Deliverable D 6.4

Comparative review of different fisheries management systems across the world (European Union, Iceland, New Zealand, Australia)

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# Table of Contents

SOCIOEC ................................................................................................................................................... 1

Socio-economic effects of management measures of the future CFP .................................................... 1

Deliverable D 6.4 ..................................................................................................................................... 1

Comparative review of different fisheries management systems across the world (European Union, Iceland, New Zealand, Australia) ............................................................................................................. 1

Abstract ............................................................................................................................................... 3

Introduction ......................................................................................................................................... 4

The complexities of fisheries management ........................................................................................ 6

Historical background .......................................................................................................................... 7

Pre-1983 period: burgeoning fisheries management ..................................................................... 7

1983-1992: development of legally-binding fisheries policies ......................................................... 8


2003-2012: towards uniform and integrated fisheries management............................................. 9

Management institutions and processes .......................................................................................... 13

Decision-making ............................................................................................................................ 13

Operational policy ......................................................................................................................... 14

Science ........................................................................................................................................... 16

Management objectives and principles ............................................................................................ 17

Management strategies .................................................................................................................... 20

Management tools ............................................................................................................................ 24

Conservation measures ................................................................................................................. 24

Access regulations ............................................................................................................................ 29

Compliance and enforcement ....................................................................................................... 32

Management performance ............................................................................................................... 35

Conservation ................................................................................................................................. 35

Economics ....................................................................................................................................... 39

Social aspects .................................................................................................................................. 41

Conclusions ........................................................................................................................................ 43

References ......................................................................................................................................... 46
Abstract

In this study, we have compared the respective strengths and weaknesses of fisheries management in the EU, Iceland, New Zealand and Australia. Australia and New Zealand have been at the forefront of bringing in stakeholders’ involvement. The EU has more recently taken significant steps to better involve stakeholders by promoting Regional Advisory Councils. New Zealand and Australia have for over two decades made explicit legally-binding fisheries management targets in their founding decrees. The general attitude of Icelandic decision-makers has been to follow scientific advice fairly closely. The CFP does not provide clear management targets, which has often resulted in EU TAC being set far away from advised catches. This distortion, however, has been reduced since the implementation of management plans. In the Mediterranean Sea, management plans have also been implemented unilaterally by some EU member states. However, many EU stocks and fisheries are still not subject to management plans. It is worth to note that ICES is now providing advice for most commercial fish stocks in the Northeast Atlantic, including DLS, thereby providing a scientific rationale to support the application of future EU management plans and TAC-setting (or effort management) to a broader range of stocks and fisheries. Gear regulations are particularly strict in Iceland compared to the EU. A strict discard ban is enforced in New Zealand and Iceland. Fisheries-restrictive area closures have been implemented in Australia, New Zealand and Iceland. There are only few examples where closed areas have effectively constrained EU fishing activities. New Zealand and Iceland have been pioneers spreading out a generalized Individual Transferable Quotas (ITQs) system. The EU has not vested authority to allocate quotas to individual fishers, but some EU member states have, however, adopted unilaterally a formal ITQ system while others have developed governance systems based on co-management. Fisheries management in Australia, New Zealand and Iceland has, overall, performed better than in the EU, in terms of fisheries resource conservation and economic efficiency. It is worth noting that the situation of EU fisheries has, overall, improved in the past ten years, especially in the Northeast Atlantic, however, the lack of recruitment recovery for many fish stocks remains a source of concern to fisheries managers and advisers.
Introduction

Fisheries management in developed countries worldwide has developed following different paths, despite generally similar management principles. These management principles have been broadly agreed during International Conferences but introduced at national levels to varying degrees. The first of these worldwide conferences was the United Nations Conference on the Human Environment that was held in Stockholm in 1972. The Stockholm Declaration resulted in 26 principles concerning the environment and development, and put forward in particular the link between ecological management, economic development and social welfare (UN 1972). Twenty years later, the 1992 Rio Declaration on Environment and Development introduced the concept of sustainable development and the precautionary principle (UN 1992). The 2002 Johannesburg World Summit on Sustainable Development called for a stronger implementation of the general sustainable development principles that were brought forward in Stockholm and Rio (UN 2002). A major outcome of the 2002 World Summit was a Plan of Implementation establishing some binding deadlines for achieving goals related to oceans and coasts that were endorsed by the signing parties. Of particular relevance to fisheries management was the implementation of the ecosystem approach to fisheries by 2010, a significant reduction of the rate of biodiversity impairment by 2010, the establishment of a marine protected areas network by 2012, and the achievement of the Maximum Sustainable Yield (MSY), wherever possible, by 2015. Finally, the political commitment engaged during previous Earth Summits was reaffirmed during the 2012 Rio Conference on Sustainable Development (UN 2012).

The degree and extent to which these principles and objectives were implemented at national or supra-national level by management agencies worldwide has been rather variable. The experience of EU fisheries management is rather unique in its scope and ambition, in that it represents the only example of reconciling and pulling together the concerns of a variety of coastal countries and eco-regions with diverse, if not divergent, interests into a Common Fisheries Policy, the CFP. The EU Common Fisheries Policy (CFP) has been incepted in 1983, and subsequently revised twice in 1993 and 2003. The third reform of the CFP is now well underway, with inception planned in 2014, although more discussion with the governments of individual EU members is still needed before full enforcement. It is notable that experiences drawn from other countries’ fisheries management are being considered to shape up the new CFP. Comparing the background, context and performances of management systems worldwide is particularly enlightening and timely to inform EU fisheries managers before the full enforcement of the new CFP. In the recent past, there have been reviews that compared specific fisheries management items across a range of countries, e.g., catch-quota balancing, individual quotas and discarding practices (Sanchirico et al. 2006), or compared fisheries management in a broader sense but across a relatively limited number of eco-regions and/or fisheries (Marchal et al. 2009; STECF 2012c; Large et al. 2013). STECF (2012c) and Nielsen et al. (2013) have reviewed and compared management performances, in terms of ecosystem conservation, for a broad range of EU eco-regions. However, we are not aware of any studies contrasting the specifics of fisheries management across the diversity of EU eco-regions and fisheries, and also with other countries outside the EU.

Although all EU fisheries are bound by the CFP, some management attitudes are specific to the eco-region where they operate. In this study, we will investigate and contrast EU fisheries management applicable to either fleets operating in specific eco-regions such as the Baltic Sea, the North Sea,
Western Waters (hereby covering the English Channel, Western Scotland, the Irish Sea, the Celtic Sea, and the Bay of Biscay), or the Mediterranean Sea. Note that this pan-European review will already embrace a great variety of fisheries management attitudes, some being fairly advanced like in the North Sea where some countries (sometimes all of them) have traditionally been at the forefront of experimenting creative management instruments and concepts (e.g., Individual Transferable Quotas, catch quotas, mixed-fisheries management, stakeholders involvement), and others where fisheries management is at a rather early stage of development like in the Mediterranean Sea. This fisheries management synthesis will then be juxtaposed to experiences drawn from a selection of contrasted non-EU countries where fisheries management is believed to have been successful: Iceland, Australia and New Zealand.

There are indeed substantial contrasts across fisheries contexts in the EU, Iceland, New Zealand and Australia, as illustrated in Table 1. First, the EU has no centralized governance, unlike Iceland, New Zealand and Australia, which are sovereign countries. Also, while New Zealand and Australia have very wide Exclusive Economic Zone (EEZ), the combined EU EEZ amounts to 25 million km², which is larger than any single country’s EEZ. The EU fisheries level of employment and landing value are larger than in Iceland, New Zealand and Australia. However the EU is the first importing nation of fishery products in the world, whereas the Icelandic and New Zealand’s economies are clearly orientated towards the exportation of these products, resulting in a positive trade balance.

This comparative review will be articulated along the historical background, the description (processes, objectives, strategies, and instruments) and the performances of the different fisheries management within and outside the EU. Note that for the purpose of easing comparisons, the focus will here be on fleets targeting fish and shellfish species harvested either exclusively in EU waters or shared with a limited number of countries. Therefore, straddling species such as tunas, salmon, or toothfish, which are managed by specific Regional Fisheries Management Organizations (e.g., ICCAT, NASCO, NEAFC, CCAMLR) are excluded from this analysis. Also, this review will address large-scale fisheries management (e.g., EU-wide or Commonwealth Australia), and not local management that may be implemented unilaterally by individual states (EU, Australia).
**Table 1.** Main fisheries statistics for the EU, Iceland, New Zealand and Australia, including the Exclusive Economic Zone (EEZ) area, fleet size, employment in harvest sector, total capture production, landings value and trade. Sources: (http://en.wikipedia.org/wiki/Exclusive_economic_zone), FAO(2012), OECD(2012).

<table>
<thead>
<tr>
<th></th>
<th>EU</th>
<th>Iceland</th>
<th>New Zealand</th>
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</thead>
<tbody>
<tr>
<td>EEZ (million km(^2))</td>
<td>25</td>
<td>0.8</td>
<td>7</td>
</tr>
<tr>
<td>No. vessels 2010</td>
<td>83,796</td>
<td>1,625</td>
<td>1,401</td>
</tr>
<tr>
<td>Employment in harvest sector 2009</td>
<td>164,714</td>
<td>4,300</td>
<td>1,820</td>
</tr>
<tr>
<td>Total capture production 2010</td>
<td>Volume (t)</td>
<td>4,943,782</td>
<td>1,062,970</td>
</tr>
<tr>
<td>Landing value 2009 (Million US $)</td>
<td>Total landings</td>
<td>9,066</td>
<td>933</td>
</tr>
<tr>
<td>Trade 2010 (Million US $)</td>
<td>Total imports</td>
<td>22,276</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>Total exports</td>
<td>3,926</td>
<td>1,842</td>
</tr>
<tr>
<td>Trade balance</td>
<td>-18,350</td>
<td>+1,756</td>
<td>950</td>
</tr>
</tbody>
</table>

The complexities of fisheries management

Most economically valuable fisheries around the world, particularly in the developed world, are managed according to quite straightforward principles: that is, commercial fishing vessels are licensed, the key stocks (historically the most economically valuable and therefore most targeted) are assessed, and limitations are placed on the catch of those stocks through input controls (e.g. restricting effort) or output controls (e.g. restricting landings or catch). This is consistent across the EU, New Zealand, Australia and Iceland. The objectives of fisheries management follow these principles but also provide for objectives relating to the wider economy and ecosystem. The ‘success’ of fisheries management is viewed against the targets placed on these objectives, but almost solely judged by the level of sustainability (e.g. biomass) of the key stocks. The complexities of management therefore reflect how these objectives fit into the decision making process. Ideally, fishing capacity will find a level that maximises yield year-on-year and not just the short term. The difficulty of managing fishing capacity is reflected in the targets assigned to the objectives and how capacity changes to meet the objectives in the short-medium term through to long term. However, it is typical of political systems that the short term view is prioritised over the long term.

Some simple indicators of the size of the EU system versus Iceland, New Zealand and Australia (IC-NZ-AU) are presented in Table 1. For example, in 2010 IC-NZ-AU had 6% the number of vessels of the EU, in 2009 IC-NZ-AU had 8% the employment in the harvest sector of the EU, in 2009 IC-NZ-AU had 25% of the landing value of the EU, and internal market demand (including imports) that approximates US$27billion in the EU versus just over US$1billion in IC-NZ-AU. This is in contrast to the total size of the EEZs where the EU is only 1.5 times the size of IC-NZ-AU. The density and pressures on EU fisheries is therefore massively greater than IC-NZ-AU, even if 84% of the fleet can
be considered as small scale (Guyader et al. 2013).

The biggest difference between EEZs in EU versus IC-NZ-AU is that in the EU all 28 countries have overlapping EEZs, with the main biological objectives managed centrally by the EU, where in IC-NZ-AU they are autonomous. One of the pillars of the Common Fisheries Policy, which has been updated twice since its inception in 1983, is relative stability, essentially ensuring that the proportions of key stocks allocated to member states remain fixed. On a yearly basis at the Council of Ministers quota allocations for the key EU stocks are agreed, with each member state representing their own best interests. The administrative complexity of the EU system is highlighted here as agreement must be reached with Governments and lobby groups arguing for their fishing industry and local communities in light of scientific advice and last year’s activity. In IC-NZ-AU, with only one country involved in each, this process is far less complicated even though the same issues are addressed. In the EU, this remains possibly the biggest reason why scientific advice has been followed less closely than in IC-NZ-AU.

Economic and market controls (e.g. ITQs) play a part in driving the behaviour of the fishing industry, as shown in IC-NZ-AU, however in the EU the political process still drives overall management targets. The CFP Reform paves the way for much greater inclusion of innovative management approaches, for example stakeholder involvement and ITQs, as in IC-NZ-AU. Even in recent years, the EU has made some significant steps in this area (e.g. pelagics in Northern Europe).

The complexity of management as described by the knowledge base varies hugely across regions. For example in the EU, considerable scientific assessment has been undertaken in the North Sea for 100 years whereas in the Mediterranean scientific assessments are not routinely conducted. Most fisheries in IC-NZ-AU are based on targeting single species where the knowledge base is good. EU fisheries are multi-species where the knowledge base is good in parts but sometimes inconsistent. This makes setting targets significantly more difficult especially where relative stability plays such a strong part. Therefore, tending towards optimal use of resources is naturally more challenging in the EU than in IC-NZ-AU. However, in the CFP Reform, transparency is a key item on the agenda especially with respect to landing obligations. It’s not possible to compare this with IC-NZ-AU, but this has the potential to drive a step-change in fisheries that has not been seen before and the knowledge gained from positive approaches in IC-NZ-AU are critical in identifying the way forward.

### Historical background

We present below a comparative review of how fisheries management in the European Union, New Zealand, Australia and Iceland have evolved over the period 1983-2012. The key milestones of this evolution are shown in Table 2.

**Pre-1983 period: burgeoning fisheries management**

Before 1983, fisheries worldwide were subject to little management. Importantly though, in line with international agreements, most maritime countries worldwide (e.g., EU members – except in the Mediterranean Sea - and Iceland in 1976, New Zealand in 1977, Australia in 1979) extended their exclusive fishing grounds from 12 to 200 nautical miles around their coasts.
The EU then consisted of 10 countries, 9 of which had a maritime border: France, Western Germany, Italy, Belgium, The Netherlands, Denmark, Ireland, the UK and Greece. The prevalent fisheries management body in the North-East Atlantic (covering the North Sea and Western Waters in particular) was the North-East Atlantic Fisheries Commission (NEAFC), which was first established in 1946. The NEAFC provided management guidance under various forms, including catch quota. However, these quotas were not legally binding, and often ignored. In 1976, following the extension of its EEZ, the European Community estimated it was best positioned to manage fisheries in the waters under its jurisdiction, and gradually took over NEAFC in the North-East Atlantic territorial waters. In 1980, the first technical measures were established for the North Sea fisheries. In the Baltic Sea, the primary fisheries management body was the International Baltic Sea Fisheries Commission (IBSFC). The IBSFC was founded in 1973 in Gdansk, Poland, as one of the first regional organization in charge of managing the common use of marine living resources. At that time, the only EU country participating to the IBSFC was Denmark. In the Mediterranean Sea and the Black Sea, the General Fisheries Commission for the Mediterranean Sea (GFCM) was established in 1949 as a regional agency of the Food and Agricultural Organization (FAO) to “promote the development, conservation, rational management and best utilization of living marine resources”. GFCM, however, did not provide strong impetus to manage fisheries in the Mediterranean Sea. The EU countries members of the GFCM were at that time France, Italy and Greece.

Before 1983, fisheries management in New Zealand and Australia was not more legally binding than in EU waters. It is, however, important to note that customary aspects have been considered by New Zealand in relation to conservation and utilization of marine living resources in their national waters. The Treaty of Waitangi (1840) guaranteed Maori “full exclusive and undisturbed possession of their lands and estates, forests, fisheries”. New Zealand legislation, however, failed to meet the expectations of the Treaty with regards Maori’s fishing rights for 152 years, until an agreement, the Treaty of Waitangi (Fisheries Claim) Settlement Act was reached in 1992 (Marchal et al. 2009). Some fisheries legislations were also adopted at an early stage in New Zealand (1877: Fisheries Protection Act; 1908: first Fisheries Act), and Australia (e.g., 1865: first fisheries legislations in New South Wales). However, these provided only little incentives to limit the exploitation of fisheries resources around these countries’ coasts.

During that period, Iceland had already been more progressive than the current EU member states, New Zealand and Australia, to manage fisheries resources in its EEZ. For instance, Total Allowable Catches (TAC) had already been legally binding for herring (1969) and cod (1976), as well as Individual Vessel Quotas (IVQ) for herring (1976), capelin (1980), and even Individual Transferable Quotas (ITQ) for herring (1979). Iceland was pioneer implementing legally-binding fisheries management at an early stage, as a result of Iceland’s economy being strongly structured by fisheries revenue and employment.

1983-1992: development of legally-binding fisheries policies
The period 1983-1992 marked the development of legally-binding fisheries policies in many countries worldwide, including those investigated here. In the EU, the Common Fisheries Policy (CFP) was incepted in 1983, resulting in legal enforcement of TAC (except in the Mediterranean Sea), technical measures (gear and mesh size restrictions, closed areas and/or seasons), and a fleet capacity reduction scheme: the Multi-Annual Guidance Programme (MAGP). The CFP superseded NEAFC management guidance in EU waters of the North-East Atlantic. In the North Sea, The Netherlands
became the first country to implement an ITQ system stepwise from 1985 onwards. In Western Waters, a main event of that period occurred in 1986, when both Spain and Portugal, two major fishing countries, joined the EU. The 1991 review concluded that the status of many fish stocks had deteriorated, particularly in the North Sea, ten years after the inception of the CFP, and emphasized the lack of management objectives and strategies of the policy (Holden 1994).

By contrast, major changes occurred in New Zealand fisheries management, with $B_{\text{MSY}}$ (average stock biomass level corresponding to the MSY) becoming legal management target in the Fisheries Act 1983. Another major change occurred in 1986 when the New Zealand government implemented a quota management system (QMS), based on ITQ for most fish stocks. The QMS replaced in particular the public-funded buyback programme in vigour until then (Squires 2010). A major challenge to the implementations of the QMS remained its inconsistency with the Treaty of Waitangi. As noted before, an agreement, the Deed of Settlement, was reached in 1992. The Settlement secured Maori 20% of the quota of any new QMS species and 50% of the shares of Sealord, the most important fishing company at that time (Hersoug 2002; Johnson and Haworth 2004; Yandle and Dewees 2008).

In 1991, the Australian Fisheries Management Authority (AFMA) became responsible for managing fisheries under Commonwealth jurisdiction in accordance with the provision of the newly incepted Fisheries Management Act 1991 and Fisheries Administration Act 1991 (Anonymous 2008; Anonymous 2009). In 1992, the Southern and Eastern Scalefish and Shark Fishery (SESSF) became managed by ITQs. In Iceland, all demersal fisheries were under IVQs from 1984, and capelin joined the list of species regulated by ITQs in 1986. With the adoption of the Fisheries Management Act in 1991, ITQs were applied uniformly, except to small vessels.

1993-2002: a gradual strengthening of fisheries management objectives and strategies
In the EU, the period 1993-1992 saw Finland and Sweden joining in (1995). The entrance of these two countries, the fishing activities of which are mainly located in the Baltic Sea, strengthened the weight of the EU in the IBSFC. In parallel, the EU became full member of the Mediterranean Sea GFCM in 1999. However, the most important advance in EU fisheries management was the emergence, in North-East Atlantic waters, of long-term management and/or recovery plans, building on quantifiable objectives (precautionary reference points) and strategies (harvest control rules). The first long-term management plans were established in 1999 through EU-Norway bilateral agreements to manage North Sea cod ($Gadus morhua$), haddock ($Melanogrammus aeglefinus$), saithe ($Pollachius virens$) and herring ($Clupea harengus$), and an EU-Norway-Faroe Island trilateral agreement to manage North-East Atlantic mackerel ($Scomber scombrus$). In Western Waters, a recovery plan was applied to the management of Bay of Biscay sole ($Solea solea$) in 2002. The CFP was subject to a new review in 2002.

In New Zealand and in Iceland, the Fisheries Act and the Fisheries Management Act were reformed both in 1996. The 1996 New Zealand Fisheries Act made explicit provision for stakeholders’ participation, the Deed of Settlement, and the ecosystem approach; the Act was amended in 1998 and 1999, with the aim of improving the flexibility of the catch-quota balancing regime (Anonymous 2005). The new Icelandic Fisheries Management Act included modifications in the ITQ system. No major changes occurred in Australian fisheries management over the period 1993-2002.

2003-2012: towards uniform and integrated fisheries management
In the EU, the 2012 review was followed by a new CFP, which came into force on 1 January 2013. The
main measures brought about by the new CFP were a generalization of recovery plans for threatened stocks and of management plans for others, the promotion of stakeholders’ participation in the management process through the newly established Regional Advisory Committees (RACs), and the withdrawal of grants allocated to build new boats (and subsequently of the MAGPs). The period 2004-2007 was marked by the entrance of 9 new EU members, with fisheries operating mainly in the Baltic Sea (Estonia, Latvia, Lithuania, Poland), the Mediterranean Sea (Cyprus, Malta, Slovenia), and the Black Sea (Bulgaria and Romania). Since all the countries around the Baltic Sea, with the exception of Russia, joined the EU, the IBSFC was dissolved in 2006 and the management function it operated turned into a bilateral agreement between the EU and Russia. As one of the instruments of the new CFP, a long-term management plan for Baltic Sea cod entered into force in 2009, while the move to a multi-species management plan was decided in 2011. ITQs were introduced stepwise in the Danish and Swedish fisheries, starting with pelagics. In the North Sea, days-at-sea limits were imposed in 2002, in relation to the cod recovery plan, along with stepwise changes in technical measures. The long-term management plans established for North Sea gadoids and herring were revisited during that period, and new management plans were developed for North Sea sole and plaice (Pleuronectes platessa). In Western Waters, new recovery and management plans were developed for Northern hake (Merluccius merluccius), Western Channel sole, Western horse mackerel (Trachurus trachurus), Celtic Sea herring, and the Bay of Biscay sole recovery plan was transformed into a long-term management plan. In 2009, the North-East Atlantic mackerel management was aborted following a dispute between the EU and Iceland over the TAC setting.

In New Zealand and Australia, management strategies and harvest control rules were formalised for both data-rich and data-limited fisheries and stocks through the enforcement of Harvest Strategy Standards (New Zealand Ministry of Fisheries 2008) and of a Harvest Strategy Policy (DAFF 2007; Smith et al. 2009), respectively. In Iceland, the main event to note during that period was the generalisation of ITQs to all small-size vessels.
<table>
<thead>
<tr>
<th>&lt; 1983</th>
<th>EU (all)</th>
<th>EU (regional waters)</th>
<th>Iceland</th>
<th>New Zealand</th>
<th>Australia</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>1979: Herring under ITQ</td>
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<td>1980: Capelin under IVQ</td>
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<td></td>
<td></td>
<td></td>
<td>1991: Fisheries Management Act; ITQs applied uniformly except small vessels</td>
<td>1986: ITQs binding</td>
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<td></td>
<td></td>
<td></td>
<td>1994: implementation of cost recovery</td>
<td>1990: ITQs changed from kgs to shares</td>
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<td></td>
<td></td>
<td></td>
<td>1996: new Fisheries Act; modifications of the ITQ system</td>
<td>1992: Deed of Settlement</td>
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<td></td>
<td></td>
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<td>2001: Hoki fishery under MSC</td>
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<td></td>
<td></td>
<td>Western Waters: 2002: Sole VIII RP</td>
<td></td>
<td>2001: FA revised; ACE introduced</td>
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<td></td>
<td></td>
<td>NEA Pelagics: 1999: 1st EU-Norway LTMP for North Sea herring; 1st EU-Norway-Faroe Islands LTMP for NEA mackerel</td>
<td></td>
<td>2001: Hoki fishery under MSC</td>
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<td></td>
<td></td>
<td>Mediterranean Sea: 1999: The EU full member of GFCA</td>
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<tr>
<td>Year</td>
<td>Event</td>
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<tr>
<td>2003-2012</td>
<td>2003: 2nd CFP reform&lt;br&gt;2004: Cyprus, Estonia, Latvia, Lithuania, Malta, Poland, Slovenia join the EU&lt;br&gt;2007: Bulgaria, Romania join the EU</td>
<td></td>
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<tr>
<td>Baltic Sea:</td>
<td>2003: IBFSC cod LTMPs; ITQ stepwise in Denmark&lt;br&gt;2006: EU &amp; Russia take over IBFSC as management body&lt;br&gt;2009: EU cod LTMPs&lt;br&gt;2010: ITQ in Sweden for pelagics</td>
<td></td>
<td></td>
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<tr>
<td>Western Waters:</td>
<td>2004: Northern hake RP&lt;br&gt;2006: Sole VIII LTMP&lt;br&gt;2007: Sole VIIe MAMP; West. horse mackerel MP; Celtic Sea herring RP&lt;br&gt;2011: Celtic Sea herring LTMP</td>
<td></td>
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</tr>
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<td>NEA Pelagics:</td>
<td>2003: ITQ stepwise in Denmark&lt;br&gt;2008: New NS herring &amp; mackerel LTMPs&lt;br&gt;2009: Abortion of the mackerel LTMP</td>
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<td>Mediterranean Sea:</td>
<td>2006: Strengthening of technical measures&lt;br&gt;2008: National MP in Italy&lt;br&gt;2009: Mesh size restrictions; effort reduction</td>
<td></td>
<td></td>
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<tr>
<td>Black Sea:</td>
<td>2007: CFP applicable to Bulgarian &amp; Romanian fisheries; some TAC management</td>
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Management institutions and processes

Decision-making

European Union

Since the inception of the CFP in 1983, the EU has vested authority for managing fisheries in the waters of its jurisdiction, and of fisheries in international waters operated by EU vessels. The EU Council is considered the primary EU institution because only it has the power to adopt legislation. The Council consists of representatives of the Member States in their area of competence. For instance, the Council includes generally the Ministers of Fisheries when making decisions on TACs. With regards to fisheries management, it has been the entire responsibility of the EU Council of Ministers to take decisions on TACs and national quotas, technical measures and fishing effort restrictions, for most of the fisheries shared by several Member states. TACs have traditionally been set by the European Council every year for most of the fish stocks in all EU waters except the Mediterranean Sea and the Black Sea. The system, however, is moving towards a greater involvement of the Parliament and of the Commission in the decision-making process, particularly regarding management plans regulations.

With regard to North-East Atlantic fish stocks, TAC decisions have typically been based on scientific advice, mainly delivered by ICES, but also on the short-term socio-economic concerns from the industry. For heavily exploited stocks, this has often resulted in the agreed TAC being a compromise between the catch options advocated by scientific advisors and the status quo. However, the advent and gradual spreading of management plans in all EU waters since the beginning of the century has increasingly riveted the TAC level to scientific advice. In a number of Regions, multilateral agreements between the EU and third countries have been sought to set TACs (EU-Norway agreement regarding North Sea gadoids and herring, EU-Russia agreement regarding Baltic Sea stocks, EU-Norway-Russia-Iceland-Faroe Islands agreement regarding Norwegian spring spawning herring), sometimes without success (North-East Atlantic mackerel most recently). The overall agreed TAC is then divided between member states based on a fixed allocation key (principle of “relative stability”), modified by “Hague Preferences” (Holden, 1994). However, exchanges of national quotas between member states are authorized. An area where the EU does not yet take responsibility is in allocating national quotas to individual fishers.

With regard to Mediterranean demersal and small pelagic fisheries, the GFCM, the EU (as contracting party of the GFCM) and national states share decision-making responsibilities. Efficient conservation action has, however, been strained because the jurisdiction of coastal states is generally limited to 6-12 miles (200 miles in the Northeast Atlantic), and because GFCM recommendations have only been binding for EU member states, which represent a minority of the GFCM countries (Smith and Garcia 2014).

Iceland

The Minister of Fisheries and Agriculture determines the annual TAC for each of the most important species in the fisheries. ICES scientific assessment of the state of the fish stocks generally constitutes
the main driver of TAC-setting every year. Consistency between scientific advice and TAC setting has been occasionally challenged when scientific reports feeding in decision-making process had marked effects on sustainability and utilization outcomes. For instance, the cod fishery plays a very substantial role in the economy and therefore, not surprisingly, successive governments were reluctant to curtail the cod TAC in accordance with the recommendations of the MRI. Only in the 1990s has the Ministry, with the general support of the vessel owners, followed this advice closely, despite some political pressure.

**New Zealand**

In New Zealand, final decisions on the majority of Regulations, all TAC setting and allocation, are made by the Minister for Primary Industries. In setting the TAC, the Minister must make allowances for customary (Maori) use, recreational take and other sources of fishing mortality. The Total Allowable Commercial Catch (TACC) is the TAC less allowances. Most but not all stocks are in the QMS. As of May 2014 there are 638 stocks (from 100 species or species groupings) in the QMS. TAC setting for QMS stocks is guided by the harvest strategy standard with fishery specific objectives detailed in National Fisheries Plans (http://www.fish.govt.nz/en-nz/Fisheries+Planning/default.htm) consistent with overarching government fisheries policy (New Zealand Ministry of Fisheries 2009). TAC setting is driven almost exclusively by scientific advice, at least in solely commercial fisheries. Policies, standards and fishery plans are all developed with wide stakeholder and public consultation. TAC setting involves extensive stakeholder and public consultation in prescribed processes.

**Australia**

The Australian Fisheries Management Authority (AFMA) manages sixteen Commonwealth commercial fisheries. Overall guidance and direction is provided by the 1991 Fisheries Management Act (Anon. 2009) and Fisheries Administration Act (Anon. 2008). The latter established AFMA at arm’s length from government, with its own independent Board empowered to make management decisions such as setting TACs. Legally-binding management plans are required for most fisheries and there is strong stakeholder and public input into these plans.

**Operational policy**

**European Union**

As part of the CFP reforms, the creation of Regional Advisory Committees (RAC) was adopted in 2004 to strengthen dialogue with stakeholders, especially the fishing industry. RACs are made up of representatives from the fishing sector (e.g., fishermen, ship-owners, producers organizations, seafood processing industry, fish mongers) and of the civil society (e.g., NGOs, aquaculture sector, recreational fishing sector). Representatives of the Commission and of national administrations as well as scientists from any of the Member States concerned may also participate in the RACs. The aim of RACs is to allow people who do not have a direct input in the CFP at the European level to participate at the regional or local level. The Commission may consult the RACs on proposals for measures such as multi-annual recovery or management plans. The RACs may also inform the Commission or the Member States of problems relating to the implementation of CFP rules and formulate recommendations. RACs have been created in relation to seven areas/fisheries: Baltic Sea, Mediterranean Sea, North Sea, North-western waters, South-western waters, Pelagic stocks and distant water fisheries. In addition to the CFP-driven RACs, there have been a number of industry-led initiatives to strengthen the participation of stakeholders into the decision-making process. For instance, the management advisory function of the “Celtic Sea Herring Management Advisory Committee” (CSHMAC), promoted by stakeholders following the decline of the Celtic Sea herring.
stock biomass and TAC in the early 2000’s, are a real example of informal co-management activities. Management plans have been co-developed between scientists and the industry under the auspices of CSHMAC, and then presented to the Pelagic RAC and STECF for assessment and approval. Note that, at the EU member states level, stakeholders’ involvement is also materializing through the strengthening of national structures, such as producers’ organizations, in the decision-making process. Examples of this involvement are given later in this report (e.g., see “Access regulations” Section).

Iceland

In Iceland, most decisions regarding fisheries management are taken by the Ministry of fisheries. Decisions regarding catch levels, seasonal and area closures, mesh sizes, etc. are based on scientific recommendations from the Marine Research Institute. The Directorate of Fisheries is responsible for the implementation of the fisheries management system which includes registration of fishing vessels and licenses, as well as collecting data on vessels, catches and quota holdings. Although the implementation of the fisheries management system in Iceland is in public hands, stakeholders have an indirect role to play, mostly through consultation. Stakeholders have a representative in the board of the Marine Research Institute and usually have representatives in official committees that handle affairs related to fisheries management, such as regarding the design and implementation of catch rules. Furthermore, various stakeholders are routinely consulted by parliament in the drafting of legislation related to fisheries management.

New Zealand

The Ministry of Primary Industries has separate groups dealing with operational policy and science, including provision of advice on regulatory controls and TAC-setting (Marchal et al. 2009). Stock assessment outputs from processes managed by, and advice from, the Science group are a major input to the Operations group. Other inputs come in the form of managers’ deliberations with commercial, recreational and customary sectors, and contracted or other relevant papers on environmental, economic and other matters. For TAC and allocation setting, and for making most regulations, the Operations group develops Initial Position Papers (IPP), which provide initial options for TAC changes and allocation, or regulations. Discussion with stakeholders, widely circulated and notified to allow for public input, occurs at this early stage. The Ministry is required to analyze and report on these submissions and to develop a Final Advice Paper (FAP), which must include a reasonable range of viable options. The Minister may select from those or alternatives within the range. The FAP is then released publicly, usually at the same time as a Minister’s Decision Letter (Marchal et al. 2009). Government expenditures (including funding of stock assessment meetings) are to a large extent cost-recovered from the fishing industry via a levy derived from the annual landings value.

Australia

A key feature of Australian fisheries management is the formalized industry liaison and consultation that occurs. Strong stakeholder engagement is a feature of the AFMA management system, with fishers, environmental NGOs and scientists represented on management advisory committees and Resource Assessment Groups (RAGs) for each fishery, and often appointed as members of the AFMA Board (Smith et al 1999). Oversight of AFMA’s performance does occur through the federal department of fisheries, and the minister of fisheries can over-ride AFMA Board decisions, though this occurs very rarely. There is also general oversight of fishery management performance by the federal department of environment. Similar to Iceland and New Zealand, the Australian fishing industry contributes financially to fisheries management expenditures through a cost-recovery
The main advisory body for EU fisheries management in the North-East Atlantic is ICES (North-East Atlantic), through its advisory committee (ACOM). In ICES, Stock Assessment Working Groups (SAWG) meet for concentrated periods to undertake annual assessments for most stocks and provide responses to requests for advice. SAWG reports are then reviewed and provided to ACOM, which formulates and reports the official ICES advice. SAWG are attended by scientists and there is limited provision for participation by stakeholders. However, there has in recent years been an attempt within ICES to allow stakeholder consideration of work prior to ACOM review and formulation of advice. It is also important to note that ICES does not provide socio-economic advise, and does not have any fisheries management function.

The ICES advisory basis to TAC setting has traditionally been founded exclusively on single-stock considerations, precautionary approach (PA) reference points (ICES 1998), and provided for data-rich stocks only (i.e., stocks for which an analytical stock assessment could be validated). There has, however, been increasing impetus in the past decade to provide additional MSY-based advice for all (data-rich and data-limited) stocks. Importantly, ICES has grouped fish stocks depending on the amount and quality of information supporting assessments, and the type of harvest control rule ICES applies to provide advice is specific to each of these stock categories (ICES 2013d). Most recently, ICES has, complementary to the traditional single-stock based advice, released annual advice building in multispecies interactions, in the North Sea and the Baltic Sea (ICES 2013a,b), and mixed-fisheries in the North Sea ecoregion (ICES 2013c).

In the Mediterranean Sea and the Black Sea, the GFCM draws advice from its Scientific Advisory Committee (SAC), on both biological and socio-economic aspects related to fisheries conservation and management. Operationally, the SAC consists of five bodies, including a sub-committee on stock assessment (SCSA), and a sub-committee on economic and social sciences (SCESS).

In addition, when formulating advice to the Council of Ministers for all waters under its jurisdiction (including the Mediterranean Sea), the European Commission is required to take advice from its own Scientific, Technical and Economics Committee on Fisheries (STECF), which does offer a further technical review, economic impact assessment, and advisory function binding together biological, social and economic aspects.

Iceland
The Marine Research Institute (MRI) is a government institute, which provides the Ministry with fisheries advice. The most extensive of the MRI activities is the systematic assessment of marine stocks and its advisory role for the management of fisheries. The stock assessment findings of the MRI are subject to review by ICES before the TAC recommendations are made. More details could be found in European Parliament (2012).
New Zealand

In New Zealand, a wide range of research providers ranging from individual scientists to research institutes such as NIWA (The National Institute of Water and Atmospheric Science), Ministry scientists and managers, industry science and other representatives, recreational and customary fisheries representatives, and occasionally environmental NGOs participate in the seven stock assessment working groups, review meetings and in the advice-drafting process, all of which are fully open to the public though subject to clear protocols. Stock assessments are carried out in line with relevant National Fisheries Plans and are managed by the Ministry, with work being undertaken by contracted science providers and subject to continuous and final review in the working groups and plenary meetings. Most of the commercially important stocks are considered every 2-3 years with final advice being compiled in plenary reports using standardized summary formats showing current status estimates and projections under multiple scenarios (Marchal et al. 2009; Ministry for Primary Industries; 2014a, 2014b).

Australia

As in New Zealand, scientific advice is provided by a range of research providers. For AFMA fisheries, this is dominated by the Commonwealth Scientific and Industrial Research Organization (CSIRO), but there are also important contributions made from state fishery scientists and from a number of scientific consultants. The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) provides an annual report on stock status, summarizing much of the research and assessments undertaken. The science and assessments are presented to and considered by Resource Assessment Groups (RAGs) that have been established for each major fishery. RAGs comprise fishery scientists, industry members, fishery economists, managers and sometimes additional interest groups such as environmental NGOs. The wide membership ensures that, in addition to scientific information on each fish stock, industry knowledge and developments in management strategies, market prices and the costs of harvesting are also taken into account. The main role of RAGs is to provide advice on the status of fish stocks, and to provide the inputs needed to the formal harvest strategies for each species and stock. They also advise on monitoring and research priorities for the fishery. RAG advice goes to the management advisory committees, but also directly to the AFMA Board.

Management objectives and principles

European Union

Management objectives and principles have been established for the EU fisheries under the legal framework of the Common Fisheries Policy 2002 (EC 2002), which is under revision at the time of writing this report. Similar to most management agencies worldwide, the overarching objectives of the CFP are: to prevent fish stocks from being overexploited and to avoid that the pressure of fishing activities targeting certain stocks is jeopardizing the reproductive capacity of the stocks concerned or putting them at risk of collapse. Where the main objectives of the CFP are biological, the CFP does also have the objective to sustain economic and social conditions (EC 2002). Specifically, article 6.3 in the CFP has the objective of including economic considerations in the impact assessments of long
term management plans (EC 2002). However, none of these objectives have any clearly defined and measurable management targets and no weightings are expressed between the environmental, social and economic objectives.

Another important objective of the CFP is to reduce the fleet of the member states, so that the capacity of the fleets are there in order to be in line with the resources available (EC 2002 – article 2). Measures to ensure capacity reductions have been made by the introduction of rules that constrains the capacity levels for each member state to a fixed reference level. Any capacity reductions that resulted from decommissioning schemes were deducted from that reference level (EC 2002, Cueff 2007). Where this has resulted in a reduction in number of vessels, GT and KW in the EU (STECF 2013c), technological progress has increased the effectiveness of vessels, which has reduced the actual capacity reduction. To ensure that these rules are applied correctly, each member state is required to deliver a report each year in April, where the development of the fishing fleets are described, the impacts of management plans on fishing capacity are reported, the compliance of entry/exit schemes are documented, a summary report of the weaknesses, strength and plans for improvement of the fleet management system is completed and last where any changes of administrative procedures relevant to fleet management are reported (EC 2003, STECF 2013c).

The EC’s structural programmes including subsidies for fisheries have often been criticised for failing adequately to control real growth in the catching capacity of Europe's fishing fleets with the apparent internal contradictions of a policy that has simultaneously provided aid for both increasing and decreasing fleet capacity (Hatcher 2000, Lindébo 2005). In 2004, The EU decided to ban public aids to new buildings and the new CFP will maintain this rule in the European maritime and fisheries fund (EMFF).

In spite of the lack of clear and quantifiable EU-wide management objectives in the CFP, quantified management targets have been established regionally since 1999 in the context of long-term management and/or recovery plans, sometimes resulting from an agreement with third countries (Norway, Russia, Faroe Islands, Iceland) for straddling stocks: in the North Sea (cod, haddock, saithe, whiting, sole, plaice and herring), in the Baltic Sea (cod), in Western Waters (Bay of Biscay sole, Bay of Biscay anchovy, Northern hake, Western horse mackerel), and in the whole North-East Atlantic (blue whiting). The scientific basis underpinning these management targets was the PA approach (precautionary approach) for the first plans, but the MSY approach and also other targets defined by expert groups have been increasingly considered in the more recent plans. It should also be noted that the stocks subject to a management or recovery plan to date, although very important economically, represent only a minority of the commercial stocks harvested in EU waters, and for which no management objectives have been identified yet.

In the EU Mediterranean Sea countries, the CFP management objectives and principles are the same as in other areas, and these have been explicitly included in the Mediterranean Regulation (EC) 1967/2006. Still, the necessary flexibility to adapt the basic principles to the various local fisheries and situations has been ensured by a 'bottom-up' integrated approach, which differs from the generally top-down management plans implemented in northeast Atlantic waters. Mediterranean Member States are requested to draw up National Management Plans (NMP) for the fisheries in their territorial waters. NMPs are important to decentralize important issues while keeping common standards for all member states and a way to start implementing a long–term approach to fisheries
management in the Mediterranean. Examples of management targets defined under these NMPs are the target exploitation rates set for the Italian trawl fisheries. Unlike most of the EU management plans incepted in northeast Atlantic waters, these reference points account for technical interactions, and are calculated for a pool of species (e.g., hake, mullet, deepwater pink shrimp, Norway lobster, and striped red shrimp).

Finally, there are ongoing developments in the EU aiming at promoting MSY as a management target (or limit), as part of the on-going reform of the CFP, and also incorporating fisheries management into an integrated maritime strategy, under the auspices of the Marine Strategy Framework Directive (MSFD). These developments will affect the definition of management objectives and targets. As far as management objectives are concerned, the issues to be debated will include the use of MSY-related targets but also importantly the shift from species-based objectives towards fleet-based and/or ecosystem-based objectives. Recent agreements between the European Parliament and Council stated that MSY should be reached if possible in 2015 and at the latest in 2020 with a timetable depending on socio-economic considerations. The MSFD has been implemented by the European Commission (EC 2008). The overarching goal of the MSFD is achieving Good Environmental Status across all European marine waters by 2020, based on 11 qualitative descriptors (EC 2010) and a set of associated indicators that is still under development. While the ecosystem approach first emerged in the context of fisheries management, the MSFD now requires its implementation of the in the wider context of integrated management involving multiple sectors beyond fisheries. The indicators initially proposed for EAFM are now finding their way into the MSFD as both share common sustainability goals. Several working groups have been set up by ICES and the European Commission to work on this. In particular, the European Scientific Technical and Economic Committee for Fisheries (STECF) has set up an expert working group on the “Development of the Ecosystem Approach to Fisheries Management in European Seas”, with the overall objective of developing a feasibility approach to provide useful advice on ecosystem status in support of the Common Fisheries Policy. In line with the MSFD implementation, one of the main objectives of this working group was to assess the health of European ecosystems, using currently available data (STECF 2012c).

Iceland

Management objectives and principles for Icelandic fisheries have been established under the legal framework of the 2006 Fisheries Act. The main objective of fisheries management in Iceland is to promote conservation and efficient utilization of exploitable marine stocks, thereby ensuring stable employment and settlement throughout the country. In practice, the main emphasis has been on economic efficiency and stocks sustainability through the use of ITQ systems for most fisheries. Although no explicit management targets are set in the 2006 Fisheries Act, it is important to note that TAC setting in Iceland has in general terms followed ICES advice and conservation objectives quite closely. Also, management targets have been made explicit in current management plans (e.g., capelin, cod, haddock, saithe), as detailed below.

New Zealand

The New Zealand Fisheries Act (1996) has the dual purpose to provide for utilization whilst ensuring
sustainability. Meeting that purpose has to take account of obligations to customary Maori and recreational users, and environmental considerations and information principles (reflecting a precautionary approach) (Anonymous 2005; Marchal et al. 2009; Large et al. 2013). There are two outstanding features in the Fisheries Act 1996: (1) the obligation that Maori interests are preserved and, (2) the explicit reference to SSB\textsubscript{MSY} as a management target. Unless estimated analytically, the default value for B\textsubscript{MSY} is assumed to be 40 per cent of the spawning biomass that would exist in the absence of fishing. Under the Harvest Strategy Standard (New Zealand Ministry of Fisheries; 2008a, 2008b), management must also ensure that recruitment is not impaired by using soft and hard limits, and formal rebuilding requirements.

**Australia**

The Australian Fisheries Management Act 1991 highlights the principles of ecological and environmental sustainability, the precautionary approach, and also the objective of optimizing resource utilization (Anonymous 2009). An original feature of the Australian Act is that the balance between conservation and utilization should be achieved by achieving the Maximum Economic Yield (MEY; the largest net economic return that can be achieved over a prolonged period of time while maintaining the stocks’ productive capacity), and its related reference points (e.g., B\textsubscript{MEY}). For many Australian stocks, B\textsubscript{MEY} is estimated by default to be 1.2 times a default B\textsubscript{MSY} value of 40 per cent of the unfished biomass (giving a default B\textsubscript{MEY} of 48 per cent of the unfished biomass), (Smith et al 2008; Large et al. 2013). Apart from the B\textsubscript{MEY} target, the harvest strategy policy also requires that there be less than a 10% chance of the stock falling below a limit reference point under application of the harvest strategy (Rayns 2007). The default limit reference point is 20% of unfished biomass.

**Management strategies**

**European Union**

Since 2003, the approach of European fisheries management has shifted from a short-term to a longer-term approach, building on two types of management plans (EC 2002; Marchal et al. 2009). Recovery plans are designed to rebuild stocks in danger of collapse while multi-annual management plans are aimed at maintaining stocks around safe biological levels. Within these plans, targets for the sustainable exploitation of stocks with regards to population size and/or long-term yields, fishing mortality and stability of catches have been established. While most of the management plans are of a “top-down” nature, there are genuine examples, particularly from the Western Waters fisheries, where the industry has been proactive putting forward formalized management proposals.

In the Baltic Sea, Western and Eastern cod are subject to management plans, with HCRs including a 10% yearly decrease in fishing until a target F is reached, and also including lower and upper bounds of 15% of TAC variation.

In the North Sea, EU-Norway long-term management plans were developed in 2008 for North Sea cod (EC Regulation No. 1342/2008), haddock, saithe and herring. The HCR would specify three possible levels of F, depending on whether the perceived SSB is below B\textsubscript{lim}, between B\textsubscript{lim} and B\textsubscript{pa}, or above B\textsubscript{pa}, with a cap corresponding to F\textsubscript{MSY}. In the case of North Sea cod, a transitional arrangement was added in the EU-Norway agreement to reduce fishing mortality by a fixed rate for several years.
before the long-term could be implemented. The North Sea cod recovery plan was also accompanied by more stringent technical measures and an annual days-at-sea cap. A joint multi-annual management plans was also implemented for North Sea plaice and sole in 2007. The plan required a gradual reduction of fishing mortality until both stocks are within safe biological limits, and then to harvest them at $F_{MSY}$ level. One original aspect of the North Sea flatfish management plan is that it considers two technically interacting stocks together, while traditional management plans are single-species. Most recently, an EU-Norway management plan was also incepted in 2013 for North Sea whiting, with a HCR based on fishing mortality levels only. Finally, the plans specified for North Sea stocks required a maximum percentage of variation of the TAC relative to that of the previous year of 15-20%.

In Western Waters, Northern hake has been subject to a recovery plan since 2004 (EC Regulation No. 811/2004). A harvest control rule was set up based on precautionary SSB and $F$ reference points and with an additional constraint to restrict the inter-annual TAC variation to 15%. The Northern hake recovery plan also included a package of technical measures (e.g., enlargement of mesh size). It should be noted, however, that ICES does not provide advice based on the settings of this recovery plan anymore, due to a drastic scale change in spawning biomass as perceived from the most recent stock assessments. Bay of Biscay sole has been subject to a recovery plan over the period 2002-2006, and then to a two-tiered multi-annual management plan (MAMP) since 2006 (EC Reg. 388/2006). The first tier of the 2006 MAMP consisted of a gradual reduction of fishing mortality by 10% per annum until $B_{pa}$ was reached, which occurred in 2008. The second tier of the MAMP, the long-term management plan (LTMP), was then triggered in 2008. However, in the absence of clear target fishing mortality in the LTMP, STECF provided TAC recommendations based on MSY reference points and on scenario proposals promoted by stakeholders themselves. It is important to note also that the Bay of Biscay sole management plan will be revisited shortly, to account for mixed fisheries considerations. While no formal management plans have been incepted for other Western Waters fisheries, there are at least three stocks for which the industry and RACs have been instrumental in proposing management plan: Bay of Biscay anchovy, Western horse mackerel and Celtic Sea herring. In the case of Bay of Biscay anchovy, a draft management plan was proposed by the EC in 2009, resulting from cooperation between STECF and the South Western RAC, and that was used to set TAC in recent years. In the case of Western horse mackerel, the Pelagic RAC promoted a management plan that has been used to establish TAC since 2011. Apart from the participative process, one original aspect of this management plan is that it does not require an analytical stock assessment. Finally, a long-term management plan was developed for Celtic Sea herring by the CSHMAC, and channeled by the Pelagic RAC, but this has not yet been agreed by STECF.

For the sake of completeness, we will also mention that multilateral management plans were also established for widely distributed northeast Atlantic stocks (blue whiting, mackerel). The mackerel management plan, however, was only incepted in 2008 due to the complexities arising after the changes in the spatial distribution of the mackerel stock.

In the Mediterranean Sea, EU fisheries are not subject to top-down management plans as in northeast Atlantic waters. Instead, in view of the specific characteristics of many Mediterranean fisheries, which are restricted to certain geographical sub-zones, and taking into account the tradition of applying effort management system at sub-regional level, it has been considered appropriate to promote national management plans (NMPs), combining in particular effort
management with specific technical measures. Among Mediterranean countries, Italy has gained great experience on the implementation of NMP. The first plans were implemented in 2008. The strategy implemented by the Italian government included eight NMPs for towed gears and other gears targeting the same demersal and benthic species, six NMPs to manage seiners, one NMP for beach seines and one for hydraulic dredges. Consider the central-southern Tyrrhenian Sea towed gears NMP enforced since 2010. The aim of the management plan is to restore stocks to within safe biological limits by reducing the exploitation rate (weighted for a pool of species: hake, mullet, deepwater pink shrimp, Norway lobster and striped red shrimp) from the present level of 0.66 to a level of 0.35 (target reference point). This NMP takes into account the state of conservation of the stocks, their biological characteristics, the characteristics of fishing activities and the economic impact of the measures on fishing. The NMP includes restriction of the fishing effort in terms of reducing fishing capacity on the basis of the reduction parameters and methods established in the Adjustment Plans mentioned in the Operational Programme for fisheries in Italy, in accordance with EU Regulation 1198/2006. NMPs are also in the state of development in other Mediterranean Sea countries, e.g., Greece is currently preparing a management plan for demersal trawl fisheries in the Aegean and Ionian seas.

Iceland

The Icelandic authorities have implemented a utilization strategy with the long-term objective of ensuring sustainable fisheries. Management plans have already been enforced for a number of fish stocks in Icelandic waters.

A multilateral two-step management plan has since 1980 been in place for capelin in the Iceland – East Greenland – Jan Mayen area, and revised several times since. The capelin fishery is managed according to a two-step management plan which builds on an escapement SSB target of no less than 400 000 t by the end of the fishing season (mid to late March). The first step in this plan is to set a preliminary TAC, based on the results of an acoustic survey carried out almost a year before the fishing season starts. The initial quota is set at two thirds of the predicted TAC, calculated on the condition that 400 000 t of the SSB should be left for spawning. The second step is based on the results of another survey conducted during the fishing season. This result is used to revise the TAC, still based on the condition that 400 000 t of the SSB should be left for spawning.

The Icelandic Government has more recently adopted a management plan for the Icelandic cod stock for the next five fishing years, starting with the 2009/2010 fishing season. The main objective of the management plan is to ensure that the spawning-stock biomass (SSB) will, with high probability, be above the current SSB level by the year 2015 ($B_{MP}$). The harvest control rule (HCR) calculates the total allowable catch (TAC) as a weighted compromise between the previous fishing season’s TAC and the product between the perceived adult biomass and the targeted harvest rate. The targeted harvest rate depends on whether the perceived SSB is below or above $B_{MP}$.

Management plan were also adopted by the Icelandic government for saithe and haddock in 2013. The harvest control rule of the saithe management plan is similar to that built in the cod management plan. The haddock HCR differed, in that the TAC is calculated depending only on whether the perceived adult biomass is below or above a trigger value, and not on the previous fishing season’s TAC, as for cod and saithe. ICES estimated in 2013 that the Icelandic haddock
management plan was in accord with the MSY approach.

**New Zealand**

In New Zealand, all QMS fish stocks have since 2008 been managed following Harvest Strategy Standards (HSS) operational guidelines (New Zealand Ministry of Fisheries 2008):

“

**The objective of the Harvest Strategy Standard is to provide a consistent and transparent framework for setting fishery and stock targets and limits and associated fisheries management measures, so that there is a high probability of achieving targets, a very low probability of breaching limits, and acceptable probabilities of rebuilding stocks that nevertheless become depleted, in a timely manner. The Harvest Strategy standard specifies appropriate probabilities that will achieve each of these outcomes. (...) The Harvest Strategy Standard consists of three core elements:**

- A specified target about which a stock or fishery should fluctuate;
- A soft limit that triggers a requirement for a formal, time-constrained rebuilding plan; and
- A hard limit below which fisheries should be considered for closure

“

The target should be based on MSY, and should be achieved with at least a 50% probability. The default soft limit is the highest of $\frac{1}{2}B_{MSY}$ and 20% $B_0$ and the biomass should be above that limit with at least a 50% probability. The default hard limit is the highest of $\frac{1}{4}B_{MSY}$ and 10% $B_0$, and the biomass should be above that limit with at least a 50% probability (Large et al. 2013).

**Australia**

In Australia, management strategies have since 2007 been made explicit for most Commonwealth fisheries, and these are referred to as HSP (Harvest Strategy Policies) (DAFF 2007). In this section, we will summarise the main features of the Commonwealth HSP, and highlight those aspects that are more particularly relevant to the management of the South-East Scalefish and Shark Fisheries.

The HSP represents an operational framework that explicitly enables the implementation of the requirements of the *Fisheries Management Act 1991*, Fisheries Administration Act 1991, but also of the holistic *Environment Protection and Biodiversity Conservation Act 1999*. Therefore, the HSP is not a single-species, but rather an ecosystem-based fisheries management (EBFM) policy (Smith et al. 2007). Therefore, while the harvest strategies summarised below are relevant to commercial fish stocks, it should be reminded that they are only one component of the more holistic EBFM framework.

A harvest strategy defines the operational management actions required to achieve biologic and economic objectives in a given fishery. Key elements of a harvest strategy are, (1) a monitoring- and assessment process and, (2) control rules to regulate fishing activity, which we will focus on in this section. Harvest control rules that are consistent with the HSP would typically include a target biomass ($B_{TARGET}$), a limit biomass reference point ($B_{LIM}$), a target fishing mortality ($F_{TARGET}$) and a limit fishing mortality ($F_{LIM}$). The recommended biological catch (RBC) is calculated by applying the $F_{TARGET}$ to the current biomass (assumed to be available from a stock assessment). The control rule specifies that as the biomass reduces below $B_{MSY}$, $F_{TARGET}$ is decreased and is set to zero below $B_{LIM}$. Minimum
standards have been established for the HSP reference points. Thus, $B_{\text{TARG}}$ and $B_{\text{LIM}}$ should respectively be above $B_{\text{MEY}}$ (or 1.2 $B_{\text{MSY}}$ if $B_{\text{MEY}}$ is unknown) and $\frac{1}{2}B_{\text{MSY}}$. $F_{\text{LIM}}$ should be lower than $F_{\text{MSY}}$, while $F_{\text{TARG}}$ should be the $F$ level required to maintain the stock biomass at about $B_{\text{TARG}}$.

Rebuilding strategies are developed for those stocks harvested below $B_{\text{LIM}}$, and these involve setting targeted catches to zero. If those stocks biomass drops substantially below $B_{\text{LIM}}$, they may also be included in the list of threatened species established by the *Environment Protection and Biodiversity Conservation Act (EPBC) 1999*. Such stocks would then be subject to a formal recovery plan via a legislation issued by the Australian Minister for the Environment and Water Resources.

An important development of the Australian HSP has been the inclusion, for some fisheries, of an even more comprehensive decision-making support framework to account for various levels of information and assessments (Smith et al. 2009). That framework, hereby referred to as the “tiered approach”, has been implemented to all SESSF stocks. The tiered approach provides an extra-layer of precaution to the HSP, which reflects the levels of uncertainty in stock status (tier levels). Typically, target exploitation rates would decrease as the uncertainty increases. Thus, a 4-Tier approach has been implemented to all SESSF stocks: Tier 1 stocks are subject to a robust and quantitative stock assessment; Tier 2 stocks are subject to a quantitative but preliminary stock assessment; Tier 3 stocks are not assessed quantitatively but $F$ estimates are available from catch curve analyses; only CPUE trends are available for Tier 4 stocks. Each Tier has its own harvest control rule that is applied to calculate RBCs (Recommended Biological Catches), which is then used to advise on TACs (Total Allowable Catches) at the end of the political process. The resource assessment groups (RAGs) covering the SESSF groups of species advise on which species and stocks belong at each tier and determine the RBCs.

**Management tools**

**Conservation measures**

The primary aim of conservation measures is to ensure a high level of productivity for fish stocks. Three types of tools may be considered in this category: (i) catch limits, (ii) fishing capacity and effort limits and, (iii) a suite of technical measures. Catch, capacity and effort limits are intended to bind the overall fishing mortality to a level allowing the full reproductive capacity of the harvested stocks. Fishing capacity and effort limitations usually apply to fleet size (e.g., number of vessels), fishing power (e.g., engine power, length), and also the time spent fishing (e.g., days at sea). The main purpose of technical measures is to limit catches and discards of specific life stages (usually juvenile fish) and also to mitigate the adverse effects of fishing activities on the ecosystem. Technical measures may take the form of gear restrictions (e.g. minimum mesh size, minimum landing size, by-catch limits, closed areas/seasons). Within the frame of the ecosystem approach to fisheries, a number of steps have been taken to preserve not only targeted commercial species, but also impacted marine habitats and incidental mortalities induced to various ecosystem compartments.

*European Union*
The EU, through the Council of Ministers, has since the inception of the CFP in 1983, gradually capped the catches of most commercially important stocks with TAC in all ecoregions, except in the Mediterranean Sea. A share of the TAC is allocated to each member state based on a fixed allocation key. It is the Member States, and not the EU, who are responsible for the allocation of the national quota. Because TACs have mainly been set on a single-species basis, the balance between aggregated catches and TAC in mixed fisheries has repeatedly been at fault. In the EU, it is illegal to exceed the TAC, but it is still tolerated to discard fish caught over quota. Therefore, one way to achieve catchquota balancing has been to discard fish over quota, or even to underreport catches. It should however be stressed that an agreement has been found within the new CFP to restrict discarding practices. It is perhaps also worth noting that the EU has made significant steps towards the provision of mixed fisheries TACs, such as funding the collection of EU-wide fisheries data by métier via the Data Collection Framework (EC 2008). This approach, which aims at improving the consistency between catches and TACs, has been supported by scientific works around the definition of métiers and the development of models allowing the integration of technical interactions in stock forecasts (Laurec et al. 1991; Vinther et al. 2004). Most recently, ICES has thus provided mixed fisheries advice in the North Sea ecoregion (ICES 2013a; ICES 2013c).

Direct effort limitations have been implemented instead of (Mediterranean Sea) or in complement to (Baltic Sea and North Sea) catch limits. In the Mediterranean Sea, where TACs do not apply (except for Bluefin tuna), fishing effort limitations have been the most important component of fishery management. For a long time an effort-regulating regime was considered - in line with the advice of most international fisheries agencies, particularly the General Fishery Commission for the Mediterranean (GFCM) - as the most appropriate conservation measure in this region (Catanzano et al. 2000, Pearce, 1980), considering the large multispecificity of Mediterranean stocks and competition of different gears for the same stocks. For many years, effort control tools have been implemented by introducing permanent and temporary withdrawal schemes. At a national level, some Mediterranean NMPs, including that applied to the Italian trawling fisheries operating in the Central-Southern Tyrrhenian Sea, include restrictions of fishing effort in terms of reducing capacity, in accord with EU Regulation 1198/2006. Direct fishing effort ceilings (annual days-at-sea or kW.days-at-sea limits) have more recently been enforced in the Baltic Sea (Council Regulation (EC) No. 1088/2012), to reduce the fishing mortality of Eastern and Western Baltic Sea cod, and in the North Sea (Council Regulation (EC) No. 43/2009), as part of the North Sea cod recovery plan.

Technical measures have been implemented to most EU fisheries. In the Baltic Sea, cod trawls have been rigged with a 120 mm "Bacoma" codend to limit discards of cod. Highgrading has been prohibited since 1 January 2010 in all Baltic Sea fisheries. The cod fisheries are regulated by a seasonal closure from 1 April to 30 April (Western cod stock) and from 1 July to 31 August (Eastern cod stock) to protect spawning aggregations. Additional closures have been implemented for longer periods to specific areas including the Bornholm Deep, the Gotland Basin, and the Gdansk Deep. In the North Sea, the minimum trawl mesh size for the gadoids mixed fishery was increased to 120 mm in the northern area in 2002. The minimum mesh size of Norway lobster trawlers is of 70-80 mm, depending on the fishing ground visited, the level of cod by-catch and/or the existence of an appropriate selectivity device. Plaice is predominantly caught by beam trawlers in the central North Sea with a minimum mesh size of 100-120 mm depending on the area under consideration. A mixed fishery targeting sole is operated in the southern North Sea with a minimum mesh size of 80 mm.
Some areas in the North Sea are of restricted access to fishing activities (e.g., Plaice Box). In addition to these technical measures decided at the EU level, a number of national or multilateral initiatives have been taken to reduce discards, e.g., implementation of real-time closures to reduce juvenile discards (Scottish Conservation Credit Scheme), or implementation of a discard ban for UK and Danish vessels equipped with a closed-circuit TV system. In Western Waters, a major component of the hake recovery plan (EC Regulation No. 494/2002) has been a substantial increase of mesh size for most demersal fleets and fisheries operating in the hake box, which consists of two restricted areas: one off the South/South-West of Ireland and one in the Bay of Biscay. The minimum mesh size of trawls is of 100 mm when targeting hake, and of 70 mm when targeting Norway lobster, under conditions (e.g., minimum proportion of target species in the catch, existence of selectivity devices). The minimum mesh size of sole nets is of 100 mm in the Bay of Biscay. Gill-netting is also prohibited deeper than 200 m, which affects anglerfish catches. In the Mediterranean Sea, Minimum mesh size and minimum landing size applicable to all EU member states are also defined in EU Regulation 1967/2006. The minimum mesh size of trawls is of 40 mm (20 mm when targeting small pelagics). The mesh size of bottom-set gillnets should be at least 16 mm, except when red seabream is targeted, in which case the minimum mesh size is of 100 mm. Overall the gear technical measures implemented in the Mediterranean Sea are clearly less conservative than in other regions in terms of protecting juveniles. In addition to the EU Regulation, there are a large number of areas (mainly gulfs) where fishing is prohibited in specific seasons based on national legislation.

The 2008 EU Marine Strategy Framework Directive and Marine Spatial Planning provide guidance to manage the conservation of marine ecosystems in EU waters. Natura 2000 areas have been established in most EU ecoregions. In order to declare areas of conservation of habitats or species of particular interest under the Natura 2000 framework, each member state may evaluate whether additional fisheries measures are needed for the area. The European Commission then needs to evaluate this fisheries management measures requests, and does it under scientific and other stakeholder consultation, especially with the RACs. In addition to this, the member state has to provide for monitoring and control measures for these fisheries management measures in the Natura 2000 areas. According to Council Regulation (EC) No. 812/2004 pingers must be used on gillnets to limit incidental catches of cetaceans. No other fisheries management measures are constraining fishing activities in the Northeast Atlantic in relation to Natura 2000. However, some countries, e.g., Germany, Denmark, The Netherlands, have made unilateral proposals to manage fisheries management inside Natura 2000, sometimes under the initiatives of the fishing industry. In the Mediterranean Sea, different member states have restricted access to some areas to protect specific ecosystem components and marine habitats, e.g., Posidonian or other spermatophytes meadows.

Another conservation measure is subsidies, which can be categorized as direct subsidies, tax reductions- or deferrals and government loans- or loan guaranties. Direct subsidies include vessel decommissioning buybacks, which was among the objectives of the CFP to reduce the capacity of the fleet. Even though reductions of the fleet numbers/GT/KW have been accomplished, many fleets are still underutilized (STECF 2013). Since 2007, the European Fisheries Fund (EFF) has enabled vessels to apply for part funding for certain vessel modernisations. Consequently, fleet capacity reductions have not reduced the issue of over-capacity in many EU fisheries. Other subsidies, such as fuel tax exemptions or government loans, provide incentives to stay fishing as it enables some vessels to remain competitive rather than to leave the industry. This increases the long term pressures on the
natural resource, because there remains a lack of balance between the fishing capacity and the fishing opportunities. There is no cost recovery of government management expenditures from the European fishing industry.

**Iceland**

Catch limitation system is the cornerstone of the management approach to conservation in Iceland. The catch limit of each vessel during the fishing year is thus determined on basis of the TAC of the relevant species and the vessel’s share in the total catch.

Because discarding is prohibited in Iceland, it was decided that every vessel could land up to 5% in excess of the vessel’s annual catch quota. All catch that is brought ashore must by law be weighted by a licensed body. A vessel’s excess catches are subject to be withdrawn from the following year’s quota. In addition, fishers can land undersized fishes with only 50% of the weight being charged against the annual catch quota up to a certain limit, generally 10% of the total landings of each species.

There are rules concerning the type of fishing gear permitted, e.g. the minimum and maximum mesh size. In particular, the mesh size in trawls was increased from 120 mm to 155 mm in 1977. Mesh size of 135 mm was only allowed in the fisheries for redfish in certain areas. Since 1998 a minimum mesh size of 135 mm is allowed in the codend in all trawl fisheries not using "Polish cover" and in the Danish seine fisheries (ICES 2013e). For the gillnet fishery both minimum and maximum mesh-sizes are restricted. Since autumn 2004 the maximum allowed mesh size in the gillfishery is 8 inches (~200 mm). The objective of this measure is to decrease the effort directed towards bigger spawners. Fishing with bottom trawl is generally prohibited 6–12 miles from the coast and in other areas, which serve as spawning and nursery areas. Sorting grids in fishing gear are obligatory in certain fisheries to prevent catches of juvenile fish. Extensive provisions are made for temporary closure of fishing areas to protect spawning fish from all fishing. Further to this, the MRI has the authority, which it uses extensively, to temporarily close fishing areas if the proportion of immature fish in the catch is deemed to exceed acceptable limits. Various area closures are in effect for longer periods of time. The closures may apply to specific fishing gear, fishing-vessel size or all fishing for certain periods of time. Annually, such temporary closures of areas are in force to protect spawning grounds of cod and other demersal species. Additionally, in some areas the use of bottom fishing gear is totally prohibited, for example where there is coral and in other vulnerable areas.

**New Zealand**

In 2013, there were 100 species and 636 separate stocks included in the QMS. As detailed earlier, only a proportion of the TAC is allocated to the commercial fishing sector: the TACC. Apart from specific small-scale fisheries, effort limitations are not implemented as a management measure in New Zealand waters. In New Zealand, and with rare exceptions, all fish and shellfish caught must be landed. Therefore, discarding cannot be considered as an option to achieve catch-quota balancing. It is legal to land above quota, but a tax has to be paid for any kg of fish sold over-quota, and that is referred to as the deemed value. Apart from that discard ban, there are only limited technical measures implemented to New Zealand fisheries. Fishing gears and mesh size are generally not restricted and only few species are assigned a minimum landing size. There are closed areas, but these are Marine Protected Areas (MPAs) that have been primarily designed to protect marine
biodiversity and specific ecosystem compartments, rather than to protect spawning grounds or juveniles of commercial species. There are two standards of protection in these MPAs. One is a “no-take” protection standard, which means that fishing is prohibited in that specific area. The other protection standard is based on limiting extraction or damage to the environment. Forty-nine Marine Protected Areas cover 8.2 per cent (14,869 km²) of New Zealand’s Territorial Sea. Approximately 86 per cent of this area is contained in 34 marine reserves. Most protection occurs around the Kermadec and Subantarctic Islands, with less comprehensive protection in other regions.

**Australia**

Australian fisheries are managed using a mixture of input (limited entry, gear restrictions, closed areas) and output (TAC) controls. Total Allowable Catches (TAC) are the main management instrument, as in most OECD countries. There is also a limit on the number of boats that operate in each sector as well as limits on mesh size and the amount of fishing gear that can be used. Buyback schemes were also implemented in several fisheries (Australian northern prawn, Southern trawl fisheries) in order to adjust capacity (Minnegal and Dwyer 2008).

Australia has also taken various steps to preserve marine habitat and by-catches. Commitment to a national system of marine protected areas (MPAs) was made in the Australia’s Ocean Policy in 1998. In 2005, the Government brought its programme of regional marine planning, known as marine bioregional plans, directly under the EPBC Act. The plans identify the conservation priorities in Commonwealth waters, as well as measures to conserve marine protected areas. A Threat Abatement Plan (TAP) for the Incidental Catch (or Bycatch) of Seabirds during Oceanic Longline Fishing Operations was first released in 1998 and revised in 2006. It was developed under the EPBC Act. In 2011, the Australian Government commenced a review of the 2006 seabird TAP. Australia initiated the negotiation of a multilateral agreement to conserve seabirds under the Convention on the Conservation of Migratory Species of Wild Animals. The Agreement on the Conservation of Albatrosses and Petrels was opened for signature in 2001. To date there are 13 signatories. In 2011 the Australian Government agreed to develop a National Plan of Action for Reducing Incidental Catch of Seabirds in Fisheries. The Commonwealth Policy on Fisheries Bycatch was released in 2000 to ensure that direct and indirect impacts of fisheries on marine systems are taken into account and managed accordingly. In 2008, AFMA released the Program for Addressing Bycatch and Discarding in Commonwealth Fisheries: an Implementation Strategy. The programme develops fishery specific work plans which focus on ‘high risk’ bycatch and threatened, endangered and protected species as identified through the ecological risk assessment process in accordance with the implementation strategy. Australia’s National Plan of Action for the Conservation and Management of Sharks was developed in 2004 in response to the corresponding International Plan of Action by the FAO. A review of Shark-plan 1 was completed in 2010 and released in May 2011. The second National Plan of Action for the Conservation and Management of Sharks was released in July 2012. The plan identifies the research and management actions that will be pursued over the life of the plan. The plan also provides a framework for the long-term conservation of Australia’s shark populations and for guiding the industries and communities that impact upon them. The National Strategy to Address Interactions between Humans and Seals: Fisheries, Aquaculture and Tourism was released in 2006 to mitigate adverse impacts of the fisheries, aquaculture and tourism sectors on seal and sea lion populations. AFMA implemented an Australian sea lion management strategy in 2010. A Key Threatening Process listed under the EPBC Act is “Injury and fatality to vertebrate marine life caused
by ingestion of, or entanglement in, harmful marine debris”. A TAP has been developed and released in 2009 to address the threat. It aims to provide a co-ordinated national approach to the implementation of measures to prevent and mitigate the impacts of harmful marine debris. It will also guide Australia’s efforts in international forums to build and strengthen collaboration to identify the origins of, and effective responses to, marine debris on a regional and international level.

**Access regulations**

The second set of fisheries management measures addresses the regulation of individual access to fish stocks. The aim here is to allocate the limited productive capacity of these stocks between fishing firms. This operation has itself two sides: selecting firms (or vessels) which are allowed to fish a given stock (or group of stocks), and fixing the share each one is allowed to fish. The main access regulation measures applied in the fisheries worldwide are Individual (catch) Quota (IQ), Individual Effort Quota (IEQ), fishing licences (or permits) and Territorial User Rights in Fisheries (TURF). We make below a focus on how catches or fishing effort are allocated to the fishing industry.

**European Union**

In terms of input-bass access regulation, most of the EU member states established fishing licenses to restrict entries, as a consequence of the CFP implementation. The EU does currently not vest authority to allocate national catch quotas to individual producers or vessel owners. Rights-based management will be part of the future CFP, but the form that it will take was not finalized at the time of writing this report. Individual Quotas, and even Individual Transferable Quotas have been increasingly implemented under the authority of individual EU member states (Marchal et al., 2009). The reasons for introducing ITQ’s in the member states include the aim to reduce the capacity- and to increase economic performances of the European fleet. We describe below current practice in the different ecoregions under consideration.

Consider the Baltic Sea and the North Sea. The Netherlands have been the first country to implement fully tradable ITQs since 1985; POs are responsible for managing and exchanging quotas. In Denmark, ITQs have been implemented stepwise since 2003. Quota may be bought only from larger vessels to prevent concentration. There are considerable discussions as to whether small-scale fisheries are sufficiently protected under current regulations. In Estonia and Lithuania, most fisheries are also currently managed under an ITQ system. In Lithuania, 5% of the quota is allocated to coastal fisheries. In the UK, POs vest authority for allocating catch quotas individually to fishing vessels. These IQ may be traded during the year. In Germany, fishers operating large vessels rigged with mobile gears receive (in person or via their cooperative) an individual quota for regulated target species from the German Agency for Agriculture and Nutrition. A better transferability of these IQs is expected in the future. At present, fishers may lose their unused catch entitlement, which is then handed over to another fisher. Smaller vessels using static gears need also a special allowance to fish in certain areas. Historically, fishing rights were linked with regional provinces and especially in former eastern Germany the regional states still regulate the fisheries inside territorial waters. In Finland, there are currently no IQ or ITQ in the fisheries operating in the open Baltic Sea.

Consider Western Waters. In France, one of the most important access regulation measures enacted
by the French government at the end of the 1980s was the Operation Permit system, a de facto limited entry scheme. Following limited entry, several decommissioning schemes were carried out in France during the 1990s, as part of the Multi-Annual Guidance Programs for capacity reduction (Guyader et al. 2007). Since 2003, eligibility for decommissioning schemes has been based on specific fish stocks and/or fishing areas and/or associated fleet segments criteria (Quillerou et al. 2013). In the Bay of Biscay, Nephrops licenses were created in 2004 and sole fishing permits in 2006. Recently, POs have implemented systems of individual landings limits by vessel. In 2011, with the increasing sub-quotas constraints, many POs have generalized a limitation system on individual landings for several species (e.g., hake, pollack, anchovy, sole, mackerel) (Larabi et al. 2013). In Spain, the anchovy TAC share for Spain is restricted to the purse seiners; the same license applies to harvest other pelagic resources. Individual catch limits are proposed by the POs within each fishing technology and made official by the government. These limits only impose a constraint on catches but are not allocated on the basis of catch records and are not transferable amongst vessels. In the case of bluefin tuna, individual quotas are allocated on an annual basis and can be pooled within a given organization, and then traded amongst the diverse Spanish fishing technologies (e.g. from purse seiners to tuna farms). In 2012, 70% of the rights allocated to purse seiners fishing with live bait in the Bay of Biscay were transferred to a Spanish company in the Mediterranean which carries out tuna farming. With respect to the Basque offshore fleets, rights are allocated to individual vessels but could also be allocated to Producers’ Organisations (POs). In the latter case, the POs must distribute the rights among their members. Members are entitled with a right which can be transferred to other vessels in the same list, regardless of PO. Rights are not attached to the vessels thus it is possible to transfer a fraction of the ITQ or even to lease rights. However, transference is always done between vessels of the same list. Transference between vessels of different POs requires that the vessel transferring rights moves to the PO receiving rights. In Ireland, the Celtic Sea Herring fishery was essentially open access until 2012. Since then, however, the fisheries minister has sought to limit access to vessels which landed herring between 2006 and 2010 (Dept. Agriculture, Food and Fisheries, 2012). In the UK, the quota management system is determined by the UK Fisheries Administrations, including DEFRA for England and Marine Scotland for the Scottish Government. The system is currently very similar as for UK vessels operating in the North Sea (summarized above).

Consider the Mediterranean Sea. The main access regulation applicable to both the Italian and Greek fishing industry is a generalized licensing scheme, considered to be the most suitable tool for managing fisheries efficiently. In France, license systems are operated, in particular for trawlers and other métiers under management plan, and IQs have been established to regulate access to tuna fisheries.

Iceland

Since the comprehensive Fisheries Management Act was incepted in 1991, most commercially important species have been managed by the ITQ system. From 2004 the ITQ system has in effect covered all the Icelandic fishing fleet, except the recently established Summer Special Coastal fishery. All commercially valuable fisheries thereby were subject to vessels having quota and in all there were 19 species subject to the individual quota system.

The basic asset in the Icelandic ITQ system is the right to a share in the annual TAC. These rights are...
of indefinite duration. They are denominated in percentage terms (of the TAC) and sum to 100%. Each licensed fishing vessel may hold permanent quota shares in the TAC for any species for which there is a TAC. These permanent quota shares, denominated as fractions, may be referred to as TAC-shares. The term or duration of the TAC-shares is not stipulated. However, it is clear that they are not explicitly in perpetuity although they may turn out to be so. More precisely, according to legal opinion, the ITQ system may be abolished and the TAC-shares withdrawn without compensation to the holders, provided a notice of several years is given. Therefore, this basic asset of the ITQ system must be regarded as being of uncertain duration. TAC shares, however, are secure in the sense of being protected by law as any other asset and they exhibit certainty exclusivity over the corresponding harvests (Arnason, 2005).

The Directorate of Fisheries issues annual catch quotas (kgs) to individual vessels as a share in the total allowable catch (TAC) which the Minister of Fisheries sets every year for each species. The annual catch quota is based on the individual vessels quota share (%). All major commercial stocks are now subject to quotas and they represent approx. 95-97% of the total annual catch value. Fishing rights can be either general catch quotas, referred to as the general ITQ system or catch quotas for hook and line boats (max 15 GT), referred to as the small vessel system. It is permitted, under given circumstances, to transfer both quota shares and annual catch quotas between vessels. It is not allowed to transfer more than 50% of the annual catch quota allocated to a vessel within a given fishing year. The quota shares can however be fully or partially transferred between vessels. Applications for transfer are submitted to The Directorate which verifies and registers the transfer.

There are specific limitations on how big a share of the quota share can be controlled by one individual, company or legal entity and related partners. These limitations take to both quota shares in individual species as well as total quota share, calculated into the so called cod equivalent. The restrictions, designed to discourage speculative quota holdings, include that (1) no vessels may purchase quotas that are clearly excessive of what the vessel can harvest, and (2) any vessel that does not harvest 50% of its annual catch quotas in two subsequent years will lose its permanent quota share. Another constraint is that the quota-shares held by any company or individual should not exceed certain limits, ranging from 12% of the TACs for cod to 35% for ocean redfish. In addition, any company or individual’s quota share should not exceed more than 12% of the value of the total quotas allocated for all species.

There is some flexibility built into the ITQ system, enabling the vessel owners and fishermen to control better the structure of their fishing pattern. Regardless of the fact that allocated catch quota can only be utilized within the fishing year in question, 20% of each vessels catch quota can be transferred to the following fishing year. It is permitted to fish up to 5% in excess of a vessels catch quota. The excess catch is in such instances withdrawn from next fishing year’s quota of the vessel. Up to a certain limit, catch quotas can be converted between species (demersal species only). Juvenile fish is only partially withdrawn from catch quotas. It is permitted to land catch (max 5%) excessive to quotas as long as the catch is auctioned and the bulk of the value of the catch goes to the Marine Research Institute.

Finally, all commercial fishing operations are subject to a permit from the Directorate of Fisheries. Certain fisheries require special permits, such as Danish seining, inshore shrimping, coastal fishing, specific fisheries by Icelandic vessels in distant waters as well as the fishing of foreign vessels within
the Icelandic exclusive economic zone (EEZ).

**New Zealand**

In New Zealand, fishing permits are required to access any commercial fishery. The major feature of New Zealand fisheries management is its freely tradable ITQ system and the way it generates Annual Catch Entitlement (ACE) which is used to balance catches; fishers do not need to own ITQ and ITQ is not linked to vessels. The TACCs of all QMS stocks are distributed to quota holders as ITQ shares. On the first day of the fishing year, each ITQ (expressed as a percentage of the TACC) generates for each quota holder, and each stock, an amount of ACE, in kg. ACE and ITQ are freely tradable on the open market and accessible to any New Zealand citizen. This is a major difference with the Icelandic ITQ system where quotas are attached to fishing vessels. As in Iceland, however, there are specific rules to restrict quota concentration. One aspect of quota concentration requirements in New Zealand is that a minimum 20 per cent share of any new QMS species has been allotted to Maori since the inception of the Fisheries Settlement. Different procedures have also been adopted to bring in more flexibility in catch-quota balancing. If there is a mismatch between catch and ACE purchased, fishers are required to pay an interim deemed value, for each unit of catch they land above their ACE holdings at the time (Marchal et al. 2009), with a final deemed value reckoning at the end of year. This is especially important in mixed fisheries with catch-balancing presenting a constant problem. ACE-holders are, however, allowed to carry forward up to 10% of their ACE (20% of ITQ in Iceland) to the following fishing year. That carry-forward is lost entirely if the TACC is reduced. This is another potential difference with the Iceland ITQ system where catches cannot exceed quotas by more than 5%, though in practice relatively few ACE holders would risk carrying forward so much ACE.

**Australia**

All fishers are required by law to hold a fishing license. Further access controls, such as ITQs are used in some fisheries. Individual Transferable Quotas (ITQs) were first introduced into the SESSF in 1992 for 16 scalefish species. However, it is only in 2005 that ITQs were broadly introduced into the SESSF for a broader range of species. Some stocks are, however, still managed under competitive (unallocated) Total Allowable Catch (TAC) limits. Despite the flexibility brought about by quota transferability, catch-quota balancing has proved to be an issue in SESSF. Disarding is generally tolerated in Australia (Sanchirico et al. 2006). Buyback programs were in some cases implemented to increase capacity adjustment in ITQs fisheries (Fox et al.; 2006, 2007).

**Compliance and enforcement**

**European Union**

The EU became the first management agency in the world to track and monitor fishing vessel activities at sea by the Vessel Monitoring System (VMS). From 2000, all vessels over 24 m in length were required to transmit their location every 2h or less. The legislation was revised in 2005 to include all vessels of 15 m and over, and then further extended in 2012 to include all vessels above 12 m. VMS enables the authorities to enforce the compliance to any regulated areas for fisheries (by monitoring of entry into and exit from specific areas) or to a larger extent to any direct constraints on
the application of the fishing effort. Hence, VMS is seen as a reliable technology capable of producing evidence of vessel activity in relation to e.g. control of compliance to spatial regulations.

In European waters, all fishing vessels (larger than 10 meters in length) have according to the Data Collection Framework (EU DCF, Commission decision EC 2008/949) to declare the catches into logbooks for every trip at sea, together with several other mandatory information (the catch area, the used gear type, the number of days at sea, etc.) so that the regulator can monitor and trace the origin of landings and control the total amount simultaneously caught by all the vessels in a given area in case of TAC, or the time spent at sea in case of effort control. However the obligation does not include the discard part of the catches. The amount of yearly discard is essential information and necessary input for a trustworthy assessment for most stock assessments. Indeed the EU TAC system in practice regulates landings rather than catches that put the stocks at risk by creating uncertainties in stock estimates when fisheries are managed on certain levels of fishing mortality. The first step into reducing the discard problem is to investigate where discard is occurring in larger amounts, to highlight the pattern in different fleet components and to document the monitoring of the sampling program. Since the introduction of the EU data collection regulation (2002-2008) and the subsequent data collection framework (Commission decision 2008/949/EC) monitoring the catches onboard commercial fishing vessels has routinely been undertaken by the member states through observers on board collecting discard data.

Improved monitoring is reinforced by mounting video cameras on fishing vessels to report for fully documented fishery (Kindt-Larsen et al., 2011). Growing interest in Europe is put on alternative management options (for the incoming CFP reform) such as discard bans or total catch quota schemes in place of the TAC system alone. Both discard bans and catch quota schemes require that both landings and discards be monitored that creates a challenge to control and enforce them in practice, because the total catches cannot be determined accurately without 100% observer coverage. However, most of these control and enforcement issues can possibly be resolved in most fisheries by the use of cameras on board of each vessel e.g. by mounting an imagery unit. The imagery unit is closed-circuit television (CCTV) cameras. During all catch events, it recorded overhead views of the working deck and catch-handling areas, and closer views of the discard chutes. Denmark and the UK have been at the forefront of experimenting such systems in their North Sea fisheries. The CCTV-system would improve compliance of reporting rules as well as any potential discard ban. However, a system of CQM with some type of discard ban cannot be successful if the right surrounding measures are not in place. Systems for receiving undersized or unwanted catch in harbors, rules of conducts etc. has to be developed so that compliance is not hindered. If only part of the fleet is equipped with CCTV, a sense of unfairness that potentially could influence compliance could be created. This has to be considered alongside the benefits of equipping only parts of the fleet following on a risk-based approach. The initial allocation of Individual vessel/business catch quotas is an important key to achieve compliance, particularly for fisheries with a large overcapacity.

Iceland

The Directorate of Fisheries undertakes monitoring of the Icelandic fisheries to ensure that all rules are being followed. Iceland operates a comprehensive enforcement regime, in particular regarding port control and weighing of all catches. According to Icelandic law, discards are prohibited, and all catches must be landed. Operationally, the Directorate of Fisheries is responsible for the
implementation of Fishery Regulations on behalf of the Ministry. A large part of the surveillance at sea falls directly under the responsibility of the Icelandic Coast Guard.

The Directorate’s key functions include implementation of regulations, collection and collation of fishery catch data, supporting research, survey work, supporting the Coastguard and surveillance activities, managing and policing the Icelandic ITQ system. All catches of Icelandic fishing vessels must be weighted and recorded at the port of landing by an official from the Directorate.

The organizational structure of the fisheries management system can be described as straightforward, with the Ministry, the Directorate of Fisheries, the Marine Research Institute and Coast Guard having central functions.

Furthermore, strict surveillance of fishing vessels, including observers on board, stiff penalties for violations of ITQ rules and regulations and flexibility in quota management allowing transfer of quotas between different species, have played an important role in addressing the high-grading issue. As a consequence, there has been no detectable increase in high-grading in Iceland.

**New Zealand**

New Zealanders use traditional Monitoring, Surveillance and Control (MSC) methods to secure compliance with rules and regulations in place such as on-board surveillance. The main instruments includes catch and effort logbooks, independent Ministry observers data, and vessel monitoring systems (VMS) data, for which the fishing industry is the main funding body. The Ministry for Primary Industries had 51 observers in 2012. New Zealand has introduced innovative features in this realm, namely self-monitoring systems in several fisheries (Starr, 2000).

**Australia**

AFMA administers compliance programmes directed at both domestic and foreign fishing vessels. The Commonwealth has flag state responsibilities for fishing by Australian vessels on the high seas.

In all Commonwealth fisheries, mandatory vessel monitoring systems are used to provide real-time position reporting of vessels and movements in and out of port. AFMA has a scientific observer programme to collect independent data on fishing activities. Fisheries monitoring and enforcement is also conducted by state/territory fisheries agencies.

Australia has developed a National Fisheries Compliance Strategy 2010-15 that outlines the objectives that Australian fisheries agencies will pursue to promote voluntary compliance and create effective deterrence to illegal fishing activities. At the center of the strategy is the need to achieve collective responsibility and action among major stakeholder groups (commercial, recreational and Indigenous fishing sectors) and the community.

AFMA has a responsibility to enforce the provisions of the Fisheries Management Act 1991 and the Torres Strait Fisheries Act 1984 through the detection and investigation of illegal activities by domestic and foreign fishing boats in the Australian Fishing Zone and Commonwealth managed fisheries.

In most of the fisheries that are managed by AFMA, vessel monitoring systems (VMS) are in place to provide real-time reporting on vessel positions and movements. Furthermore, aerial surveillance is
provided by a private contractor as well as patrol vessel surveillance by the Royal Australian Navy and the Customs Service.

In fisheries where quotas are set, a comprehensive catch and landing reporting system is used. Each fishing permit holder, or nominated authorized person, is required to complete a form upon landing the catch, detailing the species caught and weight.

Fish receivers, such as processors, are also required to be registered and maintain a record of fish received from operators. This allows for comparison between the recorded fish landed and the fish that is received on land.

**Management performance**

**Conservation**

*Indicators of conservation status*

Comparing the sustainability of fish stocks across the world and oceans is not a trivial task.

First, the range of stocks subject to assessment varies from one advisory agency to another. ICES evaluates most of fish stocks in Northeast Atlantic eco-regions (including EU and Icelandic waters) on an annual basis, but generally does not consider fisheries resources confined in territorial waters. By contrast, almost all fisheries resources in New Zealand and Australia are subject to a stock assessment, however, stock analyses are generally not carried out on an annual basis. In the Mediterranean Sea, the GFCM assesses fisheries resources with a fairly large distribution (similar to ICES), but not necessarily on an annual basis.

Second, the triggers and standards used to assess the stock status are not necessarily consistent.

ICES primarily advises on the basis of a management plan (MP) and associated reference points when available. When an MP is not agreed, ICES applies an MSY framework if possible, or a PA approach where MSY-based reference points cannot be derived. The ICES MSY framework builds on two reference points, MSY $B_{\text{trigger}}$ (a biomass reference point set to the lower bound of SSB fluctuation around $B_{\text{MSY}}$, which triggers a cautious response), and $F_{\text{MSY}}$ (level of fishing mortality generating MSY in the long term, which is targeted when SSB exceeds MSY $B_{\text{trigger}}$). The PA approach builds on two SSB reference points ($B_{\text{lim}}$, the stock size below which there may be reduced reproduction resulting in reduced recruitment and $B_{\text{pa}}$, a biomass reference point designed to avoid reaching $B_{\text{lim}}$), and two fishing mortality reference points ($F_{\text{lim}}$, the fishing mortality associated with long term stock decline and ultimately crash and $F_{\text{pa}}$, a precautionary buffer set to avoid that true fishing mortality is at $F_{\text{lim}}$). In general, $F_{\text{MSY}}$ should be lower than $F_{\text{pa}}$ and MSY $B_{\text{trigger}}$ should be equal to or higher than $B_{\text{pa}}$ by construction.

In the Mediterranean Sea, the GFCM has in recent years carried out stock assessments in relation to MSY-based reference points, generally $F_{\text{MSY}}$, but sometimes also $B_{\text{MSY}}$. 
In New Zealand, the Harvest Strategy Standard (HSS) guides fisheries management in achieving a high probability of achieving targets, a very low probability of breaching limits, and acceptable probabilities of rebuilding depleted stocks. The HSS builds on four reference points: (1) a soft limit (a biomass level – typically 20% of the unfished biomass $B_0$ or 50% of $B_{MSY}$ whichever is higher - below which a stock is deemed to be “overfished” or depleted and needs to be actively rebuilt), (2) a hard limit (a biomass level – typically 10% of the $B_0$ or 25% of $B_{MSY}$ whichever is higher - below which a stock is deemed to be “collapsed” where fishery closures should be considered in order to rebuild a stock at the fastest possible rate), (3) an overfishing threshold (a rate of extraction that, if exceeded, will lead to the stock biomass declining below management targets and/or limits) and, (4) a management target (usually $B_{MSY}$, but sometimes also $F_{MSY}$, around which stocks are expected to fluctuate, with at least a 50% probability of achieving the target).

In Australia, fish stocks are assessed against limit reference points (levels of biomass – typically 20% unfished biomass $B_0$ - and fishing pressure beyond which fish stocks become recruitment overfished) and target reference points (levels of biomass and fishing pressure that are considered to be ideal). Generally, management aims to ensure that stocks are maintained at these levels and away from limit levels. Target reference points commonly incorporate management objectives, such as maximising the sustainable yield or economic returns. For example, the Commonwealth Fisheries Harvest Strategy Policy seeks to maintain fish stocks, on average, at a target biomass equal to the biomass that would produce maximum economic yield ($B_{MEY}$, which is often estimated at 48% $B_0$ for Australian stocks).

For the purpose of this exercise, we have collated and summarized under the same template the recent status of the different stocks assessed in the Northeast Atlantic, the Mediterranean Sea, New Zealand and Australian waters, using four reference points based on limit and target levels of biomass and fishing mortality. For ICES stocks, the limit reference points were taken as the PA points $F_{pa}$ and $B_{pa}$ (or sometimes $F_{lim}$ and $B_{lim}$ depending on the stock), while the target reference points were $MSY$, $B_{trigger}$ and $F_{MSY}$. For Mediterranean Sea, we considered target reference points ($F_{MSY}$ and, sometimes, $B_{MSY}$), but no limit reference points. For New Zealand fisheries, the limit reference points were taken as the soft limit, and the target reference points were $MSY$-based. For Australian waters, the limit reference points were associated to a risk of recruitment impairment, while target reference points were $MEY$-based.

Note that the list of conservation indicators used in this study could have been broadened to include ecosystem indicators. The MSFD forms the environmental pillar of the EU’s Integrated Maritime Policy. Its overall aim is to promote sustainable use of the seas and conserve marine ecosystems, and to ensure that pressures from human activities are compatible with Good Environmental Status (GES). Thus, the main objective of the MSFD is to put in place measures to reach/maintain GES, which are associated with 11 high-level descriptors associated with human pressures, in Europe’s seas by 2020, using the ecosystem approach. In a fisheries-related context, achieving GES will primarily be brought about by appropriate evolution and implementation of the CFP, so that it ensures that commercial fish and shellfish stocks are harvested sustainably as set out in MSFD Descriptor 3 (for exploited and non-exploited species), and ensuring that the impacts of fishing activities on the wider marine ecosystem are sustainable as set out in MSFD Descriptor 1 on maintaining biodiversity, Descriptor 4 on food webs, and Descriptor 6 on seafloor habitats. It is generally understood that meeting the objectives of the MSFD for fisheries will be delivered mainly
through existing policy commitments and management mechanisms, including not only the reformed CFP but also the Habitats and Wild Birds Directives, and use of closed/reallocated areas for fishing and/or the designation of marine protected areas.

However, while a wide range of ecosystem indicators have been used to compare ecosystem status across different EU eco-regions (STECF 2012c; Nielsen et al. 2013), no comparable information could be found in the other areas under investigation to allow standard comparisons.

Stock status

We provide here the 2012 stock status information assessed against limit and target reference points for the Northeast Atlantic, including EU and Icelandic waters (ICES 2013), the Mediterranean Sea (STECF 2012a; STECF 2012b; STECF 2013a), New Zealand waters (New Zealand Ministry of Primary Industries 2012) and Australian waters (Flood et al. 2012). As suggested by Tables 3 and 4, the proportion of stocks of known status is lower in EU waters (7-27%) than in Icelandic waters, the Mediterranean Sea, and in New Zealand and Australian waters (33-74%).

The majority of stocks being assessed in the regions considered here is currently within safe limit and at target levels of SSB, except for Mediterranean Sea stocks (27% only of the Mediterranean stocks being considered have a SSB that exceeds B_{MSY}). The proportion of stocks where F is below F_{lim} is higher in New Zealand and Australia (82-95%) than in the Northeast Atlantic (0-75%). Finally, 75% of Icelandic stocks of known status were exploited at F_{MSY} level, while only 0-69% of EU fisheries resources were harvested at that level in the Northeast Atlantic and the Mediterranean Sea.
Table 3. Conservation indicators for the different countries and ecoregions under investigation. “No. stocks” represents the number of stocks for which spawning stock biomass (SSB) and/or fishing mortality (F) have been estimated relative to limit reference points ($B_{lim}$, $F_{lim}$) and/or target reference points ($B_{target}$, $F_{target}$).

<table>
<thead>
<tr>
<th>Country / Ecoregion</th>
<th>No. stocks</th>
<th>SSB &gt; $B_{lim}$</th>
<th>SSB &gt; $B_{target}$</th>
<th>F &lt; $F_{lim}$</th>
<th>F &lt; $F_{target}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>13</td>
<td>1</td>
<td>0</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Baltic Sea</td>
<td>56</td>
<td>8</td>
<td>4</td>
<td>44</td>
<td>11</td>
</tr>
<tr>
<td>North Sea</td>
<td>62</td>
<td>9</td>
<td>6</td>
<td>47</td>
<td>13</td>
</tr>
<tr>
<td>Celtic Sea &amp; Western Scotland</td>
<td>32</td>
<td>2</td>
<td>0</td>
<td>30</td>
<td>2</td>
</tr>
<tr>
<td>Bay of Biscay &amp; Atlantic Iberian waters</td>
<td>46</td>
<td>3</td>
<td>0</td>
<td>43</td>
<td>3</td>
</tr>
<tr>
<td>Widely distributed stocks</td>
<td>61</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Mediterranean Sea</td>
<td>12</td>
<td>5</td>
<td>0</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Iceland and East Greenland</td>
<td>348</td>
<td>104</td>
<td>21</td>
<td>223</td>
<td>81</td>
</tr>
<tr>
<td>New Zealand</td>
<td>150</td>
<td>101</td>
<td>10</td>
<td>39</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 4. Proportion of fish and shellfish stocks for which spawning stock biomass (SSB) and/or fishing mortality (F) have been estimated relative to limit reference points ($B_{lim}$, $F_{lim}$) and/or target reference points ($B_{target}$, $F_{target}$). For those stocks of known status, we show the proportion of stocks for which limit and/or target reference points have been attained.

<table>
<thead>
<tr>
<th>Stocks informed</th>
<th>SSB &gt; $B_{lim}$</th>
<th>SSB &gt; $B_{target}$</th>
<th>F &lt; $F_{lim}$</th>
<th>F &lt; $F_{target}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baltic Sea</td>
<td>27%</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
</tr>
<tr>
<td>North Sea</td>
<td>22%</td>
<td>67%</td>
<td>69%</td>
<td>75%</td>
</tr>
<tr>
<td>Celtic Sea &amp; Western Scotland</td>
<td>27%</td>
<td>60%</td>
<td>76%</td>
<td>63%</td>
</tr>
<tr>
<td>Bay of Biscay &amp; Atlantic Iberian waters</td>
<td>5%</td>
<td>100%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Widely distributed stocks</td>
<td>7%</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>Mediterranean Sea</td>
<td>55%</td>
<td>-</td>
<td>27%</td>
<td>-</td>
</tr>
<tr>
<td>Iceland and East Greenland</td>
<td>33%</td>
<td>100%</td>
<td>100%</td>
<td>67%</td>
</tr>
<tr>
<td>New Zealand</td>
<td>33%</td>
<td>83%</td>
<td>68%</td>
<td>82%</td>
</tr>
<tr>
<td>Australia</td>
<td>74%</td>
<td>91%</td>
<td>-</td>
<td>95%</td>
</tr>
</tbody>
</table>

1 The report focuses on the 61 Mediterranean Sea stocks considered by STECF (2012a), STECF (2012b), STECF (2013a)
Economics

The 2013 Annual Economic Report (AER) on the European Union (EU) fishing fleet provides a comprehensive overview of the latest information available on the structure and economic performance of EU Member States fishing fleets (STECF 2013b). The Results on the economic performance indicate that the EU fishing fleet was profitable in 2011, with 6% of income being retained as net profit. On the whole, the EU fleet showed improvements in most of the main economic performance indicators analysed when compared to 2010. Yet, in view of the uncertain economic climate and potentially increasing fuel prices, the economic performance of the EU fleet in the near future is unclear. Projections for 2012 indicate increased income for over three-fifths of the fleets analyzed but positive profit margins for less than half. There is no provision for cost recovery in EU fisheries management, and amountable subsidies have been instilled over time, since the inception of the 1983 CFP, although these have been reduced since the end of Multi-Annual Guidance Programmes in 2004. The economic performance of EU fleets by region (Baltic Sea, North Sea and Eastern Arctic, North Atlantic, Mediterranean and Black Sea) is shown in Table 5, based on recent trends of four economic indicators (gross value added, gross profit, net profit, gross value added per full time employment) (STECF 2013b). These economic indicators have improved (or at least remained stable) for over 50% of the fleets - of known status - operated in the Baltic Sea, North Sea and Eastern Arctic and North Atlantic. In the Mediterranean and Black Sea, however, the economic situation has deteriorated for over 50% of the documented fleets operated in this area. It should be noted that economic information was missing for a substantial amount of fleets, except those operated in the Baltic Sea.
### Table 5. Qualitative trends (I: Improving, S: Stable; D: Deteriorating; M: Missing data) in key economic indicators (GVA: Gross Value Added, GP: Gross Profit, NP: Net Profit, GVApFTE: Gross Value Added per Full Time Equivalent) derived from a regional analysis of key EU fleets.

<table>
<thead>
<tr>
<th>No. fleets</th>
<th>Trend</th>
<th>GVA</th>
<th>GP</th>
<th>NP</th>
<th>GVApFTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baltic Sea fleets</td>
<td>33</td>
<td>I</td>
<td>16</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S</td>
<td>4</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>13</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>North Sea and Eastern Arctic fleets</td>
<td>67</td>
<td>I</td>
<td>23</td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S</td>
<td>7</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>20</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>16</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>North Atlantic fleets</td>
<td>90</td>
<td>I</td>
<td>28</td>
<td>28</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>18</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>41</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>Mediterranean and Black Sea</td>
<td>70</td>
<td>I</td>
<td>19</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>40</td>
<td>33</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>
The main purpose of the vessel quota system implemented in Iceland was to improve the economic efficiency of the fisheries. The Icelandic fisheries are biologically very productive and should be able to generate high economic rents. Until the adoption of the vessel quota system, however, comparatively low rents were generated by the industry. In fact, during the years preceding the introduction of the vessel quota system in the various fisheries industry profits was often highly negative. The total net profits turned positive in the 1990s and have, for the most part, shown an increasing trend since. Research has also shown that the Icelandic fishing industry has enjoyed rapid productivity gains since 1984 (Agnarsson 2011). Although the rate of productivity growth has declined a bit in recent years it was still unusually fast until 2008. Since the inception of the ITQ system, productivity gains in the Icelandic fishing industry have been very rapid (Agnarsson 2011; Arnason 2003). Average productivity gains have been about 2% per annum on average over the last 25 years. This evidences the beneficial impact of the ITQ-system, which has strengthened the international position of the industry and greatly increased its profitability. A significant part of the productivity gain is due to higher export prices of fish products through the ability of firms to adjust their catches to market situation at each point in time. As the ITQ system results in that fishing firms do not have to race for the fish, they can plan their fishing in such a way that they can deliver to the market when prices are high and decrease their supply to the market when prices are low.

With regards New Zealand fisheries, there is a general perception that the QMS system, building in ITQs, has been successful in creating a profitable and sustainable fishing industry in New Zealand (Clark et al., 1988; Dewees 1988; Annala 1996). The economic success can be gauged in many different ways. One good indicator of the economic success or failure of the system is the value of quota as it reflects the expected future profits of the fisheries (Arnason, 1990). In the period 2005 to 2009 the total real quota value has been estimated to be around 2 ½ times the total seafood export value of USD 1.3 billion. Another measure of the economic success of the QMS in New Zealand is that there are no direct subsidies in the New Zealand fisheries. Also, cost recovery is substantial in New Zealand. On average 40-45% of the annual government expenditure on managing fisheries (including stock assessment science) is cost recovered from the New Zealand fishing industry, through a levy applied to estimated landings value.

With regards Australian fisheries, it is difficult to spot clear trends. The gross value of fisheries production in 2009-2010 was around USD 2.2 billion, representing a decrease of around 31% compared with the fishing year 2000-2001. Since 2004 the real gross value of fisheries production has declined by an average of 2% per year while aquaculture production has increased by an annual rate of 4%. The most valuable species are rock lobster and prawns which together accounted to around 46% of the total catch value in 2009-2010 (OECD 2012). Cost recovery is an important feature of the management of Australia’s Commonwealth fisheries. Cox (2000) estimated that the industry contribution to the costs of management averaged 34% between 1992/93 and 1998/99. According to this study the degree of cost recovery varied significantly between fishers as a result of differences in the attribution of the costs of management functions between industry and government.

Social aspects

Commercial fleet size and employment

Both the fleet size and the number of fishers employed on-board EU vessels have shrunk considerably since the mid-nineties. These decreasing trends were still notable in more recent years. Hence, the size of the EU fishing fleet has reduced by 7% over the period 2008-2011, and represented 82,047 vessels in 2011, with a combined gross tonnage (GT) of 1.69 million tonnes and total engine power of 6.36 million kilowatts (kW) (STECF 2013b). The number of fishers employed in
the EU fishing fleet in 2011 was 127,686, a decrease of almost 4.5% from 2010 (STECF 2013b). The number of fishers employed increased in 2009 and 2010, falling again in 2011, almost reaching 2008 levels. The number of FTEs in the EU fishing fleet in 2011 was 98,561, a decrease of 6% compared to 2010 and about 2.5% compared to 2008. This decreasing trend has resulted in a situation where other sectors such as shipping and seafood processing have increasingly replaced fisheries as employers. Average wages in the EU fish catching sector fluctuated somewhat between 2008 and 2011. The labor remuneration in the EU fishing fleet seems to have improved in 2011: the average wage per employee and per FTE in 2011 was €16,655 and €21,577 respectively. Both wage rate indicators increased around 8% between 2010 and 2011.

The size of the New Zealand fishing fleet has steadily declined over the last years, both in number of vessels and gross tonnage. Between 2006 and 2011, the number of vessels was reduced by 15%, and was of 1,401 in 2011 (OECD 2013). Over the same period, however, the number of fishers has increased by +23%, and was of 1,740 in 2011 (OECD 2013). The total employment in the fishing sector consisted of roughly 8,000 FTE in 2010, of which 5,700 were in the processing sector, 1,700 in the fishing sector, and 600 in the aquaculture sector. To this may be added other jobs interlinked with the fishing industry, such as in marketing, transport, equipment and research.

The size of the Australian Commonwealth fishing fleet was reduced by 33% over the period 2006-2011 (OECD 2013). Over the same period, however, the number of fishers has increased by +16%, and was of 7,325 in 2011 (OECD 2013).

The Icelandic fishing fleet has been gradually decreasing over the period 1999-2011, although a slight increase in the small boat segment could indicate that more vessels are entering the coastal fisheries (OECD 2013). The number of employees and the percentage of them to the national employment in the fishing and fish processing industries have constantly decreased. From 1991 to 2011, employment in the fishing sector reduced from 6,200 to 5,200 while, in the fish processing industry, employment decreased from 8,000 to 4,100. As a consequence, fishing and fish processing industry’s contribution to the national employment has also declined considerably from 10.4% to 5.3% over the same time.

Safeguarding the interests of targeted communities

Both the New Zealand and Icelandic fisheries management systems make specific provision for safeguarding the interests of targeted communities. Some consideration is also given in Australia to the customary society.

In New Zealand, the rights and roles of Maori in the fishing sector are particularly high in the agenda.

Maori were provided with a substantial stake in commercial fishing as part of the Treaty of Waitangi. With the introduction of the QMS the government bought back 10 percent of the quota shares it had given to fishers and transferred these to the Treaty of Waitangi Fisheries Commission, for the benefits of Maori. In 1992, the government gave Maori a cash settlement that was used to buy half of New Zealand’s biggest fishing company – Sealord. The government also gave Maori 20 percent of the commercial quota shares of any new species brought into the QMS. Maori have now built their commercial stake to a point where they now control or influence more than 30 percent of our
commercial fisheries. In 2004, Parliament approved the distribution to “iwi” (tribes) of substantial fisheries assets and this is now being implemented by Te Ohu Kai Moana (Maori Fisheries Trust), the organization that promotes Maori interests in the marine environment. Customary fishing rights are provided for by Maori to recognize local Maori harvesting needs (Iwi needs). The local people develop management plans that guide their harvesting decisions to ensure sustainable stocks and culturally acceptable harvesting practices while providing for adequate kaimoana (seafood) for their needs. There is a specific “permitting” process for customary take that is managed by local Iwi. Furthermore, there are specific regulations considering customary fishing, guardians and special management areas.

In Iceland, there have been concerns that quota transferability would lead to concentration of quota holdings in the urban Southwest region, which would adversely impact various villages around the country, some of which rely exclusively on fisheries. The result would be increasing unemployment in those regions and migration to the Southwest. The current fisheries management act makes TAC shares transferable without any restrictions whatsoever. Inter-regional transfer of annual catch quotas, however, is subject to some restrictions, except offsetting transfer of different species with equal value. In practice, however, few inter-regional transfers have actually been blocked. The Fisheries Management Act was revised in 2010 and 2011 to support the interests of smaller coastal communities. One of the most important changes in the Fisheries Management Act has been the establishment of the special coastal fishery. The special coastal fishery is allocated a certain part of the TAC for demersal fish every year, which is subtracted to the part of the TAC that is available to ITQ-holders. The TAC allocated to this fishery is divided on these four months as well as four geographical regions. Since the amount of catch each vessel can take in the special coastal fishery is only restricted by the overall TAC for the region and month, the fishery is strongly competitive in nature with hundreds of small vessels trying racing for fish before the TAC is reached.

In Australia, Torres Strait fisheries are managed in accordance with the Torres Strait Treaty made between Australia and Papua New Guinea. Since 1989, all non-indigenous participation in Torres Strait fisheries has been capped to reserve further expansion for traditional inhabitant commercial fishing.

Conclusions

Comparing the respective strengths and weaknesses of fisheries management in countries of similar levels of development such as the EU, New Zealand, Australia and Iceland is an instructive exercise. It is perhaps reasonable to say that New Zealand, Australia and Iceland have paved the way of modern fisheries management in many respects. Australia and New Zealand have been at the forefront of bringing in stakeholders’ involvement and co-management at all levels of the decision-making level, including funding via cost recovery levies. The EU has more recently taken significant steps to better involve stakeholders by promoting Regional Advisory Councils (RACs) following the 2003 reform of the CFP. Although the role of the RACs in the decision-making process is still limited, there are examples where they have been influential (e.g., pelagic and South Western Waters RACs in relation to the Western horse mackerel and Bay of Biscay anchovy management plans respectively). EU stakeholders’ involvement, however, does not go as far as funding fisheries management and
research as in Australia and New Zealand. A cost recovery and subsidies-free system such as that applied in Australia and New Zealand would likely be elicited by a large amount of EU tax-payers. The downside of the cost recovery system, however, is that the amount of funding available to science may be more limited than in the public-funded ICES system, especially when landings are low. In Australia and New Zealand, this has led to a situation where stock assessments have not been performed at a regular frequency, thereby delaying necessary management actions in a few cases.

New Zealand and Australia have for over two decades made explicit legally-binding fisheries management targets in their founding decrees ($B_{\text{MSY}} \sim 30-40\% B_0$ and $B_{\text{MEY}} \sim 48\% B_0$, respectively). To achieve these targets, New Zealand and Australian authorities adopted recently management strategies building in harvest control rules (referred to harvest strategy standards and harvest strategy policies respectively), to guide the management of almost all fisheries resources, including those for which information is rather poor (data-limited species – DLS). This approach to comprehensive and objective-based management has generally brought TAC setting close to scientific advice in these countries. Although management targets are not as explicit in the Icelandic Fisheries Management Act, the general attitude of decision-makers in this country has been to follow ICES advice fairly closely. This attitude has been reinforced by the inception of management plans for a number of key stocks in recent years. In the EU, the inception of management plans to several key stocks has alleviated the discrepancy between EU TACs and ICES advice in the North-East Atlantic, since the beginning of this century. In the Mediterranean Sea, management plans have also been implemented unilaterally by some EU member states to decide on fishing effort limits. However, the complexity of regulations and technical interactions, as well as differing interests between member states has, for those fisheries not subject to a management plan (DLS in particular), often resulted in EU TAC being set above ICES advised catches (SEAFISH 2013), raising concerns for their sustainability. It is also a source of concern that several valuable stocks are still not subject to any EU TAC, particularly in Western Waters (e.g., red mullet, scallops, seabass, cephalopods). However, it is likely that DLS will be included in future EU management plans. A recent example is horse mackerel, for which DLS based management targets have been set by EU promoted by the pelagic RAC and validated by STECF. It is also worth to note that ICES is now providing advice for most commercial fish stocks in the Northeast Atlantic including DLS, which may include +/- 20% changes in exploitation rates based on surveys if an analytical assessment is not conducted, thereby providing a scientific rationale to support the application of future EU management plans and TAC-setting (or effort management) to a broader range of stocks and fisheries.

Most fisheries management agencies considered in this study have implemented their respective objectives and strategies using a combination of output- and input-based measures. There are exceptions though as New Zealand fisheries management is almost exclusively output- (TAC-) based, while Mediterranean Sea fisheries are at the EU level mostly regulated by inputs (fishing effort limitations and mesh size). As noted above TAC-setting in Australia, New Zealand and Iceland has generally been more conservative than in the EU, Australian management being probably the most conservative, with the target of preserving about half of the unfished biomass for all harvested stocks. Gear regulations are also particularly strict in Iceland, with minimum mesh sizes of 135-155 mm for demersal trawls and 200 mm for gillnets) compared to the EU Northeast Atlantic fisheries (70-120 mm for bottom trawls, and 90-140 mm for gillnets), and even more compared to the EU Mediterranean Sea fisheries (40 mm for demersal trawls, 16 mm for bottom-set gillnets). Attitudes
towards discarding also differ across the different case studies, with a strict ban enforced in New Zealand and Iceland, and some tolerance in the EU and Australia (although new regulations were most recently enforced in the EU, at the time of writing). Fisheries-restrictive area closures (including real-time closures and MPAs) have been implemented in Australia, New Zealand and Iceland to protect the habitat of commercial fish stocks (e.g., nurseries, spawning grounds) and of other ecosystem components (e.g., cetaceans, seabirds). Closed areas have already been implemented by the EU in its waters of jurisdiction, but there are only few examples (e.g., the North Sea Plaice Box) where these have effectively constrained fishing activities.

Considering access regulation, New Zealand and Iceland have been pioneers spreading out a generalized Individual Transferable Quotas (ITQs) system to regulate access to their fisheries. Australian has also implemented ITQs to some fisheries, but their coverage has not been as widespread as for New Zealand and Icelanid fisheries. Regulating fisheries by means of ITQs provides a cost-efficient way to reduce fleet overcapacity and improve economic results. The New Zealand QMS system is probably more liberal than the Icelandic one, as any New Zealand citizen may acquire quota while in Iceland, quota ownership is restricted to fishers. However, ITQs are not fully market-driven, either in New Zealand or Iceland, where a combination of quota concentration limits and fixed quota share allocations have been imposed to safeguard the fishing opportunities of specific communities (e.g., Maori in New Zealand, coastal fishers in Iceland). ITQs have improved the economic efficiency of New Zealand, at the expenses of a rationalisation of the fishing fleet. The EU has not vested authority to allocate quotas to individual fishers. Some EU member states (e.g., The Netherlands, Denmark) have, however, adopted unilaterally a formal ITQ system, while others have informally adopted IQ or ITQs for some of their fisheries (e.g., the UK, France, Germany). The new reform of the CFP will promote rights-based management at the EU level, under conditions that were still being debated at the time of writing.

Considering all the elements above, it is perhaps unsurprising that management in Australia, New Zealand and Iceland has, overall, performed better than in the EU, in terms of fisheries resource conservation and economic efficiency. On the social side, the implementation of ITQs in New Zealand and Iceland has resulted in a rationalisation of the fleets. The EU was also subject to substantial reductions but that, however, was often incentivized by public subsidies, and not market-driven as in New Zealand and Iceland. As suggested above, it is not difficult to find arguments to find fault with EU fisheries management since the inception of the CFP, in comparison with other developed countries. However, it is also probably fair to say that managing the fisheries of 28 countries of various interests, economic structures and political traditions, as the EU does, is more complex than managing fisheries in one sovereign country, where decisions are made by one single Minister, as is the case in Australia, New Zealand and Iceland. Also, it is worth noting that the situation of EU fisheries has, overall, improved in the past ten years, especially in the Northeast Atlantic (Cardinale et al. 2011; Cardinale et al 2013). Although the results of this recovery are many, this is probably not without relation with the gradual inception of legally-binding management and plans for many stocks, and perhaps also the increasing involvement of stakeholders via the RACs. The EU has even be in recent years at the forefront of investigating innovative management routes, especially in relation to the North Sea fisheries, e.g., catch-quota management (with discards forbidden or discounted from vessels’ quota, and on-board CCTV monitoring), and mixed fisheries management (with TAC accounting for technical interactions and not derived on a single-species basis).
While many countries in the world, including those considered in this study, have pursued significant steps to implement an ecosystem approach to fisheries (following in particular the 2002 Johannesburg World Summit on sustainable development), the EU has engaged a step further. The future of EU fisheries management is intrinsically linked with the setting of an all-embracing European Maritime Policy, building on the existing Marine Strategy Framework Directive. This innovative approach to maritime management recognises that ecosystems and the marine environment have been significantly affected by climate changes, but also by land- and sea-based human activities over the last decades. These activities include fisheries, but also maritime transport, coastal tourism, aquaculture, seabed exploitation, and sea-based renewable and conventional energy. The purpose of the maritime policy will be to deal with the cumulative impact of human activities on the oceans and seas, which is more than the sum of the impacts of different activities taken separately. This challenges the current governance framework of maritime affairs, which has tended to look at maritime activities separately until now.

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