

Global Ocean Futures –  
Governance of marine fisheries in the Anthropocene  
Andrew Sean Merrie





# Global Ocean Futures

Governance of marine fisheries in the Anthropocene

Andrew Merrie

To Gurly and E.T.

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“How inappropriate to call this planet Earth when it is quite clearly Ocean.”

**Arthur C. Clarke**

“We have become, by the power of a glorious evolutionary accident called intelligence, the stewards of life's continuity on earth. We did not ask for this role, but we cannot abjure it. We may not be suited to it, but here we are.”

**Stephen Jay Gould**

“The future is already here; it's just not very evenly distributed”

**William Gibson**

## ABSTRACT

This PhD thesis provides an analysis of how an adaptive governance approach can be applied to address existing and emerging challenges in global governance with a focus on marine, wild-capture fisheries. All the papers share a coupled social-ecological framing while providing diverse but complementary perspectives. **Paper I** provides a lens through which it is possible to understand the types of interactions that link social and ecological components of fisheries systems at the global scale. The key result of this paper was the development of a marine social-ecological framework to guide future modelling and scenario analysis. **Paper II** describes the process of emergence and spread of new ideas in marine governance using Marine Spatial Planning as an illustrative case study. The study shows how governance innovations may contribute to resolving the mismatches between the scale of ecological processes and the scale of governance of ecosystems. A key finding of the paper is the identification and explanation of the mechanisms by which informal networks of actors are able to influence the emergence and spread of new governance forms from the local to the global scale. **Paper III** focuses on governance of ocean areas beyond national jurisdiction. The key finding from this paper is the urgent need for existing and emerging governance institutions to build capacity for responding to the challenges facing governance of marine fisheries. These challenges arise from unexpected shifts in markets, technology and society. **Paper IV** develops a set of four imaginative but plausible 'radical' futures for global fisheries drawing on trends compiled from a diverse evidence base. The four resulting narratives aim to act as lenses for engaging debate and deeper reflection on how non-linear changes in technology and society might radically shift the operating context and core assumptions of fisheries governance in the future. These papers make a novel contribution to Sustainability Science through their focus on 1) the conditions for, and mechanisms of emergence of diverse and divergent governance forms, 2) the role of agency in complex actor settings, 3) the need for governance institutions to not only deal with, but also be able to anticipate surprise, and 4) the development of scenarios of marine social-ecological futures using a creative and rigorous narrative approach.

**Keywords:** fisheries, futures, global governance, marine ecosystems, scenarios, social-ecological system

## SAMMANFATTNING

Denna doktorsavhandling analyserar hur ett adaptivt perspektiv på styrning kan användas för att hantera de växande utmaningar som den globala styrningen av marina fiskerier står inför. Samtliga papper i avhandlingen utgår från ett social-ekologiskt perspektiv och behandlar olika men samtidigt kompletterande frågeställningar gällande global styrning av marina fiskerier. I **Papper I** presenteras olika typer av interaktioner som kopplar samman sociala och ekologiska komponenter på olika nivåer i globala fiskerier. Detta pappers främsta bidrag är utvecklingen av ett social-ekologiskt ramverk, som kan vägleda framtida modelleringar och analyser av fiskeriscenarier. **Papper II** beskriver framväxten och spridningen av nya idéer och tillvägagångssätt för styrning av havs- och fiskeriresurser genom en fallstudie av havsplanering. Studien visar hur innovativa styrningsformer, som havsplanering, kan bidra till att förbättra länken mellan nivån där sociala institutioner, som förvaltar ekosystem, verkar och nivån där ekologiska processer tar sig i uttryck. Papprets främsta bidrag är att identifiera och förklara hur informella nätverk av aktörer påverkar utvecklingen och spridningen av nya styrningsformer från lokal till global nivå. **Papper III** fokuserar på styrning av marina resurser på internationellt vatten. Pappret betonar vikten av institutioner, både existerande och framväxande, med kapacitet att kunna svara på de utmaningar, orsakade av oförutsedda marknadsrelaterade, teknologiska och samhällsliga förändringar, som den globala styrningen av marina resurser står inför. **Papper IV** presenterar fyra fiktiva men samtidigt fullt möjliga framtidsscenarier av globala fiskerier. Syftet med de fyra scenarierna är att bredda debatten och skapa en djupare förståelse för hur ickelinjära teknologiska och samhällsliga förändringar kan ändra utgångspunkten för, och kontexten genom vilken styrning av fiskerier kan bedrivas i framtiden. Avhandlingens fyra papper bidrar till hållbarhetsforskningen på ett nyskapande sätt genom att fokusera på 1) villkoren och mekanismerna för olika styrningsformer, 2) aktörers roll i att påverka utformningen av olika styrningsformer, 3) behovet av institutioner som inte enbart kan hantera men också förutspå oväntade förändringar och 4) att utveckla scenarier av social-ekologiska fiskerier, med hjälp av narrativ, på ett kreativt såväl som rigoröst sätt.

**Nyckelord:** fiskerier, scenarier, global styrning, social-ekologiska system

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# Papers included in this thesis

**This thesis is based on the following papers, referred to by their upper case Roman numerals:**

- I Österblom, H., **Merrie, A.**, Metian, M., Boonstra, W.J., Blenckner, T., et al., (2013). Modelling Social-Ecological Scenarios in Marine Systems. *Bioscience* 63(9), 735-744.
- II **Merrie, A.**, Olsson, P. (2014). An innovation and agency perspective on the emergence and spread of Marine Spatial Planning. *Marine Policy* 44, 366-374.
- III **Merrie, A.**, Dunn, D., Metian, M., Boustany, A., Takei, Y., Oude Elferink, A., Ota, Y., Christensen, V., Halpin, P.N., Österblom, H. (2014). An ocean of surprises – trends in human use, unexpected dynamics and governance challenges in areas beyond national jurisdiction. *Global Environmental Change – Human and Policy Dimensions* 27, 19-31.
- IV **Merrie, A.**, Keys, P., Metian, M., Österblom, H. (*Prepared for submission to Fish and Fisheries*). Radical Fish Futures – An imaginative science fiction prototyping approach to scenarios of the future oceans [Manuscript]

## **Contributions to the papers included in this thesis:**

- I Design, and development of the ‘human dimensions’ diagram and supporting materials. Writing on the paper.
- II Joint idea generation, research design, data collection and analysis, most of the writing on the paper.  
  
This paper is loosely based on my MSc thesis ‘*An idea whose time has come – An innovation Perspective on Marine Spatial Planning Exploring the emergence of Marine Spatial Planning as a tool for ecosystem-based management*’ from Stockholm University, 2011.
- III Joint idea generation, coordination of author team, data collection, writing on the paper, overall coherence of the manuscript.
- V Idea generation, research design, lead on data collection, preparation and analysis and writing on the paper

**Relevant work outside the thesis, referred to by a lower case Roman Numeral:**

- i Österblom, H., Jouffray, J-B., Folke, C., Crona, B., Troell, M., **Merrie, A.**, Rockström, J. (2015). Transnational Corporations as Keystone Actors in Marine Ecosystems. *PLOS One* 10(5): e0127533.
- ii **Merrie, A.**, Petersson, M., van Holt, T., Valman, M., Edwards, M., Österblom H. (*Prepared for submission to Organization Science*). The Fisher Kings - Strategies of Transnational Fishing Corporations and Global Governance of Fisheries
- iii Cheung, W., Ota, Y., & Swartz, W., et al. (2015). *Predicting Future Oceans: Climate Change, Oceans & Fisheries*. The Nippon Foundation – University of British Columbia Nereus Program; Vancouver.
- iv Haider, L.J., Hentati-Sundberg, J., Giusti, M., Goodness, J., Hamman, M., Masterson, V., Meacham, M., **Merrie, A.**, Ospina-Medina, D., Schill, C., Sinare, H. (*Prepared for submission to Sustainability Science*). Building Strong Sustainability Science: The Young Interdisciplinary's Journey

# 1.0 Introduction

## 1.1 Marine fisheries and their future

Humanity faces mounting pressures from a number of different directions as it is called to preserve, develop, protect and use the ocean simultaneously. If a societal goal is to ensure both functioning marine ecosystems and the continued provision of seafood in 2050 and beyond, it is important to understand current and emerging governance trajectories operating at the global level. Given the challenges faced by marine ecosystems as nested within a larger set of environmental and social challenges at the global scale, any attempt to make a contribution to global governance must recognise that the situation is different now from what has existed in the past and that the past will not necessarily be reflective of the future. So what does the future of fisheries and the oceans hold?

If this thesis were to be submitted in 2050, what would it say about the oceans, would it even make sense to do a PhD in 2050 on global governance of fisheries? Will there be enough fisheries left to govern? Recently, Worm et al. (2006) made the prediction that by 2048, all major commercial fish stocks will have collapsed. They have since walked back this strong prediction in a subsequent paper (Worm et al. 2011) following virulent disagreement and strong scientific rebuttal from others in the scientific community (Murawski, Methot and Tromble 2007, Hilborn 2007a, Branch 2008). This fierce debate at the heart of fisheries science is revealing in terms of the governance challenge. We govern fisheries at all scales, from community managed marine parks and fisheries co-operatives operating at the village level (Allison and Ellis 2001, Chuenpagdee 2011) all the way up to the United Nations Law of the Sea Convention,<sup>1</sup> ratified by 146 countries that has forever changed how we govern the oceans with the corresponding shift in control of fisheries resources resulting from the establishment and enforcement of 200 nautical mile exclusive economic zones. Outside of these zones of national sovereignty established by international law, lies 60% of the ocean, colloquially known as the 'high seas' and more formally as areas beyond national jurisdiction (ABNJ).

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<sup>1</sup> UN Convention on the Law of the Sea, 1982. Adopted 10 December 1982, entered into force 16 November 1994. No. 31363.

Some fisheries are well managed (Hilborn 2007b) while others have undoubtedly collapsed (Bavington 2011). However, despite this variation, there are global patterns in fisheries that are cause for great concern for both the fish and those whose livelihoods depend on them. Many fisheries are over-exploited and marine ecosystems are degraded (Pauly et al 1998, Jackson 2001, Pauly et al 2005, Hall et al 2010, Pinsky et al. 2011, Nyström et al. 2012, FAO 2014, McCauley et al. 2015, Pauly and Zeller 2016). Overfishing and degradation of marine ecosystems are part of a set of cumulative human pressures on coastal and marine areas (Cheung et al. 2009, Halpern et al 2012, Halpern et al 2015). These global patterns of fisheries exploitation and marine fisheries degradation are perhaps not very surprising as the world is very different than it was not much more than half a century ago. From the 1950s onwards, humanity has embarked on a 'great acceleration' of economic, social and ecological trends (Steffen et al. 2015a), which has led to remarkable progress and achievements at great cost to the earth's life support system (Rockström et al 2009). Bavinck (2011) illustrates what this accelerative process looks like when it plays out in the oceans in a process of 'mega engineering of ocean fisheries' via intensive industrialization, the global spread of fishing fleets to all far-flung reaches of the world (Swartz et al 2010) and rapid introduction of new technologies. A number of scientists have presented compelling evidence that we have entered a new geological epoch, an era of human domination of ecosystems and anthropogenic influence on earth-system processes, labelled the Anthropocene (Crutzen and Stoermer 2000, Steffen, Crutzen and McNeill 2007). Exactly when the Anthropocene began and the implications of the concept are debated (Corlett 2014). However, the depth and breadth of the changes that are argued to be associated with crossing into a new geological epoch and the rapid acceleration of human impacts on the natural world are closely associated with the concept of Globalisation (Beck 2015 [1997]).

## 1.2 Globalisation, global change and global fisheries

This concept provides important context and part of the setting for any work in the field of global governance. There is much debate over the meaning, extent, and normative implications of globalisation (Guillen 2001, Bhagwati 2007, Beck 2015 [1997], Hirst, Thompson and Bromley 2015) but despite this diversity of perspectives, the importance of globalisation is not in dispute. Young et al. (2006) present globalisation as the unpredictable interactions between socio-economic and environmental change and the authors distinguish a set of analytical dimensions of globalisation from the literature. Two of these dimensions are particularly relevant to this thesis, 1) increasing connectedness and interdependencies within and between social and economic spheres and, 2) the acceleration of interactions and processes operating at the global level. They draw on Held (2000) in defining global social change as the: “*widening, intensifying, speeding up and growing impact of world-wide connectedness.*” Further, Young et al. (2006) define environmental changes at the global scale thus:

*“Environmental change also needs to be considered as a global phenomenon. Whether changes are systemic (e.g. climate change and variability) or cumulative (e.g. aggregate loss of biological diversity), the biophysical changes occurring today are global in scope. What is more, the large-scale environmental changes that mark the present era are increasingly anthropogenic in origin.”*

The impact of these globalisation processes is evident in the work of Rockström et al (2009) and Steffen et al. (2015b) on planetary boundaries, which identifies nine earth system processes that are being altered in different ways at the global scale as a result of interacting anthropogenic pressures. Each of these boundary processes is closely linked to the oceans and the future of marine fisheries. Another dimension is that there is mounting evidence for increasing tele-connections (Adger, Eakin and Winkels 2009) linking local resources to global drivers such as trade (Oosterveer 2008, Crona et al. 2015, Österblom et al. 2015, Eriksson et al. 2015) and even financial markets (Galaz et al. 2015).

What do these processes of globalization relevant to marine ecosystems look like in practice? Fishing happens all over the oceans within the jurisdiction of individual states along the coast and under the jurisdiction of no single state many miles from shore (Swartz et al 2010). Transnational fishing corporations connect marine ecosystems all over the world through complex, constantly adapting supply chains providing fish caught off west Africa to consumers in western Europe (Wilkinson 2006, Oosterveer 2008). Cod caught in the Baltic are flash frozen, sent to China, processed and then sent to the U.S. to be eaten as fish fingers by U.S. families (Fabinyi and Liu 2014). Schools of anchoveta off the coast of Peru are processed into fishmeal by a Chinese-owned, Peruvian company which is used as a component in feed to raise farmed salmon in massive operations controlled by Norwegian corporations with subsidiaries in Chile (Paper i, ii). Marine ecosystems themselves add layers of complication to any attempt to govern them. They move, they cross boundaries with no consideration for national borders or carefully agreed catch quotas. Some migrate many thousands of kilometres and might be caught just before they breed, and each species possesses its own idiosyncratic features. Furthermore, many species are sensitive to many of the processes of environmental change that are affecting the oceans including elevated temperatures and ocean acidification associated with climate change (Munday, Crawley, Nilsson 2009, Cheung et al. 2009, Garcia and Rosenberg 2010, Sumaila et al. 2011).

### **1.3 Global governance of marine fisheries**

The challenges around the globalisation of the fishing industry and how this process interacts with marine ecosystems are matched by an equally complicated and evolving global governing context. Countries are still critical contributors to both the continuing ‘problem’ of global overexploitation of fish stocks and a source of potential solutions (Juda 2002, Cole 2003, FAO 2014). The 21<sup>st</sup> century is a world where the authority of states has diffused and been redistributed, where NGOs and corporations act sometimes in league with the policy making goals of states, and other times in contravention (Hanna 1999, Cole 2003, Cash et al. 2006). The diffusion and reallocation of political authority has occurred willingly and unwillingly and often industry and other members in a ‘complex actor setting’ are able to create the rules of the game in a vacuum of political authority and then any attempt to govern must be built around a complex set of developments and interactions (Hollway and Koskinen 2016) as explored in **Paper III** and **Paper IV**). The rise of networks of private actors operating in coalition and conflict with other governance organisations is a reality and presents a unique set of challenges and opportunities (Dauvergne and Clapp 2016) that are considered as part of this thesis.

Often, solutions to the over-exploitation of marine resources at the global scale are presented as being self-evident and final. One example is the increasing prevalence of ownership-based approaches to fisheries management such as Individual Transferable quotas (ITQs) being advocated as ‘the’ solution to fisheries management (DeSombre and Barkin 2011). A second example is certification of fisheries, primarily through the Marine Stewardship Council, as being ‘the’ approach to sustainable fisheries and this is empirically observable with the increase in the number of certified fisheries and certification schemes (Kalfagianni and Pattberg 2013, Kalfagianni and Pattberg 2014). There is a tendency for some fisheries scientists, which goes against the complexity perspective articulated in this thesis, to argue that if all fisheries were certified and managed by a system of ITQs; the fisheries ‘crisis would be in perpetuity (Beddington, Agnew and Clark 2007, Costello, Gaines and Lynham 2008). One can go further and ask how the constraints of globalisation and neo-liberal policy prescriptions (Bernstein 2002, Wilkinson 2006) constrain the space for imagining alternative governance futures for marine resources. Identifying the evolving governance landscape as having one set of characteristics or putting everything under one ideological umbrella of course ignores the complex interactions and emergent properties of complex systems and is why it is necessary to focus on openness to surprise and the potential adaptiveness of organisations and other classes of actors in the face of unexpected dynamics and surprise (Duit et al. 2010).

This thesis presents four papers that are illustrative of and provide insight into emerging patterns that are drivers of and responses to a rapidly changing world. This is occurring against the background of the public and the private melting together in interesting ways. Shelton (2009) argues that ‘traditional custodians’ of fisheries governance; governments and Regional Fisheries Management Organisations (international organizations mandated to manage fisheries in areas beyond national jurisdiction under the auspices of the UN law of the sea) have been very slow to respond to shifts in the governance context and that a niche has been created which is increasingly being filled by a combination of NGOs and private actors. Making this point more strongly, feedbacks to and signals from marine ecosystems are often pushed under the surface and become invisible to individuals and governance institutions (Nyström et al. 2012, Crona et al. 2015).

Failing to look at the hidden, the invisible, the shadowy connections means that we focus on a few easy to discern relationships and to miss others that may in fact be much more likely to be important in shaping the governance of fisheries through patterns of emergence (Dimitrov 2003, Dimitrov et al. 2007). Each of the papers in the thesis is an effort at making something that is hidden about emergence and fisheries governance and/or the future of the oceans visible. How do networked actors shepherd a new approach to fisheries into the ‘mainstream’? What is happening out there in areas beyond national jurisdiction as industry races ahead of regulation? What are some potential hidden non-linearities in technology and society that may radically shift the future of the oceans or the ways in which humans might respond? This thesis draws on diverse and complementary theoretical perspectives, which enable the author to delve into the space between institutions and address emergent shifts at the intersection of economy, ecology, technology and society.

## 1.4 Research context - The Nereus Program

This PhD project is part of the UBC-Nippon Foundation Nereus Program, which brings together eight partner institutions to work in an interdisciplinary way to “Predict the Future Ocean.” The program has three major objectives. 1) Collaborative research across the natural and social sciences to better understand the future of global oceans. 2) Develop a network of experts that can engage in discussion of complex and multifaceted questions surrounding ocean sustainability. 3) Transfer these concepts to practical solutions in global policy forums (Paper iii).

The end of the first phase of the Nereus Program in 2015 resulted in a summary report to which all partner institutions contributed (Paper iii). This report brought together the research outputs of the program institutions and generated ‘Seven Key Statements for Future Oceans.’ These statements are primarily focused on climate change and marine fisheries whereas this thesis primarily relates to the final point on global governance of marine fisheries. **Paper I** and **Paper III** came out of interdisciplinary collaboration through the Nereus Program.

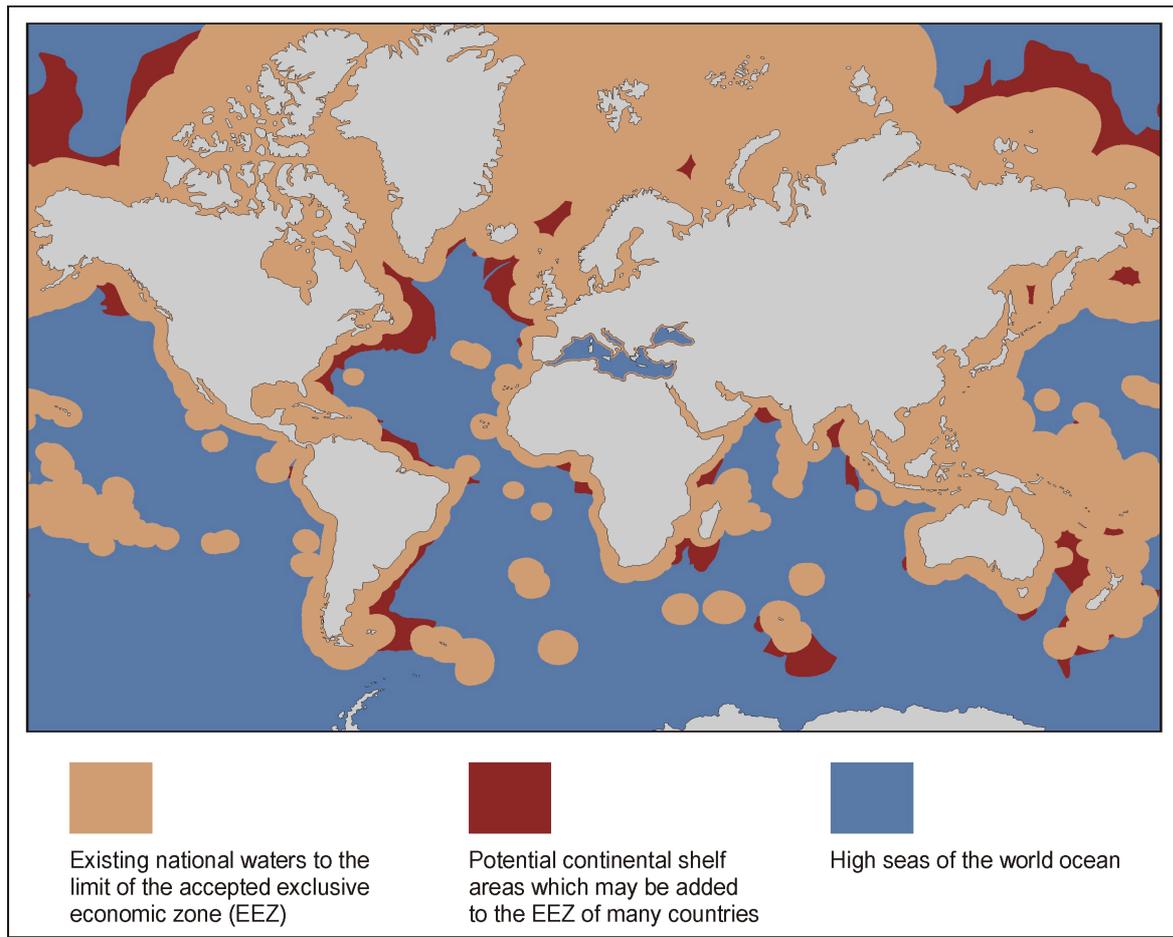
1. Due to CO<sub>2</sub> emissions, changes in global ocean properties – particularly temperatures, acidity and oxygen levels – are occurring at a scale unprecedented in the last several thousand years.
2. Climate change is expected to affect the oceans’ biological productivity – from phytoplankton to top predators.
3. Climate change has already been affecting global marine ecosystems and fisheries, with further impacts expected given current trends in CO<sub>2</sub> emissions.
4. Fishing exerts significant pressure on marine ecosystems globally – altering biodiversity and food web structures – and affects the ability of the international community to meet its sustainability goals.
5. The impacts of climate change interact with the existing problems of overfishing and habitat destruction, driven largely by excess fishing fleets, coastal development and market expansion.
6. Aquaculture is developing rapidly, with the potential to supersede marine wild capture fish supply. Yet, the full understanding of its impact, including its long-term ecological and social sustainability, is unclear.
7. Sustainable fisheries in the future require the further development and strengthening of international fisheries law, as well as the overarching international framework for ocean governance.

## **1.5 Frameworks governing fisheries at the global scale**

This subsection will provide a brief orientation to the central frameworks important for global governance of marine fisheries. It is not intended to be exhaustive as governance through the established, formal institutions associated with the United Nations Division on Oceans and the Law of the Seas and the UN food and Agriculture Organisation is not the primary focus of the thesis. However, these frameworks and the institutions and organisations associated with them will remain important to the future governance of marine fisheries at the global scale.

### **1.5.1 United Nations Law of the Sea Convention**

The 1982 Law of the Sea Convention adopted by the Third United Nations Conference on the Law of the Sea (UNCLOS III) and (entered into force 1994) put in place a new and unprecedented legal framework for marine fisheries. As noted in the introduction, the adoption of the UN Law of the Sea allowed states to establish an Exclusive Economic Zone (EEZ) in which it would have sovereign rights over living resources out to 200 nautical miles from the baseline used to determine the territorial sea (Juda 2002). The adoption of EEZs and the right for states to regulate access of vessels to the fisheries radically altered the common 'high seas' and under the Law of the Sea, over 90% of all fishing areas were to be managed under the exclusive jurisdiction of single states (Juda 2002). One of the persistent problems that has arisen with respect to fisheries governance since the establishment of EEZs is that they in no way correspond to the geographical placement of fish stocks nor how fish stocks are distributed across and between national jurisdiction (Juda 2002). This problematic was a key driving force behind the subsequent negotiation of the United Nations Fish Stocks agreement as an implementing agreement under the UN Law of the Sea (Fontaubert 1996).

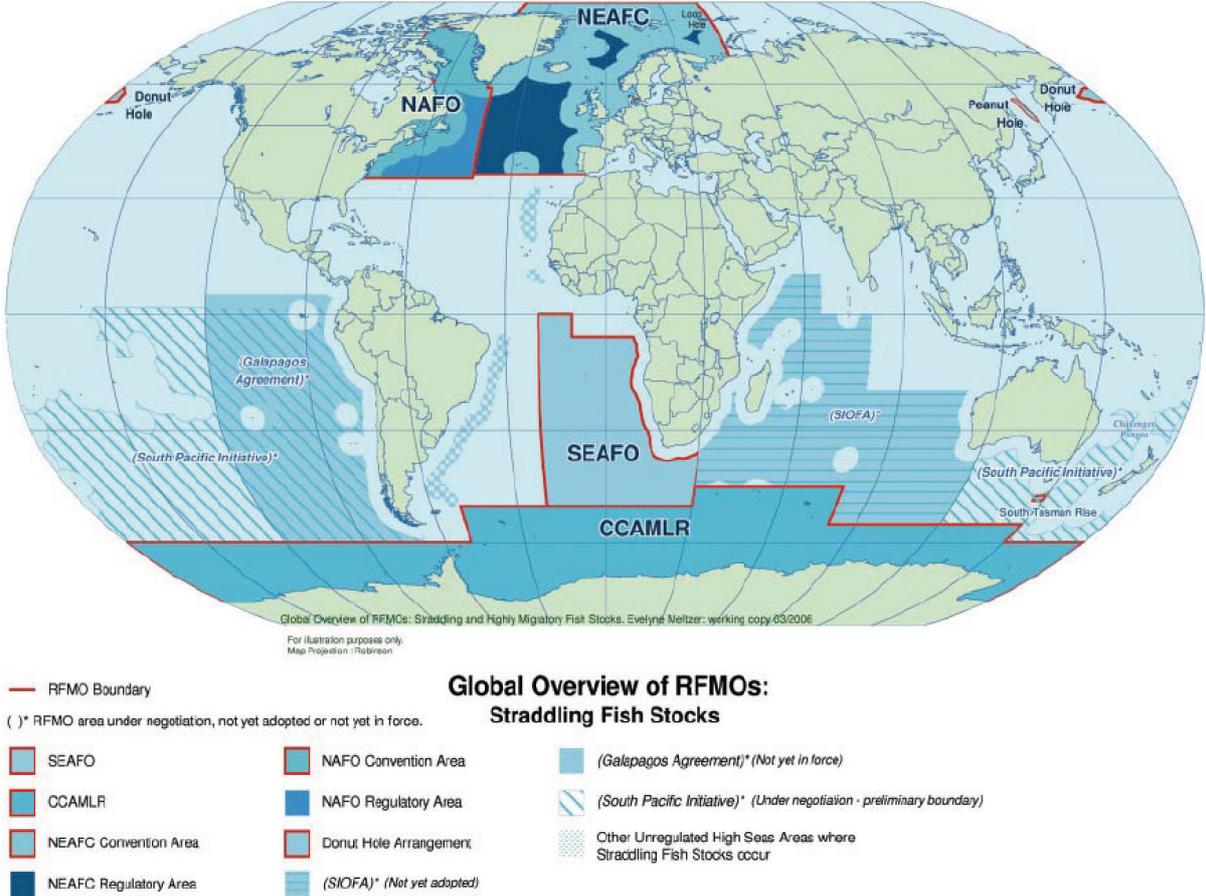


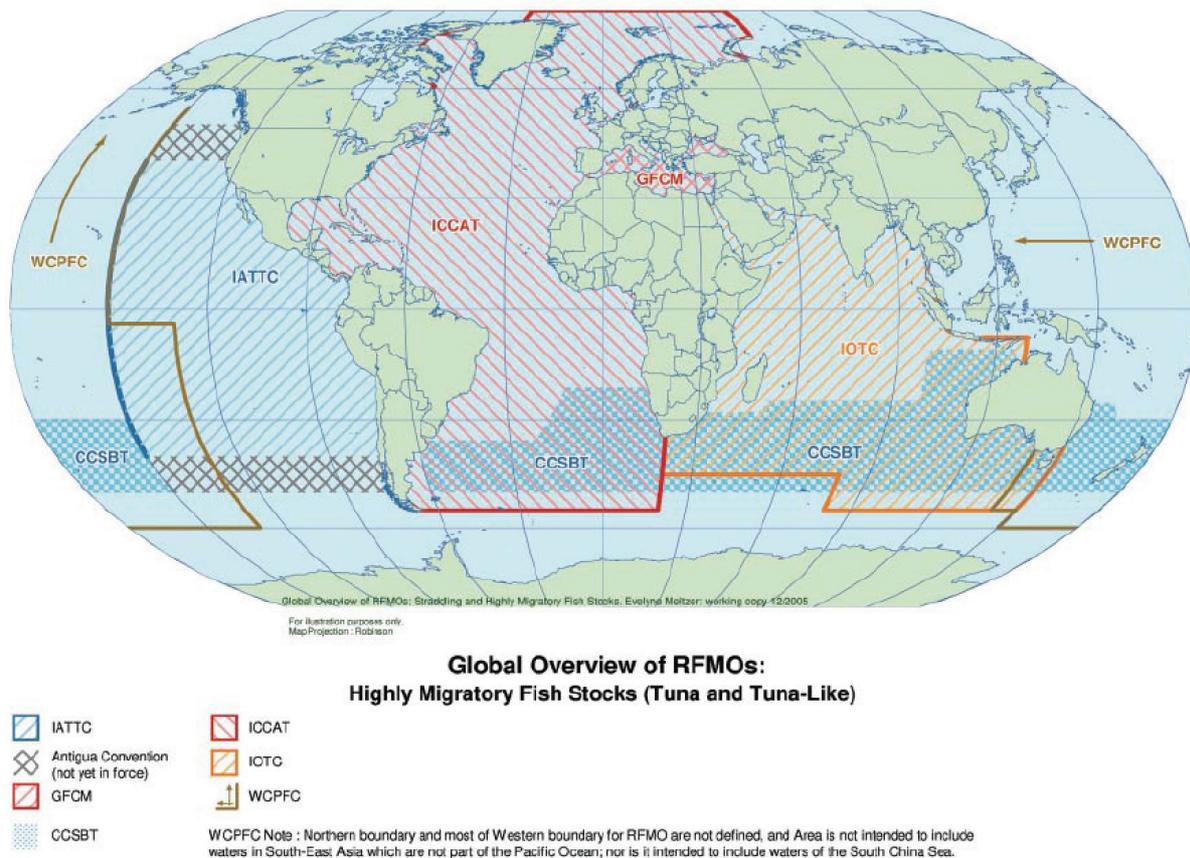
**Figure 1:** A map of the world's exclusive economic zones, extended continental shelf applications and the remaining areas of the ocean classified as Areas Beyond National Jurisdiction (ABNJ) – Reproduced from Hoyt (2011 p12).

### 1.5.2 The United Nations Fish Stocks Agreement

One of the key events that defined the regime for international fisheries governance was the negotiation of the United Nations (UN) Fish Stocks Agreement (UNFSA) adopted in August 1995 as an implementing agreement under the UN Law of the Sea Convention (entered into force 2001). At the time this was a rather surprising and progressive development that was indicative of the shift from purely government involvement in international negotiations where, in this case, non-state actors and other dynamics of governance came into play (Fontaubert 1996).

The UNFSA was developed explicitly to address the issue of highly migratory and trans-boundary straddling fish stocks (Fontaubert 1996). Further, the UNFSA mandated the formation of Regional Fisheries Management Organisations (RFMOs) charged with establishing conservation and management measures of shared stocks and provide accountability by monitoring compliance with adopted measures. These regional fisheries bodies are overseen and coordinated by the UN Food and Agriculture Organisation Committee on Fisheries (FAO 2014). Several RFMOs have also taken important steps to implement and incorporate modern principles of sustainable fisheries management, such as the ecosystem and precautionary approach to fisheries. Currently there are sixteen RFMOs in place, which includes the Convention for the Conservation of Antarctic Living Marine Resources, which is technically a regional seas convention but is responsible for sustainable management of Antarctic fish stocks in line with the mandate of other RFMOs. Beyond the establishment of RFMOs under the UNFSA, the international community has made steady progress in developing relevant legal and governance instruments relevant to areas beyond national jurisdiction (ABNJ), which are the areas beyond and between the 200 mile EEZs of states (Garcia and Hayashi 2000). Activities in ABNJ are now subject to a complex network of ever increasing regulations as described in more detail in **Paper III**.





**Figure 2:** These two maps show Regional Fisheries Management Organisations for both 'straddling' and 'highly migratory' fish stocks. These maps have been reproduced from a Chatham House report on RFMO effectiveness by Lodge et al. (2007). These two maps giving an overview of RFMOs for both straddling and highly migratory fish stocks are from 2007. As such, they do not include either the South Pacific Regional Fisheries Management Organisation (SPRFMO) whose convention bringing the organisation into force was not adopted until the 14th of November 2009. In addition, they do not include the North Pacific Fisheries Commission (NPFC), which was adopted by the members in 2012 and entered into force in 2015.

### 1.5.3 Global voluntary instruments for fisheries governance

The introduction of the FAO CCFRF (FAO code of conduct) was significant as it represents a strategic shift towards a 'voluntary' and self-compliance approach to fisheries governance (Allison 2001). Cole (2003) draws attention to 'transformations' in international economics, law making and institutions, which are indicative of this shift in the locus of policy-making. Empirically, Cole (2003) compares the 1995 fish stocks agreement and the parallel emergence of the FAO code of conduct in 1995 as a new governance instrument better in tune with contemporary global reality. However, Pitcher et al. (2009) argue that as a non-binding legal instrument dependent on voluntary compliance with its provisions, the UN FAO code of conduct has been largely ineffectual due to the failure of the vast majority of nation-states to act on it (Pitcher et al. 2009).

The FAO CCFRF is especially notable as it was one of the first international instruments to recommend principles consistent with ecosystem-based approaches to fisheries despite its voluntary nature (Pitcher et al. 2009a, Pitcher et al. 2009b). The FAO Code of Conduct for Responsible Fisheries lays out a number of principles and standards of behaviour to guide effective management and conservation of international fisheries. It considers both the impact of fishing on marine ecosystems and how ecosystems link to fisheries. Further it highlights the need to conserve biodiversity. The CCFRF is both global and intended to apply comprehensively to both members and non-members of the United Nations Food and Agriculture Organisation (FAO 2014). Under the FAO CCFRF are four International Plans of Action, which target four particular problem areas in global fisheries. Like the code itself, these plans of action are voluntary. They include an International Plan of Action on; the interactions between fisheries and seabirds, the interactions between fisheries and shark species, illegal, unreported and unregulated fishing and reducing excess capacity in international fishing fleets (FAO 2014).

## 2.0 Theory

### 2.1 Theoretical foundations

#### 2.1.1 International institutions and international regimes

International institutions, defined as: *a set of rules, decision-making procedures, and programs that define social practices, assign roles to participants in these practices, and guide interactions among the occupants of individual roles* (Young 2002, p.5) are not the explicit focus of this thesis. Rather, it investigates what happens between institutions, at the margins of formal institutions and what happens between institutions. Specifically, the focus is on; 1) Patterns of interactions between institutions and between the social and the ecological components in a system in Paper I. 2) Patterns of emergence and spread of new governance approaches (discussed more fully in a later section) in Paper II. 3) The capacity or lack thereof for governance institutions to address unexpected dynamics in Paper III. 4) Potential futures for the oceans with tangible implications for international institutions Paper IV. Each of these components will be introduced more fully in subsequent parts of the theory section. However, it is important upfront to situate this thesis with respect to the well-established literature on international institutions. In terms of distinct types of institutions, Young (2002) makes a clear distinction between ‘thin’ and ‘thick’ institutions. Thin institutions concern the parts in the definition above that are embedded in constitutive documents. This thesis is aligned with institutions conceptualised as ‘thick.’ Such an understanding of institutions moves beyond the formal constitutive documents and are concerned with; *“social practices that are based on the rules of the game but also include common discourses in terms of which to address the issues at stake, informal understandings regarding appropriate behaviour on the part of participants, and routine activities that grow up in conjunction with efforts to implement the rules.”* (Scott 1995 in Young 2002). The starting point then is a conceptualisation of institutions as ‘thick’ but the papers themselves focus on the actor context, patterns of emergence and drivers that shape and impact those thick institutions. Young (2002) creates an opening for the application of a social-ecological perspective to studying fisheries governance when he compares institutions with ecosystems where both institutions and ecosystems are linked together via sets of interdependencies operating at the same time across space at different scales (Young 2002, Cash et al 2006). The approach to the study of institutions moves beyond efficiency and effectiveness of existing institutions to a clearer focus on emergence of new governance forms and the anticipatory capacity of institutions. A synthesis article (Young 2011) brought together two decades of work on international institutions and environmental governance and identified a series of future research directions.

Two of these identified future research directions are central concerns of this thesis: the emergence of new policy mechanisms and instruments and the implications of non-linearity for the structure and functioning of environmental regimes (Young 2011). International regimes are defined as: “*Social institutions consisting of agreed-upon principles, norms, rules, procedures, and programs that govern the interactions of actors in specific issue areas*” (Levy, Young and Zürn 1995, p.274). Work on international regimes is concerned with clusters of institutions governing particular issue areas in international relations (Keohane and Nye 1977, Krasner 1982, Young 1982, Krasner 1983, Underdal 1992, Levy, Young and Zürn 1995). International regimes and the clusters of institutions from which they are constituted are important as they represent the governance architecture that is in the background and shapes this work. For example, Paper III engages with the international regime on governance of fisheries in marine Areas Beyond National Jurisdiction, Paper I considers the patterns of interactions taking into account the international regime on fisheries governance and Paper II addresses the emergence and spread of marine spatial planning against the background of the international ocean governance regime. To make the distinction clear, the regime for high seas governance is outlined in the previous section and one of the institutions that constitute it is the norms and formal and informal rules that determine how decisions are made within a particular regional fisheries management organisation. Young argues that there are three distinct types of international regimes; Spontaneous orders, negotiated orders and imposed orders (Young 1982). This is the beginning of Young’s attempts to move beyond considering existing regimes and more directly analyse the formation of international regimes rather than focusing only on their effectiveness (Underdal 1992, Young 1999). Consideration of the implications of the absence of international regimes is addressed in the international collective action subsection below.

### **2.1.2 Global governance**

In ‘The Rise of the Network Society’, Castells (2000) describes the shift from an industrial to an information society. He argues that the network is the feature that defines this era. A network as used here is considered as both a structure and a set of relationships between actors as a mode of organisation (Kahler 2009). The shift from government to governance has occurred in parallel and as a consequence of this large-scale societal shift from a society driven by the forces of industry to one driven by the forces of information. Castells notes the inherent intertwining of the social, economic and political features of society. Governance as a broad umbrella concept across a number of disciplines has been driven by the need to understand a rapidly changing world; Chhotray and Stoker (2009) highlight two forces of change - the speed and extent of globalization, both as an economic and social phenomenon, and, the spread of democratic political systems. Hence the speed of change has demanded new explanatory approaches, which can be collectively described as a shift from the study of government to governance.

Following Stoker (1998), the set of approaches that fall under the umbrella of governance share the following five characteristics. 1) Governance refers to a set of institutions and actors that are drawn from but also beyond government. 2) The concept identifies the blurring of boundaries and responsibilities for tackling social and economic issues. 3) Governance is, in part, concerned with self-governing networks of actors. 4) The governance concept recognizes the capacity to get things done which does not rest on the power of government to command or use its authority. 5) Under the governance conceptualization, government is able to use new, emerging tools and techniques to 'steer and guide' (Stoker 1998). With respect to the field of international environmental governance specifically, Bulkeley (2005) points out that in many earlier accounts both space and scale are considered to be static, pre-determined and 'natural' entities that form solid anchor points from where analysis can occur. Bulkeley (2005) instead argues that; 'a new spatial grammar of environmental governance must be sensitive to both the politics of scale and the politics of networks.' It is not enough to recognise that governance is a multi-level process (Marks 1992). The processes of scaling and the scale navigation of governance processes and actors is in itself a political process as is the creation of new arenas where governance actors configure themselves in networks. Meadowcroft (2002) and Andonova and Mitchell (2010) emphasize this point when they note that over the last half century there has been both a scaling up and a scaling down of environmental governance and politics. Tamiotti and Finger (2001) however astutely point out that in the case of environmental politics it is somewhat clear that the literature overstates the degree of transformation.

Even today, many authors would argue that many of the apparent changes wrought by the governance turn have been amplified in academic circles and are not so evident in shifting outcomes in policymaking processes (Hale and Held 2012, Kanie et al. 2012). The reality is less idealistic, more political and messier. Part of this messy, political picture involves the changing role of the state and the rise of non-state actors as important players on the global stage (Keck and Sikkink 1998, Warkentin 2001, Betsill and Corell 2001, Arts 2003, Bäckstrand 2006, Bernstein and Cashore 2007, Bexell, Tallberg and Uhlin 2010). Hooghe and Marks (2003) argue that there has been a reallocation of political authority sideways, downwards and upwards from the central state. Negotiations between ostensibly equal nation states in a multilateral process of negotiation and compromises falls short of being able to address complex environmental challenges (Underdal 2010). As articulated by Hale and Held (2012): "*The emergence of new powers, the growing challenge of collective action problems and the complexity of institutions that seek to address them, have made it increasingly difficult to govern transnational problems through multilateral cooperation.*" This quote indicates there is the potential for other kinds of actors to either augment or further constrain the capacity of nation states to address these challenges (Holzscheiter 2005, Pattberg 2005, Österblom and Bodin 2012).

The argument here is not to deny the continued importance of the nation-state as a governance actor but as articulated by Stoker (1998), it can neither act alone, nor independently of its inter-relationships with other actors. The state is increasingly permeable and woven into a complex web of interdependent relationships at the international level with new classes of actors playing influential roles either outside or entwined into the existing multilateral order (Keck and Sikkink 1998, Cashore 2002, Castells 2008, Bulkeley and Schroeder 2011, Orsini 2013). This perspective feeds into the recognition of a complex and rapidly evolving actor setting with respect to global governance of fisheries. The increasing role of non-state actors, and a network approach to governing complex challenges facing marine systems has been empirically analysed in the context of the emergence of new compliance mechanism for toothfish fisheries in the Southern Ocean in; Österblom and Sumaila (2011) and Österblom and Bodin (2012). These articles make the argument that both state and non-state actors collaborated in formal and informal networks over time in order to develop compliance mechanisms in a way that was responsive to the changing situation. Hence, the involvement of non-state actors (including NGOs and fishing companies) led to an increase in the ‘adaptive capacity’ (ability of an organisation to adapt in response to changing social and environmental conditions) of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).

Österblom and Bodin (2012) and Österblom and Folke (2013) explicitly recognise that non-state actors are not only of importance for influencing a particular governance process or outcome but directly creating and maintaining governance mechanisms in partnership with other actors. In conclusion, the ever-changing background and evolution of the governance concept and actors operating at the global level provides a second important theoretical foundation for this PhD thesis on the global governance of marine fisheries. The approach to governance taken in this thesis draws on Stoker (1998) but explicitly follows Dingwerth and Pattberg (2006) in Galaz (2014): *“The approach to governance analysis is both analytical and normative. This approach combines an empirical and theoretical understanding of societies’ capacities to steer environmental change, with a normative ambition to bring out shortcomings, and possible ways ahead.”*

### **2.1.3 International collective action**

In 1993, Oran Young made the statement; “...*there appears to be no reason to reach pessimistic conclusions about the possibilities for institutional bargaining centred on global environmental change.*” However, in contradiction to this statement, there is scholarship that points to the significant limitations on and the need to move beyond formal institutional bargaining between countries as a mechanism for addressing and responding to global environmental change (Ostrom 1999, Young 2003, Biermann and Pattberg 2008, Adger et al. 2009, Pelletier 2010, Underdal 2010, Ostrom 2010, Galaz et al. 2012a,b). One of the leading contributors to the problematic of achieving collective action at the global level is Dimitrov (2002, 2003, 2005, Dimitrov et al. 2007) who has put forward the theoretical concept of ‘non-regimes’ to explain the absence of formal multilateral agreements across a broad range of issue arenas at the international level. This perspective will be explored further in a later sub-section focusing on non-regimes and emergence of new governance forms.

A persistent collective action dilemma around managing fisheries as a commons is apparent (Hanna 1999, Ostrom 2009, Pauly and Zeller 2016). Despite the significant milestones and achievements of formal governance institutions since the ratification of the law of the sea treaty outlined in the previous section, there remains a vast governance challenge facing the oceans and fisheries at the global level (Allison 2001, Cole 2003, Wilkinson 2006, Hall et al. 2010, Worm et al. 2011). A relevant consideration here is the exact nature of the collective action problem. With respect to fisheries in particular, Barrett (2010) defines overfishing, one of the characteristic problems of governing marine fisheries as a ‘weakest link’ collective action dilemma. In Barrett’s conceptualization, this means that the provision of global public goods, in this case a sustainable supply of fish and healthy ecosystems, requires the efforts of every country, even the weakest (in terms of governance capacity and material resources). This ‘weakest link’ dilemma also applies to the success or failure of collaborative efforts to address overfishing and other environmental challenges facing marine fisheries. The most visible manifestation of this collective action dilemma operating in fisheries around the world is widespread and persistent illegal unreported and unregulated (IUU) fishing (Agnew et al 2009) and the phenomenon of ‘roving bandits’ (Berkes et al 2006). In these ‘weakest link’ collective action dilemmas, treaties and formal collective bargaining arrangements between countries are largely inadequate in and of themselves as a governance mechanism because those who do not ratify a particular treaty remain critical to addressing the issue of overfishing whether it is occurring ostensibly legally or is outright illegal.

#### **2.1.4 Non-regimes, emergence and governance**

There have been attempts to address how regimes as institutions emerge through the concept of regime formation (Young 2009, 2011, 2014). However the mechanistic, process oriented, linear ontology and focus on nation states has limitations in explaining how new governance forms emerge in a complex world. Some recent work such as Young et al. (2006), Young (2010), Galaz (2014), and Biermann (2014) have begun to engage with complex systems perspectives on the governance of global environmental change (Underdal 2010, Duit et al. 2010, Galaz, Crona and Österblom 2012). However, there remain limitations with seeing global governance of marine fisheries through the lens of international regimes and institutionalism. The concept of non-regimes (Dimitrov 2002, Dimitrov et al. 2007), offers a step beyond these limitations allowing an inquiry more amenable to complexity. In Dimitrov et al. (2007), the authors define non-regimes as: “*A transnational policy issue area characterised by the absence of multilateral institutions for ordering actors’ interactions.*” One of the most important insights of this work is the relevance of what is not visible: the absence of an established institution as an analytical object. Dimitrov et al. (2007) states: “*Regime analysis is traditionally state-centric and displays the tendency to emphasize explicit rules at the expense of broader transnational interactions.*” In Dimitrov (2002), the author makes the case that missing knowledge about the trans-boundary effects of a given problem is instrumental in impeding the formation of common interests and thus makes the creation of a binding international agreement unlikely (Dimitrov 2002). In the case of fisheries, although there is a strong governance regime in place, neither international regimes nor the theory of non-regimes is sufficient for capturing the patterns of interaction and processes of emergence that are central to the complexity of global governance of marine fisheries.

Here, emergence does not follow the often incidental and unexamined use of the term that can be found in some relevant scholarship when discussing the formation of institutions (Young 1982, Pattberg 2005, Dimitrov 2005, Biermann and Pattberg 2008, Biermann 2010, Young 2014). The foundation for a theoretically supported articulation of emergence is the work of complexity scholars (Levin 1998, 1999, Scheffer et al. 2001, Scheffer et al. 2003, Mitchell 2009, Page 2010, Chaffin and Gunderson 2016). In the classic work ‘Fragile Dominion’ Levin (1999) defines the essential features of complex adaptive systems and argues that it is these unique features that lead to processes and patterns of emergence. These three features are: 1) Diversity and individuality of components 2) Localized interactions among the components and, 3) An autonomous process that uses the outcomes of those local processes for replication or enhancement. Here Levin (1999) uses examples related to the evolution of organisms but this move from diverse, individual components interacting, leading to more complex patterns and macro-level properties generated from the interaction of the components is emergence.

Relating this specifically to governance, Duit and Galaz (2008) and Duit et al. (2010), identify four characteristics of complex adaptive systems which in sum explain a process of emergence as macro patterns result from interactions between individuals and networks of actors: 1) a diverse range of actors that follow a diversity of behaviours and interact, through this interaction 2) self-organization happens when actors take actions based on their own 'local' circumstances in interaction and independently of each other, 3) co-evolutionary processes occur as actors jostle and try to adjust their behaviour to the environment and finally all of this leads to 4) shifting system behaviour with limited predictability.

The concept of emergence from complexity science can be fruitfully linked with theories of 'social emergence' drawing on complexity perspectives in sociology (Durkheim 2014 [1895], Sawyer 2005, Elder-Vass 2010, Smith and Jenks 2013). Sawyer (2005) states that the study of emergence requires simultaneous focus on three levels of analysis; the individual (or the organisation), the dynamics of interactions between those individuals or organisations and the socially emergent properties of the group at the macro level. The approach is focused on explaining how the emergence of social properties results from interactional processes (Sawyer 2005). Thus this approach is very much aligned with the understanding of emergence developed through the theory of complex adaptive systems. However, Elder-Vass (2010) argues for the unique character of emergence in social systems and that emergence is not spatially constrained as it may be within a given ecosystem or community of organisms (Levin 1998). "[...] *Social structures, [...] we may say, can be spatially disarticulated – they can operate in the absence of any specific set of spatial relations between their parts*" (Elder-Vass 2010, p.200). Each of the papers in this thesis addresses a particular permutation of emergence that combines a complex adaptive systems and complexity in sociology understanding of emergence in social-ecological systems. This understanding of emergence and governance systems underpins the articulation of patterns of social-ecological interactions in Paper I, the emergence process of marine spatial planning described in Paper II and interactions between users of the oceans leading to the emergence of unexpected dynamics in Paper III.

## 2.2 Analytical approach

### 2.2.1 Adaptive governance

The proposed connectivity, speed and scale of activity at the global scale can be better understood by viewing governance dynamics through a complexity lens. Duit & Galaz (2008) explored the question of how; ‘different governance types can be expected to handle processes of change characterized by non-linear dynamics, threshold effects and limited predictability.’ They argue that many of the fast paced, cross scale changes and dynamics that characterise our world in the early 21<sup>st</sup> century require a different way of thinking about governance challenges. Governance frameworks that fail to acknowledge the implications of the earth as a complex adaptive system, these frameworks will prove unable to address change processes such as exponential technological change, cascading collapses of linked ecosystems and even the spread of pandemic diseases (Duit & Galaz 2008). This complexity perspective has also been applied to fisheries governance (Wilson 2006, Mahon, McConney and Roy 2008, Garcia and Charles 2008, Miller et al. 2010, Berkes 2011, Perry et al 2010, 2011, Hollway and Koskinen 2016).

The adaptive governance approach applied here follows Folke et al (2005) and Folke (2006) and holds to the underlying ontological assumption that humans and nature constitute linked and dynamic social-ecological systems (SES) (Berkes and Folke 1998). Social-ecological systems perspectives have made significant contributions to sustainability science (Chaffin, Gosnell and Cosens 2014, Xu, Marinova and Guo 2015, Schultz et al. 2015). SES systems are Complex Adaptive Systems (CAS). Scholarship has suggested that CAS (Levin et al. 2012) can be found within and across a diverse number of systems; including ecological, economic and social systems (Gunderson and Holling 2002, Scheffer and Westley 2007, Scheffer et al. 2009). The concept of resilience (Walker et al. 2004), because of its emphasis on cross-scale interactions (Cash et al. 2006), offers a useful way to make sense of the dynamic elements of these complex social-ecological systems (Walker et al. 2004, Folke et al. 2010). Adaptive governance has evolved significantly since the term was coined by (Dietz, Ostrom and Stern 2003). Adaptive governance has been described in Folke et al (2005) as *‘the social contexts needed to manage complex SES.’* The focus here is on adaptive governance in complex adaptive social-ecological systems that are able to analytically approach the interactions that comprise these complex systems through analysis of cross scale dynamics (Cash et al. 2006).

In a review of a decade of adaptive governance scholarship, Chaffin et al (2014) point out that much of the theory of adaptive governance has been developed at local scales (Olsson, Folke and Hahn 2004, Hahn et al 2006, Olsson, Folke and Hughes 2008, Huitema and Meijerink 2010). Only recently have attempts been made to apply the concept regionally in the case of governing toothfish (*Dissostichus* spp) - in the Southern Ocean (Österblom and Sumaila 2011, Österblom and Bodin 2012, Österblom and Folke 2013) in the Coral triangle (Rosen and Olsson 2013) in Latin America (Gelcich et al 2010) and in North Atlantic fisheries (Webster 2009). A key feature of the adaptive governance approach is the identification of adaptive response strategies associated with uncertain environmental risk, and an important assumption is that societies are flexible in their responses to environmental crises. Adaptive governance argues that this flexibility is, in part, achieved through governing processes via nested and networked governance structures (Galaz et al. 2012c). These governance structures have been described as ‘polycentric.’ The concept of Polycentricity draws largely on the work of Ostrom (2010). However, there is a longer tradition behind the concept stretching back to Michael Polanyi (Aligica and Tarko 2012). Polycentricity requires the creation and dissemination of detailed and current bottom-up information to support distributed decision-making processes (Ostrom 2010). Polycentricity implies that there are forms of multi-actor and multi-level responses which can be viewed as providing polycentric order, in the sense that they include the self-organizing relationship between many centres of decision-making that are formally independent of each other (Galaz et al. 2012c). It is worth noting that polycentric order is more than just networks but ‘thinking in networks’ allows us a powerful way to articulate key features of a polycentric system and to tease out the key features while providing a strong way for thinking about the emergence of certain kinds of initiatives in the field of global governance. The concept of polycentricity provides value when elucidating the complex actor setting that characterises global governance of marine fisheries. The next section moves from the underlying dynamics of the system and the complex actor setting to the actors themselves and the processes and mechanisms of agency.

### **2.2.2 Agency in complex social-ecological systems**

The institutional entrepreneurship approach to agency moves beyond the individuals as ‘champions’ characterisation of agency, where individuals are given almost all credit for the success of an idea or organisation and instead recognises that institutional entrepreneurs are often embedded as part of an (often informal) network (Garud, Hardy & Maguire 2007) which they also contribute to both building and maintaining (Westley et al. 2013). Furthermore, these networks exist in a broader system that represents an opportunity landscape that allows for the impact of crisis, serendipity and timeliness (Westley & Antadze 2009) as impacting the emergence of new governance forms (Rosen and Olsson 2013). Moore and Westley (2011) describe what characterises the institutional entrepreneur as an individual or group of agents working under constraints and limitations of knowledge and resources:

*“The skills of the institutional entrepreneur then are not those of the heroic leader. Rather they often work in obscurity to manage the emergence that they cannot actually control. They connect; span boundaries, mobilize resources of knowledge, power and resources; recognize and generate patterns; revitalize energy and keep alive a strategic focus”.*

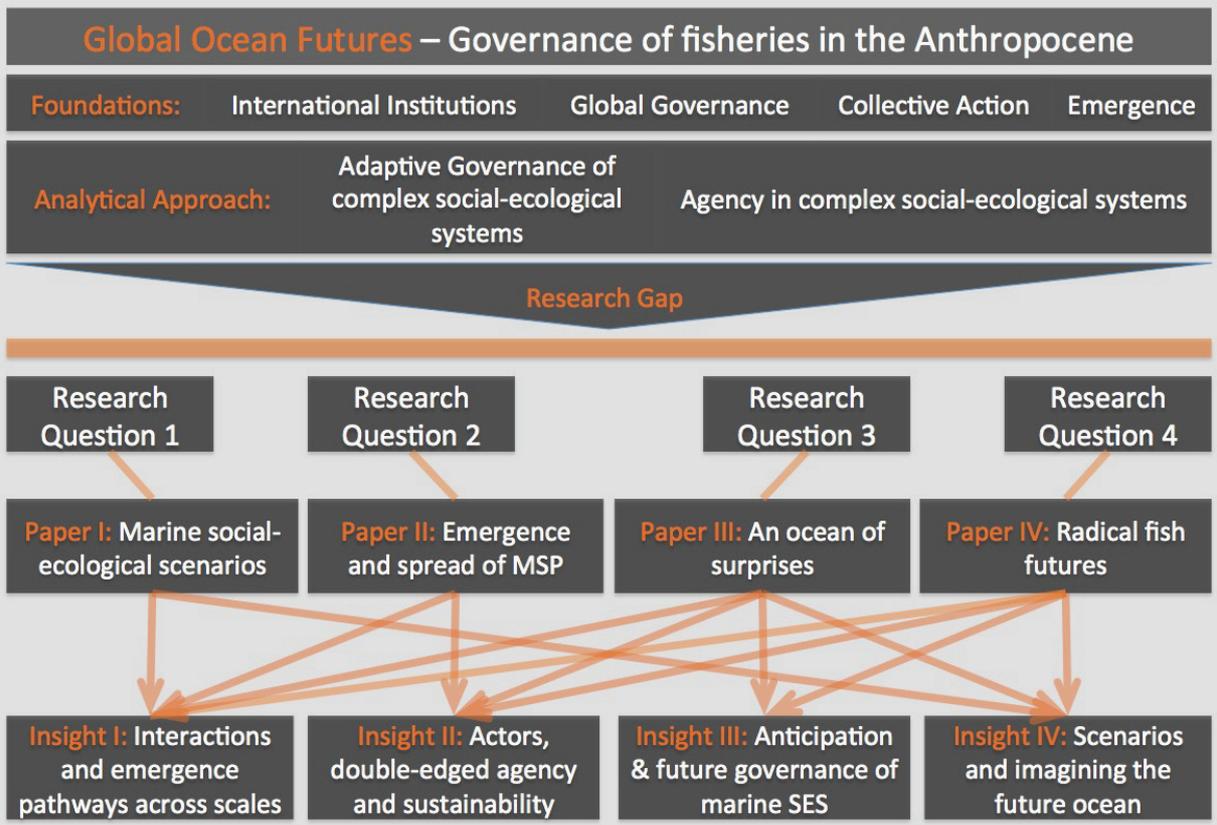
The focus here is on strategic, deliberative actors such as non-governmental organisations, corporations, public-private partnerships and epistemic communities (Haas 1992) operating in networks, sometimes in concert, sometimes in conflict, that through their interactions across scales, are able to alter emergence pathways (Cash et al. 2006). Agency as institutional entrepreneurship in complex systems is an emerging area of research (Garud, Hardy & Maguire 2007, Schoon & York 2011, Westley and Antadze 2010, Olsson and Galaz 2012, van Kerkhoff & Szlezak 2012, Westley et al 2013). The understanding of agency as institutional entrepreneurship was applied for the following four reasons: 1) this conceptualisation is well matched and applied often in scholarship on adaptive governance of social-ecological systems. 2) These theoretical approaches to agency are relevant for studying emergence of new governance forms and approaches as opposed to understanding agency from an institutional efficiency perspective. 3) The institutional entrepreneurship perspective on agency is well-suited for application to international and global governance and finally, 4) the institutional entrepreneurship literature has been applied empirically to analysis of agency in the context of ecosystem dynamics and how such agency can be used to overcome mismatches between the scale of ecosystems and the scale of governance.

This understanding of agency as institutional entrepreneurship is applied here. However, it is applied in a way that does not make the normative assumption that the mechanisms of agency as institutional entrepreneurship will necessarily operate in a way that leads towards sustainability in marine ecosystems. The complex actor setting implies that there are loose networks of agents utilising the skills of institutional entrepreneurs both in ways that ultimately may contribute to and undermine ecological sustainability. A concept from the Adaptive Governance literature to illustrate this point is the concept of a ‘shadow network’ which is defined as; *‘Informal networks that emphasize political independence outside the fray of regulation and implementation [...]’* in (Olsson et al. 2006 and Olsson, Folke and Hughes 2008). The use of this concept thus far has been applied to networks of institutional entrepreneurs who have been able to develop innovative ideas for marine ecosystem sustainability outside formal governance structures.

### **2.3 In summary – the theoretical research gap**

In summary, the research gap that this thesis addresses is in moving from analysis of efficiency and adaptiveness of governing institutions in marine fisheries to emergence and anticipatory capacity of governing institutions in marine fisheries. Work within the field of governance along with that of institutions and international regimes and the limits and challenges of collective action at the global level provide important theoretical foundations. Essential as they are, none of these foundations are sufficient as these approaches do not satisfactorily focus on underlying system dynamics nor do they start from the assumption of a coupled social-ecological system. Often ecological issues are treated as external ‘environmental crises’ and not analysed as coupled to social, political or economic systems. These coupled dynamics are critically important to governability of the future oceans, as many of the challenges facing oceans are uniquely difficult to address because of the deeply intertwined connections between the ecological, the socio-political and the economic (Perry et al, 2010). A social-ecological systems lens enables the identification of linkages and interactions between social and ecological components and how these interactions are relevant for the emergence of new tools for countering the multifaceted challenges facing marine systems. The social-ecological lens also aids in the identification of new challenges in the form of unexpected dynamics that emerge through system interactions. Adaptive governance of marine social-ecological systems is a theoretical approach that is able to make a contribution to the identified research gap by being able to describe and disentangle some of the complexity of global governance of marine fisheries in the Anthropocene through directly considering both underlying system dynamics and the interactivity of the human-environment coupling. This further allows for the analysis of patterns of interaction and processes of emergence that are discernible through the application of a complex adaptive systems lens.

The marine fisheries governance institutions of the future are unlikely to be the institutions of the present and therefore it is of theoretical value to apply analytical attention to the rapidly evolving complex actor setting (Pahl-Wostl 2009, Lubell 2015) which will be part of shaping the future of marine fisheries governance. This actor setting and the actors themselves framed as institutional entrepreneurs embedded in networks preconfigure the ground for and actively influence the emergence of new institutions. Alternatively, these actors and the complex actor setting can also be influential in incremental change or, the breakdown, or transformation (Westley et al. 2011) of existing institutions. A diagram depicting the overall approach to this thesis and its various components concludes this section prior to presentation of the research questions is described in Figure 3.



**Figure 3:** The Research Framework - shows connections between the theoretical foundations, the analytical approach, the research questions informing each paper in the thesis and shows the connections between the papers and a portfolio of insights.

## 2.4 Research questions

Formally stated and building from the identified theoretical research gap, this thesis addresses the following overarching research questions:

- How can one conceptualise social-ecological interactions for understanding patterns of emergent marine fisheries futures? **Paper I**
- How does the interaction between actors, institutions and networks influence the emergence of new governance approaches across scales? **Paper II**
- In what ways can global marine governance institutions respond to complex patterns of emergence? **Paper III**
- How can scenarios be developed in a way that improves the anticipatory capacity of actors and their ability to influence patterns of emergence? **Paper IV**

## 3.0 Methodology

### 3.1 Methodological approach – sustainability science

Sustainability science is an interdisciplinary field of scientific enquiry drawing on insights from both the social and natural sciences (Kates et al 2001, Carpenter et al 2009, Lang et al 2012, Wiek et al. 2012, Brandt et al. 2013, Pereira et al. 2015). Kates et al (2001), in their definition of sustainability science focus on the interactions between nature and society and their fundamental character. They make an explicit link between global processes and social and ecological characteristics. This foundational article in sustainability science states the purpose of the field is in part to rectify the estrangement between the science and technology communities and the predominantly social and political forces that were driving forward the agenda for sustainable development that emerged following the publication of the Brundtland report (Kates et al 2001). In the final words of the paper, a challenge is put forward for future work in the field of sustainability science:

*“The research itself must be focused on the character of nature-society interactions, on our ability to guide those interactions along sustainable trajectories and on ways of promoting the social learning that will be necessary to navigate the transition to sustainability.”*

Methodologically, Kates et al (2001) argues that sustainability science requires new methodological approaches that need to be invented, innovated on and experimented with, while incorporating the use of new technologies, participatory processes and novel combinations of existing and new datasets. This thesis operates within the sustainability science tradition in terms combining a number of approaches and attempting to study global phenomena in the absence of well-established methodological approaches well tailored to the research questions addressed in the thesis. One of the abiding challenges of this thesis, which is perhaps reflective of sustainability science more broadly (Pereira et al 2013), is seeking alignment between question, theory and method that allows for novel findings. A major tension that has arisen over the course of this PhD thesis and has manifested methodologically is between a motivation and enthusiasm for articulating and conceptualising complex, ‘big picture,’ coupled human environment challenges on the one hand while also ensuring the development of a specific, rigorous scientific skill set and toolbox for effectively engaging with these challenges (Paper iv). In terms of resolving this tension, the thesis has aimed to make a methodological contribution to the evolving field of sustainability science while also utilising methods that could adequately address the research questions driving this thesis work.

## **3.2 Methods applied**

### **3.2.1 Conceptual modelling for social-ecological scenarios**

In **Paper I**, in order to answer the research question on conceptualising interactions between the social and the ecological as pre-conditions for processes of emergence, the methodological focus was on creating a conceptual model. The conceptual model needed to be able to include social processes and address interactions between humans and ecosystems. As such, we drew on the social-process diagram developed by the Consortium for International Earth Science Networks (CIESEN 1992) as well as (Collins et al. 2011, Fulton et al. 2011, Merino et al 2010) and the Social-Ecological Systems modelling framework of Ostrom (2009). The development of the diagram went through a large number of iterations in order to reduce the complexity of the diagram so that the human dimensions diagram could be coupled to the Bretherton Ecological Diagram in a way that was able to highlight social-ecological interaction. The method used in this paper contributed to generating a starting point for understanding global governance of living marine resources as it interacted with ecosystems that underpins the other outputs of the PhD. A detailed list explaining the boxes, links and interactions in the human dimensions diagram can be found in the appendix. This method of developing the conceptual framework in collaboration with researchers from other disciplines forced one to constantly question the assumptions, the concepts used, the nature of relationships and be able to build a coarse scale picture of the human dimensions of global governance of living marine resources, which was a springboard to develop further work.

### **3.2.2 Expert interviewing**

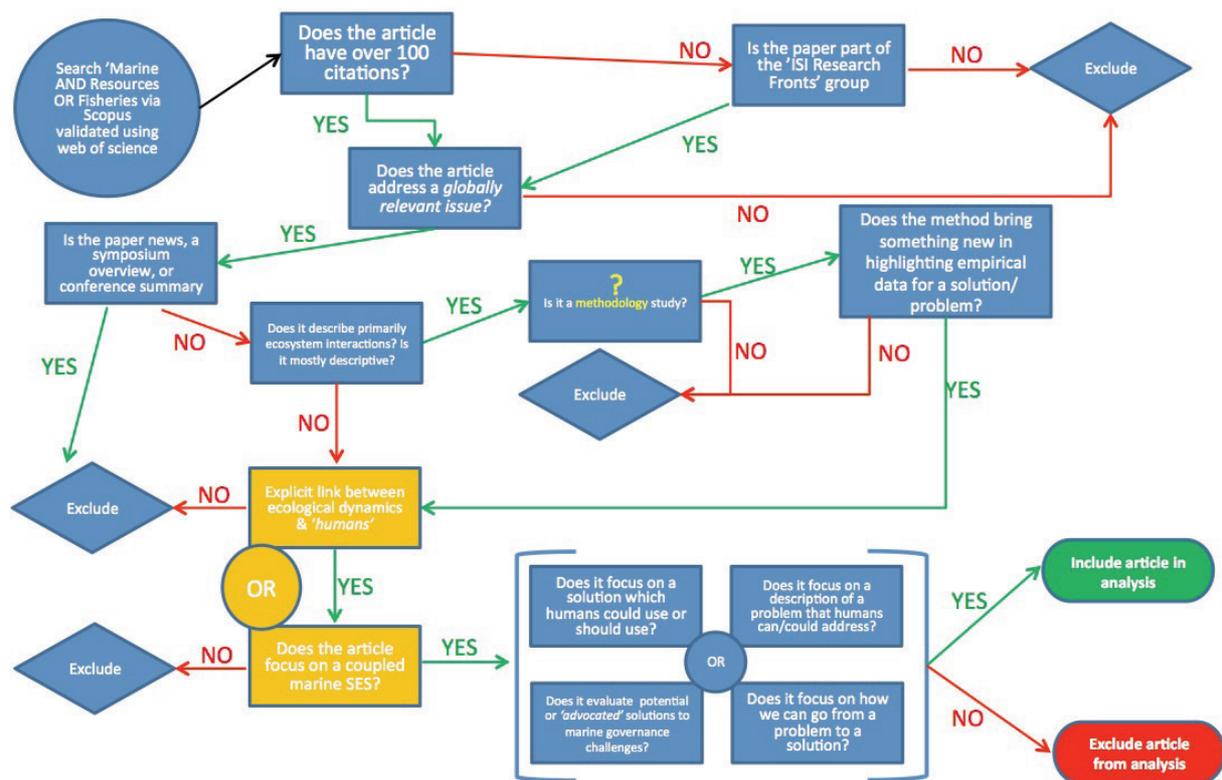
In order to describe and analyse the interactions between actors, institutions and networks that might influence the emergence of new governance approaches across scales **Paper II** used a case study approach (Bryman 2008, p. 52-64) was used to determine the emergence and spread of Marine Spatial Planning. Following a literature review of scientific papers and grey literature on Marine Spatial Planning, 9 initial exploratory interviews were undertaken. In total, 45 semi-structured, qualitative interviews were conducted with interview subjects based in Australia, the US and Europe. The interviews were transcribed and analysed using open coding and qualitative data analysis, which organised the data according to the preliminary conceptual framework that was constructed from theory prior to undertaking the fieldwork. After a process of identifying themes from the data, representative quotes were chosen to indicate patterns found within the interview data.

All interviews were conducted in a semi-structured way (Bernard and Ryan (2010)) while retaining the flexibility to allow the unexpected to emerge during the interview process. Using the semi-structured interview method proved to be a highly effective way to uncover the emergence and spread process because it allowed the respondents to naturally talk in terms of how events developed over time, key milestones, memorable crises, moments of agreement and convening so in that sense, these types of interviews were well suited to eliciting the key components of the process. However, one of the challenges of using this approach is that the interviewer can never be certain that what they are told is reflective of the best possible explanation for the phenomena in question. This is especially problematic when the respondents are part of a relatively small group, which may lead to the spread of ‘the story they tell about themselves’ which ends up being an artificial and poor representation of the phenomena being studied (Kvale and Brinkmann 2009). Certainly it is possible to guard against this in terms of interview design, the analysis process and sampling methodologies but it is impossible to avoid it entirely.

### **3.2.3 Systematic literature review & meta-analysis**

Two different types of systematic review were undertaken during the course of the dissertation. The first for **Paper III** focused on a comprehensive review of trends of human use of marine areas beyond national jurisdiction (ABNJ) to provide a foundation for exploring the question of how governance institutions might be able to respond to unexpected dynamics in the context of multiple user groups operating in marine areas beyond national jurisdiction. A workshop was held with Nereus Program researchers from the Stockholm Resilience Centre, Duke University and the University of British Columbia where the idea was conceived and initial trends sketched out. I then allocated members of the authorship group to gather different trends covering all identifiable human uses of the ocean with all available temporal data of how human uses of marine areas had changed over time. After initial data gathering, it was decided to split the presentation and consolidation of trends into human use trends related to living marine resources and non-living resources as well as scientific use of areas beyond national jurisdiction. Concurrently, data was gathered about all significant milestones related to governance of areas beyond national jurisdiction, which was then collated into a timeline. Trend information was consolidated presented together as Fisheries related trends for ABNJ and other human uses trends for ABNJ. The second use of the review methodological approach was used to provide a key part of the evidence base for **Paper IV**. The evidence base for this paper consists of four main pillars and this review method was used to develop the marine ecosystem trend pillar of the evidence base. Together the pillars of the evidence base were the foundation on which we developed the narrative scenarios of the future oceans.

We used Scopus/ISI Web of Science to identify relevant articles using “marine and resources” and “fisheries” as search terms. All articles published between 1970-2011, which were cited more than 100 times or identified through the ISE highly cited papers were included. Nature and Science are the two journals with a dramatically higher impact factor than any other journal in the field. They are important for shaping the scientific discourse and also have a global audience well beyond the scientific community, however. We therefore also included articles found using the search criteria “marine” in these journals. The identified 191 articles with these search criteria were included in the analysis if they passed a number of filters according to the decision criteria figure (4) represented below. A detailed meta-analysis of these papers was used to feed into the creation of the narrative scenarios used in **Paper IV**. This methodological approach is valuable because it is an excellent way to derive patterns over time within a particular problem area and/or body of scientific literature, which makes it suitable for research that is focused on the global scale and is a pragmatic approach for dealing with multiple layers of data that when combined allow one to make analytical inferences about the observed patterns.



**Figure 4:** The decision flow chart used to select scientific papers for inclusion for the review of the trends in marine science as part of the scientific evidence base for the Radical Fish Futures scenario paper (Paper IV)

### **3.2.4 Narrative scenarios and science fiction prototyping**

In order to make a contribution to exploring how scenarios can be developed that may improve the anticipatory capacity of actors and their ability to influence patterns of emergence, narrative scenarios were developed. This method is powerful as a complement to more quantitative modelling and scenarios approaches to *'predicting the future oceans'* as it allows for the creation of new possibility spaces that are impossible to explore or derive using data heavy models. *"Scenario planning methodologies can benefit from using diverse narrative techniques to craft compelling and infectious visions of the future"* (Burnam-Fink 2014). The application of creative and literary techniques is an emerging issue in the development of scenario methodology. Schwarz (1996) explains that scenarios; *"by extrapolating the interplay between driving forces, predetermined elements, and critical uncertainties, a set of scenarios spanning the space of plausible futures is developed and fleshed out."* The development of the narrative scenarios was undertaken through the application of Science-Fiction Prototyping (Johnson 2009, 2011). Science Fiction Prototypes are; *"Short works of fiction, grounded in scientific fact, crafted for the purpose of starting a conversation about the implications, effects, or ramifications of technology and the future"* (Burnam-Fink 2014).

### **3.3 A reflection on the methodological approach**

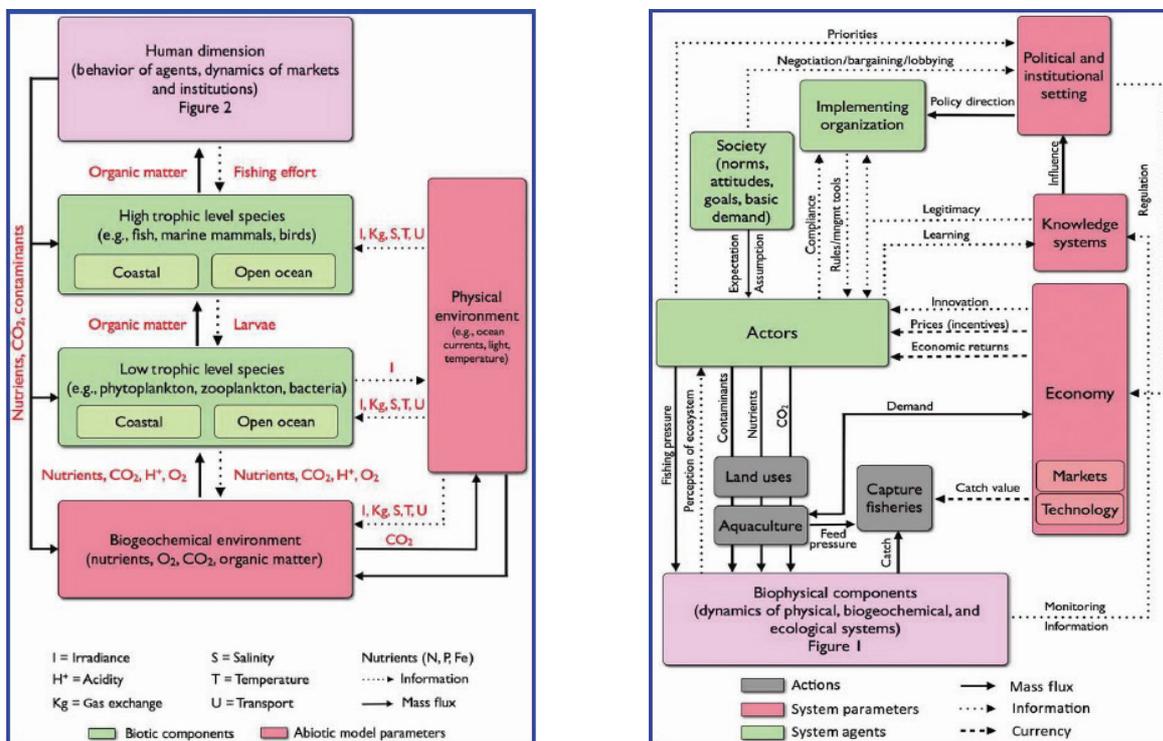
The methods applied in this thesis constituted an experimental approach that has been focused on exploring and analysing global governance of marine fisheries. It has been an abiding challenge to find theories and methods that are aligned epistemologically and thus are robust enough to answer research questions around global governance of fisheries. As a sustainability scientist, it has been important to know what is possible and to argue strongly for the additional value provided by a qualitative approach when engaged as part of a global interdisciplinary research program. In attempting to defend this stance and develop a valid study design there have been methodological cul-de-sacs and misalignments between theory and methods. This was linked to a pragmatic concern where there was a need to balance methodological appropriateness versus the time investment required to learn the method. This involved a process of aligning epistemology (theory of knowledge), ontology (core assumptions about how the world works) and methodological choices (Paper iv). This process required balancing the fit between research question and method on the one hand, and the time required to apply the method to a high standard on the other. These choices come with fair questions around the validity and legitimacy of the methodological approaches used. In summary, this has been one of the parts of the thesis where significant learning and has occurred and this difficult process will serve well in future research endeavours.

# 4.0 Summary of results and key findings

## 4.1 Paper I

### Modelling Social-Ecological Scenarios in Marine Systems

This paper offers a novel framework for a coupled human-environment approach to the interdisciplinary modelling of social-ecological ocean scenarios. The development of the paper was an intensive interdisciplinary collaboration and primary result was two conceptual models that together offer a scientifically robust toolkit for thinking about social-ecological interactions that characterise global marine fisheries and offer a starting point for exploring patterns of emergence that occur through interactions in a complex social-ecological system. The first conceptual model, (reproduced below left) represents the ecosystem components and their biogeochemical interactions that are necessary for creating social-ecological scenarios. This conceptual modes describes a number of interacting ecosystems dynamics including the physical environment, the biogeochemical environment, food-web dynamics for both high and low trophic level species. In this conceptual model, the ‘human dimensions’ are reduced to a single box representing flows of organic matter and fishing effort between humans and the ecosystems.



**Figure 5:** Conceptual models of the interactions between biogeochemical, ecosystem and human dimensions as foundation for an approach to modelling marine social-ecological systems.

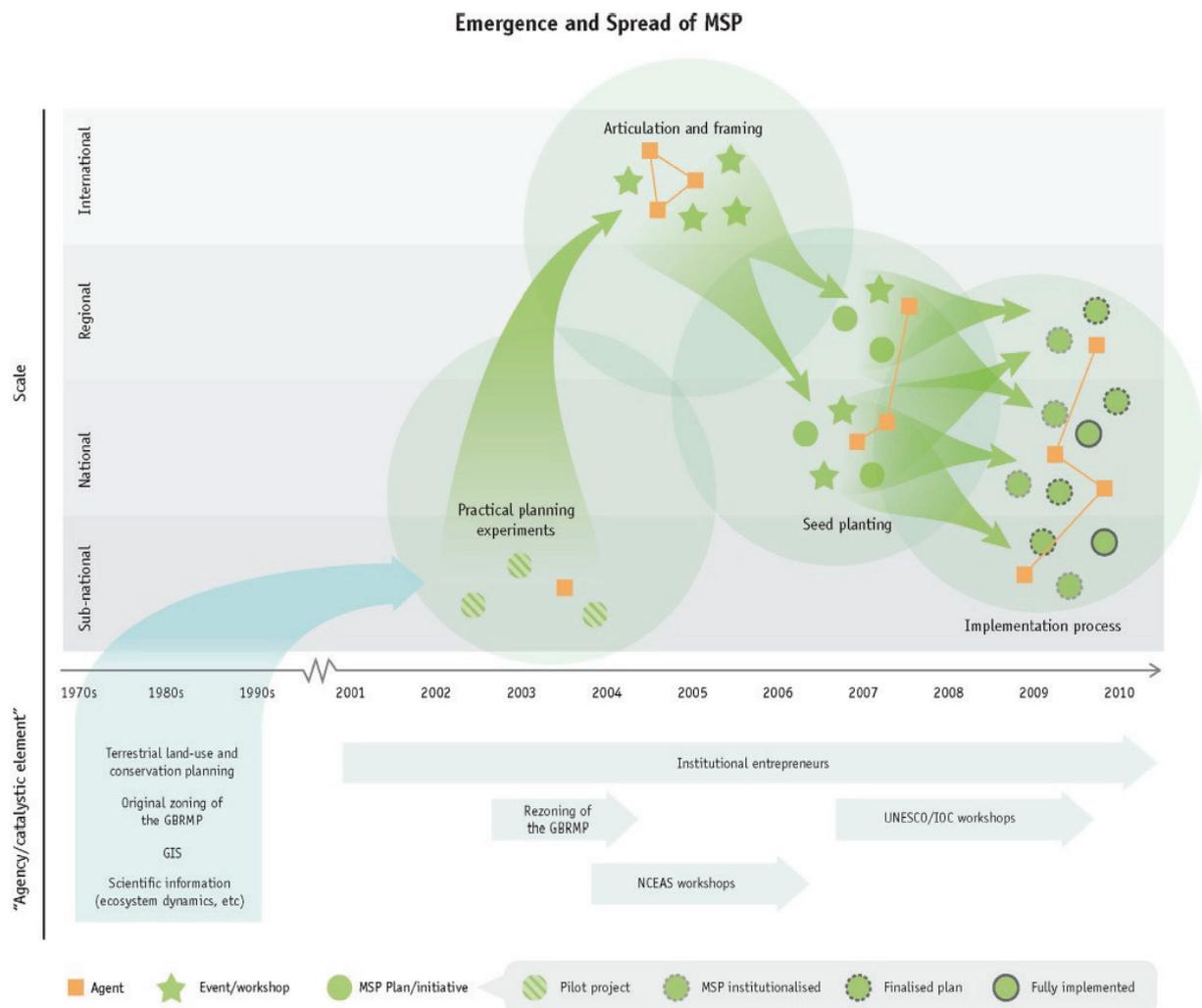
The second conceptual model, (reproduced above right) represents the human dimensions for creating social-ecological scenarios. In contrast to the ecosystem conceptual model, the biophysical components are reduced to a single box while the human dimensions are expanded out to allow exploration of potential interactions between actors, institutions, economic dynamics and social systems. Here, the behaviour of different types of actors leads to different anthropogenic impacts on marine ecosystems. Examples include contaminants and pressure from fishing effort. These actors can be influenced through various rules and management measures and also through interactions between actors and a diversity of knowledge systems and their perceived legitimacy. Other sources of micro-level interactions that lead to emergent patterns of behaviour at the macro-level include the impact of economic incentives, norms and attitudes of society and the co-evolution between the behaviour of actors and the introduction of new technologies. The organizations that have explicit or implicit responsibility for fisheries management are influenced through their interaction with diverse political and institutional settings. This paper makes a case for integrated social-ecological scenarios as a tool for exploring future possibilities that can assist in providing advice for the sustainable governance of marine social-ecological system. In order for scenarios to be realistic, they require an interdisciplinary approach and novel combinations of methods and data. The aim of such an approach is to suggest potential options for the future and also describe crucial components and interactions that may enable the emergence of change towards more normatively desirable trajectories for marine social-ecological systems while attempting to avoid undesirable development pathways.

## **4.2 Paper II**

### ***An innovation and agency perspective on the emergence and spread of marine spatial planning***

This paper uses theory on the diffusion of innovations and an institutional entrepreneurship characterisation of agency to analyse the origins, emergence and spread of Marine Spatial Planning (MSP) as a tool for operationalizing ecosystem-based management of marine fisheries and ocean space more broadly. The most significant result of this paper is the emergence and diffusion process driven by a set of networked actors over time and across scales moving from small-scale experiments in isolated areas of the ocean and then bringing together individuals operating as part of a loose, informal network who would eventually shepherd MSP to emerging as a recognised tool with great potential for making ecosystem-based governance of the oceans at the global level.

However, an associated finding showed that there was evidence that the version of MSP that emerged at the global level was de-coupled from the ecosystem. The very adaptability of the tool that aided its spread socio-politically also meant that the ecosystem management foundation of the tool was not always carried through into implementation. This paper then illustrates the complexity involved in the emergence and spread of new governance tools and approaches and the critical role of agency as a mechanism for emergence although there is no evidence that the actions and interactions of informal networks of institutional entrepreneurs will necessarily lead to a more sustainable future for marine ecosystems. The key figure from this paper is reproduced below.

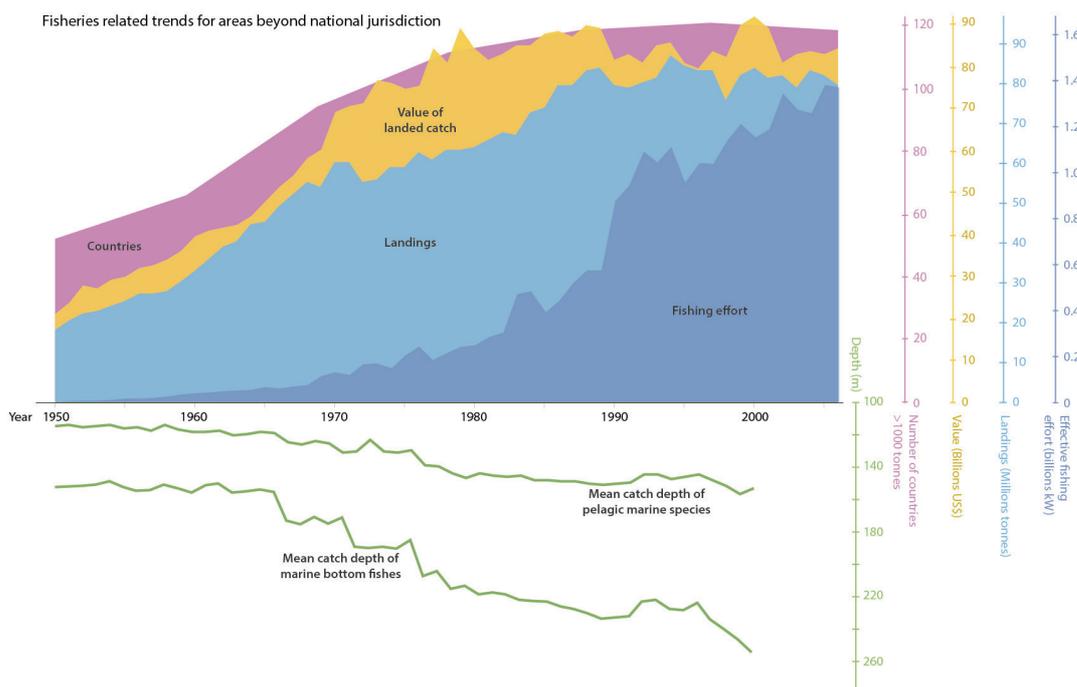


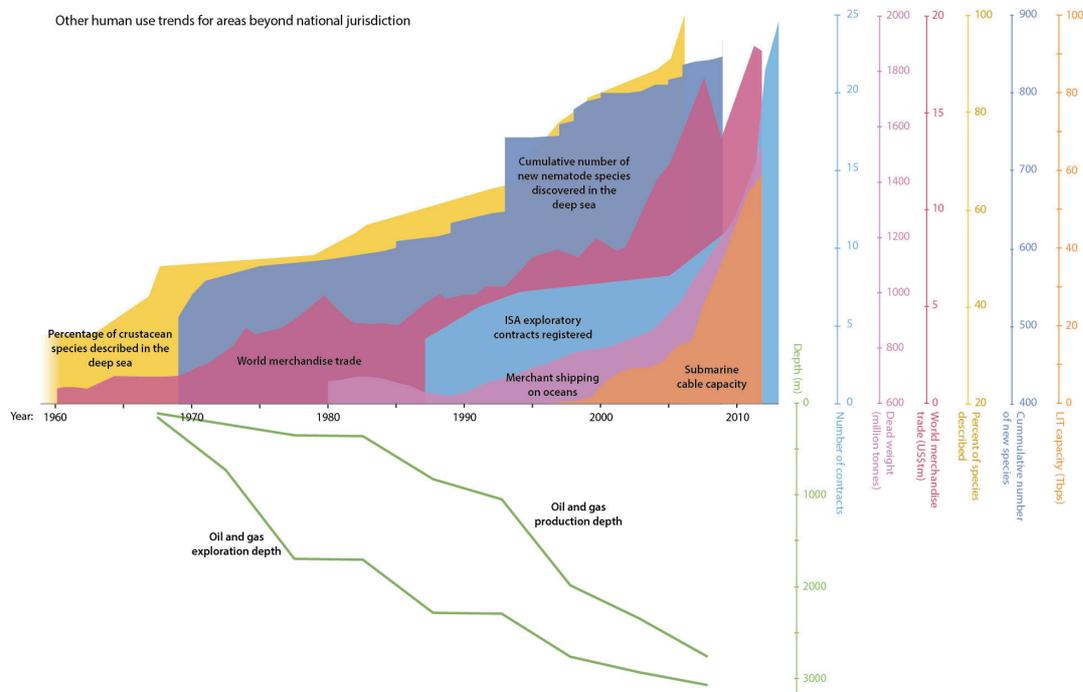
**Figure 6:** Shows the emergence and spread of marine spatial planning over time and across scales

### 4.3 Paper III

#### ***An ocean of surprises: Trends in human use, unexpected dynamics and governance challenges in areas beyond national jurisdiction***

In this paper, we find that the formal governance mechanisms put in place to govern areas beyond national jurisdiction in the global oceans are running very far behind the sorts of emergent ‘use and abuse’ dynamics that we are observable in the parts of the oceans areas beyond national jurisdiction that still operate as a global commons with the associated challenges for collective action and the introduction and enforcement of governance mechanisms for sustainability. Here the observed and compiled trends constrain the conditions for emergence of new governance forms in a way that leads to great concern for sustainable governance of the future oceans. The paper also suggests the need for anticipatory capacity within extant and emerging governance institutions in order to make visible and address emerging challenges and threats to the future sustainability of the global oceans. The compilation of trends related to all major user groups that operate or might soon operate in ocean areas beyond national jurisdiction resulted in a unique and detailed overview of existing and emergent use trends of marine areas beyond national jurisdiction by a diverse group of users. The first figure is trends related to living marine resources (primarily marine fisheries) and the second figure combines trends for other ocean users. Together these consolidated trends show that governance institutions must be able to anticipate and respond to unexpected dynamics articulated as sudden, non-linear and unpredictable ‘rude surprises’ and the nearly invisible build up of change over time that can create the conditions for the emergence of a future crisis, denoted as ‘slow burning emergencies.’





**Figure 6:** Consolidated trends for marine areas beyond national jurisdiction. The first figure relates to trends for fisheries and the second is trends for other human uses of marine areas beyond national jurisdiction.

## 4.4 Paper IV

### ***Manuscript - Radical futures for global fisheries: An imaginative narrative scenarios approach***

The Key result from this paper was the creation of four ‘radical but plausible’ future scenarios of the future oceans with a focus on global fisheries. Each of the four narrative scenarios was positioned in a ‘scenario space’ across a social dimension (from highly globally socially connected to highly globally socially fragmented) and an ecological dimension (from collapsed to sustaining). Scenarios are important tools for developing capacity for dealing with the unknown and unpredictable, as well as the unlikely but possible. A range of scientific methods for developing scenarios is available, but we argue that they have limited capacity to investigate complex social-ecological futures. We contend that 1) non-linear change is rarely incorporated and that 2) scientific scenarios attempting to engage with complexity often fail to interest an audience outside of academia. This manuscript addresses these two concerns, by drawing on narrative theory and applying the method of Science Fiction Prototyping. Using a rich and empirical scientific background on existing and emerging trends in marine natural resource use and dynamics, we develop four ‘radical’ futures for global fisheries. They are written for a wide audience and each was carefully designed to incorporate and extrapolate from existing trends. Science Fiction Prototyping can complement existing methods for developing scenarios and can assist scientists to develop a holistic understanding of complex systems dynamics and help make scenarios more accessible and interesting to non-academics.

The full versions of the narrative scenarios can be found in the manuscript. The titles of the four narrative scenarios follow:

1. **How we brought the oceans back from the brink** – In the style of a transcript of a TED – Ideas worth spreading talk. – a scenario characterised by ecological sustainability and global social connectivity
2. **Astrid and FISH Inc.** – In the style of a guest obituary – a scenario characterised by global social connectivity and ecological collapse
3. **Rime of the Last Fisherman** – In the style of translated private journal entries – a scenario characterised by ecological collapse and global social fragmentation
4. **Rising Tide** – In the style of a piece of travel journalism – characterised by ecological sustainability and global social fragmentation

## 5.0 Discussion

This section highlights the contributions of this thesis to theory, method and the field of global governance of marine fisheries by presenting a synthesis of the work in the form of four insights that focus on 1) the conditions for, and mechanisms of emergence of diverse and divergent governance forms, 2) the role of agency in complex actor settings, 3) the need for governance institutions to not only deal with, but also be able to anticipate surprise, and 4) the development of scenarios of marine social-ecological futures using a creative and rigorous narrative approach.

### 5.1 Insight 1

***Pathways of emergence for new governance forms are diverse and divergent. Pre-conditions are critical in influencing the emergence process and can act as enablers or constraints***

This thesis has made a contribution in linking how patterns of interactions might lead to pathways of emergence for new governance forms. In **Paper I**, the focus was on the creation of a novel conceptual framework that identified connections between a large number of ‘human dimensions’ and the bio-geophysical processes that occur in the global oceans. The focus in this paper was in conceptualising what connected to what and how this pattern of interactions might set the stage for emergence of fisheries governance that would likely lead to a more sustainable ocean in the future or a less sustainable ocean. The paper itself did not focus on processes or mechanisms of emergence but provided an important building block for moving towards truly integrated marine social-ecological scenarios. In **Paper II**, the focus shifted to explicitly focusing on the process of emergence and spread using the case study of Marine Spatial Planning as a tool of ecosystem-based governance of the oceans. This paper built on the adaptive governance conceptualisation of emergence as the evolution from individual actors grouping together in networks and through collaboration creating emergent institutions for addressing marine governance challenges (Österblom and Folke 2013).

Paper II presented emergence in complex actor settings as a series of phases where a particular configuration of preconditions are important for the move from beta testing/experimentation through to articulation and framing at the international and global levels through to a process of seed planting and dispersion undertaken by networked actors operating as institutional entrepreneurs through to simultaneous and diverse implementation processes of the new governance idea. An innovation lens was applied to deepen the understanding of the emergence of new ideas in society. This insight also draws attention to a key point of tension and apparent contradiction in the thesis. Paper I focuses on a structured pattern of interactions between clearly defined components of a marine social-ecological system. **Paper III** supports this more structured view by highlighting that, in a complex world of unexpected dynamics and surprise, it is useful to suggest a set of institutional design principles as a way of responding to complexity. In Paper II however, the focus is on an unpredictable process of emergence and the role of a diverse group of actors and this echoes **Paper IV** where unpredictability is in focus through a set of imaginative narrative scenarios that address the human response to non-linear shifts in technology and society. The coming together of structure and agency, interaction and emergence, institutional design and institutional accident, slow change and fast change, linear and non-linear and what these tensions mean for global governance of fisheries is an important insight and a contribution of this thesis.

## 5.2 Insight 2

***Actors must be adept at shepherding pathways of emergence to positively impact sustainable governance of the oceans. However, exploitation entrepreneurs can undermine shifts to more sustainable oceans.***

In **Paper II**, agency was seen as a critical contributing factor for the emergence and spread of marine spatial planning as a new governance approach for ecosystem-based management of ocean space. Here agency was defined in terms of ‘Institutional entrepreneurs,’ those who ‘manage the context’ (Westley et al. 2013) – these actors embedded in networks can’t directly control the patterns of interaction but they can influence different kinds of interactions between different actors while being themselves parts of patterns of interaction which can influence processes of emergence and how this leads to new governance ideas or diverse and divergent pathways leading towards different futures for marine social-ecological systems. The mechanisms, when one thinks about institutional entrepreneurship at a global level can be summed up as - pulling up ideas to the global level and dispersing outwards. In linking agency and emergence, a useful description is of these institutional entrepreneurs as ‘shepherds of emergence.’ After all, a shepherd can lead a flock in a particular direction, but there is no guarantee that they will all move in the same direction or that some of the flock will not be eaten by wolves or drowned in a river.

The agency element presented in Paper II was unarguably normative, these actors and the process that occurred were considered in terms of moving towards more sustainable marine ecosystems despite the ecosystem decoupling that occurred. However, it is clear that there is no reason why processes of agency in complex actor settings will necessarily lead towards a more sustainable future. In that sense, agency and global governance of marine fisheries can be described as double-edged. This links to the concept of the ‘shadow network’ brought up in the adaptive governance part of the theory section, defined as; “*Informal networks that emphasize political independence outside the fray of regulation and implementation [...]*” in (Olsson et al. 2006 and Olsson, Folke and Hughes 2008). When it is used within scholarship on adaptive governance, the shadow network is seen as a source of new ideas for ecosystem stewardship. However, this concept could be applied to a diversity of networks of agents operating at the global level who can directly and indirectly influence governance of marine fisheries. One example to highlight from this thesis work is the role of ‘exploitation entrepreneurs.’ This class of actors came about in the thinking process between Paper II and **Paper III** and is illustrated in one of the narrative scenarios in **Paper IV**. Exploitation entrepreneurship also informs on-going work in Paper ii. This thinking on exploitation entrepreneurs builds on recent work focusing on entrepreneurial patterns of agency in marine fisheries operating at the global level that have highly damaging impacts on marine ecosystems have been variously conceptualized as: ‘roving bandits’ (Berkes et al. 2006), ‘opportunistic exploitation’ (Branch, Lobo and Purcell 2013) and ‘contagious exploitation’ (Eriksson et al. 2015).

Exploitation entrepreneurship denotes situations where sophisticated and globally networked marine resource users are able to make large investments in technology and in so doing, can claim a first-mover advantage and open up a new exploitation frontier and exploit intensively before extant or emerging governing institutions can respond. On the other hand, the activities of these exploitation entrepreneurs may occur in a way that is essentially invisible to governance authorities or occur in areas (such as marine areas beyond national jurisdiction) where no competent governing authority is aware or has jurisdiction over the particular stock being exploited in this way. An illustrative example, which represents past, present and potential future examples of exploitation entrepreneurship in global fisheries is; Orange Roughy (*Hoplostethus atlanticus*), Antarctic Krill (*Euphausia superba*) and mesopelagic lanternfish (*Myctophidae*). In all three of these cases a particular technological breakthrough allowed the exploitation of a new frontier in the absence of governing bodies. In the case of Orange Roughy, the stocks collapsed and in the case of Antarctic Krill, exploitation is on-going but somewhat regulated under the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and the potential exploitation of lanternfish as a ‘superabundant’ source of marine protein is explored in the FISH Inc. narrative scenario in Paper IV.

The existence of exploitation entrepreneurship and the limits on adaptive and anticipatory capacity of extant and emerging governance institutions with responsibility for global marine fisheries leads directly into the next insight.

### **5.3 Insight 3**

***A shift towards more sustainable marine fisheries and oceans at the global scale will require the development of anticipatory response capacity within existing and emerging governance institutions.***

In **Paper III**, the argument was made that a complex and growing network of regulations in marine areas beyond national jurisdiction fall well short of anticipatory governance capacity (Boyd et al. 2015) and that in sum, this approach to governance is really about plugging readily identifiable governance gaps as and when they emerge in an ad-hoc way. This approach is reactive and incremental; it is about slowly increasing the efficiency of the existing high seas governance regime (Young 2009) and in areas where there is evidence of a non-regime, beginning the process of regime formation (Young 1982) through multilateral negotiation (Dimitrov et al. 2007). This is not enough for the scale of the challenge. These ad-hoc, incremental ‘plugs’ are not able to respond to the interactive patterns that generate unexpected emergent dynamics as especially highlighted through the conceptual framework in **Paper I** and the narrative scenarios in **Paper IV**.

The mechanism described above, where exploitation and degradation of marine ecosystems can occur when governing institutions are either absent, inadequate or where signals from ecosystems are ‘masked, diluted or drowned out’ (Crona et al. 2015) is critical. Such situations make clear the need to move from crisis preparedness and response, from reaction and incremental change, from adaptiveness, to building anticipatory capacity within extant and emerging governance institutions. Building this capacity goes hand in hand with the role of institutional entrepreneurs in ‘shepherding emergence.’ Galaz et al. (2011) lay important groundwork for the need for anticipatory capacity when they note that any attempts to govern processes of global environmental change must be able to address both slow change which involves preparation for addressing predictable processes of change that may have serious consequences (denoted as ‘slow burning emergencies in Paper III) while also being able to have capacity to address processes of fast change or situations where ‘behaviour in a system or across systems differs qualitatively from expectations’ (denoted as ‘rude surprises’ in Paper III).

Stating that governance institutions should possess or build anticipatory capacity to deal with emergent processes of slow and fast change that are associated with problematic dynamics such as exploitation entrepreneurship is only a first step. How might we go about building this capacity? Insight four focuses on the distinct but complementary approaches to marine social ecologic scenarios and reflects on how they can be used in aid of anticipation.

## 5.4 Insight 4

### *The envisioning of future sustainable trajectories for the global oceans requires the application of imagination and creativity*

Both scenario approaches, as presented in **Paper I** and **Paper IV**, are contributions to methodological development within the field of interdisciplinary sustainability science (Kates et al. 2001). More generally, as noted in Paper I, scenario studies operate as a set of tools, which can enable scientists to assist in the development of and facilitate the learning needed for the operationalization of an adaptive governance approach. A Strong scientific base was the bedrock of both the conceptual framework for developing social-ecological scenarios and, the narrative scenario approach in Paper I and Paper IV respectively. The value of both approaches is in the development of coupled human-environment scenarios that can inspire and facilitate adaptive governance through acting as a bridge for dialogue by stimulating a discussion about possible futures and pathways to more sustainable marine stewardship Chapin et al. (2010). However, it became clear in the process of developing Paper I that conceptual roadmaps for moving towards integrated, analytical marine social-ecological system scenarios are limited in terms of being able to envisage and present the human consequences of non-linear shifts in ecosystems even if they might be able to describe and to a limited extent, even predict those shifts in detail. Paper I then is a valuable contribution as a first attempt at trying to understand how the patterns of multiple, overlapping interactions occurring in a complex marine SES can lead to divergent emergence pathways leading towards different futures for marine SES. To emphasize this point, the approaches in Paper I and Paper IV are contrasting but complementary ways to frame and explore patterns of interactions leading to processes of emergence in complex marine social-ecological systems. More specifically, Paper IV addresses the call for anticipatory capacity brought up in **Paper III** and elaborated on in insight 3. Paper IV contributes to how one might actually go about achieving anticipatory capacity within extant and emerging governance institutions.

## 6.0 Conclusions

Despite this thesis being on ‘global governance of marine fisheries,’ a question that a reader might be left with after reading this thesis is how should marine fisheries be governed? Part of the challenge of using complexity approaches is that one is tempted to answer ‘well, it’s complex.’ This is clearly an unsatisfactory answer to an important question. In addition, framing this thesis as ‘global governance of marine fisheries’ creates the expectation that there is in fact an answer that can be applied to fisheries as a whole. This is not the case. At best, this thesis can offer some thinking about future governance directions along with a few suggestions for future research relevant to global governance of marine fisheries in the Anthropocene. One strong area of potential is to develop global governance institutions as enablers of creative experiments. Such spaces, alongside the formal fisheries governance regime could create opportunities and provide resources for radical bottom-up approaches. Global governance does not have to imply top-down governance. Often, due to the extremely detailed nature of international treaties and the painstaking work that is required to get them into place, they can be highly constraining as a place for the creation of new governance ideas that stand up to the pace and extent of global change. One can envisage a marine social-ecological innovation ‘venture fund’ that provides resources to local communities, networks connecting indigenous groups, fishing communities, scientists, NGOs and technologists with other stakeholder groups to experiment with different approaches to governing fisheries in a way that operates outside the space of formal multilateral negotiations. A tangible example would be creating a space for testing out alternate approaches to fisheries management under the common fisheries policy where smaller groups could try out approaches that are currently unthinkable or unimaginable under the weighty auspices of state relations and a legacy of anger, disappointment and failure associated with the (CFP) rightly or not. If a new initiative proved promising, effort could be directed towards capitalising on the momentum and focusing on getting attention for that niche idea in the mainstream. Research in this area could be focused on the legitimacy of such approaches while also allowing for transdisciplinary action research where such initiatives were incorporated into a research project on new governance forms in marine fisheries which is an approach that is gaining more ground within sustainability science more generally.

Another worthwhile direction for future research would be to devise a study to more systematically build on the insight about ‘double-edged agency’ and how ‘exploitation entrepreneurs’ can operate in a way that is counter sustainable futures. This would allow development of the theory on agency in complex problem domains through engaging with not only those with whom one is in normative agreement but those whose ostensibly different values and perspective on issues around sustainability mean they are using similar strategies and resources and discursive tools to undermine the emergence of a more sustainable future for marine fisheries and the oceans. Technology and global governance of fisheries would be another valuable area of further research to understand how ecologically problematic versus sustainability-enhancing technologies emerge and what role technology can play in global governance. Another future research endeavour could involve developing the methodology applied in Paper IV as a way to think imaginatively about a specific and pressing policy issue in the field of global governance of marine fisheries. One such transdisciplinary study might combine the methodological approach of science fiction prototyping and the trends that one observes in marine areas beyond national jurisdiction and use that as the focus for a participatory process of creating narrative scenario science fiction prototypes and then see how such an approach might create new possibilities for change makers to develop new approaches or shift expectations about the future oceans. Such a participatory imaginative narrative scenario project could bring together international lawyers and staff of international governmental organisations with institutional entrepreneurs, business people and scientists to try and create some ‘stories of futures for the high seas’ and then out of that bring together a network to capitalize on the process and use the narrative scenarios to influence policy development focused on governance of marine areas beyond national jurisdiction. As a final note, it is important to refer back to the starting point in Paper I and highlight the fact that operationalising the development of integrated social-ecological scenario models is a major future research challenge. In the Nereus program, the intention was to be able to create a coupled human-environment model that can ‘predict the future ocean.’ In addition to the epistemological and ontological challenges of such an effort, from a research practice perspective, this has proven incredibly challenging. There is potential to try a different approach and get closer to a meaningful integrated model that could be of use for imagining and testing out different marine social-ecological futures.

Given the challenges faced by marine ecosystems as nested within a larger set of environmental and social challenges at the global scale, any attempt to build on theory around global governance must recognise that the current and future situations are different from what has existed in the past. This thesis has made a contribution to sustainability science through creating four distinct and complementary slices of scholarship relevant to the global governance of marine fisheries. The papers have focused on the emergence of novel challenges and the emergence of new governance forms through a multifaceted analysis of patterns of interacting components. The adaptive governance approach has been applied across this thesis. A shared characterisation of the fundamental coupling between humans and the environment is at the heart of this work. This thesis builds on existing research and makes a novel contribution through: analysis of patterns of interaction leading to divergent pathways of emergence, examines the ambiguous role of agency in a complex actor settings, the impact of unexpected dynamics and surprise on existing and emerging governance institutions and this work thinks creatively and rigorously about the future of marine fisheries and the oceans. Human dominance of ecosystems and the ability of human actions to impact earth system processes changes everything. The speed, scale and connectivity dynamics of on-going processes of social, ecological and economic globalisation are fundamentally reshaping the 'rules of the game' on which extant frameworks for governing fisheries have been reliant. So what does the future of fisheries and the oceans and indeed humanity hold? Every time we think about or write about the future, we change it a little. Yes it is impossible to predict the future. The very nature of complex systems and the way they interact means that there is a sense of futility in asking ourselves what the state of fisheries will be in 2050. However, by thinking about the future, by thinking about the many possible futures, we begin to arm ourselves and change makers with the tools for contributing to a better future, by anticipating, preparing and imagining our future oceans can still provide us with seafood from healthy ecosystems into 2050 and beyond.

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