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1. Context

1.1. Rationale

European waters are affected by several threats due to the human use of coastal environments for a wide range of activities (e.g., industry, shipping, fisheries, tourism, etc.). Fisheries, whose impact has grown in the last 30 years, have led to the over-exploitation of the main commercial stocks in most areas. This situation is attributed mostly to excessive fishing capacity and failure of the management measures and programmes.

Different management and conservation measures have been adopted accordingly to the characteristics of fisheries and stocks in the different areas of European Union (EU) waters. For example, in NE Atlantic waters, where fisheries are mostly industrial and targeting a limited number of species, EU Common Fisheries Policy (CFP) has designed and implemented measures mainly based on the reduction of fishing capacity, and the limitation of annual fishing opportunities (i.e. Total Allowable Catch, TAC, and quotas). In contrast, in Mediterranean waters, where fisheries are mostly artisanal and multi-specific (both in terms of target species and gears), CFP management measures are based on reduction of fleet capacity and fishing effort in the attempt to reduce fishing mortality (F) on the exploited stocks (Colloca et al., 2011; Damalas and Vassilopoulou, 2013). Both in the Atlantic and the Mediterranean, fisheries management based on controlling the selection pattern (e.g., mesh size, minimum landing size) is also practiced.

The United Nations (UN) World Summit on Sustainable Development (WSSD), held in Johannesburg in August 2002, represented a radical shift in the management of marine fisheries and ecosystems. One of the main recommendations was to adopt the application of the ecosystem approach to fisheries management (EAF). It was also agreed to restore the world's depleted fish stocks to levels that can produce the maximum sustainable yield (MSY).

However, after a decade from the adoption of WSSD, Europe is still far from achieving these objectives (Damalas and Vassilopoulou, 2013). The CFP has been inefficient in terms of reducing fishing capacity, as well as in rebuilding marine ecosystems. Stocks and fisheries are still suffering from overfishing, fleet over-capacity, public subsidies, and decline in landings. More than 80% of the stocks in European waters are estimated as being overfished.

With the aim of addressing these issues, and working in strict coordination with the Marine Strategy Framework Directive (MSFD, Directive 2008/56/EC), a new version of

the EU CFP was adopted in 2013 (Reg. EC n. 1380/2013), entering into force on the 1st January 2014. One of the new aspects of the CFP is that fish stocks will no longer be fished in accordance to the precautionary approach. Instead, stocks will be exploited at levels that produce the "maximum sustainable yield" (MSY) (i.e. the amount that can be harvested with a view to protecting stocks and to guarantee long-term sustainable exploitation).

In addition, the new CFP also makes a number of proposals for dealing with the problem of discards, which was identified as a driver of poor economic performance and a significant threat to key components of marine ecosystem functioning. Towards eradicating discards problem, the new CFP introduced the obligation to land all catches: this represents a fundamental shift in the management approach of EU fisheries, switching from landings to catches monitoring (Damalas, 2015).

1.2. Background

European fisheries management policy is to a large extent an area of exclusive competence of the EU, meaning that management decisions are taken at the EU level unless explicitly delegated otherwise. The Common Fishery Policy (CFP) provides the framework for European and national fisheries management.

The Treaty of Rome, which created the European Economic Community (EEC) – the precursor to the EU – in 1957, contained a commitment to the formulation of a Common Fisheries Policy. In those days, however, the fisheries sector was still relatively small and industrial fishing fairly rare. Furthermore, the scope of European fisheries policy extended only to the 12 nautical mile zone then in force. Much has changed since then. Major fishing nations such as Denmark, the United Kingdom, Portugal, and Spain joined the EEC after the original formulation. Moreover, the scope of application of European fisheries policy increased with the introduction of the exclusive economic zone (EEZ), which extends to a distance of 200 nautical miles from the coastal baseline (not enforced in the Mediterranean). As a result, individual Member States (MS) acquired exclusive rights to fish in much larger areas of the sea. A Common Fisheries Policy was first adopted in 1982. Since then, the CFP has evolved and developed a series of measures which have progressively improved the scope of technical and management measures.

2. The EU Fishery Policy Context

2.1. Common Fishery Policy

The Common Fisheries Policy originally formed part of the Common Agricultural Policy. Then, it gradually developed a separate identity as the Community evolved, starting in 1970, with the adoption by Member States of exclusive economic zones (EEZs) and the entry of new Member States with large fishing fleets, such as Denmark, the United Kingdom, and in the 1980s, Portugal and Spain. These developments meant that the Community had to tackle specific fisheries problems, such as access to common resources, conservation of stocks, structural measures for fisheries fleet and international relations in fisheries.

The first mention of fishing resources in the European Community is evident in the Treaty of Rome, signed in 1957. Article 33 states that "The Common Market shall extend to agriculture and trade in agricultural products. The definition of 'Agricultural products' refers to the products of the soil, stock farming, and fisheries" (Walter, 2010). The inclusion of fisheries within the Common Market made it somewhat easier for EU countries to trade with each other, although the actual fishing rights were introduced by the European Fisheries Convention in 1964.

The legal basis for the Common Fisheries Policy (CFP) is the Treaty on the Functioning of the European Union (TFEU). Article 3 identifies "the conservation of marine biological resources under the common fisheries policy" as one of the areas in which the Union has exclusive competence to legislate. Articles 38-44 (Title III) cover agriculture and fisheries, with Article 38 stating that EU "shall define and implement a common agriculture and fisheries policy". The new Treaty explicitly recognizes for the first time the importance of fisheries to the Union, while the policy was previously included under Title II 'Agriculture' of the Treaty establishing the European Community.

The idea for a CFP was first launched in 1970, when there were only six Member States. It established the principle of non-discriminatory access to Community fishing grounds, with the implication that they were a shared resource. Fishing was far more important, however, to the economies of the four applicant countries of Ireland, Denmark, Norway and the United Kingdom, which had substantial fish stocks within their 12 miles limit. Access negotiations resulted in a move away from the fundamental principle, enshrined in the Treaty of Rome, of freedom of access to the sea resources: exclusive coastal fishing rights up to twelve miles were established and have been upheld ever since. Norway opted to stay out of the Community, but the access negotiations in 1973 delayed full application of the CFP to the other three countries for 10 years.

In 1976, fishing limits were increased from 12 to 200 miles, and from 1 January 1977 the Community's Exclusive Economic Zone (EEZ) therefore embraced numerous and potentially rich fishing grounds, the conservation and correct management of which was the responsibility of the Community. In 1982, the UN Convention on the Law of the Sea confirmed a 200 miles EEZ.

In 1983, after several years of negotiations, the Council adopted Regulation (EEC) No 170/83, establishing the new-generation CFP, which enshrined a commitment to EEZs, introduced the concept of relative stability, and provided for conservatory management measures based on Total Allowable Catches (TACs) and their annual division into quotas distributed among Member States (MS). Since then, the CFP has had to adapt to the withdrawal of Greenland from the Community in 1985, the joining of Spain and Portugal in 1986, and the reunification of Germany in 1990. These three events have had an impact on the size and structure of the Community fleet and on its catch potential.

The 1992 regulation

In 1992, Regulation (EEC) No 3760/92, containing the provisions that governed fisheries policy until 2002, endeavored to remedy the serious imbalance between fleet capacity and catch potential. The remedy it advocated was to reduce the Community fleet and alleviate the social impact by means of structural measures. The regulation introduced the concept of 'fishing effort' with a view to restoring and maintaining the balance between available resources and fishing activities. The regulation provided for access to resources through an effective licensing system.

The 2002 reform

The measures introduced in Regulation (EEC) No 3760/92 were not sufficiently effective to deal with overfishing and depletion of many fish and shellfish stocks. The critical situation led to a second reform aimed at improving the CFP with a longer-term perspective on fisheries management by shifting from annual TACs and quotas to Multi-annual Management Plans; adopting Recovery Plans for stocks outside safe biological limits; introducing the Ecosystem-Based Approach to fisheries management (EBFM); and committing to improved governance, with the creation of the Regional Advisory Councils (RACs) and the Community European Fisheries Control Agency (EFCA). Under this reform, three regulations that were adopted by the Council in December 2002 entered into force on 1 January 2003:

— Framework Regulation (EC) No 2371/2002 on the conservation and sustainable exploitation of fisheries resources (repealing Regulations (EEC) No 3760/92 and (EEC) No 101/76);

— Regulation (EC) No 2369/2002 laying down the detailed rules and arrangements regarding Community structural assistance in the fisheries sector (amending Regulation (EC) No 2792/1999);

— Regulation (EC) No 2370/2002 establishing an emergency Community measure for scrapping fishing vessels.

The primary objective of the 2002 reform was to ensure a sustainable future for the fisheries sector by guaranteeing stable incomes and jobs for fishermen, while preserving marine ecosystems. It introduced a long-term approach to fisheries management, including the preparation of emergency measures, involving multiannual recovery plans for stocks outside safe biological limits.

In order to avoid aggravating the imbalance between the overcapacity of the fleet and the actual fishing possibilities, the EFF (European Fisheries Fund) regulation introduced subsidies to investments on board fishing vessels aimed at improving safety on board, working conditions, hygiene, product quality, energy efficiency and selectivity, provided that they did not increase the ability of the vessels to catch fish. .

Measures taken to reduce fishing overcapacity by adapting the fishing fleet to fishing resources have been unsuccessful. The Court of Auditors' Special Report No 7/2007 concluded that fishing fleet overcapacity was encouraging overfishing and was not being effectively reduced or accurately reported by Member States. In addition, improvements in fishing technology were increasing the ability of the fleets to catch

fish. Although subsidies were not directly used to improve catchability, it must be noted that improved catching efficiency (or technological creep) of a fleet is usually positively related to investments in auxiliary equipment (GPS, sonar, etc.) and more efficient gears and materials, replacement of old vessels by new ones, upgraded engines, etc. (Lindebo et al. 2007). Fishing power growth has been estimated in different trawl fisheries and can range between 1.6 and 2.8% per year for beam trawl fisheries in the North Sea (Rijnsdorp et al. 2006).

For example, investments in energy-efficient engines and improvements in working and safety conditions can make it faster for fishing vessels to get to fishing grounds and can make fisheries more productive in the short term, possibly leading to internal investment and increase in fishing power.

The adoption of technical measures was promoted, such as measures regarding the structure of fishing gear, the number and size of fishing gear on board, specific measures to reduce the impact of fishing activities on marine eco-systems and non target species. In addition, incentives were introduced to promote more selective or low impact fishing.

Social-economic measures were also introduced to support fishing industry during the transition period. To ensure more effective, transparent and fair controls, the Community European Fisheries Control Agency (EFCA) was established in Vigo (Spain).

The 2002 reform gave fishermen a greater say in decisions affecting them through the creation of Regional Advisory Councils (RACs), consisting of fishermen, scientific experts, stakeholders, representatives of other sectors related to fisheries and aquaculture, regional and national authorities, environmental groups and consumers.

The 2002 reform did not live up to expectations in the short term as the deterioration of some stocks continued to increase. At the same time, it highlighted some problems that had remained unnoticed until then, such as that of discards and fishing overcapacity.

In 2009, the Commission launched a public consultation on the reform of the CFP with the aim of integrating the new principles that should govern EU fisheries in the 21st century.

In the December 2011 report “Have EU measures contributed to adapting the capacity of the fishing fleets to available fishing opportunities?”, the European Court of Auditors (ECA) concluded that overcapacity of the EU fishing fleet continues to be one of the main reasons for the CFP’s failure to ensure sustainable fishing, despite the reduction of fishing overcapacity had been a recurrent theme in previous reforms of the CFP.

After a long debate in the Council and — for the first time — in Parliament, agreement was reached on 1 May 2013 on a new fisheries regime based on three main pillars:

— the new CFP (Regulation (EU) No 1380/2013);

— the common organisation of the markets in fishery and aquaculture products (Regulation (EU) No 1379/2013);

— the new European Maritime and Fisheries Fund (EMFF) (Regulation (EU) No 508/2014).

2.2. Marine Strategy Framework Directive

The concepts behind Ecosystem-Based Fisheries Management (EBFM) are derived from more general definitions in the Convention on Biological Diversity (CBD) and by ICES (International Council for the Exploration of the Sea), being partially related to biodiversity and habitat conservation (Habitats Directive 92/43/EEC). The implementation of EBFM requires information on the state of the marine environment, including pressure indicators related to its different uses (SEC(2008) 449). The Marine Strategy Framework Directive (MSFD, Directive 2008/56/EC) establishes a framework to achieve or maintain good environmental status in the marine environment by 2020.

The importance of this approach is stated for the Atlantic Ocean in COM(2011) 782 “Developing a Maritime Strategy for the Atlantic Ocean Area”. This document emphasizes the need for a regionalized approach to fisheries management, with the establishment of fishery-based plans and mitigation measures tailored to specific fisheries, with the objective of simplifying management measures, encouraging compliance and allowing better control and enforcement. These measures should put in perspective the shared use of marine space, by introducing rights-based measures; the minimization of fishing impacts in the ecosystem, by incorporating precautionary fishing effort management tools such as spatial and/or temporal closures and applying multi-species management measures, including gear restrictions to reduce by-catch and discards.

The MSFD links to a number of EU legislation and regional agreements concerning the marine environment. The MSFD is firmly linked to the European Habitats and Birds Directives, which provide a legal basis for the designation of protected areas in marine areas under the sovereignty and jurisdiction of the Member States. Based on the evidence related to the fact that one of the primary sources of marine pollution is land-based, the regulatory structure established by the MSFD is closely linked also with the Water Framework Directive (WFD), which requires Member States to achieve good ecological and chemical status in their terrestrial and coastal water bodies by 2015.

MSFD links indirectly with CFP. In the preamble of the Directive, it is stated that fisheries management measures can be taken in the context of CFP, as set out in Council Regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy, based on scientific advice with a view to supporting the achievement of the objectives addressed by the Directive, including the full closure to fisheries of certain areas, to enable the integrity, structure and functioning of ecosystems to be maintained or restored and, where appropriate, in order to safeguard, inter alia, spawning, nursery and feeding grounds.

2.2.1. MSFD & discards

The main goal of the Marine Strategy Framework Directive (MSFD, Directive 2008/56/EC) is to achieve Good Environmental Status of EU marine waters by 2020. The Directive defines in Art. 3, Good Environmental Status (GES) as **"The environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive".** GES also means that the different uses made of the marine resources are conducted at a sustainable level, ensuring their continuity for future generations.

The reform of the Common Fishery Policy (CFP) tackles the practice of discarding through the introduction of the Landing Obligation (LO). This new approach should gradually drive the European fishing sector towards the improvement of selectivity of the fishing gears, providing, at the same time, more reliable catch data for stock assessments. Under the Landing Obligation all catches have to be kept on board, fully documented, landed and counted against the quotas. Fish over quota or under size brought to land can be used for commercial purposes, with the notable exception that fish cannot be marketed for human consumption purposes.

The Landing Obligation is actually in the stage of gradual implementation in all European waters and it will be fully implemented by January 1st 2019 (see section 3.1.1 for the progressive stages of implementation).

The full implementation of the LO will likely lead to a tangible improvement of selectivity at sea, both for the fishing gears and practices.

Improving selectivity has strong implications in the ways Member States will achieve the Good Environmental Status (GES) of the Marine Strategy Framework Directive, in particular with regards to the following Descriptors:

- Descriptor 1. Biodiversity is maintained
- Descriptor 3. The population of commercial fish species is healthy
- Descriptor 4. Elements of food webs ensure long-term abundance and reproduction
- Descriptor 6. The sea floor integrity ensures functioning of the ecosystem

Descriptor 1 – biodiversity is maintained

The key pressures on marine biodiversity are fisheries and physical damage to the sea floor. Fisheries directly impact biodiversity in two main ways. Firstly, fishing removes a considerable biomass of fish from the ecosystem, both target species and unwanted by-catch. Secondly, bottom towed gears causes extensive physical damage to the sea floor. In order to comply with the Landing Obligation, industries of EU Member States will have to adopt more selective fishing gears and practices at sea. As selectivity will need to be improved both for species and size, the result should be a decline of unwanted catches and undersized specimens which are both drivers towards biological diversity.

Moreover, effective management of marine resources needs to be based on robust scientific data. With the implementation of the LO, the full documentation of catches means that scientists will be able to better estimate the fishing mortality of the stocks and to deliver more coherent stock assessments.

Descriptor 3 – the population of commercial fish species is healthy

According to the European Commission, 63% of EU stocks (for which the information is available) are being fished beyond MSY. In addition, 30% of these stocks are outside safe biological limits, meaning that they have a high risk of depletion. Many European fisheries depend on young (and smaller) fish, which are caught before they can reproduce. This is a typical effect of overexploitation of the stocks, which results in yielding smaller (or even undersized) fish.

The Landing Obligation will bind industries of EU Member States to keep on board, land and count all catches against the quotas. In the Mediterranean, the LO applies to species for which a Minimum Conservation Reference Size has been set through the Regulation No. 1967/2006 (Annex III).

The improvement of selectivity which is expected with the implementation of the LO, should result in a firm reduction of undersized specimen of commercial species, which in terms of population dynamics means a gradual increase of the Spawning Stock Biomass and distribution of age and size, that is one indicator of healthier stocks. Reducing fishing mortality on exploited stocks across all ages, especially on the youngest age classes.

Descriptor 4 - Elements of food webs ensure long-term abundance and reproduction

Healthy and abundant food webs are crucial to ensure the survival of species. The best way to measure the functioning of an ecosystem in terms of food webs is by measuring the ratios of production at different trophic levels, the productivity of key species or groups and trophic relationships (i.e. relationships between species that have the same predators and prey in a food web).

Fishing is the human activity which exerts the greatest pressure on fish stocks and consequently has direct effects on food webs.

For the stocks that are exploited above the levels of MSY, one of the first evidence of high pressure is the reduction of size at catch. In the long term, this results in a change of a population structure, with larger individuals decreasing in abundance.

Every change in a component of a food web may have an indirect impact on its prey populations. From an ecological point of view, it is therefore crucial to have healthy stocks with homogeneous distribution of size.

The implementation of the Landing Obligation and the improvement of selectivity, which is strictly connected to it, will contribute to the achievement of the sustainability targets of the CFP, resulting in healthier stocks.

Descriptor 6 - The sea floor integrity ensures functioning of the ecosystem

The sea floor integrity is a key factor for the biodiversity conservation and the optimization of marine ecosystems.

There is a wide consensus among the scientific community that the functioning of marine ecosystems is directly linked with biodiversity and sea floor heterogeneity. As for many ecosystems in nature, all the components of the sea floor are related to one

another according to specific ecological patterns and human perturbations can result in heavy damages for a given sea bed conformation.

It is well known that fishery is one of the main human activities at sea which causes pressure to the ecosystems. This is particularly true for the sea floor, which is an extremely delicate environment, populated by demersal species which are often the main target of fisheries. Trawl fishing disturbance leads to the removal of high-biomass species that are composed mostly of emergent seabed organisms. Contrary to the belief of fishermen that trawl fishing enhances seabed production and generates food for target species, productivity is actually lowered as fishing intensity increases and high-biomass species are removed. These organisms increase the topography and complexity of the seabed which represents shelter for juvenile specimens, reducing their vulnerability to predation.

To protect the marine environment from adverse impacts, the use of towed gears, such as trawl nets, should be prohibited or limited, and alternative and less destructive fishing techniques promoted. Preventing significant adverse impacts on the sea floor, especially on vulnerable marine ecosystems (VMEs) by bottom contact fishing gears can be achieved also by means of establishing fisheries restricted areas (FRAs).

2.3. Other Regulations

2.3.1. The EU nature legislation

The cooperation of European countries on nature conservation policies started in the 1970s, especially aimed at species and habitats conservation and site designations within the frame of global agreements such as the Ramsar Convention on wetlands (1971), the Bonn Convention on migratory species (1979), the Convention on International Trade in Endangered Species (CITES, 1973) and the more specific Bern Convention on the Conservation of European Wildlife and Natural Habitats (1980).

To implement the Bern Convention two main pieces of legislation were adopted: Council Directive 79/409/EEC on the Conservation of Wild Birds (the EC Birds Directive) in 1979, and Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (the EC Habitats Directive) in 1992.

The Birds Directive was adopted unanimously by the Members States in 1979 as a response to increasing concern about the declines in Europe's wild bird populations resulting from pollution, loss of habitats as well as unsustainable use. It was also in recognition that wild birds, many of which are migratory, are a shared heritage of the Member States and that their effective conservation required international co-operation.

The Habitat Directive (HD) represents the second pillar of EU nature conservation policy. Proposed by the European Commission in the late 1980s, to respond to a continuing deterioration of European natural habitats and an increasing number of seriously threatened wild species. To date, it still remains the single most important EU instrument for safeguarding biodiversity across Member States.

2.3.2. International context

Traditionally, fisheries managers have been preoccupied with the conservation of stocks of target species, giving little or no consideration to the secondary effects of fishing on the marine ecosystem (Kaiser and De Groot, 2000). Only recently, the wider ecosystem effects of fishing activities on the marine environment were recognized to be crucial considerations in any future management plans. In those areas where intensive fisheries have long been carried out, marine ecosystems are likely to have been impacted in a manner similar to the alterations of our activities on terrestrial ecosystems (Hall, 1999).

The inclusion of ecosystem considerations in fisheries management has become known as the "Ecosystem Approach to Fisheries (EAF)" (FAO, 2003). EAF is defined as the extension of conventional fisheries management recognizing more explicitly the interdependence between human well-being and ecosystem health and the need to maintain ecosystem productivity for present and future generations (Garcia et al., 2003).

The FAO Code of Conduct for Responsible Fisheries recognises the nutritional, economic, social, environmental and cultural importance of fisheries and the interests of those concerned with the fishery sector. It also takes into account the biological characteristics of resources and their environment as well as the interests of consumers and other users.

The Code is voluntary, although certain parts of it are based on relevant rules of international law, including those reflected in the UN's Convention on the Law of the Sea. It serves as a point of reference to help individual States develop their own policies and governance to exercise responsible fisheries management, as well providing guidance on the formulation and implementation of international agreements.

The Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean adopted in 1995. The Convention's main objectives are: 1) to assess and control marine pollution; 2) to ensure sustainable management of natural marine and coastal resources; 3) to integrate the environment in social and economic development; 4) to protect the marine environment and coastal zones through prevention and reduction of pollution, and as far as possible, elimination of pollution, whether land or sea-based; 5) to protect the natural and cultural heritage; 6) to strengthen solidarity among Mediterranean coastal States; 7) to contribute to improvement of the quality of life.

The goal of sustainable fisheries, recommended by the Sustainability Summit in Johannesburg (United Nations, 2002) and ratified by means of the new EU Common Fisheries Policy (Council Regulation EC No 2371/2002, then Council Regulation EC No 1380/2013) and the European Marine Strategy Framework Directive (Directive 2008/56/EC), requires that the maximum sustainable yield (MSY) of all exploited stocks should have been implemented by the year 2015 where possible. EU MSs and GFCM are currently implementing this recommendation. The fishing mortality (F) level corresponding to MSY is FMSY, which is defined as being the value of fishing mortality (F) which produces the maximum sustainable yield in the long-term. Exploitation at or

below F_{MSY} has been a commonly accepted fisheries objective, and most management regimes have been built around this framework (Worm et al., 2009).

3. Review of EU Common Fishery Policy

According to Council Regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fishery Policy "the Common Fishery Policy shall ensure exploitation of living aquatic resources that provides sustainable economic, environmental and social conditions". However, the general consensus is that the CFP has not lived up to expectations on a number of fronts (Sissenwine and Symes, 2007; COM, 2009, 2011a). The main problem is the lack of environmental sustainability, due mainly to fleet overcapacity and excessive fishing pressure, resulting in a high proportion of stocks being overfished. Other factors contributing to the lack of environmental sustainability are discarding, lack of compliance, insufficient enforcement, the principle of relative stability and a complicated and top-down management system.

The global objective of the reform of the CFP is "To promote a fishery sector that is environmentally, economically and socially sustainable and integrated in the maritime context". To this end, specific objectives (environmental sustainability, economic sustainability, social sustainability, better governance and a more efficient dimension of the CFP) have been identified (COM, 2011b). The environmental sustainability objective of the new CFP is highly relevant to the aims of the MINOUW Project since it focuses on **improvement and availability of scientific advice**, **elimination of over-fishing in the short term**, and **reduction of discards and the harvest of juvenile fish**.

The new Common Fisheries Policy emphasizes Ecosystem based management approaches, Maximum Sustainable Yield (MSY), multi-stock management plans, transferable fishing licenses (ITQ), regionally based councils, funding conditionality, ban on discards and sustainable fisheries agreements (COM, 2011c). In order to achieve the goals of management based on the Ecosystem approach, multi-stock management plans, and MSY, it will be necessary to have much more data and carry out assessment of the many stocks that are data-deficient.

Under the third reform, with the publication in 2009 of the Commission Green Paper CEC (2009), Recovery and Multi-Annual Plans were given a broader focus through the establishment of Ecosystem-based Fishery Management (EBFM) Plans to attain stocks management at MSY level by 2015. Within this last reform, a new topic was introduced in European fisheries: the discard ban (landing obligation).

The new CFP is meant to ensure that the activities of the fishing and aquaculture sectors are environmentally sustainable in the long term and are managed in a way that is consistent with the objectives of achieving economic, social and employment benefits. The most important points are:

— Multiannual ecosystem-based management to reinforce the role that in the previous reform had been given to multiannual plans, but also to take a more ecosystem-oriented approach, exchanging single-species plans for multi-species and fisheries plans.

— Maximum Sustainable Yield (MSY): taking into account international compromises, such as the 2002 Johannesburg Summit on Sustainable Development, the new CFP will set MSY as the main target for all fisheries. Where possible by 2015, and by 2020 at the latest, fishing mortality will be set at F_{MSY} (the fishing mortality on a given stock that produces the maximum level of sustainable catches).

— Discard ban: the new reform will end one of the most unacceptable practices in EU fisheries. The discarding of regulated species is to be phased out progressively between 2015 and 2019, and flanking measures are to be introduced to implement the ban. By 2019, all EU fisheries will be implementing the new discard policy.

— The reform aims at achieving more regionalized governance by bringing the decision procedure closer to the fishing grounds. The new regulation provides that EU legislators should define the general framework while the Member States develop the implementing measures, while cooperating among themselves on the regional level.

3.1. Management Plans

Almost all important stocks and fisheries in the Atlantic waters are managed by means of a multiannual plan. The plans contain the goal for fish stock management, expressed in terms of fishing mortality and/or targeted stock size. Some plans also provide for a detailed and tailor-made roadmap for achieving the objective. Some multiannual plans include fishing effort restrictions as an additional instrument to the annual total allowable catches (TACs), and specific control rules. In Atlantic waters 9 plans has been established since 2004.

In the Mediterranean, management plans have been established according to article 18 and 19 of Council Regulation (CE) 1967/2006. In 2014, the situation was the following: 28 adopted plans and 13 in advanced preparation (Graham and Osio, 2016).

A mismatch may exist regarding the achievement of the targets and the situation of the fishery taking into account the time lag since the targets were defined and the time when the management plans are implemented.

Multiannual plans under the new CFP will include the target of fishing at maximum sustainable yield and a deadline for achieving this target. They will also contain measures for the implementation of the landing obligation. They should also contain safeguards for remedial action where needed, and review clauses, among others. Multiannual plans may also include technical measures. One of the main innovation of the reform are Discards Management Plans, which are currently being drafted by member states.

Discards Management Plans are to be defined for fisheries characterized by target species. The landing obligation (LO) will be applied on a case by case basis, and details of the implementation will be included in multiannual plans or in specific discards plans when no multiannual plan is in place. A regionalized approach would be required when Member States share a fishing area.

Details of the implementation of the landing obligation shall be specified in multiannual plans; where no multiannual plan, or no management plan is adopted for

the fishery in question, the Commission shall adopt on a temporary basis and for a period of no more than three years a specific discard plan.

To date, with the aim to obtain the *de minimis* exemption from the landing obligation, five discards plans have been introduced in EU waters covering small pelagic fisheries, large pelagic fisheries, and fisheries for industrial purposes (Commission Delegated Regulation (EU) No 1392/2014, Mediterranean Sea; No 1393/2014, north-western waters; No 1394/2014, south-western waters; No 1395/2014, North Sea; and No 1396/2014, Baltic Sea).

As for the landings obligation, a basic criterion for a small-scale fishing gear management plan to be adopted is that the fishing gear must be very selective, that is, discards and impact on the environment have to be demonstrated to be minimal when a management plan is submitted for adoption.

The approach to deal with the implementation of the landing obligation (LO) varies among Member States. In Spain, a forum for discussion made up of the fishing sector, central and autonomous administrations, NGOs and scientists has been established, the so called MESA ("Mesa Estatal de Descartes"). MESA has been promoted by the Ministry of Agriculture, Food and Environment (MAGRAMA), for the coordination of the initiatives aimed at the progressive implementation of the LO. MESA will analyze the discards plans for the different species and fisheries as these are being affected by the LO. Focus will be placed on the socio-economic impact of the LO. The working groups foreseen are: South-western waters, North-western waters and Mediterranean.

In Italy, the Ministry of Agriculture Food and Forestry in order to evaluate the effective implementation of article 15 of 1380/2013 has launched during 2014, two different calls, one directed to small pelagic and the other on demersal species, with the aim to monitor and evaluate the data on discards from fishing, the quantity of undersized fish landed by the Italian fleet and possible its use. Final reports have been delivered during 2016.

At present, the obligations derived from the LO in the Mediterranean are being dealt with through a regionalized approach. The MEDAC (Mediterranean Advisory Council) is actively involved in the development of multiannual plans (Medac, 2016a, 2016b). For instance, 3 member states (MS) are coordinating the discard plan in the Western Mediterranean (Spain, France, Italy) in the working group "PESCAMED" coordinated by MEDAC. Among the results of this group, the need to focus efforts of discards reduction on the main two target species of demersal fishing gear: hake and red mullet.

3.2. Technical measures

Fisheries management includes different types of management measures. Among these, there are technical regulations on fishing gears in order to obtain the overall goal of high sustainable yield in the fisheries. These are regulations (e.g. on mesh size) aimed at improving the selectivity of a fishing gear so that bycatch of juveniles are reduced in order to safeguard recruitment to the larger size groups of a fish stock including the spawning stock. The implementation of measures to increase selectivity,

such as the sorting grids, will require additional amount of time in order to benefit from the EMFF provisions (National Operational Programs).

Technical measures were set in Reg. (EC) 850/98. Basically, they comprise rules for the use of fishing gear, including mesh size and gear construction details, minimum landing sizes, limits on by-catches and closed areas and seasons. The introduction of Multi-annual management plans introduced new sets of measures, resulting in a high number of provisions, with multiple derogations and exceptions.

In recent years there has been a growing focus on "ecosystem effects of fisheries", addressing the impact of fishing operations not only on the target species, but also on bycatch or other effects on non-commercial species or habitats. Energy efficiency, reduced pollution and improved quality of the catch are also important aspects related to fishing gears and fishing operations (Code of Conduct for Responsible Fisheries, Article 7.2.2). Some criteria for the ideal fishing gear could be:

- highly selective for the target species and sizes, with negligible direct or indirect impact on non- target species, sizes and habitats (Code of Conduct, Paragraphs 7.2.2, 8.4.7, 8.5.1 - 8.5.4) ;
- effective, giving high catch rates of target species at lowest possible cost;
- quality oriented, producing catches of high quality (Code of Conduct, Paragraph 8.4.4).

The overall objective of MINOUW Project is to minimise unwanted catches by incentivising the adoption of fishing technologies and practices that reduce pre-harvest mortality and post-harvest discards, while avoiding damage to sensitive marine species and habitats. The general approach will be to develop and demonstrate technical/technological and socioeconomic solutions that enable and incentivise the fisher to firstly avoid taking unwanted catch and, where this cannot be reasonably or practically achieved, to utilise it productively and sustainably, but without profit to the producer.

These solutions will be developed and demonstrated in case studies, in cooperation with end users, through a multi-actor approach (fish producers; fish consumers; local fisheries managers; natural scientists; social scientists; and fisheries technologists) working collaboratively on practical solutions that are technologically feasible, environmentally sustainable and economically viable. There are a total of 19 case studies in the project, representing the three main European fish harvesting fleets: bottom trawl, pelagic purse seine, and small scale fleets; each with different technological, geographical and ecological characteristics and hence different problems regarding unwanted catches. As part of the multi-actor approach, there has been considerable dialogue with the relevant stakeholders in most case studies during the first year of the project. This has generated a variety of suggested technological solutions in 16 of the 19 case studies, such as the use of square mesh devices in trammel nets to reduce by-catch of benthic species, the use of selective grids in trawl nets and dredges, the use of traps equipped with lights to catch cod, developing less destructive slipping methods in purse seine fisheries, etc.

3.3. Landing obligation

According to Article 15 of the new CFP, all catches of species managed by quotas/catch limits and Minimum Conservation Reference Size (MCRS) should be landed. A number of exemptions are included, namely species not covered by catch limits; species where high survivability can be demonstrated and; limited volumes of permissible discards which can be triggered under certain conditions, the so called *de minimis* exemption, as well as inter-species and inter-annual quota flexibility mechanisms.

However, there are some important gaps between national and European regulation, as in many cases national regulations are more restrictive than European regulation with a greater number of species regulated by means of MCRS. Hence, undersized individuals of regulated species with MCRS under national regulations are not covered under the European regulations, and must be returned to the sea. Therefore, the regulation can only apply to species listed in Annex III of Regulation (EC) No 1967/2006, no matter if other national regulation for minimum size exists for other species.

The landed discards will be limited to purposes other than human consumption (e.g. meals and fish oils, animal feed, cosmetics, pharmaceuticals and food additives).

3.3.1. Specific provisions regarding fisheries and species covered by landing obligation

The Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 introduced articles and provisions that aimed at a gradual introduction of landing obligation, with the banning of discarding practices being the intended effect. The provisions on landing obligation are stated in Article 15.

These provisions are meant to enable MSs to develop timelines for bringing the different species in a fishery under the landing obligation. This does not concern the first stage of the landing obligation (one single date for all species). A summary of the time schedule for the implementation of the landing obligation is the following:

- From 1 January 2015:

small pelagic fisheries (i.e. mackerel, herring, horse mackerel, blue whiting, boarfish, anchovy, argentine, sardine, sprat);

large pelagic fisheries (i.e. fisheries for bluefin tuna, swordfish, albacore tuna, bigeye tuna, blue and white marlin);

fisheries for industrial purposes (i.e. capelin, sandeel and Norwegian pout);

fisheries for target species in the Baltic Sea (i.e. Salmon, Cod, Norway lobster).

- From 1 January 2016:

fisheries for target species in the North Sea (i.e. cod, haddock, whiting, saithe, hake, common sole, plaice, Norway lobster and Northern prawn);

fisheries for target species in the North Western Waters (i.e. cod, haddock, whiting, saithe, hake, common sole, plaice and Norway lobster);

fisheries for target species in the South Western Waters (i.e. hake, common sole, plaice and Norway lobster);

All fisheries for species subject to catch limits.

- From 1 January 2017:

fisheries for target species in the Mediterranean, Black Sea and all other EU waters;

fisheries for target species in non-Union waters not subject to third countries' sovereignty or jurisdiction;

for all other species in fisheries in the Baltic Sea.

- From 1 January 2019:

for all other regulated species in fisheries in all Union waters and in non-Union waters not subject to third countries' sovereignty or jurisdiction.

Timeline for the implementation of LO according the definition of fisheries can be problematic. In some cases, the timeline is defined on a fishery basis (with an attached list of target species), while in other cases, timeline is defined on the basis of a list of species (with an attached list of fisheries targeting them). This could allow for a landings obligation to apply to only e.g. cod caught by directed fisheries for cod, and not apply to cod caught in other fisheries e.g. for Norway lobster. An alternative interpretation could mean that only specific species are phased in over time, and that all fisheries irrespective of their overall contribution they make to catches of that species are subject to the landings obligation. Managers may want to consider that this may be more tractable from a control and monitoring perspective and would avoid the need to define management units based on specific catch profile (STECF, 2014).

Some MSs interpret this provision as giving them freedom in defining which species start to fall under the landing obligation at which date, in other words that MSs are free to define the fisheries as they like so that they can choose at which point in time a given species is subject to the landing obligation (for example, for a demersal species in the North Sea between January 2016 and January 2019). There are no prescriptive indications for these choices and a flexible approach seems appropriate here. However, this provision has a broader purpose beyond serving as a basis for fixing the timing of the application of the lading obligation to a given species.

In the Mediterranean, phasing-in of species to be subject to the landing obligation is to be done, at 2017 and 2019, according to whether they are the species that define the fisheries or not. This implementation could mean that in the same marine region, and possibly using the same gear, two vessels could be considered to be engaged in different fisheries, depending on their target species. Then, between 2017 and 2019, one crew will be obliged to retain their target species and the other crew could discard the same species, if it is not defined as their target species. STECF (2015) observes that it may be much more simple and achievable to phase species into the landing obligation in 2017 according only to marine geographical area or species, rather than by fisheries.

3.3.2. High survival rate exemption

In Article 15, paragraph 2(b), of the reformed CFP an exemption from the landing obligation is established for “species for which scientific evidence demonstrates high survival rates, taking into account the characteristics of the gear, of the fishing practices and of the ecosystem”. To support any proposal for an exemption for selected species or fisheries, therefore, clear, defensible, scientific evidence for high discard survival rates are required. The primary objective of this exemption is to avoid management scenarios where the introduction of the Landing Obligation (LO) could prove detrimental to the sustainability of a fishery by unintentionally increasing fishing mortality, through the enforced landing of unwanted catch that would otherwise have been discarded and survived.

This section will describe the process by which a fishery may be granted a “high survival exemption” (HSE) to the LO, for a particular regulated species. In addressing this, it will specifically explore what constitutes the two key components of this policy, namely “scientific evidence” and “high survival”, and how they are currently being interpreted by the EU Commission, and its advisory bodies. Finally, it will discuss the risks that the HSE may present to the integrity of the LO through misinterpretation and non-compliance.

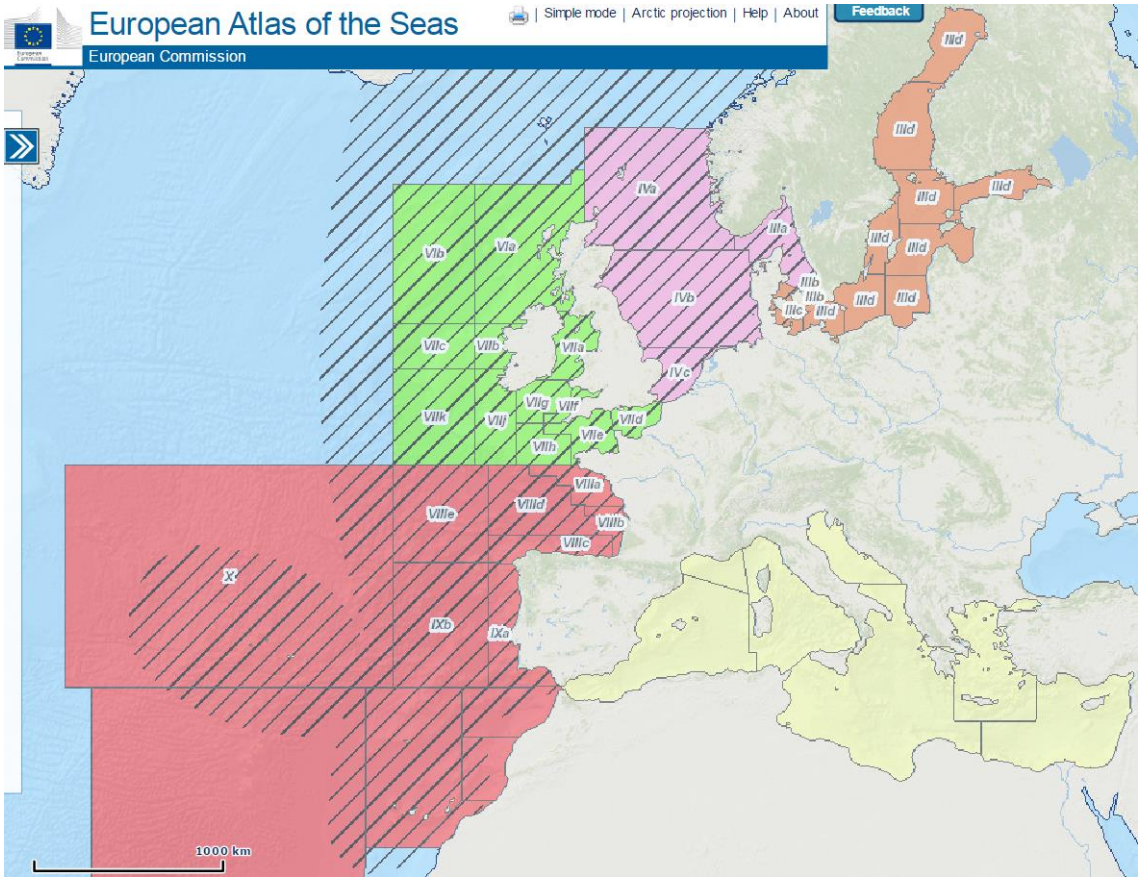

Figure 1: Map of the EU fisheries management regions and associated Regional Advisory Councils, with relevant ICES areas overlaid (in Roman numerals). [source:

http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/#lang=EN;p=w;pos=-1.847:49.227:4;bkgd=5:1;gra=0;mode=1;theme=48:0.8:1:0;]

The application process

Before describing the current process by which a fishery may be granted an exemption to the LO, it should be noted that this is only the second year since the enactment of this new policy (i.e. from 1st January 2015) and as such the procedures and processes for presenting and reviewing relevant scientific evidence are still in development, and are likely to evolve further.

Member States (MSs) may submit proposals for exemptions to the CFP Landing Obligation for consideration by the EU DG MARE. In accordance with EU regionalisation of fisheries management, the proposed exemptions should be included as part of a Joint Recommendation (JR) for an amendment to the relevant Multi-Annual Plan (MAP), or the establishment of a Discard Plan (DP) (if no MAP is in place), from a "High Level Group" (HLG) composed of all MSs with interests in the respective fisheries. Prior to submitting the JR, the HLG should also consult with the relevant Regional Advisory Councils (RACs) (i.e. North Western Waters, South Western Waters, North Sea, Mediterranean Sea, Baltic Sea, "Long Distance" and Pelagic) (see figure 1). Following submission of the JR to the commission, there then follows a period of consultation and revaluation of the proposal between DG MARE, STECF, the HLG and MSs. Figure 2 presents an overview of this consultation process, with an approximate time-table. If approved by the EU Commission, the JR is enacted as a Commission Delegated Regulation (CDR). The CDR is subject to review, at least every three years, and may be issued with specific conditions (e.g. further scientific evidence to substantiate the justification for continuation of any exemptions).

To date, there have been seven Discard Plans that include survival exemptions, which have been approved by the EU Commission and enacted as CDRs. These apply to four regions (the Baltic Sea, North Western Waters, South Western Waters & the North Sea) and provide survival exemptions for a total of eight different species (anchovy (*Engraulis encrasicolus*), herring (*Clupea harengus*), mackerel (*Scomber scombrus*), horse mackerel (*Trachurus trachurus*), jack mackerel (*Trachurus picturatus*), Atlantic cod (*Gadus morhua*), Atlantic salmon (*Salmo salar*) and Norway lobster (*Nephrops norvegicus*) caught in specific areas and fishing gears (Annex 2). In addition, five JRs for Discard Plans are currently under consultation by the EU commission that include exemptions for three species (Norway lobster and common sole, *Solea solea*) in three regions (the North Sea, North Western Waters and South Western Waters) (Annex 3). Two of these are submissions of additional evidence in support of conditional exemptions granted by the Commission in 2015, namely:

- The high survivability exemption for Norway lobster caught by trawls in ICES subareas VIII and IX (South Western Waters) (Commission Delegated Regulation (EU) 2015/2439); and

- The high survivability exemption for Norway lobster caught with certain bottom trawls (OTB, TBN) in ICES Division IIIa (North Sea) (Commission Delegated Regulation (EU) 2015/2440).

Figure 2 – An overview of the process (including approximate timetable) for drafting, consultation and approval of a Joint Recommendation for an exemption to the Landing Obligation.

Scientific Evidence

In assessing the high survival exemptions, STECF have stated that their evaluations have been based on two elements (STECF EWG 16-06):

1. Is the exemption well circumscribed in terms of the fisheries involved, the number of vessels, and indicative discard and survival rates?

2. Is the exemption underpinned by robust scientific information that justifies the exemption?

Data Requirements

With respect to element 1, STECF has provided a template of the necessary data Member States should provide for the assessment (e.g. table 1). This required data format includes:

- member state making the request;
- details of the exemption, in terms of species and fishing metier (i.e. area & gear type);
- whether the species is target or bycatch;
- number of vessels subject to the landing obligation;
- landings (in tonnes) by those vessels;

- estimated discards (in tonnes);
- estimated catch (in tonnes);
- estimated discard rate (as a percentage of total catch); and
- estimated discard survival.

This data should be presented to the commission along with supporting scientific evidence and reports. STECF anticipate that this data format will facilitate data collection, JR development and evaluation of the exemptions.

Table 1: Example of the required data for assessing the validity of high survival exemptions to the CFP Landing Obligation [source: STECF EWG 16-06]

Table 7.2.1 Summary of high survivability submitted as part of the North Sea Joint Recommendations (restricted to new or re-assessed exemptions)

Country	Exemption applied for (species, area, gear type)*	Species as bycatch or target	Number of vessels subject to the LO	Landings (by LO subject Vessels)	Estimated Discards*	Estimated Catch	Discard Rate	Estimated discard survival rate from provided studies
UK (only UK vessels involved)	Nephrops – ottertrawls with a mesh of at least 80mm equipped with a selective Netgrid in the Nephrops fishery in area IV	Target	No information provided	No information provided	No information provided	No information provided	9.6% (not clear whether this applies to all trawl vessels or only those fitted with a Netgrid)	62%
Sweden and Denmark	Nephrops – otter trawls with a mesh size of at least 70mm equipped with a species selective grid or with a mesh size of at leats 90mm equipped with a SELTRA escape panel in the Nephrops and mixed demersal fisheries in area IIIa	Target	No information provided	930 tonnes Grid and SELTRA combined (Swedish data only)	623 tonnes Grid and SELTRA combined (Swedish data only)	1553 tonnes Grid and SELTRA combined (Swedish data only)	46% Grid and SELTRA combined	55% for the grid 46% for the SELTRA trawl
UK (only UK vessels involved)	Sole below mcrs – otter trawls with a mesh size of 80-99mm in the South Eastern trawl fishery within 6 nautical miles of the English coast in ICES Area IVc	Target	72 vessels and 19 vessels in both IVc and VIId	121 tonnes	5.1 tonnes	126 tonnes	1% of the total catch; 4% of the total sole catch	51%

Methods for Estimating Discard Survival

From the first implementation of the LO, there was an urgent need for guidelines, and identification of best practice, for undertaking discard survival assessments. In September 2013, a STECF Expert Working Group (EWG 13-16) was tasked with providing this guidance. It concluded that there were three available techniques (captive observation, tagging/biotelemetry and vitality assessment) but that each of these had specific practical and scientific limitations. It was recommended that further work was required to better define best practice in methods for estimating discard survival, as well as defining criteria for critically appraising such assessments.

In response to a request from the EU Commission, the International Council for the Exploration of the Seas (ICES) established a Workshop on Methods for Estimating Discard Survival (WKMEDS) on 1st January 2014. In readiness for the first appraisal of Joint Recommendations by the Commission and STECF (see STECF PLEN 14-02), WKMEDS published its first draft guidance in April 2014 (ICES 2014). Its main recommendations were: i) assessments should be representative of discarded catch and practices, ideally in the metier as a whole; ii) methods should avoid biasing results through observation induced mortality, and ideally demonstrated with appropriate controls; and iii) the monitoring period should be sufficiently long to observe any delayed mortality. A peer reviewed publication of this guidance is anticipated later in

2016. Further to drafting this guidance, over a series of five meetings WKMEDS has provided an open forum for researchers and stakeholders actively involved in survival assessments to discuss and develop their methods. It has also developed protocols for systematically/critically reviewing survival assessments and analysing survival data (ICES 2015a, 2015b, 2016a and 2016b).

Overview of Current Research

Research aimed at estimating discard survival has been conducted for decades (for reviews see: Davis, 2002; Broadhurst et al., 2006; Revill, 2012; Uhlmann and Broadhurst, 2013; ICES 2014). Despite this body of work, STECF and WKMEDS have identified there is a lack of robust scientific data on the survival of most European regulated species, and in particular in the Mediterranean (ICES, 2014; STECF EWG 15-14 and 16-06). This is partly due to flawed methodologies in many older studies, which is being addressed through WKMEDS guidance, but also simply due to a lack of representative data for particular species/metier combinations. Therefore, since 2013, there has been considerable investment from member states in generating the required scientifically robust data, as well as developing the skills base and resources to support such a research programme.

Understandably, much of this investment in new discard survival assessments has been directed at species and areas identified in Article 51(1) for early entry into the Landing Obligation (see annex 1). In particular, the most recent assessments have focused on species and metiers which previous studies and anecdotal evidence suggest discard survival is likely to be high, for example: small pelagic species (i.e. mackerel, herring, horse mackerel, jack mackerel, anchovy, sardine, and sprat) being slipped from purse seines; Norway lobster, salmon and cod released from pots and traps; Norway lobster and flatfish (i.e. plaice and common sole) discarded from trawls; turbot released from gill nets; and elasmobranchs (i.e. skates, rays and spurdog) discard from various gears (see Annexes 2 - 5). Although some of this work has been published in the scientific literature (e.g. Tenningen et al., 2012; Depestele et al., 2014; Uhlmann et al., 2016), most of it still resides in grey literature; for example as presentations to WKMEDS (see ICES 2014, 2015a, 2015b, 2016a and 2016b) and as national reports submitted to the High Level Groups and the EU Commission. For the interested reader, the reports on survival assessments relating to JRs submitted to the EU Commission in support of HSEs (see annexes 2 - 4) are available online as background documents to the relevant STECF EWG meetings .

In addition, as part of the MINOUW project there are a number of deliverables directly addressing the survival of discarded animals, with a particular focus on Southern European and Mediterranean fisheries:

D1.4 Review of the post release survival of unwanted catches

D2.15 Guidance on promoting discard survival

D2.16 Data on the survival of unwanted catch

D1.10 Vulnerability of key benthic and by-catch species

D2.7 Training materials on promoting discard survival

D2.17 Publications on the survival of unwanted catch

As part of D2.16, there are three case studies that will be conducting discard survival assessments:

- CS 2.2 - Algarve purse seine (Sardine (*Sardina pilchardus*), Anchovy (*Engraulis encrasicolus*) & horse mackerel (*Trachurus trachurus*));
- CS 3.3 - Balearic islands seine net fisheries (transparent goby (*Aphia minuta*));
- CS 3.4 - small scale fishing in Maresme (Catalan coast) (gastropod snails (*Bolinus brandaris*)).

One of the main conclusions from the published work on discard survival is that survival rates are highly variable; not only between species and fisheries, but also within species and fisheries. The primary cause of this variability is the multitude of potential factors that can affect an individual's survival after being discarded, including: its size and age, sexual maturity, physical fitness and degree of injury, air exposure time, catch handling, temperature (in water and in air), season, depth, catch composition, haul duration, etc. (for reviews see: Davis, 2002; Broadhurst et al., 2006; Revill, 2012; Uhlmann and Broadhurst, 2013; ICES 2014). In addition, inconsistencies in survival assessment protocols and monitoring periods can introduce biases that add still further to the observed variability (ICES, 2014 and 2016b). Compounded with the limited availability of data, this inconsistency in methodologies and variability in results means that for most species/metier combinations it is not currently possible to make any definitive conclusions about discard survival rates at the fishery scale, as extrapolating results beyond the scope of individual studies could be misleading.

Assessing the "robustness of scientific evidence"

To date STECF have held seven EWGs to advise on various aspects of the Landing Obligation (STECF EWG 13-16, 13-17, 14-01, 14-11, 15-05, 15-14 and 16-06). One objective of these meetings has been to provide advice on whether the scientific evidence is sufficiently robust to support a request for a high survival exemption, in particular whether the survival assessment methods are appropriate and whether the limitations of the results have been fully explored. To this end, the ICES (WKMEDS) guidance on survival assessment protocols has been used to promote best practice and harmonisation among the most recently conducted assessments (ICES, 2014 and 2015a), as well as provide a reference for their critical review by STECF and the Commission (STECF 16-06).

Assessing the robustness of supporting scientific evidence, and its representativeness across an entire fishery, has proved challenging for STECF because of the limited availability of data, as well as the range of factors that can influence survival and their variability within a fishery. This has been reflected in the comments made with reference to many of the submitted JRs that are pending (annex 3) or were removed from submitted JRs (annex 4), where most studies have been criticised for lacking sufficient data to adequately describe the potential variability in survival at the fishery scale. Therefore, it appears that at present the Commission and STECF require direct

evidence of survival for a specific species in the particular metier of interest. Moreover, there also appears to be an increasing need to demonstrate how this survival may vary across the fishery, between vessels/handling practices and seasonally.

The only apparent exception to the species-specific requirement for evidence is in CDR 1394/2014, where a HSE has been granted for jack mackerel (*Trachurus picturatus*) released from purse seines in South Western Waters, despite no direct evidence of survival for that species. It appears to have been approved on the basis that there is high survival for other related species in the catch, namely: horse mackerel (89.7-100%), mackerel (3%-100%) and chub mackerel (100%).

High Survival

STECF have concluded that the selection of a value for "high survival" is subjective and likely to be species- and fishery-specific. Furthermore, they have stated that "the decision to accept or reject an exemption proposal based on the survival value presented is for managers to decide", which has been reiterated in each of the seven LO related EWGs (STECF EWG 13-16, 13-17, 14-01, 14-11, 15-05, 15-14 and 16-06).

STECF have emphasised that before considering the implementation of a HSE, it should be remembered that avoidance of unwanted catch, through improved selectivity or other means, is the primary objective of the LO (STECF EWG 16-06). Clearly, determining an appropriate "high survival" threshold for a particular species and metier is complex, which will require an informed understanding of a number of key issues:

- pre-existing status of the stock, and wider ecosystem, with respect to key management criteria (i.e. MSY) and safe biological limits (i.e. recruitment, fishing mortality and spawning stock biomass);
- current discarding rates, including temporal and spatial variability;
- realistic potential for changing the exploitation pattern to avoid unwanted catches;
- potential for reducing the incentive to reduce discarding, if an exemption was implemented;
- potential to undermine compliance to the LO, if an exemption was implemented;
- scientifically validated discard survival likelihood, and its variability across the fishery; and
- likely impacts on the stock, and wider ecosystem, of the LO with and without the HSE.

Finally, the choice of "high survival" threshold is indeed subjective, as identified by STECF, because it will involve trade-offs between different management and societal objectives, which will ultimately be driven by the management priority for that fishery at that particular time (e.g. improving stock sustainability; improving financial viability; or avoiding waste).

With respect to this subjectivity, it is informative to review the survival rates that have been assessed by the EU Commission as being acceptable (Annex 2), or indeed unacceptable (Annex 4), for justifying the implementation of a High Survival Exemption (HSE). Of the five proposed HSEs that were not included in the approved JRs, none appear to have unacceptably low survival rates; in all cases it appears to have been the lack of robust scientific evidence that has been the key problem (Annex 4). Among the approved HSEs, the majority have assumed survival likelihoods that intuitively appear to be nominally "high" (i.e. >75%) (Annex 2). However, two examples, both relating to *Nephrops* caught in trawls (the first in the SWW region and the other in SELTRA trawls in the Skaggerak & Kattegat), have survival likelihoods that are considerably lower: 51% and 59%, respectively. Both fisheries target *Nephrops*, but with a significant mixed bycatch, and both have substantial discard rates: 35% and 50%, respectively. Thus a substantial proportion (up to ~30%) of the *Nephrops* caught will be returned to the sea dead, or dying, as a result of the HSE. This suggests that the Commission appears to be applying the "high survival threshold" with some degree of pragmatism. However, the exemptions for both fisheries are conditional on the provision of more survival data in 2016. In the case of the SELTRA trawl fishery, this new data has in fact lowered the mean survival to 46% (see annex 3). It will be interesting to see whether the HSE remains in place for this fishery in 2017, as this would set a counter-intuitive precedent for defining "high"; i.e. only the minority of the discarded animals survive. This could be interpreted by some as opening a loophole in the legislation that could be used to circumnavigate the Landing Obligation.

Compliance Issues

As with the *de minimis* provisions, implementation of the HSE has raised concerns over its potential to undermine compliance of the LO. In particular, with the limited capacities that many control agencies have to monitor discarding practices, the HSE generates potential for masking non-legitimate discards as species eligible for release under the HSE. Furthermore, if the discarding of individuals was conditional on their vitality at the time of release (e.g. only living and active specimens could be released, while all others must be landed), it is feasible that the vitality status could be "mis-reported" to provide offenders with an opportunity to illegitimately release unwanted and dying catch, or alternatively exploit an otherwise unavailable resource (e.g. a zero TAC species).

3.3.3. *De minimis* exemption

This provision is intended to provide some flexibility to the landing obligation in order to take into account for unpredictable and unavoidable catches. There are many ways to interpret the wording of the *de minimis* exemption contained in Article 15(2c) of the regulation and this has substantial bearing on the potential impact of this exemption and many different interpretations around whether the *de minimis* should apply at an individual member state or across several states involved in a fishery or region and whether it should apply at the individual species level or for all species combined (STECF, 2013). At an operational level, it could apply at an individual vessel, fleet, member state or regional (multi- state) level. Applying the *de minimis* to total annual

catches at vessel level, or at fleet segment level, or at fishery level, or at national level, or at Union level, make a difference: the more general the level, the more room there is for high discarding levels by individual vessels, as long as it is compensated elsewhere. Under a single species *de minimis* example, where the 5% threshold included in the regulation is applied to only one target species, the overall discard "allowance" is quite modest provided it is recorded accurately to ensure compliance. Conversely, if the 5% applies to the whole catch available to the fishery unit it can result in catches substantially exceeding advised levels for a chosen species (STECF, 2013). One of the most difficult to interpret element of the *de minimis* exemption is the basis on which it should be calculated, which is defined as the 'total annual catches of all species':

This exemption is applicable when either "scientific evidence indicates that increases in selectivity are very difficult to achieve", or "to avoid disproportionate costs of handling unwanted catches" (when these unwanted catches do not represent more than a certain percentage, to be established in a plan, of the annual catches).

As regards the interpretation of the expression 'increases in selectivity are very difficult', it can be argued that technically further selectivity seems always possible, so this would (from a certain point on) rather be looked at from the cost/benefit view point. In that case, STECF 13-23 considers this as an economic rather than technical question, and therefore it suggests using an economic indicator to assess this.

3.4. Regionalisation

The purpose of regionalisation is dual: moving away from micromanagement at Union level, and ensuring that rules are adapted to the specificities of each fishery and sea area (“region”, sea-basin approach). Regionalisation can build on existing co-operation among Member States, such as Baltfish or the Scheveningen group or the co-operation between France and Spain on anchovy fishery in the Bay of Biscay.

Management plans will be established at a regional basis, with the objective of simplifying management measures, encouraging compliance and allowing better control and enforcement. They should improve a shared use of marine space, by introducing rights-based measures; the minimization of fishing impacts in the ecosystem, by incorporating precautionary fishing effort management tools such as spatial and/or temporal closures and applying multi-species management measures, including gear modifications to reduce by-catch and discards.

For example, following a proposal by the Commission, the European Parliament and the Council should decide on a long-term plan for a target species (the plan). This plan should set goals and the timeframe for these to be achieved, i.e. achieving Maximum Sustainable Yield (MSY), a lower fishing mortality or a higher biomass. The plan could prescribe selective gear and measures to avoid discarding. The plan would also have a flexibility article in order for new scientific advice to be taken into account quickly. The goals to be achieved will apply uniformly for all Member States (MSs) fishing on the stocks covered by the plan in order to provide a level-playing field for all fishermen.

Through the plan, EU legislators should empower MSs to set national measures to make the plan operational. In the framework of the sea-basin approach, the MS exploiting a certain area should meet with fishermen, stakeholders and Advisory Councils to design concrete national measures that can best manage the stocks and that can achieve the objective of the plan. Fishermen and other stakeholders would propose specific gears, area or seasonal closures, control measures, measures concerning fishing vessels or whatever other measure they believe will deliver the best results for their specific fisheries. They could also propose measures to implement the discard ban.

The heart of the sea-basin approach is that MSs implementing the plan could set up a co-ordinating system, meet at regional level, and exchange and agree on common measures, and subsequently enact these measures nationally. These measures would be the same in all MSs implementing the plan.

In developing integrated technical measures to avoid discarding practices which are difficult to monitor, and to protect special ecosystems, customized regional and local approaches are essential.

Union Regulations will continue to apply to all vessels fishing in Union waters. Furthermore rules adopted in a sea-basin approach by MS under regionalisation would be the same rules, with the only difference that instead of EU legislation they would be national laws. These laws would be notified to the MS, the European Fisheries Control Agency and the Commission so that they can be controlled by national inspectors in a uniform manner guaranteeing a level playing field.

3.5. Concerns dealing with the implementation and enforcement of the landing obligation

In drawing up a long-term policy to encourage the reduction of by-catches and elimination of discards, the Commission is looking for the technological tools that can be used to bring about the desired results.

The ability of Member States to control, monitor and enforce the landing obligation is key to successful implementation of the landing obligation.

A discard ban requires a high level of control, enforcement and at-sea monitoring, as it will have a significant impact on the way fishing is conducted. Fully documented fisheries (FDFs), where both landings and discards are monitored, recorded and documented through electronic monitoring (CCTV and sensors system), has been tested in recent years in several European fisheries and has proven to be effective in monitoring full-catch retention (Kindt-Larsen et al., 2011). However, fitting electronic monitoring in all European vessels may pose technological challenges, while relying on the collaboration of fishers using, for instance, additional fishing opportunity as an incentive, as has been the case in Europe, may not be sustainable.

The use of environmentally friendly types of gears, as well as less energy-intensive vessels and fishing methods, are also in discussion within the CFP reform with the objective of minimizing fishing impacts on the ecosystem.

The translation of these general goals into more specific targets depends on a clear understanding of fisheries. The development of effective performance indicators depends heavily on fishery-based information such as the data collected onboard by observers, or those obtained by technological tools including control instruments such as electronic monitoring devices and fishing logbooks or sales registers. The collection of data within these programs constitutes a strong support to scientific advice for guiding the management of fisheries within the current CFP reform.

The move from simple, easily (legally) defined technical measures to more complex and fishery-specific technologies implies a move from input to output control and a corresponding need to monitor total catch. Currently in EU fisheries, catch monitoring by paid observers covers an almost negligible percentage of effort and, in many fisheries, results in very large raising factors. Increasing observer coverage is expensive and the cost would have to be borne either by member states or by industry participants.

While observer coverage can be prohibitively expensive, it can be very effective when targeted sensibly. For example, where reference fleet or self-sampling data appear to show that some vessels have atypical catch profiles, observers can be used to determine whether this is a result of incompetence or intended misreporting.

Much of the work of the control experts focussed on the utility of the current systems for documentation of landings and discards, and whether changes were required in the current reporting procedures. It was concluded that the current system works reasonably well as a data capture system, but the current scope requires broadening to improve resolution in terms of catch reporting, including potential issues with permitted tolerances between declared and actual landings; estimating quantities of legitimate discards; current levels of fleet coverage and availability of data at an operational level (e.g. haul-specific information). It is important that catches of species not subject to landings obligation are documented as such information is important for stock assessment and broader ecological studies. Under the current EU control regulation (Council Regulation (EC) No 1224/2009 of 20 November 2009), it is mandatory for masters to record discards by species if they exceed 50 kg. However, anecdotal information suggests that the reliability of the data is questionable and the 50 kg threshold is too high to capture information for many species (STECF, 2013). A limited analysis, comparing reported discard estimates with those obtained by scientific observers showed significant discrepancies between the two, with the reported discarded catch being only 0.06% of the weight recorded by the scientific observer (STECF, 2013). This shows that reliability of discard estimates derived from EU logbooks represents a gross underestimation when compared to scientific observer data and that reliance on such data for monitoring the volume of discards is insufficient and unadvisable.

At-sea control through the use of patrol vessels has the advantage in that the systems are well established and their presence acts as a strong deterrent, but coverage is discontinuous and can only verify catch documentation at time of boarding and in general is likely to have a low sensitivity to detect illegal discarding. At-sea inspection with aircraft, although expensive, can cover large areas in a relatively short period of time, and while coverage is discontinuous, aircraft are able to detect discarding, however where exemptions (*de minimis*, high survival rates) are in place it cannot be

ascertained whether the discards are legal or not for both types of at-sea inspection. The effectiveness of the control activities outlined above can be enhanced by considering the risk of non-compliance, and then targeting appropriate control activities to verify compliance. Integrating information from the different sources can be used in a risk analysis framework, using pre-defined expected baselines, and using disparate data to detect potential outliers. Control can then be focussed on the 'outliers'. Effective compliance requires a 'level playing field' in terms on monitoring, control and enforcement of the landings obligation; in addition, sanctions need to be proportionate not only to offence, but also to the risk of detection. It is important to note that there is a continued requirement for the collection of scientific data from commercial fishing trips. This could potentially lead to a situation where there are two types of observer, a control observer, who is empowered to enforce the landings obligation and the associated exemptions/flexibilities, and a scientific observer for the exclusive collection of biological data. A future system with observers with very differing functions is likely to lead to confusion regarding roles and may undermine the current goodwill.

In some areas, the illegal marketing of undersized specimens of particular species for human consumption is a common practice. One potential negative outcome of the recently implemented EU landing obligation will be an increase in non-reporting and illegal marketing of undersized fish, particularly in the Small Scale Fishery (Veiga et al., 2016). First, because small-scale fishers are likely to get better prices for undersized fish in the black market (for direct human consumption), than for reduction purposes. Second, because with the landing obligation the on-board retention and transport of juveniles will be legal. This may facilitate the process of illegal commercialization, as fishers will only have to avoid landing at control points.

Other important aspect of discard ban is the impact of discarding, or not discarding, unwanted catch in the ecosystem (Borges, 2015, Sardà et al., 2015, Veiga et al., 2016). For some species, which are returned alive to the sea with high probability of surviving after being discarded, the discard ban could have negative effects at the population level by increasing fishing mortality on these species and on overall biodiversity. In contrast, at the community level, discards are a source of food for several organisms in both the pelagic and demersal ecosystems. The substantial reduction in discards from exploited marine ecosystems will have direct and indirect effects on these species that need to be properly evaluated. Also the role of discards in the energy turnover of ecosystem must be considered: discarded biomass is a source of energy that is removed and immediately returned to the exploited ecosystem. A discards ban will produce a loss of energy from the marine ecosystem that will be exported to land.

3.6. Maximum Sustainable Yield (MSY) as a target

Although there are attempts to provide scientific advice that integrates a precautionary approach, maximum sustainable yield (MSY), and an ecosystem approach into one advisory framework, the standard approach in evaluation of management strategies in European fisheries is based on single species populations models (Kell et al., 2007; ICES, 2012a). Stock assessments carried out by ICES, STECF,

and GFCM working groups are still largely based on single species age-structured methods that require time series of catch-at-age data (ICES, 2012b). For example, Virtual Population Analysis (VPA) techniques, such as XSA and ADAPT, and statistical catch-at-age models (SS3, a4a, SAM) require high quality catch-at-age and weight-at-age for every time step and an abundance index for calibration. Catch-at-age data requires sampling and determination of age based on reading growth rings on hard structures, such as otoliths, vertebrae, spines and scales. These studies are labor intensive and expensive, and only carried out for the most important species and stocks.

ICES provides advice for more than 200 stocks, of which 122 were considered not to have population estimates from which catch options can be derived using the existing MSY framework. However, it should be noted that for the first time, in 2012, ICES provided management advice for 68 data-limited stocks.

Mediterranean fisheries are characterized by their largely small-scale, multi-species nature. With the exceptions of some small pelagics, a large number of species are caught in relatively small quantities, using a great diversity of gears and are mainly landed fresh in many different ports (Lleonart and Maynou, 2003). These characteristics of Mediterranean fisheries make it difficult to obtain data for stock assessment purposes. Only few stocks can be analysed by means of quantitative assessment methods for the evaluation of stock and exploitation status, the main limiting factor being the availability and reliability of data. Sufficient data are available only for those stocks driving the main fisheries in the Mediterranean.

In fact, the most important stocks are in general monitored under the framework of DCF activities as concerns their abundance and the collection of biological and population dynamics parameters. Quantitative-analytical assessment of commercial fish and shellfish stocks in the Mediterranean started about 20 years later compared to northern European waters (Colloca et al., 2011) due to the lack of a standardized and systematic data collection that hindered the assessment of fisheries resources in the Mediterranean until the 2000s, when the EU Data Collection Regulation (DCR, EU reg. 1543/2000) was enforced in all EU MSs. In addition, the standardized collection of fisheries-independent data (i.e. MEDITS bottom trawl survey; see Bertrand et al., 2002) started relatively late in the early 1990s.

Since 2008, 46 species were assessed in the Mediterranean and Black Sea under STECF and FAO-GFCM working groups, for a total of 181 stocks assessed (GFCM, 2015; Lleonart, 2015).

A general condition of overfishing emerged for most of the stocks assessed in the Mediterranean. According to most recent estimates by STECF, about 85% of the stocks assessed in Mediterranean European countries are overfished, while only four stocks are considered sustainably exploited compared to the fishing mortality level able to provide MSY.

In recent years, there has been considerable effort on developing methods and approaches for data-deficient stocks within ICES and around the world. ICES has implemented a series of methods developed from various working groups, review groups and Expert groups such as WKFRAME (Workshop on Implementing the ICES F_{MSY} framework) to provide quantitative advice for data-limited stocks and to apply the

precautionary principle (ICES, 2012c). The underlying principles for data-limited stocks are that available information should be used, advice should follow the same principles as for data-rich stocks (i.e. exploitation consistent with the goal of MSY), and the precautionary principle should be applied when establishing limits, with more precaution the less data available.

Although discards are not included in most of the stock assessments, the possible reduction of discards is expected to provide relevant benefits to stocks structure and dynamics, thus contributing to achieving F_{MSY} targets. However, in the case of some stocks (and GSAs) where discards are considered relevant, such as European hake and deep-water rose shrimp in GSA 9, discards are included in the assessment analyses. Therefore, the effects of the reduction of discarding could be incorporated directly in the assessment models and the role of discards reduction in achieving F_{MSY} targets can be evaluated.

4. The EU CFP and the Norwegian and Icelandic Experiences

4.1. The Norwegian context

Norway is Europe's second largest fish producing nation (after Russia) producing 2,481,785 tonnes of catch and generating 19.9 billion NOK in 2015; where the five most commercially important species (by value) were: cod, mackerel, herring, saithe and haddock (Fiskeridirektoratet, 2016). Although this catch revenue only accounts for a small percentage of the nation's GDP (~0.75% in 2015; Statistics Norway, 2016), fishing still remains both culturally and politically important in Norway; due to its historical importance for coastal communities, as well as through recognition of its contribution to the global catch (i.e. 11th most productive nation; FAO 2014).

Norwegian fisheries are managed through a complex system of regulations which aims to control both input/capacity (i.e. fishing licences) and output (i.e. quotas), as well as the exploitation pattern through a multi-facetted collection of regulations and technical measures, including measures referred to as the "Discard Ban Package" (Gezelius, 2008; Johnsen and Eliasen, 2011; Gullestad et al., 2015). This section will provide an overview of the different components of the "Discard Ban Package", explaining their objectives with respect to minimising discarding practices and discuss whether they have been successful.

The "Discard Ban": in principle & practice

Unlike the EU Landing Obligation, the Norwegian Discard Ban was not initially implemented with the intention of being an all inclusive measure to eradicate the wasteful practice of discarding unwanted catch (UWC) in all fisheries. Instead, the Norwegian "Discard ban package" has evolved over ~30 years in response to specific fisheries problems – starting in 1987 with a *ad hoc* strategy to save the 1983 NE Arctic cod cohort from high grading practices (Gullestad et al., 2015). Between 1987 and

2008, a series of regulations and technical measures progressively extended the discard ban to include a further 17 commercially important species.

In 2009, the "Marine Resources Act" (section §15: Duty to Land Catches), in principle, extended the Discard Ban to encompass all living marine resources with the phrase: "All catches of fish shall be landed. …". However, in practice, the Seawater Fisheries Regulations (2015) (section §48: Prohibition against discarding fish) effectively limits the ban to 55 commercially important species. In addition, the regulation introduces a number of "pragmatic exemptions" (Gullestad et al., 2015):

The ban only applies to "dead or dying fish" (i.e. surviving fish may be released); and

Damaged catch (unfit for human consumption) can be discarded, "in small quantities".

The "Discard Ban Package"

The Discard ban package is an integrated suite of regulatory and technical measures to minimise unwanted catch, including: the Regulatory Discard Ban; gear selectivity technical measures; closed areas; and monitoring and control measures.

Regulatory Discard Ban

In defining regulations for a discard ban, it is essential to recognise and address the causes and drivers of discarding practices (Catchpole et al., 2005; Johnsen and Eliassen, 2011; Condie et al., 2014), for example:

- No commercial value: the fish has no marketable value, i.e. it is poor quality, damaged or is not a commercial marketable species or size;
- No quota: the vessel has exceeded its quota for a particular species;
- Large catches: the catch is too large for the vessel to handle/process;
- "High-grading": maximising value of limited quota, by selecting only the most valuable components of the catch; and
- Under sized/juvenile fish: below minimum landing or commercially valuable sizes.

Obligation to avoid UWC: fundamental to the ban is the responsibility of the fisher to avoid unwanted catch. This regulatory provision requires that if a fisher finds their catch exceeds UWC limits (see below), they are obliged to change fishing area and report the UWC. The fisher must *demonstrate responsible behaviour* by moving to a fishing area where, to the best of their knowledge, UWC will be within acceptable limits; otherwise they can be prosecuted. This important provision links and promotes many key components of the discard ban package, including: technical measures on gear selectivity and closed areas, as well as the responsibility to report all components of each catch.

Mandatory (& Compensated) Landings: also fundamental to the ban is the requirement to land all fish in the catch (as defined in Reg §48), even the UWC for which the vessel has no legal right to sell the fish (i.e. no quota or undersized). In

addition, the fishers may for demersal species receive 20% of the value of any UWC in compensation for the costs of transporting it to shore. In principle, this ensures there is no unutilised wastage of marine resources and, theoretically, the landing statistics are representative of the catches for regulated species. This provision is an important and pragmatic mechanism to enable fishers, who accidentally take "illegal catches", to legally dispose of their unwanted catch, without profit. In effect, it decriminalises responsible fishers (Gezelius, 2008).

Unwanted Catch (UWC) Limits: for each fishery there are specific limits on what proportion of the catch may be UWC. For example, in the Northern Shrimp trawl fishery for each 10kg of shrimp the catch may contain 8 cod, 20 haddock, 3 redfish and 3 halibut. In the gadoid trawl fishery (for cod, haddock, saithe) less than 15% of the catch can be UWC. Again, this is measured in number of fish per unit catch, for two reasons: i) this is easier to measure at sea; and ii) it independent of size, so gives equal value to each fish. It is worth noting that in recent discussions between the EU and Norway, the EU Commission expressed a preference for using weight.

Minimum Legal Size (MLS): although this is a main driver of discarding, this provision (which replaced "minimum landing size") was retained in the discard package because it is seen as essential for preserving juvenile fish and exploiting the growth potential of fish stocks. Furthermore, it is supported by various technical measures promoting fishing gear size selectivity. There are currently 38 species protected by MLS limits, where all fish below MLS are considered part of the UWC.

Tailored National Quota Regulations: again, quotas are a key cause of discarding, particularly "High-grading", but they are also seen as an important provision to protect against over-exploitation of a stock; along with capacity and effort controls. In response to the "discard ban", quotas were retained but have evolved into a system of annual Individual Vessel Quotas (IVQ), which in some fisheries are transferable within a fishery sector (ITQs) (Hannesson, 2007, 2014). This also reduced the frequency of the incentive to discard excess catches to just once a year (Gullestad et al., 2015).

More importantly, the TAC for a particular species may now include an allocation for "unavoidable UWC" in non-directed fisheries. For example, the North Sea trawl fishery for saithe has a UWC quota for cod, while a UWC quota for blue whiting is set to cover bycatches in non-directed fisheries. These are subtracted from the annual TAC before it is allocated to the IVQs in the directed fisheries. Although this is a rational policy, Gullestad et al. (2015) caution that care must be taken to: i) ensure the UWC quota is reconciled with permissible UWC limits; and ii) avoid implicitly accepting large UWC catches in non-directed fisheries. Furthermore, the partitioning of quotas between vessel groups and IVQs was a contentious issue, but has mostly been resolved through negotiation, with a significant input from the Norwegian Fishermen's Association (Gullestad et al., 2014).

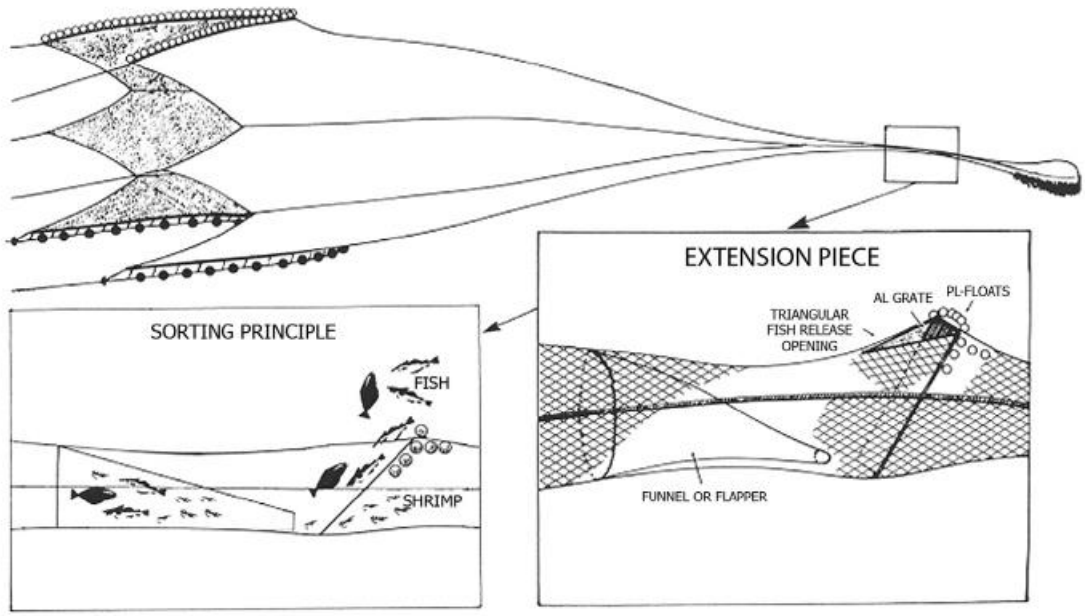

Figure 3: The "Nordmøre Grid": its position, design and sorting principle in a shrimp trawl. (Source: Gullestad et al., 2015; originally Larsen, 2006).

Selective Technical Measures

The use of technical measures to improve the selectivity of fishing gears, primarily to reduce the catch of juvenile fish, had been in place before the discard ban was implemented. For example, a minimum codend mesh size of 135mm in white fish trawls had been introduced in 1983. However, the introduction of RTCs in 1984 and the discard ban for cod and haddock in the Barents Sea in 1987 stimulated the development of more effective alternatives to mesh size increases. In particular, derogations for fishers to enter RTCs, if using experimental selective devices, catalysed an innovative partnership between industry, researchers and management, which resulted in the development of selective grids (Gullestad et al., 2015). This started with the development of the "Nordmøre grid" in 1989, which specifically aimed to reduce the bycatch of fish in the shrimp trawl fishery (e.g. Isaksen et al., 1992) (figure 3). The Nordmøre grid (with 19mm bar spacing) became mandatory in the Northern shrimp trawl fishery in 1991.

The success of the "Nordmøre grid" inspired a series of developments in grids aimed at reducing catches of undersized fish in gadoid trawl fisheries. This lead to the mandatory use of grids (with 55mm bar spacing) in gadoid trawls in the Barents Sea from 1997, starting with the "Sort-X" (Larsen and Isaksen, 1993) and "Sort-V" grids (Lisovsky et al., 1996)(both approved 1997), followed by the "single grid" (approved 2000) and the "flexigrid" (approved 2002)(Larsen, 2006)(figure 4). However, throughout this period fishers have expressed concerns about the practical implementation of the various grid designs, as well as their potential to become blocked (e.g. Larsen et al., 2013; Sistiaga et al., 2014). In addition, it has been highlighted that comparable improvements in selectivity could also have been achieved with a codend mesh size of 155mm (Jorgensen et al., 2006).

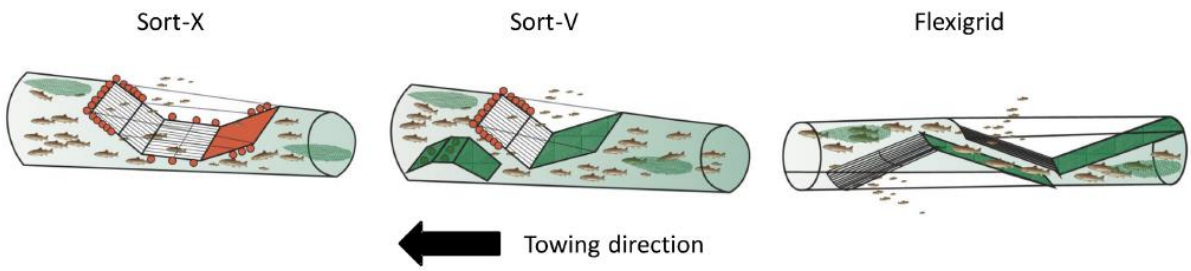

Figure 4: Later developments in selective grids used to minimise discarding in Norwegian waters: "Sort-X" and "Sort-V" (approved 1997) and "Flexigrid" (approved 2002) (source: Herman et al., 2013).

More recently, localised high densities of cod in the Barents Sea has lead to excessively large catches (>50 tonnes) in very short trawl tows (~30 mins). To address potential "high-grading" practices, as well as safety issues, there has been a drive to develop catch limiting mechanisms in both trawls and demersal seines (For a review see: ICES 2015). These developments have included: semi-detachable codends (Grimaldo et al., 2014); side-openings in the codend (Grimaldo et al., 2014); very large "brick" meshes (CRISP, 2012); mechanical gates (CRISP, 2012); the Excess Fish Exclusion Device (ExFED) (Underwood et al., 2014); and real-time camera and communications systems (CRISP, 2012).

In addition, evidence that fish released or "slipped" from purse seines can die, if overcrowded, (Huse and Vold, 2010; Tenningen et al., 2012) has stimulated an extensive research programme in Norway to minimise the likelihood of unwanted catches in purse seines, as well as improve slipping practices (for reviews see: Breen et al., 2012; ICES, 2015).

This research has included: improved acoustic techniques for species and size characterisation of target schools; early catch sampling using net mounted sampling bags and cannon deployed sampling trawls; methods for estimating and controlling the net volume; and improved designs of the bunt of the net to promote safe release (Figure 5).

Closed Areas

Another key technical measure supporting the discard ban is the provision for three different types of closed areas:

1. Permanent Closed Areas: are intended to protect ecologically sensitive areas (e.g. coral reefs and nursery grounds), as well as prevent conflicts between gears. They can be closed permanently, or just seasonally, and can be gear specific. For example, the Bear Island nursery grounds are permanently closed to trawls for 20 nautical miles around the island.
2. Real-time Closures (RTCs): are considered by the Fisheries Directorate to be a crucial element of the Discard Ban Package (Gullestad, pers. Comm., 2016). For a more detailed explanation of their operation and benefits, please refer to Gullestad et al. (2015). RTCs are triggered by the UWC limits being exceeded in an area, andtheir shape is defined by the distribution of the UWC, so can be irregular. They are re-opened only with evidence that UWC is within acceptable

limits. Although this rule is perceived by most stakeholders as a fair and effective way of addressing unpredictable distributions of UWC, there has been some discontentment amongst fishers due to extended delays in re-opening some areas; primarily due to a lack of resources to survey them (Kinsey, 2008).

3. Advisory / Voluntary Closures: these are similar to RTCs, but are defined on a precautionary basis, with no legal enforcement by the authorities. Despite this fishers generally appear to respect these closures; arguably to reduce the likelihood of the area being defined as an RTC.

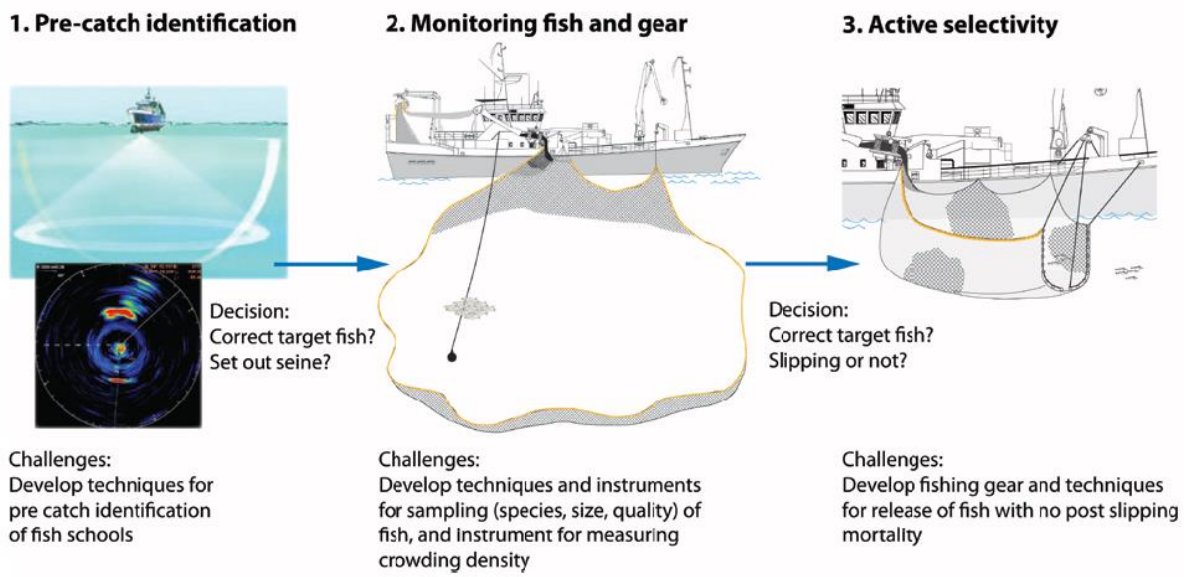

Figure 5: Overview of the Norwegian mitigation program for minimising fish mortality caused by releasing fish (or "slipping") from purse seines (source: Breen et al., 2012).

Monitoring and Control of Fishing Activity & UWC

It is recognised that while well directed regulatory measures, supported by robust science, have been an important component of addressing unsustainable fishing practices in Norway (including discarding), prudent control and enforcement of those regulations are essential to successful fisheries management (Gullestad et al., 2014). However, illegal discarding practices are very difficult to observe and control (Gullestad et al., 2015). Furthermore, Norway does not have a formal observer programme or use ship board cameras to monitor catch composition. Instead, the Norwegian Directorate of Fisheries (NDF) coordinates a suite of measures to monitor commercial fishing activities (including discarding) in Norwegian waters, which draws on regulatory responsibilities of the fishers, as well as contributions from various government agencies, for example:

- Electronic logbook – all vessels >15m are obliged to electronically report the composition of each catch, including UWC. Smaller commercial vessels between 13 and 15m are subject to a simpler reporting system using smart-phones. Each skipper is responsible for an accurate and immediate report of

the catch, which should not deviate by more than 10% from the landings (Fiskeridirektoratet, 2016; Johnson and Eliasen, 2011).

- Vessel Monitoring Systems (VMS) – Norwegian & EU vessels >15m (>12m in Skaggerak; >24m non-EU vessels) are required to report hourly, via VMS, the following data: time (minute resolution), vessel position, permit number, heading and speed (Fiskeridirektoratet, 2016; Skaar et al., 2011).
- Landing Records – all sales of raw fish are controlled by one of six national sales organisations (5 demersal (regional) and 1 pelagic). These agencies are responsible for keeping accurate records of all landings of raw and processed fish; and are regularly monitored by NDF inspectors. Data on each landing are reported in near real time to NDF and immediately made available to NDF and Coast Guard inspectors. There is a formal scheme of conversion factors for estimating original catch weights from the various products (Nedreaas et al., 2015).
- Inspections – The Norwegian Coastguard has the primary responsibility for providing a preventative presence and for inspecting fishing operations and catches for evidence of illegal activities (including discarding). To perform these duties it has 15 inspections, as well as surveillance helicopters and planes, and conducts around 2000 inspections per year (Gullestad et al., 2015).
- Scientific Monitoring – The Institute of Marine Research (IMR) is the principle scientific agency for monitoring the status of the marine ecosystem and fish stocks in Norway. Since 2000, it has operated a "Reference Fleet" of commercial vessels (currently 34) to provide scientifically valid biological data that is representative of commercial catches, including unbiased catch composition (IMR, 2014). This data, along with ecosystem surveys and modelling, is used to estimate potential discarding rates and identify high risk fisheries and areas.
- Directed Research – there is currently a joint project between NDF and IMR to better quantify discarding in "high risk" fisheries. This is using targeted case-studies of specific fisheries, identified using a risk-assessment approach, to give a high resolution, although "patchy", overview of non-compliance and worse-case estimates of discarding (Blom et al., 2015; Nedreaas et al., 2015).

The Norwegian Discard Ban – A "Positive" Experience?

Although the Discard Ban was originally introduced to specifically address high-grading in the NE Arctic cod fishery, it would be unrealistic to expect the policy to have eradicated discarding practices in all Norwegian fisheries. Indeed, the NDF recognises that discarding still occurs, although it is not considered to be widespread (Gullestad et al., 2015). Furthermore, recent studies have highlighted that discarding can be considerable in some fisheries. For example, the capelin fishery in the Barents Sea discarded 552 tonnes of cod in 2012; which is now accounted for with a 600 tonne UWC quota (Blom et al., 2015). However, in general, discarding is thought to have declined since the implementation of the Discard Ban: from ~8% of the reported catch in the 1950s and 1960, to ~4% in the 1990s and 2000s (Nedreaas et al., 2015).

The recovery of the NE Arctic cod stock since 1987 has been cited as tentative evidence of the success of the Discard Ban (European Commission, 2011; Gullestad et al., 2015). Indeed, it does present a positive story, with spawning stock biomass now at record high levels and landings in excess of the 1980's crisis years, while fishing mortality remains within maximum sustainable yield (MSY) target limits (Figure 6). However, it should be recognised that the Discard Ban has just been one part of an overall strategy to directly combat over-fishing and develop Norwegian fisheries into more responsible and sustainable harvesters of marine living resources. That is, over this same period, there has been a general shift in policy focus from economic support for coastal/fishing communities to sustainable exploitation of living resources, ultimately in the form of MSY targeted and ecosystem-based management objectives (Gullestad et al., 2014). This manifested as a substantial reduction in exploitation level through reduced fleet capacity and more restrictive TACs, in addition to the shift in exploitation pattern imparted by the Discard Ban. It is also recognised that the NE arctic cod stock may have benefitted from shifts in population distribution, and improvements in growth and recruitment attributable to climate change in the region (e.g. Drinkwater, 2005; Cheung et al., 2008; Stenevik and Sundby, 2007).

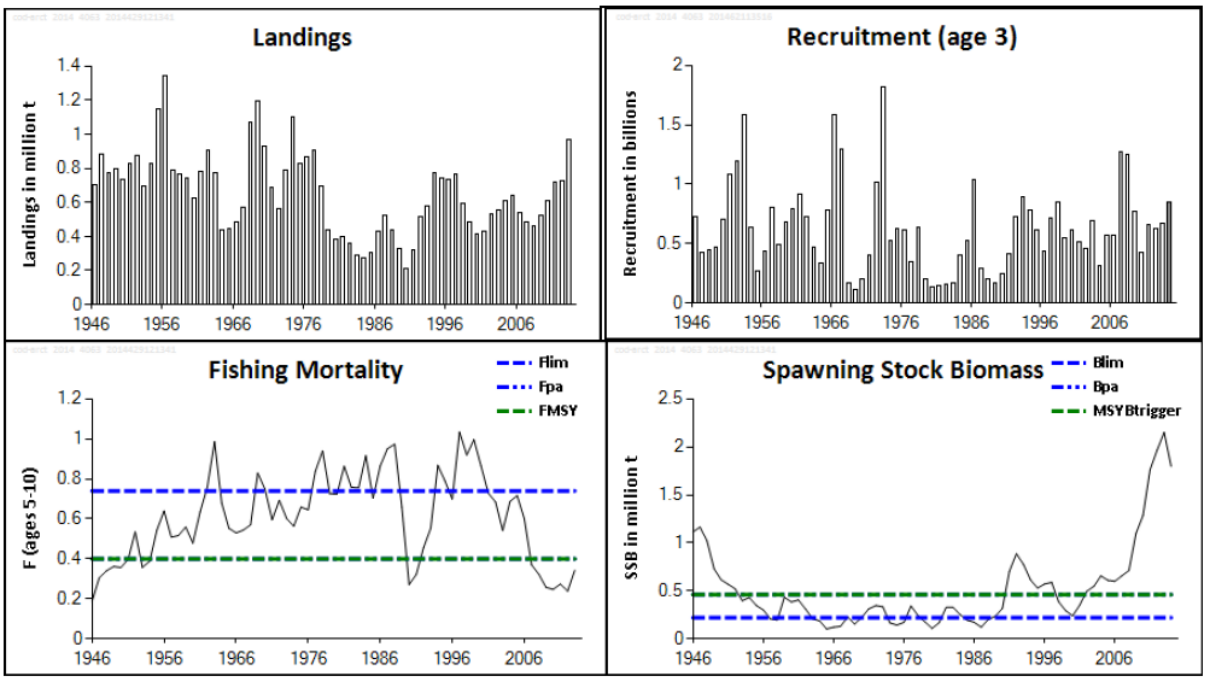

Figure 6: Summary of stock assessment for Cod in Subareas I and II (weights in thousand tonnes)(Source: ICES, 2015).

In addition to the limited quantitative evidence that the implementation of the Norwegian Discard Ban in 1987 has had a positive impact in Norwegian fisheries, it is generally recognised that its greatest impact has been in helping to catalyse a cultural shift among all stakeholders, not just the fishers. The mere existence of a discard ban emphasises - to all stakeholders - that they are responsible for the preservation of a living resource, and that needless waste of that resource is no longer acceptable. The

burden of proof on fishers to demonstrate responsible behaviour and conduct is arguably resulting in an increased professional responsibility (Johnsen and Eliasen, 2011). This change in mindset has not only driven a genuine ambition to minimise unwanted catch, but has also contributed to the development of a "common code of conduct" in relation to resources & compliance (Gezelius, 2006).

However, this cultural shift has not been easy or quick. The industry has witnessed economic hardship and a substantial reduction in the number of fishers it supports (Gullestad et al, 2014). Moreover, the process has taken over 20 years to transition from an *ad hoc* conservation measure in a single fishery to a societal shift in attitude towards a living resource; and arguably that transition is still ongoing. Also, its success has depended upon a pragmatic application of the regulations to engage the stakeholders and ensure a "level playing field" (Gullestad et al., 2015). This has required an improved dialogue between management, fishers and scientists to ensure the individual concerns of each have been recognised and that all stakeholders are working towards a common goal.

Finally, the success of the Discard Ban is probably best gauged using the testimony of those who have witnessed the transition and its consequences:

- *"Our experience is that a discard ban will not solve all the problems about dumping unwanted catches at sea. ... In principle a discard ban is absolutely more preferable than an order to discard illegal or unwanted catches over board. ... It's important to create measures (rules) that stimulate the fishermen to land all catches. ... "Prevention is (still) better than cure". Avoidance and selection should be our mantra for the future".* (*Ian Kinsey*; Norwegian Fishermen's Association, 2008)
- *"Generally, the management of our fisheries is now good. We realise that the regulations have been introduced to preserve the fish stocks for our benefit as well as for future generations. The observers and inspectors make sure that everyone is following the rules. Sometimes restrictions have been brought in that have not worked. Fortunately, the Directorate listens to us, and when we say that there is an issue they will negotiate with us to make sure that we can fish, while at the same time making sure that the fish stocks are not damaged."* (*Torfinn Pettersen, Norwegian Fisherman*; International Sustainability Unit, 2011)
- *"As a fisheries scientist, it is now far easier to talk with the sons about conservation measures, than it ever was with their fathers!"* (Kjell Nedreaas, pers comm. 2015).

4.2. The Icelandic context

Fisheries have been very important for the Icelandic economy for decades. In 2014, one million metric ton was harvested (Directorate of Fisheries, 2016) and fisheries contributed 8.3% to the GDP, and 42% of exports that year consisted of fish products (Statistics Iceland, 2016). When indirect effects of the fisheries are included the contribution to the GDP has been estimated to be as high as 28% (Hagfræðistofnun

Háskóla Íslands, 2007). These numbers were much higher during the 20th century (Agnarsson and Arnarsson, 2007). Considering the impact the fisheries have on the Icelandic economy, fisheries management and policy making can have great implications for the well being of the nation. Icelanders were however not completely in control of the marine resources until 1976 when the exclusive economic zone was extended to 200 nautical miles, which corresponds to 758,000 km^2. Before that time the fisheries management for Icelandic waters was very limited and only minimum landing size and gear restrictions applied. There was no catch limit and overexploitation of stocks did occur by both Icelandic and international fleets. After 1976, the development of the Icelandic fisheries management system began and the aim was to have sustainable and more profitable fisheries.

In 1976, days-at-sea were reduced to try to limit the catch of the overexploited cod stock but without success (Utanríkisráðuneytið, 2009). In 1975 the quota system was introduced for pelagic stocks and in 1984 for the cod and other demersal species but the management was also partly effort based. This still did not result in complete control of the total landings as they kept going over the recommended TAC. With the Fisheries Management Act in 1990 (Lög um stjórn fiskveiða 38/1990) individual transferable quota (ITQ) system was implemented for all fisheries with minor exemptions. This resulted in better control over the total landings and made the fisheries more economically efficient (Runolfsson and Arnason, 1997). A discard ban was first put into action in 1977 for six demersal species and in 1996 a discard ban was carried out for all fish species (Pálsson, 2002). The Icelandic fisheries management systems includes measures to prevent discarding such as ITQ related measures, gear restrictions and closed areas.

Regulations to reduce incentives for discards

Discarding in Iceland did most likely not start until the end of the 19th century when fishing with trawlers began. In the beginning of the 20th century, there were no rules about the fisheries but in 1937 a law of minimum length of landed fish and minimum mess size was executed (Pálsson, 2002). These regulations probably led to increased discards of fish smaller than the minimum size. Ban on discards was first put into action in Iceland in 1977 when discards of cod and haddock and four other demersal species was prohibited. The discard ban evolved and in 1986 a discard ban was enforced for all fish that was in the quota system and ten years later it applied to all fish species (Pálsson, 2002). The discard ban allows exemptions and the Minister can make regulations that allows discarding of viable fish, non-commercial fish and waste from onboard processing (Lög um umgengni um nytjastofna sjávar nr 57/1996).

ITQ systems can lead to increased rate of discarding (Kristofersson and Rickertsen, 2009). Fishermen aim for the most profitable catch and the ITQ system encourages high-grading, i.e. discarding of small and less valuable fish for larger one, as the catch size is limited. The system also encourages fishermen to discard by-catch species they do not hold quota for. The fisheries management system in Iceland has evolved to reduce the act of illegal discarding by allowing for flexibility within the ITQ system.

It is allowed to exceed the quota for species but quota for other species that the vessel holds are then reduced accordingly. This regulation comes with restrictions such as the

total quota exceeded can be no more than 5% of the total value of the demersal quota and no more than 1.5% for a single species. Quota can also be transferred from previous year or borrowed from upcoming year. It is also possible to land 5% above the quota but only 20% of the value is kept and the 80% goes to a fund for supporting research. However, if the landings exceed these 5% all of the landings are confiscated by the Directorate of Fisheries unless more quota is bought on the market. Damage catch is not calculated towards the quota up to a limit and this is done to encourage that all catch is brought ashore (Woods et al, 2015, Lög um stjórn fiskveiða nr 116/2006).

With the enforcement of the discard ban the regulations on minimum landing size was changed to minimum legal size. In the beginning all catch under the minimum legal size was confiscated by the government (Pálsson, 2002, Reglugerð um lágmarksstærðir fisktegunda nr 311/1977) but to discourage discards these regulations have been changed and fish under the minimum legal size is no longer confiscated but will only account to 50% of the quota. This does however come with restrictions such that the small fish has to be less that 10% of the total catch (Reglugerð um veiðar í atvinnuskyni fiskveiðiárið 2014/2015 nr 653/2014).

The fisheries management system in Iceland allows for temporal real-time and permanent closures. Areas have been closed permanently since the mid 20th century but real-time closures did not start until 1976. Areas that were often closed for short time have now been closed permanently. One of the main reasons for closing areas is to protect juvenile fish and studies have shown that these closures have resulted in less fishing mortality and discards of juveniles (Schopka, 2007).

Gear restrictions also apply in order to reduce fishing of small fish and of unwanted by-catch. These restrictions can be permanent or they can apply for certain areas or time. For example the minimum mesh size for cod was increased to 155 mm in 1977 (Pálsson, 2002) and the use of selection grids have been made mandatory in certain areas for some fisheries such as in shrimp and blue whiting fisheries (Schopka, 2007).

Monitoring of fisheries practises

Monitoring and enforcement is carried out by the Directorate of Fisheries and the Coast Guard to ensure compliance with the fisheries regulations. Noncompliance can result in fines, cancelation of fishing licence or even imprisonment (Lög um umgengni um nytjastofna sjávar nr 57/1996). Monitoring is carried out both on land and at sea. All landed catch is weighted on officially approved scales by accredited harbour officials who also verify species composition. Observers from the Directorate of Fisheries travel between harbours and inspect the weighting procedures. The landings are recorded and put into the Fisheries Directorate's database where it is accessible to the public. The quota status of each vessel is monitored and it made sure that the vessels hold quota for landed species. If the quota limit is reached the owners of the vessels need to acquire necessary quota or they may lose their fishing licence.

If species or size composition of landed catch of a vessel is observed to be out of the ordinary an observer is placed on board of the vessel for the next fishing trip. If an observer is onboard a vessel for more than one day or one fishing trip within the same

year the owner of the vessel is obligated to pay the salary of the observer (Lög um umgengni um nytjastofna sjávar nr 57/1996).

Observers can also go onboard vessel at random to investigate if fisheries regulations are being followed, such as legal fishing gears are in use, logbooks are checked along with the catch on board. Further, samples are taken and size distribution is estimated. If a certain proportion of the catch is fish under the legal size the Marine Research Institution is notified and the fishing area might be closed temporarily.

In 2015 observers went on 244 fishing trips (1371 days) and went onboard 38 ships to inspect logbooks, licence, total catch and composition and fishing gear and in most cases fishing regulations were followed. Temporary real-time closures were 146 that year and were mainly because of small cod in long-line fisheries (Fiskistofa, 2015).

Data was not collected systematically to estimate discards until the beginning of this century and therefore no direct measures on the effects of the fisheries regulations have had on discards exists. Since 2001 data has been collected to estimate the discard of small fish for the most important commercial species, mainly cod and haddock. From 2001 to 2010 the average discard rate was estimated to be 2% for haddock and 0.9% for cod (Palsson, 2012). Data collected for other purposes has been used to estimate discard in haddock fisheries from 1988 to 2000. Discards of haddock from 1988 to 2000 were estimated to be 8-22% and 15% for bottom trawl and long line, respectively (Palsson, 2002). These estimates indicate that the discard rate has decreased after 2000 but note that the discard is estimated with two different methods before and after 2000. There are no estimations of discarded by-catch available.

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