Fishing for Sustainability

Essays on the Economic, Social and Biological Outcomes of Fisheries Policy in the Faroe Islands

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Dissertation submitted in partial fulfilment of a *Philosophiae Doctor* degree in Environment and Natural Resources

2020

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Abstract

Most of the world's fish stocks are overfished or fully fished. Overfishing has negative ecological, economic and social consequences. Fish stocks that are overfished produce less yield and may be at risk of collapse, and because they produce less yield, they are less profitable or not profitable at all. These negative consequences naturally affect the people who rely on the resource, whether for their livelihoods or for sustenance. Fisheries-dependent communities are naturally most affected by these negative consequences.

The case study area for this PhD thesis is the Faroe Islands. The Faroe Islands, a country of 50,000 people, located in the middle of the Northeast Atlantic, are highly dependent upon their fishing industry. The marine fishery accounted for 24% of the country's Gross Domestic Product (GDP) and 52% of exports in 2017. The fishing industry is also an important source of employment, employing approximately 1,500 people in the catching sector and 1,200 in the processing sector, in total about 10% of the Faroese work force. Despite the importance of the fishing industry to the Faroe Islands, fish stocks in Faroese waters are overfished.

Paper I of this thesis explores the issue of fisheries policy in the Faroe Islands, describing and analysing how the Faroese have managed their fisheries in the period from 1948 through 2018. The Faroe Islands had five different management regimes in place in that period: open access; regulated open access; a licensing system; a brief period of individual transferable quotas; and, since 1996, an effort quota system, where the main control component comprised fishing days without total allowable catch control. The paper concludes that management of the home fleet has not effectively controlled effort, which has left the fish stocks in Faroese waters overexploited, the fleet overcapitalised, and the fishery largely unprofitable. This stands in contrast to management of the distant-water and pelagic fisheries, which have been managed predominantly with individual transferable quotas and, as a result, are more profitable and more sustainable.

In Paper II, data on economic, biological and social indicators are analysed to illustrate outcomes in the home fleet fisheries, the pelagic fishery, and the distant-water fishery in the period from 1985 to 2018. Outcomes are linked to the management frameworks in place. The paper concludes that due to overfishing and overcapacity, there was no resource rent in the home fleet fishery for a long time while the pelagic fishery especially generated large resource rents. The paper also concludes that fishers' wages in the home fleet

were lower than in the pelagic and distant-water fisheries, some years well below “normal” remuneration in the Faroe Islands. In addition to sub-optimal management, substantial fleet subsidies have exasperated the problem of overcapacity and thereby overfishing.

In Paper III, the Fishery Performance Indicators (FPI) framework, developed by Anderson *et al.* (2015), is applied to the three main fisheries in the Faroe Islands. With the FPI methodology, the paper measured triple bottom line outcomes—Ecology, Economics and Community—using 68 individual metrics across 14 dimensions. The results show that the three Faroese fisheries all scored high on the Community indicator but the home fleet trawlers scored lower than the other two fisheries due especially to a lower Career dimension score. The trawlers also had the lowest Ecology score. Despite generating large resource rent, the pelagic fleet had the lowest Economic score. This was predominantly due to poor Risk performance as a result of large volatility in the fishery. The analysis also revealed a notable lack of harvest rights in the home fishery for an industrialised fishery.

Paper IV describes and analyses the fisheries policy reform introduced in the Faroe Islands in 2018. The objectives of the reform were for fisheries to become biologically and economically sustainable but a number of barriers for success are identified, most notably that measures to ensure sustainability in the home fishery only apply to parts of the fleet, which may render them ineffective and hinder the much-needed recovery of the important cod and haddock stocks in Faroese waters.

This thesis draws attention to the fact that the home fleet fishery in the Faroe Islands has not been managed optimally and demonstrates the negative impact this has had on biological, economic and social outcomes. The outcomes in the pelagic and distant-water fisheries stand in contrast to this and illustrate the lost gains from mismanagement of the home fishery. The thesis also shows that wealth generated by the fishing industry has contributed to a high standard of living in the Faroe Islands, making sound management vitally important. For several decades, the Faroese have failed to capitalise on the potential wealth of the renewable natural resource within their EEZ, despite the importance of the resource to their economy. The fisheries policy reform does not adequately address failures in management and is unlikely to improve biological and economic outcomes in the home fleet. Future research should focus on how to reach a consensus on the management of the home fleet fishery to achieve lasting and sustainable change.

Ágrip

Flestir fiskistofnar heims eru nýttir að fullu eða ofveiddir. Ofnýting hefur í för með sér slæmar vistfræðilegar, hagrænar og félagslegar afleiðingar. Minna er hægt að veiða úr ofveiddum stofnum og hætta getur verið á hruni þeirra. Og af því að þeir gefa minna af sér eru veiðarnar ekki jafn arðbærar og geta jafnvel verið reknar með tapi. Lélegt ástand stofnanna hefur áhrif á þá sem nýta auðlindina og það getur hoggið nærri brothættum sjávarbyggðum.

Í þessari doktorsritgerð er sjónum beint að Færeyjum. Íbúar Færeyja eru um 50 þúsund og þeir eiga mikið undir sjávarútvegi. Veiðar og vinnsla standa undir 24% af vergri landsframleiðslu (VLF) og útflutningur sjávarafurða svaraði til 52% af útflutningi ársins 2017. Um 10% fólks vinnur við sjávarútveg, þar af um 1.500 við veiðar og um 1.200 við vinnslu. En þrátt fyrir mikilvægi sjávarútvegs eru helstu fiskistofanar við Færeyjar ofnýttir.

Í fyrstu grein þessarar ritgerðar er fjallað um stjórn fiskveiða í Færeyjum og hvernig hún hefur þróast á árunum 1948-2018. Færeyingar hafa reynt ýmis konar fiskveiðistjórnarkerfi; opinn aðgang, skilyrtan aðgang, leyfiskerfi og framseljanlegar aflaheimildir, en frá árinu 1996 hefur verið beitt sóknarstýringu með dagatakmörkunum. Í greininni er bent á að stjórnun heimaflotans, sem veiðir úr stofnum við Færeyjar, hefur ekki verið nægjanlega aðhaldssöm og fyrir vikið hafa helstu fiskistofnar verið ofnýttir. Veiðarnar hafa jafnframt að mestu verið óarðbærar. Þessu er öfugt farið með stjórn úthafsflotans, sem veiðir á fjarlægum miðum, og uppsjávarveiðiskipa, en þeim hefur að mestu verið stjórnað með kvótakerfi. Þar hefur hagnaður verið meiri og viðvarandi.

Í annarri greininni er borinn saman líffræðilegur, hagrænn og félagslegur árangur af ólíkri stjórn veiða heimaflotans, uppsjávarflotans og úthafsflotans 1985-2018. Sýnt er fram á að vegna þess að fiskistofnar við Færeyjar voru ofnýttir og heimaflotinn of stór, hefur aldrei náð að myndast nein auðlindarentu í þeim veiðum. Í uppsjávarveiðum hefur á hinn bóginn orðið til allgóð auðlindarenta. Laun sjómanna á skipum og bátum í heimaflotanum hafa einnig verið lægri en á öðrum skipum og sum ár jafnvel lægri en meðallaun í Færeyjum. Fjárhagslegur stuðningur hins opinbera hefur aukið á vandann með því að viðhalda of stórum heimaflota og þannig ýtt undir ofnýtingu fiskistofna við eyjarnar.

Í þriðju greininni eru beitt aðferð sem kennd er við frammistöðumælikvarða (Fishery Performance Indicators, FPI) til að gaumgæfa frekar þróun fiskveiða í Færeyjum. Allar fiskveiðarnar sem samanburðurinn nær til fá góða einkunn á samfélagslegum skala, en togarar i heimaflotanum fá þó lakari einkunn en úthafsflotinn og uppsjávarveiðiflotinn. Heimatogararnir standa sig einnig verst í vistfræðilegu tilliti. Þótt góð auðlindarenta hafa myndast í uppsjávarveiðum stendur sá floti að baki hinum flotunum tveimur í hagrænum skilningi, einkum

vegna þeirrar miklu óvissu sem fylgir stórum sveiflum í heildarafla. Greiningin sýnir einnig fram á að nýtingarréttur togskipa í heimaflotanum er veikur miðað við það sem gerist og gengur almennt í fiskveiðum í iðnvæddum löndum.

Í fjórðu og síðustu greininni er sagt frá þeim breytingum á stjórn fiskveiða í Færeyjum sem kynntar voru árið 2018, en með þeim var ætlunin að bæta líffræðilega og hagræna sjálfbærni veiðanna. Bent er á hvað gæti staðið í vegi fyrir því að þau áform gengu eftir, ekki síst þá staðreynd að umbæturnar áttu aðeins að ná til hluta heimaflotans. Því væri hætta á að breytingarnar myndu ekki hafa tilætluð áhrif og áfram yrði því bið á að hinir mikilvægu stofnar þorsks og ýsu í færeyskri lögsögu næðu að rétta úr kútnum.

Ritgerðin dregur fram að veiðum færeyska heimaflotans hefur ekki verið stjórnað á heppilegasta máta sem hefur haft vond líffræðileg, hagræn og félagsleg áhrif. Reynslan af stjórn veiða úthafsflotans og uppsjávarveiðiflotans sýnir glögglega hversu mikið sú óstjórn hefur kostað. Ritgerðin sýnir einnig að sá auður sem sjávarútvegur hefur skapað hefur átt þátt í að lyfta lífskjörum í Færeyjum. En þrátt fyrir mikilvægi sjávarútvegs í þjóðarbúskapnum og nauðsyn þess að stjórna fiskveiðum með skynsamlegum hætti hefur Færeyingum ekki lánast að gera sér meira úr auðlind sinni. Þær breytingar á stjórn fiskveiða, sem átti að hrinda í framkvæmd 2018, gengu heldur ekki nægjanlega langt. Þess vegna er mikilvægt að kannað verði hvernig hægt sé að ná samstöðu um stjórn veiða heimaflotans sem tryggi að til framtíðar verði veiðum á heimaslóð stjórnað með sjálfbærni að leiðarljósi.

Samandráttur

Henda serritgerð kannar sambandið millum fiskivinnupolitikk og lívfrøðilig, búskaparlig og sosial úrslit í Føroyum. Hon er samansett av seks kapitlum, harav fýra greinum, innleiðing, og niðurstøðum. Tríggjar greinar er útgivnar av altjóða akademiskum tíðarritum og tann fjórða er latin til ummælis.

Tann fyrsta greinin lýsir og greinar føroyskan fiskivinnupolitikk frá 1948, tá heimastýrislógin kom í gildi og føroyingar yvirtóku málsøkið fiskivinna, til og við 2018. Í hesum tíðarskeiði vóru fimm ymiskar skipanir í gildi: frí atgongd, har ongar ásetingar vóru; skipað frí atgongd, har fáar ásetingar vóru; loyvisskipan; eitt stutt tíðarskeið við kvotuskipan; og fiskidagaskipanin, sum kom í gildi í 1996. Greinin kemur til ta niðurstøðu, at grundleggjandi veikleikar hava verið í umsitingini, ið hava ført til ovurfisking og yvirkapasitet. Umsitingin av uppisjóvarflotanum og fjarfiskaflotanum hinvegin hevur vart fiskastovnarnar betur og hevur ikki ført til yvirkapasitet á sama hátt.

Næsta greinin kannar lívfrøðiligu, búskaparligu og sosialu gongdina í føroyskari fiskivinnu millum 1985 og 2018 við at kanna lyklaindikatorar. Veiðuhagtøl benda á systematiska ovurfisking av botnfiskastovnunum. Greinin vísir eisini, at tað var so at siga eingin tilfeingisrenta í heimaflotanum hesi árini, meðan tilfeingisrentan í serliga uppisjóvarflotanum var stór. Lønirnar í heimaflotanum vóru eisini lágar, summi ár sera lágar. Vánalig búskaparlig og sosial úrslit eru allarhelst ein avleiðing av ovurfisking og yvirkapasiteti. Fíggjarligur stuðul til fiskivinnuna hevur gjørt trupulleikarnar við ovurfisking og yvirkapasiteti verri.

Tann triðja greinin kannar lívfrøðiligu, búskaparligu og sosialu støðuna í føroysku fiskivinnuni í 2017 við at brúka Fishery Performance Indicators háttalagi, ið Anderson *et al.* (2015) hava útviklað, og sum fevnir um 68 indikatorar. Sama háttalag er brúkt til at kanna fleiri enn 100 fiskivinnuskipanir. Niðurstøðurnar eru, at allir flotar høvdu góð sosial úrslit, men trolarar høvdu verri sosial og lívfrøðilig úrslit enn hinir, og uppisjóvarflotin, hóast stóra tilfeingisrentu, hevði verri búskaparlig úrslit, serliga vegna stórar broytingar í veiðumongdini, sum økir um váðan. Fjarfiskaflotin hevði bestu úrslitini.

Síðsta greinin lýsir og kannar fiskivinnunýskipanina, sum løgtingið samtykti í desembur 2017. Endamálið við nýskipanina var lívfrøðilig og búskaparlig burðardygd, men greinin vísir á, at fleiri forðingar eru fyri hesum í nýggju lógini. Serliga verður víst á, at tiltøk at betra um lívfrøðiliga burðardygd ikki eru galdandi fyri allan heimaflotan.

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List of Acronyms and Abbreviations

CFP	European Union's Common Fisheries Policy
CPUE	Catch Per Unit of Effort
DKK	Danish crown, currency in the Faroe Islands
EBITDA	Earnings Before Interest, Taxes, Depreciation, and Amortisation
EEZ	Exclusive Economic Zone
EQ	Effort Quota
EU	European Union
FAO	Food and Agricultural Organisation of the United Nations
FPI	Fishery Performance Indicators
FTE	Full-Time Equivalent
GDP	Gross Domestic Product
GRT	Gross Registered Tonnage
GT	Gross Tonnage
HCR	Harvest Control Rules
HP	Engine horsepower
ICES	International Council for the Exploration of the Seas
ITQ	Individual Transferable Quotas
IUU	Illegal, Unreported and Unregulated fishing
MEY	Maximum Economic Yield
MRI	Marine Research Institute
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NEAFC	North-East Atlantic Fisheries Commission
NGO	Non-Governmental Organisations
nm	Nautical miles
SSB	Spawning Stock Biomass
TAC	Total Allowable Catch
TBL	Triple Bottom Line
UN	United Nations

List of Papers

This thesis is based on three published papers and one manuscript that is under second stage review. They are as follows:

Paper I

Danielsen, R. and Agnarsson, S. (2018) ‘Fisheries Policy in the Faroe Islands: Managing for Failure?’, *Marine Policy*, 94, pp. 204–214. doi: 10.1016/j.marpol.2018.05.010.

Paper II

Danielsen, R. and Agnarsson, S. (2020) ‘In Pursuit of the Three Pillars of Sustainability in Fisheries: A Faroese Case Study’, *Marine Resource Economics,* 35(2), pp. 177-193. doi: 10.1086/708245.

Paper III

Danielsen, R., Anderson, C. M., and Agnarsson, S. (under second stage review) ‘Trawling for the Triple Bottom Line: Applying the Fishery Performance Indicators in the Faroe Islands’

Paper IV

Danielsen, R. and Agnarsson, S. (2018) ‘Analysing the Fisheries Policy Reform in the Faroe Islands: On the Path to Sustainability?’, *Environmental Science and Policy*, 90, pp. 91-101. doi: 10.1016/j.envsci.2018.08.016

1. Introduction

1.1 A Faroese case study

This thesis examines fisheries policy and its impact on biological, economic and social outcomes in the Faroe Islands. The Faroe Islands are located in the North Atlantic Ocean, situated between Iceland, Norway, and the United Kingdom (Figure 1.1). The population of the Faroe Islands is 51,000. The country consists of 18 islands with a total land area of 1,400 km^2 and an Exclusive Economic Zone (EEZ) of 270,000 km^2.

Figure 1.1. Map of the Faroe Islands and EEZ.

With an EEZ that is almost 200 times larger than the land area, fishing is quite naturally an important industry. The marine fishery accounted for 24% of the country's Gross Domestic Product (GDP) and 52% of exports in 2017. The fishing industry is also an important source of employment, employing approximately 1,500 people in the catching sector and 1,200 in the processing sector, in total about 10% of the Faroese workforce (Statistics Faroe Islands, 2019).

The Faroe Islands have a long history as a fishing nation. The industrial fishery began after world war II when the Faroese government financed a complete modernisation and large expansion of the fishing fleet (Djurhuus *et al.*, 1963). This allowed the fleet to access foreign fishing grounds to a much greater extent than before, and by the time most nations, including the Faroe Islands, expanded their EEZs to 200 nautical miles in 1977, less than 15% of Faroese catch volume was in Faroese waters (Guttesen, 1991). Loss of access to foreign fishing grounds meant that much of the fleet had to return home, and in 1985, nearly half the catch was in Faroese waters (Guttesen, 1991).

Today the fishing fleet can be divided into three segments: the home fleet, the pelagic fleet, and the distant-water fleet. The home fleet predominantly operates in the Faroese EEZ and targets demersal stocks such as cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and saithe (*Pollachius virens*). The home fleet is divided into five vessel groups: trawlers, longliners, coastal trawlers, large coastal vessels, and small coastal vessels. The coastal fleet consists of both commercially operated vessels and vessels that are regarded as non-commercial on the basis of their landing value. In total, the home fleet contains around 90 commercially operated vessels as well as over 250 non-commercial vessels (Faroese Fisheries Directorate, 2019a).

The pelagic fleet mainly operates in Faroese and EU waters and targets pelagic species such as mackerel (*Scomber scombrus*), blue whiting (*Micromesistius poutassou*), herring (*Clupea harengus*), and capelin (*Mallotus villosus*). The fleet consists of purse seiners and industrial trawlers and counts 16 vessels in total (Faroese Fisheries Directorate, 2019a). The distant-water fleet operates in the Barents Sea and Greenlandic waters and consists of five factory trawlers. They target demersal species such as cod, haddock, Golden redfish *(Sebastes norvegicus),* and Greenland halibut (*Reinhardtius hippoglossoides*), as well as Northern shrimp (*Pandalus borealis*) (Faroese Fisheries Directorate, 2019a).

The Faroe Islands are a part of the Danish kingdom but have had a Home Rule government since 1948, when the country also gained competence of fisheries policy. The fishery remained open access until 1977 when the expansion of the EEZ prompted the authorities to introduce fisheries legislation to manage the fisheries but it was not until 1987 that steps were taken to control fishing effort by capping the size of the fleet. Catch quotas were introduced in 1994 but was scrapped after only two years in favour of fishing days for the home fleet, which have been in place since 1996. In 2017, the Faroese Parliament passed legislation to reform the fisheries policy, which was introduced in 2018. The reform set out to make some ambitious changes to

Faroese fisheries policy, but has been met with resistance and vital parts have been postponed indefinitely (Steingrund *et al.*, 2019).

This thesis was inspired by §2 in the Commercial Fisheries Act from 1994. It states that the living marine resources in Faroese waters are the property of the Faroese people and outlines the objectives of the act:

i) biological and economic sustainability.

ii) to enable as free access to the resource as possible for Faroese vessels.

iii) to provide stable employment and income opportunities in the entire country.

1.2 Research focus

This thesis explores the links between fisheries policy and economic, social and biological outcomes. Fisheries research is often conducted from the perspective of a single discipline, e.g., economics, anthropology, history, sociology, biology or ecology. A monodisciplinary approach ignores the complexity of fisheries systems, which by nature span multiple disciplines. This thesis takes an interdisciplinary approach to the Faroese fishery and examines the following questions in chronological order:

i. How has the fishery been managed?

ii. What are the economic, social, and ecological outcomes of the fisheries policy that has been in place?

iii. Using the Fishery Performance Indicators (FPI) assessment framework (Anderson *et al.*, 2015), what is the Triple Bottom Line (TBL) performance of the fishery?

iv. Will fisheries policy reform address the shortcomings of past fisheries policy?

The thesis begins with *Paper I: Fisheries Policy in the Faroe Islands: Managing for Failure?.* This paper describes and analyses the history of fisheries policy in the Faroe Islands from 1948, when the Faroe Islands gained competence of fisheries policy, to 2018, when the Faroese Parliament passed a fisheries policy reform. In the time period 1948–2018, the Faroese territorial sea expanded from 3 nm to 200 nm (Nolsøe, 1964; Guttesen, 1991), the fishing industry received heavy subsidies for, inter alia, fleet expansions, fleet renewals, wages, and scrapping (Djurhuus *et al.*, 1963; Petersen *et al.*, 2000), and the demersal stocks collapsed, taking down the Faroese economy as well (Faroese Economic Council, 1998; Petersen *et al.*, 2000; Jákupsstovu *et al.*, 2007). The paper especially focuses on the fishing days system, which was in place for the home fleet in the period 1996-2018[1], and the negative impact this has had on stocks. This is then contrasted with measures in place for the pelagic and distant-water fleets, which were under catch quota control, and the more sustainable exploitation of the pelagic stocks.

Several others have contributed to academic knowledge of the Faroese fishery (Nolsøe, 1964; Guttesen, 1980, 1991, 1992; Andersen *et al.*, 1993; Løkkegaard *et al.*, 2004; Zeller and Reinert, 2004; Thomsen, 2005; Jákupsstovu *et al.*, 2007; Gezelius, 2008; Christensen *et al.*, 2009; Baudron *et al.*, 2010; Johnsen and Eliasen, 2011; Eigaard *et al.*, 2011, 2014; Hopkins, Hegland and Wilson, 2013; Hoydal, 2014; Hegland and Hopkins, 2014; Nielsen *et al.*, 2018), none cover the entire period since the Faroese government gained competence of fisheries policy in 1948 to 2018 and in such detail. The main conclusion is that the Faroese authorities have persisted with input controls despite evidence that it leads to overfishing in order to avoid difficult decisions in relation to effectively reducing overcapacity and to avoid the repercussions of job losses in the fishing and processing sectors. These jobs have traditionally been important, especially during the economic crisis of the 1990s, when unemployment in some fishing villages reached 40% (Dimmalætting, 1993). However, that was no longer a valid concern in 2017 when unemployment was record-low.

The measures that are in place to manage a fishery naturally shape the outcomes. Little has been done to evaluate the TBL performance of the Faroese fisheries. *Paper II: In Pursuit of the Three Pillars of Sustainability in Fisheries: A Faroese Case Study* does exactly that. Using data from the Faroese Fishermen's Union, which has never been analysed before, paper II analyses the TBL performance of the Faroese fishing fleet using indicators such as average crew wages, employment, profitability, and fleet size, and links it to biological performance, measured by catch composition and stock size. In the discussion section of paper II, the results are compared to fisheries policy objectives, followed by a discussion of weaknesses in implementation and potential for improvement.

In *Paper III: Trawling for the Triple Bottom Line: Applying the Fishery Performance Indicators in the Faroe Islands,* the FPI framework developed by Anderson *et al.* (2015) is used to assess and quantify the TBL performance of three key fisheries. The results show that all three performed well on the Community indicator, which captures benefits, opportunities and services to the participants in the fishery and their families, but the demersal trawlers in the

[1] Fishing days were due to be phased out from the large vessel groups in 2018, see chapter six.

home fleet performed worse on the Community indicator due to relatively poor performance in the Career dimension. The trawlers also had the worst Ecology performance. The pelagic fishery, despite generating considerable resource rent, had the worst Economic performance due to volatility in landings. The distant-water fleet, which is managed with harvest rights, had the best overall performance.

Paper IV: Analysing the Fisheries Policy Reform in the Faroe Islands: On the Path to Sustainability?, looks to the future by analysing the fisheries policy reform passed by the Faroese Parliament in 2017. Implementation began in 2018 and was due to be complete in 2019 but that is no longer on the horizon after a change in Government. Full implementation of the policy reform would have meant wide-sweeping changes to Faroese fisheries policy, including new methods for allocation of fishing rights, a management plan for the most commercially important demersal stocks in the Faroese EEZ, and the introduction of catch quota management for the larger vessel groups in the home fleet, which are currently under fishing days control, but several of these measures have met considerable resistance from stakeholders and the introduction of Total Allowable Catch (TAC) and catch quotas in the home fleet have been postponed indefinitely (Steingrund *et al.*, 2019).

The remainder of this introductory chapter reviews challenges in fisheries management and the main theoretical frameworks used for analysis in this thesis. Section 1.3 is a general introduction to challenges in fisheries, including problems of overfishing, fleet overcapacity, and the role subsidies play in overfishing and fleet overcapacity, as well as Illegal, Unreported, and Unregulated (IUU) fishing activities.[2] Section 1.4 provides an introduction to bioeconomic theory, the theory that underpins all economic analyses of fisheries. Section 1.5 focuses on sustainability, the difference between weak and strong sustainability, and how this relates to fisheries.

1.3 Challenges in fisheries

1.3.1 Overfishing

> "It is not particularly profound to note that without fish, there can be no fishery system." – Anthony Charles (2000, p. 22).

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[2] The author recognises that one important challenge is not included here, namely climate change. Climate change is a considerable challenge for the fishing industry (Barange *et al.*, 2018)—and indeed all of humanity—but the author has decided that, however important, it is outside the scope of this thesis.

One third of the world’s fish stocks are overfished. In 1950, the annual global catch of fisheries was just under 20 million tonnes. In 2016, the annual global catch of fish had increased to around 90 million tonnes in 2016, a number that has been relatively stable since the 1980s (FAO, 2018b). It is however clear that maintaining global catch production at around 90 million since the 1980s has come at a cost: in the period 1974–2015, the proportion of overfished stocks on a global scale has increased from 10% to 33.1% (Figure 1.2).

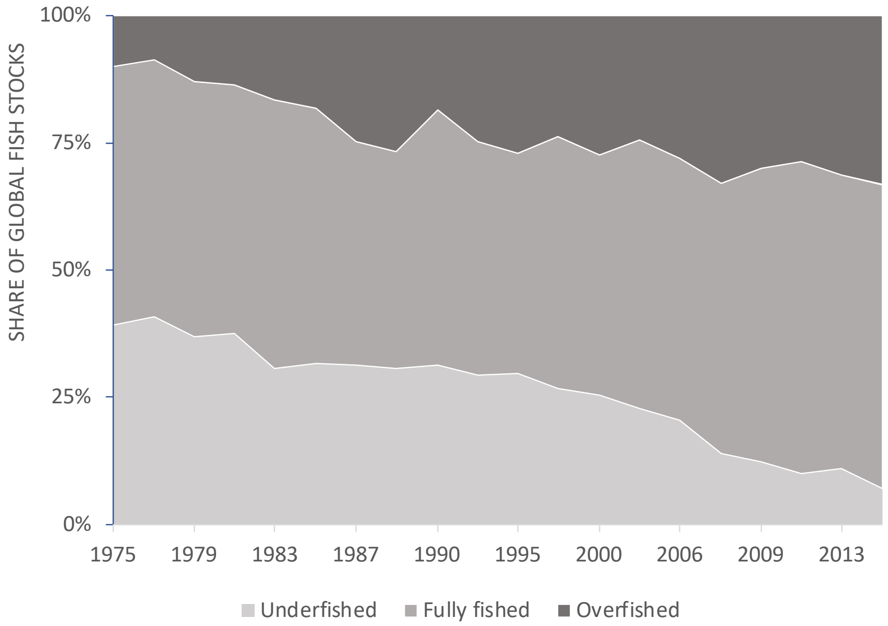

Figure 1.2. Trends in the state of the world’s marine fish stocks, 1975–2015.

Source: SOFIA, 2018.

The terms ‘overfishing’ and ‘overfished’ are often used interchangeably but they have different meanings. *Overfishing* can be defined as a harvest rate that is higher than the rate that produces the Maximum Sustainable Yield (MSY), where MSY is the largest yield that can be taken from a stock indefinitely. A fish stock is *overfished* when its stock size is below the size required to deliver MSY and its ability to reproduce may also be at risk. The former refers to the activity of fishing, the latter to the state of a stock that has been subject to overfishing. A fish stock can be overfished, subject to overfishing, or both (Beddington, Agnew and Clark, 2007; Worm *et al.*, 2009). Thus, Figure 1.2 shows the proportion of global fish stocks that have been overfished, not the proportion of fish stocks subject to overfishing, which infers something about the future state of fish stocks.

The global division of overfished stocks is not spread evenly. The Mediterranean and Black Sea has the highest percentage of overfished stocks (62%), followed by the Southeast and Southwest Pacific (61% and 59%, respectively). In the Northeast Atlantic, which is where the Faroese fleets predominantly operate, 27% of stocks are overfished (FAO, 2018b). The Atlantic cod (*Gadus morhua*), historically the most important stock in Faroese waters, is among the ten most productive species in the world but it still had a higher than average proportion of overfished stocks[3] (FAO, 2018b).

Overfishing affects the population dynamics of fish stocks. In simple terms, the size of the stock (usually) determines recruitment to the stock, which determines the future size of the stock in what is known as the stock-recruitment relationship. A single-species stock-recruitment relationship can be written as:

$$X_t = F(X_{t-1} - H_{t-1}) \qquad (1)$$

where X_t is the size of the stock at time *t*, *F* is the recruitment function, and *H* is harvest. In this simplified illustration of the stock-recruitment relationship, the size of the stock is a function of the size of the stock at time *t-1* minus the harvest at time *t-1* (Charles, 2000).

Although this stock-recruitment relationship is simple, full of assumptions, and ignores other variables such as age structure of the stock, survival rate, growth rate or random fluctuations (Clark, 1976), it serves its purpose in illustrating the impact on the size of the stock if the rate of harvest exceeds the growth rate: it will decline (Clark, 1976; Charles, 2000). If the harvest rate equals the growth rate, stocks will remain constant. Therefore, the sustainable yield is equal to the growth rate (Clark, 1976). This is the most fundamental principle of renewable resource management (Clark, 1976) and will be explored in more detail in section 1.4.

1.3.2 Overcapacity

One reason fish stocks are overfished and subject to overfishing is fleet overcapacity.

> “[T]here is no question that current fishing capacity greatly exceeds sustainable harvest levels in many fisheries, and that capacity reduction would tend to relieve the pressure on vulnerable fish stocks.” (Clark and Munro, 2002, p. 473)

[3] There are 14 separate cod stocks in the Northeast Atlantic.

Overcapacity can mean several things. It can mean that there is an overcapacity in relation to sustainable catch levels, i.e., overcapacity relating to overfishing; it can mean that the capacity of the fleet is larger than it needs to be to catch current levels of catch, i.e., overcapacity relating to inefficiency; and it can mean that the capacity of the fleet is larger than some specified optimum capacity (Clark and Munro, 2002). The first interpretation is the most common, and usually occurs in the following way: under an open access scenario, where vessels are free to enter and harvest as much as they can, vessels will continue to enter and operate in the fishery until the cost of fishing exceeds the gains due to overfishing (see 1.4). The second definition is also referred to as economic overfishing because the result is rent dissipation (Munro and Scott, 1985).

Many fisheries are managed with effort limitations where limitations are placed on the fishing effort vessels are allowed to put into the fishery, e.g., time at sea, gear type, engine size, vessel size, etc. The management objective is to limit harvesting capacity to preserve stocks (Clark and Munro, 2002; Squires *et al.*, 2017; Anderson *et al.*, 2019). These types of management systems are prone to the first type of overcapacity problems, overcapacity relating to overfishing. The reason is that vessels are incentivized to increase their harvesting capacity by adjusting unregulated effort variables. For example, if a fishery is regulated with a certain number of fishing days per season, fishers have an economic incentive to increase their harvesting capacity by adjusting unregulated variables, such as engine power, gear specifications, or improve technology in order to catch more fish. This is often referred to as a "capital stuffing" (Townsend, 1985). In addition, there is "technological creep" in which vessels continuously increase their effort with technological improvements (Munro and Scott, 1985; Marchal *et al.*, 2007). The challenge is that there are so many variables that can be adjusted to improve harvesting capacity that managers are unable to sufficiently control all. Harvesting capacity inevitably increases to the point of overcapacity, which leads to overfishing (Clark and Munro, 2002; Squires *et al.*, 2017; Anderson *et al.*, 2019).

When effort limitations fail, managers often resort to TACs in order to rebuild the stock, i.e., placing limits on how much can be harvested from a stock. TACs on their own often lead to economic overfishing because once a TAC has been reached, the fishery is closed. Therefore, the incentive is for vessels to harvest as much as possible in the shortest amount of time possible, the so-called race to fish (Beddington, Agnew and Clark, 2007; Birkenbach, Kaczan and Smith, 2017). Vessels with the largest harvesting capacity are naturally able to harvest more than others before the fishery is closed for the season, prompting individual vessels to increase their harvesting capacity—by capital stuffing—with the consequence that the fleet as a whole increases their harvesting capacity far beyond what is necessary to harvest TACs (Clark and Munro, 2002; Anderson *et al.*, 2019).

The challenge in fisheries and the reason that overcapacity is such a persistent problem is that vessels do not leave a fishery when it becomes overfished. Instead fishers try to increase their competitive advantage by increasing their capacity, thus further exasperating the problem of controlling effort. The reason is that their capital costs prevent them from leaving the fishery. Capital costs, in this instance vessel and gear costs, are ‘non-malleable’, i.e., they cannot easily be turned into other forms of capital. In other words, the investments they have made in their fishing vessels prevents them from leaving the fishery because these investments cannot easily be recovered (Clark and Munro, 2002).

Thus, overcapacity in the first meaning negatively impacts fish stock sustainability and, by implication, the long-term viability of the fishery. In the second sense, overcapacity is economically inefficient, not only due to the cost of building and maintaining excess capacity but also because the cost per unit of effort increases as stock sizes decrease from overfishing, and rent dissipation is the result (Clark and Munro, 2002).

The global fishing fleet has more than doubled in numbers over the last four decades to reach 4.5 million vessels in 2016 (World Bank, 2017; FAO, 2018a), and the number of fishers grew from 28 million to 40 million in the period 1995–2016 (FAO, 2018a). Global catches have remained stagnant for the past decades (FAO, 2018b), which naturally means that average landings per fisher have decreased. The estimated average catch per fisher in 1970 was around 5 metric tonnes, and in 2012, the number was 2.5 metric tonnes (World Bank, 2017).

The effects of overcapacity are evident. In addition to the overfishing discussed in section 1.3.1, an estimated US$ 83 billion dollars were lost globally in 2012 as a result of overcapacity, lower value of landings due to overexploitation of valuable species, and lower landings levels due to overfishing (World Bank, 2017). The cumulative economic benefits lost from fishing in the period 1974–2008 have been estimated to be US$ 2.2 trillion (Kelleher, Willmann and Arnason, 2009). Lost benefits were mainly attributed to overfishing, meaning there was less fish to catch, and to fleet overcapacity, which meant that potential economic benefits were lost through excess effort (Kelleher, Willmann and Arnason, 2009). Restoring fish stocks could increase annual landings by 13% and annual net economic benefits could grow from US$ 3 billion to US$ 86 billion. By far the largest source of economic gain (53%) can be found in reducing fishing costs by removing excess capacity (World Bank, 2017).

Overfishing and overcapacity are in effect symptoms of the same problem, namely the absence of well-defined property rights (Ward *et al.*, 2004; Anderson and Seijo, 2010). Well-defined use or property rights create incentives for fishers to maintain fish stocks, and, if rights are transferable, the process of increasing efficiency will reduce fleet capacity as rights concentrate in fewer hands (Clark and Munro, 2002; Ward *et al.*, 2004; Anderson and Seijo, 2010). This is discussed in more detail in section 1.4.

1.3.3 Subsidies

The word subsidies can mean several things. In the most narrow sense, subsidies are a financial transfer from the government to an industry, but subsidies can also take other forms, e.g., waiving fees or taxes that firms normally pay (Schrank, 2003). Therefore, fisheries subsidies are difficult to define and vary between countries, but the definition used by the World Trade Organisation is useful: subsidies are defined as direct or indirect financial transfers, foregone government revenue, goods and services provided by the government at below-market prices, and price and income support (Schrank, 2003). In short, "[t]o be a subsidy, the action must confer a benefit on the firm or individual, and it must be specific to an industry or group of industries" (Schrank, 2003, p. 4).

Fisheries subsidies can be categorised as i) direct financial contributions to the industry, which may include grants for new vessels, decommissioning schemes, unemployment insurance, and price subsidies; ii) tax waivers, e.g., fuel tax exemptions and income tax deductions for fishers; iii) loans and loan guarantees for new vessels, and iv) implicit payments, e.g., lowering the price of goods and services, or trading access to foreign fishing grounds (Schrank, 2003).

Subsidies can be justified in several ways. Subsidies can help start a new industry by providing initial capital through loans or grants, or provide temporary aid to a company or industry in order to keep them afloat (Schrank, 2003). Subsidies can, however, become perverse[4]:

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[4] Sumaila *et al.* (2010) group subsidies intro three: beneficial/'good' (fisheries management programs and services, fisheries research and development, and marine protected areas), capacity-enhancing/'bad' (fuel subsidies, fleet building, renewal and modernisation programs, port construction and renovation programs, price and marketing support, processing and storage infrastructure programs, fishery development projects and support services, including tax exemptions, and foreign access agreements), and ambiguous (fisher assistance programs, vessel buyback programs, and rural fishers' community development programs).

"Perverse subsidies, which distort the true costs of fishing and artificially inflate the rent that can be derived, are major contributors to overcapacity, making fishing more attractive economically than it really is and ultimately fueling overfishing." (World Bank, 2017, p. 58)

There are many ways that subsidies can become perverse. Subsidies in the form of vessel loans or grants increase the capacity of the fleet when the fishery may already be fully- or overexploited, or the scale of the capacity increase that will follow as a result of the subsidy may not be fully realised (Lindebo, 2005). Fuel subsidies and minimum wage guarantees lower the cost and risk of fishing, thus distorting and "mask[ing] the true cost of fishing" (World Bank, 2017, p. 58), which means vessels are able to harvest more before benefits equal costs (Clark and Munro, 2002; Lindebo, 2005). Price support creates an incentive to increase harvest overall or for specific species, which is undesirable if the fishery is already fully- or overexploited (Lindebo, 2005).

Global fisheries subsidies have been estimated to be in the region of US$ 35 billion a year. Of those, US$ 20 billion are capacity-enhancing subsidies, the largest of which is fuel subsidies, estimated to be nearly US$ 8 billion or 22% of the annual total (Sumaila *et al.*, 2016). The implications of fisheries subsidies can be quite sinister:

"[T]he global community is paying the fishing industry billions each year to continue fishing even when it would not be profitable otherwise—effectively funding the overexploitation of marine resources" (Sumaila *et al.*, 2010, p. 201).

Capacity-enhancing subsidies were found to be especially prevalent in Europe and Asia. The European Union spend an estimated US$ 4 billion on capacity-enhancing subsidies a year, with comparatively little (under US$ 1 billion) spent on 'beneficial' subsidies, such as monitoring and enforcement. For comparison, the United States of America spent US$ 3.5 billion on beneficial subsidies of a total subsidy spend of US$ 4 billion (Sumaila *et al.*, 2010).

Once in place, subsidies can be difficult to remove due to negative social and economic consequences, at which point the subsidy programme may turn into social policy where the purpose is to support employment (Clark, 1976). The consequence is inevitably increased fishing capacity (Clark and Munro, 2002; Schrank, 2003). Subsidies, since they indirectly prevent the creation of rent or economic surplus, may also have the effect of reinforcing fishers' inability to leave the fishery due to the cost invested into capital (Clark and Munro, 2002; Kelleher, Willmann and Arnason, 2009). Decommissioning schemes may be a way of reducing overcapacity by giving operators a way out of the fishery but the effectiveness of such schemes has been seriously questioned (Clark and Munro, 2002; Clark, Munro and Sumaila, 2005; Lindebo, 2005).

Using subsidies may in certain instances be justified, e.g., to achieve social policy goals (Schrank, 2003). This approach is arguably not appropriate in fisheries-dependent economies where the policy goal is—or should be—a sustainable and profitable fishing industry (Cunningham *et al.*, 2009). As discussed in *Paper I: Fisheries policy in the Faroe Islands: Managing for failure?*, fisheries subsidies have had devastating long-term consequences in the Faroe Islands. Subsidies intended to modernise the fleet in the decades after world war II created an overcapacity that ultimately led to fish stock collapse in the 1990s, thus creating a need for further subsidies to keep the industry afloat and mitigate the effects of mass unemployment. The overcapacity created by these subsidy schemes that go back half a century still impact the profitability and sustainability of the fishing industry today, as demonstrated by the analyses in *Paper II: In pursuit of the three pillars of sustainability in fisheries: A Faroese case study* and *Paper III: Trawling for the triple bottom line: Applying the Fishery Performance Indicators in the Faroe Islands*.

1.3.4 Illegal, Unreported and Unregulated fishing

Illegal, Unreported and Unregulated (IUU) fishing is another challenge in fisheries. IUU contributes to overfishing, reduces the profits of legitimate fishers by providing illegitimate fishers with unfair competitive advantages, and threatens people's ability to sustain themselves by contributing to overfishing, especially in developing countries (OECD, 2004). Illegal fishing refers to "activities conducted by vessels operating in contravention to national laws or international measures" (OECD, 2004, p. 20). Unreported fishing refers to fishing activities that have not been reported or misreported (FAO, 2001). Unregulated fishing refers to "fishing activities conducted by vessels that, while not in formal conflict with laws and regulations, are nevertheless inconsistent with conservation measures or broader state responsibilities to this effect" (OECD, 2004, p. 20). This includes using flags of convenience to avoid strict regulatory measures or avoid regulations entirely, for example by using flags not party to regional fisheries management organisations of the fishing area in question (FAO, 2001).

Illegal fishing is a bigger problem in developing countries due to lacking or ineffective monitoring, control and enforcement (Petrossian, 2014; Okafor-Yarwood, 2019). The presence of valuable species in a country's territorial waters also makes it vulnerable to illegal fishing (Petrossian, 2014). The reasons illegal fishing occurs include a perceived low risk of being caught when enforcement is lacking and the potential gains from catching high-value species (Petrossian, 2014).

Unreported catch is believed to substantially and systematically distort the global catch records collected by the FAO from individual countries (Watson and Pauly, 2001). While some nations are believed to be underreporting their catches (Watson and Pauly, 2001), the general consensus is that inaccuracies are the reason that global catch is substantially higher than FAO data indicate (FAO, 2018b). These inaccuracies may arise from omitting data from small-scale fisheries, subsistence fisheries, recreational fishing, bycatch, or illegally caught fish (FAO, 2018b). Catch reconstructions indicate catches are 53% higher than that reported by FAO (Pauly and Zeller, 2016), and whereas FAO data indicate catches have remained relatively stable for the past few decades, catch reconstructions show a large decline in catch (Pauly and Zeller, 2016; FAO, 2018b).

Unreported—or under-reported—catch and non-compliance is more of an issue in some regulatory approaches than others. The home fleet in the Faroe Islands has been managed with effort quotas since 1996. At the time of implementation, effort quotas were favoured over catch quotas because they were said to eliminate the incentive to discard, under- and mis-report, and high-grade (Jákupsstovu *et al.*, 2007; Gezelius, 2008; Hegland and Hopkins, 2014; ICES, 2015). Under catch quota management, which was in place in the home fishery from 1994 to 1996, discarding was rife as catch quotas became restrictive due to a sudden growth in the cod stock (Jákupsstovu *et al.*, 2007; Gezelius, 2008; Hegland and Hopkins, 2014).

The principle behind catch quota regulations is that vessels must hold quotas for what they land but under effort quota management, vessels are restricted by their inputs to the fishery, for example time at sea and gear specifications. As such, there is no limit to how much they can fish (Anderson *et al.*, 2019), and the assumption is that there is no incentive to discard if vessels are allowed to land everything they catch (Jákupsstovu *et al.*, 2007; Hegland and Hopkins, 2014; Laksá *et al.*, 2016). However, there are costs associated with fishing, and costs usually increase with effort (Munro and Scott, 1985). Therefore, fishers have a clear incentive to only land high-value species in order to not waste time or fuel bringing fish to shore that is of little value and may not cover costs (Laksá *et al.*, 2016). It is therefore clear that effort management does not entirely remove the incentive to discard, under-report or high-grade; the incentive is merely not as strong as under catch quota management (Squires *et al.*, 2017).

As mentioned, if a fishery is regulated with catch quotas, there are species-specific limits to how much vessels can land (Anderson *et al.*, 2019). This is how the Faroese pelagic and distant-water fisheries are managed (Grótinum *et al.*, 2016). In some cases, these vessels are able to acquire additional quotas to ensure they hold quotas for everything they land, e.g., if the quotas are transferable, or are allowed to catch against the following year's quota (Grótinum *et al.*, 2016). If they are not able to acquire additional quotas or fish against the following year's quota, the incentive to quota-discard, underreport catches, or high-grade is naturally stronger (Poos *et al.*, 2010). Vessels can choose to face the consequences of fishing in excess of their quota, or they can choose one of the before-mentioned options, all of which allow them to increase their revenue as they maximise output (Gordon, 1954).

Discarding is illegal in the Faroe Islands[5] and even though ICES estimates that discarding is negligible in the Faroese effort quota fisheries (ICES, 2018c, 2018a, 2018f), there is anecdotal evidence of discarding and high-grading in the effort quota system fisheries and of under-reporting in the catch quota fisheries (pers.obs.). A case study on discarding in Nordic fisheries revealed that 52% of the catch (i.e., total biomass) by Faroese vessels in the Barents Sea was discarded, including heads, backbones, cut-offs, liver, etc (Laksá *et al.*, 2016). Approximately 7% of the discarded biomass consisted of fillets (Laksá *et al.*, 2016). There are several international conventions and agreements in place to combat IUU, the details of which are outside the scope of this thesis, but it is clear that eliminating IUU remains a challenge in global fisheries as well as in the Faroe Islands.

1.4 Bioeconomics

> "Wealth that is free for all is valued by none because he who is foolhardy enough to wait for its proper time of use will only find that it has been taken by another." – Scott Gordon (1954, p. 135).

Fisheries bioeconomics integrates the disciplines of fish biology and ecology with economics. The objective of this section is to link bioeconomic theory to the challenges we have seen in previous sections and discuss how this theory can inform management measures to solve these challenges. In his seminal paper on bioeconomics, Gordon (1954, p. 124) wrote: "[M]ost of the problems associated with the words 'conservation' or 'depletion' or 'overexploitation' in the fishery are, in reality, manifestations of the fact that the natural resources of the sea yield no economic rent.". A static—or equilibrium—single-stock single-

[5] Commercial Fisheries Act (28/1994).

fleet model of the open access fishery will be used to demonstrate how this happens (Figure 1.3). Naturally fisheries are not static and rarely single-stock or single-fleet, but as with the stock recruitment model presented in section 1.3.1., it will serve its purpose of illustrating the problems Gordon refers to.

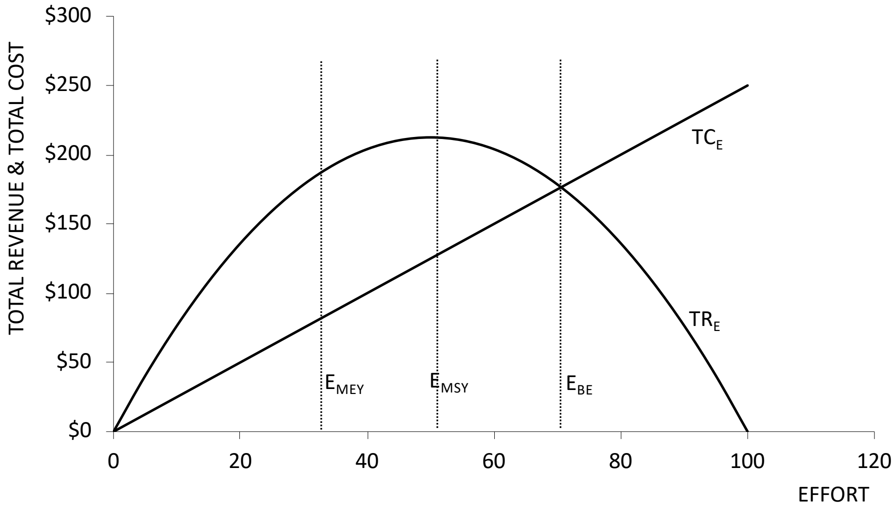

Figure 1.3. The Gordon-Schaefer model of the open access fishery.

Fish are a common-pool resource—that is, they are non-excludable—so it is difficult to prevent anyone from harvesting it, and they are rivalrous so once a fish is caught, it cannot be caught again (Munro and Scott, 1985; Seijo, Defeo and Salas, 1998; Anderson and Seijo, 2010). As the quote at the beginning of this section hints at, a fish in the sea has no value until it is caught (Gordon, 1954). A fish in the sea belongs to no one but when it has been caught it is private property. This leads to a common-property competitive exploitation scenario and affects how fishers view the resource (Clark, 1973). The goal for individual fishers is to catch as many fish as possible in order to appropriate the wealth of the resource (Gordon, 1954). Therefore, fishers are incentivised to harvest the fish as quickly as possible before someone else does it. This will soon lead to overexploitation (Gordon, 1954; Clark, 1976; Munro and Scott, 1985; Beddington, Agnew and Clark, 2007; Anderson and Seijo, 2010).

However, the long-term viability of the fishery depends on sustainable exploitation of the stock. As discussed in section 1.3.1., a fundamental principle of renewable resource management is the "fact that the sustainable yield depends on the stock level of a renewable resource" (Clark, 1976, p. 9). If the fishery is to be maintained, the harvest rate must equal the growth rate. If not, the size of the stock will decline (Clark, 1976; Munro and Scott, 1985; Anderson and Seijo, 2010).

The economic and biological outcomes of a fishery depending on the effort that goes into the fishery can be illustrated in the Gordon-Schaefer model of the equilibrium open access fishery. Figure 1.3 shows total revenue and total cost as a function of effort and stock size, where TC_E denotes total cost as a function of effort, TR_E is total revenue as a function of effort, E_{BE} is bioeconomic equilibrium, E_{MSY} is effort at MSY, E_{MEY} is effort at Maximum Economic Yield (MEY). Stock size is implicit in the total revenue curve due to the inverse relationship between effort and stock size, meaning that zero effort is the maximum stock size. It is assumed that the growth rate of the stock is logistic, i.e., the growth rate declines and becomes null when the stock reaches its carrying capacity (Clark, 1973; Beddington, Agnew and Clark, 2007; Anderson and Seijo, 2010).

The mathematical explanation of the Gordon-Schaefer model is as follows (Clark, 1976; Munro and Scott, 1985; Anderson and Seijo, 2010). The annual growth of a stock can be expressed with the following logistic function:

$$F(X) = rX\left(1 - \frac{X}{K}\right) \quad (2)$$

where *F* is the recruitment function, *X* is stock biomass, *r* is the intrinsic growth rate of the stock, and *K* is the carrying capacity of the environment.

Yield can be expressed as:

$$Y = qEX \quad (3)$$

where *Y* is yield, q is the catchability coefficient, and *E* is effort.

In equilibrium, yield is equal to the growth rate, expressed in the following way:

$$F(X) - Y = 0 \quad (4)$$

Under the assumptions of equations 2–4, total revenue as a function of effort and stock size, TR_E, can be expressed as follows:

$$TR_E = P\ (aE - bE^2) \quad (5)$$

where P is price, $a = qK$ and $b = q^2K/r$.

Total cost as a function of effort and stock size, TC_E, can be represented in the following way:

$$TC_E = C_E E \quad (6)$$

In the Gordon-Schaefer model (Figure 1.3), E_{BE} denotes the bioeconomic equilibrium. This is the steady state for an open access fishery (Gordon, 1954; Clark, 1976; Munro and Scott, 1985). At this point of equilibrium, the stock will not be able to replace what is removed from the population, so the stock size will decline[6], and the resource rent of the fishery—the sustained economic return from the stock (Nielsen, Flaaten and Waldo, 2012)—has dissipated[7] (Gordon, 1954; Munro and Scott, 1985; Beddington, Agnew and Clark, 2007). E_{BE}—the point at which dissipation of rent occurs—is illustrated by the intersection of the TC_E and TR_E curves, i.e., where total revenue equals total cost. This occurs because in an open access fishery, there is no limit to how much fishers can harvest from a stock, and individual fishers will continue to increase effort until marginal revenue equals marginal costs (Gordon, 1954; Clark, 1973; Munro and Scott, 1985; Beddington, Agnew and Clark, 2007; Anderson and Seijo, 2010).

Management interventions can change these outcomes. At E_{BE} , the fishery is open access and effort is unrestricted (Gordon, 1954; Munro and Scott, 1985). To ensure the long-term viability of the fishery, effort must be reduced to E_{MSY}, the point where effort is equal to MSY (Figure 1.3). This can be achieved by introducing measures to limit how much is taken from the stock, e.g., a TAC, or measures that reduce the effort that goes into the fishery, e.g., number of vessels, time spent at sea, vessel size, engine size, or gear (Beddington, Agnew and Clark, 2007; Anderson *et al.*, 2019). If properly implemented and enforced, such measures may prevent biological overfishing[8], but it does not necessarily prevent economic overfishing, i.e., the dissipation of rent through ‘crowding’, or economic overfishing. This is because measures to limit effort incentivises fishers to adjust unregulated variables to increase their harvest, which then leads to inefficiency (Clark, 1976; Munro and Scott, 1985; Townsend, 1985; Anderson *et al.*, 2019).

From an economic perspective, the optimal steady state is E_{MEY} (Figure 1.3). At this level of effort, the amount that is removed from the stock is smaller than what is needed for the stock to replenish and the stock will grow (Gordon, 1954; Clark, 1973, 1976; Munro and Scott, 1985; Beddington, Agnew and Clark, 2007). This is where the difference between participants’ marginal revenue and marginal cost is greatest. The resource rent generated by effort at

[6] Some species with strong schooling tendencies will not reach bioeconomic equilibrium but may go entirely extinct under such a scenario (Munro and Scott, 1985).
[7] Ignoring, for simplicity’s sake, the discussion surrounding intramarginal rent.
[8] See also section 1.3.1.

this level is illustrated by the difference between the TC_E and TR_E curves (Figure 1.3). E_{MEY} can be achieved by introducing stricter limits on how much is taken from the stock so the stock grows, but to incentivise fishers to conserve the resource (Munro and Scott, 1985) and prevent economic overfishing (Clark, 1976), it may also be desirable to introduce a form of property right. If individual fishers know that the benefits of foregoing a fish today will accrue to them in the future, they are more likely to forego that fish[9] (Gordon, 1954). This may be achieved by, for example, allocating permanent catch shares or similar rights-based schemes (Birkenbach, Kaczan and Smith, 2017; Anderson *et al.*, 2019). Catch shares also have the additional benefit of giving fishers the flexibility to harvest when it is optimal to do so, allowing them to maximise profits and reduce hazards at sea (Birkenbach, Kaczan and Smith, 2017). Finally, tradeable catch shares—often referred to as Individual Tradable Quotas (ITQs)—may increase resource rent as trading allows most efficient fishers to accumulate rights (Arnason, 2005; Anderson *et al.*, 2019).

Thus, we are back where we began this section, and can conclude that "the 'overfishing' problem has its roots in the economic organization of the industry" (Gordon, 1954, p. 128), and the most effective way to address biological and economic overfishing is by aligning economic and conservation objectives for fishers (Hilborn, 2007). The main challenge is then not necessarily how to manage the fishery to ensure objectives are aligned—with harvest rights—but how to increase future yields when stocks have become overfished. In order to increase future yields, current harvest must be reduced. "The fundamental problem then becomes one of determining the optimal trade-off to be made between current and future harvests" (Clark, 1976, p. 31). In such cases, precedence is often given to social and short-term economic objectives (Cochrane, 2000). Thus, the problem in fisheries is not the lack of tools but the failure to apply them (Beddington, Agnew and Clark, 2007).

1.5 Defining sustainability

A dictionary may define the word sustainability as "the ability to be maintained at a certain rate or level", or, more precisely in regards to natural resources, as "the avoidance of the depletion of natural resources in order to maintain an ecological balance" (Oxford Dictionaries, 2019).

Closely linked is the term "sustainable development", which derives from the 1987 United Nations report colloquially known as the Brundtland report after the chair of the commission. The Brundtland report defines sustainable

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[9] Ignoring, for simplicity's sake, the discussion surrounding the possibility for extinction and discount rates (Clark, 1973).

development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987, p. 8). In this context, development does not refer only to developing countries but to economic development: "… 'development' is what we all do in attempting to improve our lot" (United Nations, 1987, p. xi). That is, sustainable development relates to all economic and social development, meaning that both rich and poor nations need to be concerned with sustainable development. The environment is integral to social and economic development, and believing one can protect the environment without consideration to economic or social development would be naïve:

> "The environment does not exist as a sphere separate from human actions, ambitions, and needs, and attempts to defend it in isolation from human concerns have given the very word 'environment' a connotation of naivety in some political circles." (United Nations, 1987, p. xi)

Therefore, the environment and social and economic development must not be compartmentalised and treated as separate challenges but as "interdependent and integrated, requiring comprehensive approaches" (United Nations, 1987, p. 9). This is commonly referred to as the three pillars of sustainability: economic, social and environment, or sometimes people, planet, profit.

Sustainability is often separated into two paradigms—weak sustainability and strong sustainability. Weak sustainability is sometimes referred to as the substitutability paradigm (Neumayer, 2013) in reference to the works of Solow (e.g., 1974, 1986, 1993) and Hartwick (e.g., 1977, 1978). Solow reframed the long-established challenge of finite resources and inter-generational equity by proposing that there is a degree of substitutability between natural capital and manmade capital, allowing future generations to maintain net consumption[10] even if the pool of natural capital has declined, i.e., the utility derived from lost resources can be offset with other capital (1974). Solow concludes that "earlier generations are entitled to draw down the pool [of resources] (optimally, of course!) so long as they add (optimally, of course!) to the stock of reproducible capital" (1974, p. 41). Solow later expanded the argument to explicitly include social capital (Solow, 1993), thus bringing in the third pillar of sustainability. Hartwick's contribution was the idea of investing resource rents into other capital goods to offset declining stocks (Hartwick, 1977). Weak sustainability is often visualised as three overlapping circles, each of which represents one capital, where sustainability is where they all overlap (Figure 1.4).

[10] Solow defines inter-generational equity as constant per capita consumption over time.

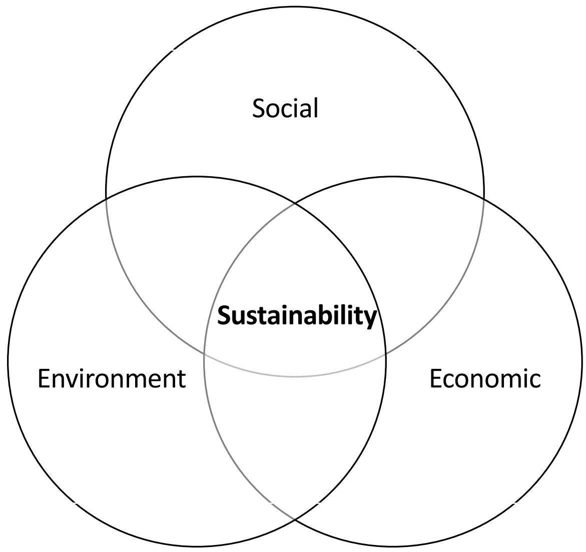

Figure 1.4. Model of weak sustainability.

Strong sustainability is more difficult to define because, unlike weak sustainability, many different authors have contributed to its creation (Neumayer, 2013). Neumayer (2013) refers to strong sustainability as the non-substitutability paradigm, and the main difference between weak and strong sustainability is that in strong sustainability natural capital is regarded as non-substitutable with other capitals (Daly, 1990; Neumayer, 2013):

> "It must be clear to anyone who can see beyond paper-and-pencil operations on a neoclassical production function, that material transformed and tools of transformation are complements, not substitutes…. Do larger nets substitute for declining fish populations?" (Daly, 1990, p. 3)

Since strong sustainability rejects substitution, it is often visualised as three nested circles, where nature encompasses society, which encompasses the economy (see Figure 1.5), to illustrate that in strong sustainability, economic growth is constrained by natural capital's ability to provide inputs (resources) and to absorb waste and pollution (Daly, 1990; Neumayer, 2013). In practical terms, this means natural capital must be preserved in terms of its physical stocks so that its functions remain intact (Neumayer, 2013)[11]. For renewable resources, this means that stocks must not deteriorate and therefore the maximum allowed harvest must be MSY (Daly, 1990).

Many papers have been written on the topic of sustainability in fisheries and several sustainability assessment frameworks for fisheries have been developed (Charles, 1994; Cochrane, 2000; Pitcher and Preikshot, 2001; Rice and Rochet, 2005; Potts, 2006; Hilborn, 2007; Leadbitter and Ward, 2007; Garmendia *et al.*, 2010; Anderson *et al.*, 2015; Asche *et al.*, 2018), as have more universal sustainability assessment frameworks that can be applied to fisheries (e.g., International Integrated Reporting Council, 2013; United Nations, 2014; Natural Capital Coalition, 2017; Social and Human Capital Coalition, 2018). In this context, it is also worth mentioning the United Nations Sustainable Development Goals, which have been developed to operationalise sustainable development (United Nations, 2019b).

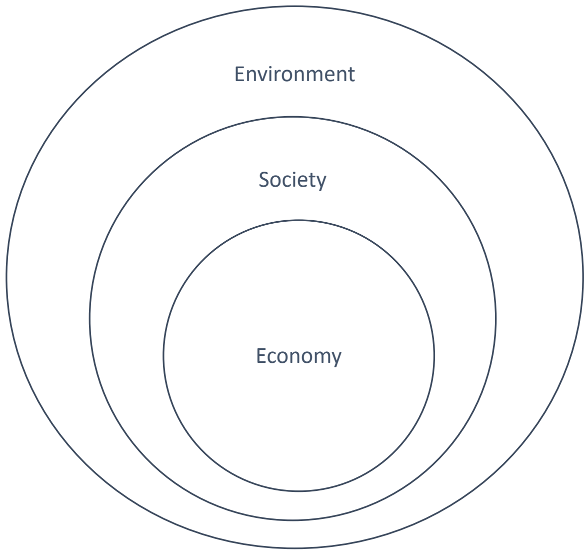

Figure 1.5. Model of strong sustainability.

[11] Another definition is that natural capital has to be preserved in value terms. This interpretation does not require natural capital to be preserved, but simply that the value of it is preserved. Therefore it allows for substitutability and compensation between natural capitals and is at odds with the idea behind strong sustainability (Neumayer, 2013). Furthermore, this definition is arguably not relevant for renewable natural resources, which can be replenished and therefore do not require substitution with other natural capitals, at least not in the narrow sphere of fisheries management (it may be relevant in deciding trade-offs with other natural capital industries).

One sustainability assessment framework developed specifically for fisheries is the FPI framework developed by Anderson *et al.* (2015). The FPI framework is used in Paper III to assess and quantify TBL[12] outcomes of three key fisheries in the Faroe Islands using 68 metrics across the three pillars of sustainability and multiple dimensions. Paper II also looks at the biological, economic and social sustainability of Faroese fisheries, focusing on a narrower, more readily available set of metrics.

Neither paper explicitly states which sustainability model is used in the assessment, but the mere fact that sustainability was assessed separately for each of the three pillars—as opposed to in a single index[13]—implies that they had the strong sustainability model in mind. If not, an index score for all pillars would have been an acceptable result. Furthermore, it is logical that in fisheries there is no substitute for the natural capital in question—fish—and therefore implicitly, the goal must be to achieve sustainability according to the strong sustainability model.

There are other benefits with the strong sustainability model. Garmendia *et al*. (2010) assess the suitability of the strong and weak sustainability model in relation to fisheries using the RapFish assessment framework (Pitcher and Preikshot, 2001), and conclude that while weak sustainability analyses in which all attributes are combined in a single index may be useful in comparing

[12] A fourth pillar has emerged in the literature, namely governance—the so-called Quadruple Bottom Line (Alibašić, 2017; Caputi *et al.*, 2018). "The fourth pillar of sustainability, governance, provides an added value to the other three components by ensuring no aspect of sustainability efforts is neglected in pursuing more sustainable organizations and communities." (Alibašić, 2017, p. 40). The FPI framework does not include governance as a pillar of sustainability along with economy, society/community and environment but governance and concepts relating to governance, such as co-management, collective action and participation, are nonetheless explicitly considered and assessed in the enabling conditions (see Paper III and section 1.6.3), which is what Alibašić (2017) and Caputi *et al.* (2018) argue—that governance is explicitly considered. One argument for not including governance as a pillar in the FPI TBL assessment is that the TBL quantifies outcomes on a scale and the enabling conditions only measure the presence of, e.g., governance. That is, in the former, a high score is better than a low score, but in the enabling conditions, a high score only reflects a higher presence, i.e., the score is agnostic (Anderson *et al.*, 2015). Alibašić (2017) discusses quantifying QBL outcomes but does not mention how to quantify governance, and Caputi *et al.* (2018) conduct a qualitative assessment of the quadruple bottom line of a fishery.

[13] Garmendia *et al.* (2010) assessed sustainability by scoring multiple attributes using the RapFish framework (Pitcher and Preikshot, 2001). In the weak sustainability assessment attributes were combined into a single index (on the rationale that all attributes are comparable and substitutable), while in the strong sustainability assessment, each attribute was individually assessed.

fisheries, the strong sustainability assessment is a better policy tool because it allows for identifying trends, which can then be used to facilitate improvement in the performance of the fishery.

1.6 Summary of methods and results

This section provides a summary of research questions, methods and results pertaining to each paper.

1.6.1 Paper I

Danielsen, R., & Agnarsson, S. (2018b). Fisheries Policy in the Faroe Islands: Managing for Failure? *Marine Policy*, 94, 204–214. http://doi.org/10.1016/j.marpol.2018.05.010

Received 5 April 2018. Received in revised form 6 May 2018. Accepted 6 May 2018. Available online 21 May 2018.[14]

For Paper I, the objective was to map and analyse the history of fisheries policy in the Faroe Islands to determine how policy had evolved and how this compared to the theory of fisheries policy and economics. It was clear from stock assessments that stocks in the Faroese EEZ had been overexploited and reports from sources such as the Faroese Economic Council concluded that parts of the fleet were overcapitalised and unprofitable. It was not clear how or why the fishery had come to be in such a state.

The paper outlines Faroese fisheries policy from 1948 when the Faroese home rule government gained competence of fisheries policy to 2018. Fisheries management in the Faroe Islands can be divided into five regimes: open access, regulated open access, licensing system, individual transferable quota system, and an effort quota system where the main management tool was fishing days. The last system has been in place since 1996. The paper describes and analyses the main characteristics of each regime to determine why management failed to prevent overfishing and overcapitalisation of the fleet.

Data was collected from primary and secondary sources. In terms of primary data, annual records of legal acts and executive orders of relevance from the Faroese Parliament in the period 1948–2018 were catalogued and analysed, as were all recorded proposed legislative changes, questions and

[14] The doctoral student, Rannvá Danielsen, conducted the research and analysis, wrote the manuscript. Sveinn Agnarsson provided guidance during the research and writing process.

comments in Parliament, and reports. A comprehensive approach was taken to the topic, and therefore all documents were reviewed relating to but not limited to:

- Fisheries regulations
- Fisheries subsidies of all kinds
- Fishing vessel and fish factory loans and loan security
- Labour laws for fishers
- Minimum wage and crew share
- Regional development policies through fishing and fish processing
- Spatial and temporal area closures, including immediate fishing bans
- Fishing by Faroese vessels in foreign fishing grounds
- Fishing by foreign vessels in Faroese fishing grounds
- Gear and technical restrictions, and minimum fish size
- Vessel measurements and regulations related to this
- Landing requirements

In excess of 1,300 documents were recorded in that initial review and from that, the most relevant were analysed in order to describe and analyse fisheries policy development.

Some secondary sources also proved vital to provide context that could not be found in Parliamentary records. A few proved especially important: a paper by Nolsøe on the initial expansion of the Faroese fishing limit (1964), Guttesen's papers on developments in the 1970s and 1980s (1980, 1991, 1992), the report that outlined the strategy for rebuilding the Faroese economy after the economic collapse in the early 1990s (Andersen *et al.*, 1993), and the report that describes the activities in especially the 1980s that led to the economic collapse in the early 1990s (Petersen *et al.*, 2000).

The primary data collection phase revealed that there were many gaps in the records held by the Faroese authorities, especially in relation to what had happened in the early 1990s during the economic collapse. Speaking to librarians at the Faroese National Library revealed that the impact of the collapse was so severe that even basic data collection and documentation ceased. Therefore, it was also difficult to determine exactly what happened with fisheries and fisheries policy in the period from 1990 to the late 1990s in the Faroe Islands. There are, for example, no records that document the political debate surrounding the policy change from ITQs to effort quotas. Papers have described after-the-fact that there were issues with TACs (e.g., Jákupsstovu *et al.*, 2007) but the political debate around this pivotal change in policy is not a matter of public record as far as the author is aware. Newspaper clippings were of some use (e.g., Dimmalætting, 1993), but difficult to navigate due to sheer volume and inability to search, and the digital newspaper archive at the Faroese National Library was also inaccessible due to technical problems for much of the period this research was conducted. Interestingly, older records from the Faroese Parliament were not found on any of the Faroese online record sites but on timarit.is, an Icelandic site.

1.6.2 Paper II

Danielsen, R. and Agnarsson, S. (2020). 'In Pursuit of the Three Pillars of Sustainability in Fisheries: A Faroese Case Study', *Marine Resource Economics,* 35(2), pp. 177-193. doi: 10.1086/708245.

Received 30 May 2019. Accepted 1 January 2020. Available online 5 May 2020.[15]

The primary objective of paper II was to evaluate the TBL performance of five key fisheries in the Faroe Islands and determine if there was a link between performance and management. Two of these fisheries were managed with harvest rights (pelagic and distant-water fleet), and three with fishing days (demersal trawlers, pair trawlers, and longliners). The results were compared with those of Asche *et al.* (2018), hence the latter were classified as limited access rights fisheries to align with the classification used by Asche *et al.* (2018) and Anderson *et al.*(2015). The secondary objective was to compare performance outcomes to official fisheries policy objectives.

To conduct the analysis, a few key indicators were selected, primarily based on data availability:

- Ecological performance: Catch composition in combination with ICES stock assessments.
- Economic performance: Economic returns (resource rent) and profitability (EBITDA and profit margins).
- Social performance: Number of fishers and fisher remuneration.

[15] The doctoral student, Rannvá Danielsen, gathered the data, calculated resource rent, conducted the analysis and wrote the manuscript. Sveinn Agnarsson provided guidance during the research and writing process.

1.6.2.1 Data collection

As will become clear, detailed data on the fishing industry in the Faroe Islands is lacking. Accounting data were taken from Statistics Faroe Islands, which were used to create two metrics for profitability, namely EBITDA[16] margin and profit margin. This is an accepted method for analysing profitability (Gunnlaugsson and Saevaldsson, 2016; Flaaten, Heen and Matthíasson, 2017). Irregular income and irregular expenses were excluded from EBITDA and profit margin calculations because the variations from one year to another were relatively large and it was not always clear what the irregular items were. Unfortunately, Statistics Faroe Islands groups the three vessel groups in the limited access system, which prevented comparisons in profitability between the three.

Due to a lack of detailed official data from sources such as Statistics Faroe Islands, data were used from the Faroese Fishermen's Union, which collects data on the activities of all vessels in the Faroese fleet. This included vessel level data on catch composition, crew composition, and remuneration for the period 1985–2014. Data were aggregated to vessel group level to preserve confidentiality and allow for meaningful analysis. The data obtained from the Faroese Fishermen's Union were incomplete in places. Where data were missing, the average from the year before and after was used as an approximate. From this, the following variables were created:

- Vessel numbers for each vessels group.
- The number of fishers employed in each vessel group.
- Average remuneration across all vessel groups.
- Catch composition for trawlers, pairtrawlers and longliners.

The data collected by the Faroese Fishermen's Union reflected the number of crew on each trip. Therefore, it did not account for crew changes and thus could not be used as an absolute measure for the number of crew in each vessel group. Instead the data were used in combination with data on total number of fishers from Statistics Faroe Islands to illustrate the relative share of fishers across vessel groups. This was based on the assumption that all vessels had the same crew change patterns.

Data on average remuneration only included crew share and did not include any wage supplements such as holiday allowance or wage subsidies. The rationale for only including the crew share in remuneration estimates was that crew share is the remuneration that the fisheries sustain. Crew share is also consistent over time; subsidies change, especially when the fishery is not able to

[16] Earnings Before Interest, Taxes, Depreciation and Amortisation (EBITDA).

sustain a wage equal to the minimum wage. As a result, remuneration data may not always represent the remuneration that fishers received but rather the basic remuneration the fishery could sustain.

Data from the Faroese Fishermen's Union on catch composition for the two vessel groups with harvest rights were not deemed of sufficient quality. Therefore, data on catch composition for these two vessel groups were taken from Statistics Faroe Islands and the Faroese Fisheries Directorate. As a result, the time series are slightly shorter.

1.6.2.2 Resource rent

Resource rent was used as an Economic indicator. The Faroese Economic Council has calculated resource rent using the following equation (2014):

$$R = \sum_{i=1}^{n} L_i p_i + OT - VC - FC \tag{7}$$

where R is resource rent; L_i is landings from stock i; p_i is price of stock i; OT is other revenue; VC is variable costs, including remuneration of labour in alternate sectors; and FC is fixed costs, including the remuneration of capital in alternate sectors.

The formula outlined in Equation 7 was used to estimate resource rent for Paper II. Rent estimations for the years 2007–2012 are based on estimates from the Faroese Economic Council. Additional data were supplied by the Faroese Ministry of Fisheries[17] that enabled the author to complete resource rent estimates for the years 2013–2017. In estimates by the Faroese Economic Council, normal annual remuneration of labour was DKK 400,000 in 2014. This value was deflated and used in rent estimates (2014). Normal remuneration of capital was set to 6%, as others have done (Nielsen, Flaaten and Waldo, 2012; Faroese Economic Council, 2014).

1.6.2.3 Correlation analysis

In a recent study by Asche *et al.* (2018), the correlation between the three pillars of sustainability was tested to determine if results varied between management systems. They concluded that ecological, economic and social[18] outcomes were at worst independent and mutually reinforcing in both access and harvest rights systems. The same correlation analysis was applied in this paper. The

[17] H. Ellefsen, pers. com., 2019.

[18] Asche *et al.* (2018) refer to it as Community outcomes, as per the FPI framework (Anderson *et al.*, 2015).

correlation analysis was conducted in the statistical computing software R using four variables across the five fisheries. The Economic pillar was represented by EBITDA (profit), Ecology by landing volume, and Social by two variables, namely jobs and average remuneration in each fishery (see Table 1.1). Spawning Stock Biomass (SSB) might have favourably been used as a variable for Ecology (Pauly, Hilborn and Branch, 2013) but data on SSB were not available for all fish stocks.

Table 1.1. Variables in the correlation analysis and number of observations for Paper II.

Pillar	Variable	Pelagic	Distant-water	Longliners	Trawlers	Pair-trawlers
Economic	EBITDA (profit)	N=30	N=30	N=30	N=25	N=30
Ecology	Total landing volume	N=25	N=14	N=30	N=30	N=30
Social	Number of fishers	N=30	N=30	N=30	N=30	N=30
Social	Average salary	N=30	N=30	N=30	N=30	N=30

1.6.3 Paper III

Danielsen, R., Anderson, C. M. & Agnarsson, S. (under second-stage review) 'Trawling for the Triple Bottom Line: Applying the Fishery Performance Indicators in the Faroe Islands'. [19]

The motivation for Paper III was to conduct a complete TBL assessment. The hypothesis was that the wealth-based approach to fisheries management (Cunningham *et al.*, 2009) generates better economic, ecological and social outcomes in fisheries-dependent, developed economies such as the Faroe Islands than the more social-centric welfare approach (Béné, Hersoug and Allison, 2010). The pelagic and distant-water fisheries have been managed more in line with the wealth-based model and the home fleet fisheries have been managed more in line with the welfare model. To test the hypothesis, the TBL performance of the pelagic fleet, the distant-water fleet and the demersal trawlers was measured using the FPI framework, a tool for assessing TBL

[19] The doctoral student, Rannvá Danielsen, collected the qualitative and quantitative data necessary to complete the analysis. The doctoral student conducted the analysis under the guidance of Chris Anderson. The doctoral student wrote the manuscript with guidance from Chris Anderson and Sveinn Agnarsson. Chris Anderson and others developed the methodology (Anderson *et al.*, 2015).

outcomes in individual fisheries and making links between outcomes, enabling conditions, and management strategies (Anderson *et al.*, 2015).

In this paper, the research questions were as follows:

- how do TBL outcomes differ between the three fisheries?
- which model of management leads to better TBL outcomes—the wealth-based model or the welfare model?

1.6.3.1 The Fishery Performance Indicators framework

The FPI framework is a rapid assessment tool developed by Anderson *et al.* (2015) for measuring the TBL performance of a fishery throughout the value chain. The motivation for developing this tool was to account for the many benefits derived from fisheries often unaccounted for, primarily due to a lack of data. While the biological and economic performance of fisheries are frequently analysed to varying degrees, there is often a lack of data and analysis on social performance and on the benefits derived from the post-harvest sector, even though it is an important part of the value chain. The FPI framework fills these gaps by providing a tool for assessing the outputs and inputs of a fishery using qualitative or quantitative data. The FPIs also separately assess enabling conditions to provide insights on matters that affect the performance of a fisheries sector, e.g., management and property rights (Anderson *et al.*, 2015).

TBL performance is captured by 68 metrics separated into 14 dimensions across the three pillars:

- Ecology
    1. Fish stock health
- Economics
    2. Harvest
    3. Harvest assets
    4. Risk
    5. Trade
    6. Product form
    7. Post-harvest asset performance
- Community
    8. Managerial returns
    9. Labour returns
    10. Health and sanitation
    11. Community services
    12. Local ownership

13. Local labour
14. Career

Harvest and post-harvest sector performance is captured by the same 68 metrics but there are only 11 dimensions in the sector assessment, so metrics are not all in the same dimension in the sector assessment. The relationships between metrics and dimensions in each assessment approach are illustrated in Figure 1 in Anderson *et al.* (2015).

Enabling conditions are assessed by 54 metrics separated into five components, which consist of 15 dimensions in total. They are:

- Macro factors
    1. General environmental performance
    2. Exogenous environmental factors
    3. Governance
    4. Economic conditions
- Property rights and responsibility
    5. Fishing access rights
    6. Harvest rights
- Co-management
    7. Collective action
    8. Participation
    9. Community
    10. Gender
- Management
    11. Management inputs
    12. Data
    13. Management methods
- Post-harvest
    14. Markets and market institutions
    15. Infrastructure

The assessment tool was developed after several iterations with extensive consulting, piloting and internal and external peer review, working with development agents and consultants, NGOs, academics, and industry. It has been extensively tested and at least 121 assessments have been conducted with the tool (Asche *et al.*, 2018). For more on the FPI methodology, see Anderson *et al.* (2015).

1.6.3.1.1 Scoring methodology

To assess the performance and enabling conditions of a fishery, a scorer needs to evaluate and score the fishery in question. This should ideally be someone who is familiar with the fishery. Drawing on the best available data, including qualitative and quantitative data, proxy data, and local expertise, each metric is scored on a continuous scale from 1 to 5 (Likert scale). Each metric has clearly defined qualitative or quantitative boundaries to ensure that scores are consistent and comparable across fisheries (see example in Table 1.2). In assessing TBL and sector performance, a high score indicates a better performance than a low score, e.g., if a fishery scores 5 on the metric *Percentage of stocks overfished*, none of the commercial stocks in the fishery are overfished, while if it scores 4, 1–25% of stocks are overfished (Table 1.2). For enabling conditions, high scores simply indicate a higher presence of what the metrics are capturing, e.g., the score on the metric *Data availability* simply indicates the extent to which biological and economic data are available.

Each score is given a quality grade based on the scorer's confidence in the score. Grades range from A to C, where A means the scorer is highly confident (95% certain) that the given score is correct; B means the scorer feels the given score is more likely than any another score; and C means the scorer is making an educated guess (see Table 1.2).

Table 1.2. Scoring the Stock performance metric *Percentage of stocks overfished.*[20]

Metric	Score system	Additional explanation	Score	Quality
Percentage of Stocks Overfished	• **5**: None overfished; • **4**: 1-25% of stocks overfished; • **3**: 26-50% overfished; • **2**: 51-75% overfished; • **1**: 76-100% overfished	Percentage of commercial stocks within the management authority's jurisdiction that are considered to be overfished, to be experiencing overfishing, or whose stock status is generally unknown. Single stock fisheries will be scored 1 or 5.	4	A

1.6.3.1.2 Scoring the Faroese fisheries

Ideally as many metrics as possible are scored using quantitative data to ensure high confidence in the scores. The vast majority of metrics received a quality grade of A or B; only a handful of metrics received the grade C. To complete the scoring, data were used from ICES (2017e, 2017c, 2017a, 2017f, 2017l, 2017b, 2017k, 2017i, 2017g, 2017j, 2017h, 2018a, 2018b, 2018c), Statistics Faroe Islands (2018a), Faroese Fisheries Directorate (2018a, 2018b), Faroese Maritime Authority (2017), Faroese Fishermen's Union (2015), World Bank

[20] Score and quality grade are for illustrative purposes only.

(2019), National Oceanic and Atmospheric Administration (2018), Marine Stewardship Council (2019a), the national budget for the Faroe Islands, grey and academic literature, legislative acts, and executive orders.

If scores could not be derived from desk research using any of the beforementioned data, or if some scores needed extra verification, stakeholders were interviewed on their specific area of expertise. All interviews were conducted over the phone except one, which was conducted via email. Although some have a preference for conducting such interviews in person (Smith *et al.*, 2019), it would have made the scoring process considerably more cumbersome and it would also somewhat defeat the purpose of a "*rapid* assessment instrument" (Anderson *et al.*, 2015, p. 3, emphasis added). The following stakeholders were interviewed:

1. Processing factory worker
2. Chief finance officer of a vertically integrated fishing company
3. Faroese fish market
4. Chief executive officer of a vertically integrated fishing company
5. Member of Parliament
6. Advisor from the Ministry of Trade
7. Fisheries expert

Smith *et al.* (2019) urge caution in relying too much on stakeholder interviews as interviewees may have unconscious or conscious conflicts of interest or biases. This precaution is not advocated in the FPI framework and was not taken into account in interviewing stakeholders beyond normal sense-checking. For the same reasons cited by Smith *et al.* (2019), it is preferable to rely on quantitative data (or proxy data if need be) as much as possible in assessing the performance of fisheries (Anderson *et al.*, 2015). All scores and grades are in the appendices to Paper III, section 4.7.

1.6.4 Paper IV

Danielsen, R., & Agnarsson, S. (2018a). Analysing the Fisheries Policy Reform in the Faroe Islands: On the Path to Sustainability? *Environmental Science and Policy*, 90, 91–101. doi:10.1016/j.envsci.2018.08.016

Received 26 May 2018. Received in revised form 28 August 2018. Accepted 29 August 2018. Available online 12 October 2018.[21]

[21] The doctoral student, Rannvá Danielsen, conducted the research and analysis, wrote the manuscript, and Sveinn Agnarsson provided guidance during the research and writing process.

The Faroese government introduced a fisheries policy reform on 1 January 2018. For Paper VI, the objective was to describe and analyse the changes introduced in the reform and discuss their potential biological and economic impacts, also in relation to the stated objectives in the reform act. The stated objectives were for the fishery to become biologically and economically sustainable, but the well-being of fishing communities was to be considered as well. The paper also discusses lessons learned from the reform process and relates it to Britain's withdrawal from the EU and therefore the Common Fisheries Policy.

The fisheries policy landscape in the Faroe Islands was described and analysed in Paper I and this analysis is used in Paper IV to provide context in the analysis of the fisheries policy reform. Reform measures were described and analysed using the Act on Management of Marine Resources (161/2017),[22] which is the legal act that implemented the reform, and the comments that accompanied the act, the management plan that was developed in accordance with the act (Steingrund *et al.*, 2019), discussions in Parliament, media content, grey literature, and data from ICES (2018a, 2018b, 2018c), the Faroese Fisheries Directorate (2018a). Impacts were analysed using theories on fisheries bioeconomics found in academic literature.

[22] Available here [in Faroese]: http://www.logir.fo/Logtingslog/161-fra-18-12-2017-um-fyrisiting-av-sjofeingi.

2. Paper I: Fisheries Policy in the Faroe Islands: Managing for Failure?

Danielsen, R. and Agnarsson, S. (2018) 'Fisheries Policy in the Faroe Islands: Managing for Failure?', *Marine Policy*, 94, pp. 204–214. doi: 10.1016/j.marpol.2018.05.010.

3. Paper II: In Pursuit of the Three Pillars of Sustainability in Fisheries: A Faroese Case Study

Danielsen, R. and Agnarsson, S. (2020) ‘In Pursuit of the Three Pillars of Sustainability in Fisheries: A Faroese Case Study’, *Marine Resource Economics,* 35(2), pp. 177-193. doi: 10.1086/708245.

4. Paper III: Trawling for the Triple Bottom Line: Applying the Fishery Performance Indicators in the Faroe Islands

Danielsen, R., Anderson, C. M., and Agnarsson, S. (under second stage review) 'Trawling for the Triple Bottom Line: Applying the Fishery Performance Indicators in the Faroe Islands'

5. Paper IV: Analysing the Fisheries Policy Reform in the Faroe Islands: On the Path to Sustainability?

Danielsen, R. and Agnarsson, S. (2018) 'Analysing the Fisheries Policy Reform in the Faroe Islands: On the Path to Sustainability?', *Environmental Science and Policy*, 90, pp. 91-101. doi: 10.1016/j.envsci.2018.08.016

6. Summary and Discussion

6.1 Summary

This body of work analyses fisheries policy in the Faroe Islands and how fisheries policy has impacted the ecological, economic and social performance of the three main fleet segments in the Faroese fishing fleet: the home fleet, the pelagic fleet and the distant-water fleet.

The topic of Paper I is fisheries policy in the Faroe Islands from the time the Faroese Home Rule government gained competence of the policy area in 1948 until 2018. The objective of Paper I was to describe and analyse fisheries policy in the Faroe Islands and to determine why management of the Faroese home fleet had failed to preserve fish stocks and prevent the fleet from becoming overcapitalised. Results were compared to management of the pelagic and distant-water fleets and inconsistencies in policy and implementation were identified. The paper concludes that the Faroese authorities have:

- Demonstrated short-sightedness in the management of the home fleet.
- (Naively) believed that fishing pressure could be directed away from overfished stocks but failed to achieve this.
- Shown an unwillingness to effectively reduce fishing pressure and implicitly given precedence to social objectives—employment—over biological and economic objectives.
- Shown an ability to manage the pelagic and distant-water fleets sustainably and rationally, demonstrating an unwillingness rather than inability to do so for the home fleet fisheries.

In Paper II, the primary objective was to assess the triple bottom line outcomes of five key fisheries in the Faroe Islands and determine if there were any differences in outcomes between management systems. The paper concludes that the fisheries managed with harvest rights—the pelagic and distant-water fleets—performed better overall: they were more sustainable, more profitable (the pelagic fleet at least), generated large resource rents, fishers were paid well, and employment numbers were growing. Fisheries managed with limited access rights—the home fleet—demonstrated systematic overfishing, generated little to no resource rent, fishers were paid relatively poorly (very poorly in the case of the longliners), and employment was declining. A correlation analysis was conducted to determine the relationship between the chosen indicators for each pillar, and results showed that the three pillars appeared to be mutually reinforcing in both systems, as there was a positive correlation between firstly, economic and social outcomes, and secondly, ecological and social outcomes. The paper also concludes that the three pillars are not incompatible[23] but complement each other, and that harvest rights systems are more likely to achieve good triple bottom line outcomes than limited access managed fisheries.

Paper III hypothesised that applying the wealth-based model to fisheries management, which argues that the policy objective in fisheries-dependent economies should be to maximise resource rent, will lead to better TBL outcomes in a resource-dependent country such as the Faroe Islands than the welfare model, which argues that fisheries should function as poverty prevention and alleviation. To test this hypothesis, the FPI tool was used to assess TBL performance in three Faroese fisheries: the pelagic and distant-water fisheries, which have been managed in line with the wealth-based model, and the demersal trawlers in the home fleet, which have been managed more in line with the welfare model, i.e., to maintain employment as discussed in Paper I and illustrated in Paper II. The paper concludes that wealth-based managed fisheries indeed had better TBL performance overall, but all three fisheries scored very high on Community performance, largely due to the high standard of living and the extensive welfare services offered by the state, which is naturally linked to the wealth generated in the country's main industry over the last few decades, namely the fishing industry. The wealth generated in the fishing industry over the last few decades has contributed to the wealth of the nation (illustrated by the high GDP per capita), raised the standard of living, and enabled the state to provide extensive welfare services[24]. Therefore, optimal

[23] Traditional fisheries economics literatures deemed ecological objectives incompatible with economic objectives, under the assumption that the fishery is open access, i.e., the "common-property competitive exploitation" scenario (Clark, 1973, p. 634). More recently, those two objectives have become aligned but there has been a perceived trade-off between economic and social objectives (Hilborn, 2007), the premise being that the social objective is to maximise MSY. With the FPI, Anderson *et al.* (2015) expand the definition of social to mean community, allowing for compatibility between all three pillars.

[24] Government expenditure was DKK 4.4 billion in 2017, of which 77% was spent on welfare services, including healthcare, education and research, and social affairs. As noted in section 3.6.2 on the economic results in the fishery, the pelagic and distant-water fisheries had far larger resource rents than the other fisheries. The pelagic fishery contributed over DKK 1bn to the public purse in resource tax, harvest fees, and auction fees in the period 2011-2017, and generated more than 4bn in resource rent in that period, on average DKK 540m a year. The home fleet did not contribute anything to the public purse in resource tax, harvest fees or auction fees in that period, and the average annual resource rent generated by the longliners and trawlers combined was DKK 39m. Forecasts in the FishRent model suggest that if ITQs had been introduced in 2019 as planned the longliners and trawlers would increase their socio-economic return (defined as resource rent + producer surplus) from DKK -74m in 2015 to DKK 209m by 2025

management of the fishery is vital to maintain the standard of living in the Faroe Islands.

The objectives of Paper IV were to describe and analyse the fisheries policy reform of 2018, its likely effectiveness, and impacts on industry. New measures introduced by the reform included:

- TACs and ITQs for the large vessel groups in the home fleet, while the fishing days system was to remain in place for the coastal fleet.
- Measures to encourage consolidation, e.g., use-it-or-lose-it measures.
- Auctions and development quotas to allocate new and revoked fishing rights.
- Harvesting fees.
- Elimination of foreign ownership and capital from the Faroese fishing industry.

Paper IV concludes that because measures to improve biological sustainability in the home fishery only apply to part of the fleet, they will most likely not be very effective at improving the status of overfished stocks. The consolidation of rights is unlikely to occur as long as the coastal fleet is managed with fishing days, as this negatively affects the quality of the rights held by longliners and trawlers, which tend to target the same stocks as the coastal fleet, thus reducing the stewardship effect, a benefit associated with ITQs (Arnason, 2005). The paper concluded that full implementation of reform measures was likely to be hindered by a lack of political consensus on management of the fishery, and this has indeed been the case. This last point is discussed in more detail in the following section.

6.2 Discussion of results

This section discusses the results from the four papers. The topics of discussion will be:

- Fisheries policy—failures, successes, and reform
- Assessing sustainability in fisheries
- The future of fisheries in the Faroe Islands

(Nielsen *et al.*, 2018). It is thus clear that applying a wealth-based approach to the management of the home fleet would increase contributions to the public purse, which in turn would strengthen the welfare state and enable it to provide even better services.

6.2.1 Fisheries policy—failures and successes

6.2.1.1 Failures

The problems in fisheries management are not a result of a lack of appropriate tools for management but rather the failure to apply them (Beddington, Agnew and Clark, 2007). That has also been the case in the Faroe Islands. The failures of fisheries management in the Faroe Islands can be summarised in the following way:

- *Overfishing:* Demersal fish stocks in Faroese waters, especially cod, have been subject to more or less constant overfishing[25], and the stock is now historically small (ICES, 2017d). Climate change does affect fish stocks (Barange *et al.*, 2018), and in relation to cod specifically, stock recruitment is strongly affected by climate when stock biomass is small (Brander, 2005), as the Faroe plateau cod has been since 2005 (ICES, 2018e). Furthermore, research from the Faroes Islands shows that increasing water temperatures in the region has affected the time and location of spawning for cod (Ottosen *et al.*, 2018), and have been linked to large variations in the abundance and nutritional quality of sandeel (*Ammodytes spp.)*—an important prey for cod and haddock—which may affect cod recruitment (Eliasen, 2013).[26] The decline in the cod stock is therefore likely due to a combination of overfishing and changes in the environment, but it is also a fact that the cod and haddock stocks have been subject to overfishing (ICES, 2017d, 2017i). Preventing overfishing is arguably even more important if stocks are made vulnerable by environmental factors.
- *Overcapacity:* From the 1950s to the 1980s, the Faroese authorities funded fleet modernisation, expansions, loans of various types as well as loan security, and, inevitably, an ineffective scrapping scheme[27]. The fleet was too large when the size of the fleet was capped in 1987 with the introduction of the licensing system, and it has been difficult to reduce capacity because the Commercial Fisheries Act allowed licenses to be sold and merged to allow larger vessels to enter the fleet in lieu of several smaller ones. While vessel numbers have declined as a result, it is unlikely

[25] ICES determined $F_{MSY} = 0.32$ in 2011, but mean F (ages 3-7) has exceeded that every year in the period 1996-2017, except 2017 (ICES, 2018f). The target mean F was ≤ 0.45 when the fishing days system was first introduced in 1996 (Jákupsstovu *et al.*, 2007), which has also been exceeded all years in the period 1996-2017, except the final (ICES, 2018f).

[26] The hypothesis is that the cod is negatively affected by increasing water temperatures but haddock less so (P. Steingrund, 2020, pers. com.).

[27] Not to mention that fleet renewal subsidies were still in place when the scrapping scheme began.

that capacity has declined significantly, if at all (Thomsen, 2005; Eigaard *et al.*, 2011). It is clear from biological and economic outcomes that the home fleet is overcapitalised, both in relation to overfishing and inefficiency (Clark, 1976; Clark and Munro, 2002).

- *Subsidies*: In addition to subsidising the modernisation, expansion, and the failed scrapping of the fleet, the government also funded operating costs of various kinds (Petersen *et al.*, 2000), landing prices through the Raw Fish Fund in order to even out landing prices and redirect fishing pressure (Guttesen, 1980, 1991, 1992), and minimum wage subsidies continued until 2010 (Statistics Faroe Islands, 2018b), well after stocks had started to decline. As discussed in section 1.3.3, these subsidies can be classed as perverse[28] because they increased the capacity of the fleet when stocks were already overfished (Lindebo, 2005; World Bank, 2017), and minimum wage subsidies lower the cost and risk of fishing, thus distorting the true cost of fishing (World Bank, 2017) and enabling fishers to continue harvesting after benefits have exceeded the true cost (Clark and Munro, 2002; Lindebo, 2005).
- *Preventing consolidation and rationalisation:* By subsidising operating and salary costs, the Faroese government prevented natural rationalisation as a result of overfishing and poor profitability from occurring (Symes and Crean, 1995; Clark and Munro, 2002). In addition to this, the Commercial Fisheries Act also had several mechanisms to prevent fishing rights from consolidating and thus the fleet from rationalising. In the ITQ system, the trade mechanism—the vital T of the ITQ—was ineffective since vessels were not allowed to permanently sell their individual quotas. In the EQ system, permanent trade across vessel groups was not possible due to the difficulty of estimating the harvesting capacity of vessels in different vessel groups in relation to fishing days. More importantly, however, is the fact that there was little to no need for vessels to acquire additional fishing days because they were so abundant[29]. Therefore, the biggest barrier for

[28] Scrapping subsidies, which aim to reduce capacity, are criticised for being ineffective and therefore Sumaila *et al.* (2010) consider them ambiguous. The Faroese authorities were funding both the renewal and scrapping of the fleet at the same time, making it a modernisation subsidy, which most likely only removed inactive operators, in effect increasing capacity. All capacity-enhancing subsidies are bad, according to Sumaila *et al.* (2010).

[29] Average utilisation in the period 1996–2015 ranged from 53% (coastal longliners) to 90% (pairtrawlers).

rationalisation was the over-allocation of fishing days[30], which eliminated the need for consolidation as fishing days did not have a binding effect.

- *Resistance to scientific advice*: The Faroese government has displayed a pattern of resistance to scientific advice. This is most evident in the Commercial Fisheries Act, which was designed to give equal weighting to scientific advice and stakeholder advice in the annual setting of fishing days.[31] This then had to pass through Parliament, giving the political system a chance to amend the allocation and divert further from scientific advice. It was clear from the beginning that the political system would use this opportunity to amend allocations—perhaps succumbing to pressure from industry (Jacobsen, 2019)—as the very first allocation of fishing days exceeded scientific advice by 69%.
- *Management plan:* The lack of a management plan for the fishery enabled the political system to ignore scientific advice because there were no harvest control rules that bound them to take measures when stocks went below certain biological reference points or thresholds (Punt, 2010).
- *Ineffective management*: There are positive aspects to EQ systems, e.g., the economic incentive to discard[32] or misreport[33] is weakened (Jákupsstovu *et al.*, 2007; Hegland and Hopkins, 2014; Squires *et al.*, 2017), fishers find it practical due to the multispecies nature of the demersal fishery in the Faroe Islands (Christensen *et al.*, 2009), and it has a high degree of stakeholder acceptance[34] (Christensen *et al.*, 2009; Hegland and Hopkins, 2014). Some

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[30] The 1:3 ratio for trading fishing from the inner fishing zone to the outer fishing zone was not helpful in this respect either.

[31] It may in fact have given preference to industry stakeholders, see footnote 34.

[32] Although Faroese fishermen privately say that discarding does occur (pers. obs.), potentially motivated by a desire to only bring to shore fish that will fetch the best price if limited by space, i.e., high grading.

[33] Misreporting also occurs by mislabelling the weight of boxes in the Faroe Islands (pers. obs.).

[34] Christensen *et al.* (2009, p. 164) describe stakeholder acceptance in the following way: "Stakeholder's acceptance involves how stakeholders perceive and respond to management." They conclude that the Faroese effort system has a high degree of stakeholder acceptance, and while Hegland and Hopkins (2014) draw the same conclusion, at least as far as industry is concerned, they also note that fishers do not support a reduction in the number of fishing days when the state of the stock would make it prudent to reduce effort. Hegland and Hopkins (2014) also note the general distrust of scientific advice by fishers, which is arguably a premise for accepting any reductions in effort. Christensen *et al.* (2009, p. 173) state the following on this matter of adjusting fishing days: "All the people interviewed assessed that the industry had greater authority when setting the number of fishing-days than the biologists. All participating stakeholders are commercial stakeholders and commercial fishing interests have particular influence in the decision-making processes." Thus, the question can be

believe the EQ system is better suited for the multispecies nature of the Faroese fishery than catch quota management (Baudron *et al.*, 2010) but there are solutions to the problem of 'choke' species[35] in catch quota systems that can prevent fishers from discarding[36]. Furthermore, neighbouring countries Iceland and Norway use the ITQ model in the management of their multispecies fisheries[37] (Eythórsson, 2000; Matthíasson, 2003; Arnason, 2008; Johnsen and Eliasen, 2011; Hannesson, 2013), where Faroese vessels also operate (see, e.g., section 5.3.1). The cost of monitoring and enforcement is sometimes used as an argument for EQ management (e.g., Squires *et al.*, 2017), but the cost of fisheries management need not be so high in ITQ systems (e.g., Arnason, Hannesson and Schrank, 2000). Some argue that the issue with the Faroese fishing days system lies with the implementation of the system, not the design, i.e., the system could work if fishing days were allocated according to scientific advice and effort was monitored[38] (Hoydal, 2014). Hoydal (2014) claims one of the advantages of the EQ system is that operators have the ability to switch between stocks and target species based on market prices, but that is precisely why EQ systems lead to overfishing: operators will continue targeting the most valuable species until the cost of doing so exceeds the profit. The literature—and experience from, e.g., Iceland (Eythórsson, 2000; Matthíasson, 2003; Arnason, 2008; Agnarsson, Matthiasson and Giry, 2016)—is clear on the challenges with EQ systems: they are ineffective at preventing overfishing and they are economically inefficient, as they in

posed, is it the management system that enjoys support, or does industry support the system due to the lack of management and the high level of control they exercise in the system? In the interest of nuance, Hegland and Hopkins (2014) note that the spatial aspects of the effort management system generally enjoys broad industry support.

35 This may occur if several species are caught together in a mixed fishery and one quota or bycatch quota is reached sooner than that for the other species, rendering the vessel unable to utilise the remainder of their quotas for other species.

36 E.g., the system may allow fishers to acquire additional quotas (Iceland), land a percentage of their catch as bycatch without utilising quota (Iceland and Norway), or land bycatch without using quota at auction and donating benefits to, e.g., a research fund (Iceland and Norway). Technical measures may also help reduce the catch of unwanted fish (Johnsen and Eliasen, 2011).

37 Hannesson notes that the Norwegian system is not a "pure" ITQ system but has "unmistakable elements of ITQs" (2013, p. 264).

38 Hoydal (2014, p. 192) writes: "There was a clear understanding that these [fishing mortality] calculations would be repeated regularly, as new stock assessments became available, thus forming the basis for estimating the number of fishing days allowed according to the rule of keeping fishing at 0.45 (33 percent of the stock in numbers) for the three main stocks in the demersal fishery. This did not happen!" He concludes (in 2014) that no such recalculation has been made to inform fishing days allocations since 1996, and as far as the author of this thesis knows, it has still not been done in 2020.

effect become regulated open access fisheries (Munro and Scott, 1985; Anderson *et al.*, 2019). In EQ systems, restrictions are placed on vessels to reduce their efficiency as a way of limiting how much they catch (Anderson *et al.*, 2019). These restrictions tend to lead to "capital stuffing" (Townsend, 1985), where fishers adjust unregulated variables, which, in addition to technological creep, makes it very difficult to limit fishing and makes the fishery increasingly inefficient (Munro and Scott, 1985; Marchal *et al.*, 2007; Eigaard *et al.*, 2014). This effect has also been documented in the Faroe Islands (Thomsen, 2005), and the lack of data collection and capacity assessments has complicated the matter of controlling effort further (Hoydal *et al.*, 2008). Ultimately, the Faroese fishing days system has failed to limit effort and is therefore in effect a regulated open access fishery. As a result, fish stocks are overfished, and the fishery is economically inefficient. The literature and experiences from other countries show that with the introduction of ITQs, stocks can be rebuilt, overcapacity can be reduced and efficiency increased, which has the potential to create a more profitable fishery for fishers and more wealth for the Faroese people (Arnason, 2008; Cunningham *et al.*, 2009; Worm *et al.*, 2009; Hannesson, 2013; Saevaldsson and Gunnlaugsson, 2015; Agnarsson, Matthiasson and Giry, 2016; Gunnlaugsson and Saevaldsson, 2016; Caputi *et al.*, 2018; Nielsen *et al.*, 2018).

The question then remains, given the importance of the fishing industry to the Faroese economy, why were these failures not corrected after the economic crisis of the 1990s had passed and it became clear that fish stock collapse could bring down the economy? Neighbouring fishing nation Iceland faced many of the same challenges as the Faroe Islands, but where the Faroe Islands continued down the same path of overfishing, fleet expansions, and subsidies, Icelanders realised the importance of biological sustainability and introduced TACs, followed by ITQs (Matthíasson, 2003). A considerable consolidation of quotas and rationalisation of the fleet has since taken place in Iceland, and while employment has declined, catch and export value has increased (Saevaldsson and Gunnlaugsson, 2015; Agnarsson, Matthiasson and Giry, 2016; Gunnlaugsson and Saevaldsson, 2016).

What is the difference between the two countries? Why did the Faroese continue down this path of failure? In the crisis years of the 1990s, there was a need to preserve as many jobs as possible at any cost. Maintaining employment has not been a concern for quite a few years (Statistics Faroe Islands, 2018a), yet the overallocation of fishing days has continued. Jacobsen analyses Faroese fisheries management through the theory of path dependence and offers the following explanation (2019, p. 4):

> "The longevity of the inefficient fisheries management regime can thus be explained by the out-sized political power of industry incumbents, particularly vessel owners, in the political bargaining over the fisheries management regime and their use of that political power to maintain their economic and political privileges into the future. Incumbents in the fisheries industry are particularly powerful stake- holders with the political power to strongly influence the political viability of any fisheries management system and block any changes to the management regime that they consider unacceptable because it undermines their entitlements to the wealth flowing from the fish re- source and their political power to influence the future shape of the fisheries management regime."

Another contributing factor might also be the massive media attention devoted to all matters relating to the fishing industry in the Faroe Islands. The scrutiny such media attention brings may simply be too unpalatable for individuals in the political system who want to introduce changes that may ultimately cause people to lose their jobs[39]. As long as there are powerful interest groups—even political parties—in favour of the status quo, change may never come. It is after all easier for the political system if job losses occur due to stock decline (which some argue is out of their control) rather than policy, and the fishing industry has no interest in losing their economic and political power (Jacobsen, 2019)[40]. The problem is not unique to the Faroe Islands:

> "The biological and ecological crises…. are driven by this social and economic importance, and the precedence frequently given to social and economic priorities over resource conservation is one of the recognised problems in fisheries management." (Cochrane, 2000, p. 7)

6.2.1.2 Successes

The pelagic and distant-water fleets were managed under the Commercial Fisheries Act from 1994 to 2018, but since these vessels also operated in the waters of other nations and targeted shared stocks, they have been subject to the management measures of applicable bilateral and multilateral agreements, as

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[39] Although given the low salary levels in especially the longliner fleet, the opportunity cost of taking up such employment would presumably in many cases be too great for the Faroese labour force (Clark, 1976).

[40] As Jacobsen (2019, p. 4) notes: "[O]wners of a vessel with a vessel license are card carrying members of a lobby group that has the ability to virtually dictate the future shape of the fisheries management regime."

well as RFMO agreements (Faroese Ministry of Fisheries, 2018). In practice, this has in most cases meant that the fisheries have been subject to TACs and vessels have been allocated catch quotas and common pool quotas.

The pelagic and distant-water fleets have not suffered from the same overcapacity issues that the home fleet has suffered from. About half of the fleet that had operated in foreign waters prior to 1977 when nations expanded their EEZs to 200nm meant many vessels lost access to foreign fishing grounds and exited the fleet (Guttesen, 1980), and data suggests they never re-entered the fleet (Faroese Fishermen's Union, 2015). This has meant that the political system has not been put in the difficult decision of forcing a rationalisation of these two fleet segments. They have however allowed new vessels to enter the fishery, e.g., when mackerel and herring stocks increased in Faroese waters, the pelagic fleet expanded (Faroese Fishermen's Union, 2015). Nonetheless, the positive outcomes of the policy approach in the pelagic and distant-water fleets has been clearly demonstrated in this body of work.

6.2.1.3 Reform

Attempts were made to address past failures in the fisheries policy reform of 2018, but these were largely unsuccessful. The management plan due to be implemented had the potential to reduce the power of industry and the role politics has played in allocating fishing days in favour of a long-term strategy for rebuilding and maintaining stocks (Punt, 2010) but it was never implemented (Steingrund *et al.*, 2019). The plan to introduce TACs and ITQs to longliners and trawlers would—if properly designed to also include the coastal fleet—most likely have had the effect of improving sustainability, encouraged a consolidation of rights, which was also supported by other measures in the act, including limitations on the length and volume of temporary transfers and revoking unutilised and underutilised rights, and thus improved economic outcomes. Forecasts using the FishRent model indicate that introducing ITQs in 2019[41] would have increased the socio-economic return[42] from the trawlers and

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[41] Four scenarios are modelled in the report with the aim of maximising socio-economic return; these numbers represent the outcome of a transition without restrictions on fleet adjustments (scenario three), i.e., the full effect of adjustment with ITQs. Other scenarios include a 4% limit on the yearly adjustment in vessel numbers per segment.

[42] Socio-economic return is here defined as the sum of the resource rent and the producer surplus. Socio-economic return is calculated as turnover minus costs minus opportunity costs of labour minus opportunity costs of capital plus extraordinary taxes paid (Nielsen *et al.*, 2018, p. 19). Note that the formula for socioeconomic return in the chapter on the Faroe Islands is not consistent with that used in the Introduction; the former leaves out extraordinary taxes paid in the description, see table 37. It is unclear if taxes paid are included in the results.

longliners from -€10m (approx. DKK 74m) in 2015 to €28m (DKK 209m) in 2025 and reduced vessel numbers from 45 to 22 (Nielsen *et al.*, 2018). There were critical design flaws in the reform plans, and they did not have the needed political support to be implemented. Therefore, the longliners and trawlers have continued to operate under the fishing days system (Steingrund *et al.*, 2019), and the poor economic and biological results will most likely continue.

Another failure that went unaddressed in the reform is fleet subsidies, now in the form of development quotas, which may be classed as an implicit subsidy (Schrank, 2003). Development quotas are in essence a continuation of the tradition of providing the fleet with subsidies, which has the undesirable outcome of maintaining capacity in a fishery that already has an overcapitalised fleet and overfished stocks, ultimately fuelling more overfishing (Clark and Munro, 2002; World Bank, 2017).

This means that the most critical failures of the previous system have yet to be addressed. As a result of a change in government, the reform has largely been overturned, meaning that most measures in the reform—including auctions and development quotas—have been abolished and fleet segments will continue to be managed as they were under the Commercial Fisheries Act. [43] It appears that the underlying reason for this is the same precedence for social objectives over economic and biological concerns that kept the EQ in place for so long (Cochrane, 2000), and it is also clear that industry has been opposed to the reform.

6.2.2 Outcomes and sustainability

The failures in management have negatively affected outcomes in the home fleet. Paper II showed that the failure to limit effort has led to systematic overfishing of the demersal stocks. Paper III found that the trawlers in the home fleet had the worst ecological score of the three fisheries under analysis, but the pelagic fleet did not score much better. As discussed in chapter 1, there is no substitution for fish in a fishery and therefore if a fishery is to be sustainable, it first and foremost has to be biologically sustainable (Daly, 1990; Neumayer, 2013). That means that management should aim to manage according to the strong sustainability model where the primary objective is biological sustainability, followed by community objectives, and then economic objectives (Figure 1.5).

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[43] Act on Management of Marine Resources (161/2017), as last amended (153/2019). Available here (in Faroese): https://logir.fo/Logtingslog/152-fra-23-12-2019-um-sjofeingi.

To achieve the primary objective, harvest cannot exceed MSY (Daly, 1990). That has clearly not been the case in the home fleet and to an extent also in the pelagic fleet, and the long-term consequences of allowing stocks to become overfished are potentially quite severe. Harvesting in excess of MSY has depleted the stocks and by enabling this, the Faroese authorities have effectively reduced the wealth of the nation by fishing down its natural capital stocks. They are in effect depleting the wealth upon which the nation was built. This may make the nation poorer in the long-term (Daly, 1990):

> "As growth in the physical dimensions of the human economy pushes beyond the optimal scale relative to the biosphere it in fact makes us poorer. Growth, like anything else, can cost more than it is worth at the margin." (Daly, 1990, p. 5)

That is, the economic growth the Faroe Islands have been experiencing from fishing down stocks has been at the expense of future growth. The difference between renewable and non-renewable resources is precisely that renewable resources can be utilised indefinitely if done sustainably (Clark, 1976). The effects of fishing down stocks have clearly manifested in the home fleet fishery. The negative economic and social outcomes in the home fleet fisheries outlined in Paper II are a result of depleting the demersal fish stocks, and the long-term effects of overfishing on social outcomes were also evident in the FPI assessment in Paper III, especially in the Community and Ecology performance. The observed difference in outcomes between the home fleet and the pelagic fishery, which also did not have a strong Ecology performance, is the degree of overfishing. While some of pelagic stocks are subject to overfishing (ICES, 2017k, 2017b), i.e., harvest is in excess of MSY, Faroese demersal stocks have been subject to overfishing and have become overfished, meaning that stocks have been smaller than biologically recommended (ICES, 2018a, 2018c, 2018f). The exception in the pelagic fishery is the herring stock, which has become overfished (ICES, 2018d).

The long-term effects of the overfishing seen in the demersal fishery have not yet manifested in the pelagic fishery but there have been consequences to the overfishing. The Marine Stewardship Council (MSC) suspended its certification of all Northeast Atlantic mackerel in January 2019 due to stock size going below the precautionary threshold. A new stock assessment was conducted and the stock was estimated to be above the precautionary threshold, but MSC refused to rescind the suspension due to the lack of a management agreement between the coastal states on how to exploit the stock (Marine Stewardship Council, 2019b; Undercurrent News, 2019a, 2019b). If overfishing of the pelagic stocks continues and stocks become overfished, the positive outcomes found in Papers II and III—especially the large generation of resource rent observed in the pelagic fishery—may not continue.

6.2.3 Objectives and the future of fisheries in the Faroe Islands

The wealth generated in the fishing industry over the last few decades is to a large extent responsible for the high standard of living in the Faroe Islands. As experiences in the 1990s showed, the negative effects of poor management and lost revenue naturally affect fisheries-dependent economies and communities most. Therefore, it is vital to ensure that successful parts of the Faroese fishing industry continue to be successful and to improve outcomes in the less successful parts. The strong sustainability model advocates that the primary policy objective should be to ensure biological sustainability (Daly, 1990; Neumayer, 2013). The wealth-based model argues the main fisheries policy objective in fisheries-dependent economies should be to maximise resource rent so the wealth can be redistributed (Cunningham *et al.*, 2009). The strong sustainability model and the wealth-based model are entirely compatible. To maximise resource rent means to harvest at MEY (Clark, 1976; Hilborn, 2007; Cunningham *et al.*, 2009), thus improving upon the objective of MSY (Daly, 1990), and to prevent the dissipation of rent through inefficiency (Clark, 1976; Clark and Munro, 2002). As demonstrated in Papers II and III, the wealth generated by this approach leads to better TBL outcomes.

The pelagic and distant-water fisheries have been managed according to the wealth-based model and the home fleet more along the lines of the welfare model, i.e., in pursuit of employment and equity objectives at the cost of biological and economic sustainability. Somewhat ironically, social outcomes were worse in the home fleet. Paper II documented declining employment and poor remuneration, and Paper III illustrated that the demersal trawlers had worse Community performance than the pelagic and distant-water fleets due primarily to lower scores on the Career metric. The path to optimising outcomes from the home fleet fishery seems clear: introduce harvest rights, manage to rebuild fish stocks (Worm *et al.*, 2009), and set harvest rates at MEY, thereby improving long-term ecological, economic and social outcomes.

The failures in management in the Faroe Islands appear to be the result of a lack of political consensus on how to manage the fisher, possibly also due to pressure from industry (Jacobsen, 2019). The pursuit of social objectives is a reflection of the same thing that led to measures to prevent consolidation and rationalisation in the Commercial Fisheries Act, to licenses being annulled in 2007, and to the introduction of auctions: the concern that fishing rights were accumulating in the hands of a select few. The greatest barrier for achieving a consensus in the political system on optimal management of the fishery is therefore this perception that the wealth of the fishery is unfairly being given to a few people for free.[44] There is a solution to this.

A key tenet in the wealth-based model is that the wealth of the fishery is extracted and redistributed (Cunningham *et al.*, 2009). This may be achieved with auctions, as intended with the policy reform, but there are other ways to achieve this that may gain broader political support and perhaps provide more stability for industry. Therefore, the author of this thesis suggests that the Faroese authorities commission a politically independent study to determine how the wealth generated in the fishing industry can be extracted in a fair, transparent and consistent manner. If the fishing industry adequately compensates the state for the harvest rights provided to them, rights are no longer free, and the concerns associated with harvest rights, accumulating wealth and unfairness would presumably be addressed.

Once that issue has been resolved, the political system can work towards building a consensus for a strategy for the fishing industry. It is only fair that the entire fishing industry compensates the state for their fishing rights, and therefore measures need to be taken to generate resource rent in the home fleet. A wealth-based approach would achieve that, and the indicators developed in Paper II and the sustainability assessment in Paper III may help build consensus and develop a strategy to improve outcomes (Potts, 2006), as at the very least the outcomes from the current approach are clear. Ultimately, the problematic fisheries policy seen in this body of work stems from problems in the political system. The will to resolve them must therefore also come from the political system (Cochrane, 2000).

6.3 Contribution to academic and practical knowledge

6.3.1 Academic

This thesis has contributed to the academic body of knowledge in a number of ways:

i) It has addressed knowledge gaps surrounding fisheries policy in the Faroe Islands from the time the Faroese government gained competence of fisheries matters until and including the reform of 2018.

[44] Case in point, the party of the now former Fisheries Minister who was responsible for the fisheries policy reform in 2017 and introduced auctions as a means of collecting resource rent from the fishery has advocated against allocating permanent harvest rights (Hoydal, 2019).

ii) It has contributed to the body of work on aligning the three pillars of sustainability in fisheries with two empirical case studies.

iii) It has contributed to academic literature with an empirical case study on the differences in outcomes from limited access system and harvest rights systems.

iv) And it has provided a case study on how a fisheries-dependent developed nation should and should not manage its fishery for optimal TBL outcomes.

Paper I describes and analyses fisheries policy in the Faroe Islands, and while others have contributed to academic knowledge on Faroese fisheries (Nolsøe, 1964; Guttesen, 1980, 1991, 1992; Andersen *et al.*, 1993; Løkkegaard *et al.*, 2004; Zeller and Reinert, 2004; Thomsen, 2005; Jákupsstovu *et al.*, 2007; Gezelius, 2008; Christensen *et al.*, 2009; Baudron *et al.*, 2010; Johnsen and Eliasen, 2011; Eigaard *et al.*, 2011, 2014; Hopkins, Hegland and Wilson, 2013; Asche, Bjørndal and Bjørndal, 2014; Hegland and Hopkins, 2014; Hoydal, 2014; Squires *et al.*, 2017; Nielsen *et al.*, 2018), none cover the entire period since the Faroese government gained competence of fisheries policy in 1948 to 2018. The academic community can therefore use Paper I as a reference for how the Faroe Islands have managed their fisheries.

Paper IV is a case study on how a fishery is reformed and can similarly be used to inform the process of reforming other fisheries. No other academic papers have as far as the author is aware been written about the outcome of the Faroese fisheries policy reform, and this paper can therefore be used to inform other academic work on fisheries policy reform. [45]

Papers II and III add to the body of literature that is moving from the weak model of sustainability (Solow, 1974, 1986, 1993; Hartwick, 1977, 1978) in fisheries (Hilborn, 2007) to the strong model of sustainability (Daly, 1990) in fisheries (Charles, 1994; Cochrane, 2000; Pitcher and Preikshot, 2001; Garmendia *et al.*, 2010; Anderson *et al.*, 2015; Asche *et al.*, 2018; Smith *et al.*, 2019). This has been achieved by illustrating with two different types of analyses that there need not be trade-offs between social objectives and ecological and economic objectives, but that social objectives can be reached by expanding the definition of social to encompass the entire community tied to and dependent upon the fishery. In this context, Paper II uses a small number of indicators that may be used for continuous low-effort monitoring of outcomes, while Paper III takes a more comprehensive approach to assessing TBL outcomes and includes the catching sector as well as the processing sector.

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[45] Bromley has written a report on the reform, noting that he has served as an advisor to the Government (Bromley, 2018).

The thesis as a whole has contributed to the body of academic work on property rights in fisheries by providing an empirical case study on the differences in outcomes from limited access system and harvest rights systems. While many papers have been written on the topic of property rights in fisheries, this thesis, especially papers II and III provide a case study on outcomes from different management approaches in the same country, meaning both systems are subject to the same institutional and cultural settings.

Finally, the thesis as a whole is an empirical case study on how a fisheries-dependent developed nation should and should not manage its fisheries.

6.3.2 Practical

This thesis makes a number of practical contributions. Paper I outlined past failures of management. These failures included subsidies of various sorts, an unwillingness to adhere to scientific advice, policies to prevent consolidation and thereby a much-needed rationalisation of the fleet, and the use of ineffective management tools to limit fishing effort. Policy makers can use this knowledge to learn from the mistakes of their predecessors—and indeed their own—and use it to inform future fisheries policy to prevent the same mistakes from being repeated.

Paper IV analysed the fisheries policy reform and identified flaws that should be addressed. Therefore, the analysis and findings in Paper IV—in combination with the findings from Paper I—can be used to aid decision-making. This is even more pertinent now that the fisheries policy appears to be under revision again following a change in government.

The findings in Paper II illustrate the differences in outcomes from using limited access systems and harvest rights systems. The findings make a strong case for managing all fisheries with harvest rights, and this conclusion can be used to aid decision-making. In addition to this, the results can be used to introduce small policy changes targeted at improving outcomes across the individual indicators. For example, introducing TACs in the home fleet fishery could—if properly set and enforced—eliminate biological overfishing and improve the status of fish stocks, but would not eliminate economic overfishing nor improve long-term economic outcomes (Clark, 1976), unless the issues of overcapacity were also addressed.

Paper III is a more comprehensive sustainability assessment and can therefore be used as a roadmap for improving TBL outcomes through the value chain. As with Paper II, this can be used to aid decision-making about fisheries policy, especially in relation to stock health, harvest, harvest assets and risk performance, where the fleets performed worse than in other areas. It may also be useful in a wider policy context, e.g., in relation to trade and market performance, where there appear to be some weaknesses based on results in paper III.

With Paper III, the Faroese authorities have a baseline sustainability assessment of the Faroese fishing industry throughout the value chain. The assessment is based on the year 2017, prior to implementation of the fisheries policy reform. This gave the authorities the opportunity to track the impact of the policy reform—had it not been abandoned—on the fishing industry by conducting intermittent FPI assessments. In a similar vein, Paper II tracks long-term developments in the fishing industry using a select few indicators. This gives the authorities the opportunity to monitor developments in the fishing industry on an annual basis with relatively low effort. Thus, with Paper II and III the authorities have been given the practical tools for annual monitoring of a few key indicators and for intermittent comprehensive TBL and value chain assessments.

It is the author's view that the biggest barrier for introducing policies that effectively address the failures of fisheries policy outlined in this body of work is the lack of political consensus. Sustainability indicators effectively communicate information to a broader audience and promote understanding, consensus building and communication around key sustainability issues (Potts, 2006), and therefore it is the author's hope that the results from Papers II and III might be used to build consensus in the Faroese political system around long-term solutions to the failures identified in this thesis.

The findings presented may also help the Faroese Islands meet the United Nations Sustainable Development Goals (SDG), specifically goal 14: Life Below Water. SDG 14 has several operational targets, but the following are especially relevant for the topic of this thesis:

> "By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics" (United Nations, 2019a, sec. View Goal Targets)

> "By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing…" (United Nations, 2019a, sec. View Goal Targets)

6.4 Limitations

In this section, the limitations and weaknesses of the thesis are discussed.

6.4.1 Data

There were substantial challenges in acquiring the data necessary to carry out the analyses conducted in this thesis. This is especially clear in Paper II. Data on vessel numbers, catch composition, employment and remuneration were collected from the Faroese Fishermen's Union. These are not public data and were only made available after an appeal from the author of this work to the board of the union, in which it was argued that this research project and research in general is in the public interest. The data were released after agreeing to pay an administration fee for them. The data go back to the 1980s and had not been entered into spreadsheets, so they were released on paper. Data were on vessel level and therefore had to be first entered and then aggregated into meaningful vessel groups. Data for some fisheries were missing in some years and therefore the average from the year before and after were used.

Another example of issues with data is in accessing financial data on the vessel groups in the home fleet. As is clear in Paper II, financial data was only available for the home fleet as a whole, which meant that the profitability of each vessel group could not be analysed.[46] Attempts were made to collect data on gross tonnage, vessel sizes, and age to analyse capacity developments but efforts were hindered especially by a change in how vessels are registered from GRT to GT, and the data were deemed of insufficient quality. Therefore, the biggest weakness in this thesis is the data from the Faroese Fishermen's Union used predominantly in Paper II but also in Paper III. The biggest limitation is the general lack of data on the fishing industry in the Faroe Islands as the scope of analysis could have been extended with more and better data.

Data limitations in fisheries are not unique to the Faroe Islands. Data limitations was one of the reasons for developing the FPI framework (Anderson *et al.*, 2015); FAO catch data is of questionable quality (Watson and Pauly, 2001; Garibaldi, 2012), meaning that something—on the surface—as simple as global marine catches have to be reconstructed (Pauly and Zeller, 2016); and controversial academic debates have arisen as a result of data limitations (Pauly, Hilborn and Branch, 2013). It is nonetheless somewhat shocking that a developed country whose economy is almost entirely fisheries-dependent does not collect detailed data on its fisheries. Not only does it pose questions about transparency and accountability, it also makes one wonder how the fishery has been monitored[47], especially in relation to capacity given the management approach. If not to increase transparency and accountability or improve

[46] The section on Recommendations discusses in detail which data should be collected and publicly available.
[47] We of course know the answer to that: it has not! (Hoydal *et al.*, 2008; Hoydal, 2014)

opportunities for research, then at the very least the data needs be collected to facilitate effective and informed management.

6.4.2 The coastal fishery

The coastal fishery is noticeably absent from the sustainability assessments in this thesis. The reason is a lack of data. As mentioned in the previous section, official and public data on the Faroese fleet and fisheries are limited, and the data sources used to conduct analyses in Papers II and III did not include data on these vessels. It is however vital for the recovery of the cod and haddock stocks that the effort of the coastal fleet is managed. As discussed in Papers I and IV, the coastal fishery operates under the effort quota system as the rest of the home fleet and there have been failures in management. Therefore, the fishing effort of these vessels is unrestricted. The coastal fleet is also responsible for a large proportion of Faroese cod and haddock catches, which have been overexploited (ICES, 2018a, 2018c).

The coastal fleet can be divided into a large coastal fleet and a small coastal fleet. The small coastal fleet counted 14 commercially operated vessels and around 280 non-commercial vessels in 2018. In total, these vessels accounted for almost a quarter of cod catch in Faroese waters and more than 10% of haddock catch (Faroese Fisheries Directorate, 2019a). The large coastal fleet consists of nine coastal vessels (15–40 GT), 10 coastal longliners (40–110 GT), and seven coastal trawlers (<110 GT). The coastal trawlers alone were responsible for 24% of cod catch in Faroese waters in 2018, and in total, the large coastal fleet caught 34% of cod catches and 37% of haddock catches in 2018 (Faroese Fisheries Directorate, 2019a). Thus, the coastal fleet as a whole caught nearly 60% of total cod and half of total haddock in Faroese waters in 2018 (Faroese Fisheries Directorate, 2019a). It is clear that the effort of the coastal fleet needs to be managed.

Some might argue that the majority of the vessels in the coastal fishery are non-commercial, but the non-commercial vessels alone accounted for 15% of cod catches in 2018 (Faroese Fisheries Directorate, 2019a). It is also clear that fishing effort in the small coastal fleet is completely unlimited. The non-commercial vessel group was allocated additional fishing days when they in 2019 utilised all their fishing days before the end of the year (Faroese Fisheries Directorate, 2019b). As a result, utilisation of fishing days in this vessel group went from about 5,800 in 2018 to nearly 10,800 in 2019 (Faroese Fisheries Directorate, 2019a). Furthermore, statistics on fishing days for the small coastal fleet only include how many fishing days they utilised, not how many they were allocated, as for other vessel groups (Faroese Fisheries Directorate, 2019a). One barrier for introducing harvest rights in all fisheries is the concern that the Faroe

Islands would find themselves in the same situation as Iceland did where the UN Human Rights Committee found the limited entry system to be in violation of the equality principle (Matthiasson and Agnarsson, 2010).

6.5 Recommendations

Based on the findings in this thesis and the process of conducting the research in this thesis, the following recommendations are made:

- In order to increase transparency and accountability, and enable research and monitoring, the Faroese authorities and relevant bodies should improve and expand data collection on the activities of the fishing industry and make them publicly available on Statistics Faroe Islands. This should at the very least include long-term trends of vessel level[48] data on:
    - Vessel numbers
    - Gross tonnage
    - Engine size
    - Estimated harvesting capacity[49]
    - Catch composition
    - Utilisation of fishing days and catch quotas
    - Permanent shares of fishing days and catch quotas
    - Allocation of fishing days and catch quotas
    - Permanent and temporary trade of fishing days and catch quotas
    - Sales volumes and values from auctions (if relevant)
    - Development quota allocations and utilisation (if relevant)
    - Catch quotas and utilisation of fishing rights in foreign fishing grounds
    - Financial accounts
    - Payments to the state, including company taxes and harvest fees

  Many of these data are collected but are difficult to find and others are publicly available but have been aggregated so they are no longer useful for monitoring and analysing trends in each vessel group, as, e.g., was the case with financial data from Statistics Faroe Islands used in

[48] Vessel level data is preferable to avoid issues with changes in vessel group definitions, e.g., the merger of single trawlers and pair trawlers.
[49] This requires that a methodology is developed and tested.

Paper III. In other cases, data are difficult to access, e.g., landings data from the Faroese Fisheries Directorate cannot be downloaded but must be manually copied into a spreadsheet. There is also a lack of transparency in how and to whom newly obtained fishing rights are allocated.[50]

- Fish stocks are the foundation of a fishery. Therefore, the demersal stocks in Faroese waters must be restored and the fisheries must become biologically sustainable. The most effective way to achieve this is by introducing TAC for all commercially important species[51]. These should be scientifically determined by the Faroese MRI/ICES and not be subject to any political influence.
- Efforts should also be made to reduce overcapacity in the home fleet. One solution is to replace the effort quota system with ITQs, which also addresses the race-to-fish problem that may follow with the introduction of TACs. As discussed in Paper I, the problems of the ITQ system of the 1990s were due to poor design. A flexible and well-designed ITQ system will not cause the issues experienced in the 1990s, as evidenced by the many fishing nations around the world that manage their fisheries with ITQs.
- A study or consultation should be conducted on how to extract resource rent from the fishery in a fair, transparent and consistent manner. As discussed in Papers II and III, the fishing industry is the foundation of the Faroese economy and if all fisheries were optimally managed, the fishing industry could and should contribute more to the public purse. Implementing a fair, consistent and transparent tax or harvest fees system is key to settling the political and public discontent surrounding the accumulation of fishing rights in the hands of a few operators.
- Findings in Papers II and III should be used to instigate a process of consensus building in the political system, so that a long-term strategy for the Faroese fishing industry can be developed.
- The TBL performance of all fisheries should be continuously monitored and evaluated, potentially using the indicators selected in Paper II. It may also be appropriate to conduct intermittent full TBL assessments using the FPI methodology, especially if long-term strategies are developed based on the findings of Paper III.

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[50] This has been at the discretion of the minister until the reform. It is unclear if this aspect of the reformed has been repealed.

[51] From an ethical and biodiversity perspective, all vulnerable species should be protected, not just those that are commercially important.

6.6 Further research

The process of writing this thesis prompted a number of questions that were out of scope and remain unaddressed. The main question was how to resolve the issue of a lack of consensus on how to manage the fishery. It was also clear that the question of equity and fairness has been a major challenge in the Faroe Islands, which could be resolved by extracting and redistributing a fair amount—whatever that may be—of the wealth generated in the fishery. Therefore, future research should also focus on how resource rent can be extracted in a fair, transparent and consistent manner.

6.6.1 Building stakeholder consensus

The main question prompted by this body of work is how to build the necessary consensus to achieve lasting change and manage for optimal TBL outcomes. The reform discussed in Paper IV has been overturned[52] after a change in Government. It has become clear that introducing a reform without broad political support will not be successful. Therefore, future research should focus on how to achieve consensus on how to manage the fishery for optimal TBL outcomes. This research should ideally involve both the political system and industry to prevent opposition from either stakeholder. The sustainability assessments conducted in Papers II and III may be of some assistance in this process as it illustrates outcomes from the policies that have been in place (Potts, 2006).

In terms of methodology, a number of approaches may be taken to achieve the goal of building consensus—and given the challenge, it will most likely require a number of different approaches. It would be beneficial to understand the main areas of contention better, including issues surrounding limiting access to the fishery, questions of fairness and equity, perceptions of sustainability, and what the objectives of the fishery should be. Conducting semi-structured interviews with a broad range of political and industry stakeholders and mapping the results, e.g., in Nvivo, may achieve the objective of improving the understanding of issues of contention better.

Interviews may be followed up with and used to inform an analysis of perspectives using the Q-methodology, which involves "the rank-ordering of a set of statements from agree to disagree" (Brown, 1996, p. 562) and subjecting the variation in ordering to statistical analysis (Steelman and Maguire, 1999). The strength of the Q-methodology is that it reveals subjective perspectives and

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[52] Act on Management of Marine Resources (161/2017), as amended (153/2019). Available here (in Faroese): https://logir.fo/Logtingslog/152-fra-23-12-2019-um-sjofeingi.

attitudes (Brown, 1996), which stakeholders may not wish to reveal in a regular semi-structured interview, and it can be used in a multitude of settings, including focus groups and questionnaires, allowing the public to participate as well, thereby facilitating public debate (Steelman and Maguire, 1999). The results can be used to define stakeholders' subjective viewpoints and perceptions, provide insights into preferred management approaches, and explicitly define areas of consensus and conflict (Steelman and Maguire, 1999). This may enable stakeholders to agree on a management strategy for the fishery.

6.6.2 How to extract fisheries wealth in a fair and transparent manner

Questions of equity and fairness are a recurring issue in Faroese fisheries management. The strategy for addressing these questions has been to prevent consolidation from taking place and to extract resource rent via auctions and harvest fees. One problem with this is a lack of consistency, but perhaps a more fundamental problem is that these strategies have only been aimed at the profitable fisheries. The home fleet fisheries have not been targeted in these efforts. Therefore, a suggestion for future research is to determine how the wealth of the fishery can be extracted in a fair, transparent and consistent manner across all fisheries and all fishing firms.[53]

Implementing a system that extracts wealth from the fishery is key to settling the public and political discontent with increased concentrations of harvest rights and thereby wealth. It is also—in the author's view—the main barrier for introducing wealth-based fisheries management in the home fleet. Once the public and political system sees that the wealth of the fishery is extracted and does not solely benefit the owners of the fishing companies, it would presumably be easier to convince the political system and the public that wealth-based fisheries management benefits everyone more than the current system. Many other countries have applied the wealth-based model in the management of their fisheries, including Iceland, Norway and New Zealand (Matthíasson, 2003; Arnason, 2008; Matthiasson, 2008; Cunningham *et al.*, 2009; Béné, Hersoug and Allison, 2010; Gunnlaugsson and Saevaldsson, 2016). The first step in this piece of research would be to look closely at how those countries extract resource rent.

[53] Assuming there will once again be wealth to extract from all fisheries. There are undoubtedly profitable firms in all fisheries.

6.7 Conclusions

Fisheries on a global scale face many challenges: overfishing, overcapacity, and subsidies. These problems do not arise from a lack of management tools but the failure to apply them. The Faroese fisheries suffer from many of the same challenges as global fisheries, especially the home fleet fisheries. This thesis has illustrated many failures in management, including a long history of substantial subsidies, a failure to place effective limitations on the effort of the fleet, and giving precedence to short-term social objectives over long-term TBL outcomes. This has led to fleet overcapacity, overfishing, declining employment, poor remuneration, and little to no wealth-generation in the home fleet fishery.

The Faroese fisheries have historically generated considerable wealth for the Faroe Islands and are integral for maintaining the high standard of living. The fisheries managed with harvest rights, however, generate substantially better outcomes. The pelagic fleet especially generated large resource rents and paid over DKK 1 billion in taxes and fees in the period 2011–2017; the firms in the pelagic fishery were more profitable; fishers were paid better, and employment was growing; and the harvest rights fisheries were more sustainable and generated better community outcomes than the trawlers that operate in the home fleet fishery. It is therefore clear that applying proper management tools and following a wealth-maximising approach generates better biological, economic and social outcomes.

The fisheries policy reform of 2018 did not succeed in addressing the most critical failures of management, and it did not enjoy enough broad political support to be fully implemented. The home fleet will continue to operate under the EQ system and the demersal stocks of the Faroese EEZ will continue to be overharvested. There is no substitute for fish in a fishery, and therefore it is vital for the continued wealth of the nation that stocks are sustainably utilised. The author recommends that the Faroese authorities substantially improve the collection of data relating to the fishing industry to enable monitoring and accountability. In order to develop a long-term strategy for the Faroese fishing industry, the author recommends instigating a study to build consensus on a strategy to rebuild fish stocks, eliminate overcapacity, and extract resource rent. A key barrier for consensus appears to be the perception that harvest rights management is unfair and increases inequality. A potential solution to this is to introduce a transparent, fair and consistent system for extracting wealth from the fishery, and therefore practical ways of extracting resource rent should also be part of future research. Addressing this is key in order to gain support for a wealth-based model of management. As this thesis has shown, wealth-based management has generated substantially better triple bottom line outcomes in the Faroe Islands than the welfare-based approach taken in the home fleet fisheries.

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