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Environment and Natural Resources

Spatial Access Priority Mapping

A Quantitative GIS Method for Inclusive Marine Spatial Planning

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HÁSKÓLI ÍSLANDS

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Final thesis for MS degree in Environment and Natural Resources

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Preface

This thesis subject was inspired by the poor biological and economic outcomes of the Faroese fisheries management system. After moving to Iceland and learning about Icelandic fisheries management, I began to wonder why the Icelandic fishery was so economically and biologically successful while the Faroese fishery was failing miserably, both economically and biologically. It also struck me that Icelandic fishermen appear to be dissatisfied with the management system while the Faroese appear less dissatisfied. Based on these two observations, I decided that I wanted to analyse what has made the Faroese fisheries management system fail and what needs to be done to improve the system without leaving fishermen discontent, and potentially even increase satisfaction. The choice fell on a Spatial Access Priority Mapping survey because I find the method novel and including fishermen in the process of placing marine protected areas appealed to me. The method also allowed me to conduct a concurrent survey on fishermen's opinions, which was a bonus.

I would like to extend a thank you to those people who helped make this thesis happen. Thank you to my parents, siblings, grandmother, boyfriend and friends for your moral support during this process. Thank you to my two supervisors, Ragnar Árnason and Geir Oddson, for your advice and constructive comments on earlier versions of this thesis. Thank you to Brynhildur Davíðsdóttir for encouraging me to pursue this topic. Thank you to Bjargey Anna Guðbrandsdóttir for being the glue of the Environment and Natural Resources programme and for answering my countless administrative questions. Thank you to the people at the Faroese Marine Research Institute, Fisheries Directorate, Ministry of Fisheries and Statistics Faroe Islands, who provided me with data, papers and answered my questions. Thank you to the Ministry of Fisheries for funding this research. Lastly, I would like to thank all fishermen who took time out of their day to participate in this survey – without them this truly would not have been possible.

Abstract

This thesis utilises a novel methodology to inform placement of marine protected areas in the Faroe Islands, which are already used in Faroese demersal fisheries management. The methodological approach builds upon efforts in the field of marine spatial planning to include fishermen in the planning process to reduce fishermen's costs, increase fishermen's satisfaction and compliance with Marine Protected Areas, and thereby increase the success of MPAs. A survey was conducted to map Faroese coastal fishermen's Spatial Access Priorities using GIS, which showed that fishermen generally placed a high SAP on fishing grounds close to land and on cod spawning grounds. A concurrent semi-structured quantitative survey was conducted that focused on fishermen's opinions on management and MPAs. The Faroese demersal effort quota management system was also analysed and found to have failed to restrict effort of the fleet, causing the cod stock to become severely overexploited and the fleet indebted. A 66% reduction in fleet size is recommended along with improved and expanded use of MPAs to aid the recovery of fish stocks.

Chapter one is an introduction to global problems in fisheries management. Chapter two presents economic and biological outcomes of Faroese demersal fisheries management. Chapter three gives an introduction to the management system, the tools of control and identifies its main flaws. Chapter three also provides an introduction to spatial management in the Faroe Islands and small-scale coastal fishermen whose SAP were surveyed. Chapter four describes the methodological approach used in mapping spatial access priorities and presents the results. Chapter five describes how the quantitative survey was conducted and presents the results thereof. Chapter six is a discussion of spatial access priority mapping results and quantitative survey in relation to management, and presents some options for future management, especially in relation to marine protected areas and small-scale coastal fishermen. Chapter seven summarises the main findings of the thesis and concludes.

Key words

Fisheries management; effort quotas; fishing days; marine protected areas; marine spatial planning; spatial access priority mapping; participatory planning; stakeholder satisfaction; increasing compliance.

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Abbreviations

CBA	Cost-Benefit Analysis
CFA	Commercial Fisheries Act 1994
DKK	Danish Crown, the currency used in the Faroe Islands
EEZ	Exclusive Economic Zone
F	Fishing mortality
FAO	Food and Agricultural Organisation of the United Nations
GDP	Gross Domestic Product
ICES	International Council for the Exploration of the Sea
IOC	Icelandic Ocean Cluster
ITQ	Individual Transferable Quota
MEY	Maximum Economic Yield
MPA	Marine Protected Area
MRI	Faroese Marine Research Institute (F: Havstovan)
SAP	Spatial Access Priority
SAPM	Spatial Access Priority Mapping/Map
SOFIA	State Of World Fisheries and Aquaculture
TAC	Total Allowable Catch
UNCLOS	United Nations Convention on the Law Of the Sea
VG	Vessel Group

1 Introduction

The importance of the ocean to human existence is clearly emphasised in FAO's most recent SOFIA report (FAO 2012). We depend on the ocean for nourishment, for employment and for economic prosperity. An estimated 54.8 million people worked in fisheries and aquaculture in 2010, of which 7 million were occasional fishers and fish farmers. Add to that all those who work in the secondary production sector - processing, packaging, distribution, manufacturing of equipment and boats, research and administration, etc. – and the number grows to 660-820 million. This means that 10-12% of the world's population, directly or indirectly, depends on fishing for their livelihood. The pure economic value of world trade in fisheries was US $102 billion in 2010 (FAO 2012).

All, however, is not well under the sea. FAO statistics show that "the world's marine fisheries have increased markedly from 16.8 million tonnes in 1950 to a peak of 86.4 million tonnes in 1996." (FAO 2012 p. 11). Catches then declined and have stabilized at approximately 80 million tonnes. This is too high. Approximately 30% of the world's fish stocks are currently overexploited and therefore give lower yields than they should and need to be managed to avoid collapse. An additional 57% of stocks are fully exploited and therefore harvested very close to their maximum sustainable production. The Johannesburg Plan of Implementation, a result of the World Summit on Sustainable Development in Johannesburg in 2002, requires that overexploited fish stocks be restored to sustainable levels by 2015 (FAO 2012). This is unlikely to happen:

> *The declining global marine catch over the last few years together with the increased percentage of overexploited fish stocks and the decreased proportion of non-fully exploited species around the world convey the strong message that the state of world marine fisheries is worsening and has had a negative impact on fishery production.* (FAO 2012 p. 12).

Overexploitation of fish stocks has negative consequences:

> Overexploitation not only causes negative ecological consequences, but it also reduces fish production, which further leads to negative social and economic consequences*. To increase the contribution of marine fisheries to the food security, economies and well-being of coastal communities,* effective management plans must be in place to rebuild overexploited stocks (FAO 2012 p. 12-13, emphasis added).

In an attempt to tackle overexploitation, some countries have implemented measures to reduce the fishing effort of their fleets. In the EU, this has led to net reductions in vessel numbers and power; other nations, such as Iceland and Norway, have also achieved net reductions in fleet size in the period 2005-2010. An estimated 3 million vessels operate in marine waters worldwide, and data indicates that fleets are generally expanding, especially in some Asian countries (FAO 2012).

Many overexploited stocks are straddling fish stocks or "exploited solely or partially in the high seas," making the task of management even more complicated (FAO 2012 p. 13). But not all of the world's overexploited fish stocks are straddling or exploited on the high seas. Some are within the boundaries of nation states and states have a sovereign right to explore, exploit, conserve and manage living and non-living marine resources within their own Exclusive Economic Zone (EEZ)[1] according to the United Nations Convention on the Law of the Sea (UNCLOS). UNCLOS also places obligations on states to conserve[2] and utilize natural resources[3] within its boundaries in a sustainable manner.[4] Not all states live up to their UNCLOS obligations. One such state is the Faroe Islands, whose demersal fisheries management system has led to severe overexploitation of the cod stock (*Gadus morhua*).

[1] Article 2 and 56.

[2] Article 61.

[3] Article 62.

[4] UNCLOS was opened for signature in 1982 but only came into force in 1994.

[3] Article 61.

[4] UNCLOS was opened for signature in 1982 but only came into force in 1994.

1.1 Study area

The Faroe Islands is a small country in the northeast Atlantic, located between Scotland and Iceland (figure 1.1). The country has a population of 48,500 (Hagstova Føroya 2013a). The nation consists of 18 islands, all but one populated. The Faroe Islands are an autonomous territory within the Kingdom of Denmark, granted autonomy by the Danish Parliament in 1948 with the Home Rule Act. Fisheries and protection of fish on Faroese territory were among the first set of issues to come under Faroese jurisdiction, a reflection of the importance of fisheries to the nation.[5] Fishing is a major source of employment and fish represents the biggest export value (Hagstova Føroya 2013b-c). Despite its economic importance, the fishery has been managed poorly, leaving fish stocks overexploited and the fleet indebted and unable to profit. To prevent a collapse of the cod stock, swift and substantial management changes must be implemented.

1.2 Purpose of study

The management system is analysed so its flaws can be identified and changes can be recommended to stop overexploitation of demersal fish stocks. This will help to show how the economic outcome of the demersal fishery can be turned into a profit. The cod stock has been severely overexploited and additional measures should be implemented to aid the stock's recovery, or prevent its collapse in case no reductions in harvesting intensity are made (ICES 2013a-c). Time-area closures is a commonly used tool in Faroese spatial management that is widely applied during spawning season to protect spawning grounds from intensive fishing, the specifics of which will be presented in chapter three. Improving and expanding the current use of area closures can aid the cod stock's recovery. Research shows that marine reserves and Marine Protected Areas generally have a positive effect on adjacent fisheries (Roberts et al 2001) and that marine spatial planning is essential for achieving ecosystem-based sea use (Douvere 2008).

Placement of MPAs is often solely informed by ecological criteria and while ecological criteria should be weighted more heavily than socioeconomic criteria, the latter should also be taken into consideration (Roberts et al 2003). By mapping

[5] Lov om Færøernes Hjemmestyre 1948.

fishermen's Spatial Access Priorities using GIS, the opportunity costs of MPAs to fishermen can be reduced and fishermen can be included in the planning process to increase satisfaction and compliance with management plans (Innes 1996). Stakeholder support has been found to be vital to the success of MPAs (Brody 2003). In this specific instance, a map of fishermen's SAP can be used to improve use of spawning ground closures and closures to protect juveniles. If area closures are expanded to protect ecosystems and habitats, the Spatial Access Priority Map (SAPM) can also be used for comparison with ecologically important areas to strike a balance between costs to fishermen and protection of ecosystems. Thus, the main audience for this thesis is Faroese fisheries management in the hopes that measures are taken to increase protection of fish stocks and ecosystems in the Faroe Islands. To this end, this thesis puts forward two hypotheses:

1. **Spatial Access Priority Mapping can be used to align socioeconomic criteria with ecological criteria when placing MPAs**

2. **Spatial Access Priority Mapping can increase economic, biological and social benefits of MPAs by reducing adverse effects on fishermen and increasing compliance**

2 The state of the Faroese fishery

The current fisheries management system in the Faroe Islands has not managed to maintain healthy demersal fish stocks. The most valuable demersal fish stock, cod, has been overexploited for the past several years (ICES 2013a). The International Council for the Exploration of the Sea (ICES) recommends that fishing mortality (F) for the Faroe Plateau cod[6] is reduced by 69% in 2014 to correspond to F = 0.16.[7] Cod F has been as high as 0.8 in 2002, but generally varied between 0.4 and 0.65 (ICES 2013a). Recruitment to the stock has been low and the Spawning Stock Biomass (SSB) small in the last decade (ICES 2013a). Haddock and saithe, also economically important demersal species, are overexploited at varying degrees. ICES' advice for 2014 was no directed fishing for haddock and that saithe F is reduced by 46% (ICES 2013b – c).

Landings and SSBs of all three species have varied but generally decreased in the last decade (figure 2.1, ICES 2013a-c). About 40,000 tonnes of cod was landed in the Faroe Islands in 2002. A decade later, in 2012, approximately 8,000 tonnes of cod was landed, a decrease of 80% in ten years, while SSB went from approximately 60,000 to 20,000 tonnes. There was a stark increase in landings from 1995 to 1996. The Faroese fishery was in the years 1994-1996 managed by a catch quota system, and replaced by an effort quota system in 1996 (Løkkegaard et al 2004). The sharp increase in cod landings in 1995 as the system changed indicates that the effort quota system allows for much higher F, as Jákupsstovu et al (2007) also note.

The cod stock is now as low as it was when it collapsed in the early 1990s before the current system was implemented (ICES 2013a). The current system has been in place relatively unchanged since 1996 and therefore has had adequate time to prove its effectiveness. The fact that the cod stock now appears to be on the brink of collapse again, after almost 20 years under the current management system, conclusively shows

[6] The Faroe Plateau cod is almost the only cod harvested in the Faroese EEZ, as the Faroe Bank cod fishery has been closed to all but small jiggers since 2009 due to very low stock size (ICES 2013d).

[7] ICES uses the maximum sustainable yield (MSY) approach where the long-term average should be F = 0.35.

that the system as currently implemented is unable to manage the resource. If the system made appropriate use of its tools, the effects of these tools would be clear by now and fish stocks would not be decreasing year-on-year. This point is further substantiated by the fact that ICES for years has recommended serious reductions in F, e.g. a 63% reduction in F cod for 2013 (ICES 2012) and 69% in 2014 (ICES 2013a), yet fishing mortality has not been reduced sufficiently.[8]

Jákupsstovu et al reached the same conclusion in their 10-year appraisal of the system (2007 p. 763):

> *The intent of the law underlying the effort management system is to constrain F below an average value of 0.45 and to maintain sufficiently large spawning stocks. During the ten-year period, this value has often been exceeded for cod, and recently also for saithe. Apparently, the current measures are insufficient to meet the objectives… The apparent failure of the system as currently applied to constrain exploitation rate on cod specifically indicates that the sustained productive capacity of this stock is not guaranteed and that the risks of future collapse remain substantial.*

Average F for cod in the last three years has been 0.52 (ICES 2013a), and as the above authors state, the management system has not kept F at the intended level of 0.45 and therefore the system is not even able to meet its own targets. Above authors further note that setting F at 0.45 is too high – ICES recommends 0.35 for cod – and therefore the system arguably set itself up for failure from the very beginning by deciding upon an inappropriate harvesting intensity (ICES 2013a). Although overexploitation is partly responsible for current stock decreases, it is not the only cause: "Apart from exploitation, environmental variations influence stock trends: large variations in local productivity affect recruitment, growth, and catchability of cod and

[8] Effort in the form of fishing days has not been reduced sufficiently, see appendix 2.

haddock, and are considered the main drivers of stock fluctuations." (Jákupsstovu et al 2007 p. 763).[9]

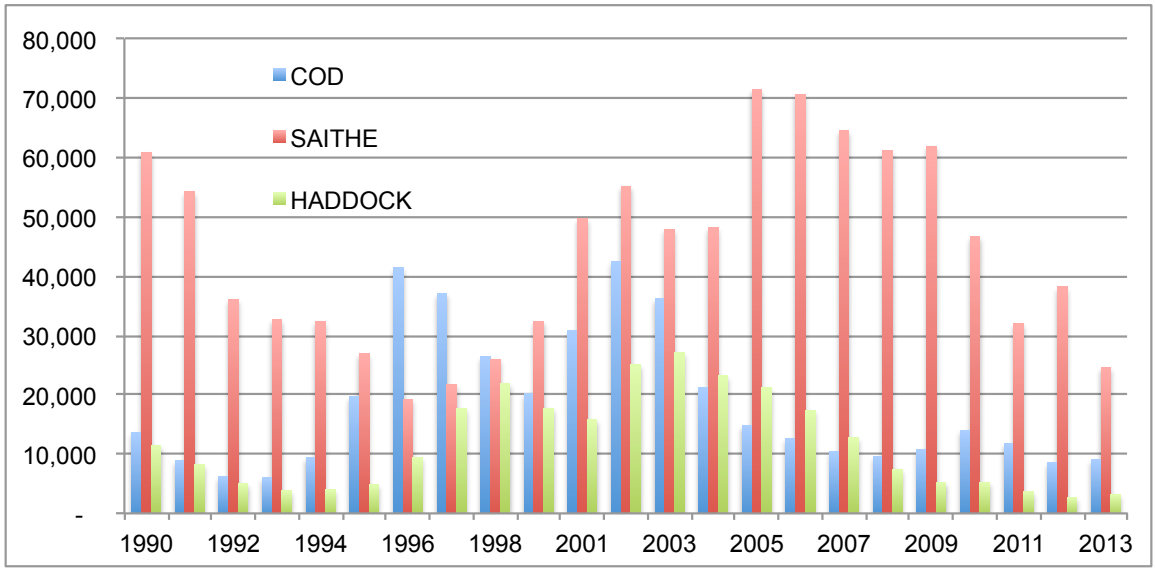


Figure 2.1 Landed cod, saithe and haddock in tonnes in the Faroe Islands, 1995-2013 [10]

2.1 Economic and social consequences

The Faroe Islands are a fishing nation and therefore overexploiting fish stocks has serious adverse economic and social consequences. Fish is the largest and most valuable export good, worth DKK 5 billion in 2012, or 37% of the Faroese GDP of DKK 13.5 billion (Hagstova Føroya 2013b; Hagstova Føroya 2014b). Demersal species are an important part of the exports and for many years made up for approximately 40% of fish export value but in 2012 demersal species only accounted for 19%. The export value of demersal stocks in 2012 was DKK 788 million and DKK 617 million in 2013 – a year-on-year decrease in value of 27% when the decrease in landings was 20%. The export value of demersal stocks was below DKK 1 billion for the first time in 2008. The highest export value from demersal stocks in this millennium was in 2002 when it was worth

[9] This claim is referenced to Steingrund, P., and E. Gaard, 2005. Relationship between phytoplankton production and cod production on the Faroe shelf. *ICES Journal of Marine Science* **62**: 163–176.

[10] Hagstova Føroya 2014.

DKK 1,368 million. This was also the year with highest landings (Hagstova Føroya 2013b).

The decrease in export value has economic consequences for the demersal fleet. The demersal fleet has had net negative economic results since 2007,[11] and net results have generally been poor since 2004 (figure 2.2). The fleet has become increasingly indebted throughout the last decade, with debt peaking at DKK 1.9 billion in 2007. The debt appears to have stabilised at DKK 1.4 billion. Owners' equity in the demersal fleet has decreased severely from 2006 to 2011 (figure 2.3). The fact that the fleet is indebted is not necessarily a bad thing in and of itself, but it becomes an issue when fishing is both unprofitable and unsustainable (Búskaparráðið 2011). The Faroese Economic Council has addressed the lack of profit in the fishing industry in several reports, and generally attributes it to the management system, e.g. this comment in a 2011 report:

> *The [economic] situation in the Faroese fishing industry indicates that there are fundamental flaws in our fisheries management system that makes it difficult for industry to make a profit* (Búskaparráðið 2011 p. 11).[12]

A profitless and indebted fishing industry has social consequences, especially when said industry is of great economic importance to a country. The fishing industry provides many jobs in the Faroe Islands, both directly and indirectly. 3,914 people were employed in fishing, fish processing and aquaculture in 2012 of a workforce counting 23,678 and therefore more than 16% of employees worked in fishing (Hagstova Føroya 2013a).[13] In addition to this there are indirect employees. The secondary sector includes shipping, manufacturing of gear and equipment, vessel repairs, research, education and

[11] The demersal fleet also targets flatfish. What characterizes the 'demersal' fleet in the Faroe Islands is that it does not process fish onboard and that it is managed under the CFA. The demersal fleet mostly harvests in the Faroese EEZ, although some hold quotas in Iceland, Greenland, Flemish Cap, and international waters, e.g. NEAFC. In the last few years, the demersal fleet has to some extent also been granted catch quotas for mackerel (Hagstova Føroya, pers. comm.). For the purpose of this thesis, the demersal fleet is assumed to mostly harvest within the Faroese EEZ and mostly harvest demersal fish stocks.

[12] Translated from Faroese to English by author who assumes all responsibility.

[13] Note that it is not the total workforce that is being referred to, only those in labour. Unemployment is 5.5% (Hagstova Føroya 2013a).

administration, e.g. the Fisheries Directorate, the Marine Research Institute, the Ministry of Fisheries, the schools that focus on maritime studies, and the many fishing companies that employ people for all sorts of tasks other than fishing and processing. Therefore the number of people employed by the fishing industry is well above 3,914 when indirect employment is included.

The number of direct employees has been decreasing. Employees in fish processing have decreased by approximately 54% since 1991 and fishermen have decreased by approximately 42% (figure 2.4). Furthermore, in some segments of the fleet, fishermen are now earning less than they were in the years after the CFA was implemented. The most notable example is the long-liners (grouped) where the average annual wage and average daily wage have gone down while time spent fishing has increased in the period 1998-2012 (table 2.1). None of the above figures say anything about the individual vessels and there are undoubtedly some vessels that are more successful than others but taken as a whole, the fleet is not performing well.

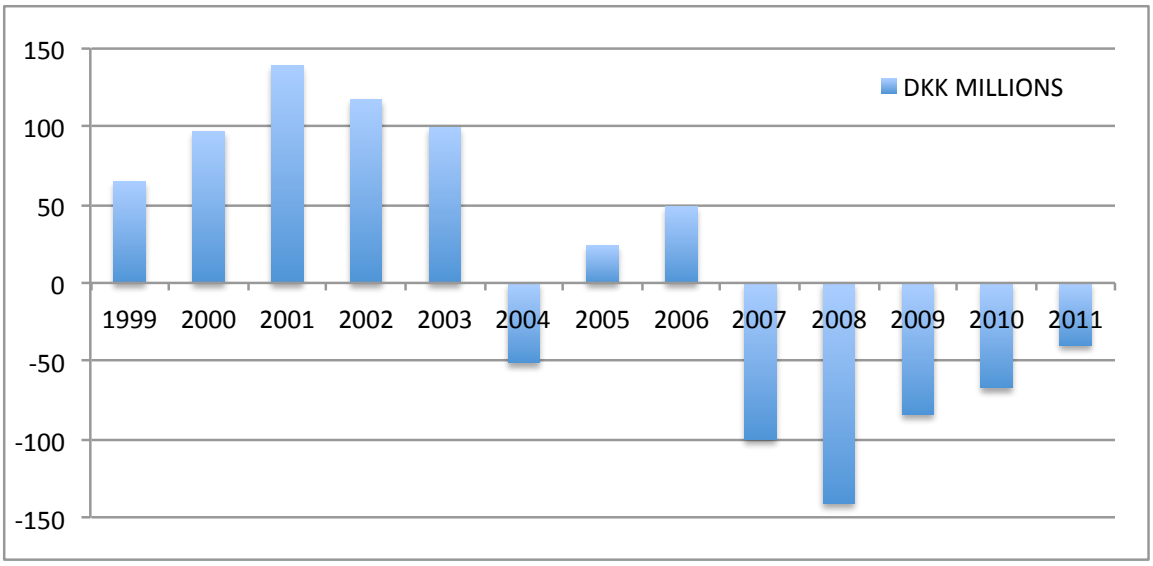


Figure 2.2 Net results for the demersal fleet, 1999-2011[14]

[14] Hagstova Føroya 2013c. No data after 2011.

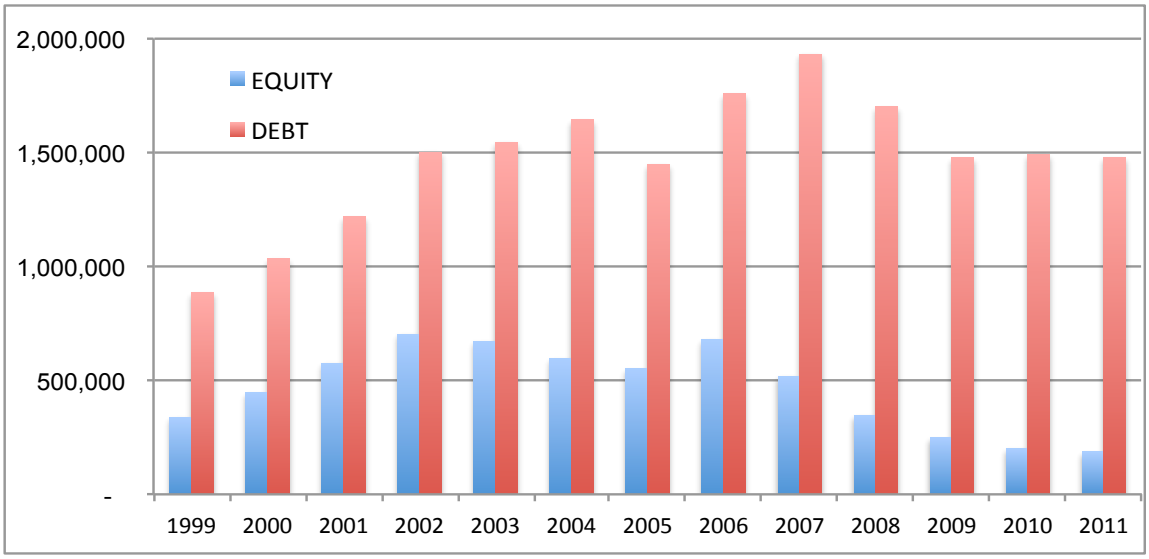


Figure 2.3 Debt and owner's equity in the demersal fleet in DKK millions, 1999-2011[15]

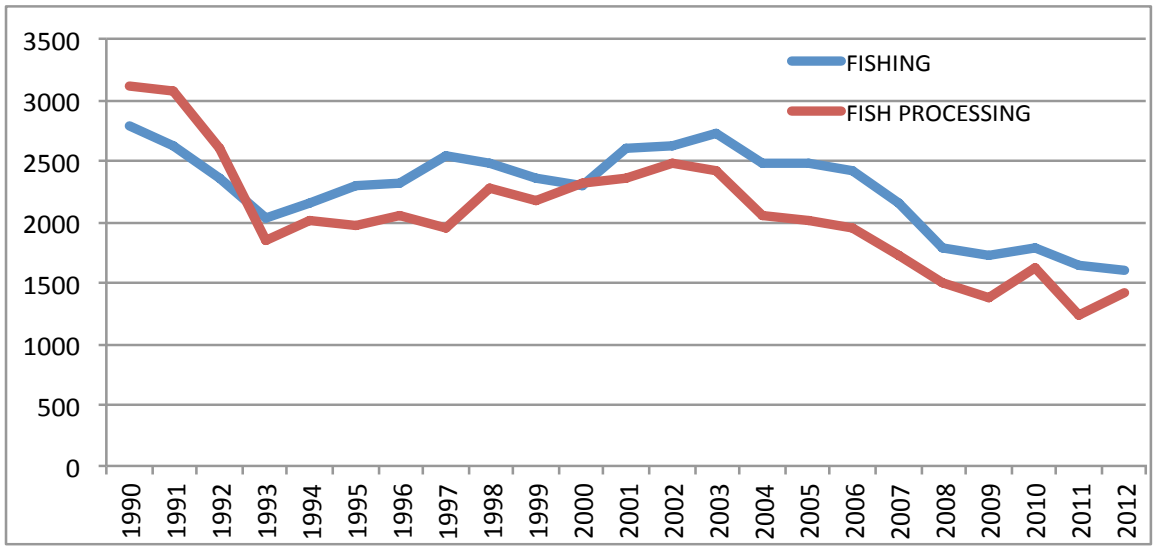


Figure 2.4 Number of people employed in fishing and fish processing, 1990-2012[16]

[15] Hagstova Føroya 2013c. No data after 2011.

[16] Hagstova Føroya 2013d. No annual statistics exist for this, only monthly. Therefore a random month was chosen to represent each year.

Table 2.1 Long-liners: Fishermen's average annual wages and average daily wages in DKK, and average number of fishing days, 1998-2012[17]

	Fishing days	Annual wage	Average daily wage
2012	228	267,000	1,171
2011	215	255,000	1,186
2010	249	290,000	1,164
2009	212	212,000	997
2008	218	266,000	1,220
2007	230	354,000	1,803
2006	229	335,000	1,464
2005	233	300,000	1,290
2004	231	304,000	1,312
2003	196	358,000	1,826
2002	222	385,000	1,732
2001	219	326,000	1,483
2000	215	269,000	1,255
1999	209	305,000	1,459
1998	206	317,000	1,539

[17] Hagstova Føroya 2014.

3 The Faroese fisheries management system

The last chapter presented the policy outcomes of the Faroese fisheries management system. The Faroese Economic Council says that the majority of fishing in the Faroe Islands is in reality free fishing and economic theory therefore predicts that the Faroese fisheries management system will fail (Búskaparráðið 2011 p. 18). It is both biologically and economically unwise to allow free fishing because you encounter the 'common property' problem (Gordon 1954). Árnason (2009 p. 742) says the problem manifests itself in the following way:

1. **Excessive fishing fleets and effort**
2. **Overexploitation**
3. **Little or no profitability and low personal incomes**
4. **Low contribution from fishing industry to the GDP**
5. **Sustainability to fishery is threatened**
6. **Sustainability of human habitation is threatened**

As demonstrated in the previous chapter, the Faroese fishery meets points 2 – 6, the central cause of these problems being the excessive fishing fleet and effort (point 1), as this chapter will demonstrate, which then leads to the other problems. The next section gives an introduction to Faroese effort quota system.

3.1 Introduction to system

The demersal fisheries management system in the Faroe Islands is an effort quota system. Effort quota systems seek to control fleets' effort, e.g. engine, gear and vessel restrictions and days-at-sea, and is also referred to as input controls, whose objective is to limit catches indirectly, such as in the previous example, while output control systems limit catches directly, e.g. by placing a limit on how much is taken out of the sea in the form of catch quotas, as is done in the ITQ system (*Sharing the Fish* 1999 p. 20). In

the Faroese system, effort is controlled by a moratorium on harvesting licenses, i.e. an upper limit on the size of the fleet; limited but transferable fishing days; and spatial management (Løkkegaard et al 2004). The system is usually referred to as the fishing day system and management is governed by the Commercial Fisheries Act 1994 (Føroya Løgting 1994).[18]

The Commercial Fisheries Act 1994 (CFA from now on) was first passed into law in 1994, a few years after the Faroese economy had collapsed. There were many reasons for the collapse, one of which was overexploitation of fish stocks and overinvestment in the fishing industry (Føroya Løgting §19-nevndin 2000; Løkkegaard et al 2004). The Danish government agreed to step in and restructure the debt, upon the condition that a new fisheries management system was implemented. Up until the 1990s, there had been practically free fishing in the Faroese EEZ, the only limitation being on vessel numbers (Føroya Løgting §19-nevndin 2000; Løkkegaard et al 2004). The CFA in its initial form was a catch quota system but only two years after it had been implemented, the Faroese fishing industry had become heavily opposed to it, claiming it led to heavy discarding. The Faroese Parliament fundamentally amended the CFA to change the management system from a catch quota system to an effort quota system in 1996 (FAO 2005; Løkkegaard et al 2004).

The core of the amended system is still in place today. Vessels are divided into Vessel Groups (VG) according to size and then subgroups according to gear to make management easier.[19] Fishing days are allocated to VG and then between vessels,[20] with the exception of small coastal vessels (VG5), in which subgroup 5B is allocated a collective set of fishing days. Spatial management is an important tool that controls where and when different vessel groups and gears can harvest, e.g. many areas are closed during spawning time and trawlers are banned from many areas.

[18] The CFA is framework legislation. It applies to the pelagic fishery but was designed only with demersal fishing in mind and therefore pelagic fishing is managed largely by executive order.

[19] With the exception of subgroups in VG5, where vessels are free to switch between long-lining and jigging. VG5 consists of full-time fishermen (5A) and part-time/leisure fishermen (5B), and as such the division is not related to gear.

[20] All the vessels in each vessel group originally received the same number of fishing days but because days can be traded permanently, the number of fishing days is no longer equal between vessels.

The stated premise of the fisheries management system in the Faroe Islands is that the marine resources in the Faroese EEZ belong to the Faroese people:

> *The living marine stocks in the Faroese marine territory are the property of the Faroese people and so are the fishing rights outside that territory that the Faroese Home Rule Government has acquired or is entitled to under international law.* (§2 of the CFA) [21]

While it is legally dubious to claim that the resource belongs to the people (Grétarsson and Danielsen 2014),[22] it is a recurring issue, especially in relation to small-scale fishermen. This claim is not unique to the Faroese system and has nothing to do with the type of system as such. The CFA also states that "the resource should be preserved, exploited and utilised in a biologically and economically sustainable manner,"[23] and benefit the economy and enable commercial activities all across the country (CFA §2). As a direct result of this last point, fish processing factories have been opened in regions with high unemployment or lack of other industry and jobs, most recently on the island of *Suðuroy* (pers. obs.).

The Faroese system operates with a double licencing system. The capacity of a vessel is specified in its harvesting licence, which is non-transferable and needed to get a fishing licence. The fishing licence states how many fishing days a vessel has at its disposal. The fishing licence is transferable and vessels can hold several fishing licences.

3.1.1 The harvesting licence

A harvesting licence (F: veiðiloyvi) is: "…an approval provided by the Minister to a specific vessel to harvest in the Faroese EEZ"[24] (CFA §5.3). In order to conduct

[21] Translation made by the author who assumes all responsibility.

[22] Operators in the fishing industry are given fishing rights, which arguably cannot be revoked without compensation and therefore it can be questioned how the property belongs to the Faroese people. See Grétarsson and Danielsen (2014) for a complete argument.

[23] The CFA does not define 'sustainable', and since there is no commonly accepted interpretation of this word, it has limited meaning in this context.

[24] Translation by author, who assumes all responsibility. The Act is only available in Faroese.

commercial fishing and get a fishing licence, a vessel must have a harvesting licence.[25] In principle, no new harvesting licences are allocated to maintain the fleet size at the size of January 1st 1995 (Løkkegaard et al 2004; Reinert et al 2007). Therefore, the harvesting licence system in effect creates a "closed-shop arrangement" (Grétarsson and Danielsen 2014 p. 105), and the only way to obtain a harvesting licence is by purchasing one (CFA §8; Løkkegaard et al 2004). In effect this means that vessels and their attached harvesting licences can be bought for utilisation or to be decommissioned and replaced by a new vessel that is allocated the licence in question (Fiskiorkunevndin 2008).

Conditions apply when a harvesting licence is transferred from a decommissioned vessel to a new one. Firstly, the new vessel cannot have a greater capacity than the decommissioned vessel. Secondly, as a main principle, the new and the decommissioned vessels must belong to the same vessel group. However, the harvesting licences of *two smaller* decommissioned vessels can be combined and transferred to a bigger vessel in a different category, granted that the capacity[26] of the larger vessel is estimated to be the same or less than the combined capacity of the smaller vessels (CFA §7, §8).[27] In reality, vessels have on occasion been traded between vessel groups due to changes in vessel group definitions (Fiskimálaráðið 2010).[28]

The "closed-shop arrangement" of the harvesting licence is reflected in a decrease in the number of harvesting licences across the various vessel groups since 1995 (table 3.1). The only vessel group that has not decreased in numbers is long-liners (VG3) due to a change in the vessel group definition. Even though the size of the demersal fleet has decreased by 60 vessels in years 1995-2011, representing a 35% reduction in

[25] Except vessels in vessel group five, which consists of small coastal vessels. They only need a fishing license (CFA §6; Executive order 54 from 26.03.1993, F: Kunngerð nr. 54 frá 26.03.1993). Entry into vessel group five is not limited in the same way and thus there is no need for harvesting licences. See also section 3.3.

[26] Capacity in the CFA is defined as vessel size and engine size.

[27] See also executive order 75 from 13.06.2006, F: Kunngerð nr. 75 frá 13.06.2006 um áseting av fiskiorku og mannagongd, tá veiðiloyvið verða flutt millum fiskifør 15 og størri, sum broytt við kunngerð nr 132. Frá 26.09.2011.

[28] In 2005, fishing vessels over 110 tons were redefined as large long-liners while vessels smaller than 110 tons were moved to group of vessels larger than 40 tons but smaller than 110 tons. This is why there were more long-liners in 2011 than 1995.

numbers, it does not naturally follow that the fishing capacity[29] of the fleet has decreased correspondingly or even at all.

Fishing capacity increases are an inevitable part of technological development and pose challenges: "The ever-increasing efficiency in fisheries (technological creep) is a challenge to every fishery management, whatever system is used" (Jákupsstovu et al 2007 p. 733). In catch quota systems, technological creep is however much less of an issue than in effort quota systems because catch quota systems set Total Allowable Catches (TAC). How the fleet takes a TAC out of the ocean is up to the fleet, and efficiency increases are in fact often considered positive in catch quota systems because it reduced harvesting costs. Technological creep poses a problem in effort quota systems because effort quotas are allocated on the basis of a specific vessel or fleet efficiency, not TACs.[30] If the efficiency of a fleet increases then so does the intended harvesting intensity from the allocated effort quota. While it should be relatively simple to control effort – i.e. fishing days – it is much more difficult to control efficiency because it necessarily involves controlling vessel and gear improvements and how time at sea is utilised (Fiskiorkunevndin 2008, Jákupsstovu et al 2007). If an effort quota system is to successfully control the fleet's fishing capacity, and thus also efficiency, it "requires constant adaptation to bring it into line with the latest technological developments" (World Ocean Review, 2010), making it complicated to manage.

Only one segment of the Faroese fleet, the pair trawlers (VG2), has been studied in relation to efficiency increases. It was found to have gone through a considerable efficiency increase since the CFA was implemented. Thomsen (2005) studied eight single trawlers that were converted to four pair trawlers and then three pair trawlers. As four pairs, catch per unit effort (kg/hour) went up and tow duration increased systematically from five to seven hours per tow while handling time between tows remained constant, increasing effective fishing time with 5%. Towing speed was found to have increased corresponding to a 14% increase in swept area per hour. Electronic equipment and plotters are supposed to increase efficiency but data on the Faroese trawlers were

[29] Capacity is often defined as time at sea + physical attributes of a vessel but due to the fact that the CFA defines capacity only as vessel and engine size, the term 'fishing capacity' will be used for effort (fishing days), capacity (physical attributes), and efficiency (changes that improve physical attributes).

[30] At least not in the Faroese system.

inconclusive – some trawlers increased their efficiency, others not. In 2003, the four pairs were replaced with three new pairs of similar size. “Comparison of old vessels with new vessels shows a 48 per cent increase in catch per day and a 41 per cent increase number of fishing days, which resulted in a 100 per cent increase in total catch per vessel in 2003.” (Thomsen 2005 section 3.1.3).

Other vessel groups have almost certainly undergone similar technological advances and accompanying efficiency increases as the pair trawlers. Banks et al (2002) assumes that technological progress leads to annual efficiency increases of 2%, while others consider an annual efficiency increase of ±4.4% to be on the conservative side (Villasante and Sumaila 2010). Irrespective of the rate, technological progress is unavoidable and poses a problem in effort quota systems. The rate of progress can be limited by regulations and effective enforcement but Faroese management has failed to implement measures to control even basic advances. The CFA does for example not state whether or not vessel owners are allowed to improve vessels to increase capacity (Grétarsson and Danielsen 2014), e.g. by increasing length, engine power or tonnage, and therefore one strongly assumes that vessel improvements are made, and in addition to efficiency increases such as those made by the pair trawlers. The CFA makes a feeble attempt at addressing efficiency increases by enabling regulations on gear requirements to be issued but this is in effect limited to minimum mesh size (CFA §9.2, Jákupsstovu et al 2007).[31]

The CFA states that tonnage shall be used as a measure of capacity when harvesting licences are transferred.[32] Data on fleet size in pure tonnage from 1994 to 2003 shows that total fleet tonnage increased by about 17% in the first decade the system was in place (table 3.2). The CFA states that engine power shall be added to tonnage when measuring the capacity of trawlers for harvesting licence transfers.[33] Data on total fleet engine power shows that engine power in groups 2-5 increased by 47.7% from 1994 to 2003 (Løkkegaard et al 2004 p. 27). There is no reason to believe that such increases

[31] Although there are rules regarding gear in certain areas, which will control effort, but it hardly addresses the issue of the technological creep.

[32] As set out in regulation no. 75/2006 on assessment of effort fishing capacity when fishing licence is transferred between vessels 15 tons and larger.

[33] Ibid.

have stopped occurring after the data ends in 2003 and therefore the fleet's engine power has increased even further. The stipulation that a vessel's capacity only can be improved by 15% has clearly not been enforced.[34]

We can conclude that capacity increases have occurred, both in terms of tonnage (table 3.2) and in terms of engine power (Løkkegaard et al 2004), and that pair trawlers (VG2) have increased their efficiency (Thomsen 2005), that the rest of the fleet is likely to have done the same, and therefore that overall efficiency of the fleet has most likely increased considerably since 1994. Thus, even though there are fewer vessels in the fleet than in 1994 (table 3.1), the harvesting licence has not served its purpose of maintaining the fleet at its 1994 size and management has failed to achieve its own objective of controlling the fleet's size. Based on economic and biological results the fleet has indeed become far too big (and may indeed have been so from the beginning, according to Jákupsstovu et al 2007). If there are too many vessels in the fleet, attempts at controlling efficiency and capacity increases may be ineffectual because capacity is already far too big due to the excessive fleet size. But it is exactly when the fleet is too big that strict enforcement of such regulations is most necessary to reduce harvesting intensity as much as possible. Therefore there is no excuse for not enforcing regulations, and the lack of control with fleet capacity suggests incompetence in design, implementation and enforcement.

Table 3.1 Vessel groups, descriptions and harvesting licences in 1995 and 2011 [35]

Vessel group	Description	1995	2011
2	Trawlers	48	36
3	Long-liners > 110 tons	19	20
4A	Coastal vessels 15-40 tons	50	21
4B	Coastal vessels 40-110 tons (long-liners)	35	22
4T	Coastal vessels 40-110 tons (trawling)	19	12
Total		**171**	**111**

[34] Executive order no. 75 from 13.06.2006, as changed by EO no. 132 from 26.09.2011. F: Kunngerð nr. 75 frá 13.06.2006 um áseting av fiskiorku og mannagongd, tá veiðiloyvið verða flutt millum fiskifør 15 og størri, sum broytt við kunngerð nr 132 frá 26.09.2011.

[35] CFA §29, Búskaparráðið 2011 p. 16

Table 3.2 Fleet tonnage (T), 1994-2003 [36]

VG	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
2	9,929	10,765	10,765	10,493	10,094	10,458	10,458	10,458	10,182	9,979
3	5,031	5,031	5031	5,031	5,031	5,031	5,031	5,176	5,642	5,268
4A	1,574	1,554	1,572	1,549	1,157	1,183	1,099	1,064	1,119	1,020
4A	30	30	30	30	30	62	62	62	129	126
4B	2,519	2,424	2,510	2,245	2,093	2,700	2,658	2,701	2,708	3,066
4B	580	612	667	761	761	723	723	723	766	898
5	4,767	5,431	6,005	6,495	7,055	7,847	7,561	7,645	7,853	8,257
Total T	24,430	25,847	26,580	26,603	26,221	28,004	27,592	27,829	28,399	28,614

3.1.2 Fishing days

Fishing days are allocated annually, first to vessel groups and then individual vessels, as stated. Fishing days are attached to vessels' fishing licences, and as stated, fishing licences are transferable and vessels can hold several fishing licences (F: fiskiloyvi). A fishing day is defined in the following way in the CFA:

> *A fishing day is every 24 hours a vessel has spent fishing in a fishing year. Every trip begins when a vessel leaves harbour and ends when a vessel is back in harbour. Every trip counts at least 24 hours.* (§5.5)[37]

Fishing day allocations are made by amendment to the CFA following a proposal from the Minister (CFA § 22). Before a proposal is made, the Minister receives recommendations on fishing days from the Faroese Marine Research Institute (MRI) and the Fishing Day Committee that is comprised of industry representatives. The MRI and Fishing Day Committee should base their recommendations on what best secures the long-term sustainability of the stocks.[38] The Minister is not obliged to follow these

[36] Løkkegaard et al 2004 p. 26. No data for the last decade was found.

[37] Translated from Faroese by author.

[38] The law does not define sustainability.

recommendations, and the result is often that the recommendations from the MRI are more or less ignored (Grétarsson and Danielsen 2014).[39]

There has nonetheless been a substantial decrease in the number of allocated fishing days since the fishing day system was implemented (table 3.3, appendix 1). Subgroup 4A – coastal vessels between 15 and 40 tons – has had its fishing days reduced most, by 82%, and this is also the vessel group that has decreased most in vessel numbers (table 3.1). Subgroup 4B was allocated 55% less in 2013/2014 than in 1996/1997. The allocation to VG5 has decreased by 63%. VG2 and VG3 experienced a smaller decrease than the other groups. The total number of allocated fishing days has decreased by 55%. Despite the decrease in allocation, the utilisation of fishing days is incredibly low (table 3.4), as utilisation is not binding. Vessel group 4A, whose fishing day allocation has decreased most, utilised the lowest share of its allocated fishing days in 2008-2012, ranging between 25-32%. 5A also utilised a low share of its allocation, ranging between 36-54%, as did 5B with a range of 35-60%. The only vessel groups to utilise their allocated fishing days fully or nearly so were VG2 and 4T, the former sometimes exceeding its allocated share.

A few conclusions can be made from the total utilisation share that ranges between only 53% and 66% in 2008-2012. The first and most logical conclusion is that the allocation of fishing days is far too generous and does in fact not restrict fishing at all based on the low utilisation share, and therefore the current use of fishing day is not actually a management tool, except perhaps in relation to vessel groups VG2 and 4T, because these groups fully utilise their fishing days. If fishing days are to be considered a management tool fishing days need to be fully utilised, otherwise fishing is not limited by fishing days and thus not controlled. The low utilisation rate means fishing in the Faroe Islands is de facto free fishing.

An alternative conclusion could be that the trading system for fishing days does not work properly, as Jákupsstovu et al also mention as an alternative conclusion (2007), and it may be true to a degree because the trading system has a barrier that prevents

[39] For example, for the 2013/2014 fishing year, the MRI not only recommended that the fishing days be reduced but also that this was done on the basis of how many fishing days had been utilised, not allocated. Thus, the 30% reduction they recommended was in reality much more (Havstovan 2013). Fishing days were reduced minimally and not for all groups, see appendix 1.

efficient trading: A vessel has to utilise at least 60% of its allocation before being allowed to trade[40] and therefore it is possible, even likely, that some vessels are utilising all their fishing days while others are unable to sell their fishing days because they have utilised less than 60% of their allocation (Fiskimálaráðið 2012). While the efficiency of the trading system can be tested, data on trading and individual allocations are not readily available and collection of such data is beyond the scope of this thesis. Fishing days *are* traded so the trading system *works* but probably not very efficiently (Toftum og Guttesen 2010; Búskaparráðið 2011). A review of the trading system might solve the problem but a simpler solution would be to reduce the allocation of fishing days so that fishing days are fully utilised in all vessel groups and the 60% rule becomes obsolete.

A third alternative, proposed by some Members of Parliament when discussing the allocation of fishing days for 2013/2014 (pers. obs.), is that fishing days are not utilised because stock biomasses are so low that harvesting is not worth the cost. While this may be true at the moment with the extraordinarily low cod stock biomass, this rhetoric turns the issue into a debate akin to the debate about the egg and the hen, except in this case overexploitation almost certainly came before low cod stock biomass. Several publications have suggested that the initial allocation of fishing days was too high, and that fishing days still have not been adjusted to the point where overexploitation is prevented (Jákupsstovu et al 2007; Fiskiorkunevndin 2008). The above reasoning can therefore only be interpreted as an attempt to perplex the issue. Motivations for perplexing the issue are not worth speculating about, but the fact that such attempts take place makes a case for removing fishing day allocations from the political system.

Allocations have been criticised by experts in several fields. In its 2013 recommendation to the Minister, the MRI recommended that fishing days be reduced by 30% from the level of *utilisation*, not *allocation*, as usual. The MRI was concerned by overexploitation and the share of unutilised days and voiced fears that once stock biomasses start to increase, assuming they do, the current excess in fishing days will give room for immediate increased effort, meaning that any recovery stocks may be experiencing will immediately be halted by excessive effort (Havstovan 2013).

[40] This is to prevent consolidation of fishing days. Executive order no. 132 from 26.09.2011, F: Kunngerð nr. 3 frá 12.01.2011 um avhending av fiskidøgum, sum broytt við kunngerð nr. 134 frá 26.09.2011)

The Faroese Economic Council has also been critical. As previously mentioned, the low utilisation of fishing days means that the Faroese fishery is *de facto* free fishing. A common property resource will lead to a 'tragedy of the commons' scenario according to the famous theory by Hardin (1968), and this is indeed what has happened in the Faroe Islands. Theory also predicts that the economic outcome of such a fishery will be poor, as the previous chapter demonstrated (Gordon 1954). The Economic Council has called for fundamental changes in the fishery for exactly these reasons:

> *The majority of fishing in the Faroe Islands is in reality* free fishing *(apart from closed areas), and is therefore not sustainable. This is made abundantly clear by the fact that even though fishing days have been reduced by approximately 35%*[41] *since the system was implemented, year by year, a large share of allocated fishing days are not utilised while fishing mortality in recent years has been far too high, especially on cod and haddock.* (Búskaparráðið 2011 p. 4, emphasis in original)[42]

The select committee that initially designed the system has defended its design in a 2008 report to the Minister:

> *Experience shows that it is difficult to set [catch] quotas with appropriate fishing mortality, the reason being that we often do not accurately know stock recruitment… and accurate stock assessments are difficult to make. With a fishing day system you can avoid the problem of getting fishing mortality right every year for all stocks harvested in a mixed fishery. Therefore there are good reasons to believe that a system with fishing days has a better chance of reaching a reasonable fishing mortality in a mixed fishery than a system with catch quotas for each individual stock. The* ***only***

[41] The decrease in fishing days calculcated by ICES (table 3.3) and the Economic Council differ. The latter however did not reference its calculation and ICES is an authority on the matter so table 3.3 and ICES are assumed to be correct.

[42] Translation by author who assumes all responsibility.

> ***condition*** *is that* ***capacity increases are closely monitored*** *and* ***efficiency gains are adjusted for*** *so that fishing mortality can be kept at sustainable levels.* (Fiskiorkunevndin 2008 p. 14, emphasis added)[43]

This is exactly one of the central problems with the CFA. Capacity increases are not monitored and efficiency gains are not adjusted for because they are not fully known, strongly implying information, monitoring and enforcement failures (Grétarsson and Danielsen 2014; Jákupsstovu et al 2007). Instead of taking these uncertainties into consideration and erring on the side of caution (or improve monitoring and enforcement), the administration and Parliament has been reckless in allocating effort. As a result of both increased capacity and uncontrolled effort, the fleet's harvesting intensity has been and continues to be far too high (ICES 2012, ICES 2013a-c). One response to overexploitation could be to implement measures to reduce vessels' efficiency but this would not improve the economic outcome of the fishery. It would be wiser to adjust the number of vessels in the fleet and allocate effort quotas that are sufficient for each vessel but on the whole drastically lower. This would allow individual vessels to increase profits while lowering fishing mortality due to an overall reduction in harvesting intensity.

However, for this to work in practice and long-term, the process of allocating fishing days should be removed from the political system to an independent body. Adjusting fishing days through Parliament is problematic as previously demonstrated. Faroese society is small and when politicians reduce allocations they are essentially infringing upon other people's property,[44] and this may not be ideal for politicians if, for example, they are hoping to get re-elected or their campaign funding comes from wealthy individuals in the fishing industry. Involving Parliament in the allocation process also complicates the process considerably and is the principal reason that fishing days have not been reduced appropriately, despite it being clear as a cloud free day that stocks are overexploited. The Faroese Economic Council has pointed out that this is an unusual

[43] Translation by author who assumes all responsibility.

[44] See Grétarsson and Danielsen 2014 where it is argued that harvesting rights to a degree constitute property rights, even though the CFA explicitly states that harvesting rights to not give holders property rights (CFA § 3).

allocation method and that the Minister of Fisheries usually manages quotas, whether catch or effort (Búskaparráðið 2011). Usual or not, the allocation of fishing days has been in the hands of politicians for two decades now. Politicians and governments have changed but the failures in controlling the resource have persisted, and therefore the problem is not just political mismanagement (or bad politicians); this method of control and allocation through the political system is too susceptible to myopic policy-making.

Table 3.3 Percentage difference in fishing day allocations in 1996/1997 and 2013/2014

Vessel group	1996/1997 allocation[45]	2013/2014 allocation[46]	Difference
2 inner/outer	8,225	4,441/1,530	- 44%
3	3,040	2,387	- 21%
4A	5,600	1,011	- 82%
4B	3,410	1,533	- 55%
4D [47]	1,650	-	-
4T [48]	-	1,386	-
5	27,000	9,865	- 63%
Total	**48,925**	**22,153**	**- 55 %**

Table 3.4 Fishing day utilisation, 2008-2012 [49]

Vessel group	2008/2009	2009/2010	2010/2011	2011/2012
2 inner/outer [50]	88%	104% [51]	91%	102%/58%
3	73%	71%	73%	77%
4A	30%	32%	31%	25%
4B	55%	66%	58%	47%
4T	88%	90%	92%	95%
5A	45%	51%	54%	36%
5B	35%	60%	57%	56%
Total	**53%**	**66%**	**65%**	**64%**

[45] Numbers from table in ICES NWWG Report 2013 p. 29, see also appendix I. The table cites the fishing year 1996/1997 twice. It was assumed for the purpose of making the above calculations that the second entry is correct.

[46] Løgtingslóg nr 28 frá 10. mars 1994 um vinnuligan fiskiskap, sum seinast broytt við løgtingslóg nr 109 frá 16. august 2013.

[47] This vessel group only existed for two years according to ICES NWWG Report 2013.

[48] This vessel group was first allocated fishing days in 2005/2006.

[49] Numbers from ICES NWWG Report 2013 p. 30, see also appendix II.

[50] The fishing grounds are separated by inshore and offshore, see fig. 3.1.

[51] It is possible for vessels to purchase fishing days, also from other vessel groups towards the end of the fishing year.

3.2 Spatial management

Area divisions and area-time closures serve as additional measures of control in the Faroese effort quota management system. Area divisions separate gears, while area-time closures[52] protect juveniles or spawning grounds. Immediate but temporary area-time closures lasting up to two weeks can be imposed to protect juveniles if the catch of juveniles is too high.[53] Spawning grounds are closed to prevent fishing in areas of high concentration and to allow fish to spawn. Currently seven different areas are closed for spawning, most from February to April, though some close in January and some do not open until May (ICES NWWG 2013, figure 3.1). The Faroese fishing grounds are divided into inshore and offshore regions, called the inner and outer ring (figure 3.1). This means that only long-liners and jigs below 110 tons, i.e. vessel groups 4A, 4B and 5, are allowed to harvest closer than 12nm from land, thereby excluding trawlers, i.e. vessel group 2 and 4T, from the more shallow waters (Jákupsstovu et al 2007; ICES NWWG 2013; Zeller and Reinert 2004).

Zeller and Reinert (2004) examined the possible impacts of area closures on stocks by conducting time-dynamic simulations using modelling software and comparing it to the status quo. Simulations showed that area closures help conserve the main demersal species, with biomass of cod, haddock and other demersal stocks increasing over a 10-year simulation period. Simulated removal of spatial closures reduced projected stock increases considerably. Countless other studies confirm that MPAs benefit fish stocks and ecosystems in general (Halpern 2003; Lauck et al 1998; Allison et al 1998; Halpern and Warner 2002; Lubchenco et al 2003). A "… synthesis of more than 100 studies of reserves worldwide shows that protection from fishing leads to rapid increases in biomass, abundance, and average size of exploited organisms and to increased species diversity." (Roberts et al 2001 p. 1920). A review on marine reserves that had been effectively enforced for at least five years concluded that "…well enforced marine reserves have a great potential to maintain or enhance fishery catches and increase

[52] The Faroese system uses the term 'area closure', but the terms 'marine protected area' and 'marine reserve' are more common and are used interchangeably in literature.

[53] See executive order no. 132 from 26.09.2011, F: Kunngerð nr. 56 frá 26.03.1993 um serlig tiltøk til vernd av ungfiski.

sustainability. They should be used much more widely and with more confidence in their function." (Gell and Roberts 2003 p. 449).

The review by Gell and Roberts (2003) includes a case study of Georges Bank in the Gulf of Maine, USA where marine reserves were implemented to reverse the effects of intensive fishing for demersal species. Reserves were closed to all gears that might incidentally catch demersal stocks or damage their habitats but long-lining was still allowed. After five years, the marine reserves in combination with reduced effort, had led to an increase in haddock stock size and several other demersal stocks. Cod was slower to respond to the measures, possibly because cod is more mobile or because the stock had been driven the furthest downward in size but even the cod showed signs of recovering (Gell and Roberts 2003 p. 449).

3.2.1 An economic case for marine protected areas

Despite the ecological and biological benefits of MPAs, they are often controversial because of the costs they incur. A full Cost-Benefit Analysis (CBA) is outside the scope of this thesis, but the most common costs and benefits can be briefly discussed. The reason that it is necessary to implement schemes to protect nature is because of "market failures" (Bator 1958). Nature has intangible, non-use values that are difficult to quantify, e.g. ecosystem services, which means that markets in certain cases fail to ensure that nature – in this case ecosystem services – is 'traded' at its true value. CBAs attempt to correct such market failures but the problem of quantifying nature persists and therefore CBAs can be misleading because they exclude the intangible or unquantifiable benefits. Costs, on the other hand are often relatively easy to quantify.

Costs and benefits are usually grouped in CBAs. Costs associated with MPAs include direct costs, such as implementation, management and enforcement, indirect costs, and opportunity costs (Dixon and Sherman 1991). It would be relatively easy to estimate direct management costs from area closures in the Faroe Islands, while indirect costs would have to be examined to establish what they could be. It would be possible but potentially difficult to estimate opportunity costs of area closures to fishermen, e.g. by calculating the increase in petrol consumption and difference in value or size of catches inside vs. outside MPAs. The opportunity cost is the most controversial and unfortunate of the three because it adversely affects fishermen. Stakeholder support is vital to the

success of MPAs (Brody 2003) and the stakeholder group that needs to support them most are fishermen. Since fishermen risk losing access to potentially valuable fishing grounds, which may negatively affect catches, increase sailing time, reduce efficiency and increase (petrol) expenses, fishermen may not support MPAs. The costs are however lower if fishermen can fish in other areas, as they can in the Faroe Islands (Smith et al 2010), and the hypothesis of this thesis is that taking fishermen's SAP into consideration when implementing such closures can reduce costs. It is also important to keep in mind and remind fishermen that they are the ones who stand to win most if MPAs are successful in increasing stock sizes.

Benefits are more difficult to group. They can be divided into use value, existence value and option value, or direct values and indirect values (Dixon and Sherman 1991). Dixon and Sherman use a more complete breakdown: Ecological processes; biodiversity; non-consumptive benefits, which are often referred to as existence value; consumptive benefits, such as fishing; future values; recreation and tourism, e.g. diving; and education and research (1991 pp. 69-70). It is clear from the list that benefits are more difficult to quantify than costs. For example, it is difficult to see how one places a value on ecological processes when such processes produce global life support. It may be possible to place a value on biodiversity, perhaps in the context of ecosystem resilience. However, such a valuation will miscalculate the true value simply because the true value cannot be quantified or monetised. This is due to information failures that can stem from processes or activities that may be excluded. It may even be undesirable to express ecosystem benefits in anything but qualitative terms (Dixon and Sherman 1991). Nevertheless, such valuations have been made. Costanza et al valued global ecosystems at a minimum of US $33 trillion, which was almost twice as much as the global GDP at the time of publication (1997). There are ways to quantify non-consumptive and recreational benefits as well as recreational value using tools of economic analysis, e.g. contingent valuation surveys in the form of revealed preference or willingness to pay, and it is also possible to value recreational benefits by calculating how much money users spend on ocean recreation such as diving and sailing.

Now that the principles of CBA have been established, the (quantifiable) costs and benefits of the status quo can be quantified. The consumptive benefits are easiest to

monetize. The value of demersal exports is known, DKK 617 million as of 2013 with current area and area-time closures (Hagstova Føroya 2013b). The value of ecological processes and biodiversity cannot be quantified, nor can any of the other benefits, at least in the context of this thesis. The opportunity costs of area closures also cannot be estimated in this thesis, but they are likely to be less than DKK 617 million, especially since fishermen are able to fish in other areas. There is also a less obvious opportunity cost - the lost income opportunity caused by overfishing. Demersal exports were worth DKK 1,368 million in 2002, more than twice as much as in 2013[54] (Hagstova Føroya 2013b), bringing the cost to DKK 751 million due to lost revenue from overexploitation. Therefore the cost-benefit analysis of the status quo scenario comes out negative by about DKK 134 million, excluding management costs and unquantifiable benefits. But negative compared to what? Dixon and Sherman write: "When evaluating the benefits and costs, it is not their total sum that is relevant, rather it is the difference in amounts between the levels associated with protecting the area and the level associated with the pre-specified alternative." (1991 p. 69). In other words, to make sense of the (somewhat lacking) CBA, we have to define the alternative(s).

There are two possible counterfactual scenarios to the status quo. The first scenario has no area closures to protect spawning grounds or juveniles. This would reduce management costs and reduce opportunity costs for fishermen (in the short run, which in this case is the time it would take to harvest fish stocks to the point of no profit). The opportunity costs of overexploitation will remain the same. As mentioned, simulated removal of spatial closures had negative consequences on demersal stocks (Zeller and Reinert 2004), and because cod SSB is near the lower advisable limit (ICES 2013a), a reduction in stock size could potentially be catastrophic. If the stock collapses or landings continue to decrease, so will export value. Therefore the benefits of scenario one are lower, the costs are higher, and the CBA comes out negative compared to status quo.

The second scenario is that *more* and *improved* area closures are implemented to protect areas vital to ecosystems, biodiversity and demersal stocks. The costs will

[54] Not adjusted for inflation.

increase with size and scope of MPAs as will the benefits. The unquantifiable benefits will come mainly in the form of better-protected ecosystems and habitats; the quantifiable benefits will be a growth in fish stocks, as stocks respond to increased protection. If the outcome of increasing and improving area closures is that the cod stock grows and the demersal export value once again reaches DKK 1,368 million, as it was in 2002, then (quantifiable) benefits will exceed increased managements costs (Hagstova Føroya 2013b). Therefore this is the only scenario with a positive outcome.

Naturally, the benefits in all three scenarios will increase if management changes are made to address overexploitation of fish stocks, and benefits in status quo may come close to costs but scenario two is still likely to have higher benefits than status quo because if the overcapacity of the fleet is addressed, then all research suggests that expanding MPAs can aid the recovery of the stock. It is recommended that the potential costs of inaction are included when conducting CBAs (IUCN-WCPA 2008). It has not been included in the above CBA but the potential costs of inaction in this case would be the economic loss if stocks were to collapse, which is either DKK 617 million if you only consider the current value of the fishery or DKK 1,368 million if you include the potential value of the fishery.

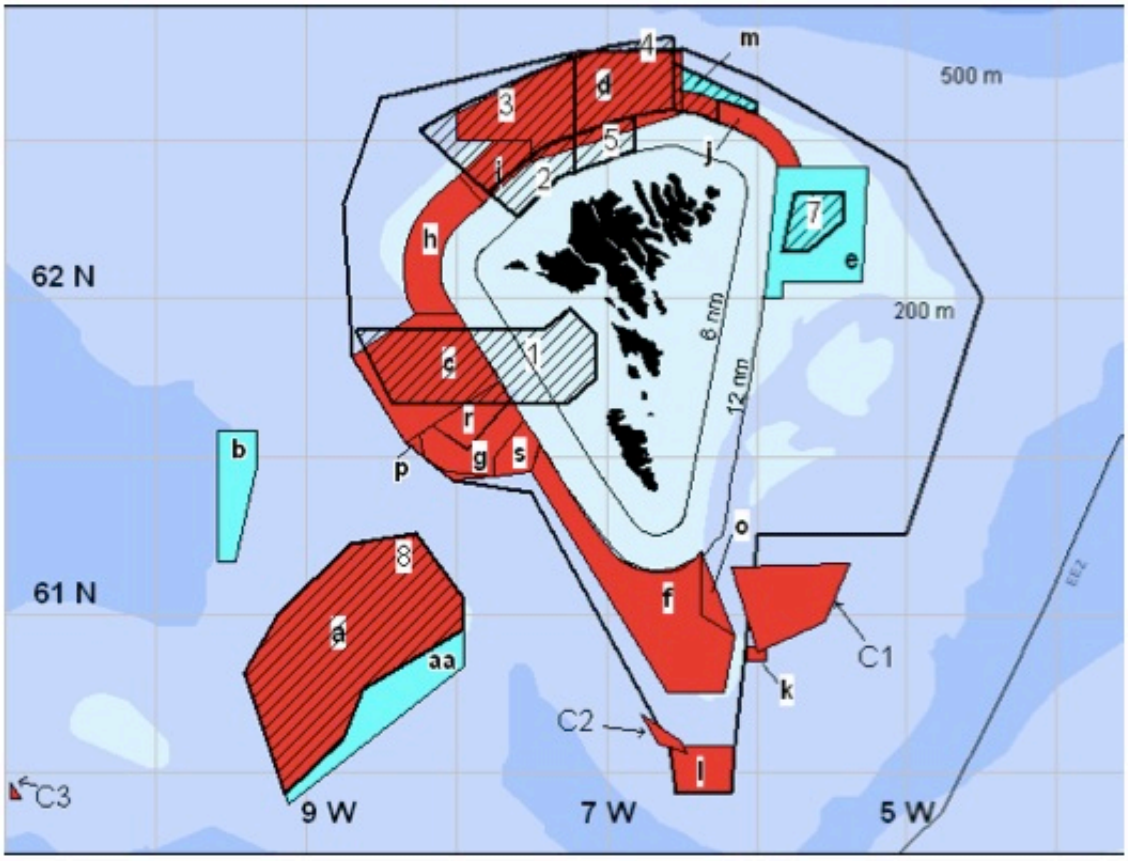


Figure 3.1 The Faroe Islands with the 12 nm ring and various area closures.
The coloured areas (also lettered) represent areas closed for trawling (red = permanent closures, blue = area-time closures). Lined areas (also numbered) are spawning ground closures and apply to all gears except jigging. Spawning ground closures vary in time but most start on February 15 and end on April 15 but some begin earlier and some end later. Areas C1, C2 and C3 (outside frame) are closed to protect corals. As is clear, some classifications overlap, e.g. area 8 is lined but also red, which means that the closure applies to all gears except jiggers[55]

3.3 Small-scale fishermen

The long Faroes tradition of fishing started with small coastal vessels. This tradition still lives in the Faroe Islands, and the vessels that conduct small-scale fishing belong to vessel group 5 (VG5). This vessel group consists of leisure, part-time and full-time fishermen. But the long history of this fleet may be coming to an end. There is a consensus in the Faroe Islands that the non-recreational segment of the small coastal fishery is slowly dying because fishing is not profitable enough (pers. obs.). The end of small-scale fishing would represent a significant cultural shift in the Faroe Islands, as the Faroese, living a relatively isolated life in the north Atlantic Ocean, have relied on the

[55] ICES NWWG 2013 p. 33; Jákupsstovu et al 2007

ocean for subsistence for centuries and to a degree still do today (pers. obs.). Despite this, little research has been conducted on coastal fishing. The cultural aspect alone warrants conducting research on this vessel group but there are several other reasons for doing so. These reasons will be presented in this section, as the details surrounding this vessel group are explained in more detail than the previous section.

VG5 is divided into two subgroups – 5A is for commercial fishermen and 5B is for leisure or part-time fishermen, and both are free to use long-lines and jigs as they like. Each vessel in 5A receives individual fishing days, as in other vessel groups, but 5B is allocated a collective set of fishing days so that fishing has to stop when the collective fishing days are up (Løkkegaard et al 2004). The CFA has a different definition of fishing days allocated to VG5: "[E]ach fishing trip counts as one fishing day even if the trip is longer than 24 hours." [56] (CFA § 5.5). Therefore VG5 is effectively allocated fishing trips, not fishing days, and control of effort concerted by VG5 is more lenient than with other groups.

Furthermore, vessels in VG5 need only hold a fishing licence, not a harvesting licence. 5B licences have traditionally been issued on request and therefore entry into this part of the fleet is more relaxed than entry into the rest of the fleet (Grétarsson and Danielsen 2014; Løkkegaard et al 2004). It is both surprising and not that entry into 5B is so relaxed. Fishermen in 5B are supposedly leisure or part-time fishermen[57] and denying entry into this part of the fleet would be culturally difficult due to the close connection to the ocean many Faroese people have (Grétarsson and Danielsen 2014). On the other hand 5B, and indeed VG5 as a whole, is responsible for a large share of demersal catches in the Faroe Islands. For example, VG5 landed more than 25% of total cod catches in the period 2002-2007 (Fiskimálaráðið 2008 p. 26). In 2013, VG5 landed more than 29% of total cod catches, and although 5B is supposed to consist of leisure and part-time fishermen, cod catches by this group far exceeds that of the larger long-liners in subgroups 4A and 4B, and equals that of trawlers in VG4, subgroup 4T (table 3.5). Naturally these data only include catches that are landed, not catches for personal consumption. Therefore the actual catches by VG5 are higher than the data suggest.

[56] Translation by author who assumes all responsibility.

[57] Landings suggest that some fishermen in 5B are more than leisure or part-time fishermen.

It is clear when looking at individual landings in 5B that some vessels land considerably more than what you would reasonably expect from a leisure fisherman. One vessel has landed as much as 116 tonnes and quite a few vessels landed for more than 250,000 DKK in 2013, and one vessel landed for values higher than 500,000 DKK (Fiskiveiðieftirlitið 2014). In comparison, the basic annual wage for a nurse in the Faroe Islands is DKK 285,000,[58] so although 250,000 DKK hardly qualifies as a good income, and expenses need to be drawn from it, it is difficult to imagine such values being the result of part-time fishing. Landings from 5B had a total value of DKK 17 million in 2013 and landings from 5A had a total value of DKK 26 million (Fiskiveiðieftirlitið 2014). This is down from DKK 32 million and 50 million respectively in 2010 (Ellefsen 2013).

The case of VG5 becomes even more peculiar when comparing the increase in landings with the stark and rapid decrease in vessels (table 3.6), which has gone from 1,312 in 1997/1998 to 418 in 2013/2014. A more serious decrease has occurred in 5A, the full-time fishermen, which has gone from 212 vessels to just 26, a decrease of 87.7%. Looking at the numbers, at least 186 fishermen no longer work full-time, assuming only one man is attached to each vessel. In reality, many vessels are manned by two, three or four fishermen, and if they use long-lines have men working on land fixing bait and repairing fishing gear (pers. obs.).

VG5 does more than land a large share of cod. It also lands a lot of small cod (figure 3.2). Most of the cod landed by both 5A and 5B only weighs 1-2 kg (cod 4 in figure 3.2). Little data on the maturation of cod in Faroese waters has been published but Tåning (1943) and Joensen and Tåning (1970) state that on average the Faroe Plateau cod are mature at 4 years.[59] In a more recent study, Steingrund and Kristiansen (2013a) found that all cod categorised as ‘cod 5’ was juvenile, ‘cod 4’ had a mixture of juveniles and adults, and no juveniles were present in categories 1-3. Therefore we can conclude that a large share of cod catches by VG5 is juvenile. Given the status of the Faroe Plateau cod stock, intense exploitation of juveniles is worrisome in the context of stock recruitment where it is widely considered necessary to let fish grow to a certain size and

[58] Basic monthly wage is DKK 23.803. 23.803 * 12 = DKK 285,648 (Felagið Føroyskir Sjúkrarøktarfrøðingar 2014).

[59] Quoted in Steingrund et al 2005. Original sources not available.

spawn before being harvested. Targeting older and heavier fish leads to a "more robust and abundant cod stock" and has economic benefits (Diekert et al 2010 p. 455).

Table 3.5 Cod catches in Faroese waters across vessel groups in 2013[60]

Vessel group	2	3	4A	4B	4T	5A	5B	Other	Total
Tonnes	912	1,346	170	495	675	890	648	62	5,198
Percentage	17.55	25.89	3.28	9.52	12.98	17.12	12.47	1.20	100

Table 3.6 Fishing licenses in vessel group 5, 1997-2014[61]

Year	5A, commercial	5B, part-time	5D, other [62]	Total
1997/98	212	132	968	1,312
1998/99	240	214	963	1,417
1999/00	224	106	314	644
2000/01	169	122	400	691
2001/02	158	150	592	900
2002/03	171	236	595	1,002
2003/04	180	1,043		1,223
2004/05	169	686		855
2005/06	148	752		900
2006/07	145	670		815
2007/08	122	744		866
2008/09	95	633		728
2009/10	69	665		734
2010/11	74	681		755
2011/12	43	619		662
2012/13	41	532		573
2013/14	26	392		418

[60] Fiskiveiðieftirlitið 2014.

[61] 2013/14 from Teyggjan 2014. Rest supplied by Ministry of Fisheries (pers. com.).

[62] VG5 used to include a subgroup called 5D, 'Other', which was reserved for leisure fishing vessels. 5D was merged with 5B in 2003/2004 so that 5B came to consist of part-time and leisure fishing vessels.

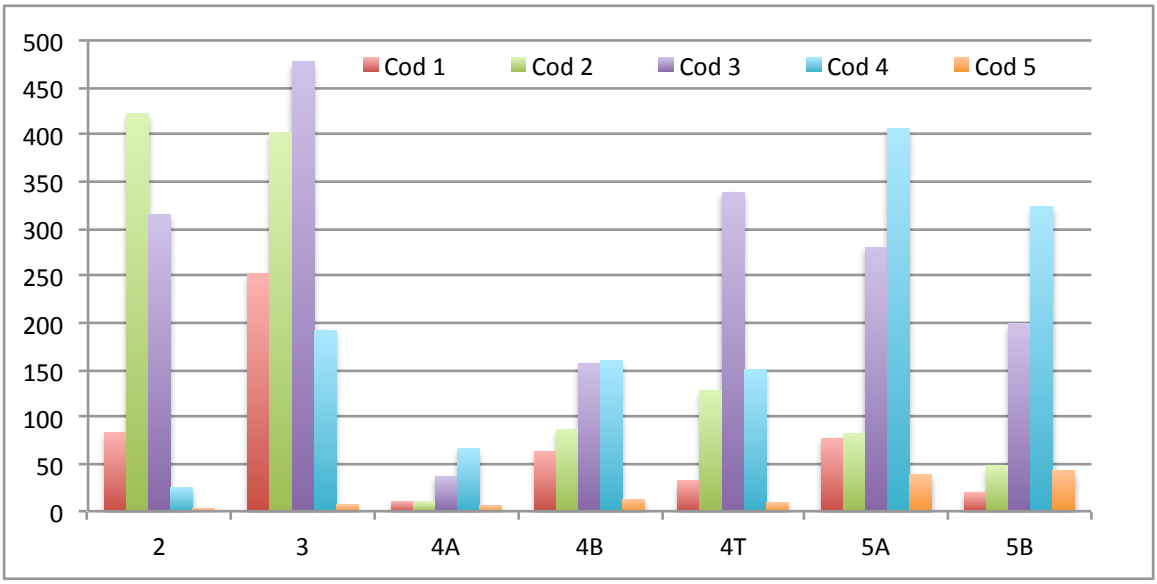


Figure 3.2 Cod catches in tonnes and size in 2013[63]
Cod groupings: Cod 1: > 7 kg, cod 2: 4-7 kg, cod 3: 2-4 kg, cod 4: 1-2 kg, and cod 5: < 1 kg[64]

[63] Fiskiveiðieftirlitið 2014

[64] Fiskamarknaður Føroya 2007

4 Spatial Access Priority Mapping

The last chapter demonstrated direct benefits of area closures on fish stocks in the Faroe Islands. In order to improve and potentially expand the use of area-time closures, it is important to involve stakeholders to benefit from their expertise and to keep them informed and engaged, all of which are necessary if such measures are to be successful (IUCN-WCPA 2008). Experience has also shown that compliance with changing fisheries management plans is better achieved by increasing understanding of the changes among stakeholders, and if they gain a sense of inclusion in the process and ownership of the outcome (Innes 1996). Involving fishermen is especially important given the apparent stakeholder power they have in the Faroe Islands. The consequences of not involving fishermen in the initial 1994 reform of the system resulted in failure and rejection of the system (Løkkegaard et al 2004).

An excellent way of getting fishermen involved and increase their satisfaction with MPAs is by mapping their Spatial Access Priorities (SAP) and then to compare these with ecological criteria when evaluating which areas should be protected. “When two sites are of equal value ecologically, then socioeconomic criteria should dominate the choice of which should be protected.” (Roberts et al 2003 p 199). Including socioeconomic criteria when planning where to place MPAs can reduce the adverse effects of MPAs on fishermen. Therefore the SAPs of VG5 was surveyed in order to create a Spatial Access Priority Map (SAPM). Small coastal vessels are not required to install Vessel Monitoring Systems (VMS) or other tracking devices, nor are they required to keep logbooks so their SAP cannot be inferred in other ways. Furthermore, VMS and logbooks do not necessarily infer SAP (Yates 2013), although VMS has been used to estimate fishing-effort distribution and inform placement of MPAs (Lee et al 2010). Fishermen’s opinions on management and other matters were surveyed concurrently in a quantitative schedule (chapter five).

4.1 Survey

The purpose of the survey was to establish the SAP of VG5 as a whole and SAP of subgroups 5A and 5B in order to see if there exists a difference between full-time fishermen and part-time/leisure fishermen. The results can be used to align the protection of fish stocks and ecosystems with the SAPs of fishermen when designing MPAs. The survey was conducted in face-to-face interviews in respondents' homes over 20 days in January and February 2014, in the Faroe Islands. Between one and four respondents were interviewed per day and interviews lasted between 30 minutes and three hours, including the quantitative schedule, which in most cases took longer than the SAPM. Participation was anonymous and all respondents were made aware of that. The basic method was simple: individual respondents were asked about their SAP so that it could be aggregated to represent the SAP of VG5, 5A and 5B. SAP was recorded using ArcGIS.

4.1.1 Method

Respondents were presented with a map of the Faroe Islands in ArcGIS. The map displayed ocean depths to help respondents navigate the map, which could be disabled if respondents found them confusing or distracting. Respondents were asked to point out which fishing grounds were of highest priority to them and told that priority did not necessarily translate into how much time they spent in a given area. Respondents were told to think of the task in terms of how much they would miss fishing in that area if access were to be restricted.

Each respondent was told he could choose as many and as large areas as he liked but had to allocate a percentage value to each area; that he had a total percentage allocation of 100% available to him; and that the percentage allocation to each area would be divided by the size of the area. Respondents were given an example of how to allocate the percentages, e.g. two areas of 50%, 10 areas of 10% or five areas of 20%. Area size was divided by percentage allocation in order to incentivise respondents to be precise and to have a correlation between area size and percentage allocation, so that a large area with a small percentage allocation did not indicate the same SAP as a small area with the same percentage allocation.

Respondents would outline an area on the programme map and the researcher would draw the area up as the respondent indicated by creating polygons. The researcher found the mapping process to be more accurate when the researcher drew polygons, not respondents, due to the technical nature of drawing maps in ArcGIS. Respondents would confirm the accuracy of each polygon or give instructions relating to potential amendments. Most respondents found the mapping part of the task relatively easy as they were already familiar with thinking about fishing grounds in the context of maps. When placing polygons, many said that the area was X hours of sailing time away from area Y. Therefore many took advantage of the distance-measuring tool in ArcGIS. The right distance was found by multiplying average speed of their vessel with sailing time.

After placing a polygon, respondents gave it a percentage allocation that was entered into ArcGIS, and respondents were informed of their remaining percentages. This process was repeated until 100% had been allocated. Once the task had been completed, respondents were shown all polygons and percentage allocations from up close and afar on the map. Respondents were encouraged to amend polygon size, shape, placement, or percentage allocation if they had changed their minds or made a mistake, and then asked to confirm their choices, whether amendments had been made or not. When all data had been entered, the programme measured the size of the polygons and automatically calculated SAP per km^2 of each polygon based on percentage allocations. Respondents were also asked which species they harvested in each polygon. Some variability in species was expected but almost all polygons indicated cod, and therefore this data was not used for anything further. Other species included haddock, saithe, halibut and lobster.

Based on the above, the researcher is confident that placement of polygons accurately reflects the areas that respondents intended them to and that percentage allocations accurately reflect SAP. There are however always uncertainties. Even though respondents were informed that the purpose of the task was to align the placement of MPAs with their SAP and that the data would be aggregated, some respondents may not have wanted to disclose their most valued fishing grounds in fear of losing competitive advantages. Since the information has been aggregated, this is an

unnecessary fear and because this was explained to each respondent, the author believes that most were sincere in completing the task. Some respondents joked that they were not going to disclose the best areas but then previous points would be reiterated. No verification of the final results has been attempted. As mentioned, vessels in VG5 are not required to write logbooks or have VMS on board so there is no data to verify the results against.

4.1.1.1 Sample

The study sample was a stratified random sample. The stratum chosen to divide the group was fishing license 5A and 5B, and only ports with a minimum of four registered vessels in VG5 were targeted, so there was an element of cluster sampling too. A list of vessel names found on the Fisheries Directorate's statistical website was used as a sampling frame.[65] The list included vessel names, licence holder, whether person or company, an address, and was also divided into regions. With this information, it was easy to find potential respondents on the telephone directory and contact them.

The sampling procedure was the following: the researcher would go to a region on the list (see figure 4.1) and call potential respondents on the list from that region, starting with those holding licence 5A, as it was deemed more important to survey full-time fishermen, and ask if they were willing to participate in the survey. The purpose and tasks were explained. Most agreed to participate, and the researcher would then go to their house to conduct the survey. Once 5A had been eliminated from the list, either by participation, decline or non-contact, the calling order was alphabetical. In cases of non-contact or decline, the next potential respondent was called. Cases of non-contact or decline were not recorded considering the circumstances in which respondents were contacted.

The method of contact may have biased the sample towards respondents who are not full-time fishermen since these are perhaps more likely to be at home during the day and afternoon when much of the sampling occurred. To eliminate that type of bias, the researcher would vary the sampling time to include evenings and weekends. The sample may also be biased in the sense that respondents who were either very

[65] Teyggjan 2014.

dissatisfied with fisheries management may have been more willing to participate in the survey. Equally, the opposite may also have been true – potential respondents who were very dissatisfied may have refused to participate, perhaps out of resentment towards anyone perceived as 'management'.

The target was to get a sample relative to the number of vessels in each region (see figure 4.1 for map of regions and homeports). At the beginning of the survey, a certain number of days were dedicated to each region based on the assumption that three respondents could be interviewed each day, which would lead to a minimum of 10% of licence holders in each region being sampled. There were however some obstacles in achieving this. It proved more difficult to get in touch with respondents in some regions, e.g. *Eysturoy*, and the weather was also extraordinarily bad in the sampling period and 6 whole survey days were lost due to unsafe driving conditions, forcing revisions in the survey schedule.

As table 4.1 shows, the 10% minimum sampling share was achieved in all regions but *Eysturoy*. *Eysturoy* is also the region with by far the most licence holders, so although the sampling share is just below 10%, the region is well represented in pure numbers. Looking at table 4.1, it may appear as if a disproportionate amount of time was spent sampling in some regions, e.g. *Vágur* or *Suðuroy*, but the reason for this was simply that more interviews were completed on some days than on others. Some days it was difficult to reach respondents and therefore maybe only one interview was completed. Other days, interviews took longer, leaving less time for further interviews. The islands are geographically isolated and so therefore even if the daily target of three interviews was reached, there were days with time for more interviews.

Figure 4.1 shows the 21 homeports of respondents. As stated, only ports with a minimum of four vessels registered in VG5 were targeted for the survey. Vessels in VG5 are registered to 63 ports but only 31 met the previous requirement, and as figure 4.1 shows, the whole of the Faroe Islands are still relatively well represented geographically. By sampling ports with a minimum of four vessels only ports that represented at least 1% of the VG5 fleet were included.[66] This sample selection is based

[66] There were 418 vessels in VG5 in 2013/2014, therefore 1% is 4.18.

on the assumption that fishermen favour fishing grounds close to their homeports, and therefore including respondents from ports with few fishermen could have biased the SAPM towards fishing grounds close to sparsely populated areas, making the results less representative geographically.

Even though regions are not entirely equally represented, a mean of 13.9% is satisfactory, given that the target was 10% of VG5. As table 4.2 shows, 418 vessels were registered in VG5 in the 2013/2014 fishing year. 26 vessels were registered in 5A and 392 in 5B. The sample share for 5A was high, 42.3%. 11.5% of the 392 registered vessels in 5B were included in the survey. These numbers are satisfactory, especially given that so many sampling days were lost to poor weather conditions. A SAPM survey conducted in Northern Ireland had 103 respondents from a fleet of 357, of which 224 vessels are registered as active (Yates 2013), making the study sample 29%/46% and much higher than in this survey. Yates' study was also conducted over a year (pers. com.) and in connection with a PhD project (2013). This survey was conducted over a much shorter time period and naturally could not be as exhaustive.

Table 4.1 Number of vessels sampled according to region

Region	Sampled, 5A	Sampled, 5B	Sampled in region	Vessels in region	Sample share
Suðurstreymoy	1	6	7	56	12.5%
Eysturoy	7	5	12	127	9.5%
Sandoy	0	3	3	27	11.1%
Suðuroy	1	13	14	81	17.3%
Vágur	1	8	9	48	18.8%
Norðurstreymoy	0	4	4	28	14.3%
Norðoyggjar	1	6	7	51	13.7%
Total	**11**	**45**	**56**	**419**[67]	**Mean: 13.9%**

Table 4.2 Sampled percentage share of vessels

	Number of vessels	Vessels in study	Sample share
5A	26	11	42.3 %
5B	392	45	11.5 %
VG5	418	56	13.4 %

[67] The list of fishing licences allocated to VG5 lists 418 vessels. The regional lists give a total of 419. It is possible that one vessel is listed in two harbours or some other mistake has occurred. Both the complete list and the regional lists have been downloaded in their entirety from Teyggjan 2014.

Figure 4.1 Names of regions in the study area and homeports of respondents (red dots).

4.1.1.2 Geographic Information System

Data from respondents had to be analysed after collection in order to create a 'heat-map' of fishermen's SAP. ArcGIS calculated the SAP per km^2 of each polygon by dividing percentage allocation and size in the following way: Fisherman1Area1 = 20%/20km^2 = 1 SAP per km^2. Several polygons overlapped and therefore the total value of overlapping polygons had to be summed to find the SAP of each km^2. To do so, all overlapping polygons were sliced along the lines of the original polygons to create a multitude of new, smaller polygons. Once sliced, no polygons overlapped and the SAP of each polygon was summed based on the remaining SAP per km^2. ArcGIS was coded to do all slicing, dividing and summing of SAP automatically.[68]

Once SAP from polygons had been summed, ArcGIS was programmed to represent the SAP values as a heat-map in what ArcGIS calls 'graduated colours'. As maps legends show (figure 4.2), the SAP per km^2 in each of the three maps range quite widely, so the values had to be classified – that is, the range of colour saturation had to be defined – in order to create a meaningful heat-map. ArcGIS offers several types of classifications. The classification range can be done manually by asking the programme to find the 'natural breaks' in values and classifying them accordingly into 30 classes. These 30 classes had the best balance between the extremely high and low values and therefore best represented how some areas have high SAP, some have medium SAP and some have low SAP. Other classifications meant that all areas were either dark or light, and thus left out the variation, and reducing the number of classes had the same effect. This representation does mean that the saturations on the maps do not correspond to the same SAP, e.g. areas marked with the darkest blue actually has a SAP that is 188 times higher than the darkest green, while SAP of the darkest blue category extends as far as the darkest purple extends. This does not reduce the validity of the results, but is important to keep in mind.

[68] ArcGIS was coded to calculate the value of polygons irrespective of size, so the value of polygons smaller than 1km^2 was calculated correctly and according to its actual size. There was no minimum size requirement.

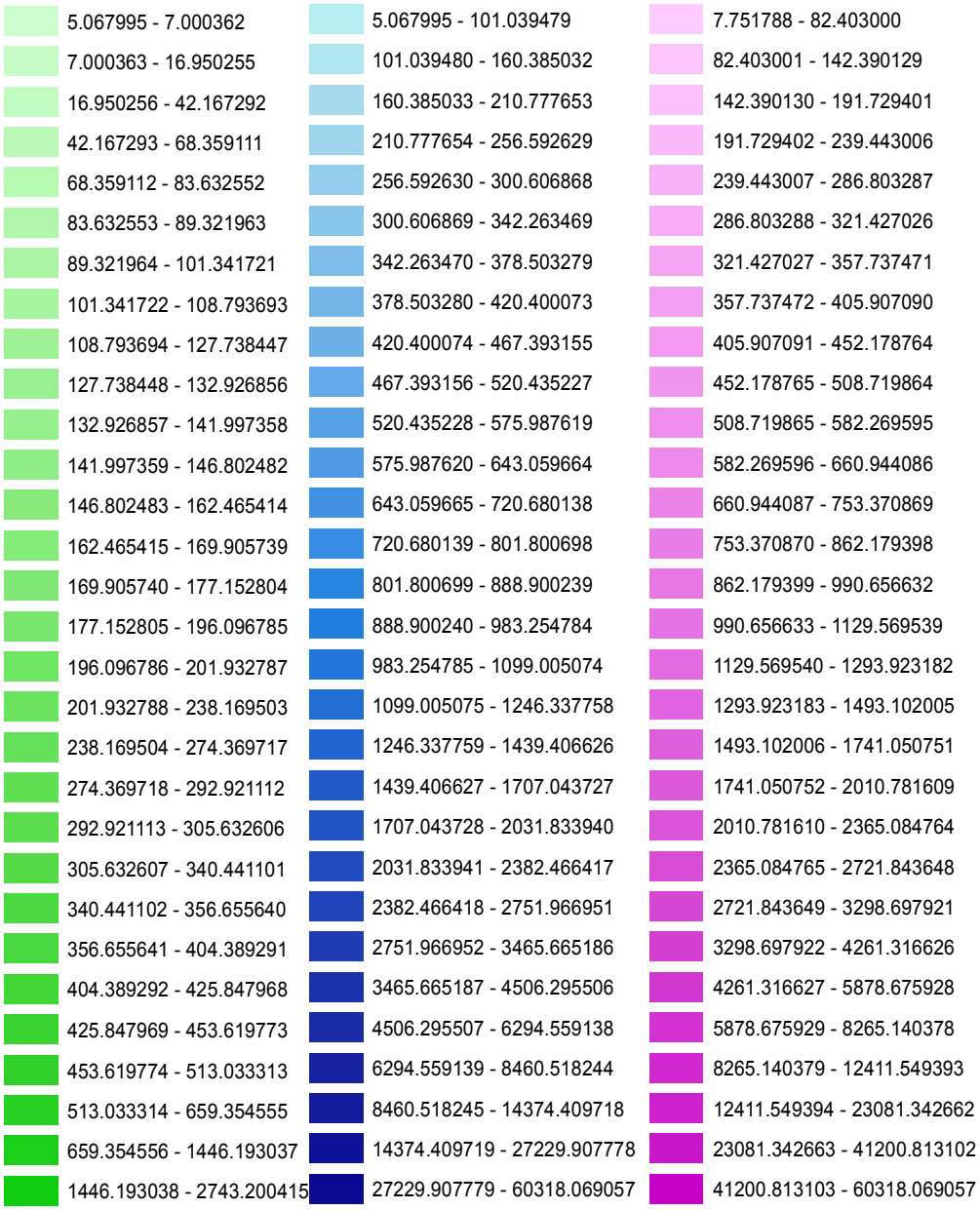


Figure 4.2 Legends for spatial access priority maps for 5A (green), SAPM VG5 (blue) and 5B (purple).

4.1.2 Results

SAPM for VG5 showed that VG5 as a whole placed a high priority on fishing close to land (fig. 4.3). In many cases, fjords were allocated a high SAP but some fjords had a small SAP and some none at all. Respondents generally agreed on which fishing grounds had a high SAP. Many respondents allocated a high SAP to the ocean north and east of the islands. There were many small but highly saturated polygons because only one or a few respondents allocated a *high* SAP to these areas. This point is best illustrated in the areas south of *Suðuroy*, the southern-most island, and west of *Mykines*, the western-most island.

The SAPM for 5A was generally further away from land SAPM for VG5 (fig. 4.4). Few fjords had a high SAP and there were many areas away from land with high SAP. Many full-time fishermen placed a high priority on the north, both in the number of polygons and in SAP allocations. Also for 5A, the area west of *Mykines* had a high SAP but only in small and precise polygons. The same pattern was visible in the ocean north of *Suðuroy*, although no 5A respondents had homeports in *Sandoy* or *Suðuroy* (table 4.1). The fact that no 5A respondents had homeports in *Suðuroy* is evident on this map because no polygons were placed in the vicinity of the island, excluding the north.

The SAPM for 5B (fig. 4.5) was similar to SAPM for VG5. The main conclusion to be drawn from fig. 4.5 is that fishermen in 5B placed a high priority on fishing grounds close to land. Placing SAPM for 5A on top of 5B (fig. 4.6) confirms that 5B prioritised fishing grounds close to land more than 5A but also shows that 5B's priorities extended almost as far out as 5A.

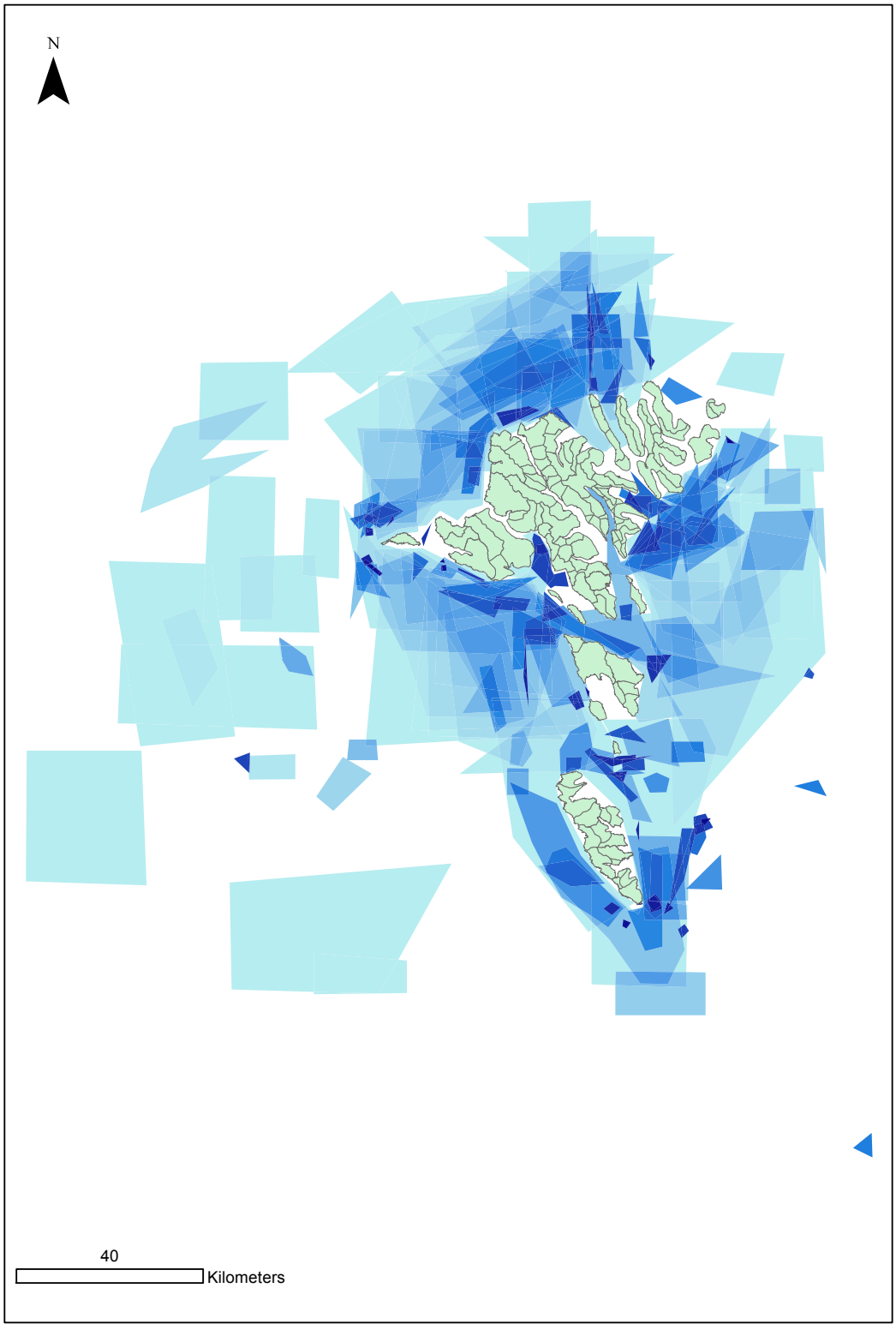


Figure 4.3 Spatial access priority map for VG5.

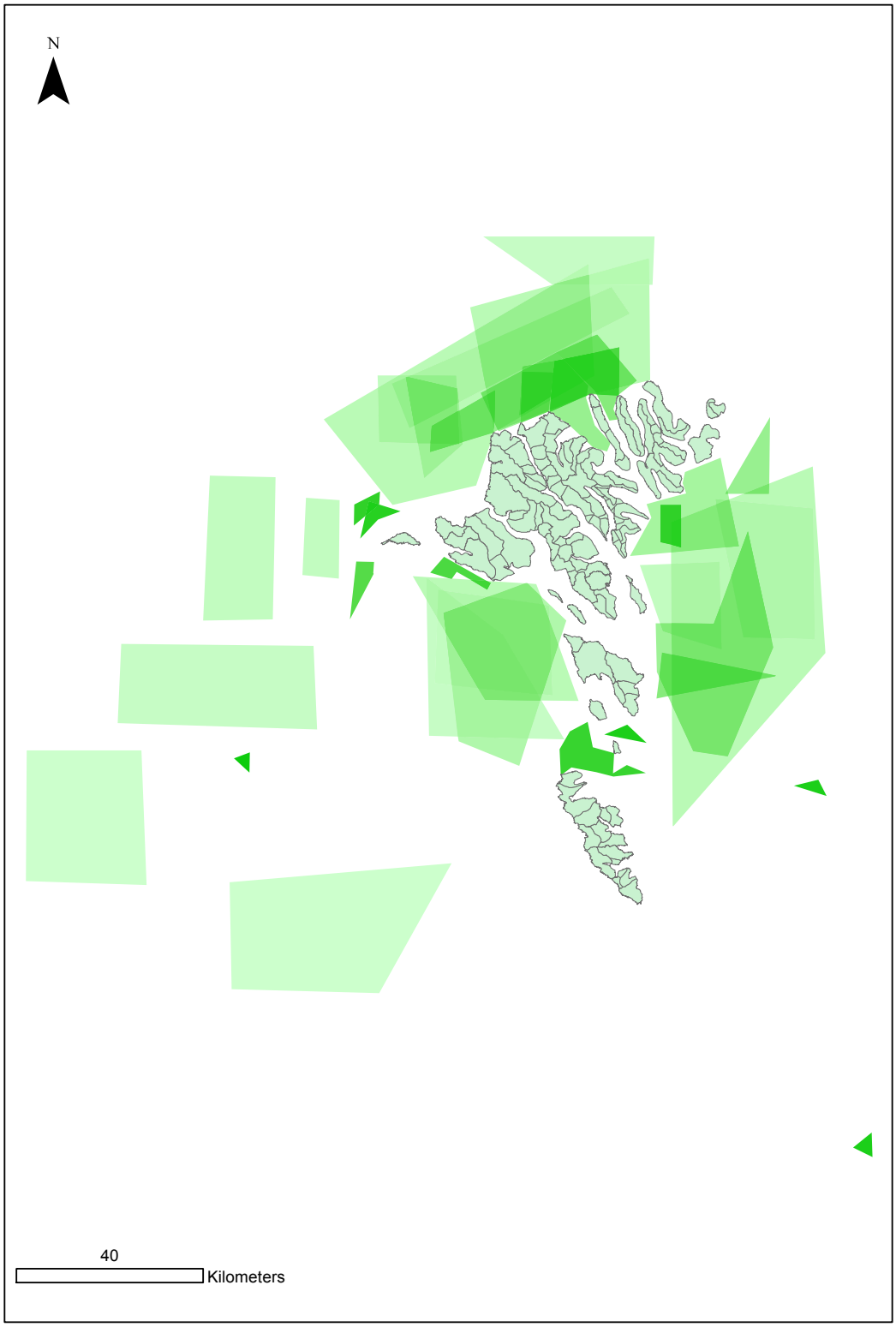


Figure 4.4 Spatial access priority map for 5A.

Figure 4.5 Spatial access priority map for 5B.

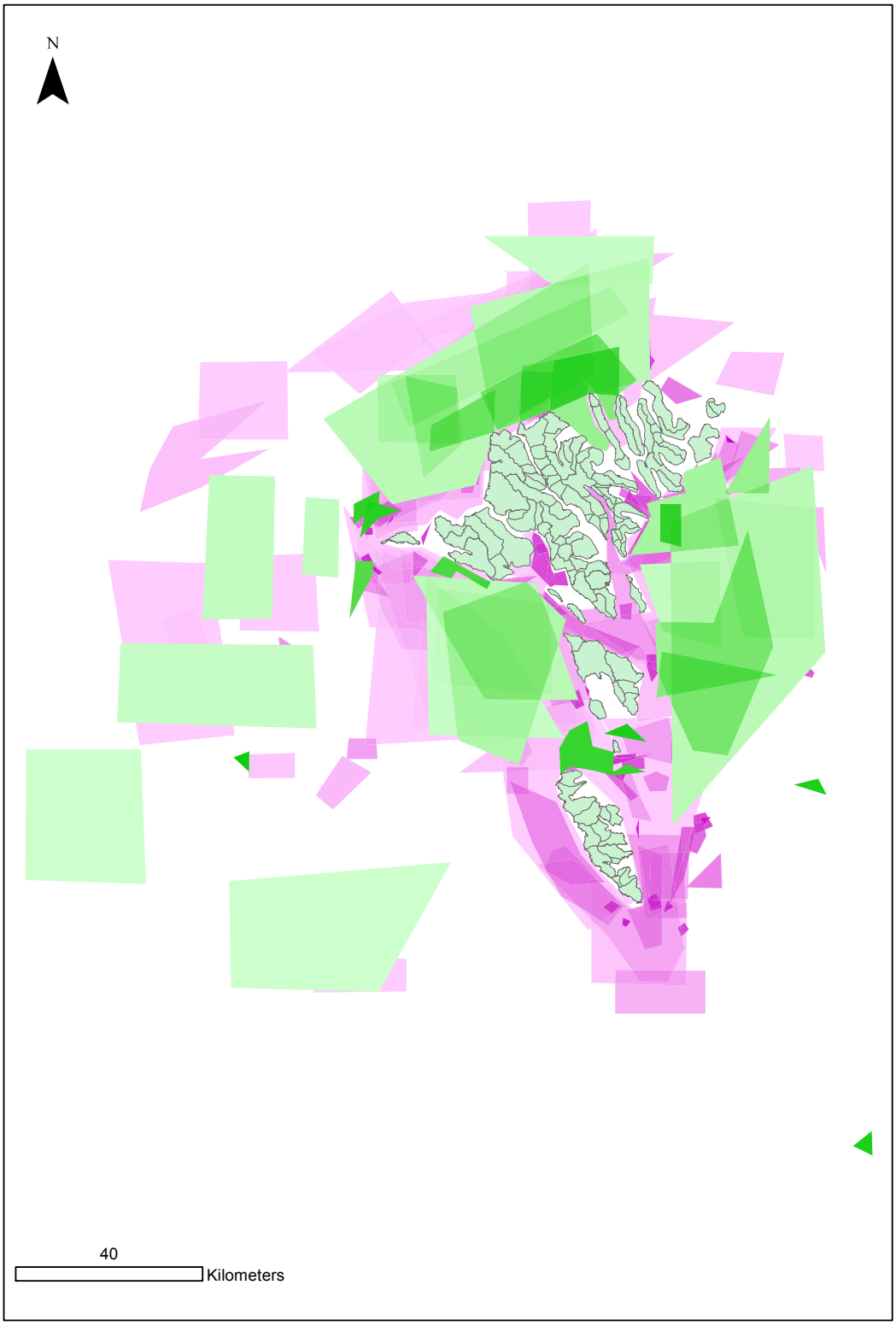


Figure 4.6 SAPM for 5B and 5A. 5A SAP is simply placed on top of 5B SAP.

5 Fishermen

A quantitative semi-structured schedule was conducted in concurrence with the SAPM. Questions focused on fishermen's opinions of current and future fisheries management, opinions on MPAs and data on themselves, e.g. income, purpose of fishing, if they are full-time fishermen, to mention a few.

5.1 Method

A schedule was created using the online survey tool SoGoSurvey. A small pilot study was conducted prior to launching the survey to evaluate clarity of questions and appropriateness of language. The latter was important because if fishermen did not understand or were confused by the language, it could make them feel uneasy or uncomfortable and become hesitant about answering truthfully, both in the schedule and the SAPM, which was usually conducted after the schedule. The pilot study was conducted in two different ways: either the questionnaire was emailed to respondents and they were interviewed upon completion, or in cases where respondents had no email address, the process was completed over the telephone and questions were noted that seemed to be unclear or cause respondents trouble. A few amendments were made to the schedule after the pilot study. The schedule had 50 questions. Many questions returned nominal values but many questions were also open-ended. Only some questions were analysed statistically.

5.1.1 Study sample and sample size

Subgroups 5A and 5B were surveyed separately with identical schedules to have separate data on full-time and part-time fishermen, so data from both subgroups could be compared and contrasted, although it was not entirely clear from the outset how accurate the division of fishermen was. The downside was that some questions may have benefited from having a single result but the difference between the two groups justified this separation. Some results were later combined for analytical purposes. As in the SAPM, 11 respondents were surveyed from 5A but only 44 respondents were surveyed from 5B because of internet connection problems with one respondent. This

reduced the sample share in 5B from 11.5% to 11.2%, but it was still above the 10% target (table 5.1). For some questions, no response was recorded. In most cases it was because the respondent did not have an answer to the question. In a few instances it appears as if the survey tool has not recorded the answer, either due to researcher error or problems with the mobile internet connection.

Table 5.1 Respondents in the quantitative survey of fishermen in 5A and 5B.

	Number of vessels	Survey respondents	Sample share
5A	26	11	42.3 %
5B	392	44	11.2 %

5.2 Results

The results have been organised into sections according to issue areas. The first section is about the personal circumstances of fishermen, and includes income, satisfaction with income and also examines the accuracy of dividing VG5 into subgroups 5A and 5B as supposed full-time and part-time fishermen (5.2.1). The second section deals with current management and future management options (section 5.2.2), while the third deals with fishermen's opinions on the use of MPAs in fisheries management and other issues relating to spatial management (section 5.2.3).

5.2.1 Fishermen

The subgroups in VG5 supposedly reflect a separation of full-time and part-time/leisure fishermen. The survey revealed that 23% (n 10) of respondents from 5B classified themselves as full-time fishermen, while 9% (n 1) of the respondents in 5A claimed not to be full-time fishermen (figure 5.1). The majority of respondents in 5B said they were not full-time fishermen (77%, n 34), and the vast majority in 5A claimed to be full-time fishermen (91%, n 10). Two respondents in 5A said to have one additional full-time fisherman worked on the boat and five said that two additional full-time fishermen working on the boat, giving a total of 12 additional full-time fishermen. 13 respondents in 5B reported to have additional fishermen. Eight had one additional fishermen, two had two additional, one had three, one had four, and one had five, meaning 24 additional full-time fishermen worked on board of vessels in 5B, and that 20 vessels in

VG5 employed 36 additional full-time fishermen. These numbers do not include anyone who might be working for vessels on land.

The mean age of the sample as a whole was 65.6 (i.e. born in year 1948.35 – only year of birth was recorded, not age, and therefore the mean age is expressed somewhat strangely) (table 5.2). 46% (n 25) of respondents were under the retirement age of 67 and 53% (n 29) were over. The mean age in 5B was 68 (i.e. born in 1946). 37.2% (n 16) of respondents in 5B were under the retirement age of 67 and 62.8% (n 27) were over 67. The mean age in 5A was 56.6 (i.e. born in year 1957.4). 81.8% (n 9) of respondents in 5A were under the retirement age and 18.2% (n 2) were over. The population mean age was between 62.7-68.2, 51.3-61.9, and 64.8-71.2 for fishermen as a whole, 5A and 5B respectively. The range in 5B was much larger than in 5A, which is reflected in the standard deviation. However, the coefficient of variation for the two groups is the same.

Table 5.2 Age tendencies and dispersion in fishermen.

Age	Sample	5A	5B
Mean	65.6	56.6	68
Standard deviation	10.8	8.8	10.4
Coefficient of variation	0.16	0.15	0.15
Mode	69	47	71
Median	67.5	59	69
Range	54	23	54
Population mean	62.7-68.2	51.3-61.9	64.8-71.2
Standard error	1.47	2.65	1.59
Confidence level	95%	95%	95%
Cases (n)	54	11	43
Missing cases	1	0	1

Some respondents from 5B who said they were full-time fishermen stated that their fishing licences had recently been moved from subgroup 5A to 5B. According to respondents, in order to qualify for a 5A licence they used to have to harvest for a minimum of DKK 80,000 and then 150,000. This was recently changed to DKK 400,000 and meant that many fishermen no longer qualify for a 5A licence and lose the privileges that come with a 5A licence. The move from 5A to 5B meant that these fishermen no longer have rights to minimum income allowance because they are not classified as full-time fishermen in the system. Many respondents reported to rely on

minimum income allowance in the winter months when small coastal vessels are unable to harvest due to weather. The change from DKK 80,000 to 400,000 left respondents puzzled and dissatisfied. Fisherman 25 said: "[Managers] just changed it without any explanation." Several respondents claimed that it is impossible to reach a harvest value of DKK 400,000 when using jigs.

Many respondents felt that the change was unfair. They pointed out that all fishermen pay towards the general Employment Fund and the Fishermen's Fund when they land their catches but fishermen in 5B do not receive anything from these funds, only fishermen in 5A. Fisherman 40 said:

> *The minimum income allowance we have had for many years was changed 2-3 years ago… Now you have to fish for DKK 400,000. It is not possible with jigs… I have retired now [so I receive retirement allowance] but some receive nothing at all from the Employment Fund[69] or from the Fishermen's Fund[70] but they still have to pay towards them. [We] are being punished.*

Respondents who had moved from 5A to 5B were also dissatisfied that they had lost their individual fishing days. Vessels in 5A are allocated individual fishing days but fishing days are collective in 5B and all fishing has to stop once the collective set of fishing days have been used. Fisherman 18 said the potential of not being able to harvest all year long and perhaps only for a few days a year leaves him in a desperate situation:

> *I used to be in 5A, which gave me a right to fish all year and plenty of days but recently an income limit of DKK 400,000 was set and because I use jigs I never get near that amount. So I lost my 5A licence and I no longer receive minimum income allowance. If the fish return, many more men will start fishing again, and there are so few days and so many boats [in 5B] that there*

[69] F: ALS – Arbeiðsloysisskipanin

[70] F: Trygdargrunnurin

will be no more than 10-12 days for each. Then I will have nothing, even though I have been a fisherman for 14 years. (Fisherman 18)

Many fishermen had low incomes in 2013 (figure 5.2). Few respondents said they earned more than DKK 200,000 annually (11%, n 5). This means that not all of the 23% in 5B who claimed to be full-time fishermen earned more than DKK 200,000. 43% (n 19) of respondents in 5B said they earned nothing at all while 27% (n 12) said they earned less than DKK 50,000. Things were different for 5A. 27% (n 3) earned DKK 500,000+ and 72% (n 8) earned more than DKK 200,000. 18% (n 2) of respondents in 5A earn less than DKK 200,000, one (9%) of whom is a full-time fisherman. The difference in income between the two is further highlighted in table 5.3. The mode in 5A was DKK 500,000+ and in 5B it was 0. The population mean was DKK 228,089-431,910 and 32,629-99,188 in 5A and 5B respectively with a confidence level of 95% and standard error of 50,955 and 16,639 respectively.

89% (n 39) of respondents in 5B said that fishing is not profitable enough, and although respondents in 5A in general had a higher income, 45% (n 5) in 5A also said that fishing is not profitable enough (figure 5.3). All respondents in 5A stated profit as their main purpose of fishing (100%, n 11) (figure 5.4), even though 9% (n 1) claimed not to be full-time fishermen. Only 23% of respondents in 5B were full-time fishermen but 55% (n 24) stated profit as their main purpose of fishing, 32% (n 14) listed profit and personal consumption, and 14% (n 6) listed personal consumption only.

Respondents were not shown or told about the data on the decline in fishermen but there was an overwhelming agreement among respondents that the number of fishermen is declining (figure 5.5). 100% (n 44) of respondents in 5B and 91% (n 10) of respondents in 5A said they were under the impression that the number of fishermen is declining. They were asked what they thought the reasons were for this decline. Half of respondents in 5B attributed the decline directly to a lack of fish and many also said it is not profitable enough to be a fisherman. A few respondents in 5A mentioned a lack of fish but tended to emphasize low fish prices, insecurity, and poor working conditions.

Soon there will be no small-scale fishermen left. It does not pay enough and young people today do not want to become fishermen, they want an education. It is a shame that it will die out but the conditions and profit is poor. The hourly wage is poor if you do the math. (Fisherman 31)

When asked if they were positive about the future, 66% (n 29) of respondents from 5B said no, compared to only 27% (n 3) in 5A (figure 5.6).

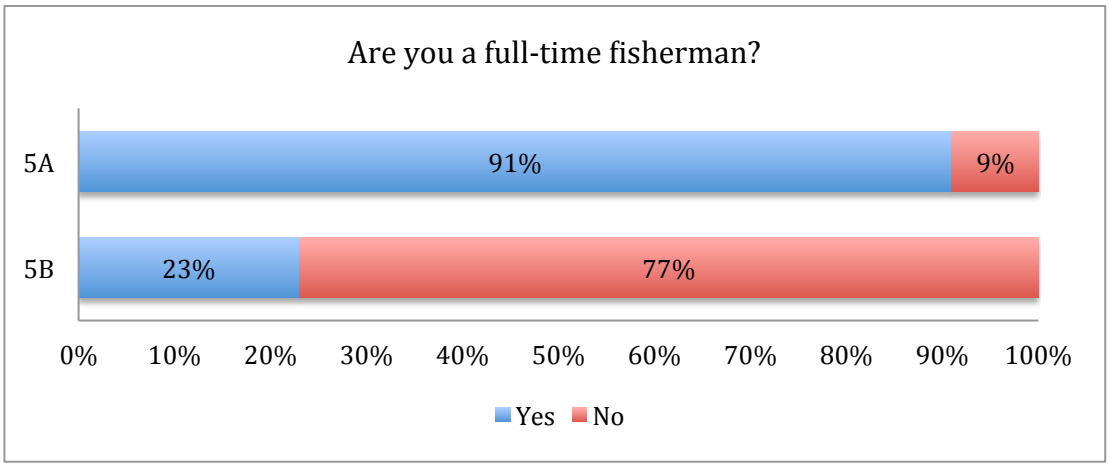


Figure 5.1 The proportion of full-time and non-full-time fishermen in 5A and 5B.

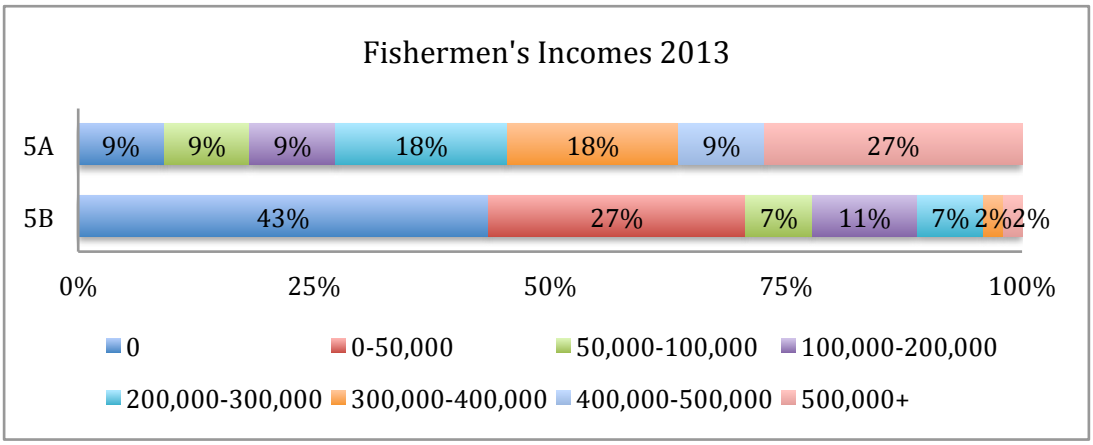


Figure 5.2 Fishermen's incomes categorised.

Table 5.3 Central tendencies and dispersion in fishermen's incomes.[71]

Income	5A	5B
Mean	330,000	65,909
Standard deviation	169,000	110,376
Coefficient of variation	0.51	1.67
Median	350,000	25,000
Mode	500,000	0
Range	500,000	500,000
Population mean	228,089-431,910	32,629-99,188
Standard error	50,955	16,639
Confidence level	95%	95%
Cases (n)	11	44

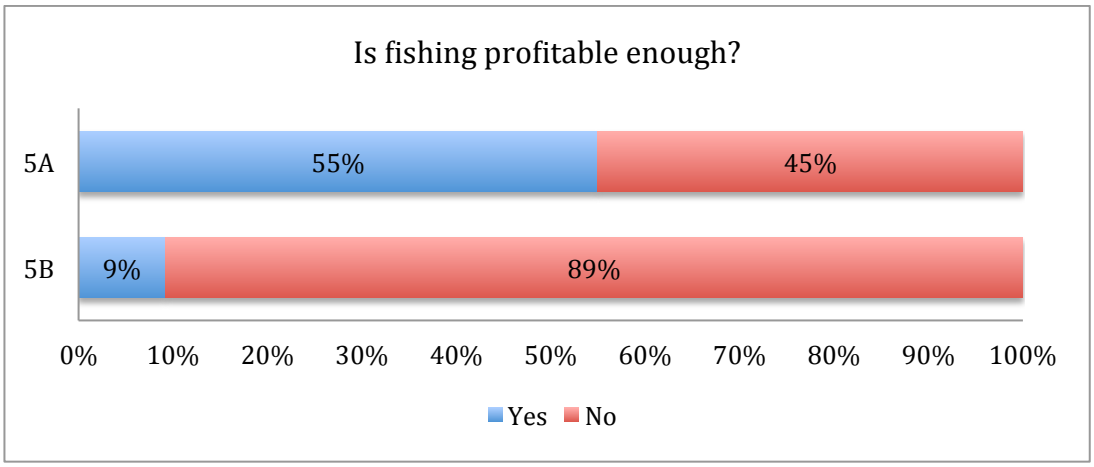
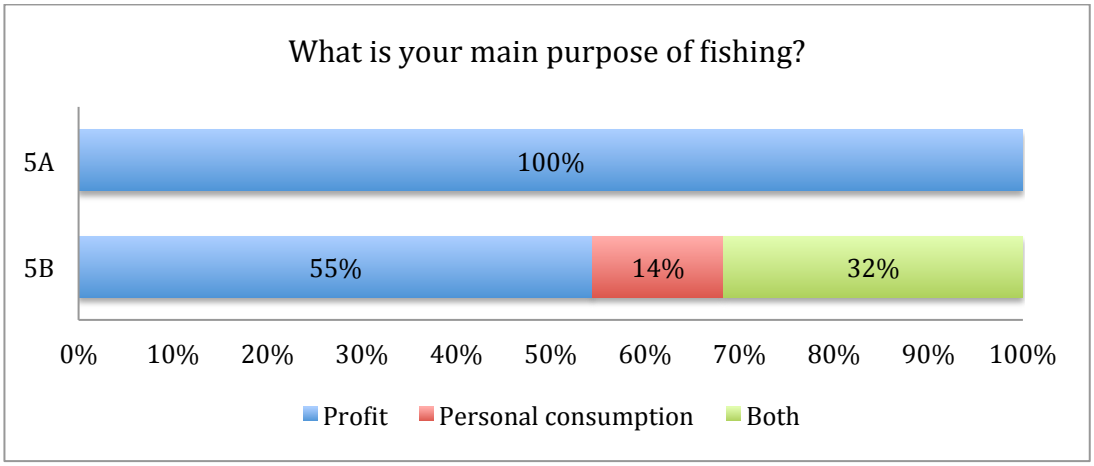


Figure 5.3 Is fishing profitable enough?



[71] Data were grouped so tendencies were calculated with midpoint values in each category (income bracket).

Figure 5.4 The main purpose of fishing for fishermen.

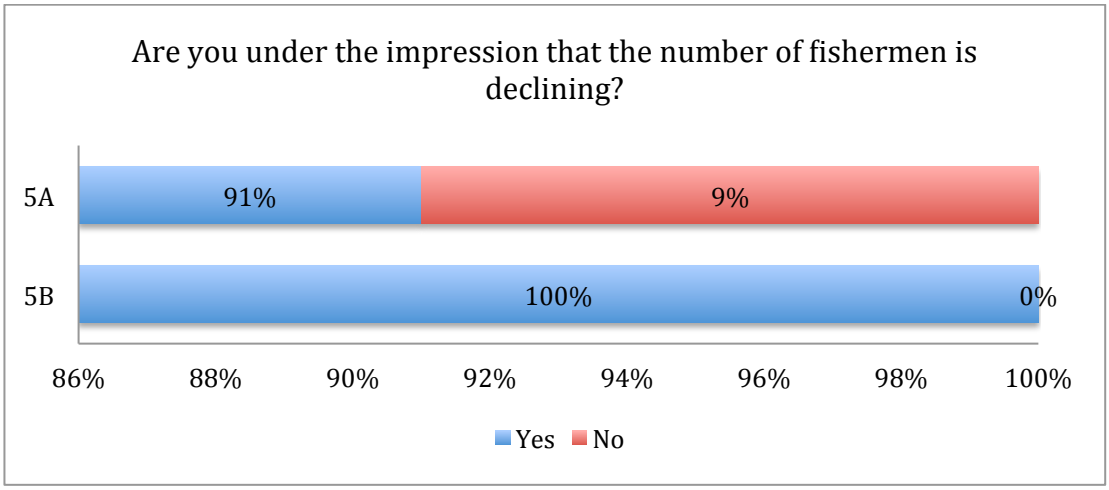


Figure 5.5 Is the number of fishermen declining?

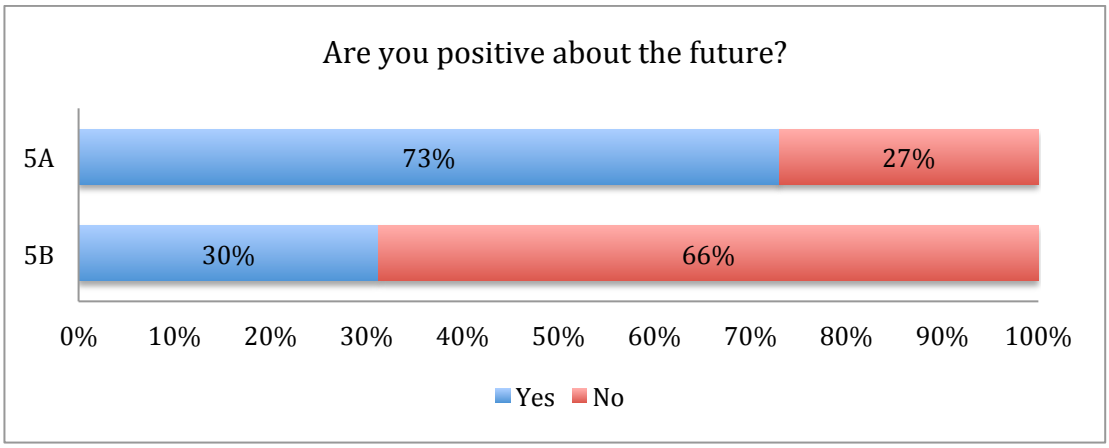


Figure 5.6 Are you positive about the future?

5.2.2 Management

Almost two-thirds of respondents in 5A were dissatisfied with the current fisheries management system (73%, n 8) (figure 5.7). Respondents from 5B were satisfied but by a majority of only 52% (n 23). 45% (n 20) of respondents in 5B said they were not satisfied. However, many satisfied respondents in 5B said they had "nothing to do with the system", they had "nothing against it", it was of "little importance because it is just a hobby", or management is "okay". Three of the 23 respondents in 5B who were satisfied with the current system were full-time fishermen. Respondents from 5B listed the following reasons for dissatisfaction:

- The changed conditions for receiving 5A licences and lost rights to minimum income allowance, as mentioned. Many felt these changes were so aggressive that they suspected management was purposefully trying to eliminate the small coastal fleet
- The Minister has too much power to allocate harvesting rights
- Lack of direction in management, randomness and arbitrary decision-making
- The system is too complex
- Fishermen's opinions are ignored
- Decrease in fishing days
- There should be free fishing for coastal vessels
- Concern that there are management plans to consolidate the fishing industry
- Harvesting licences that are allocated for free are sold for market value
- Trawlers harvest too close to land
- Low fish prices
- General overexploitation
- Uncertainty about the future[72]

Respondents from 5A who were satisfied with the current system tended to base satisfaction on comparison with the catch quota system, which they spoke negatively about and claimed it leads to discarding. Respondents from 5A listed several reasons for being dissatisfied. Repeats from 5B are listed with an asterisk:

- The decrease in fishing days *
- Lack of management interest in demersal fishing [73]
- The Minister has too much power to allocate harvesting rights [74] *
- It was unfair that VG5 did not receive mackerel quotas
- Poor treatment of small coastal fishermen who have historic rights to fish
- Large coastal vessels (long-liners) harvest too close to land, leaving little left for small coastal vessels

[72] In reference to expiration of harvesting licences in 2018.

[73] In light of the increase in pelagic fishing.

[74] In reference to a lawsuit filed against the Ministry of Fisheries by a small coastal vessel that was denied a mackerel quota. The fishermen's argument in the case is that the allocation was arbitrary.

- Area closures that apply to long-lines but not jigs
- Uncertainty about the future *

A few of the complaints were recurrent. Both groups mention the decrease in fishing days. Respondents in 5A were dissatisfied that they were unable to live off the number of fishing days they were allocated, saying they need at least 100 fishing days to make a living off fishing. 5A on average utilised 71.1 fishing days in 2013, according to themselves (range = 65) (see appendix III). 5B complained of the uncertainty of having collective fishing days and relying on the whole subgroup not fishing too much. It means they never know when they have to stop fishing and when days are up, they lose their income even if they are full-time fishermen, and they have no rights to minimum income allowance. 5B on average utilised 29.8 fishing days in 2013 (range = 100) (see appendix III).

5A was completely divided on whether or not the system produces good financial outcomes (figure 5.8). 45% of respondents said the system does not produce good financial outcomes and 45% said it does (n 5, 5, 1 did not know). 64% (n 28) of respondents in 5B said they did not think the system produces good financial outcomes and 30% (n 13, 3 did not know) said it does. Cited reasons for saying yes from both subgroups centred on the lack of discards in the system and that the system itself was good but that the resource was lacking. Cited reasons for saying no from both subgroups included lack of management; uncertainty in relation to fishing days and licences; lack of fishing days; lack of fish; too many administration fees when selling fish[75] and low prices, by many attributed to the fact that fish has to be landed in the Faroe Islands, which they felt keeps prices artificially low due to lack of competition.

Several respondents were dissatisfied that coastal fishermen who sell freshly caught fish – perhaps one or two days old – are offered the same price as trawlers and large long-liners whose fish is up to ten days old, as there is a big difference in quality. Fisherman 56 who had worked as a quality inspector at a processing plant said that trawlers would land fish that was yellow with rot. “We would get much more value out of the fish if fishing trips by law could be no longer than four days. Then we could make

[75] Some said 25% of sales value went into administration fees and payments to before-mentioned unemployment and fishermen’s funds. This has not been verified.

a high quality product out of the fish," he said. Fishermen 50 said: "We have struggled to move production [of first class products] to the Faroe Islands but we have not succeeded. Everything is shipped to Africa as [low quality products for non-human consumption]."

When asked if the system is socially just, 5B was divided (figure 5.9). 48% said yes and 48% said no (n 21, 21, 2 did not know). 55% (n 6) of respondents in 5A said no, the system is not socially just, and 46% said yes (n 5, 1 did not know). Many of those who said no felt it was unjust that the Minister has so much power to allocate fishing rights; that those who know the Minister have an advantage, and that there was a degree of corruption in the allocation of fishing rights. Others felt it was unjust that some had been allocated fishing rights worth a lot of money for free that they are free to sell, while others have to purchase expensive fishing rights in order to enter the fleet. Finally, many in 5B said it was unjust to change the conditions for acquiring a 5A licence and the benefits it brings, as previously mentioned.

When it came to the matter of managing the resource (figure 5.10), 59% (n 26) of respondents from 5B said that the resource was not managed well enough and 30% (n 13) said yes, it was managed well enough. 11% (n 5) of respondents in 5B did not know. 5A was again completely divided with 45% saying yes and 45% saying no (n 5, 5, 1 did not answer). On the matter of overexploitation, the majority of respondents said they did not believe stocks are overexploited – 82% (n 9) of respondents from 5A and 66% (n 29) from 5B. 18% (n 2) from 5A and 34% (n 15) from 5B said that stocks are overexploited (figure 5.11).

Respondents were asked about collaboration between fishermen and managers (figure 5.12). Of respondents from 5B, 35% (n 16) said it was poor, 48% (n 21) said it was tolerable and 11% (n 5) said it was good. 5% (n 2) did not answer/know. Of respondents from 5A, 45% (n 5) said it was poor, 36% (n 4) said it was tolerable and 18% (n 2) said it was good. The median in both groups was tolerable (value 2) while the mode for 5A was poor (value 1) and tolerable (value 2) for 5B (table 5.4). The population mean for 5A was 1.3-2.2 and 1.5-2 for 5B with standard errors of 0.237 and 0.102 respectively and a confidence level of 95%. Therefore fishermen in 5B are more satisfied with management collaboration but neither subgroup thinks it is good (value 3).

Repeated responses when asked what could be improved were that management did not listen to fishermen, it was difficult to get in touch with management or there was a lack of communication between fishermen and management. One fisherman said the system was a dictatorship where management decided everything and fishermen had no say. Several said fishermen and managers should collaborate more, some said they had tried to do so, and some said that there needed to be an increased understanding between the two sides. Alleged corruption in the allocation of fishing rights was mentioned by a few as a cause of distrust that hampered collaboration.

Fishermen were asked if they wanted reform (figure 5.13). 55% (n 6) of respondents from 5A said yes and 45% said no (n 5). 61% (n 27) of respondents from 5B said no, while 32% (n 27) said yes and 7% (n 3) did not know/answer. Respondents who were against reform said they were worried a catch quota system would be implemented, that the system is good as it is or that the problem is not with the system but with the resource. Most were in general supportive of the fishing day system. Reasons given for wanting reform included:

- To redistribute fishing rights for pelagic stocks to include small coastal vessels
- Reduce the number and size of MPAs or reform use of MPAs
- Reduce cod and haddock fishing mortality
- Re-evaluate system because it is too old, too inflexible or too complex
- Make fishing days binding[76]
- Reduce the conditions for receiving 5A licence, as mentioned
- Focus on value adding and long-term profits instead of quantity of catches
- Remove efficiency barriers

When asked which concrete changes they wanted in the event of reform, respondents who wanted reform said:

- Simplicity in the system
- Determine how much vessels on average harvest per fishing day

[76] I.e., if fishing rights are not utilised, e.g. a minimum number of fishing days, the rights are annulled.

- Auctioning of harvesting rights to reduce the number of vessels and to remove power from the Minister
- Trawlers are too close to land (12nm)
- Conduct research before implementing MPAs
- Remove possibility of selling fishing rights
- Implement a catch quota system

However, most respondents wanted to maintain the fishing day system - 73% (n 8) of respondents in 5A and 68% (n 30) in 5B (figure 5.14). 18% (n 8) of respondents in 5B and 9% (n 1) of 5A wanted free fishing for small coastal vessels. Only 7% (n 3) in 5B and 9% (n 1) in 5A wanted a catch quota implemented.

Table 5.5 is a cross tabulation of fishermen's satisfaction with fisheries management by income. Using the null hypothesis model, there would be no association between fishermen's satisfaction and income. If there is an association between low income and dissatisfaction with fisheries management, frequencies in the 'No' row, i.e. not satisfied, are expected to cluster in the former half of income brackets while frequencies in the 'Yes' row are expected to cluster in the latter half of income brackets. In fact 19% of the sample that is satisfied is in income bracket 1 and 17% of the sample that is dissatisfied is also in income bracket 1. In almost all of the following income brackets the two rows have relatively similar shares of the total sample. As such, there appears to be no association between income and satisfaction to the extent that income does not affect satisfaction with fisheries management. The significance of the chi square test proves this statement.

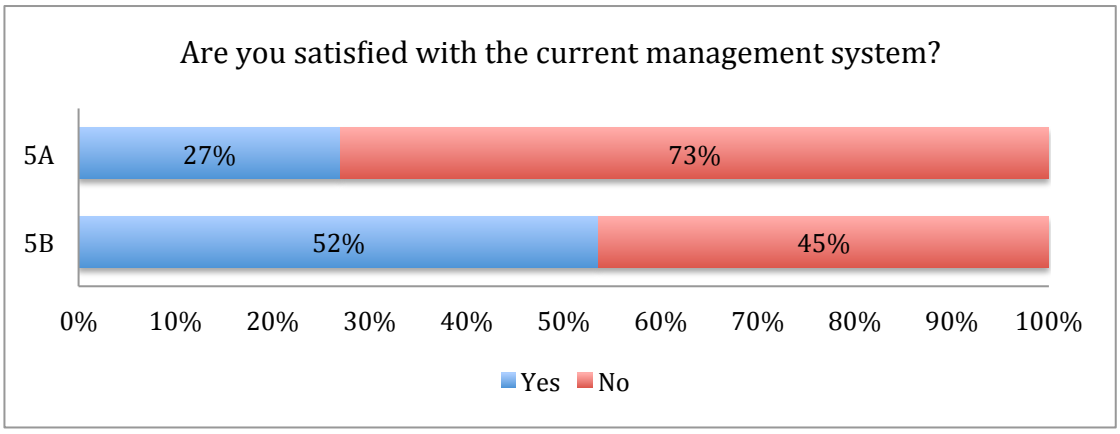


Figure 5.7 Are you satisfied with current fisheries management?

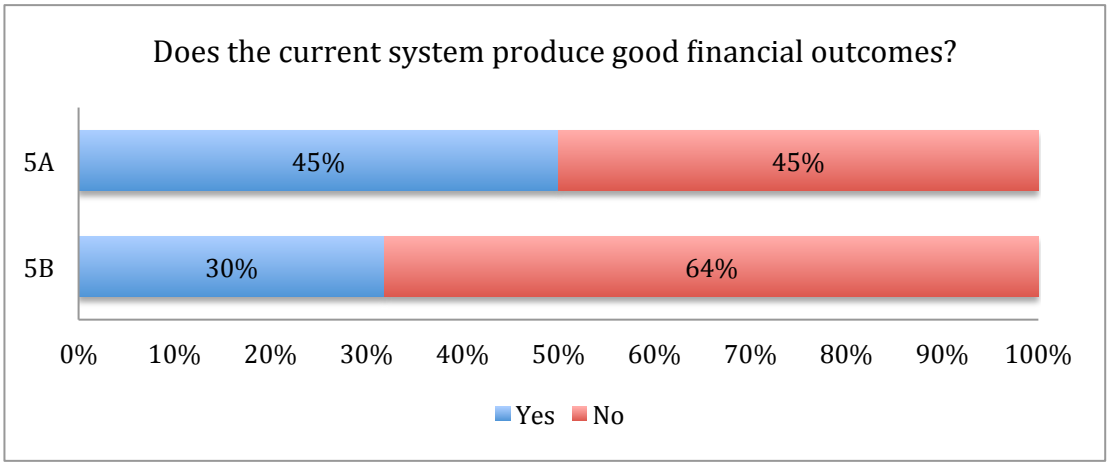


Figure 5.8 Does the current system produce good financial outcomes?

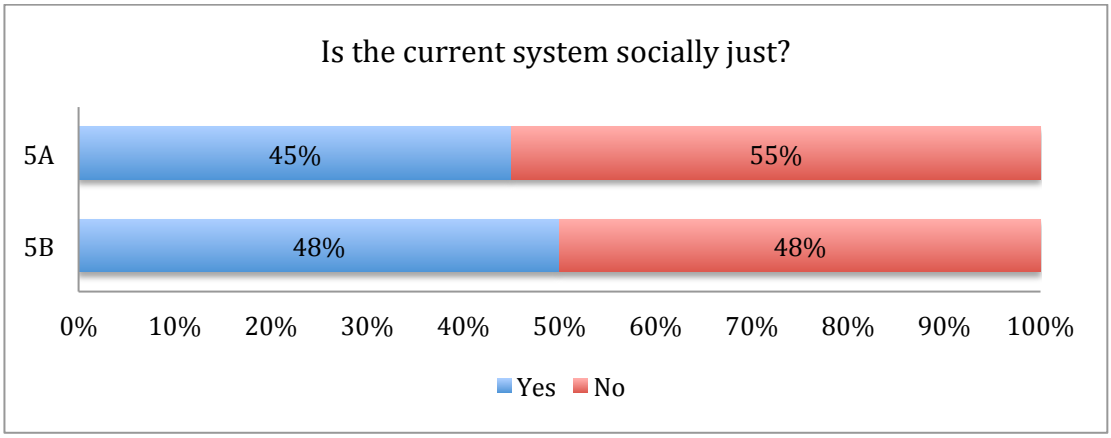


Figure 5.9 Is the current system socially just?

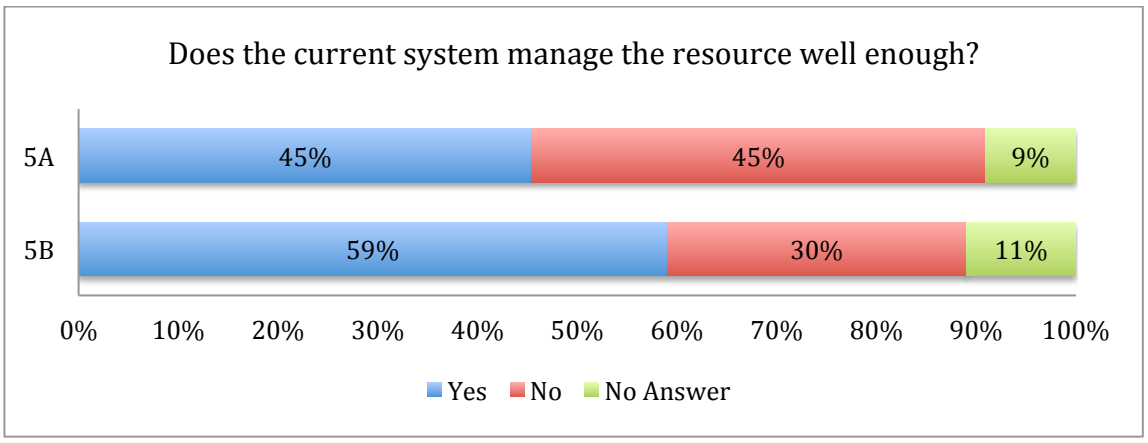


Figure 5.10 Does the current system manage the resource well enough?

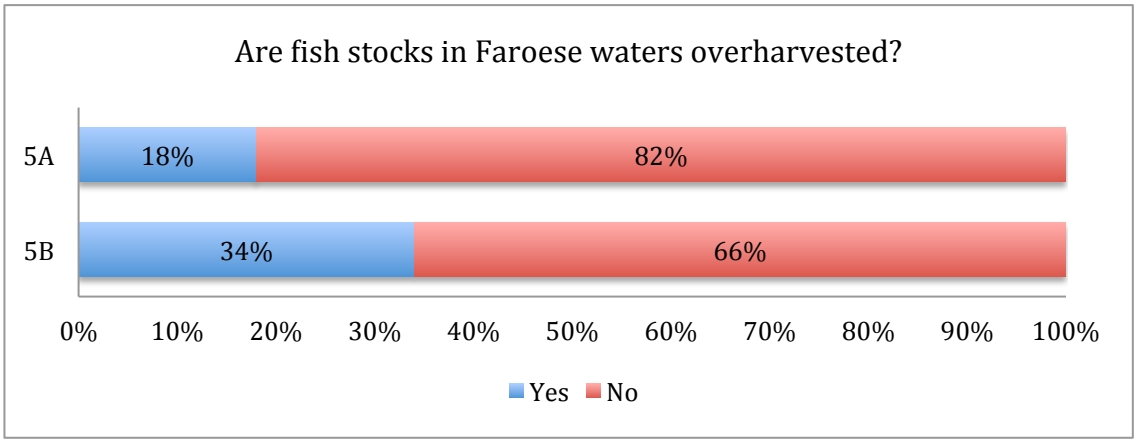


Figure 5.11 Do fishermen think fish stocks in Faroese waters are overharvested?

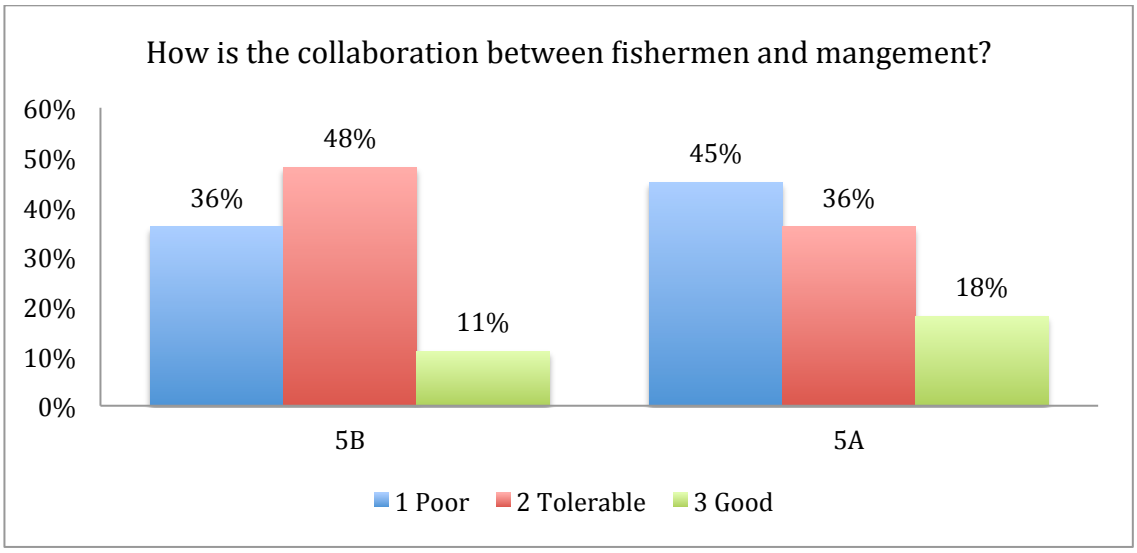


Figure 5.12 How is the collaboration between fishermen and management?

Table 5.4 Central tendencies and dispersion in the collaboration between fishermen and management.

Collaboration between fishermen and management	5A	5B
Weighted mean	1.73	1.74
Standard deviation	0.786	0.664
Coefficient of variation	0.454	0.381
Median	2	2
Mode	1	2
Standard error	0.237	0.102
Population mean	1.3-2.2	1.5-2
Confidence level	95%	95%
Cases (n)	11	42
Missing cases	0	2

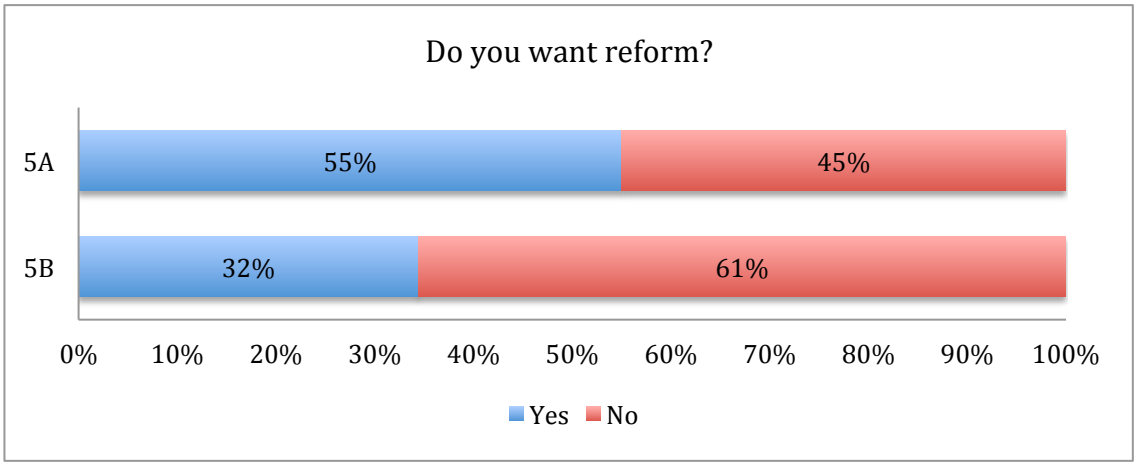


Figure 5.13 Do you want reform?

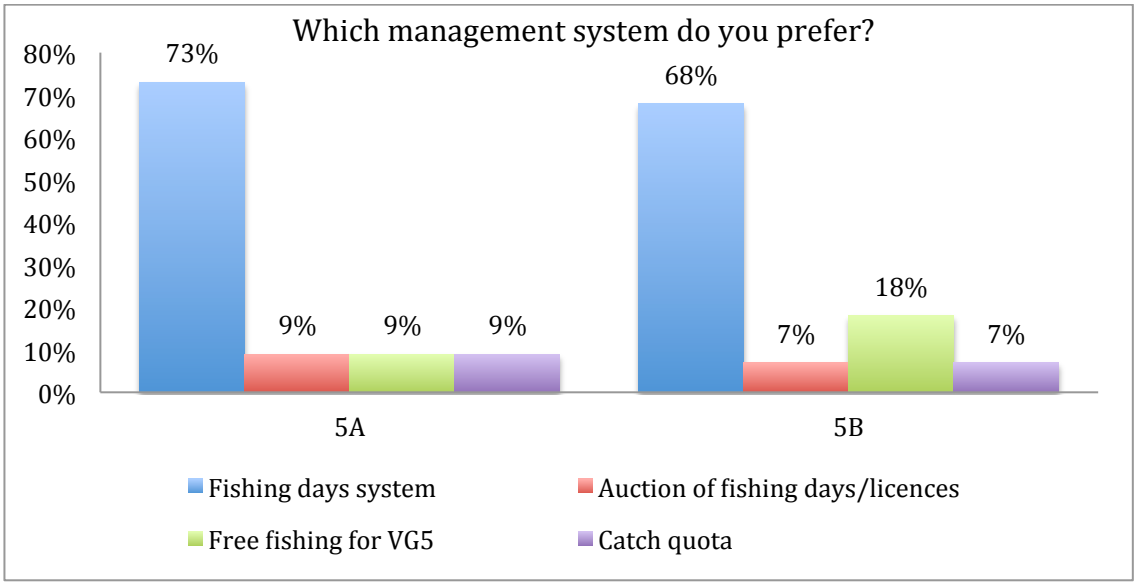


Figure 5.14 Which fisheries management system respondents preferred.

Table 5.5 Contingency table analysis of satisfaction with fisheries management (yes/no) by income (grouped in DKK 1,000).[77]

		Income Brackets								
Satisfied		0	0-50	50-100	100-200	200-300	300-400	400-500	500+	Row
		1.	2.	3.	4.	5.	6.	7.	8.	tot
n	Yes	10	7	1	3	1	1	0	2	25
Row		40%	28%	4%	12%	4%	4%	0%	8%	46%
Col		53%	54%	33%	50%	20%	33%	0%	50%	
Tot		19%	13%	2%	6%	2%	2%	0%	4%	
	No	9	6	2	3	4	2	1	2	29
		31%	21%	7%	10%	14%	7%	3%	7%	54%
		47%	46%	67%	50%	80%	67%	100%	50%	
		17%	11%	4%	6%	7%	4%	2%	4%	
Col		19	13	3	6	5	3	1	4	54
tot		35%	24%	6%	11%	9%	6%	2%	7%	100%

Chi square = 0.91 with 7 degrees of freedom Significance = 0.996

Missing cases: 1

5.2.3 Spatial management

The first question on spatial management was designed to reveal the usefulness of SAPM studies by determining how loyal fishermen are to particular fishing grounds. Respondents were asked if, during the last 10 years, they have fished in the same or in different fishing grounds (figure 5.14). All respondents from 5A said they had used the same fishing grounds (100%, n 11), and the majority of respondents from 5B also said they had used the same fishing grounds (86%, n 38). Most respondents in 5B (93%, n 41) considered MPAs a useful tool in fisheries management, 5% (n 2) said it is useful in the current system and 2% (n 2) said it is a useless tool (figure 5.16). 5A was more divided on the issue – 67% (n 7) said it is useful while 27% (n 3) said it is useless.

All respondents from 5A said their fishing activities were affected (value 3) by MPAs (100%, n 11) (figure 5.17). 57% (n 25) of respondents said they were not at all affected by MPAs (value 1), 16% (n 7) said MPAs had little effect on their fishing activities (value 2) and 27% (n 12) said they were affected by MPAs (value 3). The population mean for how affected fishermen in 5A were by MPAs was 3 (affected) and 1.4-2 for 5B (table

[77] There were not enough cases in 5A to generate separate contingency tables, and therefore data from both vessel groups were combined.

5.6). The standard error for 5A was 0 with a confidence level of 99% and for 5B it was 0.13 with a confidence level of 95%.

Quite a few respondents were dissatisfied with how MPAs are used in Faroese fisheries management (figure 5.18). Of respondents in 5A, 82% (n 9) were dissatisfied, no respondent was neutral and 18% (n 3) were satisfied. Of respondents in 5B, 39% (n 17) were dissatisfied, 14% (n 6) were neutral and 45% (n 20) were satisfied. The mode in 5A was 1 (dissatisfaction) and in 5B it was 3 (satisfaction) (table 5.7). The population mean of satisfaction for 5A was 0.9-1.9 with a standard error of 0.24 and a confidence level of 95% and for 5B the population mean was 1.8-2.4 with a standard error of 0.14 and a confidence level of 95%. Most respondents said it would increase their satisfaction with MPAs if fishermen were involved in the process of deciding where to place them (figure 5.19). The vast majority of respondents said they followed the rules on MPAs (figure 5.20). One respondent from 5A said he did not follow the rules on MPAs because he felt they were too arbitrary.

The survey revealed that respondents had the following opinions on MPAs and spatial management as a whole, many of which were offered spontaneously due to the semi-structured nature of the survey (some have been mentioned in previous sections of this chapter):

- Trawlers should not be allowed to harvest closer than 18/24 nm from land (the distance from land varied between fishermen).
- Trawlers were accused of taking measures to deliberately include juveniles in trawls
- Trawlers ruin the seabed. Trawlers use metal chains to flatten the seabed. Because of trawlers, fish have no refuge on the seabed anymore and their foraging grounds are gone
- Large long-liners are too close to land. They should not be allowed to harvest as close as 3/5/8 nm from land. It leaves nothing for small coastal vessels, which cannot go as far out
- Deep waters are not exploited enough (in reference to larger vessels)
- Spawning grounds should not be closed off for fishing for VG5 and MPAs should not be applicable to VG5
- Spawning times should be better/continuously researched to make spawning closures shorter/more precise

- Jigs should not receive preferential treatment over long-lines in VG5. It makes no sense to close an area and then let jiggers harvest there
- Some MPAs seem illogical. Managers should listen to experienced fishermen when placing MPAs, some of whom have been fishermen for 30-50 years
- MPAs are vital in protecting juveniles and spawning grounds, and vessels should not be allowed to harvest too much during spawning time
- MPAs cause other areas to be overexploited
- Some areas should be completely protected, also from jigs
- MPAs are too close to land
- MPAs mean that fishermen cannot fish where it is most lucrative/efficient
- MPAs should not be made permanent by law but should be revised continuously

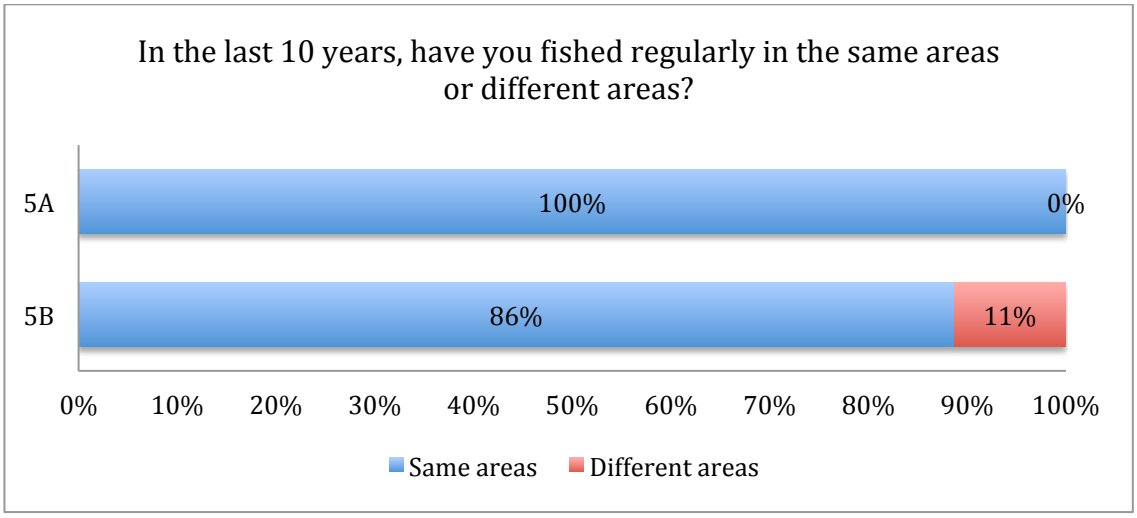


Figure 5.15 How loyal fishermen are to fishing grounds.

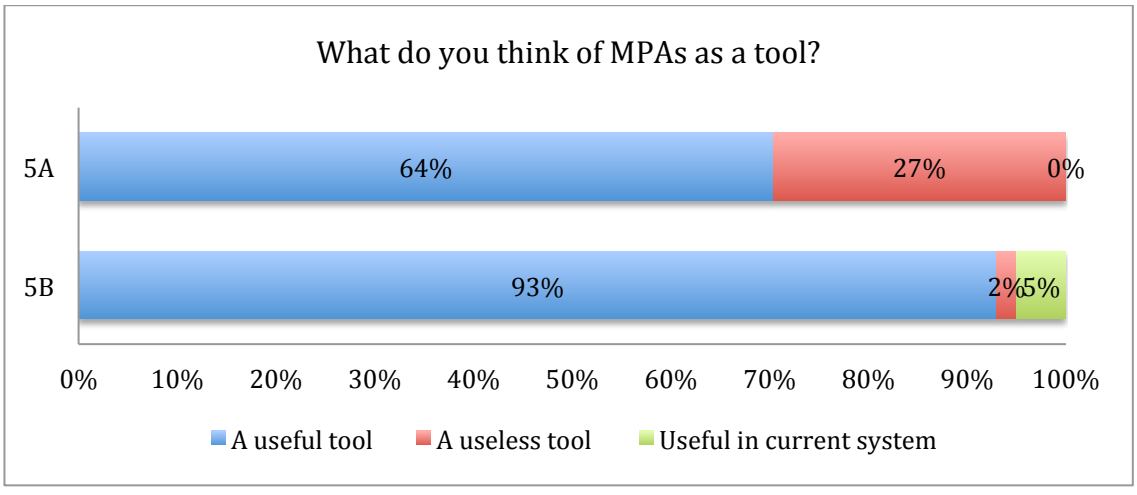


Figure 5.16 Fishermen's opinions on the use of MPAs as a tool in fisheries management.

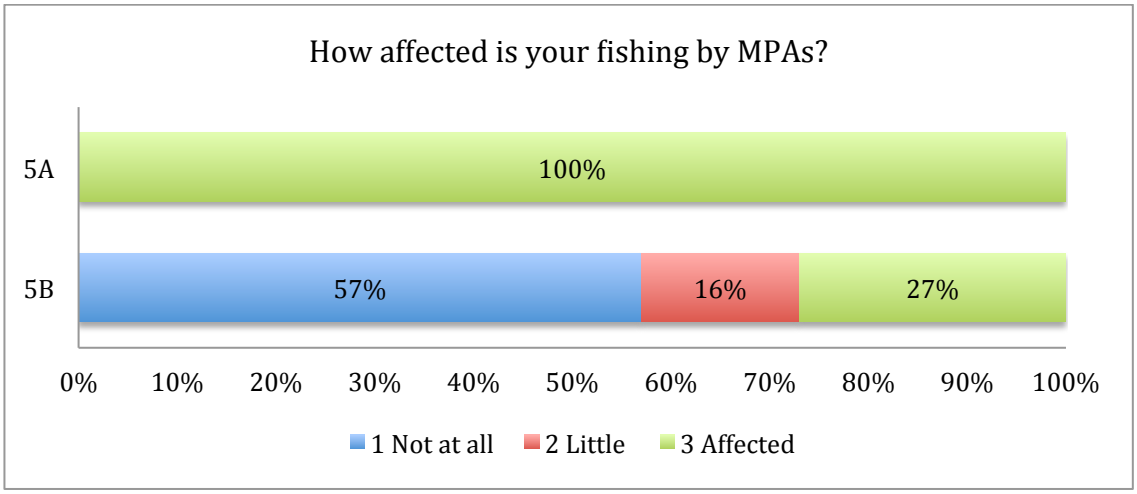


Figure 5.17 How affected fishermen's fishing activities are by MPAs.

Table 5.6 Central tendencies and dispersion in how affected fishermen are by MPAs.

How affected fishermen are by MPAs	5A	5B
Weighted mean	3	1.7
Standard deviation	0	0.878
Coefficient of variation	0	0.516
Median	3	1
Mode	3	1
Standard error	0	0.132
Population mean	3	1.4-2
Confidence level	99%	95%
Cases	11	44

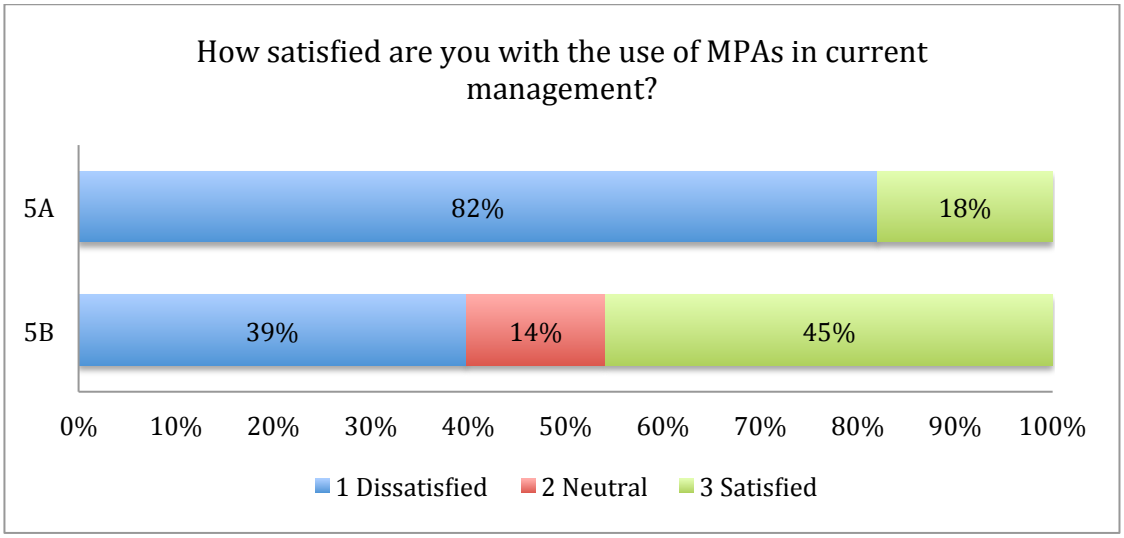


Figure 5.18 How satisfied fishermen are with the use of MPAs in current management.

Table 5.7 Central tendencies and dispersion in fishermen's satisfaction with the use of MPAs in current fisheries management.

Satisfaction with use of MPAs in current management	5A	5B
Weighted mean	1.36	2.07
Standard deviation	0.809	0.936
Coefficient of variation	0.595	0.452
Median	1	2
Mode	1	3
Standard error	0.244	0.143
Population mean	0.9-1.9	1.8-2.4
Confidence level	95%	95%
Cases (n)	11	43

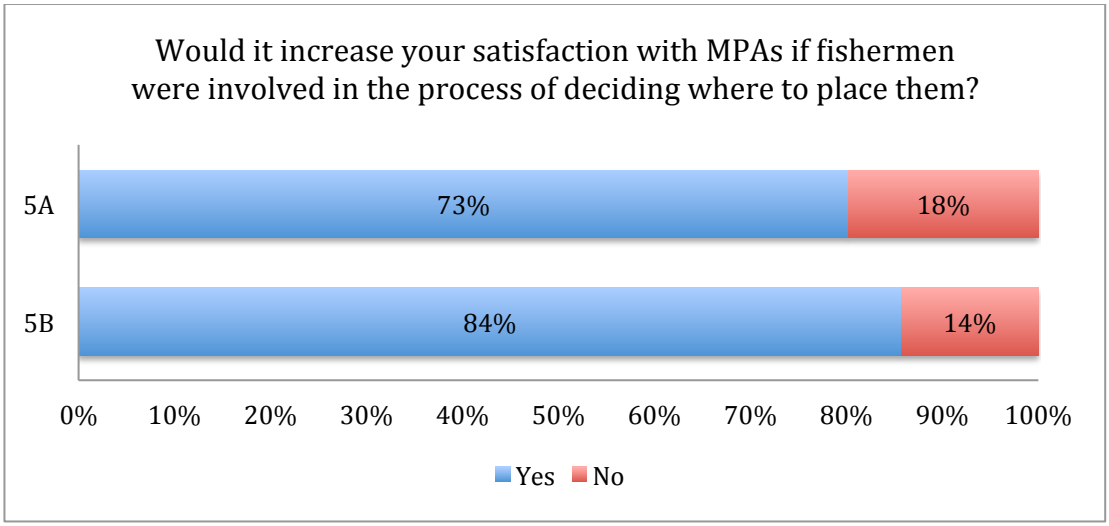


Figure 5.19 Fishermen involvement in the process of deciding where to place MPAs.

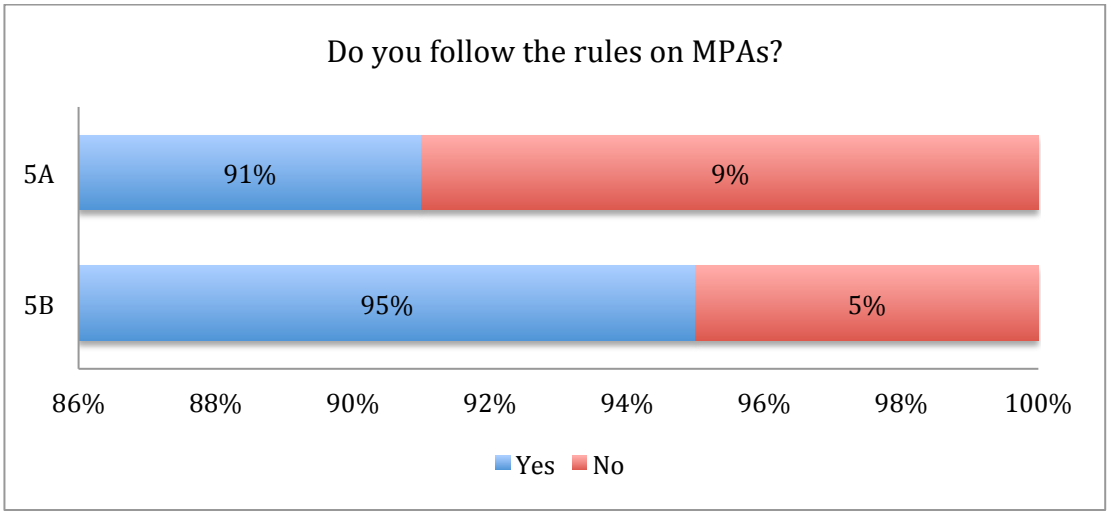


Figure 5.20 Do fishermen follow the rules on MPAs?

6 Discussion

This chapter will discuss all the information presented so far and analyse the results presented in chapters four and five in relation to area closures, spawning grounds, relationship between depth and fish size, and trawling, which was a specific concern brought up by fishermen. Following that, the management system will be discussed, and finally the future of small-scale coastal fishing.

6.1 Spatial management

6.1.1 Area closures

Fishermen's spatial access priorities (SAP) were presented in chapter four. Due to the area-time closures described in section 3.2, fishermen in VG5 do not have continuous access to all areas with high SAP. As the CBA in section 3.2.1 showed, this comes at a cost to fishermen. To establish how affected fishermen's spatial access priorities are by closures, area-time closures are compared to the SAPM for VG5 (figure 6.1), and table 6.1 explains what those area closures are, which gears they are applicable to and duration. All closures are due to spawning. Provisional closures to protect juveniles clearly cannot be mapped due to their nature but the SAPM results can be consulted prior to placing such closures in future.

Area-time closures 1, 3 and 5 coincide with high SAP areas, while area closure 6 has almost no SAP. Areas 1, 3 and 5 are only closed to long-lining, so jiggers are able to harvest inside these closures. According to respondents, mostly full-time fishermen use long-lines, and therefore the cost of area closures to full-time fishermen is higher than leisure or part-time fishermen. It is somewhat counter-productive to allow leisure fishermen to harvest freely – although *not all* fishermen who use jigs are leisure fishermen – while restricting the harvest of full-time fishermen because full-time fishermen have to live off their catches. Even if long-lines are more efficient, there are many fewer vessels using long-lines, but this could change if spawning grounds were open to long-lines, not jigs. The opportunity costs of limiting harvest for full-time fishermen is also higher than limiting harvest of leisure fishermen since the former on

average earn substantially more and on average use three times the number of fishing days.

The survey revealed that fishermen hold a wide variety of opinions on area closures. It is positive that so many fishermen support MPAs as a tool and that almost all claim to follow the rules on MPAs, because as previously mentioned, stakeholder support is vital for the success of MPAs (Brody 2003). The difference in support between 5A and 5B is potentially because fishermen in 5A are more affected by MPAs, and aligning closures with SAP can address this dissatisfaction. It is quite conceivably a symptom of dissatisfaction with MPAs when fishermen do not comply with rules and lack of compatibility between regulations and fishing practises (Raakjær Nielsen and Mathiesen 2003). One respondent openly admitted that he did not respect MPAs because they were too arbitrary in his opinion, especially the fact that jiggers are allowed to harvest in spawning grounds while long-liners are not. Although only one respondent admitted to not following the rules, others have been caught fishing illegally inside closures, most recently a vessel from 5A using long-lines,[78] possible because vessels in VG5 are not required to have VMS on board, as previously stated. It is unfortunate that some decide to break the rules on MPAs, both practically for the conservation effort, and symbolically, as it might reduce compliance among other fishermen.

A potential solution to the above problem would be to simply demand that full-time fishermen or fishermen who use long-lines install VMS. But fishing illegally in area closures is arguably a symptom of dissatisfaction, based on the survey results that 5A is both the group most affected by closures and most dissatisfied with how they are used. Demanding vessels install VMS will not solve the underlying dissatisfaction with how MPAs are used. It would serve both fishermen and management if the cause of the dissatisfaction, i.e. poor use of area closures as a tool, was addressed instead of the symptom, illegal fishing. Using the SAPM when planning MPAs in future may make fishermen more satisfied, given that almost all fishermen said they would be more satisfied with MPAs if fishermen were involved in the process of placing them, and research also shows that involving stakeholders in management plans increases

[78] See for example this news report: http://kvf.fo/greinar/2014/03/15/brimil-tikid-utrodrarbat.

compliance (Innes 1996) as well as quality of outcome (Newig 2007). It may also make them feel more satisfied with the collaboration between fishermen and management.

Taking fishermen's SAP as well as conservation criteria into consideration when placing MPAs may represent a step in the right direction. Closing areas to all gears may also improve satisfaction with area closures since the distinction in gear appears to be a cause of dissatisfaction. The reason for this distinction is naturally that long-liners harvest more intensely but it comes across as unfair to fishermen. Banning long-liners also adversely affects full-time fishermen who most need to support MPAs if they are to be successful. Banning all gears inside closed areas can also be defended from a conservation standpoint.

Occasionally additional area closures than those mapped in figure 6.1 have been applied, e.g. in 2011 when the first 1.5 nm from shore all around the islands was closed to long-liners to protect juveniles.[79] Several respondents mentioned these additional closures with frustration and accused management of arbitrary decision-making since no research had been conducted to suggest juveniles are particularly close to land, according to them. The MRI has since conducted research on juvenile catches in collaboration with fishermen in 5A. The preliminary results have been published, c.f. 6.3, but once the final results of that research is ready, scientific evidence will presumably be the basis of an eventual re-closure of the area and scientists should make an effort to explain to fishermen why these areas are closed, as building a consensus for management plans improves compliance (Innes 1996).

Table 6.1 Area closures in Faroese EEZ that are applicable to VG5.[80] Area numbers correspond to marked areas in fig. 3.7.

Area	Description	Banned gear	From	To
1	No commercial fishing, except jigs and net-fishing for monkfish	Long-lines	15.02.14	31.03.14
3	No commercial fishing, except jigs and net-fishing for monkfish	Long-lines	01.02.14	01.04.14
5	No commercial fishing, except jigs	Long-lines	15.02.14	15.04.14
6	No commercial fishing	Jigs, long-lines	15.02.14	15.04.14

[79] See executive order no. 94 from 4. July 2011. F: Kunngerð nr. 94 frá 4. juli 2011 um tíðaravmarkaðar friðingar av ávísum smáfiskaleiðum v.m., sum seinast broytt við kunngerð nr. 146 frá 26. oktober 2011.

[80] As set out in executive order no. 4 from 09.02.2006. F: Kunngerð nr. 4 frá 09.02.2006 um tíðaravmarkað veiðibann á gýtingarleiðum, sum broytt við kunngerð nr. 1 frá 10.01.2012.

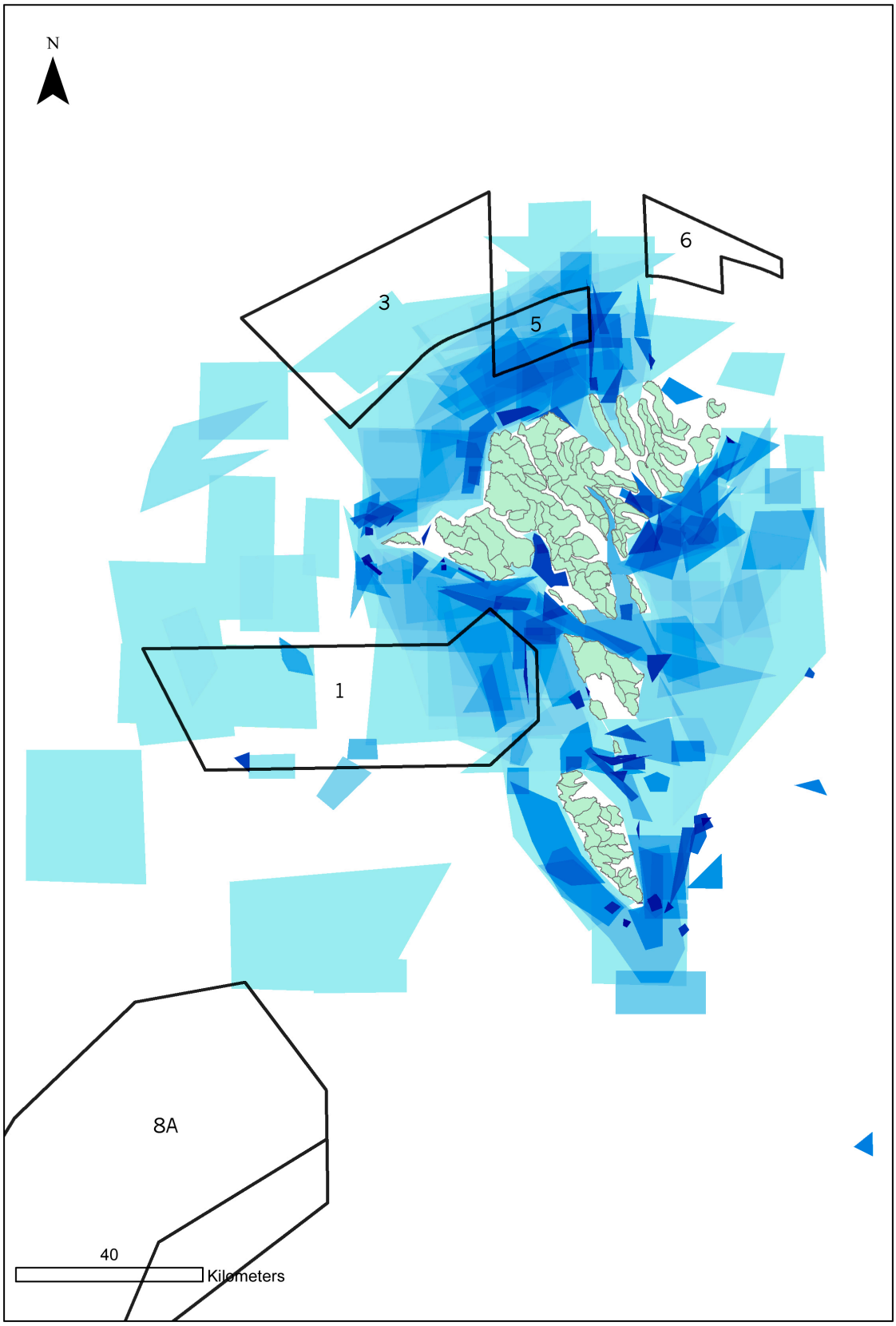


Figure 6.1 SAPM for VG5 and applicable area-time closures to protect spawning grounds.
8A is the Faroe Bank, a separate ecosystem from the Faroe Plateau and managed somewhat separately due to collapse of the Faroe Bank cod stock.

6.1.2 Spawning grounds

The ocean north of the Faroe Islands contains the most important spawning grounds for the Faroe plateau cod. Almost all of the Faroese cod spawns there, and spring harvesting in that area is popular among fishermen. There are two other important spawning grounds – west of the Islands and two areas in the southwest sea (Steingrund 2010, Jákupsstovu et al 2004). The ocean to the north has a high SAP, and comparing spawning grounds to SAPM for VG5 shows that areas of high SAP coincide with spawning grounds to the north (figure 6.2). Spawning grounds appear to extend further out than the highest SAP but fishing grounds close to land also generally have a higher SAP to VG5. The area with the highest SAP in the north is however inside the spawning grounds and also coincides with area closure 5 (figure 6.1).

The spawning grounds south of *Vágur*, the western-most region, also have a high SAP but the areas with the highest SAP do not coincide entirely with spawning grounds. A more recent map (Steingrund 2010) of spawning grounds than the one used for comparison with SAPM (Jákupsstovu et al 2004) depicts those spawning grounds as being bigger so it is possible that spawning grounds south of *Vágur* indeed coincide with SAP for VG5. Interestingly, the spawning grounds west of the islands do not at all coincide with high SAP. There are no spawning grounds on the eastern side of the islands, yet it has a high SAP. This is because of the migration route, which is close to shore on the eastern side of the islands (map of migration in appendix V).

Spawning time is a critical and vulnerable time for fish stocks. Fishing may disrupt the reproduction process and the high abundance makes harvesting very efficient, both of which are undesirable with the current state of the cod stock (Hall 2002; ICES 2013a). Considering the state of the cod stock, area closures should therefore be applicable to all gears in order to allow the cod to spawn undisturbed and to prevent intensive harvesting. Closing spawning grounds to all gears also matches the conclusion in the previous section. Since many spawning grounds and areas of high SAP coincide, placement of area closures should be revised based on new research on spawning grounds being conducted by MRI (pers. com.). A forthcoming PhD project mapping cod will provide many more data for further and more accurate analysis of spawning grounds in relation to SAPM.

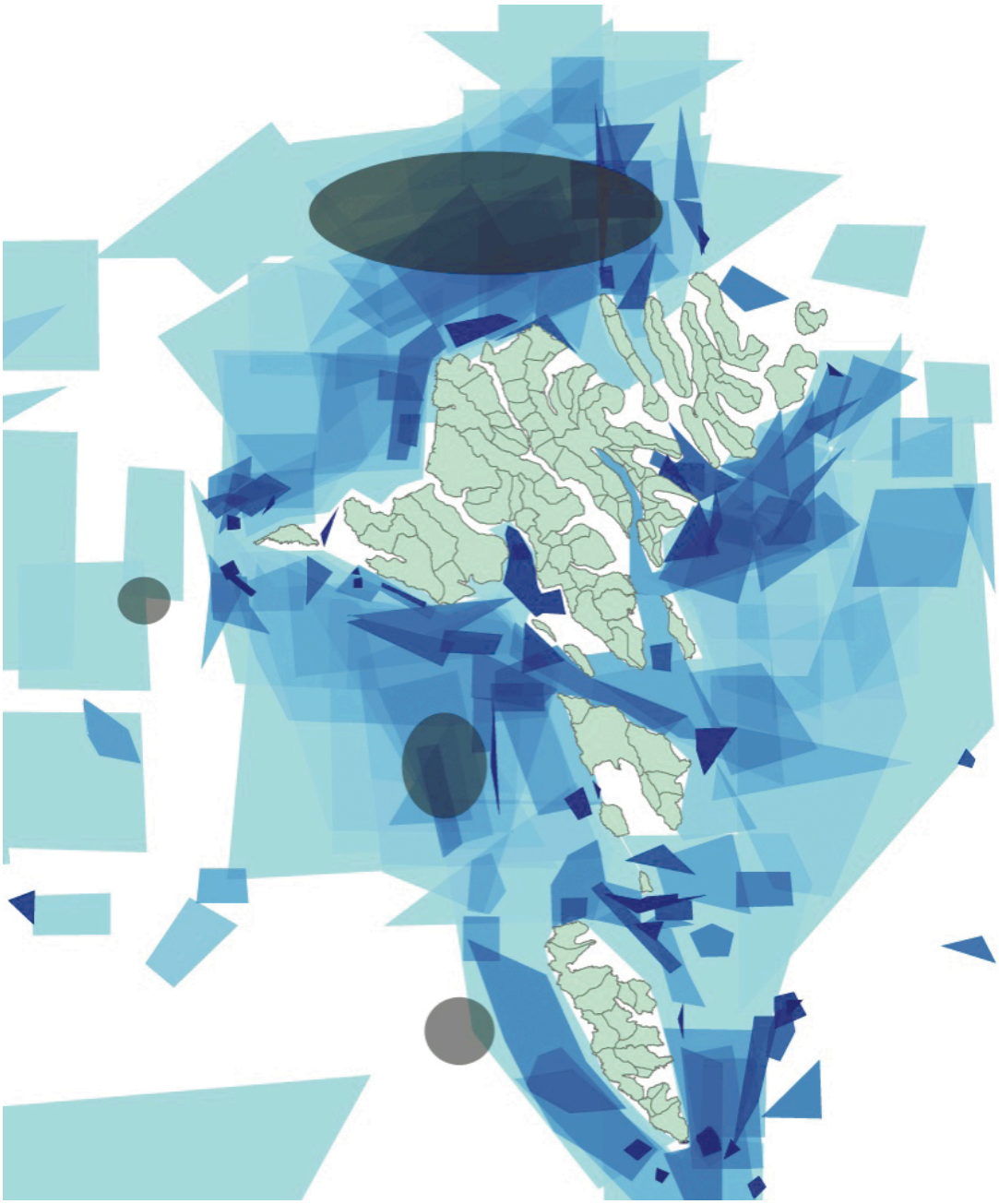


Figure 6.2 SAPM for VG5 and cod spawning grounds (black circles)
Spawning grounds have been reproduced from a map produced by Jákupsstovu et al 2004 p. 41 (see appendix V for original map). Steingrund (2010) mapped spawning grounds, which largely match the ones above, although the southern-most one appears to have merged with the one above it, creating a bigger spawning ground. The map by Steingrund was of insufficient resolution to be reproduced for application to SAPM.

6.1.3 Relationship between depth and fish size

Many areas of high SAP coincide with the 100-metre rim (circled on figure 6.3), especially on the north, west and east side of the islands. There are also some areas with high SAP further north that coincide with the 150-metre rim and several areas with

SAP that are relatively far from land coincide with the 150-, 250- and 350-metre rims west of the islands, which is noteworthy due to the distance from land. The 100-metre rim has the highest SAP of the rims but it also has the advantage of being close to land. The fact that so many areas around rims and deep areas far away from land have SAP indicates that fishermen have a preference for fishing near or on rims and in deep waters, especially given the opportunity costs that arise from sailing long distances. There is a relationship between cod maturity and vertical distribution, and this apparent preference by some fishermen to fish at depths of at least 100 metres accords with recent research that shows that large cod is caught in deep water.

Cod is known to mature close to land at depths of less than 50 metres. At the age of 2-3 years, when it is approximately 40-55 cm long, cod is usually caught at depths of 50-130 metres (Steingrund and Kristiansen 2013a). However cod is not considered mature until it is 4 years old (Steingrund et al 2005) and to establish where mature cod is likely to be caught so juveniles can be avoided, Steingrund and Kristiansen (2013a) conducted a survey in collaboration with fishermen from VG5 who use long-lines in 2011/2012. The survey was conducted after an additional area closure was implemented in July in 2011 with the goal of protecting juveniles after large amounts of juveniles had been landed, which meant that long-lining was banned in the first 1.5 nm from land all around the islands. After the closure, a number of vessels in VG5 were given a survey licence to fish in closures on the condition that they would disclose the size and location of their catches.

The survey by Steingrund and Kristiansen (2013a) found that:

- Cod caught close to land was consistently small
- Cod caught closest to land was on average a bit larger than cod caught a bit further out
- The largest cod was found at depths of 150-200 metres

According to the survey and what was previously known about vertical distribution of cod, depths of 100 metres are likely to have high abundances of small and medium-sized cod, and the deeper areas are likely to have a higher abundance of larger cod. Therefore the further out fishermen harvest, the less likely they are to catch juveniles. The fact that some fishermen place a SAP on deeper areas is positive, and indicates that

some fishermen prefer catching large fish and that they are willing to sail far to do so. One can also deduce from this that many fishermen actively target large cod rather than small. Whether there is a reason or not for fishermen having SAP for areas around rims has not been established but perhaps future research will focus on that.

Depth is not the only thing that affects the size of cod catches. The type of bait that fishermen use when fishing close to shore is important because different types of bait attract different sizes of fish. The relationship between hook size and fish size, and bait and fish size was analysed in another study by Steingrund and Kristiansen (2013b). The survey was conducted close to land at a depth of less than 100m in 2011-2012 in collaboration with a long-liner in VG5. The survey revealed that hooks have a relatively small influence on the size of catch while some bait is much more likely to catch large fish. Small fish was prone to taking whelk and squid bait while large fish was more prone to taking fish bait, such as mackerel and herring. The authors note that this is consistent with stomach content analyses of cod of various sizes. The conclusion is that it is possible to a degree to avoid catching juveniles by adjusting the bait.

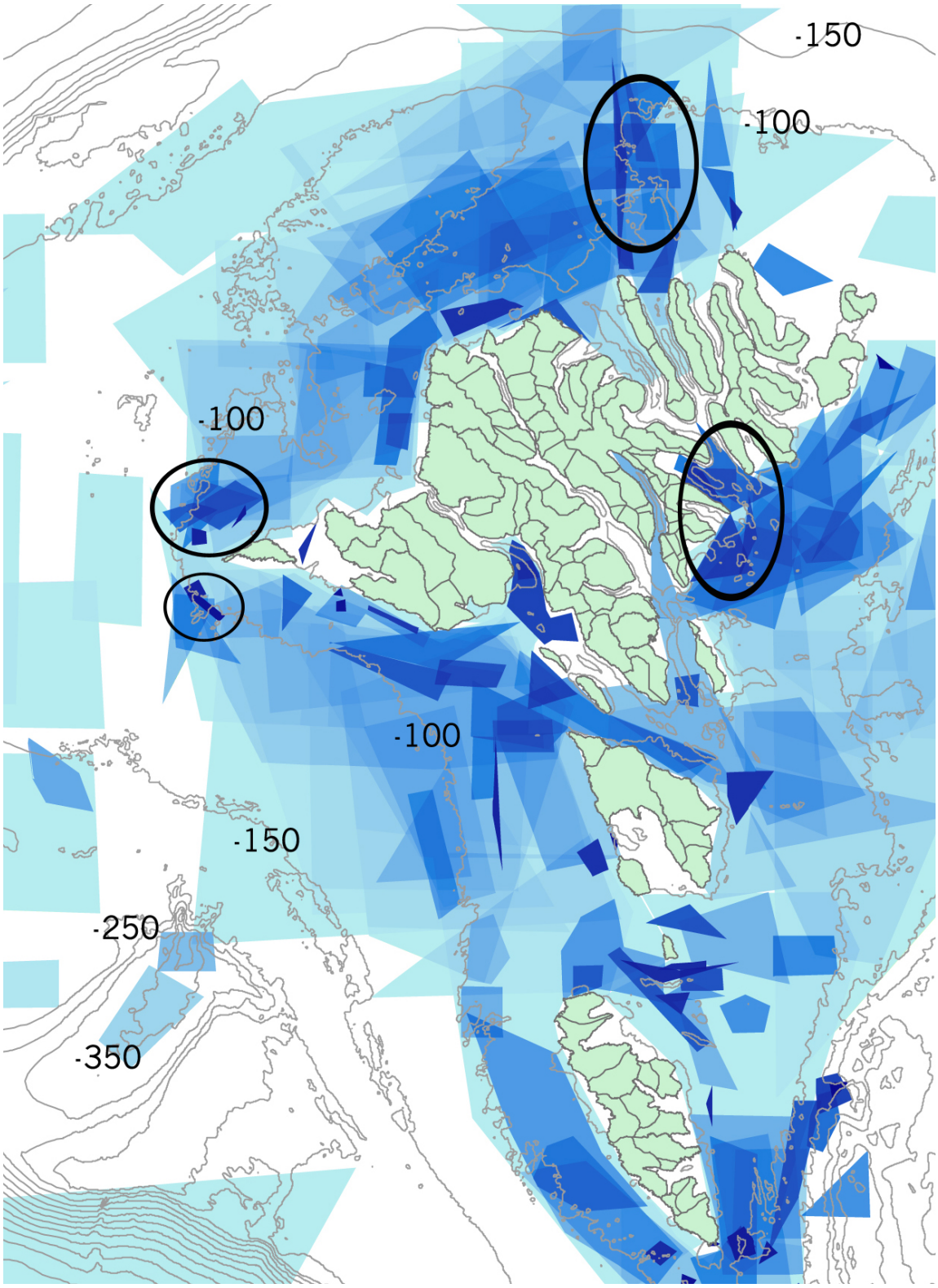


Figure 6.3 A closer look at depth map in relation to SAP for VG5. Areas of high SAP coincide with deep areas (circled).

6.1.4 Trawling

Many fishermen voiced concerns about the activity of trawlers. There is a mountain of research that shows that fishermen are right to be concerned with trawling and fishers have worried about trawling for a long time. “Fishers have been complaining about the effects of bottom trawl gear on the marine environment since at least the 14th century.” (Jones 1992 p. 59). Trawling has many negative effects. Among the direct effects are scraping and ploughing of the substrate, destruction of benthos and dumping of processing waste, while indirect effects are post-fishing mortality of affected or disturbed organisms and long-term trawl-induced changes to the benthos. The degree of damage by trawling is among other things related to weight of gear on the seabed, the type of seabed and towing speed. The recovery rate is slow in water deeper than 1,000 metres, where it most likely can be measured in decades (Jones 1992), while in shallow water, the recovery period may only be a few hours if the tide is strong (Hall 1994).

It has been documented that trawling has damaged coldwater coral reefs in the North Atlantic (Hall-Spencer 2002). Coldwater coral reefs only grow a few millimetres a year; they support a rich assemblage of species and serve as important nursery grounds for many fish species (Duncan and Roberts 2001, Roberts 2002). Coral habitat occurs at depths as shallow as 100 metres and as deep as 2,000 metres (Roberts 2002). It is therefore likely that coldwater coral habitats are adversely affected by trawling, which have been found all around the Faroe Islands (Frederiksen et al 2002, Danielsen 2009, Fiskirannsóknarstovan 2008). Area closures have been implemented specifically to protect coldwater corals in the Faroe Islands (figure 3.1, ICES NWWG 2013) but the protected areas are small in size and number and therefore only cover a small part of the coral reefs around the islands (Danielsen 2009). Video footage documenting coral reef distribution has shown that large areas of coral reefs have disappeared and been destroyed (Fiskirannsóknarstovan 2008, Danielsen 2009), and there are unconfirmed reports that Faroese fishermen deliberately have flattened coral reef areas to increase the areas where it is possible to trawl (Jákupsstovu et al 2002, Danielsen 2009). Protecting ecosystems and habitats is just as important a component of fisheries management as protecting target species (Dayton et al 1995). Ideally, trawling would be banned, but given that a full ban on trawling is unlikely to be passed, based on the

failure of previous international efforts to ban trawling (Anon 2006), more should be done to protect coral reefs with the implementation of area closures.

6.2 Management

The Faroese Economic Council believes there are too many vessels in the fleet and the way to address the biological problem is to limit access to the resource (Búskaparráðið 2011). Ellefsen (2013) has found the economically optimal size of the fleet – i.e. the size that is most likely to achieve the Maximum Economic Yield (MEY)– based on numbers from 2010, and proposes a drastic reduction in the number of large vessels (table 6.2), excluding vessel groups 4 and 5. The reduction in vessel numbers would drastically reduce the total expenditure for vessel groups 2 and 3, and Ellefsen estimates that an optimally sized fleet could change the total economic loss of DKK 61 million in 2010 to a profit of DKK 376 million. Naturally reducing vessel numbers would lead to a reduction in employment. In 2010, 432 fishermen were employed on large vessels. The optimal number of vessels would employ an estimated 104 fishermen. This is a reduction of 328 fishermen but the profit increase of an estimated DKK 438 million means that each one of those 328 lost jobs represents DKK 1.3 million a year. Ellefsen says that one can assume that these fishermen will find employment in a different sector but even if they do not, the economic benefits outweigh the social costs, especially since the fleet is so heavily indebted.

		VESSEL NUMBERS			PROFIT DKK MILLION	
VG	**Description**	**2010**	**Optimal**	**Reduction**	**2010**	**Optimal**
2	Trawlers	30	11	-64%	-53	217
3	Long-liners > 110 tons	16	5	-68%	-9	159
Total		**56**	**16**	**-66%**	**-61**	**376**

Table 6.2 Active vessels in 2010 and the economically optimal number of vessels, and fleet profit with 2010 vessel numbers and optimal vessel numbers[81]

In Ellefsen's scenario, the long-line fleet is reduced more than the trawl fleet. However, there are sound economic reasons for reducing the trawl fleet more. A

[81] Ellefsen 2013.

comparative study of the Russian fleet in the Barents Sea found that while trawlers had a higher production capacity for cod, long-liners were more species and size selective, had a lower fuel consumption, the quality of products, value and profitability was higher, and it employed more people, which may be less efficient but positive if profitability remains higher (Grekov and Pavlenko 2011). These benefits are in addition to the clear ecological benefits of banning trawling outlined in the previous section, which were also included in the study. Therefore the reduction suggested by Ellefsen is not optimal, yet Ellefsen's analysis does show that there are far too many vessels in the fleet, and this needs to be reduced to become economically and biologically optimal.

Ellefsen lists a number of different ways that the reduction in vessels can be achieved. It is possible to reduce the number of fishing days drastically – first by 50% to eliminate unutilised days and then by 66% (the reduction in the fleet) so that perhaps 15% are left – and let the fleet adjust itself accordingly, i.e. simply let the weak ones fail.[82] It is also possible to reduce the number of harvesting licences to match the optimal number of vessels but he warns that this is an inflexible system in terms of efficiency increases and biological changes, at least how it is currently implemented, which the current system with harvesting licences has already proven. Selling fishing rights at auction will most likely produce the best economic outcome since only the most efficient operators will survive, but it has not been as well tested as the effort quota system, Ellefsen said. A catch quota system will mean that the fleet will focus its efforts on reducing costs and has a proven track record of profitable industries, he concluded.

Ellefsen appears to be inclined towards implementing a catch quota system, which may be preferable when the stock is small because the Total Allowable Catch (TAC) is clear and controlled. However, fishermen spoke negatively about the catch quota system, and the industry has already rejected the catch quota system once in 1996 (Løkkegaard 2004). Without stakeholder support, a switch from effort quotas to catch quotas is unlikely to be successful (Innes 1996). By now it should be clear that Ellefsen is

[82] Naturally, this will only happen if the fleet is not kept artificially alive by the political system with catch qoutas in other fisheries, whether foreign waters or pelagic stocks in Faroese waters, with tax benefits, or by allowing cheap foreign labour into the fleet.

correct in his estimation that there is an overcapacity in the fleet that needs to be adjusted to a size that it is economically and biologically optimal. Exactly what the economically and biologically optimal number of vessels is needs to be recalculated with up-to-date numbers before the process of reducing the fleet size is begun, as he himself points out.

No matter how it is done, withdrawing fishing rights for reallocation from rights holders will be controversial and the government will most likely face legal challenges and compensation claims from holders. But given the overall failure of the system, the government has a clear mandate to do so:

> *In light of the poor policy outcomes, the Faroese government should, in principle, be able to make radical changes to the effort quota system, or even abolish it.* Current holders of fishing harvest rights cannot justifiably expect societal institutions to remain idle while the domestic demersal fishing industry continues in its current trajectory of terminal decline*. Yet it is legitimate to take into account the fact that current holders of fishing harvest rights should have reasonable expectations of continuing their economic operations.* (Grétarsson and Danielsen 2014 p. 121-122, emphasis added)

Petersen (2013) has found a potential solution to the above-mentioned problems. He has made recommendations for how to preserve the fishing day system while reducing vessel numbers and eliminating the problem of compensation claims by building compensation into the exit scheme and making it largely voluntary. He recommends a fishing day buy-back scheme to be funded by a resource fee on the currently lucrative pelagic industry. The mains steps of the buy-back scheme are the following:

- Warn operators that all 'life support' will be removed in a year or two and let them consider whether they want to continue operating without life support or not. According to Petersen, there are always a few operators who want to quit, so some will volunteer to the scheme. When Petersen says 'life support' he means aid the demersal industry gets, such as quotas in other fisheries, both pelagic and other demersal fisheries; tax benefits, minimum income support, and cheap foreign labour.

- Implement a 'reverse-auction' fishing days buy-back scheme, where the government buys back fishing days from those who are willing to sell. Operators that have used their fishing days are given market value for them, while those that have not used them are partially compensated, perhaps 20% of market value, Petersen suggests.

- Rules of operation need to be implemented to prevent capacity increases, which need to be enforced by an independent body, not the political system.

- Implement a resource fee that is to increase along with catches and fish prices. This will put less pressure on the political system to allocate more fishing licences if catches or fish prices increase.

Petersen is correct that rules of operation need to be implemented if his recommendation is to be successful. Perhaps the most important requirement is that the catch potential of an average fishing day in each vessel group is defined. As one fishermen pointed out, it has never been defined how much is caught on an average fishing day, and if no one knows this, there is no way in which an informed decision regarding the allocation of fishing days can be made. It should be relatively straightforward to gather data (landing data is already collected) and estimate an average daily catch for each vessel group. Following that, effort quota allocations can be adjusted to fit TAC recommended by the MRI/ICES. Annual calculations of average catch per day address the issue of capacity increases, since fishing days will be adjusted annually according to how much vessels harvested on average per day in the previous year. The biggest benefit of knowing vessels' average catch per day and adjusting fishing days accordingly is that the effort quota system takes on the most advantageous quality of the catch quota system, namely the ability to control total harvest via the setting of a TAC.

An added benefit from knowing average daily catches is that it will be possible to calculate roughly the minimum number of fishing days that vessels in the various vessel groups need in order to make a profit, which can be used to inform a repeat of Ellefsen's calculations of the optimal fleet size. It is important that measures to reduce the fleet size are taken when SSBs are relatively small to ensure that the capacity of the fleet is not set too high. If the SSBs are large, fleet capacity can easily be set too high because capacity will be adjusted to large fish stocks, which may be fine in the short run but if stocks decrease again – and stocks do fluctuate – the capacity of the fleet will be far too high. Adjusting the capacity of the fleet when stocks are small also means that

capacity increases become less of an issue because capacity has been set intentionally low. The unavoidable capacity increases will then grow with stocks (long-term average growth, that is, not necessarily year-on-year growth, as this fluctuates), assuming that the measures taken to reduce harvesting intensity and improved spatial management leads to larger fish stocks.

6.2.1 Fishermen's opinions on management

Fishermen had many opinions on management. Not all can be discussed in this thesis but there are however many things that can be addressed and should be discussed. Many fishermen were dissatisfied with fisheries management and it is easy to attribute dissatisfaction to low income and thus low SSB but there appears to be no association between income and satisfaction. Therefore fishermen's dissatisfaction cannot be dismissed on those grounds and should be taken seriously as management criticism, since no other source of dissatisfaction is apparent. Furthermore, proportionally more full-time fishermen were dissatisfied than part-time fishermen, so the criticism cannot be dismissed as being based on lack of involvement with the system. The survey revealed no clear answer on the question of reform but the majority of fishermen support the fishing day system so any reform that involves a change from that will not be well received.

It is understandable that fishermen find it unfair that harvesting licences, which have been allocated for free, are sold for market value. There is a relatively simple solution to this. If rights holders no longer use their rights, rights become invalid. There are no valid reasons for allowing holders to sell harvesting rights on to others for profit and there are valid reasons to prevent them from doing so, namely to avoid an excessively indebted fleet. If unutilised harvesting rights simply fall back to the state they can be reallocated to others who have applied for a licence. An annual rent or resource fee can be placed on harvesting rights, and by that the wealth that would otherwise fall into private hands can be used by the government for infrastructure or redistributed to all Faroese people, e.g. in form of a tax relief.[83]

[83] Faroese economist Hermann Oskarsson has stated that every Faroese person could receive a monthly tax deduction of DKK 3,000 if a resource fee was placed on the fishing industry: *Trý túsund krónur afturat*

Fishermen were also concerned with corruption in allocation of harvesting rights and felt that the Minister has too much power in allocating rights. Given the enormous value of harvesting rights, such allegations are not entirely unexpected but they are likely to be a big cause of distrust and dissatisfaction, so much so that the owner of one coastal vessel declined to participate in the survey because he has filed a lawsuit against the Ministry of Fisheries for being declined a share of the pelagic quotas, which have recently enriched many actors in the Faroese fishing industry (Hagstova Føroya 2013b). If an independent body governs the allocation of harvesting rights then such allegations can be avoided in future.

6.2.2 Future of small-scale fishing

Fishermen's mean income shows that describing fishermen in 5A as full-time and 5B as leisure and part-time fishermen is generally correct. The mode in 5B suggests that there are many leisure fishermen and the range in 5B suggests that there are some full-time fishermen. Fishermen who hold a 5B licence and harvest for more than DKK 400,000 are automatically moved to 5A the following season, and therefore the division into 5A and 5B is generally representative in terms of income but not in terms of self-classification and potentially effort put into fishing. 23% of fishermen in 5B are full-time fishermen but only 11% had an income of more than DKK 200,000, which again indicates that there are full-time fishermen in 5B but they are struggling financially and therefore do not make it to 5A because of the entry barrier.

Despite only 23% being full-time fishermen, 87% of fishermen in 5B harvest solely for profit or profit and consumption. Based on the population mean age of 5B fishermen, it is very possible that fishing is used to supplement retirement allowance in 5B. Decreasing the number of the part-time and leisure vessels is tempting when stocks are struggling as they are but if it is indeed the case that many of these fishermen are fishing to supplement their retirement allowance, the extent to which these fishermen rely on fishing for income should be researched before any deliberate reductions are made in this particular fleet. If such research reveals that fishermen *depend* on fishing, despite receiving retirement allowance, then adjustments should be made in the

um mánaðan – nei takk!, accessible at: http://hermannsstova.blogspot.com/2012/11/try-tusund-kronur-aftrat-um-manaan-nei.html.

retirement scheme so the need to supplement incomes by fishing disappears as a means of protecting fish stocks. It is important to keep in mind that the premise of the Faroese fisheries management system is that the resource belongs to the people and therefore limiting non-commercial activities are difficult to defend. It would most likely be better received to reduce the economic necessity for fishing, if there is such a necessity.

Raising the entry limit to 5A to DKK 400,000 was arguably unreasonably high, and it is not surprising that fishermen perceive this move as an attempt to make them leave the fishery. Many full-time fishermen who were moved from 5A to 5B most likely only use jigs with which it is impossible to reach DKK 400,000, according to fishermen. By setting the limit so high many full-time fishermen have been excluded from 5A and lost the right to their own fishing days and to a minimum income allowance. Taking away full-time fishermen's minimum income allowance is unreasonable since they are forced to pay into these foundations when they land their catches and therefore essentially finance it themselves. Furthermore, DKK 400,000 seems *unnecessarily* high. Many professions in the Faroese job market give an annual income well below DKK 400,000, and even though expenses have to be subtracted from that value to find fishermen's income, it is still high compared to other professions[84] and the poverty limit.[85]

Coastal fishermen have historic rights to fish in Faroese waters, and clearly full-time fishermen should have satisfactory working conditions. Therefore the entry limit to 5A should be reduced so that full-time fishermen in 5B, who most likely use jigs, also get the benefits that fishermen in 5A do. A suitable limit would be DKK 200,000-250,000 because anything less arguably does not constitute a full income when expenses have been subtracted and most likely falls below the poverty limit. The number is also sufficiently high to prevent part-time fishermen from getting a 5A licence and therefore a minimum income allowance. In order to ensure that full-time fishermen are able to make a living, the individual allocation of fishing days should be no less than 100, which will hopefully make fishermen feel more secure about the future.

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[84] Nurses, for example, earn a basic wage of DKK 285,000 annually (Felagið Føroyskir Sjúkrarøktarfrøðingar 2014).

[85] The poverty limit for a single person without children in 2013 was DKK 117.548 annually (Almannaráðið 2014).

The drastic decrease in vessel numbers in 5A in the last few years is not just due to fishermen being moved to 5B, as many fishermen have undoubtedly left due to lack of profit. Many fishermen in 5B have probably also stopped due to age, considering the population mean age of 5B is around retirement age. The decrease in large vessel numbers suggested by Ellefsen and improved spatial management will hopefully mean that fish stocks begin to recover, and therefore a small coastal fleet should not have detrimental effects on fish stocks. There are valid reasons for preserving the coastal fleet while reducing the larger, industrial fleet. The coastal fleet has cultural and historic value; it allows people to be self-employed and the value of the resource is more equally divided among people instead of going into the pockets of a few 'quota barons'; and there probably is no other industry in the Faroe Islands that so successfully distributes jobs across the country, which is one of the goals of the CFA. There are currently 63 ports registered as homeports for vessels in VG5 all across the islands. Although there only are 26 vessels registered in 5A and a few more full-time fishermen in 5B, several of these vessels employ several fishermen and people on land.

The coastal fleet also has benefits that the large fleet does not have, more specifically that the trawlers do not have. The ecological damage by trawlers has been demonstrated and we have also seen that long-lines bring many economic, biological and ecological benefits but the quality of products caught by long-lines is also higher (Grekov and Pavlenko 2011), which matches the claim by fishermen that they land fresher fish than the large fleet. Fishermen say auction houses make no efforts to separate fresh fish from not-so-fresh fish and everything is bought for the same price. If fresh fish is bought for the same price as 10-day-old fish, then the market for fish in the Faroe Islands clearly does not work properly. Fresh fish is naturally worth more on foreign markets than 10-day-old fish and fishermen who land fresh fish should be compensated appropriately for doing so.

The reason that fishermen are offered the same price for fresh fish as for old fish is the *distinct lack of focus on value adding and quality in the Faroese fishing industry*. The lack of profit in the fishing industry has been a central topic in this thesis, and it has largely been attributed to fleet overcapacity and low SSB but there are clearly also problems within the industry in relation to *creating value* from the resources it has at its

disposal. One does not have to look far to see the importance of focusing on value adding and quality - Iceland's profits increased substantially when focus shifted from quantity to quality and value adding (Gestsson 2013). This shift from quantity to quality has simply not taken place in the Faroe Islands. A time limit on how long vessels are allowed to harvest without landing could improve quality and prices, and an initiative equivalent to the Iceland Ocean Cluster (IOC) could increase focus on the enormous importance and potential of quality, value adding and fish by-products, case in point again being Iceland. Clearly management of the resource needs to improve drastically but the value that is created from the resource is also very important.

7 Conclusions

The Faroese demersal fisheries management system has some fundamental flaws. The harvesting licence has not been enforced and therefore not served its purpose of limiting fleet size, nor has the political system been able to restrict fishing days sufficiently to offset capacity increases in the fleet. The result is an overexploited cod stock on the brink of collapse, and an oversized, indebted, profitless fleet. Recommendations are made to reduce the fleet size by approximately 65% and fishing days by 85% to be economically and biologically optimal. The allocation of fishing days and control of capacity increases should be removed from the political system to an independent body, and measures should be taken to establish and continuously update how much vessels harvest on an average fishing day so that fishing days can be allocated according to a TAC that is recommended by biologists.

Area-time closures (also referred to as MPAs) are a part of the management system, and in order to aid the recovery of demersal stocks, or prevent a collapse in case of insufficient fleet or fishing day reductions, an expansion of current area closures is recommended. The placement of such areas should consider ecological as well as socioeconomic criteria to increase fishermen satisfaction, compliance and therefore biological benefits of closures. The SAPM for small-scale coastal fishermen revealed that fishermen generally place a high SAP on fishing relatively close to shore and on spawning grounds north of the islands. Placement of closures, whether to protect spawning grounds or juveniles, should in future be based on scientific research and communicated to fishermen to avoid dissatisfaction. Current closures should be re-evaluated with the SAPM in mind once efforts by the MRI to map cod are complete. Spawning ground closures should in future be applicable to jigs and long-lines to avoid dissatisfaction among and discrimination against full-time fishermen. Management should also consider phasing out trawling to protect coldwater coral reefs.

The quantitative survey revealed that fishermen are loyal to their fishing grounds which provides evidence that there is a purpose in conducting surveys on fishermen's SAP, as these are unlikely to change. Fishermen support MPAs but are dissatisfied with

how they are used. Satisfaction would increase if they were involved in the process of placing MPAs, decreasing the information failure between politicians and fishermen. Many fishermen are dissatisfied with current fisheries management independent of income, and therefore dissatisfaction cannot be dismissed as being due to low stock biomass and should be taken seriously as criticism of management. Fishermen were divided on the issue of reform but a clear majority support the fishing day system. In the interest of compliance, efforts should therefore focus on improving the current system rather than implementing a new one. Fishermen in vessel group 5A have a reasonable income but some full-time fishermen do not harvest enough to get a 5A licence and the benefits it provides. The limit for entry into 5A should be lowered from DKK 400,000 to 200,000-250,000 so that full-time fishermen who use jigs also are allocated individual fishing days and receive minimum income allowance when necessary.

Spatial access priority mapping can be used to align socioeconomic and ecological criteria (hypothesis 1), although ecological criteria should be weighted heavier. It is very likely that aligning fishermen's spatial access priorities with ecological criteria can increase benefits of MPAs (hypothesis 2). Fishermen said inclusion in the process of planning MPAs would increase satisfaction and they would have better access to areas of high SAP, thus reducing adverse effects of MPAs on fishermen. Better access to areas of high SAP and increased satisfaction is likely to lead to increased compliance and therefore biological benefits of MPAs will increase. But the extent of economic benefits also depends on harvesting intensity, and biological benefits also depend on the ecological criteria used to inform placement of MPAs. Therefore the potential benefits of SAPM as a tool depend a lot on how well the other tools in the toolbox are being used.

Future research should focus on which ecological criteria should be considered when placing MPAs, identifying which areas fulfil these criteria and map them. These areas can then be compared to the SAPM so that MPAs in future can have less adverse effects on fishermen's activities and increased biological benefits. Data should be collected on all vessels' landings so the average daily catch for each vessel group can be estimated and the allocation of fishing days can become more informed and based allocated according to a TAC.

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Appendices

Appendix I

Table 2.1. Number of allocated days since the fiscal year 1996/97.

Allocated number of days											At disposal	
Fleet segment	1 outer	1 inner	2 outer	2 inner	3	4 A	4 B	4 D	4 T	5	Authorities	Total days
1996/97				8225	3040	4700	3080	1540		22000	1000	43585
1996/97				8225	3040	5600	3410	1650		27000	660	49585
1997/98				7199	2660	4696	4632			23625	577	43389
1998/99				6839	2527	4461	4400			22444	548	41219
1999/2000				6839	2527	4461	4400			22444	548	41219
2000/2001				6839	2527	4461	4400			22,444	548	41219
2001/2002				6839	2527	4461	4400			22444	0	40671
2002/2003				6771	2502	4416	4356			22220	0	40265
2003/2004				6636	2452	4328	4269			21776	0	39461
2004/2005				6536	2415	4263	4205			21449	0	38868
2005/2006				5752	3578	1770	2067		1766	21235	0	36168
2006/2007				5752	3471	1717	2005		1713	20598	0	35256
2007/2008				5637	3402	1683	1965		1679	20186	0	34552
2008/2009				5073	3062	1515	1769		1511	18167	0	31097
2008/2009				4638	3095	1393	1848		1621	18167	0	30762
2009/2010				4406	2940	1323	1756		1540	17259	0	29224
2010/2011	1700	900		4274	2852	1323	1756		1540	13259	0	25004
2010/2011	1700	900		4274	2852	1323	1756		1540	13259	0	27604
2011/12			1530	4657	2567	1058	1405		1386	10607		23210
2012/13			1530	4626	2567	1011	1533		1386	10607		23260

Number of allocated fishing days, 1996-2013. Table from ICES NWWG Report 2013 p. 29.

Appendix II

Utilisation of allocated fishing days, 2008-2013. Table from ICES NWWG Report 2013 p. 30. Vessel group was excluded 1 was excluded from the calculations.

30 ICES NWWG Report 2013

Table 2.2. Number of days allocated and the number actually used since the fiscal year 2008/2009

													pr. 15. april 2013		
Fleet segment	Allocated days 2008/09	Used days 2008/09	% used days 2008/09	Allocated days 2009/10	Used days 2009/10	% used days 2009/10	Allocated days 2010/11	Used days 2010/11	% used days 2010/11	Allocated days 2011/12	Used days 2011/12	% used days 2011/12	Allocated days 2012/13	Used days pr. Dato	% used days
Group 1 - innaru leiðir							900	552.39	61%						
Group 1 - ytri leiðir							1700	785.3	46%						
Group 2 - (innaru leiði	4638	4065	88%	4406	4585	104%	4274	3883.23	91%	4657	4758.02	102%	4626	2828.49	61%
Group 2 - ytri leiðir										1530	894.94	58%	1530	742.63	49%
Group 3	3095	2273	73%	2940	2078	71%	2852	2071.16	73%	2567	1985.90	77%	2567	1062.49	41%
Group 4A	1393	415	30%	1323	426	32%	1323	405.36	31%	1058	259.5	25%	1011	180.12	18%
Group 4B	1848	1016	55%	1756	1158	66%	1756	1015.65	58%	1405	656.61	47%	1533	547.82	36%
Group 4T	1621	1434	88%	1540	1382	90%	1540	1411.98	92%	1386	1313.14	95%	1386	644.11	46%
Group 5A	7267	3256	45%	6904	3534	51%	5304	2856	54%	5060	1817	36%	4730	770	16%
Group 5B	10900	3803	35%	10355	6215	60%	7955	4523	57%	5547	3119	56%	5877	1393	24%
Total	30762	16262	53%	29224	19378	66%	27604	17504.07	63%	23210	14804.11	64%	23260	8168.66	35%

Appendix III

Utilised fishing days in 2013 according to survey for 5A and 5B.

	5A
	90.0
	90.0
	52.5
	100.0
	82.0
	86.0
	60.0
	75.0
	88.0
	57.0
	35.0
Total	815.5
Mean	74.1

5B
65
60
60
10
15
30
5
45
25
20
30
4
0
30
25
7.00
12
65
25
-
50
100
70
65
36
40
30
20
17.5
25
40
13
2
0
4
1
2
50
53
10
15

	5B cont.
	8
	35
	60
Total	1279.50
Mean	29.75581395

Appendix IV

Cod spawning grounds (circles) and migration paths (lines) in Jákupsstovu et al 2004 p. 41.