sampling/reporting program) Take action to minimize mortality of seabirds and discarded small elasmobranches Implementation of restrictions on coastal cod[a]
KRAV	Inadvertent catch of mammals, birds or fish species or sizes outside of the planned catch [32]	Must comply with current regulations (e.g closing catch area) [32] The gear shall mainly catch the target species, and deselect the smallest fish Bycatch of mammals, birds and invertebrates must be recorded and reported Use grids when trawling to increase selection The drift nets must be designed to avoid bycatch of mammals	Must comply with Norwegian regulations (e.g. discard, catch area and catch period) Restrictions on catch area and catch period (e.g. within the 12 nautical mile zone) Use of gear type (mesh size/hook size) Trawling on hard bottom, especially near coral reefs Use of bird-scaring devices Must submit a catch report No increase in bycatch of coastal cod
FOS	No clearly identified definition of bycatch [49]	*'The target species cannot be fished by gears that have discard levels higher than 8% in weight terms, considered by FAO 2005 to be the average discard level worldwide'*[49] *'The normally by-catch must not be included in the International Union for Conservation of Nature (IUCN) red list of endangered species'* *'Respects national and international legislation'* Must measure bycatch Accountable bycatch and discard reporting methodology Management plan to prevent bycatch of endangered species	Must comply with Norwegian regulations (e.g. discard, catch area and catch period) [48] Restriction on fishing days Mesh size 35 mm Use of grids Closing of areas with bycatch of juvenile cod, haddock, Greenland halibut, redfish and shrimp.

[a] These restrictions are not described in detail.

Table 12
Criteria of the eco-labels studied pertaining to energy consumption in the Norwegian eco-certified fisheries as per 2009.

Factor	MSC	KRAV	FOS
Distance	No	Several of the certified fisheries must take place outside the 12 nautical mile zone Fuel consumption: No	No
Gear type	Trawl, Danish seine, purse-seine, long-line, gill-net, hand line	Trawl, Danish-seine, long-line, gill-net, jig	Trawl
Catch area	Yes	Yes	Yes
Size of vessels	No	Yes	No
Catch rates	No	No	No
Catch volume	No	No	No
Weather and temperature	No	No	No

Table 12 gives an overview of the criteria of factors affecting energy consumption during harvesting. The eco-labels studied all had specific criteria related to one of most important factors affecting energy consumption-gear type. Passive gear types reduce energy consumption [4], and long-line and purse-seine are the least energy-demanding [31]. No gear type is excluded from an eco-certification process because of the gear type's energy consumption. MSC and KRAV had eco-certified both passive and active gear types. In 2009, none of the eco-labels studied had criteria pertaining to fuel consumption. As of January 2010, KRAV required a fuel consumption of max. 0.5 l/kg of landed fish [32]. Interesting questions with regards to this issue are how this requirement will affect fuel consumption and whether actors comply with this to qualify for use of the KRAV eco-label?

5. Conclusion

Market-based incentives have been employed to reduce environmental impacts [10,11] and develop sustainable fisheries [12]. According to Kaiser and Edward-Jones [13], eco-labeling is one such instrument. Eco-labels require fisheries to comply with a set of certification criteria to promote sustainability. In return, eco-labeled products normally achieve higher prices compared to other products [13]. Meeting the criteria for the use of an eco-label can thus become a competitive advantage in the market, representing a main driving force for the fishery industry to eco-certify their products [14]. The aim of this study was to investigate whether the criteria for eco-labeling wild-caught fish influence the harvesting patterns of Norwegian fishermen.

Few of the criteria imposed by MSC, KRAV and FOS affected the harvesting patterns of Norwegian fishermen in 2009. KRAV had more specific criteria than MSC and FOS in specific fisheries regarding fishing effort periods, catch area, fishing vessel size, gear type (e.g. hook size, and the use of beam trawlers was not permitted) and distance to the fishing ground. Energy consumption and problems related to bycatch of coastal cod may change the situation.

An energy efficient fishery is not necessary sustainable for the stock, nor is it necessarily value-creating for actors in the supply chain. The availability of cod in the Norwegian fisheries is good during the winter (near the coast) and lower during the autumn (further out from the coast). Harvesting cod in autumn increases energy consumption. Market demands are in conflict with the energy account, and low-quality fish has a negative effect on the market, which demands stable deliveries of seafood products throughout whole year. One area for further research is developing more knowledge of optimal strategies for the harvesting stage and actors in the supply chains to increase profit and minimize environmental impacts.

References

[1] FAO. Code of conduct for responsible fisheries. Rome, Italy: Food and Agriculture Organization of the United Nations; 1995.
[2] Thrane M, Ziegler F, Sonesson U. Eco-labelling of wild-caught seafood products. J Clean Prod 2009;17:416–23.
[3] Driscoll J, Tyedmers P. Fuel use and greenhouse gas emission implications of fisheries management: the case of the New England Atlantic herring fishery. Marine Policy 2010;34(3):353–9.
[4] Schau EM, Ellingsen H, Endal A, Aanondsen SA. Energy consumption in the Norwegian fisheries. J Clean Prod 2009;17(3):325–34.
[5] Le Gallic B. The use of trade measures against illicit fishing: economic and legal considerations. Ecol Econ 2008;64(4):858–66.
[6] Omann I. Multi-criteria decision aid as an approach for sustainable development analysis and implementation. Graz, German: Karl-Frantzens University; 2004.
[7] Brown BJ, Hanson ME, Liverman DM, Merideth RW. Global sustainability: toward definition. Environ Manage 1987;11(6):713–9.
[8] Garcia SM, Staples DJ. Sustainability reference systems and indicators for responsible marine capture fisheries: a review of concepts and elements for a set of guidelines. Mar Freshwater Res 2000;51(5):385–426.
[9] WCED. Our common future. World Commission on Environment and Development; 1997.
[10] Cummins A. The Marine Stewardship Council: a multi-stakeholder approach to sustainable fishing. Corporate Soc Responsibility Environ Manage 2004;11(2):85–94.
[11] Ward TJ. Barriers to biodiversity conservation in marine fishery certification. Fish Fish 2008;9(2):169–77.
[12] Potts T, Haward M. International trade, eco-labelling, and sustainable fisheries—recent issues, concepts and practices. Environ Dev Sustainability 2007;9(1):91–106.
[13] Kaiser MJ, Edwards-Jones G. The role of ecolabeling in fisheries management and conservation. Conserv Biol 2005;20(2):392–8.
[14] WWF. Assessment study of on-pack, wild-capture seafood sustainability certification programmes and seafood ecolabels. Zürich, Switzerland: Accenture AG and World Wildlife Fund (WWF) International; 2009.
[15] MSC. Marine Stewartship Council—the best environment choice of seafood. Retrieved February 24, 2011 from 〈www.msc.org〉; 2011.
[16] KRAV. KRAV Du får mer. Retrieved May 5, 2009 from 〈http://www.krav.se/〉; 2009.
[17] FOS. Friend of the Sea (FOS)—Sustainable seafood; 2009.
[18] Hermansen Ø, Dreyer B. Challenging spatial and seasonal distribution of fish landings—the experiences from rural community quotas in Norway. Mar Policy 2010;34(3):567–74.
[19] Alverson D, Freeberg MH, Murawski SA, Pope JG. A global assessment of fisheries bycatch and discards. Rome, Italy: Food and Agriculture Organization of the United Nations; 1994.
[20] Abbott JK, Wilen JE. Regulation of fisheries bycatch with common-pool output quotas. J Environ Econ Manage 2009;57(2):195–204.
[21] Hall SJ, Mainprize BM. Managing bycatch and discards: how much progress are we making and how can we do better? Fish Fish 2005;6(2):134–55.
[22] Kempf A. Ecosystem approach to fisheries in the European context—history and future challenges. J Appl Ichthyol 2010;26:102–9.
[23] MSC. Marine Stewardship Council. Fisheries assessment methodology and guidance to certification bodies. Including default assessment tree and risk-based framework. Version 2; 2009.
[24] Gulbrandsen LH. The emergence and effectiveness of the Marine Stewardship Council. Mar Policy 2009;33(4):654–60.
[25] MSC. North East Arctic offshore haddoch fishery. Retrieved December 16, 2010 from 〈http://www.msc.org/track-a-fishery/certified/north-east-atlantic/Norway-north-east-arctic-offshore-haddock/assessment-downloads-1/26.04.2010-norway-nea-offshore-haddock-pcr.pdf〉: MSC; 2010.
[26] MSC. Norwegian North East Arctic offhore cod fishery. Retrieved December 16, 2010 from 〈http://www.msc.org/track-a-fishery/certified/north-east-atlantic/Norway-north-east-arctic-offshore-cod/assessment-downloads-1/26.04.2010-norway-nea-offshore-cod-pcr.pdf〉: MSC; 2010.
[27] MSC. Marine Stewardship Council Variation request form. Retrieved March 19 2012 from 〈http://www.msc.org/track-a-fishery/certified/north-east-atlantic/Norway-north-east-arctic-offshore-cod/assessment-downloads-1/20111128_Nor_Insh_Cod_VR.pdf〉: MSC; 2012.
[28] Parkers G, Walmsley S, Cambridge T, Trumble R, Clarke S, Lambert D., et al. Review of fish sustainability information schemes, final report. London, England: Marine Resources & Fisheries Concultants; 2009.
[29] Dreyer B. Fangstmønster, næringsstruktur og energiforbruk (Norwegian text). (Harvesting pattern, structure of industry and energy comsumption). Retreived January 22, 2011 from: 〈http://www.nofima.no/filearchive/fangstmonster-naeringsstruktur.pdf〉. Tromsø, Norway: Nofima Marked; 2008.
[30] Isaksen JR, Hermansen Ø. Refusjon av CO_2- og grunnavgift i fiskeflåten (Norwegian text). (Repayment of CO_2 tax and cause tax in the fishing fleet). Report 9/2009. ISBN: 978-82-7251-673-3. Tromsø, Norway: Nofima Marked; 2009.
[31] Henriksen E, Dreyer B, Bendiksen BI. Linefiske: En sammenligning av Island og Norge (Norwegian text). (Long-line: A comparison of Iceland and Norway). Report 6/2009. ISBN: 978-82-7251-670-2. Tromsø, Norway: Nofima Marked; 2009.
[32] KRAV. Regler för KRAV-certifierad production januari 2011 (Swedish text). (Rules for KRAV-certified production January 2011). Uppsala, Sweden: KRAV ekomomisk förening; 2010.
[33] MSC. Marine Stewartship Council—the best environment choice of seafood; 2009.
[34] MSC. Public certification report for domstein longline partners cod fisheries. Derby, UK: Moody Marine Ltd; 2009.
[35] MSC. Public certification report for domstein longline partners haddock fisheries. Derby, UK:Moody Marine Ltd; 2009.
[36] MSC. Public certification report for Norwegian North East Atlantic mackerel fishery. Derby, UK: Moody Marine Ltd; 2009.
[37] MSC. Public certification report for Norwegian North Sea and skagerrak herring fisheries. Derby, UK: Moody Marine Ltd; 2009.
[38] MSC. Public certification report for norwegian spring spawning herring purse-seine and pelagic trawl fisheries. Derby, UK: Moody Marine Ltd; 2009.
[39] MSC. Public certification report for Norwegain saithe fishery. Derby, UK: Moody Marine Ltd; 2008.
[40] KRAV. Godkännande av fiske av nordostarktisk torsk utanför Vesterålen (Sweden text). (Certification of North East Arctic Cod, Vesterålen). Uppsala, Sweden: KRAV; 2007.
[41] KRAV. Godkännande av fiske av nordostartiske kolja utanför Vesterålen (Swedish text). (Certification of North East Arctic haddock, Vesterålen). Uppsala, Sweden: KRAV; 2007.
[42] KRAV. Godkännande av fiske av torsk i ICES subarea I och II, Norsk Zon (Swedish text). (Certification of cod, ICES Subareas I and II, the Norwegian Zone). Uppsala, Sweden: KRAV; 2008.
[43] KRAV. Godkännande av fiske av kolja i ICES Subarea I och II, Norsk Zon (Swedish text). (Certification of haddock, ICES Subarea I and II, The Norwegian Zone). Uppsala, Sweden: KRAV; 2008.
[44] KRAV. Godkännande av fiske av gråsej i ICES subarea I och II, Norsk Zon (Swedish text). (Certification of saihte, ICES Subareas I and II, the Norwegian Zone). Uppsala, Sweden: KRAV; 2008.
[45] KRAV. Godkännande av fiske av Nordhavsräka i Barents hav (Swedish text). (Certification of shrimp, Barents Sea). Uppsala, Sweden: KRAV; 2008.
[46] KRAV. Godkännande av fiske av torsk i ICES Subarea I och II, Barents hav och Norske havet (Swedish text). (Certification of cod, ICES Subareas I and II, the Barents Sea and Norwegian Sea). Uppsala, Sweden: KRAV; 2009.
[47] KRAV. Godkännande av fiske av kolja i ICES Subarea I och II, Barets hav och Norska havet (Swedish text). (Certification of haddock, ICES Subareas I and II, the Barents Sea and Norwegian Sea). Uppsala, Sweden: KRAV; 2009.
[48] FOS. Fishery check list (based on criteria dated 08/07/2007), Company: Norway Prawns, Product/s: Northern shrimp-Pandalus borealis. Milano, Italy: Associazione Friend of the Sea; 2008.
[49] FOS. Friend of the sea—Certification criteria check list for wild catch fisheries. Mailano, Italy. Retrieved December 20, 2010 from 〈http://www.friendofthesea.org/public/page/Checklist%20FoS%20Wild%20Catch%20Fisheries.pdf〉: Friend of the Sea; 2010.