博士論文

Conservation and sustainable use of the oceans:

Strategic behavior and unintended consequences

（海洋の保全と持続可能な利用：戦略的行動と意図せざる結果）

Robert Blasiak

ブラジアック　ロバート

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In 1951, the American author John Steinbeck wrote that "An ocean without its unnamed monsters would be like a completely dreamless sleep". Generations later, the German filmmaker Werner

Herzog echoed this line by saying “What would an ocean be without a monster lurking in the depths? It would be like sleep without dreams. And I do not want to live without dreams.” This work is dedicated to Steinbeck, Herzog, and those who live with dreams.

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Abstract

The world's oceans form an important basis for human well-being, providing over 1 billion people with their primary source of protein, regulating the global climate, and serving as a platform for global trade. Over half of the oxygen in the atmosphere today is thought to have been produced by microscopic plankton, and the oceans have absorbed 20-35% of anthropogenic carbon dioxide. Despite fish being one of the most directly and immediately tangible of the benefits derived from functional marine systems, growing concerns exist about whether fisheries are being sustainably managed. Careful study of strategic behavior and the successes and failures associated with fisheries management can serve as a model for achieving sustainable management of other ocean ecosystem services, many of which are less tangible, and therefore potentially pose more significant challenges. This thesis is specifically focused on the strategic behaviors that can be observed in the management and exploitation of fisheries resources. Of particular interest are highly migratory and straddling fish stocks, which extend into both national jurisdictions and areas beyond national jurisdiction (ABNJ). In addition, shared fish stocks, as defined by FAO, extend across the exclusive economic zone (EEZ) of two or more national jurisdictions. The thesis has a threefold focus: (1) to assess barriers to international cooperation on marine resource management as well as the potential for targeted interventions to result in destabilizing displacement; (2) to develop typologies for different types of destabilizing "balloon effects" in marine fisheries as well as different levels of hegemony among fishing nations sharing fish stocks to create a framework for future research; (3) to develop policy recommendations for enhancing sustainable ocean management based on analysis of strategic behavior and unintended consequences.

In Chapter 2, the impacts of hegemony and shifts in dominance in marine capture fisheries are

examined. Although game theory has been used extensively to model the most stable and resource-sustaining coalitions, modeled outcomes and on-the-ground realities often diverge. Within this chapter, an inductive approach is used to assess these predictions, drawing on a detailed survey of the 25 fish species with the largest catches, according to catch weights reported to the Food and Agriculture Organization of the United Nations. Cooperative behavior is of particular relevance for the sustainable management of these fisheries, as 23 out of the 25 assessed species include straddling or shared stocks. Based on the premise that it is important to not only consider the number of fishing entities involved in a fishery, but also their respective dominance (i.e. their share of the total reported catch), a dominance-based typology was generated for these 25 species distinguishing among four categories: (1) hegemonic single-player dominance (one nation reports more than 80% of total catch); (2) coupled two-player dominance (two nations collectively report more than 90% of total catch); (3) shared small group dominance (3-5 nations collectively report more than 90% of total catch); (4) non-dominated systems (no player reports more than 20% of total catch). Following this categorization, a survey was made of the existence of bilateral/multilateral cooperative agreements for the management of each fishery. A strong negative correlation was found between the level of dominance and the existence of cooperative agreements. Accordingly, even though an average of 7.4 nations were involved in each of the hegemonic single-player systems, formal bilateral/multilateral cooperative agreements did not exist for any of these species. Although a hegemon could potentially use its dominant position to take a leading role in fostering international cooperation, the opposite was found, an effect proposed by Arnason et al. in 2000 as a de facto “veto effect”. As dominance over a fishery becomes more broadly spread among participating fishing nations, the existence of formal cooperative agreements increases. These findings have considerable policy relevance, as they suggest an underlying mechanism largely independent of geography, participating nations or governance level. More importantly, as fisheries experience shifts in dominance (e.g. due to climate-induced shifts in distribution or increased investment in fisheries development), cooperative management potentials are likely to change accordingly. The example of Pacific Saury illustrates this possibility, as it has shifted from a hegemonic single-player system to a shared small group system over the past two decades. Despite efforts to establish multilateral cooperative management mechanisms over the years, it was only in the past decade when the fishery shifted to small group dominance that a cooperative agreement was reached under the newly-ratified North Pacific Fisheries Commission.

In Chapter 3, focus is placed on the potential for so-called “balloon effects” to destabilize or reshape global fisheries. Balloon effects have long been observed in other disciplines characterized by strong transboundary elements, such as drug and wildlife trafficking. In such cases, a diverse governance landscape leads to the displacement of (illicit) activities from areas with strong control or monitoring mechanisms to weak or failed states. The imagery of squeezing a balloon, and simply displacing problems rather than solving them lead to the terminology of “balloon effects”, where displacement of illicit activities has been linked with increases in criminality, corruption and unsustainable use of resources. In Chapter 3, evidence for balloon effects is considered, with a particular focus on shared, straddling and highly migratory fisheries. In an increasingly globalized world, such fisheries are particularly prone to balloon effects, particularly when a fishery extends across a broad range of national jurisdictions and/or ABNJ. Based on a review of key international fisheries, a number of balloon effects are identified, with particular attention to the case of Alaska Pollock in the Aleutian Basin and the Skipjack and Yellowfin Tuna fisheries. The former example focuses on the North Pacific Alaska Pollock fishery, one of the most lucrative and abundant fisheries in the world. A large number of distant water fishing fleets were engaged in this fishery until the formalization of the EEZ under the UN Convention on the Law of the Sea in 1982. As a result the distribution of Alaska Pollock fell largely within the national jurisdictions of the USSR (now Russia) and USA, with a small patch of international waters in the Aleutian Basin, which was fancifully referred to as the “Donut Hole”. A balloon effect was generated as distant water fishing fleets were squeezed out of the national jurisdictions and into the Donut Hole, where exploitation of the stock rapidly grew to unsustainable levels. Despite awareness of likely overexploitation of the stock, the institutional response to this new paradigm was far slower than the response of fishing fleets. Within three years, catch levels dropped precipitously from nearly 1,500,000 tons a year to almost nothing, after which a moratorium was finally established, and remains in effect today due to a failure of the stock to rebound. A second balloon effect is examined in the Western and Central Pacific (FAO fishing area #71) Skipjack and Yellowfin Tuna fisheries. From 1992-2012, reported catches in this area more than doubled, a cause for substantial concern considering that Mora et al.’s 2009 governance index finds some of the lowest levels of management effectiveness in this region, due largely to the high proportion of fishing by foreign fleets. Likewise, the region is home to multiple small island states such as Tuvalu, which has a land mass of just 26 km^2 and an EEZ of almost 750,000 km^2. The World Bank’s Governance Indicators have found a continuous drop in regulatory quality in Tuvalu over the past decade, in line with a tripling of tuna catches from 2009-2012. Drawing on these examples and balloon effect research in other disciplines, the chapter concludes with policy recommendations for predicting and addressing future balloon effects.

Chapter 4 builds on the introduction of balloon effects within a fisheries context by introducing a typology for three distinct categories of destabilizing balloon effects, namely displacement, diffusion and intensification (DDI) and their use for analyzing coalitional stability under dynamic conditions. Displacement suggests the simple one-to-one shift of fishing activities moving from one area to another; diffusion describes a more complex movement of fishing activities from one area into an opportunistic scattering of other areas; under intensification, the shifting of fishing activities from one area into another causes overall exploitation of the resource to spike. The typology is expressly non-exclusive, and even suggests that displacement/diffusion will likely lead to intensification due to the saturated state of global fisheries. Likewise, a range of factors can generate DDI effects, for instance the establishment of a new marine protected area or no-take zone, climate-induced shifts in distribution, and increased monitoring/control of fisheries within a specific national jurisdiction. Recent examples from international fisheries are introduced to illustrate these categories: Atlantic Mackerel (displacement); Skipjack Tuna (Diffusion); Alaska Pollock (Intensification). The in-depth examination of each of these cases is furthermore used to consider both the triggers of DDI effects and the resulting loss of coalitional stability.

In Chapter 5, the key findings from the case studies in Chapters 2-4 are integrated and corresponding conclusions and policy recommendations are introduced. Particular emphasis is placed on how policy interventions often carry unintended consequences that displace rather than solve critical challenges of sustainable ocean management. In addition, drawing on interdisciplinary experience with addressing and preventing balloon effects, the use of integrated and regional interventions is underscored. The chapter concludes by highlighting limitations of the study and promising areas for further research and consideration.

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List of acronyms

ABNJ – areas beyond national jurisdiction

BBNJ – biodiversity in areas beyond national jurisdiction

CBD – Convention on Biological Diversity

CCAMLR – Commission for the Conservation of Antarctic Marine Living Resources

CFCs – chlorofluorocarbons

CITES – Convention on the International Trade in Endangered Species of Wild Fauna and Flora

CPUE – catch per unit effort

CSR – corporate social responsibility

DDI – displacement, diffusion and intensification

EBSAs – ecologically for biologically significant marine areas

EEZ – Exclusive Economic Zone

FAO – Food and Agriculture Organization of the United Nations

FCMA – Fishery Conservation and Management Act

FSI – Failed State Index

GDP – gross domestic product

ICES – International Council for the Exploration of the Sea

IMO – International Maritime Organization

IPCC – Intergovernmental Panel on Climate Change

ISA – International Seabed Authority

IUU – illegal, unreported, unregulated

MA – Millennium Ecosystem Assessment

MPAs – marine protected areas

MSC – Marine Stewardship Council

MSY – maximum sustainable yield

NEAFC – Northeast Atlantic Fisheries Commission

Nei – not explicitly indicated

NPFC – North Pacific Fisheries Commission

RFMOs – regional fishery management organizations

SPRFMO – South Pacific Regional Fisheries Management Organization

TAC – total allowable catch

UN DESA – United Nations Department of Economic and Social Affairs

UNCLOS – United Nations Convention on the Law of the Sea

UNEP – United Nations Environment Programme

UNESCO – United Nations Educational, Scientific and Cultural Organization

UNISDR – United Nations International Strategy for Disaster Reduction

UNODC – United Nations Office on Drugs and Crime

VMEs – vulnerable marine ecosystems

Chapter 1: General Introduction

1.1 The case for sustainable ocean management and cooperation

The world's oceans constitute one of the principal foundations for human well-being. Nearly one-fifth of the animal protein consumed by the world's population today comes from the ocean, with a reported 93.7 million tons of fish caught in 2011 (FAO 2014). It has been estimated that microscopic oceanic plankton has contributed more than half of the oxygen in our atmosphere, and the oceans act as the world's largest carbon sink, mitigating the effects of human activities by absorbing 20-35% of anthropogenic CO_2 emissions (Khatiwala et al. 2009, Reid et al. 2009). The ocean is a crucial platform for international trade, with more than 90% of goods being transported along ocean shipping lanes, and the rapid development of seabed mineral extraction beneath the waves has been likened to a modern-day gold rush (IMO 2015, Goldenberg 2014).

In addition to these tangible physical benefits, the oceans also provide a range of less tangible, but certainly no less powerful, cultural benefits that have fundamentally shaped civilizations around the world and throughout history. Indeed, it has even been suggested that the very beginnings of human culture can be traced back to the ocean: according to archeological records, the earliest humans lived as hunter-gatherers in East Africa's Rift Valley some 2.5 million years ago, constantly moving to match the migrations of wild herds of animals (Starr and Taggart, 2006). Over time, however, some early humans moved southwards until they reached the shore of the Atlantic in present-day South Africa. Here, they found a coastline with plentiful and nutritious food, replenished on a daily basis by the tides. According to this theory, the stable food supply allowed people to stop moving, and dedicate their energies instead to developing better tools, art, language, and more: the birth of human culture (Winchester 2010). Even if this theory for the ocean's role in creating human culture may be somewhat fanciful, it is undeniable that the oceans have shaped human culture throughout recorded history – a fact reflected in the multitude of cultural festivals, cuisines, songs, stories, religious events and more that are based on the ocean and its connection to human life.

Nevertheless, the ocean has also been, and continues to be, the source of great suffering, particularly for communities living in coastal areas prone to tsunamis, typhoons and storm surges. The United Nations estimates that approximately 44% of the world's population lives within 150 kilometers of the ocean; it is a growing percentage and certainly one reason that the damage caused by natural disasters has increased over the past decades, with UN Secretary-General Ban Ki-moon remarking that since 2000, the direct losses attributable to natural disasters were around USD 2.5 trillion (UN Atlas of the Oceans 2014, UNISDR 2013) Other threats include the risk of fisheries collapse due to over-exploitation, increasing ocean acidification, and health risks associated with the introduction of micro-plastics into marine food chains.

This full range of tangible and intangible benefits as well as the risks associated with oceans are shared by humanity and provide a strong common foundation on which to build cooperation. Likewise, all of the threats and challenges listed above can be mitigated or perhaps even eliminated to a certain extent through collaboration, sustainable management, and effective disaster-risk reduction efforts. While the reports of the Intergovernmental Panel on Climate Change (IPCC) have effectively catalogued a dizzying range of emerging scenarios under which the very nature of continued human existence is threatened, the future is far from hopeless. There have been substantial successes in raising awareness and taking global action to address global challenges. One such example is the introduction in the late 1980s of increasingly stringent controls and bans under the Montreal Protocol on the use of chlorofluorocarbons (CFCs) in an effort to close the expanding hole in the ozone layer over the Antarctic (UNEP 2012). Twenty-five years later, the Montreal Protocol has been ratified by 197 UN member states and other entities, the ozone depletion rate has stabilized, and a recovery of the ozone layer to pre-1980 levels is estimated within the next 30 years (IPCC/TEAP 2005).

The prospect of successful international cooperation to solve big problems is therefore not a hopeless cause despite a prevailing climate of pessimism (Hale et al. 2013). Furthermore, solutions do not have to be achieved solely by governments in a top-down manner, but there are also considerable opportunities for bottom-up action to achieve the conservation and sustainable use of marine resources. The research that has been conducted towards completing this dissertation originated from such optimistic notions, and aims to provide not only data and analysis that further builds on the body of scientific knowledge of these issues, but also to provide concrete recommendations for effective policy-making to spur organic bottom-up action as well as facilitate more effective top-down measures.

1.2 Structure of dissertation

This dissertation is split into three parts. Following this introduction, a review is provided of existing top-down and bottom-up efforts to achieve sustainable ocean management. In addition to providing an overview of current paradigms of ocean governance from the local to global scale, examples from historical records are introduced to contextualize current trends.

In the second section, the results of three case studies are introduced and contextualized. The first of these case studies considers the possibility of international cooperation for the management of shared and straddling fisheries (Chapter 2). This study takes an inductive approach to existing theoretical literature on international fisheries cooperation, and surveys major fisheries to determine, among other things, whether the so-called de facto veto power proposed by Arnason et al. (2000) is shaping cooperative efforts. The second case study looks at the possibility of "balloon" effects causing instability in cooperative ocean management due to the displacement of fishing activities (Chapter 3). This study considers top-down efforts to control licit and illicit fishing activities, and the perverse outcomes in which such measures can result, with inter-disciplinary parallels drawn to comparable situations related to carbon leakage, and wildlife and drug trafficking. Building on this second case study, in the third part of this section, an analysis of different types of balloon effects is introduced, culminating in the development of a typology for displacement, diffusion and intensification (DDI) in marine capture fisheries (Chapter 4) illustrated with examples from the Alaska Pollock, Atlantic Mackerel and Skipjack Tuna fisheries. In line with the requirements for a cumulative PhD at the University of Tokyo, each of these three sections has been published separately in peer-reviewed journals as follows, Chapter 2: "Impacts of hegemony and shifts in dominance on marine capture fisheries" (Blasiak et al. 2015a); Chapter 3: "Balloon effects reshaping global fisheries" (Blasiak 2015); Chapter 4: "Displacement, diffusion and intensification (DDI) in marine fisheries: A typology for analyzing coalitional stability under dynamic conditions" (Blasiak et al. 2015b).

In the third, and final, section of this dissertation, a discussion and policy recommendations are provided to translate the findings of these case studies into good practices (Chapter 5). The three case studies on which this dissertation draws provide a number of findings that are of policy relevance from the local to the international scale, and are introduced here along with recommendations for further research to build on these outcomes and conclusions.

1.3 Defining the benefits of the ocean

The Millennium Ecosystem Assessment (MA) represents a seminal step towards defining and classifying the diverse range of benefits provided by the natural environment. The MA groups these benefits into four types of ecosystem services: provisioning, regulating, cultural and supporting services (MA 2003). Among these, the provisioning services are perhaps the most immediately tangible, encompassing the goods that come to the direct benefit of people, and which are generally associated with clear monetary values (MA 2003). In the case of the oceans, the primary provisioning service is currently the 90+ million tons of fish extracted on an annual basis (FAO 2014). As a result, management of the world's fish stocks constitutes one of the key starting points for international management of the oceans. Likewise, technological advances have opened up vast oceanic mineral deposits to seabed mining, leading to the need for international legislation to regulate such activities (ISA 2015). Due among other things to the need to regulate these extractive industries, the United Nations Convention on the Law of the Sea (UNCLOS) was adopted in 1982 and fundamentally reshaped ocean governance by formalizing the Exclusive Economic Zone (EEZ) of the world's nations, generally extending outwards for 200 nautical miles from coastlines (UNCLOS 1982). UNCLOS additionally set up the International Seabed Authority (ISA), an intergovernmental body charged with extractive activities beyond the EEZ. While activities within the EEZ are under the purview of sovereign states, despite some continuing boundary disputes, governance of the vast areas beyond national jurisdiction (ABNJ) outside the EEZ represent a considerable hole in the international policy framework. This hole has only partially been filled by the subsequent Fish Stocks Agreement in 1995, which calls, among other things, for adherence to the precautionary principle in fisheries management, and the establishment of multiple regional fisheries management organizations (RFMOs) to support sustainable management of straddling and highly migratory fish stocks that extend into ABNJ (UN 1995). More detail on UNCLOS will be introduced in subsequent chapters due to its specific relevance to the case studies, but it is important to note how crucial this legislation has been for establishing an initial international framework for management of the ocean's provisioning services.

Ocean regulating services, for example the buffer function of reefs and mangroves in mitigating wave strength or the ocean's absorption of carbon dioxide as a massive carbon sink, are less economically concrete, and have only recently been seen through the prism of international cooperation within the context of growing concern over climate change (Midgley et al. 2012). Calculating their value is inherently more difficult, because it is often only possible *ex post facto* based on the relative disaster risk reduction capacity. A mangrove reforestation project in Vietnam, for example, was found to have caused a 65% reduction in monetary damages from natural disasters, corresponding to millions of dollars in avoided damage (IFRC 2010). Supporting services of the ocean include the photosynthetic processes of plankton, and are so fundamental to the functioning of ecosystems that they somewhat perversely are virtually impossible to valorize, and consequently anthropogenic damage to supporting services is difficult to quantify or internalize (Costanza et al. 1997).

Cultural services constitute one of the most interesting potential drivers of sustainable ocean management. Research has shown that proximity to terrestrial ecosystems, for example a forest, results in people valuing these ecosystems more highly, even if they receive no provisioning services from them (Muhamad et al. 2014, Sodhi et al. 2010). Aside from the thin strip of populated coastlines around the world, however, people lack proximity to the oceans. Ships trace the surface of the ocean, but the vast majority of ocean ecosystems is physically remote for people, despite the ocean providing over 90% of the Earth's habitats, and an estimated 50-80% of all life on Earth existing beneath the waves (UNESCO 2012). Nevertheless, cultural services are of undeniable importance. In a border war between Chile and Bolivia in 1879 over coastal fertilizer deposits, for instance, Chile prevailed and Bolivia lost its only stretch of coastline, rendering it a landlocked country. Today, 136 years later, Bolivia's coat of arms continues to have a star representing the lost coastal province; it is perhaps the world's only landlocked country with a navy; and regaining its maritime heritage remains an issue of national importance for the public and policy-makers (Murphy 2015).

Strong cultural connections with the oceans, however, are as old as recorded history. Nearly three thousand years ago, for example, during the seventh century BC, a purple dye that could only be extracted from the tincture vein of a certain gastropod (*Haustellum brandaris*) became a symbol of authority. Minoans, Phoenicians and ultimately the Roman Empire all used this purple dye to make robes and garments that only the upper classes were allowed to wear. Thousands of this murex needed to be harvested to produce enough dye for a single piece of clothing, leading to the dye being valued at up to twenty times its weight in gold. This cultural linkage with a marine product also spurred innovation, with the Phoenicians building ever sturdier boats capable of venturing out into the Atlantic Ocean in search of murex and, for the first time, southwards along the coast of Africa (Winchester 2010).

1.4 Approaches to ocean management

Within this sub-chapter, a simple typology is introduced for distinguishing among top-down and bottom-up approaches to sustainable ocean management. In the simplest sense, however, a dichotomized categorization is suggested, drawing on Sievanen et al. (2011) and Gaymer et al. (2014), according to which top-down approaches are associated with formal authority, while bottom-up approaches are based on informal motivations. Neither term is used in the sense of scale; hence, both bottom-up and top-down action could be local, national or even global. Likewise, the two approaches are by no means mutually exclusive, and an emerging body of practice is focused on merging the two approaches in a complementary manner (Jones 2014, Ban et al. 2011).

1.4.1 Bottom-up approaches

For sustainable ocean management, bottom-up approaches vary considerably depending on the location of communities respective to the marine areas (Gaymer et al. 2014). Fishing communities are spatially proximate to the resources that form the basis of their livelihoods, leading to a broad range of informally-driven efforts to establish different forms of no-take zones, marine protected areas, seasonal closures, etc. (Bartlett et al. 2010). The strongest informal contribution of inland communities, on the other hand, to sustainable management of spatially remote resources, may be through consumption habits and purchasing decisions.

Some forms of marine protected areas (MPAs) are created through bottom-up approaches. According to the Convention on Biological Diversity (CBD), which has called under Aichi Target #11 for at least 10% of marine and coastal areas to be under protection by 2020 (CBD 2010), MPAs are:

> “[areas] confined within or adjacent to the marine environment, together with its overlying waters and associated flora, fauna, and historical and cultural features, which has been reserved by legislation or other effective means, including custom, with the effect that its marine and/or coastal biodiversity enjoy/enjoys a higher level of protection than its surroundings.” (CBD 2004)

The second element of this CBD definition relates to informal or customary MPAs that are voluntarily created and enforced by community fishing groups. Such bottom-up efforts at sustainable resource management have been identified as the most likely to endure and have higher rates of compliance than top-down efforts (Ostrom 1990, Qiu et al. 2009). In a national assessment of Japan, Yagi et al. (2010) found nearly 400 self-imposed MPAs across the country, but noted that the actual number is likely higher due to underreporting. In the Japanese case, records of bottom-up efforts by local fisheries groups can be traced back over 250 years, and remain a successful management paradigm today due to the self-interest of fishers in resource protection and low enforcement cost as a result of the small-scale of these informal MPAs (Yagi et al. 2010). This trend towards small-scale MPAs is entirely in line with existing literature of the tendency for more sustainable management to be practiced by those proximate to resources (Sodhi et al. 2010, Bartlett et al. 2010).

Proximity, however, is not a requisite for informal efforts to support sustainable ocean management. In 2007, for the first time the majority of humanity lived in urban areas, and the trend is continuing, representing a new era for natural resource conservation (UN DESA 2014).

Urban residents are now the primary consumers of marine products, and have the potential to guide management practices with their purchasing decisions. Eco-labeling to indicate Marine Stewardship Council (MSC) certification, dolphin-safe tuna, and free trade, for example, have all been found to add value to their respective products and act as a direct incentive to the fishing industry to engage in specific practices (Wessells et al. 2001). Likewise, companies with no direct connection to the oceans may choose to engage in corporate social responsibility (CSR) activities to improve their image and attract greater support from consumers (Weber 2008). A 2007 study found that 88% of “millennials” in the USA were choosing employers based on whether their CSR practices match their own values (PWC 2008). Further informal pathways for supporting marine causes include donations and volunteering activities.

1.4.2 Top-down approaches

A vast range of formal top-down approaches to sustainable ocean management exist. At the international level, UNCLOS and the Fish Stock Agreement establish a framework for global management of marine resources, and devolve many responsibilities to each of the UN member states to exercise control over their respective EEZ. In addition, the harvesting or trade of certain marine species is restricted or banned under the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) due to listing under Appendix I or II, while a moratorium on most forms of whaling was decided on in 1982 under the International Whaling Commission (IWC) and remains in effect today. Other internationally-driven processes include the designation of ecologically or biologically significant marine areas (EBSAs) in line with CBD guidelines, and vulnerable marine ecosystems (VMEs) in line with FAO guidelines, in order to subsequently place such areas under appropriate management or protection.

At the national level, countries have the capacity to make top-down decisions on how to manage the natural resources and economic activities within their EEZs. This can entail a broad range of issues including the setting of fishing quotas, fishing gear regulations, creation of seasonal moratoria on fishing, and the establishment of MPAs. It also can encompass land use planning for what economic activities or construction is allowed in coastal areas as well as a series of other marine spatial planning measures.

This dissertation is primarily focused, however, on top-down approaches that fall between these two scales, namely supra-national regional cooperation towards sustainable management of marine resources. Fish stocks, in particular, pose a challenge at the supra-national level due to the movement of shared stocks (within the EEZ of more than one state), straddling stocks (extending across the EEZ of one or more states and into ABNJ), and highly-migratory stocks (distributed across vast ocean territories including EEZ and ABNJ areas) (FAO 1995).

According to UNCLOS, "where the same stock or stocks of associated species occur within the EEZ of two or more coastal states, these states shall seek […] to agree upon the measures necessary to coordinate and ensure conservation and development of such stock […]" (UNCLOS 1982) In the case of shared stocks, this provided an institutional stimulus to transnational cooperative management to ensure long-term sustainable management of the stocks. For straddling and highly-migratory stocks, however, a key top-down instrument was created under the 1995 Fish Stocks Agreement, which provided for a network of regional fisheries management organizations (RFMOs) to collaboratively manage the stocks (UN 1995). In both cases, associated scientific bodies such as the International Council for the Exploration of the Sea (ICES) in the Northeast Atlantic monitor stock abundance levels and issue recommendations on the maximum sustainable yield (MSY) for future fishing seasons.

1.5 Objectives

Based on the case studies outlined in Chapters 2-4, this dissertation seeks to:

(1) Assess barriers to international cooperation on marine resource management as well as the potential for targeted interventions to result in destabilizing displacement;

(2) Develop typologies for different types of destabilizing “balloon effects” in marine fisheries as well as different levels of hegemony among fishing nations sharing fish stocks to create a framework for future research;

(3) Develop policy recommendations for enhancing sustainable ocean management based on analysis of strategic behavior and unintended consequences.

Above all, this research is driven by an optimistic perception of the positive impacts for ocean management that can be generated through increased awareness and enhanced cooperation at all scales extending from international decision-making bodies to local communities and households.

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Chapter 2: Drivers of international cooperation on sustainable fisheries management

2.1 Introduction[1]

Considerable work has been undertaken using the theory of strategic behavior – game theory – to understand the formation and subsequent stability of coalitions of players engaged in the management of transboundary and straddling fish stocks. Such models generally consider cooperative and competitive games, with the stability of cooperative coalitions dependent on certain conditions. Firstly, solutions should be Pareto Optimal, meaning that in a two-player game, no change could be made to the current regime that would be to the benefit of both players. Secondly, cooperation must provide additional benefit to each player vis-à-vis a non-cooperative setting (Lindroos, Kaitala and Kronbak, 2007). Splintering of a coalition into singletons "free-riding" on the cooperative management efforts of the remaining members of the coalition is presumed to arise when the potential benefits of leaving the coalition outweigh retaliatory or punitive measures levied against the singleton (Hannesson 2011). Free riding, in fact, has been characterized as the primary threat to international fisheries cooperation (Pintassilgo et al. 2010, Lodge et al. 2007)

While this provides a compelling basis for a range of models, a considerable number of assumptions are common – the assumption of rationality, symmetrical information (all players basing their decisions on the same body of information), shared management objectives, static systemic conditions, etc. Finally, the emergence of singletons makes certain assumptions about the existence of monitoring and enforcement measures as well as the existence of

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(self-)enforcement mechanisms. An inspection of major fisheries, however, points to tremendous variability across all of these points.

In general, however, research has suggested a number of characteristics common to strategic behavior in cooperative fisheries management. Firstly, the likelihood of a grand coalition involving all players sharing a fish stock decreases as the number of players increases (Hannesson 1997), although it has also been found that a larger grand coalition is mirrored by higher relative gains from cooperation (Pintassilgo et al. 2010). Secondly, depending on the respective shares of each player, it is possible for a single player to dominate a fishery to the extent of having *de facto* veto power over cooperative management of the stock (Arnason, Magnusson and Agnarsson, 2000). Thirdly, non-cooperative management of common pool resources will lead to conditions of bionomic equilibrium characterized by excess fleet capacity and overexploitation of fish stocks (Munro, Van Houtte and Willmann, 2004).

This paper seeks to inductively explore these theoretical considerations, while also considering just how little symmetry there is in the management of marine fish stocks. Throughout these calculations, the world's 25 fish species with the largest catches are used as a reference sample for global fisheries. Since 1950, these 25 species have generally comprised some 40-50% of annual reported catches (Figure 2-1) according to data provided by member states to the United Nations Food and Agriculture Organization (FAO). This data as well as relevant literature on cooperative fisheries management and recent developments in specific marine fisheries, are used to propose a new categorization system for fisheries cooperation based on player dominance (ranging from hegemonic conditions to non-dominated fisheries). This categorization system considers that the dominance of a single player over a shared fish stock encompasses both ecological aspects (i.e. the player's capacity to comprehensively impact the abundance levels of the fish stock as a whole), as well as the player's corresponding dominance in value chains, processing and distribution capacity, and negotiation processes. This focus on asymmetries in terms of catch levels likewise picks up on a surprising result of the partition function game of Pintassilgo et al. (2010) that found evidence for greater asymmetry among players – cost asymmetry in this case – being an indicator for the increased success of respective RFMOs.

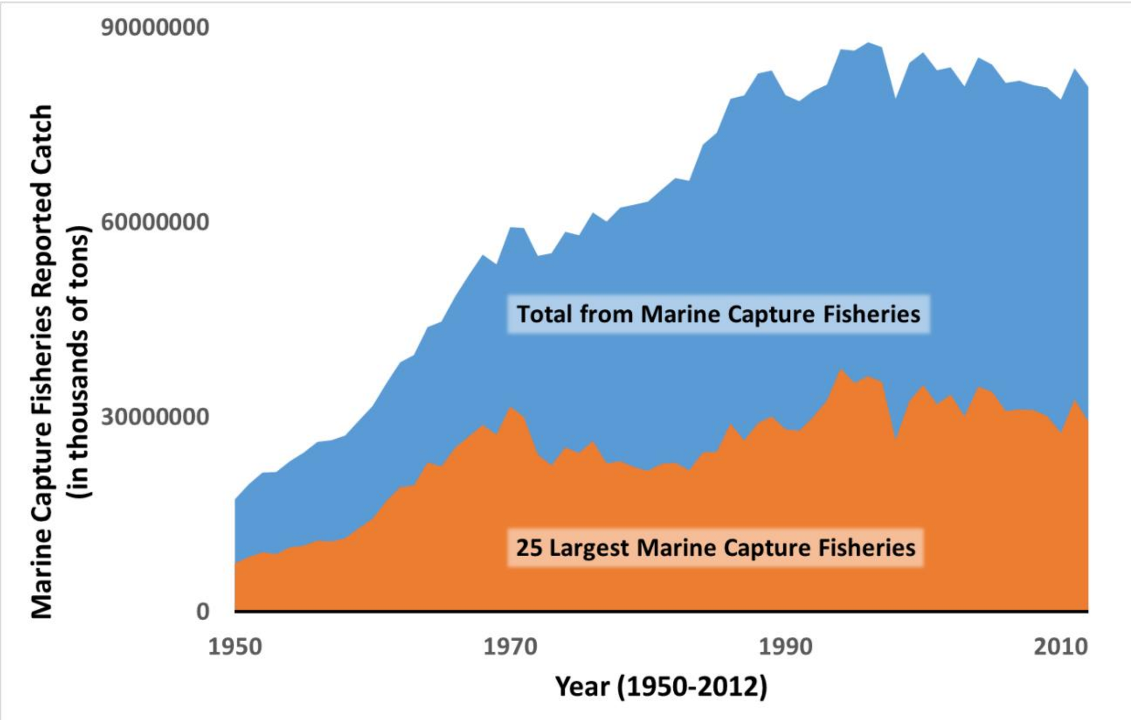

Figure 2-1: *Global fish catch reported 1950-2012 and share of 25 species with the largest catches (source: FAO FishStatJ)*

In the final discussion, policy implications are considered and the existence of "balloon effects" is briefly introduced. While external stresses may cause the intensification or reduction of certain fishing activities, balloon effects are caused by large-scale displacement of activities from one location to another. The theoretical basis and evidence for such effects has been largely generated by study of how targeted drug control efforts have displaced illicit production and transport routes into areas of least statehood (Brombacher and Maihold 2009, Chouvy 2012).

2.2 Material and methods

Containing thousands of reported and estimated catch statistics for a multitude of different species, the FAO's FishStatJ dataset is the basis for many of the calculations in this study. In addition to providing catch data by country and species, FishStatJ provides a geographical marker for each entry, corresponding to the 19 FAO Fishing Areas (FAO 2014).

Aggregated FAO marine fishery catch statistics from 1950-2012 portray a somewhat dynamic economic sector (Figure 2-1) that has remained at more-or-less steady levels since the late 1980s. To establish a meaningful sample of transboundary fish stocks for analysis in this study, the FAO catch data were sorted according to species. Over the 1950-2012 timeframe, the top 25 individual species have comprised roughly 40-50% of catch in any given year. While "marine fishes nei" (nei = not explicitly indicated) tops the list, the corresponding data lacks, by definition, a certain level of precision, representing some current limitations in the reporting capacity of member states, and a limitation in this study. Nonetheless, the relatively consistent share of these 25 species over time in global catch suggests that general trends may persist even if reporting were more specific.

Calculations were carried out to determine the level of hegemony for each of these 25 species. Four categories were defined as follows (for $x_{k1} > x_{k2} > \cdots > x_{k\epsilon}$, with x being the reported catch in tons of a certain fish species, i being one of the 19 FAO fishing areas, and k a country reporting its catch of this species to FAO):

Category 1 (hegemonic single-player dominance)

$$\sum_{i=1}^{19} x_{i,k1} > 0.8\left[\sum_{i=1}^{19} x_{i,k1} + \sum_{i=1}^{19} x_{i,k2} + \cdots + \sum_{i=1}^{19} x_{i,k\epsilon}\right] \qquad (1)$$

Category 2 (coupled two-player dominance)

$$\sum_{i=1}^{19} x_{i,k1} + \sum_{i=1}^{19} x_{i,k2} > 0.9\left[\sum_{i=1}^{19} x_{i,k1} + \sum_{i=1}^{19} x_{i,k2} + \cdots + \sum_{i=1}^{19} x_{i,k\epsilon}\right] \qquad (2)$$

Category 3 (shared small group dominance)

$$\sum_{i=1}^{19} x_{i,k1} + \sum_{i=1}^{19} x_{i,k2} + \cdots + \sum_{i=1}^{19} x_{i,k\gamma} > 0.9\left[\sum_{i=1}^{19} x_{i,k1} + \sum_{i=1}^{19} x_{i,k2} + \cdots + \sum_{i=1}^{19} x_{i,k\epsilon}\right];\ \ 3 \leq \gamma \leq\ 5 \qquad (3)$$

Category 4 (non-dominated systems)

$$\sum_{i=1}^{19} x_{i,k1} + \sum_{i=1}^{19} x_{i,k2} + \cdots + \sum_{i=1}^{19} x_{i,k\gamma} > 0.9\left[\sum_{i=1}^{19} x_{i,k1} + \sum_{i=1}^{19} x_{i,k2} + \cdots + \sum_{i=1}^{19} x_{i,k\epsilon}\right];\ \ \gamma > 5 \qquad (4)$$

The Results section introduces how the selected species can be classified into these four categories. The categorization system itself relies on four main concepts:

1) The dominance of a single player over a specific fishery can give it a *de facto* veto power over the formation of coalitions. On the one hand, the increase in the dominant player's payoff if it engages in collaboration with other players may be minimal and little encouragement to engage in potentially complex negotiations. At the same time, if the dominant player decides not to engage in collaborative behavior with others, the remaining players may likewise see little impact from collaborative sustainable management efforts. (Arnason, Magnusson and Agnarsson, 2000)

2) Past work on game theory and fisheries has found that in the cases where stable coalitions for the management of shared fish stocks are predicted, the largest potentially stable variant is often a two-player coalition. (e.g. Brasao et al. 2000, Arnason, Magnusson and Agnarsson 2000, Kwon 2006, Pintassilgo and Lindroos 2008)

3) A broad gap exists between non-dominated systems and those in which a small group of players reports the majority of catches. The extensive distribution of tuna, and the large number of countries for which catch of tuna represents the majority of fishing activities pushes these highly migratory species into a separate category.

4) A single player's dominance can extend beyond just the share of a certain fish stock in its EEZ, and the associated capacity for that player to comprehensively impact the stock's ecology. Such players can likewise exercise a dominance across other stages of the value

chain and the institutional landscape, strengthening their respective position in any negotiations or cooperative undertakings.

2.3 Results and discussion

Using equations 1-4, the 25 fish species with the largest reported catches can be broken into four dominance-based categories as shown in Table 2-1. To provide additional context within this categorization system, the existence of bilateral and multilateral cooperative agreements is included in the final column, and an overview of the type of stock (straddling, transboundary, etc) is also provided. The European Union (EU) is considered as a single player under this system due to the Common Fisheries Policy, which in effect creates a sub-game played out separately by EU states through international negotiations.

Seven of the marine species considered in this study fall within the hegemonic single-player dominance category, namely Anchoveta, Largehead Hairtail, Araucanian Herring, Akiami Paste Shrimp, Gulf Menhaden, Indian Oil Sardine, and Yellow Croaker. Figure 2-2 provides one example of how a single country not only makes up the majority of the total catch of one marine capture fishery, Largehead Hairtail in this case, but also how overall trends in the hegemon's catch levels are mirrored in the total catch.

Table 2-1: *Overview of species, dominance-levels and existence of cooperative agreements*

Species name	2012 catch (in tons)	Number of states reporting catch in 2012	Categorization	Type	Relevant bilateral or multilateral cooperative agreements
Peruvian anchovy (*Engraulis ringens*)	4,692,855	3	Hegemonic single-player dominance (Peru)	Straddling, transboundary	--
Alaska Pollock (*Theragra chalcogramma*)	3,271,426	6	Coupled two-player dominance (US, Russia)	Straddling, transboundary	"Bilateral Agreement on Marine Fisheries Relations" (by two dominant players); "Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea" (for ABNJ)

Skipjack Tuna (*Katsuwonus pelamis*)	2,795,339	88	Non-dominated	Highly migratory	Tuna RFMOs
Atlantic Herring (*Clupea harengus*)	1,849,969	21	Shared small-group dominance (Iceland, Russia, EU, Canada, US)	Straddling, transboundary	Multilateral agreement under Northeast Atlantic Fisheries Commission (NEAFC) (Iceland/Russia/EU)
Chub Mackerel (*Scomber japonicus*)	1,581,314	49	Non-dominated	Straddling, transboundary	Bilateral agreements, RFMOs
Yellowfin Tuna (*Thunnus albacares*)	1,352,204	97	Non-dominated	Highly migratory	Tuna RFMOs
Japanese Anchovy (*Engraulis japonicus*)	1,296,383	4	Shared small-group dominance (China, Japan, ROK)	Straddling, transboundary	--

Largehead Hairtail (*Trichiurus lepturus*)	1,235,373	37	Hegemonic single-player dominance (China)	Straddling, transboundary	--
Atlantic Cod (*Gadus morhua*)	1,114,382	24	Shared small-group dominance (Norway, Russia, Iceland, EU)	Straddling, transboundary	Multilateral agreement under Northeast Atlantic Fisheries Commission (NEAFC)
European Pilchard (*Sardina pilchardus*)	1,019,392	33	Coupled two-player dominance (Morocco, EU)	Transboundary	Fisheries Partnership Agreement (European Union – Morocco)
Capelin (*Mallotus villosus*)	1,006,533	7	Shared small-group dominance (Iceland, Norway, Russia)	Straddling, transboundary	Multilateral agreement under Northeast Atlantic Fisheries Commission (NEAFC)

Jumbo Flying Squid (*Dosidicus gigas*)	950,630	9	Shared small-group dominance (Peru, China, Chile)	Straddling, transboundary	---
Atlantic Mackerel (*Scomber scombrus*)	910,697	28	Shared small-group dominance (Norway, EU, Iceland, Faroe Islands, Russia)	Straddling, transboundary	Multilateral agreement under Northeast Atlantic Fisheries Commission (NEAFC)
Araucanian Herring (*Clupea bentincki*)	848,466	1	Hegemonic single-player dominance (Chile)	Contained within single EEZ*	--
Akiami Paste Shrimp (*Acetes japonicus*)	588,761	2	Hegemonic single-player dominance (China)	Transboundary	--

Gulf Menhaden (*Brevoortia patronus*)	578,693	1	Hegemonic single-player dominance (US)	Contained within single EEZ*	--
Indian Oil Sardine (*Sardinella longiceps*)	560,145	5	Hegemonic single-player dominance (India)	Transboundary	--
European Anchovy (*Engraulis encrasicolus*)	489,297	35	Shared small-group dominance (Turkey, Morocco, Ghana, EU, Ukraine)	Straddling, transboundary	Fisheries Partnership Agreement (European Union – Morocco)
Pacific Cod (*Gadus macrocephalus*)	474,047	5	Shared small-group dominance (US, Russia, Japan)	Straddling, transboundary	"Bilateral Agreement on Marine Fisheries Relations" (by two dominant players)

Pacific Saury (*Cololabis saira*)	460,961	4	Shared small-group dominance (Japan, Taiwan, Russia)	Highly migratory	--
Pacific Herring (*Clupea pallasii*)	451,457	6	Shared small-group dominance (Russia, US, ROK)	Straddling, transboundary	"Bilateral Agreement on Marine Fisheries Relations" (by two dominant players)
Bigeye Tuna (*Thunnus obesus*)	450,546	78	Non-dominated	Highly migratory	Tuna RFMOs
Chilean Jack Mackerel (*Trachurus murphyi*)	447,060	6	Coupled two-player dominance (Chile, Peru)	Straddling, transboundary	(unsuccessful attempts to empower SPRFMO with regulatory capacity)
Yellow Croaker (*Larimichthys crocea*)	437,613	3	Hegemonic single-player dominance (China)	Transboundary	--

Haddock (*Melanogrammus aeglefinus*)	430,917	20	Shared small-group dominance (Norway, Russia, Iceland, EU)	Straddling, transboundary	Multilateral agreement under Northeast Atlantic Fisheries Commission (NEAFC)
* While only a single country reported catch of this species in 2012, the existence of “nei” categories within FAO reporting as well as unreported catch precludes the conclusion that this resource is exclusively fished by a single player.					

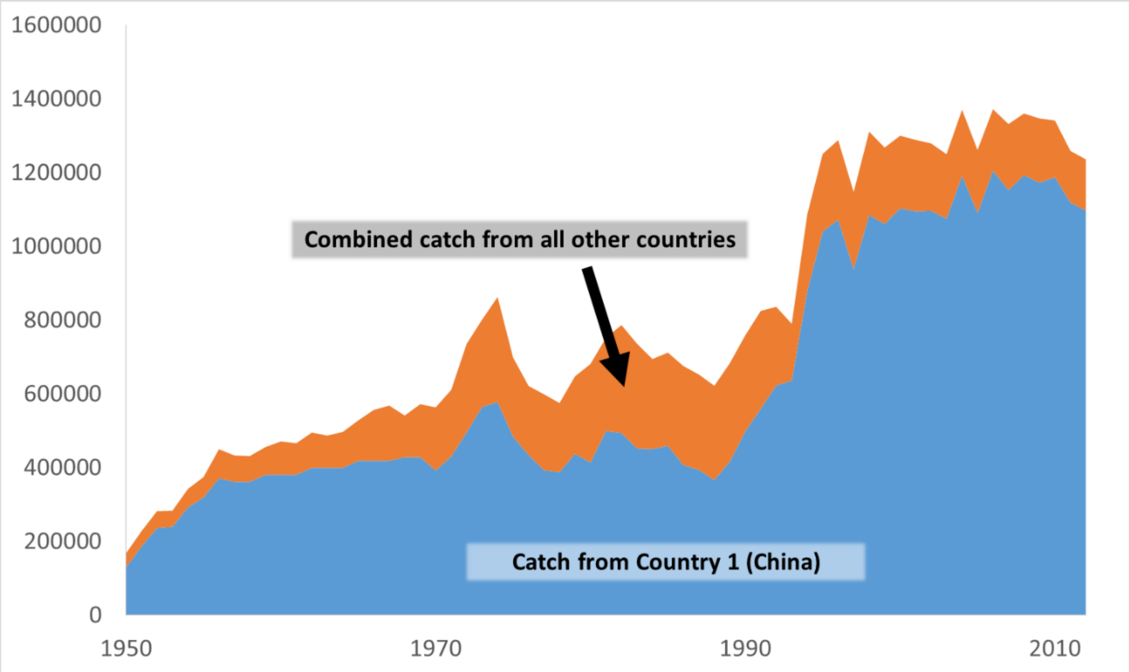

Figure 2-2: *Hegemonic single-player dominance (reported Largehead Hairtail catch)*

Although there are transboundary or straddling stocks in five of these seven fisheries, there has been a marked absence of international agreements on the cooperative management of these stocks. The existence of a single dominant player suggests the potential for a leading role by this player, but the inverse seems more prevalent, namely the emergence of a *de facto* veto power by the dominant player (Arnason, Magnusson and Agnarsson, 2000). This contrasts, however, with the literature survey by Bjørndal and Martin (2007), which concluded that a larger number of players will increase the difficulty of achieving a cooperative agreement. Fisheries that have transformed over the past decades from single-player dominated fisheries to coupled or multi-player fisheries seem to underscore this effect. One such example is provided by Pacific Saury, which over the past ten years has transformed from a single-player dominated management paradigm (Japan) to a small-group system including Japan, Taiwan and the Russian Federation (Figure 2-3). Although the same three players have reported Pacific Saury catches since the late 1980s, the readiness of all players to engage in discussion of a cooperative management agreement has only emerged recently in step with the shift to group dominance. This is reflected in the discussions over the North Pacific Fisheries Commission (NPFC), which were initiated in 2006 with a primary focus on bottom fisheries, but were recently expanded to include the highly migratory Pacific Saury as well (MAFF 2013). As of 2014, ratification processes by the Parties are underway, and the Convention's entry into force is predicted for 2015 (Balton 2014).

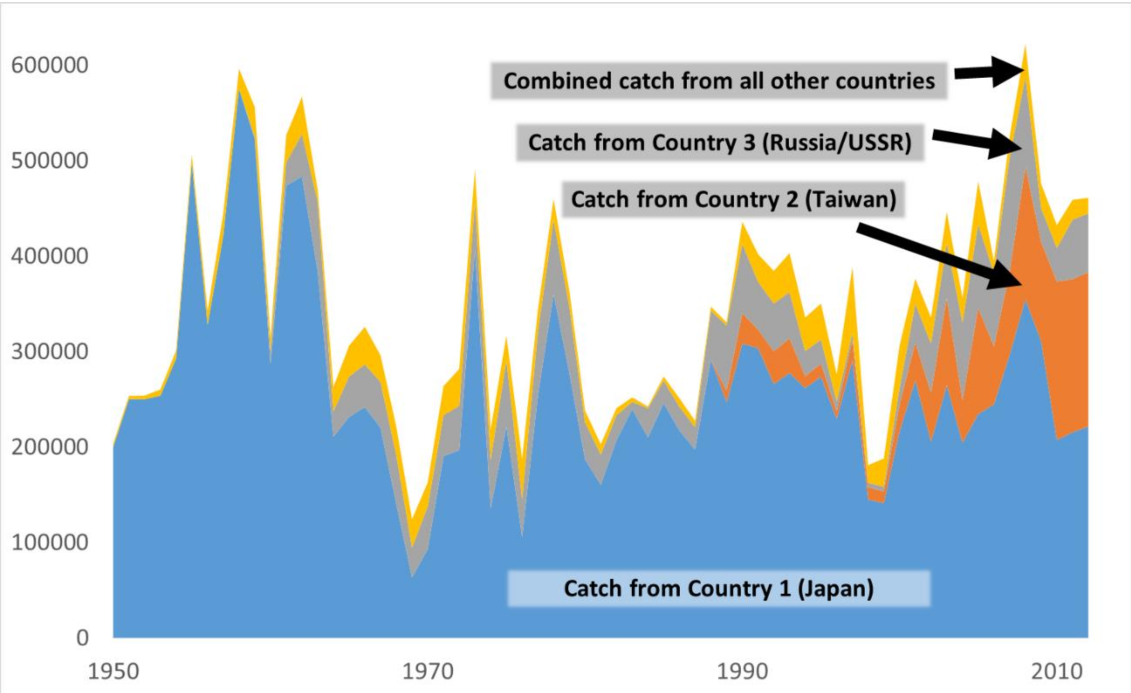

Figure 2-3: *Example of emerging shared small-group dominance (reported Pacific Saury catch)*

Three of the species considered in this study fall within the second category of coupled two-player dominance. These three species tell two interesting stories, one of an expanding field of players (Chilean Jack Mackerel) and the other of a shrinking field of players (Alaska Pollock and European Pilchard).

The latter story is one of a changing institutional landscape. The distribution of Alaska Pollock primarily ranges from the coasts of Alaska westwards along the Aleutian Islands to the Sakhalin Peninsula and the northern islands of Japan. Into the 1980s, the fishery was characterized by small-group dominance shared by the USSR, Poland, USA, Japan and North and South Korea. The formalization of the EEZ boundaries by the USSR and USA after 1977 largely generated today's coupled two-player system between the Russian Federation and USA (Figure 2-4). At the same time, distant water fleets targeting Alaska Pollock were displaced into the so-called "Donut Hole", an expanse of international waters in the Bering Sea (Bailey 2011). A closer analysis of changes in Alaska Pollock fisheries can be found in chapter 4.4.3.

Likewise, the formation of the European Union and its Common Fisheries Policy transformed the European Pilchard from a small-group system including a range of European nations and Morocco. The resulting coupled system of the EU and Morocco is formalized in the EU's most important fisheries cooperation with a third party state, the EU-Morocco Fisheries Partnership Agreement. Passed in 2007 and renewed in 2013, the agreement provides fishing vessels from 11 EU states with access to Morocco's EEZ in exchange for a range of financial contributions and fees. The FAO has found that both the Alaska Pollock and European Pilchard fisheries are stable, which stands in contrast to instability observed prior to the transition from a small group system to a coupled system (see Bailey (2011) on the depletion of Alaska Pollock in the early 1990s, and Carrera and Porteiro (2003) on stock dynamics and the drop in European pilchard catches in the 1990s).

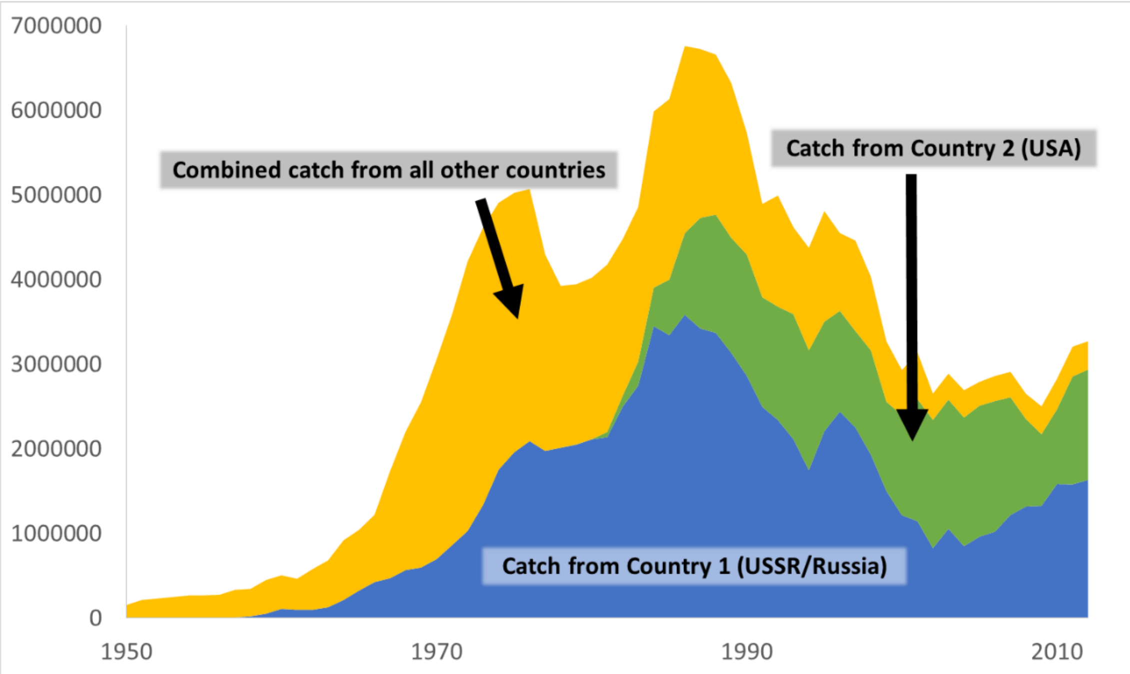

Figure 2-4: *Coupled two-player dominance (reported Alaska Pollock catch)*

An expanding field of players, however, can be found in the case of the Chilean Jack Mackerel, which is currently a coupled system dominated by Peru and Chile, which have traditionally reported approximately 15% and 80% of total catch, respectively (FAO 2014). Unlike the previous two fisheries, however, FAO classifies Chilean Jack Mackerel as overexploited, with the total reported catch peaking at nearly 5 million tons in 1995, before dropping to under 450,000 tons by 2012 (FAO 2012, FAO 2014). While ecological uncertainty persists, the South Pacific Regional Fisheries Management Organization (SPRFMO) estimates that there are four distinct stocks of Chilean Jack Mackerel, all of which are straddling (SPRFMO 2009). A lack of cooperation continues to exist between the two dominant players, with Peru raising its 2014 TAC despite agreement from Chile and other fishing nations to match a call from the SPRFMO to lower quotas, although it should be noted that Peru is not a signatory to the SPRFMO

Convention. While sustainable management of the fishery may be impossible without stronger cooperation between the dominant players, the management landscape is further complicated by a gradual growth in the number of distant water fishing nations engaged in this fishery – expanding over the ten-year period from 1999-2009 from 3 states to 14 – with most new entrants coming from Europe and East Asia.

The third category described here includes 11 species in which a group of three, four, or five states share dominance over the available stocks. While it may seem somewhat counterintuitive that a multi-player landscape would be more conducive to successful negotiation and cooperation than one in which a clear potential leader exists, it is interesting to note that international agreements on cooperative fisheries management are far more prevalent in cases of shared dominance rather than hegemonic dominance (see Table 2-2). The Atlantic mackerel fishery within this category provides an example of how changing environmental conditions have caused stocks to shift polewards and spark a descending spiral of unilateral setting of quotas starting in 2009 that remains only partially addressed five years later. (Iceland Ministry of Industries and Innovation 2014)

As previously described, Pacific Saury (Figure 2-5) represents an interesting example of shared group dominance, for it is one of the few species within this category in which a comprehensive cooperative management agreement does not exist. This may be due to the relatively recent transition from a hegemonic system, and contrasts sharply with similar catch graphs for other shared stocks although the formation of the NPFC in 2015 will establish a cooperative management mechanism for this fishery. Other small group fisheries include Capelin, which has seen considerable fluctuations in reported catch over the years like other wasp waist species

(Bakun 2006) albeit with the same set of three dominant players, while Pacific Cod catches have been in line with a shared dominance system since the early 1980s (Figure 2-5).

Table 2-2: *Category-based breakdown of 25 fish species with the largest reported catches*

Type of system	2012 catch in tons (percentage of study sample)	Number of species within this category	Average number of players	Existence of formal bilateral/ multilateral international cooperative agreement
Hegemonic single-player dominance	8,941,906 (30.5%)	7	7.4	0 / 7
Coupled two-player dominance	4,737,878 (16.2%)	3	15	2 / 3
Shared small group dominance	9,435,273 (32.2%)	11	14.8	8 / 11
No dominance	6,179,403 (21.1%)	4	78	4 / 4

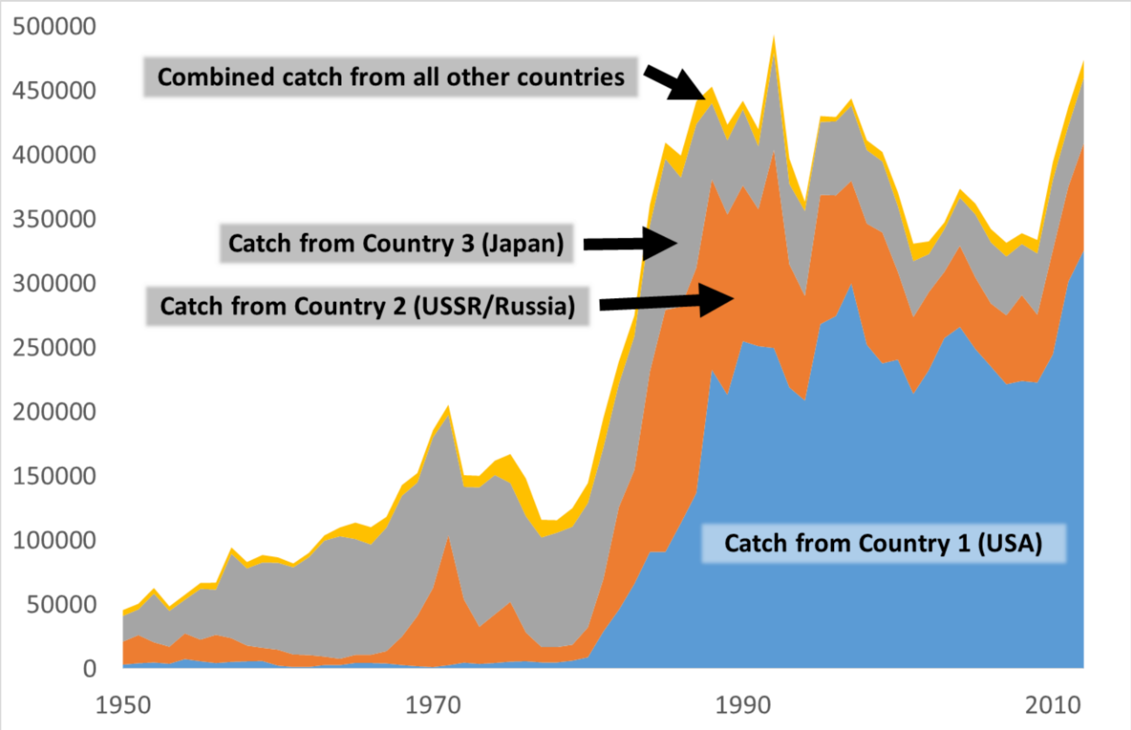

Figure 2-5: *Example of shared small-group dominance fishery. (reported catch of Pacific Cod).*

The final category of marine species considered in this study are those described as non-dominated. These are mainly major tuna species (Skipjack, Yellowfin and Bigeye) as well as Chub Mackerel, all characterized by tremendously wide distribution ranges spanning the world's oceans. Figure 2-6 illustrates the complexity of the management paradigm with the example of Skipjack Tuna, for which a total of 88 countries reported catch in 2012. As provided for by the 1995 UN Fish Stocks Agreement, a collection of tuna RFMOs comprises the primary framework for cooperative management of tuna resources. The legal framework, however, is particularly vague, with parties bound only to "enter into consultations in good faith and without delay" and membership in the respective RFMOs limited to states "having a real interest in the fisheries concerned" (UN 1995). For a comprehensive overview and comparison of compliance and management challenges across the tuna RFMOs, see e.g. Allen (2010) and Koehler (2013).

Likewise, a link has been established between state governance level and prevalence of IUU fishing activities (Agnew et al. 2009). The wide distribution of tuna implies the potential for illicit fishing activities to be sequentially displaced as they follow a path of limited statehood due to the low capacity of some flag states to adequately monitor and control activities by their fishing vessels, and the capacity of nations to monitor their national jurisdictions.

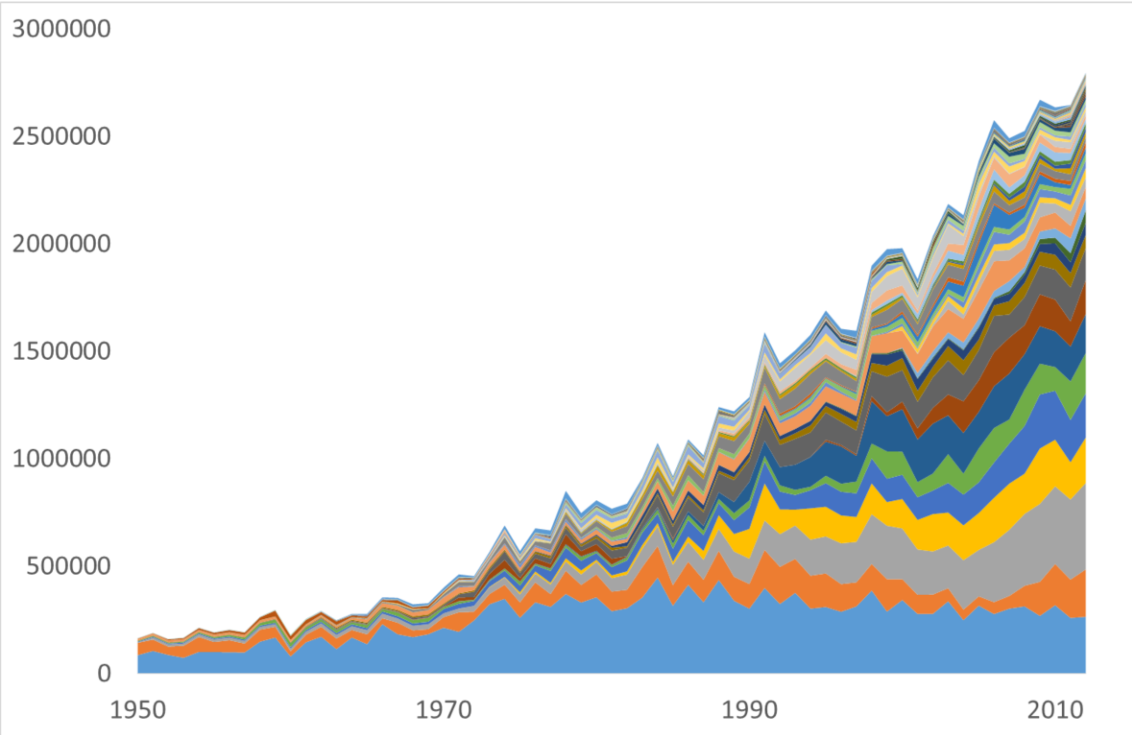

Figure 2-6: *Non-dominated system (reported Skipjack tuna catch). Each band of color illustrates the reported catch of a single player.*

It is important to note that while this study explores paradigms of strategic behavior for the management of international fisheries, which are often analyzed using game theory models, it takes a simplified inductive approach focused on self-reported catch data by fishing nations. A strength of this approach is its capacity to assess and compare a large number of fisheries, highlighting broad trends, while simultaneously limiting the number of assumptions required for the analysis. More robust conclusions could perhaps be drawn by including a larger number of variables common to the bioeconomic models frequently employed in this area, including the respective cost per unit effort (CPUE) of each player, price of fish, and fish recruitment rates.

In their summary of game theory literature based on bioeconomic modelling of RFMO resources, Bjørndal and Martin (2007) highlight one area in which this study's findings suggest a gap in the existing literature, namely the tendency for a larger number of players to result in greater difficulty in achieving a cooperative solution. This is contrasted by the results of this study, which demonstrate that the existence of a dominant hegemon within a shared or straddling fishery is a strong predictor for the absence of cooperative management agreements, irrespective of the number of players sharing the resource. Further research of such hegemonic systems could incorporate more elements of traditional bioeconomic models, while also exploring whether new-entrants into the fishery (as opposed to shifts in dominance as measured in reported catches) have any effect on emergence of cooperative management arrangements.

2.4 Conclusions

Taking the world's 25 fish species with the largest reported catches as a reference point, this research has introduced a set of dominance-based categories for cooperation. The overview provided in Table 2-2 highlights the tendency for cooperation in hegemonic scenarios to be elusive, while it is far more likely that some level of at least nominal cooperation exists in shared and non-dominated fisheries. Shifts away from hegemony, as in the case of Pacific Saury, can therefore open the door to greater cooperation and signal times when additional effort or investment in collaborative mechanisms would bear fruit. The considerable financial burden associated with the multi-year negotiations and establishment of a new RFMO or fisheries commission may serve as a useful proxy for the initial threshold on the formation of cooperative agreements and therefore a valuable area for further study, particularly in the case of hegemonic systems. Likewise, a shift away from a shared fishery towards hegemony could be interpreted as a potentially destabilizing trend for cooperative management, suggesting that additional effort may be needed to sustain international cooperation. Further analysis of the complexity inherent to non-dominated systems would prove particularly useful for the discussions currently developing around the conservation and sustainable use of biological diversity in areas beyond national jurisdiction (BBNJ).

A considerable limitation of the research presented in this chapter is that, in order to ensure comparability, assessment is conducted at species level rather than stock level. Two key considerations supported this choice. First, even for the largest and most extensively researched fish species, the number of stocks and their respective distribution remains a matter of dispute (e.g. Alaska Pollock, Atlantic Mackerel). Second, although FAO catch data would allow, for instance, for separate analysis of Pacific and Atlantic tuna fisheries, both stocks are exploited by many of the same distant water fleets. The respective dominance of these distant water fishing nations, in line with the stated assumptions on page 39, extends beyond the specific share of fish caught by the nation to also include its bargaining power in international forums and along the different stages of value chains and distribution.

Furthermore, it should be noted that among the four categories of ecosystem services defined within the Millennium Ecosystem Assessment, provisioning services, including fish as a foodstuff, constitute perhaps the most immediately tangible and easily valued of the four services (supporting, provisioning, regulating and cultural). Sustainable ocean management, however, would encompass the full range of these services, and an area for further research would be examining whether the work on coalition building in international fisheries sheds light on the potential for cooperative management of other marine ecosystem services, and whether the respective tangibility of value associated with each ecosystem service would influence such coalition building. Similarly, the potential for asymmetries among players to enhance or harm the possibility of coalition formation, suggests that broadening the mandates of RFMOs or cooperative agreements to include other ocean ecosystem services has the potential to increase their stability by providing flexibility in the form of side payments or adjustments to the cooperative management of other resources.

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Chapter 3: Balloon effects as a major hurdle to sustainable fisheries management

3.1 Introduction[2]

Unsustainable management is causing increasing depletion of marine resources (McCauley et al. 2015, Myers and Worm 2003). Reported catch from marine fisheries peaked in the mid-1990s, despite subsequent expansion into new frontiers, intensification of fishing activities and more comprehensive catch reporting methods (FAO 2014). Models of serial depletion (sometimes referred to as sequential exploitation) have shown how “roving bandits” swiftly exploit untapped fisheries, demonstrating greater flexibility and adaptability than reactive institutional mechanisms (Berkes et al. 2006). The impulses of roving bandits in a globalized world without new frontiers, however, remain predictable and are likely destabilizing. Here we explain how balloon effects are causing both licit and illicit fishing activities to be displaced into areas characterized by weak national jurisdiction and poorly regulated areas beyond national jurisdiction (ABNJ). These trends are particularly pronounced in lucrative highly migratory fisheries distributed across vast marine territories and subject to exploitation by a large number of diverse fishing nations. Globalization and increasingly sophisticated fishing technologies suggest that the paradigm of serial depletion is increasingly being replaced by a new paradigm under which the state of international fisheries is shaped by balloon effects. These findings represent a new step towards understanding the future of international fisheries, and add to a growing body of work in other disciplines pointing to the emergence of locally destabilizing balloon effects due to globalized markets, e.g. international drug control efforts, carbon leakage, wildlife trafficking (Brombacher and Mailhold 2009, Martin et

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al. 2014, UNODC 2013). A more detailed typology of balloon effects can be found in chapter 4.2.

The tragedy of the commons is particularly acute on the high seas, where a weak, yet broadly inclusive governance framework results in vast jointly held resources being exploited by states which, according to Hardin's framework, will follow a self-interested path of depletion over the short term (Hardin 1968). Communities with strong socio-cultural linkages to their surrounding landscapes have been shown to be more likely to exercise sustainable management practices (Muhamad et al. 2014). Although such connections may still be evident in coastal areas, they become largely intangible on the high seas, making these areas truly a global commons, largely anonymous and with few incentives to sustainable use (Guitierrez et al. 2011). Strong governance based on comprehensive monitoring and enforcement activities could enforce a paradigm of sustainable fisheries management, yet the governance landscape continues to be characterized by tremendous heterogeneity (FAO 2014).

Political philosopher John Gray (1998) has argued that globalization is not a force towards convergence and homogenization of markets, but in fact thrives and fundamentally depends on a diverse range of regulatory, institutional and political frameworks. This diversity causes displacement of manufacturing, production and, in some cases, fishing effort. In an unregulated market, highly migratory fish stocks ranging across vast territories would be opportunistically harvested within the territories generating the highest catch per unit effort (CPUE) due to stock abundance and location. In a diverse governance landscape, market regulations act as a driver of displacement into the areas with the weakest governance, therefore causing a tendency for fishing activities to be squeezed into areas where optimal CPUE and minimal regulation converge towards ecological limits.

A dramatic historical example is provided by the lucrative Alaska Pollock fishery in the Aleutian Basin of the northern Pacific. The formalization of the 200 nautical mile exclusive economic zone (EEZ) by the USA and USSR in 1977 caused the vast majority of Alaska Pollock fishing grounds to fall under direct control of these two countries, squeezing distant water fishing fleets into a relatively small patch of international waters in the Bering Sea known as the Donut Hole. Rapid intensification of harvesting of the Alaska Pollock stock in the Donut Hole led to peak harvests of nearly 1.5 million tons in 1993 (Ianelli et al. 2006). Within three years, the stock had collapsed and was belatedly followed by a moratorium that remains in effect today. A more detailed analysis of changes in Alaska Pollock fisheries can be found in chapter 4.4.3. Figure 3-1 demonstrates the rapid shifts in exploitation, while the dotted line provides scale by indicating the total combined fisheries production in the Mediterranean and Black Sea in 2012. Despite a remarkable capacity for fish stocks to recover, the failure of Alaska Pollock to rebound in the Donut Hole following the moratorium demonstrates another danger of balloon effects: sophisticated fishing technologies have made it possible for such effects to occur so suddenly and extensively as to precipitate trophic cascades that fundamentally alter ecosystems. The collapse of cod fisheries in the northeastern Atlantic in the 1980s provides the most vivid example, where cod has failed to rebound despite a moratorium, leading the fisheries industry to shift its focus to a burgeoning shellfish population, thriving in the absence of its traditional predator (Steneck 2012).

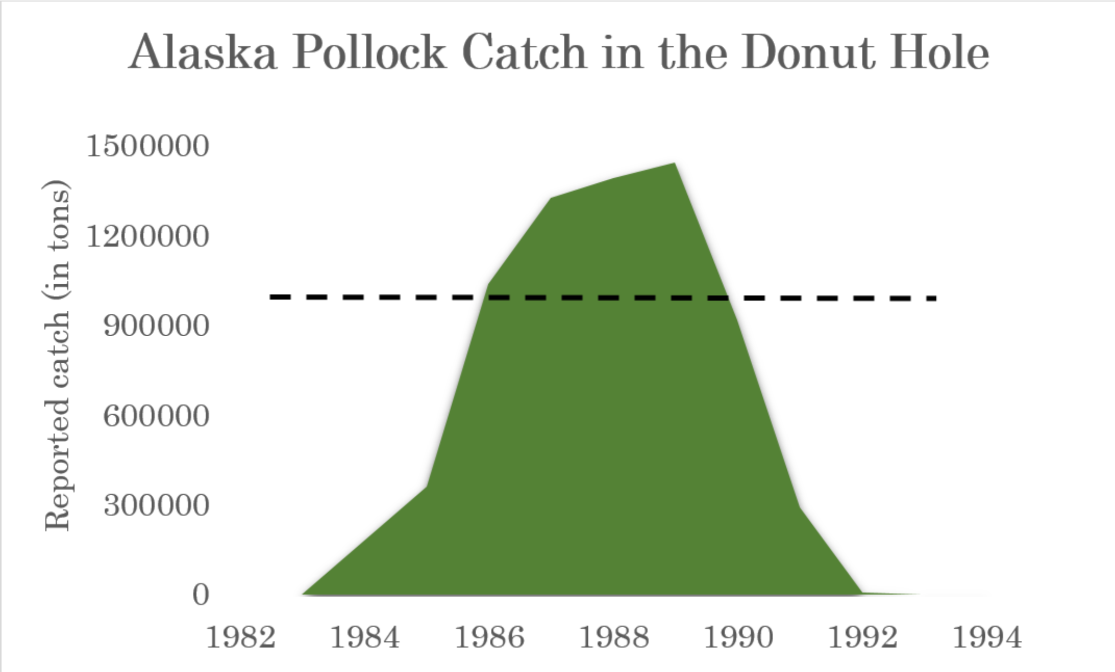

Figure 3-1: Balloon effect in the Alaska Pollock fishery. *Reported catch within international waters of the Donut Hole. To provide a sense of scale, the dotted line indicates the total fisheries production in the entire Mediterranean and Black Sea in 2012 (Ianelli et al. 2006, FAO 2015).*

3.2 Ecological pressure and state vulnerability

Globalization-driven balloon effects pose a risk not only to the ecological integrity of marine ecosystems, but also to the states dependent on their exploitation. Yellowfin Tuna and Skipjack Tuna, for instance, are often harvested together due to an overlapping distribution across vast expanses of the ocean, both within the EEZ of national jurisdictions and on the high seas, leading in 2012 to 103 different states reporting catch of these species, as depicted in Figure 3-2 (FAO 2015). Even disregarding the estimated potential for illegal, unreported and unregulated (IUU) fishing, balloon effects are increasingly squeezing the exploitation of Yellowfin Tuna and Skipjack

Tuna into the high seas and the EEZ of weak national jurisdictions (Agnew et al. 2009, Pramod et al. 2014). Thus, over a two decade period from 1992-2012, the largest increases have been in Indonesia, Papua New Guinea and the Philippines, while virtually the entire net reduction in tuna catch over this period was attributable to just two countries: Japan and France (FAO 2015). Further analysis of changes in international Skipjack Tuna fisheries can be found in chapter 4.4.2.

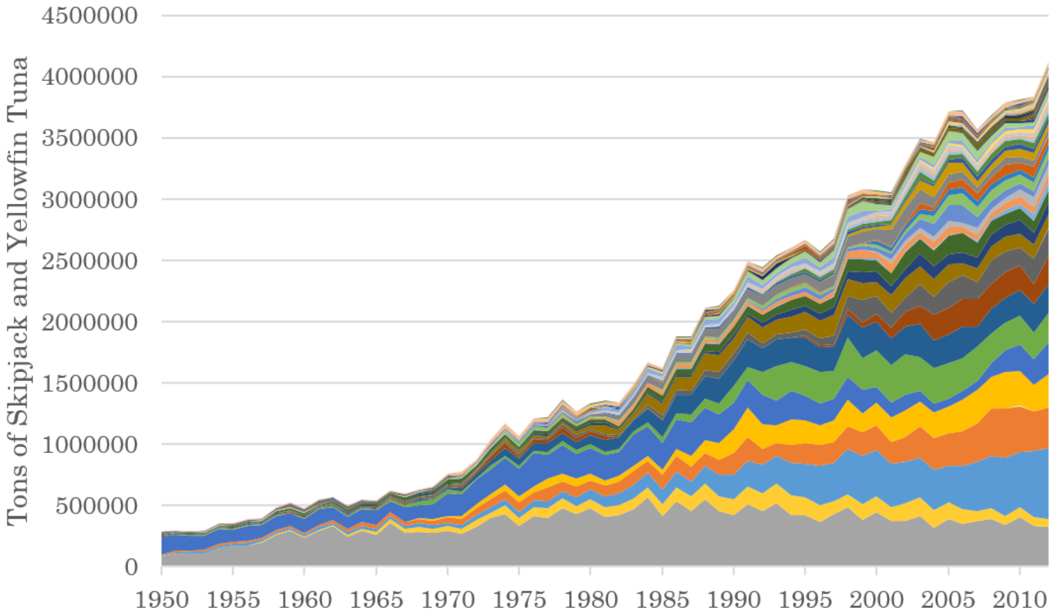

Figure 3-2: Global catch of Skipjack Tuna and Yellowfin Tuna. *Each band of color represents a state's reported catch. (FAO 2015)*

From 1992-2012, reported catches of tuna more than doubled in FAO fishing area #71 (Western and Central Pacific), where the governance index of Mora et al. (2009) finds some of the lowest levels of management effectiveness, largely due to the extent of fishing by foreign fleets. Tuvalu, for instance, has a land mass of 26 km^2 and an EEZ extending across nearly 750,000 km^2. The country's reported tuna catches tripled from 2009-2012, mirroring a continuous drop in regulatory quality as estimated by the World Bank Governance Indicators, from 0.36 in 2000 to -1.32 in 2013 (on a scale of -2.5 to 2.5). (Kaufmann et al. 2014) Acceding to forces of globalization, small island states with vast EEZs have become increasingly specialized and dependent on lucrative tuna fisheries. In 1992, only four countries relied on Skipjack and Yellowfin Tuna for the majority of their fisheries production; by 2012, that number had tripled, excluding new entrants (Figure 3-3). A growing number of states are therefore increasingly vulnerable to pressures ranging from climate-induced shifts in distribution to stock collapse and an international moratorium.

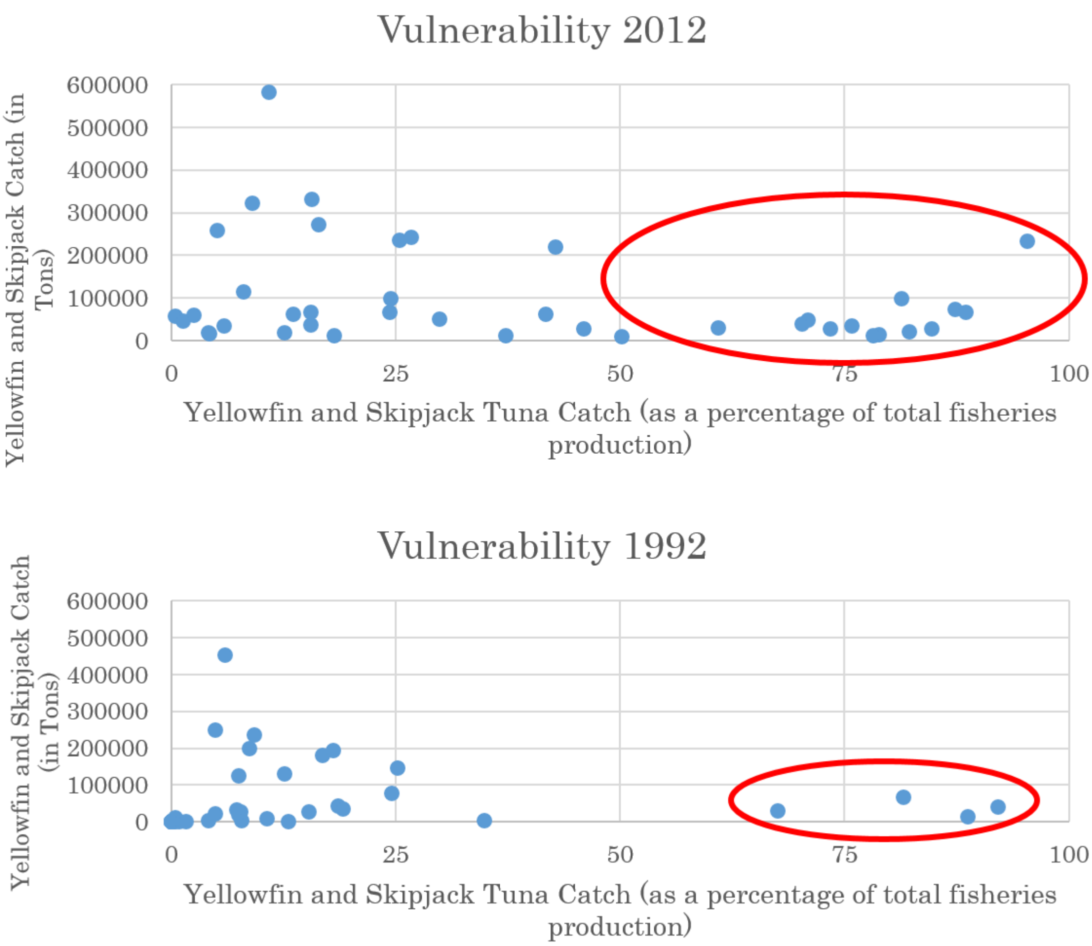

Figure 3-3: Combined catch of Skipjack Tuna and Yellowfin Tuna as a percentage of total fisheries production. *Excluding new entrants, the number of states dependent on these stocks for the majority of their fisheries production has tripled between 1992 and 2012, as indicated by the red circles; each blue dot indicates an individual state (FAO 2015).*

3.3 Predicting future balloon effects

The prevailing paradigm of serial depletion in international fisheries is increasingly being reshaped by balloon effects as the number of new frontiers diminishes. One of the final remaining frontiers is the Antarctic, where the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is charged with the conservation and management of marine resources. A consensus-based body, CCAMLR has become increasingly hamstrung as individual countries reject not only planned protected areas, but push for the expansion of fishing activities (CCAMLR 2014). Moreover, the uneven institutional framework is causing some vessels engaged in IUU fishing to simply register under flags of convenience from states that are non-signatories to CCAMLR, rendering them highly difficult to catch or subsequently prosecute (Osterblom et al. 2010).

Under these saturated conditions, opportunistic and destabilizing balloon effects can now be expected to accompany climate-related shifts in distribution, as seen for example in the rapid breakdown of transboundary cooperation in the northeastern Atlantic when mackerel stocks shifted polewards in 2009 (Blasiak et al. 2015). If fully implemented, well-intentioned efforts to create a network of marine protected areas covering 10% of the oceans by 2020, in line with Aichi Target 11 of the Convention on Biological Diversity, are likely to displace both licit and illicit fishing activities into areas of weaker governance. Likewise, globalization is causing processing activities to increasingly be displaced into locations with weaker regulatory settings such as Thailand and Vietnam, potentially weakening a link in the value chain, and opening the doors for IUU catch (Pramod et al. 2014). Falling oil prices have recently rendered distant water fishing activities economically feasible across broader swathes of the ocean, but spikes in energy prices will cause a subsequent constriction.

Based on experiences in other disciplines, the final and perhaps most substantial source of future balloon effects will be regulatory efforts by individual national jurisdictions or regional fisheries management organizations. Just as targeted measures to eradicate illicit coca production in Colombia led to the displacement of cultivation into previously unaffected Andean countries, targeted efforts to eliminate IUU fishing within the EEZ of a single national jurisdiction may be a chimerical solution, leading instead to the problem being partially or completely displaced into another country's EEZ or the high seas. Particularly in the case of highly migratory and straddling fisheries extending into the poorly regulated high seas, it is crucially important that regulatory and institutional pressures be applied broadly across the various levels of the governance landscape (Berkes et al. 2006). If not, balloon effects will materialize wherever there are weak links in the supply chain, poorly monitored expanses of ocean, or regulatory loopholes like flags of convenience. Likewise, displacement will occur more rapidly as fishing technologies continue to improve, making it imperative for regulatory and cooperative bodies to have a high degree of built-in flexibility and adaptability to act before ecological boundaries are crossed.

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Chapter 4: Avoiding the displacement of unsustainable practices

4.1 Introduction[3]

An increasingly interconnected world shaped by the movement of goods, services and production activities into the most profitable and convenient locations faces considerable challenges in achieving sustainable management of resources. Local resource users are more likely than others to conserve the resources upon which their livelihoods depend, while demand from spatially remote locations can drive a range of negative effects, including rapid processes of sequential exploitation or serial depletion (Olson 2000, Pauly 2002). In such cases, inadequate governance and management frameworks fail to react swiftly enough to sudden fluctuations in demand, leading to rapid depletion of resources, and the sequential movement of unsustainable exploitation into new areas (Robson 1979, Berkes 2006).

International pressures spurring production and exploitation activities have highlighted gaps in the governance landscape from the local to global scale. Carbon leakage, wildlife trafficking and illegal and unreported fishing can all result from the exploitation of uneven levels of monitoring and enforcement. Local-level interventions may cause, for example, the transit points for trafficking activities to shift, high-emission production activities to be displaced into poorly regulated markets, or fishing activities to be squeezed into the high seas, or the coastal waters of countries with weak governance capacity. Recognition of the emergence of these activities can be slow, particularly if there is a low level of awareness about underlying drivers. This delay can

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also seriously impact the time taken to develop appropriate responses. The aim of this chapter is to explore what kinds of effects can be identified, along with their drivers and responses.

A typology is presented in this chapter for classifying such phenomena, in the case of marine capture fisheries, into displacement, diffusion and intensification (DDI) effects. Following a brief literature review, the three types of DDI effect are introduced, and subsequently illustrated in Chapter 4.4 with examples from the Atlantic Mackerel, Alaska Pollock and Skipjack Tuna fisheries. Chapter 4.5 of the chapter draws parallels to the emerging discussion of displacement and unintended consequences, and the chapter finally concludes with policy recommendations for strengthening the resilience and stability of coalitions when addressing DDI. Although focusing on the fishing industry, the discussion of DDI and its policy effects is also relevant to other areas of environmental policy.

4.2 Literature Review

A crucial component of sustainable management of marine fisheries is cooperation among participating fishing nations. A key paradigm for international fisheries is the exclusive economic zone (EEZ), formalized under the UN Convention on the Law of the Sea (UNCLOS) in 1982, and granting states the sole right, among other things, to decide on the management of resources within an area generally extending 200 nautical miles from their coastline. Shared (also termed transboundary) stocks cross the EEZ of two or more states, while straddling stocks also extend beyond the 200 nautical mile limit into areas beyond national jurisdiction (ABNJ). The latter pose a particularly complex challenge due to deficits in the Fish Stocks Agreement and the regional fishery management organizations (RFMOs) charged with the management of these stocks.

There have been varying levels of success in achieving cooperative management of shared and straddling stocks, but this remains a key challenge considering that among the world's 25 largest fisheries, 23 include shared and/or straddling stocks, comprising some 40% of global reported catch (Blasiak et al. 2015a).

Even under static conditions, cooperative management of straddling and shared fisheries is challenging, but natural (and anthropogenic) variations in abundance and distribution add another layer of complexity. Coalitional game theory predicts internal stability of collaborative agreements if the payoffs of cooperation are greater than the net benefits accrued through singleton behavior after subtracting any penalties of leaving the coalition (Lindroos et al. 2007, Kwon 2006, Hannesson 1997). Unpredictable variability in stock abundance and distribution can result in information asymmetries among coalition players. Not only is such variability unpredictable, but the scientific community remains split on the legitimacy of the basic theories related to marine regime shifts (Möllmann et al. 2014). But these uncertainties, when combined with short-sightedness by any of the players, can trigger the emergence of singletons that engage in unilateral action beyond the scope of international agreements or norms (Pintassilgo and Lindroos 2008). The literature suggests that singleton behavior can set off a descending spiral of retaliatory behavior, leading to unsustainable resource management, loss of utility, and ultimately conditions of bionomic equilibrium under which the catch per unit effort (CPUE) becomes equivalent to the average cost of the fishing effort (Hannesson 2011, Seijo et al. 1998). Research on trophic cascades likewise suggests that unsustainable management can lead to permanent collapse of fisheries regardless of subsequent moratoria (Mumby et al. 2006, Steneck 2012).

Potential triggers of instability in coalitions of fishing nations are therefore of crucial interest for sustainable fisheries management. This chapter presents a typology for a set of destabilizing triggers associated with DDI effects in the marine capture fisheries. Three cases are presented to describe the factors leading up to the disruption of fishing activity. This typology can serve as a basis, among other things, for comparative study of instability in fishery agreements and how these have been addressed, while also carrying relevance for Aichi Target 11 of the Convention on Biological Diversity's Strategic Plan for Biodiversity 2011-2020 on the establishment of marine protected areas (MPAs), which frequently entail use restrictions that can thereby introduce destabilizing DDI effects. By pulling together these effects and analyzing them in the area of fishery management, we further discuss how such a typology may also be instructive in other areas of environmental policy.

4.3 Displacement, Diffusion and Intensification (DDI)

In other policy areas and disciplines, displacement is often seen as an unintended consequence and destabilizing factor working against the original policy objectives (Windle and Farrell 2012, Baert 1991). Early environmental regulation and, more recently, climate change mitigation efforts within one country or region, for example, have led in some cases to high emission industries simply relocating to locations with weaker regulatory frameworks – a displacement effect often referred to as spillover or leakage (Marcu et al. 2013). Likewise, anti-trafficking efforts have been found to generate so-called "balloon effects" as illicit activities are displaced into areas of limited statehood (Brombacher and Maihold 2009, Chouvy 2013, Wyler and Cook 2009). In the case of shared and straddling fisheries, displacement can be a similarly destabilizing factor, and, at times, it can become difficult to distinguish between licit and illicit activities due to the lack of monitoring and significant gaps in the legal framework for the management of ocean resources (Palma et al.

2010, Munro et al. 2004). Evidence has also been found for linkages between illicit fishing activities and other illegal practices such as drug trafficking, suggesting that balloon effects can be a source of cross-sectoral instability (Muchapondwa et al. 2012). Drawing on displacement studies conducted in these disciplines and an assessment of global fisheries, an initial typology is proposed in the following sections and graphically illustrated in Figures 4-1, 4-2 and 4-3. Although certain distinctions can be made among some DDI characteristics, the case studies presented in this chapter suggest that multiple elements of DDI may be simultaneously evident in a single fishery.

In its simplest case, displacement of fishing activities entails a one-to-one shift of operations from one location to another with the same fishing gear, practices and target species (Figure 4-1). Causes for such shifts could include the establishment of MPAs, marine sanctuaries or no-take zones. Although not policy induced, recent climate-related shifts in the distribution of marine species have caused fishing activities to be displaced from one region to another. If such displacement effects are entirely contained with the EEZ of a single country, there is a stronger potential for management solutions to adapt rapidly and effectively to the changes. In shared and straddling fisheries, however, displacement can cause substantial losses or gains for individual states (e.g. parties to an international agreement on shared management of a certain fish stock). As a result, there may be a need for complex changes to the management paradigm and associated coalitional instability until all the states reach a mutually acceptable benefit-sharing agreement. This paper considers recent developments in the Atlantic Mackerel fishery in Section 4.4.1 to provide an example of the coalitional instability generated by displacement in shared fisheries.

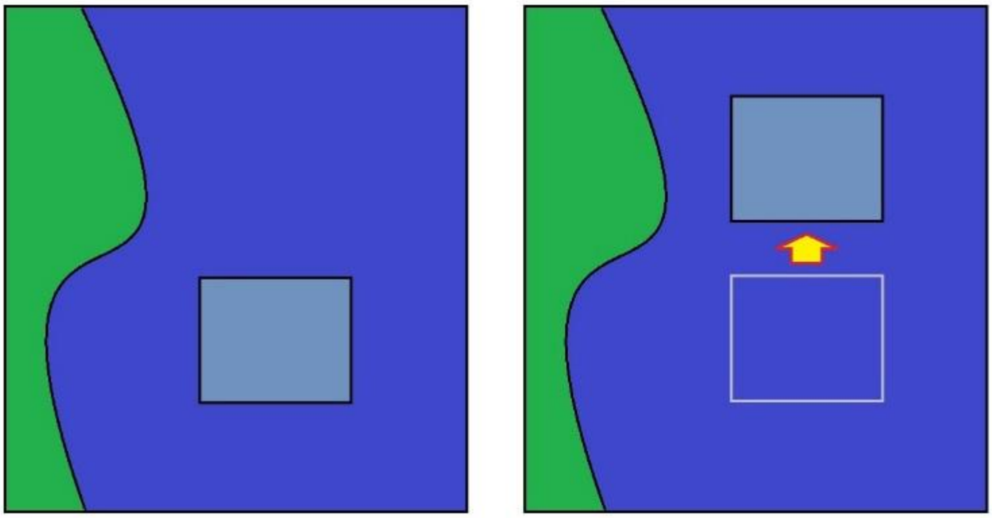

Figure 4-1: *Simple one-to-one spatial displacement of fishing activities*

The second category of DDI impacts described here is diffusion, which shares strong theoretical linkages with the “balloon effects” of international anti-trafficking efforts. A balloon being squeezed provides a useful visual image for diffusion effects. Pressure applied in one place causes the movement of air (fishery activities in this case) into areas of least resistance; excessive pressure could cause a complete breakdown of the system (Blasiak 2015). Within this typology, diffusion may be caused by many of the same drivers as displacement, but rather than fishing activities simply shifting from one area to another, they may splinter and spread out over larger, less well-defined areas (Figure 4-2). Diffusion effects are more likely to be evident and generate destabilizing impacts in spatially extensive fisheries such as highly migratory tuna, swordfish or saury stocks. With such stocks often extending across the EEZ of multiple states as well as the high seas, relevant regulations would have to be enforced across much larger areas, with low levels of enforcement capacity being exploited accordingly. Conversely, uniform enforcement of regulations governing the management of fisheries with small and discrete distribution ranges is more feasible, and reduces the likelihood of diffusion effects. We examine recent developments in the Skipjack Tuna fishery in Section 4.4.2 to provide an example of the coalitional instability generated by diffusion in shared fisheries.

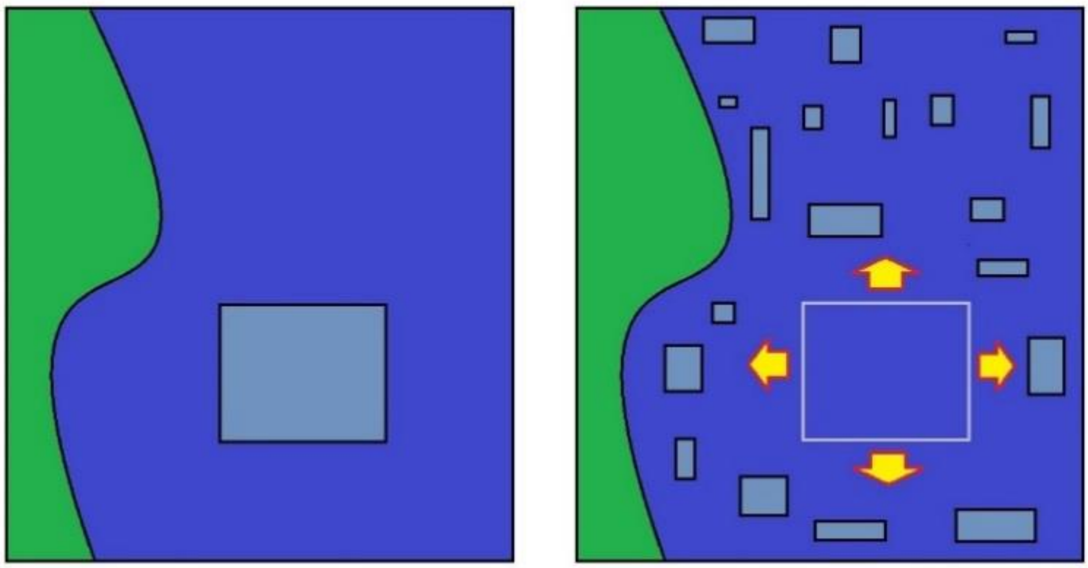

Figure 4-2: *Diffusion of fishing activities*

The third DDI category, intensification, occurs when fishing activity is substantially increased within a certain spatial area. New entrants into a fishery can generate such impacts, or intensification can also arise in tandem with displacement (Figure 4-3). Dramatic examples are provided by Berkes et al. (2006) and Huitric (2005) of sequential exploitation in which marine resources are intensively harvested in expanding rings of unsustainable management, while others use the term serial depletion in a similar context (Pauly et al. 2002). Depletion of a resource at one location after another leads to fishing activities being displaced into new emerging fisheries, which in turn see intensification as more and more displacement occurs. The destabilizing impacts of this type of reinforcing downward spiral are reflected in Figure 4-5. In Section 4.4.3, a simpler example of intensification is presented based on the Alaska Pollock fishery in the North Pacific.

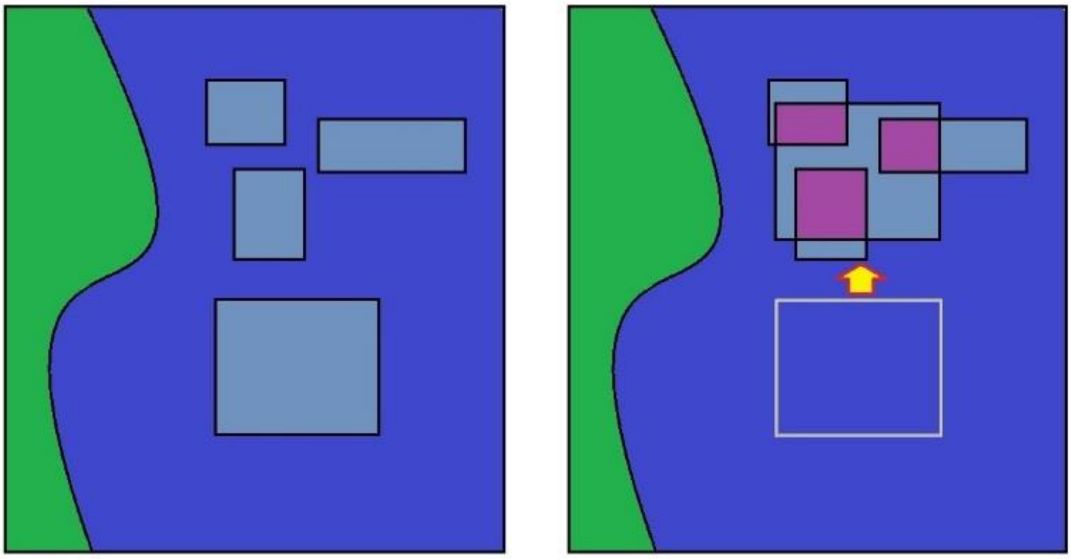

Figure 4-3: *Displacement and intensification (purple) of fishing activities*

4.4 Examples of DDI in Marine Capture Fisheries

4.4.1 Displacement Effects – Atlantic Mackerel

Researchers predict that rising sea temperatures associated with climate change will cause the distribution of certain fish species to be squeezed polewards and for shifts to occur in migratory paths (Poloczanska et al. 2013, Shoji et al. 2011). The changes in distribution threaten to destabilize cooperative agreements due to short-term changes in the attractiveness of singleton behavior (Brandt and Kronbak 2010).

One such example can be found in the North Atlantic, where mackerel is a key shared fishery and catch limits have been proposed by the International Council for Exploration of the Seas (ICES), a scientific advisory body comprised of marine institutes. Starting in 2009, however, a poleward shift in mackerel distribution caused first Iceland (in 2009) and then the Faroe Islands (in 2010) to unilaterally increase their mackerel catch (European Commission 2009), resulting in a net displacement of fishing effort (cf. Figures 4-1, 4-3). Retaliatory behavior ensued with Norway banning port entry to fishing trawlers from Iceland and the Faroe Islands (Faroe Islands Ministry of Fisheries 2011). Although Scotland denounced this singleton behavior, relations further soured with the revelation that fishers from Scotland had illegally landed excess mackerel catches from 2002-2005 (The Scotsman 2011). Instability resulting from the climate-related shift in distribution seemed poised to push the players on a downward spiral towards a complete collapse in cooperation.

Here, the theoretical work by Pintassilgo and Lindroos (2008) on the stability of coalitions is particularly relevant and was used by Hannesson (2011) to suggest that the collapse of coalitions is linked to shortsightedness because the immediate payoffs of singleton behavior would ultimately be reversed over the course of a repeated game as more and more players leave the coalition. Even in the case of hegemons, singleton behavior is not without consequences, although retaliatory behavior due to short-sighted unilateral management interventions may constitute a smaller net loss to the hegemon than such behaviors in fisheries split more evenly among different fishing nations (Blasiak et al. 2015a). As of mid-2015, however, this round of “mackerel wars” seems to have drawn to a partial close with the announcement in 2014 of a three-way deal between the EU, Norway and the Faroe Islands on mackerel quotas, with apparent “side payments” in the form of quota adjustments to haddock, saithe, whiting and others (European Commission 2014). In this case, the spatial displacement of Atlantic Mackerel has therefore also triggered a shift in the extent to which other species are being targeted. Although the cooperative agreement seems like a positive step towards sustainable management, it does provide for a quota of 1,240,000 tons of mackerel to be shared among the three signatories, although the 2014 quota recommended by ICES was 890,000 tons. Iceland remains outside the grand coalition for now, despite years of unsuccessful negotiations with the other countries sharing the stock, and it continues to express its disappointment at being excluded (MOIT 2014). One month after the announcement of the EU/Norway/Faroe Islands catch quotas, Iceland unilaterally announced its 2014 catch quota of 147,574 tons, pushing the total announced quotas to 156% of the ICES recommendation. (Iceland Ministry of Industries and Innovation 2014)

Regardless of whether the current paradigm of cooperation proves stable over time, it should be noted that five years passed between the emergence of singleton behavior and a partial return to cooperative management. This suggests that even in a region dominated by countries with some of the strongest governance and cooperative mechanisms, the available instruments were insufficient for rapid adjustment. (Kaufmann et al. 2014) The expected increase in climate instability and unpredictability is likely to result in an increase in shifting habitats for many species therefore raising concerns about how resilient other cooperative frameworks will be in the face of a sudden change and associated displacement effects. (Cheung et al. 2013)

4.4.2 Diffusion Effects – Skipjack Tuna Fisheries

The sustainable cooperative management of highly migratory species with broad distribution ranges poses a considerable challenge. Such fisheries do not always have clearly dominant players, and rely primarily on a group of RFMOs with limited capacity to impose and enforce binding regulations on fishing practices (Allen 2010, Brasão et al. 2000, Koehler 2013).

Likewise, global demand for tuna products remains strong and catches reported to the FAO of Skipjack Tuna, for example, have shown continuous growth over the past decades (see Figure 2-6).

At the same time, the broad distribution of tuna species across the high seas as well as the EEZ of states with both strong and weak monitoring and enforcement capacity suggests a highly uneven management landscape (Mora et al. 2009). The tuna RFMOs maintain lists of vessels that have engaged in illegal, unreported and unregulated (IUU) fishing activities, but the full extent of such activities is unclear. In their more specific estimates of illegal and unreported (IU) fishing activities, Agnew et al. (2009) found, for example, that the tuna fisheries are among the least affected by such activities, with maximum estimates of about 10% of total catch coming from IU fishing. On the other hand, Pramod et al. (2014) estimate that up to 35% of tuna imported into the USA in 2011 from Vietnam, Indonesia and the Philippines came from IUU activities, while up to 40% of imports from Thailand did. The wide range in these estimates reflects both variation in research methodologies as well as a lack of reliable international data, due to the myriad ways in which IUU fishing is concealed.

Drawing on the literature of enforcement balloon effects generated by drug control efforts, it can be predicted that IUU fishing will follow a path of limited statehood, with targeted control efforts causing IUU activities to scatter into the poorly monitored high seas and distant reaches of tiny island states with vast marine territories. But identifying such a balloon effect would be further complicated not only by the lack of specific IUU data, but also by stock unpredictability and natural shifts in distribution. Considering the likelihood that both legal and illegal fishing activities will follow the fish wherever they go, an assessment is presented below based on reported FAO catch data of Skipjack Tuna to consider the changes in where catches are occurring as a proxy for all fishing activities, both legal and IUU.

To test this assertion, a simple linear regression analysis of changes in reported Skipjack Tuna catch over different timeframes of the last thirty years against three different variables. The first variable corresponds to the country values of the annually published Failed State Index (FSI) based on twelve social, economic and political factors influencing stability, while the other two variables are all meant to give different measures of the capacity of a government to adequately monitor and enforce fishing regulations across its territory (Fund for Peace 2013). In a general sense, the ratio of size of EEZ to GDP can be interpreted as some proxy of this capacity. Equation 1 provides an example of the linear regression performed over the 1982-2012 timeframe for the respective country values on the FSI, with *C* being reported catch for each country *k*, intercept and slope coefficients given by α and β respectively, and error term ε.

$$\Delta C_{k,\ 2012-1982} = \alpha + \beta(FSI_{\mathrm{k}}) + \varepsilon \qquad (1)$$

Although a governance-related diffusion effect was predicted and seems at least theoretically supported by the literature, the regression analysis found no such simple correlation between FSI and changes in Skipjack catches. Among other things, this could be due to limited specific consideration of marine governance in the FSI. On the other hand, the proxy for enforcement capacity (GDP/EEZ) showed a significant correlation with positive coefficients. Since 2002, however, evidence for such a correlation has become less clear. Although this simplified analysis is suggestive, a diagnostic check for outliers highlights how strongly some of the Pacific Island states diverge from any global trend, most noticeably Kiribati, the Marshall Islands and Tuvalu. This analysis of outliers also suggests why a significant correlation was found between the size of EEZ and the change in reported catch since 2002, as this is precisely the period in which small island states in the Pacific with vast marine territories began to dramatically increase their catch levels of Skipjack Tuna, primarily by granting access to foreign fleets.

4.4.3 Intensification Effects – Alaska Pollock

One of the most substantial institutional developments in international fisheries management was the formalization in 1982 of the 200 nautical mile EEZ under UNCLOS. Among other things, this created a number of patches of international waters wholly or partially surrounded by the EEZ of one or more states, the most famous examples being the fancifully named Sea of Okhotsk “peanut hole”, Barents Sea “banana hole” and “loophole”, and the Bering Sea “donut hole” (Figure 4-4).

The Bering Sea is home to tremendous quantities of Alaska Pollock, which constitute the most lucrative fishery in the northern hemisphere. At its peak, it is estimated that the Aleutian Basin was home to approximately 20 billion fish, or as Bailey (2011) puts it, “about three fish for every person on Earth.” Although the ecology and stock composition of the Alaska Pollock remains unclear even today, the discovery of such substantial resources saw increasing exploitation by an expanding number of distant water fishing fleets as well as those of the USA and USSR/Russian Federation.

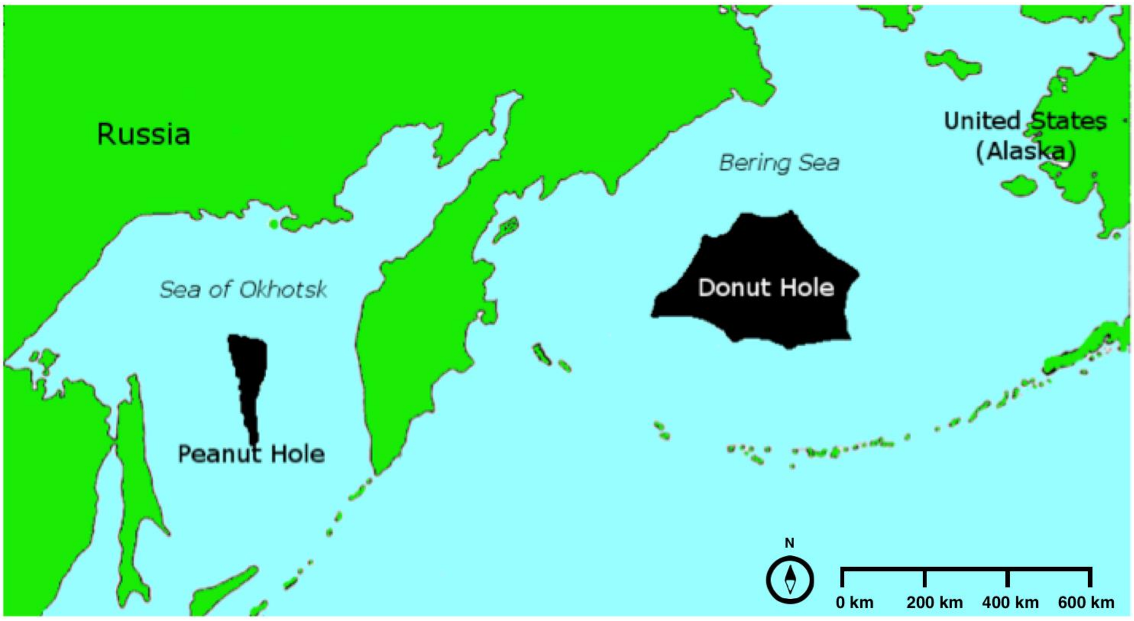

Figure 4-4: *Patches of international waters in the Sea of Okhotsk and Bering Sea are referred to as the Peanut Hole and Donut Hole, respectively, and represent significant challenges for cooperative management of straddling and highly migratory stocks. (Source: adapted from FAO 1994)*

The Bering Sea is home to tremendous quantities of Alaska Pollock, which constitute the most lucrative fishery in the northern hemisphere. At its peak, it is estimated that the Aleutian Basin was home to approximately 20 billion fish, or as Bailey (2011) puts it, “about three fish for every person on Earth.” Although the ecology and stock composition of the Alaska Pollock remains unclear even today, the discovery of such substantial resources saw increasing exploitation by an expanding number of distant water fishing fleets as well as those of the USA and USSR/Russian Federation.

A game-changing institutional shift came in 1975 with the passage of the United States Fishery Conservation and Management Act (FCMA), which claimed sovereignty over a 200 mile zone extending out from the coastline of the USA. While the FCMA did not explicitly bar foreign fleets from engaging in fishing activities within this “Fisheries Conservation Zone”, it gave a system of eight regional fishery management councils control over setting total allowable catch (TAC) levels and, crucially, gave American fishers priority in reaching these TAC levels.

Bailey (2011) provides a detailed description of the impacts of this institutional shift, but most fundamentally as the fleet capacity of the USA grew and its fishers came closer to independently filling annual TACs, the fleets of distant water fishing states were increasingly displaced from the Fisheries Conservation Zone into the international waters of the Donut Hole, where large quantities of Alaska Pollock had recently been found (Okada 1983).

From this point the Alaska Pollock fishery developed along two paths: 1) a coupled two-player system dominated by the USA and USSR spanning the EEZ of both countries, and 2) a non-dominated fishery in the high seas of the Donut Hole (Blasiak et al. 2015). The former has developed in the intervening years into a stable model of sustainable fishery production (FAO 2012). The latter rapidly collapsed by 1992 to just 6% of peak abundance levels, largely due to the intensification effects of excess fleet capacity in a small expanse of international waters, and the lack of adequate cooperative management mechanisms (Bailey 2011). Such mechanisms emerged too late for sustainable fishery activities to be implemented, and in 1993 a moratorium was imposed on the capture of Alaska Pollock in the Donut Hole, which remains in place today, under the “Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea”.

A number of factors contributed to the displacement and subsequent intensification of fishing activities within the Donut Hole destabilizing the Alaska Pollock fishery, including an incomplete understanding of the ecological conditions, excess fleet capacity and different levels of monitoring effort and capacity across the fishery's EEZ and high seas areas. The actual stock composition within the Bering Sea remains unclear, with the Donut Hole stock considered by some as not a distinct stock. In addition, a cooling trend in the Bering Sea in the late 1980s as a result of Pacific Decadal Oscillation (PDO) may have also influenced phosphate levels and caused changes in Alaska Pollock stock composition and distribution (Bulatov 2014).

A key lesson is that the harvesting activities displaced by institutional change developed far more rapidly than any steps towards negotiating cooperative management mechanisms or conducting comprehensive research about the fishery. While the precautionary approach has been enshrined in Article 6 of the UN Fish Stocks Agreement, the dynamism and unpredictability inherent to fish stocks draws attention to the vagueness of language like "states shall be more cautious when information is uncertain, unreliable or inadequate" (UN 1995).

4.5. Discussion

The cases introduced here demonstrate not only the destabilizing effects of DDI on coalitions aiming to ensure sustainable management of shared and straddling fish stocks, but also the close ties across different types of DDI, which are far from mutually exclusive. Under real world conditions, it is highly likely that sudden shifts will result in opportunistic combinations of displacement, diffusion and intensification. As described here, one effect may be more pronounced than others, but by describing the variety of potential DDI effects individually, we hope this typology provides a tool for early recognition of potentially destabilizing forces.

It also becomes apparent that DDI can be both a cause and an effect of decreased coalitional stability. In the case of Atlantic Mackerel, for example, the poleward shift of the stock and associated displacement of fishing activities caused Iceland to engage in unilateral quota-setting, which was followed the next year by an intensification of fishing activities in the Faroe Islands as it retaliated with its own unilateral quotas outside of coalitional agreements. Descending spirals of non-cooperative behavior resulted in a loss of coalitional stability and ultimately unsustainable fisheries management if measured against quotas suggested by ICES. Figure 4-5 provides a conceptual representation of how DDI can destabilize a grand coalition and induce a vicious cycle of behavior, which could lead to a total collapse of cooperation and race to the bottom of the stock, ultimately resulting in conditions of bionomic equilibrium. As illustrated here, the loss of coalitional stability and retaliatory behavior both lead to an overall loss of utility when sustainable fishing levels are exceeded. A range of policy and management instruments can be employed to stop this downward spiral and move towards greater coalitional stability, including the development of new joint treaties and agreements, formed through rounds of negotiation and potential application of side payments (negotiation facilitators). Likewise, sharing of assessment, monitoring and enforcement activities can introduce greater buy-in by cooperating nations and reframe cost-benefit analyses.

Furthermore, there are highly disproportionate reaction times by fishing entities, and by the institutions charged with ensuring the sustainable management of fisheries, to changes in stock distribution and abundance. Although a range of different drivers can lead to DDI effects, the subsequent downward spiral could be slowed or reversed by swift and coordinated action by cooperative management bodies, while delayed action fosters a climate of extended uncertainty and the potential for multiple rounds of retaliatory behavior.

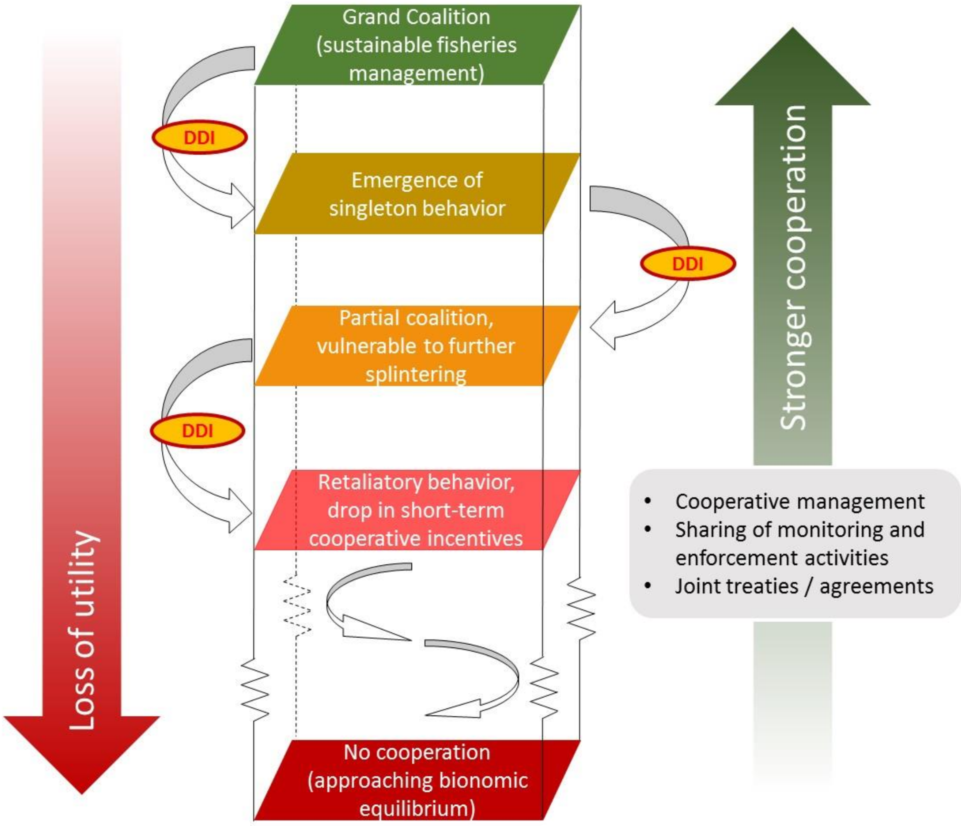

Figure 4-5: *Conceptual diagram for how DDI effects can contribute to coalitional instability and less sustainable management practices*

Looking forward, further research on fisheries in flux is needed to discern optimal strategies for mitigating the potentially destabilizing impacts of DDI. In particular, three areas in need of strengthening are:

i) Increased awareness and detection of DDI effects through targeted data collection;

ii) Better understanding and integration of fish stock migration both naturally and in response to external stimuli such as climate change;

iii) Encoding of the potential for DDI effects to destabilize grand coalitions into cooperative agreements to provide a mechanism to deal with these effects and reduce the risk of singleton behavior.

We present this framework as a means to identify and possibly anticipate unintended consequences of DDI effects. Proactive planning for such effects given the long lag time between manifestation and policy response means that early detection of DDI is imperative in order for it to be swiftly addressed. This reduces both the length and severity of any singleton or retaliatory behavior, which can take longer to remedy the longer it continues unchecked. Subsequently, time is needed to rebuild the breakdown in trust between coalition members if there has been retaliatory behavior in the interim, with potential trust-building measures including joint assessment, monitoring and enforcement activities.

4.6. Conclusion

This chapter has presented a typology of spatial effects and applied it to the management of large-scale marine capture fisheries. The typology has been developed from examining effects in other policy areas, most notably the control of illegal drug production. They have been classified based on whether the primary effect is one of displacement, diffusion or intensification of fishing activities. Using three examples, these effects have been analyzed according to their impact on the coalitional management of those fisheries and based on the framework of how DDI can cause instability in cooperative behavior. DDI can be both a cause and effect of instability in cooperative agreements and as such, recognition of such effects is crucial to avoid protracted retaliatory behavior and reduce the lag time between detection and policy remediation.

While applied here to the case of marine fisheries, we feel that understanding such effects has the potential to be of use across a wide range of policy arenas within and beyond the environmental sphere. This typology can serve as an analogue across a number of other transboundary policy areas characterized by highly varying levels of monitoring and enforcement capacity and effort, including carbon leakage and illegal drug and wildlife trafficking. Transdisciplinary dialogue may prove particularly relevant in such efforts, for example by assessing the potential for regional approaches like those used by anti-trafficking authorities and climate change bodies to halt similarly destabilizing effects.

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Chapter 5: General Discussion

5.1 Framing the challenges and perspectives of sustainable ocean management

The research contained within this thesis emerged from the supposition that the international governance landscape for ocean management is characterized by tremendous diversity, which causes efforts to manage ocean resources to frequently have unintended and potentially destabilizing consequences. Hence, to contribute to a deeper understanding of these issues within the context of sustainable ocean management, a threefold approach was taken to: (1) assess barriers to international cooperation on marine resource management as well as the potential for targeted interventions to result in destabilizing displacement; (2) develop typologies for different types of destabilizing "balloon effects" in marine fisheries as well as different levels of hegemony among fishing nations sharing fish stocks to create a framework for future research; (3) develop policy recommendations for enhancing sustainable ocean management based on analysis of strategic behavior and unintended consequences. Within this chapter, a sub-chapter is dedicated to each of these three points, with particular emphasis on policy recommendations.

5.2 Barriers to international cooperation of marine resources

Achieving cooperation in international fisheries is often challenging due to a conflux of several key issues, including a diverse governance landscape, national jurisdictions with varying monitoring and enforcement capacities, a lack of complete information about stock distribution and size, and frequently inflexible mechanisms for cooperation that often require years to respond to change (Blasiak et al. 2015a). Nevertheless, substantial successes have been achieved with managing other complex international challenges such as the efforts to control and ban the use of chlorofluorocarbons (CFCs) under the Montreal Protocol, which has now been ratified by 197 UN member states and other entities, and has been highly effective at halting ozone depletion (UNEP 2012, IPCC/TEAP 2005).

The example of recent shifts in distribution of mackerel stocks in the northeastern Atlantic illustrates just how challenging lasting cooperation can be. States in Northern European frequently top the rankings of governance indices (Fund for Peace 2013, Kaufmann et al. 2014), mackerel catch limits are recommended by the 100+-year-old International Council for Exploration of the Seas (ICES), and considerable work has been done using game theory to understand the optimal strategic behaviors for the states sharing this mackerel stock (Pintassilgo and Lindroos 2008, Hannesson 2011). Nevertheless, when stocks started to shift in 2009, cooperative agreements rapidly broke down as first Iceland and then the Faroe Islands unilaterally revised their catch limits (Blasiak et al. 2015a). In this case, two of the factors listed above were particularly relevant. Firstly, incomplete information about the stock size and distribution led to some claiming that the stock had simply shifted polewards, while others claimed that the stock size had actually increased. This uncertainty justified divergent behaviors. While both scenarios would potentially require renegotiation of fishing quotas, a shift in stock distribution would benefit some fishing jurisdictions and be to the detriment of others, while a larger stock would constitute a win-win situation for all players. Short-term strategies by the different players would have to weigh these potential gains/losses accordingly. Ultimately the existing cooperative framework collapsed due to this uncertainty as well as a lack of management instruments with enough flexibility to swiftly respond to these unexpected events or quickly bring the retaliatory unilateral behavior to a halt. In the end, a renegotiated partial agreement was not reached until five years later in 2014 (European Commission 2014, European Commission 2009).

Likewise, the large-scale DDI effect generated by the formalization of UNCLOS in 1982 led to instability in the high seas Alaska Pollock fishery (Blasiak et al. 2015b). Rapid governance response could potentially have slowed or halted the degradation of this highly lucrative fishery. In this case as well, the slow governance response was exacerbated by uncertainties about the actual stock composition in the Bering Sea and Aleutian Basin (which remains disputed today) (Bailey 2011). In both cases, destabilizing factors (e.g. shifts in distribution, unintended DDI consequences) caused conditions to rapidly worsen over the span of several years because any corrective action was slowed by the rigidity of governance frameworks and instruments.

Looking forward, uncertainties related to incomplete information can be expected to intensify as the predicted impacts of climate change and severe El Niño events cause shifts in stock size, distribution and composition (Cheung et al. 2013, Srinivisan 2015). Likewise, a new era of seabed mineral extraction is dawning, and disputed territorial claims in different parts of the world, particularly East Asia, can be expected to further alter the potential for cooperation.

5.3 Typologies of destabilizing balloon effects in marine fisheries

The instability caused by unexpected balloon effects poses a serious challenge to sustainable management of fisheries resources (Blasiak 2015). By developing typologies for studying and understanding such effects, however, it is possible not only to determine underlying commonalities across different contexts, but also to predict where vulnerabilities may emerge in the management framework, or where the conditions for engaging in cooperative behavior are particularly favorable (Blasiak et al. 2015a, Blasiak et al. 2015b).

For this purpose, two different typologies were developed within the scope of this research: a dominance-based typology for cooperative fisheries management, and a typology of balloon effects (Displacement, Diffusion and Intensification: DDI). The dominance-based typology provided a useful tool for assessing the existence of the so-called veto factor (Arnason et al. 2000) under which dominant players (hegemons) engage in strategies guided by self-interest to block efforts to establish cooperative agreements on the management of shared and straddling fish stocks. The causality of whether this veto power is conscious or unconscious remains unconfirmed, but a survey of the world's largest fisheries found that the existence of a hegemon in a shared or straddling fishery precluded the establishment of cooperative frameworks (Blasiak et al. 2015a). Literature on game theory suggests that the time and material costs of establishing cooperative frameworks would outweigh any potential benefits hegemons would accrue, while a partial coalition excluding the hegemon would likewise face considerable time and material costs, but have a limited payoff from cooperative efforts (Arnason et al. 2000, Hannesson 2011). Consequently, stasis ensues until a shift in dominance occurs – for instance from a DDI effect related to climate change or a new international governance instrument. When a shift away from a hegemonic system occurs, a significant opportunity for cooperation emerges. The typology described above found that most coupled two-player systems and shared small-group systems had cooperative agreements in place for the management of the respective fish stocks (Blasiak et al. 2015a). The case of Pacific Saury and recent cooperative management agreement under the North Pacific Fisheries Commission illustrated in Chapter 2 exemplifies such an opportunity. Carefully monitoring shifts in dominance among fish stocks according to this typology makes it possible to determine optimal stages at which additional effort to formulate cooperative management agreements are most likely to be successful. Likewise, the gradual emergence of a hegemon in a shared or straddling fishery may pose a risk to existing cooperative frameworks and signal the need for greater attention and perhaps revisions to introduce more flexibility into the existing agreement (Blasiak et al. 2015a).

The second typology, which focuses on DDI effects, seeks to establish a broad framework that enables comparability of a diverse range of destabilizing shifts in fisheries. DDI effects may result from institutional change (e.g. intensification of international Alaska Pollock fisheries into the Donut Hole following formalization of EEZ under UNCLOS), from climate-related shifts in distribution (e.g. displacement of fishing activity due to poleward shift of Atlantic Mackerel stock), and from uneven governance levels (e.g. diffusion of tuna fisheries into national jurisdictions characterized by weak regulatory capacity). In each case, researchers expect that these DDI effects have led to unsustainable fishing practices, and in some instances to retaliatory behavior driven by short-sighted strategic behaviors (Kwon 2006, Lindroos et al. 2007, Pintassilgo et al 2010). If adequate governance mechanisms are not in place or lack the flexibility to adapt to rapidly changing conditions, such DDI effects can lead to a downward spiral towards conditions of bionomic equilibrium (Berkes et al. 2006). This typology has helped to emphasize how a broad range of different conditions can lead to destabilizing DDI effects, and how slow governance response or inflexible frameworks are a key barrier to ensuring long-term sustainable management of ocean resources.

5.4 Limitations and areas of future study

This research has aimed not only to deepen understanding of strategic behavior and unintended consequences in international fisheries cooperation, but to provide useful tools for identifying, monitoring, and counteracting potentially destabilizing changes. It is the author's hope that these typologies, in particular, will contribute to sustainable ocean management, particularly within the context of increasing globalization and mobility as well as the impacts of expected climate change.

Building on the results of the dominance-based typology, a promising area of future study would be to consider not only the existence of cooperative agreements in shared and straddling fisheries under different states of dominance, but also their respective quality or effectiveness. Highly migratory tuna stocks, for instance are cooperatively managed under five RFMOs, but there is variation across these in terms of allowable fishing gear, vessel size, etc. Likewise, many cooperative management agreements constitute partial coalitions rather than grand coalitions, meaning that multiple fishing nations are frequently excluded. Expanding the typology or specifying it to take account of the number, or collective share, of excluded players would help to clarify the potential instability that such exclusions create.

A crucial finding of the work on balloon effects and DDI effects is that management interventions can have unintended and potentially negative outcomes for sustainable fisheries management. In the case studies introduced here, a common thread was the slow speed of institutional response, or the vulnerability of existing cooperative agreements due to a lack of built-in flexibility. Building on the typology of diffusion, displacement and intensification, it would be useful to conduct further work specifically focusing on the cooperative landscape before and after individual DDI effects in international fisheries to assess ex-post-facto whether existing mechanisms were sufficiently flexible to adapt to the new pressures, or where weaknesses caused cooperative agreements to fail.

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