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Management of Pelagic Fisheries in the North East Atlantic: Norwegian Spring Spawning Herring, Mackerel and Blue Whiting

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by

Trond Bjørndal
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MANAGEMENT OF PELAGIC FISHERIES IN THE NORTH EAST ATLANTIC: NORWEGIAN SPRING SPAWNING HERRING, MACKEREL AND BLUE WHITING

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ABSTRACT

The purpose of this paper is to give an overview over the fisheries for Norwegian spring spawning herring, mackerel and blue whiting and analyse how they are managed. The stocks under consideration are harvested by coastal states and distant water fishing states (DWFS). For herring, however, Norway, Russia, Iceland, the Faroe Islands and the EU are all coastal states with the stock not being exploited by any DWFS. There have been difficulties in reaching agreement of the management for all three stocks. The reason for these problems is that the distribution of the stocks and the different countries' fishing opportunities have changed from time to time, putting the existing management arrangement under pressure. Here we review the management and current sustainability of the fisheries.

1. INTRODUCTION

According to the 1995 United Nations Fish Stocks Agreement (UNFSA), straddling fish stocks and highly migratory fish stocks are to be managed by Regional Fisheries Management Organisations (RFMOs) (Bjørndal and Munro, 2003), consisting of coastal states and relevant Distant Water Fishing States (DWFSs). In the North East Atlantic there are several straddling stocks, including herring, mackerel and blue whiting that are exploited both within coastal states' 200 nautical mile Exclusive Economic Zones (EEZ) and on the high seas. Management of such stocks poses special management problems.

In this area, the North East Atlantic Fisheries Commission (NEAFC) represents the relevant RFMO (Bjørndal, 2009). Essentially, and for the purpose of this article, NEAFC's Regulatory Area consists of the North East Atlantic. A subset of this, the high sea area known as "the Banana Hole" of the Norwegian Sea (between the mainland and the island of Jan Mayen) represents the Convention Area[1]. While NEAFC sets quotas and other regulations in the Convention Area, it should be pointed out that it has no power to enforce them.

The four main fisheries in the Regulatory Area are Norwegian spring spawning herring, mackerel, blue whiting and pelagic redfish. In 2005, about 3.3 million tonnes, or 31% of the North East Atlantic catch was taken in these fisheries of which about one million tonnes was taken in the Regulatory Area (Bjørndal, 2009).

The stocks under consideration are harvested by coastal states and distant water fishing states (DWFS). For herring, Norway, Russia, Iceland, the Faroe Islands and the EU are coastal states with the stock not being exploited by any DWFS. Mackerel and blue whiting are harvested by the same countries, however, for these fisheries Russia is a DWFS, harvesting in the Banana Hole.

The purpose of this paper is to give an overview over the fisheries for Norwegian spring spawning herring, mackerel and blue whiting and analyse how they are managed. Since 2000, the combined annual catch of these three species has varied between 2 – 3.8 million tonnes. As these figures indicate, the fisheries are very important both in terms of quantity and in terms of income and employment for participating countries. We will in particular analyse the management and current sustainability of the fisheries.

The report is organised as follows: In section 2, some principles of cooperative and non-cooperative management of straddling fish stocks are discussed. Section 3 gives a

summary of the mackerel, herring and blue whiting stocks, their status, management measures, and implementation. In section 4, the economics of the fisheries is analysed, while conclusions are presented in the final section.

2. THE MANAGEMENT OF STRADDLING FISH STOCKS[2]

According to the 1995 UN Fish Stocks Agreement (UNFSA), highly migratory fish stocks and straddling fish stocks are to be managed by Regional Fisheries Management Organisations (RFMOs), consisting of relevant coastal states and Distant Water Fishing States (DWFSs) with a "real" interest in the fishery. This Agreement has now acquired the status of international law, although in principle it is binding only for the signatories.

Highly migratory stocks are represented by tunas and tuna like fish. Straddling fish stocks is a term for all fishery resources other than anadromous and highly migratory fish stocks, which are to be found both within the EEZ(s) and the adjacent high seas, and that are exploited by coastal states and DWFSs. Mackerel, Norwegian spring spawning herring and blue whiting all fit this definition.

Non-cooperative management of resources is likely to lead to overexploitation. This is clearly evidenced by the three stocks under consideration, as will be discussed below. Based on game theoretic analysis, some basic principles of cooperative management have been derived. Given the ability of players to communicate, under the right circumstances a stable cooperative management regime may be established. At least three conditions must be met for a cooperative agreement to be preferred to competitive exploitation. First, the solution must be Pareto optimal. Thus, if one country is to gain more, it can only be at the expense of others. Second, payoff from cooperation must be at least as great as under non-cooperation, i.e., everybody must gain from cooperating. Third, the solution must be time consistent or resilient.

If side payments are introduced, the scope for bargaining increases. Side payments may be introduced with a two-fold purpose: First, to enhance the scope for bargaining. Second, to enhance the flexibility and the resilience of the cooperative arrangement.

According to the UNFSA, a RFMO is to be open to all states having a "real" interest in the fishery encompassed by the RFMO; this includes coastal states and "relevant" DWFSs. Would-be new members can only be excluded on grounds of non-cooperation.

Cooperative management of straddling fish stocks will likely be more difficult than cooperative management of «shared» fish stocks. The key reason for this is that members of

an RFMO may change over time. An example is provided by Iceland in the mackerel fishery as due to changes in the migratory pattern, mackerel has in recent years been found also in the Icelandic EEZ. Under the terms of the UN Fish Stock Agreement, would-be new members cannot be barred from a RFMO unless they refuse to abide by the RFMO management regime.

Economic analysis suggests that resolution of the new member problem may call for granting "charter" members of a RFMO de facto property rights to the relevant resources. Possible solutions to the problem may be that a new country may join only if an established country leaves, a waiting period for new entrants is introduced, or fees are imposed on new entrants. Some of these issues depend critically on a legal interpretation of the UN Fish Stock Agreement.

As is well known, many of the world fish stocks are seriously depleted (FAO, 2012). This applies to straddling stocks as well. Therefore, many RFMOs will be faced with the task of rebuilding stocks. To the degree this is successful, the incentives for new countries to enter the fishery increase.

If RFMOs lead to successful cooperative resource management, relevant high seas adjacent to EEZ will become high seas in name only and the stock will be managed as a shared stock.

Unforeseen changes in fish stocks' migrations between national EEZs makes the issue of arriving at and maintaining cooperative agreements on total allowable catches (TAC) and the distribution of these among the interested nations difficult. «Zonal Attachment» is a concept that has been suggested as a way to overcome disputes on how to share the quotas of such fish stocks. The concept has been applied to the management of shared stocks between the European Union and Norway (see Bjørndal and Lindroos, 2004; Hannesson 2013a). Briefly, this works as follows. "Zonal attachment" of a stock is the share of the stock residing within a particular country's EEZ, if necessary weighted by the time it spends in a country's zone over a year. This, then, determines, or at least influences, the share that each country gets of the total catch quota for that stock.

With the division of catch quotas based on zonal attachment of fish stocks, it is unsurprising that changes in fish migrations lead to a breakdown of existing agreements. This is an example that a cooperative agreement may not be time-consistent which was indeed the reason for the temporary breakdown in the cooperative management agreement for

Norwegian spring spawning herring during the period 2003-07 (table 2 below; see Bjørndal and Munro, 2012 for further analysis).

However, the problems surrounding the zonal attachment as a basis for the division of overall fish quotas do not end there. One may ask whether zonal attachment is at all a suitable criterion to distribute fish quotas. The answer is "not necessarily", as discussed by Hannesson (2006, 2007) in the context of a given zonal attachment. Further, when Hannesson (2013a) extended the analysis to the cases where the zonal attachment varies over time and more than one stock is involved, the results largely confirmed the previous results, where stock sharing on the basis of zonal attachment was shown as likely to be unacceptable, because it would give the player with a minor interest a worse outcome than he would get by pursuing his own interest in the absence of cooperation. However, Hannesson (2013a) also showed that the scope of cooperation is greater if countries share more than one stock. For this to happen, each country has to be a dominant player with respect to one stock. If a country is a minor player for both stocks we only have an extended version of the minor player problem (Hannesson 2013c).

These results have empirical implications. As has often been pointed out, the countries involved share several stocks (herring and blue whiting, besides mackerel), all of which fluctuate over time in ways that seem largely uncorrelated. The idea has been put forward that it ought to be easier to agree on sharing these stocks if all of them were considered jointly. What these results have shown is that this is not necessarily the case (Hannesson, 2013a, b). The problem is that the Faeroe Islands and Iceland are minor players with respect to all of these stocks, and in that case agreement will not necessarily be any easier when considering all of them jointly.

3. OVERVIEW OVER RELEVANT STOCKS

3.1 Northeast Atlantic Mackerel

The International Council for the Exploration of the Seas (ICES) currently uses the term "North East Atlantic Mackerel" (*Scomber scombrus*) to define the mackerel present in the area extending from ICES Division IXa in the south to Division IIa in the north, including mackerel in the North Sea and Division IIIa.

The stock is historically divided into three components, with the North Sea component considered to be overfished since the late 1970s, and the western component

contributing the vast majority of biomass and catch to the stock (ICES, 2007a). For management purposes, they are treated as one stock because the stocks mix at times when they are jointly harvested (Kennedy, 2003). Therefore, fishing effort is in the main not directed at any one of the three separate components, but at a single combined stock. It has not been possible to calculate the total catch taken from the North Sea stock component separately because of the low stock size and low catches taken from Divisions IVbc, but it has been assumed to be 10,000 tonnes for a number of years (ICES, 2007a).

Total catches peaked in 1979 at 843,000 tonnes, and more recently in 1993 and 1994 around 820 000 tonnes (figure 1). They have remained at about 650,000 tonnes since 1995, but catches declined to around 473,000 tonnes in 2006 (1). Subsequently they recovered, with catches of 735,000 tonnes recorded in 2009.

ICES classify the stock as being harvested unsustainably. Spawning stock biomass (SSB) was around 2.5 million tonnes for the period 1992-99 but subsequently declined to 1.75 million tonnes in 2002-03. It has shown an increasing trend in recent years, with 2.98 million tonnes recorded for 2010 (figure 1). Misreporting of catches is also a serious problem. The ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (WGMHSA) has found substantial levels of unaccounted mortality, and these unaccounted removals have been estimated to be more than 60% of the reported catch (ICES, 2007). The Coastal States, the EU, the Faeroe Islands and Norway, have adopted a series of control measures regarding the weighing and inspection of landings for mackerel that should help to resolve this problem.

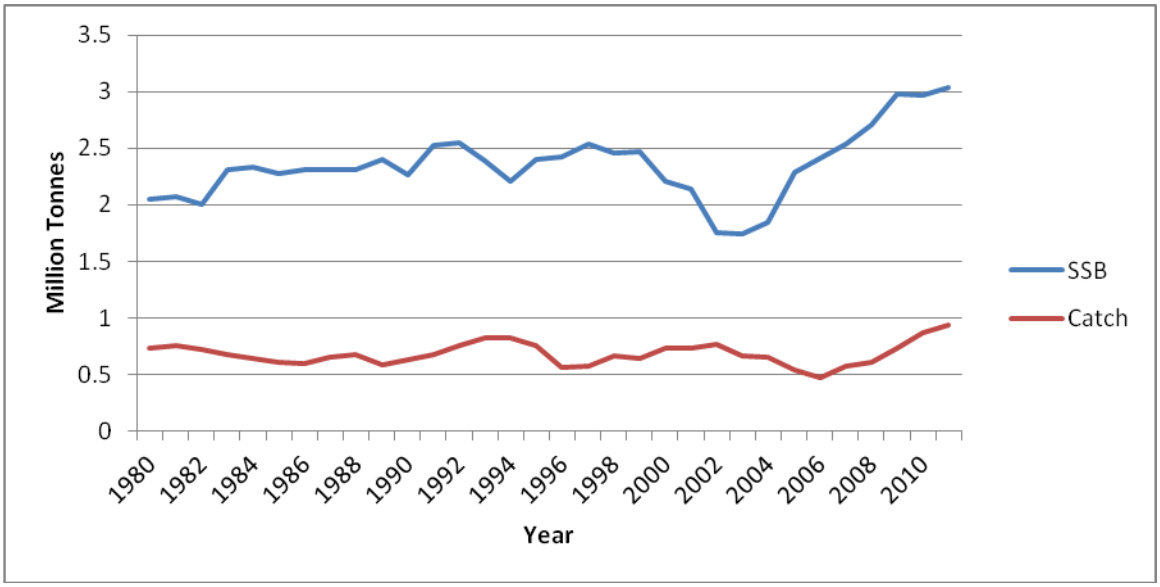

Figure 1. Spawning Stock Biomass (SSB) and Catches (including discards) of Northeast Atlantic Mackerel 1980–2011 (million tonnes).
Source: ICES Advice 2010, Book 9, table 9.4.2.7. ICES WGWIDE Report 2012 for 2010-11.

A number of countries harvest mackerel. Harvests by the main countries are given in figure 2. According to the official catch statistics, in 2005 about 60% of the catches were taken by member countries of EU, followed by Norway (28%), Russia (9%), Faeroe Islands (2%), and Iceland (less than 0.1%). In 2009, EU countries accounted for 53.5%, followed by Norway (19.2%), Iceland (18.4%), Russia (6.6%) and Faeroe Islands (2.3%). The landings of the mackerel in the Convention Area and in the Regulatory Area in 2004 were reported to be 527,000 tonnes, and 41,000 tonnes, respectively (NEAFC, 2006).

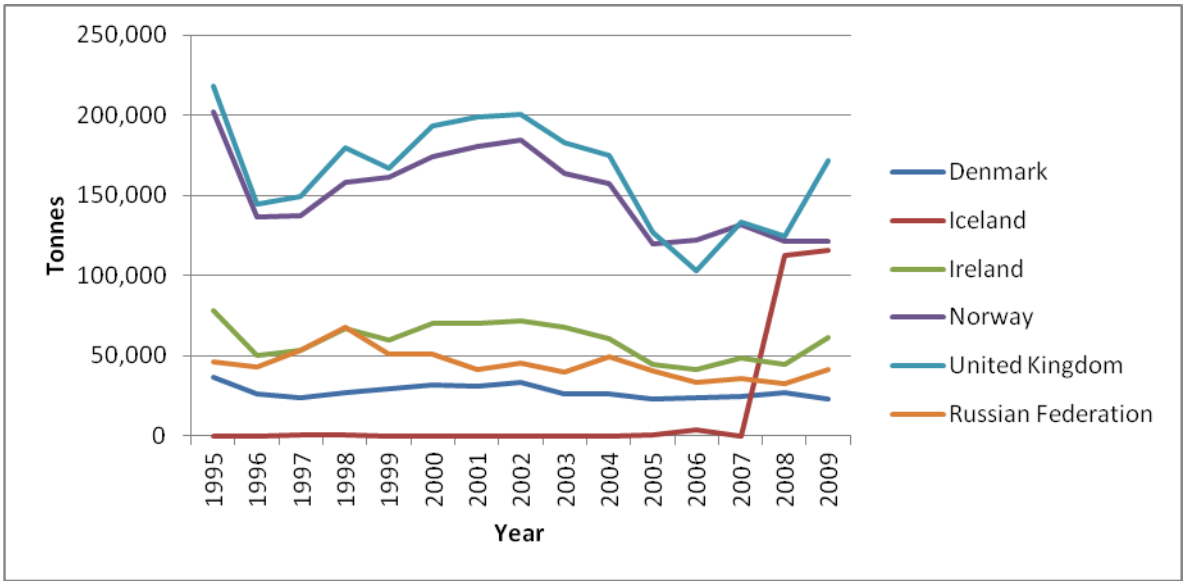

Figure 2. Catches of Mackerel by country in the Northeast Atlantic, 1995–2009. Tonnes.

While Iceland had virtually no harvest of mackerel up to 2007, this changed in 2008, when Icelandic pelagic fishing companies caught 112,000 tonnes of mackerel, increasing to 116,000 tonnes in 2009. This appears to be due to changes in the distribution pattern of mackerel which now partly migrate into the Icelandic EEZ. While Iceland had no quota and hardly any catches in the past, this is likely to change in the future. It also means that the mackerel "game" has changed, with essentially the appearance of a new coastal state. At this point it is still uncertain what impact this development may have on the management of mackerel (Hannesson 2013b).

The fishery was regulated by an internationally agreed TAC. In addition a number of management measures are in place to protect the North Sea component of the stock that is considered depleted, and to protect juvenile mackerel.

The international agreement for management of the mackerel fishery broke down after Iceland became a major player as of 2008. Even when an agreement was in place, despite the attempts to control allowable catches, the landings have exceeded the annual TACs in most years (see table 1), sometimes by a considerable amount. The situation appears to be worsening. In 2009, the total agreed TAC was 605,000 tonnes, not including the unilateral Norway/Faroe Islands' TAC first declared this year and the Icelandic TAC; the Advisory Committee for Fisheries Management (ACFM) catch was recorded at 735,000 tonnes. For 2010 there was no internationally agreed TAC.

Although the mackerel stock is at a high level, with spawning stock biomass estimated at 2.928 million tonnes for 2010 (figure 1), the fishery is considered unsustainable due to the fact there is no international management agreement for the fishery.

Table 1: Agreed TAC vs. catch of Northeast Atlantic Mackerel. '000 tonnes.

Year	ICES Advice	Total Agreed TAC [3]	Official landings[5]	Discards and Slipping[1]	ACFM catch[2,4]
1987	Given by stock component	442	616	11	655
1988	Given by stock component	610	622	36	680
1989	Given by stock component	532	576	7	590
1990	Given by stock component	562	580	16	628
1991	Given by stock component	612	609	31	668
1992	Given by stock component	707	729	25	760
1993	Given by stock component	767	784	18	825
1994	Given by stock component	837	794	5	821
1995	Given by stock component	645	729	8	756
1996	Significant reduction in F	452	509	11	564
1997	Significant reduction in F	470	517	19	570
1998	F between 0.15 and 0.2	549	627	8	667
1999	F of 0.15 consistent with PA	562	585	n/a	640
2000	F=0.17: Fpa	612	655	2	738
2001	F=0.17: Fpa	670	660	1	737
2002	F=0.17: Fpa	683	685	24	773
2003	F=0.17: Fpa	583	600	9	670
2004	F=0.17: Fpa	532	587	11	650
2005	F=0.15 to 0.20	422	447	20	543
2006	F=0.15 to 0.20	444	318[6]	18	473
2007	F=0.15 to 0.20	502	558	8	579
2008	F=0.15 to 0.20	458	420	27	611
2009	F=0.15 to 0.20	605[7]	442	13	735
2010	Harvest control rule	---[8]	-	-	869
2011	See scenarios	-	-	-	939

[1]Data on discards and slipping from only two fleets.
[2] Landings and discards from IIa, IIIa, IV, Vb, VI, VII, VIII, and IXa.
[3]All areas except some catches in international waters in II.
[4] Catches updated in 2003 with revisions from SGDRAMA in 2002.
[5]Updated with ICES FishStats data.
[6]Incomplete.
[7]Does not includes the unilateral Norway/Faroe Islands TAC first declared in 2009 and Icelandic TAC.
[8]No internationally agreed TAC for 2010.
Source: ICES Advice 2010, Book 9 table 9.4.2.1, ICES WGWIDE Report 2012 for 2010-11 catches.

From theoretical studies of fisheries games we know that non-cooperative equilibria can be extremely destructive. Could that be the case in the mackerel fishery? There is some reason to think so. The destructive non-cooperative equilibria in fisheries games are due to insensitivity of the unit cost of harvesting to the size of the fish stock, giving players maximising their individual profit an incentive to drive down the stock to a low and perhaps unsustainable level (Bjørndal, 1988). The technology applied in the mackerel fishery (mainly purse seining) is of a kind suspected to produce such stock-independent unit costs. Yet, when Hannesson (2013d) contrasted the outcome in the mackerel fishery with the predictions by the game-theoretic approach it stood out as surprisingly moderate. A possible reason is that unit costs might, after all, be stock-dependent, another that the parties could implicitly recognise the destructive character of a Nash-Cournot non-cooperative equilibrium and tacitly apply a moderate fishing strategy, even if not fully cooperative.

3.2. Norwegian spring spawning herring

The Norwegian spring spawning herring (*Clupea harengus*) or Atlanto-Scandian herring is a straddling stock that is distributed throughout large parts of the North-East Atlantic during its lifespan (Bjørndal *et al.*, 1998) and (ICES, 2007b). The fishery is important for employment and revenue in many countries, including Norway, which records the largest annual harvest, Iceland, Russia, Faeroe Islands, and some other member countries of the EU (Bjørndal, *et al*., 2004). The fishery for Norwegian spring spawning herring follows the migration of the stock closely as it moves from the wintering and spawning grounds along the Norwegian coast to the summer feeding grounds in the Faeroese, Icelandic, Jan Mayen, Svalbard, and international areas (ICES Advice to NEAFC, 2005).

In the 1950s and the 1960s, Norwegian spring-spawning herring was a major commercial species and the stock was subjected to heavy exploitation (Bjørndal, *et al*., 2004). The annual harvest peaked at 2 million tonnes in 1966, but by this time the stock was in serious decline and by the late 1960s the mature stock was almost depleted due to overfishing (Bjørndal, *et al*., 1998). A large increase in fishing effort, new technology, and environmental changes contributed to the collapse of this stock by the late 1960 (ICES Advice to NEAFC, 2005). Due to the moratorium that was put in place to allow an increase in the spawning stock, the stock recovered by the late 1980s/early 1990s (figure 3).

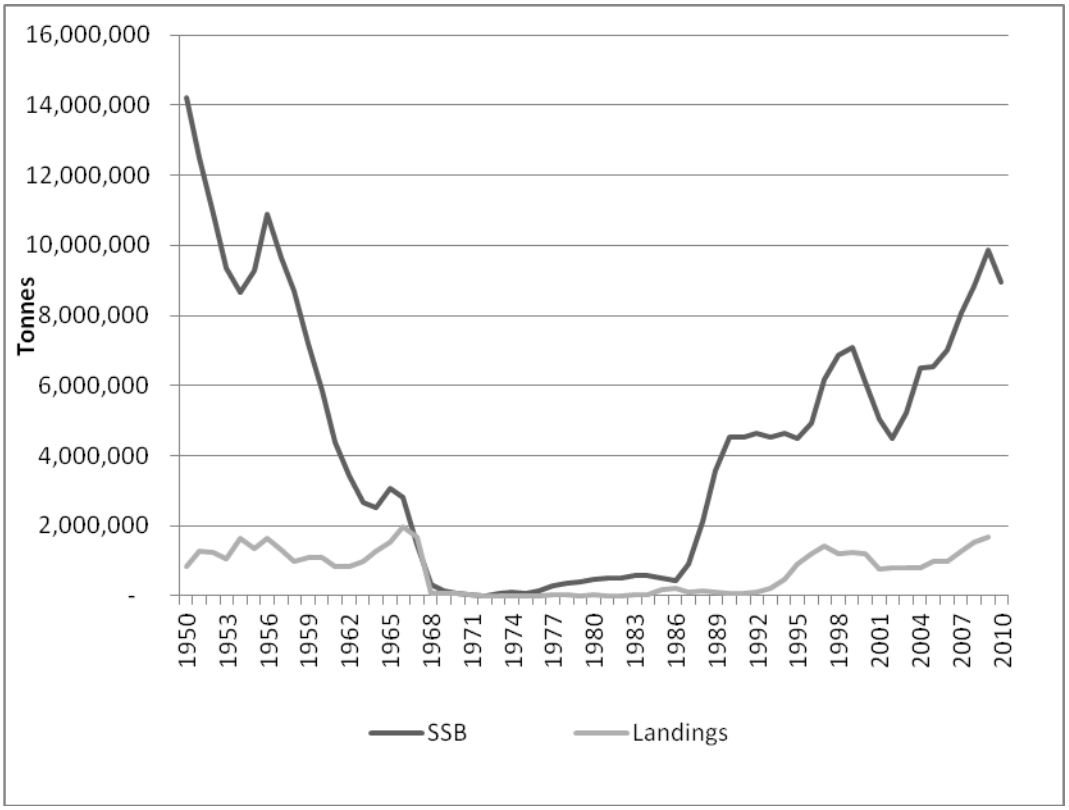

Figure 3. Spawning Stock Biomass (SSB) and Landings of Norwegian Spring-spawning Herring. 1980–2010. Mill. Tonnes.
Sources: Bjørndal and Munro (2012).

Until 1994, the fishery was almost entirely confined to Norwegian coastal waters, but during the summer of 1994 there were also catches in the offshore areas of the Norwegian Sea for the first time in 26 years, due to the herring resuming its traditional migratory pattern (ICES Advice to NEAFC, 2005). In 1995, the Advisory Committee on Fishery Management (ACFM) of the ICES recommended a TAC of 513,000 tonnes, but participating countries ignored the recommendation and the collective harvest of Norway, Russia, Iceland, Faeroe Island and the EU exceeded 900,000 tonnes, almost twice the quantity recommended by ACFM (Bjørndal, *et al*., 1998). The fishery expanded further the subsequent year (figure 3).

In 1996, the EU, the Faeroe Islands, Iceland, Norway, and Russia agreed to implement a long-term management plan for Norwegian spring-spawning herring. The management plan was part of the international agreement on total quota setting and sharing of the quota during the years 1997–2002 (ICES. 2007b). The Parties agreed to maintain a level of SSB greater than the critical level (B_{lim}) of 2,500,000 tonnes, and to restrict their fishing on

the basis of a TAC consistent with a fishing mortality rate of less than 0.125 for appropriate age groups as defined by ICES for the year 2001 and subsequent years.

In addition, there were a number of bilateral agreements between the countries involved. Fishermen from other countries were allowed to harvest part of their quota in the Norwegian EEZ and the control zone around Jan Mayen, which is under Norwegian jurisdiction, thus enabling them to harvest at a time of year when the herring contain more fat and thus are more valuable. Moreover, fishermen from other countries are allowed to land their harvests in Norway, which would tend to reduce transportation distances and thus increase the prices they would fetch. This policy would also benefit the Norwegian fish processing industry. Juvenile herring grow up in the Russian EEZ. To compensate Russia for not harvesting juvenile herring, which would imply growth overfishing, Russia is given a quota in the Norwegian EEZ.

The management plans and coastal state agreements were suspended for four years between 2003 and 2006 due to the disagreement over allocation of quotas. In this period, the bilateral agreements between Norway and other countries were also suspended, except for the one between Norway and Russia regarding juvenile herring.

In January 2007 however, the EU, the Faeroe Islands, Iceland, Norway and the Russian Federation signed an agreement on the management of this stock for 2007. The Parties agreed on a TAC for the Norwegian Spring-Spawning herring of 1.518 million tonnes in 2008. The allocation of the quotas is as follows: European Community 6.51%, Faeroe Islands 5.16%, Iceland 14.51%, Norway 61.00% and Russian Federation 12.82%. The relative quotas have remained unchanged.

The agreed TAC, compared to the actual catch and ICES advice over time, are shown in Table 2. In 2005, the total landings in the Convention Area and in the Regulatory Area were approximately 1,254,000 tonnes, and 195,000 tonnes, respectively (NEAFC, 2006).

Table 2. ICES advice about Total Allowable Catch Quots (TACs), actucal TACs and catch quantity per year, 1995-2011. '000 tonnes.

Year	ICES advice	TAC	Catch	Comment
1995	513	900[a]	906	Non-cooperative exploitation
1996[c]	-	1,425[b]	1,220	Norway, Russia, Iceland and the Faroe Islands reached agreement for total TAC. The EU was fishing at full capacity and set its own quota.
1997[c]	-	1,500	1,427	Cooperation
1998[c]	-	1,300	1,223	Cooperation
1999	1,263	1,300	1,235	Cooperation
2000	Max 1,500	1,250	1,207	Cooperation
2001	753	850	766	Cooperation
2002	853	850	808	Cooperation
2003	710	711[d]	790	Breakdown of cooperation
2004	825	825[d]	794	Breakdown of cooperation
2005	890	1,000[d]	1,003	Breakdown of cooperation
2006	732	967	969	Breakdown of cooperation
2007	1,280	1,280	1,267	Renewed cooperation
2008	1,518	1,518	1,546	Renewed cooperation
2009	1,643	1,642	1,687	Renewed cooperation
2010	1,483	1,483	1,457	Renewed cooperation
2011	-	-	993	Renewed cooperation

[a] Autonomous TACs.
[b] Autonomous TACs were set by April 1996.
[c] For 1996 and 1997, ICES advice was "keep SSB over 2.5 mill tonnes", for 1998, it was "do not exceed the harvest control rule". For these three years, the advice was not quantified in tonnes.
[d] The number is the sum of autonomous quotas for the individual parties.
Source: Bjørndal and Munro (2012); ICES WGWIDE Report 2012 for catch for 2010-11.

The Norwegian spring spawning herring fishery provides a very interesting example with regard to the management of straddling fish stocks. As mentioned, when the stock was in a depressed state, it stayed fully in the Norwegian EEZ. (Bjørndal, et al., 2004) analysed cooperative and competitive management of this stock, including the question whether it might be profitable for Norway to break away from cooperation and maintain a lower stock that would remain under Norwegian control. This was not found to be profitable. The analysis showed that cooperation would give greater benefits than competition to all players,

and that, under no alternative considered, would it benefit a player to break away from cooperation in the long run.

In the years 1997–2002, the partners agreed on the setting of the annual TAC and the shares for each country. The reason the agreement broke down in 2003 was because of Norwegian demands for a higher share of the TAC. These claims were based on the zonal attachment principle or the concept of "biomass by time'' within the zones (stock size within a zone multiplied with the duration of the stay, see (Monstad, 2004). It turned out that the herring spent more time in the Norwegian EEZ than expected when the first agreement was reached and, based on this principle, Norway laid claim to a greater share of the quota. This showed that the original cooperative agreement was not time consistent. In the end, only minor adjustments to the quota shares were made. Although Norway's quota demands were not met, Norway preferred a cooperative agreement to a non-cooperative one.

ICES classify the current status of the stock as having full reproductive capacity and being harvested sustainably.

3.3. Blue Whiting

Blue whiting (*Micromesistius poutassou*) is a pelagic gadoid that is widely distributed in the eastern part of the North Atlantic (ICES, 2007b). The highest concentrations are found along the edge of the continental shelf in areas west of the British Isles and on the Rockall Bank plateau where it occurs in large schools at depths ranging between 300 and 600 m. It is also present in almost all other management areas between the Barents Sea and the Strait of Gibraltar and west to the Irminger Sea (ICES, 2007b).

Multi-national fishing for blue whiting started at the end of the 1970s, with participation mainly from the former Soviet Union (Russia) and Norway (see Standal, 2006). In most of the 1980s and 1990s, the catches were rather stable, however, the catches increased rapidly since 1998 (figure 4), and a new catch record was set almost every year, with catches over 2 million tonnes in 2003–2006. Since then, there has been a substantial decline in catches, with 635,000 tonnes recorded for 2009.

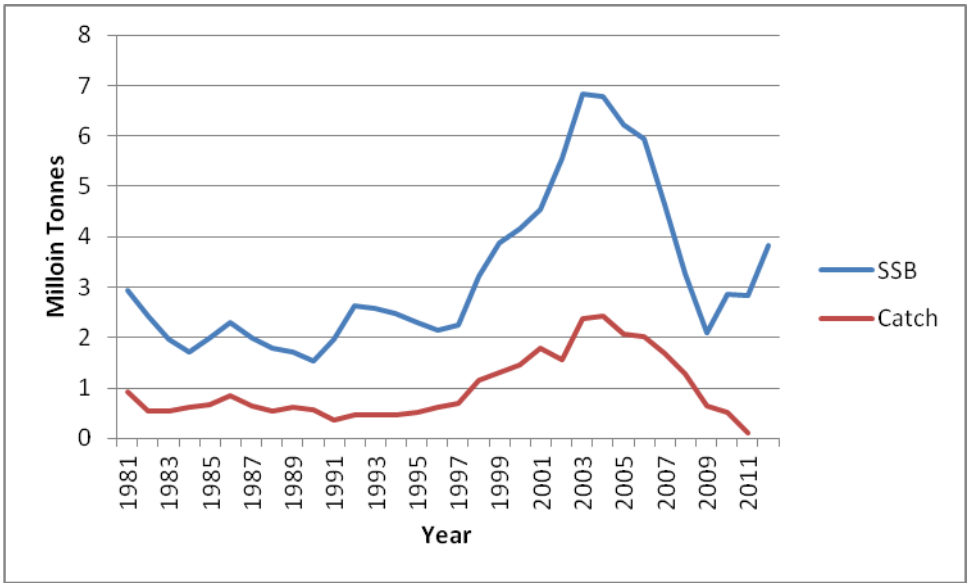

Figure 4. Spawning Stock Biomass (SSB) 1981-2012 and Landings of Blue Whiting 1981–2011 (million tonnes).
Sources: ICES Advice 2010, Book 9 table 9.4.4.5 , Fishstat (catch from 1995 onwards) and ICES WGWIDE report 2012, Table 8.4.5 for 2010-2012 SSB.

The blue whiting fishery was for a time the largest fishery in the North East Atlantic. Its total catch was in excess of two million tonnes in 2006. According to the official catch statistics of NEAFC, Norway accounted for 37% of the total catch in 2005, followed by the EU (19%), Russia (17%), Iceland (13%), and Faeroe Islands (13%). Annual catches by country for 1995–2009 are given in the appendix (table A3) and showed a very substantial increase until 2006, when they started to decline. This was in line with developments in stock size. The landings of blue whiting in the Convention Area in 2004 were 2,407,000 tonnes, of which 721,000 tonnes were in the Regulatory Area.[5]

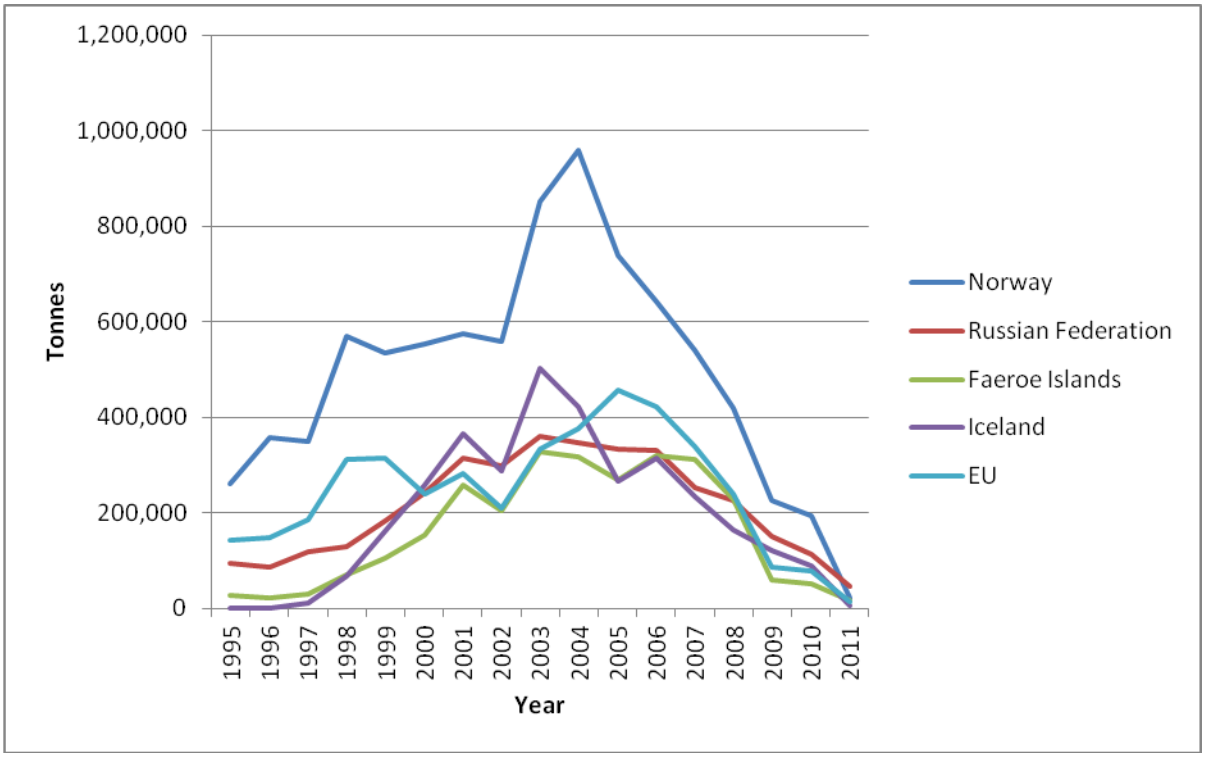

Figure 5. Catches of blue whiting by country in the Northeast Atlantic, 1995–2011 (tonnes).
Source: Appendix, table A4.

The fishery has been regulated by a TAC system since 1994. NEAFC agreed to follow the advice from ACFM regarding an annual total catch quota, but for many years the coastal nations set their own quota, the sum of which far exceeded the recommendation from ICES (Standal, 2006). In 2003, for instance, catches of blue whiting reached a record high of almost 2.4 million tonnes (figure 5), whereas advised catch limit from ICES was around 600,000 tonnes (ICES, 2004).

ICES estimate the SSB (in 2010) to below B_{lim} and F (in 2009) between F_{pa} and F_{lim}. Year classes 2005-2009 are among the lowest observed. Due to recent low recruitment, SSB has declined from its historical peak in 2003-2004 of more than 6 million tonnes to 1.3 million tonnes at the beginning of 2010. Based on the management plan, ICES calculated a TAC for 2011 at 40 100 tonnes. This TAC advice was later followed by NEAFC.

In 2009 ICES advised on the basis of the agreed management plan (F=0.18) that catches in 2010 should be 540,000 tonnes. This advice has been followed quite closely (TAC 548,000 tonnes). The advice for 2011 to follow the management plan (TAC 40,100 t) was also followed, however, the actual catches in 2010 were probably be more than twice as high due to quota transfers from 2010 and other reasons (ICES 2012).

The history leading up to the 2005 agreement is most interesting. Apart from the Russian Federation and Norway, which developed the fishery, the blue whiting was mainly fished by vessels from the Faeroe Islands and countries from the EU. Only minor fishing was carried out by Icelandic vessels until the mid-1990s (Table 4), when a new Icelandic fishery was initiated by a fleet of powerful vessels (Pálsson, 2005). As a consequence, the Icelandic catches of blue whiting increased rapidly, reaching 501,000 tonnes in 2003 (Bjørndal 2009).

The virtually unregulated blue whiting fishery prior to 2006 appears to have been a very attractive strategy for further economic expansion for agents who otherwise fish for herring and mackerel within a system where the harvest quantity is strongly quota regulated and access to the resources is strictly limited (Standal, 2006). There has been a dramatic development in the pelagic fishing fleets from the late 1970s when vessels and equipment were not suitable for the blue whiting fishery. During the past 10–12 years, there has been a considerable modernisation of the fleet of combined purse seiners/blue whiting trawlers with high financial investments and, therefore, a great need for increased catch income. Vessels that were licensed to fish blue whiting faced few restrictions in this fishery, both with respect to quantity and time (Ekerhovd, 2007) and were able to gain maximum use of their catch capacity. Within the framework of licensed-regulated fishing, where only a limited numbers of participants can take part in the otherwise unregulated blue whiting fishery, we see that modern technology has a prominent position where development is accelerated by financial motives for largest possible profit.

For many years the coastal states were not able to reach an agreement on the management of the blue whiting stock. One possible reason for this is pressure from the national fishermen organisations. Then, suddenly, when the fishermen agree, the coastal states follow. There are probably several reasons for this change in mode. One is that that the fishermen knew that the stock could not sustain such a high fishing mortality much longer without collapsing. Secondly, the catches were already decreasing compared to just a couple of years earlier, and this encouraged the vessel owners to find a solution as to how a TAC should be divided while there still was something to share. Another factor that was instrumental for the Norwegian vessel owners' willingness to negotiate was that the extraordinary blue whiting fishery in Norwegian waters during summer and autumn had not been the success they had hoped it to be, and therefore did not back up Norway's claim to 37% of TAC.

The various countries involved have presented alternative ways to show the biological zonal attachment of blue whiting. Some countries use the zonal attachment principle or the concept of "biomass by time'' within the zones (stock size within a zone multiplied with the duration of the stay), while others exclusively employ the catch statistics from the zone as the basic concept. A combination of these two methods is also used, and in some cases other factors such as economic dependency on the fishery were also considered. The relevant parties presented demands for their own quota share along with what they thought the others' shares should be, and the sum of each nation's claim amounted to almost 200% of a possible TAC. With regard to the blue whiting there exist two game theoretic studies (Ekerhovd 2010, 2008). Ekerhovd (2010) analysed within the framework of non-cooperative, endogenous formation of coalitions and coalition structures the effects of distribution scenarios between the coastal states which can harvest blue whiting within their respective EEZ. Russia is currently not recognized as a coastal state for blue whiting, but changing distribution may challenge this, with implications for the management.

A multilateral agreement included an agreement to reduce fishing mortality to sustainable levels within three years. The CPs established an allowable catch limitation of 1.25 million tonnes (NEAFC) of blue whiting for 2008. TAC allocations are as follows: European Community 350,000 tonnes; Faeroe Islands 300,000 tonnes; Norway 296,000 tonnes, and Iceland 202,000 tonnes.

On 16th December 2005, after six years of negotiations, the coastal states of the EU, Faeroe Islands, Iceland, and Norway signed an agreement. The agreement, starting in 2006, includes a long run management strategy that implies annual reductions in the landings until the management goals are reached (The Royal Norwegian Ministry of Fisheries and Coastal Affairs, 2005-2006). This arrangement provided for catches in 2006 of 2 million tonnes (Norwegian Fisheries Website) allocated as follows: EU 30.5%, Faeroe Islands 26.125%, Norway 25.745% and Iceland 17.63%. Russia will be accommodated by transfers from some of the coastal states and additional catches in the NEAFC area (ICES, 2007c). In 2006, Russian catches represented 16.3% of total catches (Table 3).

Table 3. ICES's management advice on TAC for blue whiting: the expected landings (based on the recommendations), TAC agreed upon by the NEAFC Members, and Actual landings ('000 tonnes).

Year	**ICES recommendations**	**Expected landings**	**TAC**	**Actual landings**
1994	Precautionary TAC (northern component); no recommendations on the southern component of the stock	485	650[1]	459
1995	Precautionary TAC for combined stock	518	650[1]	579
1996	Precautionary TAC for combined stock	500	650[1]	646
1997	Precautionary TAC for combined stock	540		672
1998	Precautionary TAC for combined stock	650		1,125
1999	Landings > 650,000 t may not be sustainable in the long run	650		1,256
2000	F should not exceed the proposed F_{pa}	800		1,412
2001	F should not exceed the proposed F_{pa}	628		1,780
2002	Rebuilding plan	0		1,556
2003	F should not exceed the proposed F_{pa}	600		2,321
2004	Achieve 50% probability that F will be less than F_{pa}	925		2,378
2005	Achieve 50% probability that F will be less than F_{pa}	1,075		2,027
2006	F old management plan	1,500	2,100[2]	1,966
2007	F should be less than proposed F_{pa}	980	1,847[3]	1,612
2008	F should be less than F_{pa}	835	1,250[4]	1,246
2009	Maintain stock above B_{pa}	384	606[5]	636
2010	Follow the agreed management plan	540	548	524
2011	See scenarios		40	104
2012			391	

Weights in '000 t.
[1]NEAFC proposal for NEAFC regions 1 and 2.
[2]Agreed TAC from four Coastal States of 2 million tonnes, and an additional allocation to Russia in the international zone of 100 000 t.
[3]Agreed TAC from four Coastal States of 1.7 million tonnes, and an additional allocation to Russia and Greenland of 147 000 t.
[4]Agreed TAC from four Coastal States of 1.1 million tonnes, and an additional allocation to Russia and Greenland.
[5]Agreed TAC from four Coastal States of 0.59 million tonnes, and an additional allocation to Russia (0.016 million tonnes).
Source: ICES Advice 2010, Book 9 table 9.4.4.1; WGWIDE 2011 for 2011 landings; WGDWIDE 2012 for 2012 TAC.

ICES classified the stock as having full reproductive capacity, but being harvested at increased risk. SSB increased to a historical high in 2003, but has decreased since then and was expected to be just above B_{pa} in 2009. The estimated fishing mortality was well above

F_{pa}. Recruitment of the 2005 and 2006 year classes were estimated to be in the very low end of the historical time-series. Surveys indicated that the 2007 year class could also be low.

ICES has evaluated the 2006 management plan and found it not to be in accordance with the precautionary approach in a period of low recruitment. In July 2008 a new draft management plan was proposed by the Coastal States. ICES has evaluated the draft management plan and considers it precautionary if fishing mortality in the first year should immediately be reduced to the fishing mortality that is implied by the Harvest Control Rule (ICES 2009).

4. ECONOMIC ANALYSIS OF THE FISHERIES

As is clear from above, catches of the three species have varied considerably over time. Total annual catch in the post 2000 period has varied between 2.95 and 3.8 million tonnes (table 4).

We have also made an estimate of total value of the three species. This is done on the basis of Norwegian first hand prices (appendix, table A5). In other words, we assume all fishermen harvesting these three species fetch the same prices as Norwegian fishermen.

In reality, prices vary not only by country but also by vessel group or technology (Lappo, 2013). More than that, Lappo (2013) also shows that Norwegian fishermen fetch higher prices for catches of these three species than do fishermen from the United Kingdom and Iceland. Accordingly, these estimates can only be considered an indication of the potential values involved.

Table 4. Total Catch of the Three Species and Estimated Total Value of the Three Species 2000-11.

Year	Total catch of the three species Tonnes	Total value of the three species mill NOK
2000	3,307,617	6,254,917
2001	3,220,142	8,774,930
2002	3,050,517	9,684,655
2003	3,763,616	7,961,399
2004	3,800,365	9,758,097
2005	3,510,177	11,304,725
2006	3,413,643	9,420,111
2007	3,414,291	9,545,686
2008	3,370,618	11,502,097
2009	2,953,840	10,286,549
2010	2,850,297	12,211,253
2011	2,035,409	16,917,657

Based on these assumptions, total nominal value per year varies between 6,255 million NOK (2000) and 16,918 million NOK (2011). The relative variation in value is much more substantial than that for quantities. The changes in value over time can be explained by differences in the composition of the total catch and different prices for the different species as well as changes in these variables over time (Lappo, 2013).

5. CONCLUDING REMARKS

The pelagic fisheries of the North East Atlantic are all harvested by fishermen from the same five countries/parties: the EU, Norway, Faroe Islands, Iceland and Russia. However, the countries' status is not equal in all fisheries. For instance, Russia is only regarded as a coastal state with regard to the Norwegian spring spawning herring while considered a Distant Water Fishing State (DWFS) with respect to the mackerel and blue whiting fisheries. Moreover, Iceland, a coastal state in the herring fishery, claims coastal state status with respect to blue whiting and mackerel. Initially contested, Iceland's coastal state status in the blue whiting fishery was accepted by the other coastal states when they signed a management agreement in 2005.

Since the 1980s, the mackerel fishery was an issue between the EU and Norway, setting an overall catch quota and dividing it among themselves. Later, the Faroe Islands

came to participate in this arrangement. Iceland had not previously fished mackerel in any significant amounts, but began doing so when it migrated into its waters. Iceland was not satisfied with the quota offered by the others and unilaterally set a quota for itself. Soon after, the Faroese withdrew from the cooperation with EU and Norway, finding their quota allocation unacceptably low, compared with what Iceland was taking.

The quotas are set by the coastal states, which *de facto* manage the fisheries, instead of NEAFC, the relevant RFMO (Bjørndal, 2009). This explains the importance of being a coastal state, rather than a DWFS, however "real" the interest in the fishery may be.

Another trait in common among these fisheries is the fact that the management agreement has at some point in time been shown to lack the property of time consistency. The cooperative agreements either collapsed or there have been severe difficulties achieving cooperation. This happens when there are unforeseen changes in the migrations, distribution and abundance of the stocks.

One might think, since they are harvested by the same countries, that a way to overcome these difficulties must be to manage all three stocks jointly. However, for this to be the case, each country has to be a dominant player with respect to at least one stock. The problem is that the Faroe Islands and Iceland must be considered minor players with respect to all three stocks, and considering them jointly will not necessarily make an agreement any easier to achieve.

The management history of these three straddling fish stocks illustrates many of the problems that managers of such stocks are faced with all over the world. Also, these stocks are closely linked: their habitats overlap, and they are fished by the same fishermen from only a handful of countries. In spite of these similarities, they are managed, at least formally, as if they were unrelated; and although multispecies management is no guarantee for stable and resilient cooperation, we can ask if that would be a better way to proceed in the future.

APPENDIX 1. DATA

Table A1. Spawning Stock Biomass (SSB) and Catches (including discards) of Northeast Atlantic Mackerel 1980–2010 (million tonnes).

Year	SSB	Catch
1980	2.053704	0.73495
1981	2.07611	0.754045
1982	2.007181	0.716987
1983	2.309138	0.672283
1984	2.336643	0.641928
1985	2.275007	0.614371
1986	2.306482	0.602201
1987	2.307153	0.654992
1988	2.314265	0.680491
1989	2.395977	0.58592
1990	2.266356	0.626107
1991	2.522688	0.675665
1992	2.54466	0.76069
1993	2.384252	0.824568
1994	2.206047	0.819087
1995	2.397397	0.756277
1996	2.424668	0.563472
1997	2.541173	0.573029
1998	2.457824	0.666316
1999	2.469329	0.640309
2000	2.20595	0.738606
2001	2.138374	0.737463
2002	1.749298	0.772905
2003	1.748701	0.6696
2004	1.848672	0.650221
2005	2.290881	0.543486
2006	2.409602	0.472652
2007	2.540759	0.579379
2008	2.709395	0.612856
2009	2.978321	0.734889
2010	2.973	0.869
2011	3.040	0.939

Source: ICES Advice 2010, Book 9, table 9.4.2.7: ICES WGWIDE Report 2012 for 2010-11.

Table A2. Mackerel Catches by Country.

Year	1995	1996	1997	1998	1999	2000
Belgium	108	64	106	125	178	151
Channel Islands	1	9	9	23	18	16
Denmark	36,758	26,238	24,054	27,415	29,705	31,642
Estonia	2,286	3,741	6,324	7,356	3,595	2,673
Faroe Islands	34,924	19,530	8,401	10,654	11,334	21,022
France	22,807	13,167	14,368	18,764	17,400	20,897
Germany	24,417	16,229	15,864	21,490	19,960	22,980
Iceland	-	92	927	357	144	-
Ireland	78,534	49,966	53,094	67,310	59,609	70,184
Isle of Man	1	-	-	-	4	-
Latvia	534	233	-	-	-	-
Lithuania	6,236	7,334	-	2,823	4,936	2,085
Netherlands	35,787	24,246	23,702	30,163	27,816	32,403
Norway	202,209	136,699	137,256	158,340	161,046	174,228
Poland	-	-	22	-	-	-
Portugal	3,073	3,009	2,083	2,898	2,035	2,254
Romania	30,844	7,265	-	-	-	-
Russian Federation	46,249	43,046	53,732	67,837	51,348	50,772
Spain	10,595	13,748	20,301	25,541	24,026	25,384
Sweden	6,268	5,387	4,390	5,161	5,003	4,500
United Kingdom	218,417	144,964	149,448	179,711	166,658	193,638
Total	760,048	514,967	514,081	625,968	584,815	654,829

Year	2001	2002	2003	2004	2005	2006
Belgium	98	23	4	5	1	4
Channel Islands	14	12	15	16	19	18
Denmark	31,395	33,046	26,425	26,250	23,214	24,234
Estonia	218	-	-	-	-	-
Faroe Islands	22,790	20,356	12,299	14,203	10,310	12,082
France	20,958	22,070	27,463	23,315	18,297	17,366
Germany	25,325	26,536	24,061	23,376	19,120	16,601
Iceland	1	53	122	-	363	4,222
Ireland	70,451	72,189	67,481	60,753	44,981	41,227
Isle of Man	8	6	7	7	-	-
Latvia	-	-	-	-	-	-
Lithuania	1,949	1,600	582	-	-	92
Netherlands	33,109	43,460	29,167	28,006	23,457	22,068
Norway	180,750	184,382	163,535	157,432	119,878	122,011
Poland	-	-	-	-	570	1,368
Portugal	3,121	3,090	2,902	2,779	3,064	2,856
Romania	-	-	-	-	-	-
Russian Federation	41,568	45,811	40,026	49,489	40,506	33,580
Spain	24,382	26,558	18,930	22,139	14,020	16,735
Sweden	5,098	5,232	4,449	4,574	3,205	3,386
United Kingdom	198,953	200,405	183,021	174,730	126,603	103,027
Total	660,188	684,829	600,489	587,074	447,608	420,877

Year	2007	2008	2009	2010	2011
Belgium	1	2	4	29	21
Channel Islands	12	14	16	6	17
Denmark	24,888	26,730	23,230	41,455	35,966
Estonia	-	-	-	-	-
Faroe Islands	14,124	11,920	14,469	70,987	122,050
France	15,730	13,471	11,862	10,987	12,720
Germany	18,574	15,422	22,408	19,055	24,085
Iceland	-	112,352	116,101	121,010	159,266
Ireland	48,789	44,906	61,424	57,994	61,612
Isle of Man	7	6	10	6	7
Latvia	-	7	-	-	-
Lithuania	7	-	111	-	23
Netherlands	24,773	20,395	23,419	23,084	34,500
Norway	131,698	121,496	121,229	233,950	208,070
Poland	978	2	-	-	-
Portugal	3,031	2,954	2,733	22,283	?
Romania	-	-	-	-	
Russian Federation	35,674	32,728	41,428	59,292	73,601
Spain	18,678	16,512	13,952	28,209	30,808
Sweden	3,936	3,662	7,303	3,428	3,248
United Kingdom	133,700	124,927	171,984	160,400	180,970
Total	474,600	547,506	631,683	893,130	1,014,900

Table A3. Blue Whiting by Country

Year	1995	1996	1997	1998	1999	2000
Channel Islands	-	-	1	1	1	-
Denmark	46,182	52,699	33,486	69,305	79,810	62,074
Estonia	13,715	10,982	5,678	6,321	-	-
Faroe Islands	25,936	21,483	28,773	71,217	105,106	152,687
France	6	6,442	12,446	7,992	6,343	16,042
Germany	6,314	6,865	4,722	17,970	3,170	12,654
Greenland	-	-	-	-	-	-
Iceland	369	513	10,480	68,514	160,424	259,157
Ireland	222	1,709	25,987	45,538	35,880	26,067
Japan	1,127	-	-	-	-	-
Lithuania	400	651	-	-	1,231	-
Netherlands	22,685	16,407	24,132	27,693	32,889	43,145
Norway	261,362	356,054	348,268	570,665	534,570	553,478
Poland	-	-	-	-	-	-
Portugal	2,346	3,565	2,448	1,900	2,676	2,169
Russian Federation	93,824	87,310	118,656	130,042	182,637	241,905
Spain	33,397	30,262	37,900	30,549	30,926	28,000
Sweden	13,000	4,038	4,568	6,034	15,511	3,362
United Kingdom	5,495	14,326	33,701	98,936	106,491	45,048
Total	526,380	613,306	691,246	1,152,677	1,297,665	1,445,788

Year	2001	2002	2003	2004	2005	2006
Channel Islands	-	-	-	-	-	-
Denmark	65,067	51,040	87,966	89,523	39,107	58,183
Estonia	-	-	-	-	-	-
Faroe Islands	258,334	204,524	326,593	316,868	267,447	320,592
France	19,054	14,771	16,121	19,476	7,160	21,921
Germany	19,059	17,052	26,988	15,294	22,823	36,442
Greenland	-	-	-	-	-	6,517
Iceland	365,101	286,381	501,494	422,078	265,889	314,755
Ireland	29,910	17,825	22,586	58,426	69,650	54,910
Japan	-	-	-	-	-	-
Lithuania	-	-	-	-	-	4,636
Netherlands	63,625	35,624	57,257	77,183	128,368	96,607
Norway	573,686	557,684	851,395	958,768	738,599	642,452
Poland	-	38	297	345	-	3,891
Portugal	1,763	1,698	3,527	5,749	7,675	2,650
Russian Federation	315,586	298,367	360,160	346,762	332,240	329,400
Spain	28,822	25,522	23,825	29,021	50,095	48,355
Sweden	2,058	18,483	65,532	19,957	4,385	314
United Kingdom	51,889	28,679	29,386	59,841	126,131	82,141
Total	1,793,954	1,557,688	2,373,127	2,419,291	2,059,569	2,023,766

Year	2007	2008	2009
Channel Islands	-	-	-
Denmark	52,656	17,997	247
Estonia	-	-	-
Faroe Islands	312,005	229,537	58,324
France	19,943	19,943	6,981
Germany	34,679	25,293	5,023
Greenland	5,389	5,215	60
Iceland	234,952	163,794	120,197
Ireland	31,092	22,852	9,250
Japan	-	-	-
Lithuania	9,812	5,365	-
Netherlands	80,730	78,781	35,758
Norway	539,589	418,289	225,996
Poland	7,573	-	-
Portugal	3,933	4,752	2,137
Russian Federation	252,277	225,163	149,649
Spain	31,078	21,980	15,182
Sweden	517	-	3
United Kingdom	56,466	38,151	6,350
Total	1,672,691	1,277,112	635,157

Table A4. Catches of blue whiting by country in the Northeast Atlantic, 1995–2011 (tonnes).

Country	**1995**[a]	**1996**	**1997**	**1998**	**1999**	**2000**
Norway	261,362	356,054	348,268	570,665	534,570	553,478
Russian Federation	93,824	87,310	118,656	130,042	182,637	241,905
Faeroe Islands	25,936	21,483	28,773	71,217	105,106	152,687
Iceland	369	513	10,480	68,514	160,424	259,157
EU	143,762	147,946	185,068	312,238	314,927	238,561
Total	526,380	613,306	691,246	1,152,677	1,297,665	1,445,788
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
Norway	573,686	557,684	851,396	958,768	738,599	642,452
Russian Federation	315,586	298,367	360,160	346,762	332,240	329,400
Faeroe Islands	258,334	204,524	326,593	316,868	267,447	320,592
Iceland	365,101	286,381	501,494	422,078	265,889	314,755
EU	281,247	210,732	333,485	374,815	455,394	421,539
Total	1,793,954	1,557,688	2,373,128	2,419,291	2,059,569	2,028,738
	2007	**2008**	**2009**	**2010**[b]	**2011**	
Norway	539,589	418,289	225,996	194,317	20,539	
Russian Federation	252,277	225,163	149,649	112,553	45,841	
Faeroe Islands	312,005	229,537	58,324	49,979	16,405	
Iceland	234,952	163,794	120,197	87,942	5,887	
EU	337,304	240,286	85,154	79,041	14,920	
Total	1,676,127	1,277,069	639,320	523,832	103,592	

[a] Japanese catch of 1,127 tonnes are included in 1995 total.
Source: FAO FISHSTAT
[b] Catches in 2010 and 2011. Source: ICES ACOM WGWIDE report 2012, Table 8.3.1.1.

Table A5. Prices per kg.

Year	NSSH	Mackerel	Blue whiting
2000	1.70	5.16	0.57
2001	3.82	6.93	0.71
2002	3.79	7.35	1.02
2003	2.66	6.36	0.86
2004	3.61	8.36	0.82
2005	4.19	12.60	0.71
2006	3.30	8.87	1.23
2007	2.50	7.80	1.60
2008	2.71	10.93	1.04
2009	2.47	8.25	1.43
2010	2.94	8.14	1.91
2011	5.30	12.04	3.45

Source: Norges Sildesalgslag. Omsetningsstatistikk

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[1] NEAFC also has other Regulatory Areas but not of relevance to this article.
[2] This section draws heavily on Bjørndal and Munro (2007 and 2012).

The purpose of this paper is to give an overview over the fisheries for Norwegian spring spawning herring, mackerel and blue whiting and analyse how they are managed. The stocks under consideration are harvested by coastal states and distant water fishing states (DWFS). For herring, however, Norway, Russia, Iceland, the Faroe Islands and the EU are all coastal states with the stock not being exploited by any DWFS. There have been difficulties in reaching agreement of the management for all three stocks. The reason for these problems is that the distribution of the stocks and the different countries' fishing opportunities have changed from time to time, putting the existing management arrangement under pressure. Here we review the management and current sustainability of the fisheries.

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